

MIDDLESEX COUNTY VOCATIONAL AND TECHNICAL SCHOOLS BOARD OF EDUCATION

Energy Savings Plan

Revised February 20, 2020

Honeywell

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MIDDLESEX COUNTY VOCATIONAL AND TECHNICAL SCHOOLS BOARD OF EDUCATION

Energy Savings Plan

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SECTION A EXECUTIVE SUMMARY

Honeywell is pleased to submit this Energy Savings Plan for Middlesex County Vocational and Technical Schools (MCVTS). During the development of the Energy Savings Plan, Honeywell has completed a thorough investment grade energy audit of MCVTS's buildings and grounds. Based on the audit findings and Honeywell's extensive experience in working with school district's, we can confidently state that we can deliver a financially viable, comprehensive solution to address MCVTS facility concerns. Our Energy Savings Plan includes projects that achieve energy and operational efficiencies, create a more comfortable and productive working environment and are actionable via the New Jersey Energy Savings Improvement Program (NJ ESIP) in accordance with NJ PL2012, c.55.

The Energy Savings Plan is the core of the NJ ESIP process. It describes the energy conservation measures that are planned and the cost calculations that support how the plan will pay for itself through the resulting energy savings. Under the law, the Energy Savings Plan must address the following elements:

- The results of the energy audit;
- A description of the energy conservation measures (ECMs) that will comprise the program;
- An estimate of greenhouse gas reductions resulting from those energy savings;
- Identification of all design and compliance issues and identification of who will provide these services;
- An assessment of risks involved in the successful implementation of the plan;
- Identify the eligibility for, and costs and revenues associated with, the PJM Independent System Operator for demand response and curtail-able service activities;
- Schedules showing calculations of all costs of implementing the proposed energy conservation measures and the projected energy savings;
- Maintenance requirements necessary to ensure continued energy savings, and describe how they will be provided; and
- If developed by an ESCO, a description of, and cost estimates of a proposed energy savings guarantee.

The purpose of this document is to provide all the information required for MCVTS to determine the best path forward in the implementation of a District-Wide NJ ESIP Project. It is important to note that the Energy Savings Plan provides a comprehensive evaluation of ALL potential ECMs within MCVTS identified. This is not meant to infer that all the ECMs identified can be implemented. However, if the ECM is part of this plan, it may be implemented later as additional funding becomes available or technology changes to provide for an improved financial return.

Our Energy Savings Plan is structured to clearly demonstrate compliance with the NJ ESIP law, while also presenting the information in an organized manner which allows for informed decisions to be made. The information is divided into the following sections:

A. Executive Summary (This Section)

B. Preliminary Utility Analysis – The Preliminary Utility Analysis (PUA) defines the utility baseline for MCVTS buildings included in the Energy Savings Plan. It provides an overview of the current usage

and a cost per square foot by building of utility expenses. The report also compares the MCVTS utility consumption to that of other districts in the same region on a per square foot basis.

C. **Energy Conservation Measures –** This section includes a detailed description of the ECMs we have selected and identified for your School District. It is specific to your facilities in scope, savings methodology and environmental impact. It is intended to provide a basis of design for each measure in narrative form. It is not intended to be a detailed specification for construction. ALL potential ECMs for MCVTS are identified for the purposes of potential inclusion in the program. Final selected ECMs are to be determined by MCVTS in conjunction with Honeywell during the project development phase of the NJ ESIP process.

D. **Technical and Financial Summary –** This section includes an accounting of all technical and financial outcomes associated with the ECMs as presented on the New Jersey Board of Public Utilities Forms II through IV. Information detailed on the forms includes projected implementation hard costs, projected energy savings, projected operational savings and projected environmental impact. Form VI: Annual Cash Flow Analysis provides a "rolled-up" view of the overall project financials, inclusive of financing costs, on an annual basis as well as over the entire 15 or 20-year term of the agreement.

E. **Measurement & Verification and Maintenance Plan –** This section identifies the intended methods of verification and measurement for calculating energy savings. These methods are compliant with the International Measurement and Verification Protocols (IMVP), as well as other protocols previously approved by the Board of Public Utilities (BPU) in New Jersey. This section also includes the recommended maintenance requirements for each type of equipment. Consistent maintenance is essential to achieving the energy savings projected in this plan.

F. **Design Approach –** This section includes a summary of Honeywell's best practices for the successful implementation of a NJ ESIP project. It includes a project specific Safety Management Plan and provides an overview of our project management procedure, construction management and a sample schedule for the overall completion of the project. Within the schedule, we clearly define the tasks directed towards compliance with architectural, engineering and bidding procedures in accordance with New Jersey Public Contracts Law.

G. **Independent Energy Audit –** This section includes, for reference, the independent energy audits as previously received by MCVTS through the Local Government Energy Audit (LGEA) program. The audits provided by TRC have been included on a USB drive as Appendix 1. A comparison can be made between the ECMs outlined in this Independent Energy Audit and the additional ECMs described in the overall Energy Savings Plan.

H. **Energy Calculations and Greenhouse Gas Reduction Summary –** This section titled Appendix 2: ECM Calculations includes all the energy calculations required to ensure compliance with the law and to confirm the energy savings can, and will, be achieved. These calculations are subject to an independent 3rd party engineering firm review for verification.

A summary of all savings based on the Recommended ESIP Project includes a **reduction in 1,502 Metric Tons of Greenhouse Gas (GHG) emissions**. It is the equivalent of removing **317 cars** from the road for an entire year and is the same as planting **1423 acres of forest**.

I. Equipment Cut-sheets – This section titled Appendix 3: Equipment Cut-sheets includes specification data for the equipment which shall be utilized as the basis of design for plans and specifications during the subsequent project development and NJ public bid phase.

J. Safety Management Plan – This section titled Appendix 4: Safety Management Plan establishes a plan for the implementation of Honeywell's Safe Operations Management (SOM) program. The document includes procedures and requirements specific to MCVTS necessary to support a safe workplace for all stake holders. The Safety Management Plan is a living document, which will be updated and modified to maintain its relevance throughout the project as site conditions and circumstances change.

In accordance with the NJ ESIP process, the next step in the project development phase is for Honeywell to provide our recommendations and for MCVTS to select the desired content of the project based upon MCVTS unique goals and objectives. The selections will consider the projected costs, projected energy and operational savings, available financing options at the time of the agreement, interest rates, length of term and MCVTS priorities, which will all play a part in the final selection and cash flow of ECMs. The definitive requirement under NJ PL2012, c.55 is that the project is self-funding within the 15 or 20-year term as outlined in the legislation.

Overall, it is evident that MCVTS is well positioned to implement a program that will upgrade your facilities, while funding itself within the requirements of the law and with zero impact on your taxpayer base. We welcome this opportunity to continue to partner with MCVTS to improve the comfort and efficiency of your facilities through the successful implementation of this Energy Savings Plan.

Sincerely,



Joseph Coscia
Sr. Business Consultant

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SECTION B PRELIMINARY UTILITY ANALYSIS

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Honeywell

Preliminary Utility Analysis

Middlesex County Vocational School, NJ
Middlesex County, NJ



Helping customers manage energy resources to improve financial performance

Executive Summary

Honeywell would like to thank you for the opportunity of providing you with this Preliminary Utility Analysis. A one year detailed billing analysis was completed for all utility data provided by your staff. The facility's electric and gas consumption were compared to a benchmark of typical facilities of similar use and location. It should be noted however, that some of Buildings which make up the benchmarking standards are not equipped with mechanical cooling (air conditioning). Therefore, these buildings may unjustly appear to be less efficient in comparison.

Through our Energy Services offerings, Honeywell's goal is to form a long term partnership for the purpose of meeting your current infrastructure needs by focusing to:

- Improve Operational Cost Structures
- Ensure Satisfaction
- Upgrade Infrastructure While Reducing Costs
- Meet Strategic Initiatives
- Leverage Teamwork
- Pursue Mutual Interests
- Provide Financing Options

How does it work?

Under an energy retrofit solution, Honeywell installs new, energy efficient equipment and optimizes your facility, as part of a multi-year service contract. Most of these improvements are cost-justified by energy and operational savings. Some of the energy conservation measures provide for a quick payback, and as such, would help offset other capital intensive energy conservation measures such as, boilers, package rooftop units, domestic hot water heaters, etc. The objective is to provide you with reduced operating costs, increased equipment reliability, optimized equipment use, and improved occupant comfort.

After review of the utility analysis, you can authorize Honeywell to proceed with the development of a detailed engineering report. The report development phase allows Honeywell to prepare an acceptable list of proposed energy conservation measures, which are specific to the selected facility. Some examples of typical Energy Conservation Measures include:

- Lighting
- Control Systems
- Boilers
- AC Units/Condensers
- Building Enevelope
- Package Rooftop Units
- Domestic Hot Water Heaters
- Plug Load Management

Why Honeywell?

- Honeywell is one of the world leaders in providing infrastructure improvements
- With Honeywell as your building partner, you gain the advantage of more than 115 years of leadership in building services
- Honeywell has the infrastructure and manpower in place to manage and successfully implement your project
- Honeywell has over 30 years experience in the energy retrofit marketplace with over $5 Billion in customer energy savings
- Honeywell provides you with "Single Source Responsibility" - from Engineering to Implementation, Servicing and Financing (if desired)

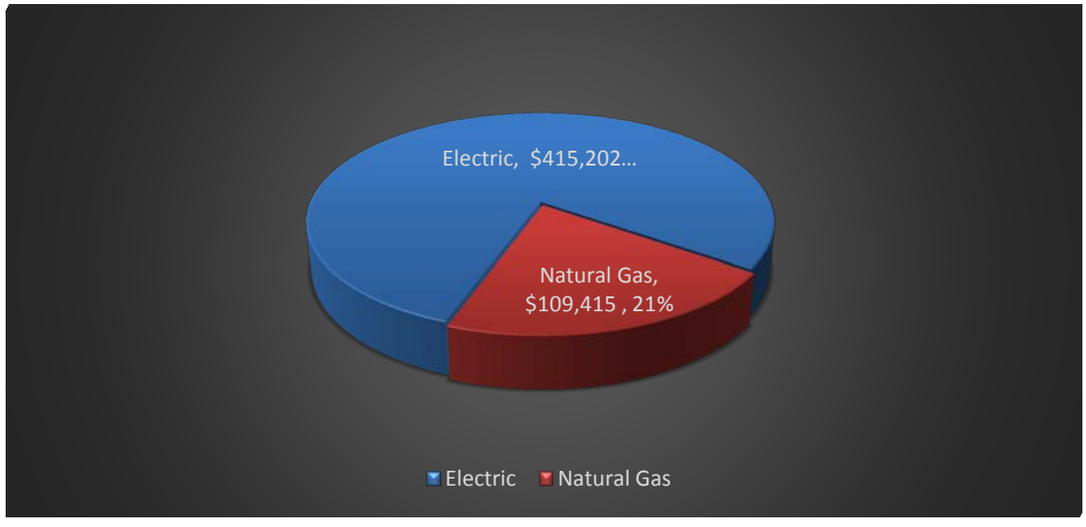
Historical Summary

Utility Analysis Period:
Jan 2018 through Dec 2018

	Electric	Natural Gas
Utility Costs*	$415,202	$109,415
Utility Usage (kWh, Therms)	3,299,533	131,480
$ Cost/Unit (kWh, Therms)	$0.12584	$0.832
Annual Electric Demand (kW)	8,818	

* Costs include energy and demand components, as well as taxes, surcharges, etc.

Actual Cost by Utility
Jan 2018 through Dec 2018



Total Cost
$524,616

Energy Benchmarking

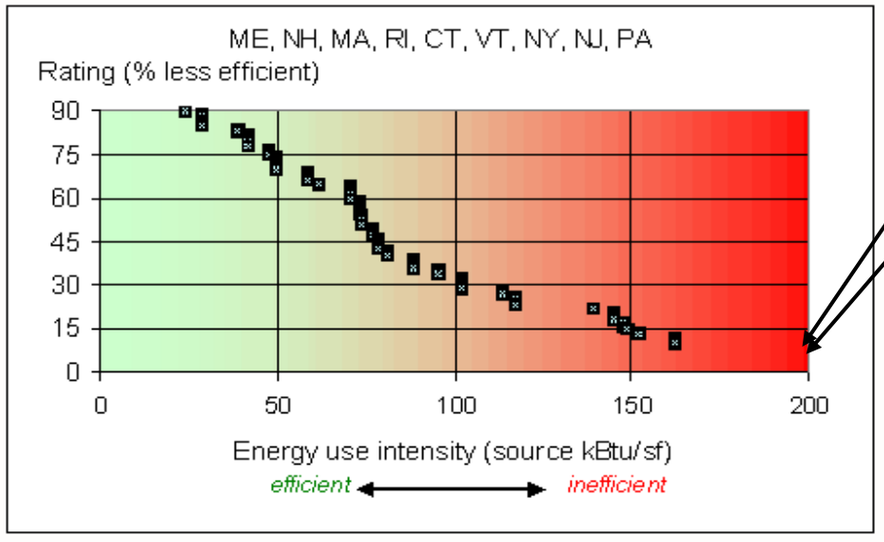
The calculation of EUI (Energy Use Intensity) is shown below. EUI, expressed in kBtu/sf, is normalized for floor area, the most dominant influence on energy use in most buildings. Its use usually provides a good approximation of how your building's energy performance compares to others. Site EUI indicates the rate at which energy is used at your building (the point of use). Source EUI indicates the rate at which energy is used at the generation sources serving your building (the point of source) and indicates the societal energy penalty due to your building The lower the EUI, the higher the rating, indicating that the building is more efficient than other buildings. The greater the EUI, the lower the rating, indicating that there is an opportunity for higher potential benefits from operational improvements.

The Source EUI below has been applied to a Department of Energy statistical model from the Oak Ridge National Laboratory web site, http://eber.ed.ornl.gov/benchmark. The Department of Energy has estimated energy use and cost reductions for building source EUI ratings (percentiles) in the table below. Please see the DOE Regional Source EUI Comparison graph below to rate your building in relation to the regional distribution of similar type buildings. (Note: The Source EUI includes the inefficiencies of electrical generation and transmission. A reduction in 'electrical' source EUI includes a benefit in terms of reduction of air pollution emissions and green house gases, and is thus an indicator of societal benefit.)

Source EUI Rating for your Building	Energy use and cost reduction potential (%)	Walk-thru energy assessment recommended?
above 60%	below 25%	No
40 to 60%	20 to 35%	Maybe
20 to 40%	35 to 50%	Yes
Below 20%	above 50%	Definitely

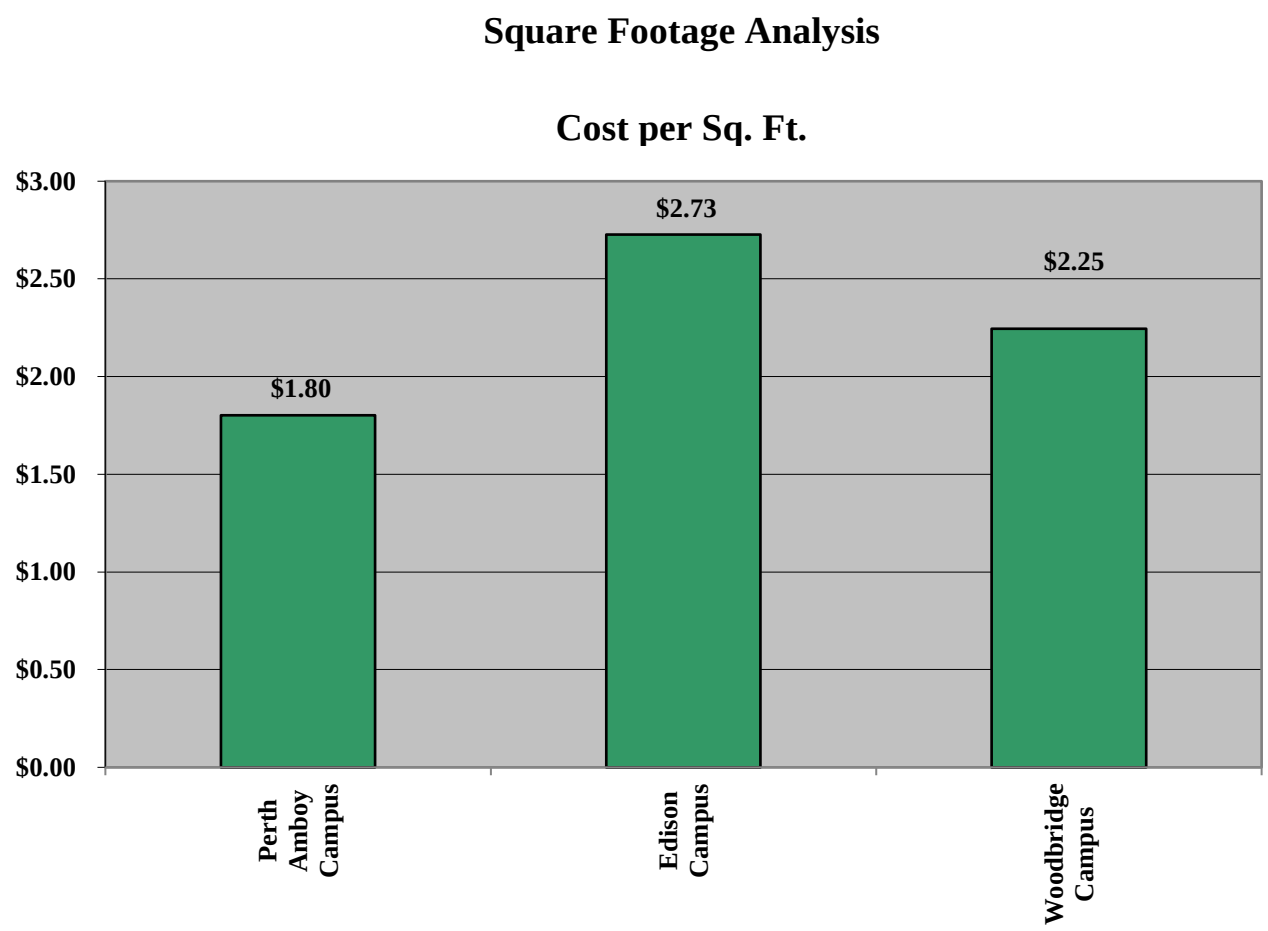
Site EUI Rank		Annual Total Electrical Use (kWh)	Annual Total Non-Electrical Fuel Use (Therms)	Building Gross Floor Area (sq-ft)	Site EUI Rating	Source EUI: Annual Total Source Energy Use per Sq-Ft (kBtu/sf)	Rating (Regional Source EUI Comparison)
1	Perth Amboy Campus	2,259,867	71,315	150,000	**99**	**203**	**10%**
2	Edison Campus	280,586	15,151	15,200	**163**	**291**	**3%**
3	Woodbridge Campus	759,080	45,015	46,000	**154**	**268**	**5%**

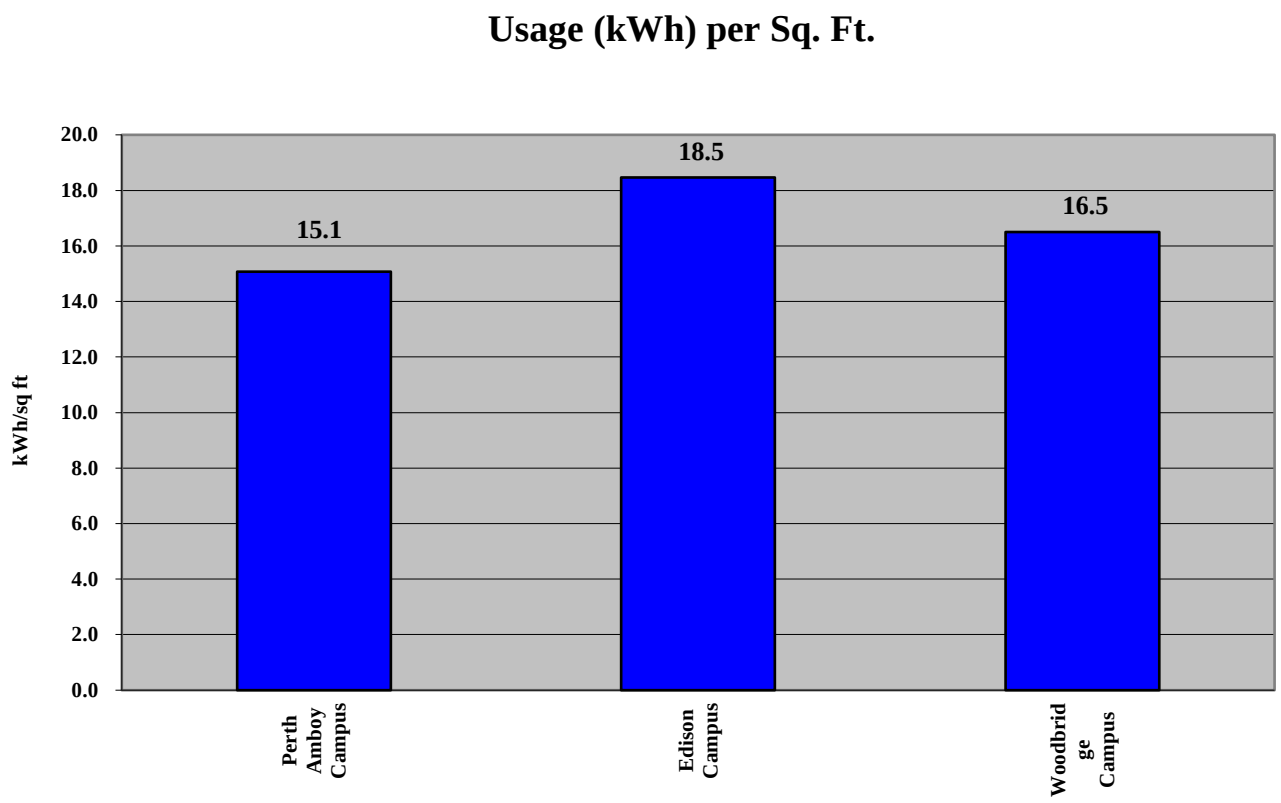
School Facilities



Source EUI	Est Regional Rating	Building
203	10%	Perth Amboy Campus
291	3%	Edison Campus
268	5%	Woodbridge Campus

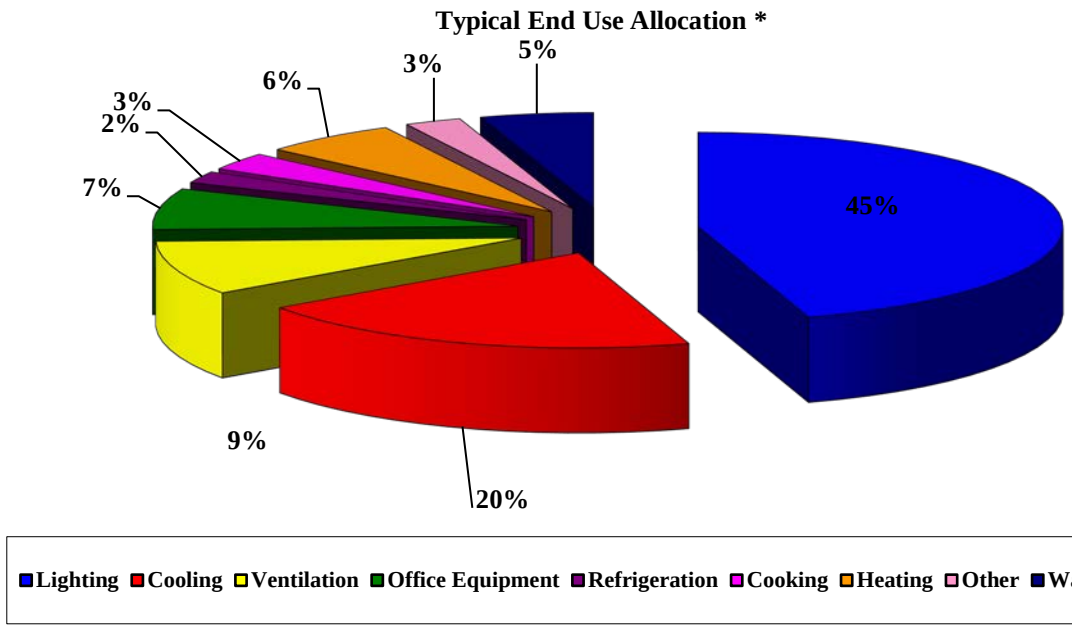
Utility Analysis
Electric





Utility Analysis

Sources of Electric Consumption

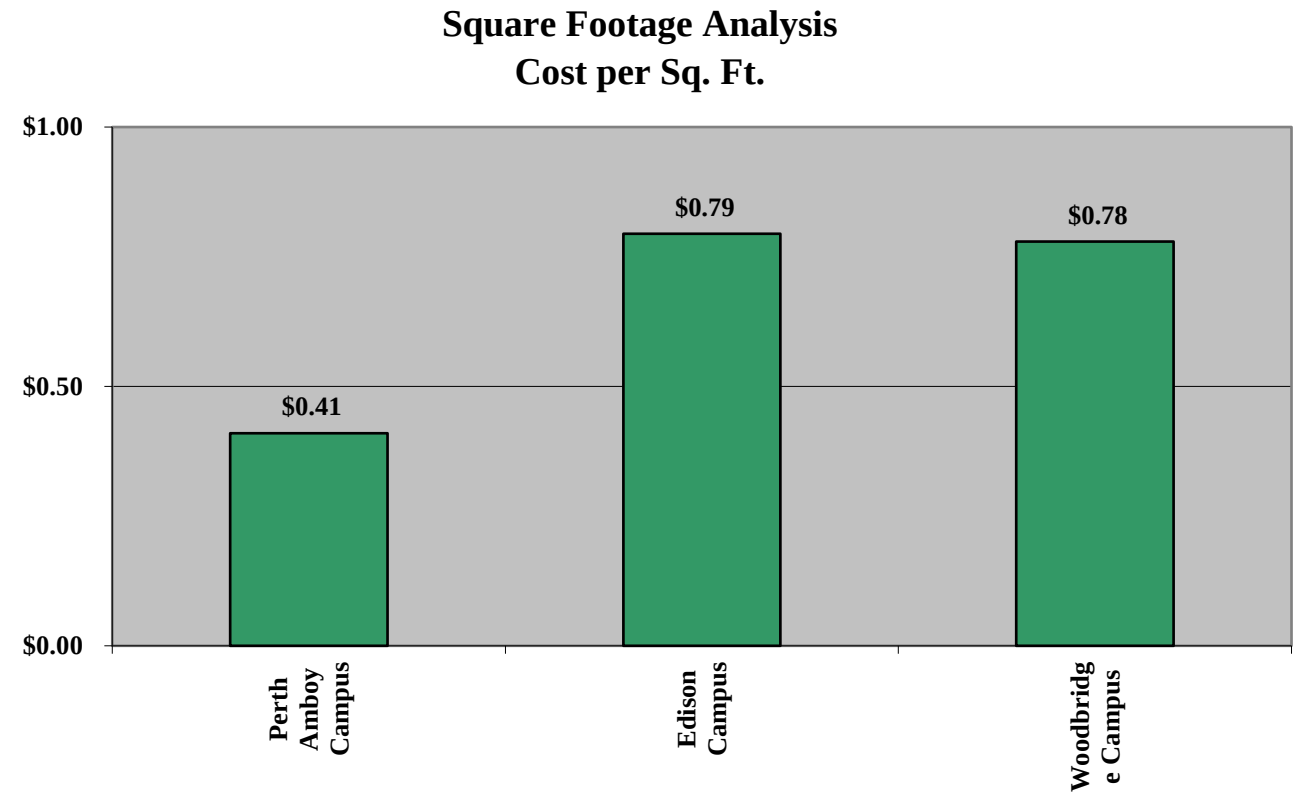


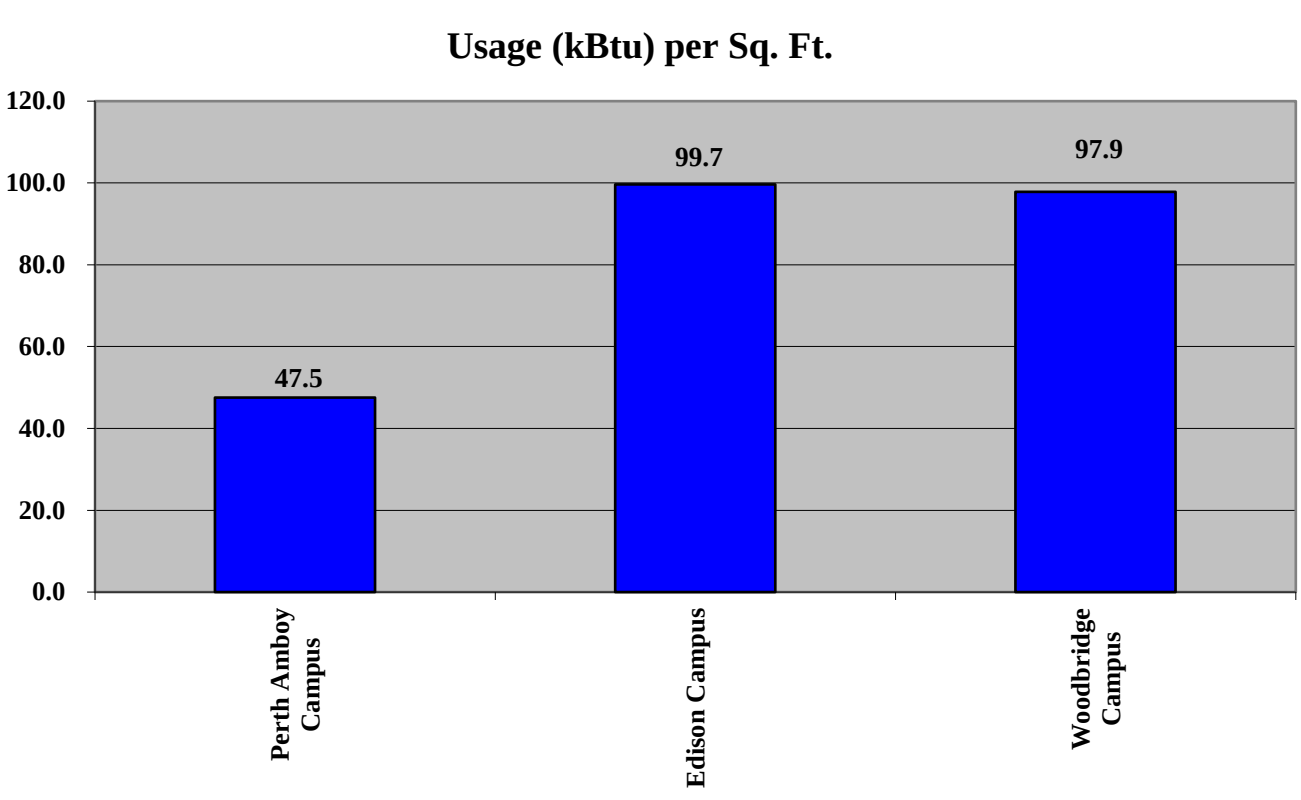
**This allocation is generic and is not a representation of the actual end use in your buildings included in this report.

Typical Allocation Applied to Your Electric Cost**

	Lighting	$186,841
	Cooling	$83,040
	Ventilation	$38,199
	Office Equipment	$29,064
	Refrigeration	$8,304
	Cooking	$12,456
	Heating	$24,912
	Other	$10,380
	Water Heating	$20,760
Your Total Cost	**Jan 2018 through Dec 2018**	**$415,202**

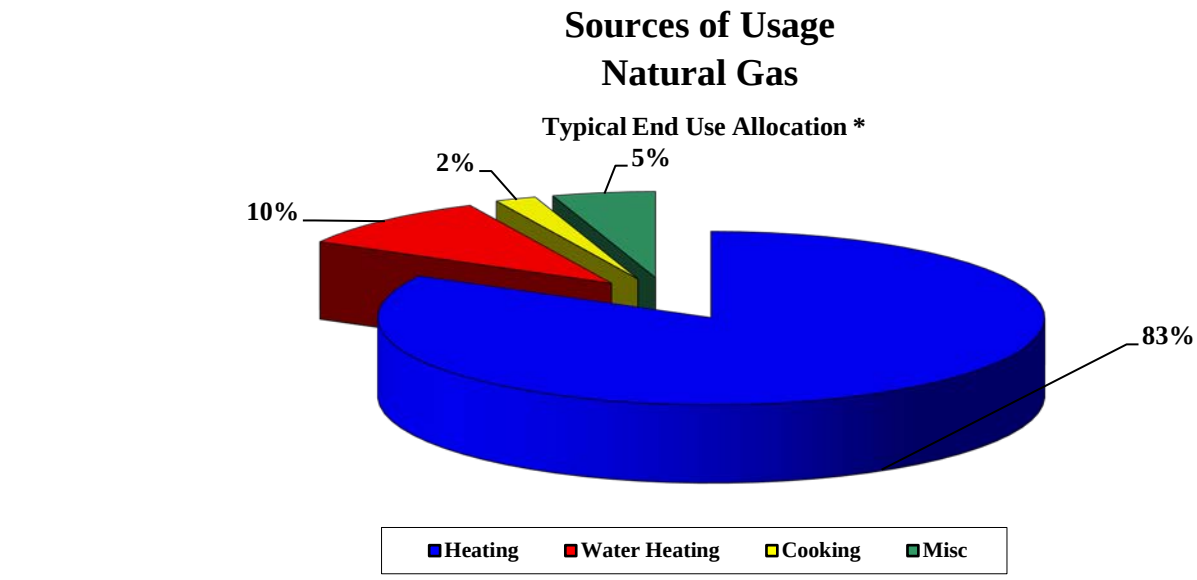
Utility Analysis
Natural Gas





There is a fairly direct correlation between your gas usage and heating degree days, indicating that the vast majority of your natural gas usage is for space heating.

Utility Analysis
Natural Gas



**This allocation is generic and is not a representation of the actual end use in your buildings included in this report.

Typical Allocation Applied to Your Cost**
Natural Gas

	Heating	$90,814
	Water Heating	$10,941
	Cooking	$2,188
	Misc	$5,471
Your Total Cost	**Jan 2018 through Dec 2018**	**$109,415**

Annual Emissions & Environmental Impact

Middlesex County Vocational School, NJ

Calendar Year Jan 2018 through Dec 2018

The following energy usage, cost and pollution have been quantified:

Total Annual Electric usage	3,299,533	kWh
Annual Natural Gas usage	131,480	Therms

Annual Greenhouse Gas Emissions

CO2	6,001,258	pounds
SO2	15,211	pounds
NOx	10,394	pounds

This is equivalent to one of the following:

300	No. of passenger vehicles - annual greenhouse gas emissions
176,715	Gallons of gasoline consumed - CO_2 emissions
3,653	Barrels of oil consumed - CO_2 emissions
134	No. of homes energy use for one year - CO_2 emissions
40,282	No. of tree seedlings grown for 10 years - carbon sequestered
335	No. of acres of pine or fir forests - carbon sequestered annually
65,458	No. of propane cylinders used for home barbeques - CO_2 emissions
8	No. of railcars' worth of coal burned - CO_2 emissions

Based on the US Environmental Protection Agency -
Clean Energy Power Profiler

Potential Retrofits

Retrofit Description	Utility/Fuel Type	Symptomatic Issues	Common Recommendations for Action
Lighting Retrofit and Motion Sensors	Electric/Natural Gas	Elevated EUI	Lighting and Controls UpGrade
De-Stratification Fans	Electric/Natural Gas	Elevated EUI	Redistribution of Conditioned Air
DHW Boiler Replacements	Electric/Natural Gas	Elevated EUI	Higher Efficiency Units
Classroom Unit Replacments	Electric	Elevated EUI	Higher Efficiency Units
RTU Replacements	Electric/Natural Gas	Elevated EUI	Higher Efficiency Units
Boiler Replacements	Natural Gas	Elevated EUI	Higher Efficiency Units
Burner Replacements	Natural Gas	Elevated EUI	Decrease Thermal Losses
Building Envelope Improvements	Electric/Natural Gas	Elevated EUI	Reduce Building In leakage
Roof Top Unit Replacements	Electric	Elevated EUI	Lower Energy Consumption
Computer Controllers	Electric	Elevated EUI	Lower Energy Consumption
Install Premium Efficient Motors	Electric	Elevated EUI	Lower Energy Consumption
CHP	Electric/Natural Gas	Elevated EUI	Lower Energy Consumption
Load Reduction	Electric	Elevated EUI	Lower Energy Supply Side Consumption

SECTION C ENERGY CONSERVATION MEASURES (ECMS)

Introduction

The information used to develop this Section was obtained through the independent energy audit building surveys to collect equipment information, interviews with operators and end users, and an understanding of the components to the systems at the sites. The information obtained includes nameplate data, equipment age, condition, the system's design and actual load, operational practices and schedules, and operations and maintenance history.

Honeywell has done a review of the Energy Conservation Measures (ECMs) which would provide energy and cost savings to MCVTS. This report aims to be an assessment of the feasibility and cost effectiveness of such measures, and an indication of the potential for their implementation. The ECMs listed below have been reviewed throughout your facilities for consideration within a complete Energy Savings Plan. What follows is a general description of the energy auditing process and the detailed descriptions of the Energy Conservation Measures for your facilities.

ENERGY CONSERVATION MEASURES

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
1A LED Lighting	●	●	●
1B Vending Misers	●	●	●
1C Destratification Fans	●		●
2A Boiler Replacements		●	
2B DHW Heater Replacements	●	●	
2C RTU Replacements	●	●	
2D Split System Replacements	●	●	●
2E Chiller Replacements			●
2F Motor and VFD Replacements	●	●	●
2G Kitchen Hood Control	●		
2H Refrigeration Controls	●		
2I Window AC Unit Replacements			●
2J Multi-Zone VRF System Replacement			●
3A Building Management Systems	●	●	●
4A Building Envelope Improvements (BEI)	●	●	●
4B Woodbridge Guidance Area BEI			●
5A Permanent Load Reduction	●	●	●
6A Solar PPA	●	●	●
7A High Efficiency Transformers	●		●
8A Water Conservation	●	●	●

OVERVIEW

Honeywell has closely evaluated and audited the District to develop the optimum mix of energy saving measures. These selected site-specific measures have been developed using the following process:

- Review Site Audits
- Engineering Team Site Visits
- Develop Measures
- Review Measures with Team

Reject and Accept Measures Based On

- Alignment with Critical Success Factors (CSF)
- Value to the School
- Economic Financial Payback
- Equipment Service Life
- Effect on Current Space Conditions

In developing the proposed measures, the following considerations were critical:

- Reduction of space heating and cooling loads by performing a systems review, with complete consideration of current indoor environmental quality standards.
- Review and redesign lighting systems noting reductions in the internal heat gain in the affected spaces.
- Load reduction measures always precede optimization measures.

Bin weather data was used from a 15-year average reported from Newark, NJ. Ventilation rates, taken from ASHRAE published standard, were predicted by using the building's population multiplied by cfm/person during occupied hours.

Reasonable infiltration rates were assumed based on the building's fenestration conditions and expected values for typical buildings. A reduced infiltration rate was assumed for the unoccupied hours. Envelope heat loss calculations assumed a reasonable heat transmission rate (U value) based on the construction of the buildings. Wall area and glass area were estimated by supplied drawings and field photographs.

Current efficiencies were derived from assumed and later to be measured boiler efficiencies, and assumed system losses due to thermal losses, distribution losses, and loose operational control. The current assumed boiler system efficiencies were then applied to the calculated load and calibrated to last year's actual fuel consumption.

Demand Sensitive Operation

Review existing and proposed thermal loads. For example, the review process will facilitate the application of:

1. Optimized flow rates (steam, water, and air).
2. Optimized operation of equipment, matching current occupancy use profiles and considering both outside and indoor space temperatures.

Benefits of Mechanical Improvements

Listed below are some of the benefits that MCVTS would reap from the mechanical portion of the measures:

1. Avoid costly repairs and replace equipment that would have to be replaced in the next five years.
2. Improve compliance with ASHRAE Ventilation Standards.
3. Trend ventilation rates; thus, insuring compliance through documentation.
4. Operate a more weather sensitive facility.
5. Allow for a greater capability of central monitoring and troubleshooting via remote.
6. Reduce costs and optimize staff efficiency through greater operating flexibility.

Indoor Air Quality

Implementation of new energy-related standards and practices has contributed to a degradation of indoor air quality. In fact, the quality of indoor air has been found to exceed the Environmental Protection Agency (EPA) standards for outdoor air in many homes, businesses, and factories.

The American Council of Governmental Industrial Hygienists' (ACGIH) booklet. "Threshold Limit Values," has published air quality standards for the industrial environment. No such standards currently exist for the residential, commercial, and institutional environments, although the ACGIH standards are typically and perhaps inappropriately used. The EPA has been working to develop residential and commercial standards for quite some time.

Recent studies indicate that for even the healthiest students, indoor air pollution can reduce the ability to learn. As an example, if you were to place several students in a room where it is hot, there is little or no air circulation and other children are coughing and sneezing, exposing the student body to airborne related illnesses such as the cold or flu. Honeywell has addressed this issue by focusing on the proper operation and replacement of the unit ventilators and air handler equipment which will assure IAQ standards are met.

ECM 1A LED LIGHTING

The key benefits of this ECM include:

- **Energy savings** from reducing total energy consumption with more efficient, state of the art technology. Today's most efficient way of illumination and lighting has an estimated energy efficiency of 80%-90% when compared to traditional lighting and conventional light bulbs.
- **Improved teacher and student performance** from enhanced lighting quality that translates to an enhanced working and learning environment.
- **Improved equipment longevity** by reducing amount of light usage and extending the useful life of your lighting system. LED bulbs and diodes have an outstanding operational life time expectation of up to 100,000 hours. This is 11 years of continuous operation, or 22 years of 50% operation. Operational savings in terms of bulb and ballast replacement are significant based on this technology.
- **Reduced maintenance and operational costs** by modernizing your lighting system and providing for longer lasting and technologically advanced lights, without the need to address deficient or bad ballasts.
- **Reduced carbon footprint** with ecologically friendly LED lights that are free of toxic chemicals. Most conventional fluorescent lighting bulbs contain a multitude of materials like mercury that are dangerous for the environment. LED lights contain no toxic materials and are 100% recyclable, and will help to reduce carbon footprint by up to a third. The long operational life time span mentioned above means also that one LED light bulb can save material and production of 25 incandescent light bulbs. A big step towards a greener future!

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
1A LED Lighting	●	●	●

Existing Conditions

Indoor lighting predominantly consists of standard T-8s and some, CFLs and few incandescent bulbs. In general lighting is operated on switches; however, some rooms have occupancy sensors. Outdoors lighting consists of wall mounted CFLs and the parking lot has post mounted HPS.

Scope of Work

The proposed lighting system is based on the recent investment grade lighting system audit where existing lighting systems were analyzed and inventoried. Honeywell proposes to retrofit all existing T-8 and T-12 fixtures with high efficiency LED lamps. A detailed line by line lighting plan is included within the calculation section of this document.




Examples of existing interior lighting

LED Parking Lot Lighting Upgrades

Existing Conditions

MCVTS parking lots consist of various types of HID light fixtures, which are not as efficient as modern LED types. Parking lot exterior lights consist of pole mounted shoe-box type and wall pack HID fixtures on daylight sensors and timers.




Example of existing/new outdoor lighting fixtures

Scope of Work

Outdoor Lighting

The exterior wall-packs and pole-mounted shoebox fixtures are currently high wattage HID lamps. These will be replaced with lower wattage LED fixtures. The LED technologies offer significant advantages such as extended lamp life, minimal lumen depreciation, “instant on,” and very high energy conversion efficiency. These fixtures will provide substantial maintenance savings via the new 100,000 hour LED lamp life versus the 20,000 hours of the existing metal halide lamps.

To retrofit these lights with energy efficient LEDs, the existing ballasts that are in the space behind the light will be removed. Once removed, we will replace them with LED drivers which will use approximately 24V and will not need the existing ballast. The existing lamps are removed and new energy efficient LED

lamps are installed in their place. Replacements or maintenance is not required on these type fixtures for up to 100,000 hours or 15-20 years depending on usage time.

The exterior wall-packs and pole-mounted shoebox fixtures are currently high wattage HID lamps. These will be replaced with lower wattage LED fixtures. The LED technologies offer significant advantages such as extended lamp life, minimal lumen depreciation, “instant on,” and very high energy conversion efficiency. These fixtures will provide substantial maintenance savings via the new 100,000 hour LED lamp life versus the 20,000 hours of the existing metal halide lamps.

To retrofit these lights with energy efficient LEDs, the existing ballasts that are in the space behind the light will be removed. Once removed, we will replace them with LED drivers which will use approximately 24V and will not need the existing ballast. The existing lamps are removed and new energy efficient LED lamps are installed in their place. Replacements or maintenance is not required on these type fixtures for up to 100,000 hours or 15-20 years depending on usage time.

Changes in Infrastructure

New LED lamps will be installed as part of this ECM. Existing poles and shoe box fixtures will be utilized.

Customer Support and Coordination with Utilities

Coordination efforts will be needed to reduce or limit impact to building occupants.

Environmental Issues

Resource Use	Energy savings will result from reduced electric energy usage. A slight increase in heating energy is resultant from the reduced heat output of more efficient lamps.
Waste Production	All lamps and ballasts that are removed will be properly disposed.
Environmental Regulations	No environmental impact is expected.

ECM 1B VENDING MISERS

The key benefits of this ECM include:

- **Energy savings** by better managing the power consumption of electrical equipment.
- **Longer equipment life** thanks to reduced usage.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
1B Vending Misers	●	●	●

The District has plug loads for equipment such as vending machines at multiple school locations. As such, Honeywell has investigated the use of plug controllers for these areas.

Existing Conditions

Vending machines are located throughout your facilities offering soft drinks to the occupants. A typical cold drink machine consumes over 5,000 kWh annually.



Vending and Snack Machines to be retrofitted with controls

Table 1B.1 Proposed Vending Machines for Vending Miser Controls

Building	Type	Location	Qty
Perth Amboy Campus	Cold Beverage	Cafeteria	1
Perth Amboy Campus	Cold Beverage	Teacher Lounge	1
Perth Amboy Campus	Cold Beverage	Gym	1
Perth Amboy Campus	Snack	Cafeteria	1
Edison Campus	Cold Beverage	Common Area	1
Edison Campus	Snack	Common Area	1
Edison Campus	Snack	Common Area	1
Woodbridge Campus	Cold Beverage	Cafeteria	1
Woodbridge Campus	Cold Beverage	Faculty Lounge	1
Total			9

Proposed Solution

During the site visit, Honeywell noted vending machines providing an opportunity for energy savings by shutting off non-critical loads during the non-occupied periods.

The Vending Miser Occupancy Control (VMOC) also monitors electrical current used by the vending machine. This ensures that the unit will never power down a vending machine while the compressor is running, so a high head pressure start never occurs. In addition, the current sensor ensures that every time the vending machine is powered up, the cooling cycle is run to completion before again powering down the vending machine. The Coca Cola Company and Pepsi Corporation approve the proposed controller for use on their machines.

Interface with Existing Equipment

All the plug load control devices are easily installed. The vending machine controllers are installed separately from the machine, and implementation will occur during working hours. A period of three (3) weeks will be required to verify proper calibration of the sensors.

With respect to the vending machines in your facilities, Honeywell has estimated the number and types of vending machines based on our site tour. During the implementation phase, Honeywell will check with the vendor about the type and specification of the vending machines as it relates to any internal time clocks which may exist inside the machine. Should this be the case, the savings and cost will be adjusted accordingly.

Changes in Infrastructure

New vending machine controls will be installed as part of this ECM.

Customer Support and Coordination with Utilities

Minor coordination efforts will be needed to reduce or limit impact to building occupants.

Environmental Issues

Resource Use	Energy savings will result from reduced electric energy usage.
Waste Production	None.
Environmental Regulations	No environmental impact is expected.

ECM 1C DESTRATIFICATION FANS

The key benefits of this ECM include:

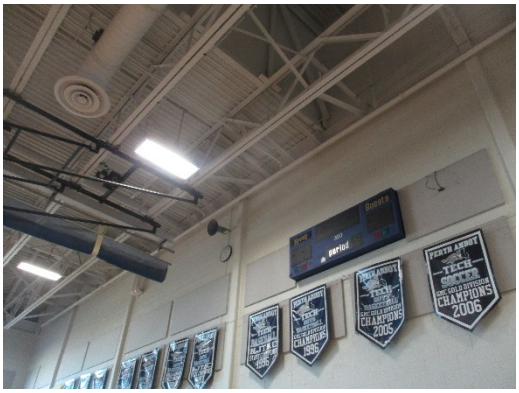
- **Improved efficiency and energy savings** through more equal distribution of conditioned air space.
- **Increased equipment longevity** due to lower utilization of equipment to condition air.
- **Increased comfort** of occupants to improve productivity of students and teacher.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
1C Destratification Fans	●	●	●

Existing Conditions

Warm air stratifies close to the ceiling in high ceiling areas such as in a gymnasium or auditorium. Elevated levels of heat transfer through the high walls and roof causes elevated heat loss.





Examples of spaces for Destratification Fans

Proposed Solution

In areas with 20+ foot ceiling heights, there is approximately a 15°F+ temperature difference between the floor and the ceiling. With higher ceilings, it is even greater. That means to generate the heat necessary to maintain a comfortable 70°F temperature at the floor level, where student activities occur, the ceiling could be 85°F or higher.

De-stratification fans de-stratify the air to a zero to 3°F differential from floor to ceiling and wall to wall. This will allow HVAC systems to run for a shorter duration because of the absence of extreme temperatures to heat or cool, thus allowing the local thermostats to be satisfied for longer periods of time.

Systems Evaluation and Selection

An energy-efficient motor drives a near-silent fan that forces a column of hotter air from the ceiling area to the cooler floor below. As this column of warm air nears the floor, it begins to flare out in a circular pattern and rise again creating a torus. While doing so, it warms the cooler air and mixes with air near the floor, increasing the temperature and comfort of occupants. Through a natural law of physics, this torus will continue to re-circulate air, mixing warmer air from the ceiling with cooler air near the floor until the ceiling and air temperatures are nearly equal. As this happens, it will require less and less energy to comfortably

heat the work area, allowing thermostats to be lowered and energy savings to be realized. Once started, the entire process of "thermal equalization" will take on average less than 24 hours.

Based on preliminary site investigation conducted by our staff, we propose to install the following as indicated in the table below:

Table 1C.1 Proposed De-Stratification Fans

School	Location	Qty	Type
Perth Amboy Campus	Cafeteria	4	Air Pear 45
Perth Amboy Campus	Auto Shop	3	Air Pear 25
Perth Amboy Campus	Gym	9	Air Pear 25
Woodbridge Campus	Multi-Purpose	3	Air Pear 25
Totals		**19**	

Scope of Work

Per De-Stratification Fan:

- Shut off the main electric power to the area in which the unit(s) will be installed.
- Install new de-stratification fan and wiring.
- Re-energize.
- Inspect unit operation by performing electrical and harmonics testing.

Changes in Infrastructure

New de-stratification fans will be installed as part of this ECM.

Customer Support and Coordination with Utilities

Coordination efforts will be needed to reduce or limit impact to building occupants.

Environmental Issues

Resource Use	Energy savings will result from reduced thermal energy usage. A slight increase in electrical energy is resultant from the increase run time of the fan motors.
Waste Production	None.
Environmental Regulations	No environmental impact is expected.

ECM 2A BOILER REPLACEMENTS

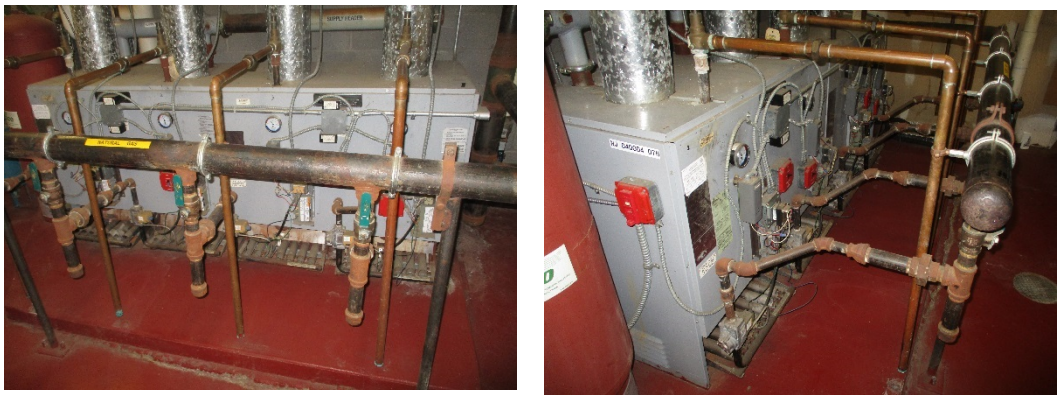
The key benefits of this ECM include:

- **Reduced energy usage** from improved boiler efficiency thanks to replacement of older equipment.
- **Lower operational costs** through less frequent maintenance and operational issues.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2A Boiler Replacements		●	

Existing Conditions

The boilers in the District are close to their useful life and are not as efficient as condensing boilers.



Existing Boilers at Edison Campus

Table 2A.1 Existing Boilers to be Replaced

Building	Location	Manufacturer	Model	Qty	Input (MBH)	Fuel
Edison Campus	Boiler Room	Hydrotherm	MR-1200-PV	1	1,200	Natural Gas

Proposed Solution

It is recommended that the boilers listed in the table above be replaced with boilers operating at higher efficiency listed in table below. New condensing hot water boilers have thermal efficiencies that range from 88% – 95% depending on the return hot water temperature from the heating loop. With proper design, it is typical to see thermal efficiencies of around 92%. Thermal efficiency is only one part of the equation that makes up the seasonal efficiency of a boiler. Compared to the existing boilers in these schools, the new boilers will provide an increase in boiler efficiency of anywhere between 10% to 15%.

Table 2A.2 Proposed Boiler Equipment

Building	Location	Manufacturer	Model	Qty	Input (MBH)	Fuel
Edison Campus	Boiler Room	Lochinvar	AWN-501PM	2	500	Natural Gas

Scope of Work

The following outlines the boiler replacement:

- Disconnect gas back to shutoff valve and electric back to source panel-board.
- Remove existing boilers.
- Install new boilers.
- Connect gas and heating hot water appurtenances to new boilers.
- Terminate and power new boiler electric circuiting.
- Start up, commissioning and operator training.

Energy Savings Methodology and Results

In general, Honeywell uses the following approach to determine savings for this specific measure:

Existing Boiler Efficiency	= Existing Heat Production/ Existing Fuel Input
Proposed Boiler Efficiency	= Proposed Heat Production/ Proposed Fuel Input
Energy Savings $	= Heating Production (Proposed Efficiency – Existing Efficiency)

Equipment Information

Manufacturer and Type	Several quality and cost effective manufacturers are available. Honeywell and the customer will determine final selections.
Equipment Identification	As part of the ECM design and approval process, specific product selection will be provided for your review and approval.

Changes in Infrastructure

New boiler will be installed in itemized locations; in addition, training for maintenance personnel will be required as well as on-going, annual preventive maintenance.

O&M Impact

The new boilers will decrease the O&M cost significantly for maintaining the boilers.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods. Continuity of service must be maintained for the customer.

Environmental Issues

Resource Use	Energy savings will result from greater combustion efficiency, reduced maintenance costs control and setback.
Waste Production	Existing boilers scheduled for removal will be disposed of properly.
Environmental Regulations	No environmental impact is expected; all regulations will be adhered to in accordance with EPA and local code requirements.

ECM 2B DOMESTIC HOT WATER (DHW) HEATER REPLACEMENTS

The key benefits of this ECM include:

- **Reduced energy usage** from improved efficiency thanks to replacement of older equipment.
- **Lower operational costs** through less frequent maintenance and operational issues.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2B DHW Heater Replacements	●	●	

Existing Conditions

The existing domestic hot water heaters are generally in good condition but are not high-efficiency units.



Existing DHW System to be replaced.

Table 2B.1 Existing Domestic Hot Water Heater Equipment

Building	Manufacturer	Model	Qty	Capacity MBH	Storage (Gal)	Fuel
Edison Campus	Lochinvar	RWN270PM	1	216	200	Natural Gas
Perth Amboy Campus	PVI	1060N250-PV	2	600	250	Natural Gas

Proposed Solution

Honeywell proposes replacing the existing DHW heaters at the above schools with highly efficient condensing DHW heaters. New condensing DHW heaters have efficiencies between 92% - 94%. They provide better control with capabilities as night setback, temperature adjustments and demand control hot water.

Table 2B.2 Proposed Domestic Hot Water Heater Equipment

Building	Manufacturer	Model	Qty	Capacity MBH	Storage (Gal)	Fuel
Edison Campus	PVI	25 L 100A-GCL	1	200	100	Natural Gas
Perth Amboy Campus	PVI	70 L 130A-GCML	2	692	130	Natural Gas

Scope of Work

The following outlines the domestic hot water heater replacement:

- Demolish and remove old water heaters and storage tanks
- Furnish and install condensing gas fired domestic hot water heaters as specified in the table above.
- Install all required piping, controls, and breeching.
- Install mixing valve.
- Install storage tank
- Test and commission.

Energy Savings Methodology and Results

The savings are calculated from the domestic hot water heater efficiency differences.

Existing Equipment Efficiency	= Existing Boiler Efficiency + Existing Heat Exchanger Efficiency
Proposed Equipment Efficiency	= Efficiency of the New Domestic Hot Water Heater
Energy Savings	= DHW Load x (Existing Equipment Efficiency – New Equipment Efficiency)

Changes in Infrastructure

A new controller for each boiler will be installed and programmed. In addition to the controllers, training for maintenance personnel will be required.

Equipment Information

Manufacturer and Type	Several quality and cost effective manufacturers are available.
Equipment Identification	As part of the measure design and approval process, specific product selection will be provided for your review and approval.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods.

Environmental Issues

Resource Use	Energy savings will result from improved thermal efficiency.
Waste Production	This ECM will produce no waste by-products.
Environmental Regulations	No environmental impact is expected.

Utility Interruptions

Proper phasing procedures will minimize gas interruptions.

ECM 2C ROOF TOP UNIT (RTU) REPLACEMENTS

The key benefits of this ECM include:

- **Reduced energy usage** from improved efficiency thanks to replacement of older equipment.
- **Lower operational costs** through less frequent maintenance and operational issues.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2C RTU Replacements	●	●	

Existing Conditions

Some Rooftop Units (RTUs) serving the schools marked above are inefficient or past their useful lives. Replacing these units with new, high efficiency units will save energy costs over the long term while reducing repair costs that would otherwise have been necessary to keep the old RTUs in operation.





Table 2C.1 Existing Rooftop Units to be Replaced.

Building	Make	Model	Location Served	Qty.	Tons
Edison Campus	Trane	YCH600AELE2A7M	Building	1	50
Edison Campus	Trane	YCH600AELE2A7M	Building	1	50
Perth Amboy Campus	McQuay	RPS040CLW	C102 Gym Unit	1	40
Perth Amboy Campus	McQuay	RPS040CLW	C103 Gym Unit	1	40
Perth Amboy Campus	McQuay	RPS040CLW	C201 Cafeteria Unit	1	40
Perth Amboy Campus	McQuay	RPS040CLW	C101 C Section First Floor Classrooms/Halls	1	40
Perth Amboy Campus	McQuay	RPS060CLW	B201 Science and Second Floor Hallways	1	60
Perth Amboy Campus	McQuay	RPS060CLW	B101 First Floor Tech Shops	1	60
Perth Amboy Campus	McQuay	RPS040CLW	C202 Kitchen and ARA Supply	1	40
Perth Amboy Campus	Lennox	LGA102HH3G	B103 HVAC Shop	1	8.5
Perth Amboy Campus	Lennox	LGA102HH3G	B104 Auto Shop	1	8.5
Perth Amboy Campus	Lennox	LGC300SH1G	B102 Wood Shop	1	25
Perth Amboy Campus	Lennox	LGA072HH2G	B107 Garage for Loading Dock	1	6
Perth Amboy Campus	Lennox	LGA102HH3G	B105 Electric Shop	1	8.5

Building	Make	Model	Location Served	Qty.	Tons
Perth Amboy Campus	AAON	RK20-3E0750	A102 Main Office	1	20
Total				15	

Proposed Solution

Honeywell proposes replacing the existing rooftop units listed in the table above. The new units will be installed in the same location as the existing units. Existing electrical power supply will be reconnected to the new RTUs. The new units will be equipped with factory-installed microprocessor controls that improve unit efficiency. The units will also communicate with the building management system.

Table 2C.2 Proposed Rooftop Units

Building	Make	Model	Location Served	Qty.	Tons
Edison Campus	Trane	YCH600BE	Building	1	50
Edison Campus	Trane	YCH600BE	Building	1	50
Perth Amboy Campus	Daikin	RPS042DLW	C102 Gym Unit	1	40
Perth Amboy Campus	Daikin	RPS042DLW	C103 Gym Unit	1	40
Perth Amboy Campus	Daikin	RPS042DLW	C201 Cafeteria Unit	1	40
Perth Amboy Campus	Daikin	RPS042DLW	C101 C Section First Floor Classrooms/Halls	1	40
Perth Amboy Campus	Daikin	RPS062DLW	B201 Science and Second Floor Hallways	1	60
Perth Amboy Campus	Daikin	RPS062DLW	B101 First Floor Tech Shops	1	60
Perth Amboy Campus	Daikin	RPS042DLW	C202 Kitchen and ARA Supply	1	40
Perth Amboy Campus	Trane	YZC102	B103 HVAC Shop	1	8.5
Perth Amboy Campus	Trane	YZC102	B104 Auto Shop	1	8.5
Perth Amboy Campus	Trane	YHD300G4	B102 Wood Shop	1	25
Perth Amboy Campus	Trane	YZC072	B107 Garage for Loading Dock	1	6
Perth Amboy Campus	Trane	YZC102	B105 Electric Shop	1	8.5
Perth Amboy Campus	Trane	YHD240G4	A102 Main Office	1	20
Total				15	

* indicates unit included in the financial summary of recommended project

Scope of Work

The following outlines the scope of work to install the units stated in the above table:

- Disconnect existing RTU electric connections.
- Disconnect piping and air ducts from the unit.
- Remove unit from the base.
- Modify base for new unit if necessary.
- Run new gas line for gas fired heater. (if required).
- Rigging and setting new unit at the base.
- Inspect piping and air ducts before reconnecting them to the unit.
- Reconnect piping and air ducts.

- Repair duct and piping insulation.
- Connect electric power.
- Start up and commissioning of new unit.
- Maintenance operator(s) training.

Energy Savings Methodology and Results

The savings approach is based on the energy efficiency between the existing and new units. The savings are generally calculated as:

Electric Energy savings	Existing unit energy consumption (kWh) – replacement unit energy consumption (kWh).

Equipment Information

Manufacturer and Type	Several quality and cost effective manufacturers are available. Honeywell and the customer will determine final selections.
Equipment Identification	Product cut sheets and specifications are available upon request. As part of the measure, design, and approval process, specific product selection will be provided for your review and approval.

Customer Support and Coordination with Utilities

Coordination of the electrical tie-in will be required.

Environmental Issues

Resource Use	Energy savings will result from higher efficiency units.
Waste Production	Existing unit scheduled for removal will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 2D SPLIT SYSTEM REPLACEMENT

The key benefits of this ECM include:

- **Energy savings** from reducing total energy consumption
- **Equipment longevity** due to more efficient and less wasteful equipment utilization
- **Operational savings** from less frequent need to repair or replace key HVAC equipment thanks to less frequent equipment use

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2D Split System Replacements	●	●	

Existing Conditions

Honeywell identified condensing units in some of your buildings as being inefficient and having exceeded their useful service life. Replacing these units with new, high efficiency units will save energy costs over the long term while reducing repair costs that would otherwise have been necessary to keep the old units in operation.





2D.1 Existing Split System Units to be Replaced

Building	Make	Model	Qty.	Tons	SEER
Perth Amboy Campus	EMI	SCC12D	1	1.0	10.5
Perth Amboy Campus	EMI	SCC12D	1	1.0	10.5
Edison Campus	Mitsubishi	PU18EK	1	1.5	10.5

Proposed Solution

Honeywell proposes replacing the existing condensing units in the table above. The new units will be installed in the same location as the existing units. Existing electrical power supply will be reconnected to the new motors. The new units will be equipped with factory-installed microprocessor controls that improve unit efficiency. The units will also communicate with the existing or enhanced building management system.

Table 2D.2 Proposed Split Systems

Building	Make	Model	Qty.	Tons	SEER
Perth Amboy Campus	Trane	4TXK8509A10N0C/ 4MXW8509A10N0C	1	1.0	20.0
Perth Amboy Campus	Trane	4TXK8509A10N0C/ 4MXW8509A10N0C	1	1.0	20.0
Edison Campus	Trane	4TXK8518A10N0C/ 4MXW8518A10N0C	1	1.5	18.0

* indicates unit included in the financial summary of recommended project.

Scope of Work

The following outlines the scope of work to install the condensing units listed in the Proposed System table above.

- Disconnect existing electric connections.
- Disconnect piping from the unit.
- Remove unit from the base.
- Modify base for new unit if necessary.
- Rigging and setting new unit at the base.
- Inspect piping and air ducts before reconnecting them to the unit.
- Reconnect piping and air ducts.
- Repair duct and piping insulation.
- Connect electric power.
- Start up and commissioning of new unit.
- Maintenance operator(s) training.

Energy Savings Methodology and Results

The savings approach is based on the energy efficiency between the existing and new units. The savings are generally calculated as:

Electric Energy savings	Existing unit energy consumption (kWh) – replacement unit energy consumption (kWh)

Equipment Information

Manufacturer and Type	Several quality and cost effective manufacturers are available. Honeywell and the customer will determine final selections.
Equipment Identification	Product cut sheets and specifications are available upon request. As part of the measure, design and approval process, specific product selection will be provided for your review and approval.

Customer Support and Coordination with Utilities

Coordination of the electrical tie-in will be required.

Environmental Issues

Resource Use	Energy savings will result from higher efficiency units.
Waste Production	Existing rooftop unit scheduled for removal will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 2E CHILLER REPLACEMENTS

The key benefits of this ECM include:

- **Energy Savings** from reducing total energy consumption.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.
- **Operational savings** from less frequent need to repair or replace key HVAC equipment thanks to less frequent equipment use.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2E Chiller Replacements			●

Existing Conditions

The chillers located throughout the District are in varying conditions based upon age of associated systems. Some of the chillers serving the school distrcit are inefficient and have exceeded their useful life. Replacing these units with new, high efficiency units will save energy costs over the long term while reducing repair costs that would otherwise have been necessary to keep the old units in operation.





Table 2E.1 Air-cooled Chillers to be Replaced

Building	Qty.	Make	Model	Tonnage	Efficiency (kw/ton)
Woodbridge Campus	1	McQuay	AGZ060	60	1.14
Woodbridge Campus	1	McQuay	AGZ070	70	1.14

Proposed Solution

Honeywell is proposing to replace the existing chillers listed in the table above. The new chillers will be sized for the existing load and be installed at the same location as the existing chiller. Electrical power will be reconnected to the new motors. The new unit will be equipped with factory installed microprocessor controls that improve unit efficiency. The units will also communicate with the existing or enhanced building management system.

Table 2E.2 Proposed Chillers

Building	Qty.	Make	Model	Tonnage	Efficiency (kw/ton)
Woodbridge Campus	1	Trane	CGAM060A	60	0.68
Woodbridge Campus	1	Trane	CGAM070A	70	0.68

Scope of Work

The following outlines the scope of work to install the chiller stated in the above table:

- Disconnect existing electric connections.
- Disconnect piping from the unit.
- Remove unit from the base.
- Modify base for new unit if necessary.
- Rigging and setting new unit at the base.
- Inspect piping before reconnecting them to the unit.
- Reconnect piping.
- Repair piping insulation.
- Connect electric power.
- Start up and commissioning of new unit.
- Maintenance operator(s) training.

Energy Savings Methodology and Results

The savings approach is based on the energy efficiency between the existing and new units. The savings are generally calculated as:

Electric Energy Savings	Current Chiller Demand – Proposed Chiller Demand.

Equipment Information

Manufacturer and Type	Several quality and cost effective manufacturers are available. Honeywell and the customer will determine final selections.
Equipment Identification	Product cut sheets and specifications are available upon request. As part of the measure, design, and approval process, specific product selection will be provided for your review and approval.

Customer Support and Coordination with Utilities

Coordination of the electrical tie-in will be required.

Environmental Issues

Resource Use	Energy savings will result from higher efficiency units.
Environmental Regulations	No environmental impact is expected.

ECM 2F MOTOR AND VFD REPLACEMENTS

The key benefits of this ECM include:

- **Energy savings** from reduced run hours and reduced motor speeds.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization and reduced startup wear.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2F Motor and VFD Replacements	●		●

ECM Overview

Variable frequency drives (VFDs) allow motors to run at specified speeds rather than just on or off while allowing systems to more accurately move heat. Honeywell recommends this ECM due to the significant savings potential given the relationship between energy consumption and motor speed.





Existing Conditions

Honeywell has identified standard efficiency electric motors on several pumps. Energy savings can be obtained by replacing the standard efficiency motors with premium efficiency motors as well as by installing VFDs on systems that have two-way control valves.

The motors that were identified in the buildings are listed as follows:

Table 2F.1 Existing Motor and VFD Replacements

Building	Equipment Description	Qty	Motor HP	Replace Motor Y/N	Add VFD Y/N
Woodbridge Campus	Chilled Water Pumps	2	5.0	Y	Y
Perth Amboy Campus	Water Supply Pump	2	3.0	Y	Y

Proposed Solution

Honeywell identified several of your buildings have pump systems, hydronic systems and the motors that serve them that are sized to meet peak heating or cooling conditions. However, we've learned that most operating hours occur during conditions that require less than peak loads.

Honeywell proposes replacing of all above-mentioned single speed standard efficiency motors (that do not have VFDs) with new premium efficiency motors, installing new couplings where applicable. In addition, Honeywell recommends installing VFDs on these pumps. Energy used by the motor can be reduced by varying the flow in response to varying loads in the space. Motor speed may be controlled either based on the pressure in the distribution system or based on time of day.

Honeywell recommends fitting unit ventilators with two-way valves (if unit ventilators located at end of piping branches are fitted with three-way valves to keep hot water moving through the distribution piping at all times).

Honeywell also recommends installing VFDs on the heating hot water pumps and chilled water pumps to better match pumping output to system requirements and reduce energy waste. Each motor will be equipped with new selector relays that will allow one drive to operate per pump with the VFD drive. Honeywell also recommends installation of new differential pressure sensors and tying them to the control system to allow to regulate the speed of the pump according to load requirements. Lastly, we recommend installation of VFDs on the cooling system pump motors that have higher horsepower. VFDs will maintain temperatures in the unit by adjusting the speed of both the motor and the pump, and can be connected to your BMS.

Energy Savings Methodology and Results

The energy consumed by electric motors varies inversely with the cube of the motor speed. Variable speed drives reduce motor speed (in response to load) thus reducing energy consumption exponentially.

Equipment Information

Manufacturer and Type	Several quality and cost effective manufacturers are available.
Equipment Identification	Product cut sheets and specifications for generally used are available upon request. As part of the measure design and approval process, specific product selection will be provided for your review and approval.

Changes in Infrastructure

New motors will be installed in place of the old motors. No expansion of the facilities will be necessary.

Customer Support and Coordination with Utilities

Coordination of the electrical tie-in will also be required.

Environmental Issues

Resource Use	Energy savings will result from reducing electrical usage by operating higher efficiency motors for the same horsepower output. The equipment uses no other resources.
Waste Production	This measure will produce waste byproducts. Old motors shall be disposed of in accordance with all federal, state, and local codes.
Environmental Regulations	No environmental impact is expected.

ECM 2G KITCHEN HOOD CONTROLS

The key benefits of this ECM include:

- **Reduced energy usage** from improved boiler efficiency thanks to replacement of older equipment.
- **Reduced cleaning costs** thanks to less utilization of existing systems.
- **Lower operational costs** through less frequent maintenance and operational issues.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2G Kitchen Hood Control	●		

Existing Conditions

Many of your kitchens utilize a constant volume kitchen exhaust hood system. This system operates at full load, even when there is no activity in the kitchen. It also requires operating the exhaust fan at full load. This wastes both fan energy and heating energy. When the hood is not utilized, an opportunity exists to reduce airflow and conserve energy.





Proposed Solution

Honeywell recommends installing a microprocessor based controls system whose sensors automatically regulate fan speed based on cooking load, time of day and hood temperature while minimizing energy usage. The system includes a temperature sensor installed in the hood exhaust collar, IP sensors on the ends of the hood that detect the presence of smoke or cooking effluent and VFD that control the speed of the fans. This will result in energy and cost savings, noise reduction, longer equipment life and reduction in cleaning costs.

Table 2G.1 Proposed Existing Kitchen Hoods to be installed with Controllers

Building	EF Name	Interlock	Location	Number of Hoods
Perth Amboy Campus	KEF-1	MUA-1 + Local Switch	Cafeteria Kitchen	1
Perth Amboy Campus	KEF-2	MUA-2 + Local Switch	Cafeteria Kitchen	1
Perth Amboy Campus	KEF-3A	MUA-3 + Local Switch	Classroom Kitchen	1
Perth Amboy Campus	KEF-3B	MUA-3 + Local Switch	Classroom Kitchen	1
Perth Amboy Campus	KEF-4A	MUA-4 + Local Switch	Classroom Kitchen	1
Perth Amboy Campus	KEF-4B	MUA-4 + Local Switch	Classroom Kitchen	1

Building	EF Name	Interlock	Location	Number of Hoods
Perth Amboy Campus	KEF-5	Local Switch	Classroom Kitchen	1
Total				7

Scope of Work

- Install a temperature sensor in the hood to monitor temperature of the exhaust gas.
- Install a set of two photo sensors on the sides to monitor smoke density across the hood.
- Install a control panel with a small point controller and a set of relays in the kitchen close to the hood.
- Provide electric wiring from the new panel to the sensors, exhaust fan motor as well as to the closest electric panel for power supply.
- Provide connection to the BMS system for remote monitoring, control, and alarming. This system could also be stand-alone to save on cost.
- Commission control components and sequences, and calibrate control loops.

Sequence of operation will enable the exhaust fans when either temperature or smoke density in the range hoods is above a pre-set value. Time delays between start and stop will be programmed to prevent motor short cycling. Schedule programming could be implemented as well.

Energy Savings Methodology and Results

The savings approach is based upon reducing the amount of conditioned air that is being exhausted when there is no cooking taking place.

Changes in Infrastructure

There will be improvements in HVAC equipment and controls for not operating fans continuously.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods.

Environmental Issues

Resource Use	Energy savings will result from reduced energy.
Waste Production	Any removed parts will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 2H REFRIGERATION CONTROLS

The key benefits of this ECM include:

- **Energy Savings** from reducing total energy consumption.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.
- **Operational savings** from less frequent need to repair or replace equipment thanks to less frequent equipment use.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2H Refrigeration Controls	●		

Existing Conditions

In many refrigeration, walk-in freezers and coolers, the compressor is oversized and cycles on/off frequently. This compressor cycling results in higher energy consumption and may reduce the life of the compressor.




Typical Walk-In Freezer and Refrigerators

Table 2H.1 *Existing Walk-In Refrigerator/Freezers to be installed with Controllers*

Building	Location	Walk-In Refrigerators	Walk-In Freezers
Perth Amboy Campus	Classroom Kitchen	1	-
Perth Amboy Campus	Classroom Kitchen	-	1
Perth Amboy Campus	Cafeteria Kitchen	1	-
Perth Amboy Campus	Cafeteria Kitchen	-	1

Existing Walk-In Refrigerator/Freezers to be Installed with Controllers

Proposed Solution

Honeywell will install a controller refrigeration sensor manufactured by Intellydyne at the above-mentioned buildings to reduce the compressor cycles of the kitchen walk-in coolers and freezers. The installation of this ECM will have no negative impact on system operation or freezing of food products. By reducing the cycling, the sensor will improve operating efficiency and reduce the electric consumption by 10% to 20%.

This control enhancement will save energy through the reduced compressor cycling in the kitchen walk-in coolers and freezers and will extend the operating life of the compressor. Consequently, the compressor will not have to be replaced as often.

Intellidyne Sensor Features

- Automatic restart on power failure.
- Surge protection incorporated into circuitry.
- Fully compatible with all energy management systems.
- UL listed.
- Maintenance free.

Intellidyne Sensor Benefits

- Patented process reduces air conditioning electric consumption typically 10% to 20%.
- Increased savings without replacing or upgrading costly system components.
- "State-of-the-art" microcomputer controller – LED indicators show operating modes.
- Protects compressor against momentary power outages and short cycling.
- Simple 15-minute installation by qualified installer.
- No programming or follow-up visits required.
- Maximum year-round efficiency.
- Reduces maintenance and extends compressor life.
- Fail-safe operation.
- Guaranteed to save energy.
- UL listed, "Energy Management Equipment".

Intellidyne's patented process determines the cooling demand and thermal characteristics of the entire air conditioning system by analyzing the compressor's cycle pattern, and dynamically modifies that cycle pattern to provide the required amount of cooling in the most efficient manner. This is accomplished in real-time by delaying the start of the next compressor "on" cycle, by an amount determined by the cooling demand analysis. These new patterns also result in less frequent and more efficient compressor cycles.

Energy Savings Methodology and Results

The energy savings for this ECM is realized by the reduction in run time of the compressors and fan motors in the freezers/refrigerators.

Changes in Infrastructure

None.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods.

Environmental Issues

Resource Use	Energy savings will result from the reduced electrical consumption of the compressor.
Waste Production	Any removed parts will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 2I WINDOW UNIT REPLACEMENT

The key benefits of this ECM include:

- **Energy savings** from reducing total energy consumption
- **Equipment longevity** due to more efficient and less wasteful equipment utilization
- **Operational savings** from less frequent need to repair or replace key HVAC equipment thanks to less frequent equipment use

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2I Window Unit Replacements			●

Existing Conditions

Honeywell identified Window AC units in some of your buildings as being inefficient and having exceeded their useful service life. Replacing these units with new, high efficiency units will save energy costs over the long term while reducing repair costs that would otherwise have been necessary to keep the old units in operation.





Table 2I.1 - Existing Window AC Units

Building	Make	Location Served	Qty.	Tons	SEER
Woodbridge Campus	Friedrich	Offices	1	1.5	12.0
Woodbridge Campus	Friedrich	Offices	1	1.5	12.0
Woodbridge Campus	Friedrich	Offices	1	1.5	12.0
Woodbridge Campus	Friedrich	Offices	1	2.0	12.0
Woodbridge Campus	Friedrich	Offices	1	2.0	12.0
Woodbridge Campus	Friedrich	Offices	1	2.0	12.0
Woodbridge Campus	Friedrich	Offices	1	1.5	12.0
Woodbridge Campus	Friedrich	Offices	1	1.5	12.0

Proposed Solution

Honeywell proposes replacing the existing condensing units in the table above. The new units will be installed in the same location as the existing units. Existing electrical power supply will be reconnected to

the new motors. The new units will be equipped with factory-installed microprocessor controls that improve unit efficiency. The units will also communicate with the existing or enhanced building management system.

Table 2I.2 Proposed Window AC Units

Building	Make	Location Served	Qty.	Tons	SEER
Woodbridge Campus	Friedrich	Offices	1	1.5	16.4
Woodbridge Campus	Friedrich	Offices	1	1.5	16.4
Woodbridge Campus	Friedrich	Offices	1	1.5	16.4
Woodbridge Campus	Friedrich	Offices	1	2.0	16.2
Woodbridge Campus	Friedrich	Offices	1	2.0	16.2
Woodbridge Campus	Friedrich	Offices	1	2.0	16.2
Woodbridge Campus	Friedrich	Offices	1	1.5	16.4
Woodbridge Campus	Friedrich	Offices	1	1.5	16.4

Scope of Work

The following outlines the scope of work to install the condensing units listed in the Proposed System table above.

- Disconnect existing electric connections.
- Disconnect piping from the unit.
- Remove unit from the base.
- Modify base for new unit if necessary.
- Rigging and setting new unit at the base.
- Inspect piping and air ducts before reconnecting them to the unit.
- Reconnect piping and air ducts.
- Repair duct and piping insulation.
- Connect electric power.
- Start up and commissioning of new unit.
- Maintenance operator(s) training.

Energy Savings Methodology and Results

The savings approach is based on the energy efficiency between the existing and new units.

The savings are generally calculated as:

Electric Energy savings	Existing unit energy consumption (kWh) – replacement unit energy consumption (kWh).

Equipment Information

Manufacturer and Type	Several quality and cost effective manufacturers are available. Honeywell and the customer will determine final selections.
Equipment Identification	Product cut sheets and specifications are available upon request. As part of the measure, design, and approval process, specific product selection will be provided for your review and approval.

Customer Support and Coordination with Utilities

Coordination of the electrical tie-in will be required.

Environmental Issues

Resource Use	Energy savings will result from higher efficiency units.
Waste Production	Existing rooftop unit scheduled for removal will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 2J MULTI-ZONE VRF SYSTEM REPLACEMENT

The key benefits of this ECM include:

- **Energy savings** from reducing total energy consumption.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.
- **Operational savings** from less frequent need to repair or replace key HVAC equipment thanks to less frequent equipment use.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
2J Multi-Zone VRF System Replacement			●

Existing Conditions

Honeywell identified condensing units in some of your buildings as being inefficient and having exceeded their useful service life. Replacing these units with new, high efficiency units will save energy costs over the long term while reducing repair costs that would otherwise have been necessary to keep the old units in operation.





2J.1 Existing Split System Units to be Replaced

Building	Make	Model	Qty.	Tons	SEER
Woodbridge Campus *	Mitsubishi	PURY-100TMU-A	1	8.5	9.0

Proposed Solution

Honeywell proposes replacing the existing condensing units in the table above. The new units will be installed in the same location as the existing units. Existing electrical power supply will be reconnected to the new motors. The new units will be equipped with factory-installed microprocessor controls that improve unit efficiency. The units will also communicate with the existing or enhanced building management system.

Table 2J.2 Proposed Split Systems

Building	Make	Model	Qty.	Tons	SEER
Woodbridge Campus*	Trane	4TVR0120B300NB/ 4MXC8524A10N0AA	1	12.0	24.5

* indicates unit included in the financial summary of recommended project.

Scope of Work

The following outlines the scope of work to install the condensing units listed in the Proposed System table above.

- Disconnect existing electric connections.
- Disconnect piping from the unit.
- Remove unit from the base.
- Modify base for new unit if necessary.
- Rigging and setting new unit at the base.
- Inspect piping and air ducts before reconnecting them to the unit.
- Reconnect piping and air ducts.
- Repair duct and piping insulation.
- Connect electric power.
- Start up and commissioning of new unit.
- Maintenance operator(s) training.

Energy Savings Methodology and Results

The savings approach is based on the energy efficiency between the existing and new units. The savings are generally calculated as:

Electric Energy savings	Existing unit energy consumption (kWh) – replacement unit energy consumption (kWh)

Equipment Information

Manufacturer and Type	Several quality and cost effective manufacturers are available. Honeywell and the customer will determine final selections.
Equipment Identification	Product cut sheets and specifications are available upon request. As part of the measure, design and approval process, specific product selection will be provided for your review and approval.

Customer Support and Coordination with Utilities

Coordination of the electrical tie-in will be required.

Environmental Issues

Resource Use	Energy savings will result from higher efficiency units.
Waste Production	Existing rooftop unit scheduled for removal will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 3A BUILDING MANAGEMENT SYSTEM (BMS) UPGRADES

The key benefits of this ECM include:

- **Operational efficiency** thanks to better control and system wide visibility.
- **Energy savings** from reducing total energy consumption with more efficient, state of the art technology.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.
- **Occupancy comfort and productivity** by way of enhanced temperature and humidity control throughout your buildings.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
3A Building Management Control Systems	●	●	●

Honeywell has performed an assessment of the existing temperature controls of MCVTS (Perth Amboy, Woodbridge, and Edison). Upon inspection, it was noted that Perth Amboy and Woodbridge are being controlled by JCI Metasys Proprietary control systems dating to 2002. Edison Academy is controlled by a CM3 system that is running well.

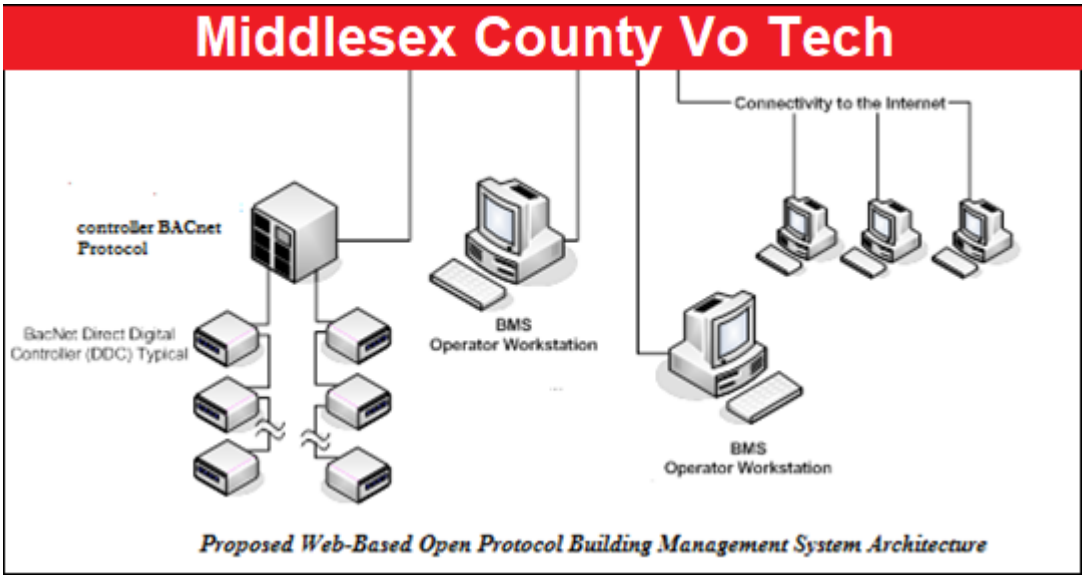
Existing Conditions

Perth Amboy, Woodbridge, and Edison schools are fully automated but do not function as designed and are no longer manufactured as the field controllers are 1-2 generations old. Many the mechanical equipment is in mechanical rooms, on the roofs of the buildings or in the attic areas. The buildings contain the following equipment but are not limited to roof top units (RTUs), air handler units (AHUs), heating ventilation units (HVs/UVs), hot water boilers, chillers, condensing units, and exhaust fans (EFs).

Proposed Conditions

Honeywell proposes to establish a consistent web-enabled BMS for MCVTS that will utilize the latest technology in building automation. The BMS shall communicate over the District's local area network (LAN) via the industry standard BACnet open protocol. Existing vintage DDC and electronic HVAC controls shall be upgraded to the latest an open protocol BACnet direct digital controllers and connected to the existing Honeywell Enterprise Building Integrator (EBI) building automation system which is controlling MCVTS East Brunswick High School.

Honeywell proposes to integrate and control equipment that are standalone and simultaneously leverage the existing systems and replace legacy controllers as needed to maximize the energy savings. In addition, three dimensional graphical representations of all connected heating, ventilating and air conditioning equipment shall be provided to allow for intuitive control, monitoring, and scheduling of all systems. Operators shall be capable of system control and/or monitoring from any local computer or smart devices via a standard internet connection. The open protocol based system provides and delivers smarter buildings and enterprise systems through the integration of things. The Result? Improved business efficiency, greater control, and faster decision making.



MCVTS Typical Local BMS Network Topology

Operational and Maintenance Impact

Upgrading and consolidating all HVAC controls under one system will result in the following benefits to MCVTS.

1. Minimize time for the maintenance department to troubleshoot problems by allowing operators to investigate and resolve facility issues at any computer connected either locally or remotely (from home) to the IT network.
2. Ensure a comfortable and productive learning environment for patrons and staff by improving the HVAC controls through technology enhancements and repairs.
3. Minimize unexpected disruptions to the buildings by notifying operators of problematic and/or inefficient system operation prior to irrevocable equipment failures.
4. Eliminate unnecessary energy consumption by individually scheduling equipment operation based on real-time space occupancy status, holiday, and summer schedules.
5. Reduce building heating, ventilating and air conditioning repair costs by providing operators with direct access to information used in the troubleshooting process.
6. Identify opportunities for improvement and prioritize repairs based on energy benchmarking data available through advanced reporting and trending capabilities.
7. Mobile access to approve personnel on and off campus to the systems.

Application and Control Programs

Outcome Based Analytics

Outcome Based Analytics is Honeywell's smart big data solution, helping you to save and make money through better decision making and improve the quality of life for those who live and work inside the building(s).

With the power to digitise the way mechanical services are carried out, Outcome Based Analytics provides facilities managers and other key stakeholders with a better view of their asset health and reduces total cost of ownership through significant savings on capital expenditure and operating

expenses. Outcome Based Analytics is an option that is available for MCVTS as part of an overall BMS strategy and platform.

Night Setback and Setup

Design and implementation of a more aggressive setback and setup schedule will help to further eliminate energy waste in each of your buildings by utilizing an optimal start/stop schedule.

Set Point Optimization

Honeywell will help deliver temperature uniformity by calibrating thermostats to the same set point, thereby achieving optimum comfort for your occupants by reducing the occurrence of hot and cold spots. We will also help you to reduce energy waste caused when adjacent areas cause your systems to overcompensate due to running in different operating modes.

Heating/Cooling Mode Selection

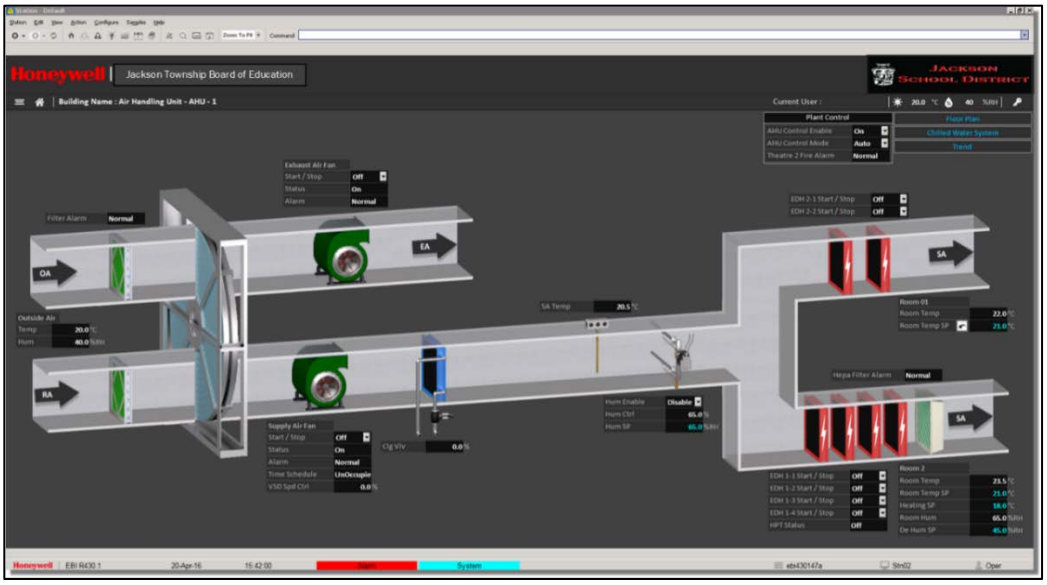
A modern, state of the art BMS can make real time decisions about the heating and cooling needs of any of your buildings. Honeywell will help you establish optimal system configurations to ensure that your buildings are always in optimal settings to deliver a more comfortable space and reduce energy waste.

Optimal Start/Stop

Honeywell understands that equipment start times are typically set to run earlier than normal to ensure optimal comfort is maintained during hot and cold weather seasons. We will work with staff to ensure that optimal start and stop features are fully utilized to optimize occupancy comfort and eliminate energy waste.

Remote Access

Facility managers will be able to login in to their BMS system from anywhere via their smartphone or iPad/Tablet or other internet enable devices. This added granular view will allow them to verify existing conditions and effectively manage their alarms and critical conditions and take steps to remediate the situation.



Sample BMS Graphic

Scope of Work

1. Perth Amboy Campus

1.1 BMS

Existing State

a. Existing JCI Metasys.
b. Six (6) N30 plant controllers with VAV controllers for classroom VAVs & DX9100 controllers for RTUs, AHUs, H&Vs & boilers.
    1. N30 Lan A Sec A 1st Floor: 20 VAVs, 3 DX9100
    2. N30 Lan B Sec A 2nd Floor: 30 VAVs, 1 UNT
    3. N30 Lan C Sec B 1st Floor: 20 VAVs, 7 DX9100, 2 UNT
    4. N30 Lan D Sec B 2nd Floor: 20 VAVs, 1 DX9100, 2 UNT (smoke dampers RTU 201)
    5. N30 Lan E Sec CA 1st Floor: 18 VAVs, 6 DX9100, 2 UNT
    6. N30 Lan F Sec C 1st Floor: 27 VAVs, 5 DX9100, 1 UNT (smoke dampers)

Proposed State

a. Honeywell proposes to expand the existing Honeywell EBI system that currently controls the East Brunswick campus to control the Perth Amboy campus.
b. Replace the six (6) JCI N30 plant controllers with Honeywell BACnet compatible plant controllers.
c. Remote access via computers, laptops, and mobile devices.
d. Ability to view and control each school from anywhere in the district via the EBI system.
e. Establish a common communication platform throughout the entire District.
f. Replace older equipment to maximize the energy savings.
g. Generate 3-dimensional graphical representation of all connected heating, cooling, ventilating, and air conditioning equipment to allow for intuitive control and monitoring of all systems.

1.2 Roof Top Units

- A101 Aaon (media center):
- A102 (faculty & admin area):
- A103 (faculty & admin area):
- B102 (auto):
- B103 (construction & technology areas)
- B104 (construction & technology areas)
- B105 (construction & technology areas)
- B106 (construction & technology areas)
- B107 (construction & technology areas)
- A201 (various areas)
- B101 (various areas)
- B201 (various areas)
- C101 (various areas)
- C201 (various areas)
- C102 (gym area)
- C103 (gym area)

Existing State

a. RTU units are controlled by JCI DX9100 & UNT controllers.
b. Some of the units contain both supply fan and return fan.

c. RTUs control various shops, admin area, gym etc.

Proposed State

a. Install new BACnet controllers to control the RTUs.
b. Establish connectivity between the RTU controllers and the network controller.
c. Generate a 3-dimensional graphical representation of the equipment allowing building operators to monitor and adjust operating parameters of the AHU.
d. Establish an equipment run schedule based on the actual building usage.

Benefits

a. **Occupancy Impact:** Improved space temperature and ventilation control ensuring a comfortable occupancy environment.
b. **Electrical Impact:** Reduce electrical consumption by increasing cooling space temperature setpoint and de-energizing the fan when the space served is unoccupied.
c. **Natural Gas Impact:** Reduce natural gas consumption by reducing heating space temperature set point when the space served is unoccupied.
d. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the Network-wide BMS.

1.3 Heating Aerco Hot Water Boiler (Typical of 5)

Existing State

a. Hot water boilers are controlled by an old JCI DX-9100 controller.

Proposed State

a. Install new open protocol BACnet controller to control and monitor the hot water boilers.
b. Control and monitor system start/stop and status.
c. Install and control VFD drives for the pumps if applicable.
d. Generate 3-D graphical representation of the boilers to monitor and control the units.
e. Create equipment schedule based on the school's hours of operation.

Benefits

a. **Student Impact:** Improve space temperature and ventilation control ensuring a comfortable learning environment.
b. **Electrical Impact:** Reduce electrical consumption by de-energizing the fan when the space is unoccupied.
c. **Natural Gas Impact:** Reduce natural gas consumption by reducing space heating temperature setpoints when the space is unoccupied.
d. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the district-wide building automation system. Reduce repair duration and class disruptions associated with hot and cold calls by providing building operators with the means to view room conditions from a BAS workstation, which allows for remote troubleshooting and issue resolution.

Heat Recovery Unit (Typical of 2)

Existing State

a. HRU 1 & HRU 2 (boys & girls' locker room) units are controlled by JCI unitary controllers.

Proposed State

a. Install new open protocol BACnet controller.
b. Establish connectivity between the new BACnet controllers and the new network controller.
c. Create 3-D representation of the new systems to allow for intuitive control and monitoring.
d. Establish equipment runtime.

Benefits

a. **Occupancy Impact:** Improve space temperature and ventilation control ensuring a comfortable occupancy environment.
b. **Electrical Impact:** Reduce electrical consumption by increasing cooling space temperature set point and de-energizing the fan when the space served is unoccupied.
c. **Natural Gas Impact:** Reduce natural gas consumption by reducing heating space temperature set point when the space served is unoccupied.
d. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the Network-wide building management system.

1.4 Kitchen Exhaust & Make-Up Air Units (Typical of 4)

Existing State

a. MAU 1-4 (kitchen) units are controlled by JCI DX9100 controllers.

Proposed State

a. Install new open protocol BACnet controller.
b. Establish connectivity between the new BACnet controllers and the new network controller.
c. Create 3-D representation of the new systems to allow for intuitive control and monitoring.
d. Establish equipment runtime.

Benefits

a. **Occupancy Impact:** Improved space temperature and ventilation control ensuring a comfortable occupancy environment.
b. **Electrical Impact:** Reduce electrical consumption by increasing cooling space temperature set point and de-energizing the fan when the space served is unoccupied.
c. **Natural Gas Impact:** Reduce natural gas consumption by reducing heating space temperature set point when the space served is unoccupied.
d. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the Network-wide building management system.

1.5 Variable Air Volume Boxes (Typical of 120)

Existing State

a. VAV A-101 to A120; A-201 to A-230; B-101 to B-120; B-201 to B-220; C-103 to C-118; C-201 to C-222 units are controlled by JCI VAV controllers.

Proposed State

a. Install new open protocol BACnet VAV controller.
b. Establish connectivity between the new BACnet controllers and the new network controller.
c. Create 3-D representation of the new systems to allow for intuitive control and monitoring.
d. Establish equipment runtime.

Benefits

a. **Occupancy Impact:** Improved space temperature and ventilation control ensuring a comfortable occupancy environment.
b. **Electrical Impact:** Reduce electrical consumption by increasing cooling space temperature set point and de-energizing the fan when the space served is unoccupied.
c. **Natural Gas Impact:** Reduce natural gas consumption by reducing heating space temperature set point when the space served is unoccupied.
d. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the Network-wide BMS.

1.6 Exhaust Fans

Existing State

a. Exhaust fans are controlled by old JCI controllers.
b. Other are either manually start/stop or run continuously.

Propose State

a. Incorporate exhaust fan command start/stop and status into the network controller.
b. Generate 3-D graphical representation of the exhaust fan allowing building operators to schedule operating hours.

Benefits

a. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the district-wide building automation system.
b. **Electrical Impact:** Reduce electrical consumption by de-energizing the fan when the space served is unoccupied.

2. Woodbridge Academy

2.1 BMS

Existing State

a. Existing JCI Metasys Win98/NT system (not functioning).
b. Two (2) N30 plant controllers with DX9100 controllers for AHUs, boilers, & chillers.

Proposed State

a. Honeywell proposes to expand the existing Honeywell EBI system that currently controls the East Brunswick campus to control the Woodbridge Academy as well.
b. Replace the two (2) JCI N30 plant controllers with Honeywell BACnet compatible plant controllers.
c. Remote access via computers, laptops, and mobile devices.
d. With the ability to view and control each school from anywhere in the district via the EBI system.
e. Establish a common communication platform throughout the entire District.
f. Replace older equipment to maximize the energy savings.
g. Generate 3-dimensional graphical representation of all connected heating, cooling, ventilating, and air conditioning equipment to allow for intuitive control and monitoring of all systems.

2.2 Air Handler Unit 1-6 (Typical of 6)

Existing State

a. AHU units are controlled by older JCI DX9100 controllers.

Proposed State

a. Install new open protocol BACnet controllers to control the respective AHU.
b. Replace existing sensors that are incompatible with the new BACnet controllers.
c. Establish connectivity between the AHU controller and the network controller.
d. Generate a 3-dimensional graphical representation of the equipment allowing building operators to monitor and adjust operating parameters of the AHU.
e. Establish an equipment run schedule based upon the actual building usage.

Benefits

a. **Occupancy Impact:** Improved space temperature and ventilation control ensuring a comfortable occupancy environment.
b. **Electrical Impact:** Reduce electrical consumption by increasing cooling space. temperature set point and de-energizing the fan when the space served is unoccupied.
c. **Natural Gas Impact:** Reduce natural gas consumption by reducing heating space temperature set point when the space served is unoccupied.
d. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the Network-wide BMS.

2.3 Air Cooled Chilled Water Systems (McQuay Typical of 2)

Existing State

a. Water cooled chillers are controlled by a JCI DX9100 controller.
b. Comprises of chiller with 2 Pumps.

Proposed State

a. Install new open protocol BACnet controller to control and monitor the chilled water system.
b. Control and monitor system status, alarm, and enable.
c. Install and control VFD drives for the pumps if applicable.
d. Generate 3-D graphical representation of the boilers to monitor and control the units.

e. Create equipment schedule based on MCVTS hours of operation.

Benefits

a. **Student Impact:** Improve space temperature and ventilation control ensuring a comfortable learning environment.
b. **Electrical Impact:** Reduce electrical consumption by de-energizing the fan when the space is unoccupied.
c. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the district-wide building automation system. Reduce repair duration and class disruptions associated with hot and cold calls by providing building operators with the means to view room conditions from a BAS workstation, which allows for remote troubleshooting and issue resolution.

2.4 Heating Hot Water Boiler/How Water System

Existing State

a. Two (2) boilers & two (2) pumps are controlled by JCI DX-9100 controller.
b. Three (3) Benchmark hot water boilers & two (2) pumps are controlled by JCI DX-9100 controller.

Proposed State

a. Install new open protocol BACnet controller to control and monitor the hot water boilers.
b. Control and monitor system start/stop and status.
c. Install and control VFD drives for the pumps if applicable.
d. Generate 3-D graphical representation of the boilers to monitor and control the units.
e. Create equipment schedule based on the school's hours of operation.

Benefits

d. **Student Impact:** Improve space temperature and ventilation control ensuring a comfortable learning environment.
e. **Electrical Impact:** Reduce electrical consumption by de-energizing the fan when the space is unoccupied.
f. **Natural Gas Impact:** Reduce natural gas consumption by reducing space heating temperature setpoints when the space is unoccupied.
g. **Operational Impact:** Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the district-wide building automation system. Reduce repair duration and class disruptions associated with hot and cold calls by providing building operators with the means to view room conditions from a BAS workstation, which allows for remote troubleshooting and issue resolution.

2.5 Air Handler Unit (Attic area) AHU -1, HRU 1 & 2 & AHU-2

Existing State

a. AHU units are controlled by older JCI DX9100 controllers.

Proposed State

a. Install new open protocol BACnet controllers to control the respective AHU.
b. Replace existing sensors that are incompatible with the new BACnet controllers.

c. Establish connectivity between the AHU controller and the network controller.
d. Generate a 3-dimensional graphical representation of the equipment allowing building operators to monitor and adjust operating parameters of the AHU.
e. Establish an equipment run schedule based upon the actual building usage.

Benefits

a. **Occupancy Impact:** Improved space temperature and ventilation control ensuring a comfortable occupancy environment.
b. **Electrical Impact:** Reduce electrical consumption by increasing cooling space. temperature set point and de-energizing the fan when the space served is unoccupied.
c. **Natural Gas Impact:** Reduce natural gas consumption by reducing heating space temperature set point when the space served is unoccupied.
   Operational Impact: Improve maintenance response times by automatically notifying building operators of system deficiencies on a real-time basis via the Network-wide BMS.

3. Edison

3.1 Existing State

a. CM3 Building Automation appears to be functioning.

Proposed State

a. Integrate existing CM3 system and map points back to Existing EBI System at East Brunswick Facility.

Energy Savings Methodology and Results

The savings approach is based upon reducing the amount of energy that needs to pre-heat or cool the outside air. The savings are generally calculated as:

Existing Heating BTU & Cost per BTU	= Metered data from existing meter readings
Cost of Existing Heating	= Average site data $/CCF or $/Gallon
Reduction in Heating/Cooling BTU	= Reduction in outside air CFM x 1.08 x Delta T x Operating Hours
	= Reduced BTU x Cost per BTU
Cost of Proposed Heating/Cooling	= Existing Costs – Proposed Costs
Energy Savings $	

The baseline adjustment calculations are included with the energy calculations.

Changes in Infrastructure

None.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods.

Environmental Issues

Resource Use	Energy savings will result from reduced energy.
Waste Production	Any removed parts will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 4A BUILDING ENVELOPE IMPROVEMENTS (BEI)

The key benefits of this ECM include:

- **Energy Savings** from reducing unwanted outside air infiltration.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.
- **Occupancy comfort and productivity** by way of enhanced temperature and humidity control throughout your buildings.
- **Improved building envelope** from addressing building gaps that allow unconditioned air penetration.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
4A Building Envelope Improvements	●	●	●

Existing Conditions

Heat loss due to infiltration is a common problem, particularly in places with long and cold winter seasons such as NJ. This problem has been shown to represent the single largest source of heat loss or gain through the building envelopes of nearly all types of buildings. Our work has found 30% to 50% of heat loss attributable to air leaks in buildings.

During our building examination, Honeywell uncovered several leaks that allow for heat loss to occur during the winter season and unwanted heat gains during the summer season. These problems include door gaps, exhaust fans in poor condition, open windows or windows in poor condition, lack of air sealing and insulation.

Honeywell has helped customers, such as you, to address these problems with a comprehensive and thorough building envelope solution that seals up your buildings to improve occupancy comfort and help eliminate unwanted energy waste. We propose to conduct a comprehensive weatherization job to weatherproof doors and windows, caulk and seal leaks, and install spray foam and rigid foam boards to stop unwanted air movement and provide a thermal barrier between spaces. Part of this process may include decoupling floor-to-floor and compartmentalizing of components of the building to equalize pressure differences.





Building Envelope Opportunities

Table 4A.1 Building Envelope Work Scope

School	AC Unit Weatherization (Units)	Caulking (LF)	Door Weather Stripping Doubles (Units)	Door Weather Stripping Singles (Units)	Roll-Up Door Weather Stripping (Units)	Roof-Wall Intersection Air Sealing (LF)	Wall Air Sealing (SF)
Edison Academy		68	2	2		306	630
Perth Amboy Campus			16	8	7		
Woodbridge Campus	11		11	9			
Total Quantity	**11**	**68**	**29**	**19**	**7**	**306**	**630**

Proposed Solution

Roof-Wall Joints

Existing – Buildings throughout the county were found to require roof-wall joint air sealing.

Proposed – Honeywell recommends using a high-performance sealant. In some buildings, two-component foam will be used. Any cantilevers off the buildings will be sealed with backer rod and sealant. Finally, the inside vestibule corners should be sealed with backer rod and sealant.

Roof Penetrations

Existing - There are many roof top exhaust fans that require damper cleaning, lubrication, and inspection for proper operation and to seal the roof deck to prevent penetration. Some units may be deemed to be too oversized for this service. Some buildings have roof-top AHUs with ducts that may show air leak during an IGA.

Proposed – Honeywell recommends if there is leak, these duct penetrations will be sealed with two-component polyurethane foam. Skylights will also be sealed. Sealant will be injected behind the drip cap to eliminate airflow.

Roof Overhangs

Existing – We found that roof overhangs at exterior doors are open to the drop ceilings, providing a pathway allowing heated and cooled air to escape between the interior and exterior of the building.

Proposed – Honeywell proposes to install rigid foam boards and seal the perimeter and any penetrations with spray foam, to prevent air leak and provide a sufficient thermal barrier between the spaces.

Windows

Existing - The operable windows in most of your buildings could present air leak issues that require weather stripping with fuzz or gasket type materials.

Proposed – Honeywell recommends installing weather stripping and door sweeps to prevent air leak.

Doors

Existing – Doors in this facility need full weather stripping replacement and/or door sweeps.

Proposed – Honeywell recommends new weather stripping and door sweeps to be installed where needed.

Benefits

This work will allow for more efficient operation of your buildings by reducing heating and cooling losses throughout the year. In addition, the draftiness of the buildings and hot and cold spots will be significantly reduced. A reduction in air infiltration will also minimize potential concerns for dirt infiltration or indoor air quality concerns including allergies.

Energy Savings Methodology and Results

The energy savings for this ECM are realized at the buildings' HVAC equipment. The improved building envelope will limit conditioned air infiltration through openings in the building air barrier. Less infiltration means less heating required by the heating system.

Changes in Infrastructure

Building envelopes will be improved with little or no noticeable changes.

Customer Support and Coordination with Utilities

Minimal coordination efforts will be needed to reduce or limit impact to building occupants.

Environmental Issues

Resource Use	Energy savings will result from reduced HVAC energy usage and better occupant comfort.
Waste Production	Some existing caulking and weather-stripping will be removed and disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 4B WOODBRIDGE GUIDANCE AREA BEI

The key benefits of this ECM include:

- **Energy Savings** from reducing unwanted outside air infiltration.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.
- **Occupancy comfort and productivity** by way of enhanced temperature and humidity control throughout your buildings.
- **Improved building envelope** from addressing building gaps that allow unconditioned air penetration.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
4B Woodbridge Guidance BEI			●

Existing Conditions

The guidance office of the Woodbridge Campus is a partially converted porch which has had issues in the past with heating and cooling of the space. The floor of the porch area is a concrete slab which is uninsulated. The windows are single pane and not efficient. Pre-set zone valves control heating and base board radiators were installed against interior walls and are not effective in tempering outside area leaking through the building envelope exterior.





Building Envelope Opportunities in Guidance office

Table 4B.1 Guidance Office Work Scope

School	Window Replacement (SF)	Radiant Floor Heating
Woodbridge Campus	354	300

Proposed Solution

Windows

Replace single pane low E windows with energy efficient high E double pane windows

Radiant Floor Heat

Install radiant floor heating in outer porch area of office tying into existing heating hydronic system.

Controls

Install thermostat control valves in place of preset zone valves to control radiant flooring and radiant heaters in office.

Benefits

This work will allow for more efficient operation of the area by reducing heating and cooling losses throughout the year. In addition, the draftiness of the buildings and hot and cold spots will be significantly reduced. A reduction in air infiltration will also minimize potential concerns for dirt infiltration or indoor air quality concerns including allergies.

Energy Savings Methodology and Results

The energy savings for this ECM are realized at the buildings' HVAC equipment. The improved building envelope will limit conditioned air infiltration through openings in the building air barrier. Less infiltration means less heating required by the heating system.

Changes in Infrastructure

Building envelopes will be improved with little or no noticeable changes.

Customer Support and Coordination with Utilities

Minimal coordination efforts will be needed to reduce or limit impact to building occupants.

Environmental Issues

Resource Use	Energy savings will result from reduced HVAC energy usage and better occupant comfort.
Waste Production	Some existing caulking and weather-stripping will be removed and disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 5A PERMANENT LOAD SHED REDUCTION PROGRAM

The key benefits of this ECM include:

- **Energy Savings** from reducing energy loads during peak hours.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.
- **Revenue generation** from participation in the demand response program.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
5A Permanent Load Reduction	●	●	●

Existing Conditions

Currently the District does not participate in the PJM Demand Response Program. The PJM programs offer the District the ability to respond to capacity emergencies when called upon by PJM, benefit from permanent kW load reductions associated with implementing Energy Efficiency (EE) improvements and general a new revenue stream from participation.





Proposed Solution

Honeywell proposes to continue to utilize a registered Demand Response Curtailment Service Provider (CSP) to provide energy response services to the District. Through the CSP, the District will participate in the PJM Capacity Market Program and PJM Energy Efficiency Program. These programs are offered through the PJM Regional Transmission Organization (RTO), and Independent System Operator (ISO). The Capacity Market Program allows PJM customers the ability to respond to capacity emergencies when called upon by PJM, and the energy efficiency program pays PJM customers for implementing ECMs that result in permanent load reductions during defined hours.

Table 5A.1 Proposed Permanent Load Reduction

Building	Permanent Load Reduction (KW)
Perth Amboy Campus	111.72
Edison Campus	25.75
Woodbridge Campus	44.23
Total	**181.70**

The PJM Energy Efficiency Program

Energy efficiency measures consist of installing more efficient devices or implementing more efficient processes/systems that exceed then-current building codes or other relevant standards. An energy efficiency resource must achieve a permanent, continuous reduction in demand for electricity. Energy efficiency measures are fully implemented throughout the delivery year without any requirement of notice, dispatch, or operator intervention. A demand response resource can reduce its demand for electricity when instructed; this means PJM considers it a “dispatchable resource”. A demand response resource can participate in the RPM market for as long as its ability to reduce its demand continues. A demand response resource must be willing to reduce demand for electricity up to 10 times each year when called for a reduction. In a year without any reduction calls, the demand response resource is required to demonstrate the ability to reduce demand for electricity during a test of reduction capability. Data will be submitted by the demand response resource to prove compliance with reductions from actual calls or reductions from capability tests. An energy efficiency resource is one that reduced their demand for electricity through an energy efficiency measure that does not require any additional action by the consumer.

Energy Savings Methodology and Results

Revenue is generated through participation in the PJM DR program.

Changes in Infrastructure

None.

Customer Support and Coordination with Utilities

Initiation of demand response curtailment will be required.

Environmental Issues

Resource Use	None.
Waste Production	This measure will produce no waste by-products.
Environmental Regulations	None.

ECM 6A SOLAR POWER PURCHASE AGREEMENT (PPA)

The key benefits of this ECM include:

- Reduced utility costs.
- Guaranteed utility rates for 15 years to provide a valuable hedge against future price volatility and deliver greater budgetary certainty utilizing clean electricity.
- Additional savings from solar can provide the District with more potential ESIP funding to expand the overall project scope and include additional projects.
- Educational asset to provide additional tools for teachers to engage students on sustainability and the environment.
- Resiliency by way of battery storage potential that can let you operate buildings in island mode during grid disruptions.
- Low risk given that maintenance is provided by the 3rd party system owner. No upfront costs.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
6A Solar PPA	●	●	●

ECM Overview

Honeywell recommends that the District further assess the feasibility of a solar photovoltaic system on district owned land and buildings to generate on-site renewable electricity. This could be provided at no upfront cost via a power purchase agreement (PPA). A PPA is a public-private partnership financial arrangement in which a third party solar company owns, operates, and maintains your photovoltaic system, while the host customer agrees to provide the site for the system on its property. The solar system's power production is purchased by you for a predetermined price ($/kWh) and for a predetermined period. This stable price for electricity will be lower than the utilities and third party suppliers, thereby allowing you to benefit from cheaper electricity prices, on-site renewable energy generation, a reduction in greenhouse gas emissions and a powerful educational tool for your teachers and students. Meanwhile, the system will not add any additional maintenance costs since it is owned by the third party solar company. One of the more significant benefits of this potential ECM is that it will provide for a rate change, helping to deliver greater savings within your ESIP project to help fund other measures.





Examples of Roof Top Solar Installations

Honeywell will oversee the design, construction and help with the operations and maintenance of the system. We will first help conduct a feasibility study during your IGA, in conjunction with your technical

consultant and legal team, to provide RFP development, solicitation and oversight of the installation of a solar photovoltaic system.

Proposed Solution

Honeywell proposes to install the solar PPA system at the buildings listed in the chart below.

Location	Rating - kW-DC
Piscataway Campus	2,400.0

Proposed Solar Arrays

Energy Savings Methodology and Results

Savings are based on the difference in kWh price between the power purchasing agreement and the current electrical supplier.

Changes in Infrastructure

The proposed solar array would be installed at various locations (roof) based on feasibility.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods.

Environmental Issues

Resource Use	None.
Waste Production	This measure will produce no waste by-products.
Environmental Regulations	Aside from the environmental benefits of increasing energy awareness no other environmental impact is expected.

ECM 7A HIGH EFFICIENCY TRANSFORMERS

The key benefits of this ECM include:

- **Energy Savings** from reducing total energy consumption with more efficient, state of the art technology.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
7A High Efficiency Transformers	●		

Existing Conditions

The transformers in locations within the electrical distribution systems in the District consist of 480 Volts. Distribution transformers are installed in the boiler rooms and in various electrical and utility closets to step down the voltage to 120-208 Volts. Typically, an electrical distribution system has some losses associated with the electrical system and a considerable portion of these losses are associated with distribution transformers.



Typical Transformers

Systems Evaluation and Selection

Typical transformers are not designed to handle harmonic loads of today's modern facilities, and suffer significant losses as a result, even if the transformer is relatively new. Typically, conventional transformer losses, which are non-linear, increase by 2.7 times when feeding computer loads. The nonlinear load loss multiplier reflects this increase in heat loss, which decreases the net transformer efficiency. Also, unlike most substation transformers that are vented to the exterior, building transformers are ventilated within the building they are located, and their heat losses therefore add to the cooling load.

Based on site investigation conducted by our staff, we identified the following transformers that we propose to replace with energy efficient replacements at a size matching the existing loads as indicated in the table below:

Table 7A.1 Existing Transformers to be Replaced

Building	Tag Number	Location ID	Designation	Qty	kVA
Perth Amboy Campus	57075	Janitor by A-109	T9	1	112.5
Perth Amboy Campus	57076	B116 Maint. Shop	T15	1	15.0
Perth Amboy Campus	57077	A-109	RPA1A	1	75.0
Perth Amboy Campus	57078	B-117	T14	1	112.5
Perth Amboy Campus	57079	B-119	HTS	1	75.0
Perth Amboy Campus	57080	B-122A	BTS	1	45.0
Perth Amboy Campus	57081	B-123	ETS	1	45.0
Perth Amboy Campus	57082	B-123	ETS2	1	75.0
Perth Amboy Campus	57083	B-124	T13	1	112.5
Perth Amboy Campus	57084	By C-153	T6	1	75.0
Perth Amboy Campus	57085	Gym Storage	T5	1	225.0
Perth Amboy Campus	57086	Boiler Rm	MR	1	45.0
Perth Amboy Campus	57087	Boiler Rm	MCB T7	1	150.0
Perth Amboy Campus	57088	ER by C-206-A	T4	1	112.5
Perth Amboy Campus	57089	B-213	T3	1	112.5
Perth Amboy Campus	57090	ER by A-224	T1	1	75.0
Perth Amboy Campus	57091	A-200-B	RPA2B	1	112.5
Total				**17**	

Proposed Solution

The proposed transformers will be Power Smiths High Efficiency K-Star Harmonic Mitigating units. They are Energy-Star rated and meet the new TP1 Law requiring replacement of transformers of 600 volts or under.

Scope of Work

Remove and install new E-saver transformers.

Per Transformer Unit:

- Shut off the main electric power to the transformer to be replaced.
- Disconnect the existing transformer and install replacement unit.
- Turn power back on.
- Inspect unit operation by performing electrical and harmonics testing.
- Dispose of old transformers properly.

Energy Savings Methodology and Results

The energy savings for this ECM is realized by reduction in electric energy lost in the existing transformers as a result of the higher efficiency of the new transformers.

Changes in Infrastructure

New transformers where indicated.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of services for the affected areas.

Environmental Issues

Resource Use	Energy savings will result from increased voltage conversion efficiency.
Waste Production	Any removed parts will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

ECM 8A WATER CONSERVATION

The key benefits of this ECM include:

- **Water Savings** from reducing total water consumption with more efficient, state of the art technology.
- **Equipment longevity** due to more efficient and less wasteful equipment utilization.

ECM Description	Perth Amboy Campus	Edison Campus	Woodbridge Campus
8A Water Conservation	●	●	●

Existing Conditions

Honeywell conducted an engineering analysis of all points of water use in the facilities. The domestic water systems (flushing, washing and bathing fixtures) is typically the largest source of savings and provides great potential for improvement of their performance. What often is find during this detailed assessment is that most buildings consume much more water in sinks, toilets and urinals than is necessary. This savings can be realized even in buildings where the toilets and urinals are already "low-flow" design. It is not unusual to find the majority of the fixtures could also operate much more effectively (perform better). Often these systems could be upgraded aesthetically as the chrome/brass piping is in poor condition, or there is a desire to add infrared (hands free) flushing and/or washing.



Typical Water Fixtures

Systems Evaluation and Selection

Our recommended approach for the domestic water systems is to eliminate only unnecessary water consumption by "tuning" (with Variable Flow Technology) each domestic water fixture to the "right" amount of water, thereby creating savings. **The objective is to save utility expense AND increase the performance of your plumbing systems.** Because each fixture will receive individual engineering attention, all infrastructure will perform at (or better than) design levels. As we retrofit a fixture, we replace all "wear" parts, those components that often require maintenance. In doing so, we establish a new "zero baseline" of maintenance. Our recommendations will include replacing existing Flushometer valve bodies as needed for standardization and aesthetics of bathrooms. The following are examples of the proposed strategies to improve the efficiency and performance of toilets, urinals, sink faucets and showers:

Table 8A.1 water fixtures to be retrofitted

Building	Bottle Fill Stations	Lavatory Sinks	General Use Sinks	Flushometer Toilets	Urinals
Woodbridge Campus	4	25	5	35	8
Perth Amboy Campus	6	71	10	49	12
Edison Campus	2	25	2	13	2
Totals	12	121	17	97	22

Scope of Work

Flushometers (Toilets and Urinals):

Benefits of our proposed approach include:

- Increased Performance and Flush-to-Flush Consistency. The first objective is to ensure each fixture operates properly. Our calibration and tuning via Variable Flow Technology will ensure each fixture is using the right amount of water.
- Standardization and Reduce Maintenance Costs. By having only one valve throughout the campus, staff may eliminate the wide variety of replacement components they now have in inventory. Likewise, the replacement of all wear parts will create a new “zero baseline” for future maintenance.

Flushometer Scope

- Valve Recommissioning: Replace diaphragm kit and inner cap. Re- engineering of the new kit will provide the proper flush curve for each fixture.
- Valve Rebuilding: Remove and replace diaphragm kit and inner cap. Re- engineering of the new kit will provide the proper flush curve for each fixture. Replace vacuum breaker, handle assembly and O-Rings.
- New Valve X-Body: Remove and replace the valve body assembly for standardization, aesthetic enhancement and a maintenance baseline.
- Spud and/or Flushtube Replacement: Remove and replace the fixture spuds and flashtubes (optional or as needed).

Tank Toilet Retrofit Upgrade

- Remove and replace the flapper, flow diverter ballcock assembly, and refill tube. As necessary, to ensure proper operation during the warranty period,
- Improved Flushing Effectiveness: all fixtures will operate at the “right” amount of water.
- Establishes New Baseline of Maintenance: all new components will resist the rigors of substantial use. This creates a new “zero baseline” for maintenance and translates into significantly reduced labor and costs for years to come.

Sinks

- Pressure Independent Performance. End-users will enjoy the same level of performance regardless of incoming pressure (flow rate is constant at pressures between 20 and 80 psi). Pressure variations within the facility would be transparent to the end-users.
- Invisible to End-Users. Because we carefully apply the appropriate flow rate and pattern to each sink (based upon sink application), end-users will not realize a decline in performance.

- Long-Life. Because our flow components are robust in their construction, these devices will serve you well for years to come. Furthermore, we protect the longevity of these products by applying tamper-resistant technology.
- One Size Fits All. No longer will you need to stock different aerators for the various faucets within your facility. Rather, because we adapt all faucets to accommodate the same-size flow control device, you need only one size.

Water Fountains

The water fountains were also identified by the staff as being in constant need of repair. It is also noted water fountains consume between 7.8 to 10.8 kWh per week of usage. This is based on a refrigeration cycle time of 60% and a 40-hour occupied week.

The District's existing drinking fountains will be retrofitted with combination water fountain/water bottle fill stations. This measure will help reduce plastic cup and bottle disposal, thereby reducing the amount of waste the school is contributing to landfills.

- Replace existing Refrigerated Water Fountains with Two (2) combination water fountain / bottle fill stations.
- Honeywell recommends retrofitting the drinking fountains with the Elkay EZH2O Model EZWSRK retrofit kit. This unit will provide pure, drinking water at a rate 3 times faster than if filling at a normal drinking fountain. The system is sanitary, no touch, sensor operated with a 20 second shut off timer. Additionally, it provides a laminar flow to minimize splashing and has a “Green Ticker” which counts the quantity of bottles saved from the landfill. Water Savings Methodology and Results.
- The energy savings for this ECM is realized by reduction in water usage by use of more efficient fittings and valves.

Changes in Infrastructure

New fixtures and/or internals where indicated.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of services for the affected areas.

Environmental Issues

Resource Use	Water savings will result from decreased usage due higher efficiency fixtures.
Waste Production	Any removed parts will be disposed of properly.
Environmental Regulations	No environmental impact is expected.

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SECTION D TECHNICAL AND FINANCIAL SUMMARY

1. Recommended ESIP Project

MCVT Project	Recommended ESIP Project
Value of Project	$4,776,591
Term of Repayment	15 Years
Projected Energy, Solar and Operational Savings	$5,711,543
Projected NJ Rebates & Incentives	$250,314
Projected Interest Rate	2.5%

Recommended Project Technical and Financial Summary Documents

Form II: Energy Conservation Measures (ECMs) Summary Form
Form III: Projected Annual Energy Savings Data Form
Form IV: Projected Annual Energy Savings Data Form in MMBTUs
Form V: ESCOs Proposed Final Project Cost Form
Form VI: ESCOs Preliminary Annual Cash Flow Analysis Form

Building by Building Simple Payback Summary

A simple payback summary broken down by building by ECM has been provided for the MCVTS use in reviewing available scope combinations and options.

Building by Building Simple Payback Summary (Hard Costs Only)

FORM II: RECOMMENDED PROJECT - ENERGY CONSERVATION MEASURES (ECMS) SUMMARY FORM

FORM II

ENERGY CONSERVATION MEASUREs (ECMs) SUMMARY FORM
MIDDLESEX COUNTY VOCATIONAL SCHOOL
ENERGY SAVING IMPROVEMENT PROGRAM

ESCO Name: **Honeywell International**

Proposed Preliminary Energy Savings Plan: ECMs (Base Project)	Estimated Installed Hard Costs (1) $	Estimated Annual Savings $	Estimated Simple Payback (years)
1A LED Lighting	$ 830,685	$ 96,663	8.59
1B Vending Misers	$ 3,207	$ 710	4.52
1C Destratification Fans	$ 56,426	$ 2,594	21.75
2A Boiler Replacements	$ 95,823	$ 1,150	83.31
2B DHW Heater Replacements	$ 124,731	$ 1,628	76.62
2C RTU Replacements	$ 1,404,303	$ 10,900	128.84
2D Multi-Zone VRFSystem Replacement	$ 139,699	$ 123	1,134.99
3A Building Management Control Systems	$ 872,396	$ 102,389	8.52
4A Solar PPA	$ -	$ 146,946	-
5A Permanent Load Reduction	$ -	$ -	-
9A Design Allowance	$ 89,094	$ -	-
0	$ -	$ -	-
Add additional lines as needed* **Project Summary:**	$ 3,616,365	$ 363,103	9.96

Optional ECMs Considered, but not included with base project at this time	Estimated Installed Hard Costs (1) $	Estimated Annual Savings $	Estimated Simple Payback (years)
2E Chiller Replacements	$ 463,288	$ 3,384	136.89
2F Motor and VFD Replacements	$ 250,946	$ 2,575	97.45
2G Kitchen Hood Control	$ 141,517	$ 3,090	45.80
2H Refrigeration Controls	$ 5,702	$ 154	36.92
2I Window AC Unit Replacements	$ 144,332	$ 225	641.93
2J Split System Replacements	$ 25,243	$ 40	624.68
4A Wooddbridge Guidance Office BEI	$ 229,423	$ 374	612.90
4B Building Envelope Improvements	$ 46,513	$ 3,275	14.20
7A Transformers	$ 230,460	$ 13,050	17.66
8A Water Conservation	$ 85,382	$ 5,572	15.32
0	$ -	$ -	-

Add additional lines as needed*

(1) The total value of Hard Costs is defined in accordance with standard AIA definitions that include: Labor Costs, Subcontractor Costs, Cost of Materials & Equipment, Temporary Facilities and Related Items, and Miscellaneous Costs such as Permits, Bonds Taxes, Insurance, Mark-ups, Overhead, Profit, etc.

FORM III: RECOMMENDED PROJECT - PROJECTED ANNUAL ENERGY SAVINGS DATA FORM

FORM III

PROJECTED ANNUAL ENERGY SAVINGS DATA FORM
MIDDLESEX COUNTY VOCATIONAL SCHOOL
ENERGY SAVING IMPROVEMENT PROGRAM

ESCO Name: **Honeywell International**

The projected annual savings for each fuel type MUST be completed using the following format. Data should be given in the form of fuel units that appear in the utility bills.

Energy/Water	ESCO Developed Baseline (Units)	ESCO Developed Baseline (Costs $)	Proposed Annual Savings (Units)	Proposed Annual Savings (Costs $)
Electric Demand (KW)	24,180	$161,364	1,935	$13,258
Electric Energy (KWH)	9,077,722	$1,139,385	2,306,958	$244,284
Natural Gas (therms)	130,673	$109,554	54,641	$44,862
Fuel Oil (Gal)	0	$0	0	$0
Steam (Pounds)				
Water (gallons)				
Other (Specify Units)				
Other (Specify Units)				
Avoided Emissions (1)	Provide in Pounds (Lbs)			
NOX	2,694			
SO2	5,098			
CO2	3,311,735			

(1) ESCOs are to use the rates provided as part of this RFP to calculate Avoided Emissions. Calculation for all project energy savings and greenhouse gas reductions will be conducted in accordance with adopted NJBPU protocols

(2) "ESCOs Developed Baseline": Board's current annual usages and costs as determined by the proposing ESCO; based off Board's utility information as provided to proposing ESCO.

(3) "Proposed Annual Savings": ESCOs proposed annual savings resulting from the Board's implementation of the proposed ESP, as based upon "ESCOs Developed Baseline".

FORM IV: RECOMMENDED PROJECT - PROJECTED ANNUAL ENERGY SAVINGS DATA FORM IN MMBTUS

FORM IV

PROJECTED ANNUAL ENERGY SAVINGS DATA FORM IN MMBTUs
MIDDLESEX COUNTY VOCATIONAL SCHOOL
ENERGY SAVING IMPROVEMENT PROGRAM

ESCO Name: **Honeywell International**

The projected annual energy savings for each fuel type MUST be completed using the following format. Data should be given in equivalent MMBTUs.

ENERGY	ESCO Developed Baseline	ESCO Proposed Savings Annual	Comments
Electric Energy (MMBTUs)	30,973	7,871	
Natural Gas (MMBTUs)	13,067	5,464	
Fuel Oil (MMBTUs)	0	0	
Steam (MMBTUs)			
Other (Specify) (MMBTUs)			
Other (Specify)			

NOTE: MMBTU Defined: A standard unit of measurement used to denote both the amount of heat energy in fuels and the ability of appliances and air conditioning systems to produce heating or cooling.

FORM V: RECOMMENDED PROJECT ESCO'S PROPOSAL PROJECT COST FORM

FORM V

FINAL COST FORM
MIDDLESEX COUNTY VOCATIONAL SCHOOL
ENERGY SAVING IMPROVEMENT PROGRAM

ESCO Name: **HONEYWELL INTERNATIONAL**

PROPOSED CONSTRUCTION FEES

Fee Category	Fees [1] Dollar ($) Value	Percentage of Hard Costs
Estimated Value of Hard Costs [2]:	$3,616,365	
Project Service Fees		
Investment Grade Energy Audit	$54,245	1.50%
Design Engineering Fees	$0	0.00%
Construction Management & Project Administration	$216,982	6.00%
System Commissioning	$27,123	0.75%
Equipment Initial Training Fees	$27,123	0.75%
ESCO Overhead	$361,636	10.00%
ESCO Profit	$180,818	5.00%
Project Service Fees Sub Total	$325,473	9.00%
TOTAL FINANCED PROJECT COSTS:	$4,484,292	24.00%
ESCO Termination Fee (To be paid only if the Board decides not to proceed beyond the ESP)	$0	0.00%

PROPOSED ANNUAL SERVICE FEES

First Year Annual Service Fees	Fees [1] Dollar ($) Value	Percentage of Hard Costs
SAVINGS GUARANTEE (OPTION)	$0.00	0.00%
Measurement and Verification (Associated w/ Savings Guarantee Option)	$25,000.00	Flat Fee
ENERGY STAR™ Services (optional)	Included	0.00%
Post Construction Services (If applicable)	N/A	-
Performance Monitoring	Included	-
On-going Training Services	N/A	-
Verification Reports	Included	-
TOTAL FIRST YEAR ANNUAL SERVICES	$25,000.00	Flat Fee

NOTES:
(1) Fees should include all mark-ups, overhead, and profit. Figures stated as a range will NOT be accepted.
(2) The total value of Hard Costs is defined in accordance with standard AIA definitions that include:

Labor Costs, Subcontractor Costs, Cost of Materials and Equipment, Temporary Facilities and Related Items, and Miscellaneous Costs such as Permits, Bonds Taxes, Insurance, Mark-ups, Overhead and Profit, etc.

ESCO's proposed interest rate at the time of submission: 5% TO BE USED BY ALLRESPONDING ESCOs FOR PROPOSAL PURPOSES

*Annual Service only applies if customer accepts energy guarantee.

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FORM VI: RECOMMENDED PROJECT ESCO'S PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM

FORM VI

ESCO's FINAL ANNUAL CASH FLOW ANALYSIS FORM
MIDDLESEX COUNTY VOCATIONAL SCHOOL
ENERGY SAVING IMPROVEMENT PROGRAM

ESCO Name: **Honeywell International**

Note: Proposers must use the following assumptions in all financial calculations:
(a) The cost of all types of energy should be assumed to inflate at: **2.4%** gas, **2.2%** electric per year and

1. Term of Agreement: **15** (Years) (Months)
2. Construction Period [2] (months): **12**
3. Cash Flow Analysis Format:

Engineering Fees	$	292,299
Project Cost Form V	$	4,484,292
Project Cost [1]:	**$**	**4,776,591**

Interest Rate Used for Proposal Purposes: **2.5%**

Year	Annual Energy Savings	Solar Savings	Annual Operational Savings	Energy Rebates/Incentives	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs [3]	Net Cash-Flow to Client
Installation	$ 46,637	$ 44,084		$ 11,250	$ 101,971	$ -	$ -	$ -	$ 101,971
1	$ 155,457	$ 146,946	$ 60,699	$ 202,481	$ 565,584	$ (561,784)	$ (586,784)	$ (25,000)	$ 3,800
2	$ 158,967	$ 150,179	$ 60,699	$ 25,318	$ 395,163	$ (391,363)	$ (391,363)	$ -	$ 3,800
3	$ 162,556	$ 153,483	$ 60,699	$ 5,633	$ 382,371	$ (378,571)	$ (378,571)	$ -	$ 3,800
4	$ 166,227	$ 156,860	$ 60,699	$ 5,633	$ 389,418	$ (385,618)	$ (385,618)	$ -	$ 3,800
5	$ 169,980	$ 160,311	$ 60,699	$ -	$ 390,990	$ (387,190)	$ (387,190)	$ -	$ 3,800
6	$ 173,818	$ 163,838		$ -	$ 337,656	$ (333,856)	$ (333,856)	$ -	$ 3,800
7	$ 177,743	$ 167,442		$ -	$ 345,185	$ (341,385)	$ (341,385)	$ -	$ 3,800
8	$ 181,757	$ 171,126		$ -	$ 352,883	$ (349,083)	$ (349,083)	$ -	$ 3,800
9	$ 185,862	$ 174,890		$ -	$ 360,752	$ (356,952)	$ (356,952)	$ -	$ 3,800
10	$ 190,059	$ 178,738		$ -	$ 368,797	$ (364,997)	$ (364,997)	$ -	$ 3,800
11	$ 194,351	$ 182,670		$ -	$ 377,022	$ (373,222)	$ (373,222)	$ -	$ 3,800
12	$ 198,741	$ 186,689		$ -	$ 385,430	$ (381,630)	$ (381,630)	$ -	$ 3,800
13	$ 203,230	$ 190,796		$ -	$ 394,026	$ (390,226)	$ (390,226)	$ -	$ 3,800
14	$ 207,820	$ 194,994		$ -	$ 402,814	$ (399,014)	$ (399,014)	$ -	$ 3,800
15	$ 212,514	$ 199,284		$ -	$ 411,798	$ (408,002)	$ (408,002)	$ -	$ 3,796
Totals	$ 2,785,718	$ 2,622,329	$ 303,495	$ 250,314	$ 5,961,857	$ (5,802,890)	$ (5,827,890)	$ (25,000)	$ 158,967

3rd P4P Rebate	$	177,163
Total Cash Flow	$	336,130

NOTES:
(1) Includes: Hard costs and project service fees defined in ESCO's PROPOSED "FORM V"
(2) No payments are made by MIDDLESEX COUNTY VOCATIONAL SCHOOL during the construction period.
(3) This figure should equal the value indicated on the ESCO's PROPOSED "FORM V". DO NOT include in the Financed Project Costs.

Annual Service only applies if customer accepts energy guarantee.

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BUILDING BY BUILDING SIMPLE PAYBACK SUMMARY (HARD COSTS ONLY)

Building & ECM	kWh Savings ($)	kW Savings ($)	Natural Gas Savings ($)	Fuel Oil Savings ($)	Water Savings ($)	Annual Energy and Operational Cost Savings ($)	Annual Operational Savings ($)	Net Cost ($)	Simple Payback
Edison Campus	**$ 19,825**	**$ 3,088**	**$ 4,885**	$ -	$ -	**$ 31,795**	**$ 3,998**	**$ 677,937**	**18.9**
1A LED Lighting	$ 8,690	$ 1,502	$ (56)	$ -	$ -	$ 14,133	$ 3,998	$ 99,927	5.5
1B Vending Misers	$ 152	$ -	$ -	$ -	$ -	$ 152	$ -	$ 1,069	7.0
2A Boiler Replacements	$ -	$ -	$ 1,150	$ -	$ -	$ 1,150	$ -	$ 95,823	83.3
2B DHW Heater Replacements	$ -	$ -	$ 137	$ -	$ -	$ 137	$ -	$ 41,577	302.6
2C RTU Replacements	$ 5,634	$ 1,586	$ -	$ -	$ -	$ 7,219	$ -	$ 376,754	52.2
3A Building Management Control Systems	$ 5,349	$ -	$ 3,654	$ -	$ -	$ 9,003	$ -	$ 62,786	7.0
Perth Amboy Campus	**$ 59,007**	**$ 7,442**	**$ 24,648**	$ -	$ -	**$ 130,821**	**$ 39,724**	**$ 2,339,903**	**13.7**
1A LED Lighting	$ 32,701	$ 6,538	$ (268)	$ -	$ -	$ 58,696	$ 19,724	$ 560,658	7.1
1B Vending Misers	$ 328	$ -	$ -	$ -	$ -	$ 328	$ -	$ 1,426	4.3
1C Destratification Fans	$ (247)	$ -	$ 2,500	$ -	$ -	$ 2,253	$ -	$ 47,517	21.1
2B DHW Heater Replacements	$ -	$ -	$ 1,490	$ -	$ -	$ 1,490	$ -	$ 83,154	55.8
2C RTU Replacements	$ 2,777	$ 904	$ -	$ -	$ -	$ 3,681	$ -	$ 1,027,549	279.2
3A Building Management Control Systems	$ 23,448	$ -	$ 20,926	$ -	$ -	$ 64,374	$ 20,000	$ 619,599	7.3
Piscataway Campus	**$ 146,946**	$ -	$ -	$ -	$ -	**$ 146,946**	$ -	$ -	**0.0**
6A Solar PPA	$ 146,946	$ -	$ -	$ -	$ -	$ 146,946	$ -	$ -	0.0
Woodbridge Campus	**$ 18,506**	**$ 2,729**	**$ 15,328**	$ -	$ -	**$ 53,540**	**$ 16,977**	**$ 509,431**	**7.2**
1A LED Lighting	$ 14,225	$ 2,729	$ (97)	$ -	$ -	$ 23,834	$ 6,977	$ 170,100	5.5
1B Vending Misers	$ 229	$ -	$ -	$ -	$ -	$ 229	$ -	$ 713	3.1
1C Destratification Fans	$ (48)	$ -	$ 389	$ -	$ -	$ 341	$ -	$ 8,909	26.1
2J Multi-Zone VRFSystem Replacement	$ 123	$ -	$ -	$ -	$ -	$ 123	$ -	$ 139,699	1135.0
3A Building Management Control Systems	$ 3,976	$ -	$ 15,037	$ -	$ -	$ 29,013	$ 10,000	$ 190,010	4.9
Project Total	$ 244,284	$ 13,258	$ 44,862	$ -	$ -	$ 363,103	$ 60,699	$ 3,527,271	8.3

2. Utility and Other Rebates and Incentives

NJ Pay-for-Performance Program (P4P)

Honeywell has been certified as a Pay for Performance Program Partner to provide technical services under direct contract to you. Acting as your energy expert, Honeywell will develop an Energy Reduction Plan for each project with a whole-building technical component of a traditional energy audit, a financial plan for funding the energy efficient measures and a construction schedule for installation. This supports your ability to take a comprehensive, whole-building approach to saving energy in your existing facilities and earn incentives that are directly linked to your savings.

Eligibility

Existing commercial, industrial and institutional buildings with a peak demand over 100 kW for any of the preceding twelve months are eligible to participate including hotels and casinos, large office buildings, multi-family buildings, supermarkets, manufacturing facilities, schools, shopping malls and restaurants. Buildings that fall into the following five customer classes are not required to meet the 100kW demand in order to participate in the Program: hospitals, public districts and universities, nonprofits, affordable multifamily housing, and local governmental entities. Your Energy Reduction Plan must define a comprehensive package of measures capable of reducing the existing energy consumption of your building by 15% or more to utilize the Pay Performance Program.

ENERGY STAR Portfolio Manager

Pay for Performance takes advantage of the ENERGY STAR Program with Portfolio Manager, EPA's interactive tool that allows facility managers to track and evaluate energy and water consumption across all their buildings. The tool provides the opportunity to load in the characteristics and energy usage of your buildings and determine an energy performance benchmark score. You can then assess energy management goals over time, identify strategic opportunities for savings, and receive EPA recognition for superior energy performance.

Incentives

Incentives for the P4P program are based on the annual electric and natural gas savings produced by the Energy Conservation Measures. There are three incentives to the program; details are included in the follow page. The first incentive is distributed after a finalized project is selected and bid. This usually occurs shortly before construction starts or shortly thereafter. The second incentive is distributed a few months after construction is completed, while the third incentive is distributed usually thirteen to fourteen months after the second incentive - once a year of building usage, post-retrofit, is completed.

Incentives, Rebates and Grants Summary

Honeywell has a great deal of experience in applying for, and successfully securing, all available incentives, rebates and grants for our clients. We have been approved and allocated for over $9M of incentives on behalf of our New Jersey customers alone since the introduction of the Energy Savings Improvement Program legislation in 2009. The New Jersey programs employed included primarily the Office of Clean Energy's Pay for Performance and Cogeneration Incentives.

Honeywell has determined that MCVTS is eligible for **$462,197** in estimated total incentives for the projects. This includes **$404,948** in the NJ Clean Energy Pay for Performance Program, **$22,531** for Permanent Load Reduction Incentives and **$34,720** in Prescriptive Lighting Savings.

Please refer to the tables on below for a breakdown of MCVTS incentive levels on a building by building basis for each type of incentive.

P4P Incentives

	P4P Incentives			
Description	**1st Incentive**	**2nd Incentive**	**3rd Incentive**	**Total Incentive**
Perth Amboy Campus	$11,250	$196,848	$196,848	$404,946
Edison Campus	$0	$0	$0	$0
Woodbridge Campus	$0	$0	$0	$0
East Brunswick Campus	$0	$0	$0	$0
Piscataway Campus	$0	$0	$0	$0
TOTALS	**$11,250**	**$196,848**	**$196,848**	**$404,946**

Permanent Load Reduction Incentives

	Permanent Load Reduction Incentives			
Description	**1st Year Incentive**	**2nd Year Incentive**	**3rd Year Incentive**	**4th Year Incentive**
Permanent Load Reduction Incentives	$5,633	$5,633	$5,633	$5,633

Prescriptive Lighting Incentives

	Prescriptive Lighting Incentives			
Description	**1st Year Incentive**	**2nd Year Incentive**	**3rd Year Incentive**	**4th Year Incentive**
Perth Amboy Campus	$0			
Edison Campus	$12,720			
Woodbridge Campus	$22,000			
TOTALS	**$34,720**			

Total Rebates and Incentives

	Total Rebates and Incentives			
Year	**P4P Incentives**	**Permanent Load Reduction Incentives**	**Prescriptive Lighting Incentives**	**Total Incentives**
Installation	$11,250			$11,250
Year 1	$196,848	$5,633	$34,720	$237,201
Year 2	$196,848	$5,633		$202,481
Year 3		$5,633		$5,633

Year	Total Rebates and Incentives			
	P4P Incentives	Permanent Load Reduction Incentives	Prescriptive Lighting Incentives	Total Incentives
Year 4		$5,633		$5,633
TOTALS	**$404,947**	**$22,531**	**$34,720**	**$462,198**

3. Financing the ESIP

In accordance with P.L.2012, c.55 an ESIP can be financed through energy savings obligations. The term refers to the two primary financing tools, debt and lease-purchase instruments. Each of these options is discussed below.

Energy savings obligations shall not be used to finance maintenance, guarantees, or the required third party verification of energy conservation measures guarantees. Energy saving obligations, however, may include the costs of an energy audit and the cost of verification of energy savings as part of adopting an energy savings plan or upon commissioning. While the audit and verification costs may be financed, they are not to be considered in the energy savings plan as a cost to be offset with savings.

In all cases, maturity schedules of lease-purchase agreements or energy savings obligations shall not exceed the estimated average useful life of the energy conservation measures.

An ESIP can also include installation of renewable energy facilities, such as solar panels. Under an energy savings plan, solar panels can be installed, and the reduced cost of energy reflected as savings.

The law also provides that the cost of energy saving obligations may be treated as an element of the local unit's utility budget, as it replaces energy costs.

DEBT ISSUANCE

The law specifically authorizes municipalities, school districts, cities, counties, and fire districts to issue refunding bonds as a general obligation, backed with full faith and credit of the local unit to finance the ESIP. Because an ESIP does not effectively authorize new costs or taxpayer obligations, the refunding bond is appropriate, as it does not affect debt limits, or in the case of a board of education, require voter approval. The routine procedures for refunding bonds found in the Local Bond Law and Public School Bond Law would be followed for issuance of debt, along with any required Bond Anticipation Notes as authorized pursuant to law.

Regarding bonds for public schools, the Department of Education (DOE) has concluded that debt financed ESIP projects are not covered by State aid for debt service or a "Section 15 EFFCA Grant" as there is no new local debt being authorized.

TAX-EXEMPT LEASE PURCHASE FINANCING

The tax-exempt lease is a common form of financing for ESIP projects. Tax-exempt leasing is a tool that meets the basic objectives of debt, spreading the cost of financing over the life of an asset, while avoiding constitutional or statutory limitations on issuing public debt. If structured properly, by including non-

appropriation language in the financing documents, the tax-exempt lease will not be considered debt for state law purposes but will be considered debt for federal income tax purposes. Thus, for federal purposes, the interest component of the lease payment is tax-exempt.

Under the New Jersey Energy Savings Improvement Program (ESIP), MCVTS may authorize a lease purchase agreement between MCVTS and a financier. Ownership of the equipment or improved facilities will pass to MCVTS when all the lease payments have been made. There are legal expenses and other minimal closing costs associated with this type of structure. The lease purchase agreement may not exceed 15 years (commencing upon completion of the construction work), or 20 years where a combined heat and power or cogeneration plant is included in the project. The primary benefits of a lease are lower rates and the acquisition of essential use property without creating debt.

Under a lease there is typically a single investor. The lease may have non-appropriation language that allows MCVTS to access low tax-exempt rates. Some previous customers have chosen to remove the non-appropriation language which has resulted in lower competitive rates.

Repayment of the lease payments is tailored to meet the requirements of MCVTS. Payments are typically scheduled to commence after the construction is complete and acceptance of the project has been received by MCVTS. Typically, payment terms are structured so there is no up-front capital expense to MCVTS and payments are aligned within your cash flow and fiscal limits.

CERTIFICATES OF PARTICIPATION (COP'S)

Certificates of Participation are another form of a lease purchase agreement with the differentiating factor being that there are multiple investors participating in the purchase of the lease. COP's require financial disclosure and are typically utilized on higher value projects where one investor doesn't have the capacity to hold a high value lease for a single customer.

ENERGY SAVINGS OBLIGATIONS

Energy Savings Obligations can be issued as refunding bonds in accordance with the requirements of N.J.S.A *40A:11-4.6(c)(3)*. These bonds may be funded through appropriation for the utility services in the annual budget of the contract unit and may be issued as refunding bonds pursuant to N.J.S.40A:2-52 et seq., including the issuance of bond anticipation notes as may be necessary, if all such bonds and notes mature within the periods authorized for such energy savings obligations. Energy savings obligations may be issued either through the contracting unit or another public agency authorized to undertake financing on behalf of the unit but does not require bond referendum.

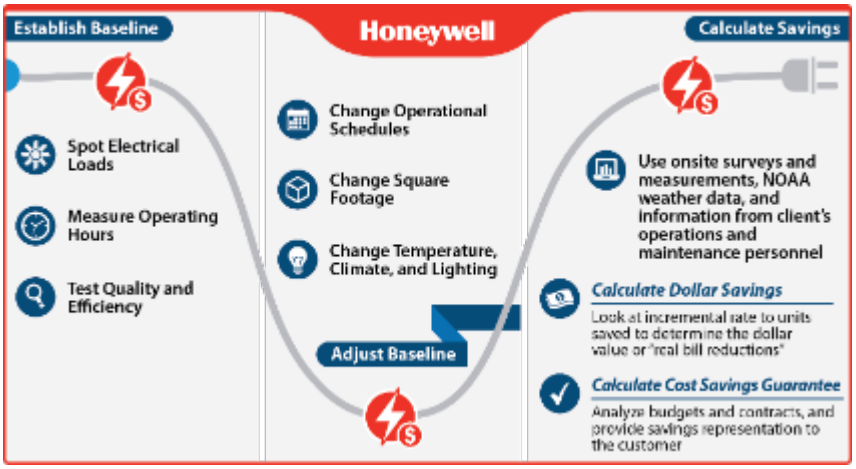
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SECTION E MEASUREMENT & VERIFICATION AND MAINTENANCE PLAN

1. Baseline

The purpose for establishing a baseline for an energy performance project is to accurately predict what the energy consumption and costs would have been as if the energy project was never completed. The baseline can then be used to measure the improvement in efficiency and determine the overall energy savings of the project. Since the energy consumption of all facilities is somewhat effected by variable weather conditions, a baseline for heating and cooling systems is typically dependent on degree-days or outside temperature. A baseline also needs to incorporate changes in facility use, such as a change in hours of operation or increased levels of outside air. Once again, if these changes would have occurred in the absence of the energy project, they should be incorporated into the project's baseline.

Honeywell will calculate the baseline based on the systems and operating conditions as they currently exist. Honeywell finds baseline development most accurate if specific measurements are taken on equipment over a period of time (early in the audit phase) to determine actual kW, kWh, oil and gas consumption, cfm, gpm, hours of use, etc. A summary of some of the methods, which will be used by Honeywell to establish baselines and support, calculated savings are listed below.



1. Spot measurements of electrical loads such as lighting, fan and pump motors, chillers, electric heat, etc.
2. Measurement of equipment operating hours using electric data recorders.
3. Measurement of existing operating conditions using data recorders for space temperature and humidity, air handler temperatures (mixed, return, cooling and heating coil discharges), and space occupancy using lighting loggers.
4. Spot measurement for boiler efficiencies, water use.
5. Running measurements of chiller operation, including simultaneous measurement of input kWh or steam flow, and chilled water supply and return temperatures and flow (gpm).
6. Records of operating conditions from building management systems and utility-grade meters.

The data from the above is used to calculate existing energy use, which is then reconciled with current facility utility bills, and adjusted as required to provide a mutually agreed baseline.

To provide valid savings evaluations, Honeywell's maintains a significant inventory of metering equipment utilized by its auditors and Energy Engineers to ascertain critical data about the operation of the facility.

Typically, Honeywell's auditors use the following equipment for their onsite measurements:

1. Recording and instantaneous power and harmonic analyzers.
2. Data loggers for pressures, temperatures, flow rates, humidity and CO_2.
3. Lighting level and recording profile/run-hour and occupancy meters.
4. Multimeters, hand held kW meters.
5. Combustion analyzers.
6. Ultrasonic flow meters.
7. Infrared thermometers

The ECMs installed in many projects allow for energy savings to be identified by direct metering or a combination of metering and calculations with accepted assumptions. In the case of lighting, for example, it is relatively easy to meter representative samples of unique fixture types, both before and after a retrofit, to determine the power consumption difference in Watts. When multiplied by the quantity of each fixture type, the total connected load reduction can be derived. In combination with run time assumptions, or meters, the electrical reduction can be accurately determined. Where possible, direct measurement of ECMs during construction (before and after the retrofit) coupled with energy savings calculations is a method the Honeywell finds to be very accurate and cost-effective.

Due to the nature of some ECMs, or when a combination of ECMs is installed, individual (discrete) metering may not be either possible or able to fully document a baseline and calculate savings. Many of these situations can be handled by combining results from metering along with either engineering-based calculations or output from nationally recognized building simulation programs such as DOE II, ASEAM, TRACE or HAP. This method would be used for ECMs such as night setback, and where no other ECMs have significant interaction with the setback measure.

Formulas exercised in energy savings calculations follow the laws of physics, and many are included in the ASHRAE Handbook of Fundamentals. However, such calculations (i.e. equipment operation profiles) must be tempered by experience, past retrofit practice, and expectations of future operating conditions to arrive at achievable values in practice. Honeywell always reviews each project, in detail, for the anticipated savings and never hesitates to reduce the anticipated energy calculations where experience dictates necessary. The result is a coupled project where the final savings are equal to or greater than anticipated.

Calculating the units of energy saved is a critical measure of energy efficiency improvements, but it does not indicate the actual dollars saved. To do this, Honeywell and MCVTS will establish the base rates that will act as "floor" rates in calculating the savings. These are usually the rates that are in effect at the time of the start of the contract or rates used for audit estimated savings.

2. Adjustment to Baseline Methodology[1]

Honeywell's methodology for establishing and adjusting the baseline is determined by the characteristics of the facility, the conservation technology being installed, the technology being replaced, the type of

[1] The energy baseline modifications shall use commonly accepted energy engineering methods that are mutually agreeable to both Honeywell and customer. Should agreement on these methods, including the climate adjustments, not be reached between Honeywell and customer, both parties could appeal to an independent engineering.

measurement and verification MCVTS requires and the needs of MCVTS for future changes in facility use.

The purpose of this flexible approach is to make the most accurate possible measurement of the changes in energy uses that are specifically attributable to Honeywell installed ECMs. This creates the ability over the life of the contract to continue measuring only savings achieved by Honeywell and leaves MCVTS free to make future changes to the building or systems without affecting the savings agreement. It also necessitates fewer provisions for making adjustments to the baseline.

Modifications to the energy baseline or savings will be made for any of the following:

1. Changes in the number of days in the annual review cycle.
2. Changes in the square footage of the facilities.
3. Changes in the operational schedules of the facilities.
4. Changes in facility indoor temperatures.
5. Significant changes in climate.
6. Significant changes in the amount of equipment or lighting utilized in the facility.

Examples of situations where the baseline needs to be adjusted are: i) changes in the amount of space being air conditioned, ii) changes in auxiliary systems (towers, pumps, etc.) and iii) changes in occupancy or schedule. If the baseline conditions for these factors are not well documented it becomes difficult, if not impossible, to properly adjust them when they change and require changes to payment calculations. To compensate for any addition and deletion of buildings and impact on the baseline model, Honeywell will use sound technical methodologies to adjust the baseline. An example would be to add or delete building energy impact via the calculated cooling load in tons as a percentage of the existing campus tonnage baseline or use indices like W/ft^2 and Btu/ft^2 to calculate the energy consumption of the building and then add or subtract the energy usage to or from the baseline energy consumption.

3. Energy Savings Calculations

In calculating energy savings, Honeywell's highly experienced audit staff uses onsite surveys and measurements, National Oceanic and Atmospheric Administration weather data, detailed discussions with the client's operations and maintenance personnel and engineers, utility records, and other sources to ensure accurate energy, water and O&M savings.
Typically, the following data is gathered:

1. Local weather data.
2. Utility bills and sub-metered consumption trends.
3. Utility rate structure.
4. Facility use and occupancy data.
5. Internal equipment loads.
6. Interviews of operations and maintenance staff and management.
7. Building construction, age, use and layout.
8. Schematics of energy and water distribution systems.
9. Identification and inventory of HVAC equipment.
10. Identification and inventory of process equipment.
11. Design, configuration and operating characteristics of HVAC systems.

12. Design, configuration and operating characteristics of process systems.
13. Control strategies and sequences of operation for HVAC and other process equipment.
14. Identification and count of all lighting fixtures and determination of power consumption for each type.
15. Identification and inventory of lighting control methods.
16. Measurement of foot-candle levels at sample locations.
17. Power quality and harmonics, power factor.
18. Indoor air quality issues.

Calculating the units of energy saved is a critical measure of energy efficiency improvements, but it does not indicate the actual dollars saved. To do this, Honeywell and MCVTS will establish the base rates that will act as "floor" rates in calculating the savings. These are usually the rates that are in effect at the time of the start of the contract or rates used for audit estimated savings.

The equation below will be used to calculate the annual savings in dollars.

Agreed($)= Annual savings in dollars (water, sewer, maintenance, etc.)

Honeywell assigns dollar values to the true incremental value of savings for energy and water. In other words, we do not combine for example, demand and consumptions numbers so that there is an average value to savings. Honeywell looks at each incremental rate to units saved to properly determine the value (dollar) to MCVTS or “real bill reductions”. As noted in the RFP energy escalation rates will be established in accordance with New Jersey Board of Public Utility guidelines.

Based on this, Honeywell will review all utility bills (hourly data), tariffs, special contracts and commodity contracts to develop the incremental value (costs) of each utility.

The O&M savings is typically a function of existing the MCVTS budgets (labor & direct costs), maintenance contracts and operations (supplier) contracts. Honeywell will analyze the information to provide a conservative savings representation for the MCVTS review and acceptance. The information will include all calculations and assumptions.

4. Measurement & Verification

The purpose of performing any monitoring and verification is to establish an agreed upon process that provides the customer both a level of satisfaction that the improvements have been delivered and ongoing information as to their operation and performance. Additionally, this effort will be used to assess the actual dollars of savings versus the guarantee level.

It is essential for the success of this program that Honeywell and MCVTS agree on a mutually acceptable methodology for measuring and verifying energy savings that are attributable to the ECMs Honeywell installs. This M&V plan provides the procedures to document the energy and cost savings of each of the proposed ECMs.

The plan for monitoring and verifying energy savings for the proposed ECMs is based on the methods described in the International Performance Measurement and Verification Protocol (IPMVP). Our approach to M&V is directly consistent with, and in compliance with, the IPMVP. This protocol provides a framework for the most widely accepted and used M&V methods by the industry.

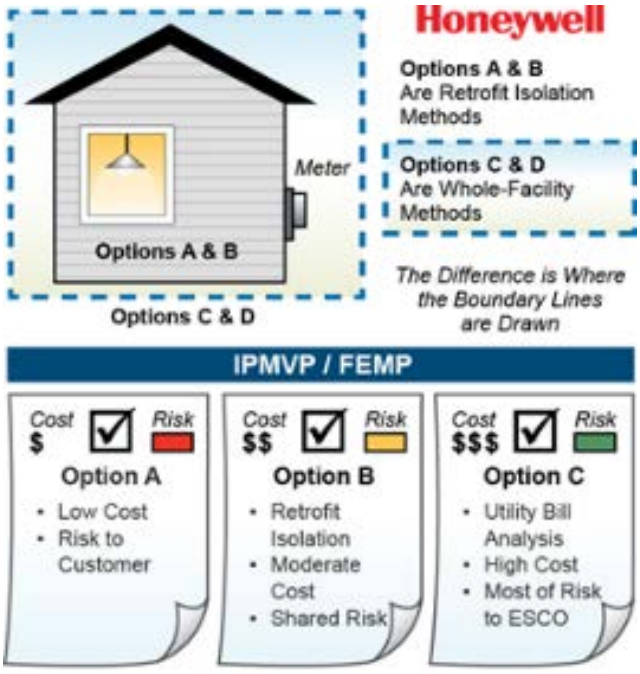
Engineering calculations of energy and cost savings for the project are based on operating parameters (such as weather, temperature settings, run hours, occupancy patterns, and space usage) and equipment performance characteristics. The M&V plan uses the operating parameters established in the baseline for all savings calculations during the term of the project.

The intent of the M&V plan is to verify that the ECMs installed by Honeywell will provide the expected energy savings. Therefore, Honeywell will collect data and relative information during the post-retrofit period to demonstrate that the installed equipment is performing at expected levels. It is assumed that MCVTS will continue to be a dynamic institution adding or renovating buildings and desiring to retain the right to set comfort and operating characteristics. To accommodate this, Honeywell will develop its M&V plan in a way that allows the District to adapt to the demands of future campus growth and changes without the need for MCVTS and Honeywell to negotiate energy baseline adjustments.

Our typical M&V plan will utilize broadband Internet access to the appropriate MCVTS control interfaces to both confirm operating status and to download trend data to verify proper equipment maintenance.

One year after the commencement date of the ECMs, Honeywell will submit a report verifying and calculating the energy and cost savings for the first year. This report will be submitted for District review and approval. For the remaining contract term, Honeywell will provide annual reports. These reports will include results of inspections of the installed equipment/systems, energy and cost savings, and recommendations to provide optimum energy performance.

All permanent measurement equipment will be purchased new with a calibration certificate from the manufacturer. The power multi-meter and the TSI multi-meter will be calibrated annually before using them in the annual inspection.



General Approach to M&V

Energy and water savings are determined by comparing the energy and water use associated with a facility or certain systems within a facility before and after the installation of an ECM or other measure. The “before” case is the baseline. The “after” case is the post-installation or performance period. Baseline and post-installation energy use measurements or estimates can be constructed using the methods associated with M&V options A, B, C, and D, as described in the IPMVP. The challenge of M&V is to balance M&V costs, accuracy, and repeatability with the value of the ECM(s) or systems being evaluated, and to increase the potential for greater savings by careful monitoring and reporting.

M&V Options

The IPMVP guidelines classify the M&V procedures into four categories, Options A, B, C, and D. As shown in the table below, these options differ in their approach to the level of complexity of the M&V procedures.

M&V Option	Performance Verification Techniques
Option A Verifying that the measure has the potential to perform and to generate savings.	**Option A** is appropriate for ECMs that have energy use that can be readily quantified, such as the use of high efficiency lighting fixtures, high efficiency constant speed motors, and other standard engineering calculations. Engineering calculations before and after installation spot measurements and use of EMS data points with stipulated values.
Option B Verifying that the measure has the potential to perform and verifying actual performance by end use.	**Option B** is appropriate for ECMs that require periodic or on-going measurements to quantify energy use; such as the use of VSDs on pump or fan motors. Engineering calculations with metering and monitoring strategy throughout term of the contract.
Option C Verifying that the measure has the potential to perform and verifying actual performance (whole building analysis.)	**Option C** is used for ECMs for which the energy use or energy savings cannot be measured directly, such as building envelope modifications. Option C is based on the use of utility meters to quantify building energy use. Utility meter billing analysis-using techniques from simple comparison to multivariable regression analysis.
Option D Verifying actual performance and savings through simulation of facility components and/or the whole facility	**Option D** is used for ECMs for which the energy use or energy savings cannot be measured directly, or savings for individual ECMs are heavily interdependent. Calibrated building simulation is used to separate the energy savings attributable to each ECM. Calibrated energy simulation/modeling; calibrated with hourly or monthly utility billing data and/or end-use metering.

In general, ECM Energy Savings = Baseline Energy Use – Post-Installation Energy Use

And Energy Cost savings ($) = Total Energy Savings x Contractual Energy Rates

Exceptions to this simple equation are as follows:

Projects where an on/off M&V method is used. For example, after a new energy management system is installed, control features are turned off for a set period to recreate baseline conditions. Thus, savings are determined after installation by comparing energy use with and without the control features activated.

Since energy use at a facility is rarely, if ever, constant, another way to define M&V is as a comparison of a facility's post-installation energy use with its usage if the ECM or system had not been installed. This considers situations in which baseline energy use must be adjusted to account for changing conditions, such as changes in facility operation, occupancy, or use or external factors such as weather.

Post-Retrofit M&V Activities

There are two components associated with M&V of performance contract projects:

1. Verifying the potential of the ECM to generate savings also stated as confirming that the proper equipment/systems were installed, are performing to specification and have the potential to generate the predicted savings.
2. Determining/verify energy savings achieved by the installed ECM(s).

Verifying the Potential to Generate Savings

Verifying baseline and post-installation conditions involves inspections (or observations), spot measurements, and/or commissioning activities. Commissioning includes the following activities:

- Documentation of ECM or system design assumptions.
- Documentation of the ECM or system design intent for use by contractors, agencies and operators.
- Functional performance testing and documentation necessary for evaluating the ECM or system for acceptance.
- Adjusting the ECM or system to meet actual needs within the capability of the system.

Post-Installation Verification

Post-installation verification will be conducted by both Honeywell and the District to ensure that the proper equipment/systems that were installed are operating correctly and have the potential to generate the predicted savings. Verification methods may include surveys, inspections, and/or spot or short-term metering.

Regular Interval Post-Installation Verification

At least annually, Honeywell will verify that the installed equipment/systems have been properly maintained, continue to operate correctly, and continue to have the potential to generate the predicted savings. Savings report for all the installed ECMs will be submitted each year after the acceptance date of the work performed by Honeywell.

Computation of Energy Savings

After the ECMs are installed, energy and cost savings will be determined annually by Honeywell in accordance with an agreed-upon M&V approach, as defined in a project-specific M&V plan.

Construction/Interim Savings

Construction or Interim savings are usually measured by using the same methodology as described in the detail M&V plan for each ECM. The start and the completion time for each ECM must be agreed to between Honeywell and MCVTS.

Electricity and thermal savings from the ECMs where no detailed long-term data is required to be collected will be stipulated and will be based on the starting and the final completion dates and verification of the operation of the ECMs.

For other ECMs where long-term data collection is required by the M&V plan, data will be used to calculate the savings using the same equations as described in the detail plan. For example, to calculate electricity savings for the installation of a VFD, the kW is spot measured at a set speed for selected motors through a sampling plan. The measured kW is subtracted from the baseline kW to calculating the

savings. Thermal savings are tied to the electrical savings in the manner described in the detail M&V plan. The results are extrapolated to cover all the VFDs installed by Honeywell. The savings for each of the monitored VFD is calculated on an interval basis.

5. Site Specific M&V Plan

ECM # and Name	Summary of ECM	Measurement and Verification Methodology / Recommendation	Description of M&V – Pre and Post Process
ECM 1A – LED Lighting	Upgrade Lighting systems: Re-lamp/Re-ballast T-8 to LED New Fixtures Incandescent to LED Metal Halide and Sodium Vapor to LED High Bays	Option A: Pre-and Post-measurements Line by Line scope and engineering calculations Option C: Thermal energy savings based on utility data	Pre-M&V: Measurement of KW for 5% sample fixtures in each category Data log usage hours Data Log occupancy schedules Update Line by Line scope with measured KW and usage hours Post M&V: Measurement of KW for 5% sample fixtures in each category Usage Hours to remain same Occupancy schedules to remain same Energy Savings: Update Line by Line scope with measured KW and usage hours and compare to pre-retrofit calculated savings
ECM 1B – Vending Misers	Install Vending machine energy management devices	Option A: Pre-and Post-measurements Line by Line scope and engineering calculations	Pre-M&V: Measurement of KW for 5% sample machines in each category Data log usage hours Data Log occupancy schedules Update Line by Line scope with measured KW and usage hours Post M&V: Measurement of KW for 5% sample machines in each category Usage Hours to remain same Energy Savings scope with measured KW and usage hours and compare to pre-retrofit calculated savings
ECM 1C - De-Stratification Fans	Install De-Stratification fans in Gymnasiums, Cafeterias and Auditoriums to minimize stratification of hot air and maintain hot air flow below the fan level	Option C: Thermal energy savings based on utility data	Pre-M&V: Verify parameters used in engineering calculations with equipment name plate data and savings assumptions
ECM 2A – Boiler Replacements	Replace boilers in select locations in kind to handle base load	Option C: Thermal energy savings based on utility data	Pre-M&V: Verify parameters used in engineering calculations with equipment name plate data and savings assumptions
ECM 2B – Domestic Hot Water Replacements	Replace existing domestic hot water heater with condensing natural gas domestic hot water heater	Option C: Thermal energy savings based on utility data	Pre-M&V: Verify parameters used in engineering calculations with equipment name plate data and savings assumptions
ECM 2C - Rooftop Unit Replacement	Replace antiquated Roof Top Units with new high	Option A: Engineering calculations based on nameplate and manufacturer	Pre-M&V: Verify manufacturer provided data for existing unit efficiency (SEER) Post M&V: Verify manufacturer provided data for new condensing unit (SEER) – verify the new equipment and controls are installed and commissioned as recommended by manufacturer

ECM # and Name	Summary of ECM	Measurement and Verification Methodology / Recommendation	Description of M&V – Pre and Post Process
	efficiency VFD equipped Rooftop Units	supplied data for the existing and replacement units	
ECM 2D– Split System Replacements	Replace Split systems at various building with new high efficiency units	Option A: Engineering calculations based on nameplate and manufacturer supplied data for the existing and replacement Units	Pre-M&V: Verify manufacturer provided data for existing unit efficiency (SEER) Post M&V: Verify manufacturer provided data for new Chiller unit (SEER) – verify the new equipment and controls are installed and commissioned as recommended by manufacturer
ECM 2E- Chiller Replacements	Replace Chillers with new high efficiency units	Option A: Engineering calculations based on nameplate and manufacturer supplied data for the existing and replacement Units	Pre-M&V: Verify manufacturer provided data for existing unit efficiency (kW/ton) Post M&V: Verify manufacturer provided data for new Chiller unit (kW/ton) – verify the new equipment and controls are installed and commissioned as recommended by manufacturer
ECM 2F - Motors and VFD Replacements	Install VFDs on hot water and chilled water pumps to operate the pump motors in response to the system load. Replace antiquated motors with new premium efficiency motors	Option A: Engineering calculations for VFD following pump affinity laws. Engineering calculations based on nameplate and manufacturer supplied data for the existing and replacement motors	Pre-M&V: Verify manufacturer provided data for the pump performance data and motor efficiencies. Post M&V: Obtain trend data for VFD operation from the BMS system to verify baseline calculation assumptions on system loads Verify efficiency of new motors Verify manufacturer provided data for new chiller efficiency (kW/ton) – verify the new equipment and controls are installed and commissioned as recommended by manufacturer
ECM 2G - Kitchen Hood Controls	Install control devices on the Kitchen hoods to control exhaust air in response to the cooking load. Replace fan motors with new premium efficiency motors and VFD drives	Option A: Engineering calculations for s following affinity laws. Engineering calculations based on nameplate, manufacturer supplied data and operating hours for the existing and replacement motors Option C: Thermal energy savings based on utility data	Pre-M&V: Verify manufacturer provided data for the motor performance data and motor efficiencies. Post M&V: Obtain trend data for VFD operation from the BMS system to verify baseline calculation assumptions on system loads Verify efficiency of new motors
ECM 2H – Refrigeration Controllers	Install control device on walk-in freezer and refrigerator evaporators to shut down the fan motor when the compressor is off on duty cycle	Option A: Stipulated Engineering calculations based on case studies for the Intellidyne control	Pre-M&V: None Post M&V: Savings stipulated based on engineering calculations for the term of contract

ECM # and Name	Summary of ECM	Measurement and Verification Methodology / Recommendation	Description of M&V – Pre and Post Process
ECM 2I –Window AC Unit Replacements	Replace/Refurbish antiquated Window AC Units	Option A: Engineering calculations based on nameplate and manufacturer supplied data for the existing and replacement units	Pre-M&V: Verify manufacturer provided data for existing unit efficiency (SEER) Post M&V: Verify manufacturer provided data for new condensing unit (SEER) – verify the new equipment and controls are installed and commissioned as recommended by manufacturer
ECM 2J – Multi-Zone VRF System Replacements	Replace Split systems at various building with new high efficiency units	Option A: Engineering calculations based on nameplate and manufacturer supplied data for the existing and replacement Units	Pre-M&V: Verify manufacturer provided data for existing unit efficiency (SEER) Post M&V: Verify manufacturer provided data for new Chiller unit (SEER) – verify the new equipment and controls are installed and commissioned as recommended by manufacturer
ECM 3A - Building Management System Upgrades	Upgrade Building Management Systems to DDC and integrate all systems to a central platform such that the systems may be monitored and controlled as programmed to maintain global settings such as night set back, optimum stop-start etc.	Option A: Electric energy savings - Engineering calculations based on programmed parameters. Option C: Thermal energy savings based on utility data	Pre-M&V: Verify existing operating parameters match the baseline calculation assumptions Post M&V: Verify that systems are installed as specified and controls are programmed to match the savings assumptions Electric Energy: Verify savings based on programmed parameters and engineering calculations
ECM 4A - Building Envelope Improvements (BEI)	Install weather stripping on doors, seal roof wall joints and roof penetrations	Option A: Electric energy savings - Engineering calculations based on programmed parameters. Option C: Thermal energy savings based on utility data	Pre-M&V: None Post M&V: Savings stipulated based on engineering calculations for the term of contract
ECM 4B – Woodbridge Guidance Office BEI	Install weather stripping on doors, seal roof wall joints and roof penetrations	Option A: Electric energy savings - Engineering calculations based on programmed parameters. Option C: Thermal energy savings based on utility data	Pre-M&V: None Post M&V: Savings stipulated based on engineering calculations for the term of contract

ECM # and Name	Summary of ECM	Measurement and Verification Methodology / Recommendation	Description of M&V – Pre and Post Process
ECM 5A – Permanent Load Reduction	Savings from KW demand reduction	N/A	Pre-M&V: N/A Post M&V: N/A
ECM 6A – Solar PPA	Install roof mounted solar PV arrays	N/A	Pre-M&V: Utilize baseline kWh consumption determine kWh produced Post M&V: Measure and Provide a report of the kWh generated
ECM 7A – High Efficiency Transformers	Replace existing secondary transformers with high efficiency equivalents	Option A: Engineering calculations based on increase in transformer efficiency	Pre-M&V: Measure typical existing transformer (typical one for each size) input and output KW to establish transformer losses Post M&V: Measure input and output KW for new transformer (typical one for each size) Verify savings with engineering calculations
ECM 8A – Water Conservation	Install high efficiency water fixtures	Option A: Engineering calculations based on increase in water usage efficiency and lower flow rates	Pre-M&V: None Post M&V: Savings stipulated based on engineering calculations for the term of contract

6. Guarantee of Savings

The approach that Honeywell utilizes in this asset management program includes two key components: a performance guarantee and financial savings. Honeywell guarantees the District that all installations and work performed are subject to final inspection and the District's acceptance. This procedure ensures all work will be to the level of quality the District expects.

Honeywell also guarantees it will meet the objectives mutually defined with the District. Honeywell takes its commitment to partner with MCVTS for the life of the contract seriously, and looks forward to a successful, long-term partnership.

Honeywell considers the guarantee to be the cornerstone of our service to you. To be considered a performance contract an energy guarantee is an optional component under the NJ ESIP legislation. The basis of an energy performance contract is that much of the risk is shifted from the District to the ESCO. The strength of the Guarantee is only as good as the Company backing it and their financial solvency. With over $41.8 Billion in assets, Honeywell has the financial strength and background to support the District for the long term.

Savings Guarantee: With the understanding that MCVTS must maintain fiscal health and accountability, Honeywell can financially guarantee the results of its programs and clearly support this obligation with the commitment to regular review of program results and reconciliation. ***Honeywell's financial strength and stability give it the ability to extend a FIRST-PARTY GUARANTEE to MCVTS. A first-party guarantee eliminates the risk on the District and places it directly onto Honeywell.*** This differs from some other ESCO's who provide a third-party guarantee, which insulates them from the owner using insurance instruments.

If, at the end of any year, the program has not met or exceeded the guaranteed savings for that year, Honeywell will refund the difference between the guaranteed amount and what was saved.

For all equipment covered by the Energy Savings Guarantee, MCVTS shall be responsible for on-going maintenance and component replacement in accordance with manufacturer's standards. The District will also be responsible for operating the equipment in accordance with manufacturer's specifications.

Honeywell will develop savings methodologies that follow current industry practice, such as outlined by the New Jersey Board of Public Utilities (BPU) and Federal Energy Management Program's (FEMP) M&V Guidelines: Measurement and Verification for Federal Energy Projects. References to M&V protocols from the IPMVP, ASHRAE Guideline 14 and the Air-Conditioning Refrigeration Institute (ARI) are used to further qualify the M&V plan.

As stated above, under the NJ ESIP legislation, acceptance of a performance guarantee is optional at MCVTS sole discretion. In the same way, the duration of the guarantee is also optional. Many of Honeywell's NJ customers have elected to keep the guarantee in force for less than the total performance periods, i.e. three (3) to five (5) years. Others have elected to accept a one (1) year guarantee, while reserving the option to renew for additional years after they have had the opportunity to review the track record of actual savings results. Obviously, this a very customer specific decision based on the risk management culture of each unique organization. The key point is that Honeywell is flexible regarding the

structure and duration of the guarantee. The final terms will be discussed and defined as part of our co-authored ESIP project.

Solely for informational purposes, it is worth noting that if the District does elect to accept a guarantee, NJ ESIP law requires that the District contract with a third-party independent firm to verify that the energy savings are realized. To preserve the independent status of this contractor these costs are required to be incurred directly by the District.

The RFP requires that the cost of the guarantee be identified during this response phase. Honeywell develops and implements every project with the same high level of detail and confidence and therefore will always provide a Savings Guarantee at no additional cost. However, if the District opts to accept the Savings Guarantee, the fee indicated on Form V in Section H-1 will be applicable to account for on-going Honeywell service costs incurred during the M&V of the savings.

All guarantees require that the owner maintain the system in accordance with the manufacturer's specifications. Regardless of guarantee acceptance, ongoing maintenance as recommended by the BPU, Honeywell and / or manufacturer specifications is required to achieve the projected energy savings. Maintenance should also include a periodic verification of the system to make sure the maintenance is properly conducted and the system is meeting the original specifications and design.

7. Recommended Preventive Maintenance Services

Per the NJ ESIP program, all services are required to be bid by MCVTS for services as desired. Based on Honeywell's vast service organization, we are uniquely qualified to develop design specification for the public bidding per NJ Law.

Honeywell strongly believes that the long-term success of any conservation program is equally dependent upon the appropriate application of energy savings technologies, as well as solid fundamental maintenance and support. One of the primary contributors to energy waste and premature physical plant deterioration is the lack of operations, personnel training and equipment maintenance.

Honeywell recommends routine maintenance on the following systems throughout MCVTS for the duration of an energy guarantee of savings.

Maintenance, Repair and Retrofit Services:

- Mechanical Systems
- Building Automation Systems
- Temperature Control Systems
- Air Filtration

Honeywell will work with MCVTS to evaluate current maintenance practices and procedures. This information will be the basis of a preventive maintenance and performance management plan designed to maximize building operating efficiencies, extend the useful life of your equipment and support the designed Energy Savings Plan.

At a minimum, we recommend the following tasks be performed on a quarterly basis with MCVTS Wide Building Management System.

System Support Services

1. Review recent mechanical system operation and issues with customer primary contact, on a monthly basis.
2. Review online automation system operation and event history logs and provide summary status to the customer primary contact. Identify systemic or commonly re-occurring events.
3. Check with customer primary contact and logbook to verify that all software programs are operating correctly.
4. Identify issues and prioritize maintenance requests as required.
5. Provide technical support services for trouble shooting and problem solving as required during scheduled visits.
6. Provide ongoing system review and operations training support; including two semi-annual lunches and learn sessions.
7. Establish dedicated, site-specific emergency stock of spare parts to ensure prompt replacement of critical components. These will be stored in a secure location with controlled access.

Configuration Management

1. Update documentation and software archives with any minor changes to software made during maintenance work.
2. Verify and record operating systems and databases.
3. Record system software revisions and update levels.
4. Archive software in designated offsite Honeywell storage facility, on an annual basis.
5. Provide offline software imaging for disaster recovery procedures, updated on a regular basis.

Front End / PC Service

1. Verify operation of personal computer and software:
2. Check for PC errors on boot up
3. Check for Windows errors on boot up
4. Check for software operations and performance, responsiveness of system, speed of software
5. Routinely backup system files, on an annual basis:
6. Trend data, alarm information and operator activity data
7. Custom graphics and other information
8. Ensure disaster recovery procedures are updated with current files
9. Clean drives and PC housing, on an annual basis:
10. Open PC and remove dust and dirt from fans and surfaces
11. Open PC interface assemblies and remove dust and dirt
12. Clean and verify operation of monitors.
13. Verify printer operation, check ribbon or ink.
14. Initiate and check log printing functions.
15. Verify modem operation (if applicable).
16. Review IVR schedule for alarms and review (if applicable).

Temperature Controls

UNIT VENTS

Services Performed

Annual Inspection

1. Inspect motor and lubricate.
2. Lubricate fan bearings.
3. Inspect coil(s) for leaks.
4. Vacuum interior.
5. Test operation of unit controls.

PUMPS

Services Performed

Preseason Inspection

1. Tighten loose nuts and bolts.
2. Check motor mounts and vibration pads.
3. Inspect electrical connections and contactors.

Seasonal Start-up

1. Lubricate pump and motor bearings per manufacturer's recommendations.
2. Visually check pump alignment and coupling.
3. Check motor operating conditions.
4. Inspect mechanical seals or pump packing.
5. Check hand valves.

Mid-season Inspection

1. Lubricate pump and motor bearings as required.
2. Inspect mechanical seals or pump packing.
3. Ascertain proper functioning.

Seasonal Shut-down

1. Switch off pump.
2. Verify position of hand valves.
3. Note repairs required during shut-down.

PACKAGED AIR-CONDITIONING SYSTEMS

Services Performed

Preseason Inspection

1. Energize crankcase heater.
2. Lubricate fan and motor bearings per manufacturer's recommendations.
3. Check belts and sheaves. Adjust as required.
4. Lubricate and adjust dampers and linkages.
5. Check condensate pan.

Seasonal Start-up

1. Check crankcase heater operation.
2. Check compressor oil level.
3. Inspect electrical connections, contactors, relays, operating and safety controls.
4. Start compressor and check operating conditions. Adjust as required.
5. Check refrigerant charge.
6. Check motor operating conditions.

7. Inspect and calibrate temperature, safety and operational controls, as required.
8. Secure unit panels.
9. Pressure wash all evaporator and condenser coils (if applicable)
10. Log all operating data.

Mid-season Inspection

1. Lubricate fan and motor bearings per manufacturer's recommendations.
2. Check belts and sheaves. Adjust as required.
3. Check condensate pan and drain.
4. Check operating conditions. Adjust as required.
5. Log all operating data.

Seasonal Shut-down *

1. Shut down per manufacturer's recommendations.

* If no Shut-down is required then (2) Mid-season Inspections are performed

BOILERS

Services Performed

Preseason Inspection

1. Inspect fireside of boiler and record condition.
2. Brush and vacuum soot and dirt from flues (not chimneys) and combustion chamber.
3. Inspect firebrick and refractory for defects.
4. Visually inspect boiler pressure vessel for possible leaks and record condition.
5. Disassemble, inspect and clean low-water cutoff.
6. Check hand valves and automatic feed equipment. Repack and adjust as required.
7. Inspect, clean and lubricate the burner and combustion control equipment.
8. Reassemble boiler.
9. Check burner sequence of operation and combustion air equipment.
10. Check fuel piping for leaks and proper support.
11. Review manufacturer's recommendations for boiler and burner start-up.
12. Check fuel supply.
13. Check auxiliary equipment operation.

Seasonal Start-up

1. Inspect burner, boiler and controls prior to start-up.
2. Start burner and check operating controls.
3. Test safety controls and pressure relief valve.
4. Perform combustion analysis.
5. Make required control adjustments.
6. Log all operating conditions.
7. Review operating procedures and owner's log with boiler operator.

Mid-season Inspection

1. Review operator's log.
2. Check system operation.
3. Perform combustion analysis.

4. Make required control adjustments.
5. Log all operating conditions.
6. Review operating procedures and log with boiler operator.

Seasonal Shut-down

1. Review operator's log.
2. Note repairs required.

SECTION F DESIGN APPROACH

In accordance with the ESIP PL 2012, c.55 as part of the implementation process, an agreement between MCVTS and Honeywell will determine the energy conservation measures (ECM's) to be implemented. The services of a NJ Licensed Engineering firm and / or Architectural firm shall then be secured to properly comply with local building codes, compliance issues and NJ Public contracts law. Specifications will be designed and developed to exact standards as recommended by Honeywell to achieve all savings outlined in this Energy Savings Plan (ESP). Once specifications are completed, Honeywell will publicly solicit contractors capable of meeting the requirements of the specification for each trade. However, even before the completion of the bidding process, Honeywell project management will be engaged to maintain the overall project schedule and ensure the MCVTS expectations are met. An overview of these activities and functions are detailed below.

1. Safety Management Plan

All of Honeywell's Project Management Plans begin with safety. By integrating health, safety and environmental considerations into all aspects of our business, we protect our customers, our people and the environment, achieve sustainable growth and accelerated productivity, drive compliance with all applicable regulations and develop the technologies that expand the sustainable capacity of our world. Our health, safety and environment management systems reflect our values and help us meet our customer's needs and our business objectives.

Honeywell's Safety Management Plan is provided in Appendix 5.

2. Project Management Process

Honeywell approaches any ESIP project with a systematic, tested, and proven delivery process based upon industry best practices including strong project management, open and collaborative communication, superior technical design, and state of the art technologies. We go above and beyond; with multiple NJ delivery teams to ensure sufficient resources, meticulous and thorough training and commissioning, and robust maintenance planning that goes the extra mile for the long term. Honeywell excels at project delivery because of our experience in NJ delivering ESIP projects with results that meet or exceed expectations.

Honeywell will demonstrate our partnership-based commitment to MCVTS throughout the development and delivery of your ESIP project, as we have done for dozens of other K-12 school districts throughout NJ under the ESIP Law. Our approach is backed by our references and track record and highly experienced engineering resources, which will be fully utilized to help you achieve your unique project goals and requirements.

Honeywell prescribes four phases in the ESIP Process that constitutes your project, including:

- Phase 1: IGA
- Phase 2: Project Implementation
- Phase 3: Commissioning and Training
- Phase 4: Energy Savings Guarantee Period

The IGA will commence with a kickoff meeting between key project stakeholders of MCVTS and Honeywell to review the ESIP Process, including the expectations of both parties during the IGA, audit parameters, reporting methods, building access protocols, availability of utility, and building data. Phase 2 will commence after our kickoff meeting has concluded with agreed upon next steps.

Honeywell takes a holistic approach in development of a comprehensive solution that is customized to meet your operational and facility needs and project goals. Our integrated project delivery approach supports continuous and collaborative communication between key stakeholders throughout the process.

A. IGA DEVELOPMENT PROCESS

Our IGA development process includes the following steps:



Step 1: Discovery

The first step of your IGA is to gain a thorough comprehension of MCVTS key priorities and requirements. Honeywell will work with you to identify what your key needs and goals include and investigate your buildings and systems with that in mind during this step.

Honeywell will initiate your IGA shortly after formal selection with a kickoff meeting involving all key project decision makers of the District and Honeywell. The purpose of this meeting is to establish preliminary project expectations and define key next steps of the process to inform the IGA.

Honeywell will develop a customized plan for developing an efficient, cost effective solutions based project including schedule, finance, performance requirements, and scheduling activities.

Honeywell will schedule site visits to commence at the earliest convenience. Utility data is a key component used for establishing your energy baseline to project potential energy savings. Building plans and operating

schedules will assist Honeywell to focus our time during the site visits and serve to provide the means for our engineers to complete their calculations. Data required for this step includes 24 months of electric, thermal, water/sewer data, original and renovation drawings, equipment lists, equipment operating schedules, occupancy data and maintenance records and repair costs.

Our goal for the site surveys is to understand your systems in each facility and to identify potential ECMs for inclusion in your final project scope. This step allows Honeywell to determine needed improvements by evaluating each building and its systems in terms of condition, performance and age, including lighting and HVAC systems, Building Automation Systems, building envelopes, electrical distribution, domestic water, and heating systems.

Step 2: Identify and Develop Project

Honeywell will take the findings of our earlier diagnostic phase to develop solutions that address your priorities and key needs as ascertained in Step 1. Our collaborative, solutions based approach will allow you to maximize savings to invest more into modernizing buildings and generate maximum rebates to help deliver the most positive cash flow available.

Our primary objective is to ensure quality control and on time delivery throughout your project. Your project will have a dedicated team consisting of project management and engineering who have helped deliver similarly sized project under ESIP in recent past.

Honeywell will create an exhaustive ECM list following the completion of the site survey process. Each opportunity is then analyzed individually to determine both economic and construction feasibility. Input from MCVTS is critical to determine how each ECM fits within your overall project priorities. Honeywell's ECM Opportunity Funnel will help further narrow down the list of potential ECMs to your final ESIP project scope, by analyzing all aspects of your energy consumption to deliver an optimal project scope based on realistic savings potential. Our unique collaborative approach ensures that we deliver on your expectations while providing for turnkey solutions that are cost effective.



Step 3: Cost and Savings Forecasting

Honeywell will then move on to analyze and quantify your unique savings guarantee utilizing MCVTS dedicated ESIP Team. During this step, we will quantify energy savings by identifying the scope of work and its impact on your facilities and systems. We will measure individual ECMs based on how they will impact future performance of the building. This will help to ensure that the ECM savings are accounted for only once. Results are then subject to peer reviews to verify accurate modeling and savings forecasts based on the proposed scope of work.

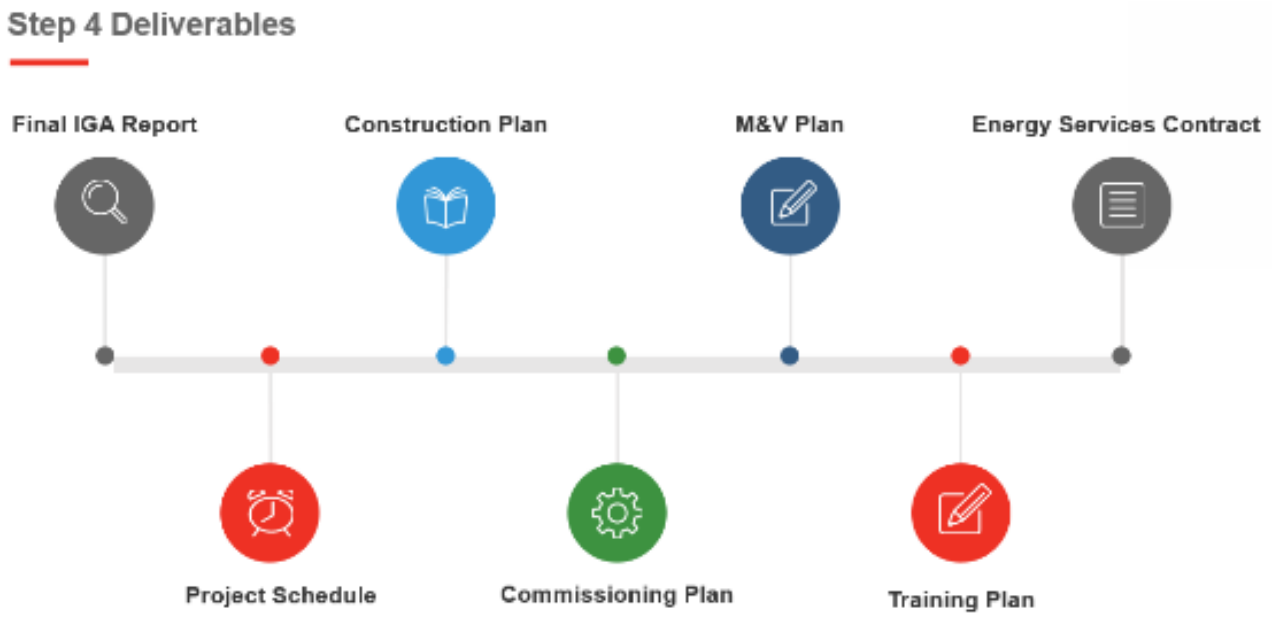
Honeywell's unique approach to engineering is why we often exceed the savings guarantee of our contracts.

Step 4: Deliver Solution

Honeywell will leverage our experience delivering more than two dozen NJ ESIP projects since 2009 to help MCVTS complete a successful project on time that maximizes realistic savings, cash rebates, and positive cash flow. We have learned through this unrivaled experience that what matters most is to meet your expectations and ensure your involvement in the decision-making process. REACT (Rebate Energy Analysis Constructability Tool) will provide for an interactive solution development experience designed to maximize New Jersey Office of Clean Energy rebates. Our No Change Orders policy (which helps distinguish Honeywell from the competition) will further reduce risk and enhance project results.

Our in-house finance team, Honeywell Global Finance (HGF), will work to ensure that you secure the most competitive financial offering and interest rate available. No ESCO offers more value throughout the ESIP Process than Honeywell.

Our deliverables during this final phase will include:



B. HONEYWELL PERFORMANCE CONTRACTING

Honeywell is the undisputed performance contracting market leader in the Northeast. Honeywell's Guaranteed Performance Contracting, which we pioneered in the early 1980's, has surpassed the $2 Billion mark in cumulative sales. Our performance contracting business features specialized and dedicated resources, including people with expertise specifically to address the needs of our customers. Our portfolio of business experience in the region is over 400 projects and over $500 Million in project investment.

C. PROJECT MANAGEMENT POLICY: HONEYWELL'S COMMITMENT TO HEALTH, SAFETY, THE ENVIRONMENT, AND SCHOOL

All of Honeywell's Project Management Plans begin with Safety. By integrating health, safety, and environmental considerations into all aspects of our business, we help our customers, our people, and the environment achieve sustainable growth and accelerated productivity, drive compliance with all applicable regulations, and develop the technologies that expand the sustainable capacity of our world. Our health, safety, and environment management systems reflect our values and help us meet our customers' needs and our business objectives.

Our Safety Commitment to Schools

In today's world, nothing is more important than safeguarding our families at home, at work, and at school. Through Honeywell's safety awareness process, we commit to our customers to protect and safeguard our construction sites, our employees, sub-contractors, your staff, and most of all your children.

Our projects all begin with the following steps:

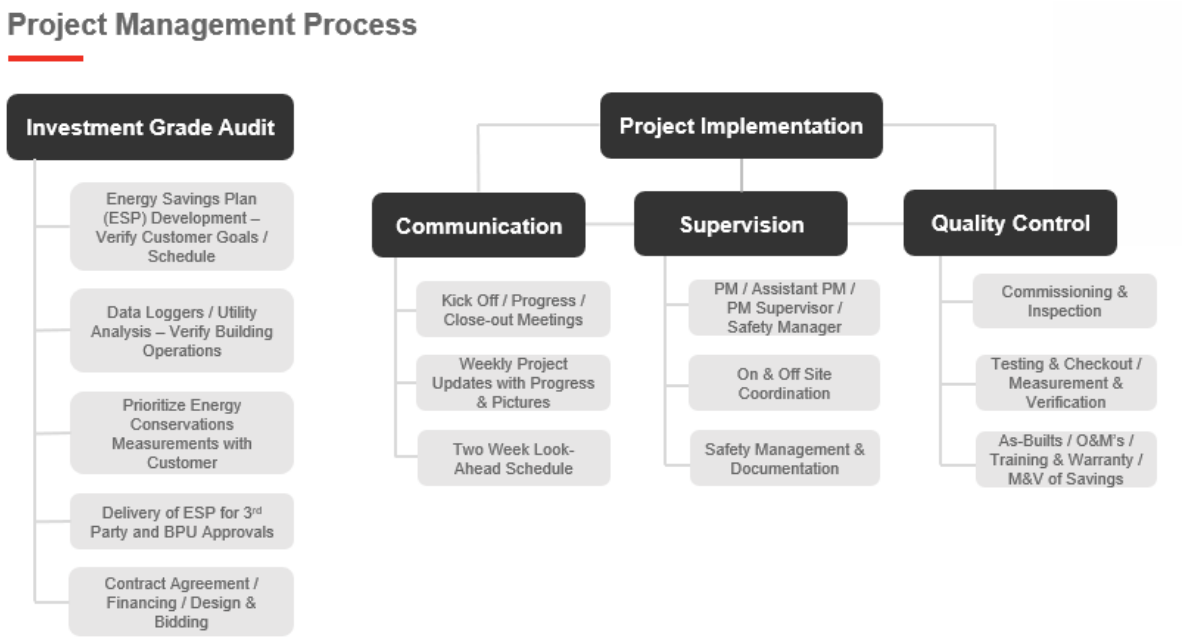
- Safety training for employee's and sub-contractors.
- Detailed work schedules around the school day.
- Detailed background checks of personnel.
- Detail logs of sub-contractor personnel.
- On-Site logs of time sheets, contact information for all personnel.
- Clearly displayed identification badges of all construction personnel.
- On-site daily supervision of all sub-contractors.
- Detailed and weekly reviews of accident reports and remediation strategy.

Our Safety Commitment to Our Customers and Employees

We protect the safety and health of our customers and employees through prevention of illness, injury, and pollution.

- We actively promote and develop opportunities for expanding sustainable capacity by increasing fuel efficiency, improving security and safety, and reducing emissions of harmful pollutants.
- We are committed to compliance with all our health, safety, environmental and legal requirements everywhere we operate.
- Our commitment to health, safety and the environment is an integral aspect of our design of products, processes and services, and of the lifecycle management of our products.
- Our management systems apply a global standard that provides protection of both human health and the environment during normal and emergency situations.
- We identify, control and endeavor to reduce emissions, waste and inefficient use of resources and energy.
- We abide by the company's own strict standards in cases where local laws are less stringent.
- Our senior leadership and individual employees are accountable for their role in meeting our commitments.
- We measure and periodically review our progress and strive for continuous improvement.
- These are our commitments to health, safety, and the environment, and to creating a safe, clean environment everywhere we operate.

D. PROJECT MANAGEMENT PROCESS



The project management process applies technical knowledge, people, and communication skills, and management talent in an on-site, pro-active manner to ensure that our contract commitments are met on time, within budget, and at the quality you expect.

A Honeywell Project Management Plan defines plans and controls the tasks that must be completed for your project. But more than task administration, our project management process oversees the efficient allocation of resources to complete those tasks.

Each project and each customer's requirements are unique. At Honeywell, we address customer needs through a formal communication process. This begins by designating one of our project managers to be responsible for keeping the customer abreast of the status of the project.

As the facilities improvements portion of the partnership begins, the Project Manager serves as a single focal point of responsibility for all aspects of the partnership. The Project Manager monitors labor, material, and project modifications related to the District/Honeywell partnership and makes changes to ensure achievement of performance requirements in the facilities modernization component. The Project Manager regularly reviews the on-going process of the project with the customers.

The Project Manager will develop and maintain effective on-going contact with the District and all other project participants to resolve issues and update project status.

There are several challenges in this position. The Project Manager must staff the project and create a work force capable of handling the technologies associated with the project (pneumatic or electric/electronic controls, mechanical systems, etc.), and plan for and use these personnel to achieve optimum results focused on occupant comfort and guarantee requirements.

3. Construction Management

Prior to any work in the buildings, our Project Manager, Bob Letso, will sit down with your administrative and building staff to outline the ECMs that we will be installing in your building. We will discuss proper contractor protocol of checking in and out of the buildings daily, wearing identifiable shirts, and checking in with your facilities staff. We will coordinate certain projects for different times of the day so we do not interrupt the building and learning environments. Our staff will work a combination of first and second shifts to accomplish the pre-set implementation schedule.

Communication is the key success factor in any construction management plan, and our project manager will be the key focal point during the installation process.

Our team will prevent schedule slippages by continuously tracking the location of all equipment and components required for the project. We make sure all equipment and components will be delivered on time prior to the scheduled date of delivery. Our thorough survey, evaluation, and analysis of existing conditions, performed prior to the commencement of construction, will also prevent schedule slippages.

Honeywell is required to subcontract various portions of our projects to local contractors. Within the District project, all subcontractors will be selected in accordance with NJ public contracts law. Typical areas that are subcontracted are as follows:

- Electrical Installation.
- Water Conservation (Plumbing).
- HVAC Installation (depends upon the project size and scope).
- Associated General Contracting specialty items to support the project etc., (ceilings, windows, concrete, structural steel, roofing, demolition and removal of equipment, painting and rigging).

Honeywell uses the following guidelines in hiring subcontractors to perform work on our projects.

- Local Presence in the Community (Customer Recommendations).
- Firm’s Qualifications and WBE/MBE Status.
- Firm’s Financial Stability.
- Ability to perform the work within the project timeline.
- Price.
- Ability to provide service on the equipment or materials installed over a long period.

Approval of subcontractors that Honeywell proposes to use lies with the District.

4. Commissioning

Honeywell provides full commissioning of ECMs as part of our responsibility on this project. We will customize this process based on the complexity of ECMs. Specifically, Honeywell will be responsible for start-up and commissioning of the new equipment and systems to be installed during the project. This will include verifying that the installed equipment meets specifications, is installed and started up in accordance with manufacturer’s recommendations, and operates as intended. A commissioning plan will be prepared that describes the functional tests to be performed on the equipment and the acceptance criteria.

Prior to District acceptance of the project, Honeywell submits the final commissioning report containing signed acceptance sheets for each ECM. Signed acceptance sheets are obtained upon demonstrating the functionality of each ECM to a District appointed representative.

Additionally, Honeywell provides training for facility operators and personnel as needed when each ECM is completed and placed into service. All training is documented in the final commissioning report.

After the completion of the Honeywell commissioning effort, in accordance with New Jersey ESIP legislation, the District will be required to secure the services of a 3rd party independent firm to verify that the new equipment and systems meet the standards set forth in the Energy Savings Plan. To maintain the independence of this review, these costs must be born directly by the District. However, at the option of the District, these services can be financed as a portion of the total project cost.

5. Installation Standards

When Honeywell designs a solution, we consider current and future operations. For any upgrades, we install, we follow building codes/standards, which dictate certain standards for energy or building improvements. Listed in tables following this section are standards for building design. During the life of the agreement, there is a partnership approach to maintaining these standards for reasons of comfort and reliability. For lighting our standard is to meet or exceed Illuminating Engineering Society (IES) light level requirements, achieving the relevant standards wherever possible.

In the case of fluorescent lighting upgrades, we recommend that a group re-lamping of lamps be done approximately five years after the initial installation depending upon run times. Your building facility staff, on an as needed basis, can complete normal routine maintenance of lamps and ballasts. This maintains the quality of the lighting levels, and color rendering qualities of the lamps.

Space temperatures will be set by the energy management system and local building controls, and will be maintained on an annual basis. Flexibility will be maintained to regulate space temperatures as required to accommodate building occupant needs.

Your facility staff and building personnel will operate the energy management system with ongoing training and support from Honeywell. Therefore, both MCVTS and Honeywell will maintain the standards of comfort. The comfort standards will be maintained throughout the life of the agreement through sound maintenance planning and services recommended as part of this ESP.

Regarding ventilation, Honeywell will upgrade ventilation to meet current standards in those areas where our scope of work involves upgrades to or replacement of systems providing building ventilation. We generally will not upgrade ventilation in those areas where our work doesn't involve the upgrade or replacement of systems or equipment providing ventilation to a building or facility.

Heating and Cooling Standards

Heating Temperatures	Cooling Temperatures	Unoccupied Temperatures
70-72° F	72-74° F	58-62° F

Honeywell uses a variety of in-house labor as well as subcontractors to install the energy conservation measures. We have on staff trained professionals in fire, security, energy management systems, all temperature control systems, and HVAC. However, per the ESIP law, all trades will be publicly bid except for specific controls applications. Listed below is a sampling of some of the disciplines that would apply to MCVTS:

Improvements	Honeywell	Subcontractor
Engineering Design/Analysis	●	
Technical Audit	●	
Construction Administration/Management	●	
On-Site Construction Supervision	●	
Installation of Energy Management System	●	●
Manufacturer of Energy Management Equipment	●	●
Installation of HVAC/Mechanical Equipment		●
Installation of Renewable Technology		●
Installation of Building Envelope		●
Energy Supply Management Analysis/Implementation	●	
Installation of Boilers		●
Maintenance of Energy Management Equipment	●	●
Manufacturer/Installation of Temperature Controls	●	●
Monitoring/Verification Guarantee	●	
Training of Owner Staff	●	
Financial Responsibility for Energy Guarantees	●	

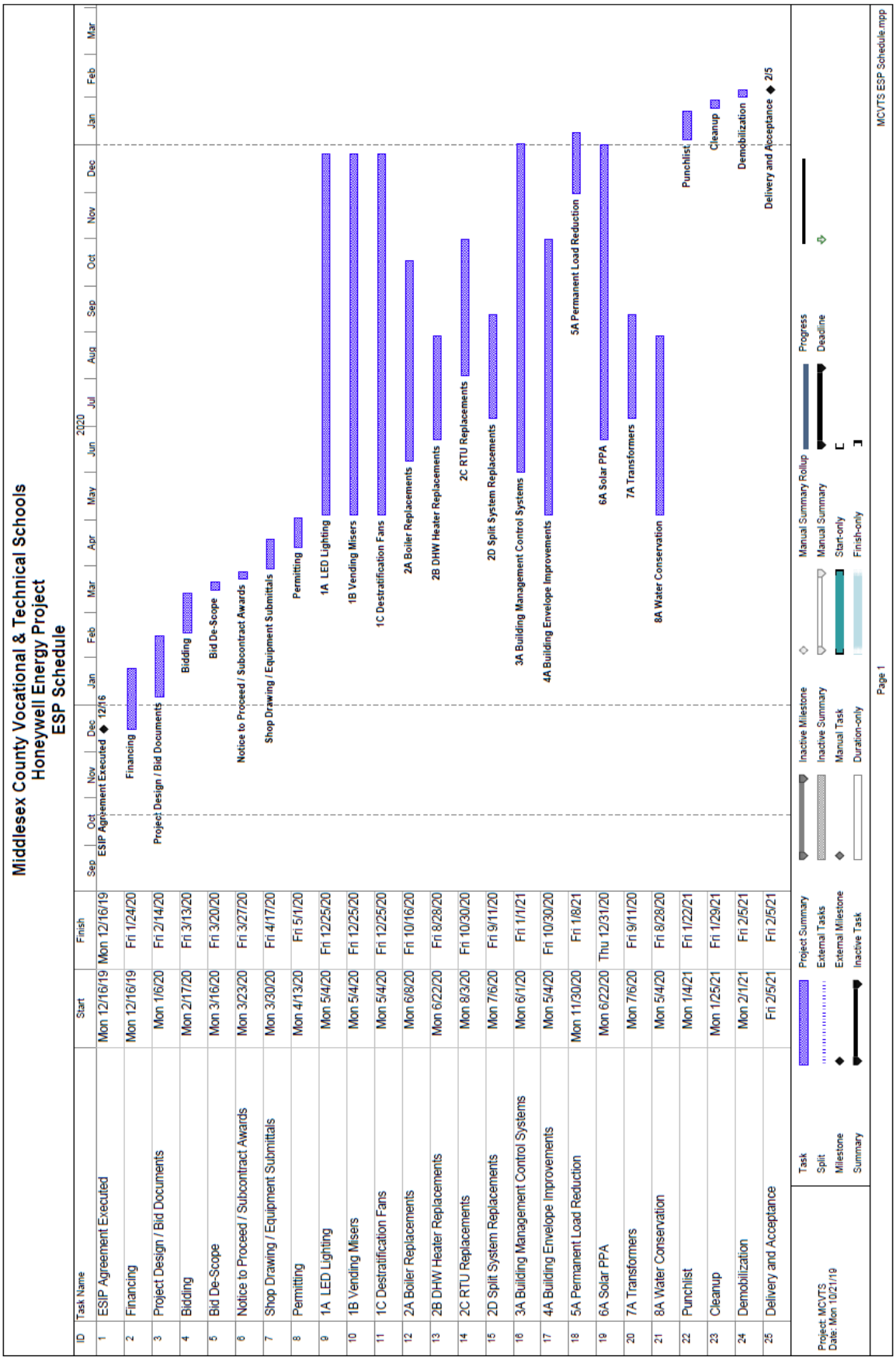
6. Hazardous Waste Disposal or Recycling

Honeywell disposes of all PCB ballasts or mercury containing materials removed as part of the project per EPA guidelines. Honeywell will complete all the required paperwork on behalf of MCVTS. Honeywell will work with MCVTS to review your hazardous material reports, and will identify the areas where work will be completed so that MCVTS can contract to have any necessary material abatement completed.

Honeywell can help schedule or coordinate waste removal, but does not contract for, or assume responsibility for, the abatement work. Honeywell also has the capabilities to assist MCVTS in working with the EPA under compliance management issues. We also develop and manufacture automated systems to track and report a wide variety of environmental factors.

7. Implementation Schedule

Attached please find a sample schedule for construction and completion of the Project.


Middlesex County Vocational & Technical Schools
Honeywell Energy Project
ESP Schedule
ID
Task Name
Start
Finish
1 ESIP Agreement Executed Mon 12/16/19 Mon 12/16/19
2 Financing Mon 12/16/19 Fri 1/24/20
3 Project Design / Bid Documents Mon 1/6/20 Fri 2/14/20
4 Bidding Mon 2/17/20 Fri 3/13/20
5 Bid De-Scope Mon 3/16/20 Fri 3/20/20
6 Notice to Proceed / Subcontract Awards Mon 3/23/20 Fri 3/27/20
7 Shop Drawing / Equipment Submittals Mon 3/30/20 Fri 4/17/20
8 Permitting Mon 4/13/20 Fri 5/1/20
9 1A LED Lighting Mon 5/4/20 Fri 12/25/20
10 1B Vending Misers Mon 5/4/20 Fri 12/25/20
11 1C Destratification Fans Mon 5/4/20 Fri 12/25/20
12 2A Boiler Replacements Mon 6/8/20 Fri 10/16/20
13 2B DHW Heater Replacements Mon 6/22/20 Fri 8/28/20
14 2C RTU Replacements Mon 8/3/20 Fri 10/30/20
15 2D Split System Replacements Mon 7/6/20 Fri 9/11/20
16 3A Building Management Control Systems Mon 6/1/20 Fri 1/1/21
17 4A Building Envelope Improvements Mon 5/4/20 Fri 10/30/20
18 5A Permanent Load Reduction Mon 11/30/20 Fri 1/8/21
19 6A Solar PPA Mon 6/22/20 Thu 12/31/20
20 7A Transformers Mon 7/6/20 Fri 9/11/20
21 8A Water Conservation Mon 5/4/20 Fri 8/28/20
22 Punchlist Mon 1/4/21 Fri 1/22/21
23 Cleanup Mon 1/25/21 Fri 1/29/21
24 Demobilization Mon 2/1/21 Fri 2/5/21
25 Delivery and Acceptance Fri 2/5/21 Fri 2/5/21
Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar
2020
ESIP Agreement Executed ◆ 12/16
Financing
Project Design / Bid Documents
Bidding
Bid De-Scope
Notice to Proceed / Subcontract Awards
Shop Drawing / Equipment Submittals
Permitting
1A LED Lighting
1B Vending Misers
1C Destratification Fans
2A Boiler Replacements
2B DHW Heater Replacements
2C RTU Replacements
2D Split System Replacements
3A Building Management Control Systems
4A Building Envelope Improvements
5A Permanent Load Reduction
6A Solar PPA
7A Transformers
8A Water Conservation
Punchlist
Cleanup
Demobilization
Delivery and Acceptance ◆ 2/5
Project: MCVTS
Date: Mon 10/21/19
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline
Page 1
MCVTS ESP Schedule.mpp

APPENDIX 1 INDEPENDENT ENERGY AUDITS

SEE ATTACHED USB DRIVE

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Local Government Energy Audit:
Energy Audit Report



Edison Campus

100 Technology Drive

Edison, New Jersey 08837

Middlesex County Vocational School District

October 30, 2018

Final Report by:

TRC Energy Services

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Disclaimer

The intent of this energy analysis report is to identify energy savings opportunities and recommend upgrades to the facility's energy using equipment and systems. Approximate savings are included in this report to help make decisions about reducing energy use at the facility. This report, however, is not intended to serve as a detailed engineering design document. Further design and analysis may be necessary in order to implement some of the measures recommended in this report.

The energy conservation measures and estimates of energy savings have been reviewed for technical accuracy. However, estimates of final energy savings are not guaranteed, because final savings may depend on behavioral factors and other uncontrollable variables. TRC Energy Services (TRC) and New Jersey Board of Public Utilities (NJBPU) shall in no event be liable should the actual energy savings vary.

Estimated installation costs are based on TRC's experience at similar facilities, pricing from local contractors and vendors, and/or cost estimates from *RS Means*. The owner of the facility is encouraged to independently confirm these cost estimates and to obtain multiple estimates when considering measure installations. Since actual installed costs can vary widely for certain measures and conditions, TRC and NJBPU do not guarantee installed cost estimates and shall in no event be held liable should actual installed costs vary from estimates.

New Jersey's Clean Energy Program (NJCEP) incentive values provided in this report are estimates based on program information available at the time of the report. Incentive levels are not guaranteed. The NJBPU reserves the right to extend, modify, or terminate programs without prior notice. The owner of the facility should review available program incentives and eligibility requirements prior to selecting and installing any energy conservation measures.

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1 EXECUTIVE SUMMARY

The New Jersey Board of Public Utilities (NJBPU) has sponsored this Local Government Energy Audit (LGEA) Report for Edison Campus.

The goal of an LGEA report is to provide you with information on how your facility uses energy, identify energy conservation measures (ECMs) that can reduce your energy use, and provide information and assistance to help facilities implement ECMs. The LGEA report also contains valuable information on financial incentives from New Jersey's Clean Energy Program (NJCEP) for implementing ECMs.

This study was conducted by TRC Energy Services (TRC), as part of a comprehensive effort to assist New Jersey local government in controlling energy costs and protecting our environment by offering a wide range of energy management options and advice.

1.1 Facility Summary

Edison Campus is a 15,200 square-foot facility constructed in 2000. The building is a two-story educational facility including but not limited to classrooms, offices, hallways and server room.

Lighting at the facility consists mainly of 32-Watt T8 fluorescent fixtures with a few U-bend 32-Watt T8 fluorescent fixtures; all of which are inefficient in performance when compared to the latest lighting technology available in the market. In addition to linear fluorescent technology, the facility also has several compact fluorescent lamps, metal halide lamps, as well as LED exit signs. Lighting control is provided by manual switches.

Cooling and ventilation is provided by rooftop packaged AC and split system AC systems. Heating is provided by a combination of gas-fired roof top units and non-condensing hot water boiler.

A thorough description of the facility and our observations are in Section 2.

1.2 Your Cost Reduction Opportunities

Energy Conservation Measures

TRC evaluated 10 measures and recommended seven measures which together represent an opportunity for Edison Campus to reduce annual energy costs by roughly $9,553 and annual greenhouse gas emissions by 63,604 lbs. CO_2e. We estimate that if all measures were implemented as recommended, the project would pay for itself in roughly 5.3 years. The breakdown of existing and potential utility costs after project implementation are illustrated in Figure 1 and Figure 2, respectively. Together these measures represent an opportunity to reduce Edison Campus's annual energy use by 11%.

Figure 1 – Previous 12 Month Utility Costs

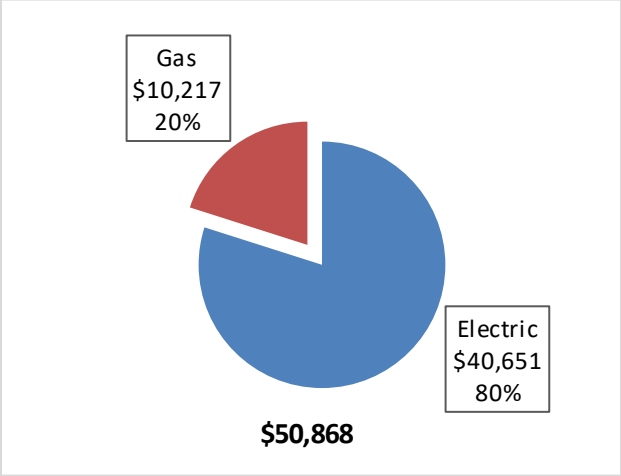
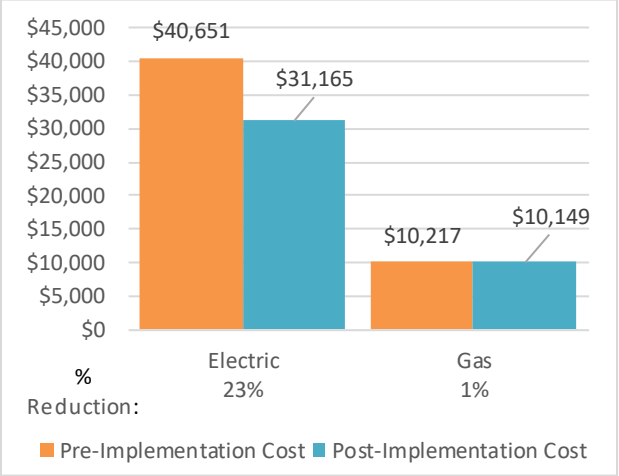


Figure 2 – Potential Post-Implementation Costs



A detailed description of Edison Campus's existing energy use can be found in Section 3.

Estimates of the total cost, energy savings, and financial incentives for the proposed energy efficient upgrades are summarized below in Figure 3. A brief description of each category can be found below and a description of savings opportunities can be found in Section 4.

Figure 3 – Summary of Energy Reduction Opportunities

Energy Conservation Measure		Recommend?	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades			**46,936**	**13.4**	**0.0**	**$7,148.42**	**$37,009.28**	**$4,755.00**	**$32,254.28**	**4.5**	**47,264**
ECM 1	Install LED Fixtures	Yes	11,542	3.3	0.0	$1,757.80	$4,880.11	$90.00	$4,790.11	2.7	11,622
ECM 2	Retrofit Fixtures with LED Lamps	Yes	35,395	10.1	0.0	$5,390.63	$32,129.17	$4,665.00	$27,464.17	5.1	35,642
Lighting Control Measures			**11,322**	**3.2**	**0.0**	**$1,724.41**	**$15,700.00**	**$1,610.00**	**$14,090.00**	**8.2**	**11,402**
ECM 3	Install Occupancy Sensor Lighting Controls	Yes	9,034	2.6	0.0	$1,375.93	$13,500.00	$1,610.00	$11,890.00	8.6	9,097
ECM 4	Install High/Low Lighitng Controls	Yes	2,288	0.7	0.0	$348.47	$2,200.00	$0.00	$2,200.00	6.3	2,304
Motor Upgrades			**1,728**	**2.2**	**0.0**	**$263.21**	**$3,404.63**	**$0.00**	**$3,404.63**	**12.9**	**1,740**
ECM 5	Premium Efficiency Motors	Yes	1,728	2.2	0.0	$263.21	$3,404.63	$0.00	$3,404.63	12.9	1,740
Electric Unitary HVAC Measures			**9,198**	**6.2**	**0.0**	**$1,400.84**	**$221,597.17**	**$0.00**	**$221,597.17**	**158.2**	**9,262**
	Install High Efficiency Electric AC	No	9,198	6.2	0.0	$1,400.84	$221,597.17	$0.00	$221,597.17	158.2	9,262
Gas Heating (HVAC/Process) Replacement			**0**	**0.0**	**111.5**	**$998.56**	**$37,725.24**	**$2,912.00**	**$34,813.24**	**34.9**	**13,054**
	Install High Efficiency Hot Water Boilers	No	0	0.0	61.5	$550.85	$23,043.29	$2,112.00	$20,931.29	38.0	7,201
	Install High Efficiency Furnaces	No	0	0.0	50.0	$447.71	$14,681.95	$800.00	$13,881.95	31.0	5,853
Domestic Water Heating Upgrade			**0**	**0.0**	**7.6**	**$67.67**	**$179.25**	**$0.00**	**$179.25**	**2.6**	**885**
ECM 6	Install Low-Flow Domestic Hot Water Devices	Yes	0	0.0	7.6	$67.67	$179.25	$0.00	$179.25	2.6	885
Plug Load Equipment Control - Vending Machine			**2,297**	**0.0**	**0.0**	**$349.82**	**$690.00**	**$0.00**	**$690.00**	**2.0**	**2,313**
ECM 7	Vending Machine Control	Yes	2,297	0.0	0.0	$349.82	$690.00	$0.00	$690.00	2.0	2,313
TOTALS FOR HIGH PRIORITY MEASURES			**62,284**	**18.8**	**7.6**	**$9,553.53**	**$56,983.16**	**$6,365.00**	**$50,618.16**	**5.3**	**63,604**
TOTALS FOR ALL EVALUATED MEASURES			**71,481**	**25.0**	**119.0**	**$11,952.92**	**$316,305.56**	**$9,277.00**	**$307,028.56**	**25.7**	**85,920**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

Lighting Upgrades generally involve the replacement of existing lighting components such as lamps and ballasts (or the entire fixture) with higher efficiency lighting components. These measures save energy by reducing the power used by the lighting components due to improved electrical efficiency.

Lighting Controls measures generally involve the installation of automated controls to turn off lights or reduce light output when not needed. Automated control reduces reliance on occupant behavior for adjusting lights. These measures save energy by reducing the amount of time lights are on.

Motor Upgrades generally involve replacing older standard efficiency motors with high efficiency standard (NEMA Premium®). Motors replacements generally assume the same size motors, just higher efficiency. Although occasionally additional savings can be achieved by downsizing motors to better meet current load requirements. This measure saves energy by reducing the power used by the motors, due to improved electrical efficiency.

Electric Unitary HVAC measures generally involve replacing older inefficient air conditioning systems with modern energy efficient systems. New air conditioning systems can provide equivalent cooling to older air condition systems at a reduced energy cost. These measures save energy by reducing the power used by the air conditioning systems, due to improved electrical efficiency.

Gas Heating (HVAC/Process) measures generally involve replacing older inefficient hydronic heating systems with modern energy efficient systems. Gas heating systems can provide equivalent heating compared to older systems at a reduced energy cost. These measures save energy by reducing the fuel demands for heating, due to improved combustion and heat transfer efficiency.

Domestic Hot Water upgrade measures generally involve replacing older inefficient domestic water heating systems with modern energy efficient systems. New domestic hot water heating systems can provide equivalent, or greater, water heating capacity compared to older systems at a reduced energy cost. These measures save energy by reducing the fuel used for domestic hot water heating due to improved heating efficiency or reducing standby losses.

Plug Load Equipment control measures generally involve installing automated devices that limit the power usage or operation of equipment that is plugged into an electric outlet when not in use.

Energy Efficient Practices

TRC also identified 16 low cost (or no cost) energy efficient practices. A facility's energy performance can be significantly improved by employing certain behavioral or operational adjustments and by performing better routine maintenance on building systems. These practices can extend equipment lifetime, improve occupant comfort, provide better health and safety, as well as reduce annual energy and O&M costs. Potential opportunities identified at Edison Campus include:

- Close Doors and Windows
- Use Window Treatments/Coverings
- Perform Proper Lighting Maintenance
- Develop a Lighting Maintenance Schedule
- Perform Routine Motor Maintenance
- Use Fans to Reduce Cooling Load
- Practice Proper Use of Thermostat Schedules and Temperature Resets
- Ensure Economizers are Functioning Properly
- Clean Evaporator/Condenser Coils on AC Systems
- Clean and/or Replace HVAC Filters
- Perform Proper Boiler Maintenance
- Perform Proper Furnace Maintenance
- Perform Proper Water Heater Maintenance
- Install Plug Load Controls
- Replace Computer Monitors
- Water Conservation

For details on these energy efficient practices, please refer to Section 5.

On-Site Generation Measures

TRC evaluated the potential for installing on-site generation for Edison Campus. Based on the configuration of the site and its loads there is a high potential for installing a photovoltaic (PV) array.

Figure 4 – Photovoltaic Potential

Potential	High	
System Potential	80	kW DC STC
Electric Generation	95,310	kWh/yr
Displaced Cost	$8,290	/yr
Installed Cost	$208,000	

For details on our evaluation and on-site generation potential, please refer to Section 6.

1.3 Implementation Planning

To realize the energy savings from the ECMs listed in this report, a project implementation plan must be developed. Available capital must be considered and decisions need to be made whether it is best to pursue individual ECMs separately, groups of ECMs, or a comprehensive approach where all ECMs are implemented together, possibly in conjunction with other facility upgrades or improvements.

Rebates, incentives, and financing are available from NJCEP, as well as other sources, to help reduce the costs associated with the implementation of energy efficiency projects. Prior to implementing any measure, please review the relevant incentive program guidelines before proceeding. This is important because in most cases you will need to submit applications for the incentives prior to purchasing materials or commencing with installation.

The ECMs outlined in this report may qualify under the following program(s):

- SmartStart
- Direct Install
- SREC (Solar Renewable Energy Certificate) Registration Program (SRP)
- Energy Savings Improvement Program (ESIP)

For facilities wanting to pursue only selected individual measures (or planning to phase implementation of selected measures over multiple years), incentives are available through the SmartStart program. To participate in this program, you may utilize internal resources, or an outside firm or contractor, to do the final design of the ECM(s) and do the installation. Program pre-approval is required for some SmartStart incentives, so only after receiving pre-approval should you proceed with ECM installation. The incentive estimates listed above in Figure 3 are based on the SmartStart program. More details on this program and others are available in Section 8.

This facility may also qualify for the Direct Install program which can provide turnkey installation of multiple measures, through an authorized network of participating contractors. This program can provide substantially higher incentives that SmartStart, up to 70% of the cost of selected measures, although measure eligibility will have to be assessed and be verified by the designated Direct Install contractor and, in most cases, they will perform the installation work.

For larger facilities with limited capital availability to implement ECMs, project financing may be available through the Energy Savings Improvement Program (ESIP). Supported directly by the NJBPU, ESIP provides government agencies with project development, design, and implementation support services, as well as, attractive financing for implementing ECMs. An LGEA report (or other approved energy audit) is required for participation in ESIP. Please refer to Section 8.4 for additional information on the ESIP Program.

The Demand Response Energy Aggregator is a (non-NJCEP) program designed to reduce electric loads at commercial facilities, when wholesale electricity prices are high or when the reliability of the electric grid is threatened due to peak power demand. Demand Response (DR) service providers (a.k.a. Curtailment Service Providers) are registered with PJM, the independent system operator (ISO) for mid-Atlantic state region that is charged with maintaining electric grid reliability. By enabling grid operators to call upon commercial facilities to reduce their electric usage during times of peak demand, the grid is made more reliable and overall transmission costs are reduced for all ratepayers. Curtailment Service Providers provide regular payments to medium and large consumers of electric power for their participation in DR programs. Program participation is voluntary and facilities receive payments whether or not they are called upon to curtail their load during times of peak demand. Refer to Section 7 for additional information on this program.

Additional information on relevant incentive programs is in Section 8 or: www.njcleanenergy.com/ci.

2 FACILITY INFORMATION AND EXISTING CONDITIONS

2.1 Project Contacts

Figure 5 – Project Contacts

Name	Role	E-Mail	Phone #
Customer			
Karl Knehr	Business Administrator	knehrk@mail.mcvts.net	732-257-3300
TRC Energy Services			
Alexander Klieverik	Auditor	AKlieverik@trcsolutions.com	(732) 855-0033

2.2 General Site Information

On February 27, 2018, TRC performed an energy audit at Edison Campus located in Edison, New Jersey. TRC's team met with Karl Knehr and Francis Cap to review the facility operations and help focus our investigation on specific energy-using systems.

Edison Campus is a 15,200 square-foot facility constructed in 2000. The building is a two-story educational facility including but not limited to classrooms, offices, hallways and server room.

2.3 Building Occupancy

The typical schedule is presented in the table below.

Figure 6 - Building Schedule

Building Name	Weekday/Weekend	Operating Schedule
Edison Campus	Weekday	9:00 AM - 5:00 PM
Edison Campus	Weekend	Off

2.4 Building Envelope

The construction of Edison campus building is typically of concrete masonry block with brick type exterior and double pane clear windows with fixed frames. The flat roof sections are clad with a built-up roof system.

Figure 7 – Building Façade



2.5 On-Site Generation

Edison Campus does not have any on-site electric generation capacity.

2.6 Energy-Using Systems

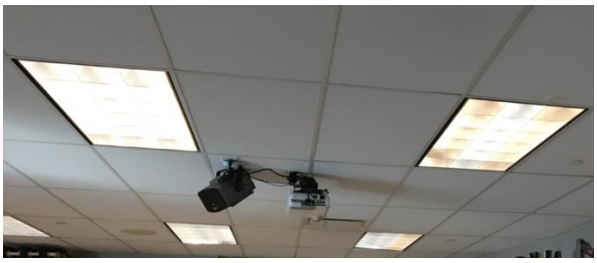
Please see Appendix A: Equipment Inventory & Recommendations for an inventory of the facility's equipment.

Lighting System

Lighting consists largely of 32-Watt T8 fluorescent fixtures with a few 32-Watt T8 U-bend fluorescent fixtures. These sources are inefficient in performance when compared to the latest lighting technology available in the market. fluorescent T8 fixtures are 2-foot U-bend and 4-foot long linear, mainly troffers with diffusers having 1-lamp to 4-lamp configurations. In addition, there are several 26-Watt compact fluorescent fixtures with 1-lamp and 2-lamp configurations. Lighting at the facility also includes 400-Watt metal halide fixtures. All the exit signs are LED based fixtures.

Interior lighting control in the building is provided by manual switches.

Figure 8 - Building Lighting Systems

Linear Fluorescent Fixtures	*Compact Fluorescent Fixtures*
	

Building Heating System

The hot water system consists of one Hydrotherm 960 kBtu/hr. output, non-condensing boiler. The boiler has a nominal combustion efficiency of 80%. Hot water from the boiler is circulated by two 2 HP hot water pumps. Pump speed control is provided by variable frequency drives. The boiler provides hot water to zone VAV boxes, cabinet heaters, and unit heaters.

Figure 9 – Hot Water Heating Systems

Hot Water Boiler	*Hot Water Pumps*
	

In addition to the hot water system, heating at the facility is also provided by two gas-fired roof top package units. Each unit has an output capacity of 324 kBtu/hr. with heating efficiency of 80%.

Direct Expansion Air Conditioning System (DX)

Cooling at the facility is provided by a combination of rooftop package units and a split system AC. There are two Trane 50-ton rooftop package units which utilizes direct expansion (DX) refrigerant coils to provide cooling. The units are connected to zone side variable air volume boxes with re-heat coils. Supply fans at both the package units have variable frequency drives for demand based speed variation. The units have outside air economizers to utilize free cooling when the outside air temperature is lower than the return air temperature.

Package units are also equipped with gas fired burners to provide heating to the building as described in the heating section of this report.

Figure 10 - Building Heating Systems

Rooftop Package Units	*Split System AC*
	

In addition to the package units, the facility also has a Mitsubishi 1.5-ton split system AC installed on the rooftop.

Domestic Hot Water Heating System

The domestic hot water heating system for the facility consists of one Lochinvar hot water boiler with an input rating of 270 kBtu/hr. and a nominal efficiency of 80%. The water heater has a separate 200-gallon storage tank. Water is produced at 180°F and mixed down to 125°F to be distributed throughout the building. There is a fractional HP pump that transfer hot water from the boiler to the tank, and another fractional HP pump to distribute through the building.

Figure 11 – Domestic Hot Water Heater

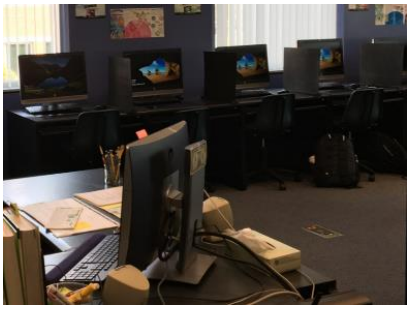
Domestic Hot Water Heater	*Storage Tank*
	

Building Plug Load

There are roughly 94 computer work stations throughout the facility. All the computers are desktop units with LCD monitors. There is no centralized PC power management software installed.

The facility contains other systems which contribute to plug load including printers, microwaves, and televisions at the facility. In addition to the typical plug load equipment, the facility also has one refrigerated and two non-refrigerated vending machines.

Figure 12 – Building Plug-load Systems

Vending Machines	*Desktop PC*
	

2.7 Water-Using Systems

Facility has several faucet aerators throughout. Faucets have 2.5 gallons per minute (gpm) flow capacity and hot water to the faucets are provided from the domestic hot water heater.

3 SITE ENERGY USE AND COSTS

Utility data for electricity and natural gas was analyzed to identify opportunities for savings. In addition, data for electricity and natural gas was evaluated to determine the annual energy performance metrics for the building in energy cost per square foot and energy usage per square foot. These metrics are an estimate of the relative energy efficiency of this building. There are several factors that could cause the energy use of this building to vary from the "typical" energy usage profile for facilities with similar characteristics. Local weather conditions, building age and insulation levels, equipment efficiency, daily occupancy hours, changes in occupancy throughout the year, equipment operating hours, and energy efficient behavior of occupants all contribute to benchmarking scores. Please refer to the Benchmarking section within Section 3.4 for additional information.

3.1 Total Cost of Energy

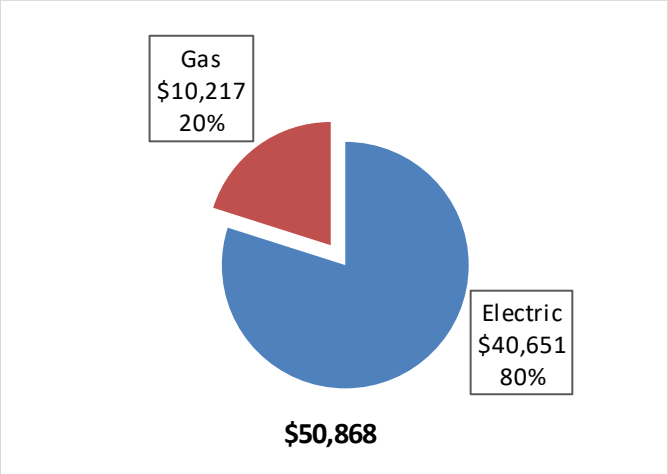
The following energy consumption and cost data is based on the last 12-month period of utility billing data that was provided for each utility. A profile of the annual energy consumption and energy cost of the facility was developed from this information.

Figure 13 - Utility Summary

Utility Summary for Edison Campus		
Fuel	**Usage**	**Cost**
Electricity	266,911 kWh	$40,651
Natural Gas	11,407 Therms	$10,217
Total		**$50,868**

The current annual energy cost for this facility is $50,868 as shown in the chart below.

Figure 14 - Energy Cost Breakdown



3.2 Electricity Usage

Electricity is provided by PSE&G. The average electric cost over the past 12 months was $0.152/kWh, which is the blended rate that includes energy supply, distribution, and other charges. This rate is used throughout the analyses in this report to assess energy costs and savings. The monthly electricity consumption and peak demand are shown in the chart below. The energy use profile appears normal for a building with an air conditioning load in a temperate climate. The demand spike in May could have been the result of an unusually hot day when the building was in full occupancy.

Figure 15 - Electric Usage & Demand

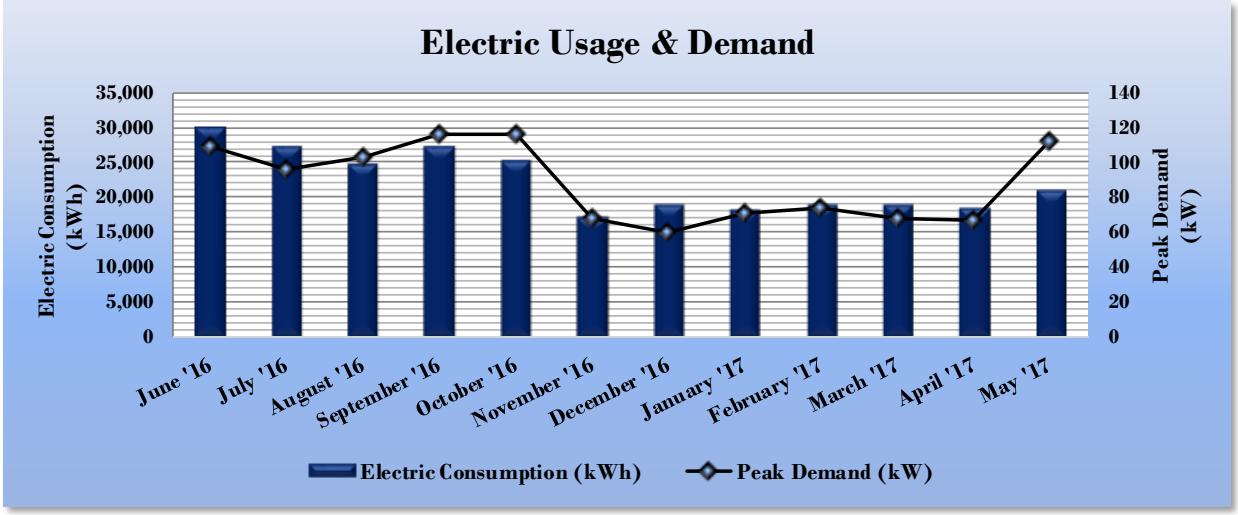


Figure 16 - Electric Usage & Demand

Electric Billing Data for Edison Campus					
Period Ending	Days in Period	Electric Usage (kWh)	Demand (kW)	Demand Cost	Total Electric Cost
6/24/16	29	29,998	109	$399	$4,917
7/26/16	32	27,287	96	$351	$4,475
8/24/16	29	24,705	103	$379	$4,293
9/23/16	30	27,215	116	$431	$4,739
10/24/16	31	25,281	116	$431	$3,460
11/22/16	29	17,085	68	$253	$2,409
12/23/16	31	18,997	59	$220	$2,687
1/25/17	33	18,310	71	$263	$2,586
2/24/17	30	18,837	73	$273	$2,653
3/27/17	31	18,846	68	$257	$2,638
4/26/17	30	18,570	67	$253	$2,605
5/25/17	29	21,049	112	$421	$3,078
Totals	**364**	**266,180**	**116.2**	**$3,929**	**$40,539**
Annual	**365**	**266,911**	**116.2**	**$3,940**	**$40,651**

3.3 Natural Gas Usage

Natural gas is provided by Elizabethtown Gas. The average gas cost for the past 12 months is $0.896/therm, which is the blended rate used throughout the analyses in this report. The monthly gas consumption is shown in the chart below. The usage profile is typical of a gas heated building in a temperate Climate with a moderate domestic hot water load.

Figure 17 - Natural Gas Usage

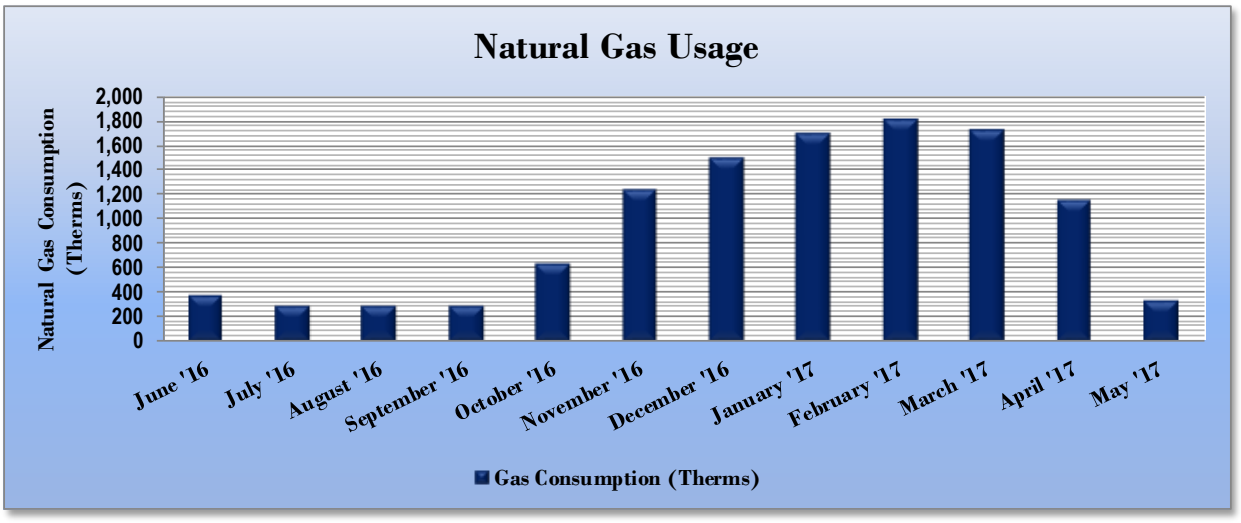


Figure 18 - Natural Gas Usage

Gas Billing Data for Edison Campus			
Period Ending	Days in Period	Natural Gas Usage (Therms)	Natural Gas Cost
6/27/16	32	384	$435
7/27/16	30	291	$374
8/26/16	30	288	$367
9/27/16	32	299	$376
10/26/16	29	641	$621
12/1/16	36	1,248	$1,114
12/27/16	26	1,506	$1,254
1/25/17	29	1,703	$1,390
2/24/17	30	1,821	$1,481
3/27/17	31	1,733	$1,417
4/27/17	31	1,161	$994
5/26/17	29	332	$394
Totals	**365**	**11,407**	**$10,217**
Annual	**365**	**11,407**	**$10,217**

3.4 Benchmarking

This facility was benchmarked using Portfolio Manager®, an online tool created and managed by the United States Environmental Protection Agency (EPA) through the ENERGY STAR® program. Portfolio Manager® analyzes your building's consumption data, cost information, and operational use details and then compares its performance against a national median for similar buildings of its type. Metrics provided by this analysis are Energy Use Intensity (EUI) and an ENERGY STAR® score for select building types.

The EUI is a measure of a facility's energy consumption per square foot, and it is the standard metric for comparing buildings' energy performance. Comparing the EUI of a building with the national median EUI for that building type illustrates whether that building uses more or less energy than similar buildings of its type on a square foot basis. EUI is presented in terms of "site energy" and "source energy." Site energy is the amount of fuel and electricity consumed by a building as reflected in utility bills. Source energy includes fuel consumed to generate electricity consumed at the site, factoring in electric production and distribution losses for the region.

Figure 19 - Energy Use Intensity Comparison – Existing Conditions

Energy Use Intensity Comparison - Existing Conditions		
	Edison Campus	National Median Building Type: School (K-12)
Source Energy Use Intensity (kBtu/ft^2)	266.9	141.4
Site Energy Use Intensity (kBtu/ft^2)	135.0	58.2

Implementation of all recommended measures in this report would improve the building's estimated EUI significantly, as shown in the table below:

Figure 20 - Energy Use Intensity Comparison – Following Installation of Recommended Measures

Energy Use Intensity Comparison - Following Installation of Recommended Measures		
	Edison Campus	National Median Building Type: School (K-12)
Source Energy Use Intensity (kBtu/ft^2)	222.5	141.4
Site Energy Use Intensity (kBtu/ft^2)	120.5	58.2

Many types of commercial buildings are also eligible to receive an ENERGY STAR® score. This score is a percentile ranking from 1 to 100. It compares your building's energy performance to similar buildings nationwide. A score of 50 represents median energy performance, while a score of 75 means your building performs better than 75 percent of all similar buildings nationwide and may be eligible for ENERGY STAR® certification. This facility has a current score of 40.

A Portfolio Manager® Statement of Energy Performance (SEP) was generated for this facility, see Appendix B: ENERGY STAR® Statement of Energy Performance.

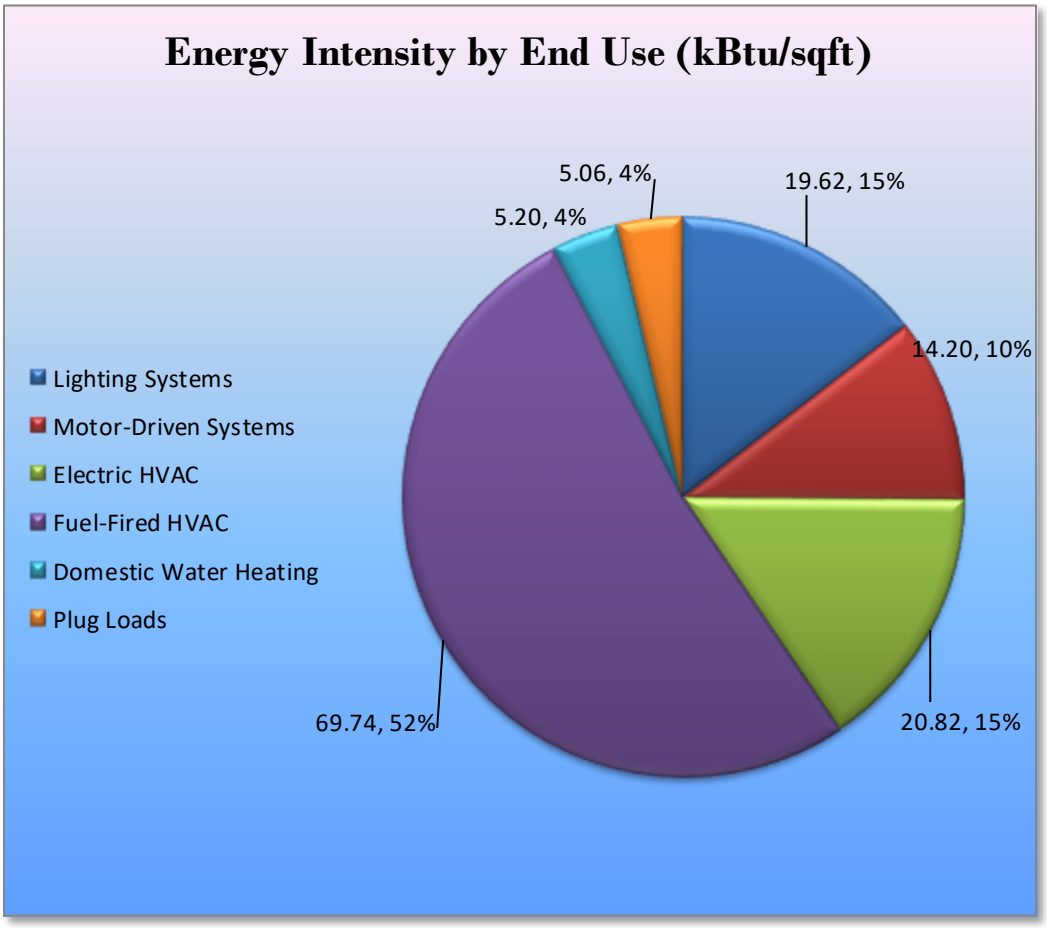
For more information on ENERGY STAR® certification go to: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification/how-app-1.

A Portfolio Manager® account has been created online for your facility and you will be provided with the login information for the account. We encourage you to update your utility information in Portfolio Manager® regularly, so that you can keep track of your building's performance. Free online training is available to help you use ENERGY STAR® Portfolio Manager® to track your building's performance at: https://www.energystar.gov/buildings/training.

3.5 Energy End-Use Breakdown

To provide a complete overview of energy consumption across building systems, an energy balance was performed at this facility. An energy balance utilizes standard practice engineering methods to evaluate all components of the various electric and fuel-fired systems found in a building to determine their proportional contribution to overall building energy usage. This chart of energy end uses highlights the relative contribution of each equipment category to total energy usage. This can help determine where the greatest benefits might be found from energy efficiency measures.

Figure 21 - Energy Balance (% and kBtu/SF)



4 ENERGY CONSERVATION MEASURES

Level of Analysis

The goal of this audit report is to identify potential energy efficiency opportunities, help prioritize specific measures for implementation, and provide information to the Edison Campus regarding financial incentives for which they may qualify to implement the recommended measures. For this audit report, most measures have received only a preliminary analysis of feasibility which identifies expected ranges of savings and costs. This level of analysis is usually considered sufficient to demonstrate project cost-effectiveness and help prioritize energy measures. Savings are based on the New Jersey Clean Energy Program Protocols to Measure Resource Savings dated June 29, 2016, approved by the New Jersey Board of Public Utilities. Further analysis or investigation may be required to calculate more precise savings based on specific circumstances. A higher level of investigation may be necessary to support any custom SmartStart or Pay for Performance, or Direct Install incentive applications. Financial incentives for the ECMs identified in this report have been calculated based the NJCEP prescriptive SmartStart program. Some measures and proposed upgrade projects may be eligible for higher incentives than those shown below through other NJCEP programs as described in Section 8.

The following sections describe the evaluated measures.

4.1 Recommended ECMs

The measures below have been evaluated by the auditor and are recommended for implementation at the facility.

Figure 22 – Summary of Recommended ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**46,936**	**13.4**	**0.0**	**$7,148.42**	**$37,009.28**	**$4,755.00**	**$32,254.28**	**4.5**	**47,264**
ECM 1	Install LED Fixtures	11,542	3.3	0.0	$1,757.80	$4,880.11	$90.00	$4,790.11	2.7	11,622
ECM 2	Retrofit Fixtures with LED Lamps	35,395	10.1	0.0	$5,390.63	$32,129.17	$4,665.00	$27,464.17	5.1	35,642
Lighting Control Measures		**11,322**	**3.2**	**0.0**	**$1,724.41**	**$15,700.00**	**$1,610.00**	**$14,090.00**	**8.2**	**11,402**
ECM 3	Install Occupancy Sensor Lighting Controls	9,034	2.6	0.0	$1,375.93	$13,500.00	$1,610.00	$11,890.00	8.6	9,097
ECM 4	Install High/Low Lighitng Controls	2,288	0.7	0.0	$348.47	$2,200.00	$0.00	$2,200.00	6.3	2,304
Motor Upgrades		**1,728**	**2.2**	**0.0**	**$263.21**	**$3,404.63**	**$0.00**	**$3,404.63**	**12.9**	**1,740**
ECM 5	Premium Efficiency Motors	1,728	2.2	0.0	$263.21	$3,404.63	$0.00	$3,404.63	12.9	1,740
Domestic Water Heating Upgrade		**0**	**0.0**	**7.6**	**$67.67**	**$179.25**	**$0.00**	**$179.25**	**2.6**	**885**
ECM 6	Install Low-Flow Domestic Hot Water Devices	0	0.0	7.6	$67.67	$179.25	$0.00	$179.25	2.6	885
Plug Load Equipment Control - Vending Machine		**2,297**	**0.0**	**0.0**	**$349.82**	**$690.00**	**$0.00**	**$690.00**	**2.0**	**2,313**
ECM 7	Vending Machine Control	2,297	0.0	0.0	$349.82	$690.00	$0.00	$690.00	2.0	2,313
TOTALS		**62,284**	**18.8**	**7.6**	**$9,553.53**	**$56,983.16**	**$6,365.00**	**$50,618.16**	**5.3**	**63,604**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

4.1.1 Lighting Upgrades

Our recommendations for upgrades to existing lighting fixtures are summarized in Figure 23 below.

Figure 23 – Summary of Lighting Upgrade ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**46,936**	**13.4**	**0.0**	**$7,148.42**	**$37,009.28**	**$4,755.00**	**$32,254.28**	**4.5**	**47,264**
ECM 1	Install LED Fixtures	11,542	3.3	0.0	$1,757.80	$4,880.11	$90.00	$4,790.11	2.7	11,622
ECM 2	Retrofit Fixtures with LED Lamps	35,395	10.1	0.0	$5,390.63	$32,129.17	$4,665.00	$27,464.17	5.1	35,642

During lighting upgrade planning and design, we recommend a comprehensive approach that considers both the efficiency of the lighting fixtures and how they are controlled.

ECM 1: Install LED Fixtures

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	11,542	3.3	0.0	$1,757.80	$4,880.11	$90.00	$4,790.11	2.7	11,622
Exterior	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend replacing existing fixtures containing 400-Watt metal halide lamps with new high-performance LED light fixtures. This measure saves energy by installing LEDs which use less power than other technologies with a comparable light output.

Additional savings from lighting maintenance can be anticipated since LEDs have lifetimes which are more than twice that of a metal halide lamp.

ECM 2: Retrofit Fixtures with LED Lamps

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	35,395	10.1	0.0	$5,390.63	$32,129.17	$4,665.00	$27,464.17	5.1	35,642
Exterior	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend retrofitting existing T8 linear fluorescent, T8 U-bend fluorescent, and compact fluorescent lighting technologies with LED lamps. Many LED tube lamps are direct replacements for existing fluorescent lamps and can be installed while leaving the fluorescent fixture ballast in place. LED bulbs can be used in existing fixtures as a direct replacement for most other lighting technologies. This measure saves energy by installing LEDs which use less power than other lighting technologies yet provide equivalent lighting output for the space.

Additional savings from lighting maintenance can be anticipated since LEDs have lifetimes which are more than twice that of a fluorescent tube.

4.1.2 Lighting Control Measures

Our recommendations for lighting control measures are summarized in Figure 24 below.

Figure 24 – Summary of Lighting Control ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Control Measures		**11,322**	**3.2**	**0.0**	**$1,724.41**	**$15,700.00**	**$1,610.00**	**$14,090.00**	**8.2**	**11,402**
ECM 3	Install Occupancy Sensor Lighting Controls	9,034	2.6	0.0	$1,375.93	$13,500.00	$1,610.00	$11,890.00	8.6	9,097
ECM 4	Install High/Low Lighitng Controls	2,288	0.7	0.0	$348.47	$2,200.00	$0.00	$2,200.00	6.3	2,304

During lighting upgrade planning and design, we recommend a comprehensive approach that considers both the efficiency of the lighting fixtures and how they are controlled.

ECM 3: Install Occupancy Sensor Lighting Controls

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
9,034	2.6	0.0	$1,375.93	$13,500.00	$1,610.00	$11,890.00	8.6	9,097

Measure Description

We recommend installing occupancy sensors to control lighting fixtures that are currently controlled by manual switches in classrooms, restrooms, media center, etc. Lighting sensors detect occupancy using ultrasonic and/or infrared sensors. For most spaces, we recommend lighting controls use dual technology sensors, which can eliminate the possibility of any lights turning off unexpectedly. Lighting systems are enabled when an occupant is detected. Fixtures are automatically turned off after an area has been vacant for a preset period. Some controls also provide dimming options and all modern occupancy controls can be easily over-ridden by room occupants to allow them to manually turn fixtures on or off, as desired. Energy savings results from only operating lighting systems when they are required.

Occupancy sensors may be mounted on the wall at existing switch locations, mounted on the ceiling, or in remote locations. In general, wall switch replacement sensors are recommended for single occupant offices and other small rooms. Ceiling-mounted or remote mounted sensors are used in locations without local switching or where wall switches are not in the line-of-sight of the main work area and in large spaces. We recommend a comprehensive approach to lighting design that upgrades both the lighting fixtures and the controls together for maximum energy savings and improved lighting for occupants.

ECM 4: Install High/Low Lighting Controls

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
2,288	0.7	0.0	$348.47	$2,200.00	$0.00	$2,200.00	6.3	2,304

Measure Description

We recommend installing occupancy sensors to provide dual level lighting control for lighting fixtures in spaces that are infrequently occupied but may require some level of continuous lighting for safety or security reasons. Typical areas for such lighting control are stairwells, interior corridors, parking lots, and parking garages.

Lighting fixtures with these controls operate at default low levels when the area is not occupied to provide minimal lighting to meet security or safety requirements. Sensors detect occupancy using ultrasonic and/or infrared sensors. The lighting systems are switched to full lighting levels whenever an occupant is detected. Fixtures are automatically switched back to low level after an area has been vacant for a preset period. Energy savings results from only providing full lighting levels when it is required.

For this type of measure the occupancy sensors will generally be ceiling or fixture mounted. Sufficient sensor coverage needs to be provided to ensure that lights turn on in each area as an occupant approaches.

Additional savings from reduced lighting maintenance may also result from this measure, due to reduced lamp operation.

4.1.3 Motor Upgrades

Our recommendations for motor upgrades are summarized in Figure 25 below.

Figure 25-Summary of Motor Upgrade ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Motor Upgrades		**1,728**	**2.2**	**0.0**	**$263.21**	**$3,404.63**	**$0.00**	**$3,404.63**	**12.9**	**1,740**
ECM 5	Premium Efficiency Motors	1,728	2.2	0.0	$263.21	$3,404.63	$0.00	$3,404.63	12.9	1,740

ECM 5: Premium Efficiency Motors

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
1,728	2.2	0.0	$263.21	$3,404.63	$0.00	$3,404.63	12.9	1,740

Measure Description

We recommend replacing standard efficiency motors with NEMA Premium® efficiency motors. Our evaluation assumes that existing motors will be replaced with motors of equivalent size and type. Although occasionally additional savings can be achieved by downsizing motors to better meet the motor's current load requirements. The base case motor efficiencies are estimated from nameplate information and our best estimates of motor run hours. Efficiencies of proposed motor upgrades are obtained from the *New Jersey's Clean Energy Program Protocols to Measure Resource Savings (2016)*. Savings are based on the difference between baseline and proposed efficiencies and the assumed annual operating hours.

4.1.4 Domestic Hot Water Heating System Upgrades

Our recommendations for domestic water heating system improvements are summarized in Figure 26 below.

Figure 26 - Summary of Domestic Water Heating ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Domestic Water Heating Upgrade		**0**	**0.0**	**7.6**	**$67.67**	**$179.25**	**$0.00**	**$179.25**	**2.6**	**885**
ECM 6	Install Low-Flow Domestic Hot Water Devices	0	0.0	7.6	$67.67	$179.25	$0.00	$179.25	2.6	885

ECM 6: Install Low-Flow DHW Devices

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
0	0.0	7.6	$67.67	$179.25	$0.00	$179.25	2.6	885

Measure Description

We recommend installing low-flow domestic hot water devices to reduce overall hot water demand. Energy demand from domestic hot water heating systems can be reduced by reducing water usage in general. Faucet aerators can reduce hot water usage, relative to standard aerators, which saves energy.

Low-flow devices reduce the overall water flow from the fixture, while still adequate pressure for washing. This reduces the amount of water used per day resulting in energy and water savings.

4.1.5 Plug Load Equipment Control - Vending Machines

Our recommendations for plug load equipment controls are summarized in Figure 27 below.

Figure 27-Summary of Plug Load Equipment Control ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Plug Load Equipment Control - Vending Machine		**2,297**	**0.0**	**0.0**	**$349.82**	**$690.00**	**$0.00**	**$690.00**	**2.0**	**2,313**
ECM 7	Vending Machine Control	2,297	0.0	0.0	$349.82	$690.00	$0.00	$690.00	2.0	2,313

ECM 7: Vending Machine Control

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
2,297	0.0	0.0	$349.82	$690.00	$0.00	$690.00	2.0	2,313

Measure Description

Vending machines operate continuously, even during non-business hours. It is recommended to install occupancy sensor controls to reduce the energy use. These controls power down vending machines when the vending machine area has been vacant for some time, then power up at regular intervals, as needed, to turn machine lights on or keep the product cool. Energy savings are a dependent on vending machine and activity level in the area surrounding the machines.

4.2 ECMs Evaluated But Not Recommended

The measures below have been evaluated by the auditor but are not recommended for implementation at the facility. Reasons for exclusion can be found in each measure description section.

Figure 28 – Summary of Measures Evaluated, But Not Recommended

Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Electric Unitary HVAC Measures	**9,198**	**6.2**	**0.0**	**$1,400.84**	**$221,597.17**	**$0.00**	**$221,597.17**	**158.2**	**9,262**
Install High Efficiency Electric AC	9,198	6.2	0.0	$1,400.84	$221,597.17	$0.00	$221,597.17	158.2	9,262
Gas Heating (HVAC/Process) Replacement	**0**	**0.0**	**111.5**	**$998.56**	**$37,725.24**	**$2,912.00**	**$34,813.24**	**34.9**	**13,054**
Install High Efficiency Hot Water Boilers	0	0.0	61.5	$550.85	$23,043.29	$2,112.00	$20,931.29	38.0	7,201
Install High Efficiency Furnaces	0	0.0	50.0	$447.71	$14,681.95	$800.00	$13,881.95	31.0	5,853
TOTALS	**9,198**	**6.2**	**111.5**	**$2,399.39**	**$259,322.40**	**$2,912.00**	**$256,410.40**	**106.9**	**22,316**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

Install High Efficiency Air Conditioning Units

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
9,198	6.2	0.0	$1,400.84	$221,597.17	$0.00	$221,597.17	158.2	9,262

Measure Description

We have evaluated replacing standard efficiency packaged air conditioning units with high efficiency packaged air conditioning units. There have been significant improvements in both compressor and fan motor efficiencies over the past several years. Therefore, electricity savings can be achieved by replacing older units with new high efficiency units. A higher EER or SEER rating indicates a more efficient cooling system. The magnitude of energy savings for this measure depends on the relative efficiency of the older unit versus the new high efficiency unit, the average cooling load, and the estimated annual operating hours.

Reasons for not Recommending

The units appear to be oversized. The customer should work with the engineer of record and right size the equipment if and when the package units are being replaced. The HVAC has relatively low hours of use due the size of the equipment. These factors combine to generate a long payback for the measure, more than the rated useful life of the replacement equipment. The measure is not recommended for implementation because of energy savings alone.

Install High Efficiency Hot Water Boilers

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
0	0.0	61.5	$550.85	$23,043.29	$2,112.00	$20,931.29	38.0	7,201

Measure Description

We have evaluated replacing older inefficient hot water boilers with high efficiency hot water boilers. Significant improvements have been made in combustion technology resulting in increased overall boiler efficiency. Energy savings results from improved combustion efficiency and reduced standby losses at low loads.

The most notable efficiency improvement is condensing hydronic boilers that can achieve over 90% efficiency under the proper conditions. Condensing hydronic boilers typically operate at efficiencies between 85% and 87% (comparable to other high efficiency boilers) when the return water temperature is above 130°F. The boiler efficiency increases as the return water temperature drops below 130°F. Therefore, condensing hydronic boilers were only evaluated when the return water temperature is less than 130°F during most of the operating hours. Therefore, condensing hydronic boilers are not recommended for this site.

Reasons for not Recommending

The unit appears to be oversized. The customer should work with the engineer of record and right size the equipment if and when the boiler is being replaced. The boiler has relatively low hours of use due the size of the equipment. These factors combine to generate a long payback for the measure, more than the rated useful life of the replacement equipment. The measure is not recommended for implementation because of energy savings alone.

Install High Efficiency Gas Fired Packaged Roof Top Units

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
0	0.0	50.0	$447.71	$14,681.95	$800.00	$13,881.95	31.0	5,853

Measure Description

We evaluated replacing existing standard efficiency roof top units with high efficiency models. Improved combustion technology and heat exchanger design optimize heat recovery from the combustion gases which can significantly improve burner efficiency. Savings result from improved system efficiency.

Reasons for not Recommending

The packaged units appear to be oversized. The customer should work with the engineer of record and right size the equipment if and when the packaged units are being replaced. The HVAC equipment has relatively low hours of use due the size. These factors combine to generate a long payback for the measure, more than the rated useful life of the replacement equipment. The measure is not recommended for implementation based on energy savings alone.

5 ENERGY EFFICIENT PRACTICES

In addition to the quantifiable savings estimated in Section 4, a facility's energy performance can also be improved through application of many low cost or no-cost energy efficiency strategies. By employing certain behavioral and operational changes and performing routine maintenance on building systems, equipment lifetime can be extended; occupant comfort, health and safety can be improved; and energy and O&M costs can be reduced. The recommendations below are provided as a framework for developing a whole building maintenance plan that is customized to your facility. Consult with qualified equipment specialists for details on proper maintenance and system operation.

Close Doors and Windows

Ensure doors and windows are closed in conditioned spaces. Leaving doors and windows open leads to a significant increase in heat transfer between conditioned spaces and the outside air. Reducing a facility's air changes per hour (ACH) can lead to increased occupant comfort as well as significant heating and cooling savings, especially when combined with proper HVAC controls and adequate ventilation.

Use Window Treatments/Coverings

A substantial amount of heat gain can occur through uncovered or untreated windows, especially older single pane windows and east or west-facing windows. Treatments such as high-reflectivity films or covering windows with shades or shutters can reduce solar heat gain and, consequently, cooling load and can reduce internal heat loss and the associated heating load.

Perform Proper Lighting Maintenance

To sustain optimal lighting levels, lighting fixtures should undergo routine maintenance. Light levels decrease over time due to lamp aging, lamp and ballast failure, and buildup of dirt and dust on lamps, fixtures and reflective surfaces. Together, these factors can reduce total illumination by 20% - 60% or more, while operating fixtures continue drawing full power. To limit this reduction, lamps, reflectors and diffusers should be thoroughly cleaned of dirt, dust, oil, and smoke film buildup approximately every 6 – 12 months.

Develop a Lighting Maintenance Schedule

In addition to routine fixture cleaning, development of a maintenance schedule can both ensure maintenance is performed regularly and can reduce the overall cost of fixture re-lamping and re-ballasting. By re-lamping and re-ballasting fixtures in groups, lighting levels are better maintained and the number of site visits by a lighting technician or contractor can be minimized, decreasing the overall cost of maintenance.

Perform Routine Motor Maintenance

Motors consist of many moving parts whose collective degradation can contribute to a significant loss of motor efficiency. In order to prevent damage to motor components, routine maintenance should be performed. This maintenance consists of cleaning surfaces and ventilation openings on motors to prevent overheating, lubricating moving parts to reduce friction, inspecting belts and pulleys for wear and to ensure they are at proper alignment and tension, and cleaning and lubricating bearings. Consult a licensed technician to assess these and other motor maintenance strategies.

Use Fans to Reduce Cooling Load

Utilizing ceiling fans to supplement cooling is a low-cost strategy to reduce cooling load considerably. Thermostat settings can be increased by 4°F with no change in overall occupant comfort when the wind chill effect of moving air is employed for cooling.

Practice Proper Use of Thermostat Schedules and Temperature Resets

Ensure thermostats are correctly set back. By employing proper set back temperatures and schedules, facility heating and cooling costs can be reduced dramatically during periods of low or no occupancy. As such, thermostats should be programmed for a setback of 5-10°F during low occupancy hours (reduce heating setpoints and increase cooling setpoints). Cooling load can be reduced further by increasing the facility's occupied setpoint temperature. In general, during the cooling season, thermostats should be set as high as possible without sacrificing occupant comfort.

Ensure Economizers are Functioning Properly

Economizers, when properly configured, can be used to significantly reduce mechanical cooling. However, if the outdoor thermostat or enthalpy control is malfunctioning or the damper is stuck or improperly adjusted, benefits from the economizer may not be fully realized. As such, periodic inspection and maintenance is required to ensure proper operation. This maintenance should be scheduled with maintenance of the facility's air conditioning system and should include proper setting of the outdoor thermostat/enthalpy control, inspection of control and damper operation, lubrication of damper connections, and adjustment of minimum damper position. A malfunctioning economizer can significantly increase the amount of heating and mechanical cooling required by introducing excess amounts of cold or hot outside air.

Clean Evaporator/Condenser Coils on AC Systems

Dirty evaporators and condensers coils cause a restriction to air flow and restrict heat transfer. This results in increased evaporator and condenser fan load and a decrease in cooling system performance. Keeping the coils clean allows the fans and cooling system to operate more efficiently.

Clean and/or Replace HVAC Filters

Air filters work to reduce the amount of indoor air pollution and increase occupant comfort. Over time, filters become less and less effective as particulate buildup increases. In addition to health concerns related to clogged filters, filters that have reached saturation also restrict air flow through the facility's air conditioning or heat pump system, increasing the load on the distribution fans and decreasing occupant comfort levels. Filters should be checked monthly and cleaned or replaced when appropriate.

Perform Proper Boiler Maintenance

Many boiler problems develop slowly over time, so regular inspection and maintenance is essential to retain proper functionality and efficiency of the heating system. Fuel burning equipment should undergo yearly tune-ups to ensure they are operating as safely and efficiently as possible from a combustion standpoint. A tune-up should include a combustion analysis to analyze the exhaust from the boilers and to ensure the boiler is operating safely. Buildup of dirt, dust, or deposits on the internal surfaces of a boiler can greatly affect its heat transfer efficiency. These deposits can accumulate on the water side or fire side of the boiler. Boilers should be cleaned regularly according to the manufacturer's instructions to remove this build up in order to sustain efficiency and equipment life.

Perform Proper Furnace Maintenance

Preventative furnace maintenance can extend the life of the system, maintain energy efficiency, and ensure safe operation. Following the manufacturer's instructions, a yearly tune-up should include tasks such as checking for gas / carbon monoxide leaks; changing the air and fuel filters; checking components for cracks, corrosion, dirt, or debris build-up; ensuring the ignition system is working properly; testing and adjusting operation and safety controls; inspecting the electrical connections; and ensuring proper lubrication for motors and bearings.

Perform Proper Water Heater Maintenance

At least once a year, drain a few gallons out of the water heater using the drain valve. If there is a lot of sediment or debris, then a full flush is recommended. Turn the temperature down and then completely drain the tank. Once a year check for any leaks or heavy corrosion on the pipes and valves. For gas water heaters, check the draft hood and make sure it is placed properly, with a few inches of air space between the tank and where it connects to the vent. Look for any corrosion or wear on the gas line and on the piping. If you noticed any black residue, soot or charred metal, this is a sign you may be having combustion issues and you should have the unit serviced by a professional. For electric water heaters, look for any signs of leaking such as rust streaks or residue around the upper and lower panels covering the electrical components on the tank. For water heaters over three to four years old have a technician inspect the sacrificial anode annually.

Plug Load Controls

There are a variety of ways to limit the energy use of plug loads including increasing occupant awareness, removing under-utilized equipment, installing hardware controls, and using software controls. Some control steps to take are to enable the most aggressive power settings on existing devices or install load sensing or occupancy sensing (advanced) power strips. For additional information refer to "Plug Load Best Practices Guide" http://www.advancedbuildings.net/plug-load-best-practices-guide-offices.

Replace Computer Monitors

Replacing old computer monitors or displays with efficient monitors will reduce energy use. ENERGY STAR® rated monitors have specific requirements for on mode power consumption as well as idle and sleep mode power. According to the ENERGY STAR® website monitors that have earned the ENERGY STAR® label are 25% more efficient than standard monitors.

Water Conservation

Installing low-flow faucets or faucet aerators, low-flow showerheads, and kitchen sink pre-rinse spray valves saves both energy and water. These devices save energy by reducing the overall amount of hot water used hence reducing the energy used to heat the water. The flow ratings for EPA WaterSense™ (http://www3.epa.gov/watersense/products) labeled devices are 1.5 gpm for bathroom faucets, 2.0 gpm for showerheads, and 1.28 gpm for pre-rinse spray valves.

Installing dual flush or low-flow toilets and low-flow or waterless urinals are additional ways to reduce the sites water use, however, these devices do not provide energy savings at the site level. Any reduction in water use does however ultimately reduce grid level electricity use since a significant amount of electricity is used to deliver water from reservoirs to end users. The EPA WaterSense™ ratings for urinals is 0.5 gallons per flush (gpf) and toilets that use as little as 1.28 gpf (this is lower than the current 1.6 gpf federal standard).

Refer to Section 4.1.4 for any low-flow ECM recommendations.

6 On-Site Generation Measures

On-site generation measure options include both renewable (e.g., solar, wind) and non-renewable (e.g., fuel cells) on-site technologies that generate power to meet all or a portion of the electric energy needs of a facility, often repurposing any waste heat where applicable. Also referred to as distributed generation, these systems contribute to Greenhouse Gas (GHG) emission reductions, demand reductions and reduced customer electricity purchases, resulting in the electric system reliability through improved transmission and distribution system utilization.

The State of New Jersey's Energy Master Plan (EMP) encourages new distributed generation of all forms and specifically focuses on expanding use of combined heat and power (CHP) by reducing financial, regulatory and technical barriers and identifying opportunities for new entries. The EMP also outlines a goal of 70% of the State's electrical needs to be met by renewable sources by 2050.

Preliminary screenings were performed to determine the potential that a generation project could provide a cost-effective solution for your facility. Before deciding to implement, a feasibility study should be conducted that would take a detailed look at existing energy profiles, siting, interconnection, and the costs associated with the generation project including interconnection costs, departing load charges, and any additional special facilities charges.

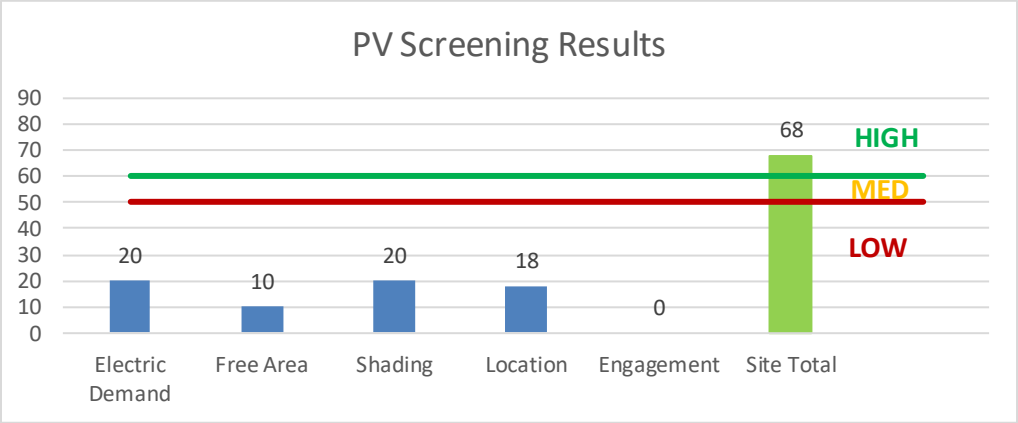
6.1 Photovoltaic

Sunlight can be converted into electricity using photovoltaics (PV) modules. Modules are racked together into an array that produces direct current (DC) electricity. The DC current is converted to alternating current (AC) through an inverter. The inverter is interconnected to the facility's electrical distribution system. The amount of unobstructed area available determines how large of a solar array can be installed. The size of the array combined with the orientation, tilt, and shading elements determines the energy produced.

A preliminary screening based on the facility's electric demand, size and location of free area, and shading elements shows that the facility has a High potential for installing a PV array.

The amount of free area, ease of installation, and the lack of shading elements contribute to the **High** potential for PV at the site. A PV array located on the roof of the building may be feasible. If Edison Campus is interested in pursuing the installation of PV, we recommended a full feasibility study be conducted.

Figure 29 - Photovoltaic Screening



Potential	High	
System Potential	80	kW DC STC
Electric Generation	95,310	kWh/yr
Displaced Cost	$8,290	/yr
Installed Cost	$208,000	

Solar projects must register their projects in the SREC (Solar Renewable Energy Certificate) Registration Program (SRP) prior to the start of construction to establish the project's eligibility to earn SRECs. Registration of the intent to participate in New Jersey's solar marketplace provides market participants with information about developed new solar projects and insight into future SREC pricing. Refer to Section 8.3 for additional information.

For more information on solar PV technology and commercial solar markets in New Jersey, or to find a qualified solar installer, who can provide a more detailed assessment of the specific costs and benefits of solar develop of the site, please visit the following links below:

- **Basic Info on Solar PV in NJ**: http://www.njcleanenergy.com/whysolar
- **NJ Solar Market FAQs**: http://www.njcleanenergy.com/renewable-energy/program-updates-and-background-information/solar-transition/solar-market-faqs
- **Approved Solar Installers in the NJ Market**: http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/tools-and-resources/tradeally/approved_vendorsearch/?id=60&start=1

6.2 Combined Heat and Power

Combined heat and power (CHP) is the on-site generation of electricity along with the recovery of heat energy, which is put to beneficial use. Common technologies for CHP include reciprocating engines, microturbines, fuel cells, backpressure steam turbines, and (at large facilities) gas turbines. Electric generation from a CHP system is typically interconnected to local power distribution systems. Heat is recovered from exhaust and ancillary cooling systems and interconnected to the existing hot water (or steam) distribution systems.

CHP systems are typically used to produce a portion of the electric power used onsite by a facility, with the balance of electric power needs supplied by grid purchases. The heat is used to supplement (or supplant) existing boilers for the purpose of space heating and/or domestic hot water heating. Waste heat can also be routed through absorption chillers for the purpose of space cooling. The key criteria used for screening, however, is the amount of time the system operates at full load and the facility's ability to use the recovered heat. Facilities with continuous use for large quantities of waste heat are the best candidates for CHP.

A preliminary screening based on heating and electrical demand, siting, and interconnection shows that the facility has a **Low** potential for installing a cost-effective CHP system.

7 DEMAND RESPONSE

Demand Response (DR) is a program designed to reduce the electric load of commercial facilities when electric wholesale prices are high or when the reliability of the electric grid is threatened due to peak demand. Demand Response service providers (a.k.a. Curtailment Service Providers) are registered with PJM, the independent system operator (ISO) for mid-Atlantic state region that is charged with maintaining electric grid reliability.

By enabling grid operators to call upon Curtailment Service Providers and commercial facilities to reduce electric usage during times of peak demand, the grid is made more reliable and overall transmission costs are reduced for all ratepayers. Curtailment Service Providers provide regular payments to medium and large consumers of electric power for their participation in DR programs. Program participation is voluntary and participants receive payments whether or not their facility is called upon to curtail their electric usage.

Typically, an electric customer needs to be capable of reducing their electric demand, within minutes, by at least 100 kW or more in order to participate in a DR program. Customers with a greater capability to quickly curtail their demand during peak hours will receive higher payments. Customers with back-up generators onsite may also receive additional DR payments for their generating capacity if they agree to run the generators for grid support when called upon. Eligible customers who have chosen to participate in a DR programs often find it to be a valuable source of revenue for their facility because the payments can significantly offset annual electric costs.

Participating customers can often quickly reduce their peak load through simple measures, such as temporarily raising temperature set points on thermostats, so that air conditioning units run less frequently, or agreeing to dim or shut off less critical lighting. This usually requires some level of building automation and controls capability to ensure rapid load reduction during a DR curtailment event. DR program participants may need to install smart meters or may need to also sub-meter larger energy-using equipment, such as chillers, in order to demonstrate compliance with DR program requirements.

DR does not include the reduction of electricity consumption based on normal operating practice or behavior. For example, if a company's normal schedule is to close for a holiday, the reduction of electricity due to this closure or scaled-back operation is not considered a demand response activity in most situations.

The first step toward participation in a DR program is to contact a Curtailment Service Provider. A list of these providers is available on PJM's website and it includes contact information for each company, as well as the states where they have active business (http://www.pjm.com/markets-and-operations/demand-response/csps.aspx). PJM also posts training materials that are developed for program members interested in specific rules and requirements regarding DR activity (http://www.pjm.com/training/training%20material.aspx), along with a variety of other DR program information.

Curtailment Service Providers typically offer free assessments to determine a facility's eligibility to participate in a DR program. They will provide details regarding program rules and requirements for metering and controls, assess a facility's ability to temporarily reduce electric load, and provide details on payments to be expected for participation in the program. Providers usually offer multiple options for DR to larger facilities and may also install controls or remote monitoring equipment of their own to help ensure compliance with all terms and conditions of a DR contract.

In our opinion this building is not a good candidate for DR.

8 PROJECT FUNDING / INCENTIVES

The NJCEP provides the incentive programs described below, and other benefits to ratepayers, because of the Societal Benefits Charge (SBC) Fund. The SBC was created by the State of New Jersey's Electricity Restructuring Law (1999), which requires all customers of investor-owned electric and gas utilities to pay a surcharge on their monthly energy bills. As a customer of a state-regulated electric or gas utility and therefore a contributor to the fund your organization is eligible to participate in the LGEA program and also eligible to receive incentive payment for qualifying energy efficiency measures. Also available through the NJBPU are some alternative financing programs described later in this section. Please refer to Figure 30 for a list of the eligible programs identified for each recommended ECM.

Figure 30 - ECM Incentive Program Eligibility

Energy Conservation Measure		SmartStart Prescriptive	SmartStart Custom	Direct Install	Pay For Performance Existing Buildings	Large Energy Users Program	Combined Heat & Power and Fuel Cell
ECM 1	Install LED Fixtures	X		X			
ECM 2	Retrofit Fixtures with LED Lamps	X		X			
ECM 3	Install Occupancy Sensor Lighting Controls	X		X			
ECM 4	Install High/Low Lighitng Controls			X			
ECM 5	Premium Efficiency Motors			X			
ECM 6	Install Low-Flow Domestic Hot Water Devices			X			
ECM 7	Vending Machine Control			X			

SmartStart is generally well-suited for implementation of individual measures or small group of measures. It provides flexibility to install measures at your own pace using in-house staff or a preferred contractor. Direct Install caters to small to mid-size facilities that can bundle multiple ECMs together. This can greatly simplify participation and may lead to higher incentive amounts, but requires the use of pre-approved contractors. The Pay for Performance (P4P) program is a "whole-building" energy improvement program designed for larger facilities. It requires implementation of multiple measures meeting minimum savings thresholds, as well as use of pre-approved consultants. The Large Energy Users Program (LEUP) is available to New Jersey's largest energy users giving them flexibility to install as little or as many measures, in a single facility or several facilities, with incentives capped based on the entity's annual energy consumption. LEUP applicants can use in-house staff or a preferred contractor.

Generally, the incentive values provided throughout the report assume the SmartStart program is utilized because it provides a consistent basis for comparison of available incentives for various measures, though in many cases incentive amounts may be higher through participation in other programs.

Brief descriptions of all relevant financing and incentive programs are located in the sections below. Further information, including most current program availability, requirements, and incentive levels can be found at: www.njcleanenergy.com/ci.

8.1 SmartStart

Overview

The SmartStart program offers incentives for installing prescriptive and custom energy efficiency measures at your facility. Routinely the program adds, removes or modifies incentives from year to year for various energy efficiency equipment based on market trends and new technologies.

Equipment with Prescriptive Incentives Currently Available:

Electric Chillers
Electric Unitary HVAC
Gas Cooling
Gas Heating
Gas Water Heating
Ground Source Heat Pumps
Lighting
Lighting Controls
Refrigeration Doors
Refrigeration Controls
Refrigerator/Freezer Motors
Food Service Equipment
Variable Frequency Drives

Most equipment sizes and types are served by this program. This program provides an effective mechanism for securing incentives for energy efficiency measures installed individually or as part of a package of energy upgrades.

Incentives

The SmartStart prescriptive incentive program provides fixed incentives for specific energy efficiency measures, whereas the custom SmartStart program provides incentives for more unique or specialized technologies or systems that are not addressed through prescriptive incentive offerings for specific devices.

Since your facility is an existing building, only the retrofit incentives have been applied in this report. Custom measure incentives are calculated at $0.16/kWh and $1.60/therm based on estimated annual savings, capped at 50% of the total installed incremental project cost, or a project cost buy down to a one-year payback (whichever is less). Program incentives are capped at $500,000 per electric account and $500,000 per natural gas account, per fiscal year.

How to Participate

To participate in the SmartStart program you will need to apply for the specific equipment to be installed. Many applications are designed as rebates, although others require application approval prior to installation. Applicants may work with a contractor of their choosing and can also utilize internal personnel, which provides added flexibility to the program. Using internal personnel also helps improve the economics of the ECM by reducing the labor cost that is included in the tables in this report.

Detailed program descriptions, instructions for applying and applications can be found at: www.njcleanenergy.com/SSB.

8.2 Direct Install

Overview

Direct Install is a turnkey program available to existing small to medium-sized facilities with a peak electric demand that does not exceed 200 kW for any recent 12-month period. You will work directly with a pre-approved contractor who will perform a free energy assessment at your facility, identify specific eligible measures, and provide a clear scope of work for installation of selected measures. Energy efficiency measures may include lighting and lighting controls, refrigeration, HVAC, motors, variable speed drives and controls.

Incentives

The program pays up to **70%** of the total installed cost of eligible measures, up to $125,000 per project. Direct Install participants will also be held to a fiscal year cap of $250,000 per entity.

How to Participate

To participate in the Direct Install program, you will need to contact the participating contractor who the region of the state where your facility is located. A complete list of Direct Install program partners is provided on the Direct Install website linked below. The contractor will be paid the measure incentives directly by the program which will pass on to you in the form of reduced material and implementation costs. This means up to 70% of eligible costs are covered by the program, subject to program caps and eligibility, while the remaining 30% of the cost is paid to the contractor by the customer.

Since Direct Install offers a free assessment of eligible measures, Direct Install is also available to small businesses and other commercial facilities too that may not be eligible for the more detailed facility audits provided by LGEA.

Detailed program descriptions and applications can be found at: www.njcleanenergy.com/DI.

8.3 SREC Registration Program

The SREC (Solar Renewable Energy Certificate) Registration Program (SRP) is used to register the intent to install solar projects in New Jersey. Rebates are not available for solar projects, but owners of solar projects MUST register their projects in the SRP prior to the start of construction in order to establish the project's eligibility to earn SRECs. Registration of the intent to participate in New Jersey's solar marketplace provides market participants with information about the pipeline of anticipated new solar capacity and insight into future SREC pricing.

After the registration is accepted, construction is complete, and final paperwork has been submitted and is deemed complete, the project is issued a New Jersey certification number which enables it to generate New Jersey SRECs. SREC's are generated once the solar project has been authorized to be energized by the Electric Distribution Company (EDC).

Each time a solar installation generates 1,000 kilowatt-hours (kWh) of electricity, an SREC is earned. Solar project owners report the energy production to the SREC Tracking System. This reporting allows SREC's to be placed in the customer's electronic account. SRECs can then be sold on the SREC Tracking System, providing revenue for the first 15 years of the project's life.

Electricity suppliers, the primary purchasers of SRECs, are required to pay a Solar Alternative Compliance Payment (SACP) if they do not meet the requirements of New Jersey's Solar RPS. One way they can meet the RPS requirements is by purchasing SRECs. As SRECs are traded in a competitive market, the price may vary significantly. The actual price of an SREC during a trading period can and will fluctuate depending on supply and demand.

Information about the SRP can be found at: www.njcleanenergy.com/srec.

8.4 Energy Savings Improvement Program

The Energy Savings Improvement Program (ESIP) is an alternate method for New Jersey's government agencies to finance the implementation of energy conservation measures. An ESIP is a type of "performance contract," whereby school districts, counties, municipalities, housing authorities and other public and state entities enter in to contracts to help finance building energy upgrades. This is done in a manner that ensures that annual payments are lower than the savings projected from the ECMs, ensuring that ESIP projects are cash flow positive in year one, and every year thereafter. ESIP provides government agencies in New Jersey with a flexible tool to improve and reduce energy usage with minimal expenditure of new financial resources. NJCEP incentive programs can be leveraged to help further reduce the total project cost of eligible measures.

This LGEA report is the first step to participating in ESIP. Next, you will need to select an approach for implementing the desired ECMs:

(1) Use an Energy Services Company or "ESCO."
(2) Use independent engineers and other specialists, or your own qualified staff, to provide and manage the requirements of the program through bonds or lease obligations.
(3) Use a hybrid approach of the two options described above where the ESCO is utilized for some services and independent engineers, or other specialists or qualified staff, are used to deliver other requirements of the program.

After adopting a resolution with a chosen implementation approach, the development of the Energy Savings Plan (ESP) can begin. The ESP demonstrates that the total project costs of the ECMs are offset by the energy savings over the financing term, not to exceed 15 years. The verified savings will then be used to pay for the financing.

The ESIP approach may not be appropriate for all energy conservation and energy efficiency improvements. Entities should carefully consider all alternatives to develop an approach that best meets their needs. A detailed program descriptions and application can be found at: www.njcleanenergy.com/ESIP.

Please note that ESIP is a program delivered directly by the NJBPU and is not an NJCEP incentive program. As mentioned above, you may utilize NJCEP incentive programs to help further reduce costs when developing the ESP. You should refer to the ESIP guidelines at the link above for further information and guidance on next steps.

9 ENERGY PURCHASING AND PROCUREMENT STRATEGIES

9.1 Retail Electric Supply Options

In 1999, New Jersey State Legislature passed the Electric Discount & Energy Competition Act (EDECA) to restructure the electric power industry in New Jersey. This law deregulated the retail electric markets, allowing all consumers to shop for service from competitive electric suppliers. The intent was to create a more competitive market for electric power supply in New Jersey. As a result, utilities were allowed to charge Cost of Service and customers were given the ability to choose a third-party (i.e. non-utility) energy supplier.

Energy deregulation in New Jersey has increased energy buyers' options by separating the function of electricity distribution from that of electricity supply. So, though you may choose a different company from which to buy your electric power, responsibility for your facility's interconnection to the grid and repair to local power distribution will still reside with the traditional utility company serving your region.

If your facility is not purchasing electricity from a third-party supplier, consider shopping for a reduced rate from third party electric suppliers. If your facility is purchasing electricity from a third-party supplier, review and compare prices at the end of the current contract or every couple of years.

A list of third-party electric suppliers, who are licensed by the state to provide service in New Jersey, can be found online at: www.state.nj.us/bpu/commercial/shopping.html.

9.2 Retail Natural Gas Supply Options

The natural gas market in New Jersey has also been deregulated. Most customers that remain with the utility for natural gas service pay rates that are market-based and that fluctuate monthly. The utility provides basic gas supply service (BGSS) to customers who choose not to buy from a third-party supplier for natural gas commodity.

A customer's decision about whether to buy natural gas from a retail supplier is typically dependent upon whether a customer seeks budget certainty and/or longer-term rate stability. Customers can secure longer-term fixed prices by signing up for service through a third-party retail natural gas supplier. Many larger natural gas customers may seek the assistance of a professional consultant to assist in their procurement process.

If your facility is not purchasing natural gas from a third-party supplier, consider shopping for a reduced rate from third-party natural gas suppliers. If your facility is purchasing natural gas from a third-party supplier, review and compare prices at the end of the current contract or every couple of years.

A list of third-party natural gas suppliers, who are licensed by the state to provide service in New Jersey, can be found online at: www.state.nj.us/bpu/commercial/shopping.html.

Appendix A: Equipment Inventory & Recommendations

Lighting Inventory & Recommendations

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Electrical Room	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.04	132	0.0	$20.10	$117.00	$20.00	4.82
Maintenance Rm	6	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,400	0.16	575	0.0	$87.64	$621.00	$95.00	6.00
Maintenance Rm	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Boiler Rm	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	4	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.09	304	0.0	$46.24	$234.00	$40.00	4.20
Elevator Machine Rm	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.02	76	0.0	$11.56	$58.50	$10.00	4.20
Womens RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.08	288	0.0	$43.82	$690.40	$100.00	13.47
Womens RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.04	152	0.0	$23.12	$117.00	$20.00	4.20
Womens RR	4	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,000	Relamp	No	4	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,000	0.05	161	0.0	$24.52	$143.60	$20.00	5.04
Janitor Closet	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.02	76	0.0	$11.56	$58.50	$10.00	4.20
Mens RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.08	288	0.0	$43.82	$690.40	$100.00	13.47
Mens RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.04	152	0.0	$23.12	$117.00	$20.00	4.20
Mens RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,000	Relamp	No	2	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,000	0.02	81	0.0	$12.26	$71.80	$10.00	5.04
Media Center	21	U-Bend Fluorescent - T8: U T8 (32W) - 3L	Wall Switch	92	2,000	Relamp	Yes	21	LED - Linear Tubes: (3) U-Lamp	Occupancy Sensor	50	1,400	0.79	2,770	0.0	$421.87	$2,217.90	$70.00	5.09
Media Center	20	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,000	Relamp	Yes	20	LED Screw-In Lamps: LED - 2L - 36W	Occupancy Sensor	36	1,400	0.35	1,220	0.0	$185.79	$2,298.12	$70.00	11.99
Media Center	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Server Closet	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	No	2	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	2,000	0.06	228	0.0	$34.68	$150.40	$30.00	3.47
Main Office	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.33	1,151	0.0	$175.29	$871.60	$155.00	4.09
Storage Closet	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.08	288	0.0	$43.82	$420.40	$30.00	8.91
Office	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.08	288	0.0	$43.82	$420.40	$65.00	8.11
Conf Room	3	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	3	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.12	432	0.0	$65.73	$495.60	$80.00	6.32
Principal Office	6	U-Bend Fluorescent - T8: U T8 (32W) - 3L	Wall Switch	92	2,000	Relamp	Yes	6	LED - Linear Tubes: (3) U-Lamp	Occupancy Sensor	50	1,400	0.23	791	0.0	$120.54	$749.40	$35.00	5.93
Main Office RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	No	1	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	2,000	0.03	114	0.0	$17.34	$75.20	$15.00	3.47
Waiting Rm	2	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	2	LED - Linear Tubes: (2) U-Lamp	Wall Switch	33	2,000	0.04	133	0.0	$20.32	$126.40	$0.00	6.22
103 CR	13	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	13	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.53	1,870	0.0	$284.84	$1,247.60	$230.00	3.57
104 CR	25	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	25	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	1.03	3,597	0.0	$547.77	$2,420.00	$445.00	3.61

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
105 CR	20	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	20	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.82	2,877	0.0	$438.22	$2,044.00	$370.00	3.82
105 CR	10	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,000	Relamp	Yes	10	LED Screw-In Lamps: LED - 2L - 36W	Occupancy Sensor	36	1,400	0.17	610	0.0	$92.90	$1,149.06	$35.00	11.99
Storage Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	No	1	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	2,000	0.03	114	0.0	$17.34	$75.20	$15.00	3.47
Server Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	No	1	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	2,000	0.03	114	0.0	$17.34	$75.20	$15.00	3.47
108 CR	12	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	12	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.49	1,726	0.0	$262.93	$1,172.40	$215.00	3.64
Faculty Room	5	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	5	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.21	719	0.0	$109.55	$646.00	$110.00	4.89
Faculty RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	No	1	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	2,000	0.03	114	0.0	$17.34	$75.20	$15.00	3.47
Wellness Center	7	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	7	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.29	1,007	0.0	$153.38	$796.40	$140.00	4.28
Wellness RR	1	U-Bend Fluorescent - T8: U T8 (32W) - 3L	Wall Switch	92	2,000	Relamp	No	1	LED - Linear Tubes: (3) U-Lamp	Wall Switch	50	2,000	0.03	98	0.0	$14.89	$79.90	$0.00	5.37
Storage Closet	1	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,000	Relamp	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,000	0.01	40	0.0	$6.13	$35.90	$5.00	5.04
Exam Rm	3	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	3	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.12	432	0.0	$65.73	$495.60	$80.00	6.32
Storage	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.16	575	0.0	$87.64	$570.80	$60.00	5.83
208 CR	24	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	24	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.98	3,453	0.0	$525.86	$2,344.80	$430.00	3.64
208 CR Prep Rm	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.25	863	0.0	$131.46	$721.20	$125.00	4.54
Storage	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	2,000	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,400	0.10	338	0.0	$51.42	$460.27	$40.00	8.17
210 CR	15	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	15	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.62	2,158	0.0	$328.66	$1,398.00	$260.00	3.46
Janitor Closet	1	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,000	Relamp	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,000	0.01	40	0.0	$6.13	$35.90	$5.00	5.04
storage	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.16	575	0.0	$87.64	$570.80	$60.00	5.83
203 CR	24	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	24	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.98	3,453	0.0	$525.86	$2,344.80	$430.00	3.64
202 CR	13	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	13	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.53	1,870	0.0	$284.84	$1,247.60	$230.00	3.57
Storage	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.02	76	0.0	$11.56	$58.50	$10.00	4.20
201 CR	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.16	575	0.0	$87.64	$570.80	$95.00	5.43
211 CR	13	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	13	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.53	1,870	0.0	$284.84	$1,247.60	$230.00	3.57
Electrical Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.02	76	0.0	$11.56	$58.50	$10.00	4.20
212 CR	11	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	11	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.45	1,583	0.0	$241.02	$1,097.20	$200.00	3.72

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
213 CR	3	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	3	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.12	432	0.0	$65.73	$495.60	$80.00	6.32
214 CR	11	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	11	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.45	1,583	0.0	$241.02	$1,097.20	$200.00	3.72
215 CR	11	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	11	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.45	1,583	0.0	$241.02	$1,097.20	$200.00	3.72
216 CR	3	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	3	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.12	432	0.0	$65.73	$495.60	$80.00	6.32
217 CR	11	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	11	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.45	1,583	0.0	$241.02	$1,097.20	$200.00	3.72
Girls RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.08	288	0.0	$43.82	$690.40	$100.00	13.47
Boys RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,400	0.08	288	0.0	$43.82	$690.40	$100.00	13.47
Boys RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,000	Relamp	No	2	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,000	0.02	81	0.0	$12.26	$71.80	$10.00	5.04
Boys RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,000	0.04	152	0.0	$23.12	$117.00	$20.00	4.20
Girls RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,400	0.05	192	0.0	$29.21	$387.00	$55.00	11.36
Girls RR	4	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,000	Relamp	Yes	4	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,400	0.06	201	0.0	$30.62	$413.60	$55.00	11.71
Corridor/Open	14	Metal Halide: (1) 400W Lamp	Wall Switch	458	2,000	Fixture Replacement	Yes	14	LED - Fixtures: Downlight Recessed	High/Low Control	137	1,400	3.32	11,651	0.0	$1,774.40	$4,195.64	$70.00	2.33
Corridor/Open	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	High/Low Control	44	1,400	0.25	863	0.0	$131.46	$651.20	$90.00	4.27
Corridor/Open	6	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,000	Relamp	Yes	6	LED Screw-In Lamps: LED - 2L - 36W	High/Low Control	36	1,400	0.10	366	0.0	$55.74	$727.44	$0.00	13.05
Corridor/Open	3	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	3	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Stair B	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,400	0.08	288	0.0	$43.82	$375.50	$30.00	7.88
Stair B	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Stair A	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,400	0.08	288	0.0	$43.82	$375.50	$30.00	7.88
Stair A	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Corridor/Open	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,000	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	High/Low Control	44	1,400	0.25	863	0.0	$131.46	$651.20	$90.00	4.27
Corridor/Open	5	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	5	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Corridor/Open	22	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,000	Relamp	Yes	22	LED Screw-In Lamps: LED - 2L - 36W	High/Low Control	36	1,400	0.38	1,342	0.0	$204.37	$2,333.93	$0.00	11.42
Corridor/Open	8	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	2,000	Relamp	Yes	8	LED Screw-In Lamps: LED - 1L - 18W	High/Low Control	18	1,400	0.07	244	0.0	$37.16	$551.62	$0.00	14.84
Corridor/Open	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,000	Relamp	Yes	1	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,400	0.03	96	0.0	$14.61	$258.50	$10.00	17.01
Entry Foyer	4	Metal Halide: (1) 400W Lamp	Wall Switch	458	2,000	Fixture Replacement	Yes	4	LED - Fixtures: Downlight Recessed	Occupancy Sensor	137	1,400	0.95	3,329	0.0	$506.97	$1,354.47	$55.00	2.56

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Entry Foyer	4	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	2,000	Relamp	No	4	LED Screw-In Lamps: LED - 1L - 18W	Wall Switch	18	2,000	0.02	72	0.0	$10.93	$175.81	$0.00	16.09
Entry Foyer	4	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,000	Relamp	Yes	4	LED Screw-In Lamps: LED - 2L - 36W	Occupancy Sensor	36	1,400	0.07	244	0.0	$37.16	$621.62	$35.00	15.79

Motor Inventory & Recommendations

		Existing Conditions						Proposed Conditions				Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Full Load Efficiency	VFD Control?	Annual Operating Hours	Install High Efficiency Motors?	Full Load Efficiency	Install VFDs?	Number of VFDs	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Rooftop	RTU-1	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-2	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	CH 1	1	Supply Fan	0.1	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	CH 2	1	Supply Fan	0.1	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	UH 1	1	Supply Fan	0.1	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	UH 2	1	Supply Fan	0.1	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	HW System	2	Heating Hot Water Pump	2.0	78.5%	Yes	1,373	Yes	86.5%	No		0.16	290	0.0	$44.09	$1,788.48	$0.00	40.56
Edison	HW System	1	Heating Hot Water Pump	0.2	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	EF-1	1	Exhaust Fan	1.0	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	EF-2	1	Exhaust Fan	0.3	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	EF-3	1	Exhaust Fan	0.3	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	EF-4	1	Exhaust Fan	0.1	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	EF-5	1	Exhaust Fan	0.3	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	EF-6	1	Exhaust Fan	0.3	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Edison	Elevator Motor	1	Other	15.0	70.0%	No	520	Yes	91.0%	No		2.05	1,439	0.0	$219.12	$1,616.15	$0.00	7.38

Electric HVAC Inventory & Recommendations

		Existing Conditions				Proposed Conditions								Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Install High Efficiency System?	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Cooling Mode Efficiency (SEER/EER)	Heating Mode Efficiency (COP)	Install Dual Enthalpy Economizer?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Rooftop	RTU-1	1	Packaged AC	50.00		Yes	1	Packaged AC	50.00		10.60		No	3.10	4,599	0.0	$700.42	$110,798.58	$0.00	158.19
Rooftop	RTU-2	1	Packaged AC	50.00		Yes	1	Packaged AC	50.00		10.60		No	3.10	4,599	0.0	$700.42	$110,798.58	$0.00	158.19
Rooftop	AC-1	1	Split-System AC	1.50		No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Fuel Heating Inventory & Recommendations

		Existing Conditions			Proposed Conditions						Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Output Capacity per Unit (MBh)	Install High Efficiency System?	System Quantity	System Type	Output Capacity per Unit (MBh)	Heating Efficiency	Heating Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Mechanical Room	Edison	1	Non-Condensing Hot Water Boiler	960.00	Yes	1	Condensing Hot Water Boiler	960.00	91.00%	Et	0.00	0	61.5	$550.85	$23,043.29	$2,112.00	38.00
Rooftop	RTU-1	1	Furnace	324.00	Yes	1	Furnace	324.00	95.00%	AFUE	0.00	0	25.0	$223.85	$7,340.98	$400.00	31.01
Rooftop	RTU-2	1	Furnace	324.00	Yes	1	Furnace	324.00	95.00%	AFUE	0.00	0	25.0	$223.85	$7,340.98	$400.00	31.01

DHW Inventory & Recommendations

		Existing Conditions		Proposed Conditions						Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Replace?	System Quantity	System Type	Fuel Type	System Efficiency	Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Mechanical Room	Edison Campus	1	Storage Tank Water Heater (> 50 Gal)	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Low-Flow Device Recommendations

	Recommedation Inputs				Energy Impact & Financial Analysis						
Location	Device Quantity	Device Type	Existing Flow Rate (gpm)	Proposed Flow Rate (gpm)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Edison	7	Faucet Aerator (Kitchen)	2.50	2.20	0.00	0	2.1	$18.95	$50.19	$0.00	2.65
Edison	4	Faucet Aerator (Kitchen)	2.50	2.20	0.00	0	1.2	$10.83	$28.68	$0.00	2.65
Edison	3	Faucet Aerator (Kitchen)	2.50	2.20	0.00	0	0.9	$8.12	$21.51	$0.00	2.65
Edison	11	Faucet Aerator (Kitchen)	2.50	2.20	0.00	0	3.3	$29.78	$78.87	$0.00	2.65

Plug Load Inventory

	Existing Conditions			
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?
Edison	94	Desktop and LCD Monitor	191.0	No
Edison	16	Printer	20.0	No
Edison	12	Projector	200.0	No
Edison	7	Microwave	300.0	No
Edison	2	Copier	515.0	No
Edison	6	Television LCD 40"	120.0	No
Edison	3	Television LCD 75"	200.0	No
Edison	2	3D Printer	40.0	No
Edison	10	Laptops	40.0	No
Edison	2	Coffee Machine	400.0	No
Edison	5	Refrigerator	50.0	No

Vending Machine Inventory & Recommendations

	Existing Conditions		Proposed Conditions	Energy Impact & Financial Analysis						
Location	Quantity	Vending Machine Type	Install Controls?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Edison	2	Non-Refrigerated	Yes	0.00	685	0.0	$104.33	$460.00	$0.00	4.41
Edison	1	Refrigerated	Yes	0.00	1,612	0.0	$245.48	$230.00	$0.00	0.94

Appendix B: ENERGY STAR® Statement of Energy Performance

ENERGY STAR® Statement of Energy Performance

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ENERGY STAR® Score[1]

Edison Campus

Primary Property Type: K-12 School
Gross Floor Area (ft²): 15,200
Built: 2000

For Year Ending: April 30, 2017
Date Generated: March 28, 2018

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Edison Campus 100 Technology Drive Edison, New Jersey 08837	Middlesex County Vocational School District 1011 Route 22 West Suite 203 Bridgewater, NC 08807 (____)____-_____	Karl Knehr 1011 Route 22 West Suite 203 Bridgewater, NC 08807 732-257-3300 x1952 knehrk@mail.mcvts.net

Property ID: 6260844

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
139.7 kBtu/ft²

Source EUI
273.4 kBtu/ft²

Annual Energy by Fuel	
Electric - Grid (kBtu)	921,245 (43%)
Natural Gas (kBtu)	1,202,883 (57%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	128.5
National Median Source EUI (kBtu/ft²)	251.4
% Diff from National Median Source EUI	9%
Annual Emissions	
Greenhouse Gas Emissions (Metric Tons CO2e/year)	166

Signature & Stamp of Verifying Professional

I _____ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: _____ Date: _____

Licensed Professional

____ _____
,
(____)____-_____
_____

Professional Engineer Stamp (if applicable)

Local Government Energy Audit:
Energy Audit Report



Perth Amboy Campus

457 High Street

Perth Amboy, New Jersey 08861

Middlesex County Vocational School District

October 30, 2018

Final Report by:

TRC Energy Services

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Disclaimer

The intent of this energy analysis report is to identify energy savings opportunities and recommend upgrades to the facility's energy using equipment and systems. Approximate savings are included in this report to help make decisions about reducing energy use at the facility. This report, however, is not intended to serve as a detailed engineering design document. Further design and analysis may be necessary in order to implement some of the measures recommended in this report.

The energy conservation measures and estimates of energy savings have been reviewed for technical accuracy. However, estimates of final energy savings are not guaranteed, because final savings may depend on behavioral factors and other uncontrollable variables. TRC Energy Services (TRC) and New Jersey Board of Public Utilities (NJBPU) shall in no event be liable should the actual energy savings vary.

Estimated installation costs are based on TRC's experience at similar facilities, pricing from local contractors and vendors, and/or cost estimates from *RS Means*. The owner of the facility is encouraged to independently confirm these cost estimates and to obtain multiple estimates when considering measure installations. Since actual installed costs can vary widely for certain measures and conditions, TRC and NJBPU do not guarantee installed cost estimates and shall in no event be held liable should actual installed costs vary from estimates.

New Jersey's Clean Energy Program (NJCEP) incentive values provided in this report are estimates based on program information available at the time of the report. Incentive levels are not guaranteed. The NJBPU reserves the right to extend, modify, or terminate programs without prior notice. The owner of the facility should review available program incentives and eligibility requirements prior to selecting and installing any energy conservation measures.

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1 EXECUTIVE SUMMARY

The New Jersey Board of Public Utilities (NJBPU) has sponsored this Local Government Energy Audit (LGEA) Report for Perth Amboy Campus.

The goal of an LGEA report is to provide you with information on how your facility uses energy, identify energy conservation measures (ECMs) that can reduce your energy use, and provide information and assistance to help facilities implement ECMs. The LGEA report also contains valuable information on financial incentives from New Jersey's Clean Energy Program (NJCEP) for implementing ECMs.

This study was conducted by TRC Energy Services (TRC), as part of a comprehensive effort to assist New Jersey local governments in controlling energy costs and protecting our environment by offering a wide range of energy management options and advice.

1.1 Facility Summary

Perth Amboy Campus is a 150,000 square-foot facility constructed in 2004. The building is a two-story educational facility including but not limited to classrooms, offices, hallways, and kitchen areas.

Lighting at the facility consists mainly of 32-Watt T8 fluorescent fixtures; all of which are inefficient when compared to the latest lighting technology available in the market. In addition to linear fluorescent technology, the facility also has several compact fluorescent, incandescent, high pressure sodium, and metal halide lamps, as well as LED exit signs. Interior lighting control is provided by manual switches. Exterior lighting at the facility is provided by a combination of metal halide, high pressure sodium, and compact fluorescent fixtures controlled photocells.

Cooling and ventilation is provided mainly by rooftop packaged AC units and make-up air units. Heating is mainly provided by four condensing hot water boilers as well as gas burners in package units.

A thorough description of the facility and our observations are located in Section 2.

1.2 Your Cost Reduction Opportunities

Energy Conservation Measures

TRC evaluated eight measures and recommended five measures which together represent an opportunity for Perth Amboy Campus to reduce annual energy costs by roughly $44,371 and annual greenhouse gas emissions by 355,654 lbs CO_2e. We estimate that if all measures were implemented as recommended, the project would pay for itself in roughly 5.5 years. The breakdown of existing and potential utility costs after project implementation are illustrated in Figure 1 and Figure 2, respectively. Together these measures represent an opportunity to reduce Perth Amboy Campus's annual energy use by 8%.

Figure 1 – Previous 12 Month Utility Costs

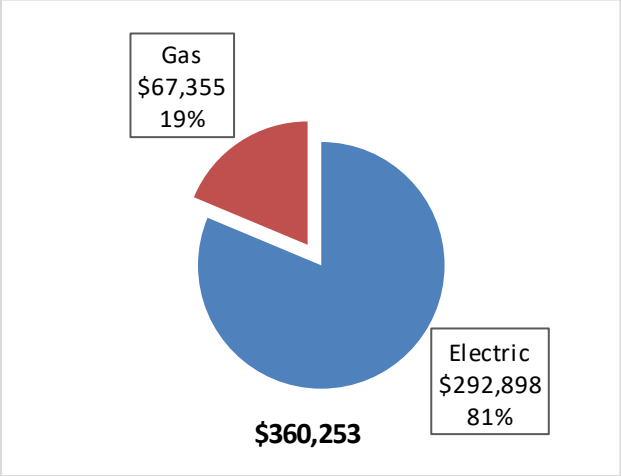
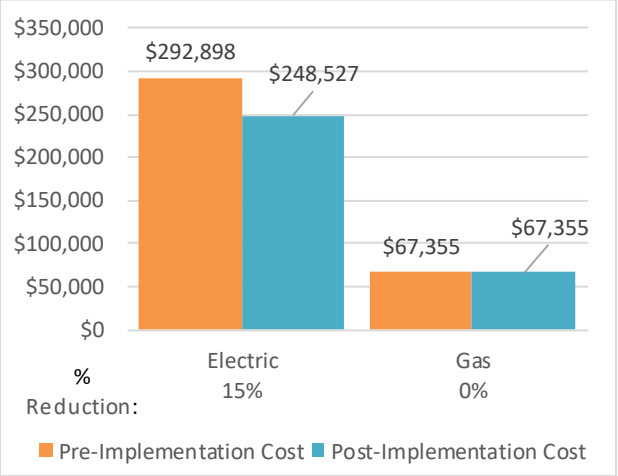


Figure 2 – Potential Post-Implementation Costs



A detailed description of Perth Amboy Campus's existing energy use can be found in Section 3.

Estimates of the total cost, energy savings, and financial incentives for the proposed energy efficient upgrades are summarized below in Figure 3. A brief description of each category can be found below and a description of savings opportunities can be found in Section 4.

Figure 3 – Summary of Energy Reduction Opportunities

Energy Conservation Measure		Recommend?	Annual Electric Savings (kWh)	Peak Demand Savings (kW	Annual Fuel Savings (MME	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Upgrades			**279,933**	**54.8**	**0.0**	**$35,168.62**	**$204,967.71**	**$24,530.00**	**$180,437.71**	**5.1**	**281,890**
ECM 1	Install LED Fixtures	Yes	44,013	6.8	0.0	$5,529.42	$47,134.08	$400.00	$46,734.08	8.5	44,321
ECM 2	Retrofit Fixtures with LED Lamps	Yes	235,920	48.0	0.0	$29,639.20	$157,833.63	$24,130.00	$133,703.63	4.5	237,570
Lighting Control Measures			**68,074**	**13.9**	**0.0**	**$8,552.23**	**$71,808.00**	**$7,475.00**	**$64,333.00**	**7.5**	**68,550**
ECM 3	Install Occupancy Sensor Lighting Controls	Yes	55,367	11.3	0.0	$6,955.85	$61,408.00	$7,475.00	$53,933.00	7.8	55,754
ECM 4	Install High/Low Lighitng Controls	Yes	12,707	2.6	0.0	$1,596.38	$10,400.00	$0.00	$10,400.00	6.5	12,796
Electric Unitary HVAC Measures			**116,179**	**76.5**	**0.0**	**$14,595.84**	**$1,370,167.51**	**$19,358.13**	**$1,350,809.38**	**92.5**	**116,991**
	Install High Efficiency Electric AC	No	91,310	60.1	0.0	$11,471.48	$1,186,792.54	$13,133.29	$1,173,659.24	102.3	91,948
	Install High Efficiency Packaged Terminal AC/HP	No	24,869	16.4	0.0	$3,124.36	$183,374.97	$6,224.83	$177,150.14	56.7	25,043
Gas Heating (HVAC/Process) Replacement			**0**	**0.0**	**242.4**	**$2,148.24**	**$50,960.87**	**$4,000.00**	**$46,960.87**	**21.9**	**28,382**
	Install High Efficiency Furnaces	No	0	0.0	242.4	$2,148.24	$50,960.87	$4,000.00	$46,960.87	21.9	28,382
Plug Load Equipment Control - Vending Machine			**5,178**	**0.0**	**0.0**	**$650.53**	**$920.00**	**$0.00**	**$920.00**	**1.4**	**5,214**
ECM 5	Vending Machine Control	Yes	5,178	0.0	0.0	$650.53	$920.00	$0.00	$920.00	1.4	5,214
TOTALS FOR HIGH PRIORITY MEASURES			**353,185**	**68.7**	**0.0**	**$44,371.38**	**$277,695.71**	**$32,005.00**	**$245,690.71**	**5.5**	**355,654**
TOTALS FOR ALL EVALUATED MEASURES			**469,364**	**145.2**	**242.4**	**$61,115.46**	**$1,698,824.09**	**$55,363.13**	**$1,643,460.96**	**26.9**	**501,028**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

Lighting Upgrades generally involve the replacement of existing lighting components such as lamps and ballasts (or the entire fixture) with higher efficiency lighting components. These measures save energy by reducing the power used by the lighting components due to improved electrical efficiency.

Lighting Control measures generally involve the installation of automated controls to turn off lights or reduce light output when not needed. Automated control reduces reliance on occupant behavior for adjusting lights. These measures save energy by reducing the amount of time lights are on.

Electric Unitary HVAC measures generally involve replacing older inefficient air conditioning systems with modern energy efficient systems. New air conditioning systems can provide equivalent cooling to older air condition systems at a reduced energy cost. These measures save energy by reducing the power used by the air conditioning systems, due to improved electrical efficiency.

Gas Heating (HVAC/Process) measures generally involve replacing older inefficient hydronic heating systems with modern energy efficient systems. Gas heating systems can provide equivalent heating compared to older systems at a reduced energy cost. These measures save energy by reducing the fuel demands for heating, due to improved combustion and heat transfer efficiency.

Plug Load Equipment control measures generally involve installing automated devices that limit the power usage or operation of equipment that is plugged into an electric outlet when not in use.

Energy Efficient Practices

TRC also identified 14 low cost (or no cost) energy efficient practices. A facility's energy performance can be significantly improved by employing certain behavioral or operational adjustments and by performing better routine maintenance on building systems. These practices can extend equipment lifetime, improve occupant comfort, provide better health and safety, as well as reduce annual energy and O&M costs. Potential opportunities identified at Perth Amboy Campus include:

- Perform Proper Lighting Maintenance
- Develop a Lighting Maintenance Schedule
- Perform Routine Motor Maintenance
- Use Fans to Reduce Cooling Load
- Practice Proper Use of Thermostat Schedules and Temperature Resets
- Ensure Economizers are Functioning Properly
- Clean Evaporator/Condenser Coils on AC Systems
- Clean and/or Replace HVAC Filters
- Perform Proper Boiler Maintenance
- Perform Proper Furnace Maintenance
- Perform Proper Water Heater Maintenance
- Install Plug Load Controls
- Replace Computer Monitors
- Water Conservation

For details on these energy efficient practices, please refer to Section 5.

On-Site Generation Measures

TRC evaluated the potential for installing on-site generation for Perth Amboy Campus. Based on the configuration of the site and its loads there is a high potential for installing a photovoltaic (PV) array.

Figure 4 – Photovoltaic Potential

Potential	High	
System Potential	215	kW DC STC
Electric Generation	256,145	kWh/yr
Displaced Cost	$22,280	/yr
Installed Cost	$559,000	

For details on our evaluation and on-site generation potential, please refer to Section 6.

1.3 Implementation Planning

To realize the energy savings from the ECMs listed in this report, a project implementation plan must be developed. Available capital must be considered and decisions need to be made whether it is best to pursue individual ECMs separately, groups of ECMs, or a comprehensive approach where all ECMs are implemented together, possibly in conjunction with other facility upgrades or improvements.

Rebates, incentives, and financing are available from NJCEP, as well as other sources, to help reduce the costs associated with the implementation of energy efficiency projects. Prior to implementing any measure, please review the relevant incentive program guidelines before proceeding. This is important because in most cases you will need to submit applications for the incentives prior to purchasing materials or commencing with installation.

The ECMs outlined in this report may qualify under the following program(s):

- SmartStart
- SREC (Solar Renewable Energy Certificate) Registration Program (SRP)
- Energy Savings Improvement Program (ESIP)

For facilities wanting to pursue only selected individual measures (or planning to phase implementation of selected measures over multiple years), incentives are available through the SmartStart program. To participate in this program, you may utilize internal resources, or an outside firm or contractor, to do the final design of the ECM(s) and do the installation. Program pre-approval is required for some SmartStart incentives, so only after receiving pre-approval should you proceed with ECM installation. The incentive estimates listed above in Figure 3 are based on the SmartStart program. More details on this program and others are available in Section 8.

For larger facilities with limited capital availability to implement ECMs, project financing may be available through the Energy Savings Improvement Program (ESIP). Supported directly by the NJBPU, ESIP provides government agencies with project development, design, and implementation support services, as well as, attractive financing for implementing ECMs. An LGEA report (or other approved energy audit) is required for participation in ESIP. Please refer to Section 8.3 for additional information on the ESIP Program.

The Demand Response Energy Aggregator is a (non-NJCEP) program designed to reduce electric loads at commercial facilities, when wholesale electricity prices are high or when the reliability of the electric grid is threatened due to peak power demand. Demand Response (DR) service providers (a.k.a. Curtailment Service Providers) are registered with PJM, the independent system operator (ISO) for mid-Atlantic state region that is charged with maintaining electric grid reliability. By enabling grid operators to call upon commercial facilities to reduce their electric usage during times of peak demand, the grid is made more reliable and overall transmission costs are reduced for all ratepayers. Curtailment Service Providers provide regular payments to medium and large consumers of electric power for their participation in DR programs. Program participation is voluntary and facilities receive payments if they are called upon to curtail their load during times of peak demand. Refer to Section 7 for additional information on this program.

Additional information on relevant incentive programs is in Section 8 or: www.njcleanenergy.com/ci.

2 FACILITY INFORMATION AND EXISTING CONDITIONS

2.1 Project Contacts

Figure 5 – Project Contacts

Name	Role	E-Mail	Phone #
Customer			
Karl Knehr	Business Administrator	knehrk@mail.mcvts.net	(732) 257-3300
TRC Energy Services			
Alexander Klieverik	Auditor	AKlieverik@trcsolutions.com	(732) 855-0033

2.2 General Site Information

On February 27, 2018, TRC performed an energy audit at Perth Amboy Campus located in Perth Amboy, New Jersey. TRC's team met with Karl Knehr and Francis Cap to review the facility operations and help focus our investigation on specific energy-using systems.

Perth Amboy Campus is a 150,000 square-foot facility constructed in 2004. The building is a two-story educational facility including but not limited to classrooms, offices, hallways, and kitchen areas.

2.3 Building Occupancy

The typical schedule is presented in the table below.

Figure 6 - Building Schedule

Building Name	Weekday/Weekend	Operating Schedule
Perth Amboy Campus	Weekday	7:00 AM - 8:00 PM
Perth Amboy Campus	Weekend	unoccupied

2.4 Building Envelope

The construction of Perth Amboy campus building is typically of concrete masonry block with brick type exterior and double pane tinted windows with operable frames. Most of the roof sections are constructed using black surface built-up roofing material.

Figure 7 – Building Façade



2.5 On-Site Generation

Perth Amboy Campus does not have any on-site electric generation capacity.

2.6 Energy-Using Systems

Please see Appendix A: Equipment Inventory & Recommendations for an inventory of the facility's equipment.

Lighting System

Lighting consists largely of 32-Watt T8 fluorescent fixtures. These sources are inefficient when compared to the latest lighting technology available in the market. Fluorescent T8 fixtures are 2-foot and 4-foot long linear, mainly troffers with diffusers having 1-lamp to 6-lamp configurations. In addition, there are several 26-Watt compact fluorescent fixtures with 1-lamp and 2-lamp configurations. Lighting at the facility also consist of 60-Watt incandescent lamps and 150-Watt metal halide fixtures serving the cafeteria and storage areas. All the exit signs are LED based fixtures.

Lighting control in the building is provided by manual switches.

Figure 8 - Building Lighting Systems

Linear Fluorescent Fixtures	*LED Wallpack*
	

Exterior lighting at the facility is provided by 26-Watt compact fluorescent fixtures with 1-lamp and 2-lamp configurations, 150-Watt high-pressure sodium, 200-Watt metal halide, and 40-Watt wall mounted LED fixtures. Exterior lighting control is provided by photocells.

Hot Water Heating System

The hot water system consists of five Benchmark 2.0 2,000 kBtu/hr. output, condensing boilers however, one of the boilers is not operating. All the boilers have a nominal combustion efficiency of 91%. The boilers are configured in a variable flow primary distribution with two hot water pumps of each 40 HP capacity. Hot water from the boilers is circulated to re-heat coils in the zone side variable air volume boxes, hot water coils in package units, unit heaters, and heat recovery units.

In addition to the hot water system, heating at the facility is also provided by six gas-fired roof top package units and four make-up air units. Furnaces in the package units have capacities between 93 kBtu/hr. and 292 kBtu/hr. The units operate at efficiencies of around 81%.

Heating is also provided by gas fired systems inside the four make-up air units. Each unit has an output capacity of 300 kBtu/hr. with heating efficiency of 75%.

Figure 9 – Hot Water Systems

Heating Hot Water Boilers	*Hot Water Pump*
	

Direct Expansion Air Conditioning System (DX)

Cooling at the facility is provided by a combination of rooftop package units, heat recovery units, and make-up air units.

There is a total of 19 package units providing cooling at the building with capacities between 6-tons and 65-tons. All the package units operate at efficiencies between 8.6 to 11.1 EER. Package units utilize direct expansion (DX) refrigerant coils to provide cooling. The units are connected to zone side variable air volume boxes with re-heat coils. Supply fans at all the package units have variable frequency drives for demand based speed variation. The units have outside air economizers to utilize free cooling when the outside air temperature is lower than the return air temperature. Package units are also equipped with gas fired burners to provide heating to the building as described in the heating section of this report.

Figure 10 – Direct Expansion Air Conditioning Systems (DX)

Rooftop Package Unit	*Make-up Air Unit*
	

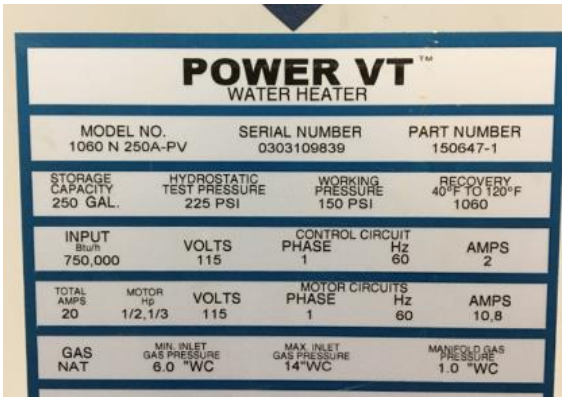
Cooling at the facility is also provided by four 24-ton make-up air units. Make-up air units provide a constant airflow of 4,500 CFM to the building spaces. Each unit has a 7.5 HP supply fan with constant speed operation due to lack of speed control. Cooling is provided by scroll compressors in the make-up air units. Additionally, the units have gas fired burners to provide heating as described in the heating section of this report.

There are two air-to-air heat recovery units with indirect heat exchangers that use exhaust air to precondition outside air being delivered to the kitchen. They have DX cooling components with a capacity of 15 tons, and hot water coils with an output capacity of 115 MBH to maintain the discharge temperature. Each heat recovery unit is equipped with a 3 HP supply fan that provides a constant supply of 3,200 CFM of conditioned air to the spaces. Heat exchanger provides heat addition and heat rejection during winter and summer months respectively.

Domestic Hot Water Heating System

The domestic hot water heating system at the facility consists of one Power VT hot water heater with an input rating of 750 kBtu/hr. and a nominal efficiency of 80%. The water heater has a 250-gallon storage tank.

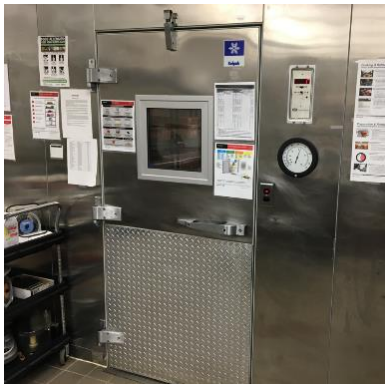
Figure 11 – Domestic Hot Water Heater

Domestic Hot Water Heater	*DHW Heater Nameplate*
	

Refrigeration

The facility has two solid door stand-up freezers of capacities between 16 – 30 cu. ft., one solid door stand-up refrigerator of capacity between 16 – 30 cu. ft., and one walk-in cooler of 1-ton capacity. The walk-in cooler has an evaporator unit with two fans operating at a constant speed condition.

Figure 12 – Refrigeration Equipment

Stand-up Freezer	*Walk-in Refrigeration Evaporator*
	

Building Plug Load

There are roughly 215 computer work stations throughout the facility. All the computers are desktop units with LCD monitors. There is no centralized PC power management software installed.

The facility contains other systems which contribute to plug load including printers, microwaves, televisions, etc. at the facility. In addition to the typical plug load equipment, the facility also has thr.ee refrigerated and one non-refrigerated vending machines.

Figure 13 – Building Plug-load Systems

Vending Machine	*Desktop PC*
	

3 SITE ENERGY USE AND COSTS

Utility data for electricity and natural gas was analyzed to identify opportunities for savings. In addition, data for electricity and natural gas was evaluated to determine the annual energy performance metrics for the building in energy cost per square foot and energy usage per square foot. These metrics are an estimate of the relative energy efficiency of this building. There are a number of factors that could cause the energy use of this building to vary from the "typical" energy usage profile for facilities with similar characteristics. Local weather conditions, building age and insulation levels, equipment efficiency, daily occupancy hours, changes in occupancy throughout the year, equipment operating hours, and energy efficient behavior of occupants all contribute to benchmarking scores. Please refer to the Benchmarking section within Section 3.4 for additional information.

3.1 Total Cost of Energy

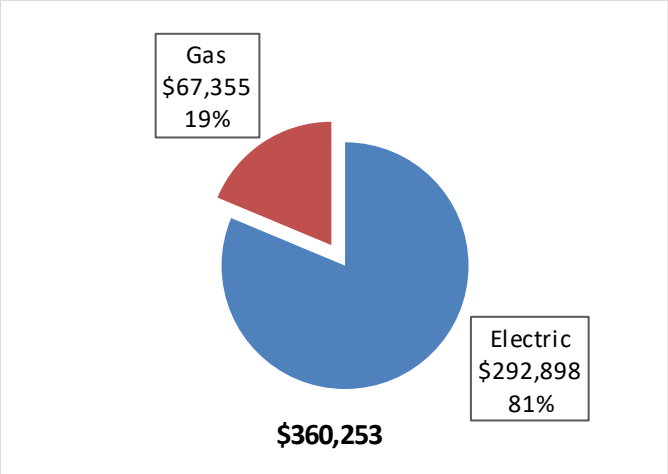
The following energy consumption and cost data is based on the last 12-month period of utility billing data that was provided for each utility. A profile of the annual energy consumption and energy cost of the facility was developed from this information.

Figure 14 - Utility Summary

Utility Summary for Perth Amboy Campus		
Fuel	**Usage**	**Cost**
Electricity	2,331,396 kWh	$292,898
Natural Gas	76,002 Therms	$67,355
Total		**$360,253**

The current annual energy cost for this facility is $360,253 as shown in the chart below.

Figure 15 - Energy Cost Breakdown



3.2 Electricity Usage

Electricity is provided by PSE&G. The average electric cost over the past 12 months was $0.126/kWh, which is the blended rate that includes energy supply, distribution, and other charges. This rate is used throughout the analyses in this report to assess energy costs and savings. The monthly electricity consumption and peak demand are shown in the chart below.

Figure 16 - Electric Usage & Demand

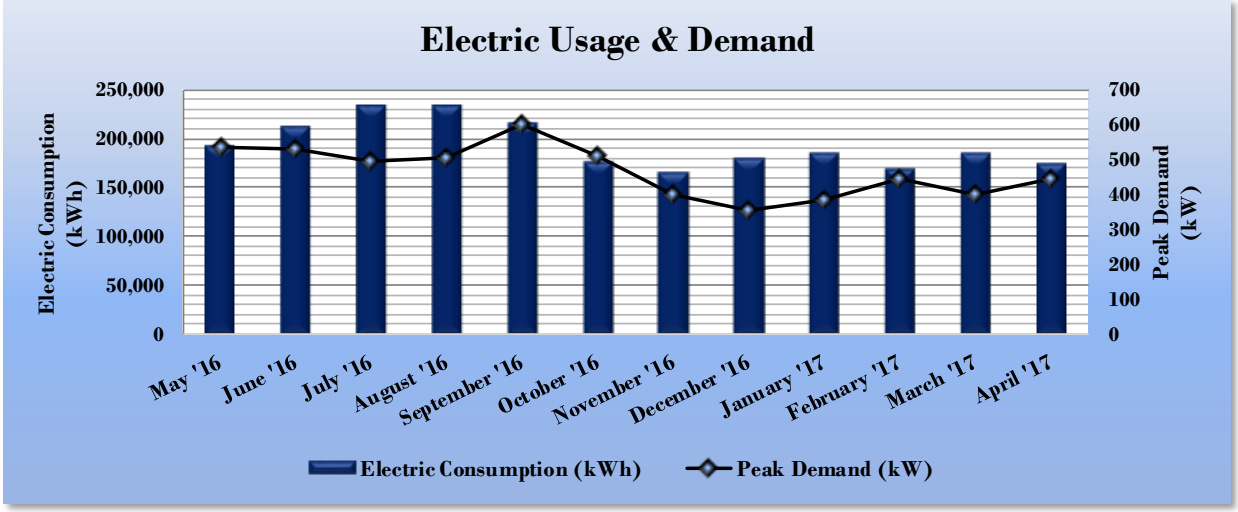


Figure 17 - Electric Usage & Demand

Electric Billing Data for Perth Amboy Campus					
Period Ending	Days in Period	Electric Usage (kWh)	Demand (kW)	Demand Cost	Total Electric Cost
5/31/16	30	192,193	534	$1,957	$22,808
6/30/16	30	212,036	531	$1,947	$29,625
7/31/16	31	234,911	496	$1,818	$31,634
8/31/16	31	234,046	503	$1,843	$31,626
9/30/16	30	216,428	600	$2,235	$31,067
10/31/16	31	175,867	508	$1,892	$20,632
11/30/16	30	165,254	398	$1,483	$19,115
12/31/16	31	180,254	355	$1,322	$21,364
1/31/17	31	184,949	385	$1,430	$21,517
2/28/17	28	169,229	445	$1,657	$20,068
3/31/17	31	184,850	397	$1,494	$21,582
4/30/17	30	174,992	442	$1,667	$21,058
Totals	**364**	**2,325,009**	**600.1**	**$20,745**	**$292,096**
Annual	**365**	**2,331,396**	**600.1**	**$20,802**	**$292,898**

3.3 Natural Gas Usage

Natural gas is provided by Elizabethtown Gas. The average gas cost for the past 12 months is $0.886/therm, which is the blended rate used throughout the analyses in this report. The monthly gas consumption is shown in the chart below.

Figure 18 - Natural Gas Usage

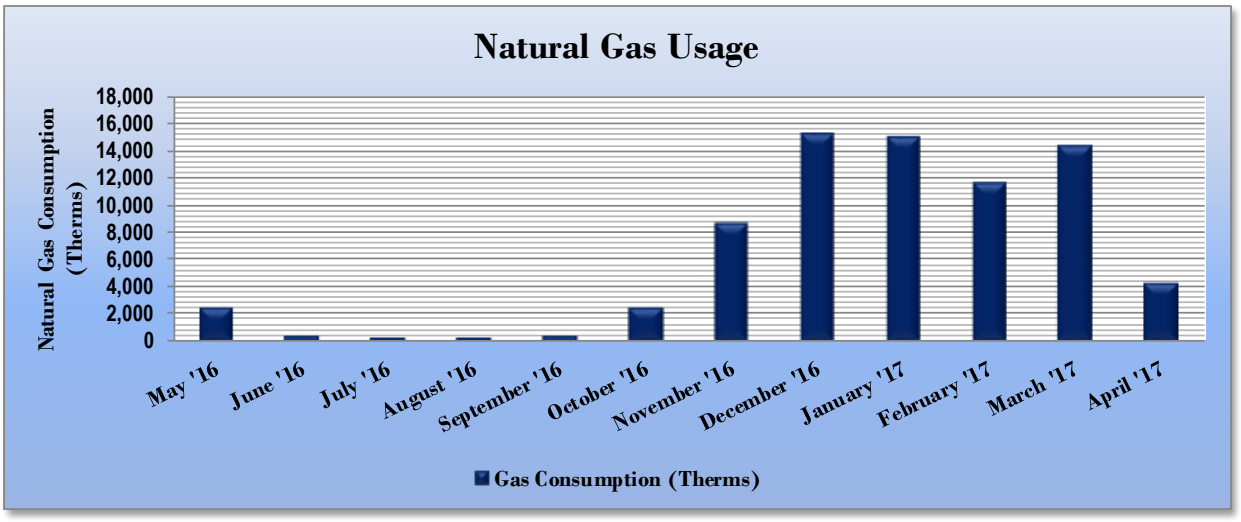


Figure 19 - Natural Gas Usage

Gas Billing Data for Perth Amboy Campus			
Period Ending	Days in Period	Natural Gas Usage (Therms)	Natural Gas Cost
6/1/16	31	2,515	$2,828
7/1/16	30	475	$1,448
8/1/16	31	299	$1,338
9/1/16	31	268	$1,296
10/1/16	30	371	$1,365
11/1/16	31	2,493	$2,901
12/1/16	30	8,681	$7,389
1/1/17	31	15,310	$11,997
2/1/17	31	15,105	$11,809
3/1/17	28	11,740	$9,423
4/1/17	31	14,445	$11,341
5/1/17	30	4,299	$4,220
Totals	**365**	**76,002**	**$67,355**
Annual	**365**	**76,002**	**$67,355**

3.4 Benchmarking

This facility was benchmarked using Portfolio Manager®, an online tool created and managed by the United States Environmental Protection Agency (EPA) through the ENERGY STAR® program. Portfolio Manager® analyzes your building's consumption data, cost information, and operational use details and then compares its performance against a national median for similar buildings of its type. Metrics provided by this analysis are Energy Use Intensity (EUI) and an ENERGY STAR® score for select building types.

The EUI is a measure of a facility's energy consumption per square foot, and it is the standard metric for comparing buildings' energy performance. Comparing the EUI of a building with the national median EUI for that building type illustrates whether that building uses more or less energy than similar buildings of its type on a square foot basis. EUI is presented in terms of "site energy" and "source energy." Site energy is the amount of fuel and electricity consumed by a building as reflected in utility bills. Source energy includes fuel consumed to generate electricity consumed at the site, factoring in electric production and distribution losses for the region.

Figure 20 - Energy Use Intensity Comparison – Existing Conditions

Energy Use Intensity Comparison - Existing Conditions		
	Perth Amboy Campus	National Median Building Type: School (K-12)
Source Energy Use Intensity (kBtu/ft^2)	219.7	141.4
Site Energy Use Intensity (kBtu/ft^2)	103.7	58.2

Implementation of all recommended measures in this report would improve the building's estimated EUI significantly, as shown in the table below:

Figure 21 - Energy Use Intensity Comparison – Following Installation of Recommended Measures

Energy Use Intensity Comparison - Following Installation of Recommended Measures		
	Perth Amboy Campus	National Median Building Type: School (K-12)
Source Energy Use Intensity (kBtu/ft^2)	194.5	141.4
Site Energy Use Intensity (kBtu/ft^2)	95.7	58.2

Many types of commercial buildings are also eligible to receive an ENERGY STAR® score. This score is a percentile ranking from 1 to 100. It compares your building's energy performance to similar buildings nationwide. A score of 50 represents median energy performance, while a score of 75 means your building performs better than 75 percent of all similar buildings nationwide and may be eligible for ENERGY STAR® certification. This facility has a current score of 20.

A Portfolio Manager® Statement of Energy Performance (SEP) was generated for this facility, see Appendix B: ENERGY STAR® Statement of Energy Performance.

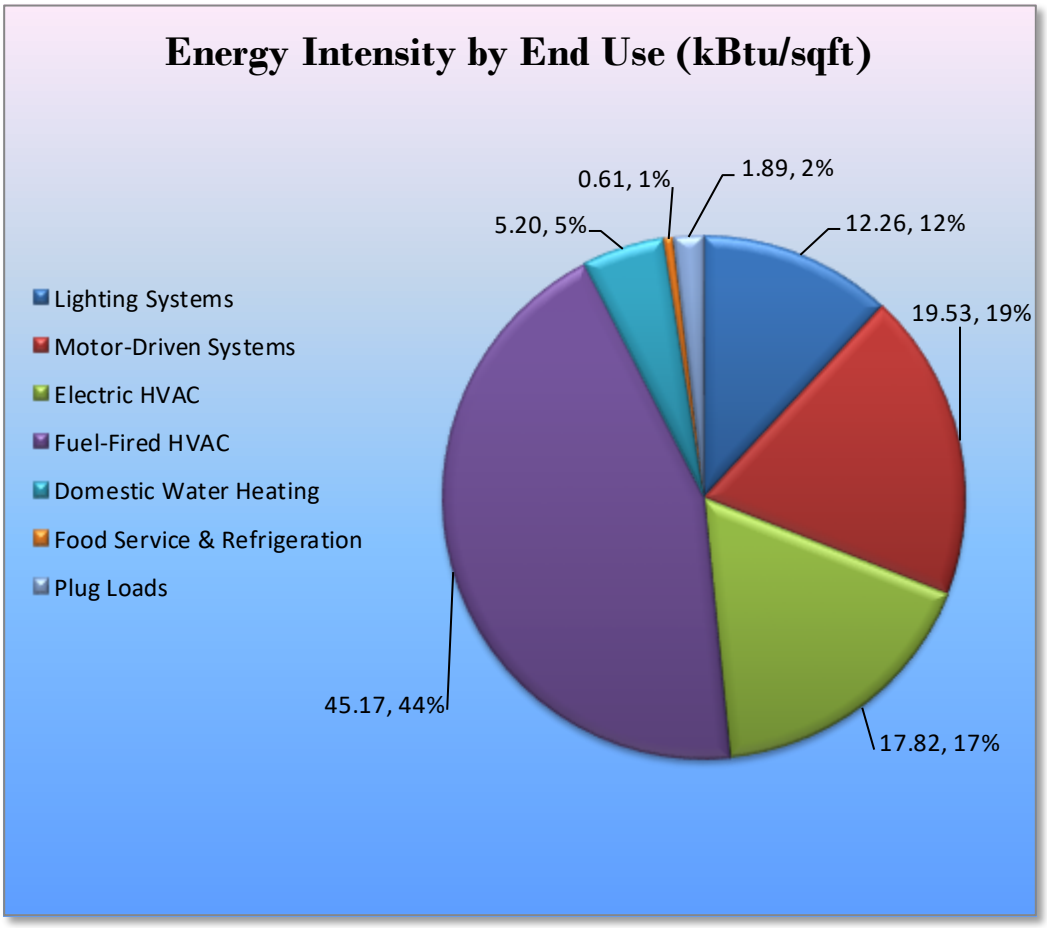
For more information on ENERGY STAR® certification go to: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification/how-app-1.

A Portfolio Manager® account has been created online for your facility and you will be provided with the login information for the account. We encourage you to update your utility information in Portfolio Manager® regularly, so that you can keep track of your building's performance. Free online training is available to help you use ENERGY STAR® Portfolio Manager® to track your building's performance at: https://www.energystar.gov/buildings/training.

3.5 Energy End-Use Breakdown

In order to provide a complete overview of energy consumption across building systems, an energy balance was performed at this facility. An energy balance utilizes standard practice engineering methods to evaluate all components of the various electric and fuel-fired systems found in a building to determine their proportional contribution to overall building energy usage. This chart of energy end uses highlights the relative contribution of each equipment category to total energy usage. This can help determine where the greatest benefits might be found from energy efficiency measures.

Figure 22 - Energy Balance (% and kBtu/SF)



4 ENERGY CONSERVATION MEASURES

Level of Analysis

The goal of this audit report is to identify potential energy efficiency opportunities, help prioritize specific measures for implementation, and provide information to the Perth Amboy Campus regarding financial incentives for which they may qualify to implement the recommended measures. For this audit report, most measures have received only a preliminary analysis of feasibility which identifies expected ranges of savings and costs. This level of analysis is usually considered sufficient to demonstrate project cost-effectiveness and help prioritize energy measures. Savings are based on the New Jersey Clean Energy Program Protocols to Measure Resource Savings dated June 29, 2016, approved by the New Jersey Board of Public Utilities. Further analysis or investigation may be required to calculate more precise savings based on specific circumstances. A higher level of investigation may be necessary to support any custom SmartStart or Pay for Performance, or Direct Install incentive applications. Financial incentives for the ECMs identified in this report have been calculated based the NJCEP prescriptive SmartStart program. Some measures and proposed upgrade projects may be eligible for higher incentives than those shown below through other NJCEP programs as described in Section 8.

The following sections describe the evaluated measures.

4.1 Recommended ECMs

The measures below have been evaluated by the auditor and are recommended for implementation at the facility.

Figure 23 – Summary of Recommended ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**279,933**	**54.8**	**0.0**	**$35,168.62**	**$204,967.71**	**$24,530.00**	**$180,437.71**	**5.1**	**281,890**
ECM 1	Install LED Fixtures	44,013	6.8	0.0	$5,529.42	$47,134.08	$400.00	$46,734.08	8.5	44,321
ECM 2	Retrofit Fixtures with LED Lamps	235,920	48.0	0.0	$29,639.20	$157,833.63	$24,130.00	$133,703.63	4.5	237,570
Lighting Control Measures		**68,074**	**13.9**	**0.0**	**$8,552.23**	**$71,808.00**	**$7,475.00**	**$64,333.00**	**7.5**	**68,550**
ECM 3	Install Occupancy Sensor Lighting Controls	55,367	11.3	0.0	$6,955.85	$61,408.00	$7,475.00	$53,933.00	7.8	55,754
ECM 4	Install High/Low Lighitng Controls	12,707	2.6	0.0	$1,596.38	$10,400.00	$0.00	$10,400.00	6.5	12,796
Plug Load Equipment Control - Vending Machine		**5,178**	**0.0**	**0.0**	**$650.53**	**$920.00**	**$0.00**	**$920.00**	**1.4**	**5,214**
ECM 5	Vending Machine Control	5,178	0.0	0.0	$650.53	$920.00	$0.00	$920.00	1.4	5,214
TOTALS		**353,185**	**68.7**	**0.0**	**$44,371.38**	**$277,695.71**	**$32,005.00**	**$245,690.71**	**5.5**	**355,654**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

4.1.1 Lighting Upgrades

Our recommendations for upgrades to existing lighting fixtures are summarized in Figure 24 below.

Figure 24 – Summary of Lighting Upgrade ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**279,933**	**54.8**	**0.0**	**$35,168.62**	**$204,967.71**	**$24,530.00**	**$180,437.71**	**5.1**	**281,890**
ECM 1	Install LED Fixtures	44,013	6.8	0.0	$5,529.42	$47,134.08	$400.00	$46,734.08	8.5	44,321
ECM 2	Retrofit Fixtures with LED Lamps	235,920	48.0	0.0	$29,639.20	$157,833.63	$24,130.00	$133,703.63	4.5	237,570

During lighting upgrade planning and design, we recommend a comprehensive approach that considers both the efficiency of the lighting fixtures and how they are controlled.

ECM 1: Install LED Fixtures

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	15,143	3.1	0.0	$1,902.49	$21,908.88	$180.00	$21,728.88	11.4	15,249
Exterior	28,869	3.8	0.0	$3,626.93	$25,225.20	$220.00	$25,005.20	6.9	29,071

Measure Description

We recommend replacing existing fixtures containing metal halide and high-pressure sodium lamps with new high-performance LED light fixtures. This measure saves energy by installing LEDs which use less power than other technologies with a comparable light output.

Additional savings from lighting maintenance can be anticipated since LEDs have lifetimes which are more than twice that of a metal halide or a high-pressure sodium lamp.

ECM 2: Retrofit Fixtures with LED Lamps

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	233,836	47.7	0.0	$29,377.38	$155,723.88	$24,130.00	$131,593.88	4.5	235,471
Exterior	2,084	0.3	0.0	$261.82	$2,109.74	$0.00	$2,109.74	8.1	2,099

Measure Description

We recommend retrofitting existing T8 linear fluorescent, incandescent, and compact fluorescent lighting technologies with LED lamps. Many LED tube lamps are direct replacements for existing fluorescent lamps and can be installed while leaving the fluorescent fixture ballast in place. LED bulbs can be used in existing fixtures as a direct replacement for most other lighting technologies. This measure saves energy by installing LEDs which use less power than other lighting technologies yet provide equivalent lighting output for the space.

Additional savings from lighting maintenance can be anticipated since LEDs have lifetimes which are more than twice that of fluorescent tubes and more than 10 times longer than many incandescent lamps.

4.1.2 Lighting Control Measures

Our recommendations for lighting control measures are summarized in Figure 25 below.

Figure 25 – Summary of Lighting Control ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Control Measures		**68,074**	**13.9**	**0.0**	**$8,552.23**	**$71,808.00**	**$7,475.00**	**$64,333.00**	**7.5**	**68,550**
ECM 3	Install Occupancy Sensor Lighting Controls	55,367	11.3	0.0	$6,955.85	$61,408.00	$7,475.00	$53,933.00	7.8	55,754
ECM 4	Install High/Low Lighitng Controls	12,707	2.6	0.0	$1,596.38	$10,400.00	$0.00	$10,400.00	6.5	12,796

During lighting upgrade planning and design, we recommend a comprehensive approach that considers both the efficiency of the lighting fixtures and how they are controlled.

ECM 3: Install Occupancy Sensor Lighting Controls

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
55,367	11.3	0.0	$6,955.85	$61,408.00	$7,475.00	$53,933.00	7.8	55,754

Measure Description

We recommend installing occupancy sensors to control lighting fixtures that are currently controlled by manual switches in areas such as restrooms, kitchen, classrooms, offices, etc. Lighting sensors detect occupancy using ultrasonic and/or infrared sensors. For most spaces, we recommend lighting controls use dual technology sensors, which can eliminate the possibility of any lights turning off unexpectedly. Lighting systems are enabled when an occupant is detected. Fixtures are automatically turned off after an area has been vacant for a preset period. Some controls also provide dimming options and all modern occupancy controls can be easily over-ridden by room occupants to allow them to manually turn fixtures on or off, as desired. Energy savings results from only operating lighting systems when they are required.

Occupancy sensors may be mounted on the wall at existing switch locations, mounted on the ceiling, or in remote locations. In general, wall switch replacement sensors are recommended for single occupant offices and other small rooms. Ceiling-mounted or remote mounted sensors are used in locations without local switching or where wall switches are not in the line-of-sight of the main work area and in large spaces. We recommend a comprehensive approach to lighting design that upgrades both the lighting fixtures and the controls together for maximum energy savings and improved lighting for occupants.

ECM 4: Install High/Low Lighting Controls

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
12,707	2.6	0.0	$1,596.38	$10,400.00	$0.00	$10,400.00	6.5	12,796

Measure Description

We recommend installing occupancy sensors to provide dual level lighting control for lighting fixtures in spaces that are infrequently occupied but may require some level of continuous lighting for safety or security reasons. Typical areas for such lighting control are stairwells, interior corridors, parking lots, and parking garages.

Lighting fixtures with these controls operate at default low levels when the area is not occupied to provide minimal lighting to meet security or safety requirements. Sensors detect occupancy using ultrasonic and/or infrared sensors. The lighting systems are switched to full lighting levels whenever an occupant is detected. Fixtures are automatically switched back to low level after an area has been vacant for a preset period. Energy savings results from only providing full lighting levels when it is required.

For this type of measure the occupancy sensors will generally be ceiling or fixture mounted. Sufficient sensor coverage needs to be provided to ensure that lights turn on in each area as an occupant approaches.

Additional savings from reduced lighting maintenance may also result from this measure, due to reduced lamp operation.

4.1.3 Plug Load Equipment Control - Vending Machines

Our recommendations for plug load equipment controls are summarized in Figure 26 below.

Figure 26-Summary of Plug Load Equipment Control ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Plug Load Equipment Control - Vending Machine		**5,178**	**0.0**	**0.0**	**$650.53**	**$920.00**	**$0.00**	**$920.00**	**1.4**	**5,214**
ECM 5	Vending Machine Control	5,178	0.0	0.0	$650.53	$920.00	$0.00	$920.00	1.4	5,214

ECM 5: Vending Machine Control

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
5,178	0.0	0.0	$650.53	$920.00	$0.00	$920.00	1.4	5,214

Measure Description

Vending machines operate continuously, even during non-business hours. It is recommended to install occupancy sensor controls to reduce the energy use. These controls power down vending machines when the vending machine area has been vacant for some time, then power up at regular intervals, as needed, to turn machine lights on or keep the product cool. Energy savings are a dependent on vending machine and activity level in the area surrounding the machines.

4.2 ECMs Evaluated But Not Recommended

The measures below have been evaluated by the auditor but are not recommended for implementation at the facility. Reasons for exclusion can be found in each measure description section.

Figure 27 – Summary of Measures Evaluated, But Not Recommended

Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Electric Unitary HVAC Measures	**116,179**	**76.5**	**0.0**	**$14,595.84**	**$1,370,167.51**	**$19,358.13**	**$1,350,809.38**	**92.5**	**116,991**
Install High Efficiency Electric AC	91,310	60.1	0.0	$11,471.48	$1,186,792.54	$13,133.29	$1,173,659.24	102.3	91,948
Install High Efficiency Packaged Terminal AC/HP	24,869	16.4	0.0	$3,124.36	$183,374.97	$6,224.83	$177,150.14	56.7	25,043
Gas Heating (HVAC/Process) Replacement	**0**	**0.0**	**242.4**	**$2,148.24**	**$50,960.87**	**$4,000.00**	**$46,960.87**	**21.9**	**28,382**
Install High Efficiency Furnaces	0	0.0	242.4	$2,148.24	$50,960.87	$4,000.00	$46,960.87	21.9	28,382
TOTALS	**116,179**	**76.5**	**242.4**	**$16,744.08**	**$1,421,128.38**	**$23,358.13**	**$1,397,770.26**	**83.5**	**145,374**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

Install High Efficiency Air Conditioning Units

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
91,310	60.1	0.0	$11,471.48	$1,186,792.54	$13,133.29	$1,173,659.24	102.3	91,948

Measure Description

We evaluated replacing standard efficiency packaged air conditioning units with high efficiency packaged air conditioning units. There have been significant improvements in both compressor and fan motor efficiencies over the past several years. Therefore, electricity savings can be achieved by replacing older units with new high efficiency units. A higher EER or SEER rating indicates a more efficient cooling system. The magnitude of energy savings for this measure depends on the relative efficiency of the older unit versus the new high efficiency unit, the average cooling load, and the estimated annual operating hours.

Reasons for not Recommending

The packaged units have relatively low use hours and also high cost of installation. This factor results in a long payback for the measure, more than the rated useful life of the replacement equipment. The measure is not recommended for implementation based on energy savings alone.

Install High Efficiency PTAC/PTHP

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
24,869	16.4	0.0	$3,124.36	$183,374.97	$6,224.83	$177,150.14	56.7	25,043

Measure Description

We evaluated replacing packaged terminal air conditioners with high efficiency PTAC. There have been significant improvements in both compressor and fan motor efficiencies over the past several years. Therefore, electricity savings can be achieved by replacing older units with new high efficiency units. A higher EER or SEER rating indicates a more efficient cooling system and a higher HPSF rating indicates more efficient heating mode for heat pumps. The magnitude of energy savings for this measure depends on the relative efficiency of the older unit versus the new high efficiency unit, the average heating and cooling loads, and the estimated annual operating hours.

Reasons for not Recommending

The make-up air units have relatively low use hours and also high cost of installation. This factor results in a long payback for the measure, more than the rated useful life of the replacement equipment. The measure is not recommended for implementation based on energy savings alone.

Install High Efficiency Furnaces

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
0	0.0	242.4	$2,148.24	$50,960.87	$4,000.00	$46,960.87	21.9	28,382

Measure Description

We evaluated replacing existing standard efficiency furnaces with high efficiency furnaces. Improved combustion technology and heat exchanger design optimize heat recovery from the combustion gases which can significantly improve furnace efficiency. Savings result from improved system efficiency.

Reasons for not Recommending

The furnaces/package units have relatively low use hours. This factor results in a long payback for the measure, more than the rated useful life of the replacement equipment. The measure is not recommended for implementation based on energy savings alone.

5 ENERGY EFFICIENT PRACTICES

In addition to the quantifiable savings estimated in Section 4, a facility's energy performance can also be improved through application of many low cost or no-cost energy efficiency strategies. By employing certain behavioral and operational changes and performing routine maintenance on building systems, equipment lifetime can be extended; occupant comfort, health and safety can be improved; and energy and O&M costs can be reduced. The recommendations below are provided as a framework for developing a whole building maintenance plan that is customized to your facility. Consult with qualified equipment specialists for details on proper maintenance and system operation.

Perform Proper Lighting Maintenance

In order to sustain optimal lighting levels, lighting fixtures should undergo routine maintenance. Light levels decrease over time due to lamp aging, lamp and ballast failure, and buildup of dirt and dust on lamps, fixtures and reflective surfaces. Together, these factors can reduce total illumination by 20% - 60% or more, while operating fixtures continue drawing full power. To limit this reduction, lamps, reflectors and diffusers should be thoroughly cleaned of dirt, dust, oil, and smoke film buildup approximately every 6 – 12 months.

Develop a Lighting Maintenance Schedule

In addition to routine fixture cleaning, development of a maintenance schedule can both ensure maintenance is performed regularly and can reduce the overall cost of fixture re-lamping and re-ballasting. By re-lamping and re-ballasting fixtures in groups, lighting levels are better maintained and the number of site visits by a lighting technician or contractor can be minimized, decreasing the overall cost of maintenance.

Perform Routine Motor Maintenance

Motors consist of many moving parts whose collective degradation can contribute to a significant loss of motor efficiency. To prevent damage to motor components, routine maintenance should be performed. This maintenance consists of cleaning surfaces and ventilation openings on motors to prevent overheating, lubricating moving parts to reduce friction, inspecting belts and pulleys for wear and to ensure they are at proper alignment and tension, and cleaning and lubricating bearings. Consult a licensed technician to assess these and other motor maintenance strategies.

Use Fans to Reduce Cooling Load

Utilizing ceiling fans to supplement cooling is a low-cost strategy to reduce cooling load considerably. Thermostat settings can be increased by 4°F with no change in overall occupant comfort when the wind chill effect of moving air is employed for cooling.

Practice Proper Use of Thermostat Schedules and Temperature Resets

Ensure thermostats are correctly set back. By employing proper set back temperatures and schedules, facility heating and cooling costs can be reduced dramatically during periods of low or no occupancy. As such, thermostats should be programmed for a setback of 5-10°F during low occupancy hours (reduce heating setpoints and increase cooling setpoints). Cooling load can be reduced further by increasing the facility's occupied setpoint temperature. In general, during the cooling season, thermostats should be set as high as possible without sacrificing occupant comfort.

Ensure Economizers are Functioning Properly

Economizers, when properly configured, can be used to significantly reduce mechanical cooling. However, if the outdoor thermostat or enthalpy control is malfunctioning or the damper is stuck or improperly adjusted, benefits from the economizer may not be fully realized. As such, periodic inspection and maintenance is required to ensure proper operation. This maintenance should be scheduled with maintenance of the facility's air conditioning system and should include proper setting of the outdoor thermostat/enthalpy control, inspection of control and damper operation, lubrication of damper connections, and adjustment of minimum damper position. A malfunctioning economizer can significantly increase the amount of heating and mechanical cooling required by introducing excess amounts of cold or hot outside air.

Clean Evaporator/Condenser Coils on AC Systems

Dirty evaporators and condensers coils cause a restriction to air flow and restrict heat transfer. This results in increased evaporator and condenser fan load and a decrease in cooling system performance. Keeping the coils clean allows the fans and cooling system to operate more efficiently.

Clean and/or Replace HVAC Filters

Air filters work to reduce the amount of indoor air pollution and increase occupant comfort. Over time, filters become less and less effective as particulate buildup increases. In addition to health concerns related to clogged filters, filters that have reached saturation also restrict air flow through the facility's air conditioning or heat pump system, increasing the load on the distribution fans and decreasing occupant comfort levels. Filters should be checked monthly and cleaned or replaced when appropriate.

Perform Regular Boiler Maintenance

Many boiler problems develop slowly over time, so regular inspection and maintenance is essential to retain proper functionality and efficiency of the heating system. Fuel burning equipment should undergo yearly tune-ups to ensure they are operating as safely and efficiently as possible from a combustion standpoint. A tune-up should include a combustion analysis to analyze the exhaust from the boilers and to ensure the boiler is operating safely. Buildup of dirt, dust, or deposits on the internal surfaces of a boiler can greatly affect its heat transfer efficiency. These deposits can accumulate on the water side or fire side of the boiler. Boilers should be cleaned regularly according to the manufacturer's instructions to remove this build up in order to sustain efficiency and equipment life.

Perform Regular Gas Burner Maintenance

Preventative furnace maintenance can extend the life of the system, maintain energy efficiency, and ensure safe operation. Following the manufacturer's instructions, a yearly tune-up should include tasks such as checking for gas / carbon monoxide leaks; changing the air and fuel filters; checking components for cracks, corrosion, dirt, or debris build-up; ensuring the ignition system is working properly; testing and adjusting operation and safety controls; inspecting the electrical connections; and ensuring proper lubrication for motors and bearings.

Perform Proper Water Heater Maintenance

At least once a year, drain a few gallons out of the water heater using the drain valve. If there is a lot of sediment or debris, then a full flush is recommended. Turn the temperature down and then completely drain the tank. Once a year check for any leaks or heavy corrosion on the pipes and valves. For gas water heaters, check the draft hood and make sure it is placed properly, with a few inches of air space between the tank and where it connects to the vent. Look for any corrosion or wear on the gas line and on the piping. If you noticed any black residue, soot or charred metal, this is a sign you may be having combustion issues and you should have the unit serviced by a professional. For electric water heaters, look for any signs of leaking such as rust streaks or residue around the upper and lower panels covering the electrical components on the tank. For water heaters over thr.ee to four years old have a technician inspect the sacrificial anode annually.

Plug Load Controls

There are a variety of ways to limit the energy use of plug loads including increasing occupant awareness, removing under-utilized equipment, installing hardware controls, and using software controls. Some control steps to take are to enable the most aggressive power settings on existing devices or install load sensing or occupancy sensing (advanced) power strips. For additional information refer to "Plug Load Best Practices Guide" http://www.advancedbuildings.net/plug-load-best-practices-guide-offices.

Replace Computer Monitors

Replacing old computer monitors or displays with efficient monitors will reduce energy use. ENERGY STAR® rated monitors have specific requirements for on mode power consumption as well as idle and sleep mode power. According to the ENERGY STAR® website monitors that have earned the ENERGY STAR® label are 25% more efficient than standard monitors.

Water Conservation

Installing low-flow faucets or faucet aerators, low-flow showerheads, and kitchen sink pre-rinse spray valves saves both energy and water. These devices save energy by reducing the overall amount of hot water used hence reducing the energy used to heat the water. The flow ratings for EPA WaterSense™ (http://www3.epa.gov/watersense/products) labeled devices are 1.5 gallons per minute (gpm) for bathroom faucets, 2.0 gpm for showerheads, and 1.28 gpm for pre-rinse spray valves.

Installing dual flush or low-flow toilets and low-flow or waterless urinals are additional ways to reduce the sites water use, however, these devices do not provide energy savings at the site level. Any reduction in water use does however ultimately reduce grid level electricity use since a significant amount of electricity is used to deliver water from reservoirs to end users. The EPA WaterSense™ ratings for urinals is 0.5 gallons per flush (gpf) and toilets that use as little as 1.28 gpf (this is lower than the current 1.6 gpf federal standard).

6 On-Site Generation Measures

On-site generation measure options include both renewable (e.g., solar, wind) and non-renewable (e.g., fuel cells) on-site technologies that generate power to meet all or a portion of the electric energy needs of a facility, often repurposing any waste heat where applicable. Also referred to as distributed generation, these systems contribute to Greenhouse Gas (GHG) emission reductions, demand reductions and reduced customer electricity purchases, resulting in the electric system reliability through improved transmission and distribution system utilization.

The State of New Jersey's Energy Master Plan (EMP) encourages new distributed generation of all forms and specifically focuses on expanding use of combined heat and power (CHP) by reducing financial, regulatory and technical barriers and identifying opportunities for new entries. The EMP also outlines a goal of 70% of the State's electrical needs to be met by renewable sources by 2050.

Preliminary screenings were performed to determine the potential that a generation project could provide a cost-effective solution for your facility. Before deciding to implement, a feasibility study should be conducted that would take a detailed look at existing energy profiles, siting, interconnection, and the costs associated with the generation project including interconnection costs, departing load charges, and any additional special facilities charges.

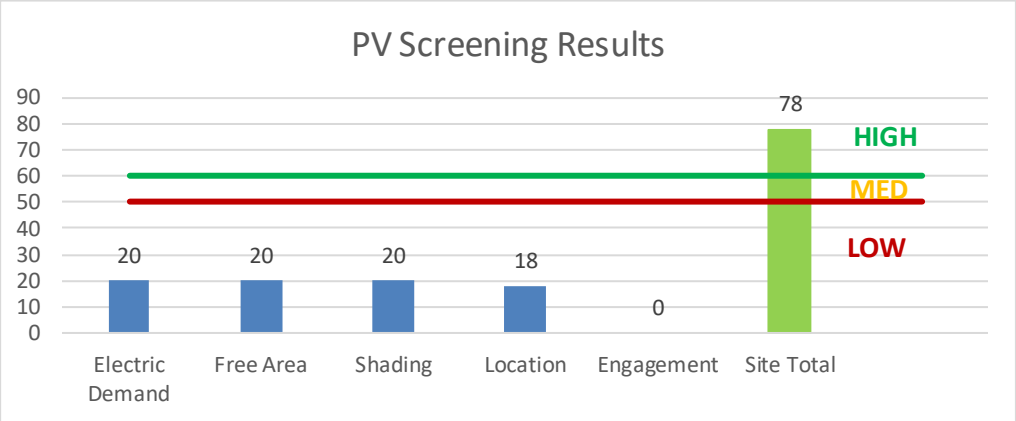
6.1 Photovoltaic

Sunlight can be converted into electricity using photovoltaics (PV) modules. Modules are racked together into an array that produces direct current (DC) electricity. The DC current is converted to alternating current (AC) through an inverter. The inverter is interconnected to the facility's electrical distribution system. The amount of unobstructed area available determines how large of a solar array can be installed. The size of the array combined with the orientation, tilt, and shading elements determines the energy produced.

A preliminary screening based on the facility's electric demand, size and location of free area, and shading elements shows that the facility has a **High** potential for installing a PV array.

The amount of free area, ease of installation (location), and the lack of shading elements contribute to the high potential for PV at the site. A PV array located on the roof of the building may be feasible. If Perth Amboy Campus is interested in pursuing the installation of PV, we recommended a full feasibility study be conducted.

Figure 28 - Photovoltaic Screening



Potential	High	
System Potential	215	kW DC STC
Electric Generation	256,145	kWh/yr
Displaced Cost	$22,280	/yr
Installed Cost	$559,000	

Solar projects must register their projects in the SREC (Solar Renewable Energy Certificate) Registration Program (SRP) prior to the start of construction in order to establish the project's eligibility to earn SRECs. Registration of the intent to participate in New Jersey's solar marketplace provides market participants with information about developed new solar projects and insight into future SREC pricing. Refer to Section 8.3 for additional information.

For more information on solar PV technology and commercial solar markets in New Jersey, or to find a qualified solar installer, who can provide a more detailed assessment of the specific costs and benefits of solar develop of the site, please visit the following links below:

- **Basic Info on Solar PV in NJ**: http://www.njcleanenergy.com/whysolar
- **NJ Solar Market FAQs**: http://www.njcleanenergy.com/renewable-energy/program-updates-and-background-information/solar-transition/solar-market-faqs
- **Approved Solar Installers in the NJ Market**: http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/tools-and-resources/tradeally/approved_vendorsearch/?id=60&start=1

6.2 Combined Heat and Power

Combined heat and power (CHP) is the on-site generation of electricity along with the recovery of heat energy, which is put to beneficial use. Common technologies for CHP include reciprocating engines, microturbines, fuel cells, backpressure steam turbines, and (at large facilities) gas turbines. Electric generation from a CHP system is typically interconnected to local power distribution systems. Heat is recovered from exhaust and ancillary cooling systems and interconnected to the existing hot water (or steam) distribution systems.

CHP systems are typically used to produce a portion of the electric power used onsite by a facility, with the balance of electric power needs supplied by grid purchases. The heat is used to supplement (or supplant) existing boilers for space heating and/or domestic hot water heating. Waste heat can also be routed through absorption chillers for space cooling. The key criteria used for screening, however, is the amount of time the system operates at full load and the facility's ability to use the recovered heat. Facilities with continuous use for large quantities of waste heat are the best candidates for CHP.

A preliminary screening based on heating and electrical demand, siting, and interconnection shows that the facility has a **Low** potential for installing a cost-effective CHP system.

7 DEMAND RESPONSE

Demand Response (DR) is a program designed to reduce the electric load of commercial facilities when electric wholesale prices are high or when the reliability of the electric grid is threatened due to peak demand. Demand Response service providers (a.k.a. Curtailment Service Providers) are registered with PJM, the independent system operator (ISO) for mid-Atlantic state region that is charged with maintaining electric grid reliability.

By enabling grid operators to call upon Curtailment Service Providers and commercial facilities to reduce electric usage during times of peak demand, the grid is made more reliable and overall transmission costs are reduced for all ratepayers. Curtailment Service Providers provide regular payments to medium and large consumers of electric power for their participation in DR programs. Program participation is voluntary and participants receive payments if their facility is called upon to curtail their electric usage.

Typically, an electric customer needs to can reduce their electric demand, within minutes, by at least 100 kW or more to participate in a DR program. Customers with a greater capability to quickly curtail their demand during peak hours will receive higher payments. Customers with back-up generators onsite may also receive additional DR payments for their generating capacity if they agree to run the generators for grid support when called upon. Eligible customers who have chosen to participate in a DR programs often find it to be a valuable source of revenue for their facility because the payments can significantly offset annual electric costs.

Participating customers can often quickly reduce their peak load through simple measures, such as temporarily raising temperature set points on thermostats, so that air conditioning units run less frequently, or agreeing to dim or shut off less critical lighting. This usually requires some level of building automation and controls capability to ensure rapid load reduction during a DR curtailment event. DR program participants may need to install smart meters or may need to also sub-meter larger energy-using equipment, such as chillers, to demonstrate compliance with DR program requirements.

DR does not include the reduction of electricity consumption based on normal operating practice or behavior. For example, if a company's normal schedule is to close for a holiday, the reduction of electricity due to this closure or scaled-back operation is not considered a demand response activity in most situations.

The first step toward participation in a DR program is to contact a Curtailment Service Provider. A list of these providers is available on PJM's website and it includes contact information for each company, as well as the states where they have active business (http://www.pjm.com/markets-and-operations/demand-response/csps.aspx). PJM also posts training materials that are developed for program members interested in specific rules and requirements regarding DR activity (http://www.pjm.com/training/training%20material.aspx), along with a variety of other DR program information.

Curtailment Service Providers typically offer free assessments to determine a facility's eligibility to participate in a DR program. They will provide details regarding program rules and requirements for metering and controls, assess a facility's ability to temporarily reduce electric load, and provide details on payments to be expected for participation in the program. Providers usually offer multiple options for DR to larger facilities and may also install controls or remote monitoring equipment of their own to help ensure compliance with all terms and conditions of a DR contract.

In our opinion this building is not a good candidate for a Demand Response measure.

8 PROJECT FUNDING / INCENTIVES

The NJCEP provides the incentive programs described below, and other benefits to ratepayers, because of the Societal Benefits Charge (SBC) Fund. The SBC was created by the State of New Jersey's Electricity Restructuring Law (1999), which requires all customers of investor-owned electric and gas utilities to pay a surcharge on their monthly energy bills. As a customer of a state-regulated electric or gas utility and therefore a contributor to the fund your organization is eligible to participate in the LGEA program and eligible to receive incentive payment for qualifying energy efficiency measures. Also available through the NJBPU are some alternative financing programs described later in this section. Please refer to Figure 29 for a list of the eligible programs identified for each recommended ECM.

Figure 29 - ECM Incentive Program Eligibility

Energy Conservation Measure		SmartStart Prescriptive	SmartStart Custom	Direct Install	Pay For Performance Existing Buildings	Large Energy Users Program	Combined Heat & Power and Fuel Cell
ECM 1	Install LED Fixtures	X					
ECM 2	Retrofit Fixtures with LED Lamps	X					
ECM 3	Install Occupancy Sensor Lighting Controls	X					
ECM 4	Install High/Low Lighitng Controls						
ECM 5	Vending Machine Control						

SmartStart is generally well-suited for implementation of individual measures or small group of measures. It provides flexibility to install measures at your own pace using in-house staff or a preferred contractor. Direct Install caters to small to mid-size facilities that can bundle multiple ECMs together. This can greatly simplify participation and may lead to higher incentive amounts, but requires the use of pre-approved contractors. The Pay for Performance (P4P) program is a "whole-building" energy improvement program designed for larger facilities. It requires implementation of multiple measures meeting minimum savings thresholds, as well as use of pre-approved consultants. The Large Energy Users Program (LEUP) is available to New Jersey's largest energy users giving them flexibility to install as little or as many measures, in a single facility or several facilities, with incentives capped based on the entity's annual energy consumption. LEUP applicants can use in-house staff or a preferred contractor.

Generally, the incentive values provided throughout the report assume the SmartStart program is utilized because it provides a consistent basis for comparison of available incentives for various measures, though in many cases incentive amounts may be higher through participation in other programs.

Brief descriptions of all relevant financing and incentive programs are in the sections below. Further information, including most current program availability, requirements, and incentive levels can be found at: www.njcleanenergy.com/ci.

8.1 SmartStart

Overview

The SmartStart program offers incentives for installing prescriptive and custom energy efficiency measures at your facility. Routinely the program adds, removes or modifies incentives from year to year for various energy efficiency equipment based on market trends and new technologies.

Equipment with Prescriptive Incentives Currently Available:

Electric Chillers
Electric Unitary HVAC
Gas Cooling
Gas Heating
Gas Water Heating
Ground Source Heat Pumps
Lighting
Lighting Controls
Refrigeration Doors
Refrigeration Controls
Refrigerator/Freezer Motors
Food Service Equipment
Variable Frequency Drives

Most equipment sizes and types are served by this program. This program provides an effective mechanism for securing incentives for energy efficiency measures installed individually or as part of a package of energy upgrades.

Incentives

The SmartStart prescriptive incentive program provides fixed incentives for specific energy efficiency measures, whereas the custom SmartStart program provides incentives for more unique or specialized technologies or systems that are not addressed through prescriptive incentive offerings for specific devices.

Since your facility is an existing building, only the retrofit incentives have been applied in this report. Custom measure incentives are calculated at $0.16/kWh and $1.60/therm based on estimated annual savings, capped at 50% of the total installed incremental project cost, or a project cost buy down to a one-year payback (whichever is less). Program incentives are capped at $500,000 per electric account and $500,000 per natural gas account, per fiscal year.

How to Participate

To participate in the SmartStart program you will need to apply for the specific equipment to be installed. Many applications are designed as rebates, although others require application approval prior to installation. Applicants may work with a contractor of their choosing and can also utilize internal personnel, which provides added flexibility to the program. Using internal personnel also helps improve the economics of the ECM by reducing the labor cost that is included in the tables in this report.

Detailed program descriptions, instructions for applying and applications can be found at: www.njcleanenergy.com/SSB.

8.2 SREC Registration Program

The SREC (Solar Renewable Energy Certificate) Registration Program (SRP) is used to register the intent to install solar projects in New Jersey. Rebates are not available for solar projects, but owners of solar projects MUST register their projects in the SRP prior to the start of construction to establish the project's eligibility to earn SRECs. Registration of the intent to participate in New Jersey's solar marketplace provides market participants with information about the pipeline of anticipated new solar capacity and insight into future SREC pricing.

After the registration is accepted, construction is complete, and final paperwork has been submitted and is deemed complete, the project is issued a New Jersey certification number which enables it to generate New Jersey SRECs. SREC's are generated once the solar project has been authorized to be energized by the Electric Distribution Company (EDC).

Each time a solar installation generates 1,000 kilowatt-hours (kWh) of electricity, an SREC is earned. Solar project owners report the energy production to the SREC Tracking System. This reporting allows SREC's to be placed in the customer's electronic account. SRECs can then be sold on the SREC Tracking System, providing revenue for the first 15 years of the project's life.

Electricity suppliers, the primary purchasers of SRECs, are required to pay a Solar Alternative Compliance Payment (SACP) if they do not meet the requirements of New Jersey's Solar RPS. One way they can meet the RPS requirements is by purchasing SRECs. As SRECs are traded in a competitive market, the price may vary significantly. The actual price of an SREC during a trading period can and will fluctuate depending on supply and demand.

Information about the SRP can be found at: www.njcleanenergy.com/srec.

8.3 Energy Savings Improvement Program

The Energy Savings Improvement Program (ESIP) is an alternate method for New Jersey's government agencies to finance the implementation of energy conservation measures. An ESIP is a type of "performance contract," whereby school districts, counties, municipalities, housing authorities and other public and state entities enter in to contracts to help finance building energy upgrades. This is done in a manner that ensures that annual payments are lower than the savings projected from the ECMs, ensuring that ESIP projects are cash flow positive in year one, and every year thereafter. ESIP provides government agencies in New Jersey with a flexible tool to improve and reduce energy usage with minimal expenditure of new financial resources. NJCEP incentive programs can be leveraged to help further reduce the total project cost of eligible measures.

This LGEA report is the first step to participating in ESIP. Next, you will need to select an approach for implementing the desired ECMs:

(1) Use an Energy Services Company or "ESCO."
(2) Use independent engineers and other specialists, or your own qualified staff, to provide and manage the requirements of the program through bonds or lease obligations.
(3) Use a hybrid approach of the two options described above where the ESCO is utilized for some services and independent engineers, or other specialists or qualified staff, are used to deliver other requirements of the program.

After adopting a resolution with a chosen implementation approach, the development of the Energy Savings Plan (ESP) can begin. The ESP demonstrates that the total project costs of the ECMs are offset by the energy savings over the financing term, not to exceed 15 years. The verified savings will then be used to pay for the financing.

The ESIP approach may not be appropriate for all energy conservation and energy efficiency improvements. Entities should carefully consider all alternatives to develop an approach that best meets their needs. A detailed program descriptions and application can be found at: www.njcleanenergy.com/ESIP.

Please note that ESIP is a program delivered directly by the NJBPU and is not an NJCEP incentive program. As mentioned above, you may utilize NJCEP incentive programs to help further reduce costs when developing the ESP. You should refer to the ESIP guidelines at the link above for further information and guidance on next steps.

9 ENERGY PURCHASING AND PROCUREMENT STRATEGIES

9.1 Retail Electric Supply Options

In 1999, New Jersey State Legislature passed the Electric Discount & Energy Competition Act (EDECA) to restructure the electric power industry in New Jersey. This law deregulated the retail electric markets, allowing all consumers to shop for service from competitive electric suppliers. The intent was to create a more competitive market for electric power supply in New Jersey. As a result, utilities could charge Cost of Service and customers were given the ability to choose a third party (i.e. non-utility) energy supplier.

Energy deregulation in New Jersey has increased energy buyers' options by separating the function of electricity distribution from that of electricity supply. So, though you may choose a different company from which to buy your electric power, responsibility for your facility's interconnection to the grid and repair to local power distribution will still reside with the traditional utility company serving your region.

If your facility is not purchasing electricity from a third-party supplier, consider shopping for a reduced rate from third-party electric suppliers. If your facility is purchasing electricity from a third-party supplier, review and compare prices at the end of the current contract or every couple of years.

A list of third-party electric suppliers, who are licensed by the state to provide service in New Jersey, can be found online at: www.state.nj.us/bpu/commercial/shopping.html.

9.2 Retail Natural Gas Supply Options

The natural gas market in New Jersey has also been deregulated. Most customers that remain with the utility for natural gas service pay rates that are market-based and that fluctuate monthly. The utility provides basic gas supply service (BGSS) to customers who choose not to buy from a third-party supplier for natural gas commodity.

A customer's decision about whether to buy natural gas from a retail supplier is typically dependent upon whether a customer seeks budget certainty and/or longer-term rate stability. Customers can secure longer-term fixed prices by signing up for service through a third-party retail natural gas supplier. Many larger natural gas customers may seek the assistance of a professional consultant to assist in their procurement process.

If your facility is not purchasing natural gas from a third-party supplier, consider shopping for a reduced rate from third-party natural gas suppliers. If your facility is purchasing natural gas from a third-party supplier, review and compare prices at the end of the current contract or every couple of years.

A list of third-party natural gas suppliers, who are licensed by the state to provide service in New Jersey, can be found online at: www.state.nj.us/bpu/commercial/shopping.html.

Appendix A: Equipment Inventory & Recommendations

Lighting Inventory & Recommendations

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Boiler Rm	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Boiler Rm	21	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	21	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.57	2,815	0.0	$353.62	$1,768.50	$280.00	4.21
HVAC shop	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
HVAC shop	52	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	52	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	1.42	6,970	0.0	$875.63	$4,392.00	$695.00	4.22
HVAC shop RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
B210 CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B210 CR	21	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	21	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.86	4,222	0.0	$530.43	$2,119.20	$385.00	3.27
B210 A1 CR	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
B211 CR	19	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	19	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.78	3,820	0.0	$479.91	$1,968.80	$355.00	3.36
B211 CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B213	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.14	670	0.0	$84.20	$562.50	$85.00	5.67
School Store	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
B220 CR	13	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	13	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.53	2,614	0.0	$328.36	$1,247.60	$230.00	3.10
B220 CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B220A	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
B221	18	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	18	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.74	3,619	0.0	$454.65	$1,893.60	$340.00	3.42
B221	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B222 CR	18	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	18	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.74	3,619	0.0	$454.65	$1,893.60	$340.00	3.42
B222 CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B222A	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
B223	18	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	18	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.74	3,619	0.0	$454.65	$1,893.60	$340.00	3.42
B223	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B215 CR	30	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	30	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	1.23	6,032	0.0	$757.76	$3,066.00	$555.00	3.31
B215 CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B215B	12	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	12	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.49	2,413	0.0	$303.10	$1,172.40	$215.00	3.16

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
B216	30	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	30	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	1.23	6,032	0.0	$757.76	$3,066.00	$555.00	3.31
B216	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
BOYS RR	4	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	4	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.06	281	0.0	$35.29	$413.60	$55.00	10.16
BOYS RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
GIRS RR	4	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	4	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.06	281	0.0	$35.29	$413.60	$55.00	10.16
GIRS RR	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.11	536	0.0	$67.36	$504.00	$75.00	6.37
Cafeterium	81	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	81	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	2.21	10,857	0.0	$1,363.96	$6,898.50	$1,090.00	4.26
Cafeterium	6	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	6	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Cafeterium	24	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	24	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.42	2,046	0.0	$257.02	$2,649.74	$70.00	10.04
Cafeterium	9	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	9	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.16	767	0.0	$96.38	$1,061.15	$35.00	10.65
Cafeterium	14	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	14	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.24	1,193	0.0	$149.93	$1,770.68	$70.00	11.34
Cafeterium	24	Metal Halide: (1) 175W Lamp	Wall Switch	215	2,795	Fixture Replacement	Yes	24	LED - Fixtures: Downlight Pendant	Occupancy Sensor	65	1,957	2.67	13,103	0.0	$1,646.10	$15,145.92	$190.00	9.09
Vending Are	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Storage	12	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	12	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.33	1,608	0.0	$202.07	$972.00	$120.00	4.22
IT Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Storage 2	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Kitchen	20	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	2,795	Relamp	Yes	20	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	1,957	0.28	1,356	0.0	$170.41	$1,504.00	$270.00	7.24
Kitchen	8	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	8	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.14	682	0.0	$85.67	$973.25	$35.00	10.95
Kitchen	9	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	9	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.16	767	0.0	$96.38	$1,061.15	$35.00	10.65
Kitchen	4	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	4	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	4	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	4	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	20	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	20	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.55	2,681	0.0	$336.78	$1,710.00	$270.00	4.28
Office B207	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$233.00	$40.00	5.73
Mens RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Womens RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Storage	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$30.00	8.22
Back Kitchen	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Hallway	11	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	11	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	0.30	1,474	0.0	$185.23	$843.50	$110.00	3.96
Kitchen CR	3	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	3	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen CR	23	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	23	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.94	4,624	0.0	$580.95	$2,269.60	$415.00	3.19
Office 208E	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$233.00	$40.00	5.73
Kitchen CR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Storage	1	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,795	0.01	56	0.0	$7.07	$35.90	$5.00	4.37
Laundry	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Mens Locker RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Womens Locker RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Lunch Kitchen	2	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	1,957	0.03	136	0.0	$17.04	$212.40	$40.00	10.12
Area CR	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.33	1,608	0.0	$202.07	$871.60	$155.00	3.55
Storage	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$387.00	$20.00	10.90
Area CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Electrical Rm	1	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	No	1	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	2,795	0.03	159	0.0	$19.99	$75.20	$15.00	3.01
C153 CR	17	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	17	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.70	3,418	0.0	$429.39	$1,818.40	$325.00	3.48
C153 CR	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
C152 CR	17	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	17	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.70	3,418	0.0	$429.39	$1,818.40	$325.00	3.48
C152 CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
WOMENS RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	2	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.03	140	0.0	$17.65	$341.80	$45.00	16.82
WOMENS RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
JANITOR CLOSET	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
MENS RR	4	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	4	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.06	281	0.0	$35.29	$413.60	$55.00	10.16
MENS RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53

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Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
GYM	24	Linear Fluorescent - T8: 4' T8 (32W) - 6L	Wall Switch	176	2,795	Relamp	Yes	24	LED - Linear Tubes: (6) 4' Lamps	Occupancy Sensor	87	1,957	1.81	8,879	0.0	$1,115.49	$4,301.36	$860.00	3.09
GYM	5	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	5	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
GYM STORAGE	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$30.00	8.22
GYM STORAGE	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.14	670	0.0	$84.20	$562.50	$50.00	6.09
Girls Locker	4	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	4	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Girls Locker	14	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	14	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.38	1,876	0.0	$235.75	$1,359.00	$210.00	4.87
Girls Locker	6	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.16	804	0.0	$101.03	$621.00	$95.00	5.21
Team Rm	6	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.16	804	0.0	$101.03	$621.00	$95.00	5.21
Gym Locker Office	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.14	670	0.0	$84.20	$562.50	$85.00	5.67
RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Fitness Center	18	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	18	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.49	2,413	0.0	$303.10	$1,593.00	$250.00	4.43
Fitness Center	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Boys Locker	20	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	20	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.55	2,681	0.0	$336.78	$1,710.00	$270.00	4.28
Boys Locker	3	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	3	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Team Rm	6	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.16	804	0.0	$101.03	$621.00	$95.00	5.21
Coach's Office	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.14	670	0.0	$84.20	$562.50	$85.00	5.67
Coach's Office	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$387.00	$55.00	9.86
C161	9	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	9	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.25	1,206	0.0	$151.55	$796.50	$125.00	4.43
C161	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
C161C	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.11	536	0.0	$67.36	$504.00	$75.00	6.37
C161B	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$233.00	$40.00	5.73
Storage	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
C139	45	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	45	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	1.85	9,047	0.0	$1,136.63	$4,464.00	$815.00	3.21
Storage	1	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	2,795	Relamp	No	1	LED - Linear Tubes: (4) 4' Lamps	Wall Switch	58	2,795	0.04	180	0.0	$22.61	$95.13	$20.00	3.32

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Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Storage	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Mens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	3	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.04	211	0.0	$26.47	$377.70	$50.00	12.38
Womens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Womens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	3	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.04	211	0.0	$26.47	$377.70	$50.00	12.38
164 CADD	38	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	38	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	1.56	7,640	0.0	$959.82	$3,667.60	$675.00	3.12
164 CADD	3	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	3	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B132	36	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	36	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	1.48	7,238	0.0	$909.31	$3,517.20	$645.00	3.16
B132	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B132	8	Incandescent: INC-60W	Wall Switch	60	2,795	Relamp	Yes	8	LED Screw-In Lamps: LED - 9W	Occupancy Sensor	9	1,957	0.28	1,381	0.0	$173.48	$621.62	$75.00	3.15
B131CR	22	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	22	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.90	4,423	0.0	$555.69	$2,194.40	$400.00	3.23
B131CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Construction Lab	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.25	1,206	0.0	$151.55	$721.20	$125.00	3.93
Construction Lab	4	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	4	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Construction Lab	54	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	54	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	1.48	7,238	0.0	$909.31	$4,509.00	$715.00	4.17
Exit Area	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.11	536	0.0	$67.36	$504.00	$75.00	6.37
Exit Area	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodshop	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodshop	48	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	48	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	1.31	6,434	0.0	$808.27	$3,888.00	$620.00	4.04
Woodshop	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$233.00	$40.00	5.73
Stroage	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Electrical Lab	24	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	24	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.66	3,217	0.0	$404.14	$1,944.00	$310.00	4.04
Electrical Lab	25	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	25	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.68	3,351	0.0	$420.98	$2,002.50	$320.00	4.00
RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
RR	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B117	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B117	86	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	86	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	2.35	11,527	0.0	$1,448.16	$7,191.00	$1,140.00	4.18
RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Office	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Storage	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.11	536	0.0	$67.36	$504.00	$40.00	6.89
Tool Storage	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.11	536	0.0	$67.36	$504.00	$40.00	6.89
B116 Maintenance Shop	24	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	24	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.66	3,217	0.0	$404.14	$1,944.00	$310.00	4.04
Emergency Exit	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Emergency Exit	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$233.00	$40.00	5.73
B114CR	18	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	18	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.74	3,619	0.0	$454.65	$1,893.60	$340.00	3.42
B114CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B114A	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
B113CR	18	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	18	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.74	3,619	0.0	$454.65	$1,893.60	$340.00	3.42
B113CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B112CR	18	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	18	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.74	3,619	0.0	$454.65	$1,893.60	$340.00	3.42
B112CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B112A	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
B111CR	18	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	18	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.74	3,619	0.0	$454.65	$1,893.60	$340.00	3.42
B111CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
B130IT	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.08	402	0.0	$50.52	$420.40	$65.00	7.04
B130IT	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
B130A	1	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	No	1	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	2,795	0.03	159	0.0	$19.99	$75.20	$15.00	3.01
B124 Center	33	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	33	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	1.35	6,635	0.0	$833.53	$3,291.60	$600.00	3.23
B124 Center	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Electrical/Storage	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$387.00	$20.00	10.90
B124B	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
B124A	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.25	1,206	0.0	$151.55	$721.20	$125.00	3.93
A1041	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.25	1,206	0.0	$151.55	$721.20	$125.00	3.93
A104j	12	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	12	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.49	2,413	0.0	$303.10	$1,172.40	$215.00	3.16
Stroage 1	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$233.00	$40.00	5.73
Storage 2	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$30.00	8.22
A104F	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.25	1,206	0.0	$151.55	$721.20	$125.00	3.93
RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Main Office RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Vault	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
A104M	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.33	1,608	0.0	$202.07	$871.60	$155.00	3.55
A104M	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
A104D	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.25	1,206	0.0	$151.55	$721.20	$125.00	3.93
A104C	10	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	10	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.41	2,011	0.0	$252.59	$1,022.00	$185.00	3.31
A104C	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Main Office Area	12	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	12	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.49	2,413	0.0	$303.10	$1,172.40	$215.00	3.16
Main Office Area	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Main Office Area	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.14	670	0.0	$84.20	$562.50	$85.00	5.67
Stroage	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Storage 2	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Stairwell 1	9	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	9	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	0.25	1,206	0.0	$151.55	$726.50	$90.00	4.20
Stairwell 1	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
A110 Faculty Rm Mens RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
A110 Faculty Rm Womens RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Lounge	12	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	12	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.49	2,413	0.0	$303.10	$1,172.40	$215.00	3.16
A110D	22	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	22	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.90	4,423	0.0	$555.69	$2,194.40	$400.00	3.23
A110D	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
A109 Wellnes Center	14	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	14	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.38	1,876	0.0	$235.75	$1,359.00	$210.00	4.87
A109 Wellnes Center	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Storage	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$387.00	$20.00	10.90
Exam Rm	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	2,795	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,957	0.10	472	0.0	$59.28	$460.27	$75.00	6.50
Exam Rm RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Exam Rm RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	3	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.04	211	0.0	$26.47	$377.70	$50.00	12.38
A101CR	26	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	26	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	1.07	5,227	0.0	$656.72	$2,765.20	$495.00	3.46
A101CR	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Womens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Womens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	3	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.04	211	0.0	$26.47	$377.70	$50.00	12.38
JANITOR CLOSET	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Mens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Mens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	3	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.04	211	0.0	$26.47	$377.70	$50.00	12.38
Media Center	14	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	14	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.24	1,193	0.0	$149.93	$1,770.68	$70.00	11.34
Media Center	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Media Center	41	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	41	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	1.68	8,243	0.0	$1,035.60	$4,163.20	$755.00	3.29
103C	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
103B Tech Support	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Storage	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$30.00	8.22
Storage	12	Metal Halide: (1) 175W Lamp	Wall Switch	215	2,795	Fixture Replacement	Yes	12	LED - Fixtures: Downlight Pendant	Occupancy Sensor	65	1,957	1.34	6,551	0.0	$823.05	$7,572.96	$60.00	9.13
Storage	8	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	2,795	Relamp	Yes	8	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	1,957	0.11	543	0.0	$68.16	$655.60	$80.00	8.44

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Entry Foyer	4	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	4	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.07	341	0.0	$42.84	$621.62	$35.00	13.69
Entry Foyer	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Entry Foyer	6	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	2,795	Relamp	Yes	6	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,957	0.29	1,416	0.0	$177.84	$840.80	$155.00	3.86
Entry Foyer	1	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	2,795	Relamp	No	1	LED Screw-In Lamps: LED - 18W	Wall Switch	18	2,795	0.01	25	0.0	$3.15	$43.95	$0.00	13.95
Exterior	11	Compact Fluorescent: CFL - 1L - 26W	Daylight Dimming	26	4,380	Relamp	No	11	LED Screw-In Lamps: LED - 18W	Daylight Dimming	18	4,380	0.06	432	0.0	$54.30	$483.48	$0.00	8.90
Exterior	23	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Daylight Dimming	40	4,380	None	No	23	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Daylight Dimming	40	4,380	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Exterior	12	Compact Fluorescent: CFL - 2L - 26W	Daylight Dimming	52	4,380	Relamp	No	12	LED Screw-In Lamps: LED - 36W	Daylight Dimming	36	4,380	0.12	943	0.0	$118.46	$1,054.87	$0.00	8.90
Exterior	13	Compact Fluorescent: CFL - 2L - 26W	Daylight Dimming	52	4,380	Relamp	No	13	LED Screw-In Lamps: LED - 36W	Daylight Dimming	36	4,380	0.13	1,022	0.0	$128.33	$571.39	$0.00	4.45
Entry Foyer	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Entry Hall	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$233.00	$40.00	5.73
Stairwell	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	0.14	670	0.0	$84.20	$492.50	$50.00	5.26
Main Office	6	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	6	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.10	511	0.0	$64.25	$797.44	$35.00	11.87
Main Office	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Main Office	10	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	10	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.27	1,340	0.0	$168.39	$855.00	$135.00	4.28
Storage	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
A202	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.08	402	0.0	$50.52	$420.40	$65.00	7.04
A203	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.08	402	0.0	$50.52	$420.40	$65.00	7.04
A208	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.08	402	0.0	$50.52	$420.40	$65.00	7.04
A206	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.11	536	0.0	$67.36	$504.00	$75.00	6.37
Kitchen	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.08	402	0.0	$50.52	$420.40	$65.00	7.04
A204	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.08	402	0.0	$50.52	$420.40	$65.00	7.04
A205	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.16	804	0.0	$101.03	$570.80	$95.00	4.71
Computer Lab	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.33	1,608	0.0	$202.07	$871.60	$155.00	3.55
Staff RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
A212 CR	19	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	19	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.52	2,547	0.0	$319.94	$1,651.50	$260.00	4.35

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
A212 CR	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
A213 CR	9	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	9	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.25	1,206	0.0	$151.55	$796.50	$125.00	4.43
A215 CR	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.33	1,608	0.0	$202.07	$871.60	$155.00	3.55
A217 CR	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.33	1,608	0.0	$202.07	$871.60	$155.00	3.55
A219 CR	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.33	1,608	0.0	$202.07	$871.60	$155.00	3.55
A221 CR	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.33	1,608	0.0	$202.07	$871.60	$155.00	3.55
A223 CR	12	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	12	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.33	1,608	0.0	$202.07	$972.00	$155.00	4.04
Storage Rm	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.05	268	0.0	$33.68	$387.00	$20.00	10.90
Student Lounge	8	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	8	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.22	1,072	0.0	$134.71	$738.00	$115.00	4.62
A226 MPR	12	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	12	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.33	1,608	0.0	$202.07	$972.00	$155.00	4.04
A224 Comp Lab	21	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	21	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.86	4,222	0.0	$530.43	$2,119.20	$385.00	3.27
A224 Comp Lab	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Storage	3	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	3	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.12	603	0.0	$75.78	$495.60	$45.00	5.95
Mens RR	6	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	6	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.09	421	0.0	$52.94	$485.40	$65.00	7.94
Mens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Custodial	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Womens RR	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.08	402	0.0	$50.52	$445.50	$65.00	7.53
Womens RR	6	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	6	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,957	0.09	421	0.0	$52.94	$485.40	$65.00	7.94
A216 ESL	21	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	2,795	Relamp	Yes	21	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,957	0.86	4,222	0.0	$530.43	$2,119.20	$385.00	3.27
A214 CR	8	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	8	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.22	1,072	0.0	$134.71	$738.00	$115.00	4.62
MCC entry	11	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	11	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.19	938	0.0	$117.80	$1,236.97	$35.00	10.20
MCC entry	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Main Hallway	6	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	6	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Main Hallway	26	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	26	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	0.71	3,485	0.0	$437.81	$2,121.00	$260.00	4.25
Main Hallway	3	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	No	3	LED Screw-In Lamps: LED - 36W	Wall Switch	36	2,795	0.03	150	0.0	$18.90	$263.72	$0.00	13.95

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Main Hallway	8	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	2,795	Relamp	Yes	8	LED Screw-In Lamps: LED - 18W	High/Low Control	18	1,957	0.07	341	0.0	$42.84	$551.62	$0.00	12.88
Hallway 1 floor	22	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	22	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Hallway 1 floor	20	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	20	LED Screw-In Lamps: LED - 36W	High/Low Control	36	1,957	0.35	1,705	0.0	$214.18	$2,158.12	$0.00	10.08
Hallway 1 floor	62	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	62	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	1.69	8,310	0.0	$1,044.02	$4,827.00	$620.00	4.03
Hallway 1 floor	17	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	2,795	Relamp	Yes	17	LED Screw-In Lamps: LED - 18W	High/Low Control	18	1,957	0.15	725	0.0	$91.03	$1,147.20	$0.00	12.60
Hallway 1 floor	54	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	54	LED Screw-In Lamps: LED - 36W	High/Low Control	36	1,957	0.94	4,603	0.0	$578.29	$5,746.92	$0.00	9.94
Hallway 1 floor	70	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	70	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	1.91	9,382	0.0	$1,178.73	$5,495.00	$700.00	4.07
Hallway 1 floor	26	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	26	LED Screw-In Lamps: LED - 36W	High/Low Control	36	1,957	0.45	2,216	0.0	$278.44	$2,885.56	$0.00	10.36
Hallway 1 floor	4	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	2,795	Relamp	No	4	LED Screw-In Lamps: LED - 18W	Wall Switch	18	2,795	0.02	100	0.0	$12.60	$175.81	$0.00	13.95
Hallway 1 floor	8	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,795	Relamp	Yes	8	LED - Linear Tubes: (1) 4' Lamp	High/Low Control	15	1,957	0.11	562	0.0	$70.59	$487.20	$40.00	6.34
Gym Entry Foyer	4	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	4	LED Screw-In Lamps: LED - 36W	Occupancy Sensor	36	1,957	0.07	341	0.0	$42.84	$621.62	$35.00	13.69
Stairwell 3	11	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	11	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	0.30	1,474	0.0	$185.23	$843.50	$110.00	3.96
Stairwell 3	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mech Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,795	0.02	106	0.0	$13.33	$58.50	$10.00	3.64
Stairwell 4	16	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	16	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	0.44	2,145	0.0	$269.42	$1,336.00	$160.00	4.36
Stairwell 4	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Stairwell 3	7	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	7	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	0.19	938	0.0	$117.87	$609.50	$70.00	4.58
Stairwell 3	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Stairwell 2	9	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	9	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	0.25	1,206	0.0	$151.55	$726.50	$90.00	4.20
Stairwell 2	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Hallway 2 floor	12	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	None	No	12	Exit Signs: LED - 2 W Lamp	Wall Switch	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Hallway 2 floor	66	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,795	Relamp	Yes	66	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,957	1.80	8,846	0.0	$1,111.37	$5,061.00	$660.00	3.96
Hallway 2 floor	55	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	55	LED Screw-In Lamps: LED - 36W	High/Low Control	36	1,957	0.96	4,688	0.0	$589.00	$5,834.83	$0.00	9.91
Hallway 2 floor	16	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	2,795	Relamp	Yes	16	LED Screw-In Lamps: LED - 18W	High/Low Control	18	1,957	0.14	682	0.0	$85.67	$1,103.25	$0.00	12.88
Hallway 2 floor	5	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	2,795	Relamp	Yes	5	LED Screw-In Lamps: LED - 36W	High/Low Control	36	1,957	0.09	426	0.0	$53.55	$639.53	$0.00	11.94

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Hallway 2 floor	5	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	2,795	Relamp	No	5	LED Screw-In Lamps: LED - 18W	Wall Switch	18	2,795	0.03	125	0.0	$15.75	$219.77	$0.00	13.95
Exterior	26	Metal Halide: (1) 200W Lamp	Daylight Dimming	232	4,380	Fixture Replacement	No	26	LED - Fixtures: Outdoor Post-Mount	Daylight Dimming	70	4,380	2.77	21,268	0.0	$2,671.97	$14,905.80	$130.00	5.53
Exterior	18	High-Pressure Sodium: (1) 150W Lamp	Daylight Dimming	188	4,380	Fixture Replacement	No	18	LED - Fixtures: Outdoor Post-Mount	Daylight Dimming	56	4,380	1.55	11,932	0.0	$1,499.00	$10,319.40	$90.00	6.82

Motor Inventory & Recommendations

		Existing Conditions						Proposed Conditions				Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Full Load Efficiency	VFD Control?	Annual Operating Hours	Install High Efficiency Motors?	Full Load Efficiency	Install VFDs?	Number of VFDs	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Perth Amboy	Irrigation	1	Water Supply Pump	5.0	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	DHW circulation	2	Heating Hot Water Pump	0.2	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	Water Booster Pumps	2	Water Supply Pump	3.0	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	Heating System Pumps	2	Heating Hot Water Pump	40.0	93.0%	Yes	2,880	No	93.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHA101	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHB101-103	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHB104	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHC101	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHC102	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHC103	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHC104	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHC105	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHC106	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	CHC107	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-B101	1	Makeup Air Fan	0.2	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-B102	1	Makeup Air Fan	0.2	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-B103	1	Makeup Air Fan	0.0	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-B104	1	Makeup Air Fan	0.0	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-B105	1	Makeup Air Fan	0.2	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-B106	1	Makeup Air Fan	0.2	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00

		Existing Conditions						Proposed Conditions				Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Full Load Efficiency	VFD Control?	Annual Operating Hours	Install High Efficiency Motors?	Full Load Efficiency	Install VFDs?	Number of VFDs	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Perth Amboy	UH-C101	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-C102	1	Makeup Air Fan	0.1	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-C103	1	Makeup Air Fan	0.0	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-C104	1	Makeup Air Fan	0.0	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	UH-C105	1	Makeup Air Fan	0.0	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	Combined Exhaust Fans	1	Exhaust Fan	43.3	65.0%	No	4,067	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	MAU-1	1	Makeup Air Fan	7.5	89.5%	No	8,760	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	MAU-2	1	Makeup Air Fan	7.5	89.5%	No	8,760	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	MAU-3	1	Makeup Air Fan	7.5	89.5%	No	8,760	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	MAU-4	1	Makeup Air Fan	7.5	89.5%	No	8,760	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	FH 1 - 4	4	Makeup Air Fan	0.5	65.0%	No	8,760	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	HRU-1	1	Supply Fan	3.0	89.5%	No	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	HRU-2	1	Supply Fan	3.0	89.5%	No	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	HRU-1	1	Exhaust Fan	2.0	88.5%	No	2,745	No	88.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	HRU-2	1	Exhaust Fan	2.0	88.5%	No	2,745	No	88.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	DHW circulation	1	Heating Hot Water Pump	0.5	65.0%	No	2,745	No	65.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-A101	1	Supply Fan	7.5	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-A102	1	Supply Fan	7.5	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-A103	1	Supply Fan	7.5	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-A201	1	Supply Fan	25.0	93.6%	Yes	4,067	No	93.6%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00

		Existing Conditions						Proposed Conditions				Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Full Load Efficiency	VFD Control?	Annual Operating Hours	Install High Efficiency Motors?	Full Load Efficiency	Install VFDs?	Number of VFDs	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Rooftop	RTU-B101	1	Supply Fan	25.0	93.6%	Yes	4,067	No	93.6%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-B102	1	Supply Fan	10.0	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-B103	1	Supply Fan	3.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-B104	1	Supply Fan	3.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-B105	1	Supply Fan	7.5	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-B106	1	Supply Fan	3.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-B107	1	Supply Fan	25.0	93.6%	Yes	4,067	No	93.6%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-B201	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-C101	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-C102	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-C103	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-C201	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	RTU-C202	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Electric HVAC Inventory & Recommendations

		Existing Conditions				Proposed Conditions								Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Install High Efficiency System?	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Cooling Mode Efficiency (SEER/EER)	Heating Mode Efficiency (COP)	Install Dual Enthalpy Economizer?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Rooftop	RTU-A101	1	Packaged AC	20.67		Yes	1	Packaged AC	20.67		12.70		No	1.89	2,865	0.0	$359.96	$34,872.91	$1,632.67	92.34
Rooftop	RTU-A102	1	Packaged AC	20.67		Yes	1	Packaged AC	20.67		12.70		No	1.89	2,865	0.0	$359.96	$34,872.91	$1,632.67	92.34
Rooftop	RTU-A103	1	Packaged AC	20.67		Yes	1	Packaged AC	20.67		12.70		No	1.89	2,865	0.0	$359.96	$34,872.91	$1,632.67	92.34
Rooftop	RTU-A201	1	Packaged AC	65.00		Yes	1	Packaged AC	65.00		12.10		No	4.32	6,562	0.0	$824.36	$144,038.16	$0.00	174.73
Rooftop	RTU-B101	1	Packaged AC	64.17		Yes	1	Packaged AC	64.17		12.10		No	4.26	6,478	0.0	$813.79	$142,191.52	$0.00	174.73
Rooftop	RTU-B102	1	Packaged AC	24.63		Yes	1	Packaged AC	24.63		12.70		No	7.71	11,707	0.0	$1,470.74	$41,566.26	$1,946.03	26.94
Rooftop	RTU-B103	1	Packaged AC	8.55		Yes	1	Packaged AC	8.55		14.00		No	1.45	2,210	0.0	$277.68	$15,237.00	$624.15	52.62
Rooftop	RTU-B104	1	Packaged AC	8.55		Yes	1	Packaged AC	8.55		14.00		No	1.45	2,210	0.0	$277.68	$15,237.00	$624.15	52.62
Rooftop	RTU-B105	1	Packaged AC	8.55		Yes	1	Packaged AC	8.55		14.00		No	1.45	2,210	0.0	$277.68	$15,237.00	$624.15	52.62
Rooftop	RTU-B106	1	Packaged AC	19.83		Yes	1	Packaged AC	19.83		12.70		No	5.99	9,094	0.0	$1,142.52	$27,644.69	$1,566.83	22.82
Rooftop	RTU-B107	1	Packaged AC	6.58		Yes	1	Packaged AC	6.58		14.00		No	1.03	1,565	0.0	$196.55	$11,717.34	$479.98	57.17
Rooftop	RTU-B201	1	Packaged AC	64.17		Yes	1	Packaged AC	64.17		12.10		No	4.26	6,478	0.0	$813.79	$142,191.52	$0.00	174.73
Rooftop	RTU-C101	1	Packaged AC	43.33		Yes	1	Packaged AC	43.33		12.20		No	3.12	4,733	0.0	$594.62	$96,025.44	$0.00	161.49
Rooftop	RTU-C102	1	Packaged AC	43.92		Yes	1	Packaged AC	43.92		12.20		No	3.16	4,797	0.0	$602.62	$97,318.09	$0.00	161.49
Rooftop	RTU-C103	1	Packaged AC	43.92		Yes	1	Packaged AC	43.92		12.20		No	3.16	4,797	0.0	$602.62	$97,318.09	$0.00	161.49
Rooftop	RTU-C201	1	Packaged AC	43.92		Yes	1	Packaged AC	43.92		12.20		No	3.16	4,797	0.0	$602.62	$97,318.09	$0.00	161.49
Rooftop	RTU-C202	1	Packaged AC	43.92		Yes	1	Packaged AC	43.92		12.20		No	3.16	4,797	0.0	$602.62	$97,318.09	$0.00	161.49
Perth	HRU-1	1	Packaged AC	15.00		Yes	1	Packaged AC	15.00		13.90		No	3.38	5,141	0.0	$645.85	$20,907.75	$1,185.00	30.54
Perth	HRU-2	1	Packaged AC	15.00		Yes	1	Packaged AC	15.00		13.90		No	3.38	5,141	0.0	$645.85	$20,907.75	$1,185.00	30.54
Perth	MAU-1 to 4	4	Packaged Terminal AC	23.94		Yes	4	Packaged Terminal AC	23.94		12.70		No	16.37	24,869	0.0	$3,124.36	$183,374.97	$6,224.83	56.70

		Existing Conditions				Proposed Conditions								Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Install High Efficiency System?	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Cooling Mode Efficiency (SEER/EER)	Heating Mode Efficiency (COP)	Install Dual Enthalpy Economizer?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Perth	EWH-1	1	Electric Forced Air Furnace		6.82	No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth	EWH-2	1	Electric Forced Air Furnace		2.56	No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth	EWH-3	1	Electric Forced Air Furnace		3.41	No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth	EWH-4	1	Electric Forced Air Furnace		2.56	No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Fuel Heating Inventory & Recommendations

		Existing Conditions			Proposed Conditions						Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Output Capacity per Unit (MBh)	Install High Efficiency System?	System Quantity	System Type	Output Capacity per Unit (MBh)	Heating Efficiency	Heating Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Perth Amboy	Building	4	Condensing Hot Water Boiler	2,000.00	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	RTU-B102	1	Furnace	292.00	Yes	1	Furnace	292.00	95.00%	AFUE	0.00	0	24.4	$216.43	$6,615.94	$400.00	28.72
Perth Amboy	RTU-B103	1	Furnace	147.00	Yes	1	Furnace	147.00	95.00%	AFUE	0.00	0	11.7	$103.88	$3,330.63	$400.00	28.21
Perth Amboy	RTU-B104	1	Furnace	147.00	Yes	1	Furnace	147.00	95.00%	AFUE	0.00	0	11.7	$103.88	$3,330.63	$400.00	28.21
Perth Amboy	RTU-B105	1	Furnace	147.00	Yes	1	Furnace	147.00	95.00%	AFUE	0.00	0	11.7	$103.88	$3,330.63	$400.00	28.21
Perth Amboy	RTU-B106	1	Furnace	223.00	Yes	1	Furnace	223.00	95.00%	AFUE	0.00	0	18.7	$165.57	$5,052.59	$400.00	28.10
Perth Amboy	RTU-B107	1	Furnace	93.20	Yes	1	Furnace	93.20	95.00%	AFUE	0.00	0	7.8	$69.47	$2,111.66	$400.00	24.64
Perth Amboy	MUA 1 - 4	4	Furnace	300.00	Yes	4	Furnace	300.00	95.00%	AFUE	0.00	0	156.3	$1,385.12	$27,188.80	$1,600.00	18.47

DHW Inventory & Recommendations

		Existing Conditions		Proposed Conditions						Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Replace?	System Quantity	System Type	Fuel Type	System Efficiency	Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Perth Amboy	Perth Amboy	1	Storage Tank Water Heater (> 50 Gal)	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Commercial Refrigerator/Freezer Inventory & Recommendations

	Existing Conditions			Proposed Condi	Energy Impact & Financial Analysis						
Location	Quantity	Refrigerator/ Freezer Type	ENERGY STAR Qualified?	Install ENERGY STAR Equipment?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Perth Amboy	1	Stand-Up Refrigerator, Solid Door (16 - 30 cu. ft.)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth Amboy	2	Stand-Up Freezer, Solid Door (16 - 30 cu. ft.)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Cooking Equipment Inventory & Recommendations

	Existing Conditions			Proposed Conditions	Energy Impact & Financial Analysis						
Location	Quantity	Equipment Type	High Efficiency Equipement?	Install High Efficiency Equipment?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Perth	2	Insulated Food Holding Cabinet (1/2 Size)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth	1	Electric Convection Oven (Half Size)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Perth	1	Electric Fryer	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Plug Load Inventory

	Existing Conditions			
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?
Perth Amboy	22	Projector	200.0	No
Perth Amboy	215	Desktop and LCD Monitor	191.0	No
Perth Amboy	61	Printer	20.0	No
Perth Amboy	69	Microwave	300.0	No
Perth Amboy	20	Television LCD 75"	200.0	No
Perth Amboy	3	Mini Fridge	6.9	No
Perth Amboy	3	Copier	515.0	No
Perth Amboy	5	Refrigerator	12.5	No
Perth Amboy	1	3D Printer	40.0	No
Perth Amboy	1	TV Tube	320.0	No
Perth Amboy	1	Shop Equipment	30,000.0	No
Perth Amboy	1	Lab Equipment	10,000.0	No

Vending Machine Inventory & Recommendations

	Existing Conditions		Proposed Conditions	Energy Impact & Financial Analysis						
Location	Quantity	Vending Machine Type	Install Controls?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Perth	3	Refrigerated	Yes	0.00	4,836	0.0	$607.50	$690.00	$0.00	1.14
Perth	1	Non-Refrigerated	Yes	0.00	343	0.0	$43.03	$230.00	$0.00	5.34

Appendix B: ENERGY STAR® Statement of Energy Performance

ENERGY STAR® Statement of Energy Performance

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ENERGY STAR® Score[1]

Perth Amboy Campus

Primary Property Type: K-12 School
Gross Floor Area (ft²): 150,000
Built: 2004

For Year Ending: April 30, 2017
Date Generated: March 28, 2018

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Perth Amboy Campus 457 High Street Perth Amboy, New Jersey 08861	Middlesex County Vocational School District 1011 Route 22 West Suite 203 Bridgewater, NC 08807 (____)____-_____	Karl Knehr 1011 Route 22 West Suite 203 Bridgewater, NC 08807 732-257-3300 x1952 knehrk@mail.mcvts.net

Property ID: 6260843

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
103.6 kBtu/ft²

Source EUI
219.3 kBtu/ft²

Annual Energy by Fuel	
Electric - Grid (kBtu)	7,932,931 (51%)
Natural Gas (kBtu)	7,600,210 (49%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	78.3
National Median Source EUI (kBtu/ft²)	165.9
% Diff from National Median Source EUI	32%
Annual Emissions	
Greenhouse Gas Emissions (Metric Tons CO2e/year)	1,284

Signature & Stamp of Verifying Professional

I _____ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: _____ Date: _____

Licensed Professional

____ _____
,
(____)____-_____
_____

Professional Engineer Stamp (if applicable)

Local Government Energy Audit:
Energy Audit Report



Woodbridge Campus

1 Convery Boulevard

Woodbridge, New Jersey 07095

Middlesex County Vocational School District

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Final Report by:

TRC Energy Services

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Disclaimer

The intent of this energy analysis report is to identify energy savings opportunities and recommend upgrades to the facility's energy using equipment and systems. Approximate savings are included in this report to help make decisions about reducing energy use at the facility. This report, however, is not intended to serve as a detailed engineering design document. Further design and analysis may be necessary to implement some of the measures recommended in this report.

The energy conservation measures and estimates of energy savings have been reviewed for technical accuracy. However, estimates of final energy savings are not guaranteed, because final savings may depend on behavioral factors and other uncontrollable variables. TRC Energy Services (TRC) and New Jersey Board of Public Utilities (NJBPU) shall in no event be liable should the actual energy savings vary.

Estimated installation costs are based on TRC's experience at similar facilities, pricing from local contractors and vendors, and/or cost estimates from *RS Means*. The owner of the facility is encouraged to independently confirm these cost estimates and to obtain multiple estimates when considering measure installations. Since actual installed costs can vary widely for certain measures and conditions, TRC and NJBPU do not guarantee installed cost estimates and shall in no event be held liable should actual installed costs vary from estimates.

New Jersey's Clean Energy Program (NJCEP) incentive values provided in this report are estimates based on program information available at the time of the report. Incentive levels are not guaranteed. The NJBPU reserves the right to extend, modify, or terminate programs without prior notice. The owner of the facility should review available program incentives and eligibility requirements prior to selecting and installing any energy conservation measures.

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1 EXECUTIVE SUMMARY

The New Jersey Board of Public Utilities (NJBPU) has sponsored this Local Government Energy Audit (LGEA) Report for the Woodbridge Campus.

The goal of an LGEA report is to provide you with information on how your facility uses energy, identify energy conservation measures (ECMs) that can reduce your energy use, and provide information and assistance to help facilities implement ECMs. The LGEA report also contains valuable information on financial incentives from New Jersey's Clean Energy Program (NJCEP) for implementing ECMs.

This study was conducted by TRC Energy Services (TRC), as part of a comprehensive effort to assist New Jersey local governments in controlling energy costs and protecting our environment by offering a wide range of energy management options and advice.

1.1 Facility Summary

The Woodbridge Campus is a 46,000 square-foot facility constructed in 1939. The building is a one story educational facility including but not limited to classrooms, offices, hallways, and server room.

Lighting at the facility consists mainly of 32-Watt T8 fluorescent fixtures with a few U-bend 32-Watt T8 fluorescent fixtures; all of which are inefficient when compared to the latest lighting technology available in the market. In addition to linear fluorescent technology, the facility also has several compact fluorescent, incandescent, and metal halide lamps, as well as LED exit signs. Lighting control is provided by a combination of manual switches and occupancy sensors.

Cooling and ventilation is provided by a combination of chillers, air handlers, rooftop packaged AC units, and split system AC systems. Heating is provided by five condensing hot water boilers.

A thorough description of the facility and our observations are located in Section 2.

1.2 Your Cost Reduction Opportunities

Energy Conservation Measures

TRC Energy Services evaluated 11 measures, and recommends 10, which together represent an opportunity for Woodbridge Campus to reduce annual energy costs by roughly $23,792 and annual greenhouse gas emissions by 179,861 lbs. CO_2e. We estimate that if all measures were implemented as recommended, the project would pay for itself in roughly 7.4 years. The breakdown of existing and potential utility costs after project implementation are illustrated in Figure 1 and Figure 2, respectively. Together these measures represent an opportunity to reduce Woodbridge Campus's annual energy use by 9%.

Figure 1 – Previous 12 Month Utility Costs

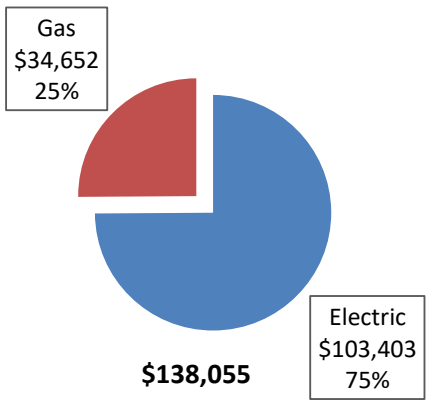
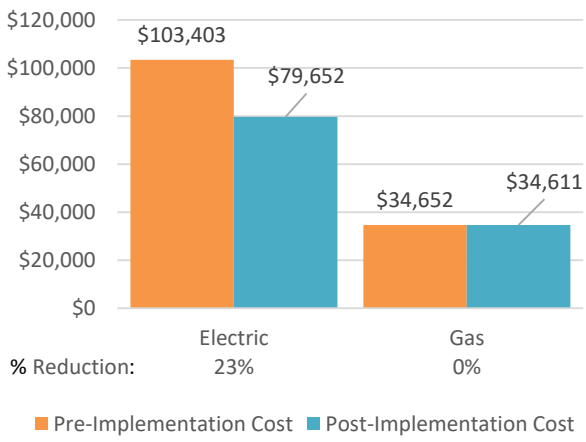


Figure 2 – Potential Post-Implementation Costs



A detailed description of Woodbridge Campus's existing energy use can be found in Section 3.

Estimates of the total cost, energy savings, and financial incentives for the proposed energy efficient upgrades are summarized below in Figure 3. A brief description of each category can be found below and a description of savings opportunities can be found in Section 4.

Figure 3 – Summary of Energy Reduction Opportunities

Energy Conservation Measure		Recommend?	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades			**79,175**	**14.1**	**0.0**	**$10,561.14**	**$47,012.11**	**$6,415.00**	**$40,597.11**	**3.8**	**79,729**
ECM 1	Install LED Fixtures	Yes	7,292	1.3	0.0	$972.64	$10,345.86	$85.00	$10,260.86	10.5	7,343
ECM 2	Retrofit Fixtures with LED Lamps	Yes	71,734	12.8	0.0	$9,568.64	$36,558.69	$6,330.00	$30,228.69	3.2	72,236
ECM 3	Install LED Exit Signs	Yes	149	0.0	0.0	$19.86	$107.56	$0.00	$107.56	5.4	150
Lighting Control Measures			**18,076**	**3.2**	**0.0**	**$2,411.22**	**$21,048.00**	**$2,545.00**	**$18,503.00**	**7.7**	**18,203**
ECM 4	Install Occupancy Sensor Lighting Controls	Yes	17,853	3.2	0.0	$2,381.41	$20,648.00	$2,545.00	$18,103.00	7.6	17,978
ECM 5	Install High/Low Lighitng Controls	Yes	223	0.0	0.0	$29.81	$400.00	$0.00	$400.00	13.4	225
Variable Frequency Drive (VFD) Measures			**22,843**	**3.1**	**0.0**	**$3,046.97**	**$16,379.25**	**$0.00**	**$16,379.25**	**5.4**	**23,002**
ECM 6	Install VFDs on Chilled Water Pumps	Yes	9,137	1.3	0.0	$1,218.79	$6,551.70	$0.00	$6,551.70	5.4	9,201
ECM 7	Install VFDs on Hot Water Pumps	Yes	13,706	1.9	0.0	$1,828.18	$9,827.55	$0.00	$9,827.55	5.4	13,801
Electric Unitary HVAC Measures			**10,871**	**8.0**	**0.0**	**$1,450.05**	**$64,900.61**	**$3,402.46**	**$61,498.15**	**42.4**	**10,947**
	Install High Efficiency Electric AC	No	10,871	8.0	0.0	$1,450.05	$64,900.61	$3,402.46	$61,498.15	42.4	10,947
Electric Chiller Replacement			**56,355**	**34.7**	**0.0**	**$7,517.24**	**$110,913.95**	**$11,700.00**	**$99,213.95**	**13.2**	**56,749**
ECM 8	Install High Efficiency Chillers	Yes	56,355	34.7	0.0	$7,517.24	$110,913.95	$11,700.00	$99,213.95	13.2	56,749
Domestic Water Heating Upgrade			**0**	**0.0**	**4.7**	**$40.02**	**$21.51**	**$0.00**	**$21.51**	**0.5**	**554**
ECM 9	Install Low-Flow Domestic Hot Water Devices	Yes	0	0.0	4.7	$40.02	$21.51	$0.00	$21.51	0.5	554
Plug Load Equipment Control - Vending Machine			**1,612**	**0.0**	**0.0**	**$215.00**	**$230.00**	**$0.00**	**$230.00**	**1.1**	**1,623**
ECM 10	Vending Machine Control	Yes	1,612	0.0	0.0	$215.00	$230.00	$0.00	$230.00	1.1	1,623
TOTALS FOR HIGH PRIORITY MEASURES			**178,061**	**55.1**	**4.7**	**$23,791.61**	**$195,604.81**	**$20,660.00**	**$174,944.81**	**7.4**	**179,861**
TOTALS FOR ALL EVALUATED MEASURES			**188,932**	**63.2**	**4.7**	**$25,241.66**	**$260,505.42**	**$24,062.46**	**$236,442.97**	**9.4**	**190,807**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

Lighting Upgrades generally involve the replacement of existing lighting components such as lamps and ballasts (or the entire fixture) with higher efficiency lighting components. These measures save energy by reducing the power used by the lighting components due to improved electrical efficiency.

Lighting Controls measures generally involve the installation of automated controls to turn off lights or reduce light output when not needed. Automated control reduces reliance on occupant behavior for adjusting lights. These measures save energy by reducing the amount of time lights are on.

Variable Frequency Drives (VFDs) are motor control devices. These measures control the speed of a motor so that the motor spins at peak efficiency during partial load conditions. Sensors adapt the speed to flow, temperature, or pressure settings which is much more efficient that usage a valve or damper to control flow rates or running the motor at full speed when only partial power is needed. These measures save energy by controlling motor usage more efficiently.

Electric Unitary HVAC measures generally involve replacing older inefficient air conditioning systems with modern energy efficient systems. New air conditioning systems can provide equivalent cooling to older air condition systems at a reduced energy cost. These measures save energy by reducing the power used by the air conditioning systems, due to improved electrical efficiency.

Electric Chiller measures generally involve replacing older inefficient hydronic chillers with modern energy efficient systems. New chillers can provide equivalent cooling compared to older chillers at a reduced energy cost. These measures save energy by reducing chiller energy usage, due to improved electrical and heat transfer efficiency.

Domestic Hot Water upgrade measures generally involve replacing older inefficient domestic water heating systems with modern energy efficient systems. New domestic hot water heating systems can provide equivalent, or greater, water heating capacity compared to older systems at a reduced energy cost. These measures save energy by reducing the fuel used for domestic hot water heating due to improved heating efficiency or reducing standby losses.

Plug Load Equipment control measures generally involve installing automated devices that limit the power usage or operation of equipment that is plugged into an electric outlet when not in use.

Energy Efficient Practices

TRC also identified 12 low cost (or no cost) energy efficient practices. A facility's energy performance can be significantly improved by employing certain behavioral or operational adjustments and by performing better routine maintenance on building systems. These practices can extend equipment lifetime, improve occupant comfort, provide better health and safety, as well as reduce annual energy and O&M costs. Potential opportunities identified at Woodbridge Campus include:

- Perform Proper Lighting Maintenance
- Develop a Lighting Maintenance Schedule
- Perform Routine Motor Maintenance
- Use Fans to Reduce Cooling Load
- Clean Evaporator/Condenser Coils on AC Systems
- Clean and/or Replace HVAC Filters
- Perform Proper Boiler Maintenance
- Perform Proper Furnace Maintenance
- Perform Proper Water Heater Maintenance
- Install Plug Load Controls
- Replace Computer Monitors
- Water Conservation

For details on these energy efficient practices, please refer to Section 5.

On-Site Generation Measures

TRC evaluated the potential for installing on-site generation for Woodbridge Campus. Based on the configuration of the site and its loads there is a high potential for installing a photovoltaic (PV) array.

Figure 4 – Photovoltaic Potential

Potential	High	
System Potential	187	kW DC STC
Electric Generation	140,707	kWh/yr
Displaced Cost	$12,240	/yr
Installed Cost	$486,200	

For details on our evaluation and on-site generation potential, please refer to Section 6.

1.3 Implementation Planning

To realize the energy savings from the ECMs listed in this report, a project implementation plan must be developed. Available capital must be considered and decisions need to be made whether it is best to pursue individual ECMs separately, groups of ECMs, or a comprehensive approach where all ECMs are implemented together, possibly in conjunction with other facility upgrades or improvements.

Rebates, incentives, and financing are available from NJCEP, as well as other sources, to help reduce the costs associated with the implementation of energy efficiency projects. Prior to implementing any measure, please review the relevant incentive program guidelines before proceeding. This is important because in most cases you will need to submit applications for the incentives prior to purchasing materials or commencing with installation.

The ECMs outlined in this report may qualify under the following program(s):

- SmartStart
- SREC (Solar Renewable Energy Certificate) Registration Program (SRP)
- Energy Savings Improvement Program (ESIP)

For facilities wanting to pursue only selected individual measures (or planning to phase implementation of selected measures over multiple years), incentives are available through the SmartStart program. To participate in this program, you may utilize internal resources, or an outside firm or contractor, to do the final design of the ECM(s) and do the installation. Program pre-approval is required for some SmartStart incentives, so only after receiving pre-approval should you proceed with ECM installation. The incentive estimates listed above in Figure 3 are based on the SmartStart program. More details on this program and others are available in Section 8.

For larger facilities with limited capital availability to implement ECMs, project financing may be available through the Energy Savings Improvement Program (ESIP). Supported directly by the NJBPU, ESIP provides government agencies with project development, design, and implementation support services, as well as, attractive financing for implementing ECMs. An LGEA report (or other approved energy audit) is required for participation in ESIP. Please refer to Section 8.4 for additional information on the ESIP Program.

The Demand Response Energy Aggregator is a (non-NJCEP) program designed to reduce electric loads at commercial facilities, when wholesale electricity prices are high or when the reliability of the electric grid is threatened due to peak power demand. Demand Response (DR) service providers (a.k.a. Curtailment Service Providers) are registered with PJM, the independent system operator (ISO) for mid-Atlantic state region that is charged with maintaining electric grid reliability. By enabling grid operators to call upon commercial facilities to reduce their electric usage during times of peak demand, the grid is made more reliable and overall transmission costs are reduced for all ratepayers. Curtailment Service Providers provide regular payments to medium and large consumers of electric power for their participation in DR programs. Program participation is voluntary and facilities receive payments whether or not they are called upon to curtail their load during times of peak demand. Refer to Section 7 for additional information on this program.

Additional information on relevant incentive programs is located in Section 8 or: www.njcleanenergy.com/ci.

2 FACILITY INFORMATION AND EXISTING CONDITIONS

2.1 Project Contacts

Figure 5 – Project Contacts

Name	Role	E-Mail	Phone #
Customer			
Karl Knehr	Business Administrator	knehrk@mail.mcvts.net	732-257-3300
TRC Energy Services			
Alexander Klieverik	Auditor	AKlieverik@trcsolutions.com	(732) 855-0033

2.2 General Site Information

On February 27, 2018, TRC performed an energy audit at the Woodbridge Campus located in Woodbridge, New Jersey. TRC's team met with Karl Knehr and Francis Cap to review the facility operations and help focus our investigation on specific energy-using systems.

Woodbridge Campus is a 46,000 square-foot facility constructed in 1939. The building is a one story educational facility including but not limited to classrooms, offices, hallways, and server room.

2.3 Building Occupancy

The typical schedule is presented in the table below.

Figure 6 - Building Schedule

Building Name	Weekday/Weekend	Operating Schedule
Woodbridge Campus	Weekday	7:00 AM - 8:00 PM
Woodbridge Campus	Weekend	Off

2.4 Building Envelope

The construction of Woodbridge campus building is typically of concrete masonry block with brick type exterior and double pane clear windows with fixed frames. The sloped roof sections are clad with slate roofing material.

Figure 7 – Building Façade



2.5 On-Site Generation

Woodbridge Campus does not have any on-site electric generation capacity.

2.6 Energy-Using Systems

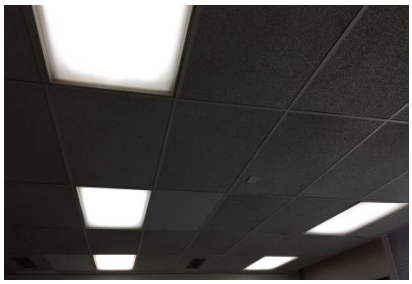
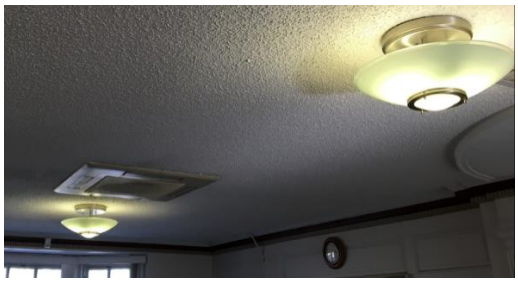
Please see Appendix A: Equipment Inventory & Recommendations for an inventory of the facility's equipment.

Lighting System

Lighting consists largely of 32-Watt T8 fluorescent fixtures with a few 32-Watt T8 U-bend fluorescent fixtures. These sources are inefficient when compared to the latest lighting technology available in the market. Fluorescent T8 fixtures are 2-foot U-bend and 4-foot long linear, mainly troffers with diffusers having 1-lamp to 4-lamp configurations. In addition, there are several 26-Watt compact fluorescent fixtures with 1-lamp, 2-lamp, and 3-lamp configurations. Lighting at the facility also consist of 20-Watt to 75-Watt incandescent lamps and 150-Watt metal halide fixtures. All the exit signs are LED based fixtures.

Lighting control in the building is provided by a combination of manual switches and occupancy sensors.

Figure 8 - Building Lighting Systems

Linear Fluorescent Fixtures	*Compact Fluorescent Fixtures*
	

Chilled Water System

The facility is served by two air-cooled scroll chillers. One chiller is 60-ton unit and the other is a 70-ton unit, each having an efficiency of 1.14 kW/ton. The chilled water loop consists of two 5-HP constant flow pumps. The chiller plant supplies chilled water to building side air handlers.

Figure 9 – Chilled Water Systems

Air-Cooled Scroll Chillers	*Chilled Water Pumps*
	

Hot Water Heating System

The hot water system consists of three Benchmark 2.0 1,860 kBtu/hr output, condensing boilers and two Aerco KC Series 930 kBtu/hr output, condensing boilers. All the boilers have a nominal combustion efficiency of 93%. The boilers are configured in a constant flow primary distribution with three hot water pumps of each 5 HP capacity.

Figure 10 – Hot Water Systems

Heating Hot Water Boilers	*Hot Water Pumps*
	

Air Handling Units

There are several chilled and hot water based air handler units serving the facility. All the air handlers are variable air volume (VAV) systems with 5-HP and 10-HP supply fans and 2-HP and 5-HP return fans. All the supply and return fans are controlled by variable frequency drives (VFDs). As space-heating or -cooling loads changes, the system flow is modulated by varying speed of the supply and return fans.

Figure 11 – Air Handling Units

Typical Air Handler	*Air Handler VFD*
	

Direct Expansion Air Conditioning System (DX)

Cooling at the facility is also provided by a combination of package units and split system AC units. There are two Airedale 5-ton direct expansion (DX) package units to provide cooling. There are also seven split system ACs with capacities between 1 ton and 8 tons serving the facility.

Figure 12 – DX Air Conditioning Systems

Rooftop Package Units	*Split System AC*
	

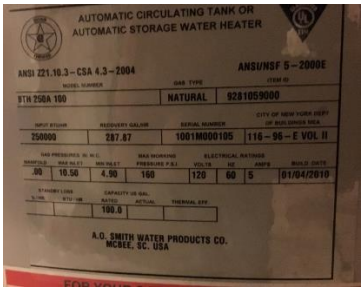
Building Energy Management System (BEMS)

Building systems are controlled by a 14-year-old Building Energy Management System (BEMS). The BEMS can provide scheduling, and setpoint controls.

Domestic Hot Water Heating System

The domestic hot water heating system for the facility consists of two A.O. Smith 100-gallon hot water heaters with an input rating of 250 kBtu/hr. and a nominal efficiency of 96%.

Figure 13 – Domestic Hot Water Heater

Domestic Hot Water Heater	*Domestic Hot Water Heater Nameplate*
	

Building Plug Load

There are roughly 94 computer work stations throughout the facility. All the computers are desktop units with LCD monitors. There is no centralized PC power management software installed.

The facility contains other systems which contribute to plug load including printers, microwaves, televisions, etc. at the facility. In addition to the typical plug load equipment, the facility also has a refrigerated vending machine.

Figure 14 – Building Plug-load Systems

Vending Machine	*Desktop PC*
	

2.7 Water-Using Systems

Facility has several faucets throughout. Faucets have 2.2 gallons per minute (gpm) and 2.75 gpm flow capacities and hot water to the faucets are provided from the domestic hot water heater.

3 SITE ENERGY USE AND COSTS

Utility data for electricity and natural gas was analyzed to identify opportunities for savings. In addition, data for electricity and natural gas was evaluated to determine the annual energy performance metrics for the building in energy cost per square foot and energy usage per square foot. These metrics are an estimate of the relative energy efficiency of this building. There are several factors that could cause the energy use of this building to vary from the "typical" energy usage profile for facilities with similar characteristics. Local weather conditions, building age and insulation levels, equipment efficiency, daily occupancy hours, changes in occupancy throughout the year, equipment operating hours, and energy efficient behavior of occupants all contribute to benchmarking scores. Please refer to the Benchmarking section within Section 3.4 for additional information.

3.1 Total Cost of Energy

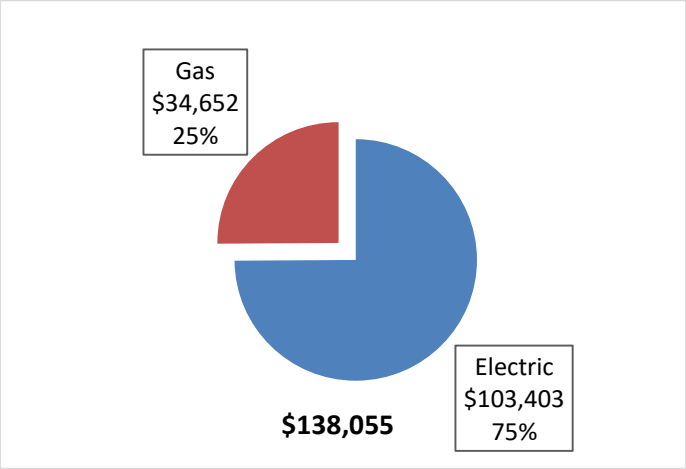
The following energy consumption and cost data is based on the last 12-month period of utility billing data that was provided for each utility. A profile of the annual energy consumption and energy cost of the facility was developed from this information.

Figure 15 - Utility Summary

Utility Summary for Woodbridge Campus		
Fuel	**Usage**	**Cost**
Electricity	775,195 kWh	$103,403
Natural Gas	40,994 Therms	$34,652
Total		**$138,055**

The current annual energy cost for this facility is $138,055 as shown in the chart below.

Figure 16 - Energy Cost Breakdown



3.2 Electricity Usage

Electricity is provided by PSE&G. The average electric cost over the past 12 months was $0.133/kWh, which is the blended rate that includes energy supply, distribution, and other charges. This rate is used throughout the analyses in this report to assess energy costs and savings. The monthly electricity consumption and peak demand are shown in the chart below. The energy use profile appears normal for a building with an air conditioning load in a temperate climate. The demand spike in May could have been the result of an unusually hot day when the building was in full occupancy.

Figure 17 - Electric Usage & Demand

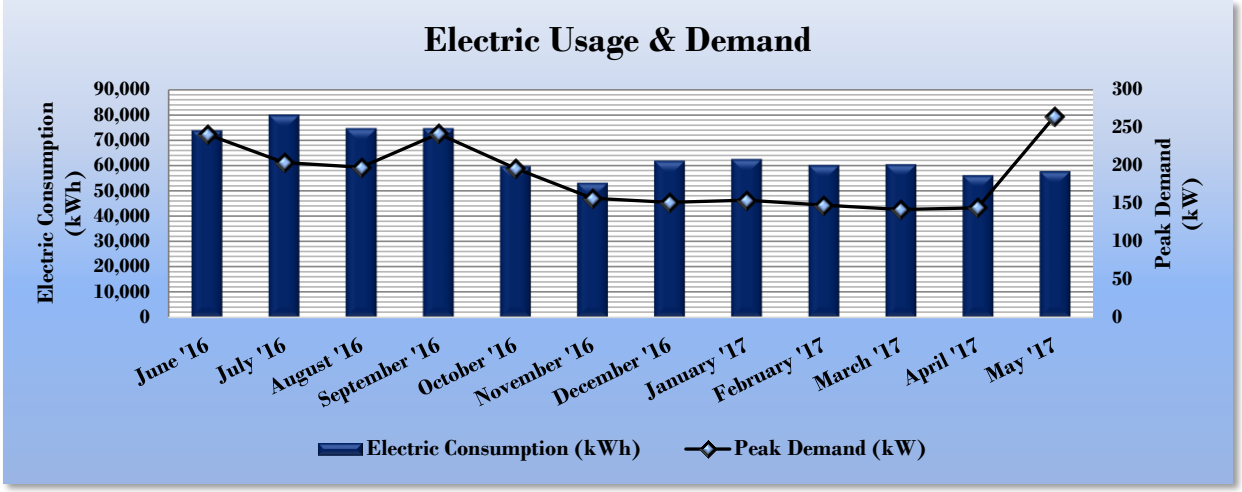


Figure 18 - Electric Usage & Demand

Electric Billing Data for Woodbridge Campus					
Period Ending	Days in Period	Electric Usage (kWh)	Demand (kW)	Demand Cost	Total Electric Cost
6/24/16	29	73,662	241	$884	$11,213
7/26/16	32	79,881	204	$747	$11,443
8/24/16	29	74,545	198	$725	$10,798
9/23/16	30	74,537	242	$898	$11,379
10/24/16	31	59,566	196	$731	$7,365
11/22/16	29	52,989	157	$585	$6,495
12/23/16	31	61,716	152	$565	$7,658
1/25/17	33	62,326	154	$574	$7,594
2/24/17	30	59,938	148	$549	$7,315
3/27/17	31	60,280	142	$534	$7,340
4/26/17	30	55,995	144	$543	$6,891
5/25/17	29	57,636	265	$998	$7,629
Totals	**364**	**773,071**	**264.8**	**$8,332**	**$103,120**
Annual	**365**	**775,195**	**264.8**	**$8,355**	**$103,403**

3.3 Natural Gas Usage

Natural gas is provided by Elizabethtown Gas. The average gas cost for the past 12 months is $0.845/therm, which is the blended rate used throughout the analyses in this report. The monthly gas consumption is shown in the chart below. The usage profile is typical of a gas heated building in a temperate Climate with a moderate domestic hot water load.

Figure 19 - Natural Gas Usage

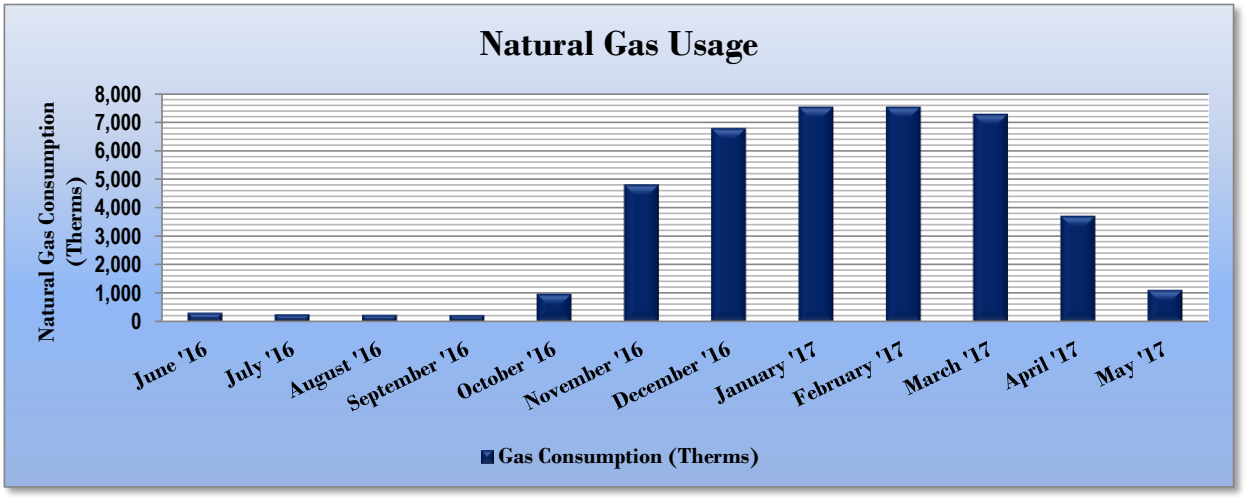


Figure 20 - Natural Gas Usage

Gas Billing Data for Woodbridge Campus			
Period Ending	Days in Period	Natural Gas Usage (Therms)	Natural Gas Cost
6/28/16	31	305	$611
7/29/16	31	250	$574
8/29/16	31	229	$200
9/29/16	31	216	$548
10/27/16	28	975	$1,095
11/29/16	33	4,814	$4,490
12/28/16	29	6,791	$5,333
1/28/17	31	7,541	$5,855
2/24/17	27	7,542	$5,866
3/27/17	31	7,290	$5,684
4/26/17	30	3,707	$3,030
5/26/17	30	1,109	$1,177
Totals	**363**	**40,769**	**$34,462**
Annual	**365**	**40,994**	**$34,652**

3.4 Benchmarking

This facility was benchmarked using Portfolio Manager®, an online tool created and managed by the United States Environmental Protection Agency (EPA) through the ENERGY STAR® program. Portfolio Manager® analyzes your building's consumption data, cost information, and operational use details and then compares its performance against a national median for similar buildings of its type. Metrics provided by this analysis are Energy Use Intensity (EUI) and an ENERGY STAR® score for select building types.

The EUI is a measure of a facility's energy consumption per square foot, and it is the standard metric for comparing buildings' energy performance. Comparing the EUI of a building with the national median EUI for that building type illustrates whether that building uses more or less energy than similar buildings of its type on a square foot basis. EUI is presented in terms of "site energy" and "source energy." Site energy is the amount of fuel and electricity consumed by a building as reflected in utility bills. Source energy includes fuel consumed to generate electricity consumed at the site, factoring in electric production and distribution losses for the region.

Figure 21 - Energy Use Intensity Comparison – Existing Conditions

Energy Use Intensity Comparison - Existing Conditions		
	Woodbridge Campus	National Median Building Type: School (K-12)
Source Energy Use Intensity (kBtu/ft^2)	274.1	141.4
Site Energy Use Intensity (kBtu/ft^2)	146.6	58.2

Implementation of all recommended measures in this report would improve the building's estimated EUI significantly, as shown in the table below:

Figure 22 - Energy Use Intensity Comparison – Following Installation of Recommended Measures

Energy Use Intensity Comparison - Following Installation of Recommended Measures		
	Woodbridge Campus	National Median Building Type: School (K-12)
Source Energy Use Intensity (kBtu/ft^2)	232.5	141.4
Site Energy Use Intensity (kBtu/ft^2)	133.3	58.2

Many types of commercial buildings are also eligible to receive an ENERGY STAR® score. This score is a percentile ranking from 1 to 100. It compares your building's energy performance to similar buildings nationwide. A score of 50 represents median energy performance, while a score of 75 means your building performs better than 75 percent of all similar buildings nationwide and may be eligible for ENERGY STAR® certification. This facility has a current score of 25.

A Portfolio Manager® Statement of Energy Performance (SEP) was generated for this facility, see Appendix B: ENERGY STAR® Statement of Energy Performance.

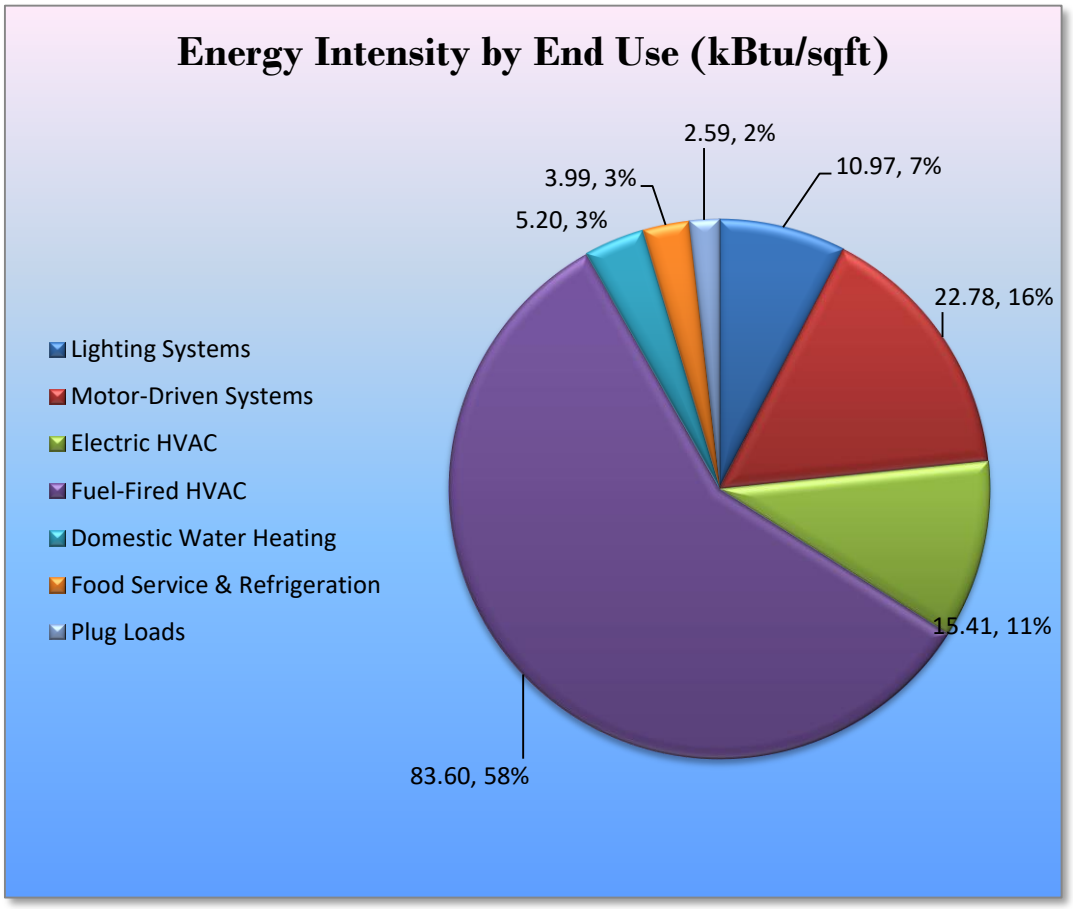
For more information on ENERGY STAR® certification go to: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification/how-app-1

A Portfolio Manager® account has been created online for your facility and you will be provided with the login information for the account. We encourage you to update your utility information in Portfolio Manager regularly, so that you can keep track of your building's performance. Free online training is available to help you use ENERGY STAR® Portfolio Manager® to track your building's performance at: https://www.energystar.gov/buildings/training.

3.5 Energy End-Use Breakdown

To provide a complete overview of energy consumption across building systems, an energy balance was performed at this facility. An energy balance utilizes standard practice engineering methods to evaluate all components of the various electric and fuel-fired systems found in a building to determine their proportional contribution to overall building energy usage. This chart of energy end uses highlights the relative contribution of each equipment category to total energy usage. This can help determine where the greatest benefits might be found from energy efficiency measures.

Figure 23 - Energy Balance (% and kBtu/SF)



4 ENERGY CONSERVATION MEASURES

Level of Analysis

The goal of this audit report is to identify potential energy efficiency opportunities, help prioritize specific measures for implementation, and provide information to the Woodbridge Campus regarding financial incentives for which they may qualify to implement the recommended measures. For this audit report, most measures have received only a preliminary analysis of feasibility which identifies expected ranges of savings and costs. This level of analysis is usually considered sufficient to demonstrate project cost-effectiveness and help prioritize energy measures. Savings are based on the New Jersey Clean Energy Program Protocols to Measure Resource Savings dated June 29, 2016, approved by the New Jersey Board of Public Utilities. Further analysis or investigation may be required to calculate more precise savings based on specific circumstances. A higher level of investigation may be necessary to support any custom SmartStart or Pay for Performance, or Direct Install incentive applications. Financial incentives for the ECMs identified in this report have been calculated based the NJCEP prescriptive SmartStart program. Some measures and proposed upgrade projects may be eligible for higher incentives than those shown below through other NJCEP programs as described in Section 8.

The following sections describe the evaluated measures.

4.1 Recommended ECMs

The measures below have been evaluated by the auditor and are recommended for implementation at the facility.

Figure 24 – Summary of Recommended ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**79,175**	**14.1**	**0.0**	**$10,561.14**	**$47,012.11**	**$6,415.00**	**$40,597.11**	**3.8**	**79,729**
ECM 1	Install LED Fixtures	7,292	1.3	0.0	$972.64	$10,345.86	$85.00	$10,260.86	10.5	7,343
ECM 2	Retrofit Fixtures with LED Lamps	71,734	12.8	0.0	$9,568.64	$36,558.69	$6,330.00	$30,228.69	3.2	72,236
ECM 3	Install LED Exit Signs	149	0.0	0.0	$19.86	$107.56	$0.00	$107.56	5.4	150
Lighting Control Measures		**18,076**	**3.2**	**0.0**	**$2,411.22**	**$21,048.00**	**$2,545.00**	**$18,503.00**	**7.7**	**18,203**
ECM 4	Install Occupancy Sensor Lighting Controls	17,853	3.2	0.0	$2,381.41	$20,648.00	$2,545.00	$18,103.00	7.6	17,978
ECM 5	Install High/Low Lighitng Controls	223	0.0	0.0	$29.81	$400.00	$0.00	$400.00	13.4	225
Variable Frequency Drive (VFD) Measures		**22,843**	**3.1**	**0.0**	**$3,046.97**	**$16,379.25**	**$0.00**	**$16,379.25**	**5.4**	**23,002**
ECM 6	Install VFDs on Chilled Water Pumps	9,137	1.3	0.0	$1,218.79	$6,551.70	$0.00	$6,551.70	5.4	9,201
ECM 7	Install VFDs on Hot Water Pumps	13,706	1.9	0.0	$1,828.18	$9,827.55	$0.00	$9,827.55	5.4	13,801
Electric Chiller Replacement		**56,355**	**34.7**	**0.0**	**$7,517.24**	**$110,913.95**	**$11,700.00**	**$99,213.95**	**13.2**	**56,749**
ECM 8	Install High Efficiency Chillers	56,355	34.7	0.0	$7,517.24	$110,913.95	$11,700.00	$99,213.95	13.2	56,749
Domestic Water Heating Upgrade		**0**	**0.0**	**4.7**	**$40.02**	**$21.51**	**$0.00**	**$21.51**	**0.5**	**554**
ECM 9	Install Low-Flow Domestic Hot Water Devices	0	0.0	4.7	$40.02	$21.51	$0.00	$21.51	0.5	554
Plug Load Equipment Control - Vending Machine		**1,612**	**0.0**	**0.0**	**$215.00**	**$230.00**	**$0.00**	**$230.00**	**1.1**	**1,623**
ECM 10	Vending Machine Control	1,612	0.0	0.0	$215.00	$230.00	$0.00	$230.00	1.1	1,623
TOTALS		**178,061**	**55.1**	**4.7**	**$23,791.61**	**$195,604.81**	**$20,660.00**	**$174,944.81**	**7.4**	**179,861**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

4.1.1 Lighting Upgrades

Our recommendations for upgrades to existing lighting fixtures are summarized in Figure 25 below.

Figure 25 – Summary of Lighting Upgrade ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**79,175**	**14.1**	**0.0**	**$10,561.14**	**$47,012.11**	**$6,415.00**	**$40,597.11**	**3.8**	**79,729**
ECM 1	Install LED Fixtures	7,292	1.3	0.0	$972.64	$10,345.86	$85.00	$10,260.86	10.5	7,343
ECM 2	Retrofit Fixtures with LED Lamps	71,734	12.8	0.0	$9,568.64	$36,558.69	$6,330.00	$30,228.69	3.2	72,236
ECM 3	Install LED Exit Signs	149	0.0	0.0	$19.86	$107.56	$0.00	$107.56	5.4	150

During lighting upgrade planning and design, we recommend a comprehensive approach that considers both the efficiency of the lighting fixtures and how they are controlled.

ECM 1: Install LED Fixtures

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	7,292	1.3	0.0	$972.64	$10,345.86	$85.00	$10,260.86	10.5	7,343
Exterior	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend replacing existing fixtures containing metal halide lamps with new high-performance LED light fixtures. This measure saves energy by installing LEDs which use less power than other technologies with a comparable light output.

Additional savings from lighting maintenance can be anticipated since LEDs have lifetimes which are more than twice that of a metal halide lamp.

ECM 2: Retrofit Fixtures with LED Lamps

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	71,734	12.8	0.0	$9,568.64	$36,558.69	$6,330.00	$30,228.69	3.2	72,236
Exterior	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend retrofitting existing T8 linear fluorescent, T8 U-bend fluorescent, incandescent, and compact fluorescent lighting technologies with LED lamps. Many LED tube lamps are direct replacements for existing fluorescent lamps and can be installed while leaving the fluorescent fixture ballast in place. LED bulbs can be used in existing fixtures as a direct replacement for most other lighting technologies. This measure saves energy by installing LEDs which use less power than other lighting technologies yet provide equivalent lighting output for the space.

Additional savings from lighting maintenance can be anticipated since LEDs have lifetimes which are more than twice that of fluorescent tubes and more than 10 times longer than many incandescent lamps.

ECM 3: Install LED Exit Signs

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	149	0.0	0.0	$19.86	$107.56	$0.00	$107.56	5.4	150
Exterior	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend replacing existing compact fluorescent exit signs with LED exit signs. LED exit signs require virtually no maintenance and have a life expectancy of at least 20 years. This measure saves energy by installing LED fixtures, which use less power than other technologies with an equivalent lighting output.

4.1.2 Lighting Control Measures

Our recommendations for lighting control measures are summarized in Figure 26 below.

Figure 26 – Summary of Lighting Control ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Control Measures		**18,076**	**3.2**	**0.0**	**$2,411.22**	**$21,048.00**	**$2,545.00**	**$18,503.00**	**7.7**	**18,203**
ECM 4	Install Occupancy Sensor Lighting Controls	17,853	3.2	0.0	$2,381.41	$20,648.00	$2,545.00	$18,103.00	7.6	17,978
ECM 5	Install High/Low Lighitng Controls	223	0.0	0.0	$29.81	$400.00	$0.00	$400.00	13.4	225

During lighting upgrade planning and design, we recommend a comprehensive approach that considers both the efficiency of the lighting fixtures and how they are controlled.

ECM 4: Install Occupancy Sensor Lighting Controls

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
17,853	3.2	0.0	$2,381.41	$20,648.00	$2,545.00	$18,103.00	7.6	17,978

Measure Description

We recommend installing occupancy sensors to control lighting fixtures that are currently controlled by manual switches in spaces such as classrooms, restrooms, offices areas, etc. Lighting sensors detect occupancy using ultrasonic and/or infrared sensors. For most spaces, we recommend lighting controls use dual technology sensors, which can eliminate the possibility of any lights turning off unexpectedly. Lighting systems are enabled when an occupant is detected. Fixtures are automatically turned off after an area has been vacant for a preset period. Some controls also provide dimming options and all modern occupancy controls can be easily over-ridden by room occupants to allow them to manually turn fixtures on or off, as desired. Energy savings results from only operating lighting systems when they are required.

Occupancy sensors may be mounted on the wall at existing switch locations, mounted on the ceiling, or in remote locations. In general, wall switch replacement sensors are recommended for single occupant offices and other small rooms. Ceiling-mounted or remote mounted sensors are used in locations without local switching or where wall switches are not in the line-of-sight of the main work area and in large spaces. We recommend a comprehensive approach to lighting design that upgrades both the lighting fixtures and the controls together for maximum energy savings and improved lighting for occupants.

ECM 5: Install High/Low Lighting Controls

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
223	0.0	0.0	$29.81	$400.00	$0.00	$400.00	13.4	225

Measure Description

We recommend installing occupancy sensors to provide dual level lighting control for lighting fixtures in spaces that are infrequently occupied but may require some level of continuous lighting for safety or security reasons. Typical areas for such lighting control are stairwells, interior corridors, parking lots, and parking garages.

Lighting fixtures with these controls operate at default low levels when the area is not occupied to provide minimal lighting to meet security or safety requirements. Sensors detect occupancy using ultrasonic and/or infrared sensors. The lighting systems are switched to full lighting levels whenever an occupant is detected. Fixtures are automatically switched back to low level after an area has been vacant for a preset period. Energy savings results from only providing full lighting levels when it is required.

For this type of measure the occupancy sensors will generally be ceiling or fixture mounted. Sufficient sensor coverage needs to be provided to ensure that lights turn on in each area as an occupant approaches.

Additional savings from reduced lighting maintenance may also result from this measure, due to reduced lamp operation.

4.1.3 Variable Frequency Drive Measures

Our recommendations for variable frequency drive (VFD) measures are summarized in Figure 27 below.

Figure 27 – Summary of Variable Frequency Drive ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Variable Frequency Drive (VFD) Measures		**22,843**	**3.1**	**0.0**	**$3,046.97**	**$16,379.25**	**$0.00**	**$16,379.25**	**5.4**	**23,002**
ECM 6	Install VFDs on Chilled Water Pumps	9,137	1.3	0.0	$1,218.79	$6,551.70	$0.00	$6,551.70	5.4	9,201
ECM 7	Install VFDs on Hot Water Pumps	13,706	1.9	0.0	$1,828.18	$9,827.55	$0.00	$9,827.55	5.4	13,801

ECM 6: Install VFDs on Chilled Water Pumps

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
9,137	1.3	0.0	$1,218.79	$6,551.70	$0.00	$6,551.70	5.4	9,201

Measure Description

We recommend installing a variable frequency drives (VFD) to control chilled water pumps. This measure requires that chilled water coils be served by 2-way valves and that a differential pressure sensor be installed in the chilled water loop. As the chilled water valves close, the differential pressure increases. The VFD modulates pump speed to maintain a differential pressure setpoint. Energy savings results from reducing pump motor speed (and power) as chilled water valves close. The magnitude of energy savings is based on the estimated amount of time that the system operates at reduced loads.

For systems with variable chilled water flow through the chiller, the minimum flow to prevent the chiller from tripping off will have to be determined during the final project design. The control system should be programmed to maintain the minimum flow through the chiller and to prevent pump cavitation.

ECM 7: Install VFDs on Hot Water Pumps

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
13,706	1.9	0.0	$1,828.18	$9,827.55	$0.00	$9,827.55	5.4	13,801

Measure Description

We recommend installing a variable frequency drives (VFD) to control a hot water pumps. This measure requires that most of the hot water coils be served by 2-way valves and that a differential pressure sensor is installed in the hot water loop. As the hot water valves close, the differential pressure increases. The VFD modulates pump speed to maintain a differential pressure setpoint. Energy savings results from reducing pump motor speed (and power) as hot water valves close. The magnitude of energy savings is based on the estimated amount of time that the system will operate at reduced load.

4.1.4 Electric Chiller Replacement

Our recommendations for electric chiller replacement are summarized in Figure 28 below.

Figure 28-Summary of Electric Chiller Replacement ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Electric Chiller Replacement		**56,355**	**34.7**	**0.0**	**$7,517.24**	**$110,913.95**	**$11,700.00**	**$99,213.95**	**13.2**	**56,749**
ECM 8	Install High Efficiency Chillers	56,355	34.7	0.0	$7,517.24	$110,913.95	$11,700.00	$99,213.95	13.2	56,749

ECM 8: Install High Efficiency Chillers

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
56,355	34.7	0.0	$7,517.24	$110,913.95	$11,700.00	$99,213.95	13.2	56,749

Measure Description

We recommend replacing older inefficient electric chillers with new high efficiency chillers. The type of chiller to be installed depends on the magnitude of the cooling load and variability of the cooling load profile. Positive displacement chillers are usually under 600 tons of cooling capacity and centrifugal chillers generally start at 150 tons of cooling capacity. Constant speed chillers should be used to meet cooling loads with little or no variation while variable speed chillers are more efficient for variable cooling load profiles. Water cooled chillers are more efficient than air cooled chillers but require cooling towers and additional pumps to circulate the cooling water. In any given size range variable speed chillers tend to have better partial load efficiency, but worse full load efficiency, than constant speed chillers.

The savings result from the improvement in chiller efficiency and matching the right type of chiller to the cooling load. The energy savings associated with this measure is based on the cooling capacity of the new chiller, the improvement in efficiency compared with the base case equipment, the cooling load profile, and the estimated annual operating hours of the chiller before and after the upgrade. Energy savings are maximized by proper selection of new equipment based on the cooling load profile.

4.1.5 Domestic Hot Water Heating System Upgrades

Our recommendations for domestic water heating system improvements are summarized in Figure 29 below.

Figure 29 - Summary of Domestic Water Heating ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Domestic Water Heating Upgrade		**0**	**0.0**	**4.7**	**$40.02**	**$21.51**	**$0.00**	**$21.51**	**0.5**	**554**
ECM 9	Install Low-Flow Domestic Hot Water Devices	0	0.0	4.7	$40.02	$21.51	$0.00	$21.51	0.5	554

ECM 9: Install Low-Flow DHW Devices

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
0	0.0	4.7	$40.02	$21.51	$0.00	$21.51	0.5	554

Measure Description

We recommend installing low-flow domestic hot water devices to reduce overall hot water demand. Energy demand from domestic hot water heating systems can be reduced by reducing water usage in general. Faucet aerators can reduce hot water usage, relative to standard aerators, which saves energy. Low-flow devices reduce the overall water flow from the fixture, while still adequate pressure for washing. This reduces the amount of water used per day resulting in energy and water savings.

4.1.6 Plug Load Equipment Control - Vending Machines

Our recommendations for plug load equipment controls are summarized in Figure 30 below.

Figure 30-Summary of Plug Load Equipment Controls ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Plug Load Equipment Control - Vending Machine		**1,612**	**0.0**	**0.0**	**$215.00**	**$230.00**	**$0.00**	**$230.00**	**1.1**	**1,623**
ECM 10	Vending Machine Control	1,612	0.0	0.0	$215.00	$230.00	$0.00	$230.00	1.1	1,623

ECM 10: Vending Machine Control

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
1,612	0.0	0.0	$215.00	$230.00	$0.00	$230.00	1.1	1,623

Measure Description

Vending machines operate continuously, even during non-business hours. It is recommended to install occupancy sensor controls to reduce the energy use. These controls power down vending machines when the vending machine area has been vacant for some time, then power up at regular intervals, as needed, to turn machine lights on or keep the product cool. Energy savings are a dependent on vending machine and activity level in the area surrounding the machines.

4.2 ECM Evaluated But Not Recommended

The measure below has been evaluated by the auditor but are not recommended for implementation at the facility. Reasons for exclusion can be found in the measure description section.

Figure 31 – Summary of Measures Evaluated, But Not Recommended

Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Electric Unitary HVAC Measures	**10,871**	**8.0**	**0.0**	**$1,450.05**	**$64,900.61**	**$3,402.46**	**$61,498.15**	**42.4**	**10,947**
Install High Efficiency Electric AC	10,871	8.0	0.0	$1,450.05	$64,900.61	$3,402.46	$61,498.15	42.4	10,947
TOTALS	**10,871**	**8.0**	**0.0**	**$1,450.05**	**$64,900.61**	**$3,402.46**	**$61,498.15**	**42.4**	**10,947**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

Install High Efficiency Air Conditioning Units

Summary of Measure Economics

Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
10,871	8.0	0.0	$1,450.05	$64,900.61	$3,402.46	$61,498.15	42.4	10,947

Measure Description

We evaluated replacing standard efficiency packaged air conditioning units with high efficiency packaged air conditioning units. There have been significant improvements in both compressor and fan motor efficiencies over the past several years. Therefore, electricity savings can be achieved by replacing older units with new high efficiency units. A higher EER or SEER rating indicates a more efficient cooling system. The magnitude of energy savings for this measure depends on the relative efficiency of the older unit versus the new high efficiency unit, the average cooling load, and the estimated annual operating hours.

Reasons for not Recommending

The packaged units and split system units have relatively low hours of use. This factor results in a long payback for the measure, more than the rated useful life of the replacement equipment. The measure is not recommended for implementation based on energy savings alone.

5 ENERGY EFFICIENT PRACTICES

In addition to the quantifiable savings estimated in Section 4, a facility's energy performance can also be improved through application of many low cost or no-cost energy efficiency strategies. By employing certain behavioral and operational changes and performing routine maintenance on building systems, equipment lifetime can be extended; occupant comfort, health and safety can be improved; and energy and O&M costs can be reduced. The recommendations below are provided as a framework for developing a whole building maintenance plan that is customized to your facility. Consult with qualified equipment specialists for details on proper maintenance and system operation.

Perform Proper Lighting Maintenance

In order to sustain optimal lighting levels, lighting fixtures should undergo routine maintenance. Light levels decrease over time due to lamp aging, lamp and ballast failure, and buildup of dirt and dust on lamps, fixtures and reflective surfaces. Together, these factors can reduce total illumination by 20% - 60% or more, while operating fixtures continue drawing full power. To limit this reduction, lamps, reflectors and diffusers should be thoroughly cleaned of dirt, dust, oil, and smoke film buildup approximately every 6 – 12 months.

Develop a Lighting Maintenance Schedule

In addition to routine fixture cleaning, development of a maintenance schedule can both ensure maintenance is performed regularly and can reduce the overall cost of fixture re-lamping and re-ballasting. By re-lamping and re-ballasting fixtures in groups, lighting levels are better maintained and the number of site visits by a lighting technician or contractor can be minimized, decreasing the overall cost of maintenance.

Perform Routine Motor Maintenance

Motors consist of many moving parts whose collective degradation can contribute to a significant loss of motor efficiency. In order to prevent damage to motor components, routine maintenance should be performed. This maintenance consists of cleaning surfaces and ventilation openings on motors to prevent overheating, lubricating moving parts to reduce friction, inspecting belts and pulleys for wear and to ensure they are at proper alignment and tension, and cleaning and lubricating bearings. Consult a licensed technician to assess these and other motor maintenance strategies.

Use Fans to Reduce Cooling Load

Utilizing ceiling fans to supplement cooling is a low-cost strategy to reduce cooling load considerably. Thermostat settings can be increased by 4°F with no change in overall occupant comfort when the wind chill effect of moving air is employed for cooling.

Clean Evaporator/Condenser Coils on AC Systems

Dirty evaporators and condensers coils cause a restriction to air flow and restrict heat transfer. This results in increased evaporator and condenser fan load and a decrease in cooling system performance. Keeping the coils clean allows the fans and cooling system to operate more efficiently.

Clean and/or Replace HVAC Filters

Air filters work to reduce the amount of indoor air pollution and increase occupant comfort. Over time, filters become less and less effective as particulate buildup increases. In addition to health concerns related to clogged filters, filters that have reached saturation also restrict air flow through the facility's air conditioning or heat pump system, increasing the load on the distribution fans and decreasing occupant comfort levels. Filters should be checked monthly and cleaned or replaced when appropriate.

Perform Proper Boiler Maintenance

Many boiler problems develop slowly over time, so regular inspection and maintenance is essential to retain proper functionality and efficiency of the heating system. Fuel burning equipment should undergo yearly tune-ups to ensure they are operating as safely and efficiently as possible from a combustion standpoint. A tune-up should include a combustion analysis to analyze the exhaust from the boilers and to ensure the boiler is operating safely. Buildup of dirt, dust, or deposits on the internal surfaces of a boiler can greatly affect its heat transfer efficiency. These deposits can accumulate on the water side or fire side of the boiler. Boilers should be cleaned regularly according to the manufacturer's instructions to remove this build up in order to sustain efficiency and equipment life.

Perform Proper Furnace Maintenance

Preventative furnace maintenance can extend the life of the system, maintain energy efficiency, and ensure safe operation. Following the manufacturer's instructions, a yearly tune-up should include tasks such as checking for gas / carbon monoxide leaks; changing the air and fuel filters; checking components for cracks, corrosion, dirt, or debris build-up; ensuring the ignition system is working properly; testing and adjusting operation and safety controls; inspecting the electrical connections; and ensuring proper lubrication for motors and bearings.

Perform Proper Water Heater Maintenance

At least once a year, drain a few gallons out of the water heater using the drain valve. If there is a lot of sediment or debris, then a full flush is recommended. Turn the temperature down and then completely drain the tank. Once a year check for any leaks or heavy corrosion on the pipes and valves. For gas water heaters, check the draft hood and make sure it is placed properly, with a few inches of air space between the tank and where it connects to the vent. Look for any corrosion or wear on the gas line and on the piping. If you noticed any black residue, soot or charred metal, this is a sign you may be having combustion issues and you should have the unit serviced by a professional. For electric water heaters, look for any signs of leaking such as rust streaks or residue around the upper and lower panels covering the electrical components on the tank. For water heaters over three to four years old have a technician inspect the sacrificial anode annually.

Plug Load Controls

There are a variety of ways to limit the energy use of plug loads including increasing occupant awareness, removing under-utilized equipment, installing hardware controls, and using software controls. Some control steps to take are to enable the most aggressive power settings on existing devices or install load sensing or occupancy sensing (advanced) power strips. For additional information refer to "Plug Load Best Practices Guide" http://www.advancedbuildings.net/plug-load-best-practices-guide-offices.

Replace Computer Monitors

Replacing old computer monitors or displays with efficient monitors will reduce energy use. ENERGY STAR® rated monitors have specific requirements for on mode power consumption as well as idle and sleep mode power. According to the ENERGY STAR® website monitors that have earned the ENERGY STAR® label are 25% more efficient than standard monitors.

Water Conservation

Installing low-flow faucets or faucet aerators, low-flow showerheads, and kitchen sink pre-rinse spray valves saves both energy and water. These devices save energy by reducing the overall amount of hot water used hence reducing the energy used to heat the water. The flow ratings for EPA WaterSense™ (http://www3.epa.gov/watersense/products) labeled devices are 1.5 gallons per minute (gpm) for bathroom faucets, 2.0 gpm for showerheads, and 1.28 gpm for pre-rinse spray valves.

Installing dual flush or low-flow toilets and low-flow or waterless urinals are additional ways to reduce the sites water use, however, these devices do not provide energy savings at the site level. Any reduction in water use does however ultimately reduce grid level electricity use since a significant amount of electricity is used to deliver water from reservoirs to end users. The EPA WaterSense™ ratings for urinals is 0.5 gallons per flush (gpf) and toilets that use as little as 1.28 gpf (this is lower than the current 1.6 gpf federal standard).

Refer to Section 4.1.5 for any low-flow ECM recommendations.

6 On-Site Generation Measures

On-site generation measure options include both renewable (e.g., solar, wind) and non-renewable (e.g., fuel cells) on-site technologies that generate power to meet all or a portion of the electric energy needs of a facility, often repurposing any waste heat where applicable. Also referred to as distributed generation, these systems contribute to Greenhouse Gas (GHG) emission reductions, demand reductions and reduced customer electricity purchases, resulting in the electric system reliability through improved transmission and distribution system utilization.

The State of New Jersey's Energy Master Plan (EMP) encourages new distributed generation of all forms and specifically focuses on expanding use of combined heat and power (CHP) by reducing financial, regulatory and technical barriers and identifying opportunities for new entries. The EMP also outlines a goal of 70% of the State's electrical needs to be met by renewable sources by 2050.

Preliminary screenings were performed to determine the potential that a generation project could provide a cost-effective solution for your facility. Before deciding to implement, a feasibility study should be conducted that would take a detailed look at existing energy profiles, siting, interconnection, and the costs associated with the generation project including interconnection costs, departing load charges, and any additional special facilities charges.

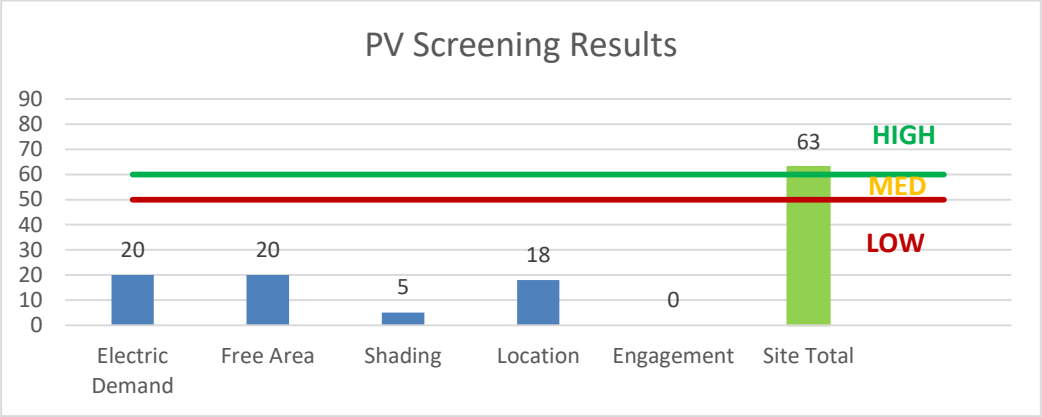
6.1 Photovoltaic

Sunlight can be converted into electricity using photovoltaics (PV) modules. Modules are racked together into an array that produces direct current (DC) electricity. The DC current is converted to alternating current (AC) through an inverter. The inverter is interconnected to the facility's electrical distribution system. The amount of unobstructed area available determines how large of a solar array can be installed. The size of the array combined with the orientation, tilt, and shading elements determines the energy produced.

A preliminary screening based on the facility's electric demand, size and location of free area, and shading elements shows that the facility has a **High** potential for installing a PV array.

The amount of free area, ease of installation, and the lack of shading elements contribute to the high potential for PV at the site. A PV array located on the roof of the building may be feasible. If Woodbridge Campus is interested in pursuing the installation of PV, we recommended a full feasibility study be conducted.

Figure 32 - Photovoltaic Screening



Potential	High	
System Potential	187	kW DC STC
Electric Generation	140,707	kWh/yr
Displaced Cost	$12,240	/yr
Installed Cost	$486,200	

Solar projects must register their projects in the SREC (Solar Renewable Energy Certificate) Registration Program (SRP) prior to the start of construction in order to establish the project's eligibility to earn SRECs. Registration of the intent to participate in New Jersey's solar marketplace provides market participants with information about developed new solar projects and insight into future SREC pricing. Refer to Section 8.3 for additional information.

For more information on solar PV technology and commercial solar markets in New Jersey, or to find a qualified solar installer, who can provide a more detailed assessment of the specific costs and benefits of solar develop of the site, please visit the following links below:

- **Basic Info on Solar PV in NJ**: http://www.njcleanenergy.com/whysolar
- **NJ Solar Market FAQs**: http://www.njcleanenergy.com/renewable-energy/program-updates-and-background-information/solar-transition/solar-market-faqs
- **Approved Solar Installers in the NJ Market**: http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/tools-and-resources/tradeally/approved_vendorsearch/?id=60&start=1

6.2 Combined Heat and Power

Combined heat and power (CHP) is the on-site generation of electricity along with the recovery of heat energy, which is put to beneficial use. Common technologies for CHP include reciprocating engines, microturbines, fuel cells, backpressure steam turbines, and (at large facilities) gas turbines. Electric generation from a CHP system is typically interconnected to local power distribution systems. Heat is recovered from exhaust and ancillary cooling systems and interconnected to the existing hot water (or steam) distribution systems.

CHP systems are typically used to produce a portion of the electric power used onsite by a facility, with the balance of electric power needs supplied by grid purchases. The heat is used to supplement (or supplant) existing boilers for space heating and/or domestic hot water heating. Waste heat can also be routed through absorption chillers for space cooling. The key criteria used for screening, however, is the amount of time the system operates at full load and the facility's ability to use the recovered heat. Facilities with continuous use for large quantities of waste heat are the best candidates for CHP.

A preliminary screening based on heating and electrical demand, siting, and interconnection shows that the facility has a **Low** potential for installing a cost-effective CHP system.

7 DEMAND RESPONSE

Demand Response (DR) is a program designed to reduce the electric load of commercial facilities when electric wholesale prices are high or when the reliability of the electric grid is threatened due to peak demand. Demand Response service providers (a.k.a. Curtailment Service Providers) are registered with PJM, the independent system operator (ISO) for mid-Atlantic state region that is charged with maintaining electric grid reliability.

By enabling grid operators to call upon Curtailment Service Providers and commercial facilities to reduce electric usage during times of peak demand, the grid is made more reliable and overall transmission costs are reduced for all ratepayers. Curtailment Service Providers provide regular payments to medium and large consumers of electric power for their participation in DR programs. Program participation is voluntary and participants receive payments whether or not their facility is called upon to curtail their electric usage.

Typically, an electric customer needs to can reduce their electric demand, within minutes, by at least 100 kW or more to participate in a DR program. Customers with a greater capability to quickly curtail their demand during peak hours will receive higher payments. Customers with back-up generators onsite may also receive additional DR payments for their generating capacity if they agree to run the generators for grid support when called upon. Eligible customers who have chosen to participate in a DR programs often find it to be a valuable source of revenue for their facility because the payments can significantly offset annual electric costs.

Participating customers can often quickly reduce their peak load through simple measures, such as temporarily raising temperature set points on thermostats, so that air conditioning units run less frequently, or agreeing to dim or shut off less critical lighting. This usually requires some level of building automation and controls capability to ensure rapid load reduction during a DR curtailment event. DR program participants may need to install smart meters or may need to also sub-meter larger energy-using equipment, such as chillers, to demonstrate compliance with DR program requirements.

DR does not include the reduction of electricity consumption based on normal operating practice or behavior. For example, if a company's normal schedule is to close for a holiday, the reduction of electricity due to this closure or scaled-back operation is not considered a demand response activity in most situations.

The first step toward participation in a DR program is to contact a Curtailment Service Provider. A list of these providers is available on PJM's website and it includes contact information for each company, as well as the states where they have active business (http://www.pjm.com/markets-and-operations/demand-response/csps.aspx). PJM also posts training materials that are developed for program members interested in specific rules and requirements regarding DR activity (http://www.pjm.com/training/training%20material.aspx), along with a variety of other DR program information.

Curtailment Service Providers typically offer free assessments to determine a facility's eligibility to participate in a DR program. They will provide details regarding program rules and requirements for metering and controls, assess a facility's ability to temporarily reduce electric load, and provide details on payments to be expected for participation in the program. Providers usually offer multiple options for DR to larger facilities and may also install controls or remote monitoring equipment of their own to help ensure compliance with all terms and conditions of a DR contract.

In our opinion this building is not a good candidate for a Demand Response measure.

8 PROJECT FUNDING / INCENTIVES

The NJCEP can provide the incentive programs described below, and other benefits to ratepayers, because of the Societal Benefits Charge (SBC) Fund. The SBC was created by the State of New Jersey's Electricity Restructuring Law (1999), which requires all customers of investor-owned electric and gas utilities to pay a surcharge on their monthly energy bills. As a customer of a state-regulated electric or gas utility and therefore a contributor to the fund your organization is eligible to participate in the LGEA program and also eligible to receive incentive payment for qualifying energy efficiency measures. Also available through the NJBPU are some alternative financing programs described later in this section. Please refer to Figure 33 for a list of the eligible programs identified for each recommended ECM.

Figure 33 - ECM Incentive Program Eligibility

Energy Conservation Measure		SmartStart Prescriptive	SmartStart Custom	Direct Install	Pay For Performance Existing Buildings	Large Energy Users Program	Combined Heat & Power and Fuel Cell
ECM 1	Install LED Fixtures	X		X			
ECM 2	Retrofit Fixtures with LED Lamps	X		X			
ECM 3	Install LED Exit Signs			X			
ECM 4	Install Occupancy Sensor Lighting Controls	X		X			
ECM 5	Install High/Low Lighitng Controls			X			
ECM 6	Install VFDs on Chilled Water Pumps						
ECM 7	Install VFDs on Hot Water Pumps						
ECM 8	Install High Efficiency Chillers	X					
ECM 9	Install Low-Flow Domestic Hot Water Devices			X			
ECM 10	Vending Machine Control			X			

SmartStart is generally well-suited for implementation of individual measures or small group of measures. It provides flexibility to install measures at your own pace using in-house staff or a preferred contractor. Direct Install caters to small to mid-size facilities that can bundle multiple ECMs together. This can greatly simplify participation and may lead to higher incentive amounts, but requires the use of pre-approved contractors. The Pay for Performance (P4P) program is a "whole-building" energy improvement program designed for larger facilities. It requires implementation of multiple measures meeting minimum savings thresholds, as well as use of pre-approved consultants. The Large Energy Users Program (LEUP) is available to New Jersey's largest energy users giving them flexibility to install as little or as many measures, in a single facility or several facilities, with incentives capped based on the entity's annual energy consumption. LEUP applicants can use in-house staff or a preferred contractor.

Generally, the incentive values provided throughout the report assume the SmartStart program is utilized because it provides a consistent basis for comparison of available incentives for various measures, though in many cases incentive amounts may be higher through participation in other programs.

Brief descriptions of all relevant financing and incentive programs are located in the sections below. Further information, including most current program availability, requirements, and incentive levels can be found at: www.njcleanenergy.com/ci.

8.1 SmartStart

Overview

The SmartStart program offers incentives for installing prescriptive and custom energy efficiency measures at your facility. Routinely the program adds, removes or modifies incentives from year to year for various energy efficiency equipment based on market trends and new technologies.

Equipment with Prescriptive Incentives Currently Available:

Electric Chillers
Electric Unitary HVAC
Gas Cooling
Gas Heating
Gas Water Heating
Ground Source Heat Pumps
Lighting
Lighting Controls
Refrigeration Doors
Refrigeration Controls
Refrigerator/Freezer Motors
Food Service Equipment
Variable Frequency Drives

Most equipment sizes and types are served by this program. This program provides an effective mechanism for securing incentives for energy efficiency measures installed individually or as part of a package of energy upgrades.

Incentives

The SmartStart prescriptive incentive program provides fixed incentives for specific energy efficiency measures, whereas the custom SmartStart program provides incentives for more unique or specialized technologies or systems that are not addressed through prescriptive incentive offerings for specific devices.

Since your facility is an existing building, only the retrofit incentives have been applied in this report. Custom measure incentives are calculated at $0.16/kWh and $1.60/therm based on estimated annual savings, capped at 50% of the total installed incremental project cost, or a project cost buy down to a one-year payback (whichever is less). Program incentives are capped at $500,000 per electric account and $500,000 per natural gas account, per fiscal year.

How to Participate

To participate in the SmartStart program you will need to apply for the specific equipment to be installed. Many applications are designed as rebates, although others require application approval prior to installation. Applicants may work with a contractor of their choosing and can also utilize internal personnel, which provides added flexibility to the program. Using internal personnel also helps improve the economics of the ECM by reducing the labor cost that is included in the tables in this report.

Detailed program descriptions, instructions for applying and applications can be found at: www.njcleanenergy.com/SSB.

8.2 Direct Install

Direct Install is a turnkey program available to existing small to medium-sized facilities with an average peak electric demand that does not exceed 200 kW over the recent 12-month period. You work directly with a pre-approved contractor who will perform a free energy assessment at your facility, identify specific eligible measures, and provide a clear scope of work for installation of selected measures. Energy efficiency measures may include lighting and lighting controls, refrigeration, HVAC, motors, variable speed drives and controls.

Incentives

The program pays up to 70% of the total installed cost of eligible measures, up to $125,000 per project. Each entity is limited to incentives up to $250,000 per fiscal year.

How to Participate

To participate in Direct Install, you will need to contact the participating contractor assigned to the region of the state where your facility is located. A complete list of Direct Install program partners is provided on the Direct Install website linked below. The contractor will be paid the measure incentives directly by the program which will pass on to you in the form of reduced material and implementation costs. This means up to 70% of eligible costs are covered by the program, subject to program caps and eligibility, while the remaining 30% of the cost is paid to the contractor by the customer.

Detailed program descriptions and applications can be found at: www.njcleanenergy.com/DI.

8.3 SREC Registration Program

The SREC (Solar Renewable Energy Certificate) Registration Program (SRP) is used to register the intent to install solar projects in New Jersey. Rebates are not available for solar projects, but owners of solar projects MUST register their projects in the SRP prior to the start of construction to establish the project's eligibility to earn SRECs. Registration of the intent to participate in New Jersey's solar marketplace provides market participants with information about the pipeline of anticipated new solar capacity and insight into future SREC pricing.

After the registration is accepted, construction is complete, and final paperwork has been submitted and is deemed complete, the project is issued a New Jersey certification number which enables it to generate New Jersey SRECs. SREC's are generated once the solar project has been authorized to be energized by the Electric Distribution Company (EDC).

Each time a solar installation generates 1,000 kilowatt-hours (kWh) of electricity, an SREC is earned. Solar project owners report the energy production to the SREC Tracking System. This reporting allows SREC's to be placed in the customer's electronic account. SRECs can then be sold on the SREC Tracking System, providing revenue for the first 15 years of the project's life.

Electricity suppliers, the primary purchasers of SRECs, are required to pay a Solar Alternative Compliance Payment (SACP) if they do not meet the requirements of New Jersey's Solar RPS. One way they can meet the RPS requirements is by purchasing SRECs. As SRECs are traded in a competitive market, the price may vary significantly. The actual price of an SREC during a trading period can and will fluctuate depending on supply and demand.

Information about the SRP can be found at: www.njcleanenergy.com/srec.

8.4 Energy Savings Improvement Program

The Energy Savings Improvement Program (ESIP) is an alternate method for New Jersey's government agencies to finance the implementation of energy conservation measures. An ESIP is a type of "performance contract," whereby school districts, counties, municipalities, housing authorities and other public and state entities enter in to contracts to help finance building energy upgrades. This is done in a manner that ensures that annual payments are lower than the savings projected from the ECMs, ensuring that ESIP projects are cash flow positive in year one, and every year thereafter. ESIP provides government agencies in New Jersey with a flexible tool to improve and reduce energy usage with minimal expenditure of new financial resources. NJCEP incentive programs can be leveraged to help further reduce the total project cost of eligible measures.

This LGEA report is the first step to participating in ESIP. Next, you will need to select an approach for implementing the desired ECMs:

(1) Use an Energy Services Company or "ESCO."
(2) Use independent engineers and other specialists, or your own qualified staff, to provide and manage the requirements of the program through bonds or lease obligations.
(3) Use a hybrid approach of the two options described above where the ESCO is utilized for some services and independent engineers, or other specialists or qualified staff, are used to deliver other requirements of the program.

After adopting a resolution with a chosen implementation approach, the development of the Energy Savings Plan (ESP) can begin. The ESP demonstrates that the total project costs of the ECMs are offset by the energy savings over the financing term, not to exceed 15 years. The verified savings will then be used to pay for the financing.

The ESIP approach may not be appropriate for all energy conservation and energy efficiency improvements. Entities should carefully consider all alternatives to develop an approach that best meets their needs. A detailed program descriptions and application can be found at: www.njcleanenergy.com/ESIP.

Please note that ESIP is a program delivered directly by the NJBPU and is not an NJCEP incentive program. As mentioned above, you may utilize NJCEP incentive programs to help further reduce costs when developing the ESP. You should refer to the ESIP guidelines at the link above for further information and guidance on next steps.

9 ENERGY PURCHASING AND PROCUREMENT STRATEGIES

9.1 Retail Electric Supply Options

In 1999, New Jersey State Legislature passed the Electric Discount & Energy Competition Act (EDECA) to restructure the electric power industry in New Jersey. This law deregulated the retail electric markets, allowing all consumers to shop for service from competitive electric suppliers. The intent was to create a more competitive market for electric power supply in New Jersey. As a result, utilities were allowed to charge Cost of Service and customers were given the ability to choose a third-party (i.e. non-utility) energy supplier.

Energy deregulation in New Jersey has increased energy buyers' options by separating the function of electricity distribution from that of electricity supply. So, though you may choose a different company from which to buy your electric power, responsibility for your facility's interconnection to the grid and repair to local power distribution will still reside with the traditional utility company serving your region.

If your facility is not purchasing electricity from a third-party supplier, consider shopping for a reduced rate from third party electric suppliers. If your facility is purchasing electricity from a third-party supplier, review and compare prices at the end of the current contract or every couple of years.

A list of third-party electric suppliers, who are licensed by the state to provide service in New Jersey, can be found online at: www.state.nj.us/bpu/commercial/shopping.html.

9.2 Retail Natural Gas Supply Options

The natural gas market in New Jersey has also been deregulated. Most customers that remain with the utility for natural gas service pay rates that are market-based and that fluctuate monthly. The utility provides basic gas supply service (BGSS) to customers who choose not to buy from a third-party supplier for natural gas commodity.

A customer's decision about whether to buy natural gas from a retail supplier is typically dependent upon whether a customer seeks budget certainty and/or longer-term rate stability. Customers can secure longer-term fixed prices by signing up for service through a third-party retail natural gas supplier. Many larger natural gas customers may seek the assistance of a professional consultant to assist in their procurement process.

If your facility is not purchasing natural gas from a third-party supplier, consider shopping for a reduced rate from third-party natural gas suppliers. If your facility is purchasing natural gas from a third-party supplier, review and compare prices at the end of the current contract or every couple of years.

A list of third-party natural gas suppliers, who are licensed by the state to provide service in New Jersey, can be found online at: www.state.nj.us/bpu/commercial/shopping.html.

Appendix A: Equipment Inventory & Recommendations

Lighting Inventory & Recommendations

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Boiler Rm	8	Compact Fluorescent: CFL - 1L - 54W	Wall Switch	54	3,225	Relamp	No	8	LED Screw-In Lamps: LED - 1L - 38W	Wall Switch	38	3,225	0.07	418	0.0	$55.75	$351.62	$0.00	6.31
Boiler Rm	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Workshop	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.08	464	0.0	$61.89	$445.50	$65.00	6.15
Maintenance Office	24	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	24	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.66	3,712	0.0	$495.11	$1,944.00	$310.00	3.30
Storage	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Sprinkler Area	2	Incandescent: INC-250W	Wall Switch	250	3,225	Relamp	Yes	2	LED Screw-In Lamps: LED - 1L - 38W	Occupancy Sensor	38	2,258	0.29	1,660	0.0	$221.38	$357.91	$45.00	1.41
Storage	40	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	40	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	1.09	6,186	0.0	$825.18	$3,220.00	$400.00	3.42
Storage	1	Incandescent: INC-250W	Wall Switch	250	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 38W	Wall Switch	38	3,225	0.14	788	0.0	$105.13	$43.95	$5.00	0.37
Basement Old Locker	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.11	619	0.0	$82.52	$504.00	$75.00	5.20
Basement Old Shower	15	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	15	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.41	2,320	0.0	$309.44	$1,417.50	$220.00	3.87
Basement Old Shower	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Basement Hallway	5	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	5	LED - Linear Tubes: (2) U-Lamp	High/Low Control	33	2,258	0.13	721	0.0	$96.22	$516.00	$0.00	5.36
Basement Hallway	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Basement Stairs	2	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	2	LED - Linear Tubes: (2) U-Lamp	High/Low Control	33	2,258	0.05	289	0.0	$38.49	$326.40	$0.00	8.48
New Boiler Rm	3	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	No	3	LED - Linear Tubes: (4) 4' Lamps	Wall Switch	58	3,225	0.11	623	0.0	$83.11	$285.40	$60.00	2.71
New Boiler Rm	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Attic Space	16	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	16	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.44	2,474	0.0	$330.07	$1,476.00	$230.00	3.77
Attic Stairs	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Gym/Auditorium	15	Metal Halide: (1) 150W Lamp	Wall Switch	190	3,225	Fixture Replacement	Yes	15	LED - Fixtures: Downlight Pendant	Occupancy Sensor	57	2,258	1.48	8,350	0.0	$1,113.84	$12,428.70	$600.00	10.62
Gym/Auditorium	5	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	5	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mech Rm	1	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	No	1	LED - Linear Tubes: (4) 4' Lamps	Wall Switch	58	3,225	0.04	208	0.0	$27.70	$95.13	$20.00	2.71
Attic space gym	16	LED Screw-In Lamps: LED - 20W	Wall Switch	20	3,225	None	Yes	16	LED Screw-In Lamps: LED - 20W	Occupancy Sensor	20	2,258	0.06	356	0.0	$47.49	$540.00	$70.00	9.90
Mech Rm 105A	1	Linear Fluorescent - T8: 2' T8 (17W) - 3L	Wall Switch	53	3,225	Relamp	No	1	LED - Linear Tubes: (3) 2' Lamps	Wall Switch	26	3,225	0.02	102	0.0	$13.60	$61.70	$15.00	3.43
Electrical/Storage	2	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	3,225	Relamp	Yes	2	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	2,258	0.08	464	0.0	$61.89	$370.40	$30.00	5.50
Guidance Office	2	Compact Fluorescent: CFL - 3L - 26W	Wall Switch	78	3,225	Relamp	No	2	LED Screw-In Lamps: LED - 3L - 55W	Wall Switch	55	3,225	0.03	174	0.0	$23.15	$263.72	$0.00	11.39

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Guidance Office	6	Compact Fluorescent: CFL - 1L - 26W	Wall Switch	26	3,225	Relamp	No	6	LED Screw-In Lamps: LED - 1L - 18W	Wall Switch	18	3,225	0.03	174	0.0	$23.15	$263.72	$0.00	11.39
Guidance Office	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Guidance Office RR	1	Compact Fluorescent: CFL - 3L - 26W	Occupancy Sensor	78	1,957	Relamp	No	1	LED Screw-In Lamps: LED - 3L - 55W	Occupancy Sensor	55	1,957	0.02	53	0.0	$7.02	$131.86	$0.00	18.78
Guidance Office RR	2	Incandescent: INC-20W	Occupancy Sensor	20	1,957	Relamp	No	2	LED Screw-In Lamps: LED - 1L - 3W	Occupancy Sensor	3	1,957	0.02	76	0.0	$10.20	$87.91	$10.00	7.63
Storage	1	Incandescent: INC-40W	Wall Switch	40	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 6W	Wall Switch	6	3,225	0.02	126	0.0	$16.82	$43.95	$5.00	2.32
Basement	1	Incandescent: INC-40W	Wall Switch	40	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 6W	Wall Switch	6	3,225	0.02	126	0.0	$16.82	$43.95	$5.00	2.32
Guidance Office	19	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	19	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.52	2,938	0.0	$391.96	$1,651.50	$260.00	3.55
Guidance RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.05	309	0.0	$41.26	$387.00	$55.00	8.05
Guidance RR	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Boys Locker	10	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	10	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.27	1,547	0.0	$206.29	$855.00	$135.00	3.49
Boys Locker	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Office	2	Linear Fluorescent - T8: 2' T8 (17W) - 3L	Wall Switch	53	3,225	Relamp	Yes	2	LED - Linear Tubes: (3) 2' Lamps	Occupancy Sensor	26	2,258	0.05	261	0.0	$34.78	$239.40	$50.00	5.45
Girls Locker	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Girls Locker	10	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	10	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.27	1,547	0.0	$206.29	$855.00	$135.00	3.49
Office	2	Linear Fluorescent - T8: 2' T8 (17W) - 3L	Wall Switch	53	3,225	Relamp	No	2	LED - Linear Tubes: (3) 2' Lamps	Wall Switch	26	3,225	0.04	204	0.0	$27.21	$123.40	$30.00	3.43
Loading Dock	6	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.16	928	0.0	$123.78	$621.00	$95.00	4.25
Loading Dock	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Science Lab CR	20	LED Screw-In Lamps: LED - 20W	Occupancy Sensor	20	1,957	None	No	20	LED Screw-In Lamps: LED - 20W	Occupancy Sensor	20	1,957	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Prep Room	4	LED Screw-In Lamps: LED - 20W	Occupancy Sensor	20	1,957	None	No	4	LED Screw-In Lamps: LED - 20W	Occupancy Sensor	20	1,957	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Wood Shop	17	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	3,225	Relamp	Yes	17	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	2,258	0.70	3,944	0.0	$526.05	$1,818.40	$325.00	2.84
Wood Shop RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Storage 1	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Storage 2	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.05	309	0.0	$41.26	$337.00	$20.00	7.68
Mech Rm	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
127 CR	16	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	16	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.77	4,356	0.0	$580.99	$2,062.13	$390.00	2.88

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Laundry Closet	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Storage	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.05	309	0.0	$41.26	$337.00	$20.00	7.68
RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Electrical/Storage	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Custodial/Closet	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
129 Conf Rm	6	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	6	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.29	1,633	0.0	$217.87	$840.80	$155.00	3.15
Storage Closet	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.05	309	0.0	$41.26	$337.00	$20.00	7.68
Storage Closet	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
130 CR	19	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	19	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.91	5,172	0.0	$689.92	$2,347.53	$450.00	2.75
130 RR	1	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	3,225	Relamp	No	1	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	3,225	0.01	59	0.0	$7.92	$48.20	$10.00	4.83
Storage	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Admin Office	4	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	4	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.19	1,089	0.0	$145.25	$650.53	$115.00	3.69
VP Office	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.10	544	0.0	$72.62	$460.27	$75.00	5.30
Back Council Office	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.10	544	0.0	$72.62	$460.27	$75.00	5.30
Office	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.10	544	0.0	$72.62	$460.27	$75.00	5.30
Office	4	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	4	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.19	1,089	0.0	$145.25	$650.53	$115.00	3.69
RR	1	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	3,225	Relamp	No	1	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	3,225	0.01	59	0.0	$7.92	$48.20	$10.00	4.83
RR	1	Incandescent: INC-40W	Wall Switch	40	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 6W	Wall Switch	6	3,225	0.02	126	0.0	$16.82	$43.95	$5.00	2.32
Faculty Rm 135	3	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Occupancy Sensor	114	1,957	Relamp	No	3	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,957	0.11	378	0.0	$50.42	$285.40	$60.00	4.47
Mens RR	1	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Occupancy Sensor	33	1,957	Relamp	No	1	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	1,957	0.01	36	0.0	$4.80	$48.20	$10.00	7.96
Womens RR	1	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Occupancy Sensor	33	1,957	Relamp	No	1	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	1,957	0.01	36	0.0	$4.80	$48.20	$10.00	7.96
Library 136	18	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	18	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.87	4,900	0.0	$653.61	$2,252.40	$430.00	2.79
137 CR	24	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	3,225	Relamp	Yes	24	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	2,258	0.98	5,568	0.0	$742.66	$2,344.80	$430.00	2.58
Prep Room	4	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	4	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.19	1,089	0.0	$145.25	$650.53	$115.00	3.69
137A	3	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	3	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.14	817	0.0	$108.94	$555.40	$95.00	4.23

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Electrical Rm	1	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	No	1	LED - Linear Tubes: (4) 4' Lamps	Wall Switch	58	3,225	0.04	208	0.0	$27.70	$95.13	$20.00	2.71
Womens RR	3	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	3,225	Relamp	Yes	3	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	2,258	0.04	235	0.0	$31.32	$414.60	$65.00	11.16
Womens RR	3	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	3,225	Relamp	No	3	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	3,225	0.03	178	0.0	$23.75	$144.60	$30.00	4.83
Mens RR	2	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	3,225	Relamp	No	2	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	3,225	0.02	119	0.0	$15.83	$96.40	$20.00	4.83
Mens RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Server Rm	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.10	544	0.0	$72.62	$460.27	$75.00	5.30
Stage	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Stage	2	Metal Halide: (1) 150W Lamp	Wall Switch	190	3,225	Fixture Replacement	Yes	2	LED - Fixtures: Downlight Pendant	Occupancy Sensor	57	2,258	0.20	1,113	0.0	$148.51	$1,657.16	$80.00	10.62
Weight Rm	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.05	309	0.0	$41.26	$233.00	$40.00	4.68
Weight Rm	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Custodial/Closet	1	Incandescent: INC-250W	Wall Switch	250	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 38W	Wall Switch	38	3,225	0.14	788	0.0	$105.13	$43.95	$5.00	0.37
Gym RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Occupancy Sensor	62	1,957	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.04	148	0.0	$19.81	$117.00	$20.00	4.90
Gym Storage	1	Incandescent: INC-250W	Wall Switch	250	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 38W	Wall Switch	38	3,225	0.14	788	0.0	$105.13	$43.95	$5.00	0.37
Gym Vestibule	1	Incandescent: INC-250W	Wall Switch	250	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 38W	Wall Switch	38	3,225	0.14	788	0.0	$105.13	$43.95	$5.00	0.37
Gym Vestibule	1	Exit Signs: Fluorescent	None	23	8,760	Fixture Replacement	No	1	LED Exit Signs: 2 W Lamp	None	6	8,760	0.01	171	0.0	$22.84	$107.56	$0.00	4.71
Storage	1	Incandescent: INC-75W	Wall Switch	75	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 11W	Wall Switch	11	3,225	0.04	236	0.0	$31.54	$43.95	$5.00	1.24
Storage Closet	1	LED Screw-In Lamps: LED - 20W	Wall Switch	20	3,225	None	No	1	LED Screw-In Lamps: LED - 20W	Wall Switch	20	3,225	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Attendar's Office	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.08	464	0.0	$61.89	$445.50	$65.00	6.15
RR	1	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Occupancy Sensor	33	1,957	Relamp	No	1	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	1,957	0.01	36	0.0	$4.80	$48.20	$10.00	7.96
120 CR	14	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	14	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.38	2,165	0.0	$288.81	$1,089.00	$175.00	3.16
118 CR	10	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	10	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.27	1,547	0.0	$206.29	$855.00	$135.00	3.49
118 Storage	1	Incandescent: INC-75W	Wall Switch	75	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 11W	Wall Switch	11	3,225	0.04	236	0.0	$31.54	$43.95	$5.00	1.24
118 Storage	1	Incandescent: INC-75W	Wall Switch	75	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 11W	Wall Switch	11	3,225	0.04	236	0.0	$31.54	$43.95	$5.00	1.24
Womens RR	1	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	3,225	Relamp	No	1	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	3,225	0.01	59	0.0	$7.92	$48.20	$10.00	4.83
Womens RR	6	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.16	928	0.0	$123.78	$621.00	$95.00	4.25

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Cafeteria	24	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	24	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.66	3,712	0.0	$495.11	$1,944.00	$310.00	3.30
Cafeteria	13	Compact Fluorescent: CFL - 2L - 26W	Wall Switch	52	3,225	Relamp	Yes	13	LED Screw-In Lamps: LED - 2L - 36W	Occupancy Sensor	36	2,258	0.23	1,279	0.0	$170.56	$1,412.78	$35.00	8.08
Cafeteria	4	Incandescent: INC-250W	Wall Switch	250	3,225	Relamp	Yes	4	LED Screw-In Lamps: LED - 1L - 38W	Occupancy Sensor	38	2,258	0.59	3,319	0.0	$442.77	$445.81	$55.00	0.88
Cafeteria	2	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	2	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	10	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	10	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.48	2,722	0.0	$363.12	$1,221.33	$235.00	2.72
Kitchen	3	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	3,225	Relamp	Yes	3	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	2,258	0.04	235	0.0	$31.32	$260.60	$50.00	6.73
Kitchen Storage	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
Kitchen Storage	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
116 CR	18	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	18	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.49	2,784	0.0	$371.33	$1,593.00	$250.00	3.62
116 CR	3	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	3,225	Relamp	Yes	3	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	2,258	0.12	696	0.0	$92.83	$495.60	$80.00	4.48
116 Storage	3	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	3,225	Relamp	Yes	3	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	2,258	0.12	696	0.0	$92.83	$445.60	$45.00	4.32
114 CR	14	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	14	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.38	2,165	0.0	$288.81	$1,089.00	$175.00	3.16
114 CR	1	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	3,225	Relamp	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	3,225	0.01	65	0.0	$8.66	$35.90	$5.00	3.57
112 CR	12	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	3,225	Relamp	Yes	12	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	2,258	0.58	3,267	0.0	$435.74	$1,411.60	$275.00	2.61
110 CR	11	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	11	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.30	1,701	0.0	$226.92	$913.50	$145.00	3.39
Storage	1	Incandescent: INC-150W	Wall Switch	150	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 23W	Wall Switch	23	3,225	0.08	473	0.0	$63.08	$43.95	$5.00	0.62
Custodial/Closet	1	Incandescent: INC-150W	Wall Switch	150	3,225	Relamp	No	1	LED Screw-In Lamps: LED - 1L - 23W	Wall Switch	23	3,225	0.08	473	0.0	$63.08	$43.95	$5.00	0.62
RR	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Occupancy Sensor	62	1,957	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,957	0.04	148	0.0	$19.81	$117.00	$20.00	4.90
Mens RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	3,225	0.02	122	0.0	$16.33	$58.50	$10.00	2.97
106 CR	12	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	12	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.33	1,856	0.0	$247.55	$972.00	$155.00	3.30
106 CR	1	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	3,225	Relamp	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	3,225	0.01	65	0.0	$8.66	$35.90	$5.00	3.57
104 CR	12	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	3,225	Relamp	Yes	12	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	2,258	0.33	1,856	0.0	$247.55	$972.00	$155.00	3.30
104 CR	1	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	3,225	Relamp	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	3,225	0.01	65	0.0	$8.66	$35.90	$5.00	3.57
Womens RR	1	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	3,225	Relamp	No	1	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	3,225	0.03	184	0.0	$24.49	$75.20	$15.00	2.46

Motor Inventory & Recommendations

		Existing Conditions						Proposed Conditions				Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Full Load Efficiency	VFD Control?	Annual Operating Hours	Install High Efficiency Motors?	Full Load Efficiency	Install VFDs?	Number of VFDs	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Woodbridge	Woodbridge	2	Heating Hot Water Pump	30.0	94.1%	Yes	2,520	No	94.1%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	Woodbridge	2	Chilled Water Pump	5.0	89.5%	No	2,520	No	89.5%	Yes	2	1.26	9,137	0.0	$1,218.79	$6,551.70	$0.00	5.38
Woodbridge	Woodbridge	3	Heating Hot Water Pump	5.0	89.5%	No	2,520	No	89.5%	Yes	3	1.88	13,706	0.0	$1,828.18	$9,827.55	$0.00	5.38
Woodbridge	AHU-6	1	Supply Fan	10.0	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-6	1	Return Fan	5.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-5	1	Supply Fan	5.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-5	1	Return Fan	2.0	86.5%	Yes	2,745	No	86.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-4	1	Supply Fan	5.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-4	1	Return Fan	2.0	86.5%	Yes	2,745	No	86.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-2	1	Supply Fan	5.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-2	1	Return Fan	2.0	86.5%	Yes	2,745	No	86.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-1	1	Supply Fan	7.5	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-1	1	Return Fan	5.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-3	1	Supply Fan	5.0	89.5%	Yes	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-3	1	Return Fan	2.0	86.5%	Yes	2,745	No	86.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-1 GYM	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-1 GYM	1	Return Fan	7.5	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	HRU-2	1	Supply Fan	5.0	89.5%	No	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	HRU-1	1	Supply Fan	5.0	89.5%	No	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-2	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00

		Existing Conditions						Proposed Conditions				Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Full Load Efficiency	VFD Control?	Annual Operating Hours	Install High Efficiency Motors?	Full Load Efficiency	Install VFDs?	Number of VFDs	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Woodbridge	AHU-2	1	Return Fan	7.5	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-2A	1	Supply Fan	15.0	92.4%	Yes	3,391	No	92.4%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AHU-2A	1	Return Fan	7.5	91.7%	Yes	3,391	No	91.7%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AC-1	1	Supply Fan	1.0	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AC-1	2	Exhaust Fan	0.5	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AC-2	1	Supply Fan	1.0	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	AC-2	2	Exhaust Fan	0.5	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	Unit Heaters	13	Ventilation Fan	0.0	85.5%	No	2,745	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Electric HVAC Inventory & Recommendations

		Existing Conditions				Proposed Conditions							Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Install High Efficiency System?	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Cooling Mode Efficiency (SEER/EER)	Heating Mode Efficiency (COP)	Install Dual Enthalpy Economizer?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Woodbridge	AC-1	1	Packaged AC	5.00		Yes	1	Packaged AC	5.00		14.00		No	1.50	2,030	0.0	$270.73	$11,344.80	$460.00	40.21
Woodbridge	AC-2	1	Packaged AC	5.00		Yes	1	Packaged AC	5.00		14.00		No	1.50	2,030	0.0	$270.73	$11,344.80	$460.00	40.21
Woodbridge	AC-3	1	Split-System AC	8.47		Yes	1	Split-System AC	8.47		11.50		No	1.40	1,892	0.0	$252.40	$9,859.46	$618.46	36.61
Woodbridge	AC-4	1	Split-System AC	2.00		Yes	1	Split-System AC	2.00		14.00		No	0.46	620	0.0	$82.76	$2,992.44	$184.00	33.93
Woodbridge	AC-5	1	Split-System AC	5.00		Yes	1	Split-System AC	5.00		14.00		No	1.15	1,551	0.0	$206.90	$7,481.10	$460.00	33.93
Woodbridge	AHUCU-1	1	Split-System AC	6.00		Yes	1	Split-System AC	6.00		11.50		No	0.63	850	0.0	$113.34	$6,982.62	$438.00	57.74
Woodbridge	CACCU-1	1	Split-System AC	1.00		Yes	1	Split-System AC	1.00		14.00		No	0.08	114	0.0	$15.26	$1,496.22	$92.00	92.00
Woodbridge	CU-1	1	Split-System AC	2.50		Yes	1	Split-System AC	2.50		14.00		No	0.57	776	0.0	$103.45	$3,740.55	$230.00	33.93
Woodbridge	CU-2	1	Split-System AC	5.00		Yes	1	Split-System AC	5.00		14.00		No	0.48	646	0.0	$86.21	$7,481.10	$460.00	81.44
Woodbridge	WAC	2	Window AC	1.00		Yes	2	Window AC	1.00		12.00		No	0.27	362	0.0	$48.28	$2,177.52	$0.00	45.11

Electric Chiller Inventory & Recommendations

		Existing Conditions			Proposed Conditions							Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Chiller Quantity	System Type	Cooling Capacity per Unit (Tons)	Install High Efficiency Chillers?	Chiller Quantity	System Type	Constant/ Variable Speed	Cooling Capacity (Tons)	Full Load Efficiency (kW/Ton)	IPLV Efficiency (kW/Ton)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Exterior	Woodbridge	1	Air-Cooled Scroll Chiller	60.00	Yes	1	Air-Cooled Centrifugal Chiller	Variable	60.00	1.24	0.74	16.02	26,010	0.0	$3,469.50	$51,191.05	$5,400.00	13.20
Exterior	Woodbridge	1	Air-Cooled Scroll Chiller	70.00	Yes	1	Air-Cooled Centrifugal Chiller	Variable	70.00	1.24	0.74	18.69	30,345	0.0	$4,047.75	$59,722.90	$6,300.00	13.20

Fuel Heating Inventory & Recommendations

		Existing Conditions			Proposed Conditions						Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Output Capacity per Unit (MBh)	Install High Efficiency System?	System Quantity	System Type	Output Capacity per Unit (MBh)	Heating Efficiency	Heating Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Old Boiler Rm	Woodbridge	3	Condensing Hot Water Boiler	1,860.00	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00
New Boiler Rm	Woodbridge	2	Condensing Hot Water Boiler	930.00	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00

DHW Inventory & Recommendations

		Existing Conditions		Proposed Conditions						Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Replace?	System Quantity	System Type	Fuel Type	System Efficiency	Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Old Boiler Rm	Woodbridge	2	Storage Tank Water Heater (> 50 Gal)	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Low-Flow Device Recommendations

	Recommedation Inputs				Energy Impact & Financial Analysis						
Location	Device Quantity	Device Type	Existing Flow Rate (gpm)	Proposed Flow Rate (gpm)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Woodbridge	1	Faucet Aerator (Lavatory)	2.20	1.00	0.00	0	1.2	$10.22	$7.17	$0.00	0.70
Woodbridge	2	Faucet Aerator (Lavatory)	2.75	1.00	0.00	0	3.5	$29.80	$14.34	$0.00	0.48

Commercial Refrigerator/Freezer Inventory & Recommendations

	Existing Conditions			Proposed Condi	Energy Impact & Financial Analysis						
Location	Quantity	Refrigerator/ Freezer Type	ENERGY STAR Qualified?	Install ENERGY STAR Equipment?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Woodbridge	1	Stand-Up Refrigerator, Solid Door (16 - 30 cu. ft.)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	1	Stand-Up Freezer, Solid Door (16 - 30 cu. ft.)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	1	Stand-Up Freezer, Solid Door (16 - 30 cu. ft.)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Cooking Equipment Inventory & Recommendations

	Existing Conditions			Proposed Conditions	Energy Impact & Financial Analysis						
Location	Quantity	Equipment Type	High Efficiency Equipement?	Install High Efficiency Equipment?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Woodbridge	1	Insulated Food Holding Cabinet (1/2 Size)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	4	Electric Convection Oven (Half Size)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Woodbridge	2	Electric Fryer	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Dishwasher Inventory & Recommendations

	Existing Conditions					Proposed Conditions	Energy Impact & Financial Analysis						
Location	Quantity	Dishwasher Type	Water Heater Fuel Type	Booster Heater Fuel Type	ENERGY STAR Qualified?	Install ENERGY STAR Equipment?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Payback w/ Incentives in Years
Woodbridge	1	Door Type (High Temp)	Electric	N/A	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Plug Load Inventory

	Existing Conditions			
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?
Woodbridge	94	Desktop and LCD Monitor	191.0	No
Woodbridge	21	Printer	20.0	No
Woodbridge	5	Projector	200.0	No
Woodbridge	6	Microwave	300.0	No
Woodbridge	4	Copier	515.0	No
Woodbridge	2	Television LCD 40"	120.0	No
Woodbridge	5	Television LCD 75"	200.0	No
Woodbridge	1	3D Printer	40.0	No
Woodbridge	2	TV Tube	320.0	No
Woodbridge	1	Mini Fridge	27.6	No
Woodbridge	5	Refrigerator	50.0	No
Woodbridge	1	Washer	450.0	No
Woodbridge	1	Dryer	800.0	No
Woodbridge	2	Electric Oven	750.0	No
Woodbridge	1	Chest Freezer	600.0	No

Vending Machine Inventory & Recommendations

	Existing Conditions		Proposed Conditions	Energy Impact & Financial Analysis						
Location	Quantity	Vending Machine Type	Install Controls?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Woodbridge	1	Refrigerated	Yes	0.00	1,612	0.0	$215.00	$230.00	$0.00	1.07

Appendix B: ENERGY STAR® Statement of Energy Performance

ENERGY STAR® Statement of Energy Performance

LEARN MORE AT energystar.gov

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ENERGY STAR® Score[1]

Woodbridge Campus

Primary Property Type: K-12 School
Gross Floor Area (ft²): 46,000
Built: 2017

For Year Ending: April 30, 2017
Date Generated: March 28, 2018

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Woodbridge Campus 1 Convery Boulevard Woodbridge, New Jersey 07095	Middlesex County Vocational School District 1011 Route 22 West Suite 203 Bridgewater, NC 08807 (____)____-_____	Karl Knehr 1011 Route 22 West Suite 203 Bridgewater, NC 08807 732-257-3300 x1952 knehrk@mail.mcvts.net

Property ID: 6260842

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
146.5 kBtu/ft²

Source EUI
273.1 kBtu/ft²

Annual Energy by Fuel	
Natural Gas (kBtu)	4,112,732 (61%)
Electric - Grid (kBtu)	2,626,235 (39%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	117.4
National Median Source EUI (kBtu/ft²)	218.8
% Diff from National Median Source EUI	25%
Annual Emissions	
Greenhouse Gas Emissions (Metric Tons CO2e/year)	510

Signature & Stamp of Verifying Professional

I _____ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: _____ Date: _____

Licensed Professional

____ _____
,
(____)____-_____
_____

Professional Engineer Stamp (if applicable)

APPENDIX 2 ECM CALCULATIONS

SEE ATTACHED USB DRIVE

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Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

ECM DESCRIPTION

Retrofit existing lighting fixtures with new energy efficient lighting fixtures, install motion sensors and implement daylight harvesting in selected areas

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Confirm lighting operation and occupancy sensors functions

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%
Safety Factor (Thermal) =	0%

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions
CALCULATIONS

		Perth Amboy Campus	Edison Campus	Woodbridge Campus
	Lighting Derate	0%	0%	0%
	Lighting Savings	316,447	73,957	125,281
	kW Savings	80	19	32
	Fuel Savings (Therms)	(309)	(72)	(122)
	Delta kW	111.72	26.11	44.23
	# of Fixtures	5,222	1,117	4,335
	Baseline Fixture Wattage (from table)	0.035165	0.036168	0.01586
	Number of Fixtures Installed	5,222	1,117	4,335
	Watttage of New Fixtures	0.013771	0.012793	0.005654
	Energy Savings (kWh/yr)	316,447	73,957	125,281
	Hours	2,575	2,575	2,575
	HVACd	0.440	0.440	0.440
	HVACe	0.100	0.100	0.100
	HVACg	(0.001075)	(0.001075)	(0.001075)
	CF	0.50	0.50	0.50
	Peak Demand Savings	80	19	32
	Fuel Savings	(309)	(72)	(122)

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

Prescriptive Lighting

This is a fixture replacement program for existing commercial customers targeted for facilities performing efficiency upgrades to their lighting systems. New fixtures and technologies available after publication will be periodically updated. Baselines will be established based on the guidelines noted below.

Algorithms

$$\Delta kW = (\#\ of\ replaced\ fixtures) * (baseline\ fixture\ wattage\ from\ table) - (\#\ of\ fixtures\ installed) * (wattage\ of\ new\ fixture)$$

$$\text{Energy Savings } \left(\frac{\text{kWh}}{\text{yr}}\right) = (\Delta\text{kW}) * (Hrs) * (1 + HVAC_e)$$

$$\text{Peak Demand Savings (kW)} = (\Delta\text{kW}) * (CF) * (1 + HVAC_d)$$

$$\text{Fuel Savings } \left(\frac{\text{MMBtu}}{\text{yr}}\right) = (\Delta\text{kW}) * (\text{Hrs}) * (\text{HVAC}_g)$$

Definition of Variables

ΔkW	= Change in connected load from baseline to efficient lighting level.
CF	= Coincidence factor
Hrs	= Annual hours of operation
$HVAC_d$	= HVAC interactive factor for peak demand savings
$HVAC_e$	= HVAC interactive factor for annual energy savings
$HVAC_g$	= HVAC interactive factor for annual fuel savings

Summary of Inputs

Prescriptive Lighting for Commercial Customers

Component	Type	Value	Source

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

Component	Type	Value	Source
ΔkW	Variable	See NGrid Fixture Wattage Table https://www1.nationalgridus.com/files/AddedPDF/POA/RILightingRetrofit1.pdf And formula above	1 Fixture counts and types, space type, floor area from customer application.
CF	Fixed	Table by Building in Performance Lighting Section Above	3
Hrs	Fixed	See Table by Building in Performance Lighting Section Above	3
$HVAC_d$	Fixed	See Table by Building Type in Performance Lighting Section Above	2
$HVAC_e$	Fixed	See Table by Building Type in Performance Lighting Section Above	2
$HVAC_g$	Fixed	See Table by Building Type in Performance Lighting Section Above	4

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

Building Type	Sector	CF	Hours
Medical - Clinic	Large Commercial/Industrial & Small Commercial	0.8	3,909
Medical - Hospital	Large Commercial/Industrial & Small Commercial	0.8	8,760[33]
Office	Large Commercial/Industrial	0.7	2,969
	Small Commercial	0.67	2,950
Other	Large Commercial/Industrial & Small Commercial	0.66	4,573
Retail	Large Commercial/Industrial	0.96	4,920
	Small Commercial	0.86	4,926
School	Large Commercial/Industrial & Small Commercial	0.50	2,575
Warehouse/ Industrial	Large Commercial/Industrial	0.7	4,116
	Small Commercial	0.68	3,799
Unknown[34]	Large Commercial/Industrial	0.50	2,575
Multifamily – Common Areas[35]	Multifamily	0.86	5,950
Multifamily – In-Unit[36]	Multifamily	0.59	679
Multifamily – Exterior[36]	Multifamily	0.00	3,338

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

HVAC Interactive Effects

Building Type	Demand Waste Heat Factor ($HVAC_d$)		Annual Energy Waste Heat Factor by Cooling/Heating Type ($HVAC_e$)			
	AC (Utility)	AC (PJM)	AC/ NonElec	AC/ ElecRes	Heat Pump	NoAC/ ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Other[36]	0.34	0.32	0.08	-0.18	-0.07	-0.26

Interactive Factor (HVACg) for Annual Fuel Savings

Project Type	Fuel Type	Impact (MMBtu/ΔkWh)
Large Retrofit (> 200 kW)	C&I Gas Heat	-0.00023
Large Retrofit (> 200 kW)	Oil	-0.00046
Small Retrofit (≤ 200 kW)	Gas Heat	-0.001075
Small Retrofit (> 200 kW)	Oil Heat	-0.000120

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Edison	1	Entry	4	METAL HALIDE, 1-320 WATT LAMP	4	SLIM62NW	SLIM WALLPACK 62W NEUTRAL LED 120 TO 277V WHITE WP3 - DLC LISTED	replace wall pack
Edison	2	Entry	4	1 - 40 WATT CFL QUAD PIN	4	9.5PLH/840/BYP	PL H G24Q/G24D 9.5W PL EDGE SERIES BYPASS 120-277V HORIZONTAL	replace lamp, ballast bypass
Edison	3	Entry	4	2 - 26 WATT CFL FIXTURE	4	21CDLA6/840/277V	6" RETROFIT 8.5/14.5/21W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Edison	4	Front Area Open	19	2 - 26 WATT CFL FIXTURE	19	21CDLA6/840/277V	6" RETROFIT 8.5/14.5/21W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Edison	5	Front Area Open	8	1 - 42 WATT STAB-IN	8	15.5PLH/840/BYP	PL H G24Q/G24D 15.5W PL EDGE SERIES BYPASS, 4000K, 120-277V HORIZONTAL	replace lamp, ballast bypass
Edison	6	Open	14	METAL HALIDE, 1-320 WATT LAMP	20	8-OC4-LED-8000L-DIM10-MVOLT-40K	8' LED LINEAR CURVE LUMINAIRE	80 feet long need 2 rows, one row 30 ft high need lift and possibly uni-strut
Edison	7	Vestibule	2	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	2	151051-103	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 20W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED	new thin panel fixtures
Edison	8	Main Office	8	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	153051-103	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X4, 36W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED	new thin panel fixtures
Edison	9	Main Office	6	*2' FIXTURE, 3-F32/T8/U3 LAMPS, ELECTRONIC BALLAST	6	151051-103	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 20W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED	new thin panel fixtures
Edison	10	Main Office	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	153051-103	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X4, 36W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED	new thin panel fixtures
Edison	11	Main Office	4	2 - 26 WATT CFL FIXTURE	4	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixtures
Edison	12	Main Office - Storage	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	153051-103	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X4, 36W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED	new thin panel fixtures
Edison	13	Main Office - Guidance	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	153051-103	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X4, 36W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED	new thin panel fixtures
Edison	14	Main Office - Restroom	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1	153051-103	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X4, 36W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED	new thin panel fixtures
Edison	15	Media	21	*2' FIXTURE, 3-F32/T8/U3 LAMPS, ELECTRONIC BALLAST	84	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro, BI LEVEL,16" Harness Kits
Edison	16	Media	20	2 - 26 WATT CFL FIXTURE	20	21CDLA6/840/277V	6" RETROFIT 8.5/14.5/21W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	Replace recessed fixtures
Edison	17	IT Closet	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	18	Hall	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	19	Hall	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	20	Mens Room	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	21	Mens Room	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over urinal
Edison	22	Mens Room	2	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over sink
Edison	23	Janitor Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	24	Mechanical	6	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	25	Electric Closet	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	26	Boiler	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	27	EMR	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	28	Womens Restroom	3	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over sinks
Edison	29	Womens Restroom	1	4' FIXTURE, 1-F25/T8 LAMP, ELECTRONIC BALLAST	1	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over sinks
Edison	30	Womens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over toilets
Edison	31	Womens Restroom	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	32	CR 103	13	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	39	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, parabolic, BI LEVEL
Edison	33	CADD Room 104	25	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	75	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Edison	34	Computer Engineering 105	20	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	60	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	35	Computer Engineering 105	10	2 - 26 WATT CFL FIXTURE	10	21CDLA6/840/277V	6" RETROFIT 8.5/14.5/21W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixtures
Edison	36	Storage	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	37	Hall	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	38	Hall	3	2 - 26 WATT CFL FIXTURE	3	21CDLA6/840/277V	6" RETROFIT 8.5/14.5/21W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Edison	39	Hall	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	40	Server	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	41	CR 108	12	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Edison	42	CR 108	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Edison	43	Wellness 111	10	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	44	Wellness 111 - Restroom	1	*2' FIXTURE, 3-F32/T8/U3 LAMPS, ELECTRONIC BALLAST	4	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Edison	45	Faculty 109	5	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	15	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	46	Faculty 109	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	47	Stair 2	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 3 EMs
Edison	48	Stair 2	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Edison	49	2nd Fl Storage	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	50	Hall	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	51	CR 210	15	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	45	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, need 16" Harness kits
Edison	52	CR 208	24	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	72	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 16" Harness kits
Edison	53	CR 205 Prep	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 16" Harness kits
Edison	54	CR 205 Prep - Storage	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	55	CR 203	24	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	72	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 16" Harness kits
Edison	56	Hall	3	2 - 26 WATT CFL FIXTURE	3	21CDLA6/840/277V	6" RETROFIT 8.5/14.5/21W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixtures
Edison	57	Storage	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro

Company Internal

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Edison	58	CR 202	13	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	39	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 16" Harness kits, 2 EMs
Edison	59	CR 202	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Edison	60	CR 202 - Office	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 16" Harness kits
Edison	61	Roof Access	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wall mount
Edison	62	Janitor Closet	1	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	1	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	63	Closet	0	0 - N/A	0	PC	*---- PLACEHOLDER ----*	No light
Edison	64	Hall	3	2 - 26 WATT CFL FIXTURE	3	21CDLA6/840/277V	6" RETROFIT 8.5/14.5/21W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixtures
Edison	65	CR 211	13	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	39	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 2 EMs
Edison	66	CR 211	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Edison	67	Electric Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	68	CR 212	11	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	33	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 2 EMs
Edison	69	CR 212	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Edison	70	Storage 213	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	71	CR 214	11	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	33	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 1 EMs
Edison	72	CR 214	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Edison	73	Hall	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	74	Mens Restroom	2	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	75	Mens Restroom	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	76	Mens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	77	CR 215	11	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	33	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 1 EMs
Edison	78	CR 215	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Edison	79	Storage 216	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, 16" Harness kits
Edison	80	CR 217	11	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	33	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL
Edison	81	Womens Restroom	2	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Edison	82	Womens Restroom	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro,over sinks
Edison	83	Womens Restroom	1	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	1	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over sinks
Edison	84	Womens Restroom	1	4' FIXTURE, 1-F25/T8 LAMP, ELECTRONIC BALLAST	1	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over sinks
Edison	85	Womens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro,over toilets
Edison	86	Stair 1	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 3 EMs
Edison	87	Stair 1	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Edison	88	Exterior	0	150 WATT MH WALL PACK	0	18.5A21/840/277V	LED A21 18.5 WATT, HIGH OUTPUT, E26 BASE, 120-277V, 4000K, NON-DIMMABLE DIRECT L	N/A
Edison	89	Exterior	2	2 - 26 WATT CFL FIXTURE	2	LY6RCS/41K/WH	SUPER THIN 12W LED 6" ROUND 4100K WHITE 110° 800LM TYPE IC DAMP ES CRI 80 - ENERGY STAR	replace recessed fixture
Edison	90	sockets	0	0 - N/A	975	FL200n	T8 NON SHUNTED SOCKET - COMMON	sockets
Edison	91	1L Harness Kits	0	0 - N/A	159	XTS-RT-1-TS-T8	1 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	1L Harness Kits
Edison	92	2L Harness Kits	0	0 - N/A	34	XTS-RT-2-TS-T8	2 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	2L Harness Kits
Edison	93	3L Harness Kits	0	0 - N/A	137	XTS-RT-3-TS-T8	3 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	3L Harness Kits
Edison	94	16" 2L Harness Kits	0	0 - N/A	169	XTS-RT-2-TS-T8-16	16 INCH- 2 LAMP HARNESS	16" 2L Harness Kits
Edison	95	U Tube Kits	0	0 - N/A	22	22C 4 W10 BL11	RETROFIT KIT FOR 2' U-TUBE (INCLUDES (4) SOCKETS)	U Tube Retro Kit
			458	**New:**	**2613**			

Company Internal

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Perth Amboy	1	Vestibule	3	2 - 26 WATT CFL FIXTURE	3	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new fixtures, VERIFY
Perth Amboy	2	Vestibule	4	2 - 26 WATT CFL FIXTURE	4	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new fixtures
Perth Amboy	3	Vestibule	5	METAL HALIDE, 1-150 WATT LAMP	5	PC	*---- PLACEHOLDER ----*	N/A
Perth Amboy	4	Hall	9	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	5	Hall	2	2 - 26 WATT CFL FIXTURE	2	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new fixtures
Perth Amboy	6	Hall	4	2 - 26 WATT CFL QUAD - PIN FIXTURE	4	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new fixtures, VERIFY
Perth Amboy	7	Media Center	14	2 - 26 WATT CFL FIXTURE	14	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new fixtures
Perth Amboy	8	Media Center	6	METAL HALIDE, 1-400 WATT LAMP - UNDER 15	6	KBL-A-UV-H-40K-8-UL-10V	KBL HIGHBAY, 27,500 LUMENS, UNIVERSAL MOUNT, 80+ CRI, 4000K, 120-277V, 0-10V DIM - DLC LISTED	New High Bays
Perth Amboy	9	Media Center	0	0 - N/A	6	CXBP16	CREE 16" MATTE SPUN CLEAR ACRYLIC REFLECTOR / SINGLE PKG	reflectors
Perth Amboy	10	Media Center	8	6-40W BIAX	8	17PLL/840/DIR	PL STAB-IN 4 PIN, 2G11, BALLAST COMPATIBLE, 17W, 4000K	change ballast/lamp
Perth Amboy	11	N/A	0	0 - N/A	16	ICN 3TT P40 SC	3L BIAX 40W BALLAST	ballasts
Perth Amboy	12	Media Center	6	METAL HALIDE, 1-400 WATT LAMP - UNDER 15	6	KBL-A-UV-H-40K-8-UL-10V	KBL HIGHBAY, 27,500 LUMENS, UNIVERSAL MOUNT, 80+ CRI, 4000K, 120-277V, 0-10V DIM - DLC LISTED	New High Bays
Perth Amboy	13	Media Center	0	0 - N/A	6	CXBP16	CREE 16" MATTE SPUN CLEAR ACRYLIC REFLECTOR / SINGLE PKG	reflectors
Perth Amboy	14	Media Center	41	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	123	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 5 EMs
Perth Amboy	15	Media Center	0	0 - N/A	5	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	16	Media Center - A103A	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	17	Media Center - A103A	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	18	Media Center - A103B	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	19	Media Center - A103B	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	20	Media Center - A103C Server	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	21	Media Center - A103C Server	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	22	Media Center - A103C Server	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	23	Media Center - A103C Server	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EM, soffitt
Perth Amboy	24	Media Center - A103C Server	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	25	Main Office	12	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL
Perth Amboy	26	Main Office	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	27	Main Office	1	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	3	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Perth Amboy	28	Mail Room	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	29	Conference Room	8	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL
Perth Amboy	30	Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1	LF-4836U-40-EM	MAXLITE - LINEAR L-FORM LED LUMINAIRE 48" 36W 120-277V 4000K, EMERGENCY BATTERY BACK-UP	new fixture, VERIFY
Perth Amboy	31	A104C	10	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, may have EMs, can change exit 2 combo - BI LEVEL
Perth Amboy	32	A104D - Asst Principal	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, may have 1 EM - BI LEVEL
Perth Amboy	33	Toilet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, on Occ
Perth Amboy	34	Vault	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EST - NO ACCESS
Perth Amboy	35	A104F - Principal	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EST - NO ACCESS
Perth Amboy	36	Toilet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EST - NO ACCESS
Perth Amboy	37	A104I - CVE Counselor	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EST - NO ACCESS - BI LEVEL
Perth Amboy	38	Storage B101	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	39	Electrical Closet	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	40	Workroom/Computer Room	12	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EST - NOT ON AUDIT - VERIFY
Perth Amboy	41	Hall	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 3 EMs
Perth Amboy	42	Hall	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs - VERIFY Fulham or APEL
Perth Amboy	43	B124D - Career Center	33	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	99	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro - BI LEVEL
Perth Amboy	44	B124A - Counselor	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro - BI LEVEL
Perth Amboy	45	B124B - Counselor's Office	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro - BI LEVEL
Perth Amboy	46	B124C - Elec Closet	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	47	A109 Hall by Courtyard	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	48	A109 Hall by Courtyard	12	2 - 26 WATT CFL FIXTURE	12	LB8R 41K	8" ECONOMY ROUND SUPER THIN RECESSED LED NEUTRAL WHITE 18W - ENERGY STAR	new fixtures
Perth Amboy	49	Mens Room Entry	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	50	Mens Room	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	51	Mens Room	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, soffit over sink
Perth Amboy	52	Mens Room	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, soffit over toilet
Perth Amboy	53	Mens Room	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	54	Janitor Closet	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	55	Womens Room Entry	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	56	Womens Room	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	57	Womens Room	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, soffit over sink
Perth Amboy	58	Womens Room	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, soffit over toilet
Perth Amboy	59	Womens Room	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	60	CR A108	8	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	61	CR A108	18	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	62	A109 Wellness Center	15	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 5 EMs, BI LEVEL
Perth Amboy	63	A109 Wellness Center	1	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	1	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, Desk
Perth Amboy	64	A109 Exam Room	2	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM, BI LEVEL
Perth Amboy	65	A109 Exam Room Toilet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	66	A109 Exam Room Toilet	2	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, desk lamp
Perth Amboy	67	A109 EMs	0	0 - N/A	7	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	68	A109 Storage	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, not in audit - VERIFY
Perth Amboy	69	A109 Restroom	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, not in audit - VERIFY
Perth Amboy	70	Courtyard	2	1 - 23 WATT CFL	2	9.5PLH/840/BYP	PL H G24Q/G24D 9.5W PL EDGE SERIES BYPASS 120-277V HORIZONTAL	Half Cut Off Round, replace lamp, VERIFY
Perth Amboy	71	Courtyard	0	0 - N/A	3	AL	**** ALREADY LED ****	Wall Packs, maybe LED
Perth Amboy	72	A110 Faculty - Entry	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro,1 EM
Perth Amboy	73	A110 Faculty - Mens Room	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM on Occ
Perth Amboy	74	A110 Faculty - Womens Room	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM on Occ
Perth Amboy	75	A110C - Faculty Lounge	9	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Perth Amboy	76	A110C - Faculty Lounge	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Perth Amboy	77	Faculty Workroom	7	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	21	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Perth Amboy	78	Faculty Workroom	15	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Perth Amboy	79	Faculty Workroom	4	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, desk
Perth Amboy	80	Faculty	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits

Company Internal

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Perth Amboy	81	Hall by Stair 1	3	1- 26 WATT CFL LAMP	3	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	new lamp, need adapter
Perth Amboy	82	Stair 1	9	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, All EMs, Do 3 EMs and 1 Exit Combo
Perth Amboy	83	Stair 1	0	0 - N/A	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	New exit sign
Perth Amboy	84	Stair 1	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	85	Vestibule	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM Remote, change exit
Perth Amboy	86	Vestibule Exit	0	0 - N/A	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	New exit sign
Perth Amboy	87	Hall by Maintenance	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, Add APEL where remote button is
Perth Amboy	88	Hall by Maintenance	0	0 - N/A	1	APEL	COOPER SURELITE LED EMERGENCY LIGHT WITH BATTERY BACKUP	New exit sign
Perth Amboy	89	B116 - Maintenance Shop	24	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	48	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	90	Hall	12	2 - 26 WATT CFL FIXTURE	12	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new fixture, 2 Ems - replace w/exit combo
Perth Amboy	91	Hall	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	92	Hall	0	0 - N/A	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	New exit sign
Perth Amboy	93	B117 - Auto Shop	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, Ramp Down,2 2 EMs
Perth Amboy	94	B117 - Auto Shop	72	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	144	204003-303	G4 HO 4 FOOT 18W 4000K FROSTED LENS SEP LED TUBE - DLC LISTED	4' retro
Perth Amboy	95	B117 - Auto Shop Office	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL, need 16" Kit, EM
Perth Amboy	96	B117 - Auto Shop Lockers	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	97	B117 - Auto Shop Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	98	B117 - Auto Shop	6	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	99	B117 - Auto Shop	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	100	B117 - Auto Shop	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wall mount
Perth Amboy	101	B117 - Auto Shop Roof Hatch	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wall mount
Perth Amboy	102	B117 - Auto Shop	0	0 - N/A	4	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	103	Hall to Exit	2	1- 26 WATT CFL LAMP	2	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	new lamp, need adapter
Perth Amboy	104	Hall to Exit	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	105	Vestibule	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	106	Exit	1	2 - 26 WATT CFL FIXTURE	1	9.5PLH/840/BYP	PL H G24Q/G24D 9.5W PL EDGE SERIES BYPASS 120-277V HORIZONTAL	EM, on 24/7
Perth Amboy	107	Exit	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	108	Exit	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	109	Hall at Lockers	36	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	72	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro,16 EMs
Perth Amboy	110	Hall at Lockers	14	2 - 26 WATT CFL FIXTURE	14	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace fixtures
Perth Amboy	111	Hall at Lockers	0	0 - N/A	16	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	112	B114	7	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	21	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Perth Amboy	113	B114	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Perth Amboy	114	B113L	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	115	B113L	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	116	B119	18	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 4 EMs
Perth Amboy	117	B119 - Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	118	B119 - Lockers	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	119	B119	32	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	64	204003-303	G4 HO 4 FOOT 18W 4000K FROSTED LENS SEP LED TUBE - DLC LISTED	4' retro
Perth Amboy	120	B119	0	0 - N/A	5	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	121	B113	7	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	21	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	122	B113	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	123	B113	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	124	B112	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	125	B112	7	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	21	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	126	B112	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	127	B111	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	128	B111	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	129	B110	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	130	B110	7	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	21	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	131	B122	18	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 4 EMs, Inside "House" - (1) 2x4 LED
Perth Amboy	132	B122 - Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	133	B122 - Lockers	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	134	B122	30	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	60	204003-303	G4 HO 4 FOOT 18W 4000K FROSTED LENS SEP LED TUBE - DLC LISTED	4' retro
Perth Amboy	135	B122	0	0 - N/A	5	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	136	Vestibule	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wall mount
Perth Amboy	137	Construction Lab - Storage	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	138	Construction Lab	39	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	78	204003-303	G4 HO 4 FOOT 18W 4000K FROSTED LENS SEP LED TUBE - DLC LISTED	4' retro, 12 EMs
Perth Amboy	139	Construction Lab - Ramp	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4' retro
Perth Amboy	140	Construction Lab	0	0 - N/A	12	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	141	B123 - Electrical Tech Shop	24	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	48	204003-303	G4 HO 4 FOOT 18W 4000K FROSTED LENS SEP LED TUBE - DLC LISTED	4' retro
Perth Amboy	142	B123 - Electrical Tech Shop	7	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	14	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4' Retro
Perth Amboy	143	B123 - Electrical Tech Shop	18	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4' Retro, 4 EMs
Perth Amboy	144	B123 - Electrical Tech Shop - Lockers	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4' Retro
Perth Amboy	145	B123 - Electrical Tech Shop - Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4' Retro, EM
Perth Amboy	146	B123 - Electrical Tech Restroom	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	147	Hall to Main	8	1- 26 WATT CFL LAMP	8	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, explosion proof, need adapter
Perth Amboy	148	Hall to Main	2	2 - 26 WATT CFL FIXTURE	2	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new recessed fixture
Perth Amboy	149	Vestibule	4	HALOGEN INCANDESCENT, (1) 150W LAMP	4	PC	*---- PLACEHOLDER ----*	N/A
Perth Amboy	150	Vestibule	3	2 - 26 WATT CFL FIXTURE	3	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new 8" fixture
Perth Amboy	151	Hall to Left	12	2 - 26 WATT CFL FIXTURE	12	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new 8" fixture
Perth Amboy	152	Hall to Left	2	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	153	Hall to Left	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	154	Hall to Left	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	155	Hall to Left	2	2 - 26 WATT CFL FIXTURE	2	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new 8" fixture
Perth Amboy	156	Stair 2	9	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 3EMs
Perth Amboy	157	Stair 2	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	158	Stair 2	0	0 - N/A	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	add exit sign
Perth Amboy	159	B130	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	160	B130	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs

Company Internal

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Perth Amboy	161	Elevator Machine Room	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wrap, EM
Perth Amboy	162	Elevator Machine Room	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	163	IT	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	164	IT	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	165	Hall	12	2 - 26 WATT CFL FIXTURE	12	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	New 8' Fixture
Perth Amboy	166	Hall	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	167	Hall	13	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	26	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 3 EMs
Perth Amboy	168	Hall	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	169	Hall	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	170	Hall	8	2 - 26 WATT CFL FIXTURE	8	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	New 8' Fixture
Perth Amboy	171	Hall	0	0 - N/A	2	FHSBATT3-C3	FULHAM HOTSPOT BATTERY - USE WITH CHARGER	fulham kits for EMs
Perth Amboy	172	Hall	0	0 - N/A	2	FHS1-UNV-3.6L	FULHAM HOTSPOT CHARGER - LED DRIVER - USE WITH ANY BATTERY	fulham kits for EMs
Perth Amboy	173	Hall	0	0 - N/A	2	FHS2-AR-4W-C	FULHAM HOTSPOT CIRCULAR LED ARRAY	fulham kits for EMs
Perth Amboy	174	B131	16	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	32	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	175	B131	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	176	B132	10	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	177	B132	26	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	52	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	178	B132	2	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	179	B133	0	0 - N/A	0	PC	*---- PLACEHOLDER ----*	No Light
Perth Amboy	180	Hall	12	1- 26 WATT CFL LAMP	12	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, explosion proof, need adapter
Perth Amboy	181	Hall	25	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	50	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 6 EMs
Perth Amboy	182	Hall	0	0 - N/A	6	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	183	Hall	10	2 - 26 WATT CFL FIXTURE	10	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	New 8' Fixture
Perth Amboy	184	Womens Restroom Entrance	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	185	Womens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	186	Womens Restroom	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, soffit
Perth Amboy	187	Womens Restroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	188	Mens Restroom Entrance	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	189	Mens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	190	Mens Restroom	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, soffit
Perth Amboy	191	Mens Restroom	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	192	Stair 4	16	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	32	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 6 EMs
Perth Amboy	193	Stair 4	0	0 - N/A	6	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	194	Stair 4	0	0 - N/A	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	add exit sign
Perth Amboy	195	C139	13	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	39	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Perth Amboy	196	C139	32	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	64	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendants
Perth Amboy	197	C139 - Storage	1	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	198	Vestibule	12	2 - 26 WATT CFL FIXTURE	12	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	New 8' Fixture
Perth Amboy	199	Exit	4	2 - 26 WATT CFL FIXTURE	4	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	New 8' Fixture
Perth Amboy	200	Exit	2	1- 26 WATT CFL LAMP	2	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, need adapter
Perth Amboy	201	C161	10	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	20	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 3 EMs
Perth Amboy	202	C161	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	203	C161B	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	204	C161B	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	205	C161C	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	206	C161C	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	207	C161 - Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	208	Mens Restroom Entrance	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	209	Mens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	210	Mens Restroom	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	211	Mens Restroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	212	Janitor Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	213	Womens Restroom Entrance	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	214	Womens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	215	Womens Restroom	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	216	Womens Restroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	217	Stair 5	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 5 EMs
Perth Amboy	218	Stair 5	0	0 - N/A	5	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	219	Stair 5	0	0 - N/A	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	add exit sign
Perth Amboy	220	Exit	2	1- 26 WATT CFL LAMP	2	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, need adapter
Perth Amboy	221	Electric Closet	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	222	C153	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	223	C153	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	224	C153	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	225	Computer CR	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	226	Computer CR	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	227	C152	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	228	C152	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	229	Gym Entry	4	2 - 26 WATT CFL FIXTURE	4	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	VERIFY, 2 EMs
Perth Amboy	230	Gym Entry	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	231	Gym	24	4' FIXTURE, 5-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	24	128017-123	2 X 4, HIGH BAY, ECO LINEAR, 160W, 4000K, 120-277VAC, DIMMABLE, MEDIUM OPTIC - DLC LISTED	new high bays
Perth Amboy	232	Gym	0	0 - N/A	24	128010-W03	WIRE GUARD, 2 PIECES FOR 2'X4' (DOUBLE LONG)	wire gurds
Perth Amboy	233	C163C	18	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	234	C163C	2	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	235	C163E- Coach's Office	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	236	C163E- Coach's Office Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	237	C163E- Coach's Office	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	238	C163F - Womens Lockers	28	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	84	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 8 EMs
Perth Amboy	239	C163F - Womens Lockers	0	0 - N/A	8	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	240	C164E- Coach's Office	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs

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Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Perth Amboy	241	C164E- Coach's Office Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	242	C164E- Coach's Office	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	243	C164F - Mens Lockers	32	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	96	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 9 EMs
Perth Amboy	244	C164F - Mens Lockers	0	0 - N/A	9	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	245	Gym Storage 1	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	246	Gym Storage 2	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	247	Gym Storage 3	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	248	Hall Behind Gym	17	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	34	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 6 EMs
Perth Amboy	249	Hall Behind Gym	8	2 - 26 WATT CFL FIXTURE	8	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new recessed fixture
Perth Amboy	250	Hall Behind Gym	0	0 - N/A	6	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	251	Exit	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	252	Exit	2	1- 26 WATT CFL LAMP	2	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp,pendant omni directional, need adapter
Perth Amboy	253	Exit	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham for EMs
Perth Amboy	254	C166 - Mechanical Room	21	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	42	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, Industrial Hood, change to strip
Perth Amboy	255	C166 - Mechanical Room	0	0 - N/A	21	400-PV-240-LED-TS	4FT 2 LAMP STRIP	new strip fixtures
Perth Amboy	256	C166A - Elevator Machine Room	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	257	C166A - Elevator Machine Room	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham for EMs
Perth Amboy	258	C164 - CADD CR	12	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	259	C164 - CADD CR	27	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	54	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	260	C164 - CADD CR	2	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	261	Stair 3	7	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	14	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	262	Stair 3	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	263	2nd Floor - Faculty Dining Room	15	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 6 EMs
Perth Amboy	264	2nd Floor - Faculty Dining Room	3	2 - 26 WATT CFL FIXTURE	3	LB8R 41K	8" ECONOMY ROUND SUPER THIN RECESSED LED NEUTRAL WHITE 18W - ENERGY STAR	new 8" fixture
Perth Amboy	265	2nd Floor - Faculty Dining Room	0	0 - N/A	6	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	266	C209	7	6-36 WATT 4 PIN CFL	7	13PLL/840/GL/DIR	GREEN CREATIVE PLL PL EDGE SERIES, 13 WATT, GLASS LENS, PLUG AND PLAY, DIRECT BALLAST, 2G11 BASE, 4000K, DIMMABLE (98479)	replace lamps
Perth Amboy	267	C209	13	2 - 26 WATT CFL FIXTURE	13	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new 8" fixture
Perth Amboy	268	C209	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	269	Storage	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	270	Mens Room	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	271	Mens Room	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EM
Perth Amboy	272	Closet	0	0 - N/A	0	NBD	*** ENTIRE AREA NOT BEING DONE ***	no light
Perth Amboy	273	Womens Room	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	274	Womens Room	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EM
Perth Amboy	275	Kitchen	8	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EM, BI LEVEL
Perth Amboy	276	Kitchen	2	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	4	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	2'Retro
Perth Amboy	277	Kitchen	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EM
Perth Amboy	278	Kitchen Storage	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	279	Kitchen Hood	3	1- 40 WATT CFL SCREW-IN	3	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp
Perth Amboy	280	Culinary Arts - Kitchen	23	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	69	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 3 EMs, BI LEVEL
Perth Amboy	281	Culinary Arts - Kitchen	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	282	Culinary Arts - Kitchen Coolers	2	1L - A LAMP 60 WATT INCANDESCENT	2	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp
Perth Amboy	283	Culinary Arts - Kitchen Coolers	8	1- 40 WATT CFL SCREW-IN	8	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp
Perth Amboy	284	Mens Lockers	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	285	Mens Lockers	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	286	Mens Toilet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	287	Mens Toilet	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	288	Laundry	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	289	Laundry	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	290	Janitor Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	291	Janitor Closet	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	292	Womens Lockers	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	293	Womens Lockers	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	294	Womens Toilet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	295	Womens Toilet	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	296	Office	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	297	Back Hall	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 4 EMs
Perth Amboy	298	Back Hall	0	0 - N/A	4	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	299	Kitchen	6	1- 40 WATT CFL SCREW-IN	6	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamps, Hoods
Perth Amboy	300	Freezers	20	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	40	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 5 EMs
Perth Amboy	301	Freezers	0	0 - N/A	5	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	302	Freezer	2	1L - A LAMP 60 WATT INCANDESCENT	2	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp
Perth Amboy	303	Storage	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	304	Hall	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	305	Hall	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	306	Office 207H	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	307	Office 207H	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	308	Mens Room	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	309	Mens Room	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	310	Womens Room	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	311	Womens Room	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	312	Serving	22	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	44	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	313	Serving	2	6-36 WATT 4 PIN CFL	2	13PLL/840/GL/DIR	GREEN CREATIVE PLL PL EDGE SERIES, 13 WATT, GLASS LENS, PLUG AND PLAY, DIRECT BALLAST, 2G11 BASE, 4000K, DIMMABLE (98479)	replace lamp
Perth Amboy	314	Serving	8	1- 26 WATT CFL LAMP	8	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, need adapter
Perth Amboy	315	Serving	9	2 - 26 WATT CFL FIXTURE	9	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new 8" fixture
Perth Amboy	316	Serving	0	0 - N/A	3	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	add exit signs
Perth Amboy	317	Cafeteria	9	2 - 26 WATT CFL FIXTURE	9	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, 2 EMs
Perth Amboy	318	Cafeteria	2	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	319	Cafeteria	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	320	Cafeteria	27	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	54	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro

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Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Perth Amboy	321	Cafeteria	24	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	48	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	322	Cafeteria	24	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	48	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	323	Cafeteria	24	METAL HALIDE, 1-400 WATT LAMP - UNDER 15	24	KBL-A-UV-H-40K-8-UL-10V	KBL HIGHBAY, 27,500 LUMENS, UNIVERSAL MOUNT, 80+ CRI, 4000K, 120-277V, 0-10V DIM - DLC LISTED	replace fixture
Perth Amboy	324	Vending	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	325	206 IT	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	326	Cafeteria - Group Meeting Space	16	2 - 26 WATT CFL FIXTURE	16	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace fixture
Perth Amboy	327	Cafeteria - Group Meeting Space	4	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	4	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	328	Cafeteria - Group Meeting Space	9	2 - 26 WATT CFL QUAD - PIN FIXTURE	9	13PLL/840/GL/DIR	GREEN CREATIVE PLL PL EDGE SERIES, 13 WATT, GLASS LENS, PLUG AND PLAY, DIRECT BALLAST, 2G11 BASE, 4000K, DIMMABLE (98479)	replace lamp
Perth Amboy	329	Storage	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	330	Storage	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	331	Mens Restroom Alcove	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	332	Mens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	333	Mens Restroom	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, soffit
Perth Amboy	334	Mens Restroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	335	Womens Restroom Alcove	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	336	Womens Restroom	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	337	Womens Restroom	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, soffit
Perth Amboy	338	Womens Restroom	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	339	Hall	6	2 - 26 WATT CFL FIXTURE	6	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture, 2 EMs
Perth Amboy	340	Hall	0	0 - N/A	2	FHS2-AR-4W-C	FULHAM HOTSPOT CIRCULAR LED ARRAY	fulham kit for EM
Perth Amboy	341	Hall	0	0 - N/A	2	FHSBATT3-C3	FULHAM HOTSPOT BATTERY - USE WITH CHARGER	fulham kit for EM
Perth Amboy	342	Hall	0	0 - N/A	2	FHS1-UNV-3.6L	FULHAM HOTSPOT CHARGER - LED DRIVER - USE WITH ANY BATTERY	fulham kit for EM
Perth Amboy	343	Hall	4	1- 26 WATT CFL LAMP	4	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, need adapter
Perth Amboy	344	Hall	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	345	Hall	2	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	346	Hall	6	2 - 26 WATT CFL FIXTURE	6	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	347	B216	10	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	348	B216	20	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	40	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	349	B216 Exit	1	2 - 26 WATT CFL FIXTURE	1	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	350	B216	2	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	351	215 Prep	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	352	Chemical	0	0 - N/A	0	PC	*---- PLACEHOLDER ----*	No Access
Perth Amboy	353	B215	10	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	354	B215	20	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	40	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	355	B215 Exit	1	2 - 26 WATT CFL FIXTURE	1	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	356	B215	2	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	357	Hall	10	2 - 26 WATT CFL FIXTURE	10	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	358	Hall	12	1- 26 WATT CFL LAMP	12	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, explosion proof, need adapter
Perth Amboy	359	Hall	26	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	52	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	360	Hall	8	2 - 26 WATT CFL FIXTURE	8	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	361	B223	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	362	B223	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	363	B223	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	364	Workroom	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	365	Workroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	366	Back Hall	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	367	Back Hall	10	2 - 26 WATT CFL FIXTURE	10	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	368	Back Hall	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	369	Back Hall	0	0 - N/A	3	FHS2-AR-4W-C	FULHAM HOTSPOT CIRCULAR LED ARRAY	fulham kit for EM
Perth Amboy	370	Back Hall	0	0 - N/A	3	FHSBATT3-C3	FULHAM HOTSPOT BATTERY - USE WITH CHARGER	fulham kit for EM
Perth Amboy	371	Back Hall	0	0 - N/A	3	FHS1-UNV-3.6L	FULHAM HOTSPOT CHARGER - LED DRIVER - USE WITH ANY BATTERY	fulham kit for EM
Perth Amboy	372	B222	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	373	B222	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	374	B222	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	375	B221	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	376	B221	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	377	B222	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	378	Workroom	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	379	Workroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	380	B220	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	381	B220	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	382	School Store B214	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, estimate, no access
Perth Amboy	383	B213	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	384	Hall	10	2 - 26 WATT CFL FIXTURE	10	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	385	Hall	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 3 EMs
Perth Amboy	386	Hall	0	0 - N/A	3	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	387	B211	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	388	B211	16	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	32	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	389	B211	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	390	Workroom	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EM
Perth Amboy	391	Workroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	392	B210	6	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	18	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	393	B210	17	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	34	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	394	B210	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	395	Hall	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	396	Hall	4	1- 26 WATT CFL LAMP	4	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, explosion proof, add adapter
Perth Amboy	397	A213	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EM
Perth Amboy	398	A213	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	399	A212	11	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	22	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EM
Perth Amboy	400	A212	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM

Company Internal

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Perth Amboy	401	Staff Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	402	A201/Reception	6	2 - 26 WATT CFL FIXTURE	6	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	403	A201/Reception	10	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	20	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4' retro, 3 EMs
Perth Amboy	404	A201/Reception	18	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4' retro, 7 EMs
Perth Amboy	405	A201/Reception	0	0 - N/A	10	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	406	Hall by 201	4	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	407	Hall by 201	14	2 - 26 WATT CFL FIXTURE	14	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	408	Electric Closet	2	2 - 26 WATT CFL FIXTURE	2	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	replace recessed fixture
Perth Amboy	409	Electric Closet	2	METAL HALIDE, 1-320 WATT LAMP	2	SLIM62NW	SLIM WALLPACK 62W NEUTRAL LED 120 TO 277V WHITE WP3 - DLC LISTED	replace fixture
Perth Amboy	410	200B	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	411	A210	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	412	Hall	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	413	Hall	4	1- 26 WATT CFL LAMP	4	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, explosion proof, add adapter
Perth Amboy	414	A214	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	415	A214	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits fro EMs
Perth Amboy	416	A215	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	417	A215	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits fro EMs
Perth Amboy	418	A217 - ESL CR	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	419	A217 - ESL CR	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits fro EMs
Perth Amboy	420	A216 - ESL Lab	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	421	A216 - ESL Lab	10	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	20	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	422	Womens Restroom Alcove	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	423	Womens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	424	Womens Restroom	6	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, Soffit
Perth Amboy	425	Womens Restroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	426	A219	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	427	A219	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	428	Janitor Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	429	A221	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	430	A221	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	431	Mens Restroom Alcove	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Perth Amboy	432	Mens Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	433	Mens Restroom	6	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, Soffit
Perth Amboy	434	Mens Restroom	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	435	A223	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	436	A223	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	437	A224 - Computer Lab	23	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	46	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	438	Storage	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	439	A226 - Multipurpose	24	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	48	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EST, no access
Perth Amboy	440	Student Lounge	8	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Perth Amboy	441	Student Lounge	0	0 - N/A	2	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kits for EMs
Perth Amboy	442	Vestibule	6	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	443	Vestibule	0	0 - N/A	2	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	new exit signs
Perth Amboy	444	Stair 6	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Perth Amboy	445	Stair 6	0	0 - N/A	1	FHSKITT04LNC	FULHAM HOTSPOT LINEAR KIT: BATTERY/DRIVER/LINEAR ARRAY	fulham kit for EM
Perth Amboy	446	Stair 6	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Perth Amboy	447	Stair 6	2	1- 26 WATT CFL LAMP	2	9A19DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIM, ENCLOSED	replace lamp, need adapter
Perth Amboy	448	Stair 6	1	2 - 13 WATT BI PIN FLUORESCENT FIXTURE WITH ELECTRONIC BALLAST	1	APC7R	COOPER SURELITE LED EXIT/EMERGENCY COMBO (RED LETTERS)	replace exit sign
Perth Amboy	449	Exterior	9	METAL HALIDE, 1-400 WATT LAMP - UNDER 15	9	ALED3T150N	ALED150 TYPE III WITH 8 POLE MOUNTING ARM NEUTRAL LED BZ - DLC LISTED	Placeholder, waiting for IVELOT pricing
Perth Amboy	450	Exterior	20	METAL HALIDE, 1-400 WATT LAMP - UNDER 15	20	ALED3T150N	ALED150 TYPE III WITH 8 POLE MOUNTING ARM NEUTRAL LED BZ - DLC LISTED	Placeholder, waiting for IVELOT pricing
Perth Amboy	451	A Lamp Adapters	0	0 - N/A	65	GU24-2-E26	GU-24 BASE TO E-26 MED SCREW-IN	A Lamp Adapters
Perth Amboy	452	sockets	0	0 - N/A	4362	FL200n	T8 NON SHUNTED SOCKET - COMMON	sockets
Perth Amboy	453	U Tube Kits	0	0 - N/A	1	22C 3 W10 BL11	RETROFIT KIT FOR 2' U-TUBE (INCLUDES (3) SOCKETS)	U Tube Retro Kit
Perth Amboy	454	1L Harness Kits	0	0 - N/A	139	XTS-RT-1-TS-T8	1 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	1L Harness Kits
Perth Amboy	455	2L Harness Kits	0	0 - N/A	1613	XTS-RT-2-TS-T8	2 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	2L Harness Kits
Perth Amboy	456	3L Harness Kits	0	0 - N/A	328	XTS-RT-3-TS-T8	3 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	3L Harness Kits
Perth Amboy	457	4L Harness Kits	0	0 - N/A	1	XTS-RT-4-TS-T8	4 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	4L Harness Kit
Perth Amboy	458	2L Harness Kits	0	0 - N/A	3	XTS-RT-2-TS-T8-16	16 INCH- 2 LAMP HARNESS	16" 2L Harness Kits
			2485	**New:**	**11734**			

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Woodbridge	1	Vestibule	0	0 - N/A	1	AL	**** ALREADY LED ****	N/A
Woodbridge	2	Entry	1	4' FIXTURE, 8-F32/T8, ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	3	Entry	1	4' FIXTURE, 8-F32/T8, ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	4	Multipurpose	15	METAL HALIDE, 1-250 WATT LAMP	15	98HID/840/277V/EX39	HID LED EX39 98W 120-277V 4000K NON-DIMMABLE	replace lamp
Woodbridge	5	Exit	1	1L - A LAMP 60 WATT INCANDESCENT	1	9A19G4DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)	replace lamp
Woodbridge	6	Storage	1	2L - A LAMP 60 WATT INCANDESCENT	1	9A19G4DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)	replace lamp
Woodbridge	7	Storage	1	1L - A LAMP 250 WATT INCANDESCENT	1	17PAR38G4DIM/940FL40	PAR38, E26 BASE, 17 WATT, HIGH CRI, 120V 40°, 4000K, DIMMABLE - ENERGY STAR	replace lamp
Woodbridge	8	Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, EM
Woodbridge	9	Stage	3	METAL HALIDE, 1-250 WATT LAMP	3	98HID/840/277V/EX39	HID LED EX39 98W 120-277V 4000K NON-DIMMABLE	replace lamp
Woodbridge	10	Weight	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	11	140 Lobby	4	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	12	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	12	140 Lobby	4	PAR 30 - 60 WATT FLOOD	4	11PAR30SNG4DIM/940FL40	PAR30, E26 BASE, 11 WATT, 120V 40°, 4000K, HIGH CRI, DIMMABLE - ENERGY STAR	replace lamp
Woodbridge	13	Girls Locker	10	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	20	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	14	Office	2	*2' FIXTURE, 3-F32/T8/U3 LAMPS, ELECTRONIC BALLAST	8	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	15	Boys Locker	10	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	20	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	16	Office	2	*2' FIXTURE, 3-F32/T8/U3 LAMPS, ELECTRONIC BALLAST	8	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	17	Custodial	2	1L - A LAMP 200 WATT INCANDESCENT	2	10A19DIM/840	LED A19 10 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE-ENCLOSED - ENERGYST	replace lamp
Woodbridge	18	Hall	13	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	39	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	19	Glass Door Vestibule	1	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	3	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	20	Boys Bathroom	2	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	6	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	21	Boys Bathroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over sink
Woodbridge	22	Science Prep	3	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 1 EM
Woodbridge	23	Storage	1	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	24	Girls Restroom	3	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	9	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	25	Girls Restroom	3	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	6	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	2'Retro, over sink
Woodbridge	26	Hall	11	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	33	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	27	Janitor Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	28	Electric Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	29	Classroom	16	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	64	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	30	Classroom - Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wall
Woodbridge	31	Classroom - Laundry	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wall
Woodbridge	32	Classroom - Storage	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wall
Woodbridge	33	Classroom - Roof Hatch	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wall
Woodbridge	34	Storage	0	0 - N/A	0	AL	**** ALREADY LED ****	Green Creative 17.5w
Woodbridge	35	CR 126	15	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	60	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	36	CR 126	2	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	37	CR 126 - Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	38	Glass Vestibule	1	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	3	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	39	CR 126 - Storage	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	40	CR 126 - Storage	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	41	Loading	0	0 - N/A	6	AL	**** ALREADY LED ****	N/A
Woodbridge	42	Lab	0	0 - N/A	20	AL	**** ALREADY LED ****	N/A
Woodbridge	43	CR 128 - Workroom	0	0 - N/A	4	AL	**** ALREADY LED ****	N/A
Woodbridge	44	129 Conference Room	6	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	45	129 Conference Room	6	PAR 30 - 60 WATT FLOOD	6	11PAR30SNG4DIM/940FL40	PAR30, E26 BASE, 11 WATT, 120V 40°, 4000K, HIGH CRI, DIMMABLE - ENERGY STAR	replace lamp
Woodbridge	46	Closet	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	47	Closet	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	48	Storage	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	49	CR 130	17	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	68	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	50	CR 130 - Lockers	2	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	51	CR 130 - Restroom	1	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	2	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	2'Retro, over sink
Woodbridge	52	Glass Vestibule	1	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	3	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	53	Admin Off 131	4	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	54	Admin Off	2	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	55	Admin Off	2	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	56	Nurse's Off	2	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	57	Nurse	4	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	58	Nurse - over bed	1	1L - A LAMP 60 WATT INCANDESCENT	1	9A19G4DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)	replace lamp
Woodbridge	59	Nurse - Restroon	1	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	2	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	2'Retro, over sink
Woodbridge	60	Faculty Break Room	0	0 - N/A	3	AL	**** ALREADY LED ****	(3) 2x4 4L GC 17.5W
Woodbridge	61	Faculty Break Room - Bathroom	2	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	4	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	2'Retro
Woodbridge	62	Hall	6	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	18	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	63	Glass Door	1	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	3	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	64	Library	18	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	72	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	65	CR 137	24	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	72	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI-LEVEL
Woodbridge	66	CR 137 - Workroom	4	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	16	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	67	CR 137	12	3' FIXTURE, 1-F39/T5 LAMPS, ELECTRONIC BALLAST	12	14.5T5HO/3F/840/DIR	LED TUBE T5 HO - 14.5 WATT 3' 4000K DIRECT BALLAST COMPATIBLE	3' retro
Woodbridge	68	Boiler Room	3	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	69	Stairs to Boiler Room Extention	2	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	6	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro, sub-basement
Woodbridge	70	Boiler Room Extention	1	METAL HALIDE, 1-320 WATT LAMP	1	25HID/840/277V/E26	HID LED E26 25W HIGH OUTPUT 277V NON-DIMMABLE, 4000K, MED BASE	replace lamp
Woodbridge	71	Boiler Room Extention	5	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	15	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	72	Downstairs Hall	5	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	15	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro, MAY NOT DO, area floods

Company Internal

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Woodbridge	73	Downstairs Old Ladies Locker	15	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	30	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro - MAY NOT DO, area floods
Woodbridge	74	Downstairs Old Mens Locker	3	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro - MAY NOT DO - industrial hood, area floods
Woodbridge	75	Downstairs Old Bake Shop	39	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	78	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro- MAY NOT DO - industrial hood, area floods
Woodbridge	76	Downstairs Boiler Room	0	0 - N/A	3	AL	**** ALREADY LED ****	DO NOT DO
Woodbridge	77	Downstairs Boiler Room	0	0 - N/A	9	AL	**** ALREADY LED ****	DO NOT DO
Woodbridge	78	Downstairs Custodial Office 104	24	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	48	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	79	Main Office	0	0 - N/A	3	AL	**** ALREADY LED ****	N/A
Woodbridge	80	Main Office	3	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	81	Principal's Office	3	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	82	Principal's Office	1	1L - A LAMP 200 WATT INCANDESCENT	1	17PAR38G4DIM/940FL40	PAR38, E26 BASE, 17 WATT, HIGH CRI, 120V 40°, 4000K, DIMMABLE - ENERGY STAR	replace lamp
Woodbridge	83	Storage	0	0 - N/A	1	AL	**** ALREADY LED ****	N/A
Woodbridge	84	122 Attendance	0	0 - N/A	5	AL	**** ALREADY LED ****	N/A
Woodbridge	85	122 Attendance Restroom	0	0 - N/A	1	AL	**** ALREADY LED ****	N/A
Woodbridge	86	Hall	13	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	39	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro, conical
Woodbridge	87	Storage	0	0 - N/A	1	AL	**** ALREADY LED ****	N/A
Woodbridge	88	CR 121	14	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	28	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendant
Woodbridge	89	CR 120	14	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	28	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendant
Woodbridge	90	CR 119	14	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	28	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendant
Woodbridge	91	CR 118	10	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	20	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, pendant
Woodbridge	92	CR 118 - Closet	1	1L - A LAMP 60 WATT INCANDESCENT	1	9A19G4DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)	replace lamp
Woodbridge	93	CR 118 - Storage	1	1L - A LAMP 60 WATT INCANDESCENT	1	9A19G4DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)	replace lamp
Woodbridge	94	CR 117	12	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	95	Womens Restroom	0	0 - N/A	1	AL	**** ALREADY LED ****	N/A
Woodbridge	96	Womens Restroom	5	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	10	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, 2 EMs
Woodbridge	97	Hall	19	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	57	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	98	Guidance	0	0 - N/A	6	PC	*---- PLACEHOLDER ----*	N/A
Woodbridge	99	Guidance - Office	1	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	2	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	2'Retro
Woodbridge	100	Guidance - Office	2	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	8	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	101	Guidance - Restroom	4	1L - A LAMP 60 WATT INCANDESCENT	4	9A19G4DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)	replace lamp, globes
Woodbridge	102	Guidance - Restroom	0	0 - N/A	2	AL	**** ALREADY LED ****	N/A
Woodbridge	103	Guidance - Closet	1	1L - A LAMP 60 WATT INCANDESCENT	1	9A19G4DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)	replace lamp, large globe
Woodbridge	104	Downstairs Storage	19	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	76	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, wraps
Woodbridge	105	Downstairs Restroom	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, over sink
Woodbridge	106	Downstairs Hall	0	0 - N/A	2	PC	*---- PLACEHOLDER ----*	N/A
Woodbridge	107	Kitchen Closet	0	0 - N/A	1	AL	**** ALREADY LED ****	N/A
Woodbridge	108	Cafeteria	24	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	72	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	109	Cafeteria	13	2 - 32 WATT QUAD-PIN CFL	13	45CDLA9.5/840/277V	9.5" RETROFIT 23.5/32/45W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE	replace fixture
Woodbridge	110	Kitchen	10	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	40	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	111	Kitchen	3	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	9	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	112	Hood	5	1 - 32 WATT CFL	5	9A19G4DIM/840	LED A19 9 WATT, FULLY OMNI, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)	replace lamp
Woodbridge	113	Storage	1	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	114	Hood	2	1L - A LAMP 100 WATT INCANDESCENT	2	14A21DIM/840	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR	replace lamp
Woodbridge	115	CR 116	18	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	54	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	116	CR 116	5	2 - 26 WATT CFL QUAD - PIN FIXTURE	5	45CDLA9.5/840/277V	9.5" RETROFIT 23.5/32/45W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE	replace fixture
Woodbridge	117	CR 116	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	118	CR 116	1	4' FIXTURE, 1-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	1	204101-113	4-FT 25W SEP PLASTIC T5 H.O. LED TUBE LAMP, 4000K, 120-277V - DLC LISTED	4' retro
Woodbridge	119	Storage	3	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	9	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	120	CR 111	14	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	42	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	121	CR 109	18	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	54	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	122	CR 114	14	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	42	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	123	CR 114	4	2 - 26 WATT CFL QUAD - PIN FIXTURE	4	45CDLA9.5/840/277V	9.5" RETROFIT 23.5/32/45W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE	replace fixture
Woodbridge	124	CR 114	1	4' FIXTURE, 1-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	1	204101-113	4-FT 25W SEP PLASTIC T5 H.O. LED TUBE LAMP, 4000K, 120-277V - DLC LISTED	4' retro, wall pack EM
Woodbridge	125	CR 112	12	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro, BI LEVEL
Woodbridge	126	Hall	3	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	9	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	U-Tube Retro
Woodbridge	127	Hall	2	2 - 26 WATT CFL QUAD - PIN FIXTURE	2	27CDLA8/840/277V	8" RETROFIT 12/19/27W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE - ENERGY STAR	new fixture
Woodbridge	128	CR 110	11	4' FIXTURE, 2-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	22	14.5T5HO/3F/840/DIR	LED TUBE T5 HO - 14.5 WATT 3' 4000K DIRECT BALLAST COMPATIBLE	4' retro
Woodbridge	129	Closet	1	1L - A LAMP 200 WATT INCANDESCENT	1	14A21DIM/840	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR	replace lamp
Woodbridge	130	Janitor Closet	1	1L - A LAMP 200 WATT INCANDESCENT	1	14A21DIM/840	LED A21 14 WATT, FULLY OMNI E26 BASE, 120V, 4000K, DIMMABLE, ENCLOSED - ENERGY STAR	replace lamp
Woodbridge	131	Janitor Closet	1	METAL HALIDE, 1-175 WATT LAMP	1	45HID/840/277V/E26	HID LED 45W 120-277V 4000K	replace lamp
Woodbridge	132	Restroom	2	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	133	Vestibule	4	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	134	Restroom	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	135	Restroom	1	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	3	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	136	105 Storage	2	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	6	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	137	105A	1	*2' FIXTURE, 3-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	3	202000-413	G4 SP 2 FOOT 8W 4000K 140LPW NANO LENS SEP LED TUBE - DLC LISTED	2'Retro
Woodbridge	138	CR 106	12	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro
Woodbridge	139	CR 106	1	4' FIXTURE, 1-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	1	204101-113	4-FT 25W SEP PLASTIC T5 H.O. LED TUBE LAMP, 4000K, 120-277V - DLC LISTED	replace lamp, wall wash
Woodbridge	140	CR 106 - by window	3	2 - 26 WATT CFL QUAD - PIN FIXTURE	3	45CDLA9.5/840/277V	9.5" RETROFIT 23.5/32/45W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE	replace fixture
Woodbridge	141	Exterior - Door 5	2	1 - 26 WATT CFL QUAD - PIN FIXTURE	2	LY4RCS/41K/WH	SUPER THIN 9W LED 4" ROUND 4100K WHITE 110° 600LM TYPE IC DAMP ES CRI 80 - ENERGY STAR	replace fixture
Woodbridge	142	CR 104	1	2 - 26 WATT CFL QUAD - PIN FIXTURE	1	45CDLA9.5/840/277V	9.5" RETROFIT 23.5/32/45W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE	replace fixture
Woodbridge	143	CR 104	3	2 - 26 WATT CFL QUAD - PIN FIXTURE	3	45CDLA9.5/840/277V	9.5" RETROFIT 23.5/32/45W INNOFIT SERIES 4000K 120-277V NON-DIMMABLE	replace fixture
Woodbridge	144	CR 104	12	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	204001-433	TUBE LIGHT, T8, G4, 10.5W, 4FT, SEP, NANO, 4000K, HIGH EFFICACY - DLC LISTED	4'Retro

Company Internal

Campus Name	#	Location	XQty	Existing Fixture / Bulb to be Replaced or Retrofitted	NQty	Sku	Replacement Fixture / Bulb	Comment
Woodbridge	145	Exterior - Poles	14	METAL HALIDE, 1-400 WATT LAMP - OVER 15'	14	ALED3T125N/PCS2	ALED125 TYPE III 8 POLE ARM NEUTRAL LED + 277V PCS BRONZE - DLC LISTED	replace fixture, verify voltage
Woodbridge	146	Exterior - Poles	8	HIGH PRESSURE SODIUM, 1-250 WATT LAMP	8	ALED3T78N/PCS2	ALED78 TYPE III 8 POLE ARM NEUTRAL LED + 277V PCS2 BRONZE - DLC LISTED	replace fixture, verify voltage
Woodbridge	147	sockets	0	0 - N/A	1795	FL200n	T8 NON SHUNTED SOCKET - COMMON	sockets
Woodbridge	148	1L Harness Kits	0	0 - N/A	15	XTS-RT-1-TS-T5	1 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T5	1L t5 Harness Kits
Woodbridge	149	1L Harness Kits	0	0 - N/A	36	XTS-RT-1-TS-T8	1 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	1L t8 Harness Kits
Woodbridge	150	2L Harness Kits	0	0 - N/A	11	XTS-RT-2-TS-T5	2 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T5	2L t5 Harness Kits
Woodbridge	151	2L Harness Kits	0	0 - N/A	239	XTS-RT-2-TS-T8	2 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	2L t8 Harness Kits
Woodbridge	152	3L Harness Kits	0	0 - N/A	127	XTS-RT-3-TS-T8	3 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	3L t8 Harness Kits
Woodbridge	153	4L Harness Kits	0	0 - N/A	138	XTS-RT-4-TS-T8	4 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	4L t8 Harness Kits
Woodbridge	154	8L Harness Kits	0	0 - N/A	2	XTS-RT-8-TS-T8	8 LAMP UNIVERSAL TOMBSTONE KIT WITH BALLAST DISCONNECT T8	8L t8 Harness Kits
Woodbridge	155	Door 3 by window 130 corn cob lamp	1	1 L - A LAMP 10 WATT LED	1	16.5A21/840/277V	16.5 WATT, A21, 4000K, 277 V, A LAMP	N/A
Woodbridge	156	Door 3 by parking lot corn cob lamp	1	1 L - A LAMP 10 WATT LED	1	16.5A21/840/277V	16.5 WATT, A21, 4000K, 277 V, A LAMP	N/A
Woodbridge	157	Door 4 corn cob lamp	1	1 L - A LAMP 10 WATT LED	1	16.5A21/840/277V	16.5 WATT, A21, 4000K, 277 V, A LAMP	N/A
Woodbridge	158	Media Center Door	1	METAL HALIDE, 1-250 WATT LAMP	1	16.5A21/840/277V	16.5 WATT, A21, 4000K, 277 V, A LAMP	N/A
Woodbridge	159	Remove 2 floods on side and back of building	2	DECOMMISSION FIXTURE, REMOVE BALLASTS, LAMPS, TOMBSTONES	2	Fixt-Rem	FIXTURE REMOVAL	N/A
Woodbridge	160	Flood light by window 110	1	1 L - A LAMP 10 WATT LED	1	FFLED26N	FUTURE FLOOD 26W LED NEUTRAL ARM ON-OFF 7X6 BRONZE - DLC LISTED	N/A
Woodbridge	161	Remove 1 floods from window 109	1	DECOMMISSION FIXTURE, REMOVE BALLASTS, LAMPS, TOMBSTONES	1	Fixt-Rem	FIXTURE REMOVAL	N/A
Woodbridge	162	Flood light in middle goes to a wall pack	1	1 L - A LAMP 10 WATT LED	1	WP1LED30N/PCS2	WALLPACK 30W NEUTRAL LED 277V PCS W/ POLYCARB LENS BZ - DLC LISTED	N/A
Woodbridge	163	2 Flood lights goes to a wall pack	2	1 L - A LAMP 10 WATT LED	2	WP1LED30N/PCS2	WALLPACK 30W NEUTRAL LED 277V PCS W/ POLYCARB LENS BZ - DLC LISTED	N/A
Woodbridge	164	Front Lantern corn cob lamp	1	1 L - A LAMP 10 WATT LED	1	16.5A21/840/277V	16.5 WATT, A21, 4000K, 277 V, A LAMP	N/A
Woodbridge	165	2 Flood lights by gym goes to a wall pack	2	1 L - A LAMP 10 WATT LED	2	WP1LED30N/PCS2	WALLPACK 30W NEUTRAL LED 277V PCS W/ POLYCARB LENS BZ - DLC LISTED	N/A
Woodbridge	166	Flood lighton corner goes to slim WP	1	1 L - A LAMP 10 WATT LED	1	SLIM26N/PC2	SLIM 26W NEUTRAL LED 277V PC WALLMOUNT BRONZE - DLC LISTED	N/A
Woodbridge	167	Remove 1 floods from gym locker doors	1	DECOMMISSION FIXTURE, REMOVE BALLASTS, LAMPS, TOMBSTONES	1	Fixt-Rem	FIXTURE REMOVAL	N/A
Woodbridge	168	Door at handicap entrance corn cob lamp	1	1 L - A LAMP 10 WATT LED	1	16.5A21/840/277V	16.5 WATT, A21, 4000K, 277 V, A LAMP	N/A
Woodbridge	169	3 Flood lights going to a wall pack	3	1 L - A LAMP 10 WATT LED	1	WP1LED30N/PCS2	WALLPACK 30W NEUTRAL LED 277V PCS W/ POLYCARB LENS BZ - DLC LISTED	N/A
			757	**New:**	**4353**			

Company Internal

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

ECM DESCRIPTION

Retrofit existing lighting fixtures with new energy efficient lighting fixtures, install motion sensors and implement daylight harvesting in selected areas

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Confirm lighting operation and occupancy sensors functions

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%
Safety Factor (Thermal) =	0%

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions
CALCULATIONS

		Perth Amboy Campus	Edison Campus	Woodbridge Campus
	Lighting Derate	0%	0%	0%
	Lighting Savings	316,447	73,957	125,281
	kW Savings	80	19	32
	Fuel Savings (Therms)	(309)	(72)	(122)
	Delta kW	111.72	26.11	44.23
	# of Fixtures	5,222	1,117	4,335
	Baseline Fixture Wattage (from table)	0.035165	0.036168	0.01586
	Number of Fixtures Installed	5,222	1,117	4,335
	Watttage of New Fixtures	0.013771	0.012793	0.005654
	Energy Savings (kWh/yr)	316,447	73,957	125,281
	Hours	2,575	2,575	2,575
	HVACd	0.440	0.440	0.440
	HVACe	0.100	0.100	0.100
	HVACg	(0.001075)	(0.001075)	(0.001075)
	CF	0.50	0.50	0.50
	Peak Demand Savings	80	19	32
	Fuel Savings	(309)	(72)	(122)

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

Prescriptive Lighting

This is a fixture replacement program for existing commercial customers targeted for facilities performing efficiency upgrades to their lighting systems. New fixtures and technologies available after publication will be periodically updated. Baselines will be established based on the guidelines noted below.

Algorithms

$$\Delta kW = (\#\ of\ replaced\ fixtures) * (baseline\ fixture\ wattage\ from\ table) - (\#\ of\ fixtures\ installed) * (wattage\ of\ new\ fixture)$$

$$\text{Energy Savings } \left(\frac{\text{kWh}}{\text{yr}}\right) = (\Delta\text{kW}) * (Hrs) * (1 + HVAC_e)$$

$$\text{Peak Demand Savings (kW)} = (\Delta\text{kW}) * (CF) * (1 + HVAC_d)$$

$$\text{Fuel Savings } \left(\frac{\text{MMBtu}}{\text{yr}}\right) = (\Delta\text{kW}) * (\text{Hrs}) * (\text{HVAC}_g)$$

Definition of Variables

ΔkW	= Change in connected load from baseline to efficient lighting level.
CF	= Coincidence factor
Hrs	= Annual hours of operation
$HVAC_d$	= HVAC interactive factor for peak demand savings
$HVAC_e$	= HVAC interactive factor for annual energy savings
$HVAC_g$	= HVAC interactive factor for annual fuel savings

Summary of Inputs

Prescriptive Lighting for Commercial Customers

Component	Type	Value	Source

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

Component	Type	Value	Source
ΔkW	Variable	See NGrid Fixture Wattage Table https://www1.nationalgridus.com/files/AddedPDF/POA/RILightingRetrofit1.pdf And formula above	1 Fixture counts and types, space type, floor area from customer application.
CF	Fixed	Table by Building in Performance Lighting Section Above	3
Hrs	Fixed	See Table by Building in Performance Lighting Section Above	3
$HVAC_d$	Fixed	See Table by Building Type in Performance Lighting Section Above	2
$HVAC_e$	Fixed	See Table by Building Type in Performance Lighting Section Above	2
$HVAC_g$	Fixed	See Table by Building Type in Performance Lighting Section Above	4

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

Building Type	Sector	CF	Hours
Medical - Clinic	Large Commercial/Industrial & Small Commercial	0.8	3,909
Medical - Hospital	Large Commercial/Industrial & Small Commercial	0.8	8,760[33]
Office	Large Commercial/Industrial	0.7	2,969
	Small Commercial	0.67	2,950
Other	Large Commercial/Industrial & Small Commercial	0.66	4,573
Retail	Large Commercial/Industrial	0.96	4,920
	Small Commercial	0.86	4,926
School	Large Commercial/Industrial & Small Commercial	0.50	2,575
Warehouse/ Industrial	Large Commercial/Industrial	0.7	4,116
	Small Commercial	0.68	3,799
Unknown[34]	Large Commercial/Industrial	0.50	2,575
Multifamily – Common Areas[35]	Multifamily	0.86	5,950
Multifamily – In-Unit[36]	Multifamily	0.59	679
Multifamily – Exterior[36]	Multifamily	0.00	3,338

Middlesex County Vocational School
Exhibit D
ECM 1A LED Lighting
Lighting Upgrade and Heating Penalty

HVAC Interactive Effects

Building Type	Demand Waste Heat Factor ($HVAC_d$)		Annual Energy Waste Heat Factor by Cooling/Heating Type ($HVAC_e$)			
	AC (Utility)	AC (PJM)	AC/ NonElec	AC/ ElecRes	Heat Pump	NoAC/ ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Other[36]	0.34	0.32	0.08	-0.18	-0.07	-0.26

Interactive Factor (HVACg) for Annual Fuel Savings

Project Type	Fuel Type	Impact (MMBtu/ΔkWh)
Large Retrofit (> 200 kW)	C&I Gas Heat	-0.00023
Large Retrofit (> 200 kW)	Oil	-0.00046
Small Retrofit (≤ 200 kW)	Gas Heat	-0.001075
Small Retrofit (> 200 kW)	Oil Heat	-0.000120

Middlesex County Vocational School
Exhibit D
ECM 1B Vending Misers
Vending Misers

ECM DESCRIPTION

Install vending machines with vending misers, mounted on the respective vending machine.

DATA / ASSUMPTIONS

Cold Drink Run Hour Reduction	34%	
Snack Machine Run Hour Reduction	40%	
Typical Cold Drink Wattage	0.339	kW
Typical Snack Machine Wattage	0.041	kW

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Confirm vending miser operation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%

Relatively high safety factor is used for this ECM because of direct measurements are proven over the time and savings are stipulated

CALCULATIONS

Detailed energy savings calculations are in the line-by-line calculation sheet

*Inputs are blue

Building	Label	Type	Qty	Location
Perth Amboy Campus	PAC-VM-1	Cold Beverage	1	Cafeteria
Perth Amboy Campus	PAC-VM-2	Cold Beverage	1	Teacher Lounge
Perth Amboy Campus	PAC-VM-3	Cold Beverage	1	Gym
Perth Amboy Campus	PAC-VM-4	Snack	1	Cafeteria
Edison Campus	EC-VM-1	Cold Beverage	1	Common Area
Edison Campus	EC-VM-2	Snack	1	Common Area
Edison Campus	EC-VM-3	Snack	1	Common Area
Woodbridge Campus	WC-VM-1	Cold Beverage	1	Cafeteria
Woodbridge Campus	WC-VM-2	Cold Beverage	1	Faculty Lounge
Totals	-	-	9	-

Middlesex County Vocational School
Exhibit D
ECM 1B Vending Misers
Vending Misers

CALCULATION

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Edison Campus	Edison Campus	Edison Campus	Woodbridge Campus	Woodbridge Campus
Label	PAC-VM-1	PAC-VM-2	PAC-VM-3	PAC-VM-4	EC-VM-1	EC-VM-2	EC-VM-3	WC-VM-1	WC-VM-2
Type	Cold Beverage	Cold Beverage	Cold Beverage	Snack	Cold Beverage	Snack	Snack	Cold Beverage	Cold Beverage
Location	Cafeteria	Teacher Lounge	Gym	Cafeteria	Common Area	Common Area	Common Area	Cafeteria	Faculty Lounge
Quantity	1	1	1	1	1	1	1	1	1
Run Hours	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**
Existing kWh Consumption	2,970	2,970	2,970	359	2,970	359	359	2,970	2,970
Proposed kWh Consumption	1,960	1,960	1,960	215	1,960	215	215	1,960	1,960
Safety Factor	0%	0%	0%	0%	0%	0%	0%	0%	0%
kWh Savings	1,010	1,010	1,010	144	1,010	144	144	1,010	1,010

Middlesex County Vocational School
Exhibit D
ECM 1C Destratification Fans
De-stratifcation fans

ECM DESCRIPTION

Install de-stratification fans in large open ares. Fans will push and hold hot air down to reduce heating losses through the roof and upper section of the outside walls due to reducing the indoor temperature in these sections above the fan.

DATA / ASSUMPTIONS

Heating Hours	3,948	Hours
Roof - R Value (Assume between 1-2" insulation)	9.0	ft2-Deg F-hr/BTU
Wall - R Value (Assume 1/2" Wall Board, 8" LWCC, 4" Brick)	4.5	ft2-Deg F-hr/BTU
Window U Value Single Pane	1.20	Btu/ft2-Deg F-hr
Window U Value Double Pane	0.45	Btu/ft2-Deg F-hr

*Heating efficiency of de-stratification fans assumed at 60%

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Verify that the installed fans operate. Install clock meter on fans to verify that fans are running 24/7 during heating season

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%
Safety Factor (Thermal) =	0%

Fuel savings recovery factor is conservatively set for 0 for the ECM due to the uncertainity in consistency of temperature difference between room and upper level temperatures, electric penalties recovery factor is at 0.

FORMULA

$W_{TOTAL} = W_{FAN} \cdot q \cdot t_{FAN}$

$Q_{SAVINGS} = Q_{TOTAL} \cdot \mu$

$Q_{TOTAL} = Q_{WALL} + Q_{ROOF} + Q_{WIN}$

$Q_{WALL} = \sum_{-5}^{60} ((T_{STRAT} - T_{OCC}) \cdot A_{WALL} \cdot U_{WALL} \cdot t_{OCC}) + ((T_{STRAT} - T_{UNOCC}) \cdot A_{WALL} \cdot U_{WALL} \cdot t_{UNOCC})$
$Q_{WIN} = \sum_{-5}^{60} ((T_{STRAT} - T_{OCC}) \cdot A_{WIN} \cdot U_{WIN} \cdot t_{OCC}) + ((T_{STRAT} - T_{UNOCC}) \cdot A_{WIN} \cdot U_{WIN} \cdot t_{UNOCC})$
$Q_{ROOF} = \sum_{-5}^{60} ((T_{STRAT} - T_{OCC}) \cdot A_{ROOF} \cdot U_{ROOF} \cdot t_{OCC}) + ((T_{STRAT} - T_{UNOCC}) \cdot A_{ROOF} \cdot U_{ROOF} \cdot t_{UNOCC})$

Variable	Units	Description
$Q_{SAVINGS}$	Therms	Annual thermal savings
$\sum_{-5}^{60}$	-	Summation of all bins from -5°F to 60°F
μ	%	Diversity factor of de-stratification fans (25% - 50%)
Q_{TOTAL}	btu	Total heat loss
Q_{WALL}	btu	Heat loss through wall (above de-stratification fan)
Q_{ROOF}	btu	Heat loss through roof
Q_{WIN}	btu	Heat loss through windows (above de-stratification fan)
T_{BIN}	°F	Temperature of respective bin
T_{OCC}	°F	Existing temperature of space during occupied hours
T_{UNOCC}	°F	Existing temperature of space during unoccupied hours
T_{STRAT}	°F	Existing stratified temperature above de-stratification fan) during all heating hours
t_{OCC}	Hrs	Occupied Bin Hours in respective temperature bin
t_{UNOCC}	Hrs	Unoccupied Bin Hours in respective temperature bin
A_{WALL}	ft^2	Exposed wall area adove de-stratification fan
A_{ROOF}	ft^2	Exposed roof area adove de-stratification fan
A_{WINDOW}	ft^2	Exposed window area adove de-stratification fan
U_{WALL}	btu / ft^2 / °F	U-factor of wall
U_{ROOF}	btu / ft^2 / °F	U-factor of roof
U_{WIN}	btu / ft^2 / °F	U-factor of windows
W_{TOTAL}	kWh	Annual electrical consumption of fans
q	-	Quantity of fans
W_{FAN}	kW	Input kW of fan
t_{FAN}	Hrs	Annual run time of de-stratification fan (annual heating hours)

ASSUMPTIONS / DATA

* Inputs are in blue

Building	Location	Wall Length Perimeter (ft)	Wall Width Perimeter (ft)	Exposed Wall Height above Fan (ft)	Ceiling Height	Ceiling Type	Roof Area (ft^2)	Window Area (ft^2)	Roof U-Factor	Window U-Factor	Wall U-Factor
Perth Amboy Campus	Cafeteria	110	47	3.0	17-31-17	Peaked Roof	5,170	0	0.11	0.45	0.22
Perth Amboy Campus	Auto Shop	90	40	3.0	26.0	Truss	3,600	420	0.11	0.45	0.22
Perth Amboy Campus	Gym	100	94	3.0	30.0	Truss	9,400	252	0.11	0.45	0.22
Woodbridge Campus	Multi-Purpose	66	43	3.0	17-23-17	Peaked Roof	2,838	160	0.11	0.45	0.22
							-				
							-				
Totals											

Middlesex County Vocational School
Exhibit D
ECM 1C Destratification Fans
De-stratifcation fans

CALCULATIONS

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Woodbridge Campus
Location #1	Cafeteria	Auto Shop	Gym	Multi-Purpose
Wall Length	110	90	100	66
Wall Width	47	40	94	43
Wall Height Above Fan	3.0	3.0	3.0	3.0
Roof Area	5,170	3,600	9,400	2,838
Window Area	-	420	252	160
Wall Exposed Area	471	(30)	330	167
Roof U-Factor	0.11	0.11	0.11	0.11
Window U-Factor	0.45	0.45	0.45	0.45
Wall U-Factor	0.22	0.22	0.22	0.22
Fan Model	Air Pear 45	Air Pear 25	Air Pear 25	Air Pear 25
Total run hours	3,948	3,948	3,948	3,948
Fan Input watts	45	35	35	35
kwh consumed by fan	178	138	138	138
SF per Fan	1,500	1,200	1,200	1,200
Total Fans	4	3	9	3
Total Kwh Consumed	711	415	1,244	415
Existing Occupied Heating Setpoint	72.0	72.0	72.0	72
Existing Unoccup. Heating Setpoint	72.0	72.0	72.0	72
Diversity Factor	80%	80%	80%	80%
Boiler Efficiency	91.0%	91.0%	91.0%	91.0%
Additional Electric Usage	(711)	(415)	(1,244)	(415)
Calculated Fuel Savings Therms	802	688	1,454	501
Safety Factor Electric	0%	0%	0%	0%
Safety Factor Thermal	0%	0%	0%	0%
Additional Electric usage	(711)	(415)	(1,244)	(415)
Calculated Fuel Savings	802	688	1,454	501

PERTH AMBOY CAMPUS

Amb. Temp Bin °F	Ave Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Bin Hours	Unoccupied Bin Hours	Exposed Wall area	Exposed Roof area	Window area	Wall U factor	Roof U factor	Window U factor	Wall Heat loss	Roof Heat Loss	Windows Heat Loss	Total Heat loss
HEATING								ft^2	ft^2	ft^2	$btu/ft^2/°F$	$btu/ft^2/°F$	$btu/ft^2/°F$	btu/Yr	btu/Yr	btu/Yr	btu/Yr
55 to 60	57.5	86	144	97	327	170	157	471	5,170	0	0.22	0.11	0.45	496,277	2,723,728	-	3,220,005
50 to 55	52.5	109	182	172	463	242	221	471	5,170	0	0.22	0.11	0.45	944,983	5,186,372	-	6,131,355
45 to 50	47.5	105	119	142	366	180	186	471	5,170	0	0.22	0.11	0.45	938,546	5,151,043	-	6,089,589
40 to 45	42.5	185	155	177	517	239	278	471	5,170	0	0.22	0.11	0.45	1,596,324	8,761,139	-	10,357,463
35 to 40	37.5	236	200	241	677	314	363	471	5,170	0	0.22	0.11	0.45	2,444,647	13,417,012	-	15,861,659
30 to 35	32.5	237	202	198	637	293	344	471	5,170	0	0.22	0.11	0.45	2,633,570	14,453,884	-	17,087,454
25 to 30	27.5	121	115	113	349	164	185	471	5,170	0	0.22	0.11	0.45	1,625,526	8,921,409	-	10,546,935
20 to 25	22.5	149	68	97	314	127	187	471	5,170	0	0.22	0.11	0.45	1,626,834	8,928,590	-	10,555,424
15 to 20	17.5	95	40	46	181	70	111	471	5,170	0	0.22	0.11	0.45	1,032,484	5,666,607	-	6,699,092
10 to 15	12.5	39	9	28	76	28	48	471	5,170	0	0.22	0.11	0.45	473,303	2,597,638	-	3,070,940
5 to 10	7.5	21	5	5	31	10	21	471	5,170	0	0.22	0.11	0.45	209,281	1,148,602	-	1,357,883
0 to 5	2.5	4	2	-	6	2	4	471	5,170	0	0.22	0.11	0.45	43,646	239,543	-	283,189
-5 to 0	-2.5							471	5,170	0	0.22	0.11	0.45	-	-	-	-
-10 to -5	-7.5							471	5,170	0	0.22	0.11	0.45	-	-	-	-
-15 to -10	-12.5							471	5,170	0	0.22	0.11	0.45	-	-	-	-
Total		1,387	1,241	1,316	3,944	1,839	2,105							14,065,421	77,195,568	-	91,260,988

PERTH AMBOY CAMPUS

Amb. Temp Bin °F	Ave Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Bin Hours	Unoccupied Bin Hours	Exposed Wall area	Exposed Roof area	Window area	Wall U factor	Roof U factor	Window U factor	Wall Heat loss	Roof Heat Loss	Windows Heat Loss	Total Heat loss
HEATING								ft^2	ft^2	ft^2	$btu/ft^2/°F$	$btu/ft^2/°F$	$btu/ft^2/°F$	btu/Yr	btu/Yr	btu/Yr	btu/Yr
55 to 60	57.5	86	144	97	327	170	157	(30)	3,600	420	0.22	0.11	0.45	(31,610)	1,896,600	896,144	2,761,134
50 to 55	52.5	109	182	172	463	242	221	(30)	3,600	420	0.22	0.11	0.45	(60,190)	3,611,400	1,706,387	5,257,597
45 to 50	47.5	105	119	142	366	180	186	(30)	3,600	420	0.22	0.11	0.45	(59,780)	3,586,800	1,694,763	5,221,783
40 to 45	42.5	185	155	177	517	239	278	(30)	3,600	420	0.22	0.11	0.45	(101,677)	6,100,600	2,882,534	8,881,457
35 to 40	37.5	236	200	241	677	314	363	(30)	3,600	420	0.22	0.11	0.45	(155,710)	9,342,600	4,414,379	13,601,269
30 to 35	32.5	237	202	198	637	293	344	(30)	3,600	420	0.22	0.11	0.45	(167,743)	10,064,600	4,755,524	14,652,380
25 to 30	27.5	121	115	113	349	164	185	(30)	3,600	420	0.22	0.11	0.45	(103,537)	6,212,200	2,935,265	9,043,928
20 to 25	22.5	149	68	97	314	127	187	(30)	3,600	420	0.22	0.11	0.45	(103,620)	6,217,200	2,937,627	9,051,207
15 to 20	17.5	95	40	46	181	70	111	(30)	3,600	420	0.22	0.11	0.45	(65,763)	3,945,800	1,864,391	5,744,427
10 to 15	12.5	39	9	28	76	28	48	(30)	3,600	420	0.22	0.11	0.45	(30,147)	1,808,800	854,658	2,633,311
5 to 10	7.5	21	5	5	31	10	21	(30)	3,600	420	0.22	0.11	0.45	(13,330)	799,800	377,906	1,164,376
0 to 5	2.5	4	2	-	6	2	4	(30)	3,600	420	0.22	0.11	0.45	(2,780)	166,800	78,813	242,833
-5 to 0	-2.5							(30)	3,600	420	0.22	0.11	0.45	-	-	-	-
-10 to -5	-7.5							(30)	3,600	420	0.22	0.11	0.45	-	-	-	-
-15 to -10	-12.5							(30)	3,600	420	0.22	0.11	0.45	-	-	-	-
Total		1,387	1,241	1,316	3,944	1,839	2,105							(895,887)	53,753,200	25,398,387	78,255,700

Middlesex County Vocational School
Exhibit D
ECM 1C Destratification Fans
De-stratifcation fans

PERTH AMBOY CAMPUS

Amb. Temp Bin °F	Ave Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Bin Hours	Unoccupied Bin Hours	Exposed Wall area	Exposed Roof area	Window area	Wall U factor	Roof U factor	Window U factor	Wall Heat loss	Roof Heat Loss	Windows Heat Loss	Total Heat loss
HEATING								ft^2	ft^2	ft^2	$btu/ft^2/°F$	$btu/ft^2/°F$	$btu/ft^2/°F$	btu/Yr	btu/Yr	btu/Yr	btu/Yr
55 to 60	57.5	86	144	97	327	170	157	330	9,400	252	0.22	0.11	0.45	347,710	4,952,233	537,686	5,837,629
50 to 55	52.5	109	182	172	463	242	221	330	9,400	252	0.22	0.11	0.45	662,090	9,429,767	1,023,832	11,115,689
45 to 50	47.5	105	119	142	366	180	186	330	9,400	252	0.22	0.11	0.45	657,580	9,365,533	1,016,858	11,039,971
40 to 45	42.5	185	155	177	517	239	278	330	9,400	252	0.22	0.11	0.45	1,118,443	15,929,344	1,729,520	18,777,308
35 to 40	37.5	236	200	241	677	314	363	330	9,400	252	0.22	0.11	0.45	1,712,810	24,394,567	2,648,627	28,756,004
30 to 35	32.5	237	202	198	637	293	344	330	9,400	252	0.22	0.11	0.45	1,845,177	26,279,789	2,853,314	30,978,280
25 to 30	27.5	121	115	113	349	164	185	330	9,400	252	0.22	0.11	0.45	1,138,903	16,220,744	1,761,159	19,120,806
20 to 25	22.5	149	68	97	314	127	187	330	9,400	252	0.22	0.11	0.45	1,139,820	16,233,800	1,762,576	19,136,196
15 to 20	17.5	95	40	46	181	70	111	330	9,400	252	0.22	0.11	0.45	723,397	10,302,922	1,118,634	12,144,953
10 to 15	12.5	39	9	28	76	28	48	330	9,400	252	0.22	0.11	0.45	331,613	4,722,978	512,795	5,567,386
5 to 10	7.5	21	5	5	31	10	21	330	9,400	252	0.22	0.11	0.45	146,630	2,088,367	226,743	2,461,740
0 to 5	2.5	4	2	-	6	2	4	330	9,400	252	0.22	0.11	0.45	30,580	435,533	47,288	513,401
-5 to 0	-2.5							330	9,400	252	0.22	0.11	0.45	-	-	-	-
-10 to -5	-7.5							330	9,400	252	0.22	0.11	0.45	-	-	-	-
-15 to -10	-12.5							330	9,400	252	0.22	0.11	0.45	-	-	-	-
Total		1,387	1,241	1,316	3,944	1,839	2,105							9,854,753	140,355,578	15,239,032	165,449,363

WOODBRIDGE CAMPUS

Amb. Temp Bin °F	Ave Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Bin Hours	Unoccupied Bin Hours	Exposed Wall area	Exposed Roof area	Window area	Wall U factor	Roof U factor	Window U factor	Wall Heat loss	Roof Heat Loss	Windows Heat Loss	Total Heat loss
HEATING								ft^2	ft^2	ft^2	$btu/ft^2/°F$	$btu/ft^2/°F$	$btu/ft^2/°F$	btu/Yr	btu/Yr	btu/Yr	btu/Yr
55 to 60	57.5	86	144	97	327	170	157	167	2,838	160	0.22	0.11	0.45	175,962	1,495,153	341,388	2,012,503
50 to 55	52.5	109	182	172	463	242	221	167	2,838	160	0.22	0.11	0.45	335,058	2,846,987	650,052	3,832,097
45 to 50	47.5	105	119	142	366	180	186	167	2,838	160	0.22	0.11	0.45	332,775	2,827,594	645,624	3,805,993
40 to 45	42.5	185	155	177	517	239	278	167	2,838	160	0.22	0.11	0.45	566,000	4,809,306	1,098,108	6,473,414
35 to 40	37.5	236	200	241	677	314	363	167	2,838	160	0.22	0.11	0.45	866,786	7,365,083	1,681,668	9,913,537
30 to 35	32.5	237	202	198	637	293	344	167	2,838	160	0.22	0.11	0.45	933,771	7,934,260	1,811,628	10,679,659
25 to 30	27.5	121	115	113	349	164	185	167	2,838	160	0.22	0.11	0.45	576,354	4,897,284	1,118,196	6,591,834
20 to 25	22.5	149	68	97	314	127	187	167	2,838	160	0.22	0.11	0.45	576,818	4,901,226	1,119,096	6,597,140
15 to 20	17.5	95	40	46	181	70	111	167	2,838	160	0.22	0.11	0.45	366,083	3,110,606	710,244	4,186,932
10 to 15	12.5	39	9	28	76	28	48	167	2,838	160	0.22	0.11	0.45	167,816	1,425,937	325,584	1,919,338
5 to 10	7.5	21	5	5	31	10	21	167	2,838	160	0.22	0.11	0.45	74,204	630,509	143,964	848,677
0 to 5	2.5	4	2	-	6	2	4	167	2,838	160	0.22	0.11	0.45	15,475	131,494	30,024	176,993
-5 to 0	-2.5							167	2,838	160	0.22	0.11	0.45	-	-	-	-
-10 to -5	-7.5							167	2,838	160	0.22	0.11	0.45	-	-	-	-
-15 to -10	-12.5							167	2,838	160	0.22	0.11	0.45	-	-	-	-
Total		1,387	1,241	1,316	3,944	1,839	2,105							4,987,102	42,375,439	9,675,576	57,038,118

Middlesex County Vocational School
Exhibit D
Boiler Efficiency Spreadsheet

*Inputs are blue
*Automatic Mechanical List pull-in colored purple

Add Controlink ECM savings to Boiler Upgrades: **N**

EXISTING												
Building	Equipment Label	Qty	Location	Replace Boiler (Y/N)	Add Burner Controls (Y/N)	Existing Fuel	Manufacturer	Model No.	Capacity (MBH)	Heating Medium	Boiler Efficiency	Percentage of Building Served
Edison Campus	EC-B-1	1	Boiler Room	Y	N	Natural Gas	Hydrotherm	MR-1200B-PV	960	Hot Water	80%	1.00
Perth Amboy Campus	PAC-B-1	5	Boiler Room	N	N	Natural Gas	Aerco	BMK-2000	1,890	Hot Water	93%	1.00
Woodbridge Campus	WC-B-1	3	Boiler Room	N	N	Natural Gas	Aerco	BMK-2000	1,860.0	Hot Water	93%	0.66
Woodbridge Campus	WC-B-2	2	Boiler Room	N	N	Natural Gas	Aerco	KC-1000	930.0	Hot Water	93%	0.33
-	-	-	-	-	-	-	-	-	-	-	0%	-
Totals		11							5,640			

PROPOSED							
Qty	Proposed Fuel	Manufacturer	Model No.	Capacity (MBH)	Heating Medium	Boiler Efficiency	Percentage of Building Served
2	Natural Gas	Lochinvar	AWN-501PM	500	Hot Water	92.0%	100.0%

BTU/SF
35

	Building Load (MBH)
Natural Gas	532
Fuel Oil #2	0
Fuel Oil #4	0
Fuel Oil #6	0
Propane	#N/A

EXISTING OVERALL BOILER EFFICIENCY

Building	Edison Campus	Perth Amboy Campus	Woodbridge Campus	Woodbridge Campus
Location	Boiler Room	Boiler Room	Boiler Room	Boiler Room
Label	EC-B-1	PAC-B-1	WC-B-1	WC-B-2
Capacity (MBTU)	960	1,890	1,860	930
Quantity	1	5	3	2
Existing Fuel	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Percentage of Building Load	100%	100%	66%	33%
Medium	Hot Water	Hot Water	Hot Water	Hot Water
Combustion Efficiency	80.0%	93.0%	93.0%	93.0%
Losses due to radiation	2.0%	2.0%	2.0%	2.0%
MCR of boilers	1.0	1.9	1.9	0.9
% Makeup water	8	8	8	8
Makeup T.D.S.	80	80	80	80
Blowdown T.D.S.	3,500	3,500	3,500	3,500
Energy Input into Boiler(s)	76	357	146	73
Feedwater temperature	180	180	180	180
Condensate Return Temperature	200	200	200	200
Makeup water temperature	60	60	60	60
Hrs/Yr of Operation	3,948	3,948	3,948	3,948
Blowdown Temperature	220	220	220	220
Heat required to raise a lb of steam	980	980	980	980
Boiler Load Rate	50.0%	50.0%	50.0%	50.0%
Present Blowdown Rate	0.00	0.00	0.00	0.00
Heat Content of Blowdown	0.00	0.00	0.00	0.00
Blowdown Loss	0.0%	0.0%	0.0%	0.0%
Radiation Losses	2.0%	2.0%	2.0%	2.0%
Overall Boiler Efficiency	**78.0%**	**91.0%**	**91.0%**	**91.0%**

PROPOSED OVERALL BOILER EFFICIENCY

	Edison Campus
Boiler Replacement	Y
Burner Control Links	N
Location	Boiler Room
Label	EC-B-1
Quantity to be Replaced	2
Proposed Fuel	Natural Gas
Combustion Efficiency	100.0%
Capacity (MBTU)	500
Medium	Hot Water
Combustion Efficiency	92.0%
Losses due to radiation	1.0%
Losses due to blowdown	2.0
% Makeup water	8
Makeup T.D.S.	80
Blowdown T.D.S.	3,500
Energy Input into Boiler(s)	76
Feedwater temperature	180
MCR of boilers	0.5
Condensate Return Temperature	200
Makeup water temperature	60
Hrs/Yr of Operation	3,948
Blowdown Temperature	230
Heat required to raise a lb of steam	980
Boiler Load Rate	50.0%
Present Blowdown Rate	0.00
Heat Content of Blowdown	0.00
Blowdown Loss	0.0%
Radiation Losses	1.0%
Overall Boiler Efficiency	**91.0%**

CALCULATIONS

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

ECM DESCRIPTION

Replace boilers in respective buildings with new high efficiency condensing boilers

DATA / ASSUMPTIONS

Typical Condensing Boiler Seasonal Efficiency =	91.5%
Heating Hours	3,948 Hours

* Utility baseline reduced by 10.5% to account for domestic hot water, science labs, and kitchen usage
* An adjusted baseline is used for the boiler baseline usage as to not double-dip on savings

MEASUREMENT AND VERIFICATION

N	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Verify all functions of the boiler control system, safety and operation. Verify air/fuel ratio is consistent through firing range. Provide training of the boiler operators

RECOVERY/SAFETY FACTOR

Safety Factor (Thermal) = 0%

A safety factor of 0 is used due to minimal variables and the proven results of this measure

FORMULAE

$Q_{savings} = ((\eta_{NEW} - \eta_{OLD}) / \eta OLD) \cdot Fuel_{ADJ}$

Variable	Units	Description
$Q_{savings}$	Therms	Thermal Savings
η_{NEW}	%	Efficiency of New Boiler
η_{OLD}	%	Efficiency of Old Boiler
$Fuel_{ADJ}$	Therms	Adjusted Boiler Fuel Usage

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

*Inputs are blue

Building	Label	Boilers to be Replaced
Edison Campus	EC-B-1	2
Totals		**2**

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions
CALCULATIONS

	Edison Campus	Total	
Label	EC-B-1		
No. of Units to be Replaced	2	**2**	
Fuel Switch	N		
Existing Fuel	Natural Gas		
Proposed Fuel	Natural Gas		
Percentage of Building Load	100%		%
Safety Factor	0%		%
Thermal Savings	1,502	**1,502**	Therms / Yr
Natural Gas Savings	1,502	**1,502**	Therms / Yr
Fuel Savings (MMBtu/yr)	150.17		
Capin	1,000		
EFLH	901		
Effb	78%		
Effq	91%		
Kbtu to MMBtu Conversion	1,000		

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

Prescriptive Boilers

This prescriptive measure targets the use of smaller-scale boilers (less than or equal to 4000 MBH) and furnaces (no size limitation) in all commercial facilities. Larger sized boilers are treated under the custom measure path.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the State of New Jersey.

Algorithms

Fuel Savings (MMBtu/yr) = Cap_{in} * $EFLH_b$ * ((Eff_q/Eff_b)-1) / 1000 kBtu/MMBtu

Definition of Variables

Cap_{in} = Input capacity of qualifying unit in kBtu/hr
$EFLH_b$ = The Equivalent Full Load Hours of operation for the average unit during the heating season in hours
Eff_b = Boiler Baseline Efficiency
Eff_q = Boiler Proposed Efficiency
1000 = Conversion from kBtu to MMBtu

Summary of Inputs

Prescriptive Boilers

Component	Type	Value	Source
Cap_{in}	Variable		Application
$EFLH_b$	Fixed	See Table Below	1
Eff_b	Variable	See Table Below	2
Eff_q	Variable		Application

$EFLH_b$ Table

Facility Type	Heating EFLH
Assembly	603
Auto repair	1910
Dormitory	465
Hospital	3366
Light industrial	714
Lodging – Hotel	1077
Lodging – Motel	619
Office – large	2034
Office – small	431
Other	681
Religious worship	722

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

Facility Type	Heating EFLH
Restaurant – fast food	813
Restaurant – full service	821
Retail – big box	191
Retail – Grocery	191
Retail – small	545
Retail – large	2101
School – Community college	1431
School – postsecondary	1191
School – primary	840
School – secondary	901
Warehouse	452

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Heating	757	723	503
High-rise, Heating	526	395	219

Baseline Boiler Efficiencies (Eff_b)

Boiler Type	Size Category (kBtu input)		Standard 90.1-2013
Hot Water – Gas fired	< 300 ≥ 300 and ≤ 2,500		82% AFUE 80% Et 82% Ec
Hot Water – Oil fired	< 300 ≥ 300 and ≤ 2,500	84% AFUE 82% Et 84% Ec	
Steam – Gas fired	< 300	80% AFUE	
Steam – Gas fired, all except natural draft	≥ 300 and ≤ 2,500	79% Et	
Steam – Gas fired, all except	> 2,500		79% Ec
Steam – Gas fired, natural draft	≥ 300 and ≤		77% Et

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

Boiler Type	Size Category (kBtu input)		Standard 90.1-2013
Steam – Gas fired, natural draft	> 2,500		77% Ec
Steam – Oil fired	< 300	82% AFUE	
	≥ 300 and ≤ 2,500	81% Et 81% Ec	

Sources

1. New York State Joint Utilities, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, V6, April 2018. Appendix G – Equivalent Full-Load Hours (EFLH), For Heating and Cooling. P. 535-540. EFLH values for NYC due to proximity to NJ.
2. ASHRAE Standards 90.1-2013. *Energy Standard for Buildings Except Low Rise Residential Buildings*; available at: https://www.ashrae.org/standards-research--technology/standards--guidelines.

Middlesex County Vocational School
Exhibit D
Domestic Hot Water Spreadsheet

*Inputs are blue
*Automatic Mechanical List pull-in colored purple
**If Domestic Hot Water is fed off boiler put "Y" in Column F and put the respective boiler equipment label in Column C

EXISTING												
Building	Equipment Label	Qty	Location	Fed off Boiler (Y/N)	Replace DHW (Y/N)	Fuel	Manufacturer	Model No.	Capacity (MBH)	Capacity (Gal)	Combustion Efficiency	Percentage of Building DHW Load
Perth Amboy Campus	PAC-DHW-1	2	Boiler Room	N	Y	Natural Gas	PVI	1060N250-PV	600	250	0.80	100%
Edison Campus	EC-DHW-1	1	Boiler Room	N	Y	Natural Gas	Lochinvar	RWN270PM	216	200	0.80	100%
Woodbridge Campus	WC-DHW-1	2	Boiler Room	N	N	Natural Gas	AO Smith	BTH-250A-100	225	100	0.90	100%
-	-	-	-	-	-	-	-	-	-	-	-	0%
-	-	-	-	-	-	-	-	-	-	-	-	0%
-	-	-	-	-	-	-	-	-	-	-	-	0%
-	-	-	-	-	-	-	-	-	-	-	-	0%
Totals		5							1,041			

PROPOSED						
Qty	Fuel	Manufacturer	Model No.	Capacity (MBH)	Capacity (Gal)	Combustion Efficiency
2	Natural Gas	PVI	70 L 130A-GCML	692	130	96.0%
1	Natural Gas	PVI	25 L 100A-GCL	240	100	96.0%
3				932		

EXISTING DHW EFFICIENCY

Building	Perth Amboy Campus	Edison Campus	Woodbridge Campus
Label	PAC-DHW-1	EC-DHW-1	WC-DHW-1
Quantity	2	1	2
Location	Boiler Room	Boiler Room	Boiler Room
Fuel Type	Natural Gas	Natural Gas	Natural Gas
Capacity (MBTU)	600	216	225
Percentage of Building Load	100%	100%	100%
Current Efficiency	80.0%	80.0%	90.0%

PROPOSED DHW EFFICIENCY

	Perth Amboy Campus	Edison Campus
Isolate Storage Tank	N	N
Label	PAC-DHW-1	EC-DHW-1
Fuel Type	Natural Gas	Natural Gas
Quantity	2	1
Location	Boiler Room	Boiler Room
Capacity (MBTU)	692.0	240.0
Proposed Efficiency	96.0%	96.0%

Middlesex County Vocational School
Exhibit D
ECM 2B DHW Heater Replacements
Domestic Hot Water Upgrades

ECM DESCRIPTION

Replacement of Domestic Hot Water Heaters with high efficiency condensing Domestic Hot Water Heaters

MEASUREMENT AND VERIFICATION

N	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Verify all functions of the boiler control system, safety and operation. Verify air/fuel ratio is consistent through firing range. Provide training of the boiler operators

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0.0%
Safety Factor (Thermal) =	0.0%

No Safety Factor is used because of a minimal of variables

DHW REPLACEMENT CALCULATION

A. DOMESTIC HOT WATER HEATER REPLACEMENT

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Perth Amboy Campus	Edison Campus	Totals	
Label	PAC-DHW-1	EC-DHW-1		
Quantity	2	1	3	
Fuel Switch	N	N		
Existing Fuel	Natural Gas	Natural Gas		
Proposed Fuel	Natural Gas	Natural Gas		
Current DHW System Efficiency	80.0%	80.0%		%
Proposed DHW System Efficiency	96.0%	96.0%		%
Safety factor	0%	0%		
Natural Gas Savings	1,756	179	-	Therms / Yr
See				
Fuel Savings (MMBtu/Yr	176	18		
EFFb	80%	80%		
EFFq	96%	96%		
SLF	0.00053	0.00195		
CAPq	692	240		
CAPb	600	250		
EF	37%	43%		
Vq	130	100		
Vb	250	200		
TE	0.80	0.80		
SLq	2.12	1.40		
SLb	2.49	1.87		
Energy Use Density	7.00	7.00		
Area	150,000	15,200		

Middlesex County Vocational School
Exhibit D
ECM 2B DHW Heater Replacements
Domestic Hot Water Upgrades

Algorithms

Fuel Savings (MMBtu/yr) = ((1 – (EFF_b / EFF_q) + SLF^{53}) * Energy Use Density * Area / 1000 kBtu/MMBtu

where,

$SLF = (SL_b – SL_q) / Cap_q$

Definition of Variables

EFF_q = Efficiency of the qualifying water heater.
EFF_b = Efficiency of the baseline water heater, commercial grade.
EF_b = Energy Factor of the baseline water heater, commercial grade.
Energy Use Density = Annual baseline water heater energy use per square foot of commercial space served (MMBtu/sq.ft./yr)
Area = Square feet of building area served by the water heater
SLF = Standby loss factor for savings of qualifying water heater over baseline
$SL_{b \text{ or } q}$ = Standby losses in kBtu/hr of the baseline and qualifying storage water heater respectively. The baseline standby losses is calculated assuming the baseline water heater has the same input capacity rating as the qualifying unit's input capacity using

ASHRAE equipment performance standards. The qualifying unit's standby losses are available on the AHRI certificate provided with the application.
Cap_q = Rated input capacity of the qualifying water heater

Summary of Inputs

Stand Alone Storage Water Heater Assumptions

Component	Type	Value	Source
EFF_q	Variable		Application
EFF_b	Variable	See Table Below	1, 2
EF_b	Variable	See Table Below	1, 2
Energy Use Density	Variable	See Table Below	3
Area	Variable		Application
Cap_q	Variable		Application
SL_b	Variable	See Table Below	1 & Application
SL_q	Variable		Application

Efficiency of Baseline Stand Alone Storage Water Heaters

ASHRAE 90.1-2007 and 2013[a]			
Equipment Type	**Size Category (Input)**	**Existing Building Baseline Efficiency (ASHRAE 90.1-2007)**	**New Building Baseline Efficiency (ASHRAE 90.1-2013)**
Gas Storage Water Heaters	≤ 75 kBtu/hr	EF = 0.62 – 0.0019 × V	EF = 0.67 – 0.0005 × V
Gas Storage Water Heaters	> 75 kBtu/hr	TE = 0.80 SL = (Cap_q / 0.8 + 110 × √V) / 1000	TE = 0.80 SL = (Cap_q / 0.799 + 16.6 × √V) / 1000

a – EF is energy factor, TE is thermal efficiency, V is the volume of the installed storage water heater, and Cap_q is the rated input of the proposed storage water heater

Middlesex County Vocational School
Exhibit D
ECM 2B DHW Heater Replacements
Domestic Hot Water Upgrades

Energy Use Density Look-up Table

Building Type	Energy Use Density (kBtu/SF/yr)
Education	7.0
Food sales	4.4
Food service	39.2
Health care	23.7
Inpatient	34.3
Outpatient	3.9
Lodging	26.5
Retail (other than mall)	2.5
Enclosed and strip malls	14.1
Office	4.8
Public assembly	2.1
Public order and safety	21.4
Religious worship	0.9
Service	15
Warehouse and storage	2.9
Other	2.3

Middlesex County Vocational School
Exhibit D
RTU Replacement Spreadsheet

*Inputs are blue
*Automatic Mechanical List pull-in colored purple

EXISTING															
Building	Equipment Label	Qty	Location	Replace (Y/N)	DCV (Y/N)	Direct Fired	Thermal Fuel	Manufacturer	Model No.	Area Served	Tonnage	Supply CFM	Fresh Air CFM	Existing IPLV	Existing Thermal Efficiency
Edison Campus	EC-RTU-1	1	Roof	Y	N	y	Natural Gas	Trane	YCH600AELE2A7M	Building	50.0	20,000	3,000	10.5	80%
Edison Campus	EC-RTU-2	1	Roof	Y	N	y	Natural Gas	Trane	YCH600AELE2A7M	Building	50.0	20,000	3,000	10.5	80%
Perth Amboy Campus	PAC-RTU-C102	1	Roof	y	N	N	None	McQuay	RPS040CLW	C102 Gym Unit	40.0	14,400	2,160	8.0	80%
Perth Amboy Campus	PAC-RTU-C103	1	Roof	y	N	N	None	McQuay	RPS040CLW	C103 Gym Unit	40.0	14,400	2,160	8.0	80%
Perth Amboy Campus	PAC-RTU-C201	1	Roof	N	N	N	None	McQuay	RPS040CLW	C201 Cafeteria Unit	40.0	14,000	2,100	8.0	80%
Perth Amboy Campus	PAC-RTU-C101	1	Roof	N	N	N	None	McQuay	RPS040CLW	C101 C Section First Floor Classrooms/Halls	40.0	13,000	1,950	8.0	80%
Perth Amboy Campus	PAC-RTU-B201	1	Roof	N	N	N	None	McQuay	RPS060CLW	B201 Science and Second Floor Hallways	60.0	20,000	3,000	8.0	80%
Perth Amboy Campus	PAC-RTU-B101	1	Roof	N	N	N	None	McQuay	RPS060CLW	B101 First Floor Tech Shops	60.0	19,000	2,850	8.0	80%
Perth Amboy Campus	PAC-RTU-C202	1	Roof	N	N	N	None	McQuay	RPS040CLW	C202 Kitchen and ARA Supply	40.0	14,000	2,100	8.0	80%
Perth Amboy Campus	PAC-RTU-B103	1	Roof	N	N	Y	Natural Gas	Lennox	LGA102HH3G	B103 HVAC Shop	8.5	3,400	510	10.5	80%
Perth Amboy Campus	PAC-RTU-B104	1	Roof	N	N	Y	Natural Gas	Lennox	LGA102HH3G	B104 Auto Shop	8.5	3,400	510	10.5	80%
Perth Amboy Campus	PAC-RTU-9	1	Roof	N	N	Y	Natural Gas	Lennox	LGC300SH1G	B102 Wood Shop	25.0	10,000	1,500	10.5	80%
Perth Amboy Campus	PAC-RTU-10	1	Roof	N	N	Y	Natural Gas	Lennox	LGA072HH2G	B107 Garage for Loading Dock	6.0	2,400	360	10.5	80%
Perth Amboy Campus	PAC-RTU-5	1	Roof	N	N	Y	Natural Gas	Lennox	LGA102HH3G	B105 Electric Shop	8.5	3,400	510	10.5	80%
Perth Amboy Campus	PAC-RTU-11	1	Roof	N	N	y	Natural Gas	AAON	RK20-3E0750	A102 Main Office	20.0	7,000	1,050	10.5	80%
Perth Amboy Campus	PAC-MAU-1	1	Roof	N	N	N	Natural Gas	DesChamps	PVW4MWB	MUA-1	24.0	9,600	1,440	10.5	80%
Perth Amboy Campus	PAC-MAU-1	1	Roof	N	N	N	Natural Gas	DesChamps	PVW4MWB	MUA-2	24.0	9,600	1,440	10.5	80%
Perth Amboy Campus	PAC-MAU-1	1	Roof	N	N	N	Natural Gas	DesChamps	PVW4MWB	MUA-3	24.0	9,600	1,440	10.5	80%
Perth Amboy Campus	PAC-MAU-1	1	Roof	N	N	N	Natural Gas	DesChamps	PVW4MWB	MUA-4	24.0	9,600	1,440	10.5	80%
Perth Amboy Campus	PAC-RTU-7	1	Roof	N	N	N	Natural Gas	Lennox	LGA240HH3G	B106	20.0	8,000	1,200	10.5	80%
Perth Amboy Campus	PAC-RTU-2	1	Roof	N	N	N	None	MqQuay	RPS040CLW	C103	40.0	16,000	2,400	10.5	0%
Perth Amboy Campus	PAC-RTU-11	1	Roof	N	N	N	None	AAON	RK20-3E0750	A101	20.0	8,000	1,200	10.5	0%
Perth Amboy Campus	PAC-RTU-11	1	Roof	N	N	N	None	AAON	RK20-3E0750	A103	20.0	8,000	1,200	10.5	0%
Perth Amboy Campus	PAC-RTU-14	1	Roof	N	N	N	None	McQuay	RPS060CLW	A201	60.0	22,000	3,300	10.5	0%
Perth Amboy Campus	PAC-RTU-11	1	Roof	N	N	N	None	AAON	RK20-3E0750	B106	20.0	8,000	1,200	10.5	0%
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0%
Totals		25									773				

PROPOSED							
Qty	Thermal Fuel	Direct Fired	Manufacturer	Model No.	Tonnage	Proposed IPLV	Proposed Thermal Efficiency
1	Natural Gas	Y	Trane	YCH600BE	50.0	14.5	80.0%
1	Natural Gas	Y	Trane	YCH600BE	50.0	14.5	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	10.9	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	10.9	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	22.5	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	15.0	80.0%
1	None	Y	Daikin	RPS062DLW	60.0	14.5	80.0%
1	None	Y	Daikin	RPS062DLW	60.0	14.5	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	22.5	80.0%
1	Natural Gas	Y	Trane	YZC102	8.5	22.5	80.0%
1	Natural Gas	Y	Trane	YZC102	8.5	22.5	80.0%
1	Natural Gas	Y	Trane	YHD300G4	25.0	15.0	80.0%
1	Natural Gas	Y	Trane	YHD072G4	6.0	14.0	80.0%
1	Natural Gas	Y	Trane	YZC102	8.5	22.5	80.0%
1	Natural Gas	Y	Trane	YHD240G4	20.0	14.0	80.0%
15					496.5		

None
Electric
Natural Gas
Fuel Oil #2
Fuel Oil #4
Fuel Oil #6
Propane

EXISTING RTU SPECIFICATIONS

Building	Edison Campus	Edison Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus
Label	EC-RTU-1	EC-RTU-2	PAC-RTU-C102	PAC-RTU-C103	PAC-RTU-C201	PAC-RTU-C101	PAC-RTU-B201	PAC-RTU-B101	PAC-RTU-C202	PAC-RTU-B103	PAC-RTU-B104	PAC-RTU-9	PAC-RTU-10	PAC-RTU-5	PAC-RTU-11	PAC-MAU-1	PAC-MAU-1	PAC-MAU-1	PAC-MAU-1	PAC-RTU-7	PAC-RTU-2	PAC-RTU-11	PAC-RTU-11	PAC-RTU-14	PAC-RTU-11
Quantity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Area Serving	Building	Building	C102 Gym Unit	C103 Gym Unit	C201 Cafeteria Unit	C101 C Section First Floor Classrooms/Halls	B201 Science and Second Floor Hallways	B101 First Floor Tech Shops	C202 Kitchen and ARA Supply	B103 HVAC Shop	B104 Auto Shop	B102 Wood Shop	B107 Garage for Loading Dock	B105 Electric Shop	A102 Main Office	MUA-1	MUA-2	MUA-3	MUA-4	B106	C103	A101	A103	A201	B106
Tonnage	50.0	50.0	40.0	40.0	40.0	40.0	60.0	60.0	40.0	8.5	8.5	25.0	6.0	8.5	20.0	24.0	24.0	24.0	24.0	20.0	40.0	20.0	20.0	60.0	20.0
Supply CFM	20,000	20,000	14,400	14,400	14,000	13,000	20,000	19,000	14,000	3,400	3,400	10,000	2,400	3,400	7,000	9,600	9,600	9,600	9,600	8,000	16,000	8,000	8,000	22,000	8,000
Fresh Air CFM	3,000	3,000	2,160	2,160	2,100	1,950	3,000	2,850	2,100	510	510	1,500	360	510	1,050	1,440	1,440	1,440	1,440	1,200	2,400	1,200	1,200	3,300	1,200
Existing EER	10.5	10.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Direct Fired	y	y	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	y	N	N	N	N	N	N	N	N	N	N
Thermal Fuel	Natural Gas	Natural Gas	None	None	None	None	None	None	None	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	None	None	None	None	None
Existing Thermal Efficiency	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%

PROPOSED RTU SPECIFICATIONS

	Edison Campus	Edison Campus	Perth Amboy Campus	Perth Amboy Campus
RTU Replacement	Y	Y	y	y
Quantity	1	1	1	1
Area Serving	Building	Building	C102 Gym Unit	C103 Gym Unit
Tonnage (Replacement)	50.0	50.0	40.0	40.0
Thermal Fuel	Natural Gas	Natural Gas	None	None
Direct Fired	Y	Y	Y	Y
Proposed EER	14.5	14.5	10.9	10.9
Proposed Thermal Efficiency	80.0%	80.0%	80.0%	80.0%

Middlesex County Vocational School
Exhibit D
ECM 2C RTU Replacements
Rooftop Unit Replacement

ECM DESCRIPTION

Replace existing Rooftop Units with high efficiency units

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Verify all functions of the rooftop system, safety and operation.

RECOVERY/SAFETY FACTOR

Safety Factor = 0%

CALCULATIONS

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Edison Campus	Edison Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus
Label	EC-RTU-1	EC-RTU-2	PAC-RTU-C102	PAC-RTU-C103	PAC-RTU-C201
Fuel Switch	N	N	N	N	N
Existing Thermal Fuel	Natural Gas	Natural Gas	None	None	None
Proposed Thermal Fuel	Natural Gas	Natural Gas	None	None	None
Area Serving	Building	Building	C102 Gym Unit	C103 Gym Unit	C201 Cafeteria Unit
Quantity	1	1	1	1	1
RTU Tonnage	50.0	50.0	40.0	40.0	40.0
Safety Factor	0%	0%	0%	0%	0%
Electrical Savings	23,973	23,973	5,971	5,971	5,971
Demand Saving	9.92	9.92	2.47	2.47	2.47
Energy Savings (kWh/Yr)	23,973	23,973	5,971	5,971	5,971
N	1	1	1	1	1
Tons	50	50	40	40	40
kBtu/Ton	12	12	12	12	12
EERb	9.8	9.8	9.8	9.8	9.8
EERq	14.5	14.5	10.9	10.9	10.9
EFLHc	1,208	1,208	1,208	1,208	1,208

Electric HVAC Systems

This measure provides energy and demand savings algorithms for C&I Electric HVAC systems. The type of systems included in this measure are: split systems, single package systems, air to air cooled heat pumps, packaged terminal systems (PTAC and PTHP), single package vertical systems (SPVAC and SPVHP), central DX AC systems, water source heat pumps, ground water source heat pumps, and/or ground source heat pumps.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the state of New Jersey.

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * CF$

Heat Pump Algorithms:

Cooling Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Heating Energy Savings (Btu/yr) = N * Tons * 12 kBtuh/Ton * $((1/(COP_b * 3.412)) - (1/(COP_q * 3.412)) * EFLH_h$

Where c is for cooling and h is for heating.

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	13 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 11.0 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Middlesex County Vocational School
Exhibit D
ECM 2C RTU Replacements
Rooftop Unit Replacement

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Water Source Heat Pumps (water to air, water loop) <=1.4 tons >1.4 to 5.4 tons >5.4 to 11.25 tons	 12.2 EER, 4.3 heating COP 13.0 EER, 4.3 heating COP 13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[37]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners <=5.4 tons >5.4 to 11.25 tons >11.25 to 20 tons	 10.0 EER 10.0 EER 10.0 EER
Single Package Vertical Heat Pumps <=5.4 tons >5.4 to 11.25 tons >11.25 to 20 tons	 10.0 EER, 3.0 heating COP 10.0 EER, 3.0 heating COP 10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918

Middlesex County Vocational School
Exhibit D
ECM 2C RTU Replacements
Rooftop Unit Replacement

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
Condensing Unit Replacement Spreadsheet

EXISTING								
Building	Equipment Label	Qty	Replace (Y/N)	Manufacturer	Model No.	Area Served	Tonnage	Existing SEER
Perth Amboy Campus	PAC-CU-1	1	y	EMI	SCC12D	Server Room	1.0	10.5
Perth Amboy Campus	PAC-CU-2	1	y	EMI	SCC12D	Server Room	1.0	10.5
Edison Campus	EC-CU-2	1	y	Mitsubishi	PU18EK	Telephone Room	1.5	10.5
Woodbridge Campus	WC-AC-3	1	Y	Mitsubishi	PURY-100TMU-A	Original Area Porch Offices	8.5	9.0
Woodbridge Campus	WC-AC-1	1	N	Trane	2TTB3060A	Clasroom	5.0	14.0
Woodbridge Campus	WC-AC-2	1	N	Trane	2TTB3060A	Classroom	5.0	14.0
Woodbridge Campus	WC-AC-4	1	N	-	-	-	2.0	14.0
Woodbridge Campus	WC-AC-5	1	N	-	-	-	5.0	14.0
Woodbridge Campus	WC-AHUCU-1	1	N	-	-	-	6.0	11.5
Woodbridge Campus	WC-CU-1	1	N	-	-	-	1.0	14.0
Woodbridge Campus	WC-CU-2	1	N	-	-	-	2.5	14.0
Totals		11					38	

PROPOSED				
Manufacturer	Model No.	Qty	Tonnage	Proposed SEER
Trane	4TXK8509A10N0C/ 4MXW8509A10N0C	1	1.0	20.0
Trane	4TXK8509A10N0C/ 4MXW8509A10N0C	1	1.0	20.0
Trane	4TXK8518A10N0C/ 4MXW8518A10N0C	1	1.5	18.0
Trane	4TVH0144B300NB/ 4MXC8524A10N0AA	1	12.0	24.5
		4	15.5	

EXISTING CONDENSING UNIT SPECIFICATIONS

Building	Perth Amboy Campus	Perth Amboy Campus	Edison Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus
Label	PAC-CU-1	PAC-CU-2	EC-CU-2	WC-AC-3	WC-AC-1	WC-AC-2	WC-AC-4	WC-AC-5	WC-AHUCU-1	WC-CU-1	WC-CU-2
Area Serving	Server Room	Server Room	Telephone Room	Original Area Porch Offices	Clasroom	Classroom	0	0	0	0	0
Quantity	1	1	1	1	1	1	1	1	1	1	1
Tonnage	1.0	1.0	1.5	8.5	5.0	5.0	2.0	5.0	6.0	1.0	2.5
Existing EER	10.5	10.5	10.5	9.0	14.0	14.0	14.0	14.0	11.5	14.0	14.0

PROPOSED CONDENSING UNIT SPECIFICATIONS

	Perth Amboy Campus	Perth Amboy Campus	Edison Campus	Woodbridge Campus
CU Replacement	y	y	y	Y
Label	PAC-CU-1	PAC-CU-2	EC-CU-2	WC-AC-3
Area Serving	Server Room	Server Room	Telephone Room	Original Area Porch Offices
Quantity	1	1	1	1
Tonnage	1.0	1.0	1.5	12.0
Proposed EER	20.0	20.0	18.0	24.5

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

ECM DESCRIPTION

Replace existing low efficiency condensing units in respective buildings with new high efficiency condensing units with an EER of 12+

CLARIFICATIONS, DELETIONS

*Run Hours based on occupancy schedule
*Full Load is estimated at (unless stated otherwise) : 97.5 °F
*Run hours are based on chiller cutoff temperature and bin weather data

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Start up equipment ensure proper operation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

The safety factor for this ECM is taken at 0 due to some variances on the run hours and the estimated part load efficiencies of the existing chiller.

CALCULATIONS

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Perth Amboy Campus	Perth Amboy Campus	Edison Campus	
Label	PAC-CU-1	PAC-CU-2	EC-CU-2	
Area Serving	Server Room	Server Room	Telephone Room	
Condensing Unit Tonnage	1.0	1.0	1.5	
Current EER	10.8	10.8	10.8	
Proposed EER	20.0	20.0	18.0	
Safety Factor	0%	0%	0%	
Electrical Savings	120	120	133	
Peak Demand Savings	0.13	0.13	0.14	
Energy Savings (kWh/Yr)	120	120	133	
N	1	1	1	
Tons	1.0	1.0	1.5	
kBtu/Ton	12	12	12	
EERb	14.0	14.0	14.0	
EERq	20.0	20.0	18.0	
EFLHc	466	466	466	
CF	0.5	0.5	0.5	

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

Electric HVAC Systems

This measure provides energy and demand savings algorithms for C&I Electric HVAC systems. The type of systems included in this measure are: split systems, single package systems, air to air cooled heat pumps, packaged terminal systems (PTAC and PTHP), single package vertical systems (SPVAC and SPVHP), central DX AC systems, water source heat pumps, ground water source heat pumps, and/or ground source heat pumps.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the state of New Jersey.

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * CF$

Heat Pump Algorithms:

Cooling Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Heating Energy Savings (Btu/yr) = N * Tons * 12 kBtuh/Ton * $((1/(COP_b * 3.412)) - (1/(COP_q * 3.412)) * EFLH_h$

Where $_c$ is for cooling and $_h$ is for heating.

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	13 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 11.0 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[37]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
ECM 2E Chiller Replacements
Chiller Replacement and Optimization

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

Building	Chiller Cutoff (°F)	Chiller Tonnage	Current Chiller Efficiency (kW/Ton)	Proposed Chiller Efficiency (kW/Ton)	Chiller Replacement (Y/N)	Chiller Optimization (Y/N)
Woodbridge Campus	65	60	1.140	0.680	Y	N
Woodbridge Campus	65	70	1.140	0.680	Y	N
Totals		130				

CALCULATIONS

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Woodbridge Campus	Woodbridge Campus
Chiller Replacement	Y	Y
Chiller Optimization	N	N
Safety Factor	0%	0%
Electrical Savings	13,756	16,049
FLV Method		
Energy Savings (kWhr/yr)	13,756	16,049
Demand Savings	19.78	19.78
N	1	1
Tons	60	70
EFLH	466	466
FLVb	1.237	1.237
FLVq	0.745	0.745
PDC	0.67	0.67

Electric Chillers

The measurement of energy and demand savings for C&I chillers is based on algorithms with key variables.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the state of New Jersey.

Algorithms

For IPLV:

Energy Savings (kWh/yr) = N * Tons * EFLH * ($IPLV_b$ – $IPLV_q$)

Peak Demand Savings (kW) = N * Tons * PDC * ($IPLV_b$ – $IPLV_q$)

For FLV:

Energy Savings (kWh/yr) = N * Tons * EFLH * (FLV_b – FLV_q)

Peak Demand Savings (kW) = N * Tons * PDC * (FLV_b – FLV_q)

Definition of Variables

N = Number of units

Tons = Rated capacity of coolling equipment.

EFLH = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off peak periods.

PDC = Peak Duty Cycle: fraction of time the compressor runs during peak hours

$IPLV_b$ = Integrated Part Load Value of baseline equipment, kW/Ton. The efficiency of the chiller under partial-load conditions.

$IPLV_q$ = Integrated Part Load Value of qualifying equipment, kW/Ton. The efficiency of the chiller under partial-load conditions.

FLV_b = Full Load Value of baseline equipment, kW/Ton. The efficiency of the chiller under full-load conditions.

FLV_q = Full Load Value of qualifying equipment, kW/Ton. The efficiency of the chiller under full-load conditions.

Summary of Inputs

Electric Chiller Assumptions

Electric Chillers Component	Type	Situation	Value	Source
Tons	Rated Capacity, Tons	All	Varies	From Application
$IPLV_b$ (kW/ton)	Variable	See table below	Varies	1
$IPLV_q$ (kW/ton)	Variable	All	Varies	From Application (per AHRI Std.

Electric Chillers Component	Type	Situation	Value	Source
				550/590)
FLV_b (kW/ton)	Variable	See table below	Varies	1
FLV_q (kW/ton)	Variable	All	Varies	From Application (per AHRI Std. 550/590)
PDC	Fixed	All	67%	Engineering Estimate
EFLH	Variable	All	See Table Below	2

Electric Chillers – New Construction

Type	Capacity	ASHRAE 90.1 2013 effective 1/1/2015 [a]			
		Path A		Path B	
		Full Load kW/ton	IPLV kW/ton	Full Load kW/ton	IPLV kW/ton
Air Cooled	tons < 150	*10.1* 1.188	*13.7* 0.876	*9.7* 1.237	*15.8* 0.759
	tons ≥ 150	*10.1* 1.188	*14.0* 0.857	*9.7* 1.237	*16.1* 0.745
Water Cooled Positive Displacement (rotary screw and scroll)	tons < 75	0.750	0.600	0.780	0.500
	75 ≤ tons < 150	0.720	0.560	0.750	0.490
	150 ≤ tons < 300	0.660	0.540	0.680	0.440
	300 ≤ tons < 600	0.610	0.520	0.625	0.410
	tons ≥ 600	0.560	0.500	0.585	0.380
Water Cooled Centrifugal	tons < 150	0.610	0.550	0.695	0.440
	150 ≤ tons < 300	0.610	0.550	0.635	0.400
	300 ≤ tons < 400	0.560	0.520	0.595	0.390
	400 ≤ tons < 600	0.560	0.500	0.585	0.380
	tons ≥ 600	0.560	0.500	0.585	0.380

a – Values in italics are EERs.

EFLH Table

Facility Type	Cooling EFLH
Assembly	669
Auto repair	426
Dormitory	800

Middlesex County Vocational School
Exhibit D
ECM 2E Chiller Replacements
Chiller Replacement and Optimization

Facility Type	Cooling EFLH
Hospital	1424
Light industrial	549
Lodging – Hotel	2918
Lodging – Motel	1233
Office – large	720
Office – small	955
Other	736
Religious worship	279
Restaurant – fast food	645
Restaurant – full service	574
Retail – big box	1279
Retail – Grocery	1279
Retail – small	882
Retail – large	1068
School – Community college	846
School – postsecondary	1208
School – primary	394
School – secondary	466
Warehouse	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
High-rise, Cooling	793	843	954

Middlesex County Vocational School
Exhibit D
ECM 2F Motor and VFD Replacements
Variable Frequency Drives and Motor Replacements

ECM DESCRIPTION

There are standard efficiency motors and motors that need to be replaced due to poor condition throughout the district. These motors will be replaced with premium high efficiency motors to save electrical energy. In addition some new motors will be equipped with variable frequency drives (VFDs) for additional savings.

DATA / ASSUMPTIONS

Load Factor	70%

*VFD run speed percentages are based on typical VFD curves for hot water / chilled water loops
*Run hours are based on the audit, data logging, and through interviews with facility staff

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Review installation documents for alignments and vibrations. Start up equipment and measure vibration through the load range along with motor kW. Verify that VFDs are capable of operating in full design range upon the control signal demand.

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%

CALCULATIONS (MOTOR)

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Woodbridge Campus	Perth Amboy Campus	Woodbridge Campus
kW Savings	0.962	0.113	0.039
kWh Savings	8,267	5,199	8,844
Motor			
Delta kW	0.050	0.146	0.050
HP	5.0	3.0	5.0
IFvfd	0.90	0.90	0.90
LF	0.75	0.75	0.75
Nbase	0.895	0.845	0.895
Nprem	0.907	0.900	0.907
Hrs	2,745	2,745	2,745
CF	0.74	0.74	0.74
Demand Savings	0.037	0.108	0.037
Energy Savings	102	300	102
VFD			
N	1	1	1
HP	5	3	5
ESF	1,633	1,633	1,548
DSF	0.185	0.185	0.096
Energy Savings	8,165	4,899	7,740
Peak Demand Savings	0.9250	0.5550	0.4800

Middlesex County Vocational School
Exhibit D
ECM 2F Motor and VFD Replacements
Variable Frequency Drives and Motor Replacements

Variable Frequency Drives

This section provides algorithms and assumptions for reporting of energy and demand savings for C/I Variable Frequency Drive (VFD) installations for HVAC systems including: supply air fans, return air fans, chilled water and condenser water pumps, hot water circulation pumps, water source heat pump circulation pumps, cooling tower fans, and boiler feed water pumps. VFD applications for other end uses should follow the custom path.

Algorithms

Energy Savings (kWh/yr) = N * HP * ESF

Peak Demand Savings (kW) = N * HP * DSF

Definitions of Variables

N = Number of motors controlled by VFD(s) per application
HP = Nameplate motor horsepower or manufacturer specification sheet per application
ESF = Energy Savings Factor (kWh/year per HP)
DSF = Demand Savings Factor (kW per HP)

Summary of Inputs

Variable Frequency Drives

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
ESF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3
DSF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3

The ESF for the supply and return fans and circulating pumps are derived from a 2014 NEEP-funded study of 400 VFD installations in eight northeast states. The derived values are based on actual logged input power data and reflect average operating hours, load factors, and motor efficiencies for the sample. Savings factors representing cooling tower fans and boiler feed water pumps are not reflected in the NEEP report. Values representing these applications are taken from April 2018 New York TRM, Appendix K, and represent average values derived from DOE2.2 simulation of various building types

and climate zones, supplemented with results from an earlier analysis of actual program data completed by NSTAR in 2010.

The DSF are derived from the same sources. The NEEP values reflect the actual average impact for the category occurring in the PJM defined peak demand period. The NY values are based on a similar but not identically defined peak period. In all cases the values are expressed in kW/HP rating of the controlled motor and reflect average load factors during the peak period and motor efficiencies for the sample.

VFD Savings Factors

Application	ESF (kWh/Year-HP)	DSF (kW/HP)	Source
Supply Air Fan	2,033	0.286	1
Return Air Fan	1,788	0.297	1
CHW or CW Pump	1,633	0.185	1
HHW Pump	1,548	0.096	1
WSHP Pump	2,562	0.234	1
CT Fan	290	-0.025	2, 3
Boiler Feedwater Pump	1,588	0.498	2, 3

Motors

For premium efficiency motors 1-200 HP.

Algorithms

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * HP * IF_{VFD} * (1/\eta_{base} - 1/\eta_{prem})$$

Demand Savings = (ΔkW) * CF

Energy Savings = (ΔkW)*HRS * LF

Definition of Variables

ΔkW = kW Savings at full load

HP = Rated horsepower of qualifying motor, from nameplate/manufacturer specs.

LF = Load Factor, percent of full load at typical operating condition

IF_{VFD} = VFD Interaction Factor, 1.0 without VFD, 0.9 with VFD

η_{base} = Efficiency of the baseline motor

η_{prem} = Efficiency of the energy-efficient motor

HRS = Annual operating hours

CF = Coincidence Factor

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
η_{base}	Fixed	ASHRAE 90.1-2013 Baseline Efficiency Table	ASHRAE
η_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

Middlesex County Vocational School
Exhibit D
ECM 2F Motor and VFD Replacements
Variable Frequency Drives and Motor Replacements

NEMA ASHRAE 90.1-2013 Motor Efficiency Table – General Purpose Subtype I

Motor	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
Horsepower	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	0.825	0.825	0.855	0.855	0.77	0.77
1.5	0.865	0.875	0.865	0.865	0.84	0.84
2	0.875	0.885	0.865	0.865	0.855	0.855
3	0.885	0.895	0.895	0.895	0.855	0.865
5	0.895	0.895	0.895	0.895	0.865	0.885
7.5	0.902	0.91	0.91	0.917	0.885	0.895
10	0.917	0.91	0.917	0.917	0.895	0.902
15	0.917	0.917	0.93	0.924	0.902	0.91
20	0.924	0.917	0.93	0.93	0.91	0.91
25	0.93	0.93	0.936	0.936	0.917	0.917
30	0.936	0.93	0.941	0.936	0.917	0.917
40	0.941	0.941	0.941	0.941	0.924	0.924
50	0.941	0.941	0.945	0.945	0.93	0.93
60	0.945	0.945	0.95	0.95	0.936	0.936
75	0.945	0.945	0.95	0.954	0.936	0.936
100	0.95	0.95	0.954	0.954	0.936	0.941
100	0.95	0.95	0.954	0.954	0.941	0.95
150	0.954	0.958	0.958	0.958	0.941	0.95
200	0.954	0.958	0.958	0.962	0.95	0.954

Annual Operating Hours Table

Motor Horsepower	Operating Hours, HRS
1 to 5 HP	2,745
6 to 20 HP	3,391
21 to 50 HP	4,067
51 to 100 HP	5,329
101 to 200 HP	5,200

Middlesex County Vocational School
Exhibit D
ECM 2G Kitchen Hood Control
Kitchen Hood Replacement

ECM DESCRIPTION

Kitchen hoods in the district's kitchens are ventilated by exhaust fans. Fans are running most of the time at full speed when kitchen is in operation even if there are no activities under the hoods. e new ventilaton control systems will control exhaust fans based on hood exhaust temperatures. The exhaust fan will be equipped with VFDs will control air flows. If the exhaust fan is combined with a make up air unit, then variable air flow will be controlled on both exhaust and make up air fans.

DATA / ASSUMPTIONS

Existing equipment schedule was given by personnel operating the kitchen equipment and with interviews with facility staff

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Test exhaust fans and make up air units that they operate per design intent, which include simulation of the exhaust temperature driving fan motor speeds. Verify all safety interlocks.

RECOVERY/SAFETY FACTOR

Recovery/Safety Factor (Electric) =	0%
Recovery/Safety Factor (Thermal) =	0%

Middlesex County Vocational School
Exhibit D
ECM 2G Kitchen Hood Control
Kitchen Hood Replacement

* Inputs are in blue

Building	Kitchen Hood Area (ft^2)	HP of Exhaust Fan Motor	HP of MAU Motor	Annual Run Hours	System Efficiency	Current Exhaust Volume (CFM)	
Perth Amboy Campus	40	1.5	3.7	1,440	65%	3,000	KEF-4A
Perth Amboy Campus	64	3.0	6.1	1,440	65%	4,900	KEF-1
Perth Amboy Campus	64	3.0	6.1	1,800	65%	4,900	KEF-2
Perth Amboy Campus	40	1.5	3.7	1,800	65%	3,000	KEF-4B
Perth Amboy Campus	40	2.0	4.3	1,800	65%	3,500	KEF-3A
Perth Amboy Campus	40	2.0	4.6	1,800	65%	3,675	KEF-3B
Totals	**288**	**13.0**	**28.5**			**22,975**	
						1200	KEF-5
						24,175	

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

Exhaust Fan Schedule

	EF Name	CFM	Fan HP	Interlock
1	KEF-1	4900	3	MUA-1 + Local Switch
2	KEF-2	4900	3	MUA-2 + Local Switch
3	KEF-3A	3500	2	MUA-3 + Local Switch
4	KEF-3B	3675	2	MUA-3 + Local Switch
5	KEF-4A	3000	1.5	MUA-4 + Local Switch
6	KEF-4B	3000	1.5	MUA-4 + Local Switch
7	KEF-5	1200	0.33	Local Switch
		24175	13.33	

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus		Total	
Safety Factor	0%	0%	0%	0%	0%	0%			%
Electrical Savings	3,401	6,753	6,753	3,401	4,525	4,525		**29,357**	kWh/Yr
Thermal Savings	9.17	14.67	14.67	9.17	9.17	9.17		**66**	Therms/Yr

Fan Savings (kWh/yr)	3,374.35	6,711.00	6,711.00	3,374.35	4,499.13	4,499.13
N	1	1	1	1	1	1
HP	1.5	3.0	3.0	1.5	2.0	2.0
LF	0.90	0.90	0.90	0.90	0.90	0.90
RH	5,250	5,250	5,250	5,250	5,250	5,250
PR	0.568	0.568	0.568	0.568	0.568	0.568
FEFF	0.89	0.895	0.895	0.89	0.89	0.89
Heating Savings (MMBtu/yr)	0.917	1.467	1.467	0.917	0.917	0.917
SF	40	64	64	40	40	40
CFM/SF	0.70	0.70	0.70	0.70	0.70	0.70
OF	1.40	1.40	1.40	1.40	1.40	1.40
FR	0.295	0.295	0.295	0.295	0.295	0.295
HDD	2,783	2,783	2,783	2,783	2,783	2,783
Heff	0.91	0.91	0.91	0.91	0.91	0.91
Cooling Savings (kWh/yr)	26.15	41.84	41.84	26.15	26.15	26.15
SF	40	64	64	40	40	40
CFM/SF	0.70	0.70	0.70	0.70	0.70	0.70
OF	1.40	1.40	1.40	1.40	1.40	1.40
FR	0.295	0.295	0.295	0.295	0.295	0.295
CDD	893	893	893	893	893	893
Ceff	3.00	3.00	3.00	3.00	3.00	3.00

Middlesex County Vocational School
Exhibit D
ECM 2G Kitchen Hood Control
Kitchen Hood Replacement

New and Retrofit Kitchen Hoods with Variable Frequency Drives

Kitchen Hoods with Variable Frequency Control utilize optical and temperature sensors at the hood inlet to monitor cooking activity. Kitchen hood exhaust fans are throttled in response to real time ventilation requirements. Energy savings result from fan power reduction during part load operation as well as a decrease in heating and cooling requirement of make-up air.

Algorithms

Electric Fan Savings (kWh/yr) = N * (HP * *LF * 0.746/FEFF) * RH * PR

Heating Savings (MMBtu/yr) = SF * CFM/SF * OF * FR * HDD * 24 * 1.08 / (HEFF * 1,000,000)

Cooling Savings (kWh/yr) = SF * CFM/SF * OF * FR * CDD * 24 * 1.08 / (CEFF * 3,412)

Definition of Variables

N = Number of Kitchen Hood Fan Motors
HP = Kitchen Hood Fan Motor HP
LF = Existing Motor Loading Factor
0.746 = Conversion factor = HP to kW
F_{EFF} = Efficiency of Kitchen Hood Fan Motors (%)
RH = Kitchen Hood Fan Run Hours
PR = Fan Motor Power Reduction resultant from VFD/Control Installation
SF = Kitchen Square Footage
CFM/SF = Code required ventilation rate per square foot for Commercial Kitchen spaces
OF = Ventilation rate oversize factor (compared to code requirement)
FR = Flow Reduction resultant from VFD/Control Installation
HDD_{mod} = Modified Heating Degree Days based on location and facility type
CDD_{mod} = Modified Cooling Degree Days based on location and facility type
24 = Hours per Day
1.08 = Sensible heat factor for air ((Btu/hr) / (CFM * Deg F))
H_{EFF} = Efficiency of Heating System (AFUE %)
C_{EFF} = Efficiency of Cooling System (COP)
3,412 = Conversion factor from Btu to kWh (3,412 Btu = 1 kWh)
1,000,000 = Btu/MMBtu

Summary of Inputs

Kitchen Hoods with VFDs

Component	Type	Value	Source
N	Variable	Quantity	Application
HP	Variable	Nameplate	Application
LF	Fixed	0.9	Melink Analysis Sample[39]
F_{EFF}	Variable	Based on Motor HP	NEMA Premium Efficiency, TEFC 1800 RPM
RH	Variable	See Table Below	2
PR	Variable	See Table Below	2
SF	Variable	Kitchen Square Footage	Application
CFM / SF	Fixed	0.7	1
OF	Fixed	1.4	Estimated Typical Kitchen Design[40]
FR	Variable	Based on Facility Type	2
HDD_{mod}	Variable	See Table Below	3
CDD_{mod}	Variable	See Table Below	4
H_{EFF}	Fixed	0.8	Estimated Heating System Efficiency[41]
C_{EFF}	Fixed	3.00	Estimated Cooling System Efficiency[42]

Middlesex County Vocational School
Exhibit D
ECM 2G Kitchen Hood Control
Kitchen Hood Replacement

Facility-Specific Values Table

Facility Type	Run Hours	Power Reduction (PR)	Flow Reduction (FR)
Campus	5250	0.568	0.295
Lodging	8736	0.618	0.330
Restaurant	5824	0.552	0.295
Supermarket	5824	0.597	0.320
Other	5250	0.584	0.310

Modified Heating Degree Days Table

Building Type	Heating Energy Density (kBtu/sf)	Degree Day Adjustment Factor	Atlantic City (HDD)	Newark (HDD)	Philadelphia (HDD)	Monticello (HDD)
Education	29.5	0.55	2752	2783	2655	3886
Food Sales	35.6	0.66	3369	3359	3204	4689
Food Service	39.0	0.73	3691	3680	3510	5137
Health Care	53.6	1.00	5073	5057	4824	7060
Lodging	15.0	0.28	1420	1415	1350	1976
Retail	29.3	0.55	2773	2764	2637	3859
Office	28.1	0.52	2660	2651	2529	3701
Public Assembly	33.8	0.63	3199	3189	3042	4452
Public Order/Safety	24.1	0.45	2281	2274	2169	3174
Religious Worship	29.1	0.54	2754	2745	2619	3833
Service	47.8	0.89	4524	4510	4302	6296
Warehouse/Storage	20.2	0.38	1912	1906	1818	2661

Modified Cooling Degree Days Table

Building Type	Degree Day Adjustment Factor	Atlantic City (CDD)	Newark (CDD)	Philadelphia (CDD)	Monticello (CDD)
Education	0.55	824	893	806	625
Food Sales	0.66	989	1071	967	750
Food Service	0.73	1094	1185	1069	830
Health Care	1.00	1499	1623	1465	1137
Lodging	0.28	420	454	410	318
Retail	0.55	824	893	806	625
Office	0.52	779	844	762	591
Public Assembly	0.63	944	1022	923	716
Public Order/Safety	0.45	675	730	659	512
Religious Worship	0.54	809	876	791	614
Service	0.89	1334	1444	1304	1012
Warehouse/Storage	0.38	570	617	557	432

Middlesex County Vocational School
Exhibit D
ECM 2H Refrigeration Controls
Walk-In Freezer/Cooler Controllers

ECM DESCRIPTION

Installation of a refrigeration controller made by intellidyne on walk-in freezers and refrigerators. This will reduce cycling and improve operating efficiency of the compressor.

DATA / ASSUMPTIONS

Assumed compressor and controller savings	15%	
Assumed Run Hours	4,200	Hours
KW of Refrigerator Unit	1.152	
KW of Freezer Unit	2.863	

MEASUREMENT AND VERIFICATION

Optption A—Retrofit Isolation with Key Parameter Measurement

COMMISSIONING

Test compressors after installation.

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

Recovery factor taken at 0 due to few installations and not proven savings record.

*Inputs are blue

Building	Location	No. of Walk-In Refrigators	No. of Walk-In Freezers	kW of Refrigator	kW of Freezer
Perth Amboy Campus	Classroom Kitchen	1	-	1.152	
Perth Amboy Campus	Classroom Kitchen	-	1		2.863
Perth Amboy Campus	Kitchen	1	-	1.152	
Perth Amboy Campus	Kitchen	-	1		2.863
-	-	-	-		
-	-	-	-		
-	-	-	-		
Totals	**-**	**2**	**2**	**2.3**	**5.7**

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

CALCULATIONS

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus
No. of Walk-In Refrigerators	1	0	1	0
No. of Walk-In Freezers	0	1	0	1
Safety Factor	0%	0%	0%	0%
Electrical Savings	214	533	214	533
kWh Savings EC	214.40	532.83	214.40	532.83
Amps Cp	3.20	7.95	3.20	7.95
Volts Cp	208	208	208	208
Phase Cp^1/2	1.73	1.73	1.73	1.73
WH	2195	2195	2195	2195
NWH	6565	6565	6565	6565

Totals	
2	
2	
1,494	kWh/Yr

Middlesex County Vocational School
Exhibit D
ECM 2H Refrigeration Controls
Walk-In Freezer/Cooler Controllers

Algorithms

Gross Energy Savings (kWh/yr) = $kWh\ Savings_{EF} + kWh\ Savings_{RH} + kWh\ Savings_{EC}$

$kWh\ SavingsEF$ = $((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * 8{,}760 * 35.52\%$

$kWh\ SavingsRH = kWh\ Savings_{EF} * 0.28 * 1.6$

$kWh\ SavingsEC$ = $(((Amps_{CP} * Volts_{CP} * (Phase_{CP})^{1/2})/1000) * 0.85 * ((35\% * WH) + (55\% * NWH)) * 5\%) + (((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * 8{,}760 * 35.52\% * 5\%)$

Gross kW Savings = $((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * D$

Definition of Variables

$kWh\ Savings_{EF}$	= Savings due to Evaporator Fan being off
$kWh\ Savings_{RH}$	= Savings due to reduced heat from Evaporator Fans
$kWh\ Savings_{EC}$	= Savings due to the electronic controls on compressor and evaporator
$Amps_{EF}$	= Nameplate Amps of Evaporator Fan
$Volts_{EF}$	= Nameplate Volts of Evaporator Fan
$Phase_{EF}$	= Phase of Evaporator Fan
0.55	= Evaporator Fan Motor power factor
8,760	= Annual Operating Hours

35.52%	= Percent of time Evaporator Fan is turned off
0.28	= Conversion from kW to tons (Refrigeration)
1.6	= Efficiency of typical refrigeration system in kW/ton [3]
$Amps_{CP}$	= Nameplate Amps of Compressor
$Volts_{CP}$	= Nameplate Volts of Compressor
$Phase_{CP}$	= Phase of Compressor
0.85	= Compressor power factor.
35%	= Compressor duty cycle during winter months
WH	= Compressor hours during winter months
55%	= Compressor duty cycle during non-winter months
NWH	= Compressor hours during non-winter months (6,565)
5%	= Reduced run time of Compressor and Evaporator due to electronic controls
D	= Diversity Factor

Middlesex County Vocational School
Exhibit D
ECM 2H Refrigeration Controls
Walk-In Freezer/Cooler Controllers

Summary of Inputs

Evaporator Fan Control - Commercial Refrigeration

Component	Type	Value	Source
$Amps_{EF}$	Variable	Manufacturer data	Application
$Volts_{EF}$	Variable	Manufacturer data	Application
$Phase_{EF}$	Variable	Manufacturer data	Application
0.55	Variable	Default	Estimate
8,760	Variable	Default	Estimate
35.52%	Variable	Default	Estimate[44]
0.28	Variable	Conversion	
1.6	Variable	Default	Estimate, 1
$Amps_{CP}$	Variable	Manufacturer data	Application
$Volts_{CP}$	Variable	Manufacturer data	Application
$Phase_{CP}$	Variable	Manufacturer data	Application
0.85	Variable	Default	Estimate
35%	Variable	Default	Estimate

Component	Type	Value	Source
WH	Variable	2,195 - Default	Estimate
55%	Variable	Default	Estimate
NWH	Variable	6,565 - Default	Estimate
5%	Variable	Default	2
D	Variable	0.228	3

Middlesex County Vocational School
Exhibit D
ECM 2I Window AC Unit Replacements
Window AC Replacement

ECM DESCRIPTION

Replace existing low efficiency window units in respective buildings with new high efficiency window units with an EER of 12+

DATA / ASSUMPTIONS

*Run Hours based on occupancy schedule
*Full Load is estimated at (unless stated otherwise) : 97.5 *F
*Run hours are based on chiller cutoff temperature and bin weather data

MEASUREMENT AND VERIFICATION

Y Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y Option C – Utility Data Analysis

COMMISSIONING

Start up equipment ensure proper operation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

d

CALCULATIONS

	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus
Label	WC-WU-1	WC-WU-2	WC-WU-3	WC-WU-4	WC-WU-5	WC-WU-6	WC-WU-7	WC-WU-8
Qty	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Area Serving	Offices	Offices	Offices	Offices	Offices	Offices	Offices	Offices
Condensing Unit Tonnage	1.5	1.5	1.5	2.0	2.0	2.0	1.5	1.5
Current EER	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Proposed EER	16.4	16.4	16.4	16.2	16.2	16.2	16.4	16.4
Safety Factor	0%	0%	0%	0%	0%	0%	0%	0%
Electrical Savings	227	227	227	281	281	281	227	227

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

Energy Savings (kWh/Yr)	227	227	227	281	281	281	227	227
Demand Savings	0.09	0.09	0.09	0.12	0.12	0.12	0.09	0.09
N	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Tons	1.5	1.5	1.5	2.0	2.0	2.0	1.5	1.5
kBtu/Ton	12	12	12	12	12	12	12	12
EERb	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
EERq	16.4	16.4	16.4	16.2	16.2	16.2	16.4	16.4
EFLHc	1,208	1,208	1,208	1,208	1,208	1,208	1,208	1,208
CF	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Middlesex County Vocational School
Exhibit D
ECM 2I Window AC Unit Replacements
Window AC Replacement

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * (1/EER_b-1/EER_q) * $EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * (1/EER_b-1/EER_q) * CF

Heat Pump Algorithms:

Cooling Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * (1/EER_b-1/EER_q) * $EFLH_c$

Heating Energy Savings (Btu/yr) = N * Tons * 12 kBtuh/Ton * ((1/ (COP_b * 3.412))-(1/ (COP_q * 3.412)) * $EFLH_h$

Where *c* is for cooling and *h* is for heating.

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	13 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 11.0 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Middlesex County Vocational School
Exhibit D
ECM 2I Window AC Unit Replacements
Window AC Replacement

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[27]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918

Middlesex County Vocational School
Exhibit D
ECM 2I Window AC Unit Replacements
Window AC Replacement

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
ECM 2J Multi-Zone VRFSystem Replacement
Multi-Zone VRF

ECM DESCRIPTION

Replace existing low efficiency condensing units in respective buildings with new high efficiency condensing units with an EER of 12+

CLARIFICATIONS, DELETIONS

*Run Hours based on occupancy schedule
*Full Load is estimated at (unless stated otherwise) : 97.5 °F
*Run hours are based on chiller cutoff temperature and bin weather data

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Start up equipment ensure proper operation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

The safety factor for this ECM is taken at 0 due to some variances on the run hours and the estimated part load efficiencies of the existing chiller.

Heat pump calcs

CALCULATIONS

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Woodbridge Campus			
Label	WC-AC-3			
Area Serving	Original Area Porch Offices			
Condensing Unit Tonnage	12.0			
Safety Factor	0%			
Electrical Savings	1,084			
Therm Savings	14.364138			

Heat Pump

Cooling Savings (kWh)	1,084
Heating Savings (Btu/year)	1,436,414
N	1
Tons	12.0
kBtu/Ton	12
EERb	10.4
EERq	12.5
EFLHc	466
EFLHh	901
COPb	3.20
COPq	3.64

Electric HVAC Systems

This measure provides energy and demand savings algorithms for C&I Electric HVAC systems. The type of systems included in this measure are: split systems, single package systems, air to air cooled heat pumps, packaged terminal systems (PTAC and PTHP), single package vertical systems (SPVAC and SPVHP), central DX AC systems, water source heat pumps, ground water source heat pumps, and/or ground source heat pumps.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the state of New Jersey.

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * CF$

Heat Pump Algorithms:

Cooling Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Heating Energy Savings (Btu/yr) = N * Tons * 12 kBtuh/Ton * $((1/(COP_b * 3.412)) - (1/(COP_q * 3.412))) * EFLH_h$

Where $_c$ is for cooling and $_h$ is for heating.

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	13 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 11.0 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[37]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
ECM 3A Building Management Control Systems
BMS Upgrades

ECM DESCRIPTION

The building managament system for the school district will be upgraded. Where the DDC system exists it will be incorporated into a web-based system. The pnaumatic control system in some buildings will be replaced with new DDC controls. The new DDC system will be a web based type that allows remote access to a personnel from any computer using a security password.

DATA / ASSUMPTIONS

Heating Hours 3,948 Hours
Elctrical use % as per 20%

*Schedules and temperatures are based on data logging trends performed throughout the building

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Verify functions of all installed controllers. Verify that control loops work properly. Verify function of all alarms installed in the system. Verify that all installed control variables and set points can be set and managed remotely

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%
Safety Factor (Thermal) =	0%

FORMULAE

	EXISTING					PROPOSED			
Building	Percentage of Building	Occupied Heating Temperature (°F)	Unoccupied Heating Temperature (°F)	Occupied Cooling Temperature (°F)	Unoccupied Cooling Temperature (°F)	Occupied Heating Temperature (°F)	Unoccupied Heating Temperature (°F)	Occupied Cooling Temperature (°F)	Unoccupied Cooling Temperature (°F)
Perth Amboy Campus	100%	72.0	72.0	70.0	72.0	72.0	60.0	72.0	80.0
Edison Campus	100%	72.0	72.0	70.0	72.0	72.0	60.0	72.0	80.0
Woodbridge Campus	100%	72.0	72.0	70.0	72.0	72.0	60.0	72.0	80.0

Middlesex County Vocational School
Exhibit D
ECM 3A Building Management Control Systems
BMS Upgrades

THERMAL NIGHT SETBACK SAVINGS CALCULATIONS

	Perth Amboy Campus	Edison Campus	Woodbridge Campus	East Brunswick Campus	Piscataway Campus
Safety Factor	0%	0%	0%	0%	0%
Thermal Savings	24,648	4,771	19,405	-	-

ELECTRIC NIGHT SETBACK SAVINGS CALCULATIONS

Safety Factor	0%	0%	0%	0%	0%
Electrical Savings	226,906	45,521	35,016	-	-

Cooling Savings (kWh/yr)	226,906	45,521	35,016
Tc	72	72	72
Hours	70	70	70
Sc	80	80	80
Pc	6%	6%	6%
Caphp	648	130	100
EFLHc	1,208	1,208	1,208
EERhp	11.00	11.00	11.00
Heating Savings (Therms)	24,648	4,771	19,405
Th	72	72	72
H	70	70	70
Sh	60	60	60
Ph	3%	3%	3%
Caph	9,450,000	1,608,000	7,440,000
EFLHh	1,191	1,191	1,191
AFUEh	91%	80%	91%

Middlesex County Vocational School
Exhibit D
ECM 3A Building Management Control Systems
BMS Upgrades

Occupancy Controlled Thermostats

The program has received a large amount of custom electric applications for the installation of Occupancy Controlled Thermostats in hotels, motels, and, most recently, university dormitories.

Standard practice today is thermostats which are manually controlled by occupants to regulate temperature within a facility. An occupancy controlled thermostat is a thermostat paired with a sensor and/or door detector to identify movement and determine if a room is occupied or unoccupied. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e., programmed setpoint). If a pre-programmed time frame elapses (i.e., 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback setpoint or off) until occupancy is sensed again. This type of thermostat is often used in hotels to conserve energy.

The occupancy controlled thermostat reduces the consumption of electricity and/or gas by requiring less heating and/or cooling when a room or a facility is vacant or unoccupied.

Algorithms

Cooling Energy Savings (kWh/yr) = $(((T_c * (H+5) + S_c * (168 - (H+5)))/168) - T_c) * (P_c * Cap_{hp} * 12 * EFLH_c/EER_{hp})$

Heating Energy Savings (kWh/yr) = $(T_h - ((T_h * (H+5) + S_h * (168 - (H+5)))/168)) * (P_h * Cap_{hp} * 12 * EFLH_h/EER_{hp})$

Heating Energy Savings (Therms/yr) = $(T_h - ((T_h * (H+5) + S_h * (168 - (H+5)))/168) * (P_h * Cap_h * EFLH_h/AFUE_h/100{,}000)$

Definition of Variables

T_h = Heating Season Facility Temp. (°F)
T_c = Cooling Season Facility Temp. (°F)
S_h = Heating Season Setback Temp. (°F)
S_c = Cooling Season Setup Temp. (°F)
H = Weekly Occupied Hours
Cap_{hp} = Connected load capacity of heat pump/AC (Tons) – Provided on Application.
Cap_h = Connected heating load capacity (Btu/hr) – Provided on Application.
$EFLH_c$ = Equivalent full load cooling hours
$EFLH_h$ = Equivalent full load heating hours
P_h = Heating season percent savings per degree setback
P_c = Cooling season percent savings per degree setup
$AFUE_h$ = Heating equipment efficiency – Provided on Application.
EER_{hp} = Heat pump/AC equipment efficiency – Provided on Application

12 = Conversion factor from Tons to kBtu/hr to acquire consumption in kWh.
168 = Hours per week.
7 = Assumed weekly hours for setback/setup adjustment period (based on 1 setback/setup per day, 7 days per week).

Summary of Inputs

Occupancy Controlled Thermostats

Component	Type	Value	Source
T_h	Variable		Application
T_c	Variable		Application
S_h	Fixed	T_h-5°	
S_c	Fixed	T_c+5°	
H	Variable		Application; Default of 84 hrs/week
Cap_{hp}	Variable		Application
Cap_h	Variable		Application
$EFLH_{c,h}$	Variable	See Table Below	1
P_h	Fixed	3%	2
P_c	Fixed	6%	2
$AFUE_h$	Variable		Application
EER_{hp}	Variable		Application

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574

Middlesex County Vocational School
Exhibit D
ECM 3A Building Management Control Systems
BMS Upgrades

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
ECM 4B Building Envelope Improvements
Building Envelope Improvements

ECM DESCRIPTION

Reduce building infiltration by weather stripping doors, sealing roof & wall joints, duct & piping penetrations, skylight perimeters and window corners.

DATA / ASSUMPTIONS

*Crack area determined by survey team

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Visual inspection per scope of work from subcontractor. Inspection might include smoke test.

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%
Safety Factor (Thermal) =	0%

Recovery factor taken at 10% due to the uncertainty of variables incorporated in the savings calculations

Middlesex County Vocational School
Exhibit D
ECM 4B Building Envelope Improvements
Building Envelope Improvements

FORMULAE

H = (K * Q_{INF} * (dp)^n * HDD * 10) / 28,900 where 28,900 = Heating efficiency factor = (1,000,000 Btu per MMBtu / (1.08 * 24 hr/day)) * 75% std htg efficiency

C = T * C2 * CDD where T = C1 * Q_{INF} * h

Q_{INF} = K * dp^n *A_{CRACK}

dp^n = 5.16

A_{CRACK} = A_{VENTS} + A_{WIN} + A_{RTU} + A_{DOORS} + A_{BULK} + $A_{ROOF/WALL}$

Variable	Units	Description
H	therms	Thermal Savings associated with air infiltration reduction
C	kWh	Electrical Savings associated with air infiltration reduction
Q_{INF}	cfm	Infiltration air flow savings
A_{CRACK}	ft^2	Total square feet of infiltration area
K	(ft^3 / min) / (Pa * ft^2)	Flow Factor
dp^n	Pa	Pressure difference across building envelope raised to nth power
CDD	(^oF-Day)/Yr	Cooling degree days
T	tons	Cooling load
h	Btu/lb	Avg. enthalpy of air
HDD	(°F-Day)/Yr	Annual heating degree days
C1	lb/ft^3 * min/hr	Cooling Constant = std air density 0.075 lb/ft^3 * 60 min/hr
C2	kW/ton	Cooling system characteristic power consumption
A_{VENTS}	ft^2	Total square feet of infiltration spaces with regards to vents
A_{WIN}	ft^2	Total square feet of infiltration spaces with regards to windows
A_{RTU}	ft^2	Total square feet of infiltration spaces with regards to RTU's
A_{DOORS}	ft^2	Total square feet of infiltration spaces with regards to doors
A_{BULK}	ft^2	Total square feet of infiltration spaces with regards to bulkheads
$A_{ROOF/WALL}$	ft^2	Total square feet of infiltration spaces with regards to the wall roof joint

Source: Public Works Canada Standards & Guidelines,: EC128 April 30, 1980

Very Good
Good
Average
Poor
Loose

ASSUMPTIONS / DATA

Subcontractor Calculations n * If Yes - Please Refer to tab 'Sub BEI Calculation' for details

Building	Building Envelope Improvements (Y/N)	Envelope Tightness	Cooling Savings Applicable (Y/N)
Perth Amboy Campus	Y	Average	Y
Edison Campus	Y	Average	Y
Woodbridge Campus	Y	Average	Y

Middlesex County Vocational School
Exhibit D
ECM 4B Building Envelope Improvements
Building Envelope Improvements

CALCULATIONS

	Perth Amboy Campus	Edison Campus	Woodbridge Campus
Building Envelope Improvements	Y	Y	Y
Envelope Tightness	Average	Average	Average
Tightness Multiplier	0.00028	0.00028	0.00028
Cooling Savings Applicable	Y	Y	Y
Heating Savings Diversity Factor	100%	100%	100%
Flow Factor	20	20	20
(AP)^n	6.1625	6.06	6.142857143
Crack Area	4.0	7.5	6.3
Air Leakage (CFM)	493	909	774
Heating Degree Days	5,450	5,450	5,450
Heating Efficiency Factor	38,580	38,580	38,580
Cooling Savings Diversity Factor	100%	100%	100%
Constant	4.5	4.5	4.5
CFM	493	909	774
Enthalpy	9.8	9.8	9.8
Tons	1.8	3.3	2.8
Constant	1.2	1.2	1.2
CDD	787	787	787
kWh	1,711	3,155	2,686
Therms	696	1,284	1,093
Electric Safety Factor	0%	0%	0%
Thermal Safety Factor	0%	0%	0%
kWh Savings	1,711	3,155	2,686
Thermal Savings	696	1,284	1,093

Middlesex County Vocational School
Exhibit D
ECM 4A Wooddbridge Guidance Office BEI
Window Replacement

ECM DESCRIPTION

Replacement of windows with double-pane, low-e, metal frame windows.

DATA / ASSUMPTIONS

Recovery/Safety Factor (Electric) =	0%	
Recovery/Safety Factor (Thermal) =	0%	
Heating Hours	3,948	Hours

*U Factors for the new windows are obtained by manufacturer data. U Factors for the existing windows are based on type, material, and thickness

MEASUREMENT AND VERIFICATION

Option C - Savings Calculations are based on regression analysis of utility billing meter data

COMMISSIONING

Verify quantities installed and total square feet.

RECOVERY/SAFETY FACTOR

Savings calculations are based on weather bin data, fresh air flows and temperature setpoints. A more conservative of 0 percent is used for this ECM due to the uncertainty of variables. The heating fuel savings calculations are based upon information provided by the equipment vendor.

FORMULAE

$$Q_{SAVINGS} = (Q_C - Q_C) + Q_{INF}$$

$$Q_{INF} = \sum_{-5}^{100} \left(1.08 \cdot (i_{WIN} - i_{WIN}) \cdot (T_{W/S} - T_{BIN}) \cdot l_W \cdot t_{BIN} \right) / 100{,}000$$

$$Q_C = \sum_{-5}^{100} \left((T_{W/S} - T_{BIN}) \cdot A_{WIN} \cdot U_{WIN} \cdot t_{BIN} \right) / 100{,}000$$

$$Q_C = \sum_{-5}^{100} \left((T_{W/S} - T_{BIN}) \cdot A_{WIN} \cdot U_{WIN} \cdot t_{BIN} \right) / 100{,}000$$

*Note W/S designates use of either winter building setpoint or summer building setpoint with the appropiate bin

Variable	Units	Description
$Q_{savings}$	Therms	Thermal Savings
Q_C	Therms	Conductive/convective cooling gain and heating loss with existing windows
Q_C	Therms	Conductive/convective cooling gain and heating loss with proposed windows
Q_{INF}	Therms	Infiltration savings with proposed windows
$\sum_{-5}^{100}$	-	Summation of all bins from -5°F to 100°F
T_W	°F	Winter building setpoint
T_S	°F	Summer building setpoint
T_{BIN}	°F	Temperature of respective bin
t_{BIN}	Hrs	Hrs in respective bin
A_{WIN}	ft^2	Existing unoccupied Bin Hours in respective temperature bin
U_{WIN}	btu / ft^2 / °F	Existing U-factor of roof
U_{WIN}	btu / ft^2 / °F	Proposed U-factor of roof
i_{WIN}	Cfm/ft	Infiltration constant for existing windows
i_{WIN}	Cfm/ft	Infiltration constant for proposed windows
l_W	ft	Linear feet of curtain wall

* Inputs are in blue

Middlesex County Vocational School
Exhibit D
ECM 4A Wooddbridge Guidance Office BEI
Window Replacement

Building	Window Area (ft^2)	U-Factor of Existing Window	U-Factor of Proposed Window	Infiltration of Existing Window (CFM / linear ft)	Infiltration of Proposed Window (CFM / linear ft)	Total Linear feet of Curtain Wall	EER of Cooling System (Average)
Woodbridge Campus	354	1.20	0.29	25.00	10.00		11.0
Totals	354						

	Woodbridge Campus	Total	
Window ft^2 Audited	354		ft^2
U of Existing Window	1.20		btu/ft^2/°F
U of Proposed Window	0.29		btu/ft^2/°F
Infiltration of Existing Windows	25.00		CFM / ft
Infiltration of Proposed Windows	10.00		CFM / ft
Total Linear Ft of Curtain Wall	-		ft
EER of Cooling System (Average)	11.0		
Existing Occupied Heating Setpoint	72.0		°F
Existing Unoccup. Heating Setpoint	72.0		°F
Existing Occupied Cooling Setpoint	70.0		°F
Existing Unoccup. Cooling Setpoint	72.0		°F
Boiler Efficiency	91.0%		%
Safety Factor	0%		%
Electrical Savings	1,661		kWh/Yr
Thermal Savings	240		Therms/Yr

Middlesex County Vocational School
Exhibit D
ECM 4A Wooddbridge Guidance Office BEI
Window Replacement

CALCULATIONS

WOODBRIDGE CAMPUS

Amb. Temp Bin °F	Avg Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Hours	Unoccupied Hours	Window Square Feet	Existing Occupied Cooling Gain and Heating Loss	Existing Unoccupied Cooling Gain and Heating Loss	Proposed Occupied Cooling Gain and Heating Loss	Proposed Unoccupied Cooling Gain and Heating Loss	Cooling or Heating Savings	Infiltration savings	Total Heating or Cooling Savings	Safety Factor
COOLING									(MMBTU)	(MMBTU)	(MMBTU)	(MMBTU)	(MMBTU)	(MMBTU)	(MMBTU)	
100 to 105	102.5	-	1	-	1	1	0	354	0.0	0.0	0.0	0.0	0.0		0.0	0%
95 to 100	97.5	-	19	2	21	15	6	354	0.2	0.1	0.0	0.0	0.2		0.2	0%
90 to 95	92.5	-	44	13	57	38	19	354	0.4	0.2	0.1	0.0	0.4		0.4	0%
85 to 90	87.5	1	167	60	228	152	76	354	1.2	0.5	0.3	0.1	1.3		1.3	0%
80 to 85	82.5	31	283	162	476	294	182	354	1.7	0.9	0.4	0.2	2.0		2.0	0%
75 to 80	77.5	191	235	280	706	352	354	354	1.2	0.9	0.3	0.2	1.6		1.6	0%
70 to 75	72.5	203	177	222	602	282	320	354	0.3	0.1	0.1	0.0	0.3		0.3	0%
65 to 70	67.5	325	165	204	694	285	409	354	-	-	-	-	-		-	0%
60 to 65	62.5	180	152	195	527	245	282	354	-	-	-	-	-		-	0%
HEATING																
55 to 60	57.5	86	144	97	327	170	157	354	1.0	0.5	0.3	0.2	1.1	-	1.1	0%
50 to 55	52.5	109	182	172	463	242	221	354	2.0	0.8	0.5	0.4	1.8	-	1.8	0%
45 to 50	47.5	105	119	142	366	180	186	354	1.9	0.6	0.5	0.5	1.6	-	1.6	0%
40 to 45	42.5	185	155	177	517	239	278	354	3.0	0.9	0.7	0.8	2.4	-	2.4	0%
35 to 40	37.5	236	200	241	677	314	363	354	4.6	1.2	1.1	1.3	3.5	-	3.5	0%
30 to 35	32.5	237	202	198	637	293	344	354	4.9	1.2	1.2	1.4	4.0	-	4.0	0%
25 to 30	27.5	121	115	113	349	164	185	354	3.1	0.6	0.8	0.8	2.6	-	2.6	0%
20 to 25	22.5	149	68	97	314	127	187	354	2.7	0.6	0.6	1.0	2.3	-	2.3	0%
15 to 20	17.5	95	40	46	181	70	111	354	1.6	0.4	0.4	0.6	1.5	-	1.5	0%
10 to 15	12.5	39	9	28	76	28	48	354	0.7	0.2	0.2	0.3	0.7	-	0.7	0%
5 to 10	7.5	21	5	5	31	10	21	354	0.3	0.1	0.1	0.1	0.3	-	0.3	0%
0 to 5	2.5	4	2	-	6	2	4	354	0.1	0.0	0.0	0.0	0.1	-	0.1	0%
-5 to 0	-2.5	4	-	-	4	1	3	354	0.0	0.0	0.0	0.0	0.0	-	0.0	0%
-10 to -5	-7.5	-	-	-	-	-	-	354	-	-	-	-	-	-	-	0%
-15 to -10	-12.5	-	-	-	-	-	-	354	-	-	-	-	-	-	-	0%
Total		2,322	2,484	2,454	7,260	3,504	3,756									

Middlesex County Vocational School
Exhibit D
ECM 5A Permanent Load Reduction
Permanent Load Reduction

ECM DESCRIPTION

PJM Demand Response Program based on Shedable Load on Peak Demand Curtailment Day

DATA / ASSUMPTIONS

Demand Response Revenue	$ 15,000	/ MW
Permanent Load Reduction	$ 31,000	/ MW
Customer Share (Typically between 60-70%)	100%	

Year	All Other $/kW
2017/2018	$25.00
2018/2019	$40.00
2019/2020	$22.00
2020/2021	$22.00
	$27.25

*Demand Response Savings = Assumed between 1 - 4% Annual Electrical Load
*Assume 2% of Total District Load as Shedable
*Savings is not Guaranteed any savings from program will be considered operational savings only

MEASUREMENT AND VERIFICATION

None - Operational Savings

COMMISSIONING

N/A

RECOVERY/SAFETY FACTOR

N/A

FORMULAE

$$\$_{savings} = kWh_{ADJ} \cdot Cust_{\%} \cdot DM_{\%}$$

Variable	Units	Description
$\$_{savings}$	Dollars	Dollar Savings from Demand Response
$DM_{\%}$	%	Demand Response Savings as a percentage of electric baseline
$Cust_{\%}$	%	Customer Percentage of Savings
kWh_{BASE}	kWh	Adjusted Boiler Fuel Usage

Middlesex County Vocational School
Exhibit D
ECM 5A Permanent Load Reduction
Permanent Load Reduction

* Inputs are in blue

Building	Demand Response/Permanent Load Reduction Participation (Y/N)
Perth Amboy Campus	Y
Edison Campus	Y
Woodbridge Campus	Y

CALCULATIONS

	Perth Amboy Campus	Edison Campus	Woodbridge Campus
Demand Response Participation	Y	Y	Y
Average Monthly kW	438	103	194
Permanent Load Shed Reduction (kW)	111.72	25.75	44.23
Sheddable Load (kW)			
Percentage of Baseline Demand	25.5%	24.9%	22.8%
Demand Response $ / MW	$ 15,000	$ 15,000	$ 15,000
Permanent Load Shed Reduction $ / MW	$ 31,000	$ 31,000	$ 31,000
Demand Hours / Year	100	$ -	
Cost to Run Generator / hr	$ -	$ -	
Cost to Run Generator / yr	$ -	$ -	$ -
Safety Factor	0%	0%	0%
DR and PLR Savings	$ 3,463	$ 798	$ 1,371
Net Demand Response Savings	$ 3,463	$ 798	$ 1,371

Middlesex County Vocational School
Exhibit D
ECM 6A Solar PPA
Solar PPA Photovoltaic System

ECM DESCRIPTION

Installation of a photovoltaic array utilizing Solar Power Purchase Agreement (PPA) - reducing grid electricity with a reduction of greenhouse gas emissions.

DATA / ASSUMPTIONS

PPA Cost per kWH	$0.060
*1-Axis Tracking System Collection Improvement:	18.6%

*Emperical studies show an that annual output increases 18.6% with use of one-axis sun tracking
**Assume two weeks of downtime for PV maintenance

Solar radiation at ground level was obtained using the data collected by the National Renewable Energy Laboratory (NREL) via the software Pvwatts.
Proposed technology is only able to convert 77% of the direct current produced at the panel to a usable alternative current for building consumption

MEASUREMENT AND VERIFICATION

Option C - Verification by dedicated electric meter.

COMMISSIONING

Test installed system - measuring the output and verify with calculations for weather conditions. Verify all electrical connections and tie-ins to the grid and the building power.

RECOVERY/SAFETY FACTOR

Safety Factor (Electrical) =	0%

FORMULAE

$$W_{PV} = \sum_{Jan}^{Dec} (Q_{RAD} \cdot A_{PV} \cdot t_{MONTH}) \cdot t_{\%}$$

Variable	Units	Description
W_{PV}	kWh	Electrical energy produced by PV array
$\sum_{Jan}^{Dec}$	-	Summation of months
Q_{RAD}	$kWh/m^2/day$	Solar radiation (averaged by month) capable of being collected with the proposed PV technology
A_{PV}	ft^2	Area of proposed system
t_{MONTH}	Days	Days in the month
$t_{\%}$	%	Percentage of operational time

Middlesex County Vocational School
Exhibit D
ECM 6A Solar PPA
Solar PPA Photovoltaic System

*Inputs are blue

Building	DC Rating of System	Install 1-Axis Tracking System (Y/N)
Perth Amboy Campus	0.0	N
Edison Campus	0.0	N
Woodbridge Campus	0.0	N
East Brunswick Campus	0.0	N
Piscataway Campus	2,400.0	N
Totals	2,400.0	

Cell ID	Newark
State	New Jersey
Latitude	40.7 N
Longitude	74.17 W

Month	Days in Month	**Solar Radiation (kWh/day)	Solar Radiation per 1-kW (kWh)
Jan	31	2.39	74.1
Feb	28	3.17	88.8
Mar	31	4.07	126.2
Apr	30	4.83	144.9
May	31	5.7	176.7
Jun	30	5.94	178.2
Jul	31	5.77	178.9
Aug	31	5.38	166.8
Sep	30	4.65	139.5
Oct	31	3.61	111.9
Nov	30	2.35	70.5
Dec	31	2.01	62.3
Total		4.16	**1,518.7**

CALCULATIONS

	Piscataway Campus
DC Rating of System	2400.0
Safety Factor	0%
Maximum DC Rating	2400.0
Install 1-Axis Tracking System	N
**Annual Operational Hours	8,424
DC to AC Safety Factor	0.82
*Efficiency gain with 1-Axis Tracking	0.0%
Total kWh AC per year Generated	2,865,381
Solar Factor	42%
kWh Savings	1,217,166

Middlesex County Vocational School
Exhibit D
ECM 7A Transformers
Transformer Replacement

ECM DESCRIPTION

Replace dry transformers with new custom designed high efficiency transformers. New transformers will save electricity and avoid the future replacements due to failure.

DATA / ASSUMPTIONS

*Input Measured kW losses (If kW losses are not none calculation will calculate efficiency using past results)
* Existing loads were obtained by data logging
* Existing efficiencies were obtained by data logging or manufacturer specifications

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Test all transformers after installation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

Recovery factor is set at 10% due to unknown flucuations in transformer loads

FORMULAE

$W_{SAVINGS} = E_E - E_T$

$E_E = E_{OCC} \cdot t_{OCC} + E_{UNOCC} \cdot t_{UNOCC}$
$E_T = E_{OCC} \cdot t_{OCC} + E_{UNOCC} \cdot t_{UNOCC}$

$E_{OCC} = [(Lf_{OCC} \cdot KVA) / \eta_L^{OCC}] - (KVA \cdot Lf_{OCC})$
$E_{OCC} = [(Lf_{OCC} \cdot KVA) / \eta_L^{OCC}] - (KVA \cdot Lf_{OCC})$

$E_{UNOCC} = [(Lf_{OCC} \cdot KVA) / \eta_L^{UNOCC}] - (KVA \cdot Lf_{OCC})$
$E_{UNOCC} = [(Lf_{OCC} \cdot KVA) / \eta_L^{UNOCC}] - (KVA \cdot Lf_{OCC})$

$\eta_L^{OCC} = Lf_{OCC} \cdot kVA \cdot \eta_E$
$\eta_L^{OCC} = Lf_{OCC} \cdot kVA \cdot \eta_T$

$\eta_L^{UNOCC} = Lf_{UNOCC} \cdot kVA \cdot \eta_E$
$\eta_L^{UNOCC} = Lf_{UNOCC} \cdot kVA \cdot \eta_T$

Variable	Units	Description
$W_{savings}$	kWh	Electrical Savings
E_T	kW	Existing annual transformer losses
E_T	kW	Proposed annual transformer losses
t_{OCC}	Hrs	Existing Run Hours
t_{UNOCC}	Hrs	Proposed Run Hours
E_{OCC}	kW	Existing transformer losses during occupied hours
E_{OCC}	kW	Proposed transformer losses during occupied hours
E_{UNOCC}	kW	Existing transformer losses during unoccupied hours
E_{UNOCC}	kW	Proposed transformer losses during unoccupied hours
kVA	kVA	kVA of existing transformer
Lf_{OCC}	-	Load Factor of transformer during occupied hours
Lf_{UNOCC}	-	Load Factor of transformer during unoccupied hours
η_L^{OCC}	%	Existing efficiency of transformer during occupied hours
η_L^{OCC}	%	Proposed efficiency of transformer during occupied hours
η_L^{UNOCC}	%	Existing efficiency of transformer during unoccupied hours
η_L^{UNOCC}	%	Proposed efficiency of transformer during unoccupied hours
η_T	%	Existing weighted efficiency of transformer at various loads
η_T	%	Proposed weighted efficiency of transformer at various loads

* Inputs are in blue

Middlesex County Vocational School
Exhibit D
ECM 7A Transformers
Transformer Replacement

Calculation is automatic. If Efficiencies are known override automatically generated efficiencies in Columns G through M when necessary

							EXISTING						PROPOSED			
Building	Replace	Tag Number	Location ID	Transormer Designation	Qty	kVA	% Load During Occupied Hours	% Load During Unoccupied Hours	Baseline kW Losses (Normal Operation)	Baseline kW Losses (Outside Op. hrs)	Efficiency at Occupied Loads	Efficiency at Unoccupied Loads	New Transformer kW Losses (Normal Operation)	New Transformer kW Losses (Outside Op. hrs)	Efficiency Occupied Loads	Efficiency Unoccupied Loads
Perth Amboy Campus	y	57075	Janitor by A-109	T9	1.00	112.5	4.9%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	y	57076	116 Maintenance Shop	T15	1.00	15.0	13.5%	8.0%	0.327	0.317	86.88%	81.90%	0.048	0.040	96.75%	95.75%
Perth Amboy Campus	Y	57077	A-109	RPA1A	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57078	B-117	T14	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	Y	57079	B-119	HTS	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57080	B-122A	BTS	1.00	45.0	4.6%	2.0%	0.635	0.633	90.53%	86.68%	0.081	0.079	97.10%	96.10%
Perth Amboy Campus	Y	57081	B-123	ETS	1.00	45.0	4.6%	2.0%	0.635	0.633	90.53%	86.68%	0.081	0.079	97.10%	96.10%
Perth Amboy Campus	Y	57082	B-123	ETS2	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57083	B-124	T13	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	Y	57084	By C-153	T6	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57085	Gym Storage	T5	1.00	225.0	1.2%	1.2%	1.758	1.758	93.49%	90.74%	0.320	0.320	98.40%	97.90%
Perth Amboy Campus	Y	57086	Boiler Rm	MR	1.00	45.0	4.9%	2.0%	0.636	0.633	90.53%	86.68%	0.082	0.079	97.10%	96.10%
Perth Amboy Campus	Y	57087	Boiler Rm	MCB T7	1.00	150.0	8.2%	3.0%	1.523	1.500	92.99%	92.99%	0.228	0.206	98.39%	97.85%
Perth Amboy Campus	Y	57088	Elec Rm by C-206-A	T4	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	Y	57089	B-213	T3	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	Y	57090	Electric Rm by A-224	T1	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57091	A-200-B	RPA2B	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Totals					17	1575										

CALCULATIONS

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	TOTAL
Replace Transformer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
kVa	112.5	15.0	75.0	112.5	75.0	45.0	45.0	75.0	112.5	75.0	225.0	45.0	150.0	112.5	112.5	75.0	112.5	**1,275.00**
Quantity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**14.00**
% Load at Occupied Hours	5%	14%	4%	5%	4%	5%	5%	4%	5%	4%	1%	5%	8%	5%	5%	4%	5%	
% Load at Unoccupied Hours	2%	8%	2%	2%	2%	2%	2%	2%	2%	2%	1%	2%	3%	2%	2%	2%	2%	
Estimated Efficiences																		
Existing Efficiency at Occupied Loads	92.5%	86.9%	93.0%	92.5%	93.0%	90.5%	90.5%	93.0%	92.5%	93.0%	93.5%	90.5%	93.0%	92.5%	92.5%	93.0%	92.5%	
Existing Efficiency at Unoccupied Loads	90.5%	81.9%	91.0%	90.5%	91.0%	86.7%	86.7%	91.0%	90.5%	91.0%	90.7%	86.7%	93.0%	90.5%	90.5%	91.0%	90.5%	
Proposed Efficiency at Occupied Loads	98.2%	96.8%	97.3%	98.2%	97.3%	97.1%	97.1%	97.3%	98.2%	97.3%	98.4%	97.1%	98.4%	98.2%	98.2%	97.3%	98.2%	
Proposed Efficiency at Unoccupied Loads	97.8%	95.8%	96.2%	97.8%	96.2%	96.1%	96.1%	96.2%	97.8%	96.2%	97.9%	96.1%	97.9%	97.8%	97.8%	96.2%	97.8%	
Measured Baseline Losses																		
Existing Losses at Occupied Loads	1.111	0.327	0.729	1.111	0.729	0.635	0.635	0.729	1.111	0.729	1.758	0.636	1.523	1.111	1.111	0.729	1.111	
Existing Losses at Unoccupied Loads	1.104	0.317	0.726	1.104	0.726	0.633	0.633	0.726	1.104	0.726	1.758	0.633	1.500	1.104	1.104	0.726	1.104	
Proposed Losses at Occupied Loads	0.172	0.048	0.115	0.172	0.115	0.081	0.081	0.115	0.172	0.115	0.320	0.082	0.228	0.172	0.172	0.115	0.172	
Proposed Losses at Unoccupied Loads	0.165	0.040	0.112	0.165	0.112	0.079	0.079	0.112	0.165	0.112	0.320	0.079	0.206	0.165	0.165	0.112	0.165	
Measured kW Losses																		
Existing kW Losses Occupied Hours	0.940	0.278	0.614	0.939	0.614	0.554	0.554	0.614	0.939	0.615	1.438	0.554	1.295	0.939	0.939	0.614	0.939	
Existing kW Losses Unoccupied Hours	0.939	0.277	0.614	0.939	0.614	0.554	0.554	0.614	0.939	0.614	1.438	0.554	1.293	0.939	0.939	0.614	0.939	
Estimated kW Losses based on Efficiences																		
Existing kW Losses Occupied Hours Calculated	0.447	0.3059	0.2145	0.4561	0.2145	0.2165	0.2165	0.2145	0.4561	0.2159	0.1849	0.2306	0.9267	0.4561	0.4561	0.2145	0.4561	
Existing kW Losses Unoccupied Hours Calculated	0.577	0.4477	0.2819	0.5891	0.2819	0.3181	0.3181	0.2819	0.5891	0.2837	0.2708	0.3389	0.9267	0.5891	0.5891	0.2819	0.5891	
Occupancy																		
Occupied Hours per Day	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	
Occupied Days per Year	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	180	180	
Estimated kWh Losses based on Efficiences																		
Existing Annual kWh Losses	4,640	3,468	2,254	4,735	2,254	2,462	2,462	2,254	4,735	2,268	2,097	2,622	8,118	4,735	4,735	2,275	4,777	
Proposed kW and kWh Losses based on Efficiences																		
Proposed kW Losses Occupied Hours	0.1010	0.0680	0.0791	0.1031	0.0791	0.0618	0.0618	0.0791	0.1031	0.0796	0.0432	0.0659	0.2009	0.1031	0.1031	0.0791	0.1031	
Proposed kW Losses Unoccupied Hours	0.0506	0.0533	0.0593	0.0506	0.0593	0.0365	0.0365	0.0593	0.0506	0.0593	0.0579	0.0365	0.0987	0.0506	0.0506	0.0593	0.0506	
Proposed Annual kWh Losses	605	514	583	611	583	401	401	583	611	584	460	414	1,192	611	611	576	595	
Safety Factor	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	10%	10%	
Total kW and kWh Savings																		
kW Savings	0.940	0.278	0.614	0.939	0.614	0.554	0.554	0.614	0.939	0.615	1.438	0.554	1.295	0.939	0.939	0.614	0.939	**10.89**
kWh Savings	8,229	2,430	5,382	8,226	5,382	4,852	4,852	5,382	8,226	5,382	12,600	4,856	11,335	8,226	7,704	5,021	7,674	**95,360**

Middlesex County Vocational School
Exhibit D
ECM 1B Vending Misers
Vending Misers

ECM DESCRIPTION

Install vending machines with vending misers, mounted on the respective vending machine.

DATA / ASSUMPTIONS

Cold Drink Run Hour Reduction	34%	
Snack Machine Run Hour Reduction	40%	
Typical Cold Drink Wattage	0.339	kW
Typical Snack Machine Wattage	0.041	kW

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Confirm vending miser operation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%

Relatively high safety factor is used for this ECM because of direct measurements are proven over the time and savings are stipulated

CALCULATIONS

Detailed energy savings calculations are in the line-by-line calculation sheet

*Inputs are blue

Building	Label	Type	Qty	Location
Perth Amboy Campus	PAC-VM-1	Cold Beverage	1	Cafeteria
Perth Amboy Campus	PAC-VM-2	Cold Beverage	1	Teacher Lounge
Perth Amboy Campus	PAC-VM-3	Cold Beverage	1	Gym
Perth Amboy Campus	PAC-VM-4	Snack	1	Cafeteria
Edison Campus	EC-VM-1	Cold Beverage	1	Common Area
Edison Campus	EC-VM-2	Snack	1	Common Area
Edison Campus	EC-VM-3	Snack	1	Common Area
Woodbridge Campus	WC-VM-1	Cold Beverage	1	Cafeteria
Woodbridge Campus	WC-VM-2	Cold Beverage	1	Faculty Lounge
Totals	-	-	9	-

Middlesex County Vocational School
Exhibit D
ECM 1B Vending Misers
Vending Misers

CALCULATION

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Edison Campus	Edison Campus	Edison Campus	Woodbridge Campus	Woodbridge Campus
Label	PAC-VM-1	PAC-VM-2	PAC-VM-3	PAC-VM-4	EC-VM-1	EC-VM-2	EC-VM-3	WC-VM-1	WC-VM-2
Type	Cold Beverage	Cold Beverage	Cold Beverage	Snack	Cold Beverage	Snack	Snack	Cold Beverage	Cold Beverage
Location	Cafeteria	Teacher Lounge	Gym	Cafeteria	Common Area	Common Area	Common Area	Cafeteria	Faculty Lounge
Quantity	1	1	1	1	1	1	1	1	1
Run Hours	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**	**8,760**
Existing kWh Consumption	2,970	2,970	2,970	359	2,970	359	359	2,970	2,970
Proposed kWh Consumption	1,960	1,960	1,960	215	1,960	215	215	1,960	1,960
Safety Factor	0%	0%	0%	0%	0%	0%	0%	0%	0%
kWh Savings	1,010	1,010	1,010	144	1,010	144	144	1,010	1,010

Middlesex County Vocational School
Exhibit D
ECM 1C Destratification Fans
De-stratifcation fans

ECM DESCRIPTION

Install de-stratification fans in large open ares. Fans will push and hold hot air down to reduce heating losses through the roof and upper section of the outside walls due to reducing the indoor temperature in these sections above the fan.

DATA / ASSUMPTIONS

Heating Hours	3,948	Hours
Roof - R Value (Assume between 1-2" insulation)	9.0	ft2-Deg F-hr/BTU
Wall - R Value (Assume 1/2" Wall Board, 8" LWCC, 4" Brick)	4.5	ft2-Deg F-hr/BTU
Window U Value Single Pane	1.20	Btu/ft2-Deg F-hr
Window U Value Double Pane	0.45	Btu/ft2-Deg F-hr

*Heating efficiency of de-stratification fans assumed at 60%

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Verify that the installed fans operate. Install clock meter on fans to verify that fans are running 24/7 during heating season

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%
Safety Factor (Thermal) =	0%

Fuel savings recovery factor is conservatively set for 0 for the ECM due to the uncertainity in consistency of temperature difference between room and upper level temperatures, electric penalties recovery factor is at 0.

FORMULA

$W_{TOTAL} = W_{FAN} \cdot q \cdot t_{FAN}$

$Q_{SAVINGS} = Q_{TOTAL} \cdot \mu$

$Q_{TOTAL} = Q_{WALL} + Q_{ROOF} + Q_{WIN}$

$Q_{WALL} = \sum_{-5}^{60} ((T_{STRAT} - T_{OCC}) \cdot A_{WALL} \cdot U_{WALL} \cdot t_{OCC}) + ((T_{STRAT} - T_{UNOCC}) \cdot A_{WALL} \cdot U_{WALL} \cdot t_{UNOCC})$
$Q_{WIN} = \sum_{-5}^{60} ((T_{STRAT} - T_{OCC}) \cdot A_{WIN} \cdot U_{WIN} \cdot t_{OCC}) + ((T_{STRAT} - T_{UNOCC}) \cdot A_{WIN} \cdot U_{WIN} \cdot t_{UNOCC})$
$Q_{ROOF} = \sum_{-5}^{60} ((T_{STRAT} - T_{OCC}) \cdot A_{ROOF} \cdot U_{ROOF} \cdot t_{OCC}) + ((T_{STRAT} - T_{UNOCC}) \cdot A_{ROOF} \cdot U_{ROOF} \cdot t_{UNOCC})$

Variable	Units	Description
$Q_{SAVINGS}$	Therms	Annual thermal savings
$\sum_{-5}^{60}$	-	Summation of all bins from -5°F to 60°F
μ	%	Diversity factor of de-stratification fans (25% - 50%)
Q_{TOTAL}	btu	Total heat loss
Q_{WALL}	btu	Heat loss through wall (above de-stratification fan)
Q_{ROOF}	btu	Heat loss through roof
Q_{WIN}	btu	Heat loss through windows (above de-stratification fan)
T_{BIN}	°F	Temperature of respective bin
T_{OCC}	°F	Existing temperature of space during occupied hours
T_{UNOCC}	°F	Existing temperature of space during unoccupied hours
T_{STRAT}	°F	Existing stratified temperature above de-stratification fan) during all heating hours
t_{OCC}	Hrs	Occupied Bin Hours in respective temperature bin
t_{UNOCC}	Hrs	Unoccupied Bin Hours in respective temperature bin
A_{WALL}	ft^2	Exposed wall area adove de-stratification fan
A_{ROOF}	ft^2	Exposed roof area adove de-stratification fan
A_{WINDOW}	ft^2	Exposed window area adove de-stratification fan
U_{WALL}	btu / ft^2 / °F	U-factor of wall
U_{ROOF}	btu / ft^2 / °F	U-factor of roof
U_{WIN}	btu / ft^2 / °F	U-factor of windows
W_{TOTAL}	kWh	Annual electrical consumption of fans
q	-	Quantity of fans
W_{FAN}	kW	Input kW of fan
t_{FAN}	Hrs	Annual run time of de-stratification fan (annual heating hours)

ASSUMPTIONS / DATA

* Inputs are in blue

Building	Location	Wall Length Perimeter (ft)	Wall Width Perimeter (ft)	Exposed Wall Height above Fan (ft)	Ceiling Height	Ceiling Type	Roof Area (ft^2)	Window Area (ft^2)	Roof U-Factor	Window U-Factor	Wall U-Factor
Perth Amboy Campus	Cafeteria	110	47	3.0	17-31-17	Peaked Roof	5,170	0	0.11	0.45	0.22
Perth Amboy Campus	Auto Shop	90	40	3.0	26.0	Truss	3,600	420	0.11	0.45	0.22
Perth Amboy Campus	Gym	100	94	3.0	30.0	Truss	9,400	252	0.11	0.45	0.22
Woodbridge Campus	Multi-Purpose	66	43	3.0	17-23-17	Peaked Roof	2,838	160	0.11	0.45	0.22
							-				
							-				
Totals											

Middlesex County Vocational School
Exhibit D
ECM 1C Destratification Fans
De-stratifcation fans

CALCULATIONS

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Woodbridge Campus
Location #1	Cafeteria	Auto Shop	Gym	Multi-Purpose
Wall Length	110	90	100	66
Wall Width	47	40	94	43
Wall Height Above Fan	3.0	3.0	3.0	3.0
Roof Area	5,170	3,600	9,400	2,838
Window Area	-	420	252	160
Wall Exposed Area	471	(30)	330	167
Roof U-Factor	0.11	0.11	0.11	0.11
Window U-Factor	0.45	0.45	0.45	0.45
Wall U-Factor	0.22	0.22	0.22	0.22
Fan Model	Air Pear 45	Air Pear 25	Air Pear 25	Air Pear 25
Total run hours	3,948	3,948	3,948	3,948
Fan Input watts	45	35	35	35
kwh consumed by fan	178	138	138	138
SF per Fan	1,500	1,200	1,200	1,200
Total Fans	4	3	9	3
Total Kwh Consumed	711	415	1,244	415
Existing Occupied Heating Setpoint	72.0	72.0	72.0	72
Existing Unoccup. Heating Setpoint	72.0	72.0	72.0	72
Diversity Factor	80%	80%	80%	80%
Boiler Efficiency	91.0%	91.0%	91.0%	91.0%
Additional Electric Usage	(711)	(415)	(1,244)	(415)
Calculated Fuel Savings Therms	802	688	1,454	501
Safety Factor Electric	0%	0%	0%	0%
Safety Factor Thermal	0%	0%	0%	0%
Additional Electric usage	(711)	(415)	(1,244)	(415)
Calculated Fuel Savings	802	688	1,454	501

PERTH AMBOY CAMPUS

Amb. Temp Bin °F	Ave Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Bin Hours	Unoccupied Bin Hours	Exposed Wall area	Exposed Roof area	Window area	Wall U factor	Roof U factor	Window U factor	Wall Heat loss	Roof Heat Loss	Windows Heat Loss	Total Heat loss
HEATING								ft^2	ft^2	ft^2	$btu/ft^2/°F$	$btu/ft^2/°F$	$btu/ft^2/°F$	btu/Yr	btu/Yr	btu/Yr	btu/Yr
55 to 60	57.5	86	144	97	327	170	157	471	5,170	0	0.22	0.11	0.45	496,277	2,723,728	-	3,220,005
50 to 55	52.5	109	182	172	463	242	221	471	5,170	0	0.22	0.11	0.45	944,983	5,186,372	-	6,131,355
45 to 50	47.5	105	119	142	366	180	186	471	5,170	0	0.22	0.11	0.45	938,546	5,151,043	-	6,089,589
40 to 45	42.5	185	155	177	517	239	278	471	5,170	0	0.22	0.11	0.45	1,596,324	8,761,139	-	10,357,463
35 to 40	37.5	236	200	241	677	314	363	471	5,170	0	0.22	0.11	0.45	2,444,647	13,417,012	-	15,861,659
30 to 35	32.5	237	202	198	637	293	344	471	5,170	0	0.22	0.11	0.45	2,633,570	14,453,884	-	17,087,454
25 to 30	27.5	121	115	113	349	164	185	471	5,170	0	0.22	0.11	0.45	1,625,526	8,921,409	-	10,546,935
20 to 25	22.5	149	68	97	314	127	187	471	5,170	0	0.22	0.11	0.45	1,626,834	8,928,590	-	10,555,424
15 to 20	17.5	95	40	46	181	70	111	471	5,170	0	0.22	0.11	0.45	1,032,484	5,666,607	-	6,699,092
10 to 15	12.5	39	9	28	76	28	48	471	5,170	0	0.22	0.11	0.45	473,303	2,597,638	-	3,070,940
5 to 10	7.5	21	5	5	31	10	21	471	5,170	0	0.22	0.11	0.45	209,281	1,148,602	-	1,357,883
0 to 5	2.5	4	2	-	6	2	4	471	5,170	0	0.22	0.11	0.45	43,646	239,543	-	283,189
-5 to 0	-2.5							471	5,170	0	0.22	0.11	0.45	-	-	-	-
-10 to -5	-7.5							471	5,170	0	0.22	0.11	0.45	-	-	-	-
-15 to -10	-12.5							471	5,170	0	0.22	0.11	0.45	-	-	-	-
Total		1,387	1,241	1,316	3,944	1,839	2,105							14,065,421	77,195,568	-	91,260,988

PERTH AMBOY CAMPUS

Amb. Temp Bin °F	Ave Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Bin Hours	Unoccupied Bin Hours	Exposed Wall area	Exposed Roof area	Window area	Wall U factor	Roof U factor	Window U factor	Wall Heat loss	Roof Heat Loss	Windows Heat Loss	Total Heat loss
HEATING								ft^2	ft^2	ft^2	$btu/ft^2/°F$	$btu/ft^2/°F$	$btu/ft^2/°F$	btu/Yr	btu/Yr	btu/Yr	btu/Yr
55 to 60	57.5	86	144	97	327	170	157	(30)	3,600	420	0.22	0.11	0.45	(31,610)	1,896,600	896,144	2,761,134
50 to 55	52.5	109	182	172	463	242	221	(30)	3,600	420	0.22	0.11	0.45	(60,190)	3,611,400	1,706,387	5,257,597
45 to 50	47.5	105	119	142	366	180	186	(30)	3,600	420	0.22	0.11	0.45	(59,780)	3,586,800	1,694,763	5,221,783
40 to 45	42.5	185	155	177	517	239	278	(30)	3,600	420	0.22	0.11	0.45	(101,677)	6,100,600	2,882,534	8,881,457
35 to 40	37.5	236	200	241	677	314	363	(30)	3,600	420	0.22	0.11	0.45	(155,710)	9,342,600	4,414,379	13,601,269
30 to 35	32.5	237	202	198	637	293	344	(30)	3,600	420	0.22	0.11	0.45	(167,743)	10,064,600	4,755,524	14,652,380
25 to 30	27.5	121	115	113	349	164	185	(30)	3,600	420	0.22	0.11	0.45	(103,537)	6,212,200	2,935,265	9,043,928
20 to 25	22.5	149	68	97	314	127	187	(30)	3,600	420	0.22	0.11	0.45	(103,620)	6,217,200	2,937,627	9,051,207
15 to 20	17.5	95	40	46	181	70	111	(30)	3,600	420	0.22	0.11	0.45	(65,763)	3,945,800	1,864,391	5,744,427
10 to 15	12.5	39	9	28	76	28	48	(30)	3,600	420	0.22	0.11	0.45	(30,147)	1,808,800	854,658	2,633,311
5 to 10	7.5	21	5	5	31	10	21	(30)	3,600	420	0.22	0.11	0.45	(13,330)	799,800	377,906	1,164,376
0 to 5	2.5	4	2	-	6	2	4	(30)	3,600	420	0.22	0.11	0.45	(2,780)	166,800	78,813	242,833
-5 to 0	-2.5							(30)	3,600	420	0.22	0.11	0.45	-	-	-	-
-10 to -5	-7.5							(30)	3,600	420	0.22	0.11	0.45	-	-	-	-
-15 to -10	-12.5							(30)	3,600	420	0.22	0.11	0.45	-	-	-	-
Total		1,387	1,241	1,316	3,944	1,839	2,105							(895,887)	53,753,200	25,398,387	78,255,700

Middlesex County Vocational School
Exhibit D
ECM 1C Destratification Fans
De-stratifcation fans

PERTH AMBOY CAMPUS

Amb. Temp Bin °F	Ave Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Bin Hours	Unoccupied Bin Hours	Exposed Wall area	Exposed Roof area	Window area	Wall U factor	Roof U factor	Window U factor	Wall Heat loss	Roof Heat Loss	Windows Heat Loss	Total Heat loss
HEATING								ft^2	ft^2	ft^2	$btu/ft^2/°F$	$btu/ft^2/°F$	$btu/ft^2/°F$	btu/Yr	btu/Yr	btu/Yr	btu/Yr
55 to 60	57.5	86	144	97	327	170	157	330	9,400	252	0.22	0.11	0.45	347,710	4,952,233	537,686	5,837,629
50 to 55	52.5	109	182	172	463	242	221	330	9,400	252	0.22	0.11	0.45	662,090	9,429,767	1,023,832	11,115,689
45 to 50	47.5	105	119	142	366	180	186	330	9,400	252	0.22	0.11	0.45	657,580	9,365,533	1,016,858	11,039,971
40 to 45	42.5	185	155	177	517	239	278	330	9,400	252	0.22	0.11	0.45	1,118,443	15,929,344	1,729,520	18,777,308
35 to 40	37.5	236	200	241	677	314	363	330	9,400	252	0.22	0.11	0.45	1,712,810	24,394,567	2,648,627	28,756,004
30 to 35	32.5	237	202	198	637	293	344	330	9,400	252	0.22	0.11	0.45	1,845,177	26,279,789	2,853,314	30,978,280
25 to 30	27.5	121	115	113	349	164	185	330	9,400	252	0.22	0.11	0.45	1,138,903	16,220,744	1,761,159	19,120,806
20 to 25	22.5	149	68	97	314	127	187	330	9,400	252	0.22	0.11	0.45	1,139,820	16,233,800	1,762,576	19,136,196
15 to 20	17.5	95	40	46	181	70	111	330	9,400	252	0.22	0.11	0.45	723,397	10,302,922	1,118,634	12,144,953
10 to 15	12.5	39	9	28	76	28	48	330	9,400	252	0.22	0.11	0.45	331,613	4,722,978	512,795	5,567,386
5 to 10	7.5	21	5	5	31	10	21	330	9,400	252	0.22	0.11	0.45	146,630	2,088,367	226,743	2,461,740
0 to 5	2.5	4	2	-	6	2	4	330	9,400	252	0.22	0.11	0.45	30,580	435,533	47,288	513,401
-5 to 0	-2.5							330	9,400	252	0.22	0.11	0.45	-	-	-	-
-10 to -5	-7.5							330	9,400	252	0.22	0.11	0.45	-	-	-	-
-15 to -10	-12.5							330	9,400	252	0.22	0.11	0.45	-	-	-	-
Total		1,387	1,241	1,316	3,944	1,839	2,105							9,854,753	140,355,578	15,239,032	165,449,363

WOODBRIDGE CAMPUS

Amb. Temp Bin °F	Ave Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Bin Hours	Unoccupied Bin Hours	Exposed Wall area	Exposed Roof area	Window area	Wall U factor	Roof U factor	Window U factor	Wall Heat loss	Roof Heat Loss	Windows Heat Loss	Total Heat loss
HEATING								ft^2	ft^2	ft^2	$btu/ft^2/°F$	$btu/ft^2/°F$	$btu/ft^2/°F$	btu/Yr	btu/Yr	btu/Yr	btu/Yr
55 to 60	57.5	86	144	97	327	170	157	167	2,838	160	0.22	0.11	0.45	175,962	1,495,153	341,388	2,012,503
50 to 55	52.5	109	182	172	463	242	221	167	2,838	160	0.22	0.11	0.45	335,058	2,846,987	650,052	3,832,097
45 to 50	47.5	105	119	142	366	180	186	167	2,838	160	0.22	0.11	0.45	332,775	2,827,594	645,624	3,805,993
40 to 45	42.5	185	155	177	517	239	278	167	2,838	160	0.22	0.11	0.45	566,000	4,809,306	1,098,108	6,473,414
35 to 40	37.5	236	200	241	677	314	363	167	2,838	160	0.22	0.11	0.45	866,786	7,365,083	1,681,668	9,913,537
30 to 35	32.5	237	202	198	637	293	344	167	2,838	160	0.22	0.11	0.45	933,771	7,934,260	1,811,628	10,679,659
25 to 30	27.5	121	115	113	349	164	185	167	2,838	160	0.22	0.11	0.45	576,354	4,897,284	1,118,196	6,591,834
20 to 25	22.5	149	68	97	314	127	187	167	2,838	160	0.22	0.11	0.45	576,818	4,901,226	1,119,096	6,597,140
15 to 20	17.5	95	40	46	181	70	111	167	2,838	160	0.22	0.11	0.45	366,083	3,110,606	710,244	4,186,932
10 to 15	12.5	39	9	28	76	28	48	167	2,838	160	0.22	0.11	0.45	167,816	1,425,937	325,584	1,919,338
5 to 10	7.5	21	5	5	31	10	21	167	2,838	160	0.22	0.11	0.45	74,204	630,509	143,964	848,677
0 to 5	2.5	4	2	-	6	2	4	167	2,838	160	0.22	0.11	0.45	15,475	131,494	30,024	176,993
-5 to 0	-2.5							167	2,838	160	0.22	0.11	0.45	-	-	-	-
-10 to -5	-7.5							167	2,838	160	0.22	0.11	0.45	-	-	-	-
-15 to -10	-12.5							167	2,838	160	0.22	0.11	0.45	-	-	-	-
Total		1,387	1,241	1,316	3,944	1,839	2,105							4,987,102	42,375,439	9,675,576	57,038,118

Middlesex County Vocational School
Exhibit D
Boiler Efficiency Spreadsheet

*Inputs are blue
*Automatic Mechanical List pull-in colored purple

Add Controlink ECM savings to Boiler Upgrades: **N**

EXISTING												
Building	Equipment Label	Qty	Location	Replace Boiler (Y/N)	Add Burner Controls (Y/N)	Existing Fuel	Manufacturer	Model No.	Capacity (MBH)	Heating Medium	Boiler Efficiency	Percentage of Building Served
Edison Campus	EC-B-1	1	Boiler Room	Y	N	Natural Gas	Hydrotherm	MR-1200B-PV	960	Hot Water	80%	1.00
Perth Amboy Campus	PAC-B-1	5	Boiler Room	N	N	Natural Gas	Aerco	BMK-2000	1,890	Hot Water	93%	1.00
Woodbridge Campus	WC-B-1	3	Boiler Room	N	N	Natural Gas	Aerco	BMK-2000	1,860.0	Hot Water	93%	0.66
Woodbridge Campus	WC-B-2	2	Boiler Room	N	N	Natural Gas	Aerco	KC-1000	930.0	Hot Water	93%	0.33
-	-	-	-	-	-	-	-	-	-	-	0%	-
Totals		11							5,640			

PROPOSED							
Qty	Proposed Fuel	Manufacturer	Model No.	Capacity (MBH)	Heating Medium	Boiler Efficiency	Percentage of Building Served
2	Natural Gas	Lochinvar	AWN-501PM	500	Hot Water	92.0%	100.0%

BTU/SF
35

	Building Load (MBH)
Natural Gas	532
Fuel Oil #2	0
Fuel Oil #4	0
Fuel Oil #6	0
Propane	#N/A

EXISTING OVERALL BOILER EFFICIENCY

Building	Edison Campus	Perth Amboy Campus	Woodbridge Campus	Woodbridge Campus
Location	Boiler Room	Boiler Room	Boiler Room	Boiler Room
Label	EC-B-1	PAC-B-1	WC-B-1	WC-B-2
Capacity (MBTU)	960	1,890	1,860	930
Quantity	1	5	3	2
Existing Fuel	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Percentage of Building Load	100%	100%	66%	33%
Medium	Hot Water	Hot Water	Hot Water	Hot Water
Combustion Efficiency	80.0%	93.0%	93.0%	93.0%
Losses due to radiation	2.0%	2.0%	2.0%	2.0%
MCR of boilers	1.0	1.9	1.9	0.9
% Makeup water	8	8	8	8
Makeup T.D.S.	80	80	80	80
Blowdown T.D.S.	3,500	3,500	3,500	3,500
Energy Input into Boiler(s)	76	357	146	73
Feedwater temperature	180	180	180	180
Condensate Return Temperature	200	200	200	200
Makeup water temperature	60	60	60	60
Hrs/Yr of Operation	3,948	3,948	3,948	3,948
Blowdown Temperature	220	220	220	220
Heat required to raise a lb of steam	980	980	980	980
Boiler Load Rate	50.0%	50.0%	50.0%	50.0%
Present Blowdown Rate	0.00	0.00	0.00	0.00
Heat Content of Blowdown	0.00	0.00	0.00	0.00
Blowdown Loss	0.0%	0.0%	0.0%	0.0%
Radiation Losses	2.0%	2.0%	2.0%	2.0%
Overall Boiler Efficiency	**78.0%**	**91.0%**	**91.0%**	**91.0%**

PROPOSED OVERALL BOILER EFFICIENCY

	Edison Campus
Boiler Replacement	Y
Burner Control Links	N
Location	Boiler Room
Label	EC-B-1
Quantity to be Replaced	2
Proposed Fuel	Natural Gas
Combustion Efficiency	100.0%
Capacity (MBTU)	500
Medium	Hot Water
Combustion Efficiency	92.0%
Losses due to radiation	1.0%
Losses due to blowdown	2.0
% Makeup water	8
Makeup T.D.S.	80
Blowdown T.D.S.	3,500
Energy Input into Boiler(s)	76
Feedwater temperature	180
MCR of boilers	0.5
Condensate Return Temperature	200
Makeup water temperature	60
Hrs/Yr of Operation	3,948
Blowdown Temperature	230
Heat required to raise a lb of steam	980
Boiler Load Rate	50.0%
Present Blowdown Rate	0.00
Heat Content of Blowdown	0.00
Blowdown Loss	0.0%
Radiation Losses	1.0%
Overall Boiler Efficiency	**91.0%**

CALCULATIONS

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

ECM DESCRIPTION

Replace boilers in respective buildings with new high efficiency condensing boilers

DATA / ASSUMPTIONS

Typical Condensing Boiler Seasonal Efficiency =	91.5%
Heating Hours	3,948 Hours

* Utility baseline reduced by 10.5% to account for domestic hot water, science labs, and kitchen usage
* An adjusted baseline is used for the boiler baseline usage as to not double-dip on savings

MEASUREMENT AND VERIFICATION

N	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Verify all functions of the boiler control system, safety and operation. Verify air/fuel ratio is consistent through firing range. Provide training of the boiler operators

RECOVERY/SAFETY FACTOR

Safety Factor (Thermal) = 0%

A safety factor of 0 is used due to minimal variables and the proven results of this measure

FORMULAE

$Q_{savings} = ((\eta_{NEW} - \eta_{OLD}) / \eta OLD) \cdot Fuel_{ADJ}$

Variable	Units	Description
$Q_{savings}$	Therms	Thermal Savings
η_{NEW}	%	Efficiency of New Boiler
η_{OLD}	%	Efficiency of Old Boiler
$Fuel_{ADJ}$	Therms	Adjusted Boiler Fuel Usage

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

*Inputs are blue

Building	Label	Boilers to be Replaced
Edison Campus	EC-B-1	2
Totals		**2**

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions
CALCULATIONS

	Edison Campus	Total	
Label	EC-B-1		
No. of Units to be Replaced	2	**2**	
Fuel Switch	N		
Existing Fuel	Natural Gas		
Proposed Fuel	Natural Gas		
Percentage of Building Load	100%		%
Safety Factor	0%		%
Thermal Savings	1,502	**1,502**	Therms / Yr
Natural Gas Savings	1,502	**1,502**	Therms / Yr
Fuel Savings (MMBtu/yr)	150.17		
Capin	1,000		
EFLH	901		
Effb	78%		
Effq	91%		
Kbtu to MMBtu Conversion	1,000		

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

Prescriptive Boilers

This prescriptive measure targets the use of smaller-scale boilers (less than or equal to 4000 MBH) and furnaces (no size limitation) in all commercial facilities. Larger sized boilers are treated under the custom measure path.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the State of New Jersey.

Algorithms

Fuel Savings (MMBtu/yr) = Cap_{in} * $EFLH_b$ * ((Eff_q/Eff_b)-1) / 1000 kBtu/MMBtu

Definition of Variables

Cap_{in} = Input capacity of qualifying unit in kBtu/hr
$EFLH_b$ = The Equivalent Full Load Hours of operation for the average unit during the heating season in hours
Eff_b = Boiler Baseline Efficiency
Eff_q = Boiler Proposed Efficiency
1000 = Conversion from kBtu to MMBtu

Summary of Inputs

Prescriptive Boilers

Component	Type	Value	Source
Cap_{in}	Variable		Application
$EFLH_b$	Fixed	See Table Below	1
Eff_b	Variable	See Table Below	2
Eff_q	Variable		Application

$EFLH_b$ Table

Facility Type	Heating EFLH
Assembly	603
Auto repair	1910
Dormitory	465
Hospital	3366
Light industrial	714
Lodging – Hotel	1077
Lodging – Motel	619
Office – large	2034
Office – small	431
Other	681
Religious worship	722

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

Facility Type	Heating EFLH
Restaurant – fast food	813
Restaurant – full service	821
Retail – big box	191
Retail – Grocery	191
Retail – small	545
Retail – large	2101
School – Community college	1431
School – postsecondary	1191
School – primary	840
School – secondary	901
Warehouse	452

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Heating	757	723	503
High-rise, Heating	526	395	219

Baseline Boiler Efficiencies (Eff_b)

Boiler Type	Size Category (kBtu input)		Standard 90.1-2013
Hot Water – Gas fired	< 300 ≥ 300 and ≤ 2,500		82% AFUE 80% Et 82% Ec
Hot Water – Oil fired	< 300 ≥ 300 and ≤ 2,500	84% AFUE 82% Et 84% Ec	
Steam – Gas fired	< 300	80% AFUE	
Steam – Gas fired, all except natural draft	≥ 300 and ≤ 2,500	79% Et	
Steam – Gas fired, all except	> 2,500		79% Ec
Steam – Gas fired, natural draft	≥ 300 and ≤		77% Et

Middlesex County Vocational School
Exhibit D
ECM 2A Boiler Replacements
Boiler Replacement Calculation

Boiler Type	Size Category (kBtu input)		Standard 90.1-2013
Steam – Gas fired, natural draft	> 2,500		77% Ec
Steam – Oil fired	< 300	82% AFUE	
	≥ 300 and ≤ 2,500	81% Et 81% Ec	

Sources

1. New York State Joint Utilities, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, V6, April 2018. Appendix G – Equivalent Full-Load Hours (EFLH), For Heating and Cooling. P. 535-540. EFLH values for NYC due to proximity to NJ.
2. ASHRAE Standards 90.1-2013. *Energy Standard for Buildings Except Low Rise Residential Buildings*; available at: https://www.ashrae.org/standards-research--technology/standards--guidelines.

Middlesex County Vocational School
Exhibit D
Domestic Hot Water Spreadsheet

*Inputs are blue
*Automatic Mechanical List pull-in colored purple
**If Domestic Hot Water is fed off boiler put "Y" in Column F and put the respective boiler equipment label in Column C

EXISTING												
Building	Equipment Label	Qty	Location	Fed off Boiler (Y/N)	Replace DHW (Y/N)	Fuel	Manufacturer	Model No.	Capacity (MBH)	Capacity (Gal)	Combustion Efficiency	Percentage of Building DHW Load
Perth Amboy Campus	PAC-DHW-1	2	Boiler Room	N	Y	Natural Gas	PVI	1060N250-PV	600	250	0.80	100%
Edison Campus	EC-DHW-1	1	Boiler Room	N	Y	Natural Gas	Lochinvar	RWN270PM	216	200	0.80	100%
Woodbridge Campus	WC-DHW-1	2	Boiler Room	N	N	Natural Gas	AO Smith	BTH-250A-100	225	100	0.90	100%
-	-	-	-	-	-	-	-	-	-	-	-	0%
-	-	-	-	-	-	-	-	-	-	-	-	0%
-	-	-	-	-	-	-	-	-	-	-	-	0%
-	-	-	-	-	-	-	-	-	-	-	-	0%
Totals		5							1,041			

PROPOSED						
Qty	Fuel	Manufacturer	Model No.	Capacity (MBH)	Capacity (Gal)	Combustion Efficiency
2	Natural Gas	PVI	70 L 130A-GCML	692	130	96.0%
1	Natural Gas	PVI	25 L 100A-GCL	240	100	96.0%
3				932		

EXISTING DHW EFFICIENCY

Building	Perth Amboy Campus	Edison Campus	Woodbridge Campus
Label	PAC-DHW-1	EC-DHW-1	WC-DHW-1
Quantity	2	1	2
Location	Boiler Room	Boiler Room	Boiler Room
Fuel Type	Natural Gas	Natural Gas	Natural Gas
Capacity (MBTU)	600	216	225
Percentage of Building Load	100%	100%	100%
Current Efficiency	80.0%	80.0%	90.0%

PROPOSED DHW EFFICIENCY

	Perth Amboy Campus	Edison Campus
Isolate Storage Tank	N	N
Label	PAC-DHW-1	EC-DHW-1
Fuel Type	Natural Gas	Natural Gas
Quantity	2	1
Location	Boiler Room	Boiler Room
Capacity (MBTU)	692.0	240.0
Proposed Efficiency	96.0%	96.0%

Middlesex County Vocational School
Exhibit D
ECM 2B DHW Heater Replacements
Domestic Hot Water Upgrades

ECM DESCRIPTION

Replacement of Domestic Hot Water Heaters with high efficiency condensing Domestic Hot Water Heaters

MEASUREMENT AND VERIFICATION

N	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Verify all functions of the boiler control system, safety and operation. Verify air/fuel ratio is consistent through firing range. Provide training of the boiler operators

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0.0%
Safety Factor (Thermal) =	0.0%

No Safety Factor is used because of a minimal of variables

DHW REPLACEMENT CALCULATION

A. DOMESTIC HOT WATER HEATER REPLACEMENT

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Perth Amboy Campus	Edison Campus	Totals	
Label	PAC-DHW-1	EC-DHW-1		
Quantity	2	1	3	
Fuel Switch	N	N		
Existing Fuel	Natural Gas	Natural Gas		
Proposed Fuel	Natural Gas	Natural Gas		
Current DHW System Efficiency	80.0%	80.0%		%
Proposed DHW System Efficiency	96.0%	96.0%		%
Safety factor	0%	0%		
Natural Gas Savings	1,756	179	-	Therms / Yr
See				
Fuel Savings (MMBtu/Yr	176	18		
EFFb	80%	80%		
EFFq	96%	96%		
SLF	0.00053	0.00195		
CAPq	692	240		
CAPb	600	250		
EF	37%	43%		
Vq	130	100		
Vb	250	200		
TE	0.80	0.80		
SLq	2.12	1.40		
SLb	2.49	1.87		
Energy Use Density	7.00	7.00		
Area	150,000	15,200		

Middlesex County Vocational School
Exhibit D
ECM 2B DHW Heater Replacements
Domestic Hot Water Upgrades

Algorithms

Fuel Savings (MMBtu/yr) = ((1 – (EFF_b / EFF_q) + SLF^{53}) * Energy Use Density * Area / 1000 kBtu/MMBtu

where,

$SLF = (SL_b – SL_q) / Cap_q$

Definition of Variables

EFF_q = Efficiency of the qualifying water heater.
EFF_b = Efficiency of the baseline water heater, commercial grade.
EF_b = Energy Factor of the baseline water heater, commercial grade.
Energy Use Density = Annual baseline water heater energy use per square foot of commercial space served (MMBtu/sq.ft./yr)
Area = Square feet of building area served by the water heater
SLF = Standby loss factor for savings of qualifying water heater over baseline
$SL_{b \text{ or } q}$ = Standby losses in kBtu/hr of the baseline and qualifying storage water heater respectively. The baseline standby losses is calculated assuming the baseline water heater has the same input capacity rating as the qualifying unit's input capacity using

ASHRAE equipment performance standards. The qualifying unit's standby losses are available on the AHRI certificate provided with the application.
Cap_q = Rated input capacity of the qualifying water heater

Summary of Inputs

Stand Alone Storage Water Heater Assumptions

Component	Type	Value	Source
EFF_q	Variable		Application
EFF_b	Variable	See Table Below	1, 2
EF_b	Variable	See Table Below	1, 2
Energy Use Density	Variable	See Table Below	3
Area	Variable		Application
Cap_q	Variable		Application
SL_b	Variable	See Table Below	1 & Application
SL_q	Variable		Application

Efficiency of Baseline Stand Alone Storage Water Heaters

ASHRAE 90.1-2007 and 2013[a]			
Equipment Type	**Size Category (Input)**	**Existing Building Baseline Efficiency (ASHRAE 90.1-2007)**	**New Building Baseline Efficiency (ASHRAE 90.1-2013)**
Gas Storage Water Heaters	≤ 75 kBtu/hr	EF = 0.62 – 0.0019 × V	EF = 0.67 – 0.0005 × V
Gas Storage Water Heaters	> 75 kBtu/hr	TE = 0.80 SL = (Cap_q / 0.8 + 110 × √V) / 1000	TE = 0.80 SL = (Cap_q / 0.799 + 16.6 × √V) / 1000

a – EF is energy factor, TE is thermal efficiency, V is the volume of the installed storage water heater, and Cap_q is the rated input of the proposed storage water heater

Middlesex County Vocational School
Exhibit D
ECM 2B DHW Heater Replacements
Domestic Hot Water Upgrades

Energy Use Density Look-up Table

Building Type	Energy Use Density (kBtu/SF/yr)
Education	7.0
Food sales	4.4
Food service	39.2
Health care	23.7
Inpatient	34.3
Outpatient	3.9
Lodging	26.5
Retail (other than mall)	2.5
Enclosed and strip malls	14.1
Office	4.8
Public assembly	2.1
Public order and safety	21.4
Religious worship	0.9
Service	15
Warehouse and storage	2.9
Other	2.3

Middlesex County Vocational School
Exhibit D
RTU Replacement Spreadsheet

*Inputs are blue
*Automatic Mechanical List pull-in colored purple

EXISTING															
Building	Equipment Label	Qty	Location	Replace (Y/N)	DCV (Y/N)	Direct Fired	Thermal Fuel	Manufacturer	Model No.	Area Served	Tonnage	Supply CFM	Fresh Air CFM	Existing IPLV	Existing Thermal Efficiency
Edison Campus	EC-RTU-1	1	Roof	Y	N	y	Natural Gas	Trane	YCH600AELE2A7M	Building	50.0	20,000	3,000	10.5	80%
Edison Campus	EC-RTU-2	1	Roof	Y	N	y	Natural Gas	Trane	YCH600AELE2A7M	Building	50.0	20,000	3,000	10.5	80%
Perth Amboy Campus	PAC-RTU-C102	1	Roof	y	N	N	None	McQuay	RPS040CLW	C102 Gym Unit	40.0	14,400	2,160	8.0	80%
Perth Amboy Campus	PAC-RTU-C103	1	Roof	y	N	N	None	McQuay	RPS040CLW	C103 Gym Unit	40.0	14,400	2,160	8.0	80%
Perth Amboy Campus	PAC-RTU-C201	1	Roof	N	N	N	None	McQuay	RPS040CLW	C201 Cafeteria Unit	40.0	14,000	2,100	8.0	80%
Perth Amboy Campus	PAC-RTU-C101	1	Roof	N	N	N	None	McQuay	RPS040CLW	C101 C Section First Floor Classrooms/Halls	40.0	13,000	1,950	8.0	80%
Perth Amboy Campus	PAC-RTU-B201	1	Roof	N	N	N	None	McQuay	RPS060CLW	B201 Science and Second Floor Hallways	60.0	20,000	3,000	8.0	80%
Perth Amboy Campus	PAC-RTU-B101	1	Roof	N	N	N	None	McQuay	RPS060CLW	B101 First Floor Tech Shops	60.0	19,000	2,850	8.0	80%
Perth Amboy Campus	PAC-RTU-C202	1	Roof	N	N	N	None	McQuay	RPS040CLW	C202 Kitchen and ARA Supply	40.0	14,000	2,100	8.0	80%
Perth Amboy Campus	PAC-RTU-B103	1	Roof	N	N	Y	Natural Gas	Lennox	LGA102HH3G	B103 HVAC Shop	8.5	3,400	510	10.5	80%
Perth Amboy Campus	PAC-RTU-B104	1	Roof	N	N	Y	Natural Gas	Lennox	LGA102HH3G	B104 Auto Shop	8.5	3,400	510	10.5	80%
Perth Amboy Campus	PAC-RTU-9	1	Roof	N	N	Y	Natural Gas	Lennox	LGC300SH1G	B102 Wood Shop	25.0	10,000	1,500	10.5	80%
Perth Amboy Campus	PAC-RTU-10	1	Roof	N	N	Y	Natural Gas	Lennox	LGA072HH2G	B107 Garage for Loading Dock	6.0	2,400	360	10.5	80%
Perth Amboy Campus	PAC-RTU-5	1	Roof	N	N	Y	Natural Gas	Lennox	LGA102HH3G	B105 Electric Shop	8.5	3,400	510	10.5	80%
Perth Amboy Campus	PAC-RTU-11	1	Roof	N	N	y	Natural Gas	AAON	RK20-3E0750	A102 Main Office	20.0	7,000	1,050	10.5	80%
Perth Amboy Campus	PAC-MAU-1	1	Roof	N	N	N	Natural Gas	DesChamps	PVW4MWB	MUA-1	24.0	9,600	1,440	10.5	80%
Perth Amboy Campus	PAC-MAU-1	1	Roof	N	N	N	Natural Gas	DesChamps	PVW4MWB	MUA-2	24.0	9,600	1,440	10.5	80%
Perth Amboy Campus	PAC-MAU-1	1	Roof	N	N	N	Natural Gas	DesChamps	PVW4MWB	MUA-3	24.0	9,600	1,440	10.5	80%
Perth Amboy Campus	PAC-MAU-1	1	Roof	N	N	N	Natural Gas	DesChamps	PVW4MWB	MUA-4	24.0	9,600	1,440	10.5	80%
Perth Amboy Campus	PAC-RTU-7	1	Roof	N	N	N	Natural Gas	Lennox	LGA240HH3G	B106	20.0	8,000	1,200	10.5	80%
Perth Amboy Campus	PAC-RTU-2	1	Roof	N	N	N	None	MqQuay	RPS040CLW	C103	40.0	16,000	2,400	10.5	0%
Perth Amboy Campus	PAC-RTU-11	1	Roof	N	N	N	None	AAON	RK20-3E0750	A101	20.0	8,000	1,200	10.5	0%
Perth Amboy Campus	PAC-RTU-11	1	Roof	N	N	N	None	AAON	RK20-3E0750	A103	20.0	8,000	1,200	10.5	0%
Perth Amboy Campus	PAC-RTU-14	1	Roof	N	N	N	None	McQuay	RPS060CLW	A201	60.0	22,000	3,300	10.5	0%
Perth Amboy Campus	PAC-RTU-11	1	Roof	N	N	N	None	AAON	RK20-3E0750	B106	20.0	8,000	1,200	10.5	0%
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0%
Totals		25									773				

PROPOSED							
Qty	Thermal Fuel	Direct Fired	Manufacturer	Model No.	Tonnage	Proposed IPLV	Proposed Thermal Efficiency
1	Natural Gas	Y	Trane	YCH600BE	50.0	14.5	80.0%
1	Natural Gas	Y	Trane	YCH600BE	50.0	14.5	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	10.9	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	10.9	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	22.5	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	15.0	80.0%
1	None	Y	Daikin	RPS062DLW	60.0	14.5	80.0%
1	None	Y	Daikin	RPS062DLW	60.0	14.5	80.0%
1	None	Y	Daikin	RPS042DLW	40.0	22.5	80.0%
1	Natural Gas	Y	Trane	YZC102	8.5	22.5	80.0%
1	Natural Gas	Y	Trane	YZC102	8.5	22.5	80.0%
1	Natural Gas	Y	Trane	YHD300G4	25.0	15.0	80.0%
1	Natural Gas	Y	Trane	YHD072G4	6.0	14.0	80.0%
1	Natural Gas	Y	Trane	YZC102	8.5	22.5	80.0%
1	Natural Gas	Y	Trane	YHD240G4	20.0	14.0	80.0%
15					496.5		

None
Electric
Natural Gas
Fuel Oil #2
Fuel Oil #4
Fuel Oil #6
Propane

EXISTING RTU SPECIFICATIONS

Building	Edison Campus	Edison Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus
Label	EC-RTU-1	EC-RTU-2	PAC-RTU-C102	PAC-RTU-C103	PAC-RTU-C201	PAC-RTU-C101	PAC-RTU-B201	PAC-RTU-B101	PAC-RTU-C202	PAC-RTU-B103	PAC-RTU-B104	PAC-RTU-9	PAC-RTU-10	PAC-RTU-5	PAC-RTU-11	PAC-MAU-1	PAC-MAU-1	PAC-MAU-1	PAC-MAU-1	PAC-RTU-7	PAC-RTU-2	PAC-RTU-11	PAC-RTU-11	PAC-RTU-14	PAC-RTU-11
Quantity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Area Serving	Building	Building	C102 Gym Unit	C103 Gym Unit	C201 Cafeteria Unit	C101 C Section First Floor Classrooms/Halls	B201 Science and Second Floor Hallways	B101 First Floor Tech Shops	C202 Kitchen and ARA Supply	B103 HVAC Shop	B104 Auto Shop	B102 Wood Shop	B107 Garage for Loading Dock	B105 Electric Shop	A102 Main Office	MUA-1	MUA-2	MUA-3	MUA-4	B106	C103	A101	A103	A201	B106
Tonnage	50.0	50.0	40.0	40.0	40.0	40.0	60.0	60.0	40.0	8.5	8.5	25.0	6.0	8.5	20.0	24.0	24.0	24.0	24.0	20.0	40.0	20.0	20.0	60.0	20.0
Supply CFM	20,000	20,000	14,400	14,400	14,000	13,000	20,000	19,000	14,000	3,400	3,400	10,000	2,400	3,400	7,000	9,600	9,600	9,600	9,600	8,000	16,000	8,000	8,000	22,000	8,000
Fresh Air CFM	3,000	3,000	2,160	2,160	2,100	1,950	3,000	2,850	2,100	510	510	1,500	360	510	1,050	1,440	1,440	1,440	1,440	1,200	2,400	1,200	1,200	3,300	1,200
Existing EER	10.5	10.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Direct Fired	y	y	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	y	N	N	N	N	N	N	N	N	N	N
Thermal Fuel	Natural Gas	Natural Gas	None	None	None	None	None	None	None	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	None	None	None	None	None
Existing Thermal Efficiency	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%

PROPOSED RTU SPECIFICATIONS

	Edison Campus	Edison Campus	Perth Amboy Campus	Perth Amboy Campus
RTU Replacement	Y	Y	y	y
Quantity	1	1	1	1
Area Serving	Building	Building	C102 Gym Unit	C103 Gym Unit
Tonnage (Replacement)	50.0	50.0	40.0	40.0
Thermal Fuel	Natural Gas	Natural Gas	None	None
Direct Fired	Y	Y	Y	Y
Proposed EER	14.5	14.5	10.9	10.9
Proposed Thermal Efficiency	80.0%	80.0%	80.0%	80.0%

Middlesex County Vocational School
Exhibit D
ECM 2C RTU Replacements
Rooftop Unit Replacement

ECM DESCRIPTION

Replace existing Rooftop Units with high efficiency units

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Verify all functions of the rooftop system, safety and operation.

RECOVERY/SAFETY FACTOR

Safety Factor = 0%

CALCULATIONS

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Edison Campus	Edison Campus	Perth Amboy Campus	Perth Amboy Campus
Label	EC-RTU-1	EC-RTU-2	PAC-RTU-C102	PAC-RTU-C103
Fuel Switch	N	N	N	N
Existing Thermal Fuel	Natural Gas	Natural Gas	None	None
Proposed Thermal Fuel	Natural Gas	Natural Gas	None	None
Area Serving	Building	Building	C102 Gym Unit	C103 Gym Unit
Quantity	1	1	1	1
RTU Tonnage	50.0	50.0	40.0	40.0
Safety Factor	0%	0%	0%	0%
Electrical Savings	23,973	23,973	5,971	5,971
Demand Saving	9.92	9.92	2.47	2.47
Energy Savings (kWh/Yr)	23,973	23,973	5,971	5,971
N	1	1	1	1
Tons	50	50	40	40
kBtu/Ton	12	12	12	12
EERb	9.8	9.8	9.8	9.8
EERq	14.5	14.5	10.9	10.9
EFLHc	1,208	1,208	1,208	1,208

Electric HVAC Systems

This measure provides energy and demand savings algorithms for C&I Electric HVAC systems. The type of systems included in this measure are: split systems, single package systems, air to air cooled heat pumps, packaged terminal systems (PTAC and PTHP), single package vertical systems (SPVAC and SPVHP), central DX AC systems, water source heat pumps, ground water source heat pumps, and/or ground source heat pumps.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the state of New Jersey.

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * CF$

Heat Pump Algorithms:

Cooling Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Heating Energy Savings (Btu/yr) = N * Tons * 12 kBtuh/Ton * $((1/(COP_b * 3.412)) - (1/(COP_q * 3.412)) * EFLH_h$

Where c is for cooling and h is for heating.

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	13 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 11.0 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Middlesex County Vocational School
Exhibit D
ECM 2C RTU Replacements
Rooftop Unit Replacement

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Water Source Heat Pumps (water to air, water loop) <=1.4 tons >1.4 to 5.4 tons >5.4 to 11.25 tons	 12.2 EER, 4.3 heating COP 13.0 EER, 4.3 heating COP 13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[37]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners <=5.4 tons >5.4 to 11.25 tons >11.25 to 20 tons	 10.0 EER 10.0 EER 10.0 EER
Single Package Vertical Heat Pumps <=5.4 tons >5.4 to 11.25 tons >11.25 to 20 tons	 10.0 EER, 3.0 heating COP 10.0 EER, 3.0 heating COP 10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918

Middlesex County Vocational School
Exhibit D
ECM 2C RTU Replacements
Rooftop Unit Replacement

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
Condensing Unit Replacement Spreadsheet

EXISTING								
Building	Equipment Label	Qty	Replace (Y/N)	Manufacturer	Model No.	Area Served	Tonnage	Existing SEER
Perth Amboy Campus	PAC-CU-1	1	y	EMI	SCC12D	Server Room	1.0	10.5
Perth Amboy Campus	PAC-CU-2	1	y	EMI	SCC12D	Server Room	1.0	10.5
Edison Campus	EC-CU-2	1	y	Mitsubishi	PU18EK	Telephone Room	1.5	10.5
Woodbridge Campus	WC-AC-3	1	Y	Mitsubishi	PURY-100TMU-A	Original Area Porch Offices	8.5	9.0
Woodbridge Campus	WC-AC-1	1	N	Trane	2TTB3060A	Clasroom	5.0	14.0
Woodbridge Campus	WC-AC-2	1	N	Trane	2TTB3060A	Classroom	5.0	14.0
Woodbridge Campus	WC-AC-4	1	N	-	-	-	2.0	14.0
Woodbridge Campus	WC-AC-5	1	N	-	-	-	5.0	14.0
Woodbridge Campus	WC-AHUCU-1	1	N	-	-	-	6.0	11.5
Woodbridge Campus	WC-CU-1	1	N	-	-	-	1.0	14.0
Woodbridge Campus	WC-CU-2	1	N	-	-	-	2.5	14.0
Totals		11					38	

PROPOSED				
Manufacturer	Model No.	Qty	Tonnage	Proposed SEER
Trane	4TXK8509A10N0C/ 4MXW8509A10N0C	1	1.0	20.0
Trane	4TXK8509A10N0C/ 4MXW8509A10N0C	1	1.0	20.0
Trane	4TXK8518A10N0C/ 4MXW8518A10N0C	1	1.5	18.0
Trane	4TVH0144B300NB/ 4MXC8524A10N0AA	1	12.0	24.5
		4	15.5	

EXISTING CONDENSING UNIT SPECIFICATIONS

Building	Perth Amboy Campus	Perth Amboy Campus	Edison Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus
Label	PAC-CU-1	PAC-CU-2	EC-CU-2	WC-AC-3	WC-AC-1	WC-AC-2	WC-AC-4	WC-AC-5	WC-AHUCU-1	WC-CU-1	WC-CU-2
Area Serving	Server Room	Server Room	Telephone Room	Original Area Porch Offices	Clasroom	Classroom	0	0	0	0	0
Quantity	1	1	1	1	1	1	1	1	1	1	1
Tonnage	1.0	1.0	1.5	8.5	5.0	5.0	2.0	5.0	6.0	1.0	2.5
Existing EER	10.5	10.5	10.5	9.0	14.0	14.0	14.0	14.0	11.5	14.0	14.0

PROPOSED CONDENSING UNIT SPECIFICATIONS

	Perth Amboy Campus	Perth Amboy Campus	Edison Campus	Woodbridge Campus
CU Replacement	y	y	y	Y
Label	PAC-CU-1	PAC-CU-2	EC-CU-2	WC-AC-3
Area Serving	Server Room	Server Room	Telephone Room	Original Area Porch Offices
Quantity	1	1	1	1
Tonnage	1.0	1.0	1.5	12.0
Proposed EER	20.0	20.0	18.0	24.5

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

ECM DESCRIPTION

Replace existing low efficiency condensing units in respective buildings with new high efficiency condensing units with an EER of 12+

CLARIFICATIONS, DELETIONS

*Run Hours based on occupancy schedule
*Full Load is estimated at (unless stated otherwise) : 97.5 °F
*Run hours are based on chiller cutoff temperature and bin weather data

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Start up equipment ensure proper operation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

The safety factor for this ECM is taken at 0 due to some variances on the run hours and the estimated part load efficiencies of the existing chiller.

CALCULATIONS

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Perth Amboy Campus	Perth Amboy Campus	Edison Campus	
Label	PAC-CU-1	PAC-CU-2	EC-CU-2	
Area Serving	Server Room	Server Room	Telephone Room	
Condensing Unit Tonnage	1.0	1.0	1.5	
Current EER	10.8	10.8	10.8	
Proposed EER	20.0	20.0	18.0	
Safety Factor	0%	0%	0%	
Electrical Savings	120	120	133	
Peak Demand Savings	0.13	0.13	0.14	
Energy Savings (kWh/Yr)	120	120	133	
N	1	1	1	
Tons	1.0	1.0	1.5	
kBtu/Ton	12	12	12	
EERb	14.0	14.0	14.0	
EERq	20.0	20.0	18.0	
EFLHc	466	466	466	
CF	0.5	0.5	0.5	

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

Electric HVAC Systems

This measure provides energy and demand savings algorithms for C&I Electric HVAC systems. The type of systems included in this measure are: split systems, single package systems, air to air cooled heat pumps, packaged terminal systems (PTAC and PTHP), single package vertical systems (SPVAC and SPVHP), central DX AC systems, water source heat pumps, ground water source heat pumps, and/or ground source heat pumps.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the state of New Jersey.

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * CF$

Heat Pump Algorithms:

Cooling Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Heating Energy Savings (Btu/yr) = N * Tons * 12 kBtuh/Ton * $((1/(COP_b * 3.412)) - (1/(COP_q * 3.412)) * EFLH_h$

Where $_c$ is for cooling and $_h$ is for heating.

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	13 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 11.0 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[37]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918

Middlesex County Vocational School
Exhibit D
ECM 2D Split System Replacements
Condensing Unit Replacement

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
ECM 2E Chiller Replacements
Chiller Replacement and Optimization

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

Building	Chiller Cutoff (°F)	Chiller Tonnage	Current Chiller Efficiency (kW/Ton)	Proposed Chiller Efficiency (kW/Ton)	Chiller Replacement (Y/N)	Chiller Optimization (Y/N)
Woodbridge Campus	65	60	1.140	0.680	Y	N
Woodbridge Campus	65	70	1.140	0.680	Y	N
Totals		130				

CALCULATIONS

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Woodbridge Campus	Woodbridge Campus
Chiller Replacement	Y	Y
Chiller Optimization	N	N
Safety Factor	0%	0%
Electrical Savings	13,756	16,049
FLV Method		
Energy Savings (kWhr/yr)	13,756	16,049
Demand Savings	19.78	19.78
N	1	1
Tons	60	70
EFLH	466	466
FLVb	1.237	1.237
FLVq	0.745	0.745
PDC	0.67	0.67

Electric Chillers

The measurement of energy and demand savings for C&I chillers is based on algorithms with key variables.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the state of New Jersey.

Algorithms

For IPLV:

Energy Savings (kWh/yr) = N * Tons * EFLH * ($IPLV_b$ – $IPLV_q$)

Peak Demand Savings (kW) = N * Tons * PDC * ($IPLV_b$ – $IPLV_q$)

For FLV:

Energy Savings (kWh/yr) = N * Tons * EFLH * (FLV_b – FLV_q)

Peak Demand Savings (kW) = N * Tons * PDC * (FLV_b – FLV_q)

Definition of Variables

N = Number of units

Tons = Rated capacity of coolling equipment.

EFLH = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off peak periods.

PDC = Peak Duty Cycle: fraction of time the compressor runs during peak hours

$IPLV_b$ = Integrated Part Load Value of baseline equipment, kW/Ton. The efficiency of the chiller under partial-load conditions.

$IPLV_q$ = Integrated Part Load Value of qualifying equipment, kW/Ton. The efficiency of the chiller under partial-load conditions.

FLV_b = Full Load Value of baseline equipment, kW/Ton. The efficiency of the chiller under full-load conditions.

FLV_q = Full Load Value of qualifying equipment, kW/Ton. The efficiency of the chiller under full-load conditions.

Summary of Inputs

Electric Chiller Assumptions

Electric Chillers Component	Type	Situation	Value	Source
Tons	Rated Capacity, Tons	All	Varies	From Application
$IPLV_b$ (kW/ton)	Variable	See table below	Varies	1
$IPLV_q$ (kW/ton)	Variable	All	Varies	From Application (per AHRI Std.

Electric Chillers Component	Type	Situation	Value	Source
				550/590)
FLV_b (kW/ton)	Variable	See table below	Varies	1
FLV_q (kW/ton)	Variable	All	Varies	From Application (per AHRI Std. 550/590)
PDC	Fixed	All	67%	Engineering Estimate
EFLH	Variable	All	See Table Below	2

Electric Chillers – New Construction

Type	Capacity	ASHRAE 90.1 2013 effective 1/1/2015 [a]			
		Path A		Path B	
		Full Load kW/ton	IPLV kW/ton	Full Load kW/ton	IPLV kW/ton
Air Cooled	tons < 150	*10.1* 1.188	*13.7* 0.876	*9.7* 1.237	*15.8* 0.759
	tons ≥ 150	*10.1* 1.188	*14.0* 0.857	*9.7* 1.237	*16.1* 0.745
Water Cooled Positive Displacement (rotary screw and scroll)	tons < 75	0.750	0.600	0.780	0.500
	75 ≤ tons < 150	0.720	0.560	0.750	0.490
	150 ≤ tons < 300	0.660	0.540	0.680	0.440
	300 ≤ tons < 600	0.610	0.520	0.625	0.410
	tons ≥ 600	0.560	0.500	0.585	0.380
Water Cooled Centrifugal	tons < 150	0.610	0.550	0.695	0.440
	150 ≤ tons < 300	0.610	0.550	0.635	0.400
	300 ≤ tons < 400	0.560	0.520	0.595	0.390
	400 ≤ tons < 600	0.560	0.500	0.585	0.380
	tons ≥ 600	0.560	0.500	0.585	0.380

a – Values in italics are EERs.

EFLH Table

Facility Type	Cooling EFLH
Assembly	669
Auto repair	426
Dormitory	800

Middlesex County Vocational School
Exhibit D
ECM 2E Chiller Replacements
Chiller Replacement and Optimization

Facility Type	Cooling EFLH
Hospital	1424
Light industrial	549
Lodging – Hotel	2918
Lodging – Motel	1233
Office – large	720
Office – small	955
Other	736
Religious worship	279
Restaurant – fast food	645
Restaurant – full service	574
Retail – big box	1279
Retail – Grocery	1279
Retail – small	882
Retail – large	1068
School – Community college	846
School – postsecondary	1208
School – primary	394
School – secondary	466
Warehouse	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
High-rise, Cooling	793	843	954

Middlesex County Vocational School
Exhibit D
ECM 2F Motor and VFD Replacements
Variable Frequency Drives and Motor Replacements

ECM DESCRIPTION

There are standard efficiency motors and motors that need to be replaced due to poor condition throughout the district. These motors will be replaced with premium high efficiency motors to save electrical energy. In addition some new motors will be equipped with variable frequency drives (VFDs) for additional savings.

DATA / ASSUMPTIONS

Load Factor	70%

*VFD run speed percentages are based on typical VFD curves for hot water / chilled water loops
*Run hours are based on the audit, data logging, and through interviews with facility staff

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Review installation documents for alignments and vibrations. Start up equipment and measure vibration through the load range along with motor kW. Verify that VFDs are capable of operating in full design range upon the control signal demand.

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%

CALCULATIONS (MOTOR)

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Woodbridge Campus	Perth Amboy Campus	Woodbridge Campus
kW Savings	0.962	0.113	0.039
kWh Savings	8,267	5,199	8,844
Motor			
Delta kW	0.050	0.146	0.050
HP	5.0	3.0	5.0
IFvfd	0.90	0.90	0.90
LF	0.75	0.75	0.75
Nbase	0.895	0.845	0.895
Nprem	0.907	0.900	0.907
Hrs	2,745	2,745	2,745
CF	0.74	0.74	0.74
Demand Savings	0.037	0.108	0.037
Energy Savings	102	300	102
VFD			
N	1	1	1
HP	5	3	5
ESF	1,633	1,633	1,548
DSF	0.185	0.185	0.096
Energy Savings	8,165	4,899	7,740
Peak Demand Savings	0.9250	0.5550	0.4800

Middlesex County Vocational School
Exhibit D
ECM 2F Motor and VFD Replacements
Variable Frequency Drives and Motor Replacements

Variable Frequency Drives

This section provides algorithms and assumptions for reporting of energy and demand savings for C/I Variable Frequency Drive (VFD) installations for HVAC systems including: supply air fans, return air fans, chilled water and condenser water pumps, hot water circulation pumps, water source heat pump circulation pumps, cooling tower fans, and boiler feed water pumps. VFD applications for other end uses should follow the custom path.

Algorithms

Energy Savings (kWh/yr) = N * HP * ESF

Peak Demand Savings (kW) = N * HP * DSF

Definitions of Variables

N = Number of motors controlled by VFD(s) per application
HP = Nameplate motor horsepower or manufacturer specification sheet per application
ESF = Energy Savings Factor (kWh/year per HP)
DSF = Demand Savings Factor (kW per HP)

Summary of Inputs

Variable Frequency Drives

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
ESF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3
DSF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3

The ESF for the supply and return fans and circulating pumps are derived from a 2014 NEEP-funded study of 400 VFD installations in eight northeast states. The derived values are based on actual logged input power data and reflect average operating hours, load factors, and motor efficiencies for the sample. Savings factors representing cooling tower fans and boiler feed water pumps are not reflected in the NEEP report. Values representing these applications are taken from April 2018 New York TRM, Appendix K, and represent average values derived from DOE2.2 simulation of various building types

and climate zones, supplemented with results from an earlier analysis of actual program data completed by NSTAR in 2010.

The DSF are derived from the same sources. The NEEP values reflect the actual average impact for the category occurring in the PJM defined peak demand period. The NY values are based on a similar but not identically defined peak period. In all cases the values are expressed in kW/HP rating of the controlled motor and reflect average load factors during the peak period and motor efficiencies for the sample.

VFD Savings Factors

Application	ESF (kWh/Year-HP)	DSF (kW/HP)	Source
Supply Air Fan	2,033	0.286	1
Return Air Fan	1,788	0.297	1
CHW or CW Pump	1,633	0.185	1
HHW Pump	1,548	0.096	1
WSHP Pump	2,562	0.234	1
CT Fan	290	-0.025	2, 3
Boiler Feedwater Pump	1,588	0.498	2, 3

Motors

For premium efficiency motors 1-200 HP.

Algorithms

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * HP * IF_{VFD} * (1/\eta_{base} - 1/\eta_{prem})$$

Demand Savings = (ΔkW) * CF

Energy Savings = (ΔkW)*HRS * LF

Definition of Variables

ΔkW = kW Savings at full load

HP = Rated horsepower of qualifying motor, from nameplate/manufacturer specs.

LF = Load Factor, percent of full load at typical operating condition

IF_{VFD} = VFD Interaction Factor, 1.0 without VFD, 0.9 with VFD

η_{base} = Efficiency of the baseline motor

η_{prem} = Efficiency of the energy-efficient motor

HRS = Annual operating hours

CF = Coincidence Factor

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
η_{base}	Fixed	ASHRAE 90.1-2013 Baseline Efficiency Table	ASHRAE
η_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

Middlesex County Vocational School
Exhibit D
ECM 2F Motor and VFD Replacements
Variable Frequency Drives and Motor Replacements

NEMA ASHRAE 90.1-2013 Motor Efficiency Table – General Purpose Subtype I

Motor	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
Horsepower	ODP	TEFC	ODP	TEFC	ODP	TEFC
1	0.825	0.825	0.855	0.855	0.77	0.77
1.5	0.865	0.875	0.865	0.865	0.84	0.84
2	0.875	0.885	0.865	0.865	0.855	0.855
3	0.885	0.895	0.895	0.895	0.855	0.865
5	0.895	0.895	0.895	0.895	0.865	0.885
7.5	0.902	0.91	0.91	0.917	0.885	0.895
10	0.917	0.91	0.917	0.917	0.895	0.902
15	0.917	0.917	0.93	0.924	0.902	0.91
20	0.924	0.917	0.93	0.93	0.91	0.91
25	0.93	0.93	0.936	0.936	0.917	0.917
30	0.936	0.93	0.941	0.936	0.917	0.917
40	0.941	0.941	0.941	0.941	0.924	0.924
50	0.941	0.941	0.945	0.945	0.93	0.93
60	0.945	0.945	0.95	0.95	0.936	0.936
75	0.945	0.945	0.95	0.954	0.936	0.936
100	0.95	0.95	0.954	0.954	0.936	0.941
100	0.95	0.95	0.954	0.954	0.941	0.95
150	0.954	0.958	0.958	0.958	0.941	0.95
200	0.954	0.958	0.958	0.962	0.95	0.954

Annual Operating Hours Table

Motor Horsepower	Operating Hours, HRS
1 to 5 HP	2,745
6 to 20 HP	3,391
21 to 50 HP	4,067
51 to 100 HP	5,329
101 to 200 HP	5,200

Middlesex County Vocational School
Exhibit D
ECM 2G Kitchen Hood Control
Kitchen Hood Replacement

ECM DESCRIPTION

Kitchen hoods in the district's kitchens are ventilated by exhaust fans. Fans are running most of the time at full speed when kitchen is in operation even if there are no activities under the hoods. e new ventilaton control systems will control exhaust fans based on hood exhaust temperatures. The exhaust fan will be equipped with VFDs will control air flows. If the exhaust fan is combined with a make up air unit, then variable air flow will be controlled on both exhaust and make up air fans.

DATA / ASSUMPTIONS

Existing equipment schedule was given by personnel operating the kitchen equipment and with interviews with facility staff

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Test exhaust fans and make up air units that they operate per design intent, which include simulation of the exhaust temperature driving fan motor speeds. Verify all safety interlocks.

RECOVERY/SAFETY FACTOR

Recovery/Safety Factor (Electric) =	0%
Recovery/Safety Factor (Thermal) =	0%

Middlesex County Vocational School
Exhibit D
ECM 2G Kitchen Hood Control
Kitchen Hood Replacement

* Inputs are in blue

Building	Kitchen Hood Area (ft^2)	HP of Exhaust Fan Motor	HP of MAU Motor	Annual Run Hours	System Efficiency	Current Exhaust Volume (CFM)	
Perth Amboy Campus	40	1.5	3.7	1,440	65%	3,000	KEF-4A
Perth Amboy Campus	64	3.0	6.1	1,440	65%	4,900	KEF-1
Perth Amboy Campus	64	3.0	6.1	1,800	65%	4,900	KEF-2
Perth Amboy Campus	40	1.5	3.7	1,800	65%	3,000	KEF-4B
Perth Amboy Campus	40	2.0	4.3	1,800	65%	3,500	KEF-3A
Perth Amboy Campus	40	2.0	4.6	1,800	65%	3,675	KEF-3B
Totals	**288**	**13.0**	**28.5**			**22,975**	
						1200	KEF-5
						24,175	

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

Exhaust Fan Schedule

	EF Name	CFM	Fan HP	Interlock
1	KEF-1	4900	3	MUA-1 + Local Switch
2	KEF-2	4900	3	MUA-2 + Local Switch
3	KEF-3A	3500	2	MUA-3 + Local Switch
4	KEF-3B	3675	2	MUA-3 + Local Switch
5	KEF-4A	3000	1.5	MUA-4 + Local Switch
6	KEF-4B	3000	1.5	MUA-4 + Local Switch
7	KEF-5	1200	0.33	Local Switch
		24175	13.33	

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus		Total	
Safety Factor	0%	0%	0%	0%	0%	0%			%
Electrical Savings	3,401	6,753	6,753	3,401	4,525	4,525		**29,357**	kWh/Yr
Thermal Savings	9.17	14.67	14.67	9.17	9.17	9.17		**66**	Therms/Yr

Fan Savings (kWh/yr)	3,374.35	6,711.00	6,711.00	3,374.35	4,499.13	4,499.13
N	1	1	1	1	1	1
HP	1.5	3.0	3.0	1.5	2.0	2.0
LF	0.90	0.90	0.90	0.90	0.90	0.90
RH	5,250	5,250	5,250	5,250	5,250	5,250
PR	0.568	0.568	0.568	0.568	0.568	0.568
FEFF	0.89	0.895	0.895	0.89	0.89	0.89
Heating Savings (MMBtu/yr)	0.917	1.467	1.467	0.917	0.917	0.917
SF	40	64	64	40	40	40
CFM/SF	0.70	0.70	0.70	0.70	0.70	0.70
OF	1.40	1.40	1.40	1.40	1.40	1.40
FR	0.295	0.295	0.295	0.295	0.295	0.295
HDD	2,783	2,783	2,783	2,783	2,783	2,783
Heff	0.91	0.91	0.91	0.91	0.91	0.91
Cooling Savings (kWh/yr)	26.15	41.84	41.84	26.15	26.15	26.15
SF	40	64	64	40	40	40
CFM/SF	0.70	0.70	0.70	0.70	0.70	0.70
OF	1.40	1.40	1.40	1.40	1.40	1.40
FR	0.295	0.295	0.295	0.295	0.295	0.295
CDD	893	893	893	893	893	893
Ceff	3.00	3.00	3.00	3.00	3.00	3.00

Middlesex County Vocational School
Exhibit D
ECM 2G Kitchen Hood Control
Kitchen Hood Replacement

New and Retrofit Kitchen Hoods with Variable Frequency Drives

Kitchen Hoods with Variable Frequency Control utilize optical and temperature sensors at the hood inlet to monitor cooking activity. Kitchen hood exhaust fans are throttled in response to real time ventilation requirements. Energy savings result from fan power reduction during part load operation as well as a decrease in heating and cooling requirement of make-up air.

Algorithms

Electric Fan Savings (kWh/yr) = N * (HP * *LF * 0.746/FEFF) * RH * PR

Heating Savings (MMBtu/yr) = SF * CFM/SF * OF * FR * HDD * 24 * 1.08 / (HEFF * 1,000,000)

Cooling Savings (kWh/yr) = SF * CFM/SF * OF * FR * CDD * 24 * 1.08 / (CEFF * 3,412)

Definition of Variables

N = Number of Kitchen Hood Fan Motors
HP = Kitchen Hood Fan Motor HP
LF = Existing Motor Loading Factor
0.746 = Conversion factor = HP to kW
F_{EFF} = Efficiency of Kitchen Hood Fan Motors (%)
RH = Kitchen Hood Fan Run Hours
PR = Fan Motor Power Reduction resultant from VFD/Control Installation
SF = Kitchen Square Footage
CFM/SF = Code required ventilation rate per square foot for Commercial Kitchen spaces
OF = Ventilation rate oversize factor (compared to code requirement)
FR = Flow Reduction resultant from VFD/Control Installation
HDD_{mod} = Modified Heating Degree Days based on location and facility type
CDD_{mod} = Modified Cooling Degree Days based on location and facility type
24 = Hours per Day
1.08 = Sensible heat factor for air ((Btu/hr) / (CFM * Deg F))
H_{EFF} = Efficiency of Heating System (AFUE %)
C_{EFF} = Efficiency of Cooling System (COP)
3,412 = Conversion factor from Btu to kWh (3,412 Btu = 1 kWh)
1,000,000 = Btu/MMBtu

Summary of Inputs

Kitchen Hoods with VFDs

Component	Type	Value	Source
N	Variable	Quantity	Application
HP	Variable	Nameplate	Application
LF	Fixed	0.9	Melink Analysis Sample[39]
F_{EFF}	Variable	Based on Motor HP	NEMA Premium Efficiency, TEFC 1800 RPM
RH	Variable	See Table Below	2
PR	Variable	See Table Below	2
SF	Variable	Kitchen Square Footage	Application
CFM / SF	Fixed	0.7	1
OF	Fixed	1.4	Estimated Typical Kitchen Design[40]
FR	Variable	Based on Facility Type	2
HDD_{mod}	Variable	See Table Below	3
CDD_{mod}	Variable	See Table Below	4
H_{EFF}	Fixed	0.8	Estimated Heating System Efficiency[41]
C_{EFF}	Fixed	3.00	Estimated Cooling System Efficiency[42]

Middlesex County Vocational School
Exhibit D
ECM 2G Kitchen Hood Control
Kitchen Hood Replacement

Facility-Specific Values Table

Facility Type	Run Hours	Power Reduction (PR)	Flow Reduction (FR)
Campus	5250	0.568	0.295
Lodging	8736	0.618	0.330
Restaurant	5824	0.552	0.295
Supermarket	5824	0.597	0.320
Other	5250	0.584	0.310

Modified Heating Degree Days Table

Building Type	Heating Energy Density (kBtu/sf)	Degree Day Adjustment Factor	Atlantic City (HDD)	Newark (HDD)	Philadelphia (HDD)	Monticello (HDD)
Education	29.5	0.55	2752	2783	2655	3886
Food Sales	35.6	0.66	3369	3359	3204	4689
Food Service	39.0	0.73	3691	3680	3510	5137
Health Care	53.6	1.00	5073	5057	4824	7060
Lodging	15.0	0.28	1420	1415	1350	1976
Retail	29.3	0.55	2773	2764	2637	3859
Office	28.1	0.52	2660	2651	2529	3701
Public Assembly	33.8	0.63	3199	3189	3042	4452
Public Order/Safety	24.1	0.45	2281	2274	2169	3174
Religious Worship	29.1	0.54	2754	2745	2619	3833
Service	47.8	0.89	4524	4510	4302	6296
Warehouse/Storage	20.2	0.38	1912	1906	1818	2661

Modified Cooling Degree Days Table

Building Type	Degree Day Adjustment Factor	Atlantic City (CDD)	Newark (CDD)	Philadelphia (CDD)	Monticello (CDD)
Education	0.55	824	893	806	625
Food Sales	0.66	989	1071	967	750
Food Service	0.73	1094	1185	1069	830
Health Care	1.00	1499	1623	1465	1137
Lodging	0.28	420	454	410	318
Retail	0.55	824	893	806	625
Office	0.52	779	844	762	591
Public Assembly	0.63	944	1022	923	716
Public Order/Safety	0.45	675	730	659	512
Religious Worship	0.54	809	876	791	614
Service	0.89	1334	1444	1304	1012
Warehouse/Storage	0.38	570	617	557	432

Middlesex County Vocational School
Exhibit D
ECM 2H Refrigeration Controls
Walk-In Freezer/Cooler Controllers

ECM DESCRIPTION

Installation of a refrigeration controller made by intellidyne on walk-in freezers and refrigerators. This will reduce cycling and improve operating efficiency of the compressor.

DATA / ASSUMPTIONS

Assumed compressor and controller savings	15%	
Assumed Run Hours	4,200	Hours
KW of Refrigerator Unit	1.152	
KW of Freezer Unit	2.863	

MEASUREMENT AND VERIFICATION

Optption A—Retrofit Isolation with Key Parameter Measurement

COMMISSIONING

Test compressors after installation.

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

Recovery factor taken at 0 due to few installations and not proven savings record.

*Inputs are blue

Building	Location	No. of Walk-In Refrigators	No. of Walk-In Freezers	kW of Refrigator	kW of Freezer
Perth Amboy Campus	Classroom Kitchen	1	-	1.152	
Perth Amboy Campus	Classroom Kitchen	-	1		2.863
Perth Amboy Campus	Kitchen	1	-	1.152	
Perth Amboy Campus	Kitchen	-	1		2.863
-	-	-	-		
-	-	-	-		
-	-	-	-		
Totals	**-**	**2**	**2**	**2.3**	**5.7**

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

CALCULATIONS

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus
No. of Walk-In Refrigerators	1	0	1	0
No. of Walk-In Freezers	0	1	0	1
Safety Factor	0%	0%	0%	0%
Electrical Savings	214	533	214	533
kWh Savings EC	214.40	532.83	214.40	532.83
Amps Cp	3.20	7.95	3.20	7.95
Volts Cp	208	208	208	208
Phase Cp^1/2	1.73	1.73	1.73	1.73
WH	2195	2195	2195	2195
NWH	6565	6565	6565	6565

Totals	
2	
2	
1,494	kWh/Yr

Middlesex County Vocational School
Exhibit D
ECM 2H Refrigeration Controls
Walk-In Freezer/Cooler Controllers

Algorithms

Gross Energy Savings (kWh/yr) = $kWh\ Savings_{EF} + kWh\ Savings_{RH} + kWh\ Savings_{EC}$

$kWh\ SavingsEF$ = $((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * 8{,}760 * 35.52\%$

$kWh\ SavingsRH = kWh\ Savings_{EF} * 0.28 * 1.6$

$kWh\ SavingsEC$ = $(((Amps_{CP} * Volts_{CP} * (Phase_{CP})^{1/2})/1000) * 0.85 * ((35\% * WH) + (55\% * NWH)) * 5\%) + (((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * 8{,}760 * 35.52\% * 5\%)$

Gross kW Savings = $((Amps_{EF} * Volts_{EF} * (Phase_{EF})^{1/2})/1000) * 0.55 * D$

Definition of Variables

$kWh\ Savings_{EF}$	= Savings due to Evaporator Fan being off
$kWh\ Savings_{RH}$	= Savings due to reduced heat from Evaporator Fans
$kWh\ Savings_{EC}$	= Savings due to the electronic controls on compressor and evaporator
$Amps_{EF}$	= Nameplate Amps of Evaporator Fan
$Volts_{EF}$	= Nameplate Volts of Evaporator Fan
$Phase_{EF}$	= Phase of Evaporator Fan
0.55	= Evaporator Fan Motor power factor
8,760	= Annual Operating Hours

35.52%	= Percent of time Evaporator Fan is turned off
0.28	= Conversion from kW to tons (Refrigeration)
1.6	= Efficiency of typical refrigeration system in kW/ton [3]
$Amps_{CP}$	= Nameplate Amps of Compressor
$Volts_{CP}$	= Nameplate Volts of Compressor
$Phase_{CP}$	= Phase of Compressor
0.85	= Compressor power factor.
35%	= Compressor duty cycle during winter months
WH	= Compressor hours during winter months
55%	= Compressor duty cycle during non-winter months
NWH	= Compressor hours during non-winter months (6,565)
5%	= Reduced run time of Compressor and Evaporator due to electronic controls
D	= Diversity Factor

Middlesex County Vocational School
Exhibit D
ECM 2H Refrigeration Controls
Walk-In Freezer/Cooler Controllers

Summary of Inputs

Evaporator Fan Control - Commercial Refrigeration

Component	Type	Value	Source
$Amps_{EF}$	Variable	Manufacturer data	Application
$Volts_{EF}$	Variable	Manufacturer data	Application
$Phase_{EF}$	Variable	Manufacturer data	Application
0.55	Variable	Default	Estimate
8,760	Variable	Default	Estimate
35.52%	Variable	Default	Estimate[44]
0.28	Variable	Conversion	
1.6	Variable	Default	Estimate, 1
$Amps_{CP}$	Variable	Manufacturer data	Application
$Volts_{CP}$	Variable	Manufacturer data	Application
$Phase_{CP}$	Variable	Manufacturer data	Application
0.85	Variable	Default	Estimate
35%	Variable	Default	Estimate

Component	Type	Value	Source
WH	Variable	2,195 - Default	Estimate
55%	Variable	Default	Estimate
NWH	Variable	6,565 - Default	Estimate
5%	Variable	Default	2
D	Variable	0.228	3

Middlesex County Vocational School
Exhibit D
ECM 2I Window AC Unit Replacements
Window AC Replacement

ECM DESCRIPTION

Replace existing low efficiency window units in respective buildings with new high efficiency window units with an EER of 12+

DATA / ASSUMPTIONS

*Run Hours based on occupancy schedule
*Full Load is estimated at (unless stated otherwise) : 97.5 *F
*Run hours are based on chiller cutoff temperature and bin weather data

MEASUREMENT AND VERIFICATION

Y Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y Option C – Utility Data Analysis

COMMISSIONING

Start up equipment ensure proper operation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

d

CALCULATIONS

	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus	Woodbridge Campus
Label	WC-WU-1	WC-WU-2	WC-WU-3	WC-WU-4	WC-WU-5	WC-WU-6	WC-WU-7	WC-WU-8
Qty	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Area Serving	Offices	Offices	Offices	Offices	Offices	Offices	Offices	Offices
Condensing Unit Tonnage	1.5	1.5	1.5	2.0	2.0	2.0	1.5	1.5
Current EER	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Proposed EER	16.4	16.4	16.4	16.2	16.2	16.2	16.4	16.4
Safety Factor	0%	0%	0%	0%	0%	0%	0%	0%
Electrical Savings	227	227	227	281	281	281	227	227

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

Energy Savings (kWh/Yr)	227	227	227	281	281	281	227	227
Demand Savings	0.09	0.09	0.09	0.12	0.12	0.12	0.09	0.09
N	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Tons	1.5	1.5	1.5	2.0	2.0	2.0	1.5	1.5
kBtu/Ton	12	12	12	12	12	12	12	12
EERb	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
EERq	16.4	16.4	16.4	16.2	16.2	16.2	16.4	16.4
EFLHc	1,208	1,208	1,208	1,208	1,208	1,208	1,208	1,208
CF	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Middlesex County Vocational School
Exhibit D
ECM 2I Window AC Unit Replacements
Window AC Replacement

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * (1/EER_b-1/EER_q) * $EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * (1/EER_b-1/EER_q) * CF

Heat Pump Algorithms:

Cooling Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * (1/EER_b-1/EER_q) * $EFLH_c$

Heating Energy Savings (Btu/yr) = N * Tons * 12 kBtuh/Ton * ((1/ (COP_b * 3.412))-(1/ (COP_q * 3.412)) * $EFLH_h$

Where *c* is for cooling and *h* is for heating.

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	13 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 11.0 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Middlesex County Vocational School
Exhibit D
ECM 2I Window AC Unit Replacements
Window AC Replacement

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[27]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918

Middlesex County Vocational School
Exhibit D
ECM 2I Window AC Unit Replacements
Window AC Replacement

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
ECM 2J Multi-Zone VRFSystem Replacement
Multi-Zone VRF

ECM DESCRIPTION

Replace existing low efficiency condensing units in respective buildings with new high efficiency condensing units with an EER of 12+

CLARIFICATIONS, DELETIONS

*Run Hours based on occupancy schedule
*Full Load is estimated at (unless stated otherwise) : 97.5 °F
*Run hours are based on chiller cutoff temperature and bin weather data

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
N	Option C – Utility Data Analysis

COMMISSIONING

Start up equipment ensure proper operation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

The safety factor for this ECM is taken at 0 due to some variances on the run hours and the estimated part load efficiencies of the existing chiller.

Heat pump calcs

CALCULATIONS

See NJ Clean Energy Program Protocols Release Date May 2019 for Algotithms and Definitions

	Woodbridge Campus			
Label	WC-AC-3			
Area Serving	Original Area Porch Offices			
Condensing Unit Tonnage	12.0			
Safety Factor	0%			
Electrical Savings	1,084			
Therm Savings	14.364138			

Heat Pump

Cooling Savings (kWh)	1,084
Heating Savings (Btu/year)	1,436,414
N	1
Tons	12.0
kBtu/Ton	12
EERb	10.4
EERq	12.5
EFLHc	466
EFLHh	901
COPb	3.20
COPq	3.64

Electric HVAC Systems

This measure provides energy and demand savings algorithms for C&I Electric HVAC systems. The type of systems included in this measure are: split systems, single package systems, air to air cooled heat pumps, packaged terminal systems (PTAC and PTHP), single package vertical systems (SPVAC and SPVHP), central DX AC systems, water source heat pumps, ground water source heat pumps, and/or ground source heat pumps.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2013, which is the current code adopted by the state of New Jersey.

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * CF$

Heat Pump Algorithms:

Cooling Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Heating Energy Savings (Btu/yr) = N * Tons * 12 kBtuh/Ton * $((1/(COP_b * 3.412)) - (1/(COP_q * 3.412))) * EFLH_h$

Where $_c$ is for cooling and $_h$ is for heating.

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	13 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 11.0 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2013
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[37]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
ECM 3A Building Management Control Systems
BMS Upgrades

ECM DESCRIPTION

The building managament system for the school district will be upgraded. Where the DDC system exists it will be incorporated into a web-based system. The pnaumatic control system in some buildings will be replaced with new DDC controls. The new DDC system will be a web based type that allows remote access to a personnel from any computer using a security password.

DATA / ASSUMPTIONS

Heating Hours 3,948 Hours
Elctrical use % as per 20%

*Schedules and temperatures are based on data logging trends performed throughout the building

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Verify functions of all installed controllers. Verify that control loops work properly. Verify function of all alarms installed in the system. Verify that all installed control variables and set points can be set and managed remotely

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%
Safety Factor (Thermal) =	0%

FORMULAE

	EXISTING					PROPOSED			
Building	Percentage of Building	Occupied Heating Temperature (°F)	Unoccupied Heating Temperature (°F)	Occupied Cooling Temperature (°F)	Unoccupied Cooling Temperature (°F)	Occupied Heating Temperature (°F)	Unoccupied Heating Temperature (°F)	Occupied Cooling Temperature (°F)	Unoccupied Cooling Temperature (°F)
Perth Amboy Campus	100%	72.0	72.0	70.0	72.0	72.0	60.0	72.0	80.0
Edison Campus	100%	72.0	72.0	70.0	72.0	72.0	60.0	72.0	80.0
Woodbridge Campus	100%	72.0	72.0	70.0	72.0	72.0	60.0	72.0	80.0

Middlesex County Vocational School
Exhibit D
ECM 3A Building Management Control Systems
BMS Upgrades

THERMAL NIGHT SETBACK SAVINGS CALCULATIONS

	Perth Amboy Campus	Edison Campus	Woodbridge Campus	East Brunswick Campus	Piscataway Campus
Safety Factor	0%	0%	0%	0%	0%
Thermal Savings	24,648	4,771	19,405	-	-

ELECTRIC NIGHT SETBACK SAVINGS CALCULATIONS

Safety Factor	0%	0%	0%	0%	0%
Electrical Savings	226,906	45,521	35,016	-	-

Cooling Savings (kWh/yr)	226,906	45,521	35,016
Tc	72	72	72
Hours	70	70	70
Sc	80	80	80
Pc	6%	6%	6%
Caphp	648	130	100
EFLHc	1,208	1,208	1,208
EERhp	11.00	11.00	11.00
Heating Savings (Therms)	24,648	4,771	19,405
Th	72	72	72
H	70	70	70
Sh	60	60	60
Ph	3%	3%	3%
Caph	9,450,000	1,608,000	7,440,000
EFLHh	1,191	1,191	1,191
AFUEh	91%	80%	91%

Middlesex County Vocational School
Exhibit D
ECM 3A Building Management Control Systems
BMS Upgrades

Occupancy Controlled Thermostats

The program has received a large amount of custom electric applications for the installation of Occupancy Controlled Thermostats in hotels, motels, and, most recently, university dormitories.

Standard practice today is thermostats which are manually controlled by occupants to regulate temperature within a facility. An occupancy controlled thermostat is a thermostat paired with a sensor and/or door detector to identify movement and determine if a room is occupied or unoccupied. If occupancy is sensed by the sensor, the thermostat goes into an occupied mode (i.e., programmed setpoint). If a pre-programmed time frame elapses (i.e., 30 minutes) and no occupancy is sensed during that time, the thermostat goes into an unoccupied mode (e.g., setback setpoint or off) until occupancy is sensed again. This type of thermostat is often used in hotels to conserve energy.

The occupancy controlled thermostat reduces the consumption of electricity and/or gas by requiring less heating and/or cooling when a room or a facility is vacant or unoccupied.

Algorithms

Cooling Energy Savings (kWh/yr) = $(((T_c * (H+5) + S_c * (168 - (H+5)))/168) - T_c) * (P_c * Cap_{hp} * 12 * EFLH_c/EER_{hp})$

Heating Energy Savings (kWh/yr) = $(T_h - ((T_h * (H+5) + S_h * (168 - (H+5)))/168)) * (P_h * Cap_{hp} * 12 * EFLH_h/EER_{hp})$

Heating Energy Savings (Therms/yr) = $(T_h - ((T_h * (H+5) + S_h * (168 - (H+5)))/168) * (P_h * Cap_h * EFLH_h/AFUE_h/100{,}000)$

Definition of Variables

T_h = Heating Season Facility Temp. (°F)
T_c = Cooling Season Facility Temp. (°F)
S_h = Heating Season Setback Temp. (°F)
S_c = Cooling Season Setup Temp. (°F)
H = Weekly Occupied Hours
Cap_{hp} = Connected load capacity of heat pump/AC (Tons) – Provided on Application.
Cap_h = Connected heating load capacity (Btu/hr) – Provided on Application.
$EFLH_c$ = Equivalent full load cooling hours
$EFLH_h$ = Equivalent full load heating hours
P_h = Heating season percent savings per degree setback
P_c = Cooling season percent savings per degree setup
$AFUE_h$ = Heating equipment efficiency – Provided on Application.
EER_{hp} = Heat pump/AC equipment efficiency – Provided on Application

12 = Conversion factor from Tons to kBtu/hr to acquire consumption in kWh.
168 = Hours per week.
7 = Assumed weekly hours for setback/setup adjustment period (based on 1 setback/setup per day, 7 days per week).

Summary of Inputs

Occupancy Controlled Thermostats

Component	Type	Value	Source
T_h	Variable		Application
T_c	Variable		Application
S_h	Fixed	T_h-5°	
S_c	Fixed	T_c+5°	
H	Variable		Application; Default of 84 hrs/week
Cap_{hp}	Variable		Application
Cap_h	Variable		Application
$EFLH_{c,h}$	Variable	See Table Below	1
P_h	Fixed	3%	2
P_c	Fixed	6%	2
$AFUE_h$	Variable		Application
EER_{hp}	Variable		Application

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574

Middlesex County Vocational School
Exhibit D
ECM 3A Building Management Control Systems
BMS Upgrades

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Middlesex County Vocational School
Exhibit D
ECM 4B Building Envelope Improvements
Building Envelope Improvements

ECM DESCRIPTION

Reduce building infiltration by weather stripping doors, sealing roof & wall joints, duct & piping penetrations, skylight perimeters and window corners.

DATA / ASSUMPTIONS

*Crack area determined by survey team

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Visual inspection per scope of work from subcontractor. Inspection might include smoke test.

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) =	0%
Safety Factor (Thermal) =	0%

Recovery factor taken at 10% due to the uncertainty of variables incorporated in the savings calculations

Middlesex County Vocational School
Exhibit D
ECM 4B Building Envelope Improvements
Building Envelope Improvements

FORMULAE

H = (K * Q_{INF} * (dp)^n * HDD * 10) / 28,900 where 28,900 = Heating efficiency factor = (1,000,000 Btu per MMBtu / (1.08 * 24 hr/day)) * 75% std htg efficiency

C = T * C2 * CDD where T = C1 * Q_{INF} * h

Q_{INF} = K * dp^n *A_{CRACK}

dp^n = 5.16

A_{CRACK} = A_{VENTS} + A_{WIN} + A_{RTU} + A_{DOORS} + A_{BULK} + $A_{ROOF/WALL}$

Variable	Units	Description
H	therms	Thermal Savings associated with air infiltration reduction
C	kWh	Electrical Savings associated with air infiltration reduction
Q_{INF}	cfm	Infiltration air flow savings
A_{CRACK}	ft^2	Total square feet of infiltration area
K	(ft^3 / min) / (Pa * ft^2)	Flow Factor
dp^n	Pa	Pressure difference across building envelope raised to nth power
CDD	(^oF-Day)/Yr	Cooling degree days
T	tons	Cooling load
h	Btu/lb	Avg. enthalpy of air
HDD	(°F-Day)/Yr	Annual heating degree days
C1	lb/ft^3 * min/hr	Cooling Constant = std air density 0.075 lb/ft^3 * 60 min/hr
C2	kW/ton	Cooling system characteristic power consumption
A_{VENTS}	ft^2	Total square feet of infiltration spaces with regards to vents
A_{WIN}	ft^2	Total square feet of infiltration spaces with regards to windows
A_{RTU}	ft^2	Total square feet of infiltration spaces with regards to RTU's
A_{DOORS}	ft^2	Total square feet of infiltration spaces with regards to doors
A_{BULK}	ft^2	Total square feet of infiltration spaces with regards to bulkheads
$A_{ROOF/WALL}$	ft^2	Total square feet of infiltration spaces with regards to the wall roof joint

Source: Public Works Canada Standards & Guidelines,: EC128 April 30, 1980

Very Good
Good
Average
Poor
Loose

ASSUMPTIONS / DATA

Subcontractor Calculations n * If Yes - Please Refer to tab 'Sub BEI Calculation' for details

Building	Building Envelope Improvements (Y/N)	Envelope Tightness	Cooling Savings Applicable (Y/N)
Perth Amboy Campus	Y	Average	Y
Edison Campus	Y	Average	Y
Woodbridge Campus	Y	Average	Y

Middlesex County Vocational School
Exhibit D
ECM 4B Building Envelope Improvements
Building Envelope Improvements

CALCULATIONS

	Perth Amboy Campus	Edison Campus	Woodbridge Campus
Building Envelope Improvements	Y	Y	Y
Envelope Tightness	Average	Average	Average
Tightness Multiplier	0.00028	0.00028	0.00028
Cooling Savings Applicable	Y	Y	Y
Heating Savings Diversity Factor	100%	100%	100%
Flow Factor	20	20	20
(AP)^n	6.1625	6.06	6.142857143
Crack Area	4.0	7.5	6.3
Air Leakage (CFM)	493	909	774
Heating Degree Days	5,450	5,450	5,450
Heating Efficiency Factor	38,580	38,580	38,580
Cooling Savings Diversity Factor	100%	100%	100%
Constant	4.5	4.5	4.5
CFM	493	909	774
Enthalpy	9.8	9.8	9.8
Tons	1.8	3.3	2.8
Constant	1.2	1.2	1.2
CDD	787	787	787
kWh	1,711	3,155	2,686
Therms	696	1,284	1,093
Electric Safety Factor	0%	0%	0%
Thermal Safety Factor	0%	0%	0%
kWh Savings	1,711	3,155	2,686
Thermal Savings	696	1,284	1,093

Middlesex County Vocational School
Exhibit D
ECM 4A Wooddbridge Guidance Office BEI
Window Replacement

ECM DESCRIPTION

Replacement of windows with double-pane, low-e, metal frame windows.

DATA / ASSUMPTIONS

Recovery/Safety Factor (Electric) =	0%	
Recovery/Safety Factor (Thermal) =	0%	
Heating Hours	3,948	Hours

*U Factors for the new windows are obtained by manufacturer data. U Factors for the existing windows are based on type, material, and thickness

MEASUREMENT AND VERIFICATION

Option C - Savings Calculations are based on regression analysis of utility billing meter data

COMMISSIONING

Verify quantities installed and total square feet.

RECOVERY/SAFETY FACTOR

Savings calculations are based on weather bin data, fresh air flows and temperature setpoints. A more conservative of 0 percent is used for this ECM due to the uncertainty of variables. The heating fuel savings calculations are based upon information provided by the equipment vendor.

FORMULAE

$$Q_{SAVINGS} = (Q_C - Q_C) + Q_{INF}$$

$$Q_{INF} = \sum_{-5}^{100} \left(1.08 \cdot (i_{WIN} - i_{WIN}) \cdot (T_{W/S} - T_{BIN}) \cdot l_W \cdot t_{BIN} \right) / 100{,}000$$

$$Q_C = \sum_{-5}^{100} \left((T_{W/S} - T_{BIN}) \cdot A_{WIN} \cdot U_{WIN} \cdot t_{BIN} \right) / 100{,}000$$

$$Q_C = \sum_{-5}^{100} \left((T_{W/S} - T_{BIN}) \cdot A_{WIN} \cdot U_{WIN} \cdot t_{BIN} \right) / 100{,}000$$

*Note W/S designates use of either winter building setpoint or summer building setpoint with the appropiate bin

Variable	Units	Description
$Q_{savings}$	Therms	Thermal Savings
Q_C	Therms	Conductive/convective cooling gain and heating loss with existing windows
Q_C	Therms	Conductive/convective cooling gain and heating loss with proposed windows
Q_{INF}	Therms	Infiltration savings with proposed windows
$\sum_{-5}^{100}$	-	Summation of all bins from -5°F to 100°F
T_W	°F	Winter building setpoint
T_S	°F	Summer building setpoint
T_{BIN}	°F	Temperature of respective bin
t_{BIN}	Hrs	Hrs in respective bin
A_{WIN}	ft^2	Existing unoccupied Bin Hours in respective temperature bin
U_{WIN}	btu / ft^2 / °F	Existing U-factor of roof
U_{WIN}	btu / ft^2 / °F	Proposed U-factor of roof
i_{WIN}	Cfm/ft	Infiltration constant for existing windows
i_{WIN}	Cfm/ft	Infiltration constant for proposed windows
l_W	ft	Linear feet of curtain wall

* Inputs are in blue

Middlesex County Vocational School
Exhibit D
ECM 4A Wooddbridge Guidance Office BEI
Window Replacement

Building	Window Area (ft^2)	U-Factor of Existing Window	U-Factor of Proposed Window	Infiltration of Existing Window (CFM / linear ft)	Infiltration of Proposed Window (CFM / linear ft)	Total Linear feet of Curtain Wall	EER of Cooling System (Average)
Woodbridge Campus	354	1.20	0.29	25.00	10.00		11.0
Totals	354						

	Woodbridge Campus	Total	
Window ft^2 Audited	354		ft^2
U of Existing Window	1.20		btu/ft^2/°F
U of Proposed Window	0.29		btu/ft^2/°F
Infiltration of Existing Windows	25.00		CFM / ft
Infiltration of Proposed Windows	10.00		CFM / ft
Total Linear Ft of Curtain Wall	-		ft
EER of Cooling System (Average)	11.0		
Existing Occupied Heating Setpoint	72.0		°F
Existing Unoccup. Heating Setpoint	72.0		°F
Existing Occupied Cooling Setpoint	70.0		°F
Existing Unoccup. Cooling Setpoint	72.0		°F
Boiler Efficiency	91.0%		%
Safety Factor	0%		%
Electrical Savings	1,661		kWh/Yr
Thermal Savings	240		Therms/Yr

Middlesex County Vocational School
Exhibit D
ECM 4A Wooddbridge Guidance Office BEI
Window Replacement

CALCULATIONS

WOODBRIDGE CAMPUS

Amb. Temp Bin °F	Avg Temp °F	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occupied Hours	Unoccupied Hours	Window Square Feet	Existing Occupied Cooling Gain and Heating Loss	Existing Unoccupied Cooling Gain and Heating Loss	Proposed Occupied Cooling Gain and Heating Loss	Proposed Unoccupied Cooling Gain and Heating Loss	Cooling or Heating Savings	Infiltration savings	Total Heating or Cooling Savings	Safety Factor
COOLING									(MMBTU)	(MMBTU)	(MMBTU)	(MMBTU)	(MMBTU)	(MMBTU)	(MMBTU)	
100 to 105	102.5	-	1	-	1	1	0	354	0.0	0.0	0.0	0.0	0.0		0.0	0%
95 to 100	97.5	-	19	2	21	15	6	354	0.2	0.1	0.0	0.0	0.2		0.2	0%
90 to 95	92.5	-	44	13	57	38	19	354	0.4	0.2	0.1	0.0	0.4		0.4	0%
85 to 90	87.5	1	167	60	228	152	76	354	1.2	0.5	0.3	0.1	1.3		1.3	0%
80 to 85	82.5	31	283	162	476	294	182	354	1.7	0.9	0.4	0.2	2.0		2.0	0%
75 to 80	77.5	191	235	280	706	352	354	354	1.2	0.9	0.3	0.2	1.6		1.6	0%
70 to 75	72.5	203	177	222	602	282	320	354	0.3	0.1	0.1	0.0	0.3		0.3	0%
65 to 70	67.5	325	165	204	694	285	409	354	-	-	-	-	-		-	0%
60 to 65	62.5	180	152	195	527	245	282	354	-	-	-	-	-		-	0%
HEATING																
55 to 60	57.5	86	144	97	327	170	157	354	1.0	0.5	0.3	0.2	1.1	-	1.1	0%
50 to 55	52.5	109	182	172	463	242	221	354	2.0	0.8	0.5	0.4	1.8	-	1.8	0%
45 to 50	47.5	105	119	142	366	180	186	354	1.9	0.6	0.5	0.5	1.6	-	1.6	0%
40 to 45	42.5	185	155	177	517	239	278	354	3.0	0.9	0.7	0.8	2.4	-	2.4	0%
35 to 40	37.5	236	200	241	677	314	363	354	4.6	1.2	1.1	1.3	3.5	-	3.5	0%
30 to 35	32.5	237	202	198	637	293	344	354	4.9	1.2	1.2	1.4	4.0	-	4.0	0%
25 to 30	27.5	121	115	113	349	164	185	354	3.1	0.6	0.8	0.8	2.6	-	2.6	0%
20 to 25	22.5	149	68	97	314	127	187	354	2.7	0.6	0.6	1.0	2.3	-	2.3	0%
15 to 20	17.5	95	40	46	181	70	111	354	1.6	0.4	0.4	0.6	1.5	-	1.5	0%
10 to 15	12.5	39	9	28	76	28	48	354	0.7	0.2	0.2	0.3	0.7	-	0.7	0%
5 to 10	7.5	21	5	5	31	10	21	354	0.3	0.1	0.1	0.1	0.3	-	0.3	0%
0 to 5	2.5	4	2	-	6	2	4	354	0.1	0.0	0.0	0.0	0.1	-	0.1	0%
-5 to 0	-2.5	4	-	-	4	1	3	354	0.0	0.0	0.0	0.0	0.0	-	0.0	0%
-10 to -5	-7.5	-	-	-	-	-	-	354	-	-	-	-	-	-	-	0%
-15 to -10	-12.5	-	-	-	-	-	-	354	-	-	-	-	-	-	-	0%
Total		2,322	2,484	2,454	7,260	3,504	3,756									

Middlesex County Vocational School
Exhibit D
ECM 5A Permanent Load Reduction
Permanent Load Reduction

ECM DESCRIPTION

PJM Demand Response Program based on Shedable Load on Peak Demand Curtailment Day

DATA / ASSUMPTIONS

Demand Response Revenue	$ 15,000	/ MW
Permanent Load Reduction	$ 31,000	/ MW
Customer Share (Typically between 60-70%)	100%	

Year	All Other $/kW
2017/2018	$25.00
2018/2019	$40.00
2019/2020	$22.00
2020/2021	$22.00
	$27.25

*Demand Response Savings = Assumed between 1 - 4% Annual Electrical Load
*Assume 2% of Total District Load as Shedable
*Savings is not Guaranteed any savings from program will be considered operational savings only

MEASUREMENT AND VERIFICATION

None - Operational Savings

COMMISSIONING

N/A

RECOVERY/SAFETY FACTOR

N/A

FORMULAE

$$\$_{savings} = kWh_{ADJ} \cdot Cust_{\%} \cdot DM_{\%}$$

Variable	Units	Description
$\$_{savings}$	Dollars	Dollar Savings from Demand Response
$DM_{\%}$	%	Demand Response Savings as a percentage of electric baseline
$Cust_{\%}$	%	Customer Percentage of Savings
kWh_{BASE}	kWh	Adjusted Boiler Fuel Usage

Middlesex County Vocational School
Exhibit D
ECM 5A Permanent Load Reduction
Permanent Load Reduction

* Inputs are in blue

Building	Demand Response/Permanent Load Reduction Participation (Y/N)
Perth Amboy Campus	Y
Edison Campus	Y
Woodbridge Campus	Y

CALCULATIONS

	Perth Amboy Campus	Edison Campus	Woodbridge Campus
Demand Response Participation	Y	Y	Y
Average Monthly kW	438	103	194
Permanent Load Shed Reduction (kW)	111.72	25.75	44.23
Sheddable Load (kW)			
Percentage of Baseline Demand	25.5%	24.9%	22.8%
Demand Response $ / MW	$ 15,000	$ 15,000	$ 15,000
Permanent Load Shed Reduction $ / MW	$ 31,000	$ 31,000	$ 31,000
Demand Hours / Year	100	$ -	
Cost to Run Generator / hr	$ -	$ -	
Cost to Run Generator / yr	$ -	$ -	$ -
Safety Factor	0%	0%	0%
DR and PLR Savings	$ 3,463	$ 798	$ 1,371
Net Demand Response Savings	$ 3,463	$ 798	$ 1,371

Middlesex County Vocational School
Exhibit D
ECM 6A Solar PPA
Solar PPA Photovoltaic System

ECM DESCRIPTION

Installation of a photovoltaic array utilizing Solar Power Purchase Agreement (PPA) - reducing grid electricity with a reduction of greenhouse gas emissions.

DATA / ASSUMPTIONS

PPA Cost per kWH	$0.050
*1-Axis Tracking System Collection Improvement:	18.6%

*Emperical studies show an that annual output increases 18.6% with use of one-axis sun tracking
**Assume two weeks of downtime for PV maintenance

Solar radiation at ground level was obtained using the data collected by the National Renewable Energy Laboratory (NREL) via the software Pvwatts.
Proposed technology is only able to convert 77% of the direct current produced at the panel to a usable alternative current for building consumption

MEASUREMENT AND VERIFICATION

Option C - Verification by dedicated electric meter.

COMMISSIONING

Test installed system - measuring the output and verify with calculations for weather conditions. Verify all electrical connections and tie-ins to the grid and the building power.

RECOVERY/SAFETY FACTOR

Safety Factor (Electrical) =	0%

FORMULAE

$$W_{PV} = \sum_{Jan}^{Dec} (Q_{RAD} \cdot A_{PV} \cdot t_{MONTH}) \cdot t_{\%}$$

Variable	Units	Description
W_{PV}	kWh	Electrical energy produced by PV array
$\sum_{Jan}^{Dec}$	-	Summation of months
Q_{RAD}	$kWh/m^2/day$	Solar radiation (averaged by month) capable of being collected with the proposed PV technology
A_{PV}	ft^2	Area of proposed system
t_{MONTH}	Days	Days in the month
$t_{\%}$	%	Percentage of operational time

Middlesex County Vocational School
Exhibit D
ECM 6A Solar PPA
Solar PPA Photovoltaic System

*Inputs are blue

Building	DC Rating of System	Install 1-Axis Tracking System (Y/N)
Perth Amboy Campus	0.0	N
Edison Campus	0.0	N
Woodbridge Campus	0.0	N
East Brunswick Campus	0.0	N
Piscataway Campus	2,277.7	N
Totals	2,277.7	

Cell ID	Newark
State	New Jersey
Latitude	40.7 N
Longitude	74.17 W

Month	Days in Month	**Solar Radiation (kWh/day)	Solar Radiation per 1-kW (kWh)
Jan	31	2.39	74.1
Feb	28	3.17	88.8
Mar	31	4.07	126.2
Apr	30	4.83	144.9
May	31	5.7	176.7
Jun	30	5.94	178.2
Jul	31	5.77	178.9
Aug	31	5.38	166.8
Sep	30	4.65	139.5
Oct	31	3.61	111.9
Nov	30	2.35	70.5
Dec	31	2.01	62.3
Total		4.16	**1,518.7**

CALCULATIONS

	Piscataway Campus
DC Rating of System	2277.7
Safety Factor	0%
Maximum DC Rating	2277.7
Install 1-Axis Tracking System	N
**Annual Operational Hours	8,424
DC to AC Safety Factor	0.82
*Efficiency gain with 1-Axis Tracking	0.0%
Total kWh AC per year Generated	2,719,366
Solar Factor	52%
kWh Savings	1,415,846

Middlesex County Vocational School
Exhibit D
ECM 7A Transformers
Transformer Replacement

ECM DESCRIPTION

Replace dry transformers with new custom designed high efficiency transformers. New transformers will save electricity and avoid the future replacements due to failure.

DATA / ASSUMPTIONS

*Input Measured kW losses (If kW losses are not none calculation will calculate efficiency using past results)
* Existing loads were obtained by data logging
* Existing efficiencies were obtained by data logging or manufacturer specifications

MEASUREMENT AND VERIFICATION

Y	Option A - Electric-Retrofit Isolation with Key Parameter Measurement
Y	Option C – Utility Data Analysis

COMMISSIONING

Test all transformers after installation

RECOVERY/SAFETY FACTOR

Safety Factor (Electric) = 0%

Recovery factor is set at 10% due to unknown flucuations in transformer loads

FORMULAE

$W_{SAVINGS} = E_E - E_T$

$E_E = E_{OCC} \cdot t_{OCC} + E_{UNOCC} \cdot t_{UNOCC}$
$E_T = E_{OCC} \cdot t_{OCC} + E_{UNOCC} \cdot t_{UNOCC}$

$E_{OCC} = [(Lf_{OCC} \cdot KVA) / \eta_L^{OCC}] - (KVA \cdot Lf_{OCC})$
$E_{OCC} = [(Lf_{OCC} \cdot KVA) / \eta_L^{OCC}] - (KVA \cdot Lf_{OCC})$

$E_{UNOCC} = [(Lf_{OCC} \cdot KVA) / \eta_L^{UNOCC}] - (KVA \cdot Lf_{OCC})$
$E_{UNOCC} = [(Lf_{OCC} \cdot KVA) / \eta_L^{UNOCC}] - (KVA \cdot Lf_{OCC})$

$\eta_L^{OCC} = Lf_{OCC} \cdot kVA \cdot \eta_E$
$\eta_L^{OCC} = Lf_{OCC} \cdot kVA \cdot \eta_T$

$\eta_L^{UNOCC} = Lf_{UNOCC} \cdot kVA \cdot \eta_E$
$\eta_L^{UNOCC} = Lf_{UNOCC} \cdot kVA \cdot \eta_T$

Variable	Units	Description
$W_{savings}$	kWh	Electrical Savings
E_E	kW	Existing annual transformer losses
E_T	kW	Proposed annual transformer losses
t_{OCC}	Hrs	Existing Run Hours
t_{UNOCC}	Hrs	Proposed Run Hours
E_{OCC}	kW	Existing transformer losses during occupied hours
E_{OCC}	kW	Proposed transformer losses during occupied hours
E_{UNOCC}	kW	Existing transformer losses during unoccupied hours
E_{UNOCC}	kW	Proposed transformer losses during unoccupied hours
kVA	kVA	kVA of existing transformer
Lf_{OCC}	-	Load Factor of transformer during occupied hours
Lf_{UNOCC}	-	Load Factor of transformer during unoccupied hours
η_L^{OCC}	%	Existing efficiency of transformer during occupied hours
η_L^{OCC}	%	Proposed efficiency of transformer during occupied hours
η_L^{UNOCC}	%	Existing efficiency of transformer during unoccupied hours
η_L^{UNOCC}	%	Proposed efficiency of transformer during unoccupied hours
η_E	%	Existing weighted efficiency of transformer at various loads
η_T	%	Proposed weighted efficiency of transformer at various loads

* Inputs are in blue

Middlesex County Vocational School
Exhibit D
ECM 7A Transformers
Transformer Replacement

Calculation is automatic. If Efficiencies are known override automatically generated efficiencies in Columns G through M when necessary

							EXISTING						PROPOSED			
Building	Replace	Tag Number	Location ID	Transormer Designation	Qty	kVA	% Load During Occupied Hours	% Load During Unoccupied Hours	Baseline kW Losses (Normal Operation)	Baseline kW Losses (Outside Op. hrs)	Efficiency at Occupied Loads	Efficiency at Unoccupied Loads	New Transformer kW Losses (Normal Operation)	New Transformer kW Losses (Outside Op. hrs)	Efficiency Occupied Loads	Efficiency Unoccupied Loads
Perth Amboy Campus	y	57075	Janitor by A-109	T9	1.00	112.5	4.9%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	y	57076	116 Maintenance Shop	T15	1.00	15.0	13.5%	8.0%	0.327	0.317	86.88%	81.90%	0.048	0.040	96.75%	95.75%
Perth Amboy Campus	Y	57077	A-109	RPA1A	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57078	B-117	T14	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	Y	57079	B-119	HTS	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57080	B-122A	BTS	1.00	45.0	4.6%	2.0%	0.635	0.633	90.53%	86.68%	0.081	0.079	97.10%	96.10%
Perth Amboy Campus	Y	57081	B-123	ETS	1.00	45.0	4.6%	2.0%	0.635	0.633	90.53%	86.68%	0.081	0.079	97.10%	96.10%
Perth Amboy Campus	Y	57082	B-123	ETS2	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57083	B-124	T13	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	Y	57084	By C-153	T6	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57085	Gym Storage	T5	1.00	225.0	1.2%	1.2%	1.758	1.758	93.49%	90.74%	0.320	0.320	98.40%	97.90%
Perth Amboy Campus	Y	57086	Boiler Rm	MR	1.00	45.0	4.9%	2.0%	0.636	0.633	90.53%	86.68%	0.082	0.079	97.10%	96.10%
Perth Amboy Campus	Y	57087	Boiler Rm	MCB T7	1.00	150.0	8.2%	3.0%	1.523	1.500	92.99%	92.99%	0.228	0.206	98.39%	97.85%
Perth Amboy Campus	Y	57088	Elec Rm by C-206-A	T4	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	Y	57089	B-213	T3	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Perth Amboy Campus	Y	57090	Electric Rm by A-224	T1	1.00	75.0	3.8%	2.0%	0.729	0.726	93.00%	91.00%	0.115	0.112	97.30%	96.20%
Perth Amboy Campus	Y	57091	A-200-B	RPA2B	1.00	112.5	5.0%	2.0%	1.111	1.104	92.50%	90.52%	0.172	0.165	98.20%	97.80%
Totals					17	1575										

CALCULATIONS

	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	Perth Amboy Campus	TOTAL
Replace Transformer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
kVa	112.5	15.0	75.0	112.5	75.0	45.0	45.0	75.0	112.5	75.0	225.0	45.0	150.0	112.5	112.5	75.0	112.5	**1,275.00**
Quantity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**14.00**
% Load at Occupied Hours	5%	14%	4%	5%	4%	5%	5%	4%	5%	4%	1%	5%	8%	5%	5%	4%	5%	
% Load at Unoccupied Hours	2%	8%	2%	2%	2%	2%	2%	2%	2%	2%	1%	2%	3%	2%	2%	2%	2%	
Estimated Efficiences																		
Existing Efficiency at Occupied Loads	92.5%	86.9%	93.0%	92.5%	93.0%	90.5%	90.5%	93.0%	92.5%	93.0%	93.5%	90.5%	93.0%	92.5%	92.5%	93.0%	92.5%	
Existing Efficiency at Unoccupied Loads	90.5%	81.9%	91.0%	90.5%	91.0%	86.7%	86.7%	91.0%	90.5%	91.0%	90.7%	86.7%	93.0%	90.5%	90.5%	91.0%	90.5%	
Proposed Efficiency at Occupied Loads	98.2%	96.8%	97.3%	98.2%	97.3%	97.1%	97.1%	97.3%	98.2%	97.3%	98.4%	97.1%	98.4%	98.2%	98.2%	97.3%	98.2%	
Proposed Efficiency at Unoccupied Loads	97.8%	95.8%	96.2%	97.8%	96.2%	96.1%	96.1%	96.2%	97.8%	96.2%	97.9%	96.1%	97.9%	97.8%	97.8%	96.2%	97.8%	
Measured Baseline Losses																		
Existing Losses at Occupied Loads	1.111	0.327	0.729	1.111	0.729	0.635	0.635	0.729	1.111	0.729	1.758	0.636	1.523	1.111	1.111	0.729	1.111	
Existing Losses at Unoccupied Loads	1.104	0.317	0.726	1.104	0.726	0.633	0.633	0.726	1.104	0.726	1.758	0.633	1.500	1.104	1.104	0.726	1.104	
Proposed Losses at Occupied Loads	0.172	0.048	0.115	0.172	0.115	0.081	0.081	0.115	0.172	0.115	0.320	0.082	0.228	0.172	0.172	0.115	0.172	
Proposed Losses at Unoccupied Loads	0.165	0.040	0.112	0.165	0.112	0.079	0.079	0.112	0.165	0.112	0.320	0.079	0.206	0.165	0.165	0.112	0.165	
Measured kW Losses																		
Existing kW Losses Occupied Hours	0.940	0.278	0.614	0.939	0.614	0.554	0.554	0.614	0.939	0.615	1.438	0.554	1.295	0.939	0.939	0.614	0.939	
Existing kW Losses Unoccupied Hours	0.939	0.277	0.614	0.939	0.614	0.554	0.554	0.614	0.939	0.614	1.438	0.554	1.293	0.939	0.939	0.614	0.939	
Estimated kW Losses based on Efficiences																		
Existing kW Losses Occupied Hours Calculated	0.447	0.3059	0.2145	0.4561	0.2145	0.2165	0.2165	0.2145	0.4561	0.2159	0.1849	0.2306	0.9267	0.4561	0.4561	0.2145	0.4561	
Existing kW Losses Unoccupied Hours Calculated	0.577	0.4477	0.2819	0.5891	0.2819	0.3181	0.3181	0.2819	0.5891	0.2837	0.2708	0.3389	0.9267	0.5891	0.5891	0.2819	0.5891	
Occupancy																		
Occupied Hours per Day	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	
Occupied Days per Year	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	180	180	
Estimated kWh Losses based on Efficiences																		
Existing Annual kWh Losses	4,640	3,468	2,254	4,735	2,254	2,462	2,462	2,254	4,735	2,268	2,097	2,622	8,118	4,735	4,735	2,275	4,777	
Proposed kW and kWh Losses based on Efficiences																		
Proposed kW Losses Occupied Hours	0.1010	0.0680	0.0791	0.1031	0.0791	0.0618	0.0618	0.0791	0.1031	0.0796	0.0432	0.0659	0.2009	0.1031	0.1031	0.0791	0.1031	
Proposed kW Losses Unoccupied Hours	0.0506	0.0533	0.0593	0.0506	0.0593	0.0365	0.0365	0.0593	0.0506	0.0593	0.0579	0.0365	0.0987	0.0506	0.0506	0.0593	0.0506	
Proposed Annual kWh Losses	605	514	583	611	583	401	401	583	611	584	460	414	1,192	611	611	576	595	
Safety Factor	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	10%	10%	
Total kW and kWh Savings																		
kW Savings	0.940	0.278	0.614	0.939	0.614	0.554	0.554	0.614	0.939	0.615	1.438	0.554	1.295	0.939	0.939	0.614	0.939	**10.89**
kWh Savings	8,229	2,430	5,382	8,226	5,382	4,852	4,852	5,382	8,226	5,382	12,600	4,856	11,335	8,226	7,704	5,021	7,674	**95,360**

APPENDIX 3 CUTSHEETS

SEE ATTACHED USB DRIVE

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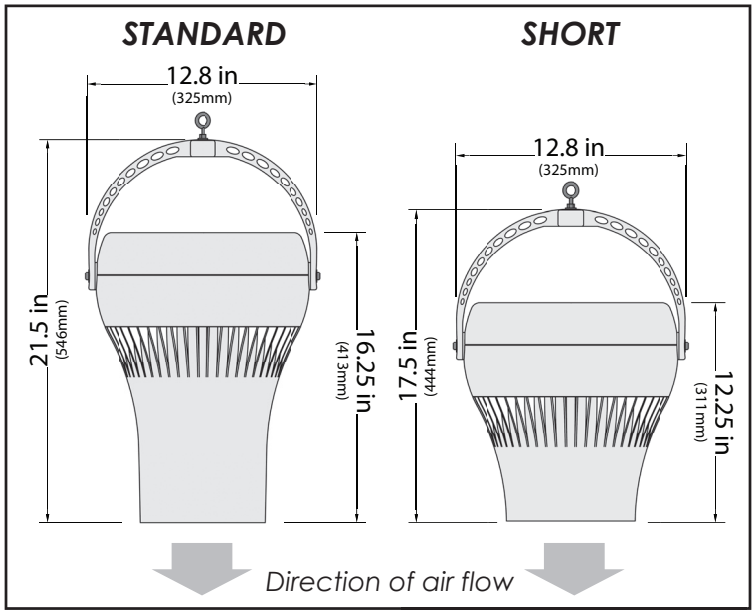
AIR PEAR 25-SP DESTRATIFICATION FAN SUBMITTAL

SPECIFICATION SECTION: 23 34 00 - HVAC FANS

MODEL	VOLTS 1Ø	HZ	*AMPS	*WATTS	*MAX RPM	*MAX CFM	**dB(A)	WEIGHT	MOUNTING HEIGHT	COVERAGE AREA
A-25-SP	120	50/60	0.30/0.32	30/35	1500/1650	459/547	45	7 lb/9 lb	Up to 25 ft.	Up to 1200 ft²
A-25-SP	230	50/60	0.14/0.13	31/33	1450/1650	459/547	45	7 lb/9 lb	Up to 25 ft.	Up to 1200 ft²
A-25-SP	277	50/60	0.13/0.17	35/45	1500/1650	459/547	45	7 lb/9 lb	Up to 25 ft.	Up to 1200 ft²

**0-static motor data supplied by fan manufacturer. Subject to change at any time.*

***Sound pressure level at 3 feet. Sound Power Level 58 dB(A), designed to meet ISO 3744 – engineering grade precision for determining sound power.*



PROJECT	
ENGINEER	
ARCHITECT	
CONTRACTOR	
SUBMITTED BY	
DATE	
CONFIGURATION	
QUANTITY	

ORDERING LOGIC

Enter part number into the configuration field above

Style	Model	Motor Type	Nozzle Length	Voltage	Color
A (Air Pear)	25	SP (Shaded Pole)	(Short) SH (Standard) STD	120 230 277	(Off White) W (Gray) G (Black) B

EXAMPLE: A - 25 - SP - **STD - 120 - W**

- **Color**
- **Voltage (AC)**
- **Nozzle Length**
- Motor Type
- Model
- Style

DESTRATIFICATION FAN DESCRIPTION

The patented Air Pear Thermal Equalizer creates uniform air temperatures from floor to ceiling for maximum thermal comfort and energy savings up to 35% in the heating season and up to 25% in the cooling season.

CERTIFICATION: *Conforms to UL-507, CAN/CSA C22.2#60335-1, UL 94 5VA and is ETL listed in USA and Canada.*

HOUSING: *PC/ABS resin, 5VA flame resistance rating*

MOTOR: *Single phase, shaded pole, single speed (variable with optional speed control), axial motor. Motor is thermally protected. Operating temperature: -4˚ F (-20˚ C) to 158˚ F (70˚ C). No lubrication required. Bearings are sealed. 6' cord and plug provided for 120V, no plug for 230V.*

STATOR: *Patented multi-vane stator significantly increases air throw for maximizing performance. PC/ABS.*

SAFETY CABLE: *6' length steel cable (fastened to body)*

WARRANTY*: Warranty - 3-years parts and workmanship. Money back guarantee - 30 days. Refurbish program after 3-year warranty period.*

FACTORY INSTALLED OPTIONS:

Item #	Description	Qty
PHI-9-C	Factory installed 9 in. PHI cell	
PHI-5-C	Factory installed 5 in. PHI cell	
GUARD25	Silver intake grille	

ACCESSORIES *(additional costs apply)*

Speed Control *(coordinate w/ electrical requirement)*

Item #	Description	Qty
TRIAC-120-1.5	120VAC, 1.5A wall mounted speed control	
TRIAC-120-5	120VAC, 5A wall mounted speed control	
TRIAC-120-15	120VAC, 15A wall mounted speed control	
TRIAC-230-8	230VAC, 8A wall mounted speed control	
TRIAC-277-5	277VAC, 5A wall mounted speed control	
TRIAC-SMART-7.5	95-250VAC, 7.5A, electrical box speed control	

COLOR OPTIONS:

"Off White" Cool Gray 2C *"Gray" Gray 432C* *Black*

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811 South Sherman Street, Longmont, Colorado 80501, Phone: 303.772.2633, Fax: 303.772.8276, info@airiusfans.com, www.airiusfans.com

May be covered by one or more of the following United States Patents: 7,381,129 B2; D514688 and other patents pending

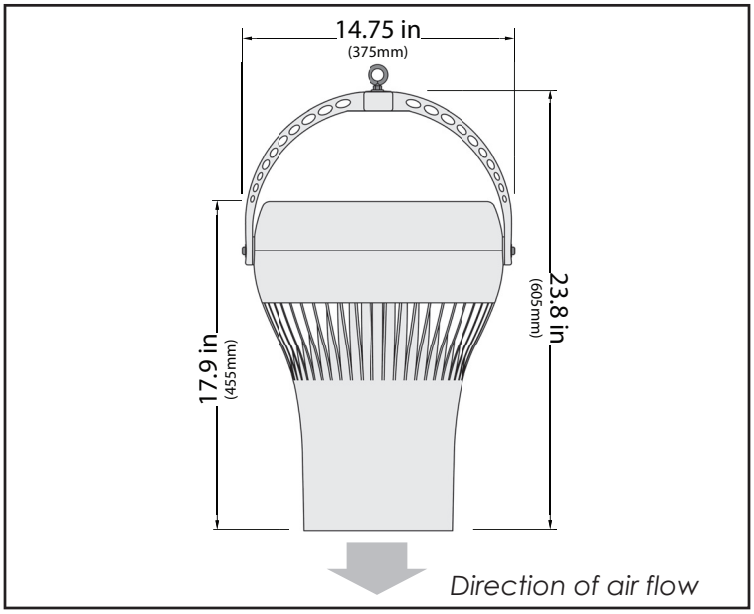
AIR PEAR 45-P4 DESTRATIFICATION FAN SUBMITTAL

SPECIFICATION SECTION: 23 34 00 - HVAC FANS

MODEL	VOLTS 1Ø	HZ	*AMPS	*WATTS	*MAX RPM	*MAX CFM	**dB(A)	WEIGHT	MOUNTING HEIGHT	COVERAGE AREA
A-45-P4	120	50/60	0.40/0.41	44/46	1400/1650	595/715	54	14 lb	Up to 38 ft.	Up to 1200 ft²
A-45-P4	230	50/60	0.19/0.2	42/45	1450/1630	595/707	54	14 lb	Up to 38 ft.	Up to 1200 ft²
A-45-P4	277	50/60	0.19/0.2	42/45	1450/1630	595/707	54	14 lb	Up to 38 ft.	Up to 1200 ft²

*0-static motor data supplied by fan manufacturer. Subject to change at any time.

**Sound pressure level at 3 feet. Sound Power Level 66 dB(A), designed to meet ISO 3744 – engineering grade precision for determining sound power.



PROJECT	
ENGINEER	
ARCHITECT	
CONTRACTOR	
SUBMITTED BY	
DATE	
CONFIGURATION	
QUANTITY	

ORDERING LOGIC

Enter part number into the configuration field above

Style	Model	Motor Type	Nozzle Length	Voltage	Color
A (Air Pear)	45	P4 (permanent split capacitor)	(Standard) STD	**120** **230** **277**	**(Off White) W** **(Gray) G** **(Black) B**

EXAMPLE: A - 45 - P4 - STD - **120 - W**

- **Color**
- **Voltage (AC)**
- Nozzle Length
- Motor Type
- Model
- Style

DESTRATIFICATION FAN DESCRIPTION

The patented Air Pear Thermal Equalizer creates uniform air temperatures from floor to ceiling for maximum thermal comfort and energy savings up to 35% in the heating season and up to 25% in the cooling season.

CERTIFICATION: *Conforms to UL-507, CAN/CSA C22.2#60335-1, UL 94 5VA and is ETL listed in USA and Canada.*

HOUSING: *PC/ABS resin, 5VA flame resistance rating*

MOTOR: *Permanent Split Capacitor, single speed (variable with optional speed control), axial motor. Motor is thermally protected. Operating temperature: -13˚ F (-25˚ C) to 158˚ F (70˚ C). No lubrication required. Bearings are sealed. 6' cord and plug provided for 120V, no plug for 230/277V*

GUARD GRILLE: *Steel, phosphated and coated in black plastic*

STATOR: *Patented multi-vane stator significantly increases air throw for maximizing performance. PC/ABS.*

SAFETY CABLE: *6' length steel cable (fastened to body)*

WARRANTY*: Warranty - 3-years parts and workmanship. Money back guarantee - 30 days. Refurbish program after 3-year warranty period.*

FACTORY INSTALLED OPTIONS:

Item #	Description	Qty
PHI-9-C	Factory installed 9 in. PHI cell	

ACCESSORIES *(additional costs apply)*

Speed Control *(coordinate w/ electrical requirement)*

Item #	Description	Qty
TRIAC-120-1.5	120VAC, 1.5A wall mounted speed control	
TRIAC-120-5	120VAC, 5A wall mounted speed control	
TRIAC-120-15	120VAC, 15A wall mounted speed control	
TRIAC-230-8	230VAC, 8A wall mounted speed control	
TRIAC-277-5	277VAC, 5A wall mounted speed control	
TRIAC-SMART-7.5	95-250VAC, 7.5A, electrical box speed control	

COLOR OPTIONS:

"Off White" Cool Gray 2C — "Gray" Gray 432C — Black

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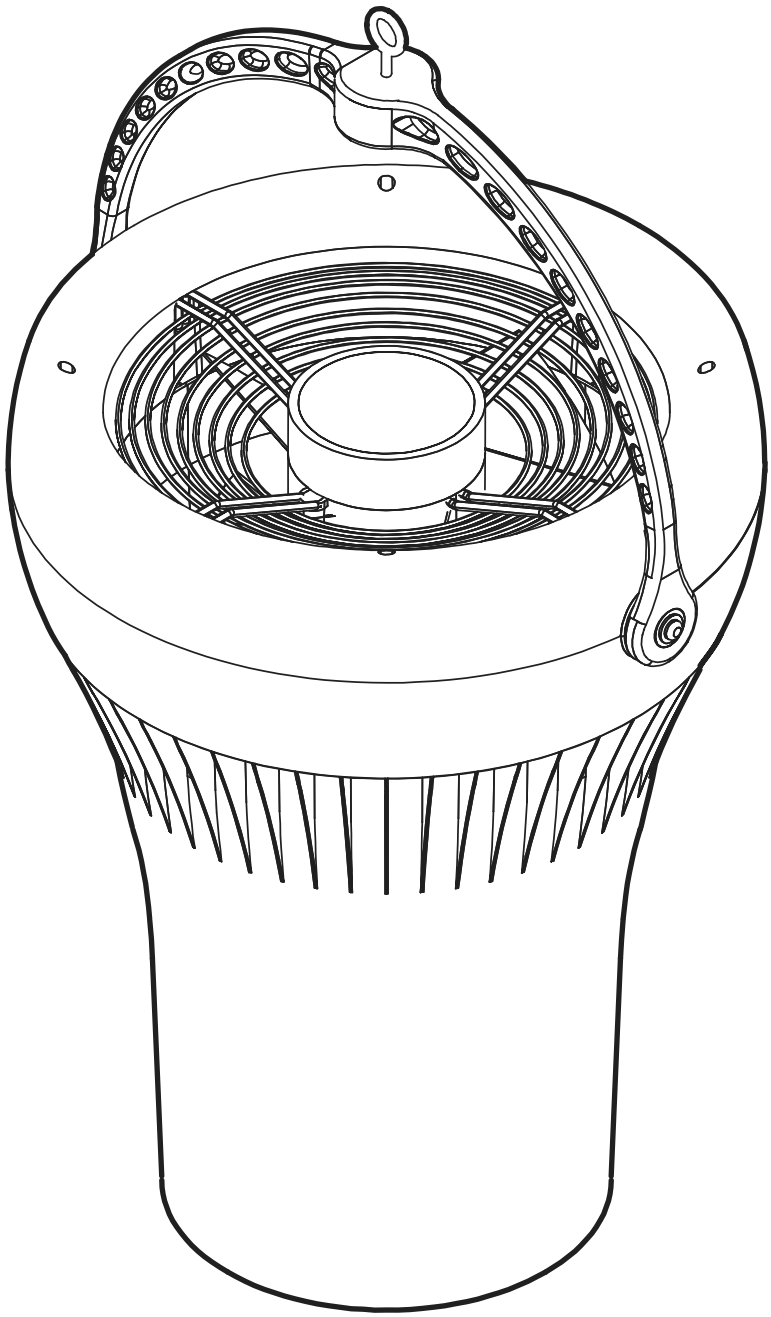
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May be covered by one or more of the following United States Patents: 7,381,129 B2; D514688 and other patents pending

AIRIUS®

The World Standard
For Destratification

AIR PEAR
INSTALLATION, OPERATION & MAINTENANCE



Air Pear®
THE THERMAL EQUALIZER
BY AIRIUS

Installation Guide: V1.2

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NOTE: Carefully check fans/controls for shipping damage. Report any damage to the carrier immediately. Do not attempt to operate if visible damage is evident to either the circuit or to the electronic components. All information contained in this manual is intended to be correct, however information and data in this manual are subject to change without notice. Airius makes no warranty of any kind with regard to this information or data. Further, Airius is not responsible for any omissions or errors or consequential damage caused by the user of the product. Airius reserves the right to make manufacturing changes that may not be included in this manual.

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INTRODUCTION

Thank You!

Congratulations on the purchase of Airius' Thermal Equalizer system (Air Pear). Our patented, American-made, air-mixing system will ensure better thermal comfort in both the summer and winter while driving down expensive energy bills. We are here to support you and if you have any questions or comments, we can be contacted through our website, www.airiusfans.com, or give us a call: 1-888-247-7327.

About Air Pear Models 10, 15, 25, 45, 60 & 100

The Air Pear unit is an energy-efficient air turbine, designed to continuously move a column of air to the floor for destratification and air circulation purposes. A typical system installation includes a series of units mounted just below the ceiling, evenly spaced throughout a facility, working in concert to improve comfort and reduce HVAC energy consumption up to 35% or more*. Airius fans are available in several sizes to accommodate a wide range of ceiling heights.

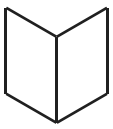
* THE PERFORMANCE AND RESULTS OF THE AIR PEAR SYSTEM ARE SUBJECT TO MANY VARIABLES SUCH AS, BUT NOT LIMITED TO, AIRFLOW OBSTRUCTIONS, THE INTERIOR ENVIRONMENT, EXTERIOR ENVIRONMENT, CONDITION OF BUILDING STRUCTURE, HVAC SYSTEM PERFORMANCE AND/OR ELECTRICAL SERVICE AND THUS, ACTUAL RESULTS MAY VARY.

What's in the Box

Each unit will arrive in its own box, fully assembled. NOTE: 120VAC versions come with a three-prong plug, and other voltages have no plug supplied. You will need to have a qualified electrician either wire the desired plug on to the power cord or hard wire directly to the power circuit. We recommend using a plug for easy removal during maintenance.



Fully Assembled Air Pear or Designer Series fan



Information Sheet



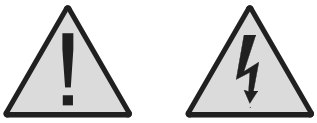
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Motor Information for Air Pear Models 10, 15, 25, 45, 60 & 100

MODEL	VOLTS 1Ø	HZ	*AMPS	*WATTS	*MAX RPM	*MAX CFM	*dB(A)	WEIGHT	MOUNTING HEIGHT	COVERAGE AREA
A-10-SP	120	50/60	0.11/0.13	13/15	1000/1050	318	24	7 lb/9 lb	Up to 12 ft.	Up to 500 ft²
A-10-SP	230	50/60	0.06/0.06	12/13	980/1000	318	24	7 lb/9 lb	Up to 12 ft.	Up to 500 ft²
A-10-EC	100-130	50/60	0.12	7	1000	318	24	7 lb/9 lb	Up to 12 ft.	Up to 500 ft²
A-10-EC	200-250	50/60	0.06	7	1000	318	24	7 lb/9 lb	Up to 12 ft.	Up to 500 ft²
A-15-SP	120	50/60	0.11/0.14	13.5/17	1230/1260	406	29	7 lb/9 lb	Up to 18 ft.	Up to 800 ft²
A-15-SP	230	50/60	0.06/0.07	15/17	1230/1260	406	29	7 lb/9 lb	Up to 18 ft.	Up to 800 ft²
A-15-EC	100-130	50/60	0.17	11	1260	406	29	7 lb/9 lb	Up to 18 ft.	Up to 800 ft²
A-15-EC	200-250	50/60	0.08	11	1260	406	29	7 lb/9 lb	Up to 18 ft.	Up to 800 ft²
A-25-SP	120	50/60	0.30/0.32	30/35	1500/1650	459/547	45	7 lb/9 lb	Up to 25 ft.	Up to 1200 ft²
A-25-SP	230	50/60	0.14/0.13	31/33	1450/1650	459/547	45	7 lb/9 lb	Up to 25 ft.	Up to 1200 ft²
A-25-SP	277	50/60	0.13/0.17	35/45	1500/1650	459/547	45	7 lb/9 lb	Up to 25 ft.	Up to 1200 ft²
A-25-EC	100-130	50/60	0.4	30	1700	620	51	7 lb/9 lb	Up to 25 ft.	Up to 1200 ft²
A-25-EC	200-250	50/60	0.26	30	1700	620	51	7 lb/9 lb	Up to 25 ft.	Up to 1200 ft²
A-45-P4	120	50/60	0.40/0.41	44/46	1400/1650	595/715	54	14 lb	Up to 38 ft.	Up to 1200 ft²
A-45-P4	230	50/60	0.19/0.2	42/45	1450/1630	595/707	54	14 lb	Up to 38 ft.	Up to 1200 ft²
A-45-P4	277	50/60	0.19/0.2	42/45	1450/1630	595/707	54	14 lb	Up to 38 ft.	Up to 1200 ft²
A-45-P2	120	50/60	1.05/1.48	120/175	2550/2700	1057/1128	64	14 lb	Up to 45 ft.	Up to 1500 ft²
A-45-P2	230	50/60	0.54/0.7	125/165	2450/2600	1072/1160	64	14 lb	Up to 45 ft.	Up to 1500 ft²
A-45-P2	277	NA/60	NA/0.7	NA/190	NA/2900	NA/1301	64	14 lb	Up to 45 ft.	Up to 1500 ft²
A-45-EC	100-130	50/60	0 - 2.2	0 - 170	0 - 2850	0 - 1180	71	14 lb	Up to 45 ft.	Up to 1500 ft²
A-45-EC	200-277	50/60	0 - 1.4	0 - 175	0 - 3050	0 - 1290	71	14 lb	Up to 45 ft.	Up to 1500 ft²
A-45-EL	100-130	50/60	0 - 2.2	0 - 170	0 - 2850	0 - 1180	71	14 lb	Up to 45 ft.	Up to 1500 ft²
A-45-EL	200-277	50/60	0 - 1.4	0 - 175	0 - 3050	0 - 1290	71	14 lb	Up to 45 ft.	Up to 1500 ft²
A-60-P4	120	50/60	0.91/0.92	88/108	1400/1620	1443/1665	60	22 lb	Up to 60 ft.	Up to 2000 ft²
A-60-P4	230	50/60	0.57/0.66	120/150	1390/1600	1667/1902	60	22 lb	Up to 60 ft.	Up to 2000 ft²
A-60-P4	277	50/60	NA/0.68	NA/170	NA/1660	NA/2002	60	22 lb	Up to 60 ft.	Up to 2000 ft²
A-60-EC	100-130	50/60	0 - 2.2	0 - 170	0 - 1660	0 - 1825	63	22 lb	Up to 60 ft.	Up to 2000 ft²
A-60-EC	200-277	50/60	0 - 1.3	0 - 170	0 - 1630	0 - 1770	63	22 lb	Up to 60 ft.	Up to 2000 ft²
A-60-EL	100-130	50/60	0 - 2.2	0 - 170	0 - 1660	0 - 1825	63	22 lb	Up to 60 ft.	Up to 2000 ft²
A-60-EL	200-277	50/60	0 - 1.3	0 - 170	0 - 1630	0 - 1770	63	22 lb	Up to 60 ft.	Up to 2000 ft²
A-100-EC	100-130V	50/60	0 - 4.2	0 - 350	0 - 1620	0 - 3210	66	45 lb	Up to 100 ft.	Up to 2500 ft²
A-100-EC	200-277V	50/60	0 - 2.5	0 - 390	0 - 1690	0 - 3358	66	45 lb	Up to 100 ft.	Up to 2500 ft²
A-100-EL	200-277V	50/60	0 - 2.5	0 - 390	0 - 1690	0 - 3358	66	45 lb	Up to 100 ft.	Up to 2500 ft²

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Safety Precautions - Read & Save



Warning! - To prevent fire, electrical shock or injury, please observe the following:

Electrical work must be performed by a qualified person(s) in accordance with all national and local codes/standards.

Air Pear® Thermal Equalizer® fans
Models 10, 15, 25, 45, 60, &100: all voltages

120V Models:
Supplied with a polarized/grounded plug molded to a 6 ft. (1.8 m) cord. To reduce the risk of electrical shock, this plug is intended to fit in a polarized/grounded outlet only one way. If the plug does not fit fully in the outlet, contact a qualified electrician. Do not attempt to defeat this safety feature.

230V & 277V Models:
Supplied with a 6 ft (1.8 m) cord with a 3-wire pigtail for attachment to a single phase plug rated for the correct voltage; NEMA type: L6-20P or similar, wire color code: UL/CSA: black-live/white-neutral/green-yellow-earth.

Warning! To prevent electrical shock and/or injury, unplug/disconnect unit from power source before you move unit, service unit or remove any part of housing.

Warning! To reduce the risk of fire or electrical shock, do not use models 10, 15 and 25 equipped with shaded pole motors or models 45, 60 and 100 with permanent split capacitor (P.S.C.) motors with any unapproved solid-state speed control device. Models 45, 60, 100 and 125 with electrically commutated motors (labeled as EC or EL) are capable of variable speeds with the proper controls. Contact Airius for additional information regarding variable speed controls and options.

Do not carry the Air Pear/Designer Series unit by the cord. Do not use the cord as a handle. Do not use the cord to attach or hang the product. Be sure to grasp the plug, not the cord, when disconnecting this unit from an electrical outlet.

Do not use this product if it has a damaged cord, faulty plug or any broken housing or motor component. If the supply cord, plug, motor or housing is damaged, it must be serviced or replaced by Airius, its service agents or similarly qualified persons to avoid a hazard.

To prevent damage, which may result in fire or shock hazard, do not expose this product to rain or direct moisture. Do not immerse product into water or allow water to drip into the motor housing. Do not install outdoors or in an area open to the weather. Shut off power to a wet motor at source before servicing.

Spinning blades may inflict eye or other physical injury. Always replace a damaged blade. Disconnect unit from power source first. Contact Airius for replacement blades. Plastic blades are rated 5VA, the highest fire-resistant rating for plastics, and they will not maintain a flame.

Caution! Some Air Pear products have an unguarded impeller/fan blade. Do not use in locations readily accessible to people or animals. Blades may inflict injury when moving or stationary.

To reduce the risk of injury to persons, install product so that bottom of moving fan blade or the lowest moving part is at least 8.2 ft. (2.5 m) above the floor or grade level.

The motor is thermally protected; overheating will cause the motor to stop operating. The motor may restart once normal operating temperatures are achieved. If motor fails to restart, disconnect motor from electric source and contact Airius. Do not disable this safety device or override this safety feature; doing so will void the warranty.

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Safety Precautions - Read & Save (cont.)

Do not use any PVC product (electrical tape) with the fans. If installing a fan in an environment with cutting oils in the air (production machine shop) contact the factory for assistance at 303-772-2633.

Do not position product near furnaces, fireplaces, stoves or other high temperature heat sources. Do not position Air Pear unit such that the downward air column created by the Air Pear will be directly bisected by another source of air flow, such as from another fan or from an open supply register. Do not position the unit close to other objects that will interfere with fan operation. Do not allow fan blades to come into contact with objects that can lock or inhibit the rotor operation.

Service and installation: No lubrication is required. Bearings are sealed. Bail adjustment can be made with a T-30 Torx driver/wrench, or a 5/32" Hex wrench may be used. Other tools for service: T-20 Torx (7/64" Hex) & T-25 Torx (1/8" Hex) and a #2 Phillips screwdriver.

The Air Pear unit is designed to be used with only the electrical voltage identified on the label located in the nozzle and on the bottom of the motor. Connecting to any other voltage could damage the motor and create an electrical hazard and will void warranty. If you have a question, please contact the factory.

Assembling Suspended Ceiling units: See additional instructions for kit included with this pamphlet or located in box containing kit.

Important: Install with hanging device or fastener rated for a minimum of 5x the weight of the unit. **Never use zip ties to hang the fan.** Use care when positioning the unit. To maximize performance, make sure the airflow is unobstructed into the top of the unit and the downward airflow is unobstructed and allowed to reach the floor.

Cleaning: Unplug unit from power source first to prevent electrical shock and to avoid injuries from spinning blades. Caution: Stationary blades can cause injury! You may clean the plastic housing with a warm cloth, using mild detergent only. Do not use petroleum products, thinners, solvents, ammonia, alcohols or other chemicals to clean any part of the Air Pear unit.

USA & Canada – ETL file #3164849 EU - CE

For additional information about
Air Pear® or Designer Series Thermal Equalizer® fans
and other products/accessories visit:

www.airiusfans.com

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PRE-INSTALLATION

Preparing the Work Site - Electrical Installation

ELECTRICAL WORK MUST BE PERFORMED BY A QUALIFIED PERSON(S) IN ACCORDANCE WITH ALL NATIONAL AND LOCAL CODES/STANDARDS.

Airius recommends installing a dedicated circuit only to be used with the Air Pear units. DO NOT wire the units into the lighting circuit, as the system will cycle on and off with the lights, greatly reducing the system's effectiveness.

Outlets are available in many configurations, check with the local electrical contractor to determine the preferred type for the facility. Outlets should generally be mounted vertically unless a "twist/locking" type is being used.

Refer to page 13 for plug wiring directions.
Refer to page 12 for specific model amperage.

To confirm electrical continuity, if possible, plug the Air Pear system into an energized outlet at floor level, similar to the outlet installed in the ceiling, before permanently mounting the Air Pear in the ceiling. Only energize the fan after hands/fingers or loose clothing are removed from/around the fan intake.

CAUTION − Make sure the fan voltage matches the intended power supply before installing. Connecting the fan to the wrong voltage will void warranty.

Preparing the Work Site - Mechanical Installation

A ladder, scissor lift or other suitable means of reaching the installation point will be required.

The Air Pear system is designed to hang vertically 12-to-18 inches below the ceiling of the facility with the discharge pointing to the floor for maximum thermal equalization. NOTE: The bail may be angled, as it is ratcheted for special situations where a vertical air column is undesirable and an angled column would be more effective.

Make sure the air column will have an unimpeded path from the discharge to the floor. **If using the fans in a grocery aisle application, mount the fan a minimum of 3 ft. from the edge of any open reach in case to minimize the possibility of introducing air into the case.**

The free-hanging units are designed to hang vertically and freely from the ceiling on hardware capable of supporting a minimum of five times the weight of the unit. Example - 1/4" (7 mm) diameter steel bolt is rated at a 60 lb. (27 kg.) load.

Hardware that may be used to hang the unit includes, but is not restricted to: hooks, chains, cables, carabiners, bridle rings, beam clamps and bolts. Roof structure, building construction, electrical outlets/service and accessibility will define the appropriate hardware for each installation.

If installing within a suspended ceiling, make sure there are no objects (ducts, sprinklers, conduit, etc.), for clearance purposes, directly above the proposed location of installation and relocate if necessary.

Refer to installation directions on page 16 for further information.

Refer to Suspended Ceiling Kit Assembly and Installation on page 20.

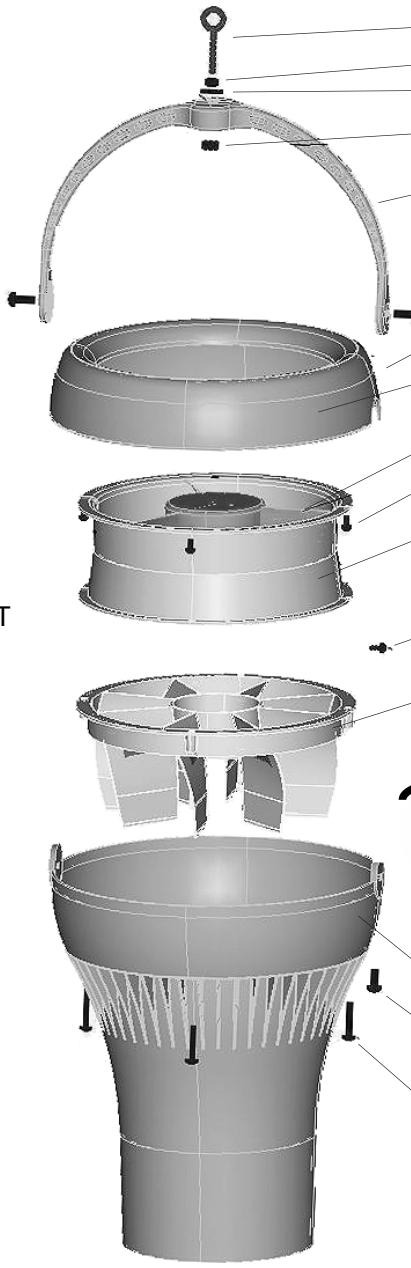
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Tools Needed

T-30 Torx Driver (5/32" Hex); other tools include T-20 Torx (7/64" Hex); T-25 Torx (1/8" Hex); #2 Phillips Driver.
All necessary tools to install mounting hardware (varies from installation to installation)

Fan Diagram 10-SP, 15-SP, 25-SP

AIR PEAR 10-SP, 15-SP, 25-SP



POWER LEADS:

"N" = NEUTRAL

UNMARKED = HOT

1) 1/4 - 20 x 1 1/2 EYE BOLT
2) 1/4 - 20 NUT
3) 1/4 x 5/8 WASHER
4) 1/4 - 20 NYLOCK NUT
5) BAIL/CROSSPIECE
6) 1/4 - 20 x 1 T-30 TORX (5/32 HEX) PAN HEAD MACHINE SCREW x 2 EA.
7) HOLE FOR STRAIN RELIEF SUPPORTING POWER CORD
8) COWL (PC/ABS)
9) FAN BLADES RATED 5VA 1 EA.
10) 8 - 32 x 3/8 T-20 TORX (7/64 HEX) PAN HEAD MACHINE SCREW x 4 EA.
11) ROTOR HOUSING - FAN MOTOR 120 OR 230 VAC THERMALLY PROTECTED (277 VAC AVAILABLE)
12) 8 - 32 x 1/4 T-20 TORX (7/64 HEX) PAN HEAD GROUNDING MACHINE SCREW x 1 EA.
13) STATOR (PC/ABS)
14) STRAIN RELIEF

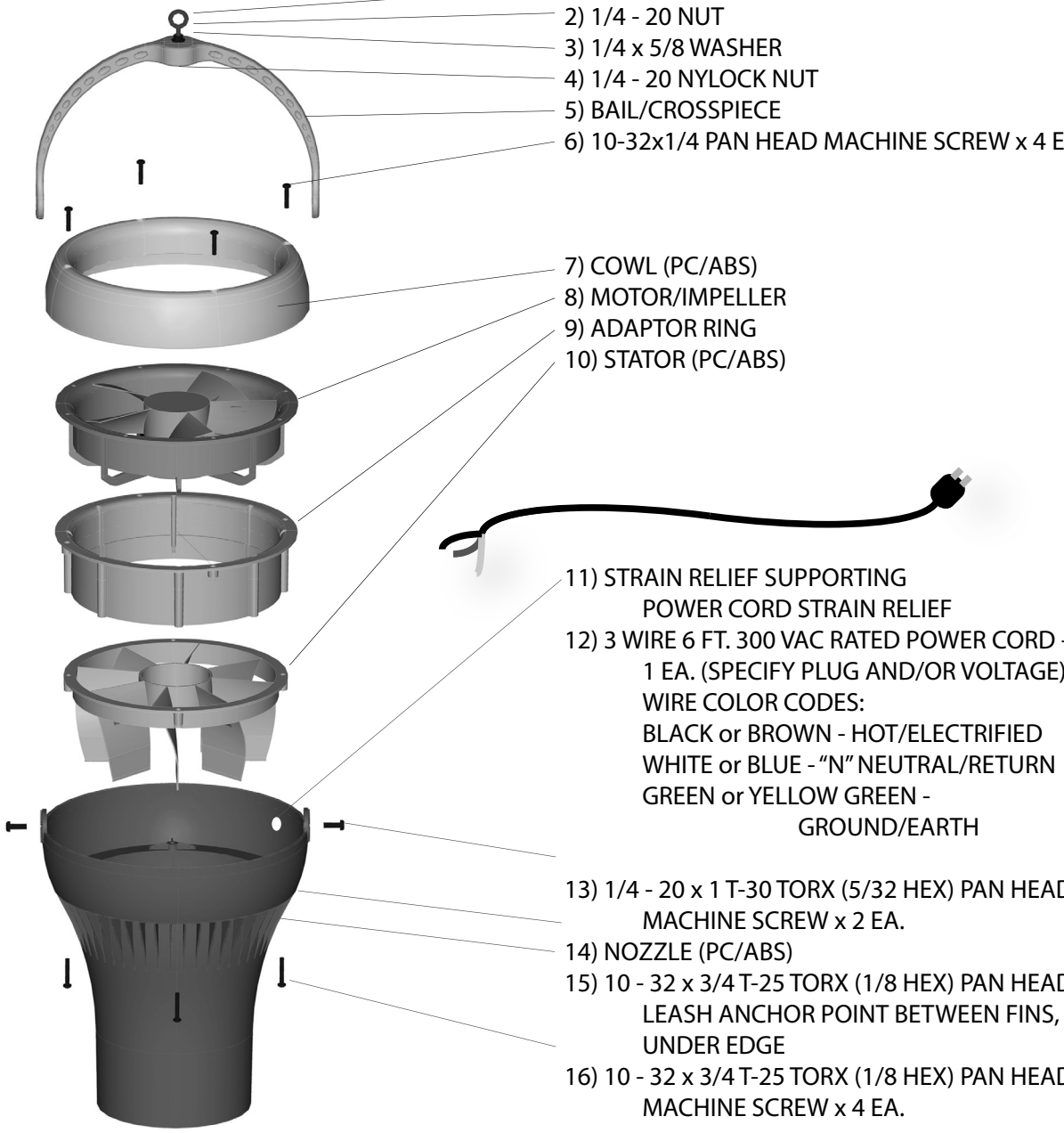


15) 3 WIRE 6 FT. 300 VAC RATED POWER CORD - 1 EA. (SPECIFY PLUG AND/OR VOLTAGE)
WIRE COLOR CODES:
BLACK or BROWN - HOT/ELECTRIFIED
WHITE or BLUE - "N" NEUTRAL/RETURN
GREEN or YELLOW GREEN - GROUND/EARTH

16) NOZZLE (PC/ABS)
17) 10 - 32 x 3/4 T-25 TORX (1/8 HEX) PAN HEAD LEASH ANCHOR POINT BETWEEN FINS, UNDER EDGE
18) 10 - 32 x 1 1/4 T-25 TORX (1/8 HEX) PAN HEAD MACHINE SCREW x 4 EA.

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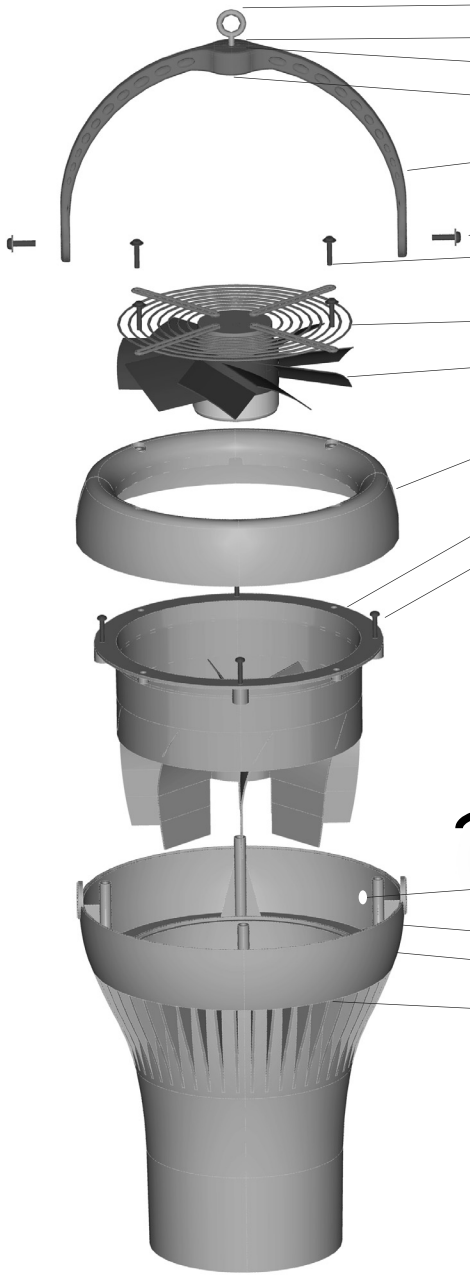
Fan Diagram 10-EC, 15-EC, 25-EC



1) 1/4 - 20 x 1 1/4 EYE BOLT
2) 1/4 - 20 NUT
3) 1/4 x 5/8 WASHER
4) 1/4 - 20 NYLOCK NUT
5) BAIL/CROSSPIECE
6) 10-32x1/4 PAN HEAD MACHINE SCREW x 4 EA.
7) COWL (PC/ABS)
8) MOTOR/IMPELLER
9) ADAPTOR RING
10) STATOR (PC/ABS)
11) STRAIN RELIEF SUPPORTING POWER CORD STRAIN RELIEF
12) 3 WIRE 6 FT. 300 VAC RATED POWER CORD - 1 EA. (SPECIFY PLUG AND/OR VOLTAGE)
WIRE COLOR CODES:
BLACK or BROWN - HOT/ELECTRIFIED
WHITE or BLUE - "N" NEUTRAL/RETURN
GREEN or YELLOW GREEN - GROUND/EARTH
13) 1/4 - 20 x 1 T-30 TORX (5/32 HEX) PAN HEAD MACHINE SCREW x 2 EA.
14) NOZZLE (PC/ABS)
15) 10 - 32 x 3/4 T-25 TORX (1/8 HEX) PAN HEAD LEASH ANCHOR POINT BETWEEN FINS, UNDER EDGE
16) 10 - 32 x 3/4 T-25 TORX (1/8 HEX) PAN HEAD MACHINE SCREW x 4 EA.

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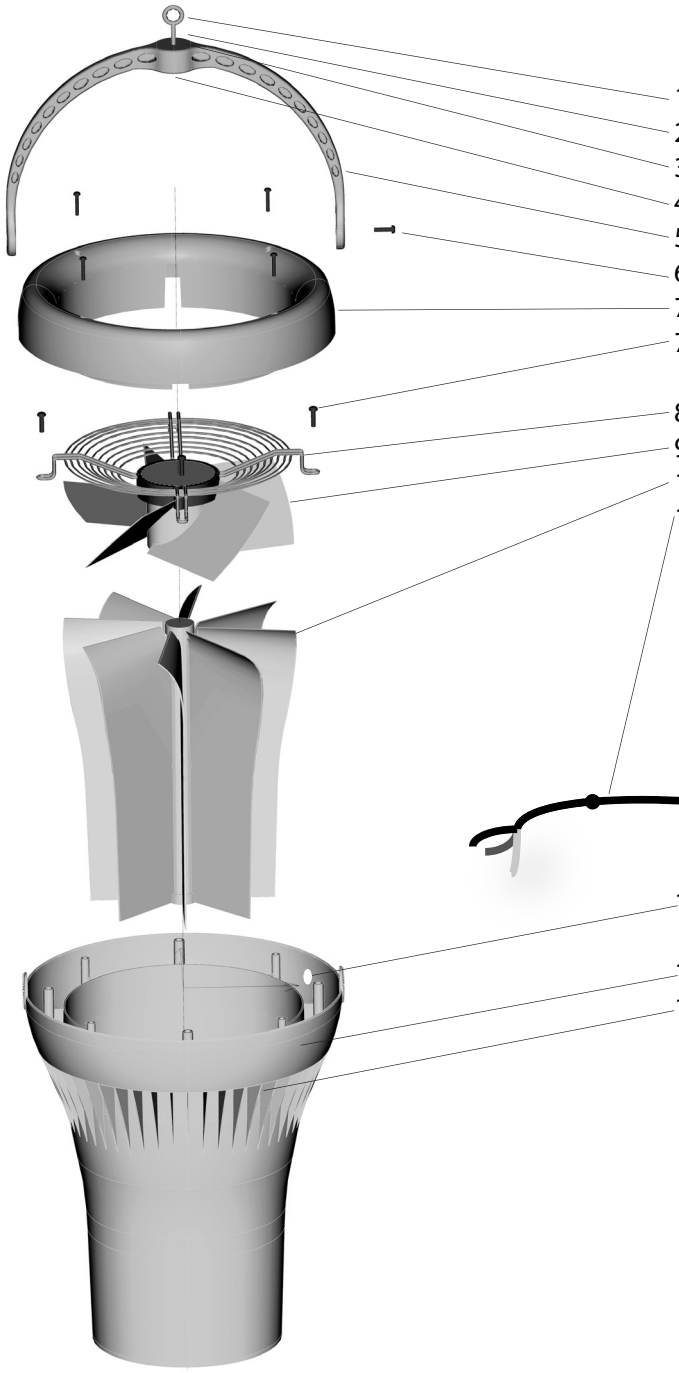
Fan Diagram 45-P4, 45-P2, 45-EC, 45-EL



1) 1/4 - 20 x 1 1/4 EYE BOLT
2) 1/4 - 20 NUT
3) 1/4 x 5/8 WASHER
4) 1/4 - 20 NYLOCK NUT
5) BAIL/CROSSPIECE
6) 1/4 - 20 x 1 T-30 TORX PAN HEAD (x2)
   #10 SAE FLAT WASHER (x2)
7) 10-32 x 2 TORX (x4)
   #10 SAE FLAT WASHER (x4)
8) STEEL GRILLE, PHOSPHATED, BLACK
9) MOTOR/IMPELLER
10) COWL (PC/ABS)
11) STATOR (PC/ABS)
12) 10-32 x 1 1/4" TORX (x4)
13) 3 WIRE 6 FT. 300 VAC RATED POWER CORD - 1 EA. (SPECIFY PLUG AND/OR VOLTAGE)
    WIRE COLOR CODES:
    BLACK or BROWN - HOT/ELECTRIFIED
    WHITE or BLUE - "N" NEUTRAL/RETURN
    GREEN or YELLOW GREEN - GROUND/EARTH
14) HOLE FOR STRAIN RELIEF SUPPORTING POWER CORD
15) HOLE FOR CONTROL WIRES w/ GROMMET
16) NOZZLE (PC/ABS)
17) 10 - 32 x 3/4 T-25 TORX (1/8 HEX) PAN HEAD LEASH ANCHOR POINT BETWEEN FINS, UNDER EDGE

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Fan Diagram 60-P4, 60-EC, 60-EL



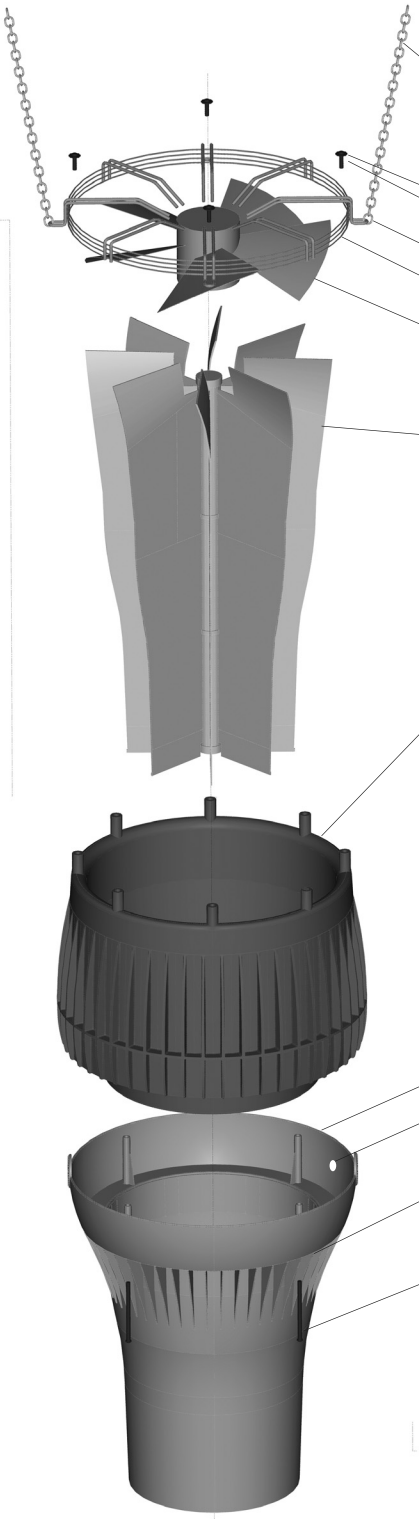
1) 1/4 - 20 x 1 1/4 EYE BOLT
2) 1/4 - 20 NUT
3) 1/4 x 5/8 WASHER
4) 1/4 - 20 NYLOCK NUT
5) BAIL/CROSSPIECE
6) 1/4 - 20 x 1 T-30 TORX PAN HEAD (x2)
7) FAN HOUSING (PC/ABS)
7) 1/4 - 20 x 1 (x4)
#12 SAE FLAT WASHER (x4)
8) STEEL GRILLE, PHOSPHATED, BLACK
9) MOTOR/IMPELLER
10) STATOR (PC/ABS)
11) 3 WIRE 6 FT. 300 VAC RATED POWER CORD - 1 EA. (SPECIFY PLUG AND/OR VOLTAGE)
WIRE COLOR CODES:
BLACK or BROWN - HOT/ELECTRIFIED
WHITE or BLUE - "N" NEUTRAL/RETURN
GREEN or YELLOW GREEN - GROUND/EARTH



12) HOLE FOR STRAIN RELIEF SUPPORTING POWER CORD
13) NOZZLE (PC/ABS)
14) 10 - 32 x 3/4 T-25 TORX (1/8 HEX) SLOT HEAD LEASH ANCHOR POINT BETWEEN FINS, UNDER EDGE

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Fan Diagram 100-EC, 100-EL



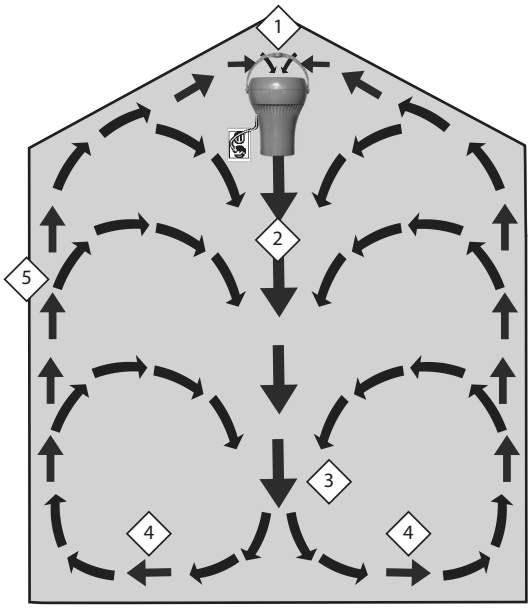
1) SUSPENSION CHAIN
2) 1/4 - 20 x 1
3) 1/4 x 7/8 WASHER
4) 3/16 x 1 7/8 QUICKLINK
5) STEEL GRILLE, PHOSPHATED, BLACK
6) MOTOR/IMPELLER
7) STATOR (ABS)
8) COWL (PC/ABS)
9) 3 WIRE 6 FT. 300 VAC RATED POWER CORD - 1 EA. (SPECIFY PLUG AND/OR VOLTAGE)
   WIRE COLOR CODES:
   BLACK or BROWN - HOT/ELECTRIFIED
   WHITE or BLUE - "N" NEUTRAL/RETURN
   GREEN or YELLOW GREEN - GROUND/EARTH



10) NOZZLE (PC/ABS)
11) HOLE FOR STRAIN RELIEF SUPPORTING POWER CORD
12) 10 - 32 x 3/4 T-25 TORX (1/8 HEX) PAN HEAD LEASH ANCHOR POINT BETWEEN FINS, UNDER EDGE
13) 1/4 - 20 x 4 T-30 TORX PAN HEAD (x4)
    #12 SAE FLAT WASHER (x4)

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Understanding Air Pear's Unique Air Flow



1. Low Velocity Intake - Low intake speed does not disturb air boundary layer under roof deck.
2. Columnar Laminar Flow - Removing the rotational component induced by the axial fan allows for the air to move in a straight, ductless column from the ceiling to the floor.
3. Entrainment - The column acts on the surrounding dead pool of air to induce entrainment and effectively multiply the air delivered to the floor.
4. Radial Spread - Once the column hits the floor, the air spreads radially until it loses velocity and migrates toward the ceiling.
5. Torus - The combination of these effects creates a torus-type air circulation and mixing pattern that effectively and efficiently achieves thermal equalization and general air movement.

Determine the number of fans, model and amperage to facilitate in the branch circuit design. Only qualified person(s) may determine the proper branch sizing and facilitate installation. If you have questions, contact your local electrical contractor.



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INSTALLATION

Power Requirements

Model Amperage 120VAC, single phase, 50/60 Hz:

Air Pear 10-SP: 0.11 / 0.13 A
Air Pear 15-SP: 0.11 / 0.14 A
Air Pear 25-SP: 0.30 / 0.32 A
Air Pear 45-P4: 0.40 / 0.41 A
Air Pear 45-P2: 1.05 / 1.48 A
Air Pear 60-P4: 0.91 / 0.92 A

Model Amperage 100-130VAC, single phase, 50/60 Hz:

Air Pear 10-EC: 0.12 A
Air Pear 15-EC: 0.17 A
Air Pear 25-EC: 0.4 A
Air Pear 45-EC: 2.2 A
Air Pear 45-EL: 2.2 A
Air Pear 60-EC: 2.2 A
Air Pear 60-EL: 2.2 A
Air Pear 100-EC: 4.2 A

Model Amperage 230VAC, single phase, 50/60 Hz:

Air Pear 10-SP: 0.06 / 0.06 A
Air Pear 15-SP: 0.06 / 0.07 A
Air Pear 25-SP: 0.14 / 0.13 A
Air Pear 45-P4: 0.19 / 0.2 A
Air Pear 45-P2: 0.54 / 0.7 A
Air Pear 60-P4: 0.57 / 0.66 A

Model Amperage 200-250VAC, single phase, 50/60 Hz:

Air Pear 10-EC: 0.06 A
Air Pear 15-EC: 0.08 A
Air Pear 25-EC: 0.26 A

Model Amperage 277VAC, single phase, 60 Hz:

Air Pear 25-SP: 0.14 A
Air Pear 45-P4: 0.2 A
Air Pear 45-P2: 0.7 A
Air Pear 60-P4: 0.68 A

Model Amperage 200-277VAC, single phase, 50/60 Hz:

Air Pear 45-EC: 1.4 A
Air Pear 45-EL: 1.4 A
Air Pear 60-EC: 1.3 A
Air Pear 60-EL: 1.3 A
Air Pear 100-EC: 2.5 A
Air Pear 100-EL: 2.5 A

Branch Circuit Protection

The Air Pear fans do not include fuses for branch circuit protection. The branch circuit must have a dedicated circuit breaker or similar device. National and local safety standards and electrical codes may determine additional requirements for installation.

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Plug Wiring (230/277VAC Models)

120VAC cord is supplied with a molded three-prong polarized/grounded plug. DO NOT DEFEAT this SAFETY DEVICE or modify the plug in any way.

230/277VAC no plug supplied. When fitting a plug always ensure that all relevant local regulations/electrical codes are understood and followed with care - if in any doubt seek expert guidance.

The power cord is a three-wire 18 AWG (or 16 AWG) 300VAC rated electrical cord UL rated in North America (NA) as SJT or for CE/EU compliance rated as HO5VV.

The three wires in the power cord are color-coded to ensure proper wiring as follows:

BLACK or BROWN = HOT/ELECTRIFIED/LIVE
WHITE or BLUE = “N” NEUTRAL/RETURN PATH
GREEN or YELLOW-GREEN = GROUND/EARTH

The cord is attached to the fan motor via two power leads with insulated 1/4” quick connects.

The cord is secured in the housing by a strain relief and knotted inside the housing for additional security.

Procedure for wiring the plug in a single-phase electrical system:

Use CAUTION when wiring/attaching the plug (Male Connector) to the Air Pear/Designer Series system or when using any electrical device.

1. Plug should be rated for 230VAC or 277VAC and fit properly into outlet (female connector) being used for power.

2. To avoid electrical shock, DO NOT plug device into energized outlet until all exposed wires and connecting terminals are enclosed by plug housing. See plug manufacturer’s instructions.

3. Locate the three stripped wires on the 300VAC rated power cord attached to the unit where the outer cord insulation jacket has been removed. Wires are coded as follows: black or brown is HOT/Live (the energized conductor), white or blue is neutral “N” (the conductor used for a return current path) and green or yellow/green is ground/earth (the conductor to connect to the earth).

4. Using the plug manufacturer’s instructions, locate the proper positions to attach the color-coded wire to the color-coded or otherwise appropriately labeled terminals on the plug.

5. Tighten all connections. Reassemble plug in accordance with plug manufacturer’s instructions.

To confirm electrical continuity, if possible, plug the Air Pear system into an energized outlet on the ground, similar to the outlet installed in the ceiling, before permanently mounting.

NOTE: The Air Pear System can be wired directly to a junction box but only by a qualified electrician or similarly qualified person. Always ensure that all relevant local regulations/electrical codes are understood and followed with care - if in any doubt seek expert guidance. Check local electrical codes. The preferred system is designed with a plug for easy service and cleaning. An on-off switch must be installed in the circuit to be able to disable the power to prevent electrical hazard when servicing the appliance.

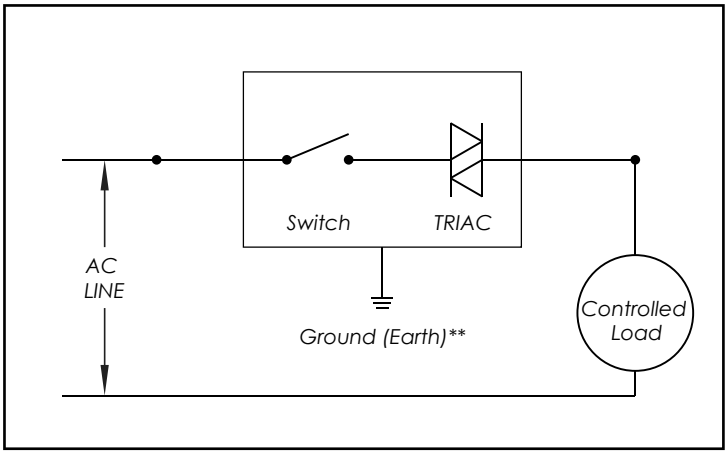
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Speed Control Wiring (Model 10-SP, 15-SP, 25-SP, 45-P2, 45-P4 & 60-P4)

SAFETY WARNING!

Unit should be installed by a qualified electrician in accordance with the National Electrical Code and other local codes that may apply. This control must be grounded when installed. Failure to follow these instructions may result in electrical shock or a fire hazard. This control is suitable for mounting in a metal or approved enclosure. These controls must not be used for loads exceeding those ratings clearly marked on the device.

CONNECTION DIAGRAM FOR 2-WIRE CONTROLS



APPLICATION

- Motor Type - Shaded Pole, PSC and Universal.
- Required Load - Fans and speed dependant loads.

WIRING

- Warning! - Power must be turned off before wiring. Connect control in series with motor and line voltage - never connect control across line.

MOUNTING

- Use 2” deep standard electrical box.
- Secure control with outer bracket tabs.

MINIMUM SPEED ADJUSTMENT

- Motor must be in actual operating conditions to achieve proper speed adjustment. (Motor will not slow down unless proper load is applied.)
- Turn main control knob clockwise to lowest speed position.
- Locate and adjust minimum speed setting on front plate with screw driver (rotate clockwise to decrease minimum speed; counter-clockwise to increase minimum speed.)
- Note: For all high-current models, 8 amps or greater, the opposite minimum speed rotation adjustment must be made so that motor runs with sufficient torque to prevent stalling.
- Motor will now operate from this preset minimum speed to full speed.

FINAL MOUNTING

- Install front dial plate - remove protective plastic.
- Turn main control until switch snaps off.
- Push on knob so that pointer is off position.

NOTE: For no switch models install front dial plate and push on knob.

TRIAC SIZING CONSIDERATIONS

- ** Some models do not require grounding. Therefore, a ground wire is not provided.
- Make sure the total circuit amperage load does not exceed the TRIAC’s rated amperage.
- Make sure TRIAC’s voltage rating matches line voltage.

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2-Speed Control Wiring (Model 10-EC, 15-EC and 25-EC only)

SAFETY WARNING!

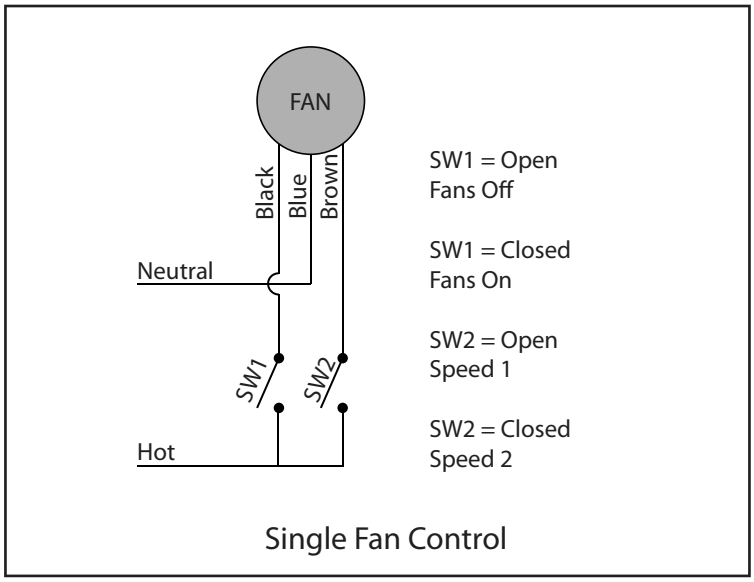
Unit should be installed by a qualified electrician in accordance with the National Electrical Code and other local codes that may apply.

APPLICATION

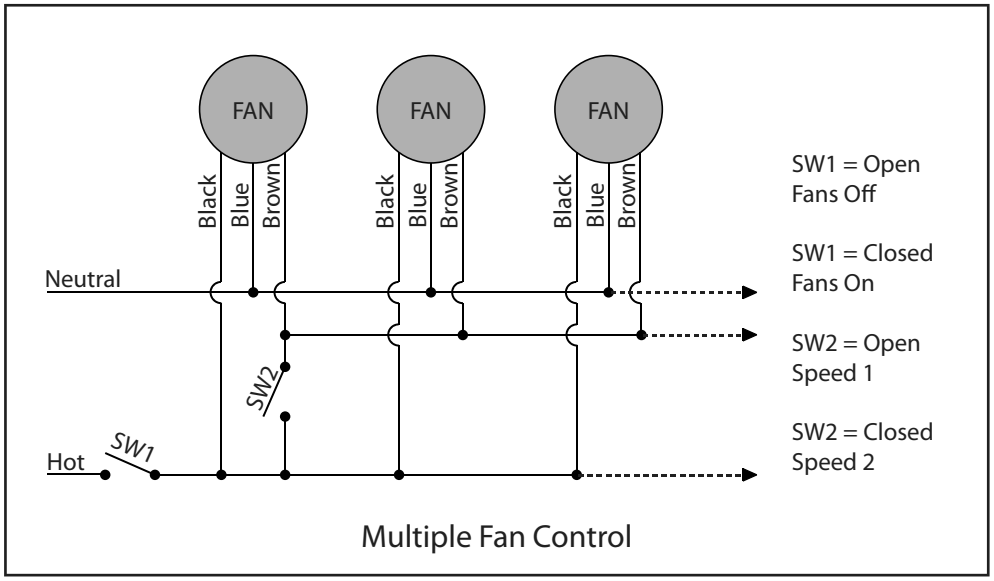
• Motor Type - Electronically Commutated, 2-speed control. The 2 speeds are factory set. Do not use this wiring method if you have the optional 0-10VDC control module or a shaded pole motor.

WIRING

• Warning! - Power must be turned off before wiring.



Single Fan Control



Multiple Fan Control

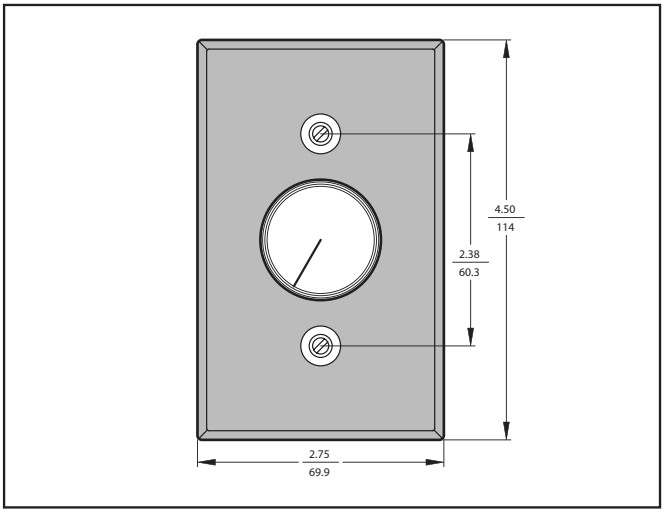
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Speed Control Wiring (10-EC, 15-EC & 25-EC with optional 0-10VDC module. Model 45-EC, 60-EC & 100-EC)

POTENTIOMETER SPEED CONTROL DESCRIPTION

Multi-turn wirewound potentiometer used to vary the speed of electrically commutated (EC) motors. Speed controls for shaded pole or PSC motors: refer to page 14. Speed control for EL fans: refer to seperate FanCenter installation & operation guide.

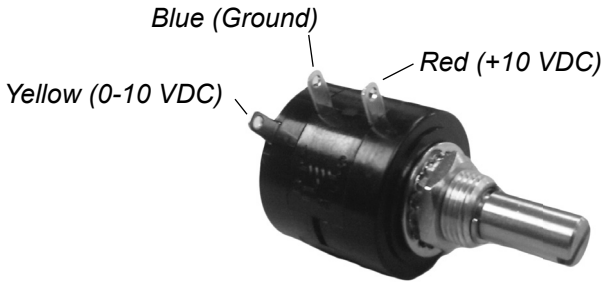
MODEL	VALUE (Ω)	LINEARITY	TOLERANCE
POT-1	10K	±0.25%	±5%

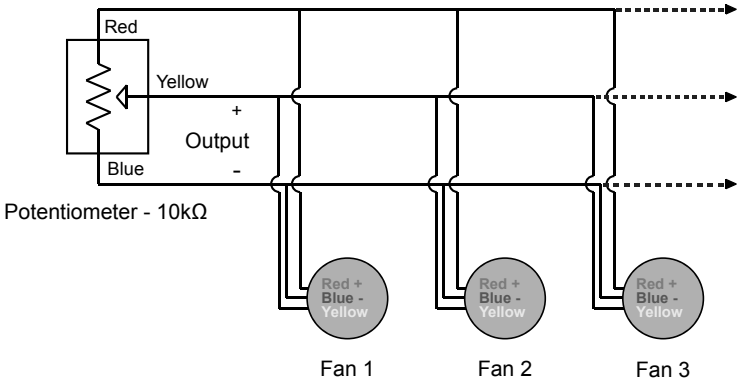


GENERAL NOTES

- The fan is supplied with current via the DC output and supplies a 0-10VDC signal that allows infinitely variable open loop speed control.
- If control wire exceeds 1300 ft. refer to Potentiometer wiring (external power source).
- A single controller can be used to control multiple fans with the same speed setting.
- Connecting the red and yellow leads will allow EC fans to operate at full speed.
- Wire runs up to 1000 feet (305 m) can be made using 20 - 24 AWG control wire. Wire runs longer than 1000 ft. will require the addition of a 10 - 12VDC power supply (not included).

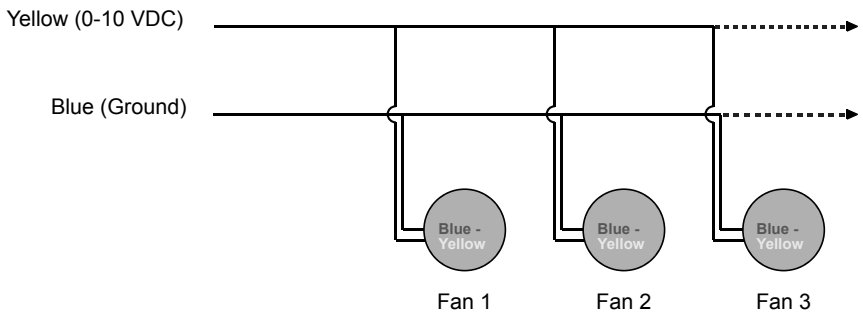
Potentiometer Control Wiring





BAS Control Wiring

The BAS should be capable of generating a 0-10VDC signal to modulate the fan speed. Use the following wiring diagram if this is the preffered connection type.



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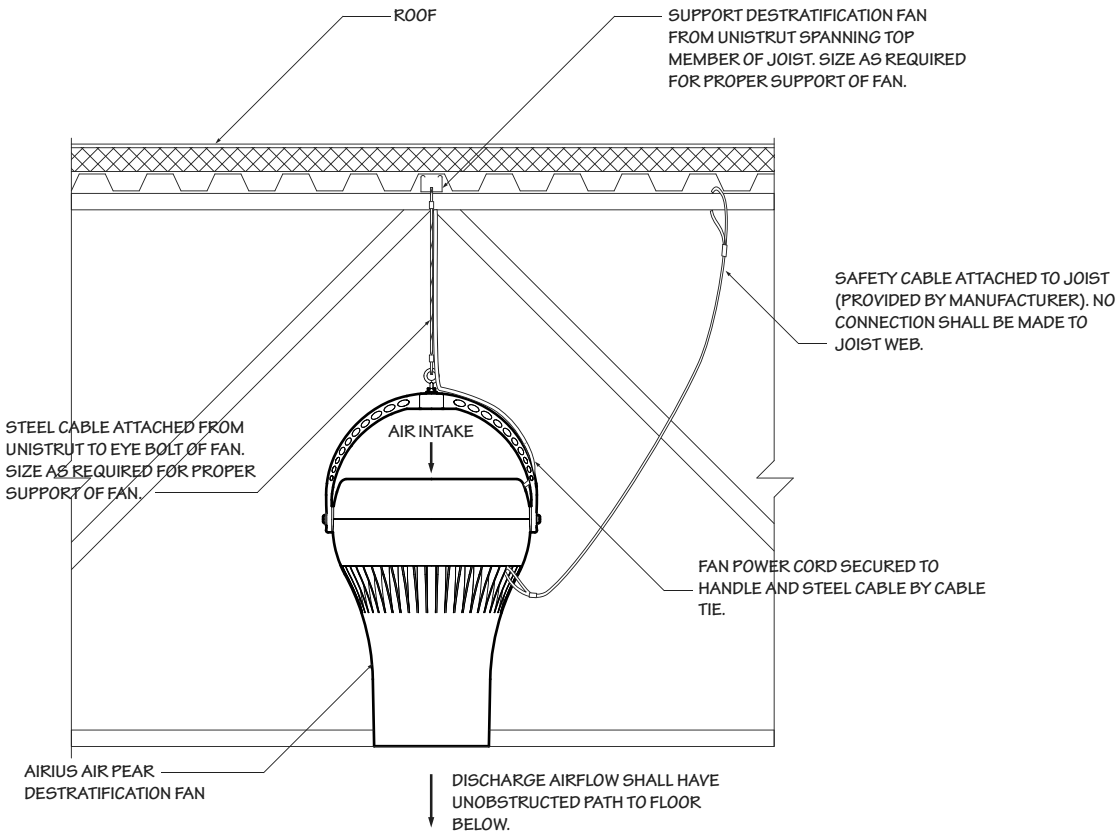
Free-Hanging Air Pear Suggested Installation Methods

Hardware that may be used to hang the unit includes, but is not restricted to: Hooks, chains, cables, carabiners, bridle rings, beam clamps and bolts. Roof structure, building construction and accessibility will define the appropriate hardware for each installation. Mount the fan as high in the ceiling as possible and do not restrict airflow into the intake.

After ensuring the Air Pear system is firmly attached and after REMOVING YOUR HANDS FROM THE UNIT, ONLY THEN is it safe to plug the unit into the power source using the approved plug to confirm function and electrical continuity.

NOTE: Secure the power cord to the ceiling structure as added security. The cord will act as a safety leash and by securing it the possibility of the plug accidentally coming out of the outlet is greatly reduced. A 50 lb. (20 kg.) rated Zip Tie or several wraps of mechanics wire are examples of methods of securing the power cord.

The following graphic is an example of hanging the typical Air Pear unit:



DESTRATIFICATION FAN DETAIL

SCALE: NONE

NOTES:

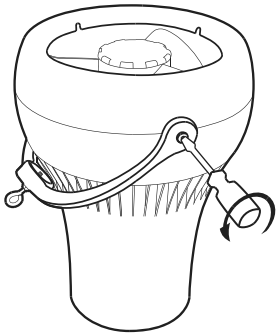
1. INSTALL FAN AS CLOSE AS POSSIBLE TO CEILING. (TYP 0'-6" TO 2'-0")
2. OPTIONAL HANGING METHODS INCLUDE: BEAM CLAMP/BRIDLE RING, CHAIN LINK/CARABINER, THREADED ROD/LOCK NUTS, ETC...
3. CONTRACTOR TO PROVIDE POWER FEED IN CONDUIT. THE ELECTRICAL CONNECTION CAN BE MADE IN A J-BOX (HARD WIRED) OR PLUG CONNECTION (J-BOX/RECEPTACLE).

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Suggested Installation Methods

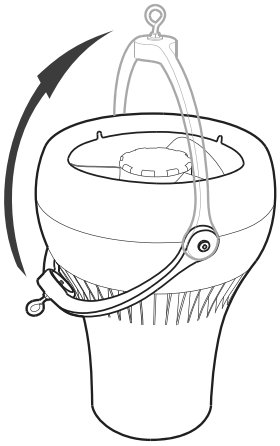
1

Remove the Air Pear from its box, then remove the plastic protective bag. The bail (handle) is attached via two Torx screws. Using T-30 Torx driver, loosen these screws enough so the bail may swing.



2

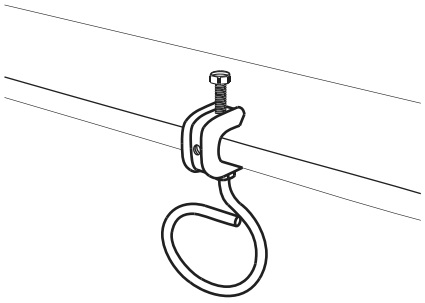
Swing the bail to the vertical position and re-tighten the two Torx screws.



3

The Air Pear system is designed to hang vertically and freely 12-to-18 inches, or as close as possible, from the ceiling on professionally installed hardware, for models 10/15/25, capable of supporting a minimum of five times the weight of the Air Pear unit, 60 lb. (27 kg.). Example - 1/4” (7 mm) diameter steel bolt is rated at 60 lb. (27 kg.) load.

A feature of the Air Pear system is its flexibility. Hardware that may be used to hang the unit includes, but is not restricted to: Hooks, chains, cables, carabiners, bridle rings, beam clamps and bolts. Roof structure, building construction and accessibility will define the appropriate hardware for each installation.

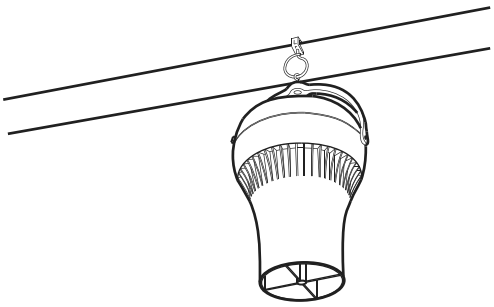


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Suggested Installation Methods

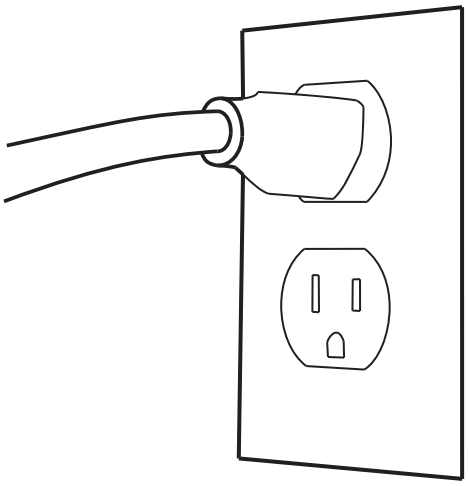
4

After ensuring the Air Pear system is firmly attached, remove your hands from the unit.



5

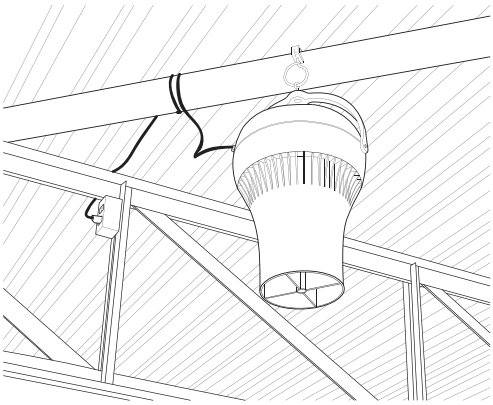
It is then safe to plug the unit into the power source using the approved plug to confirm function and electrical continuity.



6

NOTE: SECURE the power cord to the ceiling structure as added security. The cord will act as a safety leash and by securing it the possibility of the plug accidentally coming out of the outlet in the future is greatly reduced. A 50 lb. (20 kg.) rated Zip-Tie or mechanics wire are examples of methods of securing the power cord.

The graphic to the right is an example of hanging the Air Pear unit:



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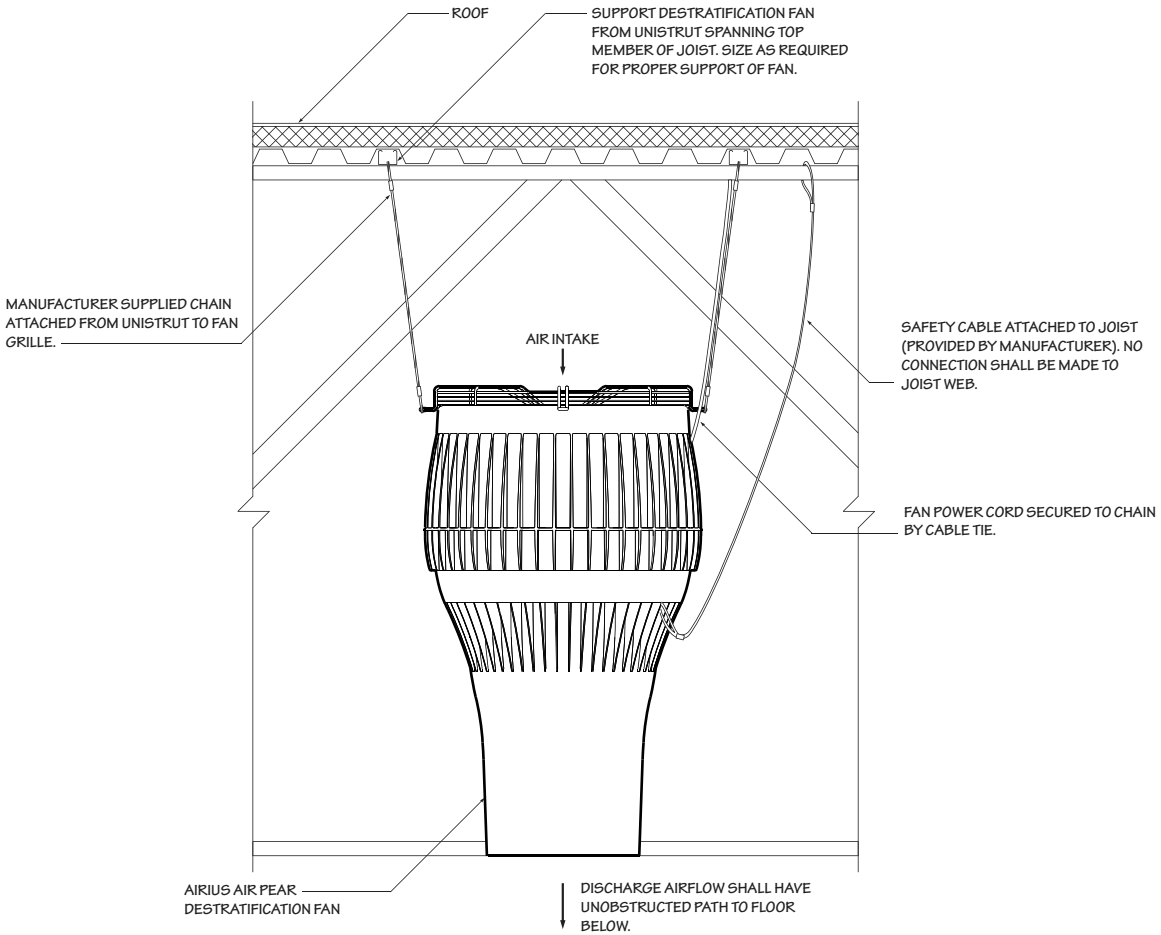
Free-Hanging Air Pear 100 Suggested Installation Method

200 lbs rated chains are supplied with the Model 100 fans that attach to the unit and the structure above. Roof structure, building construction and accessibility will define the appropriate connection hardware for each installation. Do not fasten units to joist web members or joist bridging.

After ensuring the Air Pear system is firmly attached and after REMOVING YOUR HANDS FROM THE UNIT, ONLY THEN is it safe to plug the unit into the power source using the approved plug to confirm function and electrical continuity.

NOTE: Secure the power cord to the ceiling structure as added security. The cord will act as a safety leash and by securing it the possibility of the plug accidentally coming out of the outlet is greatly reduced. A 50 lb. (20 kg.) rated Zip Tie or several wraps of mechanics wire are examples of methods of securing the power cord.

The following graphic is an example of hanging the Air Pear Model 100:



DESTRATIFICATION FAN DETAIL

SCALE: NONE

NOTES:
1. INSTALL FAN CLOSE TO CEILING. (TYP 1'-6" TO 3'-0")
2. CONTRACTOR TO PROVIDE POWER FEED IN CONDUIT. THE ELECTRICAL CONNECTION CAN BE MADE IN A J-BOX (HARD WIRED) OR PLUG CONNECTION (J-BOX/RECEPTACLE).
3. THE THIRD MANUFACTURER SUPPLIED CHAIN CAN BE USED TO TILT THE FAN AT AN ANGLE.

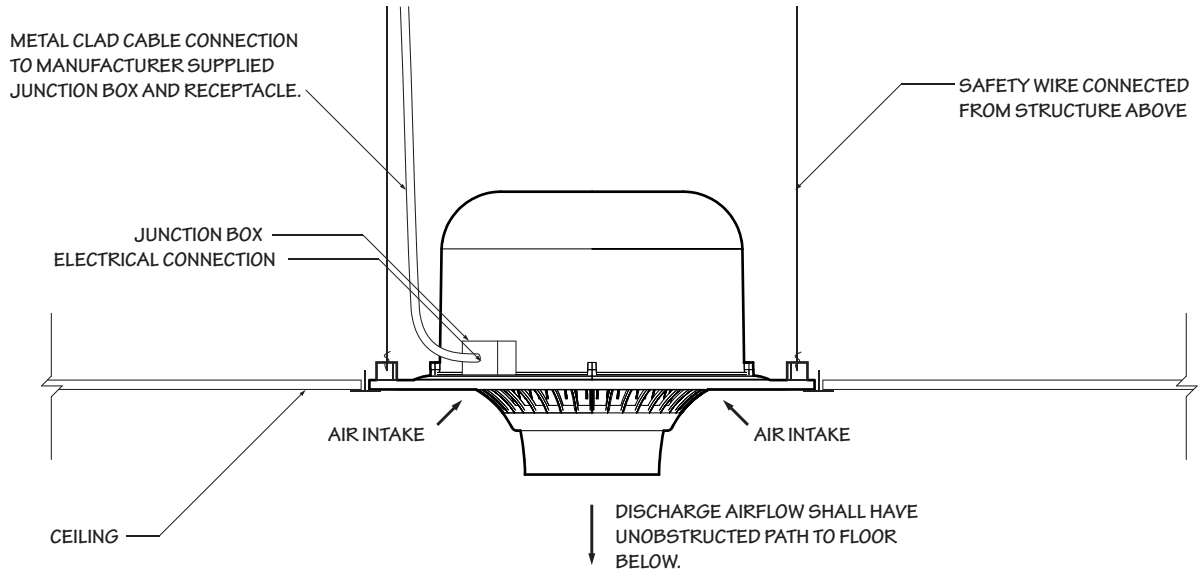
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Suspended Ceiling Air Pear Suggested Installation Methods

After ensuring the Air Pear system is firmly attached and after REMOVING YOUR HANDS FROM THE UNIT, ONLY THEN is it safe to plug the unit into the power source using the approved plug to confirm function and electrical continuity.

NOTE: Drill each of the four right angle corner tabs and secure the faceplate to the structure above with mechanics wire.

The following graphic is an example of hanging the typical Suspended Ceiling Air Pear unit:



DESTRATIFICATION FAN DETAIL

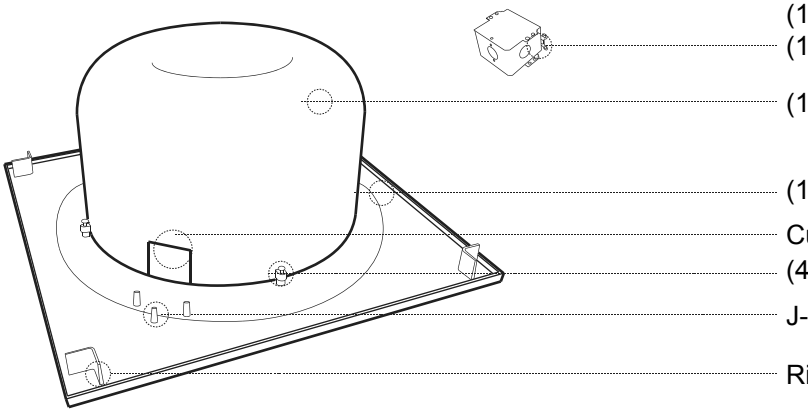
SCALE: NONE

NOTES:

1. CONTRACTOR SHALL INSTALL METAL CLAD CABLE TO MANUFACTURER SUPPLIED JUNCTION BOX AND RECEPTACLE.

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Suspended Ceiling Air Pear Assembly & Installation

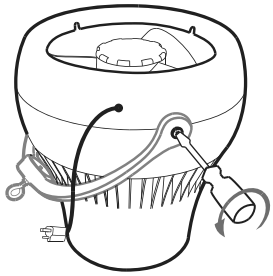


(1) J-box and (1) Faceplate
(1) 120V, 230V or 277V Receptacle, (2) Thumb Screws*
(1) Dome
(1) Air Intake Grille
Cutout for Power Cord/Receptacle
(4) Phillips Screws*
J-box Mounting Location
Right Angle Tabs

*Included in hardware bag

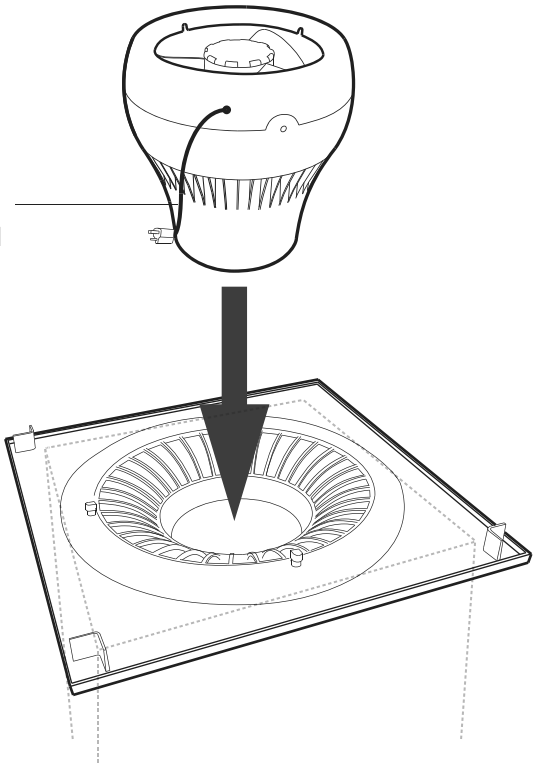
1

Remove the Air Pear from its box and plastic protective bag. The bail (handle) is attached via two Torx screws. Loosen these screws and remove the bail (discard at your discretion).



2

Remove all components from packing materials. Using the box that the suspended ceiling kit unit arrived in, open end up, place the 2’ x 2’ flat air intake grille over the open end of the box, face down. The right angle corner tabs should be facing up. Insert the Air Pear unit (with bail removed) into the center hole so that the nozzle extends below the air intake grille and the cord is hanging over the edge.



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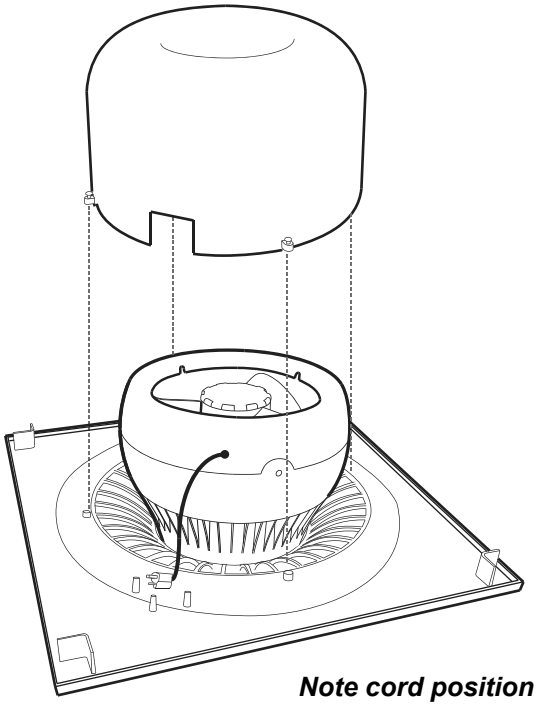
Suspended Ceiling Kit Assembly & Installation (cont.)

3

Place dome over Air Pear unit and align it with screw holes. Note that cutout should face the j-box mounting location. Dome should seat into the rim designed for it on the base, if necessary gently push the dome edge in until it seats inboard of the rim.

Insert the four Phillips screws (10-32 x 5/8” provided) through ears in dome and into threaded brass inserts. Screws will go in easily when aligned properly. Do not overtighten, as galling or stripping could occur.

When dome is installed, the power cord needs to be fed through the cutout in the dome.



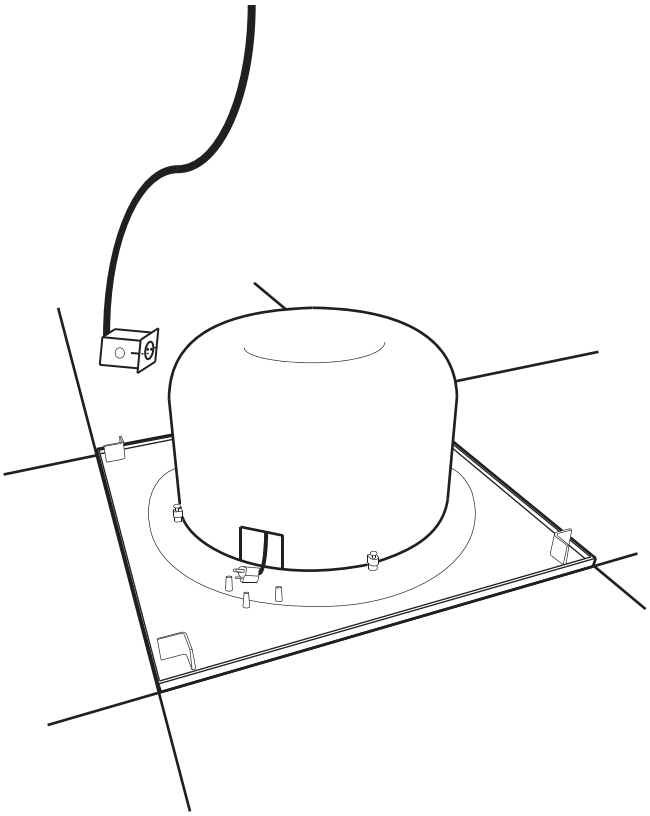
Note cord position

4

Have an electrician or similarly qualified person wire, with MC-type cable, the supplied receptacle into the j-box in close proximity to the intended installation location. Fasten the supplied metal faceplate to the j-box. Follow all local and national electric codes. MC cable should have enough length to ensure easy installation.

5

Place the assembled suspended ceiling kit into the T-bar grid. The air intake grille is designed to replace a 2’ x 2’ ceiling tile. If replacing a 2’ x 4’ tile, please use an additional piece of 2 ft. T-bar suspension material to finish the edge and provide additional strength and rigidity to the existing suspension system.

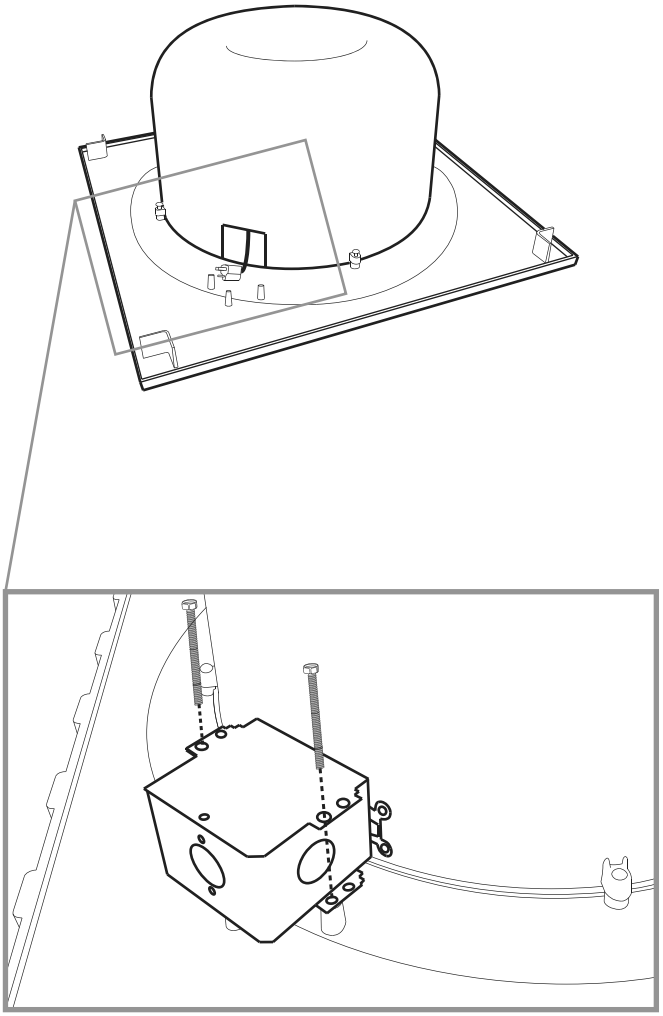


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Suspended Ceiling Air Pear Assembly & Installation (cont.)

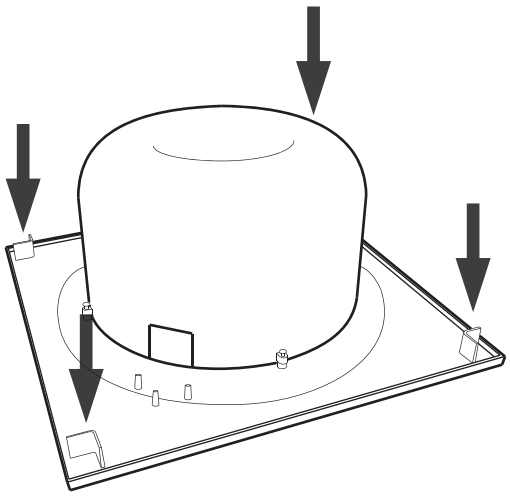
6

Plug the Air Pear power cord into the receptacle. Using the supplied thumbscrews, fasten the j-box to the air intake grill through the indicated holes as shown (wiring to j-box omitted for clarity).



7

The base has four right angle tabs located at each corner that can be drilled for additional ceiling/support wires to be added if desired.



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OPERATING THE FAN

Heating Season

Within an enclosed building space, with minimal air movement, hot lighter air rises to the ceiling while cold heavier air falls to the floor creating a temperature gradient. This condition will cause excess energy use as the HVAC system fights to maintain the thermostat set point typically at 5 ft. above floor level. This inefficient condition can also cause great thermal discomfort for the building occupants.

The Air Pear is an energy-efficient air turbine, designed to continuously move a column of air to the floor. A typical Air Pear installation includes a series of units mounted just below the ceiling, evenly spaced throughout a facility, working in concert to balance the air temperature ceiling to floor and wall to wall.

As air circulation improves and air temperatures balance, your HVAC system will require less and less energy to comfortably heat the work area, reducing the energy consumption of HVAC systems up to 35% or more. Once started, the entire process of “thermal equalization” will take, on average, less than 24 hours.

All Air Pear fans are designed to run continuously, year-round, to maintain thermal equalization and general air movement.

Cooling Season

We tend to think stratification occurs only in the heating season, but actually the condition exists year round. As you mechanically condition the air to combat rising outdoor temperatures, combined with minimal air movement, a large temperature gradient can exist.

The HVAC system will consume more energy as it fights the temperature gradient, hot and cold spots and short cycling compared to a properly mixed space. Using the Air Pear system will help alleviate the problem through thermal equalization. Keeping the thermostats satisfied longer and creating air movement that produces a cooling effect on the skin will result in the ability to raise the thermostat set points as much as 6° F, yielding up to an 18% energy savings during cooling seasons.

In non-air conditioned spaces, the Air Pear system can be used for spot cooling and general air circulation. If a large temperature differential exists between day and night, a strategy of drawing cool night air into the space and closing openings during the day can help maintain a cooler temperature internally as outdoor air temperatures rise.

A person’s head is most sensitive to comfort perception. Hot air trapped in the ceiling warms all the surrounding duct work, decking and other ceiling-mounted equipment to act as a radiant heat source and can cause the occupants to perceive discomfort. Reducing this radiant heat source through thermal equalization will help alleviate this condition.

All Air Pear fans are designed to run continuously, year-round, to maintain thermal equalization and general air movement. The fan speed can be maintained the same throughout the year or increased for the summer months to enhance the evaporative cooling effect if people in the space find this to be desirable.

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MAINTENANCE

Preventive Maintenance

Follow these easy steps to prevent any excess dirt buildup and preserve the life of the product:

No lubrication is required as bearings are sealed.

Cleaning:

- **Unplug unit from power source** first to prevent possible electrical shock and prevent injuries from spinning blades.
- Caution: Stationary blades can cause injury!
- You may clean the plastic housing with a damp cloth, using mild household detergent only.
- DO NOT use petroleum products, thinners, solvents, ammonia, alcohols or other chemicals to clean any part of the Air Pear unit.

Note: If fan is not operating or any parts are broken, contact manufacturer for replacement information.

TROUBLESHOOTING

General Troubleshooting

The Air Pear/Designer Series units are tested before they leave the factory, resulting in an extremely low rate of returns. However, mechanical devices do fail, and we recommend that you identify the problem and try the simple suggestions below.

Fan will not start:

a) Check fuses and circuit breakers.
b) Check voltage at fan connection.
c) Adjust the trim set screw in fan wall speed control (if using optional speed control). If minimum setting is too low the fan may shut off with voltage fluctuations. Increase minimum. See page 14 for more information.
d) Contact manufacturer for additional help: 1-888-AIR-PEAR (888-247-7327).

Fan airflow is too fast/slow:

a) Adjust speed control dial to produce desired flow. Adjust the trim set screw in fan wall speed control (if using optional speed control). If minimum setting is too low the fan may shut off with voltage fluctuations. Increase minimum. See page 14 for more information.

Fan has excess vibration (noise or wobbles):

a) Make certain the hanging hardware is secured tightly.
b) Contact manufacturer for additional help: 1-888-AIR-PEAR (888-247-7327).

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WARRANTY

Airius Warranty Policy

This warranty is limited to products purchased directly from Airius, LLC ("Airius") or one of its authorized resellers. To determine whether a reseller is authorized, please contact Airius at the contact information below.

Airius warrants products listed below will operate properly and be free of defects in materials and workmanship according to the following terms:

Products	Warranty Period
Air Pear Fans	3 Years (All Parts/Components)
Designer Series Fans	3 Years (All Parts/Components)
Retail Series Fans	3 Years (All Parts/Components)
Speed Controllers	1 Year (All Parts/Components)
Photohydroionization Cell	2 Years (All Parts/Components)

These include new units or units rebuilt under Airius' factory refurbish program. Airius will repair or replace such units, at Airius' sole discretion, if there is any defect in their materials or workmanship caused by Airius during the warranty period. With respect to replacement or repair rendered, Airius warrants that the parts replaced or repaired will operate properly and be free from defects in materials and workmanship for the remainder of the original warranty period.

Definitions:

1. The "warranty period" shall begin on the shipping date from the Airius factory to the customer (end user)
2. "Operate properly" applies to mechanical, electrical and structural functions only. No guarantee is made regarding the quantity of air movement or the appropriateness or the effectiveness or merchantability of any product for its intended purpose or for the customer's particular application.

Exclusions

Any of the following actions will constitute a breach of and will void all warranties:

1. Improper delivery, installation, or maintenance, including, but not limited to:
   a. Failure to follow the required installation procedures specified in the Airius "Installation Guide" and in all other documentation supplied with the fans and related equipment, including documentation provided by the manufacturers of the individual fan and control components;
   b. Failure to follow all applicable codes and ordinances, including, but not limited to the National Electric Code and state and local building codes;
   c. Failure to follow electrical engineering industry standards regarding the approved method of installing electrical equipment having the characteristics of the fans, the fan controls, and their related components, even if such standards are not explicitly referenced in any literature supplied by Airius or provided by the manufacturers of the fan and control components.
2. Any modification or alteration of, or adjustment to the fans, fan controls, and/or any disassembly of the components of the fans and fan controls for any purpose whatsoever, including any attempt to diagnose and/or repair any problem, without prior written authorization from Airius. Such disassembly includes, but is not limited to, separation of the motor from the housing assembly and/or removal of any electrical component from the fan controller unit.
3. Installation of fans into a detrimental environment with airborne oils / cutting fluids / solvents that may attack the base resin or motor, unless:
   a. Airius has provided written authorization prior to installation.
4. Misuse, abuse, accidents, unreasonable use or Acts of God.
5. Incorrect electric current, voltage or supply.
6. Failure to use fan controls supplied by Airius, unless:
   a. Airius has provided written authorization prior to installation; and
   b. The fan controls are built, operated and maintained according to specifications provided to and approved by Airius.

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Airius Warranty Policy (Continued)

7. Failure to perform periodic maintenance as detailed in the Airius-supplied "Installation Guide."
8. Consequential or incidental damages sustained by any person or entity as a result of any breach of these warranties are also excluded, except where such damages may not be excluded by law.

Acquiring Warranty Service

Do not return any item without first being assigned a Return Material Authorization (RMA) tag number. Customer must obtain a RMA# from Airius (888-AIR-PEAR or info@theairpear.com) before returning the faulty unit. RMA number must appear on the return-shipping label and be associated with any correspondence. Customer is responsible for all return shipping costs to:

Airius Warranty - RMA# ____
811 South Sherman Street
Longmont, Colorado 80501

Airius will return the unit(s) freight prepaid. Airius may elect to repair the same unit at customer site or offer replacement parts to facilitate repair and reduce customer down time and expense. Airius is not responsible for misuse of their product. Freight claims are the responsibility of the customer and all products are shipped FOB Longmont, Colorado, USA.

Remedy and Limit of Liability

The exclusive remedy of the purchaser, and the limit of liability for Airius, for any and all losses in connection with this product shall be repair or replacement of the warranted product or the affected components, as provided above.

Airius reserves the right to make the final determination, based on its own assessment, as to (1) whether the problem in question is the result of a defect in design, workmanship or materials, and not the result of error, misuse or abuse on the part of the customer, as set forth under the exclusions detailed above; (2) whether the problem or defect is material and requires action under this warranty; and (3) whether the remedy of repair or replacement is appropriate.

With regard to electrical and electronic components provided by Airius that comprise part of the products, including motors, Airius relies on the determination by the original manufacturer as to whether the failure of such component was the result of a defect. If the manufacturer of such component determines that there was no defect and therefore refuses to cover it under warranty, Airius likewise will not warranty such item.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY, REPRESENTATION OR CONDITION OF MERCHANTABILITY OR THAT THE PRODUCTS ARE FIT FOR ANY PARTICULAR PURPOSE OR USE, AND SPECIFICALLY IN LIEU OF ALL SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES. REPAIR OR REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF AIRIUS FOR ANY SPECIAL, INDIRECT, INCIDENTIAL, OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED, TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORESEEABLE.

Any and all disputes related to this warranty or any other matter related to Airius must be submitted to binding arbitration within 45 radial miles of Longmont, Colorado. The arbitrator will follow the Colorado Uniform Arbitration Act and the Rules of the American Arbitration Association. Under Colorado law, punitive damages are not recoverable by any party subject to arbitration. Moreover, jury trials are not available in arbitration. The arbitration decision or award is legally binding and enforceable. To the extent that a court rules that this paragraph is not enforceable, the parties agree to resolve any and all disputes in the Boulder District Court in Boulder, Colorado.

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CONDENSING COMMERCIAL GAS WATER HEATERS

ARMOR®

CONDENSING WATER HEATER



8 MODELS FROM 150,000 TO 800,000 BTU/HR

96% THERMAL EFFICIENCY

5:1 TURNDOWN RATIO

CONDENSING STAINLESS STEEL HEAT EXCHANGER

Lochinvar SMART SYSTEM™
W/CASCADING SEQUENCER

CONXUS®
REMOTE CONNECT CAPABLE

AN INNOVATION IN COMMERCIAL WATER HEATING

DESIGNED ★ ENGINEERED ★ ASSEMBLED
USA

Lochinvar®

ARMOR®
CONDENSING WATER HEATER

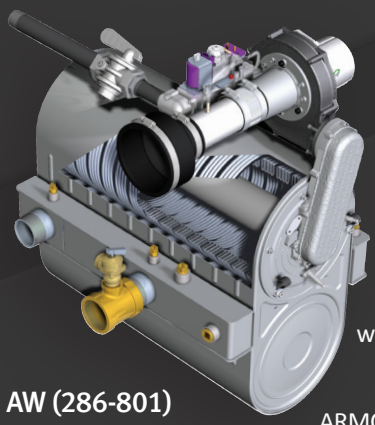


A BETTER WAY TO ACHIEVE 96% THERMAL EFFICIENCY

ARMOR is a fully condensing commercial gas water heater. Available in eight models with inputs ranging from 150,000 to 800,000 Btu/hr, the ARMOR achieves 96% thermal efficiency.

SEPARATE TANK FOR FLEXIBILITY, LOWER REPLACEMENT COSTS

With standard tank-type water heaters, your choices are limited when it comes to matching input with storage capacity to meet "peak demand" delivery requirements. With ARMOR, you can match one or more water heaters with one or more storage tanks in a wide variety of sizes. Lochinvar Lock-Temp® tanks are available from our 80-gallon vertical to the 5000-gallon vertical or horizontal model. Another advantage of the ARMOR "dual component" system is lower replacement costs. Standard tank-type designs require replacement of the entire water heater. With ARMOR, you'll save time and money by only replacing individual components as needed, such as the pump or storage tank.



AW (286-801)

FULLY MODULATING WITH 5:1 TURNDOWN

ARMOR features advanced Negative Regulation (Neg/Reg) sealed combustion technology, permitting fan speed to constantly adjust the volume of fuel and air entering the burner. This ensures that ARMOR can safely and reliably operate with supply gas pressure as low as 4 inches water column.

ARMOR is equipped with fully modulating combustion with 5:1 turndown. This means ARMOR can fire as low as 20% of maximum input when water heating demand is lowest, and increase the firing rate up to 100% as demand increases. The result is better overall efficiency and less cycling, compared to "on-off"tank-type units which can only fire at 100% input.

STAINLESS STEEL CONDENSING HEAT EXCHANGER

The ARMOR's stainless steel heat exchanger is built to ASME Section IV requirements. Its design provides superior resistance to corrosion caused by condensation from low entering water temperatures. Non - Condensing commercial water heaters will fail early with low entering water temperatures; however, with the ARMOR the lower the supply water temperature the more efficiently it performs throughout the life of the heater.

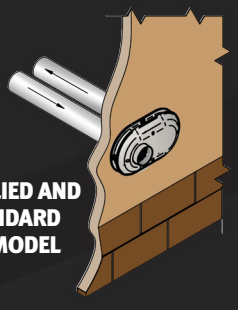
DIRECT-VENTING UP TO 100 FEET



Sidewall Vent Termination

ARMOR offers 7 venting options and tremendous flexibility for placement of units within the building, because it permits direct-vent air intake and exhaust runs up to 100 equivalent feet using either PVC, CPVC, Polypropylene or AL29-4C stainless steel vent pipe. Intake and exhaust runs can terminate horizontally through a sidewall or vertically through the roof.

**Optional Concentric Vent Kit Sold Separately (for 151-601 Models)*



FACTORY SUPPLIED AND SHIPPED STANDARD WITH EVERY MODEL

Lochinvar SMART SYSTEM™

WATER HEATER CONTROL, FROM ANYWHERE.

ARMOR features the next generation of Lochinvar's all-in-one SMART SYSTEM operating control with an advanced multi-color LCD interface. SMART SYSTEM provides outstanding functionality, and can be integrated directly into a Building Management System via ModBus and other communication protocols. And now, the CON·X·US mobile communication platform allows SMART SYSTEM to go where no other water heater has gone before.†

CON·X·US provides the ability to monitor and manage Armor water heaters without ever stepping into the mechanical room. CON·X·US will send alerts via text or e-mail with notification of changes in system status, and anytime, from anywhere, a user can check system status and re-program water heater functions. Once downloaded, the free CON·X·US mobile application allows for remote access to all SMART SYSTEM functions using any internet-capable device.



CON·X·US®

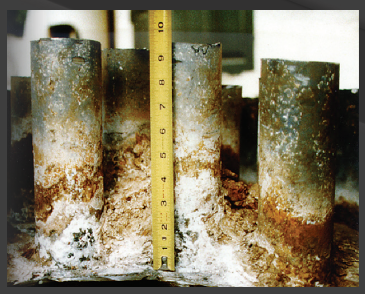
† CON·X·US board sold separately. See back cover for a complete list of SMART SYSTEM features.

LONG-LASTING "LIFE CYCLE" EFFICIENCY

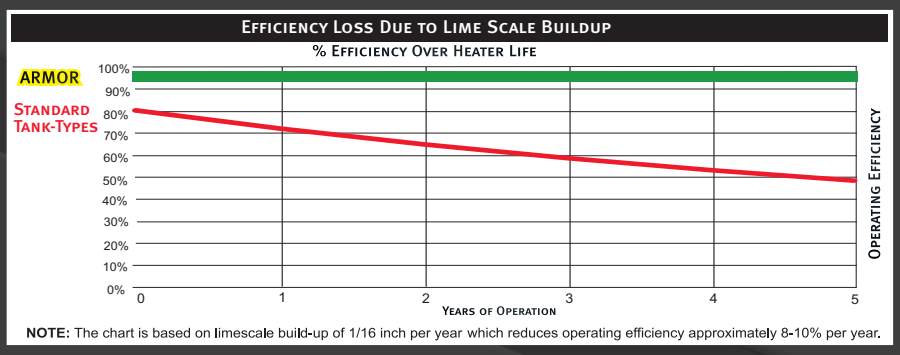
In a standard tank-type water heater, lime scale builds up over time on important heat transfer surfaces, insulating the water from the heat source. This decreases thermal efficiency and increases operating cost. Just 1/4" of lime scale can increase operating costs as much as 25%! This buildup in the bottom of the tank and around the flue tubes can cause tank-type heaters to fail in as little as 2-3 years.

ARMOR's "Better idea" concept eliminates the impact of lime scale, maintaining a high-rated thermal efficiency and low operating cost throughout its long life cycle.

The chart below illustrates how ARMOR is a better way, delivering true "life cycle efficiency" compared to standard tank-type units.

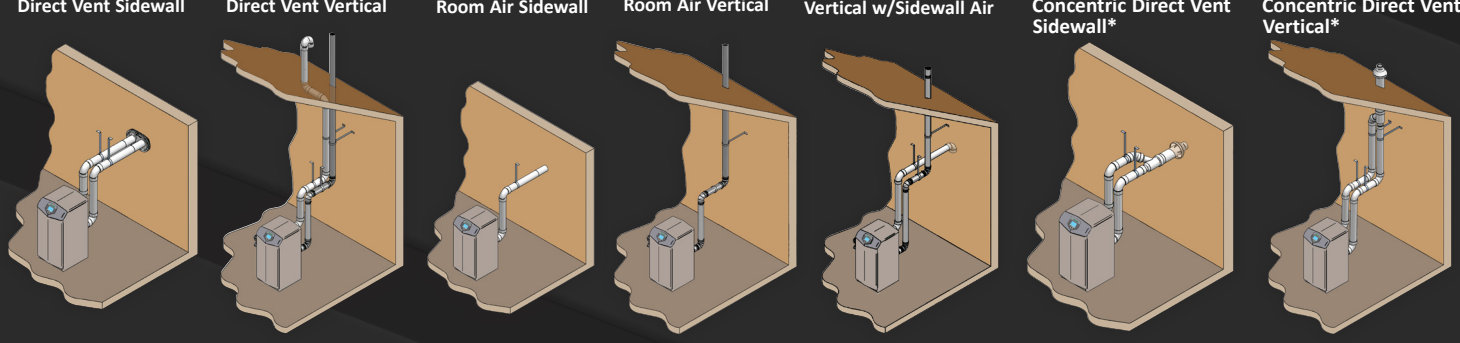


Traditional tank-type water heater flue tubes with nearly 6" of lime scale buildup



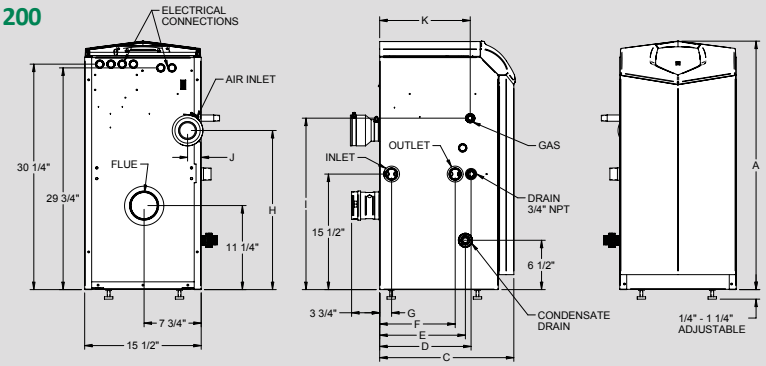
NOTE: The chart is based on limescale build-up of 1/16 inch per year which reduces operating efficiency approximately 8-10% per year.

7 FLEXIBLE VENTING OPTIONS - Up to 100 feet of air intake and 100 feet of exhaust vent with PVC, CPVC, Polypropylene or Stainless Steel.

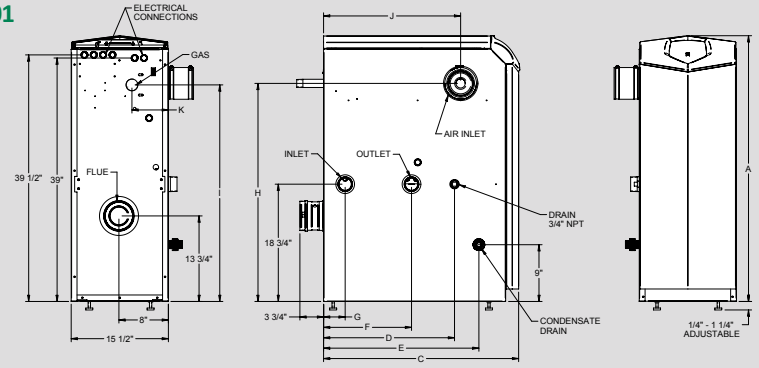


ARMOR™ WATER HEATER DIMENSIONS AND SPECIFICATIONS

MODELS 151 & 200



MODELS 286-801



Model Number Guide

AW	N	151	PM
Armor Water Heater	Natural Gas	Btu/hr Input	Pump Mount

***A**rmor **W**ater Heater,*
***N**atural Gas,*
***150**,000 Btu/hr Input,*
***P**ump **M**ount*

ARMOR WATER HEATER

AHRI CERTIFIED

DIMENSIONS & SPECIFICATIONS

Model Number	Btu/hr Input	GPH @ 100° Rise	A	C	D	E	F	G	H	I	J	K	Gas Conn.	Water Conn.	Air Inlet	Vent Size	Shipping Wt. (lbs.)
AWN151PM	150,000	175	33-1/4″	18″	12-1/4″	11-1/2″	10″	1-1/2″	21-1/4″	23″	1-3/4″	12″	1/2″	1-1/4″	3″	3″	165
AWN200PM	199,999	233	33-1/4″	22-1/4″	16-1/2″	15-3/4″	14-1/4″	5-1/4″	21-1/4″	23″	1-3/4″	16-1/4″	1/2″	1-1/4″	3″	3″	181
AWN286PM	285,000	332	42-1/2″	19-3/4″	12-3/4″	13-1/2″	6″	2″	34″	31″	11-3/4″	4-1/4″	3/4″	2″	4″	4″	236
AWN400PM	399,999	466	42-1/2″	27″	21″	20-3/4″	14″	3-1/2″	34″	34″	18-3/4″	2″	1″	2″	4″	4″	306
AWN501PM	500,000	582	42-1/2″	31-1/2″	21″	25″	14″	3-1/2″	35″	35″	22″	5-3/4″	1″	2″	4″	4″	339
AWN601PM	600,000	699	42-1/2″	36-1/4″	21″	25″	14″	3-1/2″	36″	32-3/4″	19-1/2″	5-1/2″	1″	2″	4″	4″	380
AWN701PM	700,000	815	42-1/2″	40-1/4″	23″	29″	17″	3-1/2″	36″	32-3/4″	23-1/2″	3-1/4″	1″	2″	4″	6″	461
AWN801PM	800,000	931	42-1/2″	45-1/4″	23″	33-1/4″	17″	3-1/2″	36″	32-3/4″	27-3/4″	3-1/4″	1″	2″	4″	6″	527

STANDARD FEATURES

- **› 96% Thermal Efficiency (AHRI Certified)**
- **› Modulating Burner with 5:1 Turndown**
  - Direct-Spark Ignition
  - Low NOx Operation
  - Sealed Combustion
  - Low Gas Pressure Operation
- **› Vertical & Horizontal Direct-Vent**
  - PVC, CPVC, Polypropylene or Stainless Steel up to 100 Feet
  - PVC/CPVC Sidewall Vent Termination
- **› Stainless Steel Heat Exchanger**
  - All Welded Construction, Gasketless Design
  - 160 psi Working Pressure
  - ASME Construction (AW 286-801)
  - Natural to L.P. Conversion Kit
  - Stainless Steel Circulating Pump
  - On/Off Switch
  - Flow Switch
  - ASME Temperature & Pressure Relief Valve (286-801)
  - Downstream Test Valves (AW 501-801)
  - Adjustable Leveling Legs
  - Tank Sensor
  - Adjustable High Limit w/ Manual Reset
  - Automatic Reset High Limit
  - Condensate Trap
  - Zero Clearances to Combustible Material
  - 5 Year Limited Warranty (See Warranty for Details)
  - 1 Year Parts Warranty (See Warranty for Details)

SMART SYSTEM FEATURES

- **› SMART SYSTEM Digital Operating Control**
  - Multi Color Graphic LCD Display
- **› Built in Cascading Sequencer for up to 8 Water Heaters**
  - Multiple Size Water Heater Cascade
  - Lead Lag
  - Efficiency Optimization
  - Front-End Loading Capability with CopperFin II
- **› Building Management System Integration**
  - 0-10 VDC Input to Control Modulation or Set point
  - 0-10 VDC Modulation Rate Output
  - 0-10 VDC Input to Enable/Disable call for heat
- Access to BMS Settings Through Graphic LCD Display
- Low Water Flow Safety Control & Indication
- Inlet & Outlet Temperature Sensors & Readout
- Flue Temperature Sensor
- Water Heater Pump Control
- Pump Delay with Freeze Protection
- Pump Exercise
- Night Setback
- Building Recirculation Loop Pump Control
- Night Setback of Building Recirculation Loop
- Time Clock
- **› Maintenance Reminder**
  - Ability to program installer name and number into the product as service contact
- **› High Voltage Terminal Strip**
  - 120 VAC / 60 Hertz / 1 Phase Power Supply
  - Water Heater Pump Control Contacts
  - Building Recirculation Pump Control Contacts
- **› Low Voltage Terminal Strip**
  - 24 VAC Auxiliary Device Relay
  - Auxiliary Proving Switch Contacts
  - Flow Switch Contacts
  - Alarm on Any Failure Contacts
  - Runtime Contacts
  - Tank Sensor Contacts
  - Cascade Contacts
  - 0-10 VDC BMS External Control Contacts
  - 0-10 VDC Boiler Rate Output Contacts

FIRING CONTROL SYSTEMS

M9 Standard Construction

OPTIONAL EQUIPMENT

- CON·X·US® Remote Connectivity
- Alarm on any failure
- Condensate Neutralization Kit
- High & Low Gas Pressure Switches (AW 501-801)
- Concentric Vent Kit (3" & 4" PVC/CPVC only)
- BMS Gateway to LON
- BACnet Communication
- ModBus Communication
- SMART SYSTEM PC Software
- Room Air Vent Kits
- Stack Frame

Lochinvar®

Lochinvar, LLC
300 Maddox Simpson Parkway
Lebanon, Tennessee 37090
P: 615.889.8900 / F: 615.547.1000
Lochinvar.com

LOW LEAD CONTENT

Lochinvar®
HIGH EFFICIENCY BOILERS & WATER HEATERS

ARMOR® WATER HEATER PRODUCT SUMMARY

(AW) 150,000 - 800,000 BTU/HR

	AW-151	AW-200	AW-286	AW-400	AW-501	AW-601	AW-701	AW-801
WATER								
GALLON CAPACITY	1.3	1.8	2.5	3.4	3.9	3.9	4.4	4.9
HEATING SURFACE (SQ. FT.)	16.4	21.8	29.1	41.8	50.8	50.8	57.8	65.3
WATER CONNECTIONS	1-1/4″	1-1/4″	2″	2″	2″	2″	2″	2″
DRAIN	3/4″	3/4″	3/4″	3/4″	3/4″	3/4″	3/4″	3/4″
WATER FLOW RATE (GPM)	16.0	21.0	30.0	39.0	53.0	53.0	63.0	67.0
HEAD LOSS (FT. OF HD.)	16.6	11.8	17.1	21.1	26.0	26.0	32.0	31.0
MAX. WORKING PRESSURE (PSI)	160	160	160	160	160	160	160	160
MAX. WATER HARDNESS (GRAINS)	15	15	15	15	15	15	15	15
GPH @ 70°F RISE	248	336	474	665	831	997	1164	1330
GPH @ 100°F RISE	173	235	332	465	582	698	815	931
GPH @ 140°F RISE	124	168	237	332	416	499	582	665
# OF RELIEF VALVES	1	1	1	1	1	1	1	1
RELIEF VALVE SIZE	1"	1"	3/4″	3/4″	3/4″	3/4″	3/4″	3/4″
RELIEF VALVE RATING (MBH)	500	500	500	500	1,912	1,912	1,912	1,912
RELIEF VALVE PRESSURE RATING (PSI)	150	150	150	150	150	150	150	150
RELIEF VALVE TEMPERATURE RATING (°F)	210	210	210	210	210	210	210	210
GAS								
INLET CONNECTION	1/2″	1/2″	3/4″	1″	1″	1"	1"	1"
MAX. INLET PRESSURE, NAT	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.
MIN. INLET PRESSURE, NAT	4.0″ w.c.	4.0″ w.c.	4.0″ w.c.	4.0″ w.c.	4.0″ w.c.	4.0″ w.c.	4.0″ w.c.	4.0″ w.c.
MAX. INLET PRESSURE, LP	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.	14.0″ w.c.
MIN. INLET PRESSURE, LP	8.0″ w.c.	8.0″ w.c.	8.0″ w.c.	8.0″ w.c.	8.0″ w.c.	8.0″ w.c.	8.0″ w.c.	8.0″ w.c.
BTU/HR INPUT	150,000	199,999	285,000	399,999	500,000	600,000	700,000	800,000
ELECTRICAL								
VOLTAGE/HEATER	120	120	120	120	120	120	120	120
VOLTAGE/PUMP	120	120	120	120	120	120	120	120
VOLTAGE/CONTROL	24	24	24	24	24	24	24	24
TOTAL AMPS W/PUMP	3.0	3.2	4.5	6.5	5.7	5.7	12.8	12.8
# OF ELECTRICAL CONNECTIONS	1	1	1	1	1	1	1	1
DIMENSIONS								
HEIGHT	33-1/4″	33-1/4″	42-1/2″	42-1/2″	42-1/2″	42-1/2″	42-1/2″	42-1/2″
WIDTH	15-1/2″	15-1/2″	15-1/2″	15-1/2″	15-1/2″	15-1/2″	15-1/2″	15-1/2″
DEPTH	18″	22-1/4″	19-3/4″	27″	31-1/4″	36-1/4"	40-1/4"	42-1/4"
SERVICE CLEARANCES								
FRONT	24″	24″	24″	24″	24″	24″	24″	24″
BACK	24″	24″	24″	24″	24″	24″	24″	24″
RIGHT SIDE	0″	0″	0″	0″	0″	0″	0″	0″
LEFT SIDE (PIPING)	24″	24″	24″	24″	24″	24″	24″	24″
TOP	24″	24″	24″	24″	24″	24″	24″	24″
DIRECT VENTING								
VENT SIZE	3″	3″	4″	4″	4″	4"	6"	6"
AIR INTAKE SIZE	3″	3″	4″	4″	4″	4"	4"	4"
VENT CATEGORY	IV	IV	IV	IV	IV	IV	IV	IV
VENT MATERIAL (all models)	PVC / CPVC / Polypropylene / Stainless Steel							

Lochinvar, LLC • 300 Maddox Simpson Pkwy • Lebanon, TN 37090 • 615-889-8900 / Fax: 615-547-1000
www.Lochinvar.com

Building Sealant Recommendations and Surface Preparation Guide for Weatherseal Applications

Weatherseal

Dow Corning has a full line of high-performance primers for sealants. Primers are used to enhance adhesion.

	Dow Corning® 756 SMS Building Sealant	*Dow Corning*® 790 Silicone Building Sealant[1]	*Dow Corning*® 791 Silicone Weatherproofing Sealant	*Dow Corning*® 795 Silicone Building Sealant
Substrate	**Surface Prep**			
Concrete and Masonry				
Brick	Limited Data/Field Test	No Primer	1200 OS/Primer P	Primer P
Concrete	Field Test	No Primer	1200 OS/Primer P	Primer P
Mortar	Primer P	No Primer	Primer P	Primer P
EIFS[2]				
All Manufacturers[3]	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Stone				
Granite	No Primer	No Primer	Limited Data/Field Test	1200 OS/Primer P
Travertine	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Marble[4]	1200 OS/Primer P	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Limestone[8]	1200 OS/Primer P	Limited Data/Field Test	Limited Data/Field Test	Primer P
(Natural Stone) Sandstone[9]	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Primer P
Paints				
Acrylic Latex	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Duracron	No Primer	Limited Data/Field Test	No Primer	1200 OS/Primer P
Polyester Powder Coating[7]	Limited Data/Field Test	1200 OS	No Primer	No Primer
Polyurethane	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Polyvinyl Chloride (PVC)	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Fluoropolymer				
Kynar®	No Primer	Limited Data/Field Test	No Primer	Primer-C OS
Duranar®	No Primer	Limited Data/Field Test	No Primer	Primer-C OS
Duranar Sunstorm®	Limited Data/Field Test	Limited Data/Field Test	No Primer	Primer-C OS
Fluropon®	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Primer-C OS
Metals				
Aluminum – Chromate Conversion, Alodine®	No Primer	Limited Data/Field Test	No Primer	No Primer
Aluminum – Mill Finish	No Primer	1200 OS	1200 OS	1200 OS
Aluminum – Anodized	No Primer	1200 OS	No Primer	No Primer
Copper	Do Not Use	Do Not Use	No Primer	No Primer
Lead	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test

	Dow Corning® 756 SMS Building Sealant	*Dow Corning*® 790 Silicone Building Sealant[1]	*Dow Corning*® 791 Silicone Weatherproofing Sealant	*Dow Corning*® 795 Silicone Building Sealant
Substrate	**Surface Prep**			
Glass[6]				
Coated Glass	No Primer	1200 OS	No Primer	No Primer
Clear Glass	No Primer	No Primer	No Primer	No Primer
Steel				
Red Lead Primer	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Weathered	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Stainless	Limited Data/Field Test	Limited Data/Field Test	1200 OS	1200 OS
Galvanized	No Primer	1200 OS	No Primer	1200 OS/Primer P
Cold Rolled	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test	Limited Data/Field Test
Plastics				
PVC	Limited Data/Field Test	Limited Data/Field Test	1200 OS/Primer P	No Primer
Acrylic	Limited Data/Field Test	Do Not Use	Limited Data/Field Test	Limited Data/Field Test
Polycarbonate	Do Not Use	Do Not Use	Limited Data/Field Test	Limited Data/Field Test

Key: 1200 OS: *Dow Corning*® 1200 OS Primer; PC: *Dow Corning*® Primer-C OS; PP: *Dow Corning*® Primer P; NA: Not applicable
Dow Corning must test all materials for adhesion in structural applications.
Field adhesion tests must be performed at the jobsite to verify sealant adhesion.

[1] When using a primer with *Dow Corning*® 790 Silicone Building Sealant, apply the primer before installing backer rod and allow the primer to dry. Cold weather and porous surfaces require additional drying time.
[2] Do not apply sealant to EIFS finish coat unless approved by EIFS manufacturer.
[3] Cleaning procedures for EIFS systems should be followed.
[4] The extremely porous nature of some marble, particularly white marble, can contribute to the potential for fluid migration into this substrate. Contact a Dow Corning Specialist when working with marble.
[5] Laminated glass with polyvinyl buyvol (PVB) interlayer may delaminate up to 1/4” at the edges when in contact with a sealant.
[6] Do not use *Dow Corning*® 790 Silicone Building Sealant on copper sputter coated glass.
[7] See *Organic Solvent Usage* in the *Dow Corning Americas Technical Manual* (62-1112) for comment.
[8] Some limestone and other porous stone substrates contain iron and other impurities that can interact with *Dow Corning*® 756 SMS Building Sealant, causing discoloration of the sealant and/or substrate. Prior to use, *Dow Corning*® 756 SMS Building Sealant should be tested for compatibility with these substrates using water immersion.

This surface preparation guide is intended to aid in proper selection of surface preparation techniques and primers, if necessary, to gain adhesion that meets Dow Corning’s requirements. The suggestions in this guide are not blanket-approval recommendations; Dow Corning requires all surface prep recommendations in this guide be verified by field or shop adhesion testing and documented prior to starting the project for each substrate/sealant combination. Failure to verify and document adhesion results may result in adhesion loss that is not covered by the Dow Corning Warranty. Recommendations in this guide have been shown to be the best overall recommendations but do not cover every substrate for each material type or finish listed in this guide. Additionally, substrate manufacturers should be contacted to obtain recommendations for proper cleaning solvents for use with their materials. The entire *Weatherproofing* section of the *Dow Corning Americas Technical Manual*, Form No. 62-1112, should be read and understood before proceeding with the evaluations. The following sections within the manual must be followed to verify and document adhesion:

- *Substrate Cleaning Procedure*
- *“Two Cloth” Cleaning Method*
- *Primer Application Procedure*
- *Field Adhesion Testing Procedure*
- *Field Adhesion Hand Pull Test Criteria*
- *Field/Shop Adhesion Log and Sealant Quality Control Logs*

Structural

All structural applications must be tested by the Dow Corning test lab.

	Dow Corning® 795 Silicone Building Sealant	*Dow Corning*® 983 Structural Glazing Sealant	*Dow Corning*® 995 Silicone Structural Sealant	*Dow Corning*® 121 Structural Glazing Sealant
Substrate	**Surface Prep**			
Paints				
Acrylic Latex	Limited Data/Lab Test	Limited Data/Lab Test	Limited Data/Lab Test	Limited Data/Lab Test
Duracron	Primer-C OS	Primer-C OS	Primer-C OS	Primer-C OS
Polyester Powder Coating[1]	Primer-C OS, 1200 OS	Primer-C OS, 1200 OS	No Primer	Primer-C OS
Fluoropolymer				
Kynar®	Primer-C OS	Primer-C OS, 1200 OS	No Primer	Primer-C OS
Duranar®	Primer-C OS	Primer-C OS	Primer-C OS	Primer-C OS
Duranar Sunstorm®	Primer-C OS	Primer-C OS	Primer-C OS	Limited Data/Lab Test
Fluropon®	Primer-C OS	Primer-C OS	Primer-C OS	Limited Data/Lab Test
Metals				
Aluminum – Chromate Conversion, Alodine®	No Primer, 1200 OS	No Primer, 1200 OS	1200 OS	1200 OS
Aluminum – Anodized	No Primer	No Primer, 1200 OS	1200 OS	1200 OS
Glass – Surface to be Glazed to				
Clear	No Primer	No Primer	No Primer	No Primer
Float	No Primer	No Primer	No Primer	No Primer
Laminated[2]	No Primer	No Primer	No Primer	No Primer
Plate	No Primer	No Primer	No Primer	No Primer
Tinted	No Primer	No Primer	No Primer	No Primer
Ceramic Frit Coating	No Primer	No Primer	No Primer	No Primer
Reflective Glass	No Primer	No Primer	No Primer	No Primer
Low E High (T) Glass	No Primer	No Primer	No Primer	No Primer

Key: 1200 OS: *Dow Corning*® 1200 OS Primer; PC: *Dow Corning*® Primer-C OS; PP: *Dow Corning*® Primer P; NA: Not applicable
Dow Corning must test all materials for adhesion in structural applications.
Field adhesion tests must be performed at the shop or jobsite to verify sealant adhesion.

[1] See *Organic Solvent Usage* in the *Dow Corning Americas Technical Manual* (62-1112) for comment.
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- *Substrate Cleaning Procedure*
- *“Two Cloth” Cleaning Method*
- *Primer Application Procedure*

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Your exclusive remedy for breach of such warranty is limited to refund of purchase price or replacement of any product shown to be other than as warranted.

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DOW CORNING

We help you invent the future.™

TRANE

Product Catalog

Air-Cooled Scroll Chillers
Model CGAM — Made in USA
20 to 130 Nominal Tons (60 Hz and 50 Hz)



July 2017

CG-PRC017N-EN

Ingersoll Rand

Introduction

Design and manufacturing excellence makes Trane a leader in the air-cooled chiller market place. This tradition of using excellence to meet market demands is illustrated with the Trane 20 to 130 ton air-cooled scroll chiller. This next-generation chiller is an exciting step forward in energy-efficiency, sound, reliability, ease of serviceability, control precision, application versatility, and operational cost-effectiveness. The chiller is designed to deliver proven Trane performance based on the redesign of a European model that has been a market leader, plus all the benefits of new heat transfer and fan designs, as well as, low-speed, direct-drive scroll compressors.

Important Design Features and New Features

- Higher full-load and part-load energy efficiency that exceed ASHRAE 90.1 and reduce operating costs
- Significantly lower noise levels than other scroll compressor chillers.
- R-410A optimized design.
- Flow switch and water strainer are factory installed in the optimum locations for seamless operation and reduced chiller installation and maintenance time.
- Tracer® CH530 with Adaptive Control™ has improved fan algorithms for more reliable operation at extreme conditions.
- Single chiller time of day scheduling communication for easier control of small jobs.
- Easily integrated with existing BAS via BACnet® or LonTalk® communication interface.
- All major service components are close to the unit edge for safe and easy maintenance.
- The chiller is designed for easy serviceability with input from our extensive experience in design, testing and field operation.

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Revision History

- Updated flow rates in General Data table.
- Correction to Table 15, p. 41 for 100 ton unit dimensions.
- Update AHRI back cover logo.

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Features and Benefits

Reliability

- Years of laboratory testing, including running the chiller at extreme operating conditions, have resulted in optimized compressor and chiller systems reliability by confirming a robust design and verifying quality each step of the way.
- Direct-drive, low-speed scroll compressors with fewer moving parts provide maximum efficiency, high reliability, and low maintenance requirements. Suction gas-cooled motor stays at a uniformly low temperature for long motor life.
- The third generation microprocessor control system provides improved control capabilities with Adaptive Control™ to keep the unit operating even in adverse conditions. Advanced microelectronics protect both the compressor and the motor from typical electrical fault conditions like thermal overload and phase rotation.
- Standard factory-installed water strainer helps prevent system debris from affecting unit flow or heat transfer.
- Flow switch is factory-installed at the optimum location in the piping for reduced chiller installation cost and superior flow sensing, reducing the potential for nuisance trips.
- Microchannel condenser uses all-aluminum coils with fully-brazed construction. This design reduces risk of leaks. Their flat streamlined tubes with small ports and metallurgical tube-to-fin bond enable exceptional heat transfer and dramatic reduction in refrigerant use.
- The optional round tube and plate fin condenser with its exceptionally rigid coil structure is manufactured with hairpin tubes which reduces the number of braze joints by half, significantly reducing the potential for leaks.
- Innovative condenser pressure integrated fan control algorithms and variable frequency drive on circuits' lead fans provides more reliable operation at extreme temperature conditions.

Life Cycle Cost-Effectiveness

- Industry leading full- and part-load efficiencies
- Electronic expansion valve and high speed suction temperature sensor enables tight chilled water temperature control and low superheat, resulting in more efficient full-load and part-load operation than previously available.
- Partial heat recovery available to save energy on pre-heat or reheat applications.
- Optional pump package features variable speed drive on the pump motors, eliminating the need for energy sapping chilled water system triple-duty or balancing valves. Additionally, system commissioning and flexibility is greatly enhanced. Chilled water supply reliability is increased with the dual pump design, due to standard failure/recovery functionality.

Application Versatility

- Industrial/low temperature process cooling - Excellent operating temperature range and precise control capabilities enable tight control.
- Ice/thermal storage - Utilities and owners benefit from reduced cooling energy cost. The chiller's dual setpoint control and industry leading energy storage efficiency assures reliable operation and superior system efficiency. Trane's partnership with CALMAC brings a proven track record of successful installations across many markets; from churches and schools to sky scrapers and office buildings.
- Partial heat recovery - An optional factory-installed heat exchanger provides hot water for many needs; water preheat and reheat for enhanced system humidity control are just two. This option reduces operating costs associated with boilers/domestic hot water.

Simple, Economical Installation

- Reduced sound levels, compared to other scroll compressor chillers, perfect for applying outdoor HVAC equipment in neighborhoods, such as K-12 schools.
- System integration available with LonTalk® or BACnet® through a single twisted-pair wire for a less expensive translation to an existing building automation system.
- Powder-coated paint provides superior durability, corrosion protection, and is less likely to be damaged while rigging/lifting/installing the chiller.
- Factory commissioned unit-mounted starter reduces overall job cost and improves system reliability by eliminating job site design, installation and labor coordination requirements.

Precision Control

- Easily integrated with existing BAS via BACnet® or LonTalk® communication interfaces.
- Microprocessor-based Tracer® CH530 controls monitor and maintain optimal operation of the chiller and its associated sensors, actuators, relays, and switches, all of which are factory-installed and tested prior to shipping.
- Adaptive Control maintains chiller operation under adverse conditions, when many other chillers might simply shut down. The chiller control is able to compensate for conditions such as high condensing pressure and low suction pressure.
- Advanced microprocessor controls enable variable primary flow applications providing chilled water temperature control accuracy of ±2°F (1.1°C) with flow changes up to 10 percent per minute, while keeping the chiller online through flow changes up to 30 percent per minute.
- Easy-to-use operator interface displays all operating and safety messages, with complete diagnostics information, on a highly readable panel with a scrolling touch-screen display. Status and diagnostic messages are in plain language - no codes to interpret - and are available in 20 languages.

Improved Serviceability

- All major serviceable components are close to the edge. Service shutoff valves and water strainer are conveniently located to enable easy service.
- Water piping connections are factory piped to the edge of the unit to make installation safer and faster.
- Electronic expansion valve designed so controls can be removed and serviced without refrigerant handling.
- The optional pump package is designed to be serviced in place. The unit structure includes a rigging point for pump servicing, making inspection, cleaning and pump seal changes easier.
- High pressure transducer and temperature sensors mountings enable troubleshooting and replacement without removing refrigerant charge, greatly improving serviceability over the life of the unit.
- Dead front panel construction provides for enhanced service technician safety.

Application Considerations

Certain application constraints should be considered when sizing, selecting and installing Trane CGAM chillers. Unit and system reliability is often dependent upon proper and complete compliance with these considerations. Where the application varies from the guidelines presented, it should be reviewed with your local Trane account manager.

Note: *The terms water and solution are used interchangeably in the following paragraphs.*

Unit Sizing

See TOPSS™ performance selection software for unit capacities. Intentionally over-sizing a unit to assure adequate capacity is not recommended. Erratic system operation and excessive compressor cycling are often a direct result of an oversized chiller. In addition, an oversized unit is usually more expensive to purchase, install, and operate. If oversizing is desired consider using two smaller units.

Water Treatment

The use of untreated or improperly treated water in chillers may result in scaling, erosion, corrosion, and algae or slime buildup. This will adversely affect heat transfer between the water and system components. Proper water treatment must be determined locally and depends on the type of system and local water characteristics.

Neither salt nor brackish water is recommend for use in Trane air-cooled CGAM chillers. Use of either will lead to a shortened life. Trane encourages employing a qualified water treatment specialist, familiar with local water conditions, to assist in establishing a proper water treatment program.

Foreign matter in the chilled water system can also increase pressure drop and, consequently, reduce water flow. For this reason it is important to thoroughly flush all water piping to the unit before making the final piping connections to the unit.

Effect of Altitude on Capacity

At elevations substantially above sea level, the decreased air density will decrease condenser capacity and, therefore, unit capacity and efficiency. S

Ambient Limitations

Trane chillers are designed for year-round operation over a range of ambient temperatures. The air-cooled model CGAM chiller will operate in ambient temperatures of 32 to 125°F (0 to 52°C) for high ambient or 0 to 125°F (-18 to 52°C) for wide ambient. Extreme low ambient operation is offered down to -20°F (-28.9°C). Operation below 32°F requires the use of variable speed fans unless otherwise specified.

The minimum ambient temperatures are based on still conditions (winds not exceeding five mph). Greater wind velocities will result in a drop in head pressure, therefore increasing the minimum starting and operating ambient temperature. The Adaptive Control™ microprocessor will attempt to keep the chiller on-line when high or low ambient conditions exist, making every effort to avoid nuisance trip-outs and provide the maximum allowable tonnage.

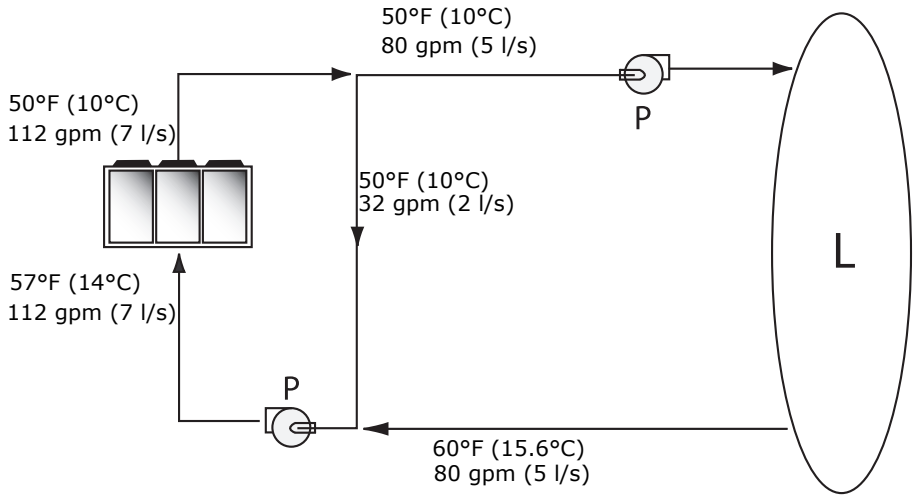
Water Flow Limits

The minimum water flow rates are given in the General Data section of this catalog. Evaporator flow rates below the tabulated values will result in laminar flow causing freeze-up problems, scaling, stratification and poor control. The maximum evaporator water flow rate is also given. Flow rates exceeding those listed may result in very high pressure drop across the evaporator.

Flow Rates Out of Range

Many process cooling jobs require flow rates outside of the published minimum and maximum flow rates for the CGAM evaporator. A simple piping change can alleviate this problem. For example: a plastic injection molding process requires 80 gpm (5.0 l/s) of 50°F (10°C) water and returns that water at 60°F (15.6°C). The selected chiller can operate at these temperatures, but has a minimum flow rate of 106 gpm (6.6 l/s). The system layout in Figure 1 can satisfy the process.

Figure 1. Flow rate out of range systems solution



Flow Proving

Trane provides a factory-installed water flow switch monitored by CH530 which protects the chiller from operating in loss of flow conditions.

Variable Flow in the Evaporator

Variable Primary Flow (VPF) systems present building owners with several cost-saving benefits when compared with Primary/Secondary chilled water systems. The most obvious cost savings results from eliminating the constant volume chiller pump(s), which in turn eliminates the related expenses of the associated piping connections (material, labor), and electrical service and switch gear. In addition to the installed cost advantage, building owners often cite pump related energy savings as the reasons that prompted them to select a VPF system.

The CGAM is capable of handling variable evaporator flow without losing control of the leaving water temperature. The microprocessor and capacity control algorithms are designed to handle a 10 percent change in water flow rate per minute while maintaining a ±2°F (1.1°C) leaving water temperature control accuracy. The chiller tolerates up to 30 percent per minute water flow variation as long as the flow is equal or above the minimum flow rate requirement.

With the help of a software analysis tool such as System Analyzer™, DOE-2 or TRACE™, you can determine whether the anticipated energy savings justify the use of variable primary flow in a particular application. Existing constant flow chilled water systems may be relatively easily converted to VPF and benefit greatly from the inherent efficiency advantages.

Water Temperature

Leaving Water Temperature Limits

Trane CGAM chillers have three distinct leaving water temperature categories:

- standard, with a leaving solution range of 42 to 65°F (5.5 to 18°C)
- low temperature process cooling, with leaving solution range of 10 to 65°F (-12 to 18°C)
- ice-making, with leaving solution range of 20 to 65°F (-7 to 18°C)
- low leaving temperature, with leaving solution below 10°F (-12.2°C)

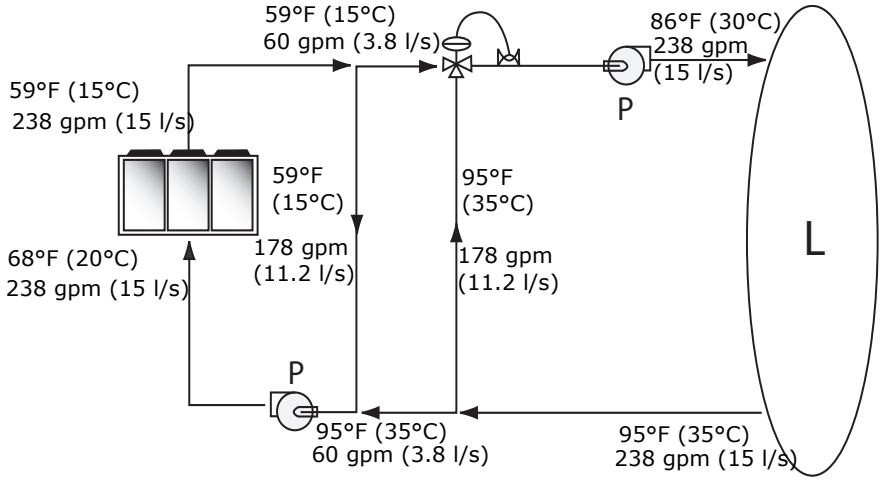
Since a leaving solution temperature below 42°F (5.5°C) results in a suction temperature at or below the freezing point of water, a glycol solution is required for all low temperature and ice-making machines. Ice making control includes dual setpoint controls and safeties for ice making and standard cooling capabilities. Consult your local Trane account manager for applications or selections involving low temperature or ice making machines.

The maximum water temperature that can be circulated through the CGAM evaporator when the unit is not operating is 125°F (51.7°C). Evaporator damage may result above this temperature.

Leaving Water Temperature Out of Range

Similar to the flow rate limitations above, many process cooling jobs require temperature ranges that are outside the allowable minimum and maximum operating values for the chiller. Figure 2 below shows a simple example of a mixed water piping arrangement change that can enable reliable chiller operation while meeting such cooling conditions. For example, a laboratory load requires 238 gpm (5 l/s) of water entering the process at 86°F (30°C) and returning at 95°F (35°C). The chiller's maximum leaving chilled water temperature of 65°F (15.6°C) prevents direct supply to the load. In the example shown, both the chiller and process flow rates are equal, however, this is not necessary. For example, if the chiller had a higher flow rate, there would simply be more water bypassing and mixing with warm water returning to the chiller.

Figure 2. Temperature out of range system solution



Supply Water Temperature Drop

The cataloged performance data for the Trane CGAM chiller is based on a chilled water temperature drop of 10°F (6°C) for I-P data and 9°F (5°C) for SI data. Full load chilled water temperature drops from 6 to 18°F (3.3 to 10°C) may be used as long as minimum and maximum water temperature and minimum and maximum flow rates are not exceeded. Temperature drops outside this range

at full load conditions are beyond the optimum range for control and may adversely affect the microcomputer's ability to maintain an acceptable supply water temperature range. Furthermore, full load temperature drops of less than 6°F (3.3°C) may result in inadequate refrigerant superheat which is critical to long term efficient and reliable operation. Sufficient superheat is always a primary concern in any refrigerant system and is especially important in a packaged chiller where the evaporator is closely coupled to the compressor.

Typical Water Piping

All building water piping must be flushed prior to making final connections to the chiller. To reduce heat loss and prevent condensation, insulation should be applied. Expansion tanks are also usually required so that chilled water volume changes can be accommodated.

Avoidance of Short Water Loops

Adequate water volume is an important system design parameter because it provides for stable chilled water temperature control and helps limit unacceptable short cycling of chiller compressors.

The chiller's temperature control sensor is located in the supply (outlet) water connection or pipe. This location allows the building to act as a buffer to slow the rate of change of the system water temperature. If there is not sufficient water volume in the system to provide an adequate buffer, temperature control can suffer, resulting in erratic system operation and excessive compressor cycling.

Typically, a two-minute water loop circulation time is sufficient to prevent short water loop issues. Therefore, as a guideline, ensure the volume of water in the chilled water loop is greater than or equal to two times the evaporator flow rate. For systems with a rapidly changing load profile the volume should be increased.

If the installed system volume does not meet the above recommendations, the following items should be given careful consideration to increase the volume of water in the system and, therefore, reduce the rate of change of the return water temperature.

- A volume buffer tank located in the return water piping.
- Larger system supply and return header piping (which also reduces system pressure drop and pump energy use).

Minimum water volume for a process application

If a chiller is attached to an on/off load such as a process load, it may be difficult for the controller to respond quickly enough to the very rapid change in return solution temperature if the system has only the minimum water volume recommended. Such systems may cause chiller low temperature safety trips or in the extreme case evaporator freezing. In this case, it may be necessary to add or increase the size of the mixing tank in the return line.

Multiple Unit Operation

Whenever two or more units are used on one chilled water loop, Trane recommends that their operation be coordinated with a higher level system controller for best system efficiency and reliability. The Trane Tracer system has advanced chilled plant control capabilities designed to provide such operation.

Ice Storage Operation

An ice storage system uses the chiller to make ice at night when utility rates are lower. The stored ice reduces or even replaces mechanical cooling during the day when utility rates are at their highest. This reduced need for cooling results in significant utility cost savings and source energy savings.

Another advantage of an ice storage system is its ability to eliminate chiller oversizing. A "rightsized" chiller plant with ice storage operates more efficiently with smaller support equipment while lowering the connected load and reducing operating costs. Best of all, this system still provides a capacity safety factor and redundancy by building it into the ice storage capacity for practically no cost compared to oversized systems.

Trane air-cooled chillers are uniquely suited to low temperature applications like ice storage because of the ambient relief experienced at night. Chiller ice making efficiencies are typically similar to or even better than standard cooling daytime efficiencies as a result of nighttime dry-bulb ambient relief.

Standard smart control strategies for ice storage systems are another advantage of the CGAM chiller. The dual mode control functionality is integrated right into the chiller. Trane Tracer building management systems can measure demand and receive pricing signals from the utility and decide when to use the stored cooling and when to use the chiller.

Partial Heat Recovery Operation

Partial heat recovery is designed to capture a portion of the heat that is normally rejected to the atmosphere and put it to beneficial use. With the addition of a heat recovery cycle, heat removed from the building cooling load can be transferred to a preheat application. Keep in mind that the heat recovery cycle is only possible if a cooling load exists to act as a heat source.

To provide a heat recovery cycle, a supplemental heat exchanger is mounted in series to the air-cooled condenser. The supplemental heat exchanger is piped into a preheat circuit. During the heat recovery cycle, the unit operates just as it does in the cooling-only mode except that a portion of the cooling load heat is rejected to the water heating circuit rather than to the air through the air-cooled condenser. Water circulated through the heat recovery heat exchanger by the pumps absorbs cooling load heat from the compressed refrigerant gas discharged by the compressors. The heated water is then used to satisfy heating requirements.

Partial heat recovery can be used in applications where hot water is needed for use in kitchens, lavatories, etc. It is comparatively smaller in size and its heating capacity is not controlled. The partial heat recovery heat exchanger cannot operate alone without a load on the chiller.

The partial heat recovery heat exchanger can get up to 157°F (69.4°C) leaving temperature. For more information see TOPSS™ performance selection program.

Unit Placement

Setting The Unit

A base or foundation is not required if the selected location is level and strong enough to support the unit's operating weight (see "Weights" section of this catalog).

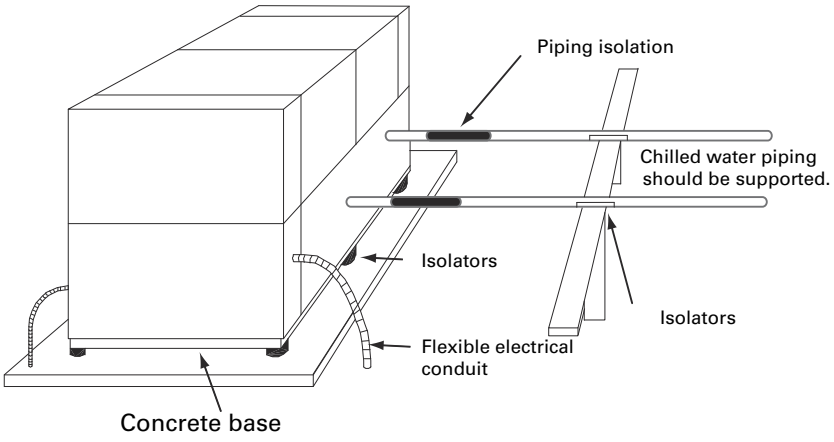
For a detailed discussion of base and foundation construction, refer to the sound engineering bulletin or the unit IOM. Manuals are available through the local Trane office.

HVAC equipment must be located to minimize sound and vibration transmission to the occupied spaces of the building structure it serves. If the equipment must be located in close proximity to a building, it should be placed next to an unoccupied space such as a storage room, mechanical room, etc. It is not recommended to locate the equipment near occupied, sound sensitive areas of the building or near windows. Locating the equipment away from structures will also prevent sound reflection, which can increase sound levels at property lines or other sensitive points.

Isolation and Sound Emission

Structurally transmitted sound can be reduced by elastomeric vibration eliminators. Elastomeric isolators are generally effective in reducing vibratory noise generated by compressors, and therefore, are recommended for sound sensitive installations. An acoustical engineer should always be consulted on critical applications.

Figure 3. Installation example



For maximum isolation effect, water lines and electrical conduit should also be isolated. Wall sleeves and rubber isolated piping hangers can be used to reduce the sound transmitted through water piping. To reduce the sound transmitted through electrical conduit, use flexible electrical conduit.

Local codes on sound emissions should always be considered. Since the environment in which a sound source is located affects sound pressure, unit placement must be carefully evaluated. Sound power levels for chillers are available on request.

Servicing

Adequate clearance for evaporator and compressor servicing should be provided. Recommended minimum space envelopes for servicing are located in the dimensional data section and can serve as a guideline for providing adequate clearance. The minimum space envelopes also allow for control panel door swing and routine maintenance requirements. Local code requirements may take precedence.

Unit Location

General

Unobstructed flow of condenser air is essential to maintain chiller capacity and operating efficiency. When determining unit placement, careful consideration must be given to assure a sufficient flow of air across the condenser heat transfer surface. Two detrimental conditions are possible and must be avoided: warm air recirculation and coil starvation. Air recirculation occurs when discharge air from the condenser fans is recycled back to the condenser coil inlet. Coil starvation occurs when free airflow to the condenser is restricted.

Condenser coils and fan discharge must be kept free of snow or other obstructions to permit adequate airflow for satisfactory unit operation. Debris, trash, supplies, etc., should not be allowed to accumulate in the vicinity of the air-cooled chiller. Supply air movement may draw debris into the condenser coil, blocking spaces between coil fins and causing coil starvation.

Both warm air recirculation and coil starvation cause reductions in unit efficiency and capacity because of the higher head pressures associated with them. The air-cooled CGAM chiller offers an advantage over competitive equipment in these situations. Operation is minimally affected in many restricted air flow situations due to its advanced Adaptive Control™ microprocessor which has the ability to understand the operating environment of the chiller and adapt to it by first optimizing its performance and then staying on line through abnormal conditions. For example, high ambient temperatures combined with a restricted air flow situation will generally not cause the air-cooled model CGAM chiller to shut down. Other chillers would typically shut down on a high pressure nuisance cut-out in these conditions.

Cross winds, those perpendicular to the condenser, tend to aid efficient operation in warmer ambient conditions. However, they tend to be detrimental to operation in lower ambients due to the accompanying loss of adequate head pressure. Special consideration should be given to low ambient units. As a result, it is advisable to protect air-cooled chillers from continuous direct winds exceeding 10 mph (4.5 m/s) in low ambient conditions.

The recommended lateral clearances are depicted in the close spacing engineering bulletin available from your local office.

Provide Sufficient Unit-to-Unit Clearance

Units should be separated from each other by sufficient distance to prevent warm air recirculation or coil starvation. Doubling the recommended single unit air-cooled chiller clearances will generally prove to be adequate.

Walled Enclosure Installations

When the unit is placed in an enclosure or small depression, the top of the surrounding walls should be no higher than the top of the fans. The chiller should be completely open above the fan deck. There should be no roof or structure covering the top of the chiller. Ducting individual fans is not recommended.

Model Number Descriptions

Digits 1-4— Chiller Model

CGAM= Air-Cooled Scroll Packaged Chiller

Digits 5-7— Unit Nominal Ton

020 = 20 Tons
026 = 26 Tons
030 = 30 Tons
035 = 35 Tons
040 = 40 Tons
052 = 52 Tons
060 = 60 Tons
070 = 70 Tons
080 = 80 Tons
090 = 90 Tons
100 = 100 Tons
110 = 110 Tons
120 = 120 Tons
130 = 130 Tons

Digit 8— Unit Voltage

A = 208 Volt 60 Hz 3 Phase
B = 230 Volt 60 Hz 3 Phase
D = 380 Volt 60 Hz 3 Phase
E = 400 Volt 50 Hz 3 Phase
F = 460 Volt 60 Hz 3 Phase
G = 575 Volt 60 Hz 3 Phase

Digit 9— Manufacturing Plant

2 = Pueblo, USA

Digits 10-11— Design Sequence

** = Factory/ABU Assigned

Digit 12— Unit Type

2 = High Efficiency
3 = Extra Efficiency

Digit 13— Agency Listing

X = No Agency Listing
A = UL Listed to U.S. and Canadian Safety Standard

Digit 14— Pressure Vessel Code

X = No Pressure Vessel Code

Digit 15— Unit Application

B = High Ambient (32-125°F/0-52°C)
D = Wide Ambient (0-125°F/-18-52°C)
J = Extreme Low Ambient — down to -20°F (-28.9°C)

Digit 16— Refrigerant Isolation Valves

2 = Refrigerant Isolation Valves (Discharge Valve)

Digit 17— Structural Options

A = Standard Unit Structure
B = Seismic to International Building Code (IBC)
C = California Office of Statewide Health Planning and Development (OSHPD) Certification
D = Wind Load for Florida Hurricane

Digit 18— Freeze Protection (Factor-Installed Only)

X = Without Freeze Protection
1 = With Freeze Protection (External T-Stat Control)

Digit 19— Insulation

A = Factory Insulation - All Cold Parts
B = Insulation for High Humidity/ Low Evap Temp

Digit 20— Factory Charge

1 = Full Factory Refrigerant Charge (R-410A)
2 = Nitrogen Charge

Digit 21— Evaporator Application

A = Standard Cooling (42 to 65°F/5.5 to 18°C)
B = Low Temperature Process (10 to 42°F/-12.2 to 5.5°C)
C = Ice-Making - Hardwired Interface (20 to 65°F/-7 to 18°C)
D = Low Leaving Water (below 10°F/-12.2°C)

Digit 22— Water Connections

1 = Grooved Pipe Connection

Digit 23— Condenser Fin Material

A = Lanced Aluminum Fins
C = Non-Lanced Copper Fins
D = Lanced Aluminum Fins w/ CompleteCoat™
H = Microchannel Coils
J = Microchannel Coils w/ CompleteCoat

Digit 24— Condenser Heat Recovery

X = No Heat Recovery
1 = Partial Heat Recovery with Fan Control

Digit 25— Not Used

X

Digit 26— Starter Type

A = Across the Line Starter/ Direct on Line

Digit 27— Incoming Power Line Connection

1 = Single Point Power Connection

Digit 28— Power Line Connection Type

A = Terminal Block
C = Circuit Breaker
D = Circuit Breaker with High Fault Rated Control Panel

Digit 29— Enclosure Type

1 = Water Tight (per UL 1995 Standard)

Digit 30— Unit Operator Interface

A = Dyna-View/English

Digit 31— Remote Interface (Digital Comm)

X = No Remote Digital Communication
2 = LonTalk®/Tracer® Summit Interface
3 = Time of Day Scheduling
4 = BACNet® Interface

Digit 32— External Chilled/Hot Water and Current Demand Limit Setpoint

X = No External Chilled Water Setpoint
A = External Chilled Water and Demand Limit Setpoint 4-20mA
B = External Chilled Water and Demand Limit Setpoint 2-10Vdc

Digit 33— Percent Capacity

X = Without % Capacity
1 = With % Capacity

Digit 34— Programmable Relays

X = No Programmable Relays
A = Programmable Relays

Digit 35— Pump Type

X = No Pumps and No Contactors
8 = Dual High Head Pump

Digit 36— Pump Flow Control

X = No Pump Control
B = Pump Flow Controlled by Variable Speed Drive

Digit 37 — Buffer Tank

X

Digit 38— Short Circuit Rating

X = No Short Circuit Rating
A = Default A Short Circuit Rating
B = High A Short Circuit Rating

Digit 39— Installation Accessories

X = No Installation Accessories
1 = Elastomeric Isolators
3 = Seismically Rated Isolators
5 = Elastomeric Pads

Digit 40— Water Strainer

A = With Water Strainer Factory Installed

Digit 41— Sound Attenuator Package

3 = Super Quiet
5 = Comprehensive Acoustic Package

Model Number Descriptions

Digit 42— Appearance Options

X = No Appearance Options
A = Architectural Louvered Panels
B = Half Louvers

Digit 43— Exterior Finish

1 = Standard Paint

Digit 44— Label, Literature Language

B = Spanish and English
D = English
E = French and English

Digit 45— Phase Reversal Protection

1 = Phase Reversal Protection

Digit 46— Shipping Package

X = No Skid (Standard)
A = Unit Containerization Package

Digit 47— Performance Test Options

X = No Performance Test
2 = Test with Report
3 = Witness Test with Report

Digit 48— Flow Switch Set Point

C = Flow Switch Set Point 15
F = Flow Switch Set Point 35
H = Flow Switch Set Point 45
L = Flow Switch Set Point 60

Digit 49— Not Used

X

Digit 50— Specials

X = None
S = Special

Note: *If a digit is not defined it may be held for future use.*

General Data

Table 1. General data, 60 Hz, high efficiency (I-P)

Size		20	26	30	35	40	52	60	70	80	90	100	110	120	130
Compressor															
Number	#	2	2	2	2	4	4	4	4	4	4	4	4	4	6
Tonnage/ckt[a]		10+10	13+13	15+15	15+20	10+10	13+13	15+15	15+20	20+20	20+25	25+25	25+30	30+30	20+20 +25
Evaporator															
Water storage	(gal)	1.4	2.2	2.2	3.2	2.4	4.1	5.0	7.5	7.0	9.0	10.3	11.5	11.5	12.3
Min. flow (LWT ≥42°F)	(gpm)	23.2	29.8	33.1	39.2	45.4	58.8	67.1	79.5	91.8	102.6	115.5	125.2	135.9	146.9
Min. flow (LWT 40 to 41.9°F)	(gpm)	29.1	37.2	41.8	49.1	56.7	73.5	83.9	99.4	114.7	128.3	144.4	156.5	169.9	183.7
Max. flow	(gpm)	69	89	100	117	136	176	201	238	275	307	346	375	407	440
Water connection	(in)	2	2.5	2.5	2.5	3	3	3	3	4	4	4	4	4	4
Condenser															
Round Tube and Plate Fin Coils															
Quantity of coils	#	1	1	1	1	2	2	2	2	4	4	4	4	4	4
Coil length	(in)	91	91	127	127	91	91	127	127	121	121	144	144	144	180
Coil height	(in)	68	68	68	68	68	68	68	68	42	42	42	42	42	42
Number of rows	#	2	2	2	2	2	2	2	2	3	3	3	3	3	3
Fins per foot	(fpf)	192	192	192	192	192	192	192	192	192	192	192	192	192	192
Microchannel Coils															
Quantity of coils	#	1	1	1	1	2	2	2	2	8	8	8	8	8	8
Coil length	(in)	91	91	127	127	91	91	127	127	68+46	68+46	68+68	68+68	68+68	68+ 104
Coil height[b]	(in)	42+10	42+10	42+10	42+10	42+10	42+10	42+10	42+10	34+7	34+7	34+7	34+7	34+7	34+7
Tube width	(in)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fan															
Quantity	#	2	2	3	3	4	4	6	6	6	6	8	8	8	10
Diameter	(in)	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8
Airflow per fan	(cfm)	9413	9420	9168	9173	9413	9420	9168	9173	9470	9472	9094	9096	9098	9094
Power per motor	(HP)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor RPM	(rpm)	840	840	840	840	840	840	840	840	840	840	840	840	840	840
Tip speed	(ft/min)	6333	6333	6333	6333	6333	6333	6333	6333	6333	6333	6333	6333	6333	6333
General Unit															
Refrig circuits	#	1	1	1	1	2	2	2	2	2	2	2	2	2	2
Capacity steps	%	50-100	50-100	50-100	43-100	25-50-75-100	25-50-75-100	25-50-75-100	21-43-71-100	25-50-75-100	22-44-72-100	25-50-75-100	23-45-73-100	25-50-75-100	15-31-46-62-81-100
Min ambient - wide	(°F)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min ambient - high	(°F)	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Min ambient - extreme low	(°F)	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20

Table 1. General data, 60 Hz, high efficiency (I-P) (continued)

Size		20	26	30	35	40	52	60	70	80	90	100	110	120	130
Round Tube and Plate Fin Coils															
Refrig charge/ckt[a]	(lbs)	32	34	44	48	32	32	44	48	74	78	90	86	86	112
Oil charge/ckt[a]	(gal)	1.7	1.7	1.9	3.5	1.7	1.7	1.9	3.5	3.5	3.5	3.5	3.7	3.8	5.8
Microchannel Coils															
Refrig charge/ckt [a]	(lbs)	19	22.5	28	35	19	20.5	28	35.5	45	47	49	46	50	66
Oil charge/ckt[a]	(gal)	1.4	1.4	1.6	2.9	1.4	1.4	1.6	2.9	2.9	2.9	2.9	3.0	3.1	5.4
Pump Package															
Avail head pressure[c]	(ft H_2O)	78.2	77.7	71.1	67.6	67.1	58.6	76.7	63.5	82.0	78.1	69.0	61.9	71.3	62.2
Power	(HP)	5	5	5	5	5	5	7.5	7.5	10	10	10	10	15	15
Expansion tank volume	(gal)	5	5	5	5	5	5	5	5	6	6	6	6	6	6
Buffer tank volume	(gal)	140	140	140	140	140	140	140	140	152	152	195	195	195	195
Partial Heat Recovery															
Water storage/ckt[a]	(gal)	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.06	0.06
Max flow	(gpm)	39	39	39	39	78	78	78	78	127	127	127	127	127	127
Water connection	(in)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5

(a) Data shown for one circuit only. The second circuit always matches.
(b) Microchannel coils are split horizontally between the condenser and subcooler coil.
(c) Pump available head pressure is based on 44/54°F evaporator with water, .0001 hr-ft^2-°F/Btu, 95°F ambient and 0 ft elevation.

Table 2. General data, 60 Hz, high efficiency (SI)

Size		20	26	30	35	40	52	60	70	80	90	100	110	120	130
Compressor															
Number	#	2	2	2	2	4	4	4	4	4	4	4	4	4	6
Tonnage/ckt[a]		10+10	13+13	15+15	15+20	10+10	13+13	15+15	15+20	20+20	20+25	25+25	25+30	30+30	20+20 +25
Evaporator															
Water storage	(l)	5.3	8.3	8.3	12.1	9.1	15.5	18.9	28.4	26.5	34.1	39.0	43.5	43.5	46.6
Min. flow (LWT ≥5.56°C)	(l/s)	1.5	1.9	2.1	2.5	2.9	3.7	4.2	5.0	5.8	6.5	7.3	7.9	8.6	9.3
Min. flow (LWT 4.44 to 5.55°C)	(l/s)	1.8	2.3	2.6	3.1	3.6	4.6	5.3	6.3	7.2	8.1	9.1	9.9	10.7	11.6
Max. flow	(l/s)	4.4	5.6	6.3	7.4	8.6	11.1	12.7	15.1	17.4	19.4	21.9	23.7	25.7	27.8
Water connection	(mm)	50.8	63.5	63.5	63.5	76.2	76.2	76.2	76.2	101.6	101.6	101.6	101.6	101.6	101.6
Condenser															
Round Tube and Plate Fin Coils															
Qty of coils	#	1	1	1	1	2	2	2	2	4	4	4	4	4	4
Coil length	(mm)	2311	2311	3226	3226	2311	2311	3226	3226	3073	3073	3658	3658	3658	4572
Coil height	(mm)	1727	1727	1727	1727	1727	1727	1727	1727	1067	1067	1067	1067	1067	1067
Number of rows	#	2	2	2	2	2	2	2	2	3	3	3	3	3	3
Fins per foot	(fpf)	192	192	192	192	192	192	192	192	192	192	192	192	192	192
Microchannel Coils															
Quantity of coils	#	1	1	1	1	2	2	2	2	8	8	8	8	8	8
Coil length	(mm)	2311	2311	3226	3226	2311	2311	3226	3226	1727+ 1168	1727+ 1168	1727+ 1727	1727+ 1727	1727+ 1727	1727+ 2642
Coil height[b]	(mm)	1067+ 254	1067+ 254	1067+ 254	1067+ 254	1067+ 254	1067+ 254	1067+ 254	1067+ 254	864+ 178	864+ 178	864+ 178	864+ 178	864+ 178	864+ 178
Tube width	(mm)	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4
Fan															
Quantity	#	2	2	3	3	4	4	6	6	4	6	8	8	8	10
Diameter	(mm)	732	732	732	732	732	732	732	732	732	732	732	732	732	732
Airflow per fan	(m^3/h)	15993	16005	15577	15585	15993	16005	15577	15585	16090	16093	15451	15454	15458	15451
Power per motor	(HP)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor RPM	(rpm)	840	840	840	840	840	840	840	840	840	840	840	840	840	840
Tip speed	(m/s)	32	32	32	32	32	32	32	32	32	32	32	32	32	32
General Unit															
Refrig circuits	#	1	1	1	1	2	2	2	2	2	2	2	2	2	2
Capacity steps	%	50-100	50-100	50-100	43-100	25-50-75-100	25-50-75-100	25-50-75-100	21-43-71-100	25-50-75-100	22-44-72-100	25-50-75-100	23-45-73-100	25-50-75-100	15-31-46-62-81-100
Min ambient - wide	(°C)	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18
Min ambient - high	(°C)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Min ambient - extreme low	(°C)	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9	-28.9

Table 2. General data, 60 Hz, high efficiency (SI) (continued)

Size		20	26	30	35	40	52	60	70	80	90	100	110	120	130
Round Tube and Plate Fin Coils															
Refrig charge/ckt[a]	(kg)	14.5	15.4	20	21.8	14.5	14.5	20	21.8	33.6	35.4	40.8	39	39	50.8
Oil charge /ckt[a]	(l)	6.6	6.6	7.2	13.4	6.6	6.6	7.2	13.4	13.4	13.4	13.4	13.9	14.4	22.0
Microchannel Coils															
Refrig charge/ckt[a]	(kg)	8.6	10.2	12.7	15.9	8.6	9.3	12.7	16.1	20.4	21.3	22.2	20.9	22.7	29.9
Oil charge /ckt[a]	(l)	5.4	5.4	5.9	11.0	5.4	5.4	5.9	11.0	11.0	11.0	11.0	11.4	11.8	18.0
Pump Package															
Avail head pressure[c]	(kPa)	233.7	232.3	212.6	202.1	200.6	175.0	229.2	189.7	245.1	233.3	206.3	185.0	213.1	185.8
Power	(HP)	5	5	5	5	5	5	7.5	7.5	10	10	10	10	15	15
Expansion tank volume	(l)	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	22.7	22.7	22.7	22.7	22.7	22.7
Buffer tank volume	(l)	530	530	530	530	530	530	530	530	575	575	727	727	727	727
Partial Heat Recovery															
Water storage/ckt[a]	(l)	0.07	0.09	0.09	0.11	0.07	0.09	0.09	0.11	0.12	0.16	0.16	0.16	0.21	0.21
Max flow	(l/s)	2.5	2.5	2.5	2.5	5.0	5.0	5.0	5.0	8.0	8.0	8.0	8.0	8.0	8.0
Water connection	(mm)	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	63.5	63.5	63.5	63.5	63.5	63.5

(a) Data shown for one circuit only. The second circuit always matches.
(b) Microchannel coils are split horizontally between the condenser and subcooler coil.
(c) Pump available head pressure is based on 6.7/12.2°C evaporator with water, .01761 m²°C/kW, 35°C ambient and 0 m elevation.

Table 3. General data, 50 Hz, high efficiency (I-P)

Size		20	26	30	35	40	52	60	70	80	90	100	110	120
Compressor														
Number	#	2	2	2	2	4	4	4	4	4	4	4	4	4
Tonnage/ckt[a]		10+10	13+13	15+15	15+20	10+10	13+13	15+15	15+20	20+20	20+25	25+25	25+30	30+30
Evaporator														
Water storage	(gal)	1.4	2.2	2.2	3.2	2.4	4.1	5.0	7.5	7.0	9.0	10.3	11.5	11.5
Min. flow (LWT ≥42°F)	(gpm)	19.7	25.1	28.2	32.7	38.1	49.4	56.4	66.0	77.5	86.8	98.0	105.8	113.1
Min. flow (LWT 40 to 41.9°F)	(gpm)	24.6	31.3	35.3	40.9	47.7	61.8	70.5	82.5	96.9	108.5	122.5	132.3	141.4
Max. flow	(gpm)	59	75	85	98	115	149	170	199	234	262	296	319	341
Water connection	(in)	2	2.5	2.5	2.5	3	3	3	3	4	4	4	4	4
Condenser														
Round Tube and Plate Fin Coils														
Quantity of coils	#	1	1	1	1	2	2	2	2	4	4	4	4	4
Coil length	(in)	91	91	127	127	91	91	127	127	121	121	144	144	144
Coil height	(in)	68	68	68	68	68	68	68	68	42	42	42	42	42
Number of rows	#	2	2	2	2	2	2	2	2	3	3	3	3	3
Fins per foot	(fpf)	192	192	192	192	192	192	192	192	192	192	192	192	192
Microchannel Coils														
Quantity of coils	#	1	1	1	1	2	2	2	2	8	8	8	8	8
Coil length	(in)	91	91	127	127	91	91	127	127	68+46	68+46	68+68	68+68	68+68
Coil height[b]	(in)	42+10	42+10	42+10	42+10	42+10	42+10	42+10	42+10	34+7	34+7	34+7	34+7	34+7
Tube width	(in)	1	1	1	1	1	1	1	1	1	1	1	1	1
Fan														
Quantity	#	2	2	3	3	4	4	6	6	6	6	8	8	8
Diameter	(in)	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8
Airflow per fan	(cfm)	7796	7783	7587	7590	7795	7801	7587	7590	7827	7829	7503	7505	7506
Power per motor	(HP)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor RPM	(rpm)	700	700	700	700	700	700	700	700	700	700	700	700	700
Tip speed	(ft/min)	5278	5278	5278	5278	5278	5278	5278	5278	5278	5278	5278	5278	5278
General Unit														
Refrig circuits	#	1	1	1	1	2	2	2	2	2	2	2	2	2
Capacity steps	%	50-100	50-100	50-100	43-100	25-50-75-100	25-50-75-100	25-50-75-100	21-43-71-100	25-50-75-100	22-44-72-100	25-50-75-100	23-45-73-100	25-50-75-100
Min ambient - wide	(°F)	0	0	0	0	0	0	0	0	0	0	0	0	0
Min ambient - high	(°F)	32	32	32	32	32	32	32	32	32	32	32	32	32
Round Tube and Plate Fin Coils														
Refrig charge/ckt[a]	(lbs)	32	34	44	48	32	32	44	48	74	78	90	86	86
Oil charge/ckt[a]	(gal)	1.7	1.7	1.9	3.5	1.7	1.7	1.9	3.5	3.5	3.5	3.5	3.7	3.8
Microchannel Coils														
Refrig charge/ckt[a]	(lbs)	19	22.5	28	35	19	20.5	28	35.5	45	47	49	46	50
Oil charge/ckt[a]	(gal)	1.4	1.4	1.6	2.9	1.4	1.4	1.6	2.9	2.9	2.9	2.9	3.0	3.1
Partial Heat Recovery														
Water storage/ckt[a]	(gal)	0.02	0.02	0.02	.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04
Max flow	(gpm)	39	39	39	39	78	78	78	78	127	127	127	127	127
Water connection	(in)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5

(a) Data shown for one circuit only. The second circuit always matches.
(b) Microchannel coils are split horizontally between the condenser and subcooler coil.

Table 4. General data, 50 Hz, high efficiency (SI)

Size		20	26	30	35	40	52	60	70	80	90	100	110	120
Compressor														
Number	#	2	2	2	2	4	4	4	4	4	4	4	4	4
Tonnage/ckt[a]		10+10	13+13	15+15	15+20	10+10	13+13	15+15	15+20	20+20	20+25	25+25	25+30	30+30
Evaporator														
Water storage	(l)	5.3	8.3	8.3	12.1	9.1	15.5	18.9	28.4	26.5	34.1	39.0	43.5	43.5
Min. flow (LWT ≥5.56°C)	(l/s)	1.2	1.6	1.8	2.1	2.4	3.1	3.6	4.2	4.9	5.5	6.2	6.7	7.1
Min. flow (LWT 4.44 to 5.55°C)	(l/s)	1.6	2.0	2.2	2.6	3.0	3.9	4.4	5.2	6.1	6.8	7.7	8.3	8.9
Max. flow	(l/s)	3.7	4.8	5.4	6.2	7.3	9.4	10.8	12.6	14.8	16.5	18.7	20.2	21.6
Water connection	(mm)	50.8	63.5	63.5	63.5	76.2	76.2	76.2	76.2	101.6	101.6	101.6	101.6	101.6
Condenser														
Round Tube and Plate Fin Coils														
Quantity of coils	#	1	1	1	1	2	2	2	2	4	4	4	4	4
Coil length	(mm)	2311	2311	3226	3226	2311	2311	3226	3226	3073	3073	3658	3658	3658
Coil height	(mm)	1727	1727	1727	1727	1727	1727	1727	1727	1067	1067	1067	1067	1067
Number of rows	#	2	2	2	2	2	2	2	2	3	3	3	3	3
Fins per foot	(fpf)	192	192	192	192	192	192	192	192	192	192	192	192	192
Microchannel Coils														
Quantity of coils	#	1	1	1	1	2	2	2	2	8	8	8	8	8
Coil length	(mm)	2311	2311	3226	3226	2311	2311	3226	3226	1727+ 1168	1727+ 1168	1727+ 1727	1727+ 1727	1727+ 1727
Coil height[b]	(mm)	1067+ 254	1067+ 254	1067+ 254	1067+ 254	1067+ 254	1067+ 254	1067+ 254	1067+ 254	864+ 178	864+ 178	864+ 178	864+ 178	864+ 178
Tube width	(mm)	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4
Fan														
Quantity	#	2	2	3	3	4	4	6	6	6	6	8	8	8
Diameter	(mm)	732	732	732	732	732	732	732	732	732	732	732	732	732
Airflow per fan	(m^3/h)	13245	13223	12890	12895	13244	13254	12890	12895	13298	13302	12748	12751	12753
Power per motor	(HP)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor RPM	(rpm)	700	700	700	700	700	700	700	700	700	700	700	700	700
Tip speed	(m/s)	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8
General Unit														
Refrig circuits	#	1	1	1	1	2	2	2	2	2	2	2	2	2
Capacity steps	%	50-100	50-100	50-100	43-100	25-50-75-100	25-50-75-100	25-50-75-100	21-43-71-100	25-50-75-100	22-44-72-100	25-50-75-100	23-45-73-100	25-50-75-100
Min ambient - wide	(°C)	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18
Min ambient - high	(°C)	0	0	0	0	0	0	0	0	0	0	0	0	0
Round Tube and Plate Fin Coils														
Refrig charge/ckt[a]	(kg)	14.5	15.4	20	21.8	14.5	14.5	20	21.8	33.6	35.4	40.8	39	39
Oil charge/ckt[a]	(l)	6.6	6.6	7.2	13.4	6.6	6.6	7.2	13.4	13.4	13.4	13.4	13.9	14.4
Microchannel Coils														
Refrig charge/ckt[a]	(kg)	8.6	10.2	12.7	15.9	8.6	9.3	12.7	16.1	20.4	21.3	22.2	20.9	22.7
Oil charge/ckt[a]	(l)	5.4	5.4	5.9	11.0	5.4	5.4	5.9	11.0	11.0	11.0	11.0	11.4	11.8
Partial Heat Recovery														
Water storage/ckt[a]	(l)	0.07	0.07	0.09	0.09	0.07	0.07	0.09	0.09	0.12	0.12	0.12	0.16	0.16
Max flow	(l/s)	2.5	2.5	2.5	2.5	5.0	5.0	5.0	5.0	8.0	8.0	8.0	8.0	8.0
Water connection	(mm)	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	63.5	63.5	63.5	63.5	63.5

(a) Data shown for one circuit only. The second circuit always matches.
(b) Microchannel coils are split horizontally between the condenser and subcooler coil.

Table 5. General data, 60 Hz, extra efficiency (I-P)

Size		20	26	30	35	40	52	60	70	110	120
Compressor											
Number	#	2	2	2	2	4	4	4	4	4	4
Tonnage/ckt[a]		10+10	13+13	15+15	15+20	10+10	13+13	15+15	15+20	25+30	30+30
Evaporator											
Water storage	(gal)	1.4	2.2	2.2	3.2	2.4	4.1	5.0	7.5	11.5	11.5
Min. flow (LWT ≥42°F)	(gpm)	23.2	29.8	33.1	39.2	45.4	58.8	67.1	79.5	125.2	135.9
Min. flow (LWT 40 to 41.9°F)	(gpm)	29.1	37.2	41.8	49.1	56.7	73.5	83.9	99.4	156.5	169.9
Max. flow	(gpm)	69	89	100	117	136	176	201	238	375	407
Water connection	(in)	2	2.5	2.5	2.5	3	3	3	3	4	4
Condenser											
					Round Tube and Plate Fin Coils						
Quantity of coils	#	1	1	1	1	2	2	2	2	4	4
Coil length	(in)	91	91	127	127	91	91	127	127	144	144
Coil height	(in)	68	68	68	68	68	68	68	68	42	42
Number of rows	#	3	3	3	3	3	3	3	3	3	3
Fins per foot	(fpf)	192	192	192	192	192	192	192	192	192	192
Fan											
Quantity	#	2	2	3	3	4	4	6	6	8	8
Diameter	(in)	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8
Airflow per fan	(cfm)	9413	9420	9168	9173	9413	9420	9168	9173	9096	9098
Power per motor	(HP)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor RPM	(rpm)	840	840	840	840	840	840	840	840	840	840
Tip speed	(ft/min)	6333	6333	6333	6333	6333	6333	6333	6333	6333	6333
General Unit											
Refrig circuits	#	1	1	1	1	2	2	2	2	2	2
Capacity steps	%	50-100	50-100	50-100	43-100	25-50-75-100	25-50-75-100	25-50-75-100	21-43-71-100	23-45-73-100	25-50-75-100
Min ambient - wide	(°F)	0	0	0	0	0	0	0	0	0	0
Min ambient - high	(°F)	32	32	32	32	32	32	32	32	32	32
					Round Tube and Plate Fin Coils						
Refrig charge/ckt[a]	(lbs)	45	48	62	68	42	42	57	62	86	86
Oil charge/ckt[a]	(gal)	1.7	1.7	1.9	3.5	1.7	1.7	1.9	3.5	3.7	3.8
Pump Package											
Avail head pressure[b]	(ft H_2O)	78.2	77.7	71.1	67.6	67.1	58.6	76.7	63.5	61.9	71.3
Power	(HP)	5	5	5	5	5	5	7.5	7.5	10	15
Expansion tank volume	(gal)	5	5	5	5	5	5	5	5	6	6
Buffer tank volume	(gal)	140	140	140	140	140	140	140	140	195	195
Partial Heat Recovery											
Water storage/ckt[a]	(gal)	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.04	0.06
Max flow	(gpm)	39	39	39	39	78	78	78	78	127	127
Water connection	(in)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5

(a) Data shown for one circuit only. The second circuit always matches.
(b) Pump available head pressure is based on 44/54°F evaporator with water, .0001 hr-ft^2-°F/Btu, 95°F ambient and 0 ft elevation.

Table 6. General data, 60 Hz, extra efficiency (SI)

Size		20	26	30	35	40	52	60	70	110	120
Compressor											
Number	#	2	2	2	2	4	4	4	4	4	4
Tonnage/ckt[a]		10+10	13+13	15+15	15+20	10+10	13+13	15+15	15+20	25+30	30+30
Evaporator											
Water storage	(l)	5.3	8.3	8.3	12.1	9.1	15.5	18.9	28.4	43.5	43.5
Min. flow (LWT ≥5.56°C)	(l/s)	1.5	1.9	2.1	2.5	2.9	3.7	4.2	5.0	7.9	8.6
Min. flow (LWT 4.44 to 5.55°C)	(l/s)	1.8	2.3	2.6	3.1	3.6	4.6	5.3	6.3	9.9	10.7
Max. flow	(l/s)	4.4	5.6	6.3	7.4	8.6	11.1	12.7	15.1	23.7	25.7
Water connection	(mm)	50.8	63.5	63.5	63.5	76.2	76.2	76.2	76.2	101.6	101.6
Condenser											
		Round Tube and Plate Fin Coils									
Qty of coils	#	1	1	1	1	2	2	2	2	4	4
Coil length	(mm)	2311	2311	3226	3226	2311	2311	3226	3226	3658	3658
Coil height	(mm)	1727	1727	1727	1727	1727	1727	1727	1727	1067	1067
Number of rows	#	3	3	3	3	3	3	3	3	3	3
Fins per foot	(fpf)	192	192	192	192	192	192	192	192	192	192
Fan											
Quantity	#	2	2	3	3	4	4	6	6	8	8
Diameter	(mm)	732	732	732	732	732	732	732	732	732	732
Airflow per fan	(m^3/h)	15993	16005	15577	15585	15993	16005	15577	15585	15454	15458
Power per motor	(HP)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor RPM	(rpm)	840	840	840	840	840	840	840	840	840	840
Tip speed	(m/s)	32	32	32	32	32	32	32	32	32	32
General Unit											
Refrig circuits	#	1	1	1	1	2	2	2	2	2	2
Capacity steps	%	50-100	50-100	50-100	43-100	25-50-75-100	25-50-75-100	25-50-75-100	21-43-71-100	23-45-73-100	25-50-75-100
Min ambient - wide	(°C)	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18
Min ambient - high	(°C)	0	0	0	0	0	0	0	0	0	0
		Round Tube and Plate Fin Coils									
Refrig charge/ckt[a]	(kg)	20.4	21.8	28.1	30.8	19.1	19.1	25.9	28.1	39	39
Oil charge /ckt[a]	(l)	6.6	6.6	7.2	13.4	6.6	6.6	7.2	13.4	13.9	14.4
Pump Package											
Avail head pressure[b]	(kPa)	233.7	232.3	212.6	202.1	200.6	175.0	229.2	189.7	185.0	213.1
Power	(HP)	5	5	5	5	5	5	7.5	7.5	10	15
Expansion tank volume	(l)	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	22.7	22.7
Buffer tank volume	(l)	530	530	530	530	530	530	530	530	727	727
Partial Heat Recovery											
Water storage/ckt[a]	(l)	0.07	0.09	0.09	0.11	0.07	0.09	0.09	0.11	0.16	0.21
Max flow	(l/s)	2.5	2.5	2.5	2.5	5.0	5.0	5.0	5.0	8.0	8.0
Water connection	(mm)	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	63.5	63.5

(a) Data shown for one circuit only. The second circuit always matches.
(b) Pump available head pressure is based on 6.7/12.2°C evaporator with water, .01761 m²°C/kW, 35°C ambient and 0 m elevation.

Table 7. General data, 50 Hz, extra efficiency (I-P)

Size		20	26	30	35	40	52	60	70	110	120
Compressor											
Number	#	2	2	2	2	4	4	4	4	4	4
Tonnage/ckt[a]		10+10	13+13	15+15	15+20	10+10	13+13	15+15	15+20	25+30	30+30
Evaporator											
Water storage	(gal)	1.4	2.2	2.2	3.2	2.4	4.1	5.0	7.5	11.5	11.5
Min. flow (LWT ≥42°F)	(gpm)	19.7	25.1	28.2	32.7	38.1	49.4	56.4	66.0	105.8	113.1
Min. flow (LWT 40 to 41.9°F)	(gpm)	24.6	31.3	35.3	40.9	47.7	61.8	70.5	82.5	132.3	141.4
Max. flow	(gpm)	59	75	85	98	115	149	170	199	319	341
Water connection	(in)	2	2.5	2.5	2.5	3	3	3	3	4	4
Condenser											
		Round Tube and Plate Fin Coils									
Quantity of coils	#	1	1	1	1	2	2	2	2	4	4
Coil length	(in)	91	91	127	127	91	91	127	127	144	144
Coil height	(in)	68	68	68	68	68	68	68	68	42	42
Number of rows	#	2	2	2	2	2	2	2	2	3	3
Fins per foot	(fpf)	192	192	192	192	192	192	192	192	192	192
Fan											
Quantity	#	2	2	3	3	4	4	6	6	8	8
Diameter	(in)	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8
Airflow/fan	(cfm)	7796	7783	7587	7590	7795	7801	7587	7590	7505	7506
Power/motor	(HP)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor RPM	(rpm)	700	700	700	700	700	700	700	700	700	700
Tip speed	(ft/min)	5278	5278	5278	5278	5278	5278	5278	5278	5278	5278
General Unit											
Refrig circuits	#	1	1	1	1	2	2	2	2	2	2
Capacity steps	%	50-100	50-100	50-100	43-100	25-50-75-100	25-50-75-100	25-50-75-100	21-43-71-100	23-45-73-100	25-50-75-100
Min ambient - wide	(°F)	0	0	0	0	0	0	0	0	0	0
Min ambient - high	(°F)	32	32	32	32	32	32	32	32	32	32
		Round Tube and Plate Fin Coils									
Refrig charge/ckt[a]	(lbs)	45	48	62	68	42	42	57	62	86	86
Oil charge/ckt[a]	(gal)	1.7	1.7	1.9	3.5	1.7	1.7	1.9	3.5	3.7	3.8
Partial Heat Recovery											
Water storage/ckt[a]	(gal)	0.02	0.02	0.02	.02	0.02	0.02	0.02	0.02	0.04	0.04
Max flow	(gpm)	39	39	39	39	78	78	78	78	127	127
Water connection	(in)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5

(a) Data shown for circuit one only. The second circuits always matches.

Table 8. General data, 50 Hz, extra efficiency (SI)

Size		20	26	30	35	40	52	60	70	110	120
Compressor											
Number	#	2	2	2	2	4	4	4	4	4	4
Tonnage/ckt[a]		10+10	13+13	15+15	15+20	10+10	13+13	15+15	15+20	25+30	30+30
Evaporator											
Water storage	(l)	5.3	8.3	8.3	12.1	9.1	15.5	18.9	28.4	43.5	43.5
Min. flow (LWT ≥5.56°C)	(l/s)	1.2	1.6	1.8	2.1	2.4	3.1	3.6	4.2	6.7	7.1
Min. flow (LWT 4.44 to 5.55°C)	(l/s)	1.6	2.0	2.2	2.6	3.0	3.9	4.4	5.2	8.3	8.9
Max. flow	(l/s)	3.7	4.8	5.4	6.2	7.3	9.4	10.8	12.6	20.2	21.6
Water connection	(mm)	50.8	63.5	63.5	63.5	76.2	76.2	76.2	76.2	101.6	101.6
Condenser											
		Round Tube and Plate Fin Coils									
Quantity of coils	#	1	1	1	1	2	2	2	2	4	4
Coil length	(mm)	2311	2311	3226	3226	2311	2311	3226	3226	3658	3658
Coil height	(mm)	1727	1727	1727	1727	1727	1727	1727	1727	1067	1067
Number of rows	#	2	2	2	2	2	2	2	2	3	3
Fins per foot	(fpf)	192	192	192	192	192	192	192	192	192	192
Fan											
Quantity	#	2	2	3	3	4	4	6	6	8	8
Diameter	(mm)	732	732	732	732	732	732	732	732	732	732
Airflow/fan	(m^3/h)	13245	13223	12890	12895	13244	13254	12890	12895	12751	12753
Power/motor	(HP)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Motor RPM	(rpm)	700	700	700	700	700	700	700	700	700	700
Tip speed	(m/s)	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8
General Unit											
Refrig circuits	#	1	1	1	1	2	2	2	2	2	2
Capacity steps	%	50-100	50-100	50-100	43-100	25-50-75-100	25-50-75-100	25-50-75-100	21-43-71-100	23-45-73-100	25-50-75-100
Min ambient - wide	(°C)	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18
Min ambient - high	(°C)	0	0	0	0	0	0	0	0	0	0
		Round Tube and Plate Fin Coils									
Refrig charge/ckt[a]	(kg)	20.4	21.8	28.1	30.8	19.1	19.1	25.9	28.1	39	39
Oil charge/ckt[a]	(l)	6.6	6.6	7.2	13.4	6.6	6.6	7.2	13.4	13.9	14.4
Partial Heat Recovery											
Water storage/ckt[a]	(l)	0.07	0.07	0.09	0.09	0.07	0.07	0.09	0.09	0.16	0.16
Max flow	(l/s)	2.5	2.5	2.5	2.5	5.0	5.0	5.0	5.0	8.0	8.0
Water connection	(mm)	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	63.5	63.5

(a) Data shown for circuit one only. The second circuit always matches.

Controls

LCD Touch-Screen Display with Multi-Language Support

The standard DynaView display provided with the CH530 control panel features an LCD touch-screen that is navigated by file tabs. This is an advanced interface that allows the user to access any important information concerning setpoints, active temperatures, modes, electrical data, pressure, and diagnostics. It uses full text display available in 19 languages.

Display Features Include:

- LCD touch-screen with LED backlighting, for scrolling access to input and output operating information
- Single-screen, folder/tab-style display of all available information on individual components (evaporator, condenser, compressor, etc.)
- Password entry/lockout system to enable or disable display
- Automatic and immediate stop capabilities for standard or immediate manual shutdown
- Fast, easy access to available chiller data in tabbed format, including:
  - Modes of operation, including standard cooling as well as ice making
  - Water temperatures and setpoints
  - Loading and limiting status and setpoints
  - Outdoor air temperature
  - Start/stop differential timers
  - Pump status and override
  - Chilled water reset settings
- Optional external setpoints, including:
  - Chilled water, demand limit, ice building

Reports, listed on a single tabbed screen for easy access, including:

- ASHRAE reports, including all Guideline 3 information
- Evaporator, condenser, compressor reports, containing all operational information for individual components, including:
  - Water temperatures, refrigerant pressures, temperatures, and approach
  - Flow switch status, EXV position, compressor starts and run-time

Alarm and diagnostic information, including:

- Flashing alarms with touch-screen button for immediate address of alarm condition
- Scrollable list of last ten active diagnostics
- Specific information on applicable diagnostic from list of over one-hundred
- Automatic or manual resetting diagnostic types

Adaptive Control

Adaptive Control directly senses the control variables that govern the operation of the chiller: evaporator pressure and condenser pressure. When any one of these variables approaches a limit condition at which damage may occur to the unit or it may shutdown on a safety, Adaptive Control takes corrective action to avoid shutdown and keep the chiller operating. This happens through combined actions of compressor and/or fan staging. Whenever possible, the chiller is allowed to continue making chilled water. This keeps cooling capacity available until the problem can be solved. Overall, the safety controls help keep the building or process running smoothly.

Stand-Alone Controls

Single chillers installed in applications without a building management system are simple to install and control: only a remote auto/stop for scheduling is required for unit operation. Signals from the chilled-water pump contactor auxiliary, or a flow switch, are wired to the chilled-water flow interlock. Signals from a time clock or some other remote device are wired to the external auto/stop input.

- Auto/Stop — A jobsite provided contact closure turns the unit on and off.
- External Interlock — A jobsite provided contact opening wired to this input turns the unit off and requires a manual reset of the unit microcomputer. This closure is typically triggered by a job-site provided system such as a fire alarm.

Time of Day Scheduling

Time of day scheduling allows the customer to perform simple chiller scheduling without the need for a building automation system.

This feature allows the user to set ten events in a seven day time period. For each event the user can specify an activation time and the days of the week the event is active. Any available setpoints can be specified for each event, such as the leaving chilled water temperature (standard) and the demand limit setpoint (optional if ordered).

Time of day scheduling (selectable option with chiller) is required.

Additional options that may be incorporated into the scheduling:

- External chilled water setpoint, external demand limit setpoint
- Ice-making initiation

Hardwire Points

Microcomputer controls allow simple interface with other control systems, such as time clocks, building automation systems, and ice storage systems via hardwire points. This means you have the flexibility to meet job requirements while not having to learn a complicated control system.

Remote devices are wired from the control panel to provide auxiliary control to a building automation system. Inputs and outputs can be communicated via a typical 4–20 mA electrical signal, an equivalent 2–10 Vdc signal, or by utilizing contact closures.

This setup has the same features as a stand-alone water chiller, with the possibility of having additional optional features:

- Ice making control
- External chilled water setpoint, external demand limit setpoint
- Chilled water temperature reset
- Programmable relays - available outputs are: alarm-latching, alarm-auto reset, general alarm, warning, chiller limit mode, compressor running, and Tracer control

BACnet Interface

BACnet® interface capabilities are available, with communication link via single twisted-pair wiring to a factory-installed and tested communication board.

BACnet® Interface (selectable option with chiller) is required.

BACnet® is a data communication protocol for building automation and control networks developed by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

LonTalk LCI-C Interface

LonTalk® (LCI-C) communications capabilities are available, with communication link via single twisted-pair wiring to factory-installed, tested communication board.

LonTalk®/Tracer® Summit Interface (selectable option with chiller) is required.

LonTalk® is a communications protocol developed by the Echelon® Corporation. The LONMARK® association develops control profiles using the LonTalk® communication protocol. LonTalk® is a unit level communications protocol.

LonTalk® Communications Interface for Chillers (LCI-C) provides a generic automation system with the LONMARK® chiller profile inputs/outputs. In addition to the standard points, Trane provides other commonly used network output variables for greater interoperability with any automation system. The complete reference list of Trane LonTalk® points is available on the LONMARK® web site.

Trane controls or another vendor's system can use the predefined list of points with ease to give the operator a complete picture of how the system is running

Tracer Summit

The chiller plant control capabilities of the Trane Tracer® Summit building automation system are unequaled in the industry. Trane's depth of experience in chillers and controls makes us a well-qualified choice for automation of chiller plants using air-cooled chillers. Our chiller plant automation software is fully pre-engineered and tested.

Required features:

- LonTalk®/Tracer® Summit Interface (selectable option with chiller)
- Building Control Unit (external device required)

Energy Efficiency

- Sequenced starting of chillers to optimize the overall chiller plant energy efficiency
  - Individual chillers operate as base, peak, or swing based on capacity and efficiency
  - Automatically rotates individual chiller operation to equalize runtime and wear between chillers.
  - Evaluates and selects the lowest energy consumption alternative from an overall system perspective.

Easy Operation and Maintenance

- Remote monitoring and control
- Displays both current operation conditions and scheduled automated control actions
- Concise reports assist in planning for preventative maintenance and verifying performance
- Alarm notification and diagnostic messages aid in quick and accurate troubleshooting

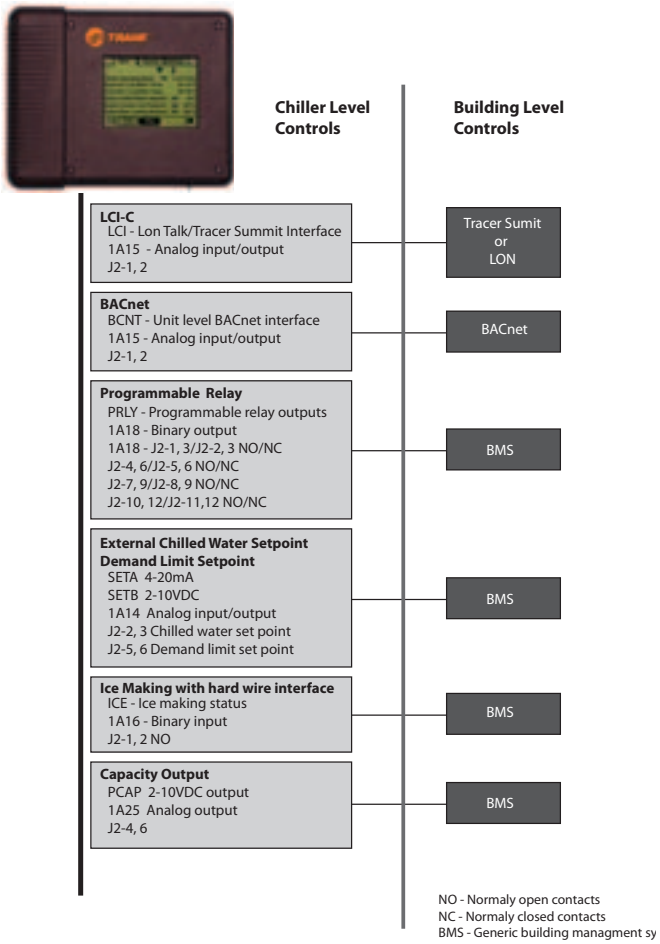
Tracer SC

The Tracer® SC system controller acts as the central coordinator for all individual equipment devices on a Tracer building automation system. The Tracer® SC scans all unit controllers to update information and coordinate building control, including building subsystems such as VAV and

chiller water systems. With this system option, the full breadth of Trane's HVAC and controls experience are applied to offer solutions to many facility issues. The LAN allows building operators to manage these varied components as one system from any personal computer with web access. The benefits of this system are:

- Improved usability with automatic data collection, enhanced data logging, easier to create graphics, simpler navigation, pre-programmed scheduling, reporting, and alarm logs.
- Flexible technology allows for system sizes from 30-120 unit controllers with any combination of LonTalk® or BACnet® unit controllers.
- LEED certification through site commissioning report, energy data collection measurement, optimizing energy performance, and maintaining indoor air quality.

Energy savings programs include: fan pressure optimization, ventilation reset, and chiller plant control (adds and subtracts chillers to meet cooling loads).



Electrical

Table 9. Electrical data - 60 Hz

Unit Size	Rated Power	Number Circuits	Qty Comp	Qty Fans	Fan Motor Power (kW)	Cond Fan FLA	Compressor RLA[a]	Compressor LRA[b]	No pump MCA[c]	No pump MOP[d]	Pump MCA[c]	Pump MOP[d]
	208/60/3	1	2	2	1	6.2	39-39	267-267	106	125	122	150
	230/60/3	1	2	2	1	6.7	39-39	267-267	106	125	122	150
20	380/60/3	1	2	2	1	3.7	22-22	160-160	60	80	n/a	
	460/60/3	1	2	2	1	3.2	19-19	142-142	51	60	64	80
	575/60/3	1	2	2	1	2.6	15-15	103-103	42	50	52	60
	208/60/3	1	2	2	1	6.2	51-51	315-315	131	175	148	175
	230/60/3	1	2	2	1	6.7	44-44	315-315	117	150	134	175
26	380/60/3	1	2	2	1	3.7	26-26	177-177	69	90	n/a	
	460/60/3	1	2	2	1	3.2	21-21	158-158	56	70	69	80
	575/60/3	1	2	2	1	2.6	19-19	126-126	50	60	59	70
	208/60/3	1	2	3	1	6.2	50-50	351-351	137	175	154	200
	230/60/3	1	2	3	1	6.7	48-48	351-351	133	175	149	175
30	380/60/3	1	2	3	1	3.7	29-29	208-208	79	100	n/a	
	460/60/3	1	2	3	1	3.2	24-24	197-197	66	90	79	100
	575/60/3	1	2	3	1	2.6	19-19	146-146	54	70	64	80
	208/60/3	1	2	3	1	6.2	53-74	320-485	169	225	186	250
	230/60/3	1	2	3	1	6.7	54-67	320-485	162	225	175	225
35	380/60/3	1	2	3	1	3.7	31-40	210-260	94	125	n/a	
	460/60/3	1	2	3	1	3.2	26-33	160-215	79	110	92	110
	575/60/3	1	2	3	1	2.6	21-26	135-175	64	90	73	90
	208/60/3	2	4	4	1	6.2	39-39/39-39	267-267/267-267	197	225	214	250
	230/60/3	2	4	4	1	6.7	39-39/39-39	267-267/267-267	198	225	214	250
40	380/60/3	2	4	4	1	3.7	22-22/22-22	160-160/160-160	112	125	n/a	
	460/60/3	2	4	4	1	3.2	19-19/19-19	142-142/142-142	95	110	108	125
	575/60/3	2	4	4	1	2.6	15-15/15-15	103-103/103-103	79	90	89	100
	208/60/3	2	4	4	1	6.2	51-51/51-51	315-315/315-315	246	250	263	300
	230/60/3	2	4	4	1	6.7	44-44/44-44	315-315/315-315	220	250	237	250
52	380/60/3	2	4	4	1	3.7	26-26/26-26	177-177/177-177	129	150	n/a	
	460/60/3	2	4	4	1	3.2	21-21/21-21	158-158/158-158	106	125	119	125
	575/60/3	2	4	4	1	2.6	19-19/19-19	126-126/126-126	93	110	103	110
	208/60/3	2	4	6	1	6.2	50-50/50-50	351-351/351-351	257	300		
	230/60/3	2	4	6	1	6.7	48-48/48-48	351-351/351-351	250	250	n/a	
60	380/60/3	2	4	6	1	3.7	29-29/29-29	208-208/208-208	149	175		
	460/60/3	2	4	6	1	3.2	24-24/24-24	197-197/197-197	125	125	141	150
	575/60/3	2	4	6	1	2.6	19-19/19-19	146-146/146-146	100	110	112	125
	208/60/3	2	4	6	1	6.2	53-74/74-54	320-485/485-320	316	350		
	230/60/3	2	4	6	1	6.7	50-67/67-50	350-485/485-350	297	350	n/a	
70	380/60/3	2	4	6	1	3.7	31-40/40-31	210-260/260-210	177	200		
	460/60/3	2	4	6	1	3.2	26-33/33-26	160-215/215-160	148	175	164	175
	575/60/3	2	4	6	1	2.6	21-26/26-21	135-175/175-135	120	125	131	150

Table 9. Electrical data - 60 Hz (continued)

Unit Size	Rated Power	Number Circuits	Qty Comp	Qty Fans	Fan Motor Power (kW)	Cond Fan FLA	Compressor RLA[a]	Compressor LRA[b]	No pump MCA[c]	No pump MOP[d]	Pump MCA[c]	Pump MOP[d]
	208/60/3	2	4	6	1	6.2	74-74/74-74	485-485/485-485	358	400	388	450
	230/60/3	2	4	6	1	6.7	67-67/67-67	485-485/485-485	331	350	362	400
80	380/60/3	2	4	6	1	3.7	40-40/40-40	260-260/260-260	194	225	n/a	
	460/60/3	2	4	6	1	3.2	33-33/33-33	215-215/215-215	162	175	186	200
	575/60/3	2	4	6	1	2.6	26-26/26-26	175-175/175-175	131	150	150	175
	208/60/3	2	4	6	1	6.2	74-91/91-74	485-560/560-485	397	450	428	500
	230/60/3	2	4	6	1	6.7	67-85/85-67	485-560/560-485	370	450	401	450
90	380/60/3	2	4	6	1	3.7	40-55/55-40	260-310/310-260	227	275	n/a	
	460/60/3	2	4	6	1	3.2	33-42/42-33	215-260/260-215	182	200	206	225
	575/60/3	2	4	6	1	2.6	26-34/34-26	175-210/210-175	149	175	168	200
	208/60/3	2	4	8	1	6.2	91-91/91-91	560-560/560-560	444	500	475	500
	230/60/3	2	4	8	1	6.7	85-85/85-85	560-560/560-560	418	500	449	500
100	380/60/3	2	4	8	1	3.7	55-55/55-55	310-310/310-310	263	300	n/a	
	460/60/3	2	4	8	1	3.2	42-42/42-42	260-260/260-260	206	225	230	250
	575/60/3	2	4	8	1	2.6	34-34/34-34	210-210/210-210	169	200	188	200
	208/60/3	2	4	8	1	6.2	91-110/110-91	560-680/680-560	485	500	516	600
110 High Effic	230/60/3	2	4	8	1	6.7	85-109/109-85	560-680/680-560	473	500	504	600
	380/60/3	2	4	8	1	3.7	55-60/60-55	310-360/360-310	275	300	n/a	
	460/60/3	2	4	8	1	3.2	42-51/51-42	260-320/320-260	226	250	250	250
	575/60/3	2	4	8	1	2.6	34-39/39-34	210-235/235-210	179	200	198	225
	208/60/3	2	4	8	1	6.2	91-114/114-91	560-500/500-560	494	600	525	600
110 Extra Effic	230/60/3	2	4	8	1	6.7	85-114/114-85	560-500/500-560	483	600	514	600
	380/60/3						n/a					
	460/60/3	2	4	8	1	3.2	42-52/52-42	260-235/235-260	229	250	253	250
	575/60/3	2	4	8	1	2.6	34-42/42-34	210-187/187-210	186	200	205	225
	208/60/3	2	4	8	1	6.2	110-110/110-110	680-680/680-680	521	600	n/a	
120 High Effic	230/60/3	2	4	8	1	6.7	109-109/109-109	680-680/680-680	522	600	568	600
	380/60/3	2	4	8	1	3.7	60-60/60-60	360-360/360-360	285	300	n/a	
	460/60/3	2	4	8	1	3.2	51-51/51-51	320-320/320-320	244	250	268	300
	575/60/3	2	4	8	1	2.6	39-39/39-39	235-235/235-235	188	225	207	225
	208/60/3	2	4	8	1	6.2	139-139/139-139	500-500/500-500	583	700	n/a	
120 Extra Effic	230/60/3	2	4	8	1	6.7	132-132/132-132	500-500/500-500	540	650	558	600
	380/60/3						n/a					
	460/60/3	2	4	8	1	3.2	62-62/62-62	235-235/235-235	249	300	285	300
	575/60/3	2	4	8	1	2.6	50-50/50-50	187-187/187-187	202	350	231	225

Table 9. Electrical data - 60 Hz (continued)

Unit Size	Rated Power	Number Circuits	Qty Comp	Qty Fans	Fan Motor Power (kW)	Cond Fan FLA	Compressor RLA[a]	Compressor LRA[b]	No pump MCA[c]	No pump MOP[d]	Pump MCA[c]	Pump MOP[d]
	208/60/3	2	6	10	1	6.2	74-74-91/91-74-74	485-485-560/ 560-485-485	569	600	n/a	
	230/60/3	2	6	10	1	6.7	67-67-85/85-67-67	485-485-560/ 560-485-485	531	600	578	600
130	380/60/3	2	6	10	1	3.7	40-40-55/55-40-40	260-260-310/ 310-260-260	321	350	n/a	
	460/60/3	2	6	10	1	3.2	33-33-42/42-33-33	215-215-260/ 260-215-215	261	300	285	300
	575/60/3	2	6	10	1	2.6	26-26-34/34-26-26	175-175-210/ 210-175-175	212	225	231	250

Notes:
1. Local codes may take precedence.
2. Voltage Utilization Range: +/- 10% of rated voltage
   Rated voltage (use range): 208/60/3 (187.2-228.8), 230/60/3(208-254), 380/60/3 (342-418), 460/60/3 (414-506), 575/60/3 (516-633)
3. One separate 120/60/1, 15 amp customer provided power connection is required to power the heaters.
4. n/a - not available

(a) RLA - Rated Load Amps - Rated in accordance with UL Standard 1995.
(b) LRA - Locked Rotor Amps - Based on full winding starts.
(c) MCA - Minimum Circuit Ampacity - 125 percent of largest compressor RLA plus 100 percent of all other loads.
(d) MOP or Max fuse size - 225 percent of the largest compressor RLA plus all other loads.

Table 10. Lug size range - 60 Hz

Unit Size	Rated Power	No Pump			Pump		
		Terminal Blocks	Std Fault Ckt Breaker[a]	High Fault Ckt Breaker[a]	Terminal Blocks	Std Fault Ckt Breaker[a]	High Fault Ckt Breaker[a]
20	208/60/3	#6 - 350 MCM	#8 - 3/0	#8 - 3/0	#6 - 350 MCM	#4 - 4/0	#4 - 4/0
	230/60/3	#6 - 350 MCM	#8 - 3/0	#8 - 3/0	#6 - 350 MCM	#4 - 4/0	#4 - 4/0
	380/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	n/a	n/a	n/a
	460/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
	575/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
26	208/60/3	#6 - 350 MCM	#4 - 4/0	#4 - 4/0	#6 - 350 MCM	#4 - 4/0	#4 - 4/0
	230/60/3	#6 - 350 MCM	#4 - 4/0	#4 - 4/0	#6 - 350 MCM	#4 - 4/0	#4 - 4/0
	380/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	n/a	n/a	n/a
	460/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
	575/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
30	208/60/3	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	230/60/3	#6 - 350 MCM	#4 - 4/0	#4 - 4/0	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	380/60/3	#6 - 350 MCM	#14 - 3/0	#14 - 3/0	n/a	n/a	n/a
	460/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
	575/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
35	208/60/3	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	230/60/3	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	380/60/3	#6 - 350 MCM	#8 - 3/0	#8 - 3/0	n/a	n/a	n/a
	460/60/3	#6 - 350 MCM	#8 - 3/0	#8 - 3/0	#6 - 350 MCM	#8 - 3/0	#8 - 3/0
	575/60/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
40	208/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	230/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	380/60/3	#4 - 500 MCM	#4 - 4/0	#4 - 4/0	n/a	n/a	n/a
	460/60/3	#4 - 500 MCM	#8 - 3/0	#8 - 3/0	#4 - 500 MCM	#4 - 4/0	#4 - 4/0
	575/60/3	#4 - 500 MCM	#8 - 3/0	#8 - 3/0	#4 - 500 MCM	#8 - 3/0	#8 - 3/0
52	208/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]
	230/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	380/60/3	#4 - 500 MCM	#4 - 4/0	#4 - 4/0		n/a	
	460/60/3	#4 - 500 MCM	#4 - 4/0	#4 - 4/0	#4 - 500 MCM	#4 - 4/0	#4 - 4/0
	575/60/3	#4 - 500 MCM	#8 - 3/0	#8 - 3/0	#4 - 500 MCM	#8 - 3/0	#8 - 3/0
60	208/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]			
	230/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM		n/a	
	380/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM			
	460/60/3	#4 - 500 MCM	#14 - 3/0	#14 - 3/0	#4 - 500 MCM	#4 - 4/0	#4 - 4/0
	575/60/3	#4 - 500 MCM	#14 - 3/0	#14 - 3/0	#4 - 500 MCM	#4 - 4/0	#4 - 4/0
70	208/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]			
	230/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]		n/a	
	380/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM			
	460/60/3	#4 - 500 MCM	#4- 4/0	#4 - 4/0	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	575/60/3	#4 - 500 MCM	#4- 4/0	#4 - 4/0	#4 - 500 MCM	#4- 4/0	#4 - 4/0

Notes:
1. Copper wire only, based on nameplate Minimum Circuit Ampacity (MCA).
2. Data shown for circuit one. The second circuit is always the same.
3. n/a - not available

Table 10. Lug size range - 60 Hz (continued)

Unit Size	Rated Power	No Pump			Pump		
		Terminal Blocks	Std Fault Ckt Breaker[a]	High Fault Ckt Breaker[a]	Terminal Blocks	Std Fault Ckt Breaker[a]	High Fault Ckt Breaker[a]
80	208/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 350 MCM[b]	2/0 - 500 MCM[2]	#4 - 500 MCM[2]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]
	230/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 350 MCM[b]	2/0 - 500 MCM[2]	#4 - 500 MCM[2]	#1 - 600 MCM or #1 - 350 MCM[b]	2/0 - 500 MCM[b]
	380/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM		n/a	
	460/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	575/60/3	#4 - 500 MCM	#4- 4/0	#4 - 4/0	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
90	208/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]
	230/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]
	380/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM		n/a	
	460/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	575/60/3	#4 - 500 MCM	#4- 4/0	#4 - 4/0	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
100	208/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]	#6 - 350 MCM	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]
	230/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]	#6 - 350 MCM	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]
	380/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]		n/a	
	460/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	575/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
110	208/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]	#6 - 350 MCM	2/0-500 MCM[b]	2/0-500 MCM[b]
	230/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]	#6 - 350 MCM	2/0-500 MCM[b]	2/0-500 MCM[b]
	380/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]		n/a	
	460/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
	575/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
120	208/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]		n/a	
	230/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]	#6 - 350 MCM	2/0-500 MCM[b]	2/0-500 MCM[b]
	380/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]		n/a	
	460/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]
	575/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#6 - 350 MCM	3/0 - 350 MCM	3/0 - 350 MCM
130	208/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]		n/a	
	230/60/3	#4 - 500 MCM[b]	2/0 - 500 MCM[b]	2/0 - 500 MCM[b]	#4 - 500 MCM[b]	2/0-500 MCM[b]	2/0-500 MCM[b]
	380/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]		n/a	
	460/60/3	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]	#4 - 500 MCM	#1 - 600 MCM or #1 - 250 MCM[b]	2/0 - 500 MCM[b]
	575/60/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM

Notes:
1. Copper wire only, based on nameplate Minimum Circuit Ampacity (MCA).
2. Data shown for circuit one. The second circuit is always the same.
3. n/a - not available

(a) Optional circuit breaker and high fault circuit breaker.
(b) Will accept two conduits per phase in this size.

Table 11. Electrical data - 50Hz

Unit Size	Rated Power	Number Circuits	Qty Comp	Qty Fans	Fan Motor Power (kW)	Cond Fan FLA	Compressor RLA[a]	Compressor LRA[b]	MCA[c]	MOP[d]
20	400/50/3	1	2	2	1	2.4	17-17	142-142	46	60
26	400/50/3	1	2	2	1	2.4	21-21	158-158	55	70
30	400/50/3	1	2	3	1	2.4	23-23	197-197	63	80
35	400/50/3	1	2	3	1	2.4	27-33	160-215	79	110
40	400/50/3	2	4	4	1	2.4	17-17/17-17	142-142/142-142	85	100
52	400/50/3	2	4	4	1	2.4	21-21/21-21	158-158/158-158	102	110
60	400/50/3	2	4	6	1	2.4	24-24/24-24	197-197/197-197	120	125
70	400/50/3	2	4	6	1	2.4	27-33/33-27	160-215/215-160	147	175
80	400/50/3	2	4	6	1	2.4	33-33/33-33	215-215/215-215	160	175
90	400/50/3	2	4	6	1	2.4	33-43/43-33	215-260/260-215	181	200
100	400/50/3	2	4	8	1	2.4	43-43/43-43	260-260/260-260	204	225
110 High	400/50/3	2	4	8	1	2.4	43-47/47-43	260-320/260-320	214	250
110 Extra	400/50/3	2	4	8	1	2.4	43-62/62-43	260-253/253-260	245	300
120 High	400/50/3	2	4	8	1	2.4	47-47/47-47	320-320/320-320	223	250
120 Extra	400/50/3	2	4	8	1	2.4	62-62/62-62	253-253/253-253	284	300

Notes:
1. Local codes may take precedence.
2. Voltage Utilization Range: +/- 10% of rated voltage. Rated voltage (use range): 400/50/3 (360-440)
3. One separate 120/50/1, 15 amp customer provided power connection is required to power the heaters.
4. n/a - not available
5. Pump package not available with 50 Hz units.

(a) RLA - Rated Load Amps - Rated in accordance with UL Standard 1995.
(b) LRA - Locked Rotor Amps - Based on full winding starts.
(c) MCA - Minimum Circuit Ampacity - 125 percent of largest compressor RLA plus 100 percent of all other loads.
(d) MOP or Max fuse size - 225 percent of the largest compressor RLA plus all other loads.

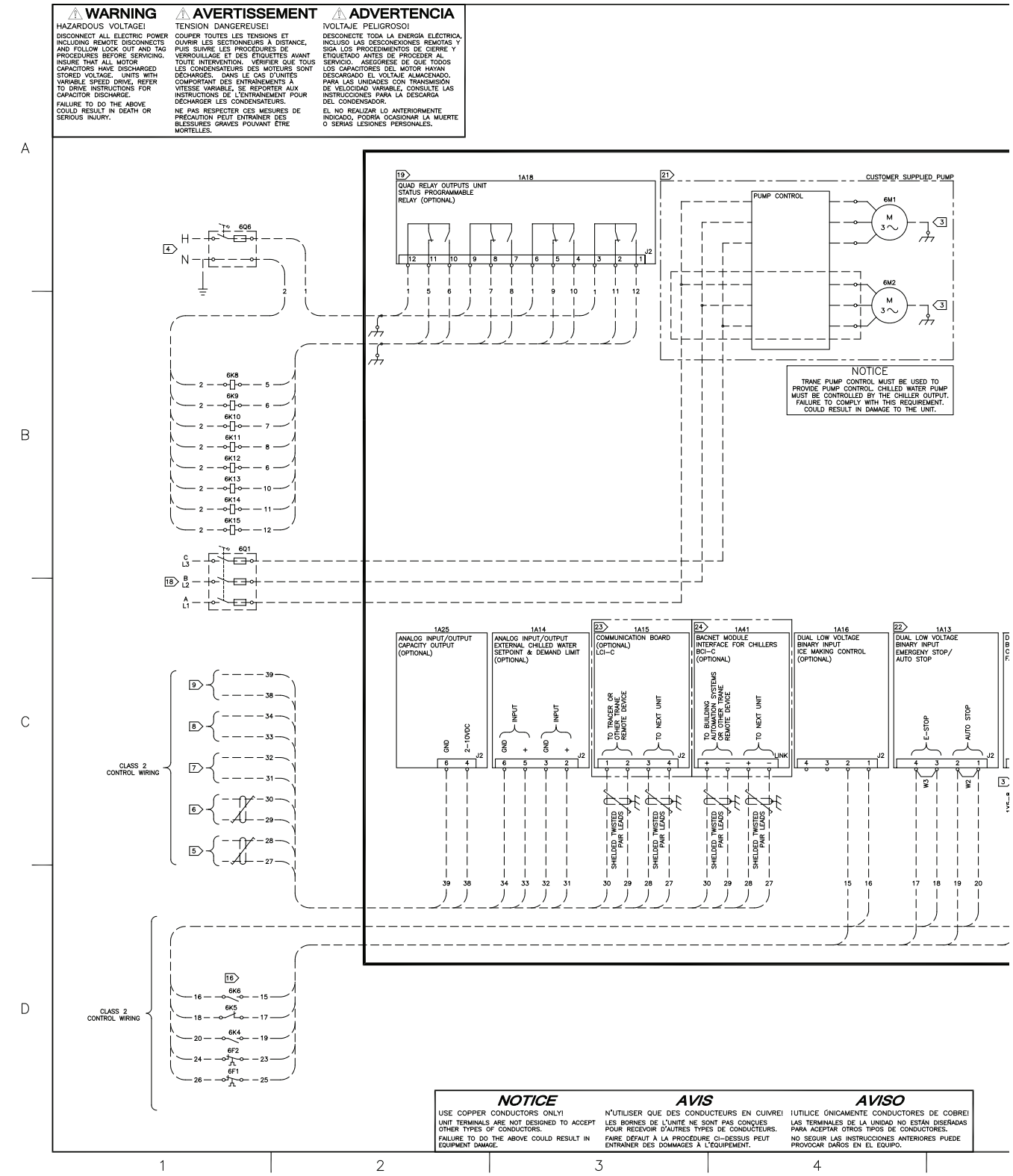
Table 12. Lug size range - 50 Hz

Unit Size	Rated Power	Terminal Blocks	Std Fault Ckt Breaker[a]	High Fault Ckt Breaker[a]
20	400/50/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
26	400/50/3	#6 - 350 MCM	#14 - 1/0	#8 - 3/0
30	400/50/3	#6 - 350 MCM	#14 - 3/0	#14 - 3/0
35	400/50/3	#6 - 350 MCM	#8 - 3/0	#8 - 3/0
40	400/50/3	#4 - 500 MCM	#8 - 3/0	#6 - 350 MCM
52	400/50/3	#4 - 500 MCM	#8 - 3/0	#6 - 350 MCM
60	400/50/3	#4 - 500 MCM	#14 - 3/0	#14 - 3/0
70	400/50/3	#4 - 500 MCM	#4 - 4/0	#6 - 350 MCM
80	400/50/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
90	400/50/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
100	400/50/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
110	400/50/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM
120	400/50/3	#4 - 500 MCM	3/0 - 350 MCM	3/0 - 350 MCM

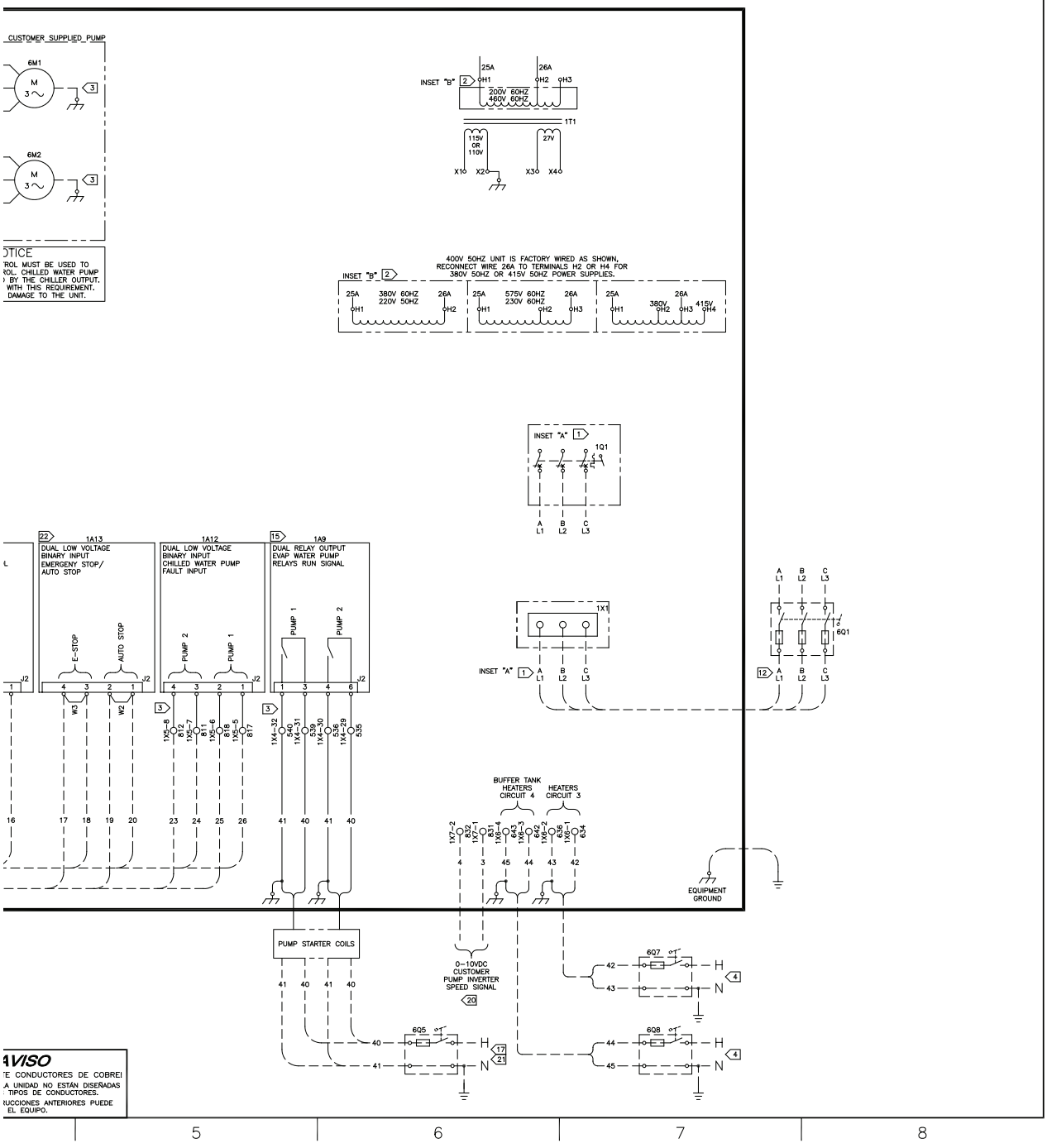
Notes:
1. Copper wire only, based on nameplate Minimum Circuit Ampacity (MCA).
2. Data shown for circuit one. The second circuit is always the same.

(a) Optional circuit breaker and high fault circuit breaker.

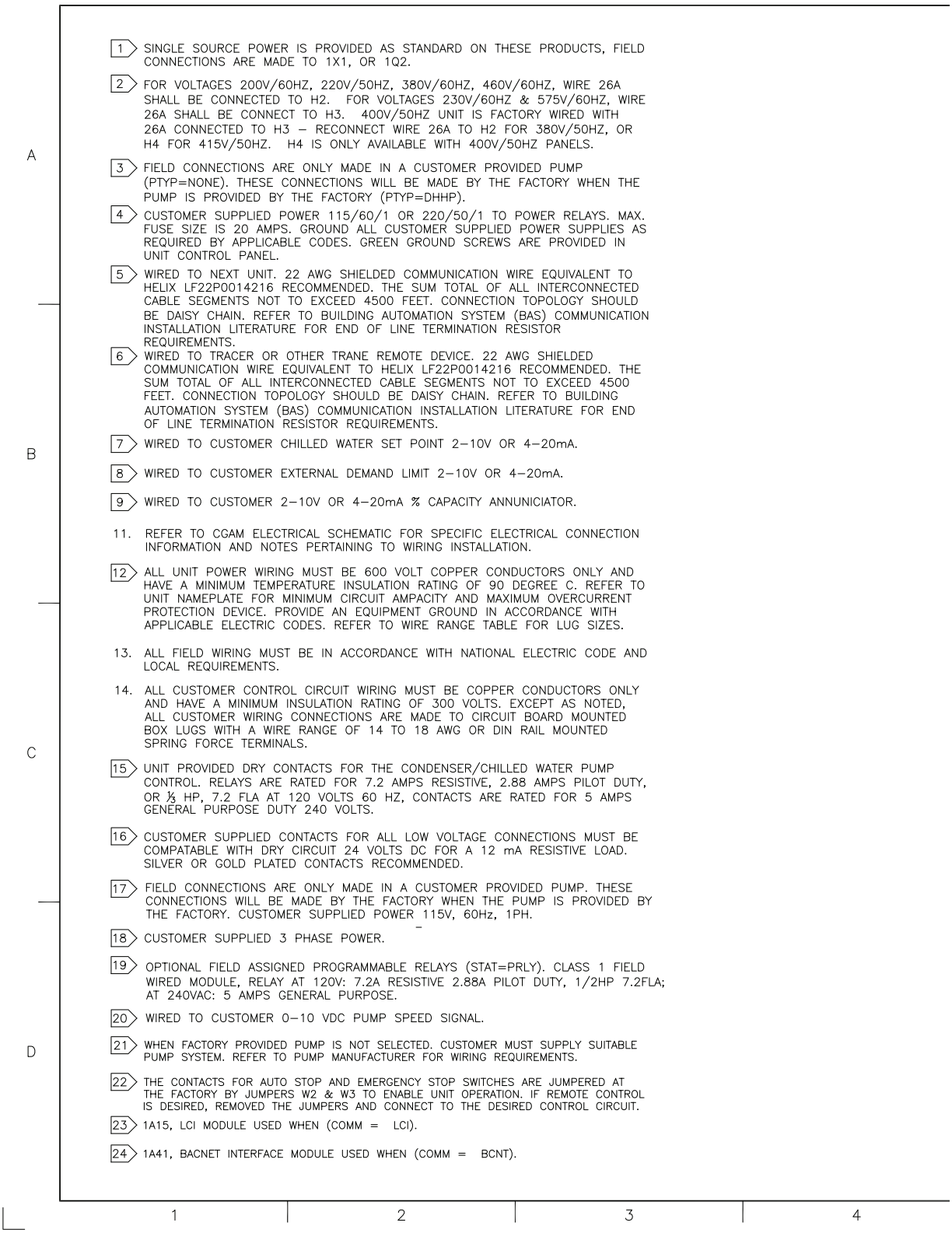
Electrical Connections



TRANE	2309–2076	SHEET 1 OF 2	REV F
THIS DRAWING IS PROPRIETARY AND SHALL NOT BE COPIED OR ITS CONTENTS DISCLOSED TO OUTSIDE PARTIES WITHOUT THE WRITTEN CONSENT OF TRANE	FIELD WIRING DIAGRAM		
DRAWN BY: ©TRANE DATE: 12/5/08	CGAM (NAR)		
REPLACES:	SLANT, V & W UNITS		
REVISION DATE:			
SIMILIAR TO:			



5 6 7 8



1. SINGLE SOURCE POWER IS PROVIDED AS STANDARD ON THESE PRODUCTS, FIELD CONNECTIONS ARE MADE TO 1X1, OR 1Q2.
2. FOR VOLTAGES 200V/60HZ, 220V/50HZ, 380V/60HZ, 460V/60HZ, WIRE 26A SHALL BE CONNECTED TO H2. FOR VOLTAGES 230V/60HZ & 575V/60HZ, WIRE 26A SHALL BE CONNECT TO H3. 400V/50HZ UNIT IS FACTORY WIRED WITH 26A CONNECTED TO H3 – RECONNECT WIRE 26A TO H2 FOR 380V/50HZ, OR H4 FOR 415V/50HZ. H4 IS ONLY AVAILABLE WITH 400V/50HZ PANELS.
3. FIELD CONNECTIONS ARE ONLY MADE IN A CUSTOMER PROVIDED PUMP (PTYP=NONE). THESE CONNECTIONS WILL BE MADE BY THE FACTORY WHEN THE PUMP IS PROVIDED BY THE FACTORY (PTYP=DHHP).
4. CUSTOMER SUPPLIED POWER 115/60/1 OR 220/50/1 TO POWER RELAYS. MAX. FUSE SIZE IS 20 AMPS. GROUND ALL CUSTOMER SUPPLIED POWER SUPPLIES AS REQUIRED BY APPLICABLE CODES. GREEN GROUND SCREWS ARE PROVIDED IN UNIT CONTROL PANEL.
5. WIRED TO NEXT UNIT. 22 AWG SHIELDED COMMUNICATION WIRE EQUIVALENT TO HELIX LF22P0014216 RECOMMENDED. THE SUM TOTAL OF ALL INTERCONNECTED CABLE SEGMENTS NOT TO EXCEED 4500 FEET. CONNECTION TOPOLOGY SHOULD BE DAISY CHAIN. REFER TO BUILDING AUTOMATION SYSTEM (BAS) COMMUNICATION INSTALLATION LITERATURE FOR END OF LINE TERMINATION RESISTOR REQUIREMENTS.
6. WIRED TO TRACER OR OTHER TRANE REMOTE DEVICE. 22 AWG SHIELDED COMMUNICATION WIRE EQUIVALENT TO HELIX LF22P0014216 RECOMMENDED. THE SUM TOTAL OF ALL INTERCONNECTED CABLE SEGMENTS NOT TO EXCEED 4500 FEET. CONNECTION TOPOLOGY SHOULD BE DAISY CHAIN. REFER TO BUILDING AUTOMATION SYSTEM (BAS) COMMUNICATION INSTALLATION LITERATURE FOR END OF LINE TERMINATION RESISTOR REQUIREMENTS.
7. WIRED TO CUSTOMER CHILLED WATER SET POINT 2–10V OR 4–20mA.
8. WIRED TO CUSTOMER EXTERNAL DEMAND LIMIT 2–10V OR 4–20mA.
9. WIRED TO CUSTOMER 2–10V OR 4–20mA % CAPACITY ANNUNICIATOR.
11. REFER TO CGAM ELECTRICAL SCHEMATIC FOR SPECIFIC ELECTRICAL CONNECTION INFORMATION AND NOTES PERTAINING TO WIRING INSTALLATION.
12. ALL UNIT POWER WIRING MUST BE 600 VOLT COPPER CONDUCTORS ONLY AND HAVE A MINIMUM TEMPERATURE INSULATION RATING OF 90 DEGREE C. REFER TO UNIT NAMEPLATE FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM OVERCURRENT PROTECTION DEVICE. PROVIDE AN EQUIPMENT GROUND IN ACCORDANCE WITH APPLICABLE ELECTRIC CODES. REFER TO WIRE RANGE TABLE FOR LUG SIZES.
13. ALL FIELD WIRING MUST BE IN ACCORDANCE WITH NATIONAL ELECTRIC CODE AND LOCAL REQUIREMENTS.
14. ALL CUSTOMER CONTROL CIRCUIT WIRING MUST BE COPPER CONDUCTORS ONLY AND HAVE A MINIMUM INSULATION RATING OF 300 VOLTS. EXCEPT AS NOTED, ALL CUSTOMER WIRING CONNECTIONS ARE MADE TO CIRCUIT BOARD MOUNTED BOX LUGS WITH A WIRE RANGE OF 14 TO 18 AWG OR DIN RAIL MOUNTED SPRING FORCE TERMINALS.
15. UNIT PROVIDED DRY CONTACTS FOR THE CONDENSER/CHILLED WATER PUMP CONTROL. RELAYS ARE RATED FOR 7.2 AMPS RESISTIVE, 2.88 AMPS PILOT DUTY, OR ½ HP, 7.2 FLA AT 120 VOLTS 60 HZ, CONTACTS ARE RATED FOR 5 AMPS GENERAL PURPOSE DUTY 240 VOLTS.
16. CUSTOMER SUPPLIED CONTACTS FOR ALL LOW VOLTAGE CONNECTIONS MUST BE COMPATABLE WITH DRY CIRCUIT 24 VOLTS DC FOR A 12 mA RESISTIVE LOAD. SILVER OR GOLD PLATED CONTACTS RECOMMENDED.
17. FIELD CONNECTIONS ARE ONLY MADE IN A CUSTOMER PROVIDED PUMP. THESE CONNECTIONS WILL BE MADE BY THE FACTORY WHEN THE PUMP IS PROVIDED BY THE FACTORY. CUSTOMER SUPPLIED POWER 115V, 60Hz, 1PH.
18. CUSTOMER SUPPLIED 3 PHASE POWER.
19. OPTIONAL FIELD ASSIGNED PROGRAMMABLE RELAYS (STAT=PRLY). CLASS 1 FIELD WIRED MODULE, RELAY AT 120V: 7.2A RESISTIVE 2.88A PILOT DUTY, 1/2HP 7.2FLA; AT 240VAC: 5 AMPS GENERAL PURPOSE.
20. WIRED TO CUSTOMER 0–10 VDC PUMP SPEED SIGNAL.
21. WHEN FACTORY PROVIDED PUMP IS NOT SELECTED. CUSTOMER MUST SUPPLY SUITABLE PUMP SYSTEM. REFER TO PUMP MANUFACTURER FOR WIRING REQUIREMENTS.
22. THE CONTACTS FOR AUTO STOP AND EMERGENCY STOP SWITCHES ARE JUMPERED AT THE FACTORY BY JUMPERS W2 & W3 TO ENABLE UNIT OPERATION. IF REMOTE CONTROL IS DESIRED, REMOVED THE JUMPERS AND CONNECT TO THE DESIRED CONTROL CIRCUIT.
23. 1A15, LCI MODULE USED WHEN (COMM = LCI).
24. 1A41, BACNET INTERFACE MODULE USED WHEN (COMM = BCNT).

TRANE	2309–2076	SHEET 2 OF 2	REV F
THIS DRAWING IS PROPRIETARY AND SHALL NOT BE COPIED OR ITS CONTENTS DISCLOSED TO OUTSIDE PARTIES WITHOUT THE WRITTEN CONSENT OF TRANE.	FIELD WIRING DIAGRAM		
DRAWN BY: © TRANE DATE: 12/5/08	CGAM (NAR)		
REPLACES:	SLANT, V & W UNITS		
REVISION DATE:			
SIMILIAR TO:			

FUSE REPLACEMENT TABLE

FUSE	VOLTAGE	HERTZ (Hz)	CLASS	AMPS	NOTES
1F1	ALL	ALL	CC	10	FUSE, COMPRESSOR CRANKCASE HEATER, CIRCUIT 1
1F2	ALL	ALL	CC	10	
1F3	ALL	ALL	CC	10	FUSE, COMPRESSOR CRANKCASE HEATER, CIRCUIT 2
1F4	ALL	ALL	CC	10	
1F5 – 1F6	200	60	CC	10	FUSE, CONTROL POWER TRANSFORMER, PRIMARY
	230	60	CC	8	
	380	60	CC	5	
	400	50	CC	5	
	460	60	CC	5	
	575	60	CC	4	
1F7	200	60	CC	10	FUSE, THIRD PHASE, PHASE PROTECTION MONITOR
	230	60	CC	8	
	380	60	CC	5	
	400	50	CC	5	
	460	60	CC	5	
	575	60	CC	4	
1F8 – 1F10	200	60	CC	10	FUSE, DUAL POINT, POWER SECOND PHASE, PHASE PROTECTION MONITOR
	230	60	CC	8	
	380	60	CC	5	
	400	50	CC	5	
	460	60	CC	5	
	575	60	CC	4	
1F11	ALL	ALL	CC	10	FUSE, CONTROL POWER TRANSFORMER, SECONDARY, 115V
1F12 – 1F13	ALL	ALL	CC	6	FUSE, CONTROL POWER TRANSFORMER, SECONDARY, 24V
1F14 – 1F16 1F17 – 1F19	200–460	ALL	CC	30	FUSE, INVERTER, FAN (FAST ACTING EXCEPT 575V)
	575	60	CC	6	
1F38 – 1F40 1F44 – 1F46	ALL	ALL	CC	30	FUSE, FAST ACTING, ATM–R–30
1F35 – 1F37 1F41 – 1F43	ALL	ALL	CC	30	FUSE, FAST ACTING, (USED ON W UNITS ONLY)
FACTORY PROVIDED PUMP INVERTER FUSE					
1F32 – 1F34	200,230	60	CC	30	3.7Kw VSD
	460,575			25	5.5Kw VSD
	200,230		J	60	7.5Kw VSD
	460,575		CC	30	
	200–230		J	60	11Kw VSD
	460,575			40	

4 | 5 | 6 | 7 | 8

Dimensions

Unit Dimensions

Unit without Options

Note: *The number of fans shown does not represent the number of fans installed.*

Figure 4. Dimensions, 20 to 35 ton units, no options

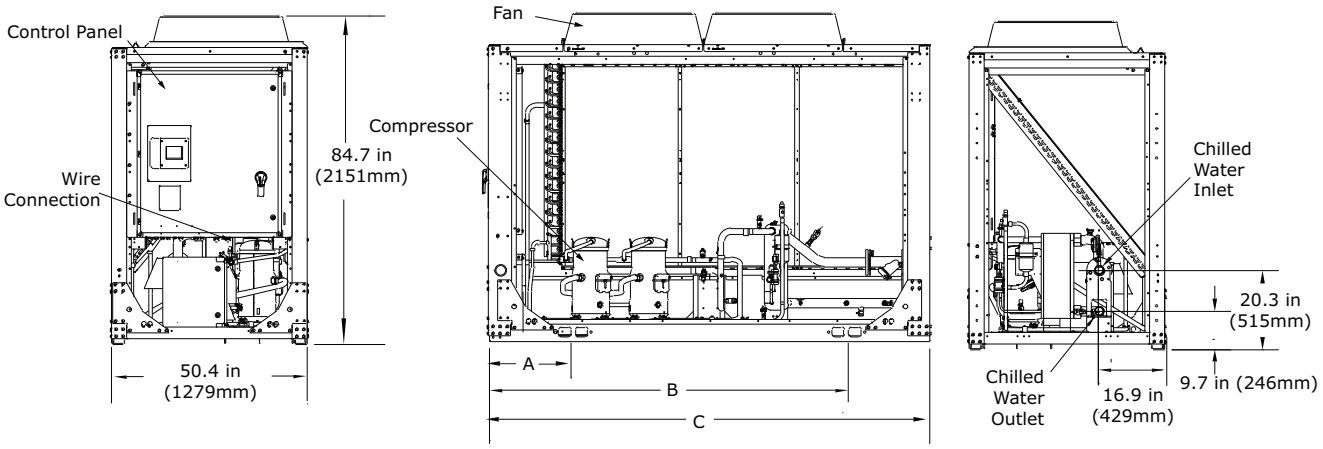


Table 13. Dimensions, 20 to 35 ton units, no options

	A		B		C		Water Connection (from end of chiller)	
Unit Size (tons)	in	mm	in	mm	in	mm	in	mm
20, 26	21.2	535	92.7	2354	113.8	2890	1.7	44
30, 35	21.3	541	128.4	3263	149.8	3804	1.6	40

Figure 5. Dimensions, 40 to 70 ton units, no options

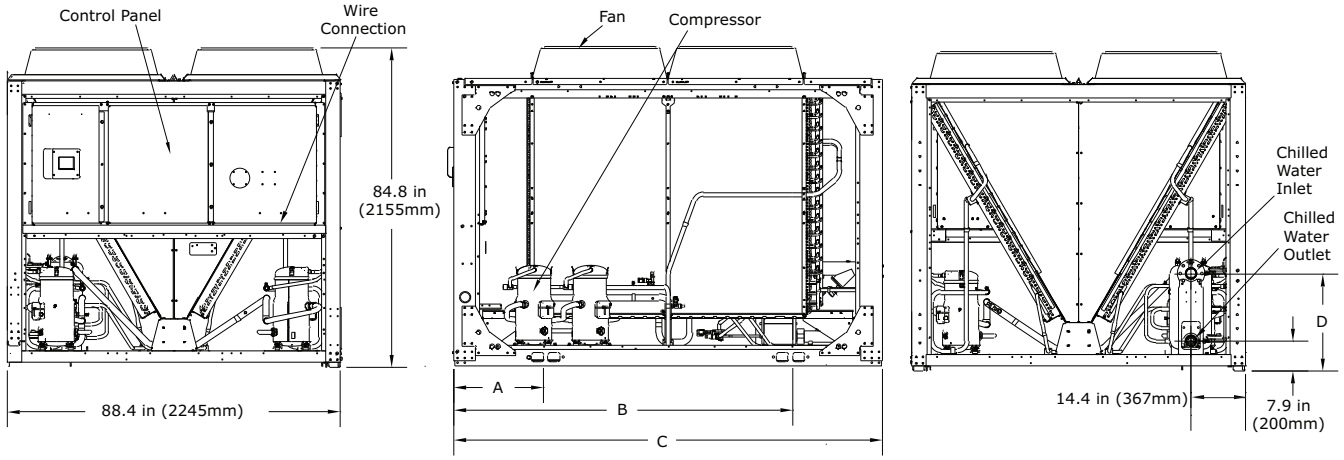


Table 14. Dimensions, 40 to 70 ton units, no options

Unit Size (tons)	A		B		C		D		Water Connection (from end of chiller)
	in	mm	in	mm	in	mm	in	mm	
40, 52	23.8	603	89.9	2282	113.8	2890	25.8	656	Even with unit end
60, 70	23.8	603	125.8	3196	149.8	3804	31.1	790	Even with unit end

Figure 6. Dimensions, 80 to 120 ton units, no options

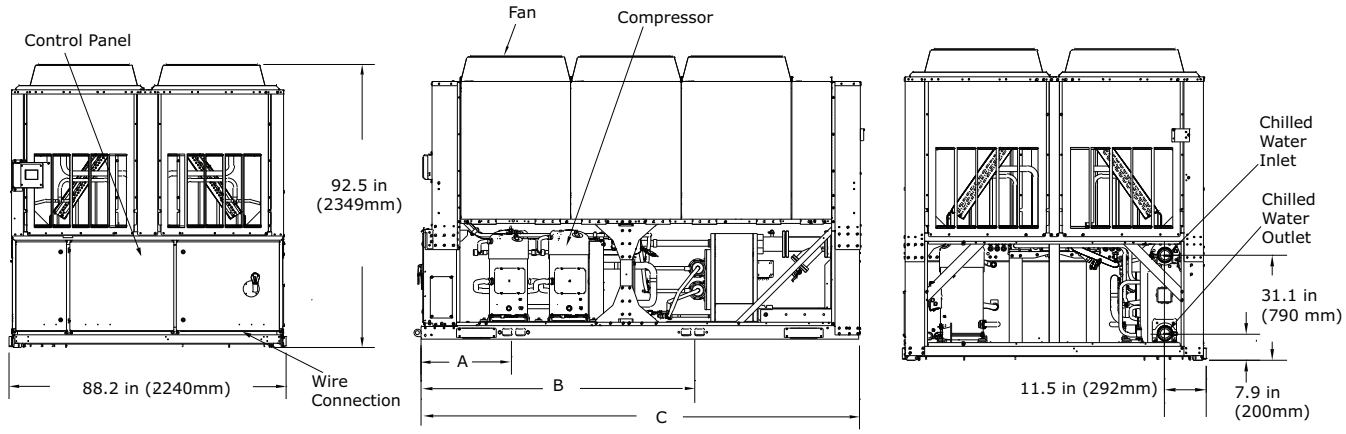
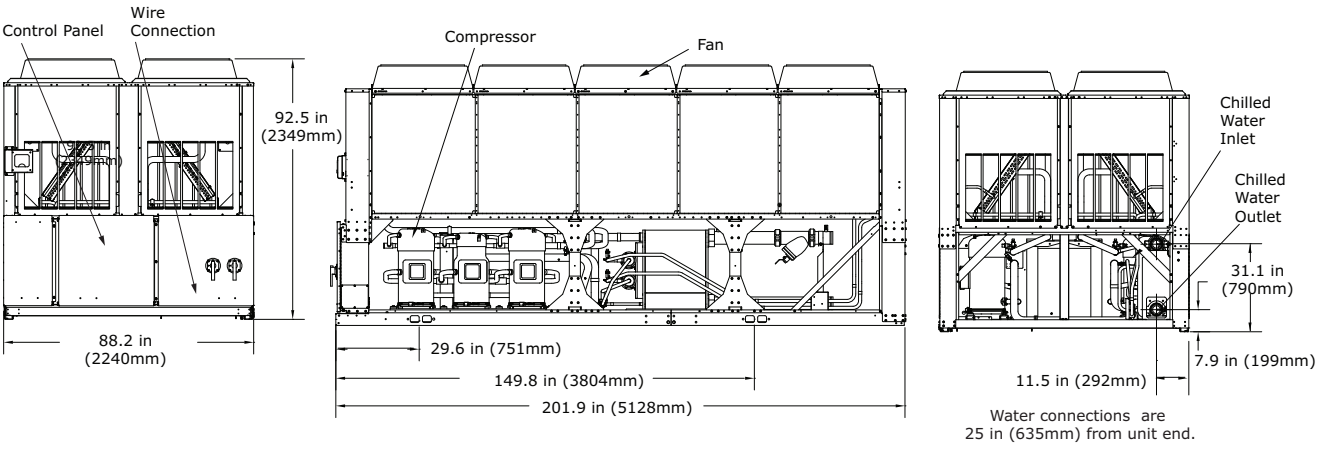


Table 15. Dimensions, 80 to 120 ton units, no options

	A		B		C		Water Connection (from end of chiller)	
Unit Size (tons)	in	mm	in	mm	in	mm	in	mm
80, 90	29.6	751	89.2	2265	143.1	3634	5.5	139
100, 110, 120	29.6	751	111.7	2837	165.9	4214	5.5	139

Figure 7. Dimensions, 130 ton unit, no options



Units with Options
Pump Package, Buffer Tank, Partial Heat Recovery

General Dimensions and Components

Notes:

- *Graphics in this section, use the following acronyms:*
  PP — pump package, BT — buffer tank, PHR — Partial Heat Recovery
- *See "Water connection dimensions, 80 to 130 ton units with options," p. 46 for dimensions of water connections for various options.*

Figure 8. Dimensions, 20 to 35 ton units with options

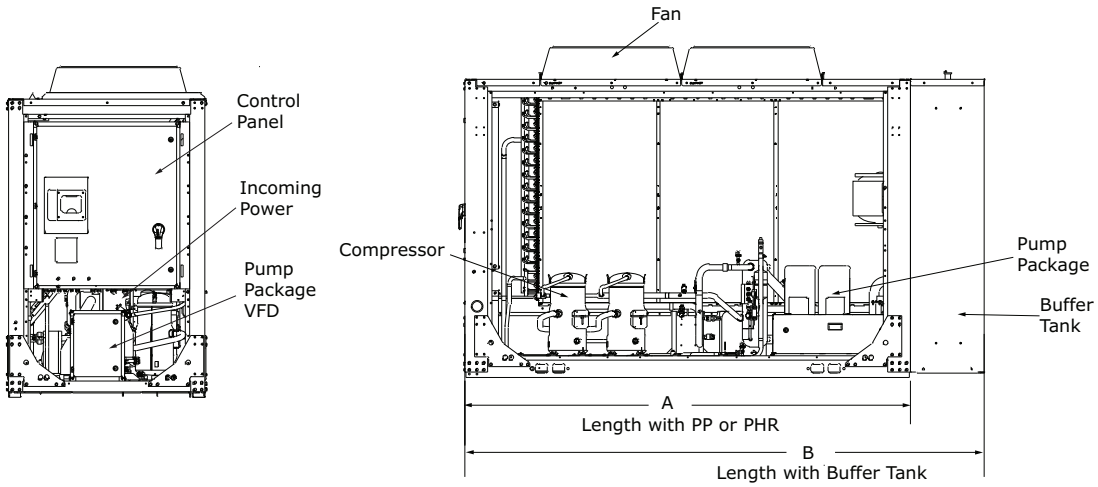


Table 16. Dimensions, 20 to 35 ton units with options

	A		B	
Unit Size (tons)	in	mm	in	mm
20, 26	113.8	2890	134.0	3404
30, 35	149.8	3804	170.1	4320

Figure 9. Dimensions, 40 to 70 ton units with options

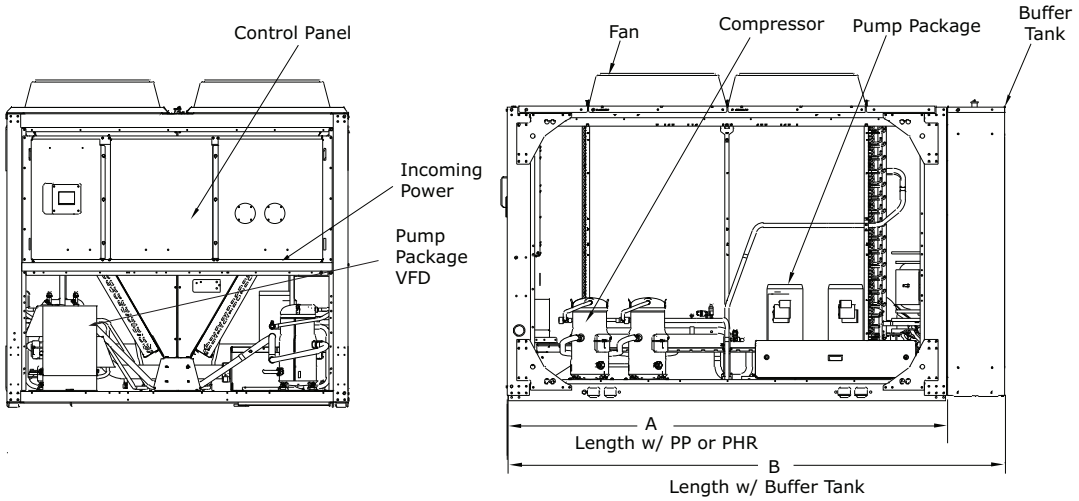


Table 17. Dimensions, 40 to 70 ton units with options

	A		B	
Unit Size (tons)	**in**	**mm**	**in**	**mm**
40, 52	113.8	2890	134.2	3409
60, 70	149.8	3804	170.0	4318

Figure 10. Dimensions, 80 to 120 ton units with options

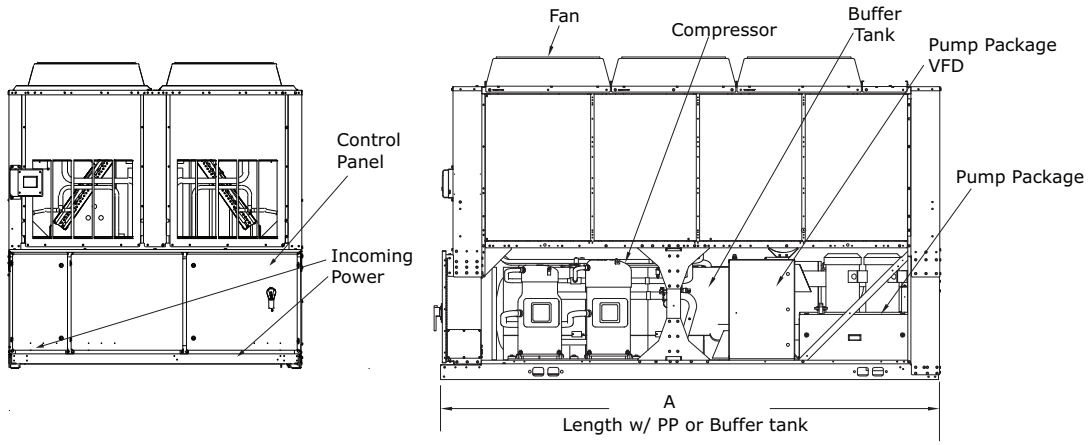


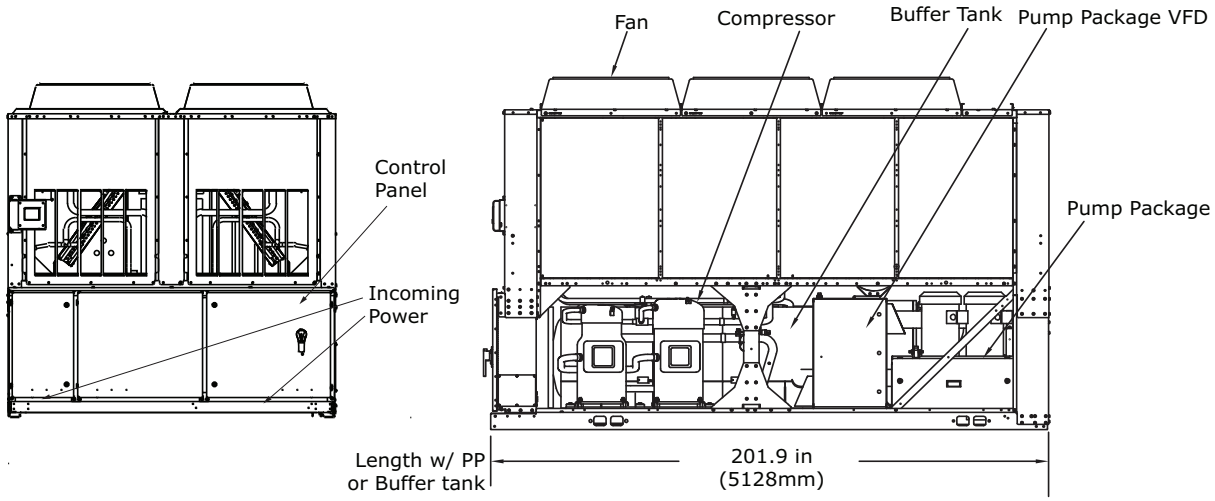
Table 18. Dimensions, 80 to 120 ton units with options

	A	
Unit Size (tons)	**in**	**mm**
80, 90, 100	143.1	3634
110, 125	165.9	4214

Note: *For PHR units, add 2.2 in (56mm) to overall length.*

Dimensions

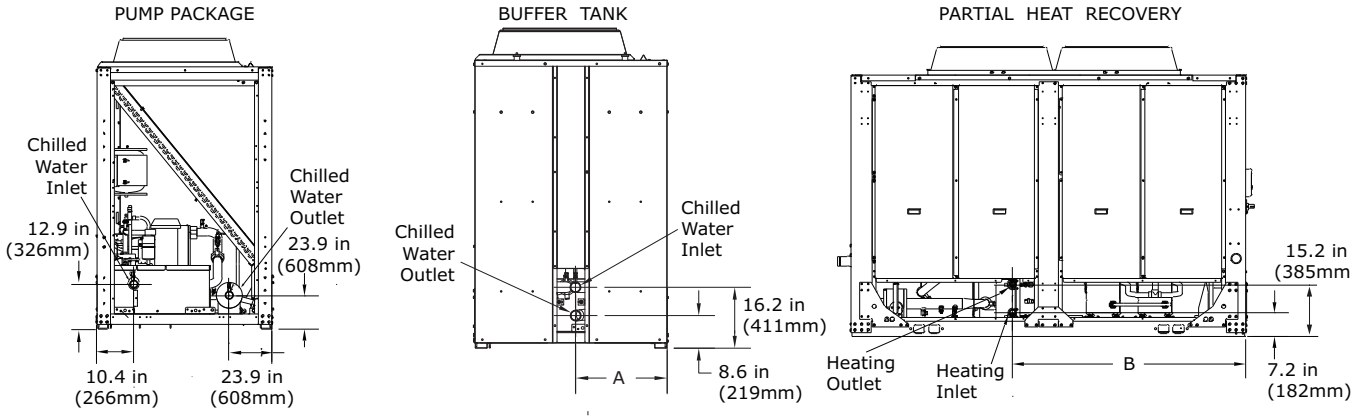
Figure 11. CGAM 130 ton, with options



Note: *For PHR units, add 2.2 in (56mm) to overall length.*

Water Connections

Figure 12. Water connection dimensions, 20 to 35 ton units with options



Water connections are recesssed 1.3 in (33mm) from unit end.

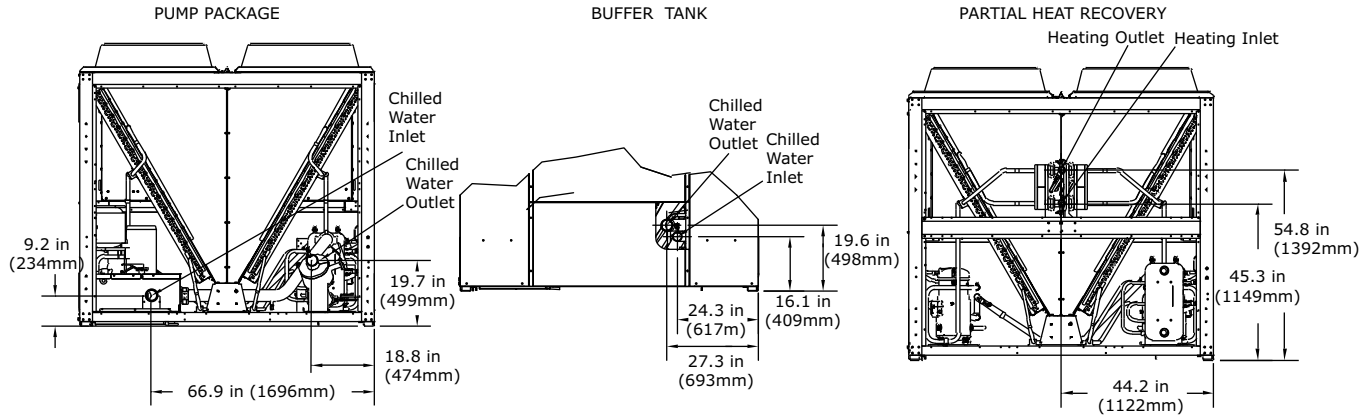
Water connections are recesssed from unit end.
Inlet: 3.2 in (81mm)
Outlet: 10.3 in (262mm)

Partial heat recovery connections are even with unit edge. The chilled water inlet and outlet connections are the same as the standard unit unless pump package or buffer tank are ordered.

Table 19. Water connection dimensions, 20 to 35 ton units with options

	A		B	
Unit Size (tons)	**in**	**mm**	**in**	**mm**
20, 26	24.1	613	70.3	1784
30, 35	23.9	608	67.4	1712

Figure 13. Water connection dimensions, 40 to 70 ton units with options



Water connections are recessed 1.3 in (33mm) from unit end.

Water connections are recessed from unit end:
Inlet:3.2 in (81mm)
Outlet: 8.5 in (216mm)

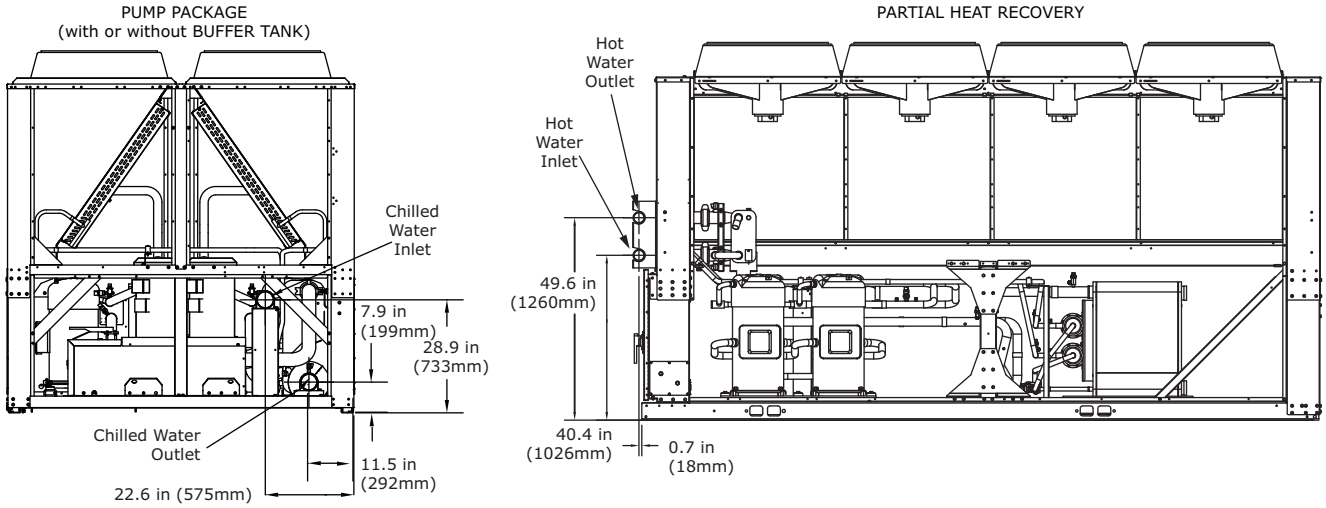
Partial heat recovery connections are even with unit end. The chilled water connections are the same as the standard unit unless pump packageor buffer tank are ordered.

Table 20. Water connection dimensions, 40 to 70 ton units with options

	A		B		C	
Unit Size (tons)	**in**	**mm**	**in**	**mm**	**in**	**mm**
40, 52	24.3	617	45.3	1149	54.8	1392
60, 70	24.2	615	45.6	1158	55.2	1401

Dimensions

Figure 14. Water connection dimensions, 80 to 130 ton units with options [a]



(a) See Table 21 for water connections distance from end/side of unit.

Table 21. Water connection dimensions, 80 to 130 ton units with options

	Pump Package[a]				Buffer Tank[a]				Partial Heat Recovery[b]			
	Inlet		Outlet		Inlet		Outlet		Inlet		Outlet	
Unit Size (tons)	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
80, 90T	5.9	151	5.9	151	6.2	158	6.2	158	1.1	28	1.1	28
100, 110, 120T	5.9	151	5.9	151	6	153	6	153	1.1	28	1.1	28
130T	6.3	159	25	635	5.9	150	27.7	703	1.1	28	1.1	28

(a) Distance from end of unit.
(b) Distance from side of unit.

Service Clearances

Figure 15. CGAM service clearances

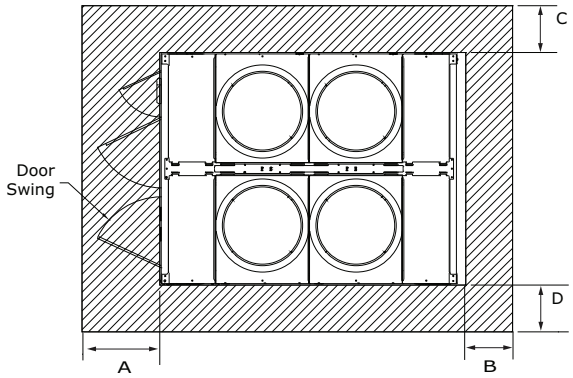


Table 22. CGAM service clearance dimensions

	A		B		C		D	
Unit Size	**in**	**mm**	**in**	**mm**	**in**	**mm**	**in**	**mm**
20 to 35 ton	47.2	1200	31.5	800	23.6	600	39.4	1000
40 to 70 ton	47.2	1200	31.5	800	39.4	1000	39.4	1000
80 to 130 ton	47.2	1200	39.4	1000	39.4	1000	39.4	1000

Notes:

- *Number of fans and panel doors shown does not represent the number of fans installed.*
- *More clearance may be needed for airflow, depending on installation.*

Mounting Locations

Important: *All mounting holes are 0.75 in (19mm) in diameter.*

Unit without Wind Load Rating

Note: *Mounting locations shown below are for units without wind load rating. For units with wind load rating (model number digit 17=D), additional mounting points are required. See "Units with Wind Load Rating," p. 51.*

Figure 16. Mounting locations, 20 to 35 ton

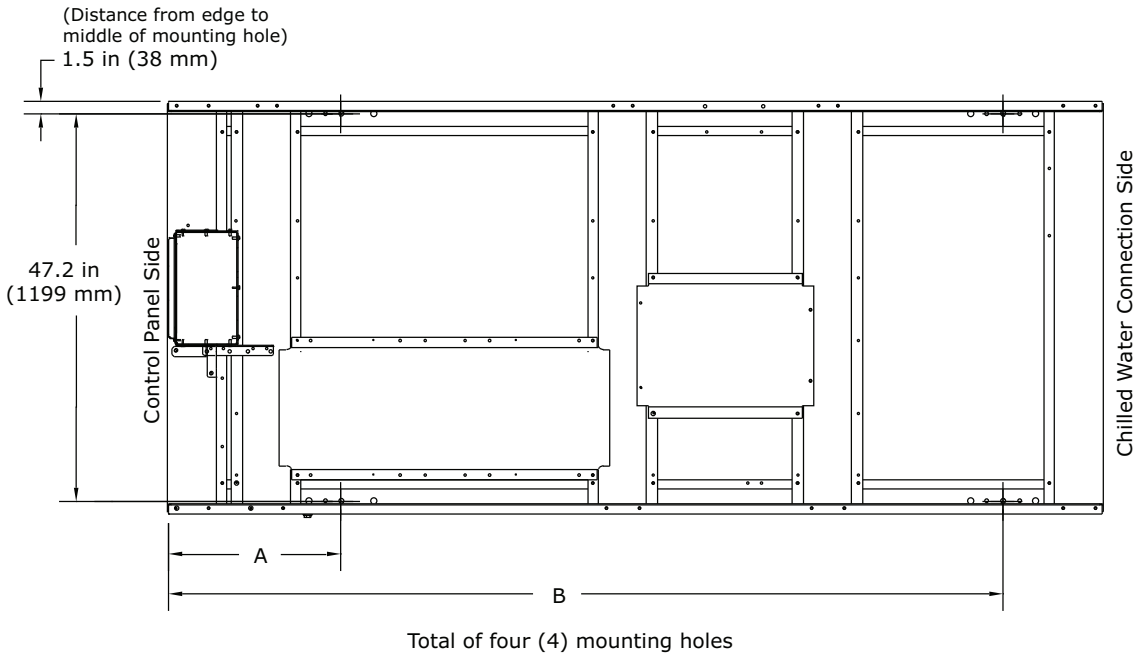


Table 23. Mounting locations, 20 to 35 ton units without wind load option

	A		B	
Unit Size (tons)	**in**	**mm**	**in**	**mm**
20, 26	21.0	533	101.2	2570
30, 35	21.9	556	132.2	3358

Figure 17. Mounting locations, 40 and 52 ton

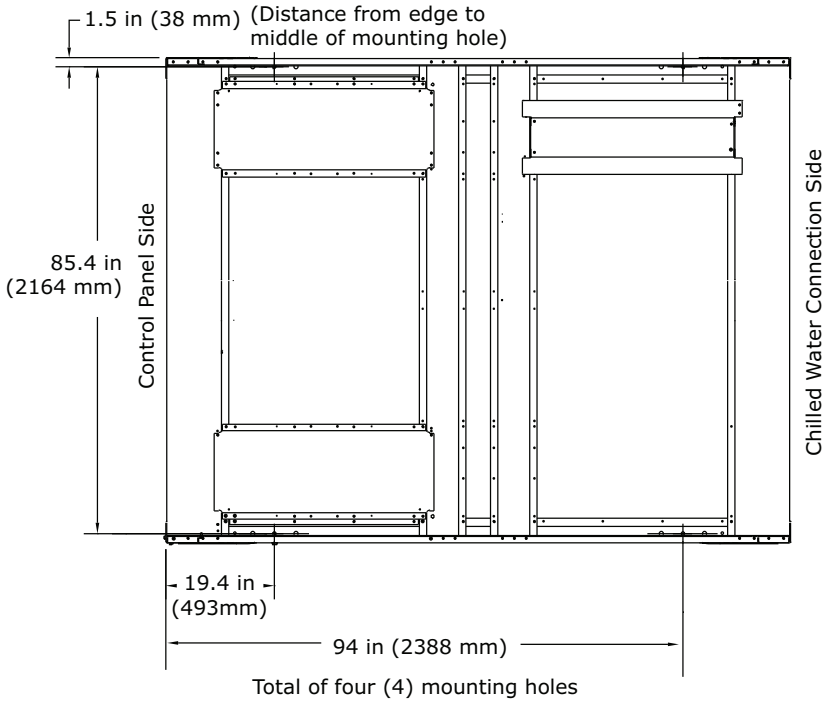


Figure 18. Mounting locations, 60 and 70 ton

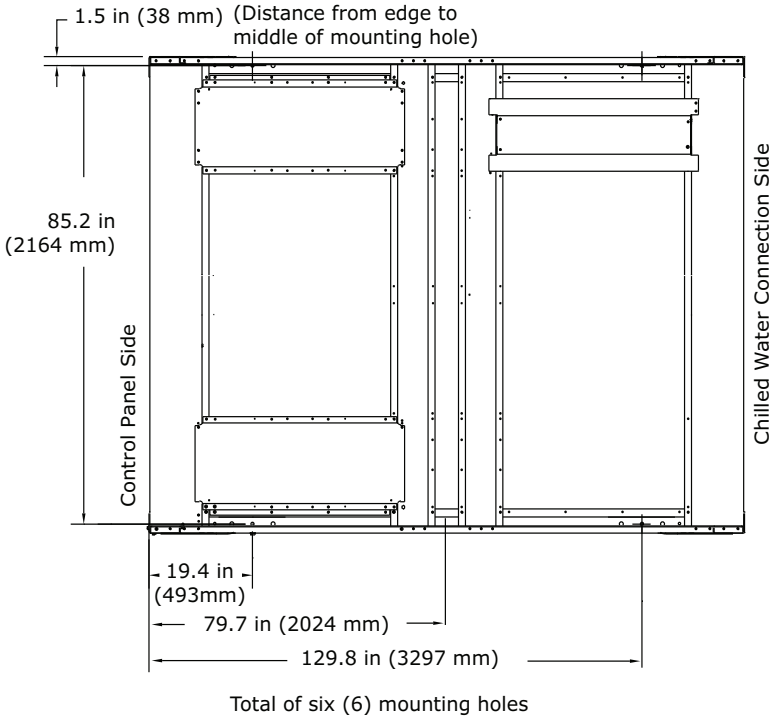


Figure 19. Mounting locations, 80 to 120 ton

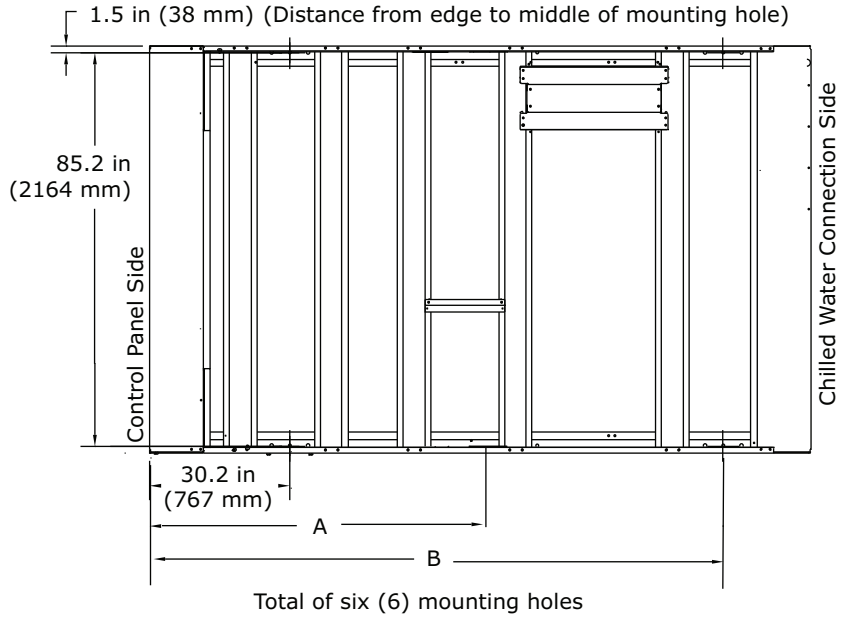
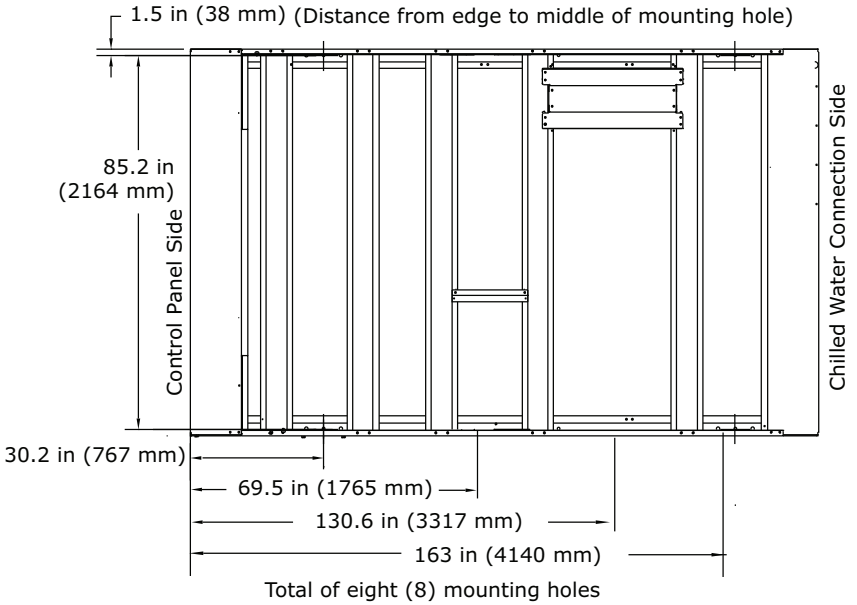


Table 24. Mounting locations, 80 to 120 ton units without wind load option

	A		B	
Unit Size (tons)	**in**	**mm**	**in**	**mm**
80, 90	83.7	2126	123.9	3147
100, 110, 120	89.2	2266	146.9	3731

Figure 20. Mounting locations, 130 ton



Units with Wind Load Rating

For units with wind load rating (model number digit 17 = D), additional mounting points are required as shown below. All mounting points in previous section remain the same.

Figure 21. Additional mounting locations for 40 and 52 ton units with wind load option

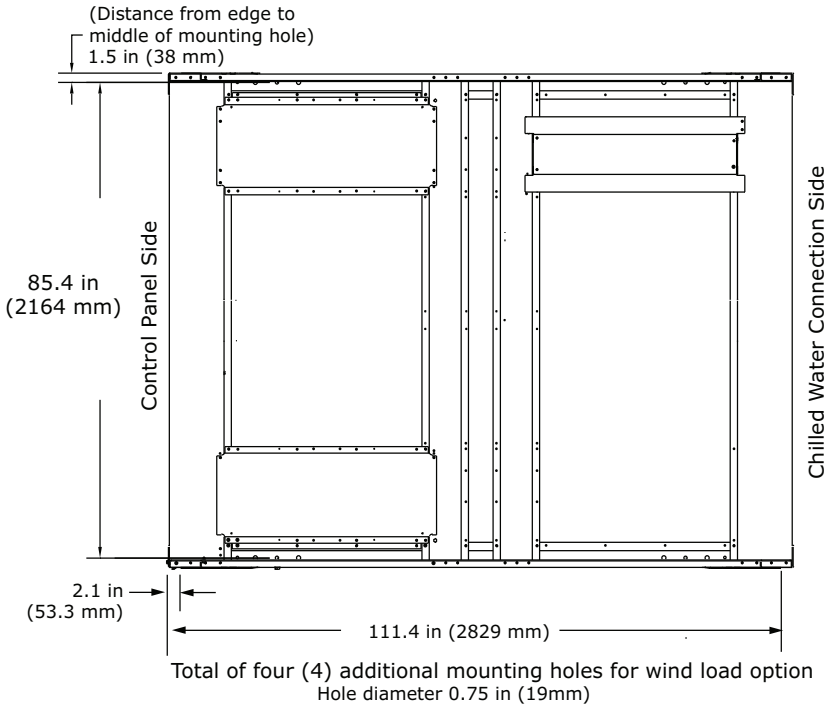


Figure 22. Additional mounting locations for 60 and 70 ton units with wind load option

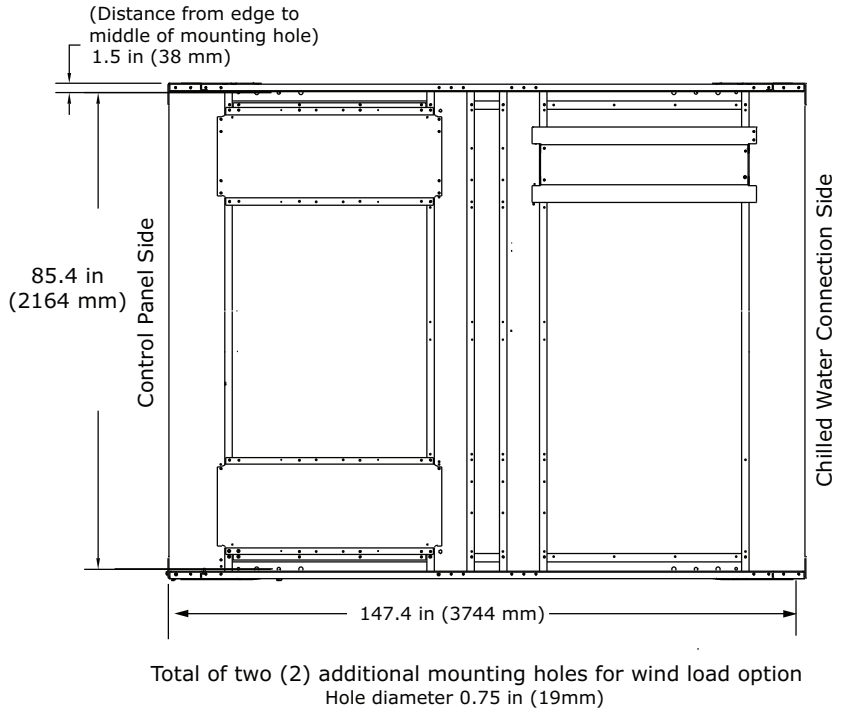
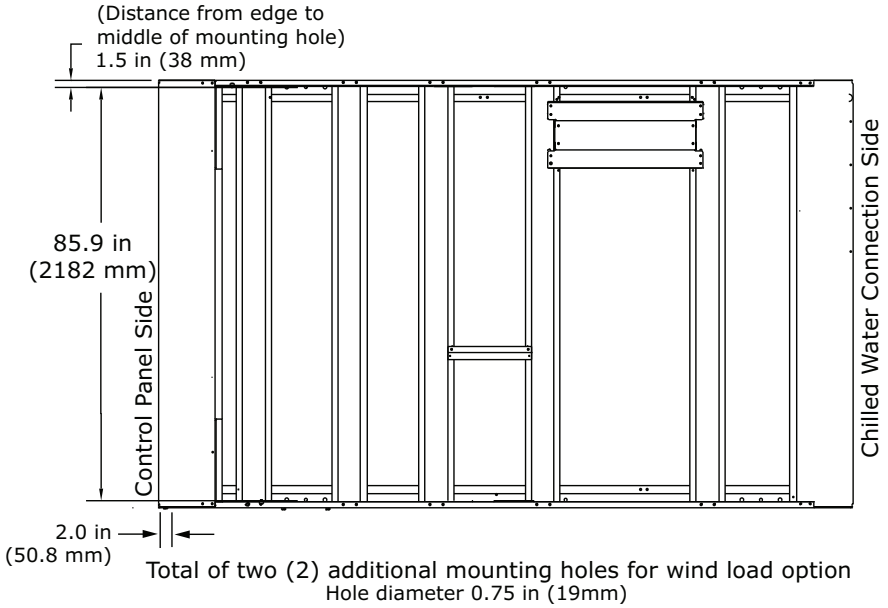


Figure 23. Additional mounting locations for 80 to 130 ton units with wind load option



Weights

Base Units

Round Tube and Plate Fin Condenser Coils

Notes:

- *Base unit weights include aluminum fins, refrigerant charge, elastomeric isolators, circuit breakers and louvers.*
- *For units with microchannel condenser coils, see "Microchannel Condenser Coils," p. 56.*
- *These weights do NOT include the following options: partial heat recovery, copper fins or seismic isolators. See "Option Weights," p. 58 for additional weight added by these option selections.*

Table 25. Base unit weights, 60 Hz, round tube and plate fin condenser — I-P (lb)

Unit Size (Tons)	Base Unit		Base Unit With Pump Package		Base Unit With Pump Package and Buffer Tank	
	Shipping	Operating	Shipping	Operating	Shipping	Operating
High Efficiency						
20	2185	2208	2726	2814	3252	4491
26	2249	2278	2790	2891	3317	4562
30	2846	2880	3388	3497	3915	5163
35	2878	2920	3420	3546	3947	5204
40	3666	3697	4285	4383	4876	6116
52	3761	3806	4379	4506	4971	6225
60	4978	5033	5814	5986	6406	7695
70	5045	5121	5881	6094	6473	7782
80	5607	5692	6486	6790	7077	8561
90	5859	5961	6738	7075	7329	8830
100	6646	6759	7549	7909	8265	10136
110	6724	6846	7627	8005	8343	10223
120	6762	6884	8018	8396	8733	10614
130	7753	7900	9006	9430	9722	11623
Extra Efficiency						
20	2258	2281	2798	2887	3325	4564
26	2322	2351	2863	2964	3389	4634
30	2945	2979	3487	3596	4014	5262
35	3023	3065	3565	3691	4092	5349
40	3812	3843	4431	4529	5022	6262
52	3959	4004	4578	4705	5169	6423
60	5177	5232	6013	6184	6604	7893
70	5118	5194	5954	6166	6545	7855
110	6724	6846	7627	8005	8343	10223
120	6762	6884	8018	8396	8733	10614

Note: All weights ±3%.

Table 26. Base unit weights, 60 Hz, round tube and plate fin condenser — SI (kg)

Unit Size (Tons)	Base Unit		Base Unit With Pump Package		Base Unit With Pump Package and Buffer Tank	
	Shipping	Operating	Shipping	Operating	Shipping	Operating
High Efficiency						
20	991	1002	1236	1277	1475	2037
26	1020	1034	1265	1311	1504	2069
30	1291	1306	1537	1586	1776	2342
35	1305	1325	1551	1608	1790	2360
40	1663	1677	1944	1988	2212	2774
52	1706	1726	1987	2044	2255	2824
60	2258	2283	2637	2715	2906	3490
70	2289	2323	2668	2764	2936	3530
80	2543	2582	2942	3080	3210	3883
90	2658	2704	3056	3209	3324	4005
100	3015	3066	3424	3587	3749	4598
110	3050	3105	3460	3631	3784	4637
120	3067	3122	3637	3808	3961	4814
130	3517	3583	4085	4277	4410	5272
Extra Efficiency						
20	1024	1035	1269	1310	1508	2070
26	1053	1066	1298	1344	1537	2102
30	1336	1351	1582	1631	1821	2387
35	1371	1390	1617	1674	1856	2426
40	1729	1743	2010	2054	2278	2840
52	1796	1816	2077	2134	2345	2914
60	2348	2373	2727	2805	2996	3580
70	2322	2356	2701	2797	2969	3563
110	3050	3105	3460	3631	3784	4637
120	3067	3122	3637	3808	3961	4814

Note: All weights ±3%.

Table 27. Base unit weights, 50 Hz, round tube and plate fin condenser

Unit Size (Tons)	I-P Units (lb)		SI Units (kg)	
	Shipping	Operating	Shipping	Operating
High Efficiency				
20	2187	2210	992	1002
26	2249	2278	1020	1034
30	2846	2880	1291	1306
35	2878	2920	1305	1325
40	3666	3697	1663	1677
52	3761	3806	1706	1726
60	4978	5033	2258	2283
70	5045	5121	2289	2323
80	5607	5692	2543	2582
90	5858	5960	2657	2703
100	6630	6743	3007	3059
110	6713	6835	3045	3100
120	6758	6880	3065	3121
Extra Efficiency				
20	2260	2283	1025	1035
26	2322	2351	1053	1066
30	2945	2979	1336	1351
35	3023	3065	1371	1390
40	3812	3843	1729	1743
52	3959	4004	1796	1816
60	5177	5232	2348	2373
70	5118	5194	2322	2356
110	6713	6835	3045	3100
120	6758	6880	3065	3121

Note: All weights ±3%.

Microchannel Condenser Coils

Notes:

- *Base unit weights include refrigerant charge, isolators, circuit breakers and louvers.*
- *For units with round tube and plate fin condensers, see "Round Tube and Plate Fin Condenser Coils," p. 53.*

Table 28. Base unit weights, 60 Hz, microchannel condenser — I-P (lb)

Unit Size (Tons)	Base Unit		Base Unit With Pump Package		Base Unit With Pump Package and Buffer Tank	
	Shipping	Operating	Shipping	Operating	Shipping	Operating
			High Efficiency			
20	1967	1975	2507	2582	3034	4259
26	2030	2046	2571	2659	3098	4329
30	2388	2403	2929	3021	3456	4686
35	2608	2630	3150	3256	3677	4914
40	3307	3314	3926	3999	4517	5732
52	3402	3422	4021	4122	4612	5840
60	4136	4156	4972	5108	5563	6817
70	4579	4616	5415	5589	6006	7278
80	4888	4899	5766	5996	6357	7768
90	5141	5163	6020	6277	6611	8032
100	5816	5838	6719	6988	7434	9215
110	5893	5924	6796	7083	7511	9301
120	5930	5966	7186	7477	7902	9696
130	6722	6757	7976	8287	8691	10480

Note: All weights ±3%.

Table 29. Base unit weights, 60 Hz, microchannel condenser — SI (kg)

Unit Size (Tons)	Base Unit		Base Unit With Pump Package		Base Unit With Pump Package and Buffer Tank	
	Shipping	Operating	Shipping	Operating	Shipping	Operating
			High Efficiency			
20	892	896	1137	1171	1376	1932
26	921	928	1166	1206	1405	1964
30	1083	1090	1329	1370	1568	2126
35	1183	1193	1429	1477	1668	2229
40	1500	1503	1781	1814	2049	2600
52	1543	1552	1824	1870	2092	2649
60	1876	1885	2255	2317	2523	3092
70	2077	2094	2456	2535	2724	3301
80	2217	2222	2616	2720	2884	3523
90	2332	2342	2731	2847	2999	3643
100	2638	2648	3048	3170	3372	4180
110	2673	2687	3083	3213	3407	4219
120	2690	2706	3260	3392	3584	4398
130	3049	3065	3618	3759	3942	4754

Note: All weights ±3%.

Table 30. Base unit weights, 50 Hz, microchannel condenser

Unit Size (Tons)	I-P (lb)		SI (kg)	
	Shipping	Operating	Shipping	Operating
		High Efficiency		
20	1967	1978	892	897
26	2030	2046	921	928
30	2388	2403	1083	1090
35	2608	2630	1183	1193
40	3307	3314	1500	1503
52	3402	3422	1543	1552
60	4136	4156	1876	1885
70	4579	4616	2077	2094
80	4888	4899	2217	2222
90	5139	5163	2331	2342
100	5798	5822	2630	2641
110	5882	5913	2668	2682
120	5926	5961	2688	2704

Note: All weights ±3%.

Option Weights

Note: *Weights listed below are in addition to base unit weights found in previous section. For total unit weight, add option weights to base unit weight found in "Round Tube and Plate Fin Condenser Coils," p. 53.*

Table 31. Option weights, 60 Hz, round tube and plate fin condenser

Unit Size (tons)	I-P Units (lb)				SI Units (kg)			
	Partial Heat Recovery		Copper Fins	Seismic Isolator	Partial Heat Recovery		Copper Fins	Seismic Isolator
	Shipping	Operating			Shipping	Operating		
High Efficiency								
20	39	63	258	160	18	28	117	73
26	39	70	258	160	18	32	117	73
30	47	82	359	160	21	37	163	73
35	47	91	359	160	21	41	163	73
40	94	128	516	160	43	58	234	73
52	94	143	516	160	43	65	234	73
60	111	170	719	240	50	77	326	109
70	111	191	719	240	50	87	326	109
80	170	260	1270	240	77	118	576	109
90	170	279	1270	240	77	126	576	109
100	178	298	1512	240	81	135	686	109
110	178	307	1512	240	81	139	686	109
120	178	310	1512	240	81	140	686	109
130	178	335	1889	320	81	152	857	145
Extra Efficiency								
20	39	63	258	-	18	28	117	-
26	39	70	258	-	18	32	117	-
30	47	82	360	-	21	37	163	-
35	47	91	360	-	21	41	163	-
40	94	128	516	-	43	58	234	-
52	94	143	516	-	43	65	234	-
60	111	170	720	-	50	77	326	-
70	111	191	720	-	50	87	326	-
110	178	307	1512	-	81	139	686	-
120	178	310	1512	-	81	140	686	-

Note: All weights ±3%.

Table 32. Option weights, 50 Hz, round tube and plate fin condenser

Unit Size (tons)	I-P Units (lb)				SI Units (kg)			
	Partial Heat Recovery		Copper Fins	Seismic Isolator	Partial Heat Recovery		Copper Fins	Seismic Isolator
	Shipping	Operating			Shipping	Operating		
High Efficiency								
20	40	24	258	160	18	11	117	73
26	40	31	258	160	18	14	117	73
30	46	35	359	160	21	16	163	73
35	46	44	359	160	21	20	163	73
40	95	33	516	160	43	15	234	73
52	95	49	516	160	43	20	234	73
60	110	60	719	240	50	27	326	109
70	110	79	719	240	50	36	326	109
80	170	90	1270	240	77	41	576	109
90	170	108	1270	240	77	49	576	109
100	179	119	1512	240	81	54	686	109
110	179	130	1512	240	81	59	686	109
120	179	130	1512	240	81	59	686	109
Extra Efficiency								
20	40	24	258	-	18	11	117	-
26	40	31	258	-	18	14	117	-
30	46	35	359	-	21	16	163	-
35	46	44	359	-	21	20	163	-
40	95	33	516	-	43	15	234	-
52	95	49	516	-	43	22	234	-
60	110	60	719	-	50	27	326	-
70	110	79	719	-	50	36	326	-
110	179	130	1512	-	81	59	686	-
120	179	130	1512	-	81	59	686	-

Note: All weights ±3%.

Mechanical Specifications

General

Units are constructed of galvanized steel frame with galvanized steel panels and access doors. Component surfaces are finished with a powder-coated paint. Each unit ships with full operating charges of refrigerant and oil.

Certified AHRI Performance

Trane air-cooled chillers are rated within the scope of the Air-Conditioning, Heating & Refrigeration Institute (AHRI) Certification Program and display the AHRI Certified® mark as a visual confirmation of conformance to the certification sections of AHRI Standard 550/590 (I-P) and ANSI/AHRI Standard 551/591 (SI). The applications in this catalog specifically excluded from the AHRI certification program are:

- Custom Units
- Units produced outside of the USA for installations outside the USA
- Evaporatively-cooled chillers
- Units with evaporators that use fluid other than fresh water except units containing freeze protection fluids in the condenser or in the evaporator with a leaving chilled fluid temperature above 32°F [0°C] are certified when rated per the Standard with water.

Compressor and Motor

The unit is equipped with two or more hermetic, direct-drive, 3600 rpm 60 Hz (3000 rpm 50 Hz) suction gas-cooled scroll compressors. The simple design has only three major moving parts and a completely enclosed compression chamber which leads to increased efficiency. Overload protection is included. The compressor includes: centrifugal oil pump, oil level sight glass and oil charging valve. Each compressor will have compressor heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

Unit-Mounted Starter

The control panel is designed per UL 1995. The starter is an across-the-line configuration, factory-mounted and fully pre-wired to the compressor motor and control panel. A factory-installed, factory-wired 820 VA control power transformer provides all unit control power (120 Vac secondary) and Trane CH530 module power (24 Vac secondary). Power line connection type is standard with a terminal block.

Evaporator

Braze plate heat exchanger is made of stainless steel with copper as the braze material. It is designed to withstand a refrigerant side working pressure of 430 psig (29.6 bars) and a waterside working pressure of 150 psig (10.5 bars). Evaporator is tested at 1.1 times maximum allowable refrigerant side working pressure and 1.5 times maximum allowable water side working pressure. It has one water pass. Immersion heaters protect the evaporator to an ambient of -20°F (-29°C).

The evaporator is covered with factory-installed 0.75 inch (19.05 mm) Armaflex II or equal (k=0.28) insulation. Foam insulation is used on the suction line. Water pipe extensions with insulation go from the evaporator to the edge of the unit.

Condenser

Air-cooled microchannel condenser coils use all aluminum brazed fin construction. Each slab is split horizontally into separate condensing and subcooling coils that are connected by either a

copper tube or receiver tank. The maximum allowable working pressure of the condenser is 650 psig (44.8 bars). Condensers are factory proof and leak tested at 715 psig (49.3 bars). Coils can be cleaned with high pressure water.

Optional round tube and plate fin air-cooled condenser coils have aluminum fins mechanically bonded to internally-finned copper tubing. The condenser coil has an integral subcooling circuit. The maximum allowable working pressure of the condenser is 650 psig (44.8 bars). Condensers are factory proof and leak tested at 715 psig (49.3 bars).

Direct-drive vertical discharge condenser fans are balanced. Three-phase condenser fan motors with permanently lubricated ball bearings and external thermal overload protection are provided.

Units start and operate from 0°F to 125°F (-18°C to 52°C) for wide ambient. Wide ambient allows operation down to 0°F which is accomplished by a variable speed fan on each circuit that modulates to maintain system differential pressure.

Refrigerant Circuit and Capacity Modulation

The 20-35 ton units have single refrigerant circuits. The 40-130 ton units have dual refrigerant circuits. Each refrigerant circuit has Trane scroll compressors piped in parallel with a passive oil management system. A passive oil management system maintains proper oil levels within compressors and has no moving parts. Each refrigerant circuit includes filter drier, electronic expansion valve, and liquid line and discharge service valves.

Capacity modulation is achieved by turning compressors on and off. The 20-35 ton units have two capacity stages. The 40-120 ton units have four capacity stages. The 130 ton unit has six capacity stages.

Unit Controls (Trane CH530)

The microprocessor-based control panel is factory-installed and factory-tested. The control system is powered by a pre-wired control power transformer, and will turn on and off compressors to meet the load. Microprocessor-based chilled water reset based on return water is standard.

The Trane CH530 microprocessor automatically acts to prevent unit shutdown due to abnormal operating conditions associated with low evaporator refrigerant temperature and high condensing temperature. If an abnormal operating condition continues and the protective limit is reached, the machine will shut down.

The panel includes machine protection for the following conditions:

- Low evaporator refrigerant temperature and pressure
- High condenser refrigerant pressure
- Critical sensor or detection circuit faults
- High compressor discharge temperature (with low temp evaporator)
- Lost communication between modules
- Electrical distribution faults: phase loss, phase reversal or over temperature protection
- External and local emergency stop
- Loss of evaporator water flow

When a fault is detected, the control system conducts more than 100 diagnostic checks and displays results. The display will identify the fault, indicate date, time, and operating mode at time of occurrence, and provide type of reset required and a help message.

Clear Language Display Panel

Factory-mounted to the control panel door, the operator interface has an LCD touch-screen display for operator input and information output. This interface provides access to the following information: evaporator report, condenser report, compressor report, ASHRAE Guideline 3 report, operator settings, service settings, service tests, and diagnostics. All diagnostics and messages are displayed in "clear language."

Data contained in available reports includes:

- Water and air temperatures
- Refrigerant pressures and temperatures
- Flow switch status
- EXV position
- Compressor starts and run-time

All necessary settings and setpoints are programmed into the microprocessor-based controller via the operator interface. The controller is capable of receiving signals simultaneously from a variety of control sources, in any combination, and priority order of control sources can be programmed. The control source with priority determines active setpoints via the signal it sends to the control panel. Control sources may be:

- Local operator interface (standard)
- Hard-wired 4-20 mA or 2-10 Vdc signal from an external source (interface optional; control source not supplied)
- Time of day scheduling (optional capability available from local operator interface)
- LonTalk® LCI-C (interface optional; control source not supplied)
- BACNet® (interface optional; control source not supplied)
- Trane Tracer® Summit system (interface optional; control source not supplied)

Quality Assurance

The quality management system applied by Trane has been subject to independent third-party assessment and approval to ISO 9001-2008. The products described in this catalog are designed, manufactured and tested in accordance with the approved system requirements described in the Trane Quality Manual.

Options

Application Options

Ice-Making with Hardwired Interface

Unit controls are factory set to handle ice-making for thermal storage application. An additional temperature sensor, at the compressor discharge, enables full load operation of the chiller with entering evaporator fluid temperature between 20°F (-7°C) and 65°F (18°C) with glycol.

High Ambient

The unit starts and operates from 32°F to 125°F (0°C to 52°C).

Low-Temperature Processing

An additional temperature sensor, at the compressor discharge, enables leaving evaporator fluid temperature between 10°F (-12.2°C) and 42°F (5.5°C) with glycol.

Leaving evaporator fluid temperatures below 10°F (-12.2°C) are also possible for specific applications.

Partial Heat Recovery with Fan Control

A supplemental brazed plate heat exchanger is mounted in series to the condenser coil. Connecting piping and inlet and outlet water sensors are included. CH530 controls display heat recovery inlet and outlet water temperatures and controls the fans. The heat rejection to the partial heat recovery heat exchanger is not controlled. Flow and temperature variations through the partial heat recovery heat exchanger will vary. The partial heat recovery heat exchanger is typically used to preheat water before it enters a boiler or other water heating process.

Dual High Head Pump Package

Pump package includes: two high head pumps, VFD, expansion vessels, drainage valves, shut-off valves at entering and leaving connections.

The pump package is single point power integrated into the chiller unit power with a separate factory wired control panel. The control of the pump is integrated into the chiller controller. The CH530 displays evaporator pump starts and run-times. Freeze protection down to an ambient of -20°F (-29°C) is included as standard. The cold parts of the pump package will also be insulated.

Designed with one redundant pump, the chiller controls both pumps through a lead/lag and failure/recovery functionality.

A variable speed drive is installed in an additional panel to control the pump. The inverter is adjusted upon start up to balance the system flow and head requirements. The purpose is to save on wasted pump energy caused by a traditional balancing valve.

Buffer Tank (only available with pump package)

The water tank is factory-installed for easy installation at the building site. The tank is engineered for continuous flow and is fully insulated as standard and is designed with freeze protection down to -20°F (-29°C). The purpose of the tank is to increase the chilled water circuit inertia, which is necessary with short water loops. A high circuit inertia reduces the compressor's cycling to increase the compressor life span and allow for more precise water temperature accuracy. It also saves energy as compared to hot gas bypass.

Electrical Options

Circuit Breaker

A molded case standard interrupting capacity circuit breaker, factory pre-wired with terminal block power connections and equipped with a lockable external operator handle, is available to disconnect the chiller from main power.

Circuit Breaker with High Fault Rated Control Panel

A molded case high interrupting capacity circuit breaker, factory pre-wired with terminal block power connections and equipped with a lockable external operator handle, is available to disconnect the chiller from main power.

Short Circuit Rating

Short circuit rating of 5 kA or up to 65 kA is available.

Control Options

BACNet Interface

Allows user to easily interface with BACNet® via a single twisted-pair wiring to a factory-installed and tested communication board.

LonTalk/Tracer Summit Interface

LonTalk® (LCI-C) or Tracer® Summit communications capabilities are available with communication link via single twisted-pair wiring to factory-installed and tested communication board. This option will support the functionality required to obtain LONMARK® certification.

Time of Day Scheduling

Time of day scheduling capabilities are available for scheduling single chiller applications through Trane CH530 panel (without the need for building automation system - BAS). This feature allows the user to set up to ten events in a seven day time period.

External Chilled Water and Demand Limit Setpoint

Controls, sensors, and safeties allow reset of chilled water temperature, based on temperature signal, during periods of low outdoor air temperature (chilled water reset based on return chilled water temperature is standard). The demand limit setpoint is communicated to a factory-installed and tested communication board through a 2-10 Vdc or 4-20 mA signal.

Percent Capacity

Output the number of compressors that are operating as an analog 2-10 Vdc or 4-20 mA signal.

Programmable Relays

Predefined, factory-installed, programmable relays allow the operation to select four relay outputs. Available outputs are: Alarm-Latching, Alarm-Auto Reset, General Alarm, Warning, Chiller Limit Mode, Compressor Running, and Tracer Control.

Other Options

Architectural Louvered Panels

Louvered panels cover the complete condensing coil and service area beneath the condenser.

Half Louvers

Louvered panels cover the condenser coil only. Available on the 80-130 ton units only.

Comprehensive Acoustic Package

This option includes acoustical treatment for compressor.

Condenser Coil - CompleteCoat

Condenser coils are made of aluminum fins (plate fins) mechanically bonded to internally finned copper tubes. The condenser box is then submerged in an epoxy polymer bath where an electrostatic charge is used to uniformly deposit the epoxy onto the coil. This option resists bi-metallic corrosion and allows for operation in coastal environments.

Condenser Coil - Copper

Condenser coils are made of non-slit copper fins (plate fins) mechanically bonded to internally finned copper tubes. Copper fins and copper tubes reduce material deterioration due to galvanic corrosion.

Condenser Coil - Microchannel

Microchannel condensing coils are all-aluminum coils with fully-brazed construction. This design reduces risk of leaks and provides increased coil rigidity — making them more rugged on the jobsite.

Microchannel all-aluminum construction provides several additional benefits:

- Light weight (simplifies coil handling)
- Easy to recycle
- Minimize galvanic corrosion

Their flat streamlined tubes with small ports and metallurgical tube-to-fin bond allow for exceptional heat transfer.

Bottom line, less refrigerant is being used, which creates a healthier and greener environment.

Isolators

Molded elastomeric isolators sized to reduce vibration transmission to the supporting structure when the unit is installed. Isolators ship with the chiller.

Isolators - Seismically Rated

Spring isolators are designed and tested to control the motion of the chiller during a seismic event.

Insulation for High Humidity

The evaporator is covered with factory-installed 1.25 inch (31.8 mm) Armaflex II or equal (k=0.28) insulation. Foam insulation is used on the suction line.

Nitrogen Charge

Unit is shipped with oil and a nitrogen charge in lieu of refrigerant.

Performance Test

Performance tests are available to certify chiller performance before shipment.

Rapid Restart Test

After completion of a standard full load witness test, power to the chiller will be cut and then reapplied to demonstrate the chiller's rapid restart capabilities for disaster relief.

Seismically Rated Unit — IBC

Unit is built and certified for seismic applications in accordance with the following International Building Code (IBC) releases 2000, 2003, 2006 and 2009.

Seismically Rated Unit — OSHPD

Unit is built and certified for seismic applications in accordance with California Office of Statewide Health Planning and Development (OSHPD).

Wind Load for Florida Hurricane

Unit is built and certified to meet the requirements of the 2014 Florida Building Code and ASCE 7-10 for 186 mph wind speed, Exposure 'C', Risk Category III. Available for non-rooftop mounted units only.

Ingersoll Rand (NYSE:IR) advances the quality of life by creating comfortable, sustainable and efficient environments. Our people and our family of brands—including Club Car®, Ingersoll Rand®, Thermo King® and Trane®—work together to enhance the quality and comfort of air in homes and buildings; transport and protect food and perishables; and increase industrial productivity and efficiency. We are a global business committed to a world of sustainable progress and enduring results.

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Ingersoll Rand has a policy of continuous product and product data improvement and reserves the right to change design and specifications without notice.
We are committed to using environmentally conscious print practices.

CG-PRC017N-EN 06 Jul 2017
Supersedes CG-PRC017M-EN (21 Feb 2017)

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E-SAVER OPAL-R™ Series

E-SAVER OPAL-R TRANSFORMERS ARE OPTIMIZED FOR RETROFIT PROJECTS DELIVERING AN 80% AVERAGE REDUCTION IN LOSSES WHEN REPLACING OLDER UNITS

APPLICATION

E-SAVER OPAL 80R and 81R, are ultra-efficient dry-type transformer models optimized to maximize energy savings and provide the fastest payback in retrofit applications

Powersmiths has actively measured load profiles and losses for thousands of low-voltage transformers it has retrofitted for applications from K-12 schools to college and hospital campuses, from courthouses to military bases, from general commercial and office buildings to mission critical data centers.

Powersmiths has found that the most common profile is a lightly loaded transformer that feeds predominately electronic equipment.

The 80R and 81R have been optimized specifically for this profile delivering a per project average of an 80% reduction in losses when replacing existing older transformers.

For transformers optimized to feed dedicated equipment like fans, motors, elevators, or heavy harmonic rich loads, see the rest of the OPAL Series™ as well as OPAL T1000™.

OPAL™ - OPTIMIZED DESIGNS FOR RETROFITS

There is more to a transformer retrofit than simply matching the kVA and voltages with a typical transformer from the distributor's warehouse. A transformer has much more impact in an electrical system than just efficiency because of electrical characteristics that affect fault levels, arc flash levels and inrush. Other important considerations for a retrofit should also include site conditions, footprint and internal terminal layout.

Powersmiths has developed a transformer design best practice called OPAL - Optimized Performance for the Application Load to specifically address transformer retrofit considerations.

OPAL considers the system as a whole, including goals like managing impedance, arc flash, fault level, inrush, harmonics, and more. OPAL is possible thanks to the tight feedback loop between design, onsite manufacturing, and extensive real world performance verification.

Our flexible design and manufacturing process enables us to deliver solutions for the wide variety of site conditions and transformer manufacturers including footprint and internal terminal layouts, while the result is the most savings per dollar spent.

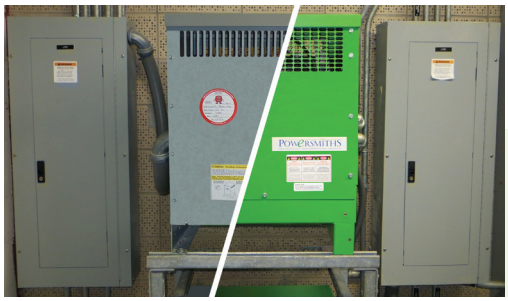
DOE IDENTIFIES BILLIONS IN SAVINGS BEYOND DOE 2016

Most manufacturers design low-voltage transformers to just meet the minimum requirement of U.S. Dept. of Energy law (DOE 2016). DOE 2016 has been set at a single 35% load point, under an ideal sine wave factory test profile, sacrificing performance elsewhere.

By exceeding the minimum efficiency, the DOE has quantified the savings potential to be in billions of dollars and that lifecycle savings can be maximized by optimizing for real-world loading. OPAL enables access to these savings – backed by real-world performance verification.

DEPARTMENT OF DEFENCE UFC COMPLIANCE

The OPAL-R with the T115 option complies with the US Department of Defense's Unified Facilities Criteria (UFC) - Interior Electrical Systems.



E-Saver OPAL-R™ Retrofits deliver maximum energy savings and follow best practices to measure & verify lifecycle savings, and ensure hassle-free transformer replacements.

RETROFITS REQUIRE A BEST PRACTICE

To replace existing transformers cost effectively, Powersmiths' professional engineers use a multi-step best practice for the entire project cycle including: vetted project savings calculations, comprehensive site audits and tagging, individualized product selection, baseline and post installation field measurements of load profiles, losses and efficiency, following IPMVP protocols, performance reports and more.

GUARANTEED PERFORMANCE FOR 32 YEARS

In a world filled with small print disclaimers and limited DOE compliance testing, you can count on Powersmiths performance. We guarantee that every transformer we manufacture meets our published technical data, and furthermore, that this performance is met over the full term of the 32-year pro-rated warranty. Trusting that savings are both real and long-term is part of why organizations choose Powersmiths.

K-RATING IS A MODERN REQUIREMENT

Typically, transformers are purchased and installed with lowest first cost in mind, however, these transformers' are UL listed on the basis of feeding only linear load. Today, most connected loads are electronic with nonlinear profiles, and in order to have a valid UL listing, a low-voltage transformer needs to be appropriately K-rated for most applications

EXPANDED KVA SELECTION ENABLES RIGHT-SIZING

Powersmiths enables right-sizing of electrical infrastructure by offering a much broader selection of transformer kVA sizes. The capital cost, operating cost and footprint reductions can be dramatic - on the order of 30-50%, through smaller transformers, breakers, conductors, and distribution panels.

ENVIRONMENTAL/GREEN BUILDING/LEED®/NET ZERO

By going meaningfully beyond the DOE 2016 baseline efficiency, the E-Saver™ contributes to green building, LEED®, Net Zero and carbon footprint reduction. goals. Additional benefits include our ISO14001 certified manufacturing, integrated metering and ability to integrate with the Powersmiths WOW™ - Building Resource Management Platform.

CERTIFICATIONS & TESTING

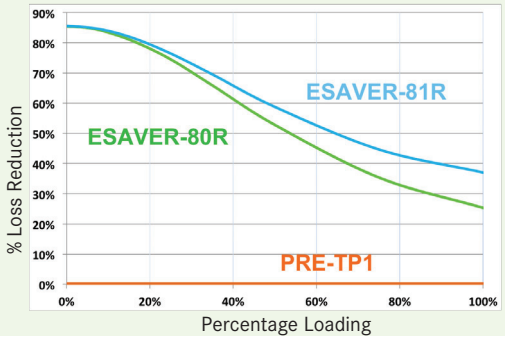
Powersmiths certifications include ISO9001 (Quality), ISO14001 (Environment) ISO17025 (Efficiency Test Lab), UL and CSA. Powersmiths has a production-integrated nonlinear load test program that enables efficiency verification under real-world conditions, as well as Certified Test Lab Profile Test Reports.

METERING & ARC FLASH OPTIONS

Integrated metering can provide information about capacity utilization, load profiles, power quality and energy use. The lockable hinged door option as well as our patented 360º Rotatable IR Port™ option enable quick and safe access to internal transformer connections, and reduces arc flash risk.

Powersmiths offers also transformers with Integrated Power Distribution, see the Energy Station TX™ brochure.

E-SAVER OPAL-R™ Loss Reduction Curves



KEY FEATURES

- Optimized for light, nonlinear loads found in most applications K-rated as required by UL to feed modern electronic equipment
- Retrofit Best Practice ensures a smooth retrofit with verified savings
- Significant savings beyond DOE 2016 legislation
- Electrical system consideration: impedance, inrush, fault & arc flash levels
- Available with a wide range of safety & performance features like integrated hinged doors, 360º Rotatable IR Port™, and Cyberhawk™ Metering and Logging
- Manufactured in a certified ISO 9001, ISO 14001 and ISO 17025 facility for quality, low environmental impact, and transformer efficiency testing

[1] U.S. Dept. of Energy 10 CFR Part 431, [Docket No. EERE–2010–BT–STD–0048] Energy Conservation Program: Energy Conservation Standards for Distribution Transformers, Final Rule April 18, 2013.

TECHNICAL SPECIFICATIONS

The E-Saver™-80R and 81R are ultra-efficient low-voltage dry-type transformers that meaningfully exceed the U.S. Dept. of Energy's new minimum efficiency law, commonly referred to as DOE 2016. All E-Saver transformers carry a UL Listing and CSA Approval, with application appropriate K-factor.

The aluminum wound E-Saver-80R and the copper wound E-Saver-81R are both K-factor listed per UL 1561 and are K-7 rated per C57.110. Both models are compatible with electronic equipment all the way up to full load. The standard temperature rise is 130°C with a 115°C option available.

E-Savers have a common-core (3-phase models), 10kV BIL, 200% rated neutral, are 60Hz rated (std), built to NEMA ST-20, UL1561, IEEE C57.110 and other applicable ANSI and IEEE standards. Both primary and secondary terminals and voltage taps (typically six 2.5%) are all front-accessible. E-Savers have a 220°C class insulation system that is NOMEX-based with an Epoxy Co-polymer impregnant with technical performance characteristics that embed lower environmental impact, long term reliability and long life expectancy. E-Savers carry OSHPD and IBC Seismic Certification. The seismic bracing option provides a higher 2.28g certification. All E-Saver models come standard in a Type 2 ventilated drip-proof indoor enclosure made of heavy gauge steel finished with epoxy powder coating for durability and low environmental impact, and are UL Listed for 2" rear clearance - a significant improvement over the typical industry 6" limit. A wide variety of enclosures and options are available.

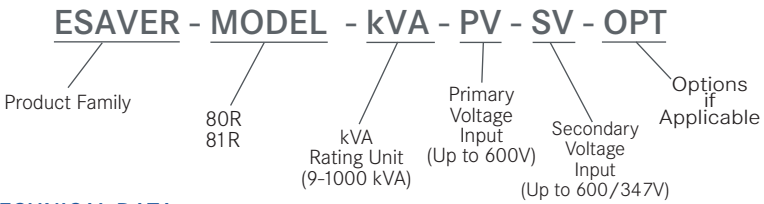
Low Noise: Keeping audible noise at a minimum is key. While the NEMA ST-20 standard sets levels referenced by industry only a type test, not a production test, is required – so transformers on actual projects may be noisy. Powersmiths builds 3dB quieter than NEMA standard values, and furthermore every unit is tested to ensure quiet operation. For very sensitive environments an additional 2dB lower noise option is available.

Management of Impedance, Inrush, Fault Level, Arc Flash: Powersmiths OPAL™ design best practice includes addressing key transformer attributes like impedance, inrush, fault level, arc flash, to ensure smooth integration into an electrical system, avoiding the negative impacts often associated with high efficiency transformers. See individual technical data sheets for comprehensive values for all parameters.

Impedance: For both the E-Saver-80R and E-Saver-81R, impedance is kept at or above 4.0% in order to manage downstream fault current and arc flash levels, and maintain compatibility with equipment interrupting capacity (kAIC) ratings. Higher impedance is available to meet specific project needs.

Inrush: Inrush currents are managed in order to avoid nuisance tripping of the primary breaker and to enable design engineers to use standard 125% rated primary protection, thereby avoiding expensive design changes that otherwise may be needed. Very low inrush designs are available as specific projects may require, for example some datacenter and medical applications.

ORDERING INFORMATION



TECHNICAL DATA

kVA	Audible Noise	80R, 81R Model Weight Range (lbs)	Standard Case Size (in)	Alternate Smaller Case Size (in)
15	42 dB	230-300	17.5W x 17D x 27.5H	17.5W x 14.5D x 25H
20	42 dB	260-340	25.5W x 18D x 30H	23W x 15.5D x 27.5H
25	42 dB	300-380	25.5W x 18D x 30H	23W x 15.5D x 27.5H
30	42 dB	340-420	25.5W x 18D x 30H	23W x 15.5D x 27.5H
45	42 dB	400-540	25.5W x 18D x 30H	25.5W x 16D x 29H
50	42 dB	450-600	25.5W x 18D x 30H	No Alternate
63	47 dB	500-650	31.5W x 21.5D x 40H	26.5H x 20D x 33H
75	47 dB	610-700	31.5W x 21.5D x 40H	26.5H x 20D x 33H
100	47 dB	675-900	31.5W x 21.5D x 40H	30.5H x 20D x 35H
112	47 dB	770-990	31.5W x 21.5D x 40H	30.5H x 20D x 35H
125	47 dB	875-1120	37.5W x 26.5D x 48H	33W x 23D x 38H
150	47 dB	1010-1230	37.5W x 26.5D x 48H	33W x 23D x 38H
175	52 dB	1100-1360	37.5W x 26.5D x 48H	34.5W x 26.5D x 42H
200	52 dB	1175-1450	37.5W x 26.5D x 48H	34.5W x 26.5D x 42H
225	52 dB	1295-1600	37.5W x 31.5D x 52H	34.5W x 26.5D x 42H
250	52 dB	1400-1800	37.5W x 31.5D x 52H	37.5W x 26.5D x 48H
300	52 dB	1575-1960	37.5W x 31.5D x 52H	37.5W x 26.5D x 48H
400	57 dB	2025-2450	51.5W x 38D x 61H	43.5W x 33.5D x 55.5H
450	57 dB	2200-2600	51.5W x 38D x 61H	43.5W x 33.5D x 55.5H
500	57 dB	2475-2900	51.5W x 38D x 61H	43.5W x 33.5D x 55.5H
600	59 dB	2725-3600	64W x 47D x 67H	51.5W x 38D x 61H
750	61 dB	3200-4300	64W x 47D x 67H	Contact Factory
850	61 dB	3600-5000	64W x 53D x 67H	Contact Factory
1000	61 dB	4200-6000	64W x 53D x 67H	Contact Factory

AVAILABLE OPTIONS

Metering: Express Logger™, SMART™ or Cyberhawk TX™ (see product cut sheets for details)
CC: Core & Coils available for OEM Integration
3R: Type 3R, sprinkler proof/outdoor ventilated enclosure
OSEC: Enclosure for outdoor public areas
SS: Painted stainless steel enclosure
NVI: Non-ventilated indoor enclosure
IRP: 360° Rotatable IR Port™
HD: Hinged Door
F50: 50 Hz design
1S: Single electrostatic shield
2S: Dual electrostatic shields
3S: Triple electrostatic shields
SPD: (120/208 V OR 277/480V)
- **PRO80:** 80kA, 7 mode, Filter
- **PRO120:** 120kA, 7 mode, Filter
- **PRO160:** 160kA, 7 mode, Filter
- **PROXX:** Where XX is custom ID

VLI: Very Low Inrush
IMP: Custom Impedance
COL: Custom color
TS: Thermal sensors at 170°C and 200°C
RTR: Routine Test Report
NLT: Nonlinear Load Test with Certificate
2016TR: DOE 2016 Test Report
CTL: ISO 17025 Certified Test Lab, load profile test
SE: Sensitive environment, extra low noise
SB: Certified Seismic bracing for 2.28g (for Certificate details contact Powersmiths)
WM: Wall-mount kit up to 75kVA is available (sold separately)
T115: 115°C Temperature Rise

NOTE: The above data applies to the standard configuration of each kVA. Selection of some options may change enclosure size and/or transformer weight. Some options may be mutually exclusive. Consult factory for detailed product data sheet for these and other configurations. Efficiencies tested according to U.S. Dept. of Energy's 10 CFR Part 431, a linear load test at 35% of nameplate capacity. Refer to technical data sheet for comprehensive information for each specific model, kVA, and option selected.

As design optimization is continuous, technical data is updated over time. Please check with Powersmiths for latest revision.

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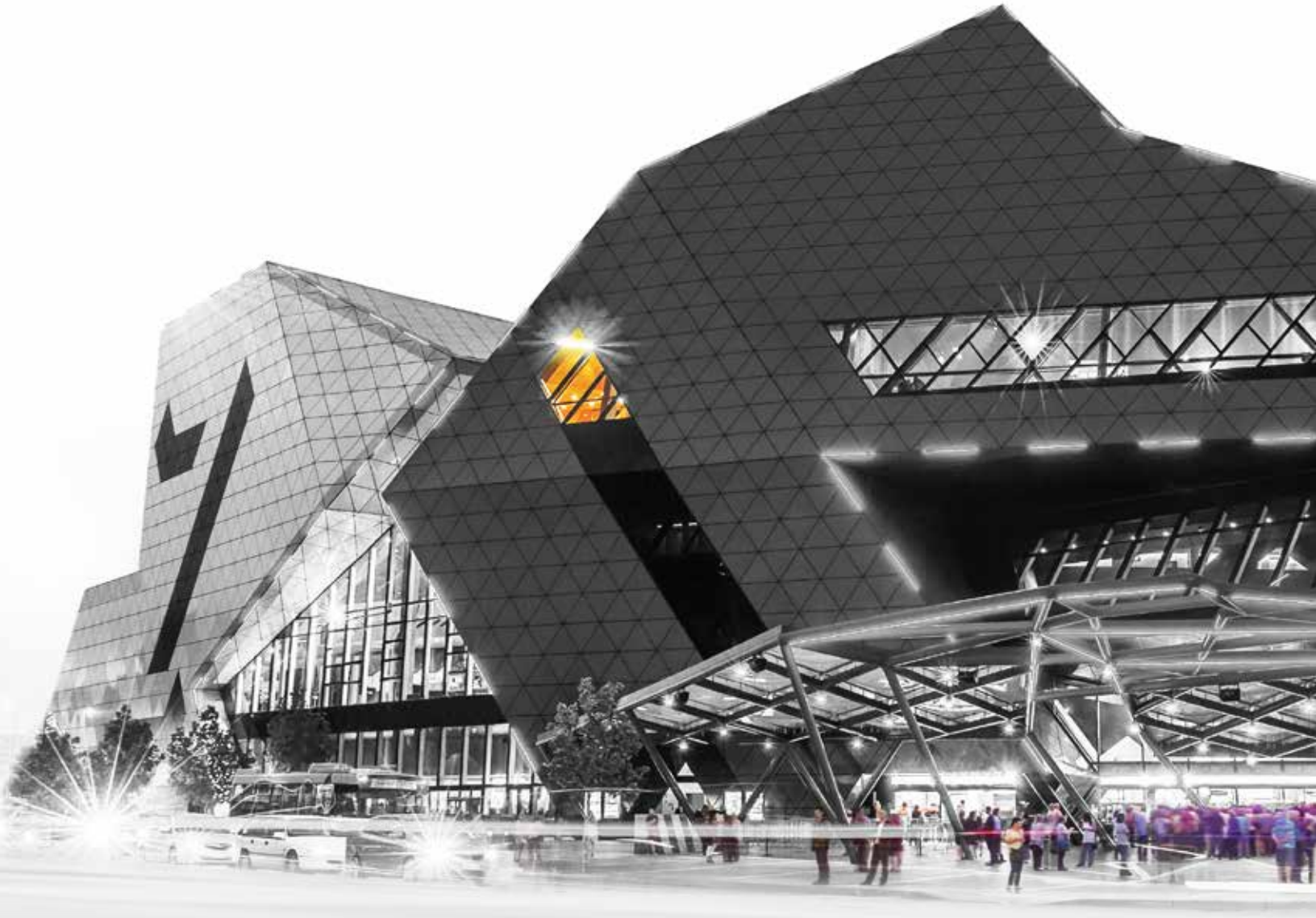
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Honeywell | Connected Buildings



Enterprise Buildings Integrator Release 500

Experience Real Outcomes

Understanding your Business Challenges



Today's building owners and managers are faced with balancing decreasing budgets against escalating targets. The drive to increase revenue, reduce costs and create and maintain a safe, secure, and energy efficient environment is paramount. You want real outcomes, real fast... to respond rapidly to incidents, maximize operational efficiency, enable compliance with your local standards and enhance your customers' experience. In essence, you have to do more, with less.

Today, the world is also becoming increasingly connected via the 'cloud' and through the explosion of mobile devices and remotely accessible objects. Capturing data from this rapidly expanding universe of endpoints has become a 'Big Data' challenge.

Fueling the growth of Connected Buildings

Internet of Things (IoT)
50 Billion devices
expected by 2020



Source: Accenture

The rise of the cloud and Big Data

In 2012...
2.8EB of data
16% in the cloud



By 2020...
40EB of data
37% in the cloud



Source: IDC, Cisco Visual Index Report

The 'Internet of Things' (IoT), combined with the growing demand for more efficient and seamless business processes, is driving increasing demands for more flexible, powerful and cost-effective integration capabilities.



Experience Real Outcomes with EBI R500

EBI R500 promotes real outcomes in real time and supports smarter buildings through the simple, seamless 'Integration of Things'.

Providing a unified view across your building systems, EBI R500 streamlines operational control and promotes faster, better informed decision making, helping mitigate risks and reduce the impact of critical incidents and downtime.

EBI R500 makes integration with third-party systems easier while new cloud connectivity and mobile applications help drive operational efficiency, and a safer, more secure facility.

The results? A smarter building using connectivity and data analytics to provide automatic, real time actionable insights, promoting improved business efficiency, greater control, faster decision making and a better experience for occupants.



Delivering real-time performance

- **Real time facility data** promotes increased productivity, optimized efficiency and the safety and security of your facility.
- **Intelligent automated workflow** promotes reduced operational, engineering and maintenance costs.
- **Performance improvements** allow a 200% increase in point capacity, reducing cost on larger systems, in comparison with our previous releases of EBI.
- **Alarm shelving** of apparent nuisance alarms helps focus on high priority alarms, optimizing operators' time and promoting a safer, more secure facility.
- **Security improvements** such as enhanced occupier access via the Occupant App, e-locks, Easy Lobby visitor management and cardholder access.

Enhanced user experience

- **Better uniformity and operational efficiency** improve the customer experience and make interaction with all aspects of EBI R500 more consistent and easier to adopt.
- **Intuitive new interface** – easier to use, and increased operator engagement. Promotes the saving of time and cost.

Real-time assurance for your facility

- **Product of Honeywell's QA systems** and rigorous standardized development processes.
- Supports certain **green building accreditations** such as LEED and BREEAM.

Cloud connectivity and mobility promote real outcomes

Cloud connectivity and mobile applications enable access to real-time data, giving authorized facility operators and occupants enhanced control of their facilities.

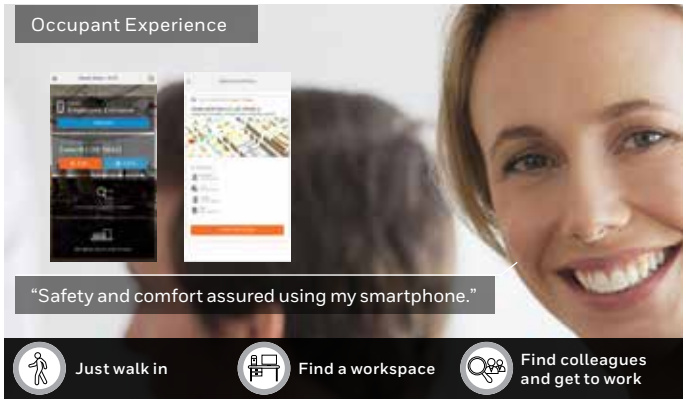
- **Detect risks faster** with near anytime, anywhere access to critical information through mobile apps that promote enhanced facility control, faster situational awareness and operational efficiency without the cost of duplicating hardware and data.
- Cloud enabled **Attune™ Advisory Services analytics** facilitate more informed decisions on improving building performance and reducing energy costs.





Improved Workflow Management

Know your building's performance with the Building Manager App. Whenever. Wherever.





EBI R500 Features

- **Platform and Security** Alarm Management, Enterprise Model, Software Update Service, Policy Enforcer, Windows® operating system compliance.
- **Mobility and Remote Access** HTML5, smartphone access via EasyMobile, full featured tablet access.
- **Intelligent Integration** Building Manager, Security Manager, Life Safety Manager, Digital Video Manager, Energy Manager.
- **Unified Global Schedules** Advanced diagnostics, exception and base schedules, schedule log, integrated download summary.
- **Automation Engine** Integration made easier through simple, rules based automation.
- **Open Systems** HTML5, BACnet® AWS, OPC®, Enterprise Web Services, Building 2 Building using Web Services, ONVIF® and LonWorks®.
- **Access Control** Access control solutions by adding Temaline Voyager iClass support, IdentIPoint logical security extensions, PCSC fault tolerant, and Visitor Management improvements to audit visitor assets and simplify visitor registration.
- **Distributed Systems Architecture** Scalable system comprised of independent nodes which can share information to create a fully distributed yet fault tolerant architecture.
- **Energy Enabled** Honeywell Energy Manager, Attune Services, Automated Demand Response Gateway.



Find out more

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ONVIF® is a registered trademark
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Building	Location	Wall Length Perimeter (ft)	Wall Width Perimeter (ft)	Ceiling Height (ft)	Ceiling Type	Model	Quantity	Speed Control	Configuration	Fan Unit Price	Estimated S/H per fan	Speed Controller Price	Total (USD)
Perth Amboy Campus	Cafeteria	110	47	17-31-17	Peaked Roof	A-45-P4-STD-120-W	4	TRIAC 120-5AMP	1 row of 4 fans, evenly spaced down the peak	$695	$35	$39	$2,959
Perth Amboy Campus	Auto Shop	90	40	26	Truss	A-25-SP-STD-120-W	3	TRIAC 120-5AMP	1 row of 3 fans, evenly spaced down the center	$415	$25	$39	$1,359
Perth Amboy Campus	Gym	100	94	30	Truss	A-25-SP-STD-120-W	9	TRIAC 120-5AMP	2 rows of 3 fans, evenly spaced in the gym	$415	$25	$39	$3,999
Woodbridge Campus	Multi-Purpose	66	43	17-23-17	Peaked Roof	A-25-SP-STD-120-W	3	TRIAC 120-5AMP	1 row of 3 fans, evenly spaced down the center	$415	$25	$39	$1,359

Notes:
Pricing valid through 2019
All fans should be placed so that they do not interfere with any obstructions in the ceiling (ie. folding hoops) and all should have a clear path from ceiling to floor (not above any cafeteria tables, equipment, or desks)
S/H estimates on document are for budgetary purposes; if the entire order ships to one location at one time the freight cost will likely be much less
I can provide a more formal s/h estimat at any time per your request.

Please reach out with any questions.

Chad Bonfiglio
Factory Sales, US East, Airius Fans
direct: 720-204-1236
e: chad.bonfiglio@airiusfans.com

Intelli-Hood®
Melink Corporation

Product Specification



Melink®
Energy solutions for a brighter tomorrow™

●Specifications are subject to change as updates are completed●

melinkcorp.com 5140 River Valley Road Milford, OH 45150 USA 513.965.7300

Revision 130717

Intelli-Hood®

Intelli-Hood System Overview

1 SYSTEM CONTROLLER

Receives input from the Touchpad(s) and Hood Controller(s) to control the outputs for the VFDs.



2 HOOD CONTROLLER

Oversees Temperature and Optic Sensors on each hood and sends sensor data to the System Controller via RS-485 communication.



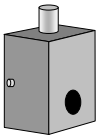
3 Touchpad

Provides switches for operation of hood lights and fans, bypass, monitoring LEDs and programming.



4 OPTIC SENSORS

Monitor the presence of smoke and vapors inside the hood. Send a signal to the Hood Controller to increase fan speed during cooking.



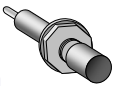
5 AIR PURGE UNITS

Miniature blowers send air into Optic Sensor housings to prevent smoke and grease from collecting on lenses.



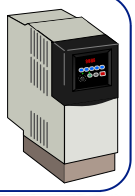
6 TEMPERATURE SENSOR

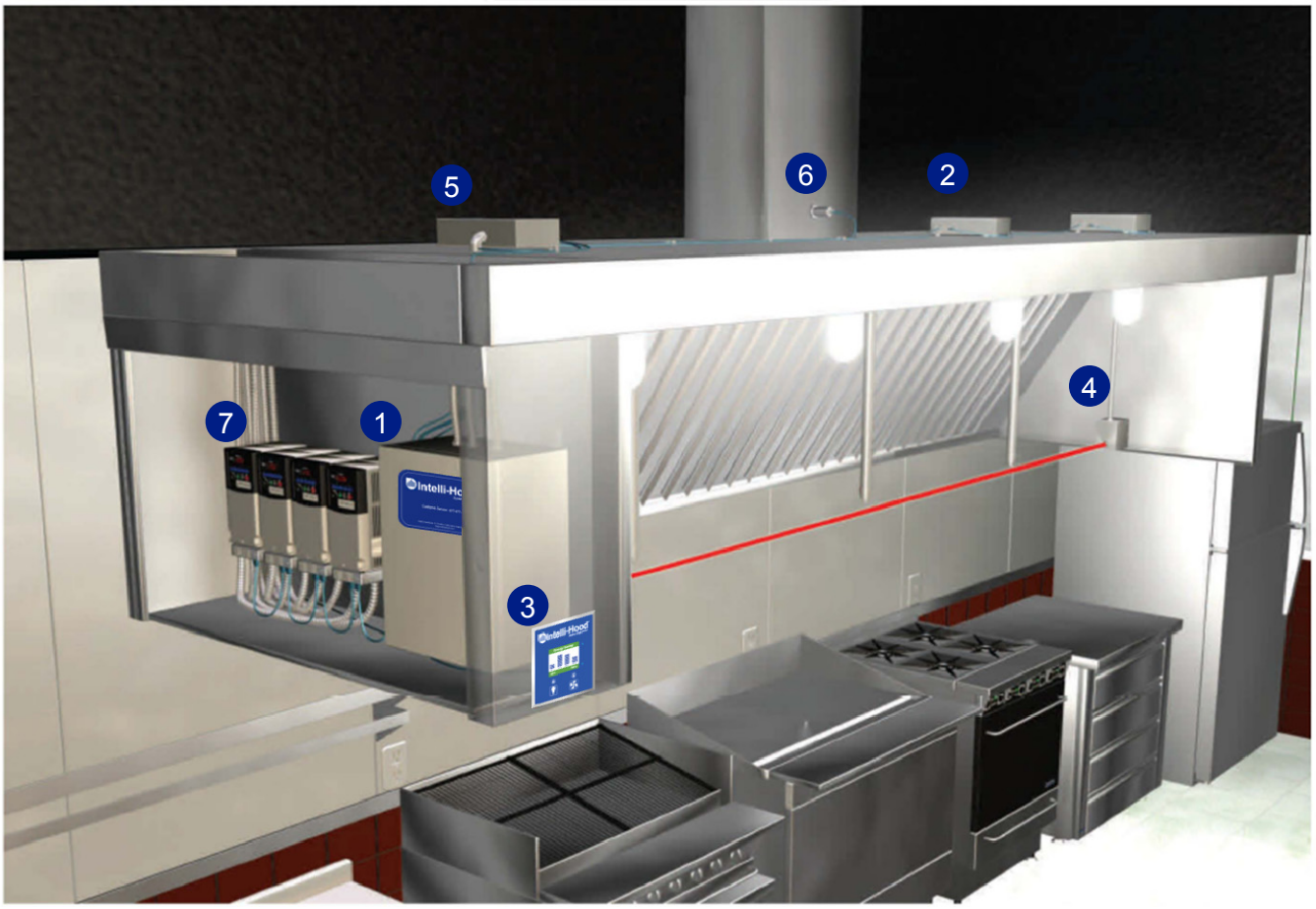
Monitors the exhaust air temperature in the duct and sends a signal to the Hood Controller to vary fan speed in proportion to heat load.



7 VFDs

Variable Frequency Drives receive signals from the Hood Controller to control the speed of the fans based on heat and smoke load.





●Specifications are subject to change as updates are completed●

melinkcorp.com 5140 River Valley Road Milford, OH 45150 USA 513.965.7300

Intelli-Hood®

System Controller

Functional Description

The System Controller controls the lights and fans for up to 39 Hood Controllers. It is typically mounted above the ceiling and communicates between the hood sensors and VFDs via low-voltage Hood Network Cables. It is also connected to a Touchpad mounted on the front face of one of the hoods for easy user interface.

Control Specifications

Painted enclosure for durable construction and smooth finish

Communicates to Hood Controller(s), Touchpad(s), Temp Sensor(s), and Optic Sensor(s) via proprietary RS-485 Protocol

- May communicate with up to (39) Hood Controllers, (10) Touchpads, (10) Aux Touchpads, (10) Aux Power Supplies, and (10) Aux Light Controllers. Some limitations apply.

Communicates to Variable Frequency Drives via Modbus Protocol

- Refer to VFD submittal sheet for more information
- Supports up to 64 VFDs

Programmable I/0: (3) Digital Inputs, (4) Digital Outputs, (1) Analog Output, (1) Analog Input

Adjustable Temperature vs. Fan Speed Curve

Automatic On/Off based on Hood Temperature or Clock Schedule

Versatile programming parameters for setting up exhaust and supply airflow control

Removable Memory stores setup files and operational history data

BACnet over TCP/IP Interface

Internet-based Service Application for programming and monitoring

Automatic notification of faults/alarms via BACnet and email

●Specifications are subject to change as updates are completed●

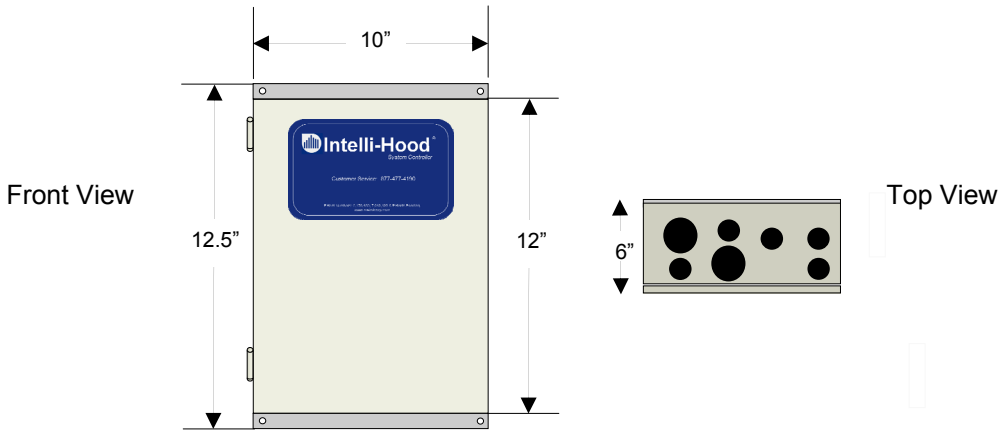
Intelli-Hood®

System Controller

Electrical Specifications

Input Voltage :	120 VAC to 220 VAC
Frequency :	50 Hz to 60 Hz +/- 3%
Power Consumption :	170 W
Ambient Temperature :	5 to 40°C, 32 to 120°F
Line Voltage Output Power Capacity:	15A General Purpose Load, Fused 6A Tungsten Load

Low Voltage plenum-rated, shielded cables to VFD(s), Optic Sensors, APU(s) and Temperature Sensors



●Specifications are subject to change as updates are completed●

Intelli-Hood®

Hood Controller

Functional Description

The Hood Controller oversees Temperature and Optic Sensors on each kitchen hood and sends the sensor data to the System Controller via RS-485 communication.

Mechanical Specifications

Galvanized Steel Enclosure, 7”x7”, 2.1” tall

Temperature Rating: 0 to 49°C, 32 to 120°F

Steel Beam Clamps for installation on hoods or other mechanical structures above hood.

(4) 3/4” conduit holes for connections of Intelli-Hood Hood Network cables

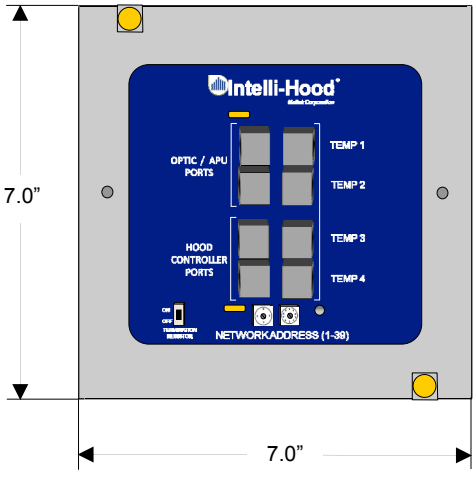
(4) 3/4” conduit knockouts for connections of Intelli-Hood Hood Network cables

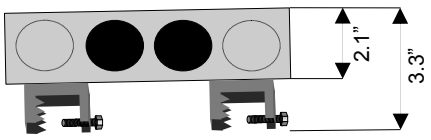
Electrical Specifications

Low Voltage: 24VDC from the Hood Network, via Hood Network Cables

Power Consumption: A fully loaded Hood Controller with four temperature sensors, two air purge units, and one set of optic sensors consumes approximately 15W.

Front View





Side View

●Specifications are subject to change as updates are completed●

Intelli-Hood®

Touchpad

Functional Description

The Touchpad is the human interface point of the Intelli-Hood system. FANS and LIGHTS switches provide interface points of kitchen staff to control the hoods. A full-color screen displays the status of the fans and sensors. Setup switches provide a means of programming the system.

A System Controller may have up to ten (10) Touchpads connected to it. Programmable parameters allow the Setup Technician to dictate Touchpad and Hood relationships. Every System Controller is required to have at least one (1) Touchpad device connected to it to allow for human interface to diagnostics and programming parameters.

General Specifications

Full Color Screen: 2.5” diagonal, QVGA resolution, displays operating status and programming menus

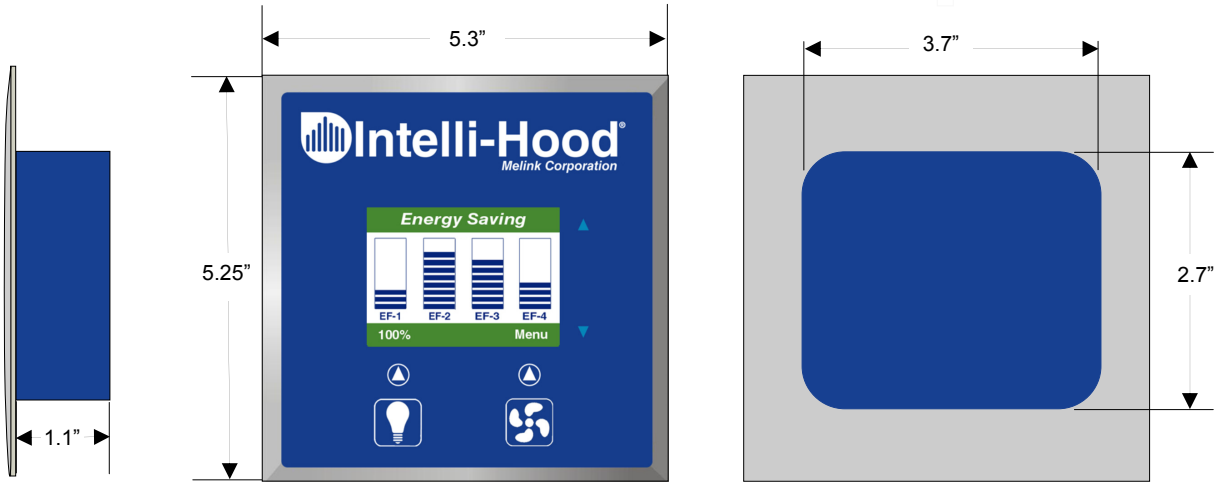
Switches:	FANS:	Changes system from Energy Saving Mode (fans running) to Standby Mode (fans off)
	LIGHTS:	Changes state of line voltage relays which may be used to control Hood Lights circuits.
	Soft Keys:	Allow user to boost fan speeds to full speed, access programming menus, access diagnostic and help screens

Stainless steel cover plate (304L) for durable construction and smooth finish

Synthetic membrane keypad for water protection

Temperature Rating: 5 to 40°C, 41 to 104°F

Low voltage: 24VDC from the Hood Network, via Hood Network Cable



●Specifications are subject to change as updates are completed●

Intelli-Hood®

Temperature Sensors

Functional Description

A three-wire platinum resistive temperature device (RTD) sensor encased in a stainless steel tube. Threaded housing is designed to be assembled into UL-listed “Quick-Seal” exhaust duct fittings. Temperature Sensors are wired to the Hood Controllers via Hood Network Cables.

Standard sensors are installed in exhaust ducts, while Canopy sensors are installed in the hood canopy to provide enhanced automatic on/off functionality.

General Specifications

Stainless Steel Probe: 0.25” outside diameter, 2 lengths available (Standard and Canopy)

Three-Wire Configuration

Brass Body, ½” external pipe thread

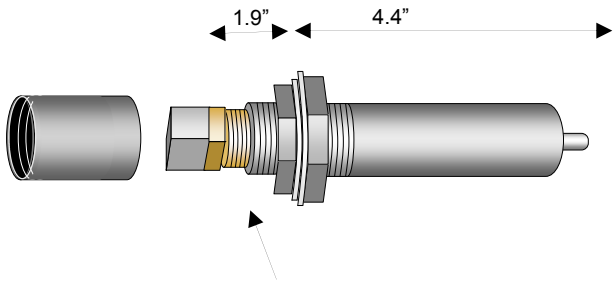
8 pin, RJ-45 connector

Temperature Rating: 0 to 535°C, 32 to 1000°F

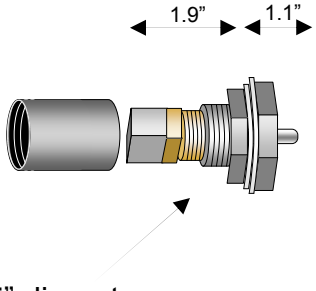
RTD Rating: 100 Ohms with 0.385 platinum coefficient

Electrical Connection: Hood Network Cable

Standard



Canopy



Recommended duct cut-out: 1.125” diameter.

●Specifications are subject to change as updates are completed●

Intelli-Hood®

Optic Sensors

Functional Description

The Optic Sensors consist of an Emitter and a Receiver which are installed on opposite ends of the kitchen hood. An infrared beam spans the length of the hood to detect any smoke or other vapors generated by the cooking appliances. Upon detection, a signal is sent to the System Controller which automatically ramps the associated fan(s) to 100% speed until the effluent is evacuated. Optic Sensors are wired to the Hood Controllers via Hood Network Cables.

General Specifications

Stainless Steel Housing for durable construction and smooth finish

Optic Span: 3 to 40 feet (automatic gain adjustment for distance)

Auto-calibration: Every day at start-up or 24 hours

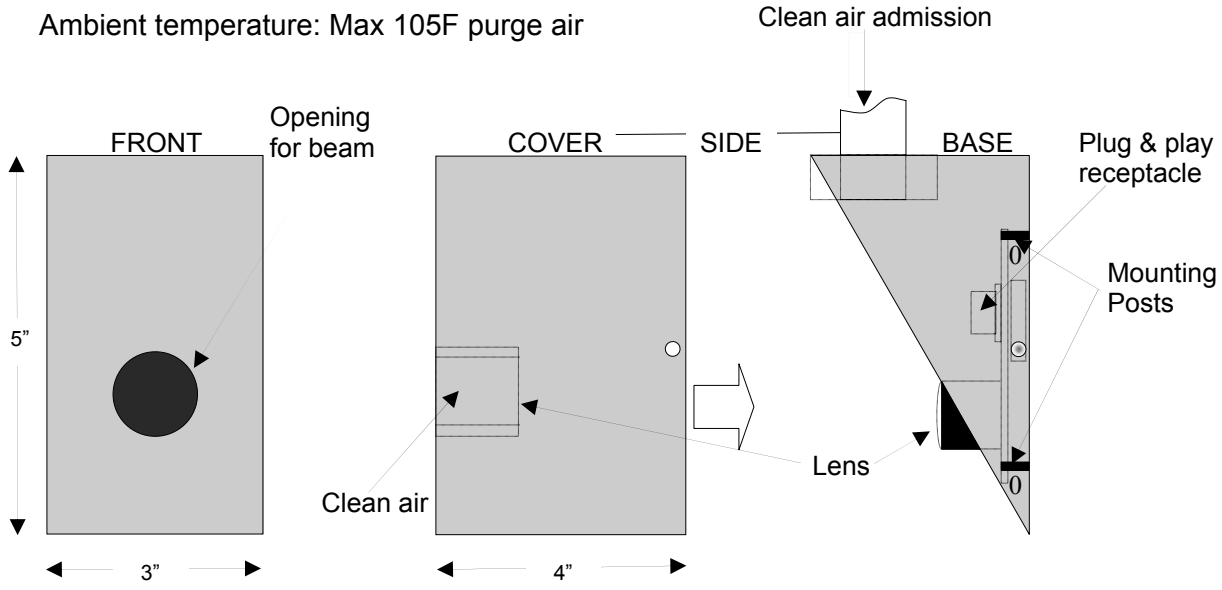
Conformal-coated circuit boards and water-tight cable connectors at sensor PCB connections

Temperature Rating: 0 to 85°C, 32 to 185°F

Response Time: 0.2 seconds

Low Voltage: 12VDC from the Hood Controller, via Hood Network Cable

Ambient temperature: Max 105F purge air



●Specifications are subject to change as updates are completed●

Intelli-Hood®

Air Purge Unit

Functional Description

The Air Purge Unit (APU) consists of a miniature blower in a steel box, mounted on each end of the hood above the optic sensors. The purpose of the APU is to pressurize the optic sensors housings with clean air to prevent grease vapors from fouling the lens. The blowing air also cools the optic circuit boards.

The stainless steel conduit pipe that connects the APU and Optic Sensor provides a path for the air flow and optic sensor control cable.

General Specifications

Enclosure constructed of 18 gauge galvanized steel

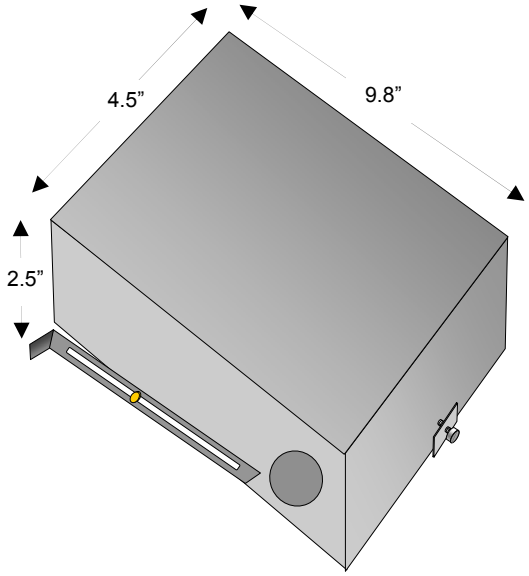
Adjustable support leg

Blower fan bearings permanently lubricated

Temperature Rating: 0 to 51°C, 0 to 125°F

Low Voltage: 12 VDC from the Hood Controller, via Hood Network Cable

Power Consumption: Approximately 7W



●Specifications are subject to change as updates are completed●

Intelli-Hood®

Variable Frequency Drive

Functional Description

The electronic motor starter is a variable frequency drive (VFD) which is used to control the exhaust and supply fan motors. The VFD modulates the speed of the fan motors by varying the output voltage and frequency based on a serial RS-485 signal received from the System Controller. The VFD also sends a feedback signal to the System Controller in order for the Touchpad to display the actual speed of the motor.

Mechanical Specifications

NEMA 1 Enclosure.

Soft-start capability.

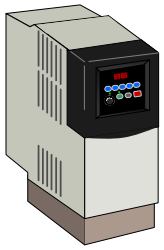
Digital keypad displays output frequency, current, voltage, and allows programming for field modifications.

Protective Functions: motor overload, overheating, overcurrent, overvoltage, output shorts, etc.

High and low frequency limiters.

Adjustable torque boost.

Daisy-chained via Hood Network Cables



Electrical Specifications

Input Voltage :	200-240 V/1ϕ AC, 200-230 V/3ϕ AC, 380-480 V/3ϕ AC, or 460-600 V/3ϕ AC
Input Frequency :	50 Hz to 60 Hz +/- 3%
Output Voltage :	80-240 V/ 3ϕ AC or 160-480 V/ 3ϕ AC
Ambient Temperature :	-10 to 50°C, 14 to 122°F
Humidity :	20%-95% relative humidity (non-condensing)

●Specifications are subject to change as updates are completed●

Intelli-Hood®

Hood Network Cables

Functional Description

Custom 8-conductor cables connect the various components of Intelli-Hood. The cable is shielded, plenum rated, UL Type CMP OR CL3P FT-6. Per NFPA 70, the cable is allowed to be run in horizontal plenums and vertical chases without conduit when carrying current-limited low-voltage power and signals as it does with the Intelli-Hood.

Construction Specifications

UL TYPE OR STYLE:	CMP OR CL3P FT-6
PRIMARY INSULATION TYPE:	SGPVC
JACKET THICKNESS:	.015"
JACKET COLOR:	SPECIAL BLUE
JACKET MATERIAL:	CMP
NOMINAL O.D.:	0.190"
TEMP. RATING:	60C
CONDUCTOR/PAIR COUNT:	4 PAIRS
INSULATION THICKNESS:	0.007"
GAUGE & STRANDING:	24 AWG, 7/32 BC
VOLTAGE RATING:	300V
SHIELD:	FFE ALUMINUM POLYESTER
DRAIN WIRE:	24 AWG, 7/32 TC

Stock Pre-Terminated Lengths

2CB3-001: 1’ (0.3m)
2CB3-005: 5’ (1.5m)
2CB3-015: 15 (4.5m)
2CB3-030: 30’ (9.1m)
2CB3-050: 50’ (15.2m)
2CB3-075: 75’ (22.8m)
2CB3-100: 100’ (30.5m)
2CB3-200: 200’ (61m)

●Specifications are subject to change as updates are completed●

Intelli-Hood®

Aux Touchpad

Functional Description

The Aux Touchpad is an additional human interface point of the Intelli-Hood system. FANS, LIGHTS, and 100% switches provide interface points of kitchen staff to control the hoods. Indicator LEDs provide status for the FANS, LIGHTS, 100%, and Faults.

A System Controller may have up to ten (10) Aux Touchpads connected to it. Programmable parameters allow the Setup Technician to dictate Aux Touchpad and Hood relationships.

General Specifications

FANS Switch: Changes associated Hoods between Active Mode (fans running) to Standby Mode (fans off)

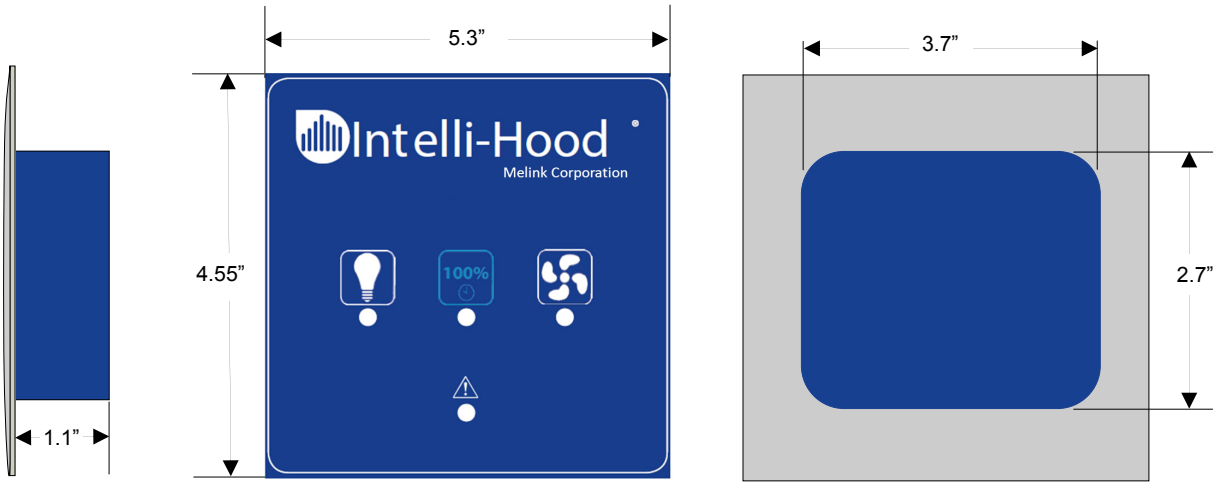
LIGHTS Switch: Changes state of associated line voltage relays which may be used to control Hood Lights circuits.

100% Switch: Allows user to temporarily boost fan speeds to full speed on associated Hoods.

Stainless steel cover plate (304L) for durable construction and smooth finish

Synthetic overlay for water protection

Low Voltage: 24VDC from the Hood Network, via Hood Network Cable



●Specifications are subject to change as updates are completed●

Intelli-Hood®

Aux Power Supply

Functional Description

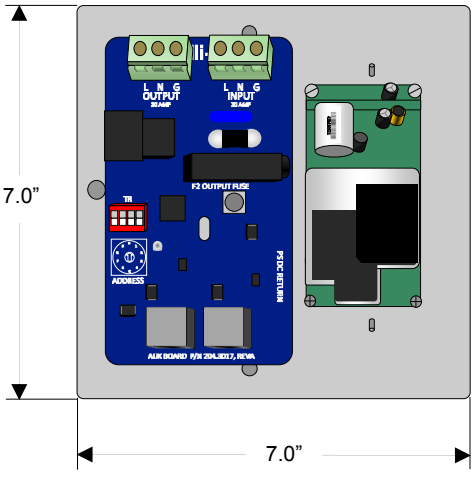
The Aux Power Supply (APS) may be used for large installations additional power is needed to operate Hood Controllers, Optic Sensors, and Touchpads. Since each Hood Network Port is power-limited, depending on the quantity of devices in a series line and the length of cable between devices, Aux Power Supply Device(s) may be needed to provide power to the Hood Network.

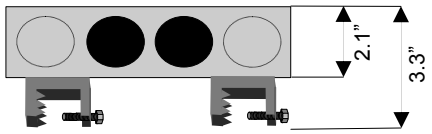
A System Controller may have up to 10 Aux Power Supplies connected to it.

Electrical Specifications

Input Voltage :	120 VAC to 220 VAC
Frequency :	50 Hz to 60 Hz +/- 3%
Output Voltage:	24VDC
Frequency :	50 Hz to 60 Hz +/- 3%
Power Consumption :	60W (max)
Ambient Temperature :	5 to 40°C, 41 to 104°F
Hood Network Connection:	24VDC from the Hood Network, via Hood Network Cable

Front View





Side View

●Specifications are subject to change as updates are completed●

Intelli-Hood®

Aux Lighting Controller

Functional Description

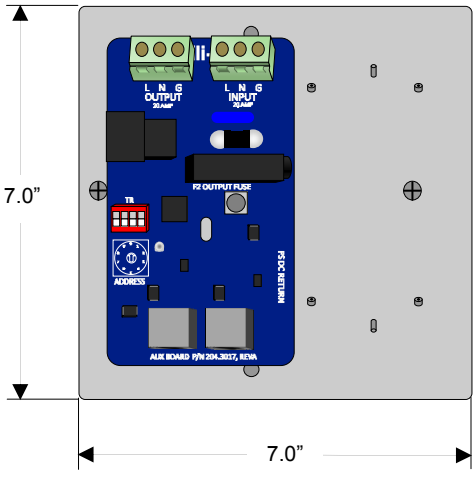
The Aux Light Controller (ALC) may be used for large installations where there is a need to control multiple light circuits. A System Controller may have up to 10 Aux Light Controllers connected to it. Relationships among the ALC and Touchpads are programmable via field editable parameters.

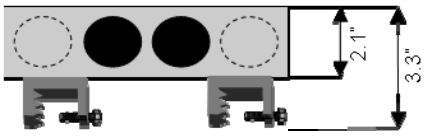
A System Controller may have up to 10 Aux Lighting Controllers connected to it.

Electrical Specifications

Input Voltage :	120 VAC to 220 VAC
Frequency :	50 Hz to 60 Hz +/- 3%
Power Consumption :	5W (not including lights)
Ambient Temperature :	5 to 40°C, 41 to 104°F
Hood Lights (voltage matches input):	120 VAC to 220 VAC (15A max)
Line Voltage Output Power Capacity:	15A General Purpose Load, Fused 6A Tungsten Load

Front View





Side View

●Specifications are subject to change as updates are completed●

ZR-T TrueWhite® Series

ZR24™ 2' x 4' TrueWhite® Series LED Troffer with Gloss Finish

Product Description

The ZR-T TrueWhite® Series LED troffer delivers up to 5000 lumens of superior 90+ CRI light quality and is perfect for both new construction and renovation. Powered by Cree TrueWhite® Technology, the slim and lightweight ZR-T LED troffer boasts an efficacy of up to 114 LPW performance along with 0-10V dimming to meet local energy codes. The ZR24™ LED troffer embodies a breakthrough in balancing energy savings, visual comfort and initial cost.



Performance Summary

Utilizes Cree TrueWhite® Technology

Efficacy: 100-114 LPW

Initial Delivered Lumens: 4,000 or 5,000 lumens

Input Power: 40-44 watts

CRI: 90+ CRI

CCT: 3000K, 3500K, 4000K, 5000K

Input Voltage: 120-277 VAC or 347 VAC

Limited Warranty†: 10 years on luminaire

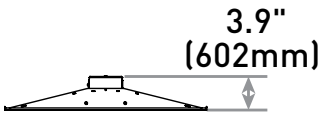
Limited Warranty Emergency Back Up (EB) Battery: 1 Year on Battery Back Up. Test regularly in accordance with local codes

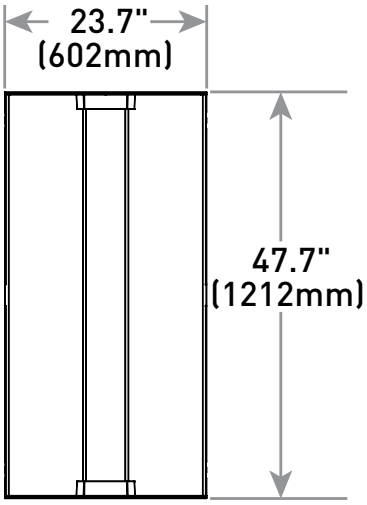
Controls: 0-10V dimming to 5%

Mounting: Recessed*

Room-side accessible snap and lock removable lens

† See http://lighting.cree.com/warranty for warranty terms
* Not intended for use with 9/16" T-Bar grids unless used with a 9/16" accessory clip like "Armstrong® LFC- Fixture Clip" which can be purchased through distribution. Consult factory for non-standard grid applications.





Accessories

Field-Installed	
Drywall Grid Adapter DGA24-WHT **Surface Mount Kit** SMK-ZR24 - Not for use with EB14 or SmartCast® Technology **6' Flexible Power Whip** PW-18/4-06-9T/SS - For use in non-dimming applications only	**Wireless 0-10V Dimming/Switching Interface with Cree Smartcast® Technology** CIF-10V-CWC-SNSR - For use with luminaires with 10V controls when integral SmartCast isn't available **Cree SmartCast® Technology Configuration Tool** CCT-CWC-1 - One required per project when CIF-10V is selected **Chicago Plenum Field Kit** CPLZR - Fits all ZR types to be installed in the field

Ordering Information

Example: ZR24T-40L-35K-10V

ZR24T				10V	
Product	**Initial Delivered Lumens**	**CCT**	**Voltage**	**Control**	**Options**
ZR24T	**40L** 40W, 4,000 Lumens **50L** 44W, 5,000 Lumens	**30K** 3000K **35K** 3500K **40K** 4000K **50K** 5000K	**Blank** 120-277 Volt **34** 347 Volt - Available with 40L only	**10V** 0-10V dimming to 5%	**EB14 Emergency Backup** - 1,400 lumens - Not available with 347 Volt - Provides 90 minutes of emergency operation

Rev. Date: V2 05/04/2017

US: lighting.cree.com T (800) 236-6800 F (262) 504-5415
Canada: www.cree.com/canada T (800) 473-1234 F (800) 890-7507

Product Specifications

CREE TRUEWHITE® TECHNOLOGY

A revolutionary way to generate high-quality white light, Cree TrueWhite® Technology is a patented approach that delivers an exclusive combination of 90+ CRI, beautiful light characteristics, and lifelong color consistency, all while maintaining high luminous efficacy – a true no compromise solution.

CONSTRUCTION & MATERIALS

- Durable 22 ga. cold rolled steel housing provides strength and uniformity
- Ultra-thin 3.9" (99mm) luminaire height and lightweight design effectively target a broad range of plenum spaces and allow for easy installations
- Luminaire is pre-painted for enhanced gloss finish
- Includes t-bar clips and holes for mounting support wires (by others)
- Luminaire sides and ends are hemmed in for safe, easy handling
- Includes lens gasket to prevent ingress of insects
- Not for installation within 3" (76mm) of insulation
- Removable lens for easy maintenance and cleaning
- Magnetic lens to prevent dust and bug intrusion

OPTICAL SYSTEM

- Unique luminaire design creates perfect balance of both horizontal and vertical illumination
- Optimized smooth acrylic lens eliminates pixelation and delivers a low-glare, diffused light distribution

ELECTRICAL SYSTEM

- Cree born components including highly efficacious Cree® LED chips along with an integral high-efficiency Cree® driver
- **Power Factor:** = 0.9 nominal for 120-277V
- **Input Power:** Stays constant over life
- **Input Voltage:** 120-277V or 347V, 60Hz
- **Operating Temperature Range:** 0˚C - + 35˚C (32˚F - + 95˚F)
- **Total Harmonic Distortion:** < 20% for standard fixtures; < 25% for EB option

CONTROLS

- Continuous dimming to 5% with 0-10V DC control protocol
- **10V Source Current:** 0.25mA
- For use with Class 2 dimming systems only
- Use only lighting controls with neutral connection or controls intended for use with LED fixtures
- Reference www.creelink.com/exLink.asp?7098214OZ58R34I26620963 for recommended dimming controls and wiring diagrams

REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus Listed
- Suitable for damp locations
- Designed for indoor use
- UL924 (EB option). Maximum mounting height: 15.0' (4.6m)
- RoHS compliant. Consult factory for additional details
- Meets FCC Part 15, Subpart B, Class A standards for conducted and radiated emissions
- DLC qualified. Please refer to www.designlights.org/QPL for most current information

Electrical Data*

Initial Delivered Lumens	System Watts 120-347V	Total Current (A)				
		120V	208V	240V	277V	347V
40L	40	0.37	0.21	0.19	0.16	0.13
40L w/EB14 Option	44	0.41	0.24	0.20	0.18	N/A
50L	44	0.41	0.24	0.20	0.18	N/A
50L w/EB14 Option	48	0.44	0.26	0.22	0.19	N/A

* Electrical data at 25˚C (77˚F). Actual wattage may differ by +/- 10% when operating between 120-347V +/- 10%

Recommended ZR-T Series Lumen Maintenance Factors (LMF)[1]

Ambient	Initial LMF	25K hr Projected[2] LMF	50K hr Projected[2] LMF	75K hr Calculated[3] LMF	100K hr Calculated[3] LMF
0˚C (32˚F)	1.04	1.04	1.04	1.04	1.04
5˚C (41˚F)	1.03	1.03	1.03	1.03	1.03
10˚C (50˚F)	1.02	1.02	1.02	1.02	1.02
15˚C (59˚F)	1.02	1.02	1.02	1.02	1.02
20˚C (68˚F)	1.01	1.01	1.01	1.01	1.01
25˚C (77˚F)	1.00	1.00	1.00	1.00	1.00
30˚C (86˚F)	0.99	0.99	0.99	0.99	0.99
35˚C (95˚F)	0.98	0.98	0.98	0.98	0.98

[1] Lumen maintenance values at 25˚C are calculated per TM-21 based on LM-80 data and in-situ luminaire testing
[2] In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ([DUT) i.e. the packaged LED chip)
[3] In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ([DUT) i.e. the packaged LED chip)

Application Reference

Open Space

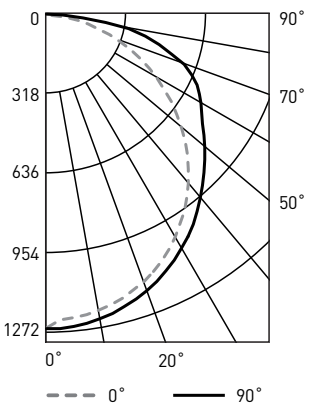
Spacing	Initial Delivered Lumens	Lumens	Wattage	LPW	w/ft²	Average fc
8 x 8	40L	4,000	40	100	0.6	56
	50L	5,000	44	114	0.66	70
8 x 10	40L	4,000	40	100	0.5	47
	50L	5,000	44	114	0.55	59
10 x 10	40L	4,000	40	100	0.4	38
	50L	5,000	44	114	0.44	47
10 x 12	40L	4,000	40	100	0.32	30
	50L	5,000	44	114	0.35	38

10' ceiling: 80/50/20 reflectances; 2.5' workplane, open room. LLF: 1.0 Initial. Open Space: 50' x 40' x 10'

Photometry

ZR24T-40L-30K-10V BASED ON CREE REPORT TEST #: PL10459-001A

Luminaire photometry has been conducted by a NVLAP accredited testing laboratory in accordance with IESNA LM-79-08. IESNA LM-79-08 specifies the entire luminaire as the source resulting in a luminaire efficiency of 100%.



Coefficients Of Utilization – Zonal Cavity Method				
RC %:	80			
RW %:	70	50	30	10
RCR: 0	119	119	119	119
1	107	102	97	93
2	97	88	81	74
3	88	77	68	61
4	80	68	58	51
5	74	60	51	44
6	68	54	45	38
7	63	49	40	33
8	59	45	36	30
9	55	41	32	27
10	51	38	30	24

Effective Floor Cavity Reflectance: 20%

Zonal Lumen Summary			
Zone	Lumens	% Lamp	Luminaire
0-30	977	N/A	24.8%
0-40	1,602	N/A	40.7%
0-60	2,875	N/A	73.0%
0-90	3,940	N/A	100%
0-180	3,940	N/A	100%

Average Luminance Table (cd/m²)				
	Horizontal Angle			
Vertical Angle		0°	45°	90°
	45°	7,611	8,140	8,535
	55°	7,198	8,166	8,990
	65°	6,614	8,787	10,676
	75°	5,606	10,589	12,209
	85°	4,023	11,023	11,402

Reference http://lighting.cree.com/products/indoor/troffers/zr-series for detailed photometric data

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US: lighting.cree.com T (800) 236-6800 F (262) 504-5415 **Canada: www.cree.com/canada** T (800) 473-1234 F (800) 890-7507

OSQ Series

OSQ™ LED Area/Flood Luminaire – Large

Product Description

The OSQ™ Area/Flood luminaire blends extreme optical control, advanced thermal management and modern, clean aesthetics. Built to last, the housing is rugged cast aluminum with an integral, weathertight LED driver compartment. Versatile mounting configurations offer simple installation. Its slim, low-profile design minimizes wind load requirements and blends seamlessly into the site providing even, quality illumination. The 'T' input power designator is a suitable upgrade for HID applications up to 750 Watts, and the 'U' input power designator is a suitable upgrade for HID applications up to1000 Watts.

Applications: Parking lots, walkways, campuses, auto dealerships, office complexes, and internal roadways

Performance Summary

NanoOptic® Precision Delivery Grid™ optic

Assembled in the U.S.A. of U.S. and imported parts

Initial Delivered Lumens: Up to 27,103

Efficacy: Up to 139 LPW

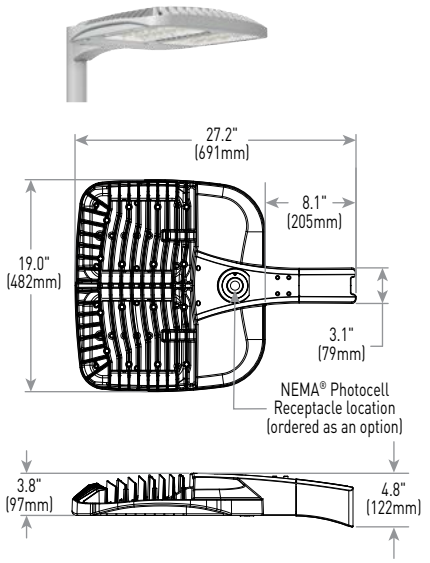
CRI: Minimum 70 CRI (4000K & 5700K; 3000K asymmetric optics); 80 CRI (3000K symmetric optics)

CCT: 3000K (+/- 300K), 4000K (+/- 300K), 5700K (+/- 500K)

Limited Warranty†: 10 years on luminaire/10 years on Colorfast DeltaGuard® finish

†See http://lighting.cree.com/warranty for warranty terms

DA Mount



Weight
28.5 lbs. (13kg)

Accessories

Field-Installed	
Backlight Shield OSQ-BLSLF – Front facing optics OSQ-BLSLR – Rotated optics	**Hand-Held Remote** XA-SENSREM - For successful implementation of the programmable multi-level option, a minimum of one hand-held remote is required

Ordering Information

Fully assembled luminaire is composed of two components that must be ordered separately:
Example: **Mount:** OSQ-AASV + **Luminaire:** OSQ-A-NM-2ME-T-40K-UL-SV

Mount (Luminaire must be ordered separately)*			
OSQ-			
OSQ-AA Adjustable Arm **OSQ-DA** Direct Arm	**Color Options:**	**SV** Silver **BK** Black	**BZ** Bronze **WH** White

* Reference EPA and pole configuration suitability data beginning on page 7

Luminaire (Mount must be ordered separately)

OSQ	A	NM						
Product	**Version**	**Mounting**	**Optic**	**Input Power Designator**	**CCT**	**Voltage**	**Color Options**	**Options**
OSQ	**A**	**NM** No Mount	**Asymmetric** **2ME*** Type II Medium **4ME*** Type IV Medium **3ME*** Type III Medium **Symmetric** **5ME** Type V Medium **25D** 25° Flood **5SH** Type V Short **40D** 40° Flood **WSN** Wide Sign **60D** 60° Flood **15D** 15° Flood	**T** 166W **U** 215W	**30K** 3000K **40K** 4000K **57K** 5700K	**UL** Universal 120-277V **UH** Universal 347-480V	**BK** Black **BZ** Bronze **SV** Silver **WH** White	**DIM 0-10V Dimming** - Control by others - Refer to Dimming spec sheet for details - Can't exceed wattage of specified input power designator **F Fuse** - When code dictates fusing, use time delay fuse - Available for U.S. applications only **ML Multi-Level** - Refer to ML spec sheet for details - Available with UL voltage only - Intended for downlight applications at 0° tilt **PML Programmable Multi-Level, up to 40' Mounting Height** - Refer to PML spec sheet for details - Intended for downlight applications at 0° tilt **PML2 Programmable Multi-Level, 10-30' Mounting Height** - Refer to PML spec sheet for details - Intended for downlight applications at 0° tilt **Q9/Q8/Q7/Q6/Q5/Q4/Q3/Q2/Q1 Field Adjustable Output** - Must select Q9, Q6, Q5, Q4, Q3, Q2, or Q1 for T input power designator - Must select Q9, Q8, Q7, Q6, Q5, Q4, Q3, Q2, or Q1 for U input power designator - Offers full range adjustability - Refer to pages 9-10 for power and lumen values **R NEMA® Photocell Receptacle** - Intended for downlight applications with maximum 45° tilt - 3-pin receptacle per ANSI C136.10 - Photocell and shorting cap by others **RL Rotate Left** - LED and optic are rotated to the left **RR Rotate Right** - LED and optic are rotated to the right

* Available with Backlight Shield when ordered with field-installed accessory (see table above)

Rev. Date: V13 12/19/2017

US: lighting.cree.com T (800) 236-6800 F (262) 504-5415

Canada: www.cree.com/canada T (800) 473-1234 F (800) 890-7507

Product Specifications

CONSTRUCTION & MATERIALS

- Slim, low profile design minimizes wind load requirements
- Luminaire housing is rugged die cast aluminum with an integral, weathertight LED driver compartment and high performance heat sink
- Convenient interlocking mounting method on direct arm mount. Mounting adaptor is rugged die cast aluminum and mounts to 3-6" (76-152mm) square or round pole, secured by two 5/16-18 UNC bolts spaced on 2" (51mm) centers
- Mounting for the adjustable arm mount adaptor is rugged die cast aluminum and mounts to 2" (51mm) IP, 2.375" (60mm) O.D. tenon
- Adjustable arm mount can be adjusted 180˚ in 2.5˚ increments
- Designed for uplight and downlight applications
- Exclusive Colorfast DeltaGuard® finish features an E-Coat epoxy primer with an ultra-durable powder topcoat, providing excellent resistance to corrosion, ultraviolet degradation and abrasion. Silver, bronze, black, and white are available
- **Weight:** 28.5 lbs. (13kg)

ELECTRICAL SYSTEM

- **Input Voltage:** 120-277V or 347-480V, 50/60Hz, Class 1 drivers
- **Power Factor:** > 0.9 at full load
- **Total Harmonic Distortion:** < 20% at full load
- Integral 10kV surge suppression protection standard
- When code dictates fusing, a slow blow fuse or type C/D breaker should be used to address inrush current
- **10V Source Current:** 0.15mA

REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus Listed
- Suitable for wet locations
- Enclosure rated IP66 per IEC 60529 when ordered without R option
- Consult factory for CE Certified products
- Certified to ANSI C136.31-2001, 3G bridge and overpass vibration standards
- 10kV surge suppression protection tested in accordance with IEEE/ANSI C62.41.2
- Meets FCC Part 15, Subpart B, Class A standards for conducted and radiated emissions
- Luminaire and finish endurance tested to withstand 5,000 hours of elevated ambient salt fog conditions as defined in ASTM Standard B 117
- Meets Buy American requirements within ARRA
- DLC and DLC Premium qualified versions available. Some exceptions apply. Please refer to https://www.designlights.org/search/ for most current information
- RoHS compliant. Consult factory for additional details
- Dark Sky Friendly, IDA Approved when ordered with 30K CCT. Please refer to http://darksky.org/fsa/fsa-products/ for most current information

Electrical Data*

Input Power Designator	System Watts 120-480V	Total Current (A)					
		120V	208V	240V	277V	347V	480V
T	166	1.41	0.83	0.72	0.62	0.49	0.35
U	215	1.83	1.08	0.93	0.81	0.62	0.45

* Electrical data at 25˚C (77˚F). Actual wattage may differ by +/- 10% when operating between 120-480V +/-10%

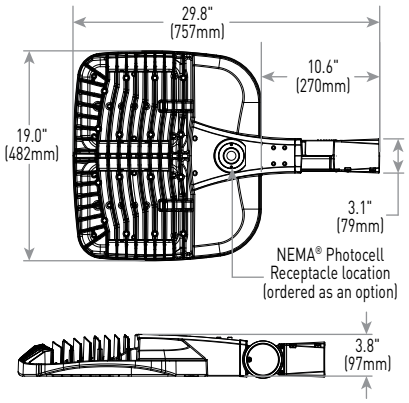
OSQ Series Ambient Adjusted Lumen Maintenance[1]

Ambient	Optic	Initial LMF	25K hr Projected[2] LMF	50K hr Projected[2] LMF	75K hr Projected[2]/ Calculated[3] LMF	100K hr Projected[2]/ Calculated[3] LMF
5˚C (41˚F)	Asymmetric	1.04	1.00	0.95	0.91[3]	0.87[3]
	Symmetric	1.05	1.04	1.03	1.03[2]	1.02[2]
10˚C (50˚F)	Asymmetric	1.03	0.99	0.94	0.90[3]	0.86[3]
	Symmetric	1.04	1.03	1.02	1.01[2]	1.00[2]
15˚C (59˚F)	Asymmetric	1.02	0.98	0.93	0.89[3]	0.86[3]
	Symmetric	1.02	1.02	1.01	1.00[2]	0.99[2]
20˚C (68˚F)	Asymmetric	1.01	0.97	0.93	0.89[3]	0.85[3]
	Symmetric	1.01	1.01	1.00	0.99[2]	0.98[2]
25˚C (77˚F)	Asymmetric	1.00	0.96	0.92	0.88[3]	0.84[3]
	Symmetric	1.00	0.99	0.98	0.98[2]	0.97[2]

[1] Lumen maintenance values at 25˚C (77˚F) are calculated per TM-21 based on LM-80 data and in-situ luminaire testing. Luminaire ambient temperature factors (LATF) have been applied to all lumen maintenance factors
[2] In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ([DUT) i.e. the packaged LED chip)
[3] In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ([DUT) i.e. the packaged LED chip)

AA Mount



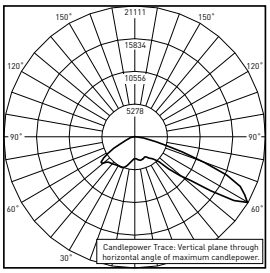


Weight
28.5 lbs. (13kg)

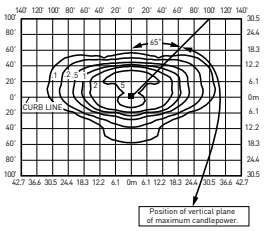
Photometry

All published luminaire photometric testing performed to IESNA LM-79-08 standards by a NVLAP accredited laboratory. To obtain an IES file specific to your project consult: http://lighting.cree.com/products/outdoor/area/osq-series

2ME



CESTL Test Report #: PL07701-001A
OSQ-A-**-2ME-U-40K-UL
Initial Delivered Lumens: 26,946

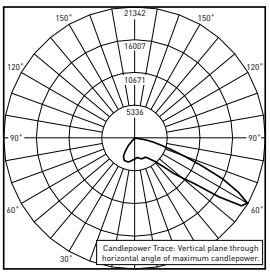


OSQ-A-**-2ME-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 26,583
Initial FC at grade

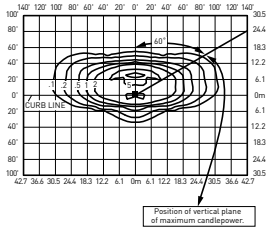
Type II Medium Distribution

Input Power Designator	3000K		4000K		5700K	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
T	20,688	B3 U0 G3	21,902	B3 U0 G3	22,330	B3 U0 G3
U	25,246	B3 U0 G3	26,583	B3 U0 G3	27,103	B3 U0 G3

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt



CESTL Test Report #: PL07700-001A
OSQ-A-**-2ME-U-57K-UL w/OSQ-BLSLF
Initial Delivered Lumens: 22,822



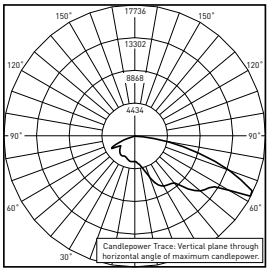
OSQ-A-**-2ME-U-40K-UL w/OSQ-BLSLF
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 20,427
Initial FC at grade

Type II Medium w/BLS Distribution

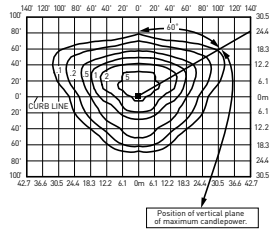
Input Power Designator	3000K		4000K		5700K	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
T	15,897	B2 U0 G2	16,830	B3 U0 G2	17,159	B3 U0 G2
U	19,400	B3 U0 G2	20,427	B3 U0 G2	20,826	B3 U0 G2

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

3ME



CESTL Test Report #: PL07698-001A
OSQ-A-**-3ME-U-40K-UL
Initial Delivered Lumens: 27,305

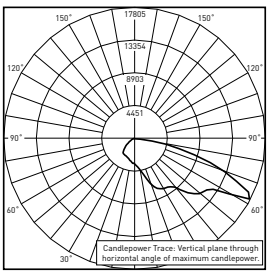


OSQ-A-**-3ME-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 26,583
Initial FC at grade

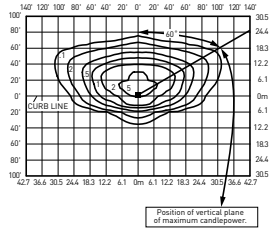
Type III Medium Distribution

Input Power Designator	3000K		4000K		5700K	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
T	20,688	B3 U0 G3	21,902	B3 U0 G3	22,330	B3 U0 G3
U	25,246	B3 U0 G3	26,583	B3 U0 G3	27,103	B3 U0 G3

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt



CESTL Test Report #: PL07699-001A
OSQ-A-**-3ME-U-57K-UL w/OSQ-BLSLF
Initial Delivered Lumens: 23,601



OSQ-A-**-3ME-U-40K-UL w/OSQ-BLSLF
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 20,986
Initial FC at grade

Type III Medium w/BLS Distribution

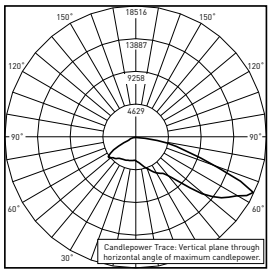
Input Power Designator	3000K		4000K		5700K	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
T	16,333	B2 U0 G2	17,291	B2 U0 G2	17,629	B2 U0 G3
U	19,931	B2 U0 G3	20,986	B2 U0 G3	21,397	B2 U0 G3

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

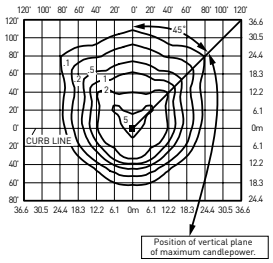
Photometry

All published luminaire photometric testing performed to IESNA LM-79-08 standards by a NVLAP accredited laboratory. To obtain an IES file specific to your project consult: http://lighting.cree.com/products/outdoor/area/osq-series

4ME



CESTL Test Report #: PL07690-001A
OSQ-A-**-4ME-U-40K-UL
Initial Delivered Lumens: 27,527

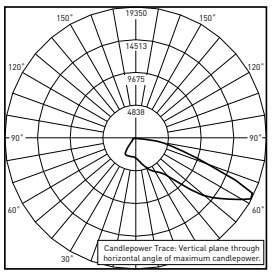


OSQ-A-**-4ME-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 26,583
Initial FC at grade

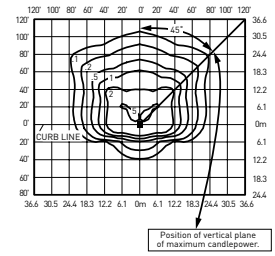
Type IV Medium Distribution

Input Power Designator	3000K		4000K		5700K	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
T	20,688	B3 U0 G3	21,902	B3 U0 G3	22,330	B3 U0 G3
U	25,246	B4 U0 G3	26,583	B4 U0 G3	27,103	B4 U0 G3

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt



CESTL Test Report #: PL07692-001A
OSQ-A-**-4ME-U-57K-UL w/OSQ-BLSLF
Initial Delivered Lumens: 22,793



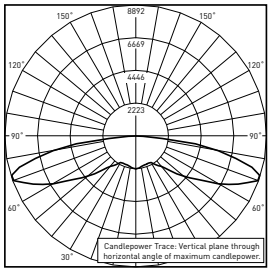
OSQ-A-**-4ME-U-40K-UL w/OSQ-BLSLF
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 20,427
Initial FC at grade

Type IV Medium w/BLS Distribution

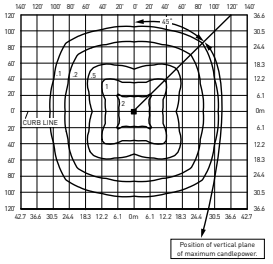
Input Power Designator	3000K		4000K		5700K	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
T	15,897	B2 U0 G3	16,830	B2 U0 G3	17,159	B2 U0 G3
U	19,400	B3 U0 G3	20,427	B3 U0 G3	20,826	B3 U0 G3

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

5ME



CESTL Test Report #: PL07882-001A
OSQ-A-**-5ME-U-30K-UL
Initial Delivered Lumens: 21,410



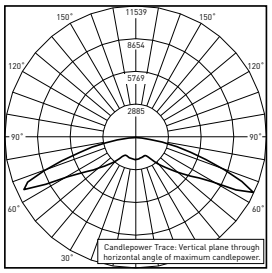
OSQ-A-**-5ME-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 24,666
Initial FC at grade

Type V Medium Distribution

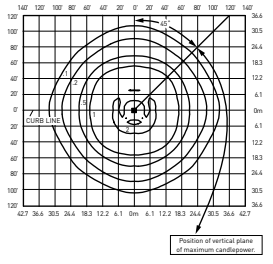
Input Power Designator	3000K		4000K		5700K	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Pe TM-15-11
T	18,544	B4 U0 G5	21,469	B5 U0 G5	21,842	B5 U0 G5
U	21,305	B5 U0 G5	24,666	B5 U0 G5	25,095	B5 U0 G5

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

5SH



CESTL Test Report #: PL0754-001A
OSQ-A-**-5SH-U-40K-UL
Initial Delivered Lumens: 25,679



OSQ-A-**-5SH-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 26,051
Initial FC at grade

Type V Short Distribution

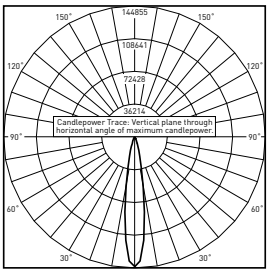
Input Power Designator	3000K		4000K		5700K	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
T	19,586	B5 U0 G3	22,675	B5 U0 G3	23,069	B5 U0 G3
U	22,502	B5 U0 G3	26,051	B5 U0 G3	26,504	B5 U0 G4

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

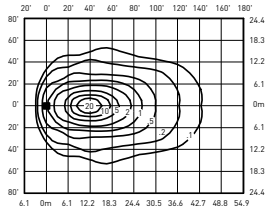
Photometry

All published luminaire photometric testing performed to IESNA LM-79-08 standards by a NVLAP accredited laboratory. To obtain an IES file specific to your project consult: http://lighting.cree.com/products/outdoor/area/osq-series

15D



CESTL Test Report #: PL07689-001A
OSQ-A-**-15D-U-30K-UL
Initial Delivered Lumens: 23,254

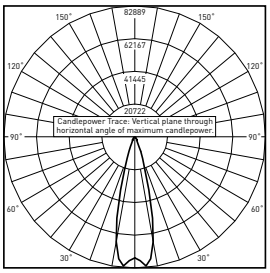


OSQ-A-**-15D-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 26,051
Initial FC at grade

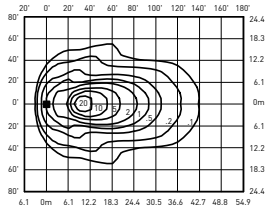
15° Flood Distribution			
Input Power Designator	3000K	4000K	5700K
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
T	19,586	22,675	23,069
U	22,502	26,051	26,504

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens

25D



CESTL Test Report #: PL07687-001A
OSQ-A-**-25D-U-30K-UL
Initial Delivered Lumens: 23,265

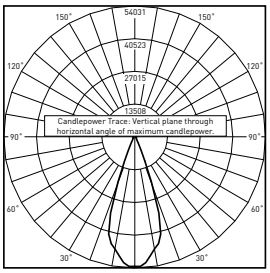


OSQ-A-**-25D-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 26,051
Initial FC at grade

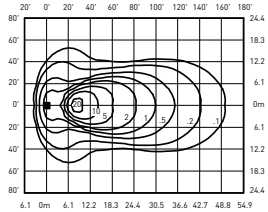
25° Flood Distribution			
Input Power Designator	3000K	4000K	5700K
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
T	19,586	22,675	23,069
U	22,502	26,051	26,504

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens

40D



CESTL Test Report #: PL07697-001A
OSQ-A-**-40D-U-30K-UL
Initial Delivered Lumens: 22,943



OSQ-A-**-40D-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 26,051
Initial FC at grade

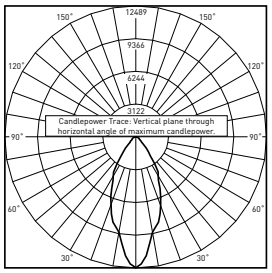
40° Flood Distribution			
Input Power Designator	3000K	4000K	5700K
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
T	19,586	22,675	23,069
U	22,502	26,051	26,504

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens

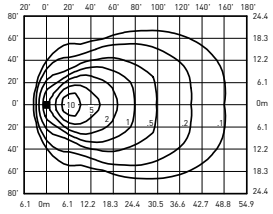
Photometry

All published luminaire photometric testing performed to IESNA LM-79-08 standards by a NVLAP accredited laboratory. To obtain an IES file specific to your project consult: http://lighting.cree.com/products/outdoor/area/osq-series

60D



CESTL Test Report #: PL08100-001B
OSQ-A-**-60D-B-30K-UL
Initial Delivered Lumens: 10,079

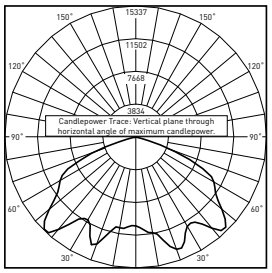


OSQ-A-**-60D-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 26,051
Initial FC at grade

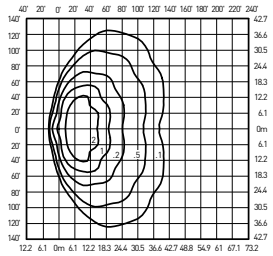
60° Flood Distribution			
Input Power Designator	3000K	4000K	5700K
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
T	19,586	22,675	23,069
U	22,502	26,051	26,504

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens

WSN



CESTL Test Report #: PL07695-001A
OSQ-A-**-WSN-U-30K-UL
Initial Delivered Lumens: 23,116



OSQ-A-**-WSN-U-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° tilt
Initial Delivered Lumens: 26,051
Initial FC at grade

Wide Sign Distribution			
Input Power Designator	3000K	4000K	5700K
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
T	19,586	22,675	23,069
U	22,502	26,051	26,504

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens

Luminaire EPA

Fixed Arm Mount – OSQ-DA Weight: 28.5 lbs. (13kg)					
Single	2 @ 180˚	2 @ 90˚	3 @ 90˚	3 @ 120˚	4 @ 90˚
					
0.80	1.61	1.26	2.06	1.68	2.52

Adjustable Arm Mount – OSQ-AA Weight: 28.5 lbs. (13kg)							
Single	2 @ 180˚	2 @ 90˚	3 @ 90˚	3 @ 120˚	3 @ 180˚	4 @ 180˚	4 @ 90˚
Tenon Configuration (0˚-80˚ Tilt); If used with Cree tenons, please add tenon EPA with Luminaire EPA							
 PB-1A*; PT-1; PW-1A3**	 PB-2A*; PB-2R2.375; PD-2A4(180); PT-2(180); PW-2A3**	 PB-2A*; PD-2A4(90); PT-2(90)	 PB-3A*; PD-3A4(90); PT-3(90)	 PB-3A*; PT-3(120)	 PB-3A*; PB-3R2.375	 PB-4A*(180)	 PB-4A*(90); PB-4R2.375; PD-4A4(90); PT-4(90)
0˚ Tilt							
0.80	1.61	1.26	2.06	1.68	3.33	4.66	2.52
10˚ Tilt							
0.81	1.61	1.62	2.42	2.32	4.40	6.08	3.24
20˚ Tilt							
1.24	1.61	2.04	2.84	3.13	5.68	7.80	4.08
30˚ Tilt							
1.64	1.64	2.44	3.24	3.97	6.88	9.40	4.88
45˚ Tilt							
2.20	2.20	3.00	3.80	5.07	8.55	11.64	6.00
60˚ Tilt							
2.63	2.63	3.43	4.23	5.73	9.84	13.36	6.86
70˚ Tilt							
2.82	2.82	3.62	4.42	5.73	10.41	14.12	7.24
80˚ Tilt							
2.93	2.93	3.73	4.53	5.73	10.74	14.56	7.46
Tenon Configuration (90˚ Tilt); If used with Cree tenons, please add tenon EPA with Luminaire EPA							
PB-1A*; PT-1; PW-1A3**	PB-2A*; PB-2R2.375; PD-2A4(180); PT-2(180); PW-2A3**	PB-2A*	PB-3A*	PB-3A*; PT-3(120)	PB-3A*; PB-3R2.375	PB-4A*(180)	PB-4A*(90); PB-4R2.375
90˚ Tilt							
2.95	2.95	4.84	6.52	5.73	10.81	14.64	11.19

* Specify pole size: 3 (3"), 4 (4"), 5 (5"), or 6 (6") for single, double or triple luminaire orientation or 4 (4"), 5 (5"), or 6 (6") for quad luminaire orientation
** These EPA values must be multiplied by the following ratio: Fixture Mounting Height/Total Pole Height. Specify pole size: 3 (3"), 4 (4"), 5 (5"), or 6 (6")

Tenon EPA

Part Number	EPA
PB-1A*	None
PB-2A*	0.82
PB-3A*	1.52
PB-4A*(180)	2.22
PB-4A*(90)	1.11
PB-2R2.375	0.92
PB-3R2.375	1.62
PB-4R2.375	2.32
PD Series Tenons	0.09
PT Series Tenons	0.10
PW-1A3**	0.47
PW-2A3**	0.94
WM-2	0.08
WM-4	0.25
WM-DM	None

* Specify pole size: 3 (3"), 4 (4"), 5 (5"), or 6 (6") for single, double or triple luminaire orientation or 4 (4"), 5 (5"), or 6 (6") for quad luminaire orientation
** These EPA values must be multiplied by the following ratio: Fixture Mounting Height/Total Pole Height. Specify pole size: 3 (3"), 4 (4"), 5 (5"), or 6 (6")

Tenons and Brackets‡ (must specify color)

Square Internal Mount Vertical Tenons (Steel)
- Mounts to 3-6" (76-152mm) square aluminum or steel poles

PB-1A* – Single
PB-2A* – 180˚ Twin
PB-3A* – 180˚ Triple
PB-4A*(90) – 90˚ Quad
PB-4A*(180) – 180˚ Quad

Square Internal Mount Horizontal Tenons (Aluminum)
- Mounts to 4" (102mm) square aluminum or steel poles

PD-2A4(90) – 90˚ Twin
PD-2A4(180) – 180˚ Twin
PD-3A4(90) – 90˚ Triple
PD-4A4(90) – 90˚ Quad

Wall Mount Brackets
- Mounts to wall or roof

WM-2 – Horizontal for OSQ-AA mount
WM-4 – L-Shape for OSQ-AA mount
WM-DM – Plate for OSQ-DA mount

Round External Mount Vertical Tenons (Steel)
- Mounts to 2.375" (60mm) O.D. round aluminum or steel poles or tenons

PB-2R2.375 – Twin
PB-3R2.375 – Triple
PB-4R2.375 – Quad

Round External Mount Horizontal Tenons (Aluminum)
- Mounts to 2.375" (60mm) O.D. round aluminum or steel poles or tenons
- Mounts to square pole with PB-1A* tenon

PT-1 – Single (Vertical)
PT-2(90) – 90˚ Twin
PT-2(180) – 180˚ Twin
PT-3(90) – 90˚ Triple
PT-4(90) – 90˚ Quad

Mid-Pole Bracket
- Mounts to square pole

PW-1A3** – Single
PW-2A3** – Double

Ground Mount Post
- For ground mounted flood luminaires

PGM-1 - for OSQ-AA mount

‡ Refer to the Bracket and Tenons spec sheet for more details

Direct Mount Configurations

Compatibility with OSQ-DA Direct Mount Bracket					
Input Power Designator	2 @ 90˚	2 @ 180˚	3 @ 90˚	3 @ 120˚	4 @ 90˚
3" Square					
T & U	N/A	✓	N/A	N/A	N/A
3" Round					
T & U	N/A	✓	N/A	N/A	N/A
4" Square					
T & U	✓	✓	✓	N/A	✓
4" Round					
T & U	✓	✓	✓	✓	✓
5" Square					
T & U	✓	✓	✓	N/A	✓
5" Round					
T & U	✓	✓	✓	✓	✓
6" Square					
T & U	✓	✓	✓	N/A	✓
6" Round					
T & U	✓	✓	✓	✓	✓

Field Adjustable Output (Q9/Q6/Q5/Q4/Q3/Q2/Q1) Option Description:

The Field Adjustable Output option enables the OSQ area luminaires to be tuned to the exact needs of a particular application through multiple levels of adjustment. When ordered with the Q option, the luminaire will be shipped from the factory at the selected Q setting and will be fully adjustable between the nine settings.

Q Option Power & Lumen Data – Designator T

Q Option Setting	CCT/CRI	System Watts	Lumen Values						Optics Qualified on DLC QPL	
		120-480V	Asymmetric	5ME	5SH & Floods	2ME w/BLS	3ME w/BLS	4ME w/BLS	Standard	Premium
Q9 (Full Power)	30K	166	20,688	18,544	19,586	15,897	16,333	15,897	5ME, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME, 5SH
	40K		21,902	21,469	22,675	16,830	17,291	16,830	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K		22,330	21,842	23,069	17,159	17,629	17,159	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q6	30K	151	18,826	16,875	17,823	14,466	14,863	14,466	5ME, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME, 5SH
	40K		19,931	19,537	20,634	15,315	15,735	15,315	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K		20,320	19,876	20,993	15,615	16,042	15,615	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q5	30K	135	16,964	15,206	16,061	13,036	13,393	13,036	5ME, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME, 5SH
	40K		17,960	17,605	18,594	13,801	14,179	13,801	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K		18,311	17,910	18,917	14,070	14,456	14,070	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q4	30K	115	15,102	13,537	14,298	11,605	11,923	11,605	5ME, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME, 5SH
	40K		15,988	15,672	16,553	12,286	12,622	12,286	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K		16,301	15,945	16,840	12,526	12,869	12,526	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q3	30K	96	13,033	11,683	12,339	10,015	10,290	10,015	5ME, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME, 5SH
	40K		13,798	13,525	14,285	10,603	10,893	10,603	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K		14,068	13,760	14,533	10,810	11,106	10,810	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q2	30K	79	10,551	9,457	9,989	8,107	8,330	8,107	5ME, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME, 5SH
	40K		11,170	10,949	11,564	8,583	8,818	8,583	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K		11,388	11,139	11,765	8,751	8,991	8,751	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q1/	30K	58	8,689	7,788	8,226	6,677	6,860	6,677	5ME, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME, 5SH
	40K		9,199	9,017	9,524	7,069	7,262	7,069	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K		9,379	9,174	9,689	7,207	7,404	7,207	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN

Field Adjustable Output (Q9/Q8/Q7/Q6/Q5/Q4/Q3/Q2/Q1) Option Description:

The Field Adjustable Output option enables the OSQ area luminaires to be tuned to the exact needs of a particular application through multiple levels of adjustment. When ordered with the Q option, the luminaire will be shipped from the factory at the selected Q setting and will be fully adjustable between the nine settings.

Q Option Power & Lumen Data – Designator U

Q Option Setting	CCT/CRI	System Watts	Lumen Values						Optics Qualified on DLC QPL	
		120-480V	Asymmetric	5ME	5SH & Floods	2ME w/BLS	3ME w/BLS	4ME w/BLS	Standard	Premium
Q9 (Full Power)	30K	215	25,246	21,305	22,502	19,400	19,931	19,400	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		26,583	24,666	26,051	20,427	20,986	20,427	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		27,103	25,095	26,504	20,826	21,397	20,826	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
Q8	30K	191	23,226	19,601	20,702	17,848	18,337	17,848	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		24,456	22,693	23,967	18,793	19,307	18,793	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		24,935	23,087	24,384	19,160	19,685	19,160	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
Q7	30K	171	21,207	17,896	18,902	16,296	16,742	16,296	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		22,330	20,719	21,883	17,159	17,628	17,159	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		22,767	21,080	22,263	17,494	17,973	17,494	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
Q6	30K	152	19,439	16,405	17,327	14,938	15,347	14,938	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		20,469	18,993	20,059	15,729	16,159	15,729	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		20,869	19,323	20,408	16,036	16,476	16,036	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
Q5	30K	133	17,672	14,914	15,751	13,580	13,952	13,580	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		18,608	17,266	18,236	14,299	14,690	14,299	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		18,972	17,567	18,553	14,578	14,978	14,578	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
Q4	30K	113	15,400	12,996	13,726	11,834	12,158	11,834	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		16,216	15,046	15,891	12,460	12,801	12,460	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		16,533	15,308	16,167	12,704	13,052	12,704	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
Q3	30K	94	13,128	11,079	11,701	10,088	10,364	10,088	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		13,823	12,826	13,547	10,622	10,913	10,622	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		14,094	13,049	13,782	10,830	11,126	10,830	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
Q2	30K	77	11,108	9,374	9,901	8,536	8,770	8,536	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		11,697	10,853	11,462	8,988	9,234	8,988	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		11,925	11,042	11,662	9,163	9,415	9,163	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
Q1	30K	53	7,574	6,392	6,751	5,820	5,979	5,820	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME
	40K		7,975	7,400	7,815	6,128	6,296	6,128	3ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 4ME
	57K		8,131	7,529	7,951	6,248	6,419	6,248	5ME, 5SH, 15D, 25D, 40D, 60D, WSN	2ME, 3ME, 4ME

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ZR-T TrueWhite® Series

ZR22™ 2' x 2' TrueWhite® Series LED Troffer with Gloss Finish

Product Description

The ZR-T TrueWhite® LED troffer delivers 3200 lumens of superior 90+ CRI light quality and is perfect for both new construction and renovation. Powered by Cree TrueWhite® Technology, the slim and lightweight ZR-T LED troffer boasts an efficacious 100 LPW along with 0-10V dimming to meet local energy codes. The ZR22™ LED troffer embodies a breakthrough in balancing energy savings, visual comfort and initial cost.

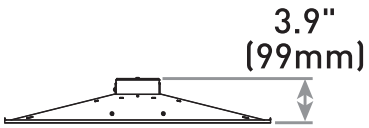


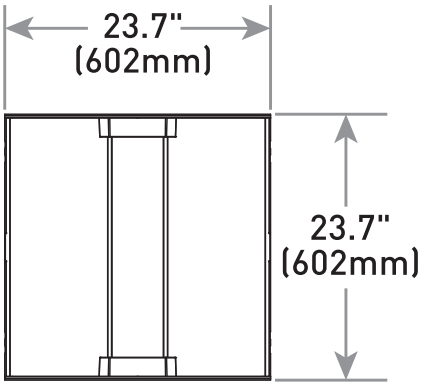
Performance Summary

- Utilizes Cree TrueWhite® Technology
- **Efficacy:** 100 LPW
- **Initial Delivered Lumens:** 3,200 lumens
- **Input Power:** 32 watts
- **CRI:** 90+ CRI
- **CCT:** 3000K, 3500K, 4000K, 5000K
- **Input Voltage:** 120-277 VAC or 347 VAC
- **Limited Warranty†:** 10 years on luminaire
- **Limited Warranty Emergency Back Up (EB) Battery**: 1 Year on Battery Back Up. Test regularly in accordance with local codes
- **Controls:** 0-10V dimming to 5%
- **Mounting:** Recessed*
- Room-side accessible snap and lock removable lens

† See http://lighting.cree.com/warranty for warranty terms

* Not intended for use with 9/16" T-Bar grids unless used with a 9/16" accessory clip like "Armstrong® LFC- Fixture Clip" which can be purchased through distribution. Consult factory for non-standard grid applications.





Accessories

Field-Installed	
Drywall Grid Adapter DGA22-WHT **Surface Mount Kit** SMK-ZR22 - Not for use with EB14 or SmartCast® Technology **6' Flexible Power Whip** PW-18/4-06-9T/SS - For use in non-dimming applications only	**Wireless 0-10V Dimming/Switching Interface with Cree Smartcast® Technology** CIF-10V-CWC-SNSR - For use with luminaires with 10V controls when integral SmartCast isn't available **Cree SmartCast® Technology Configuration Tool** CCT-CWC-1 - One required per project when CIF-10V is selected **Chicago Plenum Field Kit** CPLZR - Fits all ZR types to be installed in the field

Ordering Information

Example: ZR22T-32L-35K-10V

ZR22T	32L			10V	
Product	**Initial Delivered Lumens**	**CCT**	**Voltage**	**Control**	**Options**
ZR22T	**32L** 32W, 3,200 Lumens	**30K** 3000K **35K** 3500K **40K** 4000K **50K** 5000K	**Blank** 120-277 Volt **34** 347 Volt	**10V** 0-10V dimming to 5%	**EB14 Emergency Backup** - 1,400 lumens - Not available with 347 Volt - Provides 90 minutes of emergency operation

Rev. Date: V2 05/04/2017

US: lighting.cree.com T (800) 236-6800 F (262) 504-5415

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Product Specifications

CREE TRUEWHITE® TECHNOLOGY

A revolutionary way to generate high-quality white light, Cree TrueWhite® Technology is a patented approach that delivers an exclusive combination of 90+ CRI, beautiful light characteristics, and lifelong color consistency, all while maintaining high luminous efficacy – a true no compromise solution.

CONSTRUCTION & MATERIALS

- Durable 22 ga. cold rolled steel housing provides strength and uniformity
- Ultra-thin 3.9" (99mm) luminaire height and lightweight design effectively target a broad range of plenum spaces and allow for easy installations
- Luminaire is pre-painted for enhanced smooth finish
- Includes t-bar clips and holes for mounting support wires (by others)
- Luminaire sides and ends are hemmed in for safe, easy handling
- Includes lens gasket to prevent ingress of insects
- Not for installation within 3" (76mm) of insulation
- Removable lens for easy maintenance and cleaning
- Magnetic lens to prevent dust and bug intrusion

OPTICAL SYSTEM

- Unique luminaire design creates perfect balance of both horizontal and vertical illumination
- Optimized smooth acrylic lens eliminates pixelation and delivers a low-glare, diffused light distribution

ELECTRICAL SYSTEM

- Cree born components including highly efficacious Cree® LED chips along with an integral high-efficiency Cree® driver
- **Power Factor:** = 0.9 nominal for 120-277V
- **Input Power:** Stays constant over life
- **Input Voltage:** 120-277V or 347V, 60Hz
- **Operating Temperature Range:** 0˚C - + 35˚C (32˚F - + 95˚F)
- **Total Harmonic Distortion:** < 20% for standard fixtures; < 25% for EB option

CONTROLS

- Continuous dimming to 5% with 0-10V DC control protocol
- **10V Source Current:** 0.25mA
- For use with Class 2 dimming systems only
- Use only lighting controls with neutral connection or controls intended for use with LED fixtures
- Reference www.creelink.com/exLink.asp?7098214OZ58R34I26620963 for recommended dimming controls and wiring diagrams

REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus Listed
- Suitable for damp locations
- Designed for indoor use
- UL924 (EB option). Maximum mounting height: 15.0' (4.6m)
- RoHS compliant. Consult factory for additional details
- Meets FCC Part 15, Subpart B, Class A standards for conducted and radiated emissions
- DLC qualified. Please refer to www.designlights.org/QPL for most current information

Electrical Data*

Initial Delivered Lumens	System Watts 120-347V	Total Current (A)				
		120V	208V	240V	277V	347V
32L	32	0.25	0.16	0.14	0.12	0.10
32L w/EB14 Option	36	0.32	0.19	0.17	0.14	0.12

* Electrical data at 25˚C (77˚F). Actual wattage may differ by +/- 10% when operating between 120-347V +/- 10%

Recommended ZR-T Series Lumen Maintenance Factors (LMF)[1]

Ambient	Initial LMF	25K hr Projected[2] LMF	50K hr Projected[2] LMF	75K hr Calculated[3] LMF	100K hr Calculated[3] LMF
0˚C (32˚F)	1.04	1.04	1.04	1.04	1.04
5˚C (41˚F)	1.03	1.03	1.03	1.03	1.03
10˚C (50˚F)	1.02	1.02	1.02	1.02	1.02
15˚C (59˚F)	1.02	1.02	1.02	1.02	1.02
20˚C (68˚F)	1.01	1.01	1.01	1.01	1.01
25˚C (77˚F)	1.00	1.00	1.00	1.00	1.00
30˚C (86˚F)	0.99	0.99	0.99	0.99	0.99
35˚C (95˚F)	0.98	0.98	0.98	0.98	0.98

[1] Lumen maintenance values at 25˚C are calculated per TM-21 based on LM-80 data and in-situ luminaire testing
[2] In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ([DUT) i.e. the packaged LED chip)
[3] In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ([DUT) i.e. the packaged LED chip)

Application Reference

Open Space

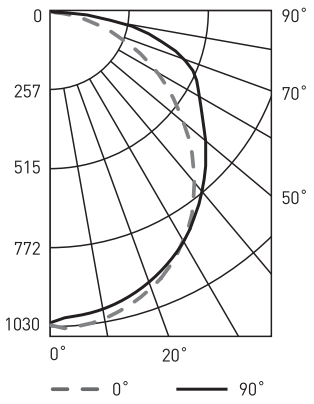
Spacing	Lumens	Wattage	LPW	w/ft²	Average fc
8 x 8	3,200	32	100	0.48	45
8 x 10				0.40	38
10 x 10				0.32	30
10 x 12				0.26	24

10' ceiling: 80/50/20 reflectances; 2.5' workplane, open room. LLF: 1.0 Initial Open Space: 50' x 40' x 10'

Photometry

ZR22T-32L-30K -10V BASED ON DTC REPORT TEST #: PL10546-001

Luminaire photometry has been conducted by a NVLAP accredited testing laboratory in accordance with IESNA LM-79-08. IESNA LM-79-08 specifies the entire luminaire as the source resulting in a luminaire efficiency of 100%.



Coefficients Of Utilization – Zonal Cavity Method				
RC %:	80			
RW %:	70	50	30	10
RCR: 0	119	119	119	119
1	108	102	98	93
2	97	88	81	75
3	88	77	68	62
4	81	68	59	52
5	74	61	51	44
6	68	54	45	39
7	63	49	40	34
8	59	45	36	30
9	55	41	33	27
10	52	38	30	25

Effective Floor Cavity Reflectance: 20%

Zonal Lumen Summary			
Zone	Lumens	% Lamp	Luminaire
0-30	791	N/A	25.3%
0-40	1,294	N/A	41.4%
0-60	2,308	N/A	73.8%
0-90	3,127	N/A	100%
0-180	3,127	N/A	100%

Average Luminance Table (cd/m²)				
Vertical Angle	Horizontal Angle			
	0°	45°	90°
45°	13,826	14,649	15,216
55°	12,758	14,590	15,944
65°	11,451	15,430	18,755
75°	9,523	17,908	21,834
85°	6,777	17,451	20,038

Reference http://lighting.cree.com/products/indoor/troffers/zr-series for detailed photometric data

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CREE™

LED 40/60/75w

A19 REPLACEMENTS



WE BELIEVE IN BETTER LIGHT™

SUGGESTED USE:



OMNIDIRECTIONAL LIGHT SOURCE

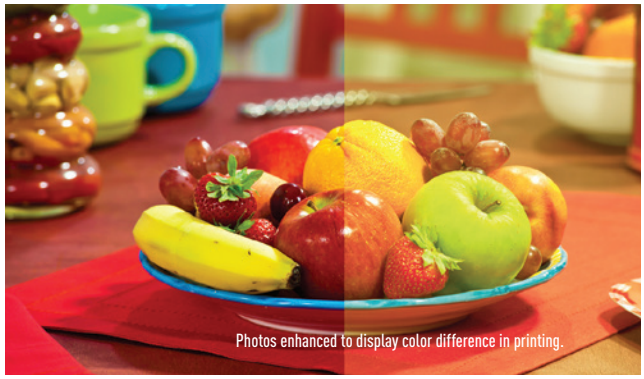
Better light is beautiful light; it makes colors appear richer, true and natural.

Choose better.

At Cree®, we believe in better lighting. Better light is beautiful light. But it's more than just beautiful. It is light that makes you feel more productive, more relaxed and safer. Better light changes everything.

That's why the new and improved Cree LED bulbs feature high color rendering that enhances your space and makes the colors of your décor appear vibrant, richer and more natural – true colors the way they are meant to be experienced.

Cree Light | Other Light





CREE 40, 60 & 75W REPLACEMENT LED LIGHT BULBS

	40-Watt Soft White/Daylight Replacement	60-Watt Soft White/Daylight Replacement	75-Watt Soft White/Daylight Replacement
Color Temperature (K)	2700/5000	2700/5000	2700/5000
Lumens	465/470	815/820	1130/1150
Energy Used (Watts)	5.5/5	9.5/8.5	11.2/10.2
Annual Savings†	$4.16/$4.22	$6.08/6.20	$7.68/$7.81
Color Rendering Index	85+	85+	85+
Rated Life (Hours)	35,000	35,000	35,000
Beam Spread	Omnidirectional	Omnidirectional	Omnidirectional
Bulb Size	A19	A19	A19

† At $0.11 per kWh when compared to 40W/60W/75W incandescent. 25,000 hour lifetime

What makes them better?

Unlike some others, Cree doesn't compromise.

85+ CRI — **High color rendering**
Better light for better colors

Longer LED lifetime lasts 32 years (35,000 hours)
Up to 7x as long as the cheap LED bulbs

5 year commercial use warranty
Better light lasts longer and saves your more

Dimmable. No buzz. No hum.
For a list of compatible dimmers visit creebulb.com/dimmers

Omnidirectional light source
Shines up, down and all-around like a light bulb should

ENERGY STAR® qualified
For high performance and superior energy efficiency

CREE™ lighting.cree.com

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CAT/SSHT-C077 Rev. Date: 04/24/2017

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A19 Series

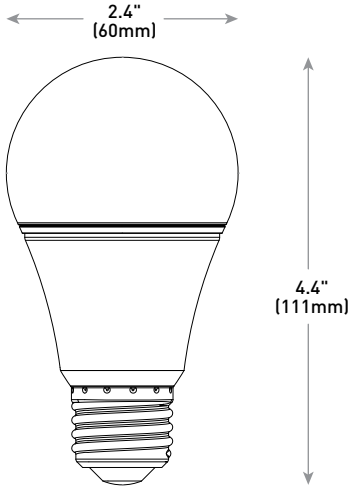
LED Lamps

Product Description

At Cree®, we believe in better lighting. Better light is beautiful light. But it's more than just beautiful. It is light that makes you feel more productive, more relaxed and safer. Better light changes everything. That's why the new and improved Cree LED bulbs feature high color rendering that enhances your space and makes the colors of your décor appear vibrant, richer and more natural – true colors the way they are meant to be experienced.

The Cree® LED A19 bulbs deliver up to 1,150 lumens of soft white 2700K light or 5000K daylight, while consuming at least 84% less energy than the incandescent bulbs they replace. These lamps feature a consistent and balanced omnidirectional light source, turn on instantly, and are compatible with most standard incandescent dimmers; no buzz, no hum. The Cree® LED A19 bulbs are ENERGY STAR® certified and are designed to last 35,000 hours.





Performance Summary

Lamp Delivered Light Output: 465-1,150 lumens

Input Power: 5.0-5.5 watts (40W equivalent); 8.5-9.5 watts (60W equivalent); 10.2-11.2 watts (75W equivalent)

CRI: 85

CCT: 2700K, 5000K

Limited Warranty†: 5 years Commercial use

Lifetime: Designed to last at least 35,000 hours

Dimming: Dimmable to 5% with select dimmers

ENERGY STAR® Certified

Must order in multiples of master carton (MC) quantities; MC = (24) Single-Lamp Cartons

† See http://lighting.cree.com/warranty for warranty terms

Ordering Information

Example: A19-40W-27K-U1

A19						U1
Product	**Watt Equivalent**	**CCT**	**Voltage**	**Base**	**CRI**	**Packaging**
A19	**40W** 40 Watt, 465-470 lumens **60W** 60 Watt, 815-820 lumens **75W** 75 Watt, 1,130-1,150 lumens	**27K** 2700K **50K** 5000K	**Blank** 120 Volt	**Blank** E26 (screw base)	**Blank** 85	**U1 Single-Lamp Carton** Master Carton = (24) Single-Lamp Cartons

US: lighting.cree.com T (800) 236-6800 F (262) 504-5415

Canada: www.cree.com/canada T (800) 473-1234 F (800) 890-7507

Product Specifications

CONSTRUCTION & MATERIALS

- 40 & 60W A-type bulb design weighs 3.0 ounces (86g)
- 75W A-type bulb design weighs 5.1 ounces (145.0g)
- Bulb meets ANSI standards for A19 dimensions
- Uses a standard E26 screw base
- Mercury free
- **Dimensions:** 4.5" H x 2.375" W x 2.375" D (Single-Lamp Carton); 5.0" H x 10.125" W x 15.0" D (Master Carton)

OPTICAL SYSTEM

- Omnidirectional light distribution
- Plastic globe offers increased optical spread

ELECTRICAL SYSTEM

- **Power Factor:** > 0.9 nominal
- **Input Voltage:** 120V, 60Hz
- **Dimming:** Dimmable to 5% with select dimmers. Refer to https://www.creelink.com/viewcontent.asp?qv=1&docid=5344 for additional details
- **Operating Temperature Range:** -25˚C - +45˚C (-13˚F - +113˚F)

REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus Listed
- Suitable for damp locations, but not for use where exposed directly to weather or water
- Do not use in enclosed fixtures
- Meets FCC Part 15, Subpart B, Class B standards for conducted and radiated emissions
- ENERGY STAR® certified. Please refer to http://www.energystar.gov/productfinder/product/certified-light-bulbs/ results for most current information
  A19-40W-27K-U1
  A19-40W-50K-U1
  A19-60W-27K-U1
  A19-60W-50K-U1
  A19-75W-27K-U1
  A19-75W-50K-U1
- RoHS compliant. Consult factory for additional details

Packaging

(24) Single-Lamp Cartons in Master Carton (24 Total Lamps)









Ordering Number	Single-Lamp Carton UPC	Description	Bulb Type	Watts	CCT	Single-Lamp Cartons per Master Carton	Master Carton ITF-14	Total Lamps per Master Carton	Master Cartons per Pallet Qty	CRI	Lumens	Rated Life (Hrs)
A19-40W-27K-U1	849665017516	40W Soft White A19 Equivalent	A19	5.5	2700K	24	10849665017513	24	80	85	465	35,000
A19-40W-50K-U1	849665017523	40W Daylight A19 Equivalent	A19	5.0	5000K	24	10849665017520	24	80	85	470	35,000
A19-60W-27K-U1	849665017530	60W Soft White A19 Equivalent	A19	9.5	2700K	24	10849665017537	24	80	85	815	35,000
A19-60W-50K-U1	849665017547	60W Daylight A19 Equivalent	A19	8.5	5000K	24	10849665017544	24	80	85	820	35,000
A19-75W-27K-U1	849665017554	75W Soft White A19 Equivalent	A19	11.2	2700K	24	10849665017551	24	80	85	1,130	35,000
A19-75W-50K-U1	849665017561	75W Daylight A19 Equivalent	A19	10.2	5000K	24	10849665017568	24	80	85	1,150	35,000

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US: lighting.cree.com T (800) 236-6800 F (262) 504-5415 **Canada: www.cree.com/canada** T (800) 473-1234 F (800) 890-7507

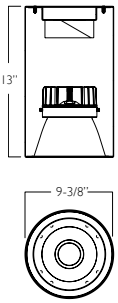
SCH8-LED 8” ARCHITECTURAL CYLINDER LED DOWNLIGHT & UP/DOWNLIGHT

Catalog Number	SCH8-LED-WM-3000L-DIM10-120-WD-85-HH8-8501-CL-WH
Project Name	Type

SAME DAY SHIPPING AVAILABLE

NEW



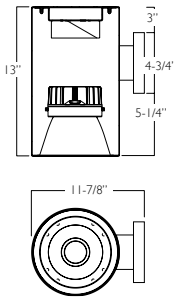


SCH8-LED-CM

4000 LUMENS



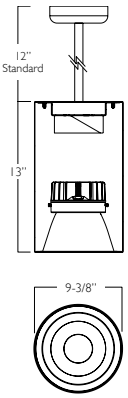
SCH8-LED-WM



SCH8-LED-UWM

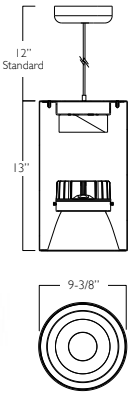


SCH8-LED-PM





SCH8-LED-SM



INPUT VOLT.	INPUT FREQ.	INPUT CUR.	THD	POWER FACTOR	INPUT POWER	LUMENS
120/277	50/60Hz	408mA/176mA	<20%	>0.9	49W(+/-5%)	4000
120/277	50/60Hz	383mA/166mA	<20%	>0.9	40W(+/-5%)	3000
120/277	50/60Hz	266mA/115mA	<20%	>0.9	32W(+/-5%)	2000
120/277	50/60Hz	200mA/86mA	<20%	>0.9	24W(+/-5%)	1200
120/277	50/60Hz	150mA/65mA	<20%	>0.9	16W(+/-5%)	900

DESCRIPTION - 8” LED Architectural Cylinder Downlight with integral LED heat management casting and driver (installed on junction box). Available in 900 lumens, 1200 lumens, 2000 lumens, 3000 lumens & 4000 lumens. Lighting is smooth and comfortable while using 50% less energy than the common CFL downlight. Plus the eco-friendly MAXILUME LED system features 70% lumen maintenance at 50,000hrs of life, with Energy Star and California Title-24 (compliances pending).

FEATURES - MAXILUME LED luminaires are ideally suited for use in hospitality, health care, commercial, academic institutions, retail and other architectural applications.

PROUDLY ASSEMBLED in AMERICA

c UL us LISTED

c ETL us Intertek

ENERGY STAR PENDING

OPTICS - MAXILUME LED Optilux technology combines unmatched performance with visual comfort. Spun 0.05” thick reflector has been designed to gather the light scattered by the LED chip and shape it into functional beams that minimize brightness and glare, while eliminating lamp image. Reflector offers a 55 degree cutoff and smooth frost acrylic diffuser distributes light even throughout the workplace.

PERFORMANCE - Operating system delivers 900 lumens, 1200 lumens, 2000 lumens, 3000 lumens & 4000 lumens. All MAXILUME LED luminaries are rated at 85+, 90+ and 98+ CRI. Elite’s highly selective LED chips produce zero ultraviolet and virtually no infrared light. All LED luminaries are rated and tested to LM-79 and LM-80 standards by an independent laboratory.

THERMAL MANAGEMENT SYSTEM - Using a proprietary cooLED Advanced Thermodynamic Design, Die-cast aluminum housing and heat management system are engineered for extremely long life and service period. Heat sink is attached to top of housing. The LED light engine is attached to the die-cast heat sink and is easily replaceable and upgradable. Life tests have shown the MAXILUME light engine output will be maintained at 70% of initial at 50,000hrs of operation.

DIMMABLE - The MAXILUME LED system is fully dimmable down to 1% of initial light output with a 0-10 Volt dimmer when ordered with the following options (DIM10-120, DIM10-277). Fixtures can be shipped with a Lutron Hi-lume A series Driver which can be dimmed with Lutron Dimming Systems when ordered with the following options (120-LUTH, 277-LUTH). Triac & Electronic Low Voltage dimming driver also available when ordered with the following options (DIMTR-120). Consult Factory for details. All fixtures with 3000L and below are dimmable down to 1% and the fixtures with 4000L and above can be dimmed down to 10%.

BODY - Post painted die-formed construction for maximum heat dissipation and rust protection. Matte white finish standard.

LED DRIVER/JUNCTION BOX - The LED driver is rated for 50 to 60Hz at 120V /277V input, produces less than 20%THD, and has a power factor between 90% and 100% and is thermally protected for additional safety. MAXILUME’s LED driver is installed on the junction box cover so it may be serviced from below the ceiling. UL Listed for through-branch circuit wiring, provided with four 1/2” knockouts, one 3/4” knockout and four Romex knockouts with true pry out slots and strain clamps.

MOUNTING BRACKET - Ceiling mount bracket provided for direct installation with 3-1/4” to 4” octagonal and square junction box. Pendant mount option is available and supplied with 10-1/2” stem and 5” diameter canopy cover. Ideal for slope applications up to 45 degrees. Suspended mount option is also available supplied with aircraft adjustable cable.

OUR WORD - The MAXILUME LED lighting system carries a five-year carefree warranty for parts and components. (Labor not included.)

LISTING

c-UL-us / c-ETL-us - listed for Damp location.
c-UL-us / c-ETL-us - listed for feed Through Wiring.
LM79 / LM80

DIMMING INFORMATION

DIM10 (0-10V Dimming)
LUTH (Lutron® Hi-lume® Dimming)
DIMTR (Triac & Electronic Low Voltage Dimming)

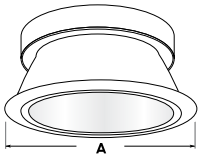
Custom color available, please consult factory.
Must provide RAL#

Example: **SCH8-LED-CM-WH-900L-DIM10-120-MD-30K-90-HH8-8501-CL-WH**

SCH8-LED - WM		- 3000L-DIM10			- 120	- WD		- 85		- HH8-8501		- CL-WH	
TYPE	FINISH	LUMENS/DRIVER			VOLTAGE	OPTICS	CCT	CRI	EMERGENCY	TRIM TYPE		REFLECTOR/ RING FINISH	DISC
		900L SERIES	1200L SERIES	1500L SERIES						NO DISC	WITH DISC		
SCH8-LED	❑ WH-WHITE	❑ 900L-DIM10	❑ 1200L-DIM10	❑ 1500L-DIM10	❑ 120	❑ WD (Wide)	❑ 27K	❑ 85+	☐ EMG-LED	❑ HH8-8501	❑ HH8-8509	❑ CL-WH	❑ BLUE
MOUNTING	❑ BK-BLACK	❑ 900L-DIMTR [1]	❑ 1200L-DIMTR [1]	❑ 1500L-DIMTR [1]	❑ 277	❑ MD (Medium)	❑ 30K	❑ 90+	Typical lumen output of the fixture is up to 1000L in emergency mode. Contact the factory for details.	❑ HH8-8507	❑ HH8-8510	❑ CL-SCH	❑ RED
❑ CM-CEILING MOUNT	❑ Bz- BRONZE	❑ 900L-LUTH [2]	❑ 1200L-LUTH [2]	❑ 1500L-LUTH [2]	❑ 347 (DIM10 only)	❑ ND (Narrow)	❑ 35K	❑ 98+ [4]		❑ HH8-8521	❑ HH8-8511	❑ SHZ-SHZ	❑ GREEN
❑ WM-WALL MOUNT	❑ SI-SILVER	❑ 900L-LUT2W [1]	❑ 1200L-LUT2W [1]	❑ 1500L-LUT2W [1]			❑ 40K			❑ HH8-8522	❑ HH8-8528	❑ SHZ-WH	❑ FROST
❑ UWM-UP/DOWN WALL MOUNT ONLY		❑ 900L-ELDO10-.1 [2]	❑ 1200L-ELDO10-.1 [2]	❑ 1500L-ELDO10-.1 [2]			❑ 50K [3] (85+CRI only)			❑ HH8-8523		❑ W-WH	❑ AL
❑ PM12-12”		❑ 900L-ELDODALI -.1 [2]	❑ 1200L-ELDODALI -.1 [2]	❑ 1500L-ELDODALI -.1 [2]						❑ HH8-8525		❑ MB-WH	❑ BZ
❑ PM18-18”		❑ 900L-ELDODMX -.1 [2]	❑ 1200L-ELDODMX -.1 [2]	❑ 1500L-ELDODMX -.1 [2]						❑ HH8-8577		❑ WT-WH	❑ WH
❑ PM24-24”		2000L SERIES	3000L SERIES	4000L SERIES									
❑ PM36-36”		❑ 2000L-DIM10	❑ 3000L-DIM10	❑ 4000L-DIM10									
❑ PM48-48”		❑ 2000L-DIMTR [1]	❑ 3000L-LUTH [2]	❑ 4000L-LUTH [2]									
❑ SM-10’ SUSPENDED MOUNT (Consult factory for other sizes)		❑ 2000L-LUTH [2]	❑ 3000L-LUT2W [1]	❑ 4000L-LUT2W [1]									
		❑ 2000L-LUT2W [1]	❑ 3000L-ELDO10-.1 [2]	❑ 4000L-ELDO10-.1 [2]									
		❑ 2000L-ELDO10-.1 [2]	❑ 3000L-ELDODALI -.1 [2]	❑ 4000L-ELDODALI -.1 [2]									
		❑ 2000L-ELDODALI -.1 [2]	❑ 3000L-ELDODMX -.1 [2]	❑ 4000L-ELDODMX -.1 [2]									
		❑ 2000L-ELDODMX -.1 [2]											

[1] **LUT2W** and **DIMTR** are available in 120V only [2] **LUTH, ELD010-.1, ELDODALI -.1, and ELDODMX-.1** are available in 120V and 277V [3] **50K** series are available with 85+ CRI only [4] **98+** CRI is available in 27K, 30K and 40K only

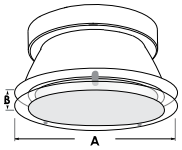




A= 9-1/4"

EXAMPLE: HH8-8501-CL-WH
HH8-8501 - REFLECTOR WITH DIFFUSE LENS
REFLECTOR/RING FINISH:
CL-WH CL-SCH WT-WH SHZ-WH W-WH SHZ-SHZ MB-WH

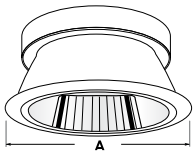




A= 9-1/4"
B= 1"

EXAMPLE: HH8-8509-CL-WH
HH8-8509 - DECO GLASS REFLECTOR WITH DIFFUSE LENS
REFLECTOR/RING FINISH:
CL-WH CL-SCH WT-WH SHZ-WH W-WH SHZ-SHZ MB-WH
GLASS FINISH:
BLUE, RED, GREEN, FROST

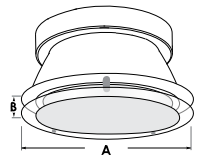




A= 9-1/4"

EXAMPLE: HH8-8507-CL-WH
HH8-8507 - WALL WASH REFLECTOR WITH DIFFUSE LENS
REFLECTOR/RING FINISH:
CL-WH CL-SCH WT-WH SHZ-WH W-WH SHZ-SHZ MB-WH

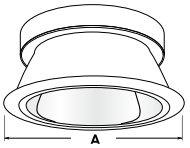




A= 9-1/4"
B= 1"

EXAMPLE: HH8-8525-CL-WH
HH8-8525 - CENTRAL ETCHED FLOAT GLASS WITH DIFFUSE LENS
REFLECTOR/RING FINISH:
CL-WH CL-SCH WT-WH SHZ-WH W-WH SHZ-SHZ MB-WH

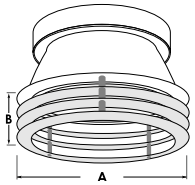




A= 9-1/4"

EXAMPLE: HH8-8577-CL-WH
HH8-8577 - DOUBLE WALL WASH REFLECTOR WITH DIFFUSE LENS
REFLECTOR/RING FINISH:
CL-WH CL-SCH WT-WH SHZ-WH W-WH SHZ-SHZ MB-WH





A= 9-1/4"
B= 2-3/4"

EXAMPLE: HH8-8511-CL-WH
HH8-8511 - TRIPLE RING GLASS WITH DIFFUSE LENS
REFLECTOR/RING FINISH:
CL-WH CL-SCH WT-WH SHZ-WH W-WH SHZ-SHZ MB-WH
GLASS FINISH:
BLUE, RED, GREEN, FROST



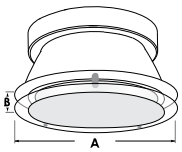
EXAMPLE: HH8-8528-CL-WH-AL
HH8-8528 - REFLECTOR WITH ALUMINIUM DISC AND DIFFUSE LENS
REFLECTOR FINISH:
CL-WH CL-SCH WT-WH SHZ-WH W-WH SHZ-SHZ MB-WH
DISC FINISH:
AL, WH, BZ



HH8-8528-CL-W-WH



HH8-8528-CL-WH-BZ

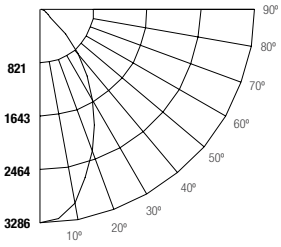


A= 9-1/4"
B= 1"

SCH8-LED-CM-WH-3000L-DIM10-120-WD-40K-HH8-8501-SHZ-SHZ TEST NO.: **EL-101367**

INPUT WATTS: **46** LUMENS: **3025** CRI: **85+** EFFICACY: **65.7** CCT: **4000K** SPACING CRITERIA: **0.88**

Candle Power Distribution (Candelas)



Cone of Light		
4.0	205.4	4.2'
8.0	51.3	8.5'
12.0	22.8	12.7'
16.0	12.8	17.0'
20.0	8.2	21.2'
Distance to Plane	Initial Footcandle at Nadir	Beam diameter

BEAM DIA. MEASURED AT 50% OF NADIR F.C.

Zonal Lumens Summary

Zone	Lumens	%Lamp	%Fixt
0-20	1011.97	33.70	33.50
0-30	1849.76	61.60	61.20
0-40	2553.15	85.00	84.40
0-60	2991.76	99.60	98.90
0-80	3021.47	100.60	99.90
0-90	3024.83	100.70	100.00

Luminance (Average candela/M^2)

Angle in Degrees	Average 0°	Average 45°	Average 90°
45	24409	24342	14865
55	8248	6564	2499
65	4297	1336	821
75	1194	794	406
85	2402	1746	231

Lumens Per Zone

Zone	Lumens
0-10	295.05
10-20	716.92
20-30	837.79
30-40	703.40
40-50	352.64
50-60	85.97
60-70	23.34
70-80	6.36
80-90	3.36

Candela Tabulation

	0
0	3285
5	3228
15	2677
25	1965
35	1253
45	549
55	150
65	57
75	9
85	6
90	5

Coefficients of Utilization - Zonal Cavity Method
Effective Floor Cavity Reflectance 0.20

	RC	80%				70%				50%			30%			10%			0%
	RW	70%	50%	30%	10%	70%	50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%	0%
ROOM CAVITY RATIO	0	120	120	120	120	117	117	117	117	112	112	112	107	107	107	103	103	103	101
	1	114	111	108	106	111	109	106	104	105	103	101	101	99	98	97	96	95	93
	2	108	102	98	94	105	101	97	93	97	94	91	94	92	89	92	89	87	86
	3	102	95	89	85	100	93	88	84	91	86	83	88	85	82	86	83	80	79
	4	96	88	82	77	94	87	81	77	84	80	76	82	78	75	80	77	74	73
	5	91	82	75	71	89	81	75	70	79	74	70	77	73	69	76	72	68	67
	6	86	76	70	65	84	75	69	65	74	68	64	72	68	64	71	67	63	62
	7	81	71	65	60	80	70	64	60	69	64	60	68	63	59	67	62	59	57
	8	77	67	60	56	76	66	60	56	65	59	55	64	59	55	63	58	55	53
	9	73	63	56	52	72	62	56	52	61	56	52	60	55	51	59	55	51	50
	10	69	59	53	49	68	58	53	49	58	52	48	57	52	48	56	51	48	47

***RC** - Ceiling Cavity Reflectance* ***RW** - Wall Reflectance*

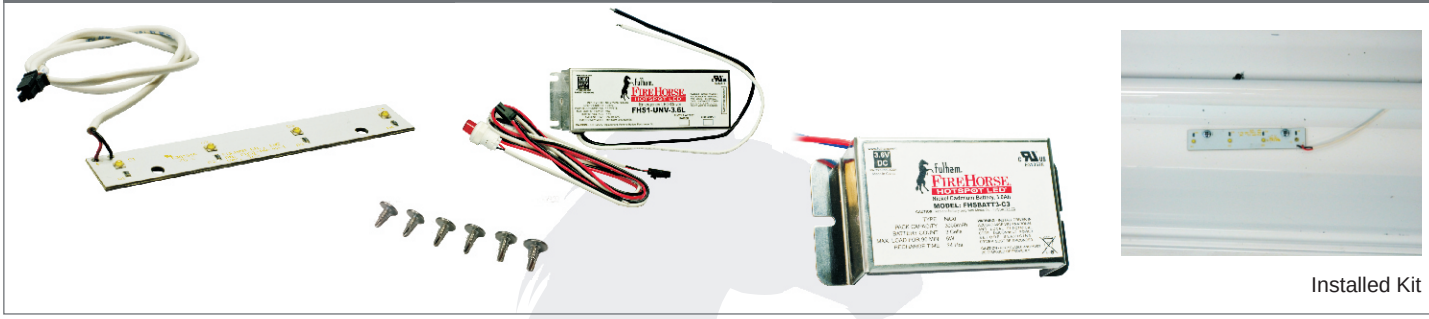
Due to the changes of constant improvement in LED technology, all details are subject to change without notice.
Consult factory for up to date information.

Specification Sheet : FHSKITT04LNC

Project:_____Type:_____Model No.:_____

Remarks:_____

HotSpot UL Classified Kits



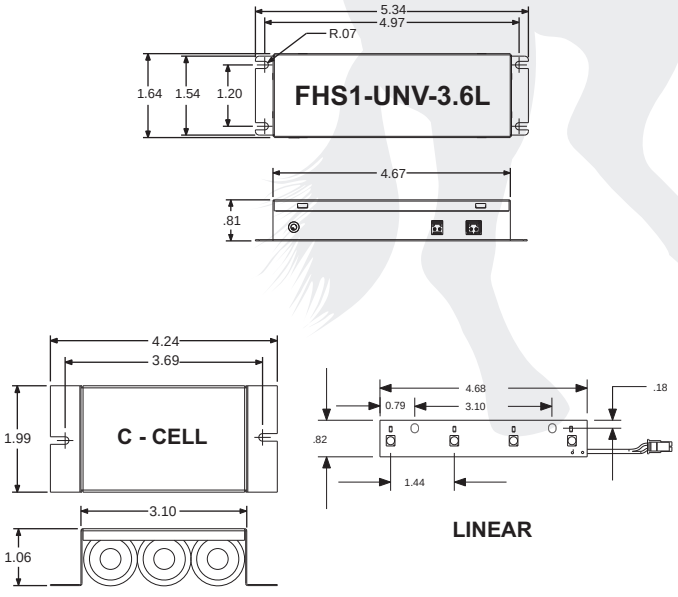
Installed Kit

Specification:

CLASSIFIED c UL us E365124

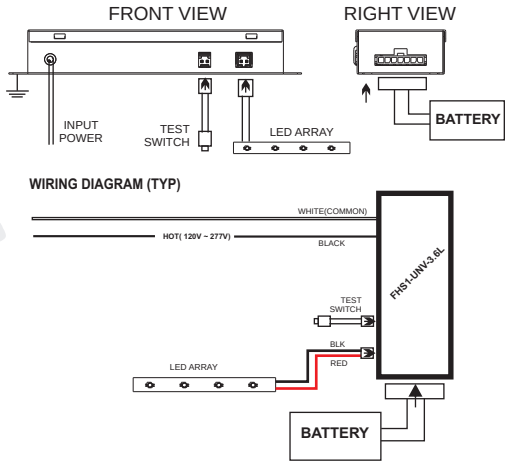
INPUT VOLTAGE	120V - 277V ± 10%, 47-63Hz
SURGE PROTECTION	C62.41 (TVS)
OVER CURRENT PROTECTION	FUSE
INPUT CURRENT	0.07A
INPUT POWER	<4W
LUMEN OUTPUT	500 LUMENS
MAXIMUM OUTPUT CURRENT	2.1 AMP WHEN USED WITH # FHSBATT3-C3
OUTPUT VOLTAGE	3.6V
OUTPUT SHORT CIRCUIT PROTECTION	SELF RESETTING PTC
RECHARGE TIME REQUIRED	24 HRS
BATTERY TYPE	NiCd 3.6VDC
BATTERY CAPACITY AVAILABLE	3Ah
ILLUMUNATION TIME	MINIMUM 90 MIN
ESTIMATED RUN TIME	145 MIN
OUTPUT CLASSIFICATION	UL 1310 / CLASS 2
AMBIENT TEMPERATURE	0ºC - 50ºC

Mechanical Data:



Wiring Diagram

WIRE	BLACK	WHITE	BATTERY- LED ARRAY- TEST SWITCH- PILOT LIGHT
LENGTH - INCHES	12 ± 1"	12 ± 1"	24 ± 1"



Fulham extends a limited warranty only to the original purchaser or to the first user for a period of 5 years from the date of manufacture when properly installed and operated under normal conditions of use. For complete terms and conditions, please reference the Fulham product catalog (www.fulham.com)
Due to a program of continuous improvement, Fulham reserves the right to make modifications or variations in design or construction to the equipment described.

INSTALLATION INSTRUCTIONS

1.5X4



2X2



2X4



FHSKIT-TXXLNXX or FHSKIT-TXXXHXX

HotSpot1 LED Emergency Kit

Troffer Luminaires

TABLE OF CONTENTS

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3.0 HOTSPOT LED KIT PARTS ..... PAGE 4

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5.0 HOTSPOT LED KIT SETUP ..... PAGES 7-12

6.0 WARRANTY ..... PAGE 13

1.0 INSTALLATION INSTRUCTION WARNINGS

IMPORTANT SAFEGUARDS READ AND FOLLOW ALL SAFETY INSTRUCTIONS.

1. “THIS PRODUCT MUST BE INSTALLED IN ACCORDANCE WITH THE APPLICABLE INSTALLATION CODE BY A PERSON FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THE PRODUCT AND THE HAZARDS INVOLVED.”
2. "WARNING - Risk of fire or electric shock. LED Retrofit kit installation requires knowledge of luminaires electrical systems. If not qualified, do not attempt installation. Contact a qualified electrician.”
3. "WARNING - Risk of fire or electric shock. Install this kit only in the luminaries that has the construction features and dimensions shown in the photographs and/or drawings."
4. "WARNING - To prevent wiring damage or abrasion, do not expose wiring to edges of sheet metal or other sharp objects."
5. “WARNING – Risk of fire or electric shock. Luminaire wiring and electrical parts may be damaged when drilling for installation of LED retrofit kit. Check for enclosed wiring and components.”
6. “WARNING - Do not mount near gas or electric heaters.”
7. “WARNING - Equipment should be mounted in locations and at heights where it will not be subjected to tampering by unauthorized personnel.”
8. “WARNING - The use of accessory equipment not recommended by the manufacturer may cause an unsafe condition.”
9. “WARNING - Do not use this equipment for other than its intended use.”
10. “WARNING - Maximum luminaire mounting height: 10 Feet”

SAVE THESE INSTRUCTIONS.

2.0 ORIGINAL FIXTURE

Intended for the following luminaires:

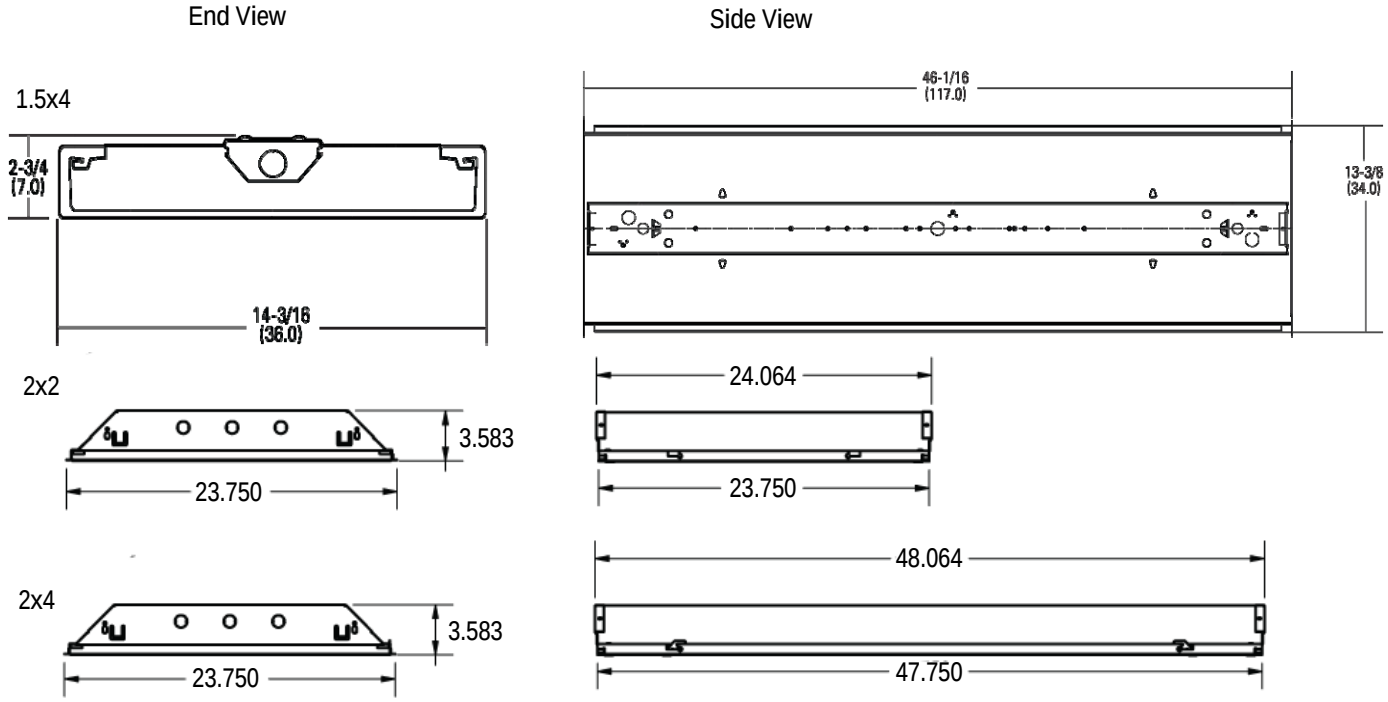


Illustration 1: Luminaire Dimensions

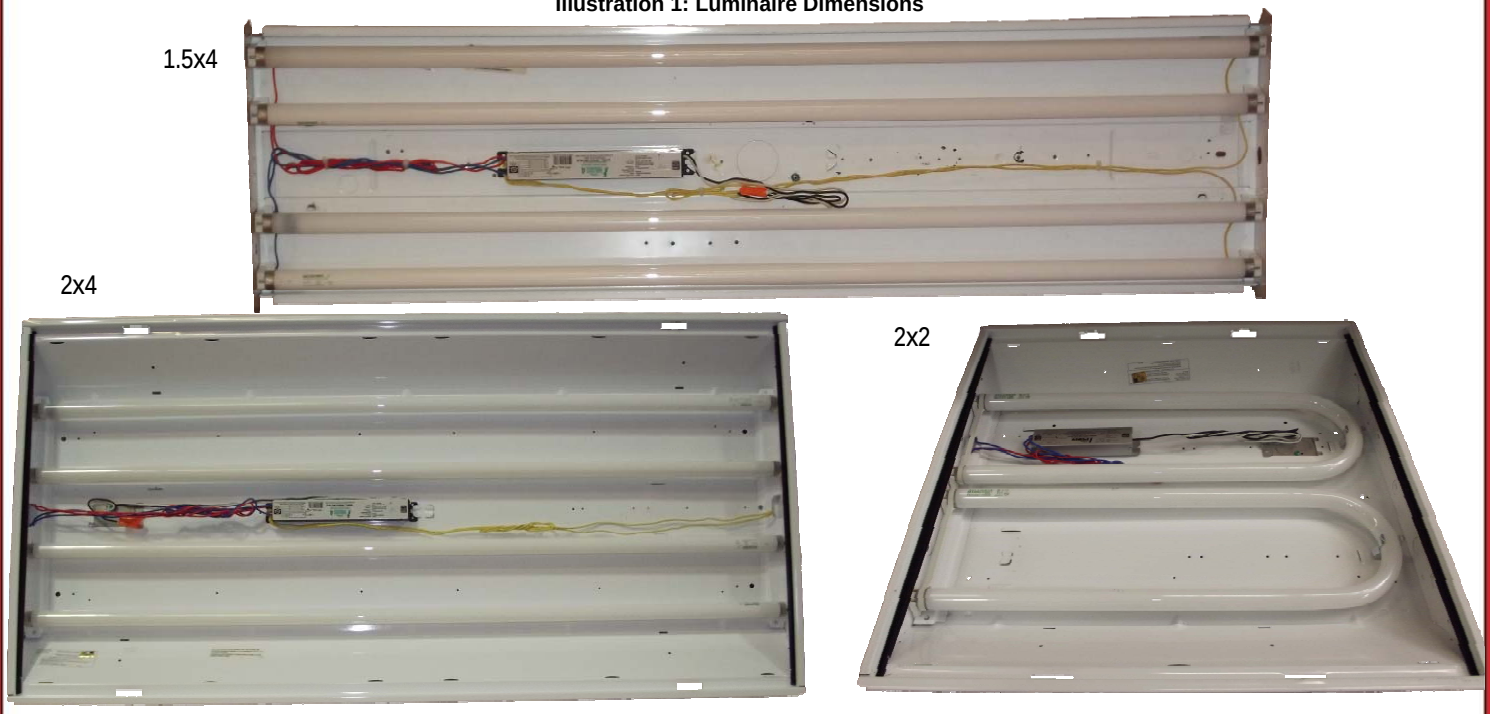


Figure 1: Original Luminaire

NOTE: NOT Suitable for installation in sealed or gasketed compartments

Original Luminaire Disassembly:

- Remove lamps (if installed) and wire-way cover from the luminaire.

3.0 HOTSPOT LED KIT PARTS

A) Hotspot LED Driver



FHS1-UNV-3.6L

B) LED Battery



FHSBATT3-D4



FHSBATT3-C3

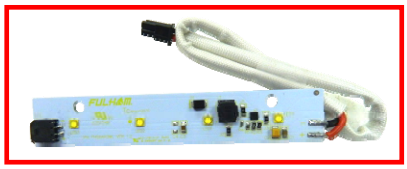


FHSBATT3-F7L

C) LED Module



Linear Module
(FHS1-AR-4W-L)



Linear Module w/ multiple connections
(FHS6-AR-3W-L)



"H" Configuration Module
(FHS3-AR-6W-SH), (FHS4-AR-8W-LH)
(FHS3-AR-10W-SH), (FHS4-AR-10W-LH)

D) Hardware: Screw quantities may change depending on setup



Figure 2: Hotspot LED Kit Parts

FHSKIT-TXXXXXX LED Kit Parts:

2x4 Troffer

A) LED Driver: FHS1-UNV-3.6L
- Battery: FHSBATT3-C3
- LED Arrays: FHS1-AR-4W-L or FHS3-AR-6W-SH

B) LED Driver: FHS1-UNV-3.6L
- Battery: FHSBATT3-F7L
- LED Arrays: FHS1-AR-4W-L, FHS3-AR-6W-SH, FHS4-AR-8W-LH, FHS3-AR-10W-SH, FHS4-AR-10W-LH, FHS6-AR-3W-L x1, FHS6-AR-3W-L x2, or FHS6-AR-3W-L x3

2x2 Troffer

A) LED Driver: FHS1-UNV-3.6L
- Battery: FHSBATT3-C3
- LED Arrays: FHS1-AR-4W-L or FHS3-AR-6W-SH

1.5x4 Troffer

A) LED Driver : FHS1-UNV-3.6L
- Battery: FHSBATT3-C3
- LED Arrays: FHS1-AR-4W-L

B) LED Driver FHS1-UNV-3.6L
- Battery: FHSBATT3-D4
- LED Arrays: FHS1-AR-4W-L, FHS6-SR-3W-L x1, or FHS6-SR-3W-L x2

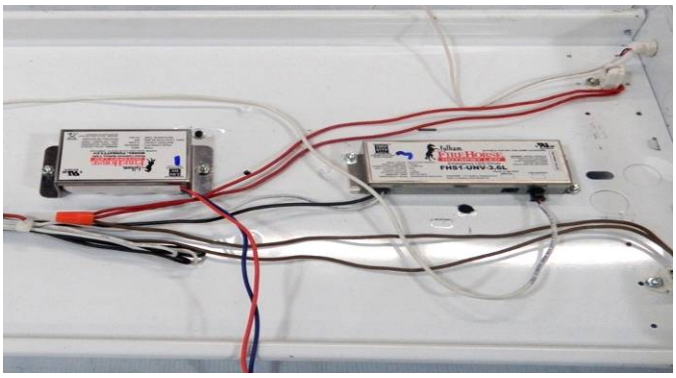
C) LED Driver: FHS1-UNV-3.6L
- Battery: FHSBATT3-F7L
- LED Arrays: FHS1-AR-4W-L, FHS6-AR-3W-L x1, FHS6-AR-3W-L x2, or FHS6-AR-3W-L x3

Hardware:
- #6-20x3/8" Phillips Pan Head Self Drilling Screws
- Quantity: 6-10 (Depending on setup)

4.0 HOTSPOT LED KIT INSTALLATION

1. Remove the wire way cover and place the Emergency LED Driver and LED battery pack onto the luminaire's wire-way area. See picture #1.
2. Place the selected LED Module onto the luminaire, in the space between the original lamps. See picture #2.
3. Secure all LED components to the luminaire by using the provided screws.
4. On the already removed wire way cover, drill one 1/2" hole into the luminaire's wire-way cover for the Test Switch. See picture #3. Exact location of the drilled hole can be found on page 12 (LED indicator/test switch must be visable after installation).
5. Insert the Test Switch into the pre-drilled hole in the luminaire's wire-way cover and secure it in place. See picture #3.
6. Connect all LED components based on Illustration #2. For examples of completed installation with wire way please see page 12.

Note:
If additional wire is needed to complete installation; only wire with a minimum rating of 300V should be used.



Picture #1



Picture #2



Picture #3

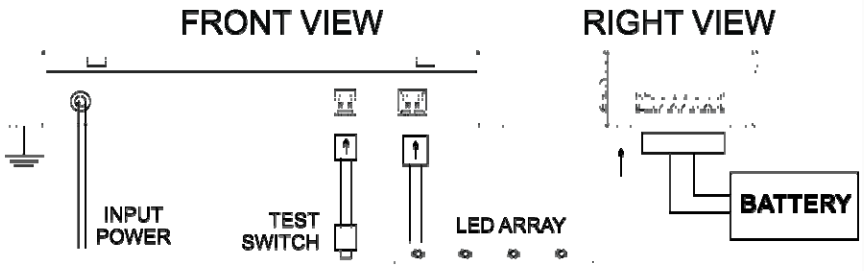
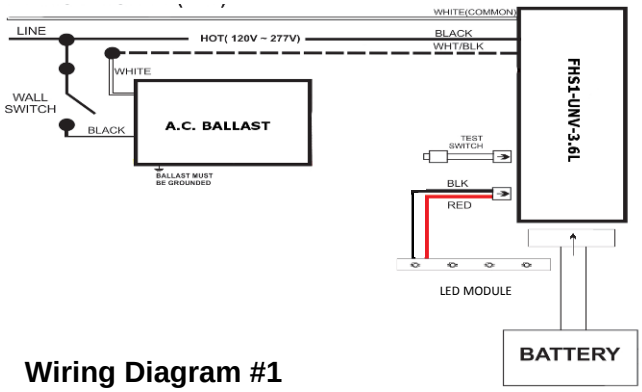


Illustration #2

4.1 HOTSPOT LED KIT INSTALLATION

7. Wire all LED components based on the Wiring Diagram #1.
8. Test the setup by connecting the LED Battery Pack connector to Emergency LED Driver side Terminal. See picture #4.
9. Re-attach the wire-way cover and the original lamps. See picture #5.
10. Depending on the LED setup and preference, completed installation should look like the following (see pages 7-11).

Note:
If additional wire is needed to complete installation; only wire with a minimum rating of 300V should be used.



Wiring Diagram #1



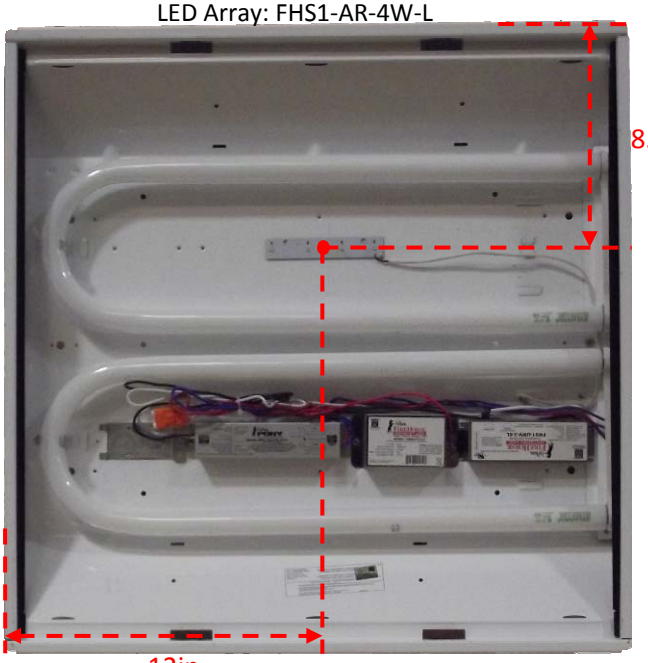
Picture #4



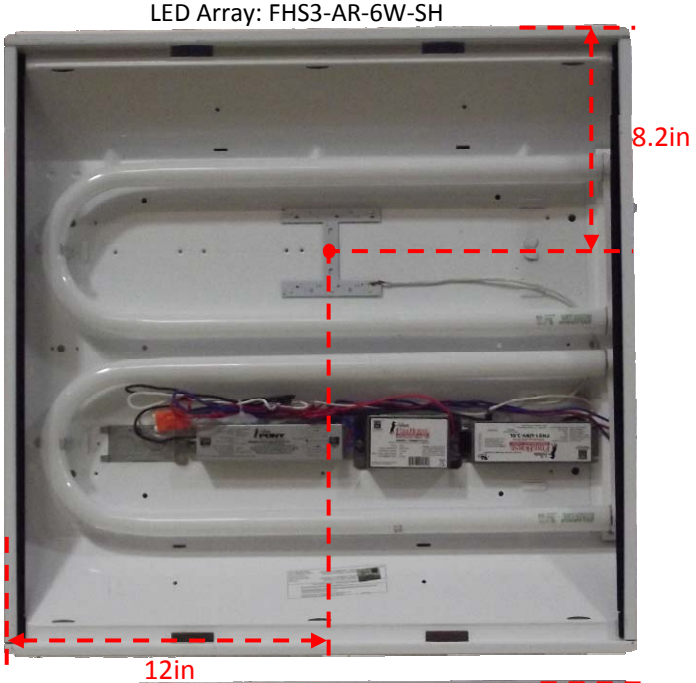
Picture #5

5.0 HOTSPOT LED KIT SETUP

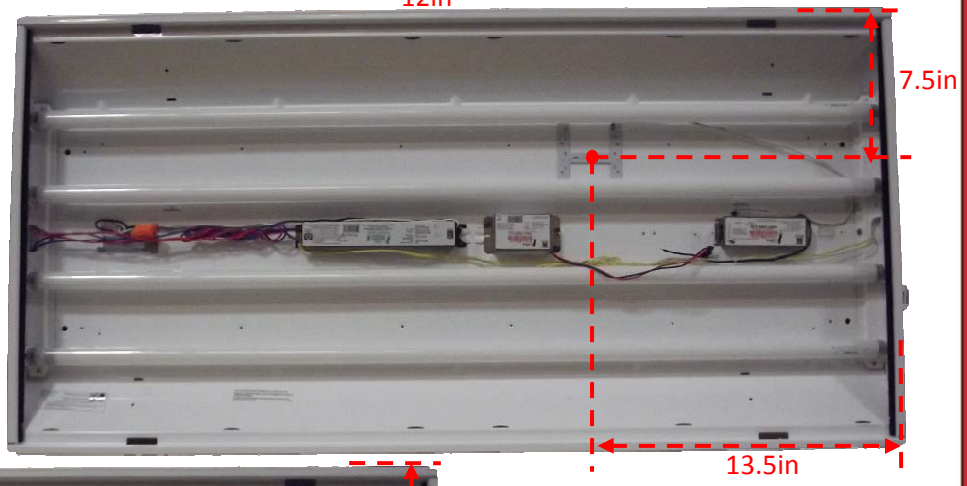
2X2 Troffer
Battery: FHSBATT3-C3
LED Array: FHS1-AR-4W-L

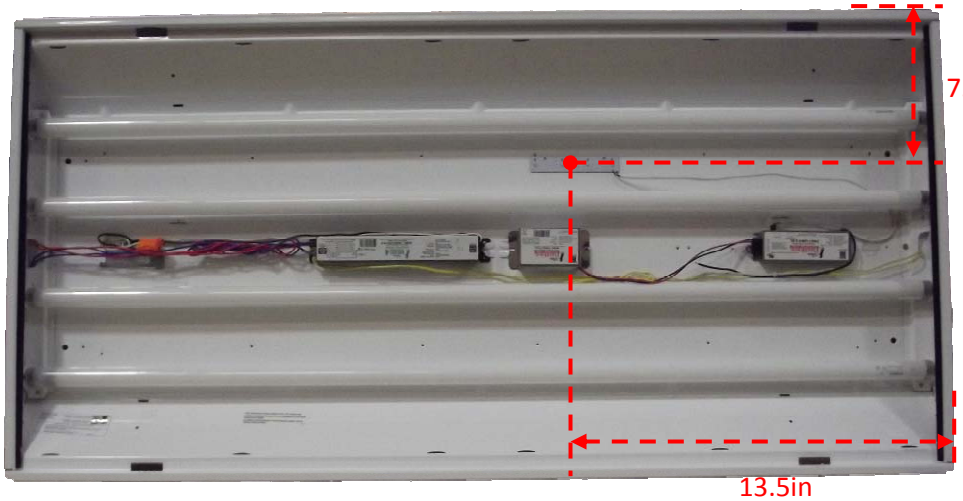


2X2 Troffer
Battery: FHSBATT3-C3
LED Array: FHS3-AR-6W-SH



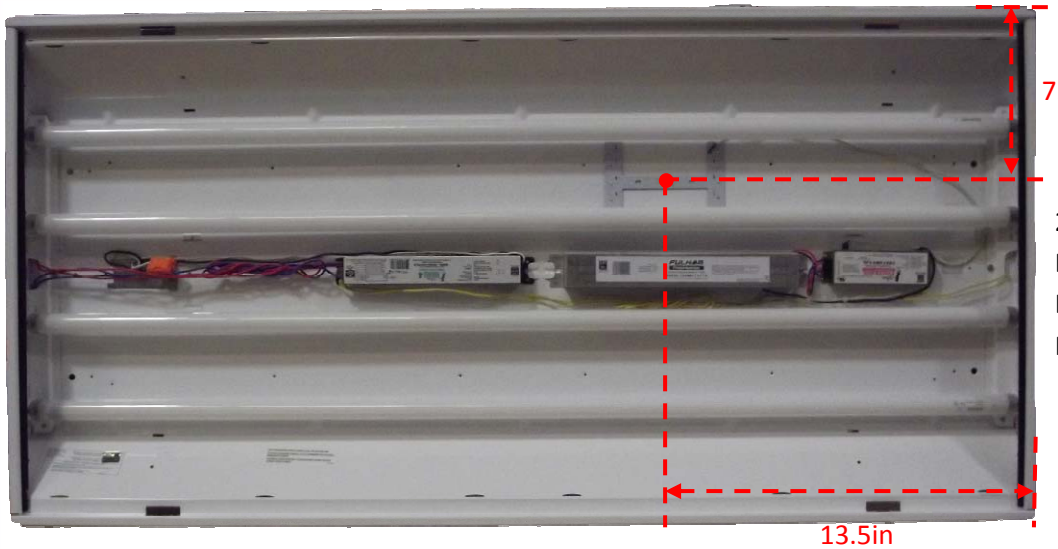
2X4 Troffer
Battery: FHSBATT3-C3
LED Array: FHS3-AR-6W-SH



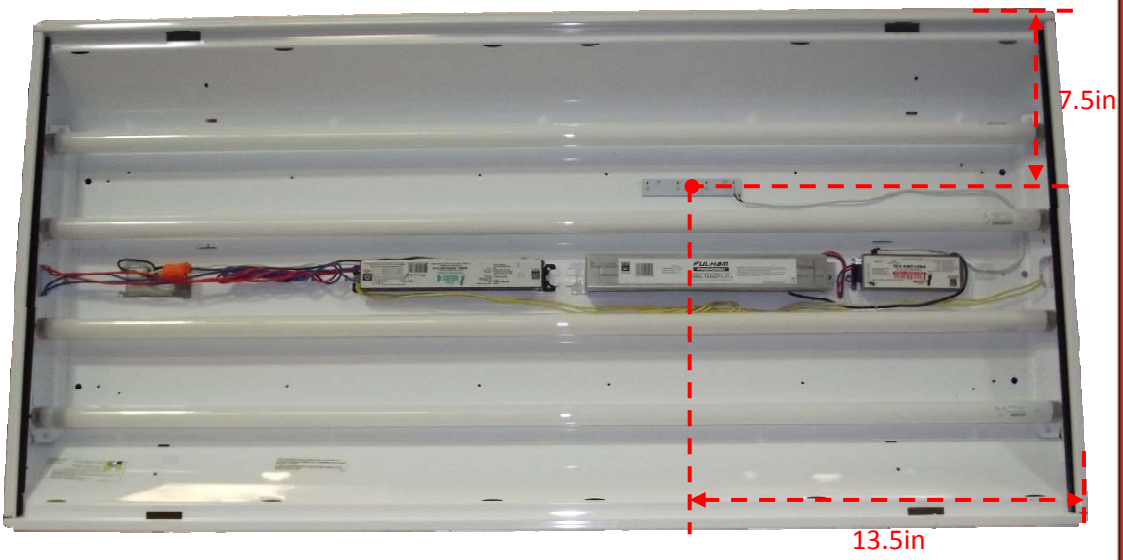


2X4 Troffer
Battery: FHSBATT3-C3
LED Array: FHS1-AR-4W-L

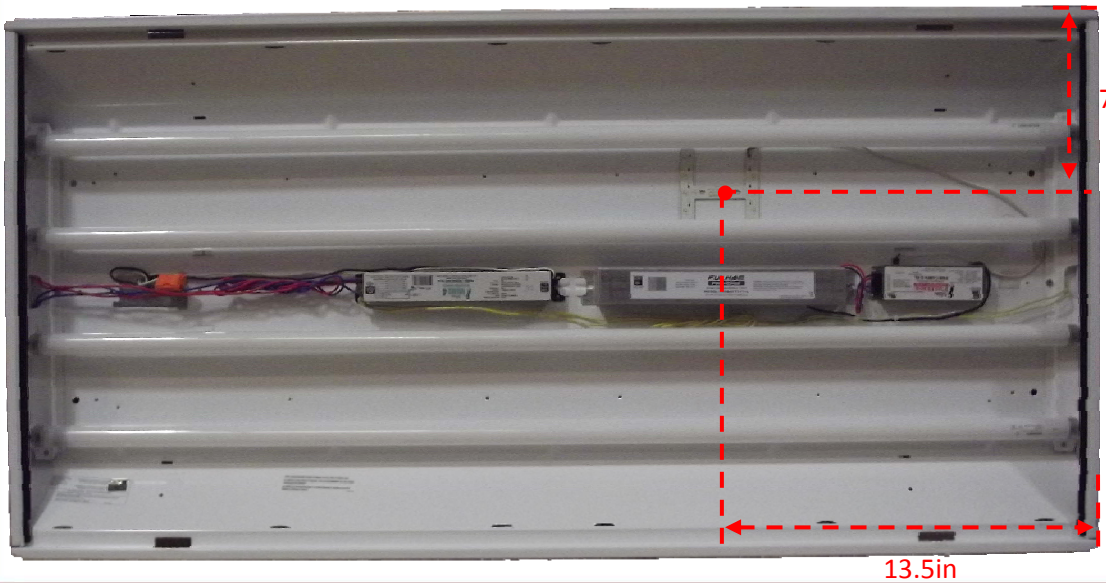
5.1 HOTSPOT LED KIT SETUP



2X4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS4-AR-8W-LH,
FHS4-AR-10W-LH

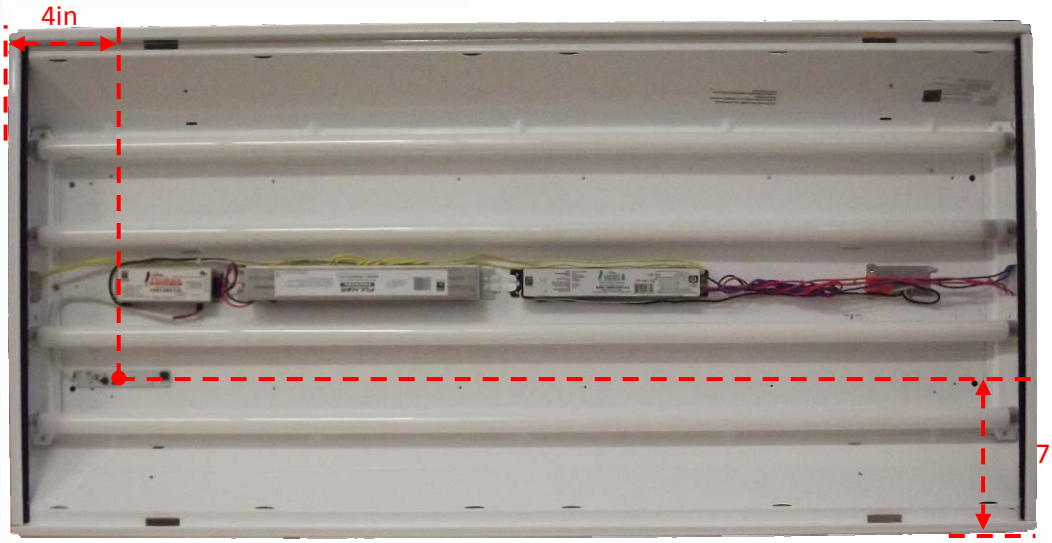


2X4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS1-AR-4W-L

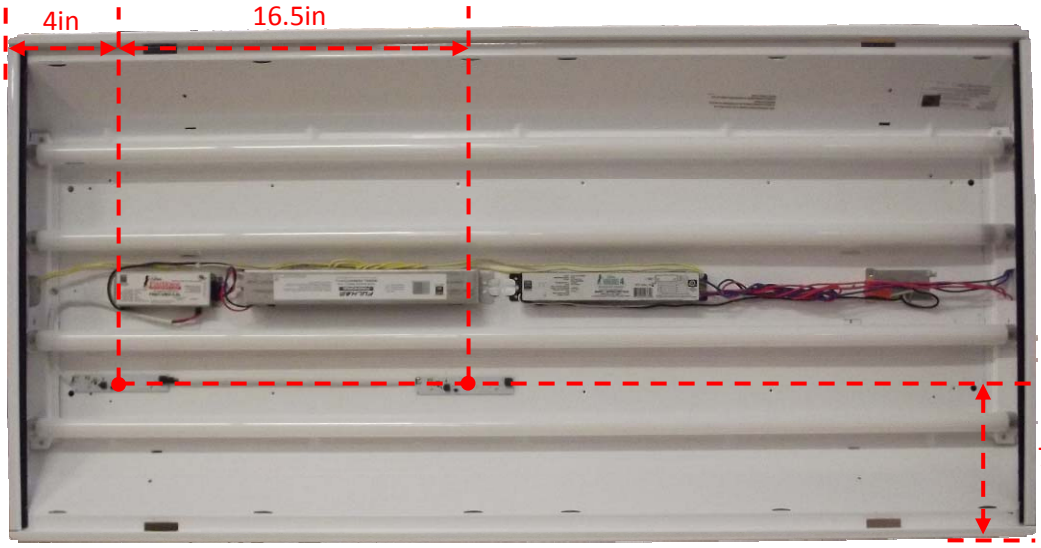


2X4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS3-AR-6W-SH,
FHS4-AR-10W-SH

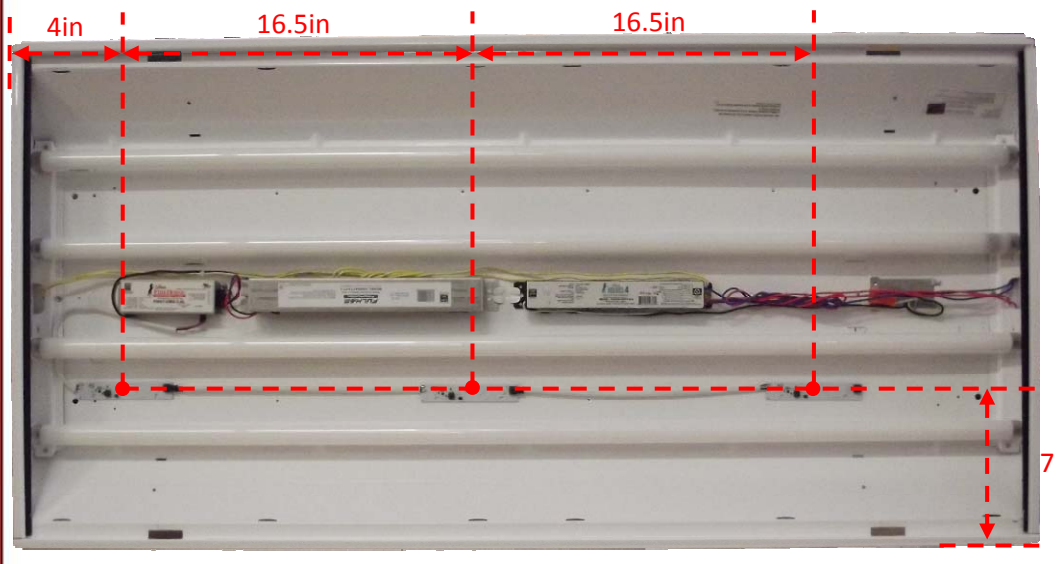
5.2 HOTSPOT LED KIT SETUP



2X4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS6-AR-3W-L x1

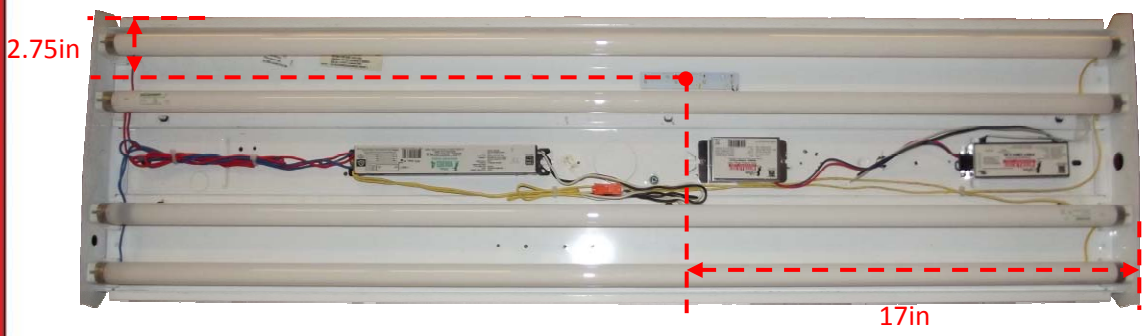


2X4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS6-AR-3W-L x2

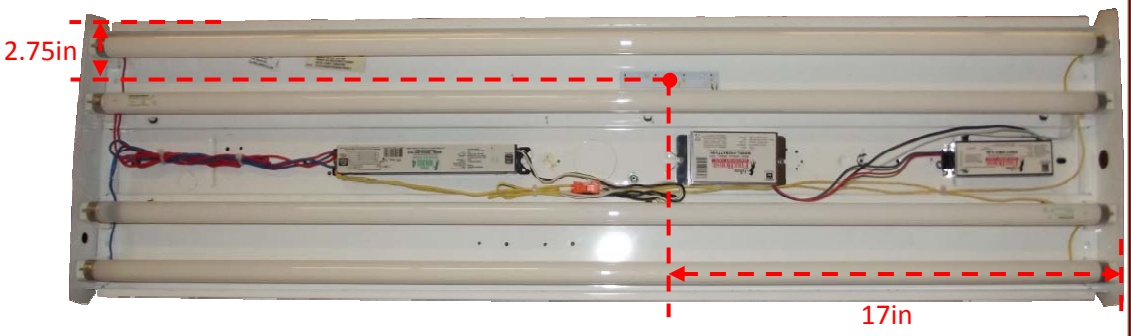


2X4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS6-AR-3W-L x3

5.3 HOTSPOT LED KIT SETUP



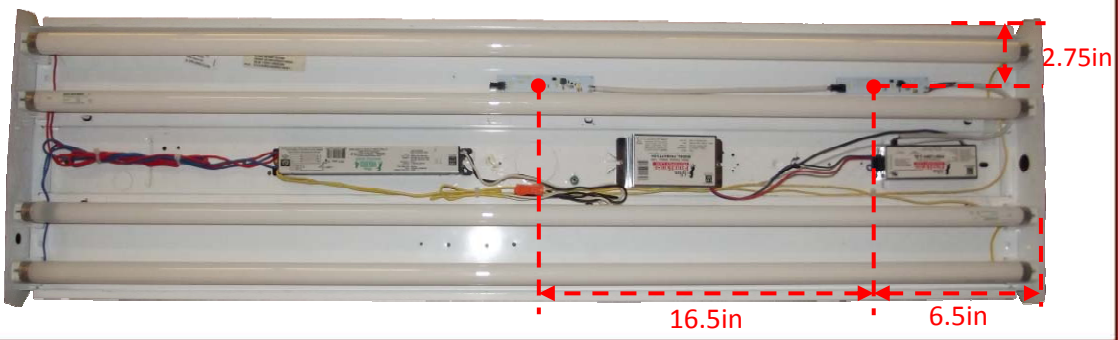
1.5x4 Troffer
Battery: FHSBATT3-C3
LED Arrays: FHS1-AR-4W-L



1.5x4 Troffer
Battery: FHSBATT3-D4
LED Arrays: FHS1-AR-4W-L

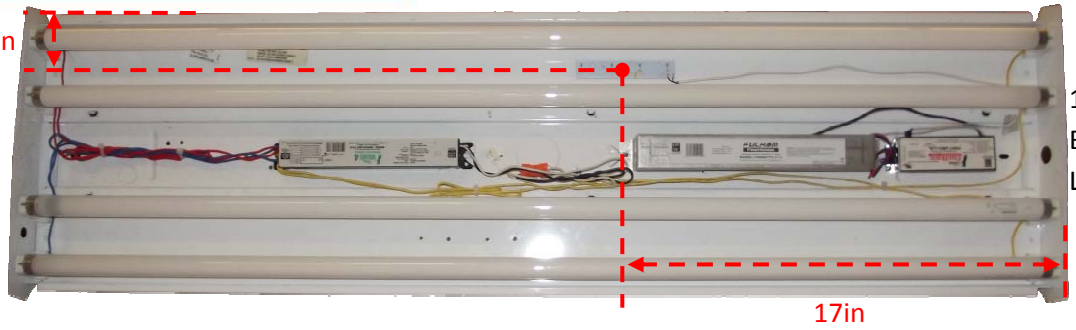


1.5x4 Troffer
Battery: FHSBATT3-D4
LED Arrays: FHS6-AR-3W-L x1



1.5x4 Troffer
Battery: FHSBATT3-D4
LED Arrays: FHS6-AR-3W-L x2

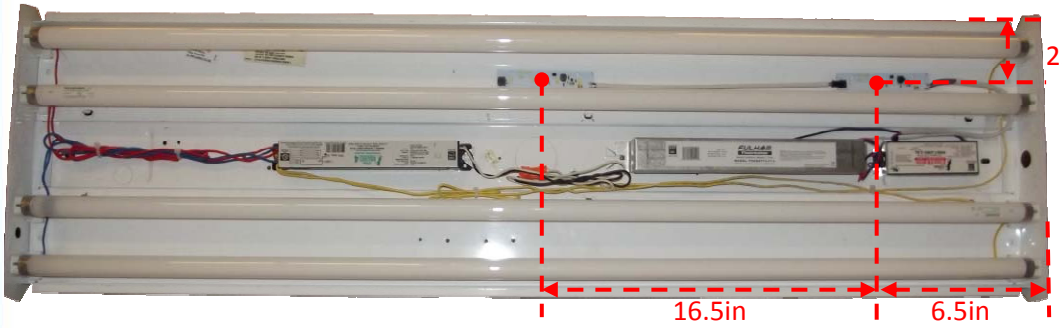
5.4 HOTSPOT LED KIT SETUP



1.5x4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS1-AR-4W-L

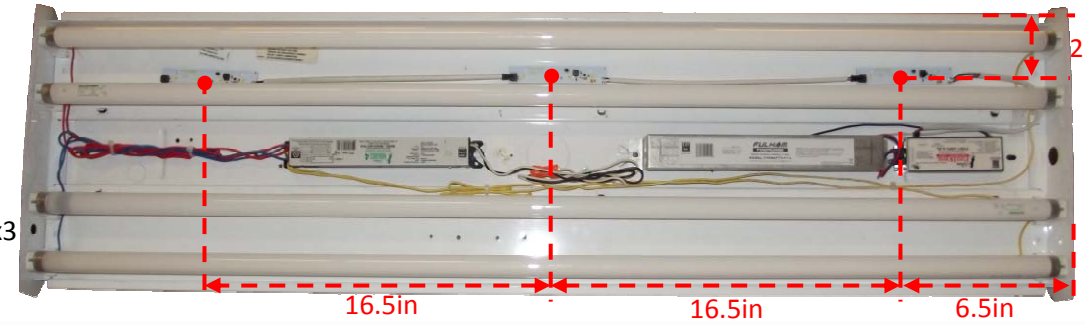
1.5x4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS6-AR-3W-L x1





1.5x4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS6-AR-3W-L x2

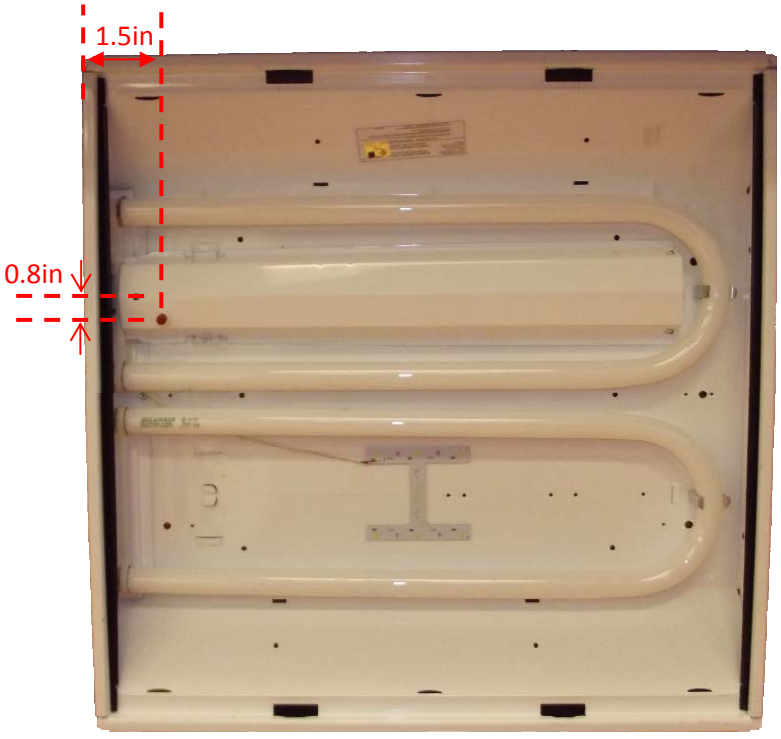
1.5x4 Troffer
Battery: FHSBATT3-F7L
LED Arrays: FHS6-AR-3W-L x3



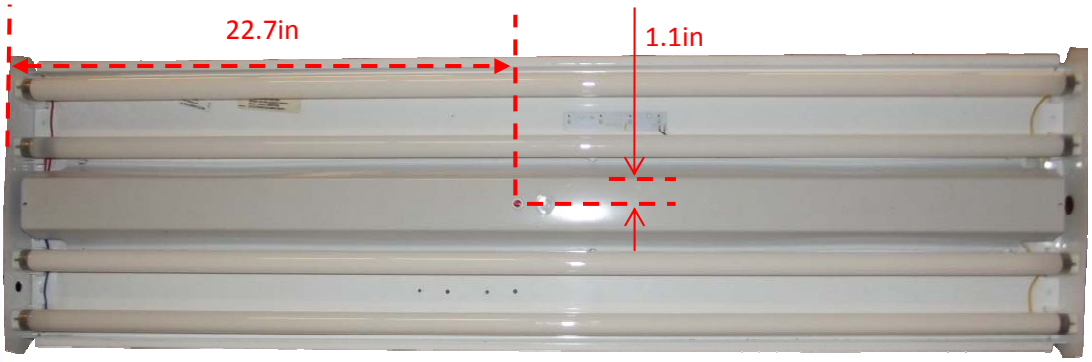
5.5 HOTSPOT LED KIT SETUP



Example of 2X4 Troffer with completed installation and wire way reattached



Example of 2X2 Troffer with completed installation and wire way reattached



Example of 1.5X4 Troffer with completed installation and wire way reattached

6.0 WARRANTY

Warranty

Please see our warranty policy on Fulham's LED Emergency Lighting Program.

Component Part Numbers

To order Hotspot LED Modules, Drivers, Battery Packs, and/or Hotspot LED kits, please contact us and use the part numbers below to order:
Hotspot LED Module: FHS1-AR-4W-L, FHS3-AR-6W-SH, FHS3-AR-10W-SH, FHS4-AR-8W-LH, FHS4-AR-10W-LH, or FHS6-AR-3W-L
Hotspot LED Driver: FHS1-UNV-3.6L
Hotspot LED Battery Pack: FHSBATT3-C3, FHSBATT3-D4, or FHSBATT3-F7L
Hotspot LED Retrofit Kit Part Number: FHSKIT-TXXLNXX or FHSKIT-TXXXHXX

PAR38 17W DIM. TITANIUM CR

Paterson BOE PS9
Tri State LED
#17PAR38G4DIM/940FL40

GREENCREATIVE

ENERGY STAR

HIGH CRI
LED TECHNOLOGY

REFINE SERIES

CRI^{SP}





17W REPLACES



120W Hal.

80% Energy Savings

$331 Savings per lamp*

- Full-face REFINE optic and sleek design
- Exceptional color rendering CRI 90
- Richer reds and natural skin tones (R9 50, R13 90)
- Tight LED binning for consistent CCT across all lamps
- Suitable for use in totally enclosed fixtures
- Wet location rated for outdoor use

40,000 H

DIMMABLE

WET LOCATION

5 YR WARRANTY

90 CRI (Ra)

ENCLOSED**

c UL us LISTED

FC

lighting facts LED Product Partner

LM 79 LM 80 TM 21 IES

PATENT PENDING REFINE OPTIC

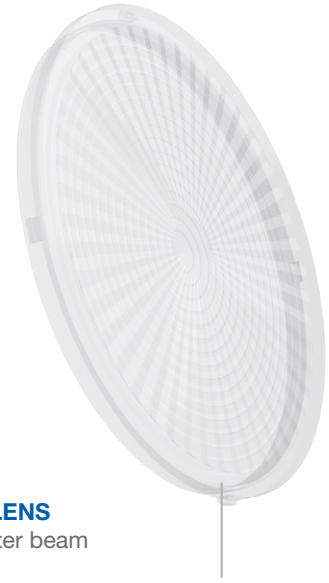
The innovative REFINE optic provides a high candela to lumen ratio, optimizing light usage for directional applications.

REFINE SERIES

REFLECTOR
Directs light



FOCUS LENS
Focuses center beam



SHAPING LENS
Refines beam pattern

WATCH THE VIDEO

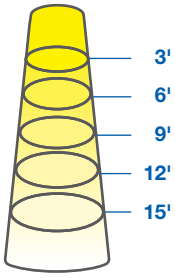
PAR38 17W DIM. TITANIUM CRI^{SP} LED SERIES 4.0

GREENCREATIVE

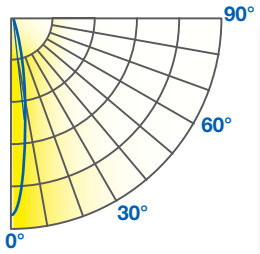
Ref.#: DS061-PAR38-17W

ILLUMINANCE & CANDELA DISTRIBUTION

18.5PAR38G4DIM/930SP15

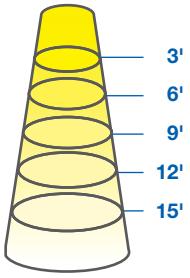


Diameter	Footcandles
0.8	1222
1.6	306
2.4	136
3.2	76
3.9	49

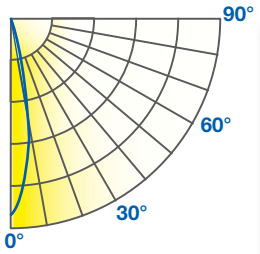


Degree	Candela
0	11,000
5	6028
15	835
25	188
35	111
45	83

18.5PAR38G4DIM/930NF25

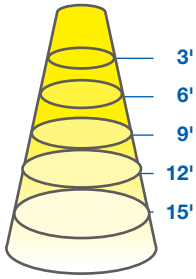


Diameter	Footcandles
1.3	656
2.7	164
4	73
5.3	41
6.7	26

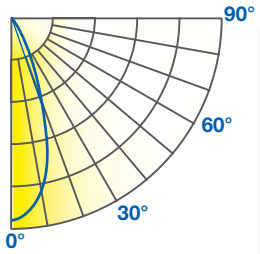


Degree	Candela
0	5900
5	5326
15	156
25	321
35	116
45	92

17PAR38G4DIM/930FL40



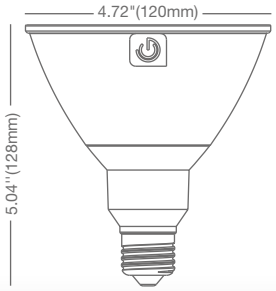
Diameter	Footcandles
2.2	278
4.4	69
6.6	31
8.7	17
10.9	11



Degree	Candela
0	2500
5	2329
15	1489
25	381
35	143
45	74

For other CCT use the following multipliers: 2700K .95, 4000K 1.1

Base: E26
Voltage: 120V
Dimmable: Yes***
PF: 0.9
Lifetime: 40,000 hrs
Weight: 0.75lb / 340g



SPECIFICATIONS

Model	Product	Power (W)	CCT	CRI (typ.)	R9 / R13 (typ.)	Lumens	LPW	Beam Angle	CBCP (cd)
18.5PAR38G4DIM/927SP15	16147	18.5	Warm White 2700K	90	50 / 90	950	51	SP 15°	10,500
18.5PAR38G4DIM/927NF25	16148	18.5	Warm White 2700K	90	50 / 90	1105	60	NF 25°	5800
17PAR38G4DIM/927FL40	16149	17	Warm White 2700K	90	50 / 90	1105	65	FL 40°	2400
18.5PAR38G4DIM/930SP15	16150	18.5	Warm White 3000K	90	50 / 90	1000	54	SP 15°	11,000
18.5PAR38G4DIM/930NF25	16151	18.5	Warm White 3000K	90	50 / 90	1150	62	NF 25°	5900
17PAR38G4DIM/930FL40	16152	17	Warm White 3000K	90	50 / 90	1150	68	FL 40°	2500
17PAR38G4DIM/940FL40	16155	17	Natural White 4000K	90	50 / 90	1200	71	FL 40°	2650
18.5PAR38G4DIM/930SP15/B •	16256	18.5	Warm White 3000K	90	50 / 90	1000	54	SP 15°	11,000
18.5PAR38G4DIM/930NF25/B •	16257	18.5	Warm White 3000K	90	50 / 90	1150	62	NF 25°	5900
17PAR38G4DIM/930FL40/B •	16258	17	Warm White 3000K	90	50 / 90	1150	68	FL 40°	2500

• Black finish

* Savings per lamp based on $0.11 / kw energy cost, 12 hrs / day lamp usage, $8 halogen with 1500-hr lifetime, $32 LED with 40,000-hr lifetime
** Suitable for use in totally enclosed fixtures
*** List of tested dimmer switches available on website
**** Suitable for wet locations

Green Creative - 17PAR38G4DIM/940FL40

Specifications

ENERGY STAR Partner:	Green Creative
Product Finder Bulb Type:	Reflector (Flood/Spot)
Base Type:	E26 (Medium)
Lamp Category:	Directional
Technology:	LED
Warranty (years):	5
Energy Used (watts):	17.0
Efficacy (lumens/watt):	70.6
Wattage Equivalency (watts):	120
Maximum Overall Length (mm):	129.2
Maximum Overall Diameter (mm):	120.3
CBCP:	2728
Beam Angle:	40
Life (hrs):	25000
Brightness (lumens):	1200
Power Factor:	1.0
Light Appearance (Kelvin):	4000
Color Quality (CRI):	94
R9:	70
Connected Lamp:	No
Dimmable:	Dimmable
Dims Down to %:	4
Three Way:	No
Lamp Rated for Enclosed Fixtures:	Yes

Special Features:	Wet Location Rated,Recessed Fixtures
Date Qualified:	12/27/2016
Date Available on Market:	08/01/2016
Markets:	United States, Canada

6'' CDL 21W TITANIUM LED SERIES

Paterson BOE PS2
Tri State LED
#21CDLA6/840/277V

GREENCREATIVE

ENERGY STAR

INNOFIT SERIES

PRO





Patent Pending

- For retrofit or new construction installation
- Universal housing compatibility – IC-Rated
- Adjustable lumen output – 3 defined light levels
- Easy fit installation – Spring-action housing clips
- Universal voltage 120-277V
- Available in 2700K, 3000K, 3500K & 4000K CCT

40,000 H | 120-277V UNIVERSAL | LUMEN OUTPUT ADJUSTABLE | 5 YR WARRANTY | 80 CRI (Ra) | SEMI DIRECTIONAL

c UL us LISTED | c CLASSIFIED UL us | FC | lighting facts LED Product Partner | LM 79 | LM 80 | TM 21 | IES

COMMERCIAL DOWNLIGHT PRODUCT FEATURES

Adjustable Lumen Output



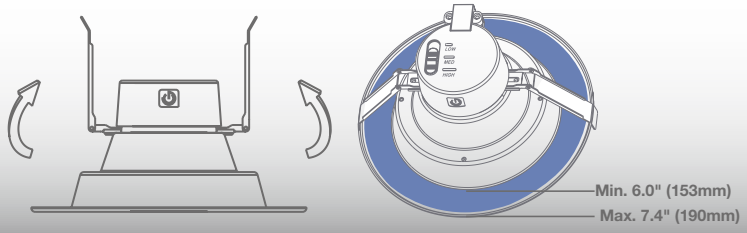
Fluorescent Equivalence Table

Power	Lumens	Equivalent
LOW-8.5W	700	1X18W
MED-13.5W	1000	1X26W / 2X13W
HIGH-21W	1500	1X32W / 2X18W

This commercial downlight features adjustable lumen output for three distinct lumen levels equivalent to various CFL lamp combinations. Simply adjust the lamp power to the desired lumen output by sliding the selector switch on top of the fixture.

Easy-Fit Installation

The adjustable housing clips allow for installation in a large range of commercial and architectural housings ranging from 6.0''-7.4'' (153-190mm). These spring-action clips push up easily and fit securely for both retrofit and new construction installations.



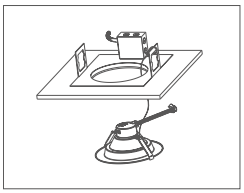
6'' CDL 21W TITANIUM LED SERIES

GREENCREATIVE

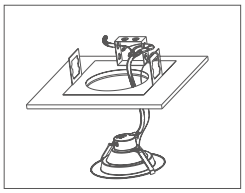
Ref.#:DS123-CDLA-21W-277V-080217

SIMPLE RETROFIT OR ECONOMICAL NEW CONSTRUCTION INSTALLATION

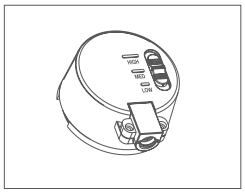
Retrofit Installation



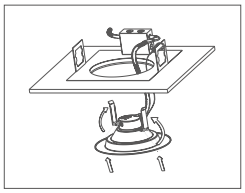
Attach safety clip



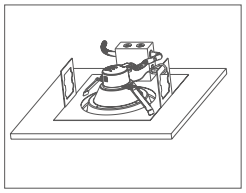
Bypass ballast & wire to j-box



Adjust lumens to desired output

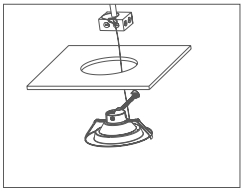


Push clips up & install into fixture

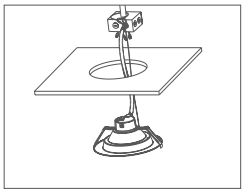


Ensure fixture is flush. Installation is complete

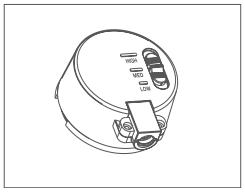
New Construction Installation



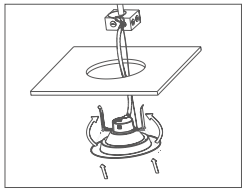
Attach safety clip



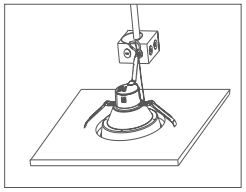
Wire to j-box



Adjust lumens to desired output



Push clips up & install into opening



Ensure fixture is flush. Installation is complete

SPECIFICATIONS

Product Model	57868 21CDLA6/827/277V	57869 21CDLA6/830/277V	57870 21CDLA6/835/277V	57871 21CDLA6/840/277V
Type	6'' Commercial Downlight	6'' Commercial Downlight	6'' Commercial Downlight	6'' Commercial Downlight
Power (W)	8.5 / 13.5 / 21	8.5 / 13.5 / 21	8.5 / 13.5 / 21	8.5 / 13.5 / 21
Voltage - Frequency	120-277V 50-60Hz	120-277V 50-60Hz	120-277V 50-60Hz	120-277V 50-60Hz
Color Temp. (ANSI)	Soft White 2700K	Warm White 3000K	Neutral White 3500K	Cool White 4000K
CRI (Ra) (typ.)	80	80	80	80
Typical lumens (lm)	650 / 930 / 1400	700 / 1000 / 1500	700 / 1000 / 1500	700 / 1000 / 1500
Efficacy (LPW)	76 / 69 / 67	82 / 74 / 71	82 / 74 / 71	82 / 74 / 71
Beam Angle	110°	110°	110°	110°
Dimmable	No	No	No	No
Power Factor	0.9	0.9	0.9	0.9
Rated Lifetime - L70 (hrs.)	40,000	40,000	40,000	40,000
Dia. x MOL	8.27''x4.02'' (210x102mm)	8.27''x4.02'' (210x102mm)	8.27''x4.02'' (210x102mm)	8.27''x4.02'' (210x102mm)
Weight (lb. / g)	1.24lb / 562g	1.24lb / 562g	1.24lb / 562g	1.24lb / 562g

* Suitable for damp locations. Not for use where directly exposed to weather or water
** Full installation guide and more details available on website

Green Creative - LED commercial downlight : 21CDLA6/840/277V

Specifications

ENERGY STAR Partner:	Green Creative
Indoor/Outdoor:	Indoor
Fixture Type:	Downlight Recessed
Technology:	LED
Total Light Output (lumens):	1500
Appearance/Correlated Color Temperature (K):	4000/4100K
Total Input Power (Watts):	21.0
Energy Efficiency - Measured Outside the Fixture (lumens/Watt):	78.6
Power Factor:	0.99
Color Quality (CRI):	83
Light Source Life (hrs):	25000
Can Rating(s):	Type Non-IC
Special Features:	Non-Dimmable
Light Source Connection/Base Type:	N/A
Date Available On Market:	01/01/2016
Date Certified:	02/04/2015
Markets:	United States, Canada

8'' CDL 27W TITANIUM LED SERIES

Paterson BOE PS2
Tri State LED
#27CDLA8/840/277V

GREENCREATIVE

ENERGY STAR

PRO



INNOFIT SERIES



Patent Pending

- For retrofit or new construction installation
- Universal housing compatibility
- Adjustable lumen output – 3 defined light levels
- Easy fit installation – Spring-action housing clips
- Universal voltage 120-277V
- Available in 2700K, 3000K, 3500K & 4000K CCT

40,000 H | 120-277V UNIVERSAL | LUMEN OUTPUT ADJUSTABLE | 5 YR WARRANTY | 80 CRI (Ra) | SEMI DIRECTIONAL

c UL us LISTED | c CLASSIFIED UL us | FC | lighting facts LED Product Partner | LM 79 | LM 80 | TM 21 | IES

COMMERCIAL DOWNLIGHT PRODUCT FEATURES

Adjustable Lumen Output



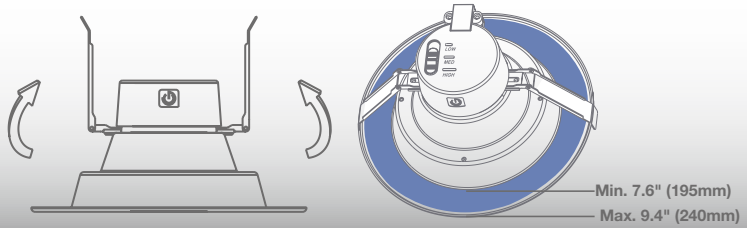
Fluorescent Equivalence Table

Power	Lumens	Equivalent
LOW-12W	1000	1X26W / 2X13W
MED-19W	1500	1X32W / 2X18W
HIGH-27W	2000	1X42W / 2X26W

This commercial downlight features adjustable lumen output for three distinct lumen levels equivalent to various CFL lamp combinations. Simply adjust the lamp power to the desired lumen output by sliding the selector switch on top of the fixture.

Easy-Fit Installation

The adjustable housing clips allow for installation in a large range of commercial and architectural housings ranging from 7.6''- 9.4'' (195-240mm). These spring-action clips push up easily and fit securely for both retrofit and new construction installations.



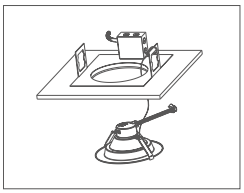
8'' CDL 27W TITANIUM LED SERIES

GREENCREATIVE

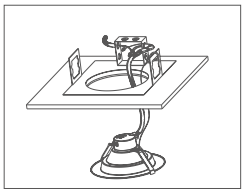
Ref.#:DS124-CDLA-27W-277V

SIMPLE RETROFIT OR ECONOMICAL NEW CONSTRUCTION INSTALLATION

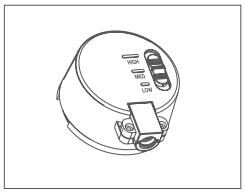
Retrofit Installation



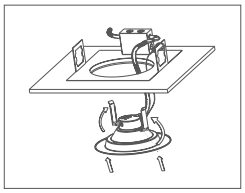
Attach safety clip



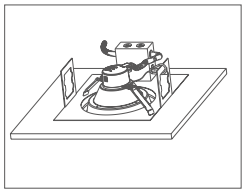
Bypass ballast & wire to j-box



Adjust lumens to desired output

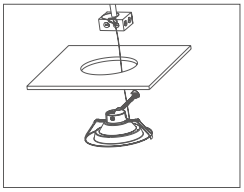


Push clips up & install into fixture

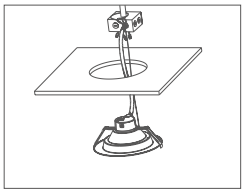


Ensure fixture is flush. Installation is complete

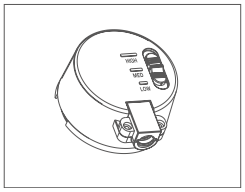
New Construction Installation



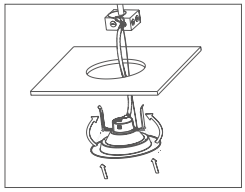
Attach safety clip



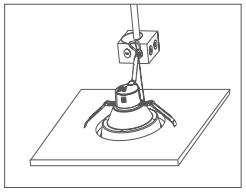
Wire to j-box



Adjust lumens to desired output



Push clips up & install into opening



Ensure fixture is flush. Installation is complete

SPECIFICATIONS

Product Model	57873 27CDLA8/827/277V	57874 27CDLA8/830/277V	57875 27CDLA8/835/277V	57876 27CDLA8/840/277V
Type	8'' Commercial Downlight	8'' Commercial Downlight	8'' Commercial Downlight	8'' Commercial Downlight
Power (W)	12 / 19 / 27	12 / 19 / 27	12 / 19 / 27	12 / 19 / 27
Voltage - Frequency	120-277V 50-60Hz	120-277V 50-60Hz	120-277V 50-60Hz	120-277V 50-60Hz
Color Temp. (ANSI)	Soft White 2700K	Warm White 3000K	Neutral White 3500K	Cool White 4000K
CRI (Ra) (typ.)	80	80	80	80
Typical lumens (lm)	930 / 1400 / 1860	1000 / 1500 / 2000	1000 / 1500 / 2000	1000 / 1500 / 2000
Efficacy (LPW)	78 / 74 / 69	83 / 79 / 74	83 / 79 / 74	83 / 79 / 74
Beam Angle	110°	110°	110°	110°
Dimmable	No	No	No	No
Power Factor	0.9	0.9	0.9	0.9
Rated Lifetime - L70 (hrs.)	40,000	40,000	40,000	40,000
Dia. x MOL	10.24''x3.33'' (260x110mm)	10.24''x3.33'' (260x110mm)	10.24''x3.33'' (260x110mm)	10.24''x3.33'' (260x110mm)
Weight (lb. / g)	1.58 lb. / 717g	1.58 lb. / 717g	1.58 lb. / 717g	1.58 lb. / 717g

* Suitable for damp locations. Not for use where directly exposed to weather or water
** Full installation guide and more details available on website

Green Creative - LED commercial downlight : 27CDLA8/840/277V

Specifications

ENERGY STAR Partner:	Green Creative
Indoor/Outdoor:	Indoor
Fixture Type:	Downlight Recessed
Technology:	LED
Total Light Output (lumens):	2000
Appearance/Correlated Color Temperature (K):	4000/4100K
Total Input Power (Watts):	27.0
Energy Efficiency - Measured Outside the Fixture (lumens/Watt):	83.3
Power Factor:	0.99
Color Quality (CRI):	84
Light Source Life (hrs):	25000
Can Rating(s):	Type Non-IC
Special Features:	Non-Dimmable
Light Source Connection/Base Type:	N/A
Date Available On Market:	01/01/2016
Date Certified:	02/04/2016
Markets:	United States, Canada

9.5'' CDL 45W TITANIUM LED SERIES

Paterson BOE PS9
Tri State LED
#45CDLA9.5/840/277V

GREENCREATIVE

ENERGY STAR

INNOFIT SERIES

PRO





Patent Pending

- For retrofit or new construction installation
- Universal housing compatibility
- Adjustable lumen output – 3 defined light levels
- Easy fit installation – Spring-action housing clips
- Universal voltage 120-277V
- Available in 2700K, 3000K, 3500K & 4000K CCT

40,000 H | 120-277V UNIVERSAL | LUMEN OUTPUT ADJUSTABLE | 5 YR WARRANTY | 80 CRI (Ra) | SEMI DIRECTIONAL

c UL us LISTED | c UL us CLASSIFIED | FC | lighting facts LED Product Partner | LM 79 | LM 80 | TM 21 | IES

COMMERCIAL DOWNLIGHT PRODUCT FEATURES

Adjustable Lumen Output



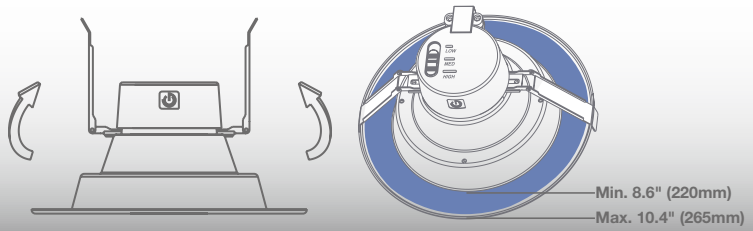
Fluorescent Equivalence Table

Power	Lumens	Equivalent
LOW-23.5W	2000	1X42W / 2X26W
MED-32W	2500	1X57W / 2X32W
HIGH-45W	3200	2X42W

This commercial downlight features adjustable lumen output for three distinct lumen levels equivalent to various CFL lamp combinations. Simply adjust the lamp power to the desired lumen output by sliding the selector switch on top of the fixture.

Easy-Fit Installation

The adjustable housing clips allow for installation in a large range of commercial and architectural housings ranging from 8.6''-10.4'' (220-265mm). These spring-action clips push up easily and fit securely for both retrofit and new construction installations.



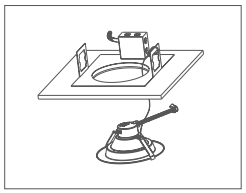
9.5'' CDL 45W TITANIUM LED SERIES

GREENCREATIVE

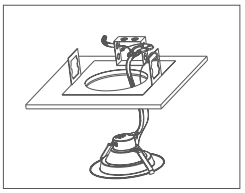
Ref.#:DS126-CDLA-45W-277V

SIMPLE RETROFIT OR ECONOMICAL NEW CONSTRUCTION INSTALLATION

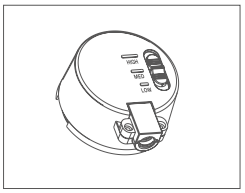
Retrofit Installation



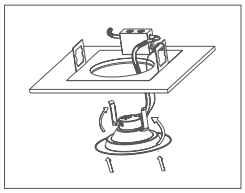
Attach safety clip



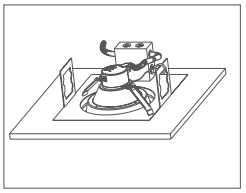
Bypass ballast & wire to j-box



Adjust lumens to desired output

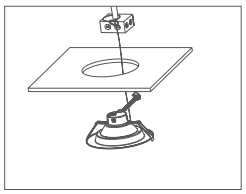


Push clips up & install into fixture

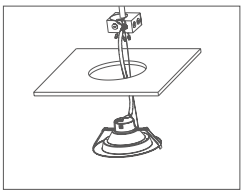


Ensure fixture is flush. Installation is complete

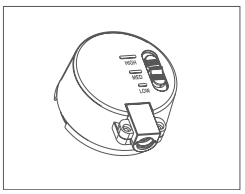
New Construction Installation



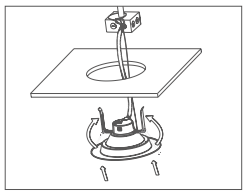
Attach safety clip



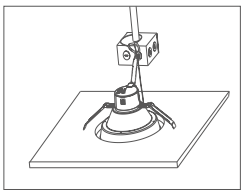
Wire to j-box



Adjust lumens to desired output



Push clips up & install into opening



Ensure fixture is flush. Installation is complete

SPECIFICATIONS

Product Model	57878 45CDLA9.5/827/277V	57879 45CDLA9.5/830/277V	57880 45CDLA9.5/835/277V	57881 45CDLA9.5/840/277V
Type	9.5'' Commercial Downlight	9.5'' Commercial Downlight	9.5'' Commercial Downlight	9.5'' Commercial Downlight
Power (W)	23.5 / 32 / 45	23.5 / 32 / 45	23.5 / 32 / 45	23.5 / 32 / 45
Voltage - Frequency	120-277V 50-60Hz	120-277V 50-60Hz	120-277V 50-60Hz	120-277V 50-60Hz
Color Temp. (ANSI)	Soft White 2700K	Warm White 3000K	Neutral White 3500K	Cool White 4000K
CRI (Ra) (typ.)	80	80	80	80
Typical lumens (lm)	1860 / 2325 /2975	2000 / 2500 / 3200	2000 / 2500 / 3200	2000 / 2500 / 3200
Efficacy (LPW)	79 / 73 / 66	85 / 78 / 71	85 / 78 / 71	85 / 78 / 71
Beam Angle	110°	110°	110°	110°
Dimmable	No	No	No	No
Power Factor	0.9	0.9	0.9	0.9
Rated Lifetime - L70 (hrs.)	40,000	40,000	40,000	40,000
Dia. x MOL	11.26''x4.84'' (286x123mm)	11.26''x4.84'' (286x123mm)	11.26''x4.84'' (286x123mm)	11.26''x4.84'' (286x123mm)
Weight (lb. / g)	2.02 lb. / 915g	2.02 lb. / 915g	2.02 lb. / 915g	2.02 lb. / 915g

* Suitable for damp locations. Not for use where directly exposed to weather or water
** Full installation guide and more details available on website

Green Creative - LED commercial downlight : 45CDLA9.5/840/277V

Specifications

ENERGY STAR Partner:	Green Creative
Indoor/Outdoor:	Indoor
Fixture Type:	Downlight Recessed
Technology:	LED
Total Light Output (lumens):	3200
Appearance/Correlated Color Temperature (K):	4000/4100K
Total Input Power (Watts):	45.0
Energy Efficiency - Measured Outside the Fixture (lumens/Watt):	89.9
Power Factor:	0.99
Color Quality (CRI):	86
Light Source Life (hrs):	40000
Can Size(s):	>= 9
Can Rating(s):	Type Non-IC
Special Features:	Non-Dimmable
Light Source Connection/Base Type:	N/A
Date Available On Market:	03/20/2016
Date Certified:	04/27/2016
Markets:	United States, Canada

PL H 9.5W BYP TITANIUM LED SERIES

GREENCREATIVE

PL EDGE SERIES

PRO



9.5W REPLACES



26W CFL

60% Energy Savings

- **HYBrid installation - DIRect or BYPass**
- **Compatible with magnetic ballasts - DIRect installation**
- **Built-in universal voltage driver - Bypass installation**
- **Compatible with G24d, GX24d, G24q & GX24q bases**
- **Exceptional efficacy 100 LPW**
- **Lasts 4 times longer than CFL**

50,000 H

MAGNETIC BALLAST COMPATIBLE

120-277V UNIVERSAL

5 YR WARRANTY

82 CRI (Ra)

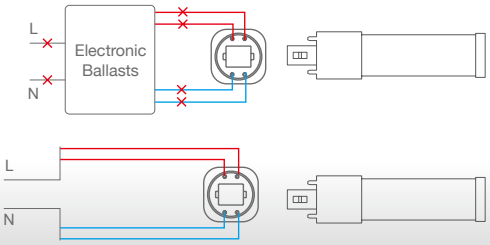
SEMI DIRECTIONAL

CLASSIFIED cULus FC lighting facts LED Product Partner LM 79 LM 80 TM 21 IES

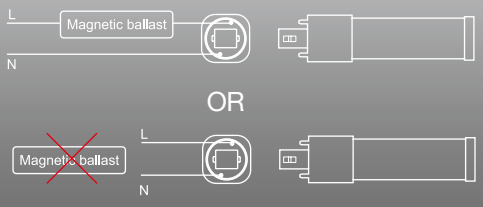
PL PRODUCT FEATURES

BYPass Installation - Electronic Ballasts

This PL H lamp is not compatible with electronic ballasts and requires bypassing the ballast during installation. The lamp runs directly off line voltage to eliminate compatibility problems, incidental power loss, lifetime issues, and maintenance costs associated with ballasts.



HYBrid Installation - DIRect or BYPass - Magnetic Ballasts



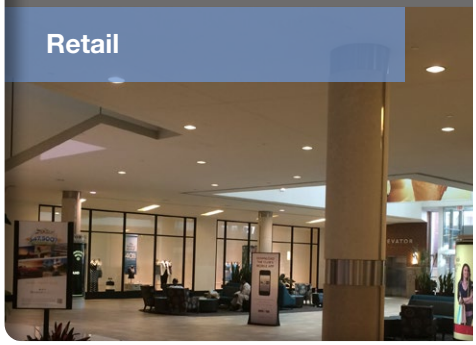
When used with a magnetic ballast, the PL H can function as a plug & play lamp and operate with the existing ballast. If the ballast is not compatible, it can be bypassed and the lamp can run directly off line voltage.

PL H 9.5W BYP TITANIUM LED SERIES

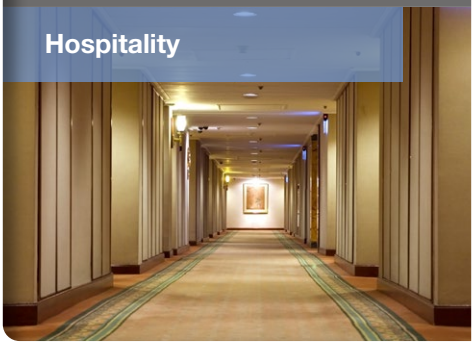
GREENCREATIVE

APPLICATIONS

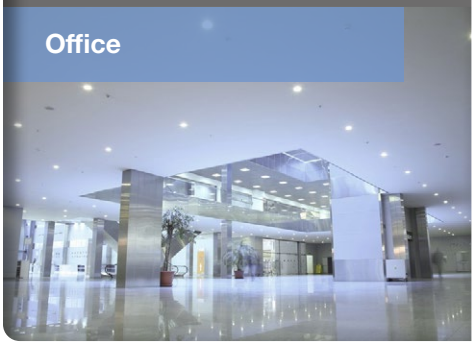
Retail



Hospitality



Office



Ref.#: DS182-PLH-9.5W-BYP-291216

Base:	G24d, GX24d, G24q & GX24q (2/4-pin CFL)
Voltage:	Magnetic ballast compatible 120-277V
Dimmable:	No
PF:	0.9
Lifetime (L70):	50,000 hrs
Weight:	0.18lb / 82g



SPECIFICATIONS

Model	Product	Power (W)	CCT	CRI (typ.)	Lumens	LPW	Beam Angle
9.5PLH/827/BYP	28354	9.5	Soft White 2700K	82	870	92	110°
9.5PLH/830/BYP	28355	9.5	Warm White 3000K	82	920	97	110°
9.5PLH/835/BYP	28356	9.5	Neutral White 3500K	82	920	97	110°
9.5PLH/840/BYP	28357	9.5	Cool White 4000K	82	950	100	110°

* Suitable for damp locations. Not for use where directly exposed to weather or water
** Not intended for use in enclosed fixtures
*** Full installation guide and more details available on website

HID LED 80W TITANIUM LED SERIES

GREENCREATIVE

PRO





80W REPLACES



175-250W HID

70% Energy Savings

$181 Savings per lamp*

- **Direct line voltage 120-277V - Not compatible with ballasts**
- **Designed for use in post top applications**
- **Compatible with EX39 & E39 sockets**
- **Fully omnidirectional 320° beam angle**
- **Available in 4000K & 5000K CCT**
- **Suitable for use in totally enclosed fixtures**

50,000 H

120-277V UNIVERSAL

OMNI DIRECTIONAL

5 YR WARRANTY

80 CRI (Ra)

ENCLOSED**

LM 79 LM 80 TM 21 IES

HID LED PRODUCT FEATURES

Suitable for Enclosed Fixtures



This HID LED lamp replaces a 175-250W HID and is suitable for use in totally enclosed fixtures. Its high lumen output and exceptional efficacy make it an ideal choice for outdoor post top applications.

CoolSink Technology

The CoolSink passive cooling system allows air to flow freely through the lamp. This unique design uses an increased cooling surface area to reduce the operating temperature of the LED and power supply, thus resulting in longer lamp life and lumen maintenance.

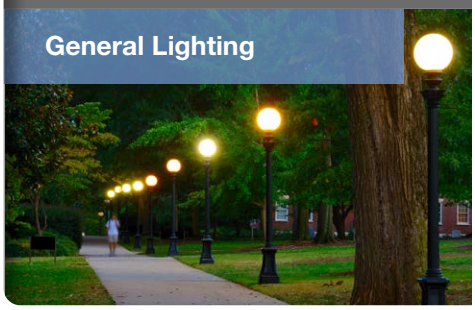


HID LED 80W TITANIUM LED SERIES

GREENCREATIVE

APPLICATIONS

General Lighting



Teardrop Lighting



Post Top Lighting



Ref.#: DS148-HID-LED-80W-277V-050617

SPECIFICATIONS

Product Model	57948 80HID/840/277V/EX39/R	57949 80HID/850/277V/EX39/R
Type	HID LED	HID LED
Base	EX39 (Compatible with E39)	EX39 (Compatible with E39)
Power (W)	80	80
Voltage - Frequency	120-277V	120-277V
Color Temp. (ANSI)	Cool White 4000K	Daylight 5000K
CRI (Ra) (typ.)	80	80
Bare Lamp lumens (lm)	9300	9600
Bare Lamp efficacy (LPW)	116	120
Fixture lumens (lm)* **	7960	7960
Fixture efficacy (LPW)* **	97	97
Beam Angle	320°	320°
Dimmable	No	No
Power Factor	0.9	0.9
Rated Lifetime - L70 (hrs.)	50,000	50,000
Temperature Rating	-4°F/-20°C - 95°F/35°C	-4°F/-20°C - 95°F/35°C
Dia. x MOL	5.87''x10.16'' (148x258mm)	5.87''x10.16'' (148x258mm)
Weight (lb. / g)	3.8lbs / 1724g	3.8lbs / 1724g

HID EQUIVALENCE

GREEN CREATIVE HID LED		Metal Halide		Mercury Vapor		High Pressure Sodium	
Power	**Lumens**	**Power**	**Mean Lumens**	**Power**	**Mean Lumens**	**Power**	**Mean Lumens**
80W	**9600**	**175W**	**10,800**	**250W**	**11,000**	**100W**	**8000**

* Savings per fixture based on $0.11 / kw energy cost, 12 hrs / $12 HID with 10,000-hr lifetime, $70 ballast, $285 LED HID with 50,000 hr lifetime
** Suitable for use in totally enclosed fixtures

*** Fixture lumens and efficacy based on DLC testing in Post Top fixture with prismatic diffuser: GE Patriarch Luminaire
**** Suitable for damp locations. Not for use where directly exposed to weather or water
***** Not suitable for use in horizontal applications

HID LED 16.5W HO 277V TITANIUM LED SERIES

GREENCREATIVE

ENERGY STAR

PRO





Optional Lamp Extender

16.5W REPLACES



50-70W HID

70% Energy Savings

$72 Savings per lamp*

- **Direct line voltage 120-277V - Not compatible with ballasts**
- **Compact form factor - Ideal for bollards & post tops**
- **Exceptional efficacy 121 LPW in Cool White**
- **Frosted diffuser maintains low glare**
- **Optional lamp extender available for use in larger fixtures**
- **Suitable for use in totally enclosed fixtures**

40,000 H

120-277V UNIVERSAL

121 LPW EFFICACY

5 YR WARRANTY

82 CRI (Ra)

ENCLOSED**

c UL us LISTED

FC

LM 79 LM 80 TM 21 IES

HID LED PRODUCT FEATURES

Suitable for Enclosed Fixtures



This HID LED lamp replaces a 50-70W HID and is suitable for use in enclosed fixtures. Its high lumen output and exceptional efficacy make it an ideal choice for bollard, post top and other outdoor applications. An optional lamp extender is also available for use in larger fixtures.

Omnidirectional Lighting

This HID LED emits 330° of uniform light and meets ENERGY STAR requirements. Its compact form factor and omnidirectional output provides a fuller distribution than other LED lamps.



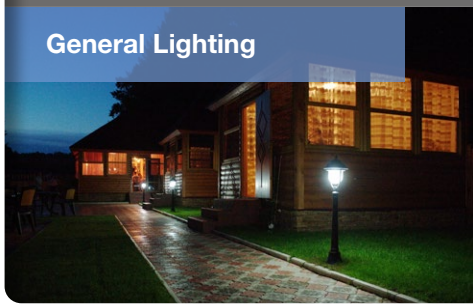


HID LED 16.5W HO 277V TITANIUM LED SERIES

GREENCREATIVE

APPLICATIONS

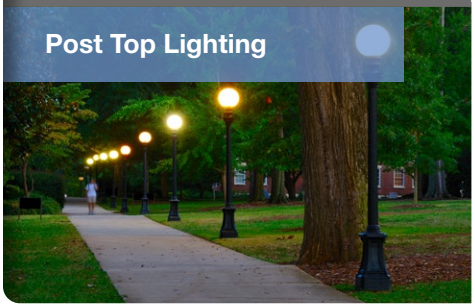
General Lighting



Bollard Lighting



Post Top Lighting



Ref.#: DS180-A21-16.5W-277V-100217

SPECIFICATIONS

Product Model	58238 16.5A21/830/277V	58239 16.5A21/840/277V	58240 16.5A21/850/277V
Type	HID LED	HID LED	HID LED
Base	E26	E26	E26
Power (W)	16.5	16.5	16.5
Voltage - Frequency	120-277V 50/60Hz	120-277V 50/60Hz	120-277V 50/60Hz
Color Temp. (ANSI)	Warm White 3000K	Cool White 4000K	Daylight 5000K
CRI (Ra) (typ.)	82	82	82
Typical lumens (lm)	2000	2000	2050
Efficacy (LPW)	121	121	124
Beam Angle	330°	330°	330°
Dimmable	No	No	No
Power Factor	0.9	0.9	0.9
Rated Lifetime - L70 (hrs.)	40,000	40,000	40,000
Dia. x MOL	2.55''x5.00'' (65x127mm)	2.55''x5.00'' (65x127mm)	2.55''x5.00'' (65x127mm)
Weight (lb. / g)	0.50lb. / 227g	0.50lb. / 227g	0.50lb. / 227g

* Savings per lamp based on $0.11 / kw energy cost, 12 hrs / day lamp usage, $12 HID with 10,000-hr lifetime, $35 LED with 40,000-hr lifetime

** Suitable for use in totally enclosed fixtures

*** Suitable for damp locations. Not for use where directly exposed to weather or water

KBL Series

LED Low-Bay/High-Bay Luminaire

Product Description

KBL LED delivers 20,900(M) or 27,500(H) lumens, allowing for one-for-one replacement or fixture count reduction of 250W, 400W HID or up to six lamp 54W T5HO fixtures. With energy savings of up to 65% over traditional light sources, lightweight construction and multiple mounting options, the KBL is optimized for new construction or retrofit installations.

The KBL delivers even illumination with reflector choices of aluminum, clear acrylic, clear polycarbonate, or white acrylic. Optional lenses offer enhanced uplight and maximum uniformity, making it ideal for a variety of applications including retail, gymnasiums, light manufacturing, and warehouses.

Applications: Retail, gymnasiums (aluminum or polycarbonate reflector), industrial, manufacturing and warehouse spaces.

Performance Summary

Initial Delivered Lumens: 20,900 or 27,500 lumens

Operating Temperature Range: M Lumen Package: -40˚C to 50˚C (-40˚F to +122˚F); H Lumen Package: -40˚C to 40˚C (-40˚F to +104˚F)

Efficacy: Up to 150 LPW

CRI: 70, 80+

CCT: 3000K, 3500K, 4000K, 5000K

Input Voltage: 120-277 VAC or 347-480 VAC (without step-down transformer)

L_{70} Lifetime: > 100,000 hours at maximum operating temperature

Limited Warranty†: 10 years on luminaire

Universal Mounting: Accommodates J-Box, pendant, hook, cord & plug

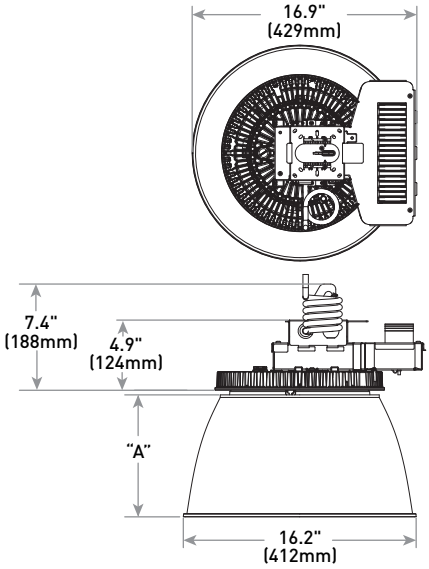
Weight: Maximum 14 lbs. (6.4kg)

Controls: 0-10V dimming to 10% or Multi-Level Occupancy

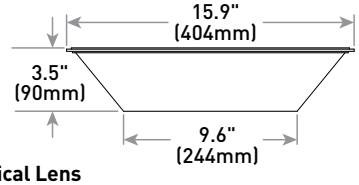
† See http://lighting.cree.com/warranty for warranty terms

Shown Fully Assembled with Prismatic Reflector and Universal Mount

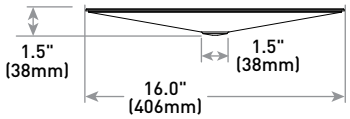




Drop Lens



Clear Conical Lens



Reflector	"A" Height
CXBA16N (Aluminum)	9.0" (229mm)
CXBP16 (Clear Prismatic)	8.5" (216mm)
CXBW16 (White Acrylic)	8.5" (216mm)
CXBC16 (Clear Polycarbonate)	8.5" (216mm)

Ordering Information

Example: KBL-A-UV-H-40K-7-UL-10V

KBL	A	UV					
Product	**Version**	**Mounting**	**Lumen Package***	**CCT**	**CRI**	**Voltage**	**Controls**
KBL	**A**	**UV** Universal Mount: hook and cord with 6ft whip, adaptor plate for J-box and pendant	**M** 20,900 Lumens **H** 27,500 Lumens	**30K** 3000K **40K** 4000K **35K** 3500K **50K** 5000K	**7** 70 CRI **8** 80 CRI	**UL** 120-277V **UH** 347-480V	**10V** 0-10V Dimming **ML** Multi-Level - Refer to ML install instructions for details

* Lumen Package codes identify approximate light output only. Actual lumen output levels vary depending on CCT and reflector/lens selection. Refer to Delivered Lumens & Electrical Data and Reflector Illumination Performance tables for specific lumen values

Rev. Date: V1 11/27/2017

US: lighting.cree.com T (800) 236-6800 F (262) 504-5415

Canada: www.cree.com/canada T (800) 473-1234 F (800) 890-7507

Product Specifications

CONSTRUCTION & MATERIALS

- Die cast aluminum heatsink
- Luminaire is post-painted with white powder coat finish
- IP65 optics with tempered glass lens protect LEDs while keeping the dust out
- Low-profile, lightweight design provides ease of installation
- Mounting choices of direct J-Box/pendant and hook, cord & plug
- J-box mount mounts directly over existing 4" (102mm) single gang square, rectangular and octagonal junction boxes for direct mount
- J-box mount has provision to accept ¾ IP pendant (by others)
- UV mount is provided with factory installed spring lock hook for mounting and factory installed 6' (1.8m) 16/3 AWG white power cord
- Factory calibrated to hang straight
- Designed for downlight applications only
- **Weight:** Maximum 14 lbs. (6.4kg)

OPTICAL SYSTEM

- 16" (406mm) all reflectors
- LED system delivers proper uniformity & spacing

ELECTRICAL SYSTEM

- Integral, high-efficiency driver
- **Input Voltage:** 120-277V or 347-480V 50/60Hz
- **Power Factor:** > 0.9 at full load
- **Total Harmonic Distortion:** < 20% at full load
- **Operating Temperature Range:** M Lumen Package: -40˚C to 50˚C (-40˚F to +122˚F); H Lumen Package: -40˚C to 40˚C (-40˚F to +104˚F)
- **Transient Protection:** 6kV/3kA tested in accordance to IEEE/ANSI
- When code dictates fusing, a slow blow fuse or type C/D breaker should be used to address inrush current

0-10V DIMMING

- Continuous dimming to 10% with 0-10V DC control protocol
- 10V Source Current: 0.15mA
- Use only lighting controls with neutral connection or controls intended for use with LED fixtures
- Reference dimming document for additional information

MULTI-LEVEL OPTION

- Passive infrared (PIR) occupancy sensing
- High/low occupancy, dim to min of 30%
- Covers mounting heights from 15-45' (4.6-13.7 m). Detects walking to 35' (10.8 m) and fork lifts to 45' (13.7 m)
- Available with UL and UH voltages
- Refer to KBL install instructions for details on sensor functionality, operation and lumen and power multipliers

REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus Listed (UL1598; UL8750)
- Suitable for damp locations
- Requires minimum 90°C supply conductors
- Not intended for use in environments containing airborne corrosive agents such as chemical solvents, cleaners, or cutting fluids
- IP65 rated LED optics
- Meets FCC Part 15, Subpart B, Class A standards for conducted and radiated emissions
- Assembled in the U.S.A. of U.S. and imported parts
- DLC and DLC Premium qualified versions available. Some exceptions apply. Please refer to https://www.designlights.org/search/ for most current information

Delivered Lumens & Electrical Data*

Lumen Package	CCT	Delivered Lumens**		System Watts	Efficacy (LPW at 70CRI)	Total Current (A)					
		70 CRI	80 CRI	120-480V		120V	208V	240V	277V	347V	480V
M	3000K	21,300	18,800	142	150	1.20	0.69	0.60	0.51	0.41	0.29
	3500K	22,000	19,700		155						
	4000K	22,100	20,500		156						
	5000K	22,100	20,700		156						
H	3000K	28,000	24,700	189	148	1.60	0.92	0.80	0.68	0.54	0.39
	3500K	28,800	25,900		152						
	4000K	29,100	26,900		154						
	5000K	29,000	27,200		153						

* Data provided at 25˚C (77˚F). Actual wattage may differ by +/- 10% when operating between 120-480V +/- 10%.
** Initial delivered lumen values based on luminaire without reflector. Refer to reflector Illumination Performance table for lumen multipliers when using reflector accessory

Reflector Uplight Illumination Performance

Reflector	% of Uplight	Lumen Multiplier
CXBA16N (Aluminum)	0%	0.86
CXBA16N w/CLA16 (Aluminum w/Clear Conical Lens)	0%	0.76
CXBA16N w/DLA16 (Aluminum w/Clear Drop Lens)	2%	0.77
CXBP16 (Clear Prismatic)	3%	0.96
CXBP16 w/CL16 (Clear Prismatic w/Clear Conical Lens)	6%	0.93
CXBP16 w/DL16 (Clear Prismatic w/Clear Drop Lens)	8%	0.93
CXBW16 (White Acrylic)	13%	0.93
CXBW16 w/CL16 (White Acrylic w/Clear Conical Lens)	16%	0.88
CXBW16 w/DL16 (White Acrylic w/Clear Drop Lens)	16%	0.90
CXBC16 (Clear Polycarbonate)	2%	0.89
CXBC16 w/CL16 (Clear Polycarbonate w/Clear Conical Lens)	5%	0.85
CXBC16 w/DL16 (Clear Polycarbonate w/Clear Drop Lens)	7%	0.84

Reference http://lighting.cree.com/products/indoor/high-bay-low-bay/kbl-series for detailed photometric data

KBL Series Ambient Adjusted Lumen Maintenance[1]

Ambient	Initial LMF	36K hr Projected[2] LMF	50K hr Calculated[3] LMF	75K hr Calculated[3] LMF	100K hr Calculated[3] LMF
25˚C (77˚F)	1.00	0.95	0.94	0.93	0.92
30˚C (86˚F)	0.99	0.94	0.93	0.92	0.91
35˚C (95˚F)	0.98	0.93	0.92	0.91	0.90
40˚C (104˚F)	0.97	0.92	0.91	0.90	0.90
45˚C (113˚F)	0.96	0.91	0.90	0.89	0.89
50˚C (122˚F)	0.95	0.90	0.89	0.89	0.88

[1] Lumen maintenance values at 25˚C are calculated per TM-21 based on LM-80 data and in-situ luminaire testing. Luminaire ambient temperature factors (LATF) have been applied to all lumen maintenance factors
[2] In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ([DUT) i.e. the packaged LED chip)
[3] In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times (6X) the IESNA LM-80-08 total test duration (in hours) for the device under testing ([DUT) i.e. the packaged LED chip)
Note: H Lumen package is only rated up to 40˚C

Accessories

Reflector

CXBA16N (Single Pack)
CXBA16N-MP (Multi-Pack)
- 16" (406mm) Aluminum

CXBP16 (Single Pack)
CXBP16-MP (Multi-Pack)
- 16" (406mm) Clear Acrylic
- Acrylic reflector is not impact resistant nor intended for use unprotected in a gymnasium

CXBW16 (Single Pack)
CXBW16-MP (Multi-Pack)
- 16" (406mm) White Acrylic
- Acrylic reflector is not impact resistant nor intended for use unprotected in a gymnasium

CXBC16 (Single Pack)
CXBC16-MP (Multi-Pack)
- 16" (406mm) Clear Polycarbonate
- Suitable for use in gymnasiums; WG-AP wire guard recommended

Notes:
- Single pack SKUs ship as one reflector per box
- Multi-pack SKUs require a minimum order of 10 pieces or more, and ship together in as few boxes as possible

Reflector Accessories

16" (406mm) Wire Guards
WG-A
- For Aluminum Reflector

WG-AP
- For Acrylic and Polycarbonate Reflectors

Note: Lenses and wire guard accessories can't be used together

16" (406mm) Clear Prismatic Drop Acrylic Lenses
DLA16
- For Aluminum Reflector

DL16
- For Acrylic Reflector

16" (406mm) Clear Conical Acrylic Lenses
CLA16
- For Aluminum Reflector

CL16
- For Acrylic Reflector

Safety Cables

Galvanized Safety Cables
SC-5
- 5.0' (1.5m) Cable

SC-10
- 10.0' (3.0m) Cable

Field-Installed NEMA® Plugs

AP-515P
- 15 amp 120V Straight Blade Plug

AP-L515P
- 15 amp 120V Twist Lock Plug

AP-L615P
- 15 amp 240V Twist Lock Plug

AP-L715P
- 15 amp 277V Twist Lock Plug

AP-L2420P
- 20 amp 347V Twist Lock Plug

AP-L820P
- 20 amp 480V Twist Lock Plug

Optional Reflectors/Lens

shown fully assembled with universal mount

Aluminum Reflector w/Drop Lens



Clear Prismatic Reflector



White Acrylic Reflector w/Conical Lens



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US: lighting.cree.com T (800) 236-6800 F (262) 504-5415

Canada: www.cree.com/canada T (800) 473-1234 F (800) 890-7507

Cree® KBL Series

LED Low-Bay/High-Bay Luminaire



UP TO 150 LPW TO LIGHTEN THAT OVERHEAD

Exceptional Efficacy

The KBL Series High-Bay offers extreme efficacy in the industry's favorite form factor. Available in 18,000 and 24,000 nominal lumen packages, the KBL Series delivers up to 150 LPW while saving up to 65% energy over traditional light sources. Switching to LED has never been easier than with the KBL Series, offering you the ability to maximize rebates and virtually eliminate maintenance costs.

Industrial-Grade Reliability

The higher the mounting height, the higher the stakes. Built with industry-leading drivers and paired with our premium LED arrays, the KBL Series ensures worry-free operation for years to come. Robust 6kV/3Ka transient protection, IP65 sealed optics and lumen maintenance over 100K hours make the KBL Series the fixture you can count on.

Versatile Design with Stylish Aesthetics

The KBL Series' clean lines and visually comfortable optics blend into any space while delivering the performance you expect. Customize the KBL Series to your space with your choice of aluminum, clear or white acrylic reflectors; optional bottom lenses maximize uplight to reduce dark ceilings and give your space a more open feel.

Remarkable Application Flexibility

The KBL Series is versatile and flexible enough for almost any space, whether new construction or retrofit - providing better light to support a safer, more productive environment. Its compact, lightweight construction and universal mounting option make the KBL Series ideal for retail, industrial, warehouse and manufacturing applications.

CREE™

KBL SERIES LED LOW-BAY/HIGH-BAY LUMINAIRE

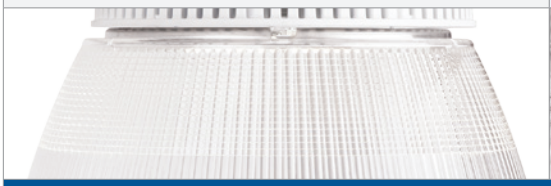
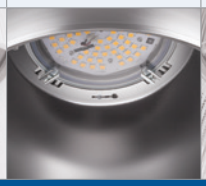
At Cree, we're continuing to improve high-bay/low-bay LED performance with the introduction of the KBL Series, delivering extreme energy savings and exceptional lumen maintenance without sacrificing what's important — better light and near maintenance-free operation. With multiple lumen, CRI and CCT packages; reflectors and lenses, the KBL Series makes selecting the ideal solution for your application quick and easy — whether it's grocery, gymnasium, industrial, retail, manufacturing or warehouse. Lightweight construction and universal mounting make installations near effortless, getting you back to what's important. And with high lumens per watt that qualify for DLC Premium certification, the Cree® KBL Series is exceptionally rebate friendly!

PERFORMANCE SUMMARY
Nominal Delivered Lumens: 18,000 or 24,000 lumens
Input Power: 142 or 189 watts
Efficacy: Up to 150 LPW
CRI: 70 or 80+
CCT: 3000K, 3500K, 4000K, 5000K
Input Voltage: 120-277 VAC or 347-480 VAC
Limited Warranty: 10 years
Mounting: Universal mounting easily converts to support J-box, pendant or hook & cord installations
Weight: Maximum 14 lbs.
Dimming: 0-10V dimming to 10% or multi-level occupancy





Shown with Wire Guard

REFLECTOR OPTIONS	Clear Prismatic Acrylic	White Diffuse Acrylic	Matte Spun Aluminum	Clear Prismatic Polycarbonate
				
LENS OPTIONS FOR MAXIMUM UPLIGHT & UNIFORMITY				
 **Open Reflector**	**3%**	**13%**	**0%**	**2%**
 **Clear Acrylic Prismatic Drop Lens**	**8%**	**16%**	**2%**	**7%**
 **Clear Acrylic Conical Bottom Lens**	**6%**	**16%**	**0%**	**5%**

Visit **lighting.cree.com** or contact a Cree lighting representative to learn more

info@cree.com | 800.236.6800

© 2017 Cree, Inc. All rights reserved. For informational purposes only. Not a warranty or specification. See lighting.cree.com/warranty for warranty and specifications. Cree® is a registered trademark and the Cree logo is a trademark of Cree Inc. CAT/SSHT-C099 Rev. Date: 09/18/17

Dimming



Diva® 0–10V

- 0–10V dimmer for fluorescent and LED fixtures

Two models available:

- DVSTV
  - Controls 120–277V without a power pack
  - Provides 3-way preset switching functionality
- DVTV
  - Requires a power pack
  - Use with a power pack for Class 2 installations, with wired occupancy sensors, for 347V operation, and for loads greater than 8A

Voltage

- DVSTV
  - 8A, 120-277V
- DVTV
  - 16A with PP-DV, 120-277V
  - 16A with PP-347, 347V

Ideal for applications requiring 0–10V fixtures, such as private offices and conference rooms

The Lutron Advantage

- Patented technology extends relay life to 10 years
- Low-end and high-end trim in one product
- No derating for 277V installations
- No neutral

Energy-saving strategies

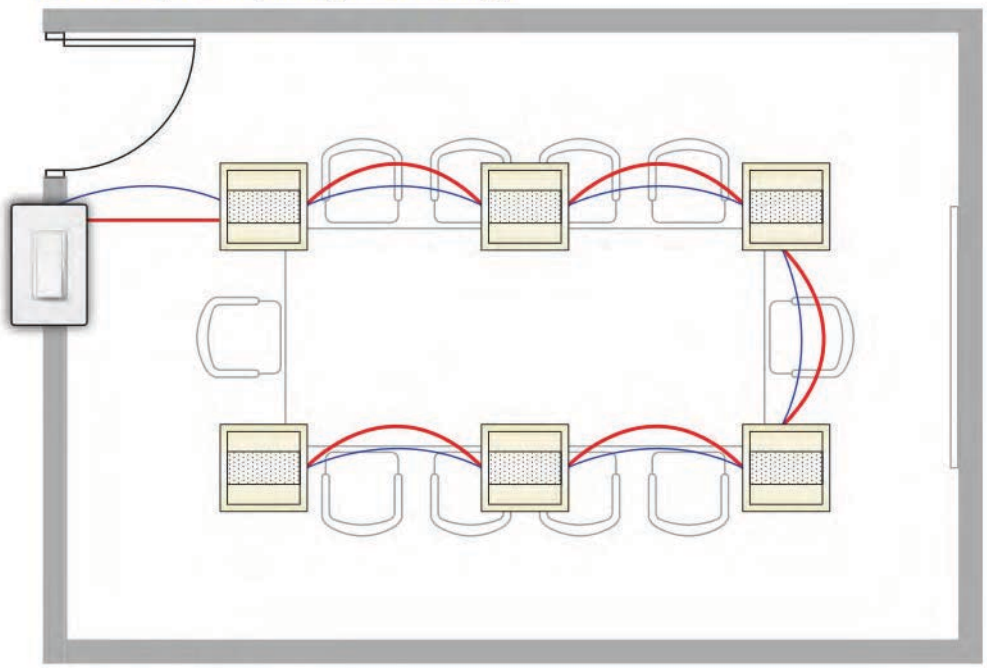
- Dimming
- High-end trim

Codes met

- Automatic shut-off with wired occupancy sensors through a power pack
- Area control
- Multi-level lighting control

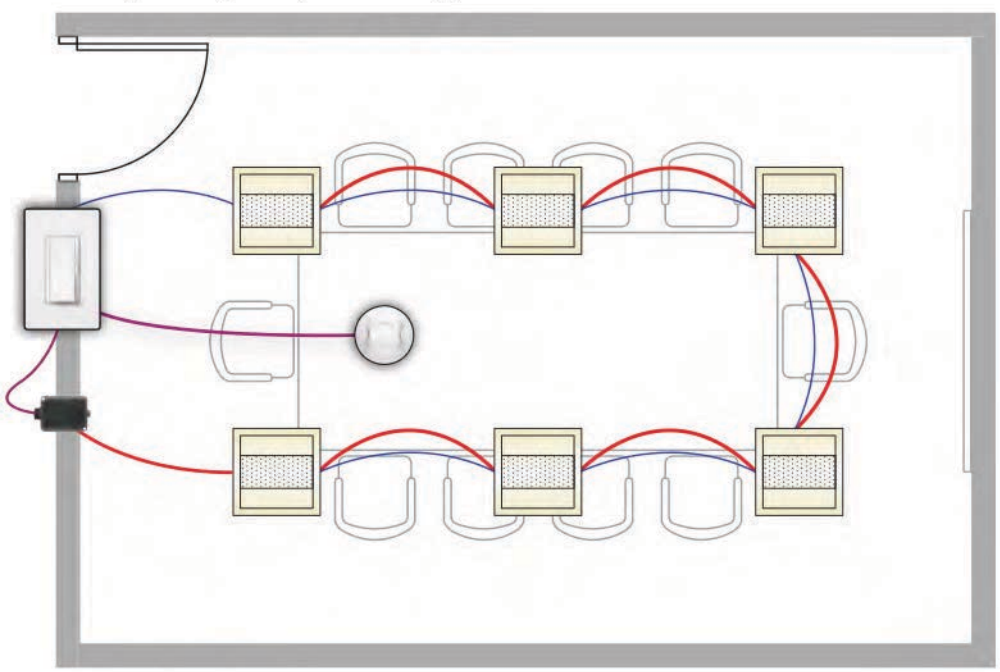
Application examples: Conference room

Without power pack (DVSTV Only)



Line-voltage wiring
Low-voltage wiring

With power pack (DVTV Only)



Line-voltage wiring
Low-voltage wiring
Occupancy signal

ALED3T78



Specification Grade Area lights available in IES Type III distributions. For use in parking lots, roadways, pathways and general area lighting. Mounts to 4" square steel poles at 15-25'. Designed to replace 250W Metal Halide Area Lights. Patent Pending thermal management system. 5 Year Warranty.

Color: Bronze

Weight: 30.4 lbs

Project:	Type:
Prepared By:	Date:

Driver Info		LED Info	
Type:	Constant Current	Watts:	78W
120V:	0.66A	Color Temp:	5100K (Cool)
208V:	0.41A	Color Accuracy:	67 CRI
240V:	0.35A	L70 Lifespan:	100000
277V:	0.30A	Lumens:	6,911
Input Watts:	78W	Efficacy:	88 LPW
Efficiency:	99%		

Technical Specifications

Optical

Lumen Maintenance:

100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

Replacement:

The ALED78 replaces 250W Metal Halide Area Lights.

BUG Rating:

B1 U0 G2

Construction

IES Classification:

The Type III distribution is ideal for roadway, general parking and other area lighting applications where a larger pool of lighting is required. It is intended to be located near the side of the area, allowing the light to project outward and fill the area.

IP Rating:

Ingress Protection rating of IP66 for dust and water.

Ambient Temperature:

Suitable for use in 40°C ambient temperatures.

Cold Weather Starting:

The minimum starting temperature is -40°F/-40°C.

Thermal Management:

Superior heat sinking with external Air-Flow fins.

Effective Projected Area:

EPA = 0.75

Housing:

Die cast aluminum housing, lens frame and mounting arm.

Reflector:

Specular vacuum-metallized polycarbonate

Gaskets:

High temperature silicone gaskets.

Finish:

Our environmentally friendly polyester powder coatings are formulated for high-durability and long-lasting color, and contains no VOC or toxic heavy metals.

Green Technology:

Mercury and UV free.

For use on LEED Buildings:

IDA Dark Sky Approval means that this fixture can be used to achieve LEED Credits for Light Pollution Reduction.

LED Characteristics

LEDs:

Six (6) multi-chip, 13W, high-output, long-life LEDs.

Color Consistency:

3-step MacAdam Ellipse binning to achieve consistent fixture-to-fixture color.

Color Stability:

LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Uniformity:

RAB's range of CCT (Correlated color temperature) follows the guidelines of the American National Standard for Specifications for the Chromaticity of Solid State Lighting (SSL) Products, ANSI C78.377-2015.

Electrical

Driver:

Constant Current, Class 2, 2000mA, 100-277V, 50-60Hz, 1.1A, Power Factor 99%

THD:

5.3% at 120V, 13.3% at 277V

Surge Protection:

4kV

Surge Protector:

ALED78 is available with a 6kV surge protector (SP6). SP6 available .

Listings

IESNA LM-79 & IESNA LM-80 Testing:

RAB LED luminaires have been tested by an independent laboratory in accordance with IESNA LM-79 and 80, and have received the Department of Energy "Lighting Facts" label.

Dark Sky Approved:

The International Dark Sky Association has approved this product as a full cutoff, fully shielded luminaire.

UL Listing:

Suitable for wet locations as a downlight.

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Technical Specifications (continued)

Listings

DLC Listed:

This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.
DLC Product Code: P0000179S

Other

California Title 24:

See ALED3T78/D10, ALED3T78/BL, ALED3T78/PCS, ALED3T78/PCS2, or ALED3T78/PCT for a 2013 California Title 24 compliant product. Any additional component requirements will be listed in the Title 24 section under technical specifications on the product page.

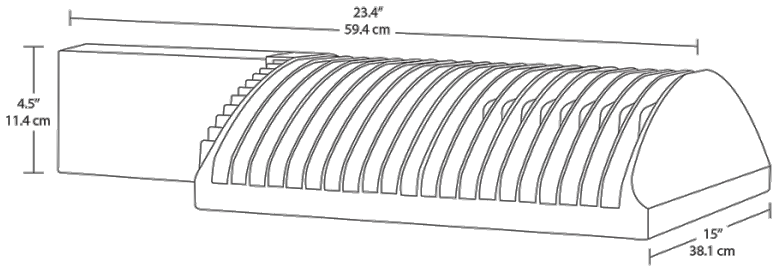
Warranty:

RAB warrants that our LED products will be free from defects in materials and workmanship for a period of five (5) years from the date of delivery to the end user, including coverage of light output, color stability, driver performance and fixture finish.

Patents:

The ALED design is protected by patents in the U.S. Pat. 668,370, Canada Pat. 144956, China ZL201230100154.X, and Mexico Pat. 38423. Pending patents in Taiwan.

Dimensions



Features

- High output LED light engine
- Maintains 70% of initial lumens at 100,000 hours
- Weatherproof high temperature silicone gaskets
- Superior heat sinking with die cast aluminum housing and external fins
- Replaces 250W MH area lights
- 5-year warranty

Ordering Matrix

Family	Distribution	Watts	Mount	Color Temp	Finish	Voltage	Photocell	Dimming	Sensor	Bi-Level
ALED										
	2T = Type II **3T** = Type III **4T** = Type IV	**78** = 78W	= Arm **SF** = Slipfitter	= 5000K (Cool) **Y** = 3000K (Warm) **N** = 4000K (Neutral)	= Bronze **W** = White **RG** = Gray	= 120-277V **/480** = 480V	= No Photocell **/PC** = 120V Button **/PC2** = 277V Button **/PCS** = 120V Swivel **/PCS2** = 277V Swivel **/PCT** = 120-277V Twistlock **/PCS4** = 480V Swivel	= No Dimming **/D10** = Dimmable	**/WS2** = Multi-Level Motion Sensor (Only available for 120-277V with /D10 for 78W)	= No Bi-Level **/BL** = Bi-Level

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FFLED39N



Rectangular shaped LED floodlight designed to replace 150W Metal Halide. Patent Pending airflow technology ensures long LED and driver lifespan. Use for building facade lighting, sign lighting, LED landscape lighting and instant-on security lighting.

Color: Bronze Weight: 12.5 lbs

Project:	Type:
Prepared By:	Date:

Driver Info		LED Info	
Type:	Constant Current	Watts:	39W
120V:	0.35A	Color Temp:	4000K
208V:	0.20A	Color Accuracy:	71 CRI
240V:	0.18A	L70 Lifespan:	100000
277V:	0.15A	Lumens:	5651
Input Watts:	42W	Efficacy:	134 LPW
Efficiency:	92%		

Technical Specifications

LED Characteristics

Lifespan:

100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

LEDs:

Two multi-chip, 26Watt high performance LEDs.

Color Consistency:

3-step MacAdam Ellipse binning to achieve consistent fixture-to-fixture color.

Color Stability:

LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Uniformity:

RAB's range of CCT (Correlated Color Temperature) follows the guidelines of the American National Standard for (SSL) Products, ANSI C78.377-2015.

Listings

DLC Listed:

This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.
DLC Product Code:_P0000173J

IESNA LM-79 & LM-80 Testing:

RAB LED luminaires have been tested by an independent laboratory in accordance with IESNA LM-79 and LM-80, and have received the Department of Energy "Lighting Facts" label.

UL Listing:

Suitable For Wet Locations. Suitable for ground mounting.

Construction

IP Rating:

Ingress Protection rating of IP66 for dust and water

Ambient Temperature:

SuitableFor use in 40°C (104°F) ambient temperatures.

Cold Weather Starting:

Minimum starting temperature is -40°C (-40°F)

Thermal Management Housing:

Superior heat sinking with external Air-Flow fins.

Mounting:

Heavy-duty mounting arm with "O" ring seal & stainless steel screw.

Effective Projected Area:

EPA = 0.65

Reflector:

Specular vacuum-metallized polycarbonate

Gaskets:

High-temperature silicone gaskets

Finish:

Formulated for high-durability and long lasting color.

Green Technology:

Mercury and UV free. RoHS compliant components. Polyester powder coat finish formulated without the use of VOC or toxic heavy metals.

Threaded Size:

1/2" threaded arm.

Optical

NEMA Type:

NEMA Beam Spread of 7H x 6V

Electrical

Driver:

Constant Current, Class 2, 1050mA, 100-277V, 50/60Hz, 0.6A, Power Factor 99%

Surge Protection:

4kV

Other

California Title 24:

Select an FFLED39 model equipped with 0-10V driver (look for /D10 in the catalog #) for a 2013 California Title 24 compliant model.

Warranty:

RAB warrants that our LED products will be free from defects in materials and workmanship for a period of five (5) years from the date of delivery to the end user, including coverage of light output, color stability, driver performance and fixture finish.

Patents:

The FFLED design is protected by U.S. Pat. D643,147, Canada Pat. 140798, China Pat. ZL201130171304.1, Mexico Pat. 36757 and pending patent in Taiwan.

American Bureau of Shipping (ABS) :

For use on Mobile Offshore Drilling Units (MODU) and shipping vessels.

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Technical Specifications (continued)

Other

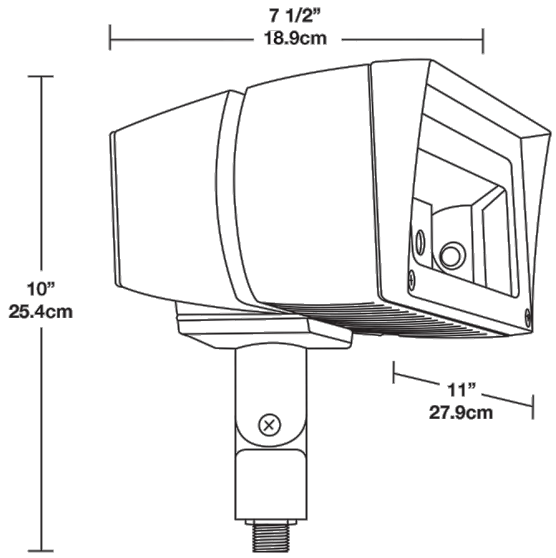
Equivalency:

Equivalent to 150W Metal Halide.

Buy American Act Compliance:

RAB values USA manufacturing! Upon request, RAB may be able to manufacture this product to be compliant with the Buy American Act (BAA). Please contact customer service to request a quote for the product to be made BAA compliant.

Dimensions



Features

- Ultra efficient LED and optical design
- Replaces 150W MH floodlights
- 100,000 hour life based on LM-80 tests
- Air-flow technology heatsink
- 5-year warranty

Ordering Matrix

Family	Wattage	Mounting	Color Temp	NEMA Type	Finish	Driver	Photocell Options
FFLED	39		N				
	80 = 80W **52** = 52W **39** = 39W **26** = 26W	**Blank** = Swivel Arm **SF** = Slipfitter **T** = Trunnion	**Blank** = 5000K (Cool) **N** = 4000K (Neutral) **Y** = 3000K (Warm)	**Blank** = 7H x 6V **B55** = 5H x 5V **B44** = 4H x 4V	**Blank** = Bronze **W** = White	**Blank** = On/Off **/D10** = 0-10V Dimming **/480** = 480V On/Off (not available for 80W models)	**Blank** = No Option **/PC** = 120V Photocell **/PC2** = 277V Photocell **/PCS** = 120V Swivel Photocell **/PCS2** = 277V Swivel Photocell **/PCS4** = 480V Swivel Photocell

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FFLED52TNW



Rectangular shaped LED floodlight designed to replace 175W Metal Halide. Patent Pending airflow technology ensures long LED and driver lifespan. Use for building facade lighting, sign lighting, LED landscape lighting and instant-on security lighting.

Color: White Weight: 14.2 lbs

Project:	Type:
Prepared By:	Date:

Driver Info		LED Info	
Type:	Constant Current	Watts:	52W
120V:	0.45A	Color Temp:	4000K
208V:	0.27A	Color Accuracy:	71 CRI
240V:	0.24A	L70 Lifespan:	100000
277V:	0.21A	Lumens:	6917
Input Watts:	56W	Efficacy:	124 LPW
Efficiency:	93%		

Technical Specifications

Listings

UL Listing:

Suitable For Wet Locations. Suitable for mounting within 1.2M(4FT) of the ground.

IESNA LM-79 & LM-80 Testing:

RAB LED luminaires have been tested by an independent laboratory in accordance with IESNA LM-79 and LM-80, and have received the Department of Energy "Lighting Facts" label.

LED Characteristics

Lifespan:

100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

LEDs:

Two multi-chip, 26Watt high performance LEDs.

Color Consistency:

3-step MacAdam Ellipse binning to achieve consistent fixture-to-fixture color.

Color Stability:

LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Uniformity:

RAB's range of CCT (Correlated Color Temperature) follows the guidelines of the American National Standard for (SSL) Products, ANSI C78.377-2017.

Construction

IP Rating:

Ingress Protection rating of IP66 for dust and water

Ambient Temperature:

SuitableFor use in 40°C (104°F) ambient temperatures.

Cold Weather Starting:

Minimum starting temperature is -40°C (-40°F)

Thermal Management Housing:

Superior heat sinking with external Air-Flow fins.

Housing:

Die-cast aluminum housing, lens frame and mounting arm.

Threaded Size:

1/2" threaded arm.

Mounting:

Heavy-duty Trunnion mount with stainless steel hardware.

Effective Projected Area:

EPA = 0.65

Reflector:

Specular polycarbonate

Gaskets:

High-temperature silicone gaskets

Finish:

Formulated for high-durability and long lasting color.

Green Technology:

Mercury and UV free. RoHS compliant components. Polyester powder coat finish formulated without the use of VOC or toxic heavy metals.

Optical

NEMA Type:

NEMA Beam Spread of 7H x 6V

Electrical

Driver:

Constant Current, Class 2, 100-277V, 50/60 Hz, 4 kV surge protection, 120V: 0.45A, 208V: 0.27A, 240V: 0.24A, 277V: 0.21A

Other

California Title 24:

Select an FFLED52TN model equipped with a 0-10V driver (look for /D10 in the catalog #) for a 2013 California Title 24 compliant model.

Warranty:

RAB warrants that our LED products will be free from defects in materials and workmanship for a period of five (5) years from the date of delivery to the end user, including coverage of light output, color stability, driver performance and fixture finish.

Patents:

The FFLED design is protected by U.S. Pat. D643,147, Canada Pat. 140798, China Pat. ZL201130171304.1, Mexico Pat. 36757 and pending patent in Taiwan.

American Bureau of Shipping (ABS) :

For use on Mobile Offshore Drilling Units (MODU) and shipping vessels.

Equivalency:

Equivalent to 175W Metal Halide.

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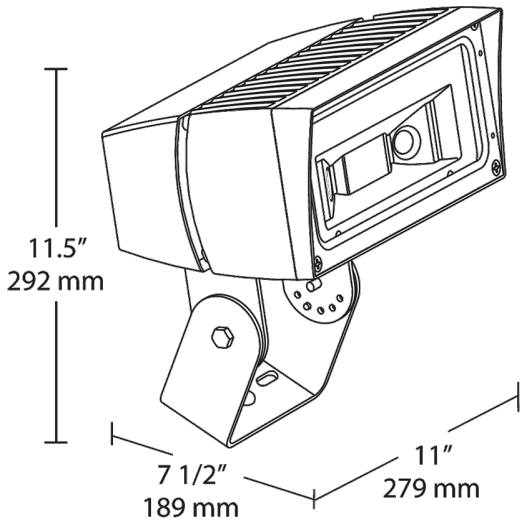
Technical Specifications (continued)

Other

Buy American Act Compliance:

RAB values USA manufacturing! Upon request, RAB may be able to manufacture this product to be compliant with the Buy American Act (BAA). Please contact customer service to request a quote for the product to be made BAA compliant.

Dimensions



Features

- Ultra efficient LED and optical design
- Replaces 175W MH floodlights
- 100,000 hour life based on LM-80 tests
- Air-flow technology heatsink
- 5-year warranty

Ordering Matrix

Family	Wattage	Mounting	Color Temp	NEMA Type	Finish	Driver	Photocell Options
FFLED	52	T	N		W		
	80 = 80W **52** = 52W **39** = 39W **26** = 26W	**Blank** = Swivel Arm **SF** = Slipfitter **T** = Trunnion	**Blank** = 5000K (Cool) **N** = 4000K (Neutral) **Y** = 3000K (Warm)	**Blank** = 7H x 6V **B55** = 5H x 5V **B44** = 4H x 4V	**Blank** = Bronze **W** = White	**Blank** = On/Off **/D10** = 0-10V Dimming **/480** = 480V On/Off (not available for 80W models)	**Blank** = No Option **/PC** = 120V Photocell **/PC2** = 277V Photocell **/PCS** = 120V Swivel Photocell **/PCS2** = 277V Swivel Photocell **/PCS4** = 480V Swivel Photocell

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SLIM37



37, 57 and 62 Watt SLIM Wallpacks are designed to cover the footprint of most traditional wallpacks. They are suitable for mounting heights from 20' to 30', and replace HID Wattages from 200W MH to 320W MH. These ultra-high efficiency fixtures are available in cutoff or full cutoff models.

Color: Bronze

Weight: 7.5 lbs

Project:	Type:
Prepared By:	Date:

Driver Info		LED Info	
Type:	Constant Current	Watts:	37W
120V:	0.31A	Color Temp:	5000K (Cool)
208V:	0.19A	Color Accuracy:	75 CRI
240V:	0.16A	L70 Lifespan:	100000
277V:	0.14A	Lumens:	2,688
Input Watts:	37W	Efficacy:	73 LPW
Efficiency:	N/A		

Technical Specifications

Listings

UL Listing:

Suitable for wet locations. Wall Mount only.

IESNA LM-79 & LM-80 Testing:

RAB LED luminaires have been tested by an independent laboratory in accordance with IESNA LM-79 and LM-80, and have received the Department of Energy "Lighting Facts" label.

DLC Listed:

This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.
DLC Product Code: P0000171T

Construction

Footprint:

Designed to replace RAB HID WP1 wallpacks, both in size and footprint template, so upgrading to LED is easy and seamless.

IP Rating:

Ingress Protection rating of IP66 for dust and water.

Cold Weather Starting:

The minimum starting temperature is -40°F/-40°C.

Ambient Temperature:

Suitable for use in 40°C (104°F) ambient temperatures.

Thermal Management:

Superior thermal management with internal Air-Flow fins.

Housing:

Precision die-cast aluminum housing and door frame.

Mounting:

Die-cast back box with four (4) conduit entry points and knockout pattern for junction box or direct wall mounting. Hinged housing and bubble level for easy installation.

Cutoff:

Cutoff (7.5°)

Recommended Mounting Height:

Up to 20 ft.

Lens:

Microprismatic diffusion glass lens reduces glare and has smooth and even light distribution.

Reflector:

Specular thermoplastic.

Gaskets:

The unique design of the tight-lock gasket ensures no water or environmental elements will ever get inside the SLIM.

Finish:

Our environmentally friendly polyester powder coatings are formulated for high-durability and long-lasting color, and contains no VOC or toxic heavy metals.

Green Technology:

Mercury and UV free, and RoHS compliant.

LED Characteristics

LED:

Long-life, high-efficiency, micro-power, surface mount LEDs; binned and mixed for uniform light output and color.

Lifespan:

100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

Correlated Color Temp. (Nominal CCT):

5000K

Color Stability:

LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Consistency:

7-step MacAdam Ellipse binning to achieve consistent fixture-to-fixture color.

Electrical

Driver:

Constant Current, 100-277V. 50/60Hz, 100-277VAC 0.6A, 4kV Surge Protection, 700mA, Power Factor 99.6%.

THD:

7.3% at 120V, 8.5% at 277V

Other

HID Replacement Range:

The SLIM37 can be used to replace 200W MH based on delivered lumens.

Accessories:

Available accessories include polyshield and wire guard. Click to see all accessories.

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Technical Specifications (continued)

Other

California Title 24:

See SLIM37/BL for a 2013 California Title 24 compliant product. Any additional component requirements will be listed in the Title 24 section under technical specifications on the product page.

Patents:

The design of the SLIM™ is protected by patents pending in US, Canada, China, Taiwan and Mexico.

Warranty:

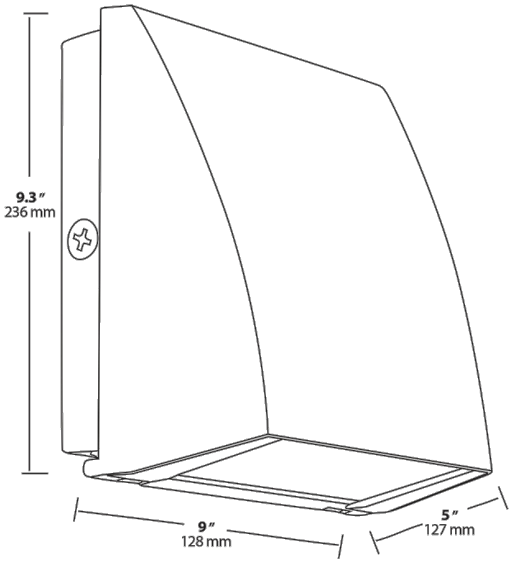
RAB warrants that our LED products will be free from defects in materials and workmanship for a period of five (5) years from the date of delivery to the end user, including coverage of light output, color stability, driver performance and fixture finish.

Optical

BUG Rating:

B1 U1 G1

Dimensions



Features

- Covers footprint of most traditional wallpacks
- Easy installation with hinged access, bubble level and multiple conduit entries
- Tight-lock gasket keeps elements out
- 100,000-hour LED lifespan
- 5-Year warranty

Ordering Matrix

Family	Cutoff	Watts	Color Temp	Finish	Photocell	Bi-Level
SLIM						
	= Standard **C** = Cutoff **FC** = Full Cutoff	**62** = 62W **57** = 57W **37** = 37W	= 5000K (Cool) **Y** = 3000K (Warm) **N** = 4000K (Neutral)	= Bronze **W** = White	= No Photocell **/PC** = 120V Button **/PC2** = 277V Button **/PCS** = 120V Swivel **/PCS2** = 277V Swivel	= No Bi-Level **/BL** = Bi-Level

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Model # SLIM37N(All Fixture Colors)

Manufacturer: RAB Lighting
Brand: RAB Lighting
Technical Requirements Version: 2
Date Qualified: 10/24/2013
Product ID: P00001722

Categorization

Main: Outdoor Luminaires
General Application: Low Output
Primary Use: Outdoor Full-Cutoff Wall-Mounted Area Luminaires

Classification: Standard
Is Parent Product: Yes
DLC Family Code: AAAGQR
Dimming Status: NotYetVerified
Listing Status: Listed

Tested Data | Reported Data | Zonal Lumens | Family Data

Light Output: 2578 lm
Wattage: 37.6 W
Efficacy: 68.8 lm/W
Power Factor: 0.954
CCT: 3620 K
CRI: 82
Total Harmonic Distortion: 7.6 %

VANLED20



Low-profile vandal-resistant fixture covers the footprint of most traditional canopy lights. Available in flat or drop lens.

Color: Bronze

Weight: 12.0 lbs

Project:	Type:
Ridgewood	ECM HN99 & HN100
Prepared By:	**Date:**
Carrie Kaltwasser	1.5.17

Driver Info		LED Info	
Type:	Constant Current	Watts:	20W
120V:	0.30A	Color Temp:	5000K
208V:	0.20A	Color Accuracy:	74 CRI
240V:	0.17A	L70 Lifespan:	100000
277V:	0.15A	Lumens:	2,352
Input Watts:	22W	Efficacy:	108 LPW
Efficiency:	92%		

Technical Specifications

Listings

UL Listing:

Suitable for wet locations.

IESNA LM-79 & LM-80 Testing:

RAB LED luminaires have been tested by an independent laboratory in accordance with IESNA LM-79 and LM-80, and have received the Department of Energy "Lighting Facts" label.

DLC Listed:

This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.
DLC Product Code: PZQ1Z223

Electrical

Driver:

Class 2, Constant Current, 100-277V, 50-60Hz, 500mA

THD:

6.1% at 120V, 10.1% at 277V

Construction

Maximum Ambient Temperature:

Suitable for use in 104°F (40°C) ambient temperatures

Cold Weather Starting:

The minimum starting temperature is -40°F (-40°C)

Housing:

Die-cast aluminum housing and lens frame with (4) 1/2" NPS side conduit entries and weatherproof rear wire plug and access plate

Mounting:

Ceiling mount to recessed junction with knockout template or directy to ceiling surface, utilizing side conduit entry points.

IP Rating:

Ingress Protection rating of IP66 for dust and water

Lens:

Vandal-resistant polycarbonate textured opaque for low glare drop lens

Reflector:

Semi-specular, vacuum-metalized polycarbonate

Gaskets:

High-temperature silicone gaskets

Finish:

Our environmentally friendly polyester powder coatings are formulated for high-durability and long-lasting color, and contain no VOC or toxic heavy metals.

Green Technology:

Mercury and UV free. RoHS compliant components. Polyester powder coat finish formulated without the use of VOC or toxic heavy metals.

LED Characteristics

LEDs:

Discreet LEDs on PCB board

Color Stability:

RAB LEDs exceed industry standards for chromatic stability.

Color Uniformity:

RAB's range of CCT (Correlated Color Temperature) follows the guidelines of the American National Standard for Specifications for the Chromaticity of Solid State Lighting (SSL) Products, ANSI C78.377-2011.

Other

Warranty:

RAB warrants that our LED products will be free from defects in materials and workmanship for a period of five (5) years from the date of delivery to the end user, including coverage of light output, color stability, driver performance and fixture finish. See our full warranty .

California Title 24:

See VANLED20/PCS, VANLED20/PCS2 or VANLED20MS for a 2013 California Title 24 compliant model.

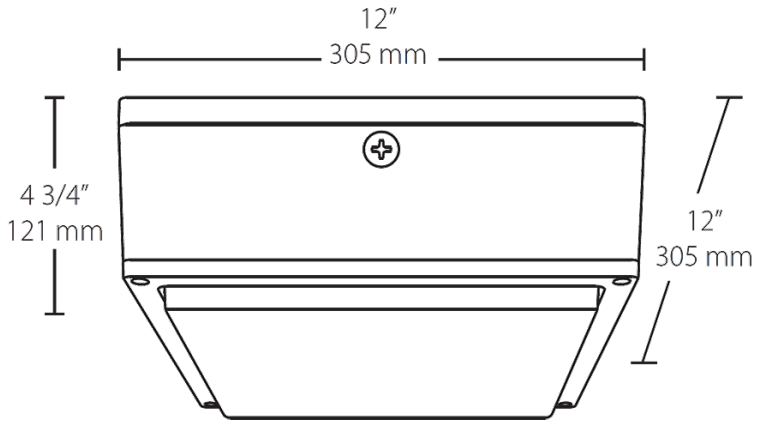
Replacement:

The VANLED 20W replaces up to 70W Metal Halide.

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VANLED20

Dimensions



Features

- Fits the footprint of older canopy lights
- Vandal resistant and UV resistant lens
- Ultra-high efficiency
- Clean, contemporary, low-profile design
- Available with drop lens or flat lens
- IP66 rated, keeps dust, bugs and water out
- Photo and motion sensor options available

Ordering Matrix

Family	Watts	Color Temp	Lens	Finish	Voltage	Dimming
VANLED						
	10 = 10W **20** = 20W **40** = 40W **52** = 52W **65** = 65W **75** = 75W	**Blank** = 5000K (Cool) **Y** = 3000K (Warm) **N** = 4000K (Neutral)	**Blank** = Drop lens **F** = Flat lens	**Blank** = Bronze **W** = White	**Blank** = 120-277V **/480** = 480V (10W & 20W not available)	**Blank** = No Dimming **/D10** = Dimmable (10W & 20W not available)

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Model # VANLED20Y[All Fixture Colors]

Manufacturer: RAB Lighting
Brand: RAB Lighting
Technical Requirements Version: 2.1
Date Qualified: 06/01/2015
Product ID: PQ5Q3JZN

Categorization

Main: Outdoor Luminaires
General Application: Low Output
Primary Use: Fuel Pump Canopy Luminaires

Classification: Standard
Is Parent Product: Yes
DLC Family Code: CCCDZG
Dimming Status: NotDimmable
Listing Status: Listed

Tested Data | Zonal Lumens | Family Data

Light Output: 2255 lm
Wattage: 21.5 W
Efficacy: 104.9 lm/W
Power Factor: 0.924
CCT: 3087 K
CRI: 71
Total Harmonic Distortion: 20.1 %

WPLED2T150N



Ultra high output, high efficiency 150 Watt LED wallpacks. Patent Pending airflow technology ensures long LED and driver lifespan. 5 Year Warranty.

Color: Bronze Weight: 34.8 lbs

Project:	Type:
Prepared By:	Date:

Driver Info		LED Info	
Type:	Constant Current	Watts:	150W
120V:	1.31A	Color Temp:	4000K
208V:	0.80A	Color Accuracy:	71 CRI
240V:	0.69A	L70 Lifespan:	100000
277V:	0.60A	Lumens:	17213
Input Watts:	151W	Efficacy:	114 LPW
Efficiency:	99%		

Technical Specifications

Listings

UL Listing:

Suitable for wet locations.

DLC Listed:

This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.
DLC Product Code: P0000174E

IESNA LM-79 & LM-80 Testing:

RAB LED luminaries have been tested by an independent laboratory in accordance with IESNA LM-79 and LM-80, and have been received the Department of Energy "Lighting Facts" label.

Dark Sky Approved:

The International Dark Sky Association has approved this product as a full cutoff, fully shielded luminaire.

LED Characteristics

Lifespan:

100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

LEDs:

Multi-chip, high-output, long-life LEDs

Color Consistency:

3-step MacAdam Ellipse binning to achieve consistent fixture-to-fixture color.

Color Stability:

LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Uniformity:

RAB's range of CCT (Correlated Color Temperature) follows the guidelines of the American National Standard for Specifications for the Chromaticity of Solid State Lighting (SSL) Products, ANSI C78.377-2017.

Construction

IES Classification:

The Type II distribution is ideal for wide walkways, on ramps and entrance roadways, bike paths and other long and narrow lighting applications. This type is meant for lighting larger areas and usually is located near the roadside. This type of lighting is commonly found on smaller side streets or jogging paths.

IP Rating:

Ingress Protection rating of IP66 for dust and water

Maximum Ambient Temperature:

Suitable for use in 40°C (104°F) ambient temperatures

Cold Weather Starting:

Minimum starting temperature is -40°C (-40°F)

Thermal Management:

Superior thermal management with external "Air-Flow" fins.

Housing:

Die-cast aluminum housing, lens frame and mounting arm

Mounting:

Heavy-duty mounting arm with "O" ring seal & stainless steel screws

Reflector:

Specular vacuum-metallized polycarbonate

Gaskets:

High-temperature silicone gaskets

Finish:

Formulated for high-durability and long lasting color.

Green Technology:

Mercury and UV free. RoHS compliant components. Polyester powder coat finish formulated without the use of VOC or toxic heavy metals.

For use on LEED Buildings:

IDA Dark Sky Approval means that this fixture can be used to achieve LEED Credits for Light Pollution Reduction.

Electrical

Drivers:

Two Drivers, Constant Current, Class 2, 2000mA, 100-277V, 50-60Hz, Power Factor 99%

THD:

5.9% at 120V, 11.2% at 277V

Other

Warranty:

RAB warrants that our LED products will be free from defects in materials and workmanship for a period of five (5) years from the date of delivery to the end user, including coverage of light output, color stability, driver performance and fixture finish.

Patents:

The design of WPLED150 is protected by patents pending in US, Canada, China, Taiwan and Mexico.

Buy American Act Compliance:

RAB values USA manufacturing! Upon request, RAB may be able to manufacture this product to be compliant with the Buy American Act (BAA). Please contact customer service to request a quote for the product to be made BAA compliant.

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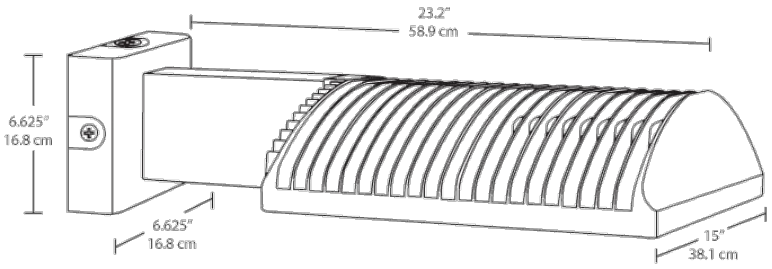
Technical Specifications (continued)

Optical

BUG Rating:

B2 U0 G2

Dimensions



Features

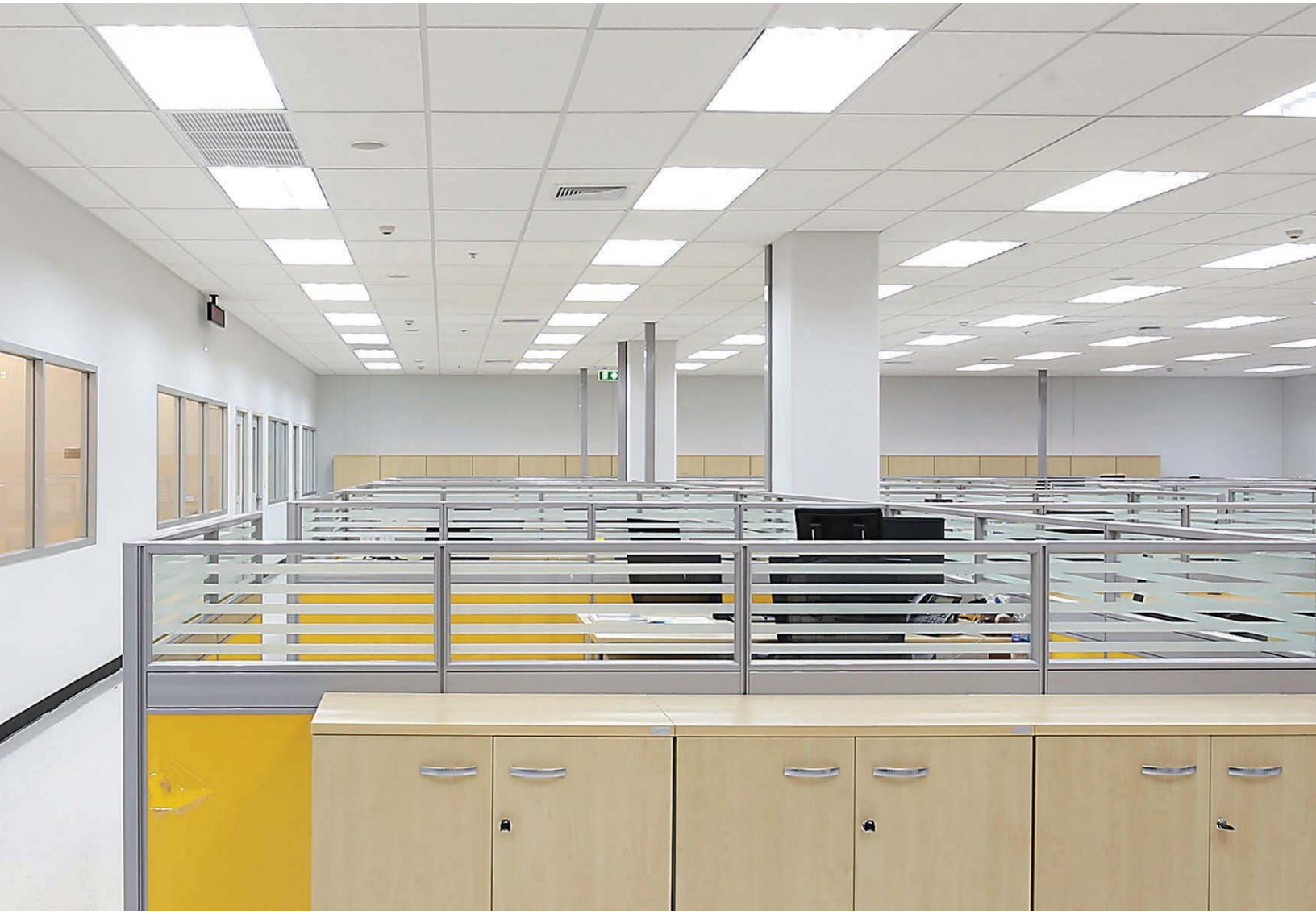
- High output, high efficiency LED
- Maintains 70% of initial lumens at 100,000 hours
- Weatherproof high temperature silicone gaskets
- Superior heat sinking with die cast aluminum housing and external fins
- 100 up to 277 Volts
- 5-year warranty

Ordering Matrix

Family	Distribution	Wattage	Color Temp	Mount	Finish	Photocell	Dimming	Sensor	Bi-Level
WPLED									
	2T = Type II **3T** = Type III **4T** = Type IV	**150** = 150W	**Blank** = 5000K (Cool) **Y** = 3000K (Warm) **N** = 4000K (Neutral)	**Blank** = Standard **FX** = Flat Wall	**Blank** = Bronze **W** = White	**Blank** = No Photocell **/PC** = 120V Button **/PC2** = 277 Button **/PCS** = 120V Swivel **/PCS2** = 277V Swivel **/PCT** = 120-277V Twistlock	**Blank** = No Dimming **/D10** = Dimmable	**/WS4** = Multi-Level Motion Sensor (Only available for 120-277V with /D10 for 150W)	**Blank** = No Bi-Level **/BL** = Bi-Level

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Revolution Lighting



Specification Sheet:

Uni-Fit G2 T5 LED Tubes

Indoor

177 Broad Street, 12th Floor, Stamford, CT 06901 T – 203 504 1111 rvlti.com

THE POWER TO OUTPERFORM

Specification Sheet: Uni-Fit G2 T5 LED Tubes

Retrofitting Is Easy with Our Energy Efficient Led Tubes

Our lightweight, shatterproof, all-plastic T5 Uni-Fit LED tubes can reduce your lighting energy use by as much as 40% compared to fluorescent lights and provide a superior quality of light.

Our plug-n-play tubes are ballast ready for easy installation without rewiring and are backed with our industry-leading 70,000 hour lamp life and 10-year warranty.

APPLICATIONS

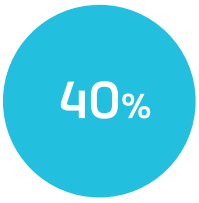
- Offices & Commercial Buildings
- Retail Settings
- Hotels
- Schools
- Hospitals
- Warehouses
- Assisted Living Facilities
- Food Processing Centers
- Parking Garages
- Recreation Centers

ILLUMINATION ANGLE



Revolution Lighting Light Distribution

CAN DECREASE ENERGY USAGE BY



vs. Similar Fluorescent Lamps

WARRANTY



Our Industry-Leading 10-Year Limited Warranty Guarantees Unsurpassed Quality

PRODUCT BENEFITS

OPERATIONAL

- 3X greater lamp life than fluorescent, supported by industry-leading 10-year warranty
- 70,000-hour lamp life reduces long-term maintenance costs
- Instant on, no warm-up time

SAFETY

- No glass
- Negligible light depreciation over time
- Superior light output

SUSTAINABILITY

- Lack of UV or IR minimizes concerns with fading or discoloration
- Mercury-free, allowing for non-hazardous disposal
- 100% recyclable



ORDER LOGIC (Ex. UF2-46-27-F-HO-35)

Product Description		Length (in.)		Bare Lamp Wattage		Lens		Output		CCT (K Temp)
UF2 = Uni-Fit, G2 (Ballast-Ready)	-	46 = 45.25 in.	-	27 14	-	F = Frosted	-	HO = High Output HE = High Efficiency	-	30 = 3000K 35 = 3500K 40 = 4000K 50 = 5000K

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For more information, visit **rvlti.com** or call **763-424-3702.**

Specification Sheet: Uni-Fit G2 T5 LED Tubes

TECHNICAL DATA (Subject to change.)*

Catalog No.	Product SKU No.	Rated Wattage	Lens	Base	Input Voltage	Color Temp (K)	Rated Lumens	Rated Efficacy	CRI	Illumination Angle	Rated Life (Hours)	Operating Temp. (°F)
G2 Uni-Fit 27W T5 HO Tube												
UF2-46-27-F-HO-30	204321-210	31.7	Frosted	G5	T5 Ballast	3000	3,354	106	84	310	70,000	-4 to 122
UF2-46-27-F-HO-35	204321-211	31.7	Frosted	G5	T5 Ballast	3500	3,419	108	84	310	70,000	-4 to 122
UF2-46-27-F-HO-40	204321-212	31.7	Frosted	G5	T5 Ballast	4000	3,485	110	84	310	70,000	-4 to 122
UF2-46-27-F-HO-50	204321-213	31.7	Frosted	G5	T5 Ballast	5000	3,615	114	83	310	70,000	-4 to 122
G2 Uni-Fit 14W T5 HE Tube												
UF2-46-14-F-HE-30	204320-210	16.1	Frosted	G5	T5 Ballast	3000	1,797	112	84	310	70,000	-4 to 122
UF2-46-14-F-HE-35	204320-211	16.2	Frosted	G5	T5 Ballast	3500	1,832	113	84	310	70,000	-4 to 122
UF2-46-14-F-HE-40	204320-212	16.2	Frosted	G5	T5 Ballast	4000	1,868	115	84	310	70,000	-4 to 122
UF2-46-14-F-HE-50	204320-213	16.4	Frosted	G5	T5 Ballast	5000	1,938	119	84	310	70,000	-4 to 122

Product is DLC listed.

** NOTE: The above rated performance specs were obtained with standard T5 HO/HE ballasts having a ballast factor of 1.0. Ballast-performance information is provided for reference only. Actual performance will vary.*

SHIPPING DATA (Subject to change)

Catalog No.	Product SKU No.	Product Dimensions (in.)	Case Qty.	Case Weight (lb)	Case Dimensions (in.)	Pallet Case Qty.	Pallet Weight (lb)	Pallet Dimensions (in.)
G2 Uni-Fit 27W T5 HO Tube								
UF2-46-27-F-HO-30	204321-210	45.8L x 0.71 Dia.	25	10	48.23L x 6.34W x 6.77H	40	420	48L x 40W x 68H
UF2-46-27-F-HO-35	204321-211	45.8L x 0.71 Dia.	25	10	48.23L x 6.34W x 6.77H	40	420	48L x 40W x 68H
UF2-46-27-F-HO-40	204321-212	45.8L x 0.71 Dia.	25	10	48.23L x 6.34W x 6.77H	40	420	48L x 40W x 68H
UF2-46-27-F-HO-50	204321-213	45.8L x 0.71 Dia.	25	10	48.23L x 6.34W x 6.77H	40	420	48L x 40W x 68H
G2 Uni-Fit 14W T5 HE Tube								
UF2-46-14-F-HE-30	204320-210	45.8L x 0.71 Dia.	25	10	48.23L x 6.34W x 6.77H	40	420	48L x 40W x 68H
UF2-46-14-F-HE-35	204320-211	45.8L x 0.71 Dia.	25	10	48.23L x 6.34W x 6.77H	40	420	48L x 40W x 68H
UF2-46-14-F-HE-40	204320-212	45.8L x 0.71 Dia.	25	10	48.23L x 6.34W x 6.77H	40	420	48L x 40W x 68H
UF2-46-14-F-HE-50	204320-213	45.8L x 0.71 Dia.	25	10	48.23L x 6.34W x 6.77H	40	420	48L x 40W x 68H

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For more information, visit **rvlti.com** or call **763-424-3702.**

Specifications subject to change without notice.

Revolution Lighting

For More Information
Visit rvlti.com or call 1-844-785-8324.

177 Broad Street, 12th Floor, Stamford, CT 06901

Revolution Lighting



Specification Sheet:

T8 SEP LED Nano Tubes

Indoor

177 Broad Street, 12th Floor, Stamford, CT 06901 T – 203 504 1111 rvlti.com

THE POWER TO OUTPERFORM

Specification Sheet: T8 SEP LED Nano Tubes

Retrofitting Is Easy with Our Energy Efficient Led Tubes

Revolution Lighting's latest and most advanced T8 single-end-power LED Nano-Tube outperforms its competition. Our exclusive LED tube lamp has been integrated with our cutting-edge "Nano" lens technology to achieve superior performance and light output with as little as 8 watts. While reducing lighting energy use by up to 65%, our LED Nano-Tubes continue to outperform, enhancing light output to deliver up to 162 lumens per watt.

Designed for installation into any new or existing fixture intended for similar fluorescent lamps, our LED Nano-Tubes are direct-wire, require no ballast, and will work with any non-shunted socket at 120VAC to 277VAC. Coupled with our industry-leading 10-year warranty, and 70,000-hour lamp life, the T8 SEP LED Nano-Tube surpasses its competition.

APPLICATIONS

- Offices & Commercial Buildings
- Retail Settings
- Hotels
- Schools
- Hospitals
- Warehouses
- Assisted Living Facilities
- Parking Garages
- Recreation Centers

ILLUMINATION ANGLE



Revolution Lighting Light Distribution

CAN DECREASE ENERGY USAGE BY



vs. Similar Fluorescent Lamps

WARRANTY



Our Industry-Leading 10-Year Limited Warranty Guarantees Unsurpassed Quality

PRODUCT BENEFITS

OPERATIONAL

- Very high efficacies up to 162 lm/W
- 3X greater lamp life than fluorescent, supported by industry-leading 10-year warranty
- 70,000 hour lamp life and eliminated ballast reduce long-term maintenance costs
- Instant on, no warm-up time

SAFETY

- No glass
- Advanced Nano Technology PC tube
- Negligible light depreciation over time
- Superior light output

SUSTAINABILITY

- Lack of UV or IR minimizes concerns with fading or discoloration
- Mercury-free, allowing for non-hazardous disposal
- 100% recyclable



ORDER LOGIC (Ex. SEPG4-48-15-N-35)

Product Description		Length (in.)		Bare Lamp Wattage		Lens		CCT (K Temp)
SEPG4 = Single-End-Power Gen. 4	–	24 = 2 ft	–	8	–	N = Nano	–	30 = 3000K 35 = 3500K 40 = 4000K 50 = 5000K
SEPG4 = Single-End-Power Gen. 4	–	48 = 4 ft	–	15				
SEPG4 = Single-End-Power Gen. 4		48 = 4 ft	–	10.5		N = Nano		35 = 3500K 40 = 4000K 50 = 5000K

Note: All current order configurations listed below.

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Specifications subject to change without notice.

For more information, visit **rvlti.com** or call **763-424-3702.**

Specification Sheet: T8 SEP LED Nano Tubes

TECHNICAL DATA (Subject to change)

Catalog No.	Product SKU No.	Rated Wattage	Lens	Base	Input Voltage (VAC)	Color Temp (K)	Rated Lumens	Rated Efficacy	CRI	Illumination Angle	Rated Life (Hours)	Operating Temp. (°F)
2-foot 8W G4 Single-End-Power LED Tube												
SEPG4-24-8-N-30	202000-411	8	Nano	G13	120-277	3000	1,100	137.5	83	312	>70,000	-4 to 122
SEPG4-24-8-N-35	202000-412	8	Nano	G13	120-277	3500	1,100	138	83	312	>70,000	-4 to 122
SEPG4-24-8-N-40	202000-413	8	Nano	G13	120-277	4000	1,100	138	83	312	>70,000	-4 to 122
SEPG4-24-8-N-50	202000-415	8	Nano	G13	120-277	5000	1,100	138	83	312	>70,000	-4 to 122
4-foot 10.5W G4 Single-End-Power LED Tube												
SEPG4-48-10.5-N-35	204001-432	10.5	Nano	G13	120-277	3500	1,700	162	83	312	>70,000	-4 to 122
SEPG4-48-10.5-N-40	204001-433	10.5	Nano	G13	120-277	4000	1,700	162	83	312	>70,000	-4 to 122
SEPG4-48-10.5-N-50	204001-435	10.5	Nano	G13	120-277	5000	1,700	162	83	312	>70,000	-4 to 122
4-foot 15W G4 Single-End-Power LED Tube												
SEPG4-48-15-N-30	204002-411	15	Nano	G13	120-277	3000	2,100	140	83	312	>70,000	-4 to 122
SEPG4-48-15-N-35	204002-412	15	Nano	G13	120-277	3500	2,100	140	83	312	>70,000	-4 to 122
SEPG4-48-15-N-40	204002-413	15	Nano	G13	120-277	4000	2,100	140	83	312	>70,000	-4 to 122
SEPG4-48-15-N-50	204002-415	15	Nano	G13	120-277	5000	2,100	140	83	312	>70,000	-4 to 122

Product is DLC listed.

SHIPPING DATA (Subject to change)

Catalog No.	Product SKU No.	Product Dimensions (in.)	Product Weight (lb)	Case Qty.	Case Weight (lb)	Case Dimensions (in.)	Pallet Case Qty.	Pallet Weight (lb)	Pallet Dimensions (in.)
2-foot 8W G4 Single-End-Power LED Tube									
SEPG4-24-8-N-30	202000-411	24L x 1 Dia.	0.24	25	10	26L x 8W x 8H	80	810	48L x 44W x 70H
SEPG4-24-8-N-35	202000-412	24L x 1 Dia.	0.24	25	10	26L x 8W x 8H	80	810	48L x 44W x 70H
SEPG4-24-8-N-40	202000-413	24L x 1 Dia.	0.24	25	10	26L x 8W x 8H	80	810	48L x 44W x 70H
SEPG4-24-8-N-50	202000-415	24L x 1 Dia.	0.24	25	10	26L x 8W x 8H	80	810	48L x 44W x 70H
4-foot 10.5W G4 Single-End-Power LED Tube									
SEPG4-48-10.5-N-35	204001-432	48L x 1 Dia.	0.30	25	12.5	50L x 9W x 9H	32	435	48L x 40W x 78H
SEPG4-48-10.5-N-40	204001-433	48L x 1 Dia.	0.30	25	12.5	50L x 9W x 9H	32	435	48L x 40W x 78H
SEPG4-48-10.5-N-50	204001-435	48L x 1 Dia.	0.30	25	12.5	50L x 9W x 9H	32	435	48L x 40W x 78H
4-foot 15W G4 Single-End-Power LED Tube									
SEPG4-48-15-N-30	204002-411	48L x 1 Dia.	0.44	25	18	50L x 8W x 8H	40	745	48L x 40W x 70H
SEPG4-48-15-N-35	204002-412	48L x 1 Dia.	0.44	25	18	50L x 8W x 8H	40	745	48L x 40W x 70H
SEPG4-48-15-N-40	204002-413	48L x 1 Dia.	0.44	25	18	50L x 8W x 8H	40	745	48L x 40W x 70H
SEPG4-48-15-N-50	204002-415	48L x 1 Dia.	0.44	25	18	50L x 8W x 8H	40	745	48L x 40W x 70H

Revolution Lighting Technologies, Inc.
177 Broad Street · 12th Floor · Stamford, CT 06901
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For more information, visit **rvlti.com** or call **763-424-3702.**

Specifications subject to change without notice.

Revolution Lighting

For More Information
Visit rvlti.com or call 1-844-785-8324.

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Fixture-Specific Measurement and Verification Approaches:

- **Sinks.** To measure sink flow rate (gallons per minute), we will utilize a flow-through measuring unit manufactured by Blue-White® Industries (Model F-1000-RB). This device has a rated accuracy of 2.0%, with 1.0% repeatability. HydraMetrics sends this device out periodically for calibration. Essentially, as water passes through this meter, flow is registered.



Sink Flow Measuring Device

- **Showers.** To measure shower flow rate (gallons per minute), we will utilize a flow-through measuring unit manufactured by Blue-White® Industries (Model F-1000-RB). This device has a rated accuracy of 2.0%, with 1.0% repeatability. HydraMetrics sends this device out periodically for calibration. Essentially, as water passes through this meter, flow is registered. Essentially, as water passes through this meter, flow is registered.



Shower Flow Measuring Device

- **Flushometers (Water Closets and Urinals).** To measure flushometer volume (gallons per flush), we'll make use of a direct read digital in-line flow meter, which has a computer that totalizes volume. Great Plains Industries, Inc. (model number G2S10N09GMA) manufactures this device. This device has a rated accuracy of 1.0% with 0.1% repeatability. HydraMetrics sends this device out periodically for calibration. We'll install this flow meter in series with the flushometer. In doing so, we'll carefully create identical operating conditions: (1) we do not change the flushometer valve, (2) we adjust the control stop to the same position, ensuring identical supply system pressure and flow. All water that passes through the flushometer also passes through the meter, which in turn provides an accurate accounting of flush volume.



Flushometer Measuring Equipment

- **Tank Toilets.** To measurement volume (gallons per flush) on tank toilets, we'll make use of a direct read digital in-line flow meter, which has a computer that totalizes volume. Great Plains Industries, Inc. (model number G2S10N09GMA) manufactures this device. This device has a rated accuracy of 1.0% with 0.1% repeatability. HydraMetrics sends this device out periodically for calibration. We'll install our water meter in series with the supply line that serves the fill valve. All water that passes through the toilet during a flush first passes through our meter, which in turn provides an accurate accounting of flush volume.



Tank Toilet Measuring Equipment

Premium Efficient Motors





Product Overview and Options

Nidec Motor Corporation offers an extensive line of industrial and commercial U.S. MOTORS® brand high efficiency electric motors that meet or exceed NEMA Premium®† standards, ensuring your facility complies with local electrical codes and safety regulations.

Industrial Cast Iron Motors for Hostile, Severe Environments

- Hostile Duty Motors
- CORRO-DUTY® Motors
- 841 PLUS® Motors

Commercial Duty Motors Used In Office Buildings, Schools, and Other Federal Facilities

- Open Dripproof Motors
- UNIMOUNT® Motors

HVAC Motors for Air Moving and Conditioning Applications

- Cooling Tower Duty Motors
- Open Dripproof Motors
- UNIMOUNT® Motors

HOSTILE DUTY™ Motors



- Totally Enclosed Fan Cooled
- Three Phase, 60 Hz
- 1.00 and 1.15 Service Factor
- 1–350 HP
- 2, 4, 6, and 8 Poles
- 143–286 Frame
- Cast Iron Frame and Brackets
- Ball and Roller Bearing Options

CORRO-DUTY® Motors



- Totally Enclosed Fan Cooled
- Three Phase, 60 Hz
- 1–200 HP
- 2, 4, and 6 Poles
- 143–447 Frame
- All Cast Iron Construction

841 PLUS® Motors



- Totally Enclosed Fan Cooled
- Three Phase, 60 Hz
- 1.0 or 1.15 Service Factor
- 1–400 HP
- 2, 4, 6, and 8 Poles
- 143–447 Frame
- VBBX®† Bearing Isolators by Inpro/Seal
- Meets IEEE®† 841 GM7E-TA Specifications
- Five Year Warranty*
- Footed and C-Face Footless

Product Overview and Options *continued*

Open Dripproof Motors



- Three Phase, 60 Hz
- 1.0 and 1.15 Service Factor
- 1/4–400 HP
- 2, 4, 6, and 8 Poles
- 48–449 Frame
- Close Coupled Ratings Available

UNIMOUNT® Motors



- Totally Enclosed Fan Cooled
- Three Phase, 60 Hz
- 1.25 Service Factor
- 1/4–30 HP
- 2, 4, 6, and 8 Poles
- 50–286 Frame
- C-Face, Footed and Footless
- Removable Base 180 Frame and Above
- F2 Field Assembly
- Close Coupled Ratings Available

Hazardous Location Motors



- Totally Enclosed Fan Cooled
- Three Phase
- 1 to 200 HP
- 2, 4, and 6 Poles
- 143 to 447 Frame
- Single and Dual Label

Automotive Duty, U-frame Motors



- Totally Enclosed Fan Cooled
- Three Phase, 60 Hz
- 1/4–300 HP
- 2, 4, 6, and 8 Poles
- 56–5008 Frame
- Motors Available that Meet GM-7EQ, GM-7EH, Ford EM1 and Chrysler NPEM-105 specifications

Cooling Tower Motors



- Totally Enclosed Fan Cooled and Totally Enclosed Air Oven Options
- Three Phase, 60 Hz
- 2–100 HP
- 4, 6, 4/8 Poles
- 145–449 Frame
- Single Speed and Two Speed Options
- Motors Available that Meet Specifications for Baltimore Aircoil Company, Inc., Evapco, Inc., and SPX Cooling Technologies, Inc.

The Energy Independence and Security Act

On December 19, 2010, commercial and industrial motor manufacturers and importers will raise efficiencies to the NEMA Premium®† levels for all general purpose motors up to 600 volts, from 1 to 200 horsepower, in NEMA frame sizes. Additional categories of motors will be raised to energy efficient levels.

What does this mean for your business?

- The implementation of NEMA Premium®† and the elimination of the corresponding energy efficiency standards has removed models in both stock and configured categories.
- All customers, whether OEM, reseller or end-user need to comply.
- OEMs may require 3rd party certification of their equipment through UL® / CSA®.
- End-user will see first cost go up, but will benefit from life cycle reduction in energy costs.

We make the transition EASY

Nidec Motor Corporation's line of high performance commercial and industrial U.S. MOTORS® brand motors is designed to help industry reduce energy consumption and comply with EISA regulations. This line features upgraded open dripproof and totally enclosed motors that meet or exceed NEMA Premium®† requirements.

All high performance motors carry a nameplate including both 50 and 60 Hz operating data, a NEMA Premium®† trademark and European IE efficiency marks, providing a clear means for both users and OEM's to verify global regulatory compliance.

In addition to a full line of horizontal motors, the U.S. MOTORS® brand line of vertical motors are available at Premium efficiency levels to address customer requirements.

The NEMA Premium®† line also complies with recent Canadian and Mexican standards.

Want to learn more about motor efficiency and saving energy costs?

The online MotorPro® training tool features a new module on electric motor energy efficiency. Just visit www.usmotors.com/motorpro, and choose Module 3 for complete details on energy laws and efficiency — and on how you can reduce your energy usage and operating costs.

† All marks shown within this document are properties of their respective owners.
Note: For premium efficient vertical motor designs, visit www.usmotors.com

NIDEC MOTOR CORPORATION

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RoofPak®
Applied Rooftop Systems





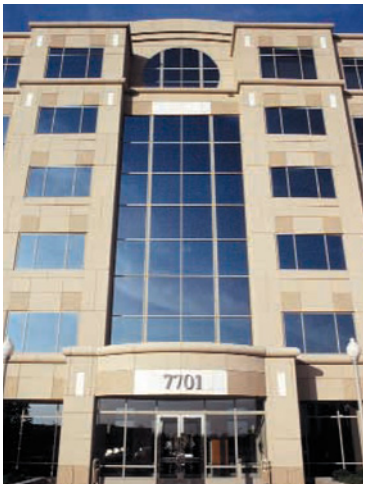
RoofPak Applied Rooftop Systems

Design flexibility, energy efficiency, system performance and reliability make Daikin RoofPak applied rooftop systems the ideal solution for your one to eight-story building projects. Available in air-cooled and evaporative-cooled models, with capacities from 15 to 150 tons, they combine the lower installation costs and interior space savings of a roof-mounted system with the operating and maintenance efficiencies of central heating and cooling systems.

With their unique, modular design, RoofPak applied rooftop systems can be customized to fit your building as if they were made for it. The result is superior energy efficiency and indoor air quality. Applications range from offices, schools and libraries, to airport terminals, manufacturing facilities, shopping malls, casinos and condominiums. Arriving at your job site as a complete package, RoofPak applied rooftop systems maximize your design and installed cost savings. They also can add to your building's profit margins year after year with efficient, reliable performance.

All units are ASHRAE 90.1-2007 compliant to meet new federal efficiency requirements. Most units exceed the minimum efficiencies required in 2010 per this guideline (see chart).

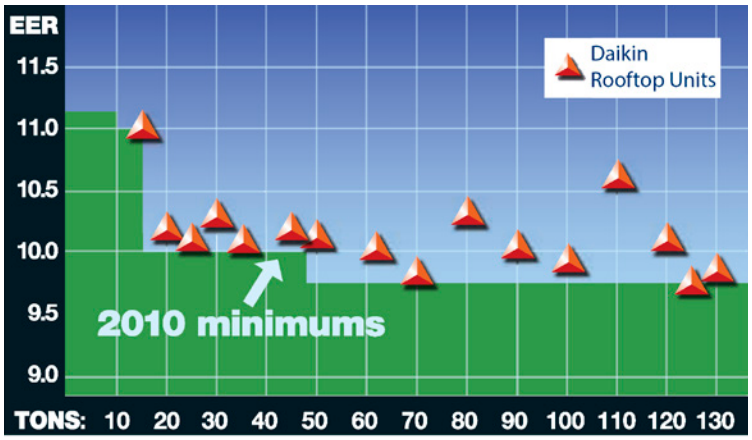








RoofPak air-cooled rooftop systems are available with EERs that exceed ASHRAE 90.1-2007 requirements for the year 2010, which are approximately 6% more efficient than ASHRAE 90.1-2004 requirements.







High Efficiency and Low Cost Operation

With some of the highest energy efficiency ratings in the industry, RoofPak applied rooftop systems can deliver the low operating costs that increase profit margins for building owners.

Optimal air design option (50°F supply air) reduces CFM requirements, resulting in lower energy costs and smaller duct work requirements.

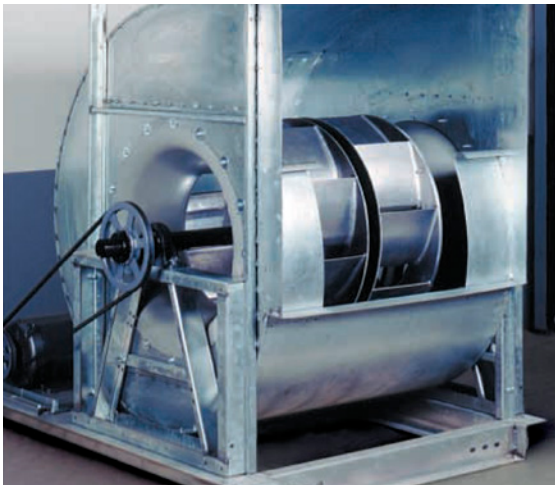
Economizer option monitors outdoor and indoor air temperatures and humidity to take full advantage of natural conditions for "free" cooling.

Patented, UltraSeal™ low-leak dampers provide superior leak resistance, reducing **energy costs.**

High-efficiency airfoil fans and factory-installed variable-frequency drives provide lower fan operating costs and quiet operation.

A wide range of fan sizes, coil face areas, and compressor combinations allows you to optimize selections for operating and energy efficiency.

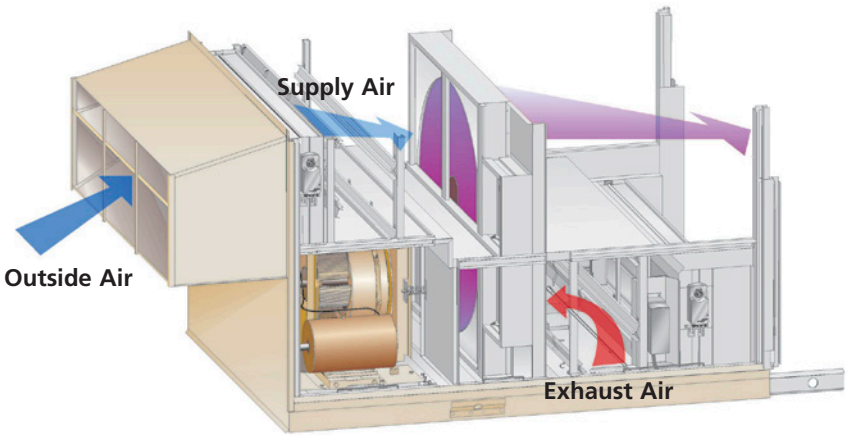
Large-face-area intakes/outlets, dampers, filters and coils reduce system pressure drops, improving operating and energy efficiency.



Airfoil fans are energy efficient and quiet.

Full double-wall construction with R-6.5 insulation reduces cabinet heat loss/gain, improving operating and energy efficiency.

Energy recovery wheels option recovers approximately 75% of both sensible and latent energy from the exhaust air to reduce energy consumption.



Factory-installed energy recovery wheels offer a cost-effective and efficient method to reduce energy costs while meeting the ventilation requirements of ASHRAE Standard 62.1-2001.

Superior Indoor Air Quality

RoofPak applied rooftop systems provide superior indoor air quality control that keeps owners and tenants satisfied.

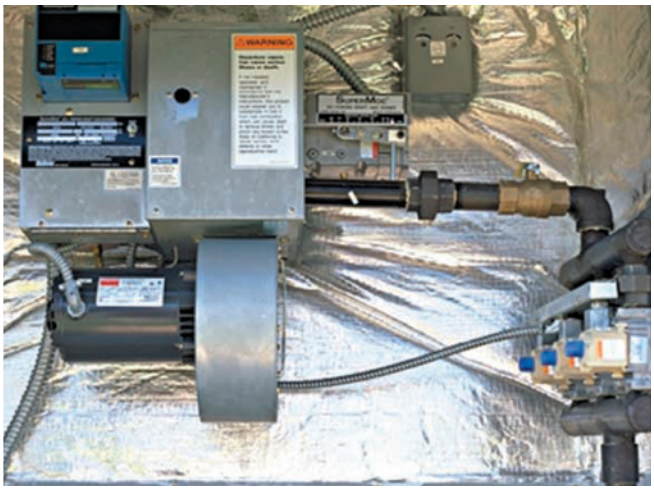
Stainless steel, sloped drain pan eliminates standing water.

Full double-wall construction avoids damage to unit insulation and encourages regular cleaning to inhibit microbial growth.

Flexible filter options, including charcoal filters, electronic filters and 95% blow-through final filters, allow you to meet virtually any application requirement.

Optional, factory-installed UVGI lamps (ultraviolet germicidal irradiation) can improve IAQ by destroying mold, fungi and bacteria on coil and drain pan surfaces.

DesignFlow™ precision ventilation air control system continuously controls outdoor air intake volume with an accuracy of ±5.0% to precisely maintain minimum fresh air intake per ASHRAE Standard 62.1-2004.



SuperMod™ high turndown gas burner provides precise temperature control for a comfortable tenant environment.



Filter choices offer a wide range of media selections and face areas to suit your specific applications.

SuperMod™ gas burner with 20:1 turndown provides precise temperature control for tenant comfort in conventional or high minimum outdoor air applications.

Modulating hot gas reheat option provides the ultimate in dehumidification control and is ideal for 100% outdoor air applications.

MicroTech® III humidity control logic maintains comfort conditions in a wide range of applications. Up to 6 steps of compressor capacity control, with hot gas bypass on each circuit, provide stable discharge temperatures and humidity control for superior tenant comfort.

Environmentally friendly R-410A refrigerant is used on air-cooled units and R-407C on evaporative condenser units.

Design Flexibility

Engineers, building owners and contractors can profit from the performance and cost benefits provided by the flexibility of RoofPak applied rooftop systems.

RoofPak Applied Rooftop Systems	What they do for you
Modular flexibility	Let's you specify a unit that precisely meets your requirements.
Blow-through and draw-through coil configurations	Blow-through provides high sensible cooling, a quiet tenant environment and energy savings. Draw-through provides higher latent cooling for make-up air systems or systems with high humidity loads.
100% outdoor air, dehumidification, VAV or constant-volume operation	Let's you match application requirements with the optimum roof-mounted cooling/heating solution.
Multiple filter, fan, coil and heating options in flexible sizes	Let's you match system requirements, resulting in energy savings, superior indoor air quality and lower maintenance costs.
Return or exhaust air fans	Return air fans provide proper building pressure and outdoor air ventilation control for ducted return systems. Exhaust fans can save energy on plenum return systems with low air pressure drops.
Blank sections throughout the unit	Let's you specify factory-installed specialty equipment at lower installation costs while optimizing system performance.
Optional return/supply locations	Let's you match system configuration requirements with lower installed costs, reduced air pressure drop and quieter operation.
Copeland® scroll compressors with dual circuits	Provide optimum system performance with proven reliability.
IBC seismic certification	Available with construction that is certified and labeled compliant with International Building Code (IBC) 2009 seismic requirements for mechanical equipment.
MicroTech® III Controller with Open Choices™ feature	Select either BACnet® or LonWorks® communications to communicate control and monitoring information to your building automation system without costly gateways. Units with optional LonWorks communication modules are LonMark® certified.

LonMark 3.4

Member of BACnet International

100% Outdoor Air Applications

RoofPak systems are ideal for 100% outdoor air (DOAS) applications. Units can be equipped with energy recovery wheels and/or modulating hot gas reheat to increase occupant comfort and avoid over-cooling.



Low Cost Installation, Maintenance and Service

RoofPak applied rooftop systems are designed for easy, low-cost installation, maintenance and service. The result is higher profit margins available for building owners.

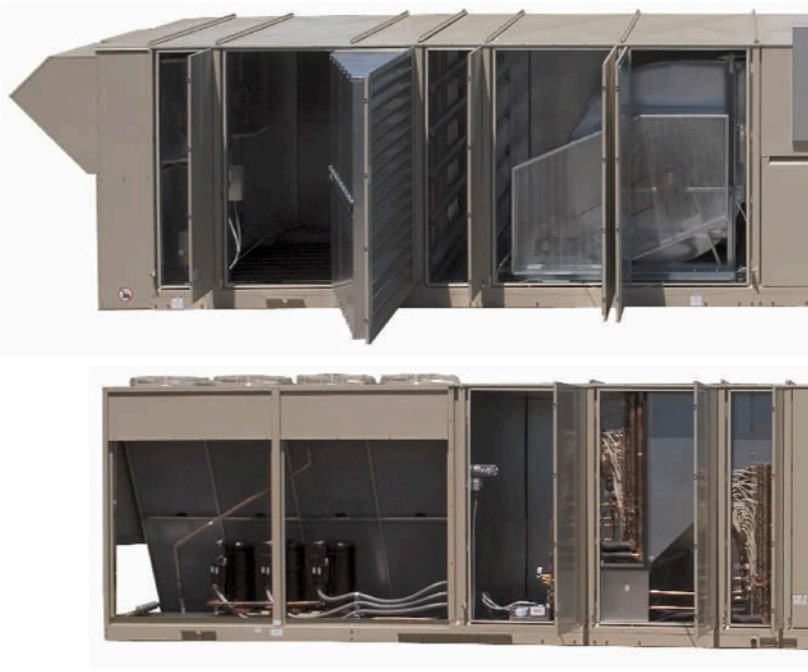
Units arrive at your job site as a complete package—assembled, factory-tested and ready to go—for quick start-up and reliable performance.

Fully integrated and factory-tested MicroTech III controls can significantly reduce costly field commissioning and are easily accessed for system diagnostics and quick adjustments.

Large access doors on every section, with single-lever latches and door holders, encourage regular maintenance for peak system performance and extended unit life.

Exact-fit replacement of Daikin models dating back 30 years — using existing roof curbs — for easy, low-cost installation of upgraded units.

Recessed condenser coils provide built in hail protection.



Hinged access doors on both sides of each section put all components within easy reach for maintenance and service.



Exact-fit replacement units make it easy to replace older units with modern Daikin technology.





Durable Design and Construction

Daikin is a proven manufacturer of high-quality applied rooftop systems known for durability and reliable performance.

Leak-resistant cabinet design with prepainted surfaces withstands the toughest operating conditions—from high humidity and salt air, to severe cold and heat.

Full double-wall construction can extend the life of the unit by avoiding insulation damage and allowing interior surfaces to be easily cleaned.

Efficient Copeland® semi-hermetic or scroll compressors have proven reliable over years of service in thousands of applications.

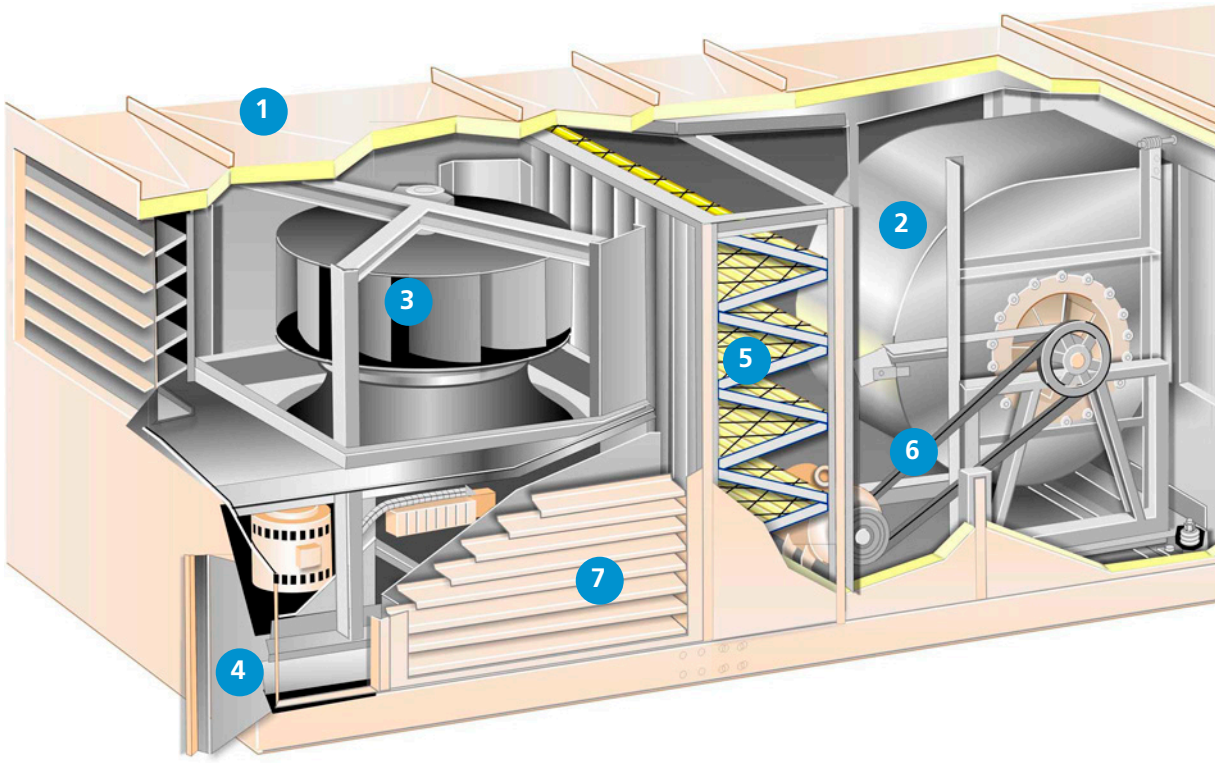


Full double-wall construction protects the unit insulation and provides a wipe-clean surface.

Daikin's Unique Features and Options

RoofPak Applied Rooftop Systems

Note: The benefits of Daikin McQuay's packaged rooftop systems are also available in a rooftop air handler configuration.



1. Durable Construction

- Pre-painted exterior cabinet panels pass 1000-hour ASTM B 117 Salt Spray Test for durability
- Weather-resistant construction with capped seams and sloped top panels
- Double-wall construction protects R-6.5 insulation and provides wipe-clean surface
- Stainless steel, sloped drain pans to avoid standing water

2. Airfoil Fans

- DWDI airfoil fans with housings provide maximum efficiency
- Flexible selection allows larger diameter, lower RPM choices and quieter operation

3. Return or Exhaust Fan



- Customize the unit to fit the application and return duct pressure drop
- Exhaust fans typically save energy at low return duct pressure drops
- Return fans provide better building pressure and ventilation control as return duct pressure drop increases

4. Hinged Access Doors

- On both sides of every section for easy access to all components
- Single lever latch and door holders provide easy entry
- Double-wall construction protects insulation during maintenance

5. Extended Face Area Filters

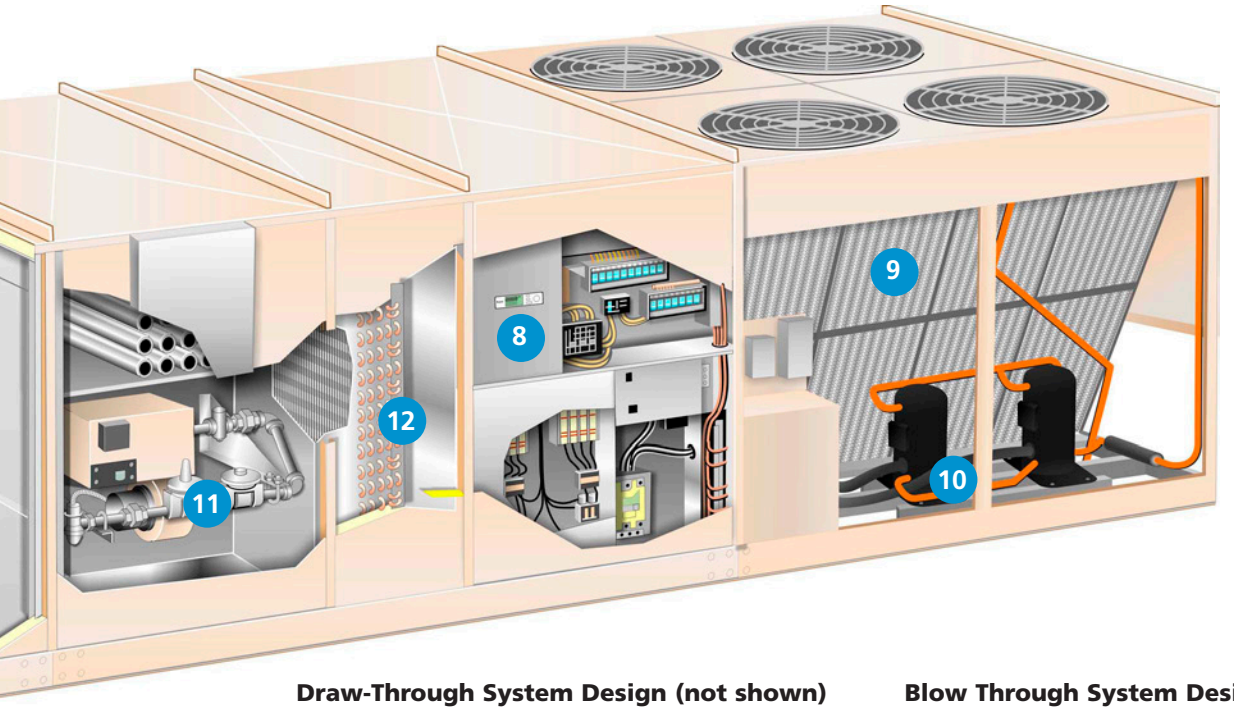
- 2" pleated or rigid cartridge

6. Factory-mounted Variable Frequency Drives

- Control fan motor speed for lower operating costs and quieter operation

7. Economizer

- Outside air enters from both sides, improving mixing for better temperature control
- DesignFlow™ Precision Ventilation Air Measurement System measures incoming air volume with an accuracy of ±5.0% for optimum control of minimum outdoor air intake and good IAQ
- Patented UltraSeal™ low-leak dampers minimize air leakage, reducing energy costs



Draw-Through System Design (not shown)

- High latent cooling for make-up air systems or systems with high humidity loads

Blow Through System Design (shown)

- High sensible heat ratio for optimized cooling performance and energy efficiency
- Quieter tenant environment by putting distance between fan and building occupants

8. MicroTech® III Unit Controller



- Easily accessed for system diagnostics and adjustments via a keypad and display on unit
- Remote user interface option provides all functionality of unit-mounted interface
- Outdoor air and humidity control logic maintains minimum fresh air intake and optimum humidity levels
- Open Choices™ feature provides interoperability with BACnet or LonMark certified communications for easy integration into your building automation system of choice

9. Microchannel Condenser Coils

- Proven technology from the automotive industry
- Suited for R-410A
- All aluminum design
- No corrosion between fins, tubes and header

10. R-410A Refrigerant

- No ozone depletion potential or phase-out date
- Units meet or exceed ASHRAE 90.1-2010 energy requirements
- Dual refrigerant circuits provide redundancy for high unit reliability

11. SuperMod™ High Turndown Gas Burner

- Full 20:1 turndown and multiple sizes enable precise temperature control while reducing design, installation, and life-cycle costs
- Maintain comfortable tenant environment in VAV, 100% outdoor air, and dehumidification applications

12. UVGI Lights

- For pennies a day, UVGI can improve IAQ by destroying mold, fungi, and bacteria on coil and drain pan surfaces

Blank Sections

- Available throughout unit to factory-mount air blenders, filters, sound attenuators, humidifiers or other specialty equipment (air purification shown)
- Allow customization for maximum system performance and efficiency
- Reduce design and installation costs





For more information or the name of your local Daikin Representative, call 1-800-432-1342 or visit www.DaikinApplied.com

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ASP 31-156 (11/19)

DAIKIN

Catalog 214-17

RoofPak®
Applied Rooftop Systems

Heating & Cooling
Models RCS/RDT/RFS/RPS
15 to 140 Tons
R-410A Refrigerant



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A New Standard in Rooftop Flexibility

- 15 through 140 tons with the flexibility to provide 120 to 600 cfm/ton
- 100% make-up air, dehumidification, VAV or CV operation
- Modular construction and customized application flexibility
- Multiple fan, coil, filter and heat selections, and high efficiency compressor combinations
- Factory integrated and commissioned MicroTech® III advanced DDC control system
- Daikin's innovative Open Choices™ feature provides building automation system interoperability with BACnet® and LonWorks® communications capability
- Unit controllers are LonMark® 3.4 certified with an optional LonWorks communication module
- Durable, double wall construction with access doors on both sides of each section
- Blow-through configuration for high sensible cooling and quiet operation
- Draw-through configuration for high latent cooling or high humidity applications
- Modulating hot gas reheat for superior dehumidification
- DesignFlow™ ventilation control maintains proper amounts of outdoor air
- SuperMod™ furnace provides superior turndown and comfort control
- Return fans allow superior building pressure control
- Final filters for hospitals, labs or clean rooms
- Energy recovery (see catalog CAT 220)
- Quiet condensing unit option
- Premium efficiency options
- All offered in a fully tested, factory packaged unit

Agency Listed

Nomenclature

RCS / R DT / RFS / R P S 070 D L A 2 S 5 0

RoofPak

Unit configuration
DT = Draw-through
P = Heating, mechanical cooling
F = Heating, future mechanical cooling
C = Condensing section only

Singlezone unit

Nominal capacity (tons)

Design series

DX coil
L = Large face area
S = Standard face area

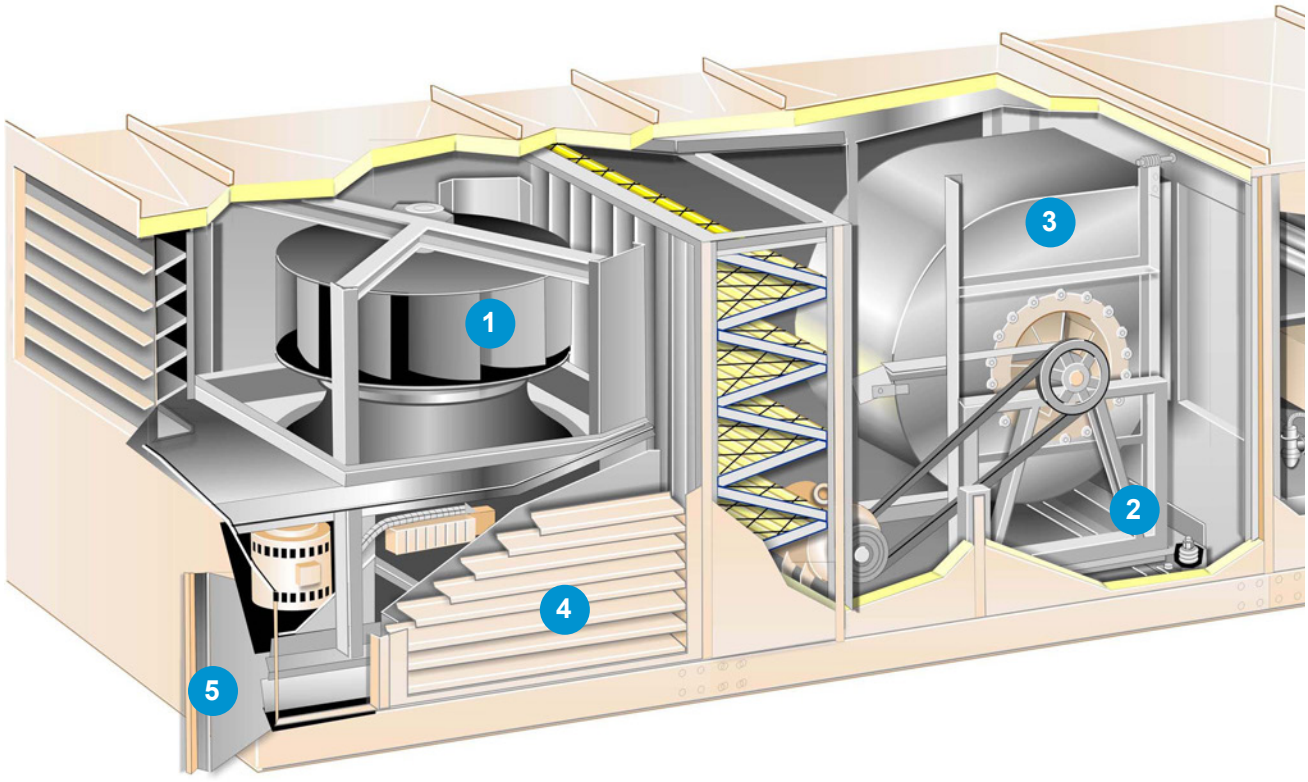
SAF diameter (045 – 063 only)
0 = 30"
none = 33"

DX coil
4 = 12 fpi, 4-row or 10 fpi, 5-row
5 = 12 fpi, 5-row or 10 fpi, 6 row
6 = 12 fpi, 6 row
Y = Other

VFD
S = SAF VFD
Y = No VFD
V = SAF & Compressor VFD

Voltage (VFD compressor only)
2 = 208
4 = 230, 460, 575

Heating medium
A = Natural gas
E = Electric
S = Steam
W = Hot water
Y = None (cooling only)



1 Return or Exhaust Fans



- Customize the unit to fit the application and return duct pressure drop
- Return fans provide better building pressure and ventilation control as return duct pressure drop increases
- Exhaust fans can save energy as return duct pressure drop requirements decrease

2 Factory-Mounted Variable Frequency Drives



- Control fan motor speed can lower fan operating costs and sound levels in VAV systems

3 Airfoil Fans



- More energy efficient and quieter than forward curved fans
- Double width, double inlet (DWDI) or single width, single inlet (SWSI) plenum fans

4 Economizer

- Outside air enters from both sides, improving mixing for better temperature control
- Patented DesignFlow Precision Outdoor Air Control System accurately measures and maintains outdoor air intake
- Patented UltraSeal™ low leak dampers minimize air leakage, reducing energy costs

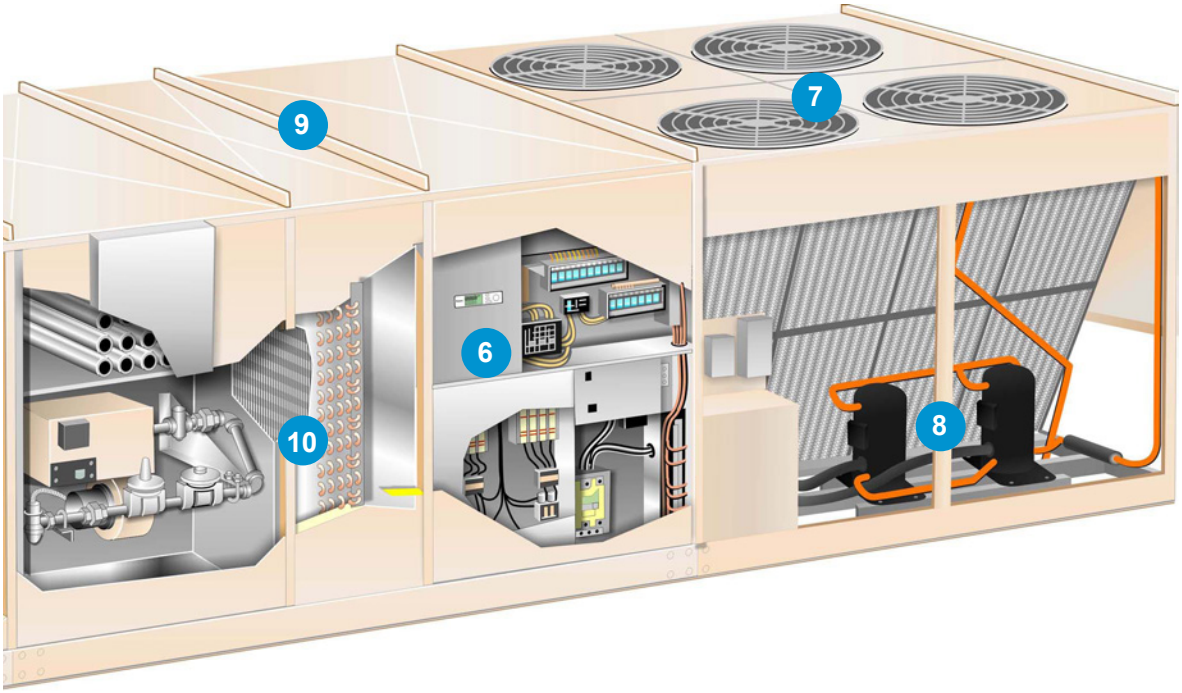
5 Hinged Access Doors

- On both sides of every section for easy access to all components
- Single lever latch and door holders provide easy entry and support routine maintenance
- Double-wall construction protects insulation during maintenance

Blank Sections



- Available throughout unit to factory-mount air blenders, carbon or charcoal filters, sound attenuators (shown), humidifiers, or other specialty equipment
- Allow customization for maximum system performance and efficiency
- Can reduce design and installation costs



6 MicroTech III Control System



- Factory-installed and tested to help minimize costly field commissioning
- Open Choices feature for easy integration into the BAS of your choice using open, standard protocols such as BACnet or LonWorks communication
- Easily accessed for system diagnostics and adjustments via a keypad/display on unit
- Optionally add a remote keypad and display that is identical to the unit mounted user interface
- Optionally add the Intelligent Equipment™ control solution, whichprovides real-time data streams for benchmarking performance, monitoring system operations and implementing remote diagnostics and control

7 High Efficiency Condensing Section

- Open air design for unrestricted airflow and access to compressors and refrigerant piping
- Up to 6 steps of compressor capacity control, with hot gas bypass on each circuit, provides a stable discharge temperature and humidity control
- Microchannel condensers are more robust than traditional coils
- Premium efficiency option
- Quiet condensing unit option

8 Variable Speed Compressor

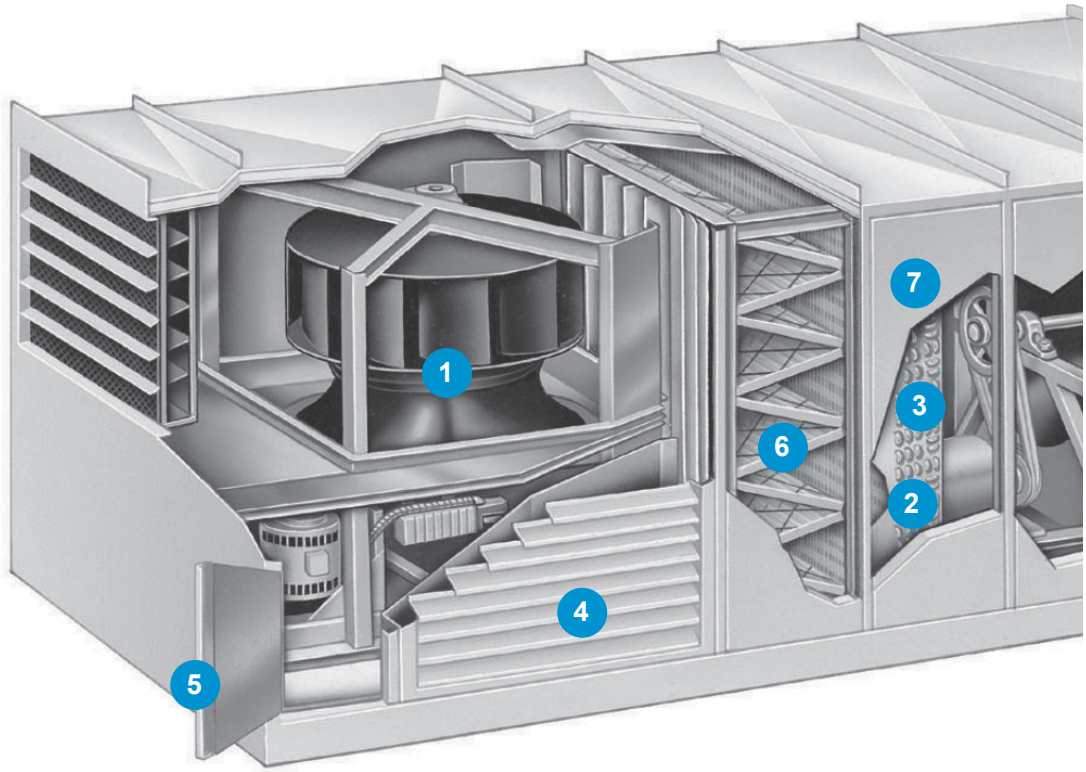
- Enhanced part load efficiency—lower operating costs
- Improved comfort—precise temperature and humidity control
- Reduced refrigerant fluctuations
- Superior acoustics at part load
- Minimized compressor cycling
- Reduced wear on compressors

9 Durable Construction

- Pre-painted exterior cabinet panels pass 1000-hour ASTM B 117 Salt Spray Test for durability
- Capped seams prevent water leaks into the cabinet
- Cross-broken top panels help eliminate standing water
- Double-wall construction protects R-6.5 insulation and provides wipe clean surface
- Stainless steel, sloped drain pans help eliminate standing water

10 Blow-through or Draw-throughCooling Coils

- Customize your unit to fit the application and building load
- Blow-through provides greater sensible heat ratios and a colder unit leaving air temperature per ton
- Draw-through arrangement provides more dehumidification per ton



1 Return or Exhaust Fans



- Custom return duct pressure drop
- Exhaust fans typically save energy at low return duct pressure drops
- Return fans provide better building pressure and ventilation control as return duct pressure drop increases

2 Factory-Mounted Variable Frequency Drives



- Control fan motor speed can lower fan operating costs and sound levels in VAV systems

3 Airfoil Fans



- More energy efficient and quieter than forward curved fans
- Double width, double inlet (DWDI) or single width, single inlet (SWSI) plenum fans

4 Economizer

- Outside air enters from both sides, improving mixing for better temperature control
- DesignFlow™ Precision Ventilation Air Measurement System measures incoming air volume with an accuracy of ±5% for optimum control of minimum outdoor air intake and good IAQ
- Patented UltraSeal low leak dampers minimize air leakage, reducing energy costs

5 Hinged Access Doors

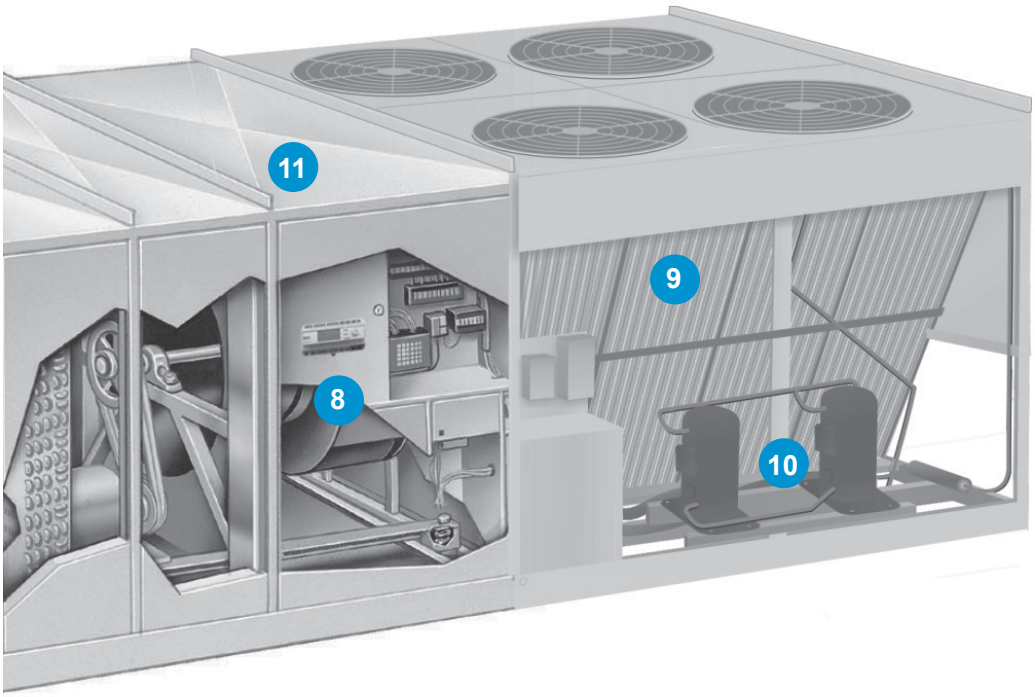
- On both sides of every section for easy access to all components
- Single lever latch and door holders provide easy entry and support routine maintenance
- Double-wall construction protects insulation during maintenance

6 Extended Face Area Filters

- 2" pleated or rigid cartridge
- 2" MERV 8 or MERV 13
- 12" MERV 11 or MERV 14 with prefilter

7 Draw-through System Design

- High latent cooling for make-up air systems or systems with high humidity loads



8 MicroTech III Control System



- Easily accessed for system diagnostics and adjustments via the unit controller keypad display
- Remote user interface option provides all functionality of unit-mounted interface
- Open Choices feature provides interoperability with BACnet or LonWorks communications for easy integration into your building automation system of choice
- Optionally add the Intelligent Equipment™ control solution, whichprovides real-time data streams for benchmarking performance, monitoring system operations and implementing remote diagnostics and control

9 Air Cooled Condenser

- Up to 6 steps of compressor capacity control—with hot gas bypass on each circuit—provides stable discharge temperature and humidity control
- Open air design for unrestricted airflow and access to compressors and refrigerant piping
- Micro-channel condensers are more robust than traditional coils
- Premium efficiency option
- Quiet condensing unit option

10 Variable Speed Compressor

- Enhanced part load efficiency—lower operating costs
- Improved comfort—precise temperature and humidity control
- Reduced refrigerant fluctuations
- Better acoustics at part load
- Minimized compressor cycling
- Reduced wear on compressors

11 Durable Construction

- Pre-painted exterior cabinet panels pass 1000-hour ASTM B 117 Salt Spray Test for durability
- Capped seams prevent water leaks into the cabinet
- Cross-broken top panels help eliminate standing water
- Double-wall construction protects R-6.5 insulation and provides wipe clean surface
- Stainless steel, sloped drain pans help eliminate standing water

Daikin RoofPak systems are built to perform, with features and options that provide for lower installed costs, high energy efficiency, good indoor air quality, quiet operation, low cost maintenance and service, and longevity. Completed systems are factory tested and shipped with an ETL or ETL Canada Safety Listing.

Unit Construction

- Nominal unit cooling capacities from 15 to 140 tons
- Units up to 52-feet long can be shipped completely assembled
- Weather resistant cabinet design with standing top seams and cross-broken top panels to provide positive drainage
- Pre-painted exterior surfaces that withstand a minimum 1000-hour salt spray test per ASTM B117
- Full size, double-wall hinged access doors on both sides of each section. All positive pressure door latches have a safety catch designed to prevent the door from opening rapidly if it is opened while the cabinet is under positive pressure
- Single lever latch mechanism and door holders on each access door
- Heavy-gauge galvanized steel unit base with formed recess to seat on roof curb gasket and provide positive weather-tight seal
- Heavy duty lifting brackets strategically placed for balanced cable or chain hook lifting
- Full double-wall construction is available throughout the unit to protect R-6.5 insulation, enhance performance and satisfy IAQ requirements
- Perforated liners are available in the plenum areas to enhance sound performance
- Available auxiliary blank sections provide the flexibility for factory-installed or field-installed specialty equipment
- Factory-mounted and factory-wired service lights with switch and outlet are available in each fan section
- Seismic certification to IBC 2009 requirements for most unit arrangements

Figure 1: Full Double-Wall Construction



R-410A Refrigerant

- R-410A refrigerant is an environmentally friendly HFC refrigerant with zero ozone depletion. Customers have no phase out and replacement concerns
- R-410A efficiency is excellent. Daikin R-410A rooftop units are available with EERs that exceed ASHRAE 90.12004. Alternative HFC refrigerants like R-407C inevitably force the unit to be significantly less efficient or more expensive, while R-410A reduces energy costs
- R-410A refrigerant is a blend, but the glide is negligible. This is not true for R-407C. If R-407C leaks, the remaining charge may not have a proper mix of components. R-410A does not have this problem so leaks are easier to repair
- Micro-channel condensers are used on all of these rooftop units. The condensers are much more robust and corrosion resistant than traditional copper tube and aluminum fin coils. Micro-channel condensers also have smaller diameter tubes so they require less refrigerant. Daikin micro-channel condensers last longer than competitive condensers and are perfect for LEED buildings

Superior Efficiency

- Energy costs continue to increase so better rooftop efficiency is extremely important to the building owner. Daikin offers several levels of efficiency including some of the most efficient units on the market
- Federal EPACT laws regulate rooftop minimum EERs up to 760 MBH and require ASHRAE 90.1-2010 compliance. Local codes regulate EERs above 760 MBH and either ASHRAE 90.1-2004 and ASHRAE 90.1-2010 are generally used
- Utility rebates oftem provide owners with tremendous incentives to purchase units with premium EERs that are well above ASHRAE 90.1 minimum values. Many utility rebates are based on CEE Tiers I and II EERs
- Daikin offers three levels of rooftop EERs to meet all of the above requirements as shown in the chart (Figure 2) and data (Table 1)

Table 1: Energy Efficiency Ratios

ASHRAE 90 1-2013				ASHRAE 90 1-2004	
High Efficiency		Premium Efficiency		Standard Efficiency	
Model	EER	Model	EER	Model	EER
15	11.0	21	10.6	68	9.2
20	10.0	26	10.5	75	9.2
25	10.0	51	10.5	85	9.7
30	10.0	63	10.5	105	9.5
35	10.2	71	10.3	140	9.2
42	10.2	81	10.9		
45	10.5	91	10.8		
50	10.0	101	10.8		
61	10.0				
70	9.7				
79	9.7				
80	10.3				
90	9.9				
100	9.8				
110	10.5				
120	10.0				
125	9.7				
130	9.8				

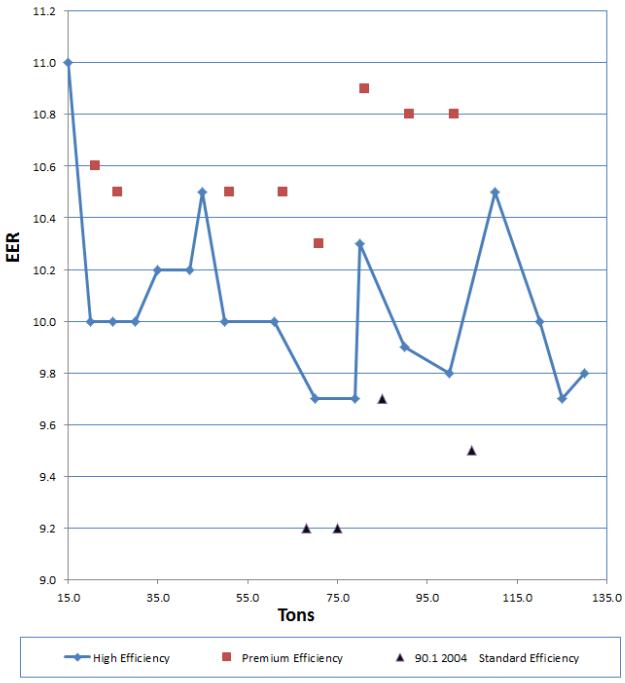
1) These also have 90.1-2013 EERs

2) These also have Premium EERs

3) Based on AHRI 360

4) EER varies slightly depending on the supply fan and DX coil options. These EERs are based on the best fan and coil combination.

Figure 2: EER Options



Micro-Channel Condensers

Micro-channel coils are an all-aluminum construction composed of:

1. Extended flat tubes (Figure 3) with many small flow channels.
2. Flat fins (Figure 3) that are brazed to adjoining tubes.
3. Two refrigerant manifold headers (Figure 3) that are arranged in a two-pass configuration (Figure 4).

- Flat tubes have better fluid-to-tube heat transfer. Therefore, micro-channel coils have more heat transfer per square foot than traditional coils and require much less refrigerant charge per ton of cooling
- All aluminum construction eliminates galvanic corrosion associated with dissimilar metals. All aluminum coils are much more resistant to normal condenser corrosion in any location including the sea coast
- Epoxy and UV coated coil cooling option is recommended for seacoast or other corrosive applications and ambient environments
- Aluminum is lighter than copper, so Daikin R-410A condensers are lighter than competitive condensers
- Micro-channel coils were pioneered in the auto industry and one reason is their more robust construction. Fins are brazed between adjoining tubes so there are no exposed and vulnerable edges. Fin damage is therefore virtually eliminated

Figure 3: Supply and Return Manifolds

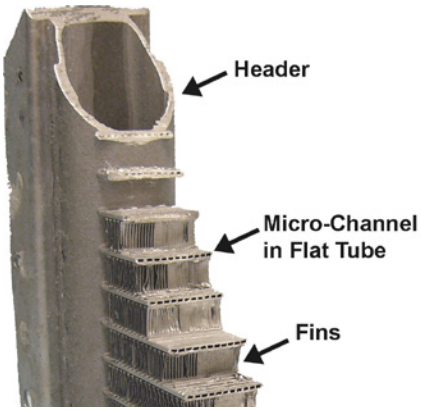
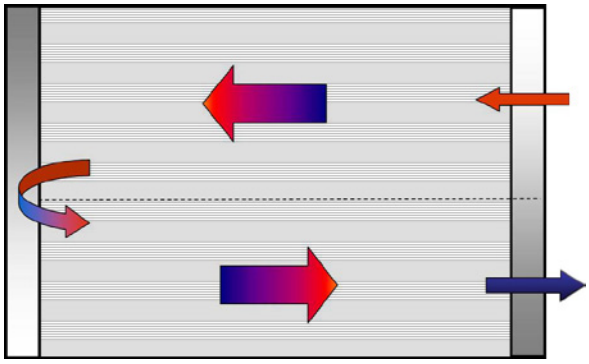


Figure 4: Typical 2-Pass Construction



Variable Speed Scroll Compressor

Daikin units with variable speed inverter compressor engineered with fixed speed compressor/s in such a way that unit delivers only the required energy to satisfy space conditions and provides you with exceptional energy savings. It improves comfort through precise temperature and humidity control. Variable speed compressor enhanced energy efficiency and capable of providing modulation down to 15%, eliminates compressors cycling and reduces wear on compressor. It also provides superior acoustics at part load capacity.

Condensing Section

- Open design permits unrestricted condenser airflow, access to compressors, refrigeration components and piping, and access for roof maintenance
- Unique rail support system allows the roof deck and insulation to help block compressor noise from entering the building.
- High efficiency Copeland® scroll compressors
- Each refrigerant circuit is furnished with an accessible sightglass, filter drier, manual shutoff valve, high pressure switch, low pressure switch, liquid line solenoid valve, TXV and manual control circuit switch
- All units feature dual refrigeration circuits for redundancy and efficient capacity control
- Large face area micro-channel condenser coils
- Vertical air discharge minimizes noise
- Three-phase condenser fan motors eliminate reverse rotation failures
- Up to six steps of compressor capacity control, with hot gas bypass (on one or both circuits) provides for stable discharge temperature and humidity control
- Optional VFDs provide accurate head pressure control and allow mechanical cooling to 0°F ambient temperatures
- Cross wire PVC coated coil guards are available to protect the condensing section from vandals
- Recessed V-bank condenser coils have built-in hail damage protection

Cooling Coil Section

- Large face area evaporator coils with high efficiency, enhanced copper tubing and aluminum fins, provide for low air pressure drop and high full and part load operating efficiencies
- All evaporator coils feature interlaced circuiting to keep the full face of the coil active and eliminate air temperature stratification
- Long-life painted, galvanized steel or stainless steel, sloped (1/8-in./ft. incline) drain pans. An intermediate drain pan in the coil bank helps to provide condensate removal without carryover
- 3, 4, or 5 row evaporator coils with 8, 10, or 12 fins/inch spacing allow a custom match to specific design loads. Multiple coil face areas allow units to be properly matched to wide ranging conditions from 100% outside air to high cfm comfort cooling applications

Figure 5: Extended Face Area Coils



Modulating Hot Gas Reheat

In a packaged rooftop system, hot refrigerant gas leaving the compressor can be channeled to a separate coil to reheat the air leaving the cooling coil, as pictured below. This reheat costs no energy and is an excellent way to optimize dehumidification.

For best performance, Daikin precisely controls or modulates the supply of the hot gas to the reheat coil. This modulation helps to maintain a constant, desired supply air temperature. Without it, supply air temperatures can vary significantly as the unit's compressors cycle ON and OFF. See Figure 6.

Typical Applications

- 100% Outdoor Air units providing neutral air for terminal unit systems, including fan coils and VRV DX systems, and supplying spaces with large ventilation requirements, such as hospitals and laboratories. See Figure 8
- Large single-zone applications, especially with dense occupancy, such as churches, theaters and gyms. These systems cannot dehumidify at part-load without reheat because DX coil latent air temperatures rise at part load. See Figure 9

Features

- MicroTech III controls with integrated compressor and reheat control. Reheat is automatically energized whenever dehumidification is needed.Modulating valves on both the condenser coil and reheat coil for more precise modulation
- Enhancements on RoofPak systems that allow +/-1 degree of supply air temperature control. These include an averaging discharge sensor and VFDs that modulate condenser fan speed and maintain a constant head pressure
- Microchannel reheat and condenser coils, which are more robust than traditional fin-tube coils and more resistant to corrosion. Flat tubes and microchannel flow allow more heat transfer per square foot of coil. And, because microchannel coils require far less charge, refrigeration service is less expensive. No receivers or oil flushing cycles are required and subcooling is always provided

Benefits

- Effective humidity control without using additional energy to reheat the cooled air.Without hot gas reheat, a separate heating system would be required to reheat the cooled, dehumidified air to the desired level, which often violates ASHRAE 90.1-2007 guidelines. Or, higher humidity levels would have to be accepted in the conditioned space
- More consistent humidity and temperature control in the conditioned space. Through compressor control, Daikin systems maintain a constant dew point in the air leaving the cooling coil (beware of inferior competitive alternatives). By modulating the hot gas to the reheat coil, Daikin systems are able to maintain a constant leaving air temperature. See Figure 6

Figure 6: Dual 2-way Valve Refrigerations Schematic

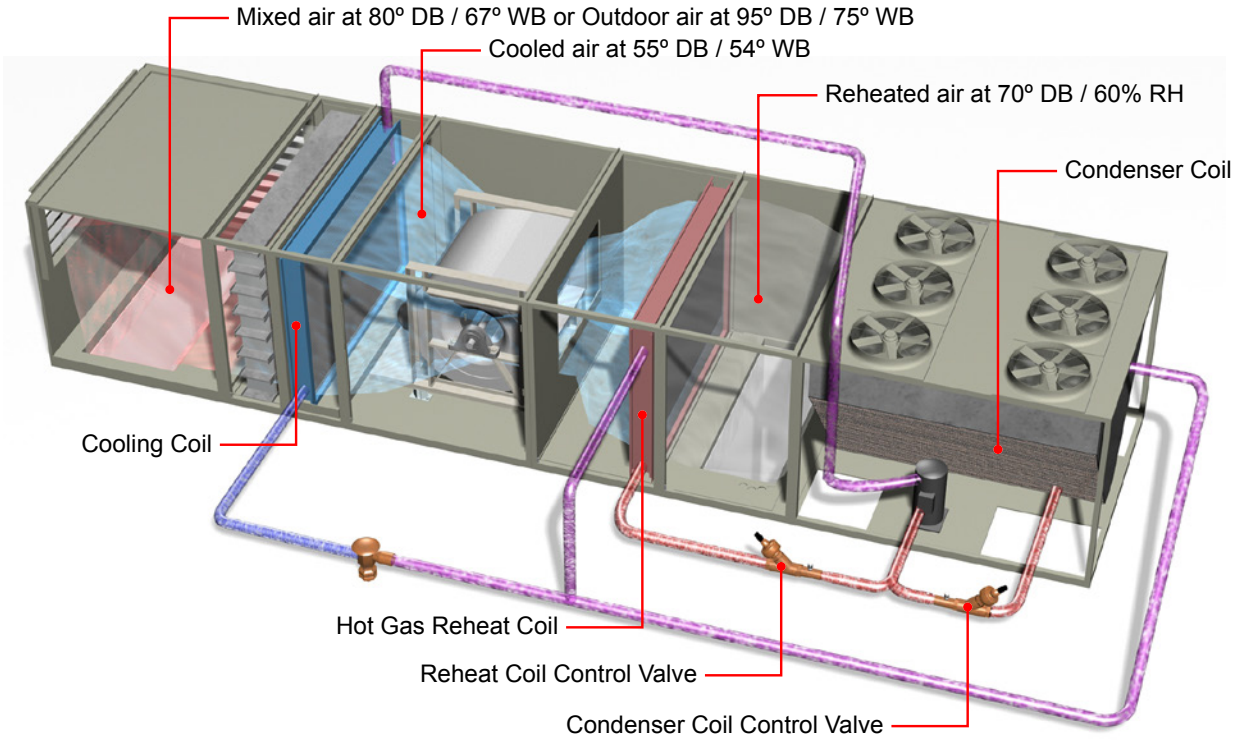


Figure 7: Modulation prevents excessive variation in leaving air temperature (LAT) and allows ±1° LAT control

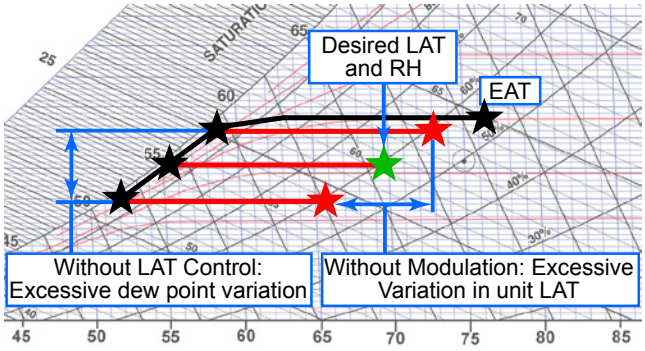


Figure 8: Modulating hot gas reheat is the best way to provide dehumidified 100% outdoor air at 70ºF/60% RH

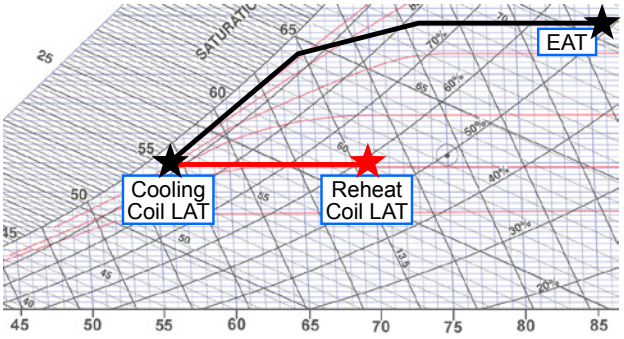
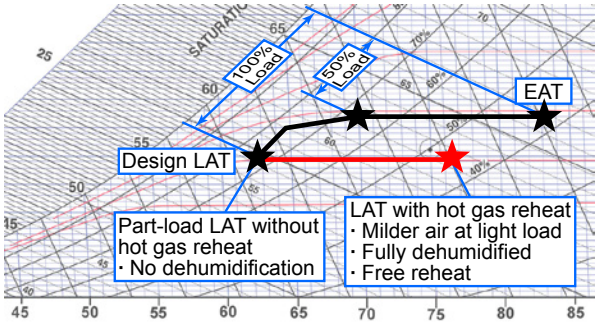


Figure 9: Hot gas reheat provides dehumidification at part load and a safety factor for humid climates



Supply and Return Fan Section

- Multiple double width, double inlet (DWDI) single width, single inlet (SWSI) forward curved and airfoil supply air fan selections provide efficient, quiet operation at wide ranging static pressure and cfm requirements
- Each fan assembly is dynamically trim balanced at the factory before shipment
- Neoprene gasket isolates the fan housing and eliminates vibration transmission to the fan bulkhead
- Solid steel fan shafts rotate in 200,000 hour, greaseable ball bearings
- All fan assemblies are isolated from the main unit on RIS or 2-in. deflection spring mounts
- Open drip-proof or totally enclosed motors comply with EPACT efficiency requirements. Premium efficiency motor upgrades available
- All fan drives are factory sized according to job specific airflow, static pressure, and power requirements
- Single width, single inlet (SWSI) airfoil return fans effectively handle high return duct static pressures and provide superior building static pressure control in VAV systems
- For seismic sensitive regions, spring fan isolators are available with seismic restraints
- 150% service factor drives extend service life of the fan belts
- Fan motor power factor correction to a minimum of 0.90
- Fan motor and drive assembly belt guards

Figure 10: DWDI Airfoil Fans (RPS/RFS)



Figure 11: SWSI Airfoil Fans (RDT)



Variable Air Volume Control

- Energy saving advanced technology variable frequency drive (VFD), fan speed control is available with the convenience and cost savings of factory mounting and testing.
- All VFD selections are plenum rated and are conveniently mounted within the filtered air stream for extended service life and easy accessibility to maintenance and service personnel.
- To manage building static pressure, dedicated VFDs are used for the supply and return fans.
- MicroTech III controls provide advanced duct and building static pressure control and equipment diagnostics capability.

Figure 12: Factory-Installed Variable Frequency Drive



Supply and Return Air Plenum

- Application flexibility of bottom, side, top and front (RFS only) discharge locations and bottom and back return locations to match complex system configuration requirements
- Available with burglar bars in both the discharge and return openings for added building security

Main Heat Section

Wide ranging natural gas, electric, steam and hot water heat selections effectively handle almost any heating demand from morning warm-up control to full heat.

Control of all heating options is fully integrated into the unit's MicroTech III control system.

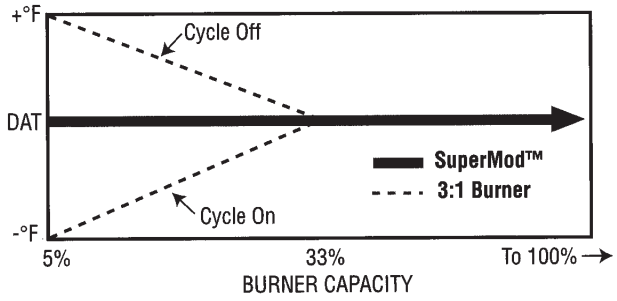
Gas Heat

- Extensive selection flexibility from 200 to 2,000 MBh output can satisfy wide ranging needs. Two-stage, 3:1 and patented SuperMod 20:1 modulating control provides the flexibility to solve diverse needs
- All gas burners exceed ASHRAE Standard 90.1 efficiency requirement of 78% for low fire and 80% for high fire with efficiencies as high as 88% and 85%, respectively
- Gas furnace assemblies are ETL or ETL-Canada listed
- Special order capability with FM or IRI/FIA gas trains
- All burner assemblies are factory tested and adjusted prior to shipment
- Heat exchangers are a two-pass, drum-and-tube design with stainless steel primary and secondary surfaces
- Air temperature rise capability of up to 100°F on most models
- Burners are forced draft type with all controls and valves housed in the burner vestibule
- Designed for ease of inspection, cleaning and maintenance
- Patented design of integral flue improves combustion gas distribution, resulting in lower surface temperatures, reduced stresses and higher efficiencies
- High-pressure regulators (2 psi to 10 psi) also available.
- 321 stainless steel heat exchangers provide long life in 100% outside air applications
- Fuel lines may be conveniently routed through the curb or the burner vestibule door
- Heating control fully integrated into the unit's MicroTech III control system

SuperMod High Turndown Gas Burner

- Full 20:1 turndown with continuous modulation between 5% and 100% of rated capacity provides precise temperature control for a comfortable tenant environment, even in demanding applications such as dehumidification, 100% make-up air and VAV systems
- Solves the mixed air tempering requirements of VAV systems when meeting ASHRAE 62.1-2001 ventilation requirements at cold ambient, light load conditions
- Operates at normal inlet gas pressures, throughout the entire modulation range
- 14 burner sizes ranging from 200 MBh to 2,000 MBh output capacity
- Patent pending design featuring four unique design innovations and 37 patent claims

Figure 13: SuperMod 20:1 Burner Versus 3:1 Burner



Electric Heat

- 40 kW to 320 kW selections factory assembled, installed and tested
- Single-stage or multi-stage capability for application flexibility
- Durable low watt density, nickel chromium elements for longer life
- Entire heat bank protected by a linear high limit control with each heater element protected by an automatic reset high limit control
- Fuses provided in each branch circuit
- MicroTech III controls sequence circuits for operating economy and reduced cycling wear

Steam Heat

- Steam heating coils are 1-row or 2-row, 5/8-in. O.D. copper tube/aluminum fin jet distributing type with patented HI-F5 fin design
- Rated in accordance with ARI Standard 430
- Four different steam coil selections offered to size heating output to application needs
- Factory-installed two-way modulating control valve, piping and modulating spring return actuator provide system control and full flow through the coil in the event of a power failure
- Available with factory-mounted freezestat

Hot Water Heat

- Hot water coils are 1-row or 2-row, 5/8-in. O.D. copper tube/aluminum fin design with patented HI-F5 fins
- Rated in accordance with ARI Standard 430
- Multiple coil selections offered to size heating output to application needs
- Factory-installed three-way modulating control valve, piping and modulating spring return actuator provide system control and full flow through the coil in the event of a power failure
- Heating control fully integrated into the unit's MicroTech III control system
- Available with factory-mounted freezestat

Outside/Return Air Section

100% Return Air Option

- Includes a return air plenum with a bottom, back or top return air opening

0% to 30% Outside Air Option

- Includes return air plenum and 0% to 30% outside air intake hood with patented UltraSeal low leak dampers to minimize leakage during off cycles

  UltraSeal damper leakage is only 1.5 cfm per ft² of damper area at 1" static pressure differential and is 3 to 6 times better than ASHRAE 90.1 damper leakage requirements
- Damper is field adjusted to a fixed open position that is easily set using the MicroTech III keypad
- Available with two-position or modulating control

100% Outside Air Option

- Includes a weather hood factory mounted to the filter section, bird screen to help prevent infiltration of foreign objects and UltraSeal low leak dampers to minimize leakage during off cycles

  UltraSeal damper leakage is only 1.5 cfm per ft² of damper area at 1" static pressure differential and is 3 to 6 times better than ASHRAE 90.1 damper leakage requirements
- Dampers arranged vertically and controlled by a two-position actuator, factory wired to sequence open when the supply fan is running and to close when the supply fan is OFF

0% to 100% Economizer Option

- Includes return air plenum with back or bottom opening, exhaust air dampers and UltraSeal low leak economizer intake dampers to minimize leakage during off cycles
- Available with or without a full return air fan

  UltraSeal damper leakage is only 1.5 cfm per ft² of damper area at 1" static pressure differential and is 3 to 6 times better than ASHRAE 90.1 damper leakage requirements
- Outside air is introduced from both sides of the unit through outside and return air dampers that are arranged vertically to converge the multiple air streams in circular mixing patterns, minimizing temperature stratification and improving system performance
- 0% to 100% economizer sections use horizontal louvered intakes, eliminating unsightly hood assemblies
- Economizer control is fully integrated into the unit's MicroTech III control system and features spring return actuator, adjustable minimum outside air set point and adjustable changeover
- DesignFlow outdoor air control system measures outside air intake volume and automatically adjusts damper position to maintain minimum volume requirements
- Outside air enthalpy, comparative enthalpy or dry-bulb temperature changeover provides control flexibility to bring in the most economical amount of outside air for "free" cooling
- Exhaust dampers exhaust air out the back of the unit

Figure 14: Economizer Airflow

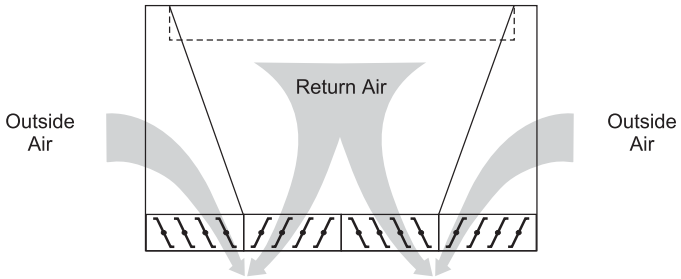
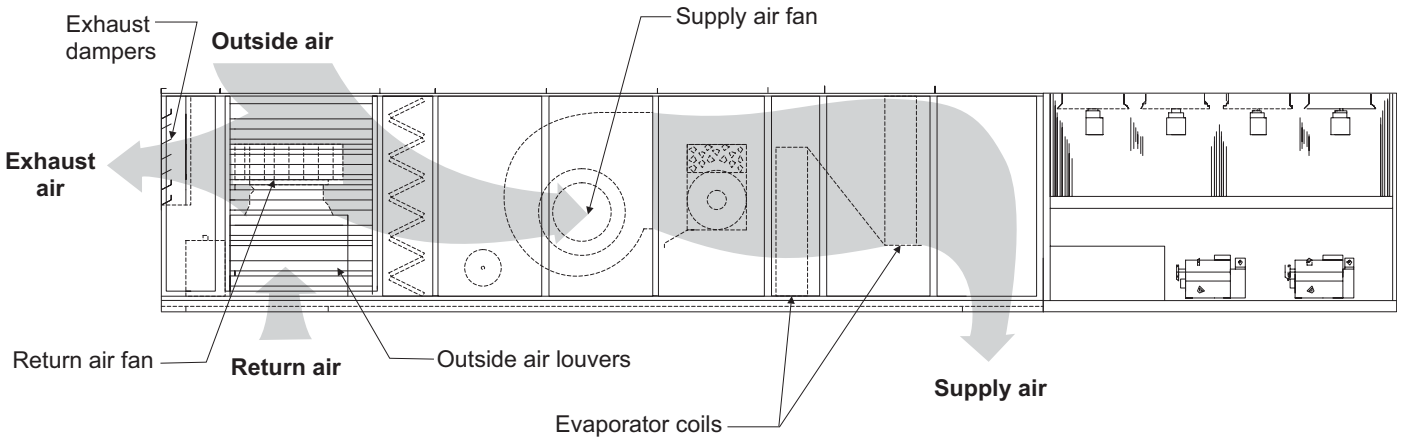


Figure 15: 0% to 100% Economizer with Propeller Exhaust Fans Centrifugal Return Fan Airflow Configuration



0% to 100% Economizer with Centrifugal Return Fan

Figure 15 shows return fan air flow configuration.

- All 0% to 100% economizer components are included
- Includes a DWDI forward curved or SWSI air foil, centrifugal return fan
- Return fans are in series with the supply fan and operate simultaneously with the supply fan to control building pressure and handle the return duct ESP at all times

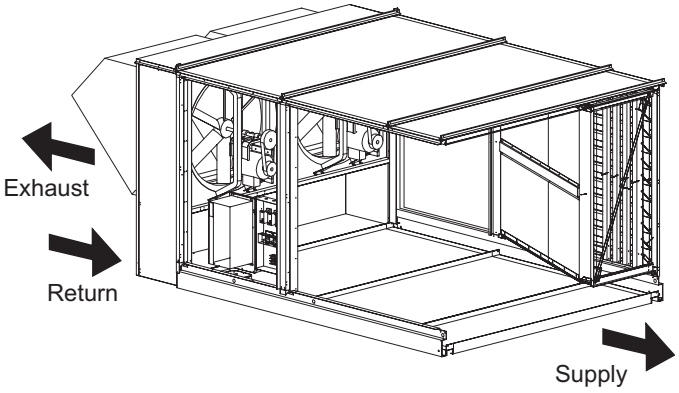
NOTE: Return fans and exhaust fans have different performance characteristics and are not interchangeable. See page 33 for application recommendations.

Figure 16 shows exhaust fan air flow configuration.

- All 0% to 100% economizer components are included
- Includes one to three propeller fans, depending on required capacity, all controlled from one VFD
- Exhaust fans are in parallel with the supply fan and may only operate during the economizer mode to control building pressure. They do not handle the return duct ESP design

NOTE: Return fans and exhaust fans have different performance characteristics and are not interchangeable. Economizer, Return Fan and Exhaust Fan Application on page 35.

Figure 16: Airflow Configuration—Exhaust Fan



DesignFlow Precision Ventilation Air Control System

- Patented precision mass flow sensor assemblies directly measure the total mass volume of air flowing through the outdoor air intakes with accuracy exceeding 95% at the values indicated in Table 2
- Repeatable accuracy helps provide adequate ventilation air for good indoor air quality (IAQ), energy efficiency and compliance with ASHRAE Standard 62.1-2001. See Table 3 on page 30 for ventilation airflow measurement ranges verified by Intertek Testing Services, Inc.
- Pre-engineered, factory-installed and calibrated system requires no additional field-installed devices
- MicroTech III controls automatically respond to mass flow sensor signals and adjusts outdoor air damper position to maintain ventilation rate set point

Table 2: Ventilation airflow measurement range

Unit size	Ventilation airflow measurement range
015C to 030D	540 to 9,400 cfm
036C to 040D	808 to 13,120 cfm
045C to 075D	1080 to 18,000 cfm
080C to 135D	1594 to 37,126 cfm

Filter Section

- Selection flexibility includes large face, area angular filter racks with 2-inch, 30% (MERV 8) or 85% (MERV 13) panel filters, or high efficiency 65% (MERV 11) and 95% (MERV 14) cartridge filter assemblies with pre-filters
- Multiple access doors allow easy filter changes from either side of the unit
- 65% (MERV 11) and 95% (MERV 14) efficient filter selections feature permanent gaskets to seal against the cartridge filters and include a 2-inch, 30% MERV 8 pre-filter
- Extended filter face area arrangements meet a wide range of airflow requirements
- Double wall, 95% efficient final filter selections are available as the last section before the discharge plenum

Figure 17: Multiple Filter Options



Static Air Mixers

- Factory installed between the outside/return air section and the filter section
- Provides blended air temperatures to minimize the potential for freezestat trips when using a hydronic heating source
- Blended outside/return air streams improve system control and avoid uneven temperature distribution at the duct take-offs

Sound Attenuators

- Factory-installed downstream of the supply fan to dampen fan noise in sound sensitive applications
- Can reduce sound levels by as much as half in the lower octave bands and more than half in the higher octave bands
- Tedlar™ coating available for added protection of the acoustic insulation

Figure 18: Factory-Installed Sound Attenuators



Humidifiers

- Factory installed steam humidifier distribution grids downstream of the supply air fan

Electrical

- Units are completely wired and tested at the factory, with control wiring routed in an accessible, protective wire raceway at the base of the unit
- Wiring complies with NEC requirements and all applicable UL standards
- For ease of use, wiring and electrical components are number coded and labeled according to the electrical diagram
- Units have a 115V convenience receptacle
- Supply and return air fan motors, compressor motors, and condenser fan motor branch circuits have individual short circuit protection
- A single point power connection with power block or disconnect switch is standard
- A unit-mounted disconnect includes a service handle on the exterior of the control panel door
- Electrical power feeds inside the perimeter roof curb through factory provided knockouts in the bottom of the main control panel
- Dual disconnects are available on size 045C to 135C units to satisfy emergency power requirements. Supply and return fan motors and controls are on the emergency power circuit and the balance of the unit is on the other
- Phase-failure/under-voltage protection is available to protect three phase motors

Ultraviolet Lights

Factory-installed ultraviolet lights are available on the downstream side of all cooling coils and above the unit drain pan.

All ultraviolet lights are pre-engineered and factory installed for ease of use and proper placement for maximum effectiveness. The ultraviolet lamps irradiate the coil and drain pan surfaces with light in the 245 nanometer wavelength of the light spectrum (UV-C). UV-C light has proven effective in killing most bacteria, molds, and viruses in both laboratory and practical application. This complete package of equipment and ultraviolet lights includes Intertek Services Inc. (ETL) safety agency certification.

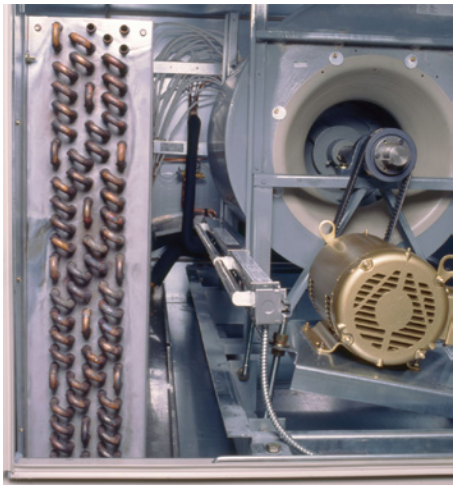
Features

- High-output, hot cathode lamps produce Ultraviolet Germicidal Irradiation (UVGI) for 254 nm that constantly irradiates the coil and drain pan surfaces
- Fixture design and stainless steel construction make the ultraviolet light device suitable for saturated air conditions
- Automatic disconnects are standard on all doors (or panels) with line-of-sight access to the lamps to help prevent eye contact with the UV-C ultraviolet light
- Special ultraviolet filtering glass windows block ultraviolet light, allowing the coil, drain pan, and lights to be inspected while in use from outside the unit

Benefits

- For pennies a day, UVGI can improve IAQ by destroying mold, fungi, and bacteria on coil and drain pan surfaces
- Clean coil surfaces maintain peak heat transfer for “near new” performance and lower energy costs
- Reduced coil and drain pan maintenance requirements and costs
- Satisfies GSA federal facilities standard requirements for UVGI lights to be incorporated downstream of all cooling coils and above all drain pans to control airborne and surface microbial growth and transfer-

Figure 19: Ultraviolet Light



Variable Air Volume

Daikin RoofPak variable air volume systems (VAV) employ the concept of varying the air quantity to a space at a constant temperature thereby balancing the heat gains or losses and maintaining the desired room temperature. This true variable volume system is commonly referred to as a “squeeze-off” or “pinch-off” system. Unlike a “bypass” or “dump” system, supply air is diverted from areas where it is not required to areas that need cooling and, at system part load conditions, reduces the total fan volume. This ability to reduce supply air quantities not only provides substantial fan energy savings at partial load conditions, but it also minimizes equipment sizing.

Variable volume systems offer the following advantages:

- Lowers system first cost by using system diversity to reduce equipment and duct sizes
- Lowers operating costs by reducing fan energy demands, especially at part load conditions
- Lowers first cost by reducing space requirements for duct trunks and mechanical equipment
- Provides system flexibility to match changing occupancy demands

Variable Frequency Drives

Variable frequency drives offer reliable operation over a wide range of airflow, with advantages in sound and energy performance.

Variable frequency drives provide the most efficient means of variable volume control by taking advantage of the fan law relation between fan speed (rpm) and fan brake horsepower (bhp). Also, since airflow is reduced by changing fan speed, the noise penalties often associated with mechanical control devices, e.g. inlet vanes, are not introduced. The following equation illustrates how fan bhp varies as the cube of the change in fan speed:

$$hp_2 = hp_1 \left(\frac{density_2}{density_1}\right)\left(\frac{rpm_2}{rpm_1}\right)^3$$

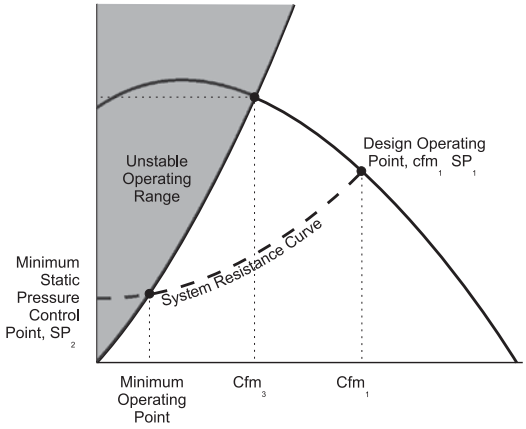
In an ideal system, at 50% fan speed, brake horsepower would be reduced to 12.5% of that at full speed.

Variable frequency control varies the speed of the fan by adjusting the frequency and voltage to the motor. Keeping a constant volts/frequency ratio (constant magnetic flux) to the motor allows the motor to run at its peak efficiency over a wide range of speeds and resulting fan airflow volumes. Figure 21 illustrates on a fan curve the effect of varying air volume with a variable frequency drive.

Figure 20: Variable Frequency Drive



Figure 21: Variable Frequency Drive Control



Airfoil Fans

To further enhance VAV system performance, Daikin RoofPak VAV systems use efficient airfoil fan selections. Daikin airfoil fan selections feature:

- Higher operating efficiencies than commonly used forward curved fans, reducing system energy demands and electrical requirements
- A non-overloading brake horsepower curve
- A single wheel design, eliminating potential problems with fan paralleling at light loads

Roof Curbs

- Constructed in accordance with NRCA guidelines with 12-gauge galvanized steel
- Fits inside the unit base around the perimeter of air handling section
- Duct frames are provided as part of each curb assembly to allow duct connections to be completed before the unit is placed
- Gasket seals between the curb duct frame and the unit
- Separate, factory-supplied steel rail supports condensing section to isolate noise and vibration from the air handling section, and to allow open roof access under the condensing section

Intelligent Equipment®

Intelligent Equipment (IE) from Daikin Applied is a secure, cloud-based controls solution that enables delivery of equipment and/or system information to customers via web or mobile devices.

A power measurement module and communications gateway installed on Daikin equipment enables the unit to be directly connected to the Internet via wireless (cellular, WI-FI) or local area network (LAN), providing management, monitoring control analysis and decision-making functionality for Daikin rooftop systems and the facility.

Features

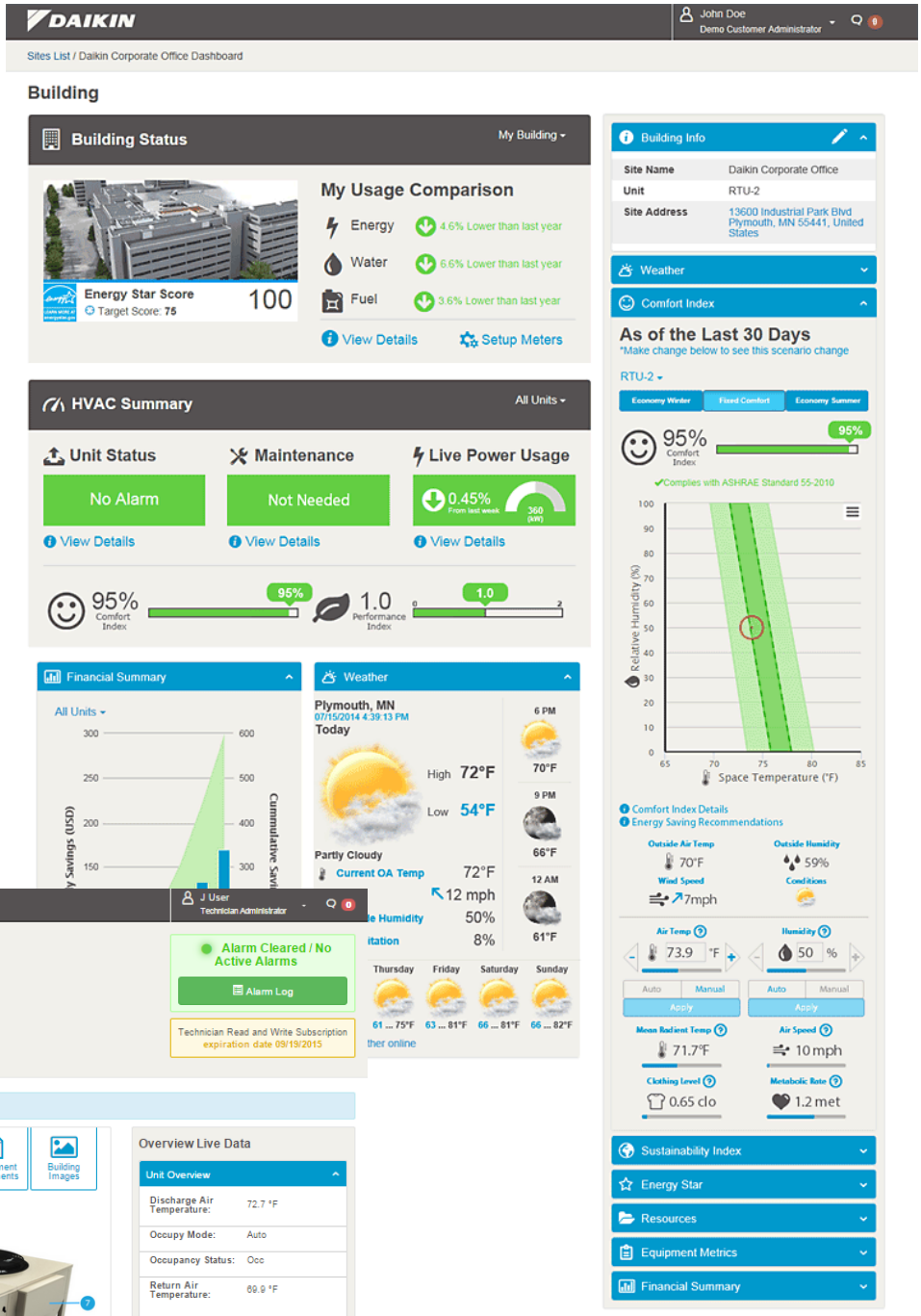
- Remote monitoring and control of Daikin rooftop units
- Remote servicing capabilities
- Integration to the Energy Star® Portfolio Manager®
- Advanced data analytics including equipment performance, financial performance and building Comfort Index metrix based on ASHRAE Standard 55-2010
- Dynamic user dashboards with photo-realistic graphics and responsive-design interface optimized for users' mobile devices, tablets or PCs
- Secure, role-based user access

Benefits

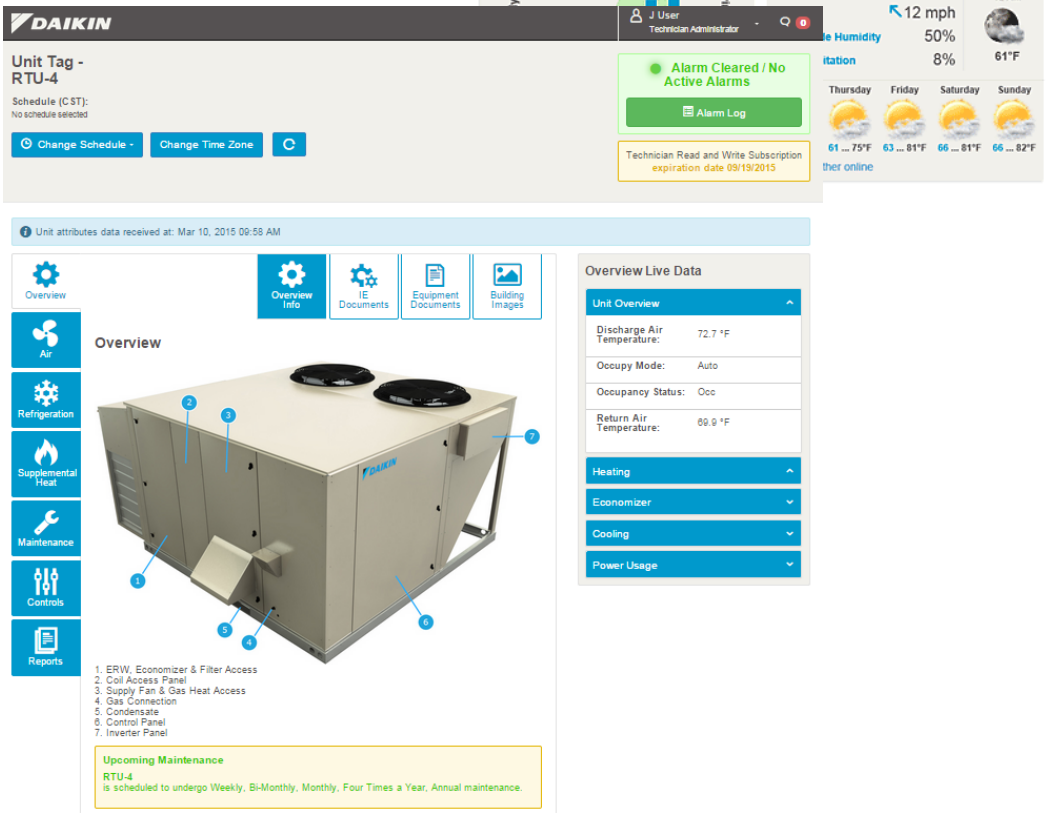
- Informed decision-making
- Increased equipment efficiency
- 24/7 monitoring capability
- Real-time equipment information
- Accelerated equipment payback
- Historical performance data
- Can be used with, or without, an existing building automation system (BAS)

Figure 22: Intelligent Equipment Dashboards

Customer Dashboard



Technician Dashboard



- Integrated MicroTech III DDC controls with unit-mounted user interface featuring a 5-line, 22 character English display for fast equipment diagnostics and adjustments
- Factory-installed and commissioned prior to shipment
- 100% make-up air, dehumidification, VAV, or CV control capabilities
- Factory integrated minimum ventilation airflow measurement and control capability
- Open Choices feature allows interoperability with any BAS that uses BACnet and LonWorks protocols

Figure 23: MicroTech III Keypad/Display



MicroTech III Remote User Interface

In addition to the unit-mounted user interface provided with MicroTech III controls, Daikin applied rooftop systems and indoor vertical self-contained systems can be equipped with a remote user interface that handles up to eight units per interface. The remote user interface provides convenient access to unit diagnostics and control adjustments, without having to access your roof or mechanical rooms located on each floor.

Each remote user interface offers similar functionality as its unit-mounted counterpart, including:

- Push-and-roll navigation wheel with an 8-line by 30-character display format
- Digital display of messages in English language
- All operating conditions, system alarms, control parameters and schedules are monitored

Features

- Can be wired up to 700 meters from units for flexibility in placing each remote user interface within your building
- Unit and remote user interfaces are both active

Benefits

- Allows you to access the user interface for each unit from one location, inside the building
- Users need to learn one format because the remote user interface is nearly identical to the unit-mounted version
- No additional field commissioning is required for the remote user interface

Figure 24: Remote User Interface

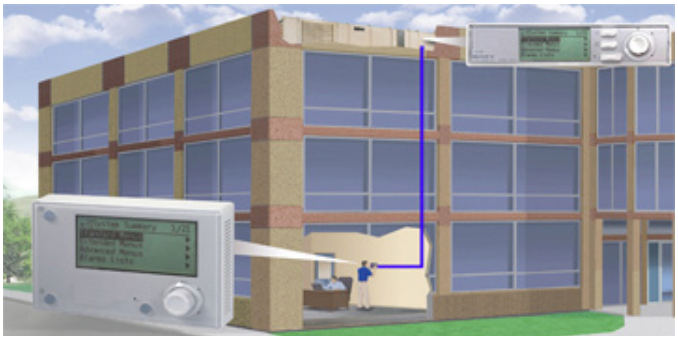
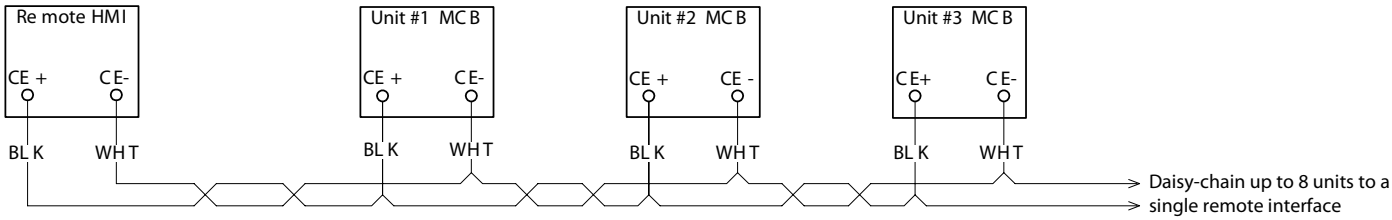


Figure 25: Process Bus Wiring Connections



MicroTech III VAV Fan Tracking Control

A key element in successful VAV application is the ability to track supply and return air fan volumes so that proper building static pressure is maintained. Daikin, a pioneer in the development of rooftop VAV systems, developed its exclusive VaneTrol fan tracking control logic to solve this issue. Incorporating over 30 years of rooftop VAV system experience, the latest generation MicroTech III controls with VaneTrol logic provide advanced and accurate duct static pressure control plus supply and return fan tracking control that effectively and efficiently manages building static pressure.

The MicroTech III controller provides complete control of your variable frequency drive applications.

Daikin applied rooftop units are equipped with a complete MicroTech III controls system. The unit controllers are factory mounted and configured for stand-alone operation or integration with a building automation system (BAS) through an optional communication module with our Open Choices feature.

Open Choices Benefits for Easy Integration

- Easy, low cost integration into most building automation systems without costly gateway panels
- Flexibility to select either BACnet or LonWorks communication. Units are LonMark 3.4 certified with the appropriate communications module for LonWorks networks
- Comprehensive unit control and status information is available at the BAS regardless of communication protocol
- Long-term choices for equipment adds or replacements, and for service support
- Flexible alarm notification and prioritization with Intrinsic Alarm Management (BACnet)
- Simplified BAS integration with the ability to set network parameters at the unit controller, reducing installation time and costs
- Easy monitoring and troubleshooting of communication status from the unit controller to the BAS

Components

Each RoofPak applied rooftop system is equipped with a complete MicroTech III unit control system that is preengineered, preprogrammed, and factory tested prior to shipment. These components include:

- Unit controller with user interface display and navigation wheel
- Optional expansion modules
- Communication module (optional)
- Pressure transducers
- Unit-mounted temperature sensors
- Zone temperature sensor packages
- Humidity sensor

MicroTech III Unit Controller

The unit controller is preprogrammed with the software necessary to control the unit. Use the unit controller keypad display to keep schedules, set points and parameters from being lost, even during a long-term power outage. The unit controller processes system input data and then determines and controls output responses. An optional field- or factory-mounted BACnet or LonWorks communication module provides a network interface to the BAS.

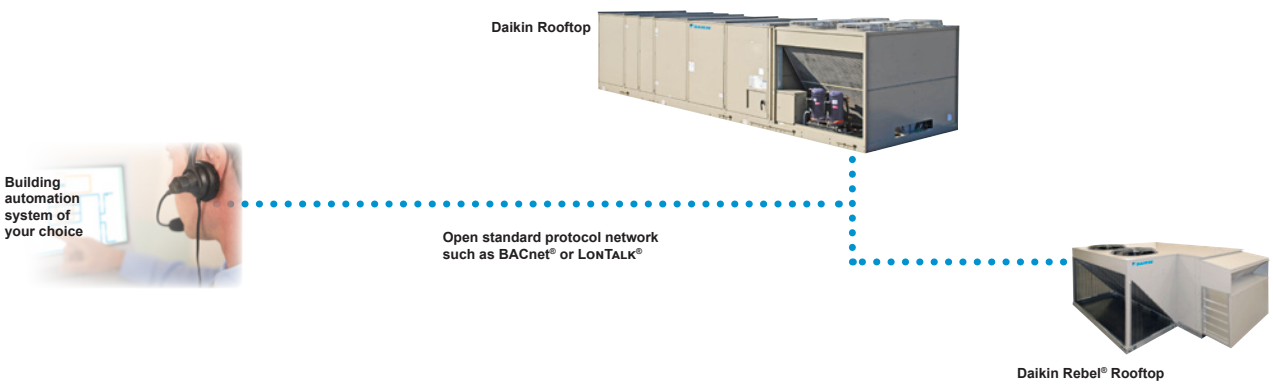
Expansion Modules

These boards are used to expand the input and output capability of the unit controller. Each board communicates via serial data communications. These microprocessor based boards provide independent operation and alarm response even if communication is lost with the unit controller.

Communication Module

An optional communication module provides the means to factory or field configure MicroTech III unit controls for interoperability with an independent BAS. Communication modules are available to support industry recognized communication protocols including BACnet MS/TP, BACnet/IP and LonWorks.

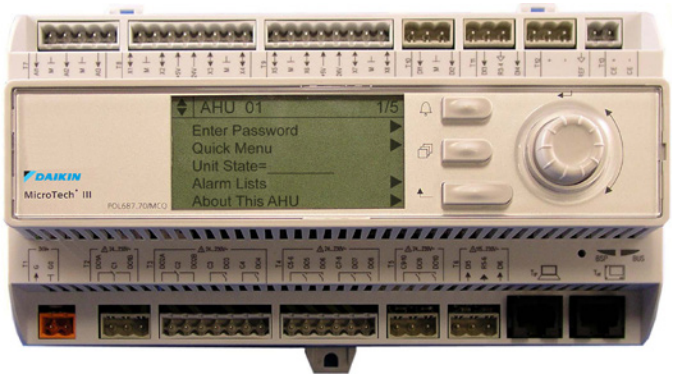
Figure 26: Open Choices Integration



Keypad/Display

All MicroTech III unit controllers include a push/pull navigation wheel and display. The display is a supertwist nematic type with highly visible black characters on a yellow background. The 5-line by 22-character format allows for easy to understand plain English display messages. All operating conditions, system alarms, control parameters and schedules can be monitored from the keypad/display. If the correct password has been entered, any adjustable parameter or schedule can be modified from the keypad.

Figure 27: MicroTech III Keypad/Display



Temperature and Humidity Sensors

With the exception of the zone sensor, all temperature sensors are factory installed and tested. Zone sensor packages are available to suit any application. When required for dehumidification applications, a humidity sensor is available for field installation.

Static Pressure Transducers

All pressure transducers are factory installed and tested. Connection and routing of field-supplied sampling tubes is done at time of unit installation.

Zone Temperature Sensors

Two optional zone temperature sensors are available:

- Zone sensor with tenant override switch.
- Zone sensor with tenant override switch and remote set point adjustment.

Timed tenant override is a standard MicroTech III control feature.

Zone sensors are required for the controller's purge cycle, space reset of supply air set point, and night setback or setup features. All zone sensors are field installed with field wiring terminated at a separate, clearly marked terminal strip.

Stand-alone Controller Features

MicroTech III applied rooftop unit controls include all of the essential features required to make them capable of completely independent, stand-alone operation.

Internal Time Clock

An internal, battery-backed time clock is included in the MicroTech III unit controller. Current date and time can be quickly and easily set at the user interface keypad.

Internal Schedule

Seven daily schedules and one holiday schedule can be entered at the keypad of all unit controllers. For each of these eight schedules, one start and one stop time can be entered. Up to 10 holiday periods, of any duration, can be designated. The unit will automatically run according to the holiday schedule on the holiday dates. To handle special occasions, an additional 'one event' schedule can also be used.

In lieu of its internal schedule, the unit can be operated according to a network schedule from a BAS.

External Time Clock or Tenant Override Input

An input is supplied that can be used to accept a field wired start/stop signal from a remote source. An external time clock, a tenant override switch, or both may be connected. Whenever the external circuit is closed, the controller overrides the internal schedule (if activated) and places the unit into the occupied mode.

If the internal schedule or a BAS network schedule is used, field wiring is not required.

Timed Tenant Override

Off-hour operation flexibility is a must in today's office environments and even stand-alone MicroTech III controls handle it with ease. When unit operation is desired during unoccupied hours, initiate timed tenant override by pressing the tenant override button on either of the optional zone sensor packages. The unit then starts and runs in the occupied mode for a keypad-adjustable length of time (up to five hours). If the button is pressed again while the unit is operating, the timer resets to the full time allowance without interrupting unit operation. Tenant override operation also can be initiated by a BAS.

Three Remote Set Point Adjustment Options

1. Remote user interface option (RUI). See Variable Air Volume on page 19.
2. Building automation system (BAS). See Open Choices Benefits for Easy Integration on page 23.
3. All constant air volume-zone temperature control (CAV-ZTC) unit controllers include an input that can be used to remotely adjust the zone cooling and heating set points. To use this feature, wire the optional zone sensor package with set point adjustment to the controller. The remote set point adjustment feature can be enabled or disabled from the keypad at any time. When enabled, remote set point adjustment is available even if the return temperature is selected to be the Control Temperature.

Auto/Manual Operation Selection

Automatic or manual operation can be controlled either remotely or at the keypad.

All controllers include three inputs that can be used to enable or disable cooling, heating, and fan operation from remote switches. With the “heat enable” and “cool enable” terminals, the operator can enable cooling, heating, or both as desired. Using the system “off” terminals, the operator can disable the fans, and thus the entire unit.

From the keypad, there are a variety of occupancy and auto/manual control mode selections available to the operator:

- Occupancy modes
  - Auto
  - Occupied
  - Unoccupied
  - Bypass (tenant override)
- Control modes
  - Off manual
  - Auto
  - Heat/cool
  - Cool only
  - Heat only
  - Fan only

Compressor Lead-lag Selection

All unit controllers are capable of automatic compressor, lead-lag control. If automatic control is not desired, the operator can assign fixed lead and lag designations to the compressor circuits.

Lead and Lag is not available on units with variable speed inverter compressors.

Compressor Sequencing Selection

Because all applications are not the same, MicroTech III controls provide two choices for compressor capacity staging. For high sensible demand, comfort cooling applications, “cross-circuit” unloading can be chosen to maximize part load efficiency. Cross circuit unloading takes maximum advantage of available condenser and evaporator surface areas. Select “lead-loading” whenever part load dehumidification capability is of primary importance.

Economizer Changeover Selection

On units equipped with an economizer, there are three methods of determining whether the outdoor air is suitable for free cooling: two methods sense enthalpy (dry bulb temperature and humidity) and one senses outdoor air dry bulb temperature.

The two enthalpy changeover methods use external, factory installed controls. One compares the outdoor ambient enthalpy to a set point; the other is a solid state device that compares the outdoor ambient enthalpy to the return air enthalpy. This comparative enthalpy control can improve total economizer performance.

All unit controls include an internal dry bulb changeover strategy that can be selected at the keypad. When this method is selected, the controller compares the outdoor air dry-bulb temperature to a keypad programmable set point. The external enthalpy control input is then ignored.

Cooling and Heating Lockout Control

All unit controls include separate keypad programmable set points for locking out mechanical cooling and heating. Mechanical cooling is locked out when the outdoor temperature is below the cooling lockout set point; heating is locked out when the outdoor temperature is above the heating lockout set point. This feature can save energy cost by eliminating unnecessary heating and cooling during warm-up or cool-down periods or when the outdoor air temperature is mild.

Night Setback and Setup Control

When one of the zone temperature sensors is connected to the unit controller, night setback heating and night setup cooling control are available. Separate, keypad programmable night heating and cooling set points are used to start the unit when necessary. After the unit starts, night setback and setup control is similar to normal occupied control except that the minimum outside air damper position is set to zero. If the outside air is suitable for free cooling, it is used during night setup operation.

Except for 100% outside air applications, night setback control is available even if the unit is not equipped with any heating equipment. When the space temperature falls to the night setback set point, the fans simply start and run until the temperature rises above the differential. This feature might be useful for applications that use, for example, duct-mounted reheat coils.

Morning Warm-up Control

If the Control Temperature (space or return) is below set point when the unit enters the occupied mode, the morning warm-up control function will keep the outside air dampers closed while heat is supplied to satisfy set point. The outside air damper will remain closed until either the space temperature rises to the heating set point or the keypad adjustable morning warm-up timer expires (default is 90 minutes). The morning warm-up timer supplies the minimum required amount of outdoor air after a certain time regardless of the space temperature.

Morning warm-up control is automatically included on all except 100% outside air units. It is available even if the unit is not equipped with any heating equipment, for applications that utilize, for example, duct-mounted reheat coils.

Proportional Integral (PI) Control

The Proportional Integral (PI) control algorithm controls modulating actuators to maintain a measured variable (temperature or pressure) at or near its set point. For example, it controls economizer dampers to maintain the discharge cooling set point and it controls the supply fan variable frequency drives to maintain the duct static pressure set point. The integral control feature effectively eliminates “proportional droop” (load dependent offset) resulting in the tightest possible control.

For each PI loop, four keypad adjustable parameters allow the control loop to be properly tuned for any application:

- Period
- Dead band
- Proportional band
- Integral time

Appropriate default values for these parameters are loaded into each controller. These default values will provide proper control for most applications; therefore, field tuning is usually not required and thus start-up time is reduced.

Change Algorithm

The PI function is also used to adjust set points instead of controlling variable speed drives or actuators directly. For example, in zone control applications, the PI loop automatically “changes” the discharge temperature set point (cooling or heating) as the Control Temperature deviates from the zone set point. Another PI loop then controls the economizer actuator or heating valve actuator using the current discharge temperature set point. Unlike a typical “master-submaster” reset strategy, this “cascade control” continuously adjusts the discharge set point, even if the Control Temperature’s deviation from set point remains constant. This means that the unit’s cooling or heating output is set according to the actual load, not just the current zone temperature. The tightest possible zone temperature control results because “proportional droop” (load dependent offset) is eliminated.

Calibrate

When initiated at the keypad by an operator, the Calibrate function automatically calibrates all actuator position feedback inputs and all pressure transducer inputs. It does this by shutting the unit down and then driving all actuators to the full closed and full open positions. The controller records the input voltage values that correspond to these positions. The pressure transducer input voltages, which are assumed for 0.00-in. W.C., are also recorded. When Calibrate is finished, enter an operator command at the keypad to start the unit.

Field Output Signals

All MicroTech III RoofPak controls include two solid-state relay outputs that are available for field connection to any suitable device: the remote alarm output and the occupied output. These two outputs are used to signal field equipment of unit status.

Remote Alarm Output:

The remote alarm output can be used to operate a 24 volt relay to provide a remote alarm signal to a light, audible alarm, or other device when an alarm condition exists at the unit.

Fan Operation Output:

The fan operation output is used to operate a 24 volt relay to control field equipment that depends on fan operation; for instance, to open field installed isolation dampers or VAV boxes. To allow actuators enough time to stroke, the fan operation output is energized three minutes before the fans start. It then remains energized until thirty seconds after the unit airflow switch senses no airflow. The fan operation output is on whenever the unit airflow switch senses airflow.

Standard Control Options

Model RPS. RDT, and RFS applied rooftop systems are available for most any constant or variable air volume application. MicroTech III controls offer three basic control configurations: variable air volume with discharge temperature control (VAV-DTC), constant air volume with zone temperature control (CAV-ZTC), and constant air volume with discharge temperature control (CAV-DTC), that use sophisticated state change control logic to provide stable, reliable and efficient control. When combined with MicroTech III’s many available control capabilities, both factory installed and keypad programmable, these three basic configurations can be customized to meet the requirements of the most demanding applications.

Variable Air Volume with Discharge Temperature Control (VAV)

All VAV units provide true discharge temperature control in addition to duct static pressure control. Cooling only, cooling with single-stage “morning warm-up” heat, and cooling with modulating heat configurations are available. On units with a return fan, two building static pressure control options are available: VaneTrol™ logic tracking or direct building pressure control. Because proper ventilation rates have been identified as critical to maintaining good indoor air quality, all RoofPak VAV controllers include software algorithms designed to maintain minimum outside air volume at all times when the unit is in the Occupied mode.

Constant Air Volume with Zone Temperature Control (CAV-ZTC)

CAV-ZTC units are available in either cooling only or cooling with modulating heat configurations. Either of these configurations is available for 100% recirculated, mixed, or 100% outdoor air applications. On units that have a return fan, a direct building static pressure control option is also available.

Constant Air Volume with Discharge Temperature Control (CAV-DTC)

CAV-DTC units are available in cooling only, cooling with single-stage “morning warm-up” heat, or cooling with modulating heat configurations. This unit configuration can be used for applications that have zone controlled terminal reheat coils or for constant volume, 100% outdoor air applications. The discharge temperature control strategies used with the hybrid CAV-DTC unit are identical to those used with the VAVDTC unit. On units that have a return fan, a direct building static pressure control option is available (constant supply air volume applications only).

Discharge Temperature Control

MicroTech III VAV-DTC and CAV-DTC controls provide sophisticated and flexible discharge air temperature control that is only possible with DDC systems. Separate discharge air temperature set points are used for cooling and modulating heating control. At the keypad, the operator can either enter the desired set points or select separate reset methods and parameters for each set point (see Supply Air Reset on page 28).

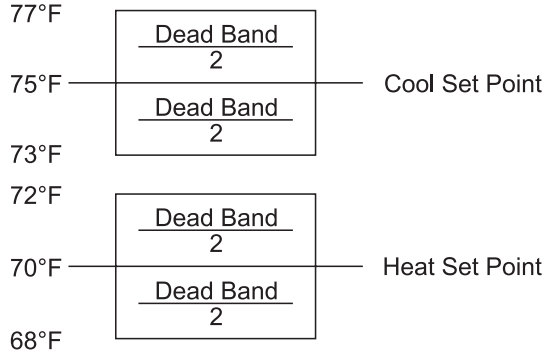
Control Temperature

The Control Temperature makes the heat/cool changeover decision. It determines whether cooling or heating is enabled; the discharge temperature then determines whether cooling or heating is actually supplied. At the keypad, the operator can choose the source of the Control Temperature from among the following selections.

- Space temperature sensor
- Return temperature sensor
- Outside air temperature sensor (modulating heat only)
- Network communication

The operator enters separate cool and heat enable set points and deadbands that the Control Temperature is compared with (see Figure 28). When the Control Temperature is greater than or equal to the cooling set point plus DB/2, cooling is enabled. When the Control Temperature is less than or equal to the heat set point minus DB/2, heating is enabled. If desired, these set points and differentials can be set so that there is a dead band in which both cooling and heating are disabled. The controller’s software prevents simultaneous cooling and heating.

Figure 28: Control Temperature Logic



Proportional Integral Modulation

When operating in economizer free cooling or unit heating, the previously described PI algorithm maintains discharge temperature control. It provides precise control of the economizer dampers, modulating gas heat, steam or hot water valves.

Compressor Staging

Two staging algorithms are available to control a unit's multiple steps of capacity control, Degree-Time (also known as "average") and Nearest. These control algorithms provide reliable discharge temperature control while managing compressor cycling rates. Constraints on compressor staging are essential for preventing short cycling, which can reduce compressor life by causing improper oil return and excessive heat buildup in the motor windings.

The Degree-Time Compressor staging algorithm keeps track of the discharge temperature and stages cooling up or down to maintain an average temperature that is equal to the discharge cooling set point. A stage change can occur only (1) after the keypad adjustable inter-stage timer has expired (five minute default setting) and (2) if the discharge temperature is outside a keypad programmed dead band. After these two conditions have been met, staging occurs as the controller attempts to equalize two running totals: degree-time above set point and degree-time below set point. The result is that the average discharge temperature is maintained at the cooling set point.

The Nearest Compressor staging algorithm keeps track of the discharge temperature and stages cooling up or down to maintain the discharge temperature as close as possible to set point. A stage change can occur only (1) after the keypad adjustable inter-stage timer has expired (five minute default setting) and (2) if the control logic calculates that a stage change will result in a discharge temperature closer to set point than the existing condition. The controller logic continually calculates the expected effect of a stage change and uses this information before making a change. A change is made only if it will bring the discharge temperature closer to set point, resulting in a more consistent discharge temperature, reduced compressor cycling and more stable control VAV box control.

Supply Air Reset

By automatically varying the discharge air temperature to suit a building's cooling or heating needs, supply air temperature reset can increase the energy efficiency of VAV and CAV-DTC systems. MicroTech III controllers offer a variety of different reset strategies that can be selected at the keypad. Because they are keypad programmable, reset strategies can be changed or eliminated as desired. Separate strategies can be selected for both cooling and modulating heat. If reset is not desired, a fixed discharge cooling or heating set point can be entered.

The following reset methods are available:

- Space temperature
- Return temperature
- Outdoor air temperature
- Supply airflow (VAV, cooling set point only)
- External 0–10 VDC or 0–20 mA signal
- Network communication

For all temperature reset methods, the minimum and maximum cooling and heating set points are keypad programmable along with the corresponding minimum and maximum space, return or outdoor air temperature parameters. For the supply airflow method, the discharge set point will be reset as the supply fan modulates between 30% adjustable and 100% adjustable. For the external method, the discharge set point will be reset as the voltage or current signal varies over its entire range. For units in a BAS network, the discharge set points are reset via the communication signal.

Zone Temperature Control

MicroTech III CAV-ZTC controls provide the sophisticated and flexible zone temperature control that is only possible with DDC systems. Zone temperature sensors are available with or without a remote set point adjustment. With the remote adjustment model, the space set point can be set at the keypad or at the zone sensor package. Even if a zone sensor is connected, remote set point adjustment can be enabled or disabled as desired at the keypad.

Control Temperature

The Control Temperature is the representative zone temperature. When compared with the zone set points, the Control Temperature determines whether the unit supplies heating, cooling, or neither. It also determines the amount of cooling or heating required to satisfy the load. Its source can be selected at the keypad from among the following selections:

- Zone temperature sensor
- Return temperature sensor

Because it is the representative zone temperature, the Control Temperature is the primary input to the MicroTech III zone temperature control algorithms. Control Temperature parameters are described below. The controller's software will prevent cooling and heating from being inadvertently enabled at the same time.

Change and Proportional Integral Modulation

When economizer “free” cooling or unit heating is required, the two MicroTech III PI loops combine for cascade-type control, providing the tightest possible zone temperature control. By controlling the discharge temperature along with the zone temperature, these functions eliminate temperature variations near the diffusers that could otherwise occur as a result of traditional zone control’s inherent lag effect.

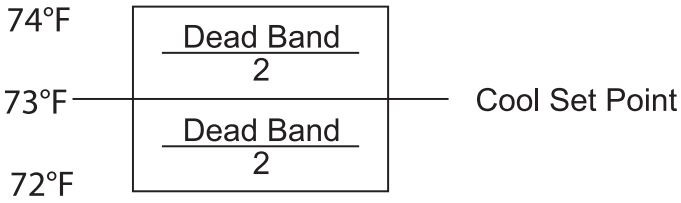
Change: If the Control Temperature is above or below the set point by more than the dead band, the Change PI loop periodically adjusts the cooling or heating discharge air temperature set point either up or down as necessary. The amount of this set point change corresponds to the Control Temperature’s position in the modulation range. The farther the Control Temperature is from the set point, the greater the discharge set point change will be. The Change-adjusted discharge cooling and heating set points are limited to ranges defined by keypad programmable maximum and minimum values.

PI: Using the Change function’s current discharge set point, the PI function maintains precise discharge temperature control by modulating the economizer dampers and gas heat, steam or hot water heating valves.

Compressor Staging

Compressor staging is controlled directly by the Control Temperature. When the Control Temperature is warmer than the zone cooling set point, cooling is staged up; when the Control Temperature is cooler than the zone cooling set point, cooling is staged down. However, a stage change can only occur when the Control Temperature is outside the dead band (see Figure 29). Staging is constrained by an inter-stage delay timer (five minute default setting) and minimum and maximum discharge air temperature limits (all keypad programmable). These constraints protect the compressors from short cycling while eliminating temperature variations near the diffusers.

Figure 29: Compressorized Logic



Project Ahead Algorithm

Because the inherent lag effect in zone temperature control applications can cause overshoot during warm-up or cool-down periods, MicroTech III features a “Project Ahead” control algorithm. Project Ahead calculates the rate at which the Control Temperature is changing and reduces the unit’s cooling or heating output as the zone temperature nears its set point, essentially eliminating overshoot.

Duct Static Pressure Control

On all VAV-DTC units, duct static pressure control is maintained by the PI algorithm, which provides precise control of the supply fan variable speed drive. The keypad programmable set point can be set between 0.20-in. W.C. and 4.00-in. W.C.

On larger buildings with multiple floors, multiple trunk runs or large shifts in load due to solar effects (east/west building orientation), an optional second duct static sensor is offered. The MicroTech III controller automatically selects and uses the lower of the two sensed pressures to control fan volume to provide adequate static pressure to the most demanding space at all times.

Building Static Pressure Control

VaneTrol™ Fan Tracking Control

(does not apply to exhaust fans)

VaneTrol fan tracking control logic offers close and reliable building static pressure control for VAV units equipped with a return air fan. With the VaneTrol logic method, the return fan’s variable speed drive assembly tracks the supply fan volume as the supply fan maintains the required duct static pressure using the additional parameter of maintaining a field programmable offset between supply fan and return fan volume. The result is that building pressure is maintained, regardless of the building cooling load, because the proper relationship between supply and return fan volume is maintained. Because the return fan/supply fan tracking relationship is established once during controlled test-and-balance conditions, ongoing building pressure control is not affected by a fluctuating ambient pressure reference signal or the temporary effects of opening and closing doors on a pressure sensor in the lobby.

VaneTrol control logic uses four keypad programmable parameters to maintain the required relationship between return fan and supply fan volumes. These are the supply and corresponding return fan volumes as measured by variable speed drive position, at both maximum and minimum airflow conditions.

Table 3 shows an example of how supply and return air fan modulation must vary to maintain the correct balance of supply and return air volumes based on the building’s parameters and therefore maintain building pressure. Determining the building’s correct VaneTrol parameters is easy with MicroTech III’s Balance feature. With Balance, start-up time is reduced because final adjustments are made at the keypad.

Table 3: VaneTrol Logic Air Balancing

SAF cfm	RAF cfm	Building exhaust
16000 (100%)	14000 (100%)	2000
14000 (88%)	12000 (80%)	2000
12000 (75%)	10000 (71%)	2000
10000 (63%)	8000 (57%)	2000
8000 (50%)	6000 (43%)	2000

Direct Space Pressure Control
(for return or exhaust fans)

Any constant or variable air volume unit equipped with a variable volume return or exhaust fan can be provided with direct building static pressure control capability. With the direct method, building static pressure is measured and processed by the PI algorithm. This algorithm provides precise control of the return fan variable speed drive or inlet vanes to maintain the space pressure set point. The range of the keypad programmable set point is between minus 0.25-in. W.C. and 0.25-in. W.C.

This type of control can be used for either whole building or lab pressurization (positive or negative) applications, or exhaust fan control where VaneTrol control logic does not apply.

Minimum Ventilation Air Volume Control

Consistently maintaining the minimum outdoor air requirements of ASHRAE Standard 62-1999 has been a long standing control challenge for VAV systems. As supply air fan volumes were reduced, the volume of air introduced through a fixed position, minimum outdoor air damper was also reduced, compromising indoor air quality. To meet this challenge, MicroTech III controls feature four user-selected control methods for maintaining outdoor air volume.

- The MicroTech III controller can accept a signal from a DesignFlow Precision Ventilation Air Control System, which is continuously measuring outdoor air volume, and adjust outdoor air damper position to maintain the minimum volume set point.
- MicroTech III controls have a keypad selected control function that automatically adjusts outdoor air damper position in response to changes in supply air fan volume. Regardless of supply air volume, this strategy maintains a nearly constant outdoor air volume at all times.The MicroTech III controller can accept an external 0–10 VDC signal from a CO_2 sensor or other control device and adjust outdoor air damper position.
- If desired, a fixed minimum damper position can be keypad programmed. This selection may be acceptable when ventilation requirements are met through other sources.

During cold ambient conditions where outdoor/return mixed air conditions can become too low, MicroTech III controls maintain the cooling discharge temperature set point by controlling the unit heating system. For applications where ambient temperatures and minimum outdoor air requirements can generate this condition, order the RoofPak unit with modulating heating equipment, such as the SuperMod gas burner.

Table 4 illustrates the effect of minimum ventilation control and cold ambient conditions on unit discharge air temperature and how it dictates the need for mixed air tempering capability at the light load/low ambient conditions. It assumes a VAV unit with a 20% outdoor air requirement at design conditions and a 40% minimum airflow requirement.

Table 4: Effect of Minimum Ventilation Control on Discharge Temperature

Supply fan volume (cfm)	Outdoor air volume (cfm)	Outdoor air volume (%)	Outdoor air temp (°F)	Mixed air temp (°F)
10,000	2,000	20	95	79
8,000	2,000	25	70	73.8
6,000	2,000	33.3	40	63.3
4,000	2,000	50	0	37.5

Operating States

Operating states define the current overall status of the rooftop system. At the user interface, the operator can display the current operating state and thereby quickly assess the unit's operating condition. Figure 30 shows all possible operating states and the status information they summarize. Depending on unit options, some operating states may not apply. For example, a 100% outside air unit does not have a Morning Warm-Up, Economizer or Unoccupied Economizer operating state. Below are descriptions of each operating state.

Alarm Management and Control

MicroTech III unit controllers are capable of sophisticated alarm management and controlled response functions. Each alarm is prioritized, indicated, and responded to with the appropriate action. The active alarm (up to 10 alarms, arranged by alarm priority) and previous alarm (up to 25 alarms, arrange by date/time cleared), each with a time and date stamp, can be displayed at the user interface. Generally speaking, whenever a current alarm is cleared, it is logged as a previous alarm and the oldest previous alarm is removed.

Alarm Priority

The various alarms that can occur are prioritized according to the severity of the problem. Three alarm categories are used: faults, problems, and warnings.

1. Faults are the highest priority alarms. If a fault condition occurs, the complete unit is shut down until the alarm condition is gone and the fault is manually cleared at the keypad. A fault example is Fan Fail alarm.
2. Problems are the next lower priority to faults. If a problem occurs, the complete unit does not shut down, but its operation is modified to compensate for the alarm condition. A problem automatically clears when the alarm condition that caused it is gone. Compressor Fail is an example of a problem where only the affected compressor is shut down.
3. Warnings are the lowest priority alarms. No control action is taken when a warning occurs; it is simply indicated to alert the operator that the alarm condition needs attention. To remind the operator to read warnings, they must be manually cleared. Dirty Filter indication is an example of a warning.

Generally, a specific alarm condition generates an alarm that falls into only one of these categories. Under different sets of circumstances, however, the freezestat and most of the sensor failure alarm conditions can generate alarms that fall into multiple categories.

Adjustable Alarm Limits

Four alarm triggers have adjustable limits. The high return temperature alarm and the high and low supply temperature alarms are adjusted at the user interface. The dirty filter alarm(s) is adjusted at the sensing device. See Table 5.

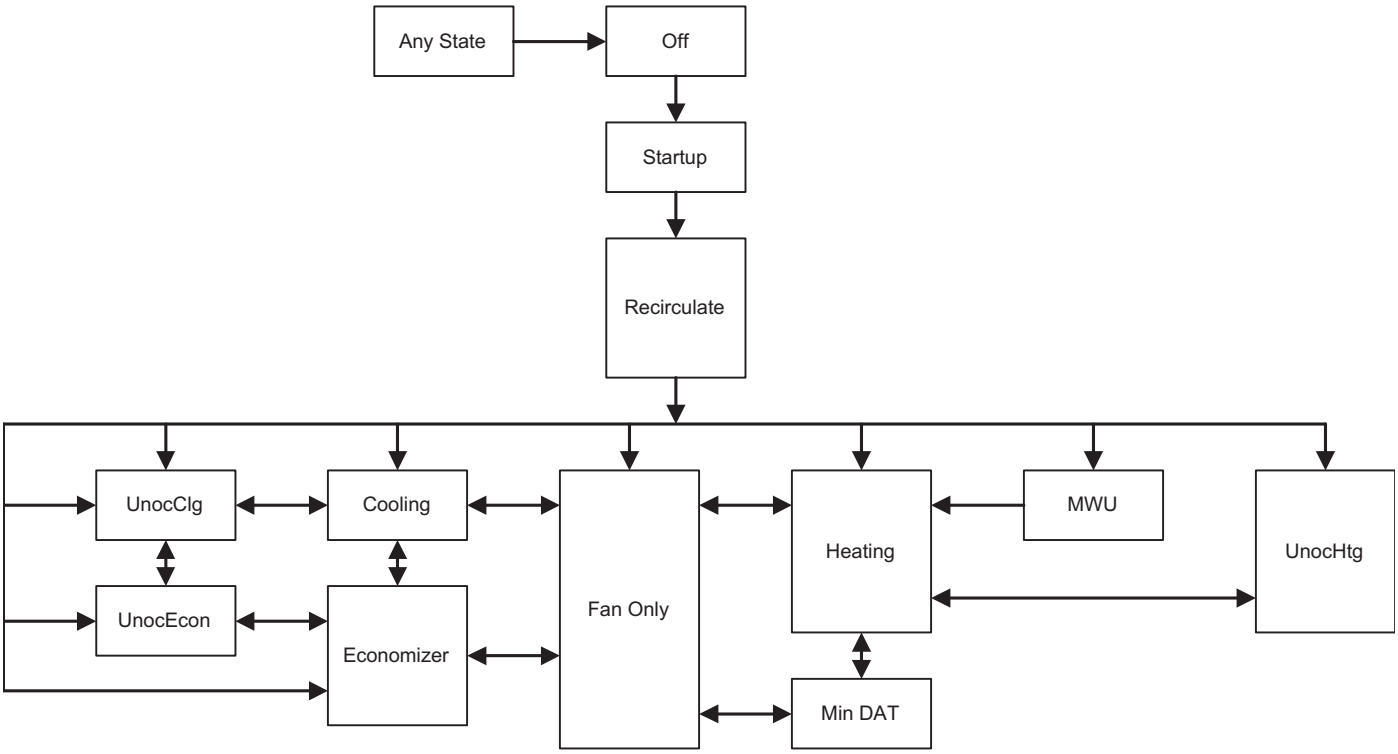
Multiple Air Handler Control

For applications in which multiple units are connected in a common duct system, it is important to control all units from a common duct static pressure sensor and to control all operating units in unison. Centralized duct static pressure control can be accomplished through communication with the BAS network.

Table 5: MicroTech III Alarm Summary

Alarm name	Fault	Problem	Warning
Freeze	X	X	
Smoke	X		
Temperature sensor fail	X	X	
Duct high limit	X		
High return temp	X		
High discharge temp	X		
Low discharge temp	X		
Fan fail	X		
Fan retry		X	
Discharge Air Capacity Feedback	X		
OA Damper Stuck	X		
Auxiliary Control Board Enable		X	
Auxiliary control board communications		X	
Low airflow		X	
Heat fail		X	
Circuit 1 & 2 high pressure		X	
Circuit 1 & 2 low pressure		X	
Circuit 1 & 2 frost protect		X	
Compressor 1–6 fail		X	
Circuit 1 & 2 incomplete pumpdown		X	
Airflow switch (false airflow)			X
Dirty filter			X
Dirty final filter			X

Figure 30: Operating State Sequence Chart



The following section contains basic application and installation guidelines that must be considered as part of the detailed analysis of any specific project.

General

Units are intended for use in normal heating, ventilating and air conditioning applications. Consult your local Daikin sales representative for applications involving operation at high ambient temperatures, high altitudes, non-cataloged voltages and for applications requiring modified or special control sequences. Consult your local Daikin sales representative for job specific unit selections that fall outside of the range of the catalog tables, such as 100% outside air applications.

For proper operation, units should be rigged in accordance with instructions stated in IM 485. Fire dampers, if required, must be installed in the ductwork according to local or state codes. No space is allowed for these dampers in the unit.

Follow factory check, test and start procedures explicitly to achieve satisfactory start-up and operation (see IM 485).

Most rooftop applications take advantage of the significant energy savings provided with economizer operation. When an economizer system is used, mechanical refrigeration is typically not required below an ambient temperature of 50°F. Standard RoofPak refrigeration systems are designed to operate in ambient temperatures down to 45°F. For applications where an economizer system cannot be used, Daikin's VFD, condenser fan, head pressure control system is available for operations down to 0°F. However, if the condenser coils are not properly shielded from the wind, the minimum ambient conditions stated above must be raised.

Unit Location

The structural engineer must verify that the roof has adequate strength and ability to minimize deflection. Take extreme caution when using a wooden roof structure.

Locate the unit fresh air intakes away from building flue stacks or exhaust ventilators to reduce possible reintroduction of contaminated air to the system. Unit condenser coils should be located to avoid contact with any heated exhaust air.

Allow sufficient space around the unit for maintenance/service clearance as well as to allow for full outside air intake, removal of exhaust air and for full condenser airflow. Refer to Application Considerations on page 33 for recommended clearances. Consult your Daikin sales representative if available clearances do not meet minimum recommendations. Where code considerations, such as the NEC, require extended clearances, they take precedence.

In applications utilizing a future cooling unit (RFS), take care in choosing a location of the unit so it provides proper roof support and service and ventilation clearance necessary for the later addition of a mechanical cooling section (RCS).

Split Units

Units may sometimes have to be split into multiple pieces to accommodate shipping limitations or jobsite lifting limitations. Units exceeding 52 feet in length may need to be split for shipping purposes. Units exceeding the rating of an available crane or helicopter may also need to be split for rigging purposes. Unit can be split between the supply fan and heat section. Contact your local Daikin sales representative for more details.

Curb Installation

The roof curb is field assembled and must be installed level (within 1/16 in. per foot side to side). A sub-base has to be constructed by the contractor in applications involving pitched roofs. Gaskets are furnished and must be installed between the unit and curb. For proper installation, follow NRCA guidelines. Typical curb installation is illustrated in Roof Curbs Dimensions on page 90. In applications requiring post and rail installation, an I-beam securely mounted on multiple posts should support the unit on each side.

Applications in geographic areas that are subjected to seismic or hurricane conditions must meet code requirements for fastening the unit to the curb and the curb to the building structure.

For acoustical considerations, the condensing section is provided with a support rail versus a full perimeter roof curb. When curbs are installed on a built-up roof with metal decking, an inverted 6-in. channel should be provided on both sides of the unit. Acoustical material should be installed over the decking, inside the roof curb. Only the supply and return air ducts should penetrate the acoustical material and decking. Apply appropriate acoustical and vibration design practices during the early stages of design to provide noise compatibility with the intended use of the space. Consult your Daikin sales representative for unit sound power data.

Acoustics

Good acoustical design is a critical part of any installation and should start at the earliest stages in the design process. Each of the four common sound paths for rooftop equipment must be addressed. These are:

- Radiated sound through the bottom of the unit (air handling section and condensing section) and into the space. Structure-borne vibration from the unit to the building
- Airborne sound through the supply air duct
- Airborne sound through the return air duct

Locating rooftop equipment away from sound sensitive areas is critical and the most cost effective means of avoiding sound problems. If possible, rooftop equipment should always be located over less sensitive areas such as corridors, toilet facilities or auxiliary spaces and away from office areas, conference rooms and classrooms. If the air handler must be located above or near a sensitive area, then consider an RFS/RCS split system and move the RCS to a less sensitive area.

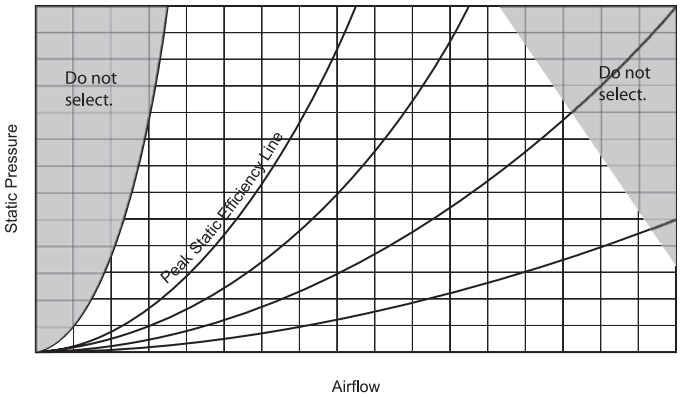
Some basic guidelines for good acoustical performance are:

- Use the Quiet Condenser option when radiating noise is a concern
- Always provide proper structural support under all areas of the unit
- Always locate the unit's center of gravity close to a main support to minimize roof deflection. Maintaining a roof deflection under 1/3 in. minimizes vibration-induced noise
- Use a concrete deck or pad when a unit has to be located over an occupied space where good acoustics are essential
- Only the supply and return air ducts should penetrate the acoustical material and decking within the curb perimeter, and the openings must be sealed once the duct is installed
- Don't overlook the return air path. Never leave a clear "line of sight" into a return or exhaust fan; always include some duct work (acoustically lined tee) at the return inlet
- Place an acoustical material in the area directly beneath the condensing section
- Select acoustical material that does not encourage microbial growth
- Minimize system static pressure losses to reduce fan sound generation
- Select the appropriate fan for the application. Fans should be selected as close as possible to their peak static efficiency. To assist you, peak static efficiency is identified by the first system curve to the right of the shaded "Do not select" region, as illustrated in Figure 31
- Design duct systems to minimize turbulence
- Account for low frequency duct breakout in system design. Route the first 20 ft. of rectangular duct over non-sensitive areas and avoid large duct aspect ratios. Consider round or oval duct to reduce breakout
- When an added measure of airborne fan sound control is required, sound attenuators can be supplied, factory installed in a unit discharge air section, to treat the supply fan. On the return side, additional attenuation can often be achieved by routing the return duct within the curb area beneath the unit

There are many sound sources in rooftop systems. Fans, compressors, condenser fans, duct take-offs, etc. all generate sound. For guidelines on reducing sound generation in the duct system, refer to the 2003 ASHRAE Applications Handbook, Chapter 47.

Contact your local Daikin sales representative for equipment supply, return and radiated sound power data specific to your application.

Figure 31: Optimal Fan Selection Line



Economizer, Return Fan and Exhaust Fan Application

Rooftop economizer applications usually require return or exhaust fans to properly control building pressure and minimum ventilation. Daikin offers both exhaust and return fan capability. They are not generally interchangeable for a given design and perform differently. In general:

- Return air fans (RAF) are best suited for ducted return systems (return ESP exceeds 0.4" to 0.5").
- Exhaust air fans (EAF) are best suited for open return systems (return ESP is less than 0.4" to 0.5").
- Supply air fan (SAF) selection depends on whether a return or exhaust fan is used.
  - RAF system-SAF handles only the supply ESP at design.
  - EAF system-SAF handles both the supply and return ESP at design (EAF is off).

Figure 32 illustrates why SAF only units often cannot control building pressure and ventilation, especially as return ESP increases.

- Desired space pressure is approximately 0.1" as shown
- No exhaust will occur from the rooftop because the economizer section must be at a negative pressure. Therefore, space pressure rises until exhaust occurs through doors and walls
- The air balancer must adjust the outdoor air damper to be “almost shut” and generate large pressure drops at minimum ventilation settings (about 0.9" in Figure 32). Otherwise excess outdoor air would be pulled in. Ventilation control is much less accurate at the “almost shut” damper position, especially on VAV systems where minimum position varies with load

Figure 32: Supply Air Fan Only System Static Pressures with 1" Return Duct ESP

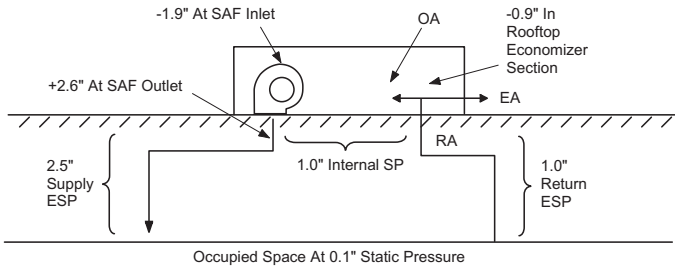
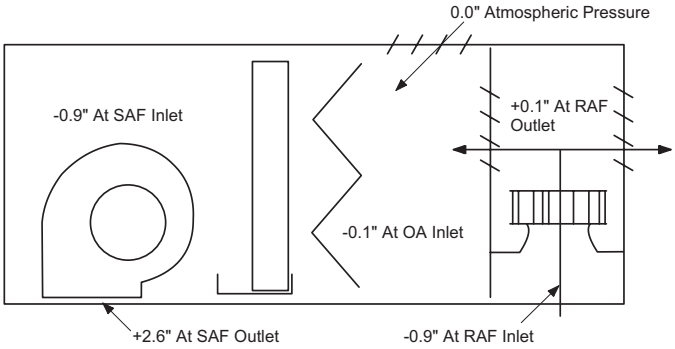


Figure 33 illustrates how the addition of a RAF corrects these problems. The RAF is responsible for return system ESP and maintains a slightly positive pressure in the economizer section (about +0.1" in Figure 33) to allow for proper exhaust and better ventilation control.

Figure 33: RAF System Allows Proper Exhaust and Outdoor Air Control



EAFs are very different from RAFs.

- EAFs provide less effective building pressure and ventilation control as return duct ESP increases.The EAF is normally off during non-economizer operation. During these minimum outdoor air conditions, the system essentially acts like a SAF only system
- EAFs cannot maintain a slightly positive pressure in the economizer section, so ventilation control is no better than that of an SAF only system
- EAFs can successfully operate and save energy on designs with reduced return ESP for the following reasons
  - EAFs and RAFs are generally much less efficient than SAFs. EAFs can sometimes be cycled off while RAFs must always run. If a non-overloading, airfoil SAF is used then energy generally is saved when the EAF is cycled OFF
  - Exhaust fans are designed for peak exhaust CFM which occurs during economizer operation. RAFs must be sized for design return CFM. Peak exhaust CFM generally is less than the design return CFM

Fan Isolation

All Daikin RoofPak systems feature internally isolated fans. All supply and return air fans are statically and dynamically balanced in the factory and mounted on rubber-in-shear (RIS) or 2-in. deflection spring isolators. Flexible isolation is provided as standard between the fan outlet and the discharge bulkhead to prevent hard contact and vibration transmission. Spring isolated fan assemblies also are available with seismic restraints.

The choice of 2-in. deflection spring isolation or RIS isolation depends on an analysis of the roof structure and whether or not an isolation curb is being provided. When using an isolation curb, consult with the curb manufacturer before selecting spring isolation in the rooftop unit. Doubling or “stacking” spring isolation can generate a resonant vibration.

Indoor Fan and Motor Heat, Blow-Through vs Draw-Through Cooling

Daikin offers blow-through and draw-through cooling coils so the unit can be best selected to match job requirements.

Indoor Fan and Motor Heat

- The indoor fan and motor electrical consumption is a sensible cooling load approximately equal to 2.8 MBh per BHP (depending slightly on motor efficiency). This occurs at the fan. See Figure 34 and Figure 35. The fan and motor preheat the mixed air before it enters a blow-through cooling coil. The fan and motor reheat the air leaving a draw-through cooling coil. Refer also to 2001 ASHRAE Fundamentals Handbook, Chapter 31
- Fan and motor temperature rise is equal to Btuh/(1.08 × cfm) and is typically about 3°F
- Due to fan and motor heat placement (Figure 34), blow-through coils provide a high sensible heat ratio while draw-through coils provide more latent cooling per total ton. Blow-through coils achieve a higher sensible heat ratio because they operate with a higher coil approach temperature and a lower entering relative humidity. Conversely, draw-through coils cool air at a lower approach temperature and a higher relative humidity, increasing latent cooling
- Blow-through coils effectively provide colder supply air temperatures per ton of air conditioning and greater sensible heat ratio. This potentially allows a significant reduction in design cfm for buildings with high sensible heat ratios and a resulting reduction in building energy use

Figure 34: Blow-Through vs. Draw-Through Concept

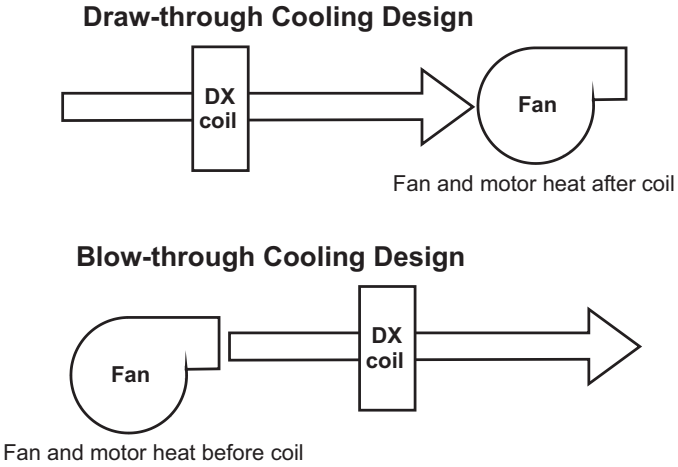
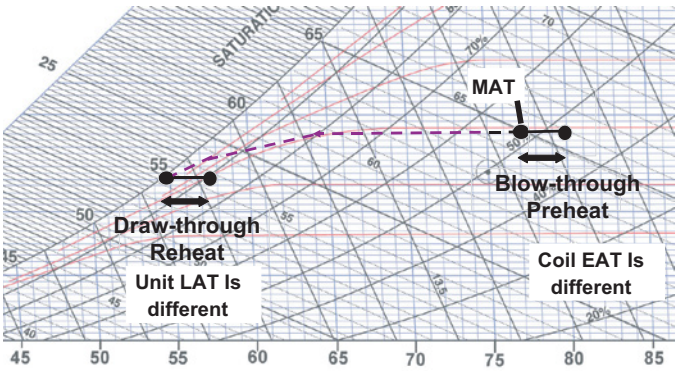


Figure 35: Blow-Through vs. Draw-Through Performance



Draw-Through

(available on all units)

In a draw-through unit, the fan is located after the DX cooling coil. In this arrangement, fan heat is applied as reheat to the cold, conditioned air coming off of the coil. This arrangement has a lower sensible heat ratio and higher dehumidification capability than a blow-through coil arrangement. Draw-through arrangements are well suited for 100% outside air applications and applications needing more dehumidification. A draw-through arrangement is mandatory for all applications requiring final filters. The discharge temperature available to the supply duct is always the sum of the coil leaving air temperature plus the fan temperature rise. This must be considered when selecting the supply air volume required to satisfy space requirements.

Example:

55°F leaving coil temperature + 3°F fan temp. rise = 58°F discharge air temperature

Blow-Through

(RPS/RFS 035D–140D only)

In a blow-through unit, the fan is located before the DX cooling coil. In this arrangement, fan heat is applied as preheat to the coil. Preheating the air lowers its relative humidity, giving this arrangement a high sensible heat ratio. Blow-through arrangements are well suited for comfort conditioning applications where space heat gains are primarily sensible and the primary latent load is from ventilation air. The discharge temperature available to the supply duct is the coil leaving air temperature.

Altitude Adjustments

Fan curve performance is based on 70°F air temperature and sea level elevation. Selections at any other conditions require the following adjustment for air densities listed in Table 6. Higher elevations generally require more rpm to provide a given static pressure but less bhp due to the decrease in air density.

1. Assume 32,000 cfm is required at 3.11" TSP. The elevation is 5000 ft. and 70°F average air temperature is selected. A 40" DWDI airfoil fan is selected.
2. The density adjustment factor for 5000 ft. and 70°F is 0.83.
3. TSP must be adjusted as follows: 3.11" / 0.83 = 3.75".
4. Locate 32,000 cfm and 3.75 on the fan curve (Figure 36). Rpm = 900 and bhp = 27.5. The required fan speed is 900 rpm.
5. The consumed fan power at design = 27.5 bph × 0.83 = 22.8 bhp.

Table 6: Temperature and Altitude Conversion Factors

Air temp (°F)	Altitude (feet)								
	0	1000	2000	3000	4000	5000	6000	7000	8000
-20	1.20	1.16	1.12	1.08	1.04	1.00	0.97	0.93	0.89
0	1.15	1.10	1.08	1.02	0.99	0.95	0.92	0.88	0.85
20	1.11	1.06	1.02	.098	0.95	0.92	0.88	0.85	0.82
40	1.06	1.02	0.98	0.94	0.91	0.88	0.84	0.81	0.78
60	1.02	0.98	0.94	0.91	0.88	0.85	0.81	0.79	0.76
70	1.00	0.96	0.93	0.89	0.86	0.83	0.80	0.77	0.74
80	0.98	0.94	0.91	0.88	0.84	0.81	0.78	0.75	0.72
100	0.94	0.91	0.88	0.84	0.81	0.78	0.75	0.72	0.70
120	0.92	0.88	0.85	0.81	0.78	0.76	0.72	0.70	0.67
140	0.89	0.85	0.82	0.79	0.76	0.73	0.70	0.78	0.65

Condenser Performance

Altitudes greater than sea level require a derate in condenser and cooling performance that can be estimated as follows:

- 0 to 6000 feet
  - Cooling capacity decrease factor = 0.5% per 1000 feet
  - Compressor kW increase factor = 0.6% per 1000 feet

The actual derate varies with each individual unit and design conditions. Your local Daikin representative can provide exact performance data.

Furnace Performance

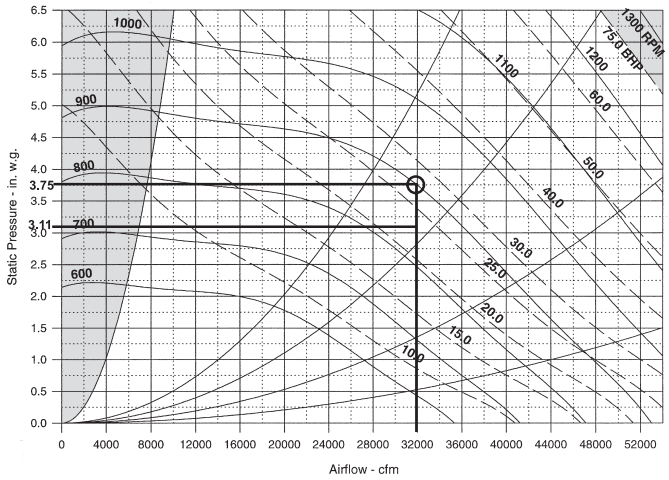
- Gas heat performance data is based on standard 70°F combustion air temperature and zero feet altitude (sea level)
- Furnace altitude derate may be 4% per 1000' above 2000' due to lesser combustion air density
- However, if design ambient is cold enough, then the combined affect of colder temperature and altitude may have an offsetting impact on combustion air density

Example:

A 1000 MBh furnace at 70°F ambient and at an altitude of 5000 feet is derated (0.04 × 3 = 0.12). At 1000 MBh input (1000 × 0.12 MBh), the actual input is (1000 – 120 = 880 MBh) at 5000 feet.

- Above 6000 feet, consult factory

Figure 36: RPS 105C to 135C 40" DWDI Airfoil



System Operating Limits

Daikin RoofPak systems are designed to operate over an extensive operating range. However, for proper system operation some limits do apply.

To help prevent moisture blow-off, design guidelines have been established for cooling coil selection.

Based on laboratory testing, average coil face velocities should not exceed the following limits:

- 650 ft./min. for 8 & 10 fpi selections
- 600 ft./min. for 12 fpi selections
- For applications outside of these limits, consult your Daikin sales representative. Velocities exceeding these limits not only present the potential for moisture carryover, but also high face velocities generate high air pressure drops, resulting in poor fan energy performance

In addition to maximum face velocity limitations, minimum velocity guidelines must also be followed. In order to maintain proper refrigeration performance, the minimum coil face velocity is 200 ft./min., regardless of coil fin spacing. When selecting a variable air volume unit, it is necessary to design the system such that the 200 ft./min. limit is maintained at light load conditions.

Coil Freeze Protection

When applying roof-mounted equipment in areas that experience subfreezing conditions, coil freeze protection measures must be provided. Subfreezing temperatures can adversely affect water and steam coils during controlled or uncontrolled unit shutdowns and even during unit operation. Daikin RoofPak economizer dampers are arranged to direct the outside and return air streams in multiple mixing patterns, minimizing air stratification. Even though this is one of the most effective mixing arrangements available, there may not always be a uniform unit temperature profile under all load and ambient temperatures. Some temperature stratification will occur, particularly at low ambient temperatures and the associated reduced airflow inherent with VAV systems. When required, static air mixers/blenders are available that can significantly improve mixing and reduce stratification. This can result in improved protection against freeze-up.

Glycol is strongly recommended as a positive means of freeze protection for water coils. No control sequence can prevent coil freezing in the event of a power failure or equipment malfunction. During those periods, glycol is the only positive means of freeze protection. When selecting water coils, specify glycol to account for performance differences.

An optional non-averaging freezestat equipment protection control can be provided, located downstream of the heating coil. If a potential freezing condition is sensed, a sequence is initiated by the unit control system, closing outdoor air dampers, opening the heating valve and deenergizing the fan. The freezestat setting should be some increment higher than freezing to provide an added margin of protection. The use of a freezestat control may cause nuisance trips. It cannot prevent freeze-up in the event of power failure or equipment malfunction.

Freeze protection control strategies must be designed to keep unit cabinet temperatures from exceeding 150°F during a unit shutdown. Temperatures in excess of 150°F may exceed the design limits of motors, electrical components, gaskets, etc. potentially leading to premature failure of components.

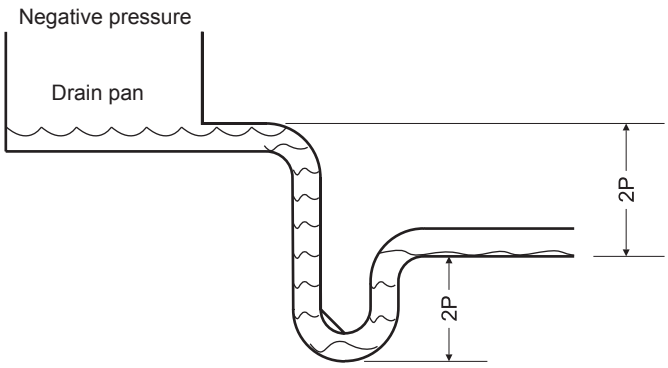
Piping and Condensate Drainage

Always follow good industry practice in the design of the water piping system. Do not apply undue stress at the connection to coil headers. In addition, support piping independently from the coils with adequate piping flexibility for thermal expansion.

Provide all drain pans with a properly sized p-trap to allow free drainage of coil condensate. Provide traps to prevent cabinet static pressure from leaking air at the drain line in blow-through coil applications. For draw-through coil applications, a properly sized and installed trap is essential to allow for proper condensate drainage. An improper trap could cause condensate to build up in the drain pan and overflow into the unit. For trap sizing, follow instruction given in IM 485. Run all traps and drain lines full size from the threaded unit connection to the roof drain.

Units providing steam heat must be installed level to provide proper drainage and adequate steam pressure at the steam valve and coil. Condensate must be properly trapped with vacuum breakers installed on the coil (See Figure 37). For steam piping recommendations, see Daikin Steam Coil Catalog 413.

Figure 37: Drain Pan Traps



Zone Sensor Placement

Placement of the zone temperature sensor is critical for proper and economical operation of the heating and cooling system. It is generally recommended that the space sensor be located on an inside wall (3 to 5 feet from an outside wall) in a space having a floor area of at least 400 square feet. Do not locate the sensor below the outlet of a supply diffuser, in the direct rays of the sun, on a wall adjacent to an unheated or abnormally warm room (boiler or incinerator room), or near any heat producing equipment. Where zone sensor placement is a problem, all zone control systems, as standard, have the capability to use a return air sensor for heating and cooling.

Unit Wiring

All units require three phase, 60 Hz, 208, 230, 460 or 575 volt power or three phase, 50 Hz, 400 volt power. Units do not operate satisfactorily at ±10% of rated voltage, at the power connections to the units. All units include branch circuit, short circuit protection and are available with one or multiple power blocks or non-fused disconnect switches. Each unit is provided with a 115-volt convenience outlet circuit. Per the NEC, this circuit must be fed independent of the main unit power supply.

All wiring must be installed in accordance with the National Electric Code (NEC) and local codes.

Condenser Coil Protection

If the Rooftop is installed in a corrosive environment, such as near a sea coast, Daikin recommends the optional e-coated condenser coils. Copper fin or e-coated DX coil options should also be considered.

Winter Shipment

Flat bed shipment in winter can expose units to harsh road chemicals. Since equipment size and configuration precludes covering during transit, wash units free of these chemicals as soon as possible to help prevent corrosion.

Achieving the optimal performance of a rooftop system requires both accurate system design and proper equipment selection. Factors that control the unit selection include applicable codes, ventilation and air filtration requirements, heating and cooling loads, acceptable temperature differentials, and installation limitations. Daikin RoofPak units offer a wide selection of component options providing the capability to meet diverse application requirements.

The Daikin SelectTools™ software selection program allows your local Daikin sales representative to provide you with fast, accurate and complete selection of Daikin RoofPak units. You also can select your unit through reference to physical, performance, dimensional, and unit weight data included in this catalog. Due to the variety of cooling coil options available, only a sample of cooling capacity data is presented in the catalog.

To properly select unit equipment:

1. Select unit size and cooling coil.
2. Select heating coils and equipment.
3. Select fans and motors.

Below are examples that illustrate the equations and catalog references used in the unit selection process.

Selection Example

A constant volume system with DX cooling and natural gas heat is required to meet the following criteria:

Supply air volume	=	22,000 cfm
Return air volume	=	20,000 cfm
Minimum outside air volume	=	2000 cfm
Maximum face velocity	=	560 fpm
Supply fan external SP	=	2.60-in. w.g.
Return fan external SP	=	1.00-in. w.g.
Altitude	=	Sea level
Economizer with return air fan	=	Required
30% throw-away filters	=	Required
Voltage	=	460V/60Hz/3Ph
Fully modulating gas heat	=	Required
Double-wall construction	=	Required

Summer design:

Mixed air temperature	=	80°F/67°F
Blow-through Coil entering temperature	=	83°F/67.9°F (80°F/67°F + fan Dt
Total sensible load	=	640,000Btu/hr
Total load	=	780,000 Btu/hr
Space supply air temperature	=	53.5°F
Ambient conditions	=	95°F/76°F
Est. supply fan sensible heat rise (included in above sensible load)	=	3°F

Winter design:

Return air temperature	=	70°F
Ambient temperature	=	10°F
Space heating load	=	450,000 Btu/hr

Selecting Unit Size to Satisfy Summer Design

Unit size is based on coil face area and cooling capacity requirements. Supply air capacity and maximum face velocity constraints should serve as a guide for selecting coil dimensions and cabinet size. Many model sizes are available with a standard and a high airflow coil selection. This flexibility prevents the need to increase cabinet size to accommodate high airflow per ton applications.

Based on the given data, the appropriate coil face area may be determined as follows:

Minimum face area = supply air volume/maximum face velocity
= 22,000 cfm/550 fpm
= 39.3 square feet

NOTE: Unit data is based on standard air conditions of 70°F at sea level. Refer to Application Considerations on page 33 for temperature/altitude conversion factors for nonstandard conditions.

Referring to Physical Data on page 43, the 39.5 square foot, small face area coil of the RPS 045D to 075D units satisfies the required face velocity.

The unit selection is an RPS 070D with a small face area, 5-row, 10 fins/inch DX coil. Unit performance equals 792,000 Btu/hr. total, 626,000 Btu/hr. sensible by interpolation.

Supply air dry bulb = 83°F – 626 MBh/(1.085 × 22,000 cfm) = 53.2°F

Once the initial unit selection is made, determine the actual supply fan heat rise and check and verify the selection for net capacity and supply air temperature.

Selecting the Unit Heating System

Heating equipment and coils can be specified directly from figures and tables incorporated in Heating Capacity Data on page 47.

Calculating Total Heating Load

Total heating load = space heating load + outdoor air load – supply fan heat

From the data given, the outdoor air load is (1.085) (4000) (70 – 10) / 1000 = 260 MBh and supply fan heat is 65 MBh. Total heat load = 450 MBh + 260 MBh – 65 MBh = 645 MBh

Gas Heat: When selecting a gas furnace, the system heating load, minimum airflow and maximum temperature rise constraints are needed. Refer to Figure 38 on page 47 for furnace model size selection. Enter the graph at 20,000 cfm and move up vertically to the intersection of 602 MBh output. In this example, the intersection of Minimum cfm and MBh Output occurs between model lines. Therefore, the larger model size, Model 640, should be selected for adequate heating.

For all heat exchangers, there exists a maximum temperature rise. This limitation is determined by the heat exchanger surface area to airflow ratio. Refer to Table 11 on page 47 for verification of the temperature rise capability of the furnace selected. Also, use this table when specifying baffle position based on minimum airflow design. Refer to Altitude Adjustments on page 37.

NOTE: In VAV applications, consider range of airflow modulation when selecting furnace model and baffle position.

Electric Heat: Referring to the Electric Heat on page 14 for the RPS 070D, the design load of 645 Mbh falls between heater models 200 and 240. The Model 240 heater would be chosen to satisfy the design conditions.

Selecting Fans and Motors

Fan and motor selections are based on total static pressure drop and design airflow. Total static pressure includes internal air pressure drops of unit components and external air pressure drops in supply and return ducts. Refer to Component Pressure Drops on page 56 for internal pressure drops of unit components.

When selecting unit fans and motors, use the fan curves provided in Fan Performance Data—Supply Fans on page 60 and Fan Performance Data—Propeller Exhaust Fans on page 68

Careful consideration is needed in regards to return duct ESP:

- RAF system - The RAF handles return ESP at design.
- EAF system - The SAF handles return ESP at design.

See page 35 for details.

To optimize fan performance, select the fan size having design airflow and static pressure intersecting as close to the first system curve as possible after the shaded Do Not Select region. Refer to Application Considerations on page 33.

Select the motor size as close below the horsepower curve as possible to the actual bhp requirements to prevent motor oversizing. An oversized motor (large horsepower to load ratio) can greatly increase electric consumption due to the reduction in motor performance.

Return Fan and Motor

Select an economizer with a return fan for the given system. A return (or exhaust fan) system is often necessary for maintaining proper pressure in a building. See Application Considerations on page 33 for more information on the economizer and return fan application.

Use the external air pressure drop of the return duct along with the design return airflow to select a return fan. Based on Figure 79 on page 71, the return fan size is 40 inches and the bhp = 6.5. The required fan motor size is 7.5 hp.

Exhaust Fan and Motor

Exhaust fans must be sized for maximum exhaust cfm and return duct ESP at those conditions. See Fan Performance Data—Propeller Exhaust Fans on page 68 for more information.

Supply Fan and Motor

Since this system includes a return fan, the return duct static pressure drop is not added to the supply fan pressure drop. Therefore, the total static pressure for the supply fan in the example is as follows:

Internal pressure drops (from Table 24 on page 57):

0–100% economizer, with RAF = 0.38-in. w.g.
30% angular filters = 0.16-in. w.g.
Gas furnace = 0.24-in. w.g.
Evaporative coil (small 5-row, 10 fpi) = 0.79-in. w.g.
Total internal pressure drop = 1 57-in w g

External pressure drops:

Supply duct = 2.60-in. w.g.
Total external pressure drop = 2 60-in w g
Total static pressure = internal drops + external drops
= 1.57 + 2.60
= 4.17-in. w.g.

NOTE: When gas or electric heat is provided, do not add the cooling coil diffuser pressure drop. In VAV applications with gas heat, consult your Daikin sales representative for design pressure drop determinations.

For a constant volume system a forward curve or airfoil type fan can be selected. Reference Application Considerations on page 33 for discussion on acoustical consideration. Considering its favorable brake horsepower, an airfoil type fan is selected.

Entering the standard 30-in. airfoil fan curve (see Figure 65 on page 63) at 20,000 cfm and 4.08-in. w.g., the required fan motor size is 25 hp. Fan brake horsepower is 21.2 horsepower.

The total fan and motor heat for the supply and return fan is as follows:

(6.5 + 21.2) bhp × 2.8 MBh/bhp = 78 MBh

Supply Power Wiring for Units without Electric Heat

Sizing supply power wire for a unit is based on the circuit with the largest amperage draw. All electrical equipment is wired to a central panel for single or optional multipower connections. Refer to Electrical Data on page 97 for FLA and RLA ratings of equipment. Determination of Minimum Circuit Ampacity (MCA) for a 460-volt unit with standard condenser fans is as follows:

Fans and Cooling:

MCA = 1.25 × RLA or FLA of largest motor + 1.00 × FLA of other loads

Example FLA/RLA

Compressors (6) = 17.9 amps ea.
Condenser fan motors, (6) 1 hp = 2 amps ea.
Supply fan motor, 25 hp = 31 amps
Return fan motor, 7.5 hp = 10.8 amps

Therefore,

MCA = 1.25 × 17.9 + [(17.9) (5) + (6)2 + 31 + 10.8] = 165.7 amps

Select power supply wire based on 165.7 amperes.

Supply Power Wiring for Units with Electric Heat

When selecting units with nonconcurring electric heat, MCA must be calculated for both the cooling mode and the heating mode, and then the greater of the two used.

For heating:

MCA = 1.25 [FLA of electric heater + FLA of all other loads]
= 1.25 × [287.2 + 31 + 10.8]
= 409 amps

For cooling:

MCA = 165.7 amps

The controlling load is when in the electric heat mode. Unit MCA = 409 amps.

Calculating Unit Length

Referring to unit Dimensional Data on page 72 for a blow-through RPS 061D, Figure 85 on page 75:

Total unit length = economizer w/RAF + angular filter fan section + heat section + DX coil section + discharge plenum + condensing unit
= 72 in. + 24 in. + 72 in. + 48 in. + 24 in. + 48 in. + 83 in.
= 371 inches.

NOTE: When selecting unit curb length, do not include the length of the condensing unit.

Calculating Unit Weight

Referring to unit Unit Weights on page 102 for a RPS 070D, Table 44 on page 102:

Total unit weight = RPS basic unit + economizer + 30% filters + 30" AF SAF + 40" AF RAF + 5-row, 12 fpi Al. fin small face area coil + 640 MBh gas furnace + SAF motor + RAF motor + cabinet liners
= 7580 + 1065 + 4 + 965 + 629 + 600 + 428 + 266 + 82 + (25 × 288/12)
= 12,215 lbs.

Table 7: Physical data, Sizes 015D to 042D

Data		Unit Size					
		015/016D[f]	020/020D[f], 021D[d]/021D[f]	025/025D[f], 026D[d]/026D[f]	030/031D[f]	035/035D[f]	042D/42D[f]
Compressor[c]	Quantity–hp	2–7	1–10, 2–4.5	1–11.5, 2–5.5	1–13, 2–6	4–7.5	4–8.5
	Capacity control	100-50-0	100-78-44-22-0	100-78-44-22-0	100-78-44-22-0	100-75-50-25-0	100-75-50-25-0
Compressor[f]	Quantity/Type	(1) Variable Speed compressor & (1) Fixed Speed				(1) Variable & (2) Fixed Speed Compressors	
	Capacity control	Modulating	Modulating	Modulating	Modulating	—	Modulating
	Unit Capacity Steps %	20–100	15–100	15–100	17–100	—	13–100
	Number of circuits	2	2	2	2	—	2
Condenser fans	Qty–diameter (in)	2–26	2–26	2–26	4–26	4–26	4–26
Condenser fan motors	Qty–hp	2–1.0	2–1.0	2–1.0	4–1.0	4–1.0	4–1.0
Supply fans	Type	Forward curved LP				Forward curved LP/MP	
	Qty–diameter (in)	2–15×6*	2–15×6*	2–15×6*	2–15×6*	1–24	1–24
	Qty–diameter (in)	2–15×15	2–15×15	2–15×15	2–15×15	—	—
	Airlow range (cfm)	4000–12000	4000–12000	5400–16000	5400–16000	5400–17550	5400–17550
	Motor hp range	1–20	1–20	1–20	1–20	1–25	1–25
	Type	DWDI airfoil					
	Qty–diameter (in)	1–20	1–20	1–20	1–20	1–24	1–24
	Airlow range (cfm)	4000–10000	4000–12000	5400–16000	5400–16000	5400–17550	5400–17550
	Motor hp range	1–20	1–20	1–20	1–20	1–25	1–25
Return fans	Type	Forward curved					
	Diameter (in)	2–15×15	2–15×15	2–15×15	2–15×15	—	—
	Airlow range (cfm)	4000–10000	4000–12000	5400–16000	5400–16000	—	—
	Motor hp range	1–10	1–10	1–10	1–10	—	—
	Type	SWSI airfoil					
	Qty–diameter (in)	1–30	1–30	1–30	1–30	1–30, 1–40	1–30, 1–40
	Airlow range (cfm)	4000–10000	4000–12000	5400–16000	5400–16000	5400–17550	5400–17550
	Motor hp range	1–10	1–10	1–10	1–10	1–10	1–10
Evaporator coils	Standard F.A. (sq ft)	18.5	18.5	—	—	—	—
	Large F.A. (sq ft)	—	—	27.0	27.0	27.0	27.0
Hot water coils	Type–rows	5WH–1	5WH–1	5WH–1	5WH–1	5WH–1	5WH–1
	Type–rows	5WS–2	5WS–2	5WS–2	5WS–2	5WS–2	5WS–2
	FPI	9	9	9	9	9	9
	Face area (sq ft)	20.3	20.3	20.3	20.3	20.3	20.3
Steam coils	Type–rows	5JA–1	5JA–1	5JA–1	5JA–1	5JA–1	5JA–1
	FPI	6, 12	6, 12	6, 12	6, 12	6, 12	6, 12
	Face area (sq ft)	20.3	20.3	20.3	20.3	20.3	20.3
Gas furnace	Input (MBh)	250, 312, 400, 500, 625, 800, 812, 988, 1000, 1250					
	Nom. output (MBh)	200, 250, 320, 400, 500, 640, 650, 790, 800, 1000					
Electric heat	Nom. output (kW)	20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240					
Panel filters	Type	85% or 30% pleated					
	Area (sq ft)	50.0	50.0	50.0	50.0	50.0	50.0
	Qty–size (in)	10–16×20×2 10–16×25×2	10–16×20×2 10–16×25×2	10–16×20×2 10–16×25×2	10–16×20×2 10–16×25×2	10–16×20×2 10–16×25×2	10–16×20×2 10–16×25×2
Prefilters (for cartridge filters)	Type	Prefilter, standard low					
	Area (sq ft)	24.0	24.0	24.0	24.0	24.0	24.0
	Qty–size (in)	4–24×24×2 4–12×24×2	4–24×24×2 4–12×24×2	4–24×24×2 4–12×24×2	4–24×24×2 4–12×24×2	“4–24×24×2 4–12×24×2	4–24×24×2 4–12×24×2
Cartridge filters	Type	65% or 95%, standard low					
	Area (sq ft)	24.0	24.0	24.0	24.0	24.0	24.0
	Qty–size (in)	4–24×24×12 4–12×24×12	4–24×24×12 4–12×24×12	4–24×24×12 4–12×24×12	4–24×24×12 4–12×24×12	“4–24×24×12 4–12×24×12	4–24×24×12 4–12×24×12

* 100% OA only.
a. Gas furnace size availability is limited by minimum airlow, See Table 11 on page 47.
b. 460-volt capacities are shown. Electric heat availability is limited by minimum airlow, See Table 14 through Table 16.
c. Compressor information for units with fixed speed compressors only.
d. Premium efficiency model number.
f. Units model number and compressor information with variable speed compressors.

Table 8: Physical Data, Sizes 045D to 079D

Data		Unit size						
		045D[d] /045D[f]	050/050[f]/051D[d,f]	061/063D[d,f]	068D	070/071D[d]	075D/074D[d,f]	079D
Compressor[c]	Quantity—hp	4—10	4—11.5	4—13	4—15	6—10	6—11.5	3-11.5/3-13
	Capacity control	100-75-50-25-0				100-83-67-50-33-17-0		
Compressor[f]	Quantity/ Type	(1) Variable Speed compressor & (2) Fixed Speed			—	—	(1)Variable & (3) Fixed Speed Compressors	—
	Capacity control	Modulating	Modulating	Modulating	—	—	Modulating	—
	Unit Capacity Steps %	16-100	16-100	14-100	—	—	11-100	—
	Number of circuits	2	2	2	—	—	2	—
Condenser fans	Qty—diameter (in)	4—26	4—26	6—26	6—26	6—26	8—26	8—26
Condenser fan motors	Qty—hp	4—1.0	4—1.0	6—1.0	6—1.0	6—1.0	8—1.0	8—1.0
RPS supply fans	Type	DWDI airfoil						
	Qty—diameter (in)	1—30, 33	1—30, 33	1—30, 33	1—30, 33	1—30, 33	1—30, 33	1—30, 33
	Motor hp range	3–50	3–50	3–50	3–50	3–50	3–50	3–50
RDT supply fans	Type	SWSI airfoil						
	Qty—diameter (in)	1—40,44	1—40,44	1—40,44	1—40,44	1—40,44	1—40,44	1—40,44
	Motor hp range	3–50	3–50	3–50	3–50	3–50	3–50	3–50
Return fans	Type	SWSI airfoil						
	Qty—diameter (in)	1—40	1—40	1—40	1—40	1—40	1—40	1—40
	Motor hp range	2–30	2–30	2–30	2–30	2–30	2–30	2–30
Exhaust fans	Type	Propeller						
	Diameter (in)	36	36	36	36	36	36	36
	Quantity	1 or 2 per unit	1 or 2 per unit	1 or 2 per unit	1 or 2 per unit	1 or 2 per unit	1 or 2 per unit	1 or 2 per unit
	Motor hp	5 each	5 each	5 each	5 each	5 each	5 each	5 each
Evaporator coils	Standard F.A. (sq ft)	39.5	39.5	39.5	39.5	39.5	39.5	39.5
	Large F.A. (sq ft)	—	47.1	47.1	47.1	47.1	47.1	47.1
Hot Water coils	Type—rows	5WH—1	5WH—1	5WH—1	5WH—1	5WH—1	5WH—1	5WH—1
		5WS—2	5WS—2	5WS—2	5WS—2	5WS—2	5WS—2	5WS—2
	FPI	9	9	9	9	9	9	9
	Face area (sq ft)	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Steam coils	Type—rows	5JA—1, 2	5JA—1, 2	5JA—1, 2	5JA—1, 2	5JA—1, 2	5JA—1, 2	5JA—1, 2
	FPI	6, 12	6, 12	6, 12	6, 12	6, 12	6, 12	6, 12
	Face area (sq ft)	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Gas furnace	Input (MBh)	250, 312, 400, 500, 625, 800, 812, 988, 1000, 1250						
	Nom. output (MBh)	200, 250, 320, 400, 500, 640, 650, 790, 800, 1000						
Electric heat	Nom. output (kW)	40, 60, 80, 100, 120, 160, 200, 240						
Panel filters	Type	85% or 30% pleated						
	Area (sq ft)	73.9	73.9	73.9	73.9	73.9	73.9	73.9
	Qty—size (in)	7—16×20×2 21—16×25×2	7—16×20×2 21—16×25×2	7—16×20×2 21—16×25×2	7—16×20×2 21—16×25×2	7—16×20×2 21—16×25×2	7—16×20×2 21—16×25×2	7—16×20×2 21—16×25×2
Prefilters (for cartridge filters)	Type	Prefilter, standard low						
	Area (sq ft)	40.0	40.0	40.0	40.0	40.0	40.0	40.0
	Qty—size (in)	4—12×24×2 8—24×24×2	4—12×24×2 8—24×24×2	4—12×24×2 8—24×24×2	4—12×24×2 8—24×24×2	4—12×24×2 8—24×24×2	4—12×24×2 8—24×24×2	4—12×24×2 8—24×24×2
	Type	Prefilter, medium low						
	Area (sq ft)	48.0	48.0	48.0	48.0	48.0	48.0	48.0
	Qty—size (in)	8—12×24×2 8—24×24×2	8—12×24×2 8—24×24×2	8—12×24×2 8—24×24×2	8—12×24×2 8—24×24×2	8—12×24×2 8—24×24×2	8—12×24×2 8—24×24×2	8—12×24×2 8—24×24×2
Cartridge filters	Type	65% or 95%, standard low						
	Area (sq ft)	40.0	40.0	40.0	40.0	40.0	40.0	40.0
	Qty—size (in)	4—12×24×12 8—24×24×12	4—12×24×12 8—24×24×12	4—12×24×12 8—24×24×12	4—12×24×12 8—24×24×12	4—12×24×12 8—24×24×12	4—12×24×12 8—24×24×12	4—12×24×12 8—24×24×12
	Type	65% or 95%, medium low						
	Area (sq ft)	48.0	48.0	48.0	48.0	48.0	48.0	48.0
	Qty—size (in)	8—12×24×12 8—24×24×12	8—12×24×12 8—24×24×12	8—12×24×12 8—24×24×12	8—12×24×12 8—24×24×12	8—12×24×12 8—24×24×12	8—12×24×12 8—24×24×12	8—12×24×12 8—24×24×12

a. Gas furnace size availability is limited by minimum airlow, See Table 11 on page 47.
b. 460-volt capacities are shown. Electric heat availability is limited by minimum airlow, See Table 14 through Table 16.
c. Compressor information for units with fixed speed compressors only.
d. Premium efficiency model number.
f. Units model number and compressor information with variable speed compressors.

Table 9: Physical Data, Sizes 080D to 105D

Data		Unit size				
		080/081D	085D	090/091D	100/101D	105D
Compressor	Quantity—hp	6—11.5	6—13	6—13	3—13 3—15	6—15
	Std. capacity control	100-83-67-50-33-17-0			100-83-67-49-33-16-0	100-84-67-50-33-17-0
Condenser fans	Qty—diameter (in)	6—26	6—26	8—26	9—26	8—26
Condenser fan motors	Qty—hp	6—1.0	6—1.0	8—1.0	9—1.0	8—1.0
Supply fans	Type	DWDI airfoil				
	Qty—diameter (in)	1—33, 36	1—33, 36	1—33, 36	1—36, 40	1—36, 40
	Motor hp range	5–75	5–75	5–75	5–75	5–75
RDT supply fans	Type	SWSI airfoil				
	Qty—diameter (in)	1—44, 49				
	Motor hp range	5–75				
Return fans	Type	SWSI airfoil				
	Qty—diameter (in)	1—44.5	1—44.5	1—44.5	1—44.5	1—44.5
	Motor hp range	5–60	5–60	5–60	5–60	5–60
Exhaust fans	Type	Propeller				
	Diameter (in)	36	36	36	36	36
	Quantity	1–3 per unit	1–3 per unit	1–3 per unit	1–3 per unit	1–3 per unit
	Motor hp	5 each	5 each	5 each	5 each	5 each
Evaporator coils	Standard F.A. (sq ft)	53.9	53.9	53.9	60.8	60.8
	Large F.A. (sq ft)	60.8	60.8	60.8	76.0	76.0
Hot water coils	Type—rows	5WH—1	5WH—1	5WH—1	5WH—1	5WH—1
		5WS—2	5WS—2	5WS—2	5WS—2	5WS—2
	FPI	9	9	9	9	9
	Face area (sq ft)	42.2	42.2	42.2	42.2	42.2
Steam coils	Type—rows	5JA—1, 2	5JA—1, 2	5JA—1, 2	5JA—1, 2	5JA—1, 2
	FPI	6, 12	6, 12	6, 12	6, 12	6, 12
	Face area (sq ft)	42.2	42.2	42.2	42.2	42.2
Gas furnace	Input (MBh)	625, 800, 812, 988, 1000, 1250, 1375, 1750, 1875, 2500				
	Nom. output (MBh)	500, 640, 650, 790, 800, 1000, 1100, 1400, 1500, 2000				
Electric heat	Nom. output (kW)	80, 100, 120, 160, 200, 240, 280, 320				
Panel filters	Type	85% or 30% pleated				
	Area (sq ft)	116.1	116.1	116.1	116.1	116.1
	Qty—size (in)	11—16×20×2 33—16×25×2	11—16×20×2 33—16×25×2	11—16×20×2 33—16×25×2	11—16×20×2 33—16×25×2	11—16×20×2 33—16×25×2
Prefilters (for cartridge filters)	Type	Prefilter, standard flow		Prefilter, medium flow		
	Area (sq ft)	56.0	56.0	56.0	64.0	64.0
	Qty—size (in)	4—12×24×2 12—24×24×2	4—12×24×2 12—24×24×2	4—12×24×2 12—24×24×2	16—24×24×2	16—24×24×2
	Type	Prefilter, medium flow		Prefilter, high flow		
	Area (sq ft)	64.0	64.0	64.0	80.0	80.0
	Qty—size (in)	16—24×24×2	16—24×24×2	16—24×24×2	8—12×24×2 16—24×24×2	8—12×24×2 16—24×24×2
Cartridge filters	Type	65% or 95% standard flow		65% or 95% medium flow		
	Area (sq ft)	56.0	56.0	56.0	64.0	64.0
	Qty—size (in)	4—12×24×12 12—24×24×12	4—12×24×12 12—24×24×12	4—12×24×12 12—24×24×12	16—24×24×12	16—24×24×12
	Type	65% or 95% medium flow		65% or 95% high flow		
	Area (sq ft)	64.0	64.0	64.0	80.0	80.0
	Qty—size (in)	16—24×24×12	16—24×24×12	16—24×24×12	8—12×24×12 16—24×24×12	8—12×24×12 16—24×24×12

a. Gas furnace size availability is limited by minimum airflow, See Table 11 on page 47.
b. 460-volt capacities are shown. Electric heat availability is limited by minimum airflow, See Table 14 through Table 16..

Table 10: Physical Data, Sizes 110D to 140D

Data		Unit size				
		110D	120D	125D	130D	140D
Compressor	Quantity—hp	6—15	3—15 3—20	6—20	6—20	3—20 3—25
	Std. capacity control	100-84-67-50-33-17-0	100-83-67-49-33-16-0	100-84-67-50-33-17-0		100-83-67-49-33-16-0
Condenser fans	Qty—diameter (in)	8—26	9—26	10—26	12—26	12—26
Condenser fan motors	Qty—hp	8—1.0	9—1.0	10—1.0	12—1.0	12—1.0
Supply fans	Type	DWDI airfoil				
	Qty—diameter (in)	1—36, 40	1—36, 40	1—36, 40	1—36, 40	1—36, 40
	Motor hp range	5–75	5–75	5–75	5–75	5–75
RDT supply fan	Type	SWSI airfoil				
	Qty—diameter (in)	1—44, 49				
	Motor hp range	5–75				
Return fans	Type	SWSI airfoil				
	Qty—diameter (in)	1—44.5	1—44.5	1—44.5	1—44.5	1—44.5
	Motor hp range	5–60	5–60	5–60	5–60	5–60
Exhaust fans	Type	Propeller				
	Diameter (in)	36	36	36	36	36
	Quantity	1–3 per unit	1–3 per unit	1–3 per unit	1–3 per unit	1–3 per unit
	Motor hp	5 each	5 each	5 each	5 each	5 each
Evaporator coils	Standard F.A. (sq ft)	60.8	60.8	—	—	—
	Large F.A. (sq ft)	76.0	76.0	76.0	76.0	76.0
Hot water coils	Type—rows	5WH—1	5WH—1	5WH—1	5WH—1	5WH—1
		5WS—2	5WS—2	5WS—2	5WS—2	5WS—2
	FPI	9	9	9	9	9
	Face area (sq ft)	42.2	42.2	42.2	42.2	42.2
Steam coils	Type—rows	5JA—1, 2	5JA—1, 2	5JA—1, 2	5JA—1, 2	5JA—1, 2
	FPI	6, 12	6, 12	6, 12	6, 12	6, 12
	Face area (sq ft)	42.2	42.2	42.2	42.2	42.2
Gas furnace	Input (MBh)	625, 800, 812, 988, 1000, 1250, 1375, 1750, 1875, 2500				
	Nom. output (MBh)	500, 640, 650, 790, 800, 1000, 1100, 1400, 1500, 2000				
Electric heat	Nom. output (kW)	80, 100, 120, 160, 200, 240, 280, 320				
Panel filters	Type	85% or 30% pleated				
	Area (sq ft)	116.1	116.1	116.1	116.1	116.1
	Qty—size (in)	11—16×20×2 33—16×25×2	11—16×20×2 33—16×25×2	11—16×20×2 33—16×25×2	11—16×20×2 33—16×25×2	11—16×20×2 33—16×25×2
Prefilters (for cartridge filters)	Type	Prefilter, standard flow		Prefilter, medium flow		
	Area (sq ft)	64.0	64.0	64.0	64.0	64.0
	Qty—size (in)	16—24×24×2	16—24×24×2	16—24×24×2	16—24×24×2	16—24×24×2
	Type	Prefilter, medium flow		Prefilter, high flow		
	Area (sq ft)	80.0	80.0	80.0	80.0	80.0
	Qty—size (in)	8—12×24×2 16—24×24×2	8—12×24×2 16—24×24×2	8—12×24×2 16—24×24×2	8—12×24×2 16—24×24×2	8—12×24×2 16—24×24×2
Cartridge filters	Type	65% or 95% standard flow		65% or 95% medium flow		
	Area (sq ft)	64.0	64.0	64.0	64.0	64.0
	Qty—size (in)	16—24×24×12	16—24×24×12	16—24×24×12	16—24×24×12	16—24×24×12
	Type	65% or 95% medium flow		65% or 95% high flow		
	Area (sq ft)	80.0	80.0	80.0	80.0	80.0
	Qty—size (in)	8—12×24×12 16—24×24×12	8—12×24×12 16—24×24×12	8—12×24×12 16—24×24×12	8—12×24×12 16—24×24×12	8—12×24×12 16—24×24×12

a. Gas furnace size availability is limited by minimum airflow, See Table 11 on page 47.
b. 460-volt capacities are shown. Electric heat availability is limited by minimum airflow, See Table 14 through Table 16.

Gas Heat

Figure 38: Gas Heat Capacity

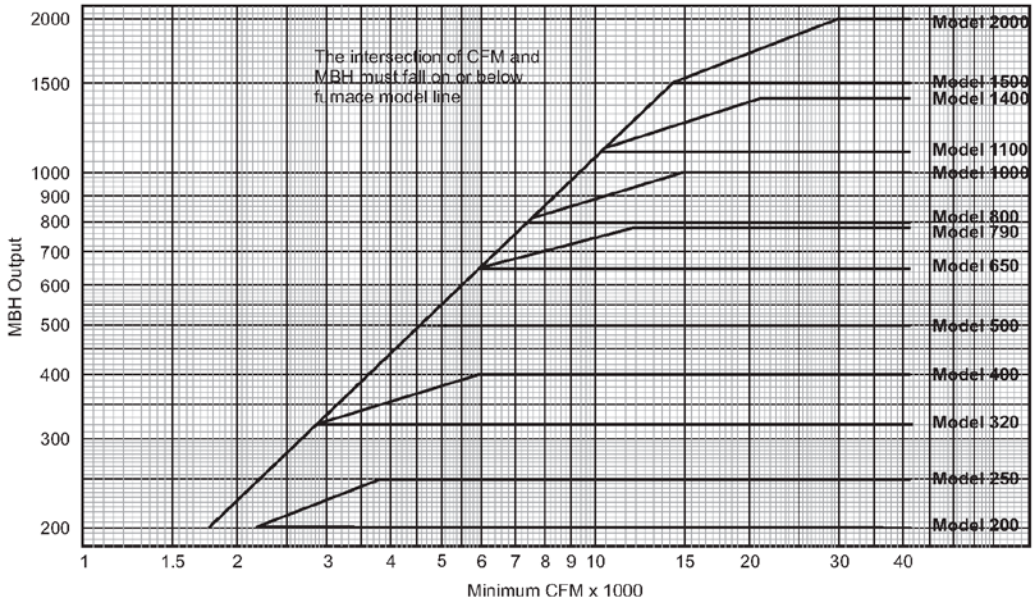


Table 11: Gas Furnace Design Maximum Air Temperature Rise (°F) and Minimum Airflow

Baffle Position	Maximum Temperature Rise (°F)—Minimum Airflow (cfm—Furnace Size (MBh)												
	Column Number For Pressure Drop (see Table 61 on page 74).												
	200	250	320	400	500	650	790	800	1000	1100	1400	1500	2000
A	80	61	100	61	100	100	61	100	61	100	61	100	61
	2300	3800	2950	6000	4600	5970	12000	7340	15000	10100	21000	13700	30000
	1	1	1	1	2	3	3	3	3	4	4	7	7
B	62	42	78	35	63	73	52	76	50	73	34	82	49
	3000	5500	3800	10500	7400	8200	14000	9800	18500	14000	38000	17000	38000
	4	4	4	4	5	4	4	4	4	6	6	8	8
C	46	15	59	31	55	65	46	71	40	64	33	73	40
	4000	15000	5000	12000	8400	9200	16000	10400	23000	16000	39000	19000	46000
	9	9	9	9	10	10	10	10	10	10	10	10	10

Note:
Temperature rise and airflow limit applicable to all burner types.
VAV application, consider the minimum turndown airflow when selecting baffle position.
Furnace Availability:
200–1000 MBh output furnaces available in RPS/RFS sizes 015D–079D.
500–2000 MBh output furnaces available in RPS/RFS sizes 080D–140D

Table 12: Gas Burner Connection Size (inches)

Description		Furnace Size (MBh Output)												
		200	250	320	400	500	650	790	800	1000	1100	1400	1500	2000
Natural Gas (CFH)		250	312	400	500	625	812	1000	1000	1250	1375	1750	1875	2500
Minimum Gas Inlet Pressure (in. W.C.)	Standard Burner	6.00	6.00	7.00	7.00	7.00	7.00	7.50	7.50	9.00	7.00	8.00	8.00	9.00
	20:1 Burner	4.50	5.50	6.00	5.00	5.50	7.00	6.50	6.50	6.50	5.00	5.00	5.00	6.00
Gas Pipe Connection Size (N.P.T.)	Through 0.5 psi	0.75	0.75	0.75	1.00	1.00	1.25	1.25	1.25	1.25	1.50	1.50	1.50	2.00
	2–3 psi	0.75	0.75	0.75	1.00	1.00	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.50
	5–10 psi	0.75	0.75	0.75	1.00	1.00	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25

Table 13: Gas Furnace Inlet Pressure Range

Regulator	Furnace Model Number												
	200	250	320	400	500	650	790	800	1000	1100	1400	1500	2000
Minimum Pressure (in W.C.)	6.00	6.00	7.00	7.00	7.00	7.00	7.50	7.50	9.00	7.00	8.00	8.00	9.00
	4.50	5.50	6.00	5.00	5.50	7.00	6.50	6.50	6.50	5.00	5.00	5.00	6.00
Maximum Pressure (psig)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
High Pressure (psig)	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0	2.0–10.0

Electric Heat

208 Volts

Table 14: RPS and RFS 015D to 042D—208V Electric Heat Air Temperature Rise (°F)

Airflow (cfm)	Electric Heater Model Number					
	20	40	60	80	100	120
	Electric Heater Capacity (MBh)					
	51	102	154	204	255	306
6000	7.8	15.7	23.7	31.3	39.2	47.0
7000	6.7	13.4	20.3	26.9	33.6	40.3
8000	5.9	11.8	17.7	23.5	29.4	35.3
9000	5.2	10.4	15.8	20.9	26.1	31.3
10000	4.7	9.4	14.2	18.8	23.5	28.2
11000	4.3	8.5	12.9	17.1	21.4	25.6
12000	3.9	7.8	11.8	15.7	19.6	23.5
13000	3.6	7.2	10.9	14.5	18.1	21.7
14000	3.4	6.7	10.1	13.4	16.8	20.1
15000	3.1	6.3	9.5	12.5	15.7	18.8
16000	2.9	5.9	8.9	11.8	14.7	17.6

The maximum temperature rise allowed for electric heat is 60°F with leaving air temperature not to exceed 140°F.
The minimum airflow required for unit sizes 015D to 040D with electric heat is 6,000 cfm.

Table 15: RPS and RFS 045D to 079D—208V Electric Heat Air Temperature Rise (°F)

Airflow (cfm)	Electric Heater Model Number					
	40	60	80	100	120	160
	Electric Heater Capacity (MBh)					
	102	154	204	255	306	408
14000	6.7	10.1	13.4	16.8	20.1	26.9
15000	6.3	9.5	12.5	15.7	18.8	25.1
16000	5.9	8.9	11.8	14.7	17.6	23.5
17000	5.5	8.3	11.1	13.8	16.6	22.1
18000	5.2	7.9	10.4	13.1	15.7	20.9
19000	4.9	7.5	9.9	12.4	14.8	19.8
20000	4.7	7.1	9.4	11.8	14.1	18.8
21000	4.5	6.8	9.0	11.2	13.4	17.9
22000	4.3	6.5	8.5	10.7	12.8	17.1
23000	4.1	6.2	8.2	10.2	12.3	16.3
24000	3.9	5.9	7.8	9.8	11.8	15.7
25000	3.8	5.7	7.5	9.4	11.3	15.0
26000	3.6	5.5	7.2	9.0	10.8	14.5
27000	3.5	5.3	7.0	8.7	10.4	13.9
28000	3.4	5.1	6.7	8.4	10.1	13.4
29000	3.2	4.9	6.5	8.1	9.7	13.0
30000	3.1	4.7	6.3	7.8	9.4	12.5

The maximum temperature rise allowed for electric heat is 60°F with leaving air temperature not to exceed 140°F.
The minimum airflow required for unit sizes 045D to 079D with electric heat is 14,000 cfm.

Table 16: RPS and RFS 080D to 140D—208V Electric Heat Air Temperature Rise (°F)

Airflow (cfm)	Electric Heater Model Number		
	80	100	120
	Electric Heater Capacity (MBh)		
	204	255	306
22000	8.5	10.7	12.8
24000	7.8	9.8	11.8
26000	7.2	9.0	10.8
28000	6.7	8.4	10.1
30000	6.3	7.8	9.4
32000	5.9	7.3	8.8
34000	5.5	6.9	8.3
36000	5.2	6.5	7.8
38000	4.9	6.2	7.4
40000	4.7	5.9	7.1
42000	4.5	5.6	6.7
44000	4.3	5.3	6.4
46000	4.1	5.1	6.1
48000	3.9	4.9	5.9
50000	3.8	4.7	5.6

The maximum temperature rise allowed for electric heat is 60°F with leaving air temperature not to exceed 140°F.
The minimum airflow required for units 080D to 140D with electric heat is 22,000 cfm.

230, 460, and 575 Volts

Table 17: RPS and RFS 015D to 042D—230V, 460V, 575V Electric Heat Air Temperature Rise (°F)

Airflow (cfm)	Electric Heater Model Number											
	20	40	60	80	100	120	140	160	180*	200*	220*	240*
	Electric Heater Capacity (MBh)											
	63	125	188	249	312	374	439	499	564	624	689	748
6000	9.7	19.2	28.9	38.2	47.9	57.5	n/a	n/a	n/a	n/a	n/a	n/a
7000	8.3	16.5	24.8	32.8	41.1	49.2	57.8	n/a	n/a	n/a	n/a	n/a
8000	7.3	14.4	21.7	28.7	35.9	43.1	50.6	57.5	n/a	n/a	n/a	n/a
9000	6.5	12.8	19.3	25.5	32.0	38.3	45.0	51.1	57.8	n/a	n/a	n/a
10000	5.8	11.5	17.3	22.9	28.8	34.5	40.5	46.0	52.0	57.5	n/a	n/a
11000	5.3	10.5	15.8	20.9	26.1	31.3	36.8	41.8	47.3	52.3	57.7	n/a
12000	4.8	9.6	14.4	19.1	24.0	28.7	33.7	38.3	43.3	47.9	52.9	57.5
13000	4.5	8.9	13.3	17.7	22.1	26.5	31.1	35.4	40.0	44.2	48.8	53.0
14000	4.1	8.2	12.4	16.4	20.5	24.6	28.9	32.9	37.1	41.1	45.4	49.2
15000	3.9	7.7	11.6	15.3	19.2	23.0	27.0	30.7	34.7	38.3	42.3	46.0
16000	3.6	7.2	10.8	14.3	18.0	21.5	25.3	28.7	32.5	35.9	39.7	43.1

The maximum temperature rise allowed for electric heat is 60°F with leaving air temperature not to exceed 140°F.
The minimum airflow required for units 015D to 042D with electric heat is 6,000 cfm.
140 through 240 electric heaters available at 460 or 575 volts only.

Table 18: RPS and RFS 045D to 079D—230V, 460V, 575V Electric Heat Air Temperature Rise (°F)

Airflow (cfm)	Electric Heater Model Number								
	40	60	80	100	120	160	180	200	240
	Electric Heater Capacity (MBh)								
	125	188	249	312	374	499	564	624	748
14000	8.2	12.4	16.4	20.5	24.6	32.9	37.1	41.1	49.2
15000	7.7	11.6	15.3	19.2	23.0	30.7	34.7	38.3	46.0
16000	7.2	10.8	14.3	18.0	21.5	28.7	32.5	35.9	43.1
17000	6.8	10.2	13.5	16.9	20.3	27.1	30.6	33.8	40.6
18000	6.4	9.6	12.7	16.0	19.2	25.6	28.9	32.0	38.3
19000	6.1	9.1	12.1	15.1	18.1	24.2	27.4	30.3	36.3
20000	5.8	8.7	11.5	14.4	17.2	23.0	26.0	28.8	34.5
21000	5.5	8.3	10.9	13.7	16.4	21.9	24.8	27.4	32.8
22000	5.2	7.9	10.4	13.1	15.7	20.9	23.6	26.1	31.3
23000	5.0	7.5	10.0	12.5	15.0	20.0	22.6	25.0	30.0
24000	4.8	7.2	9.6	12.0	14.4	19.2	21.7	24.0	28.7
25000	4.6	6.9	9.2	11.5	13.8	18.4	20.8	23.0	27.6
26000	4.4	6.7	8.8	11.1	13.3	17.7	20.0	22.1	26.5
27000	4.3	6.4	8.5	10.7	12.8	17.0	19.3	21.3	25.5
28000	4.1	6.2	8.2	10.3	12.3	16.4	18.6	20.5	24.6
29000	4.0	6.0	7.9	9.9	11.9	15.9	17.9	19.8	23.8
30000	3.8	5.8	7.6	9.6	11.5	15.3	17.3	19.2	23.0

The maximum temperature rise allowed for electric heat is 60°F with leaving air temperature not to exceed 140°F.
The minimum airflow required for units 045D to 079D with electric heat is 14,000 cfm.
180 through 240 electric heaters available at 460 or 575 volts only.

Table 19: RPS and RFS 080D to 140D—230V, 460V, 575V Electric Heat Air Temperature Rise (°F)

Airflow (cfm)	Electric Heater Model Number							
	80	100	120	160	200	240	280	320
	Electric Heater Capacity (MBh)							
	249	312	374	499	624	748	873	998
22000	10.4	13.1	15.7	20.9	26.1	31.3	36.6	41.8
24000	9.6	12.0	14.4	19.2	24.0	28.7	33.5	38.3
26000	8.8	11.1	13.3	17.7	22.1	26.5	30.9	35.4
28000	8.2	10.3	12.3	16.4	20.5	24.6	28.7	32.9
30000	7.6	9.6	11.5	15.3	19.2	23.0	26.8	30.7
32000	7.2	9.0	10.8	14.4	18.0	21.5	25.1	28.7
34000	6.7	8.5	10.1	13.5	16.9	20.3	23.7	27.1
36000	6.4	8.0	9.6	12.8	16.0	19.2	22.4	25.6
38000	6.0	7.6	9.1	12.1	15.1	18.1	21.2	24.2
40000	5.7	7.2	8.6	11.5	14.4	17.2	20.1	23.0
42000	5.5	6.8	8.2	11.0	13.7	16.4	19.2	21.9
44000	5.2	6.5	7.8	10.5	13.1	15.7	18.3	20.9
46000	5.0	6.3	7.5	10.0	12.5	15.0	17.5	20.0
48000	4.8	6.0	7.2	9.6	12.0	14.4	16.8	19.2
50000	4.6	5.8	6.9	9.2	11.5	13.8	16.1	18.4

The maximum temperature rise allowed for electric heat is 60°F with leaving air temperature not to exceed 140°F.
The minimum airflow required for units 080D to 140D with electric heat is 22,000 cfm.
160 through 320 electric heaters available at 460 or 575 volts only.

Hot Water Heat

RPS, RFS, RDT 015D to 042D

Figure 39: Hot Water Coil, Low Capacity, 015D to 042D

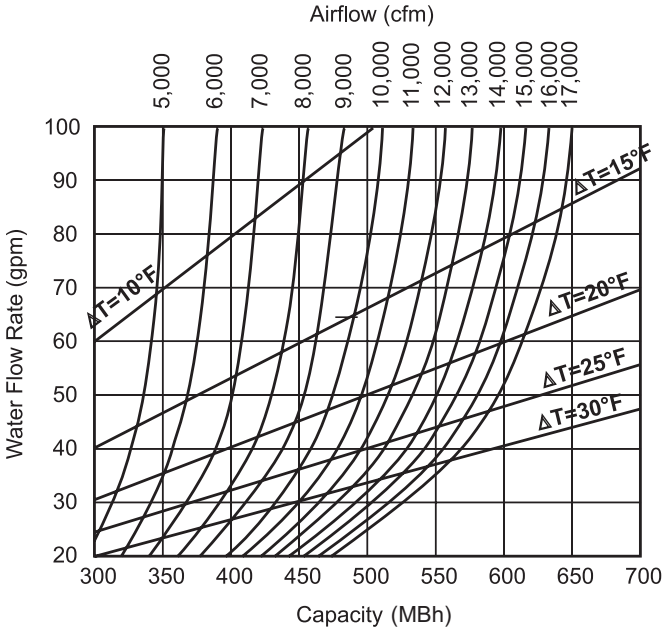


Figure 40: Hot Water Coil, High Capacity, 015D to 042D

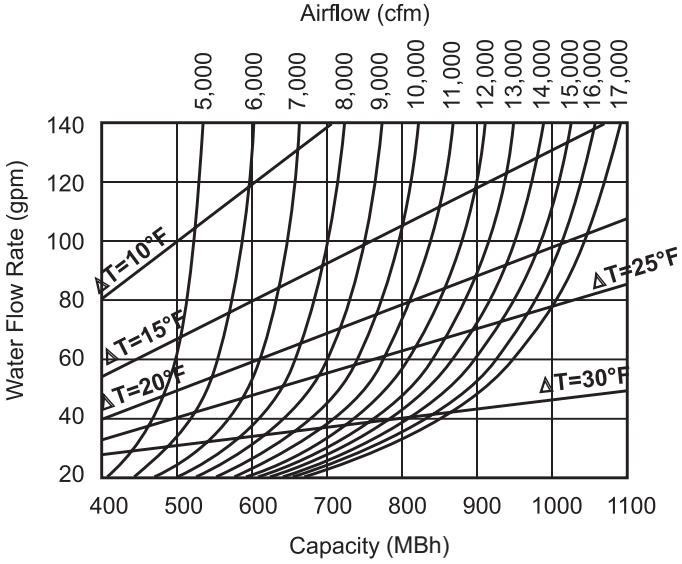


Figure 41: Hot Water Coil Pressure Drop (Headers Included), 015D to 042D

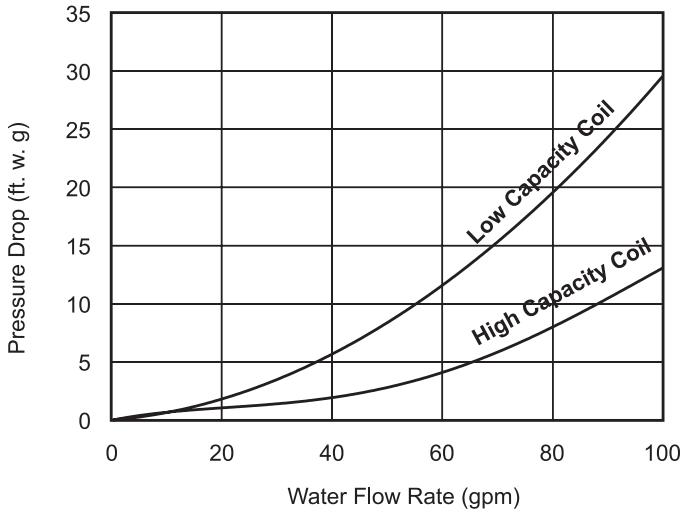
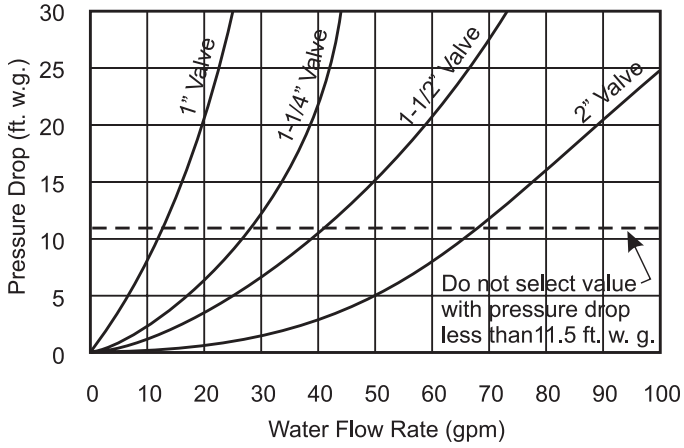


Figure 42: Hot Water Valve and Piping Pressure Drop, 015D to 042D



RPS, RFS, RDT 045D to 140D

Figure 43: Hot Water Coil, Low Capacity, 045D to 079D

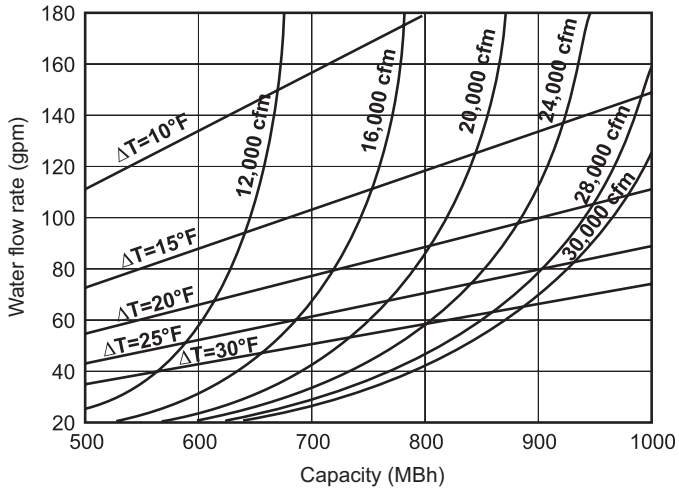


Figure 44: Hot Water Coil, High Capacity, 045D to 079D

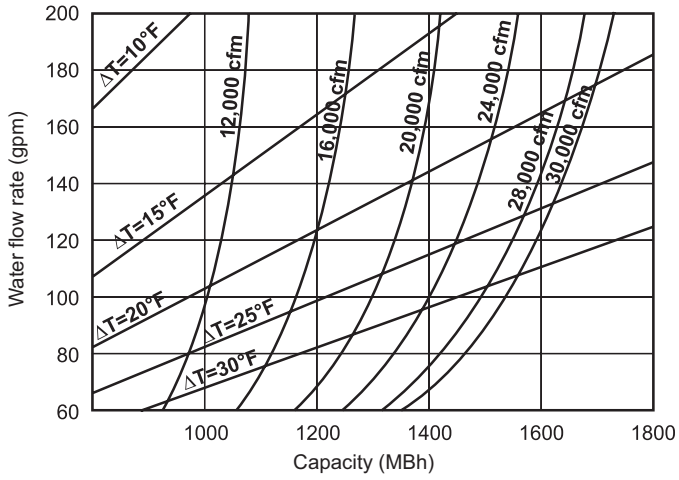


Figure 45: Hot Water Coil, Low Capacity, 080D to 140D

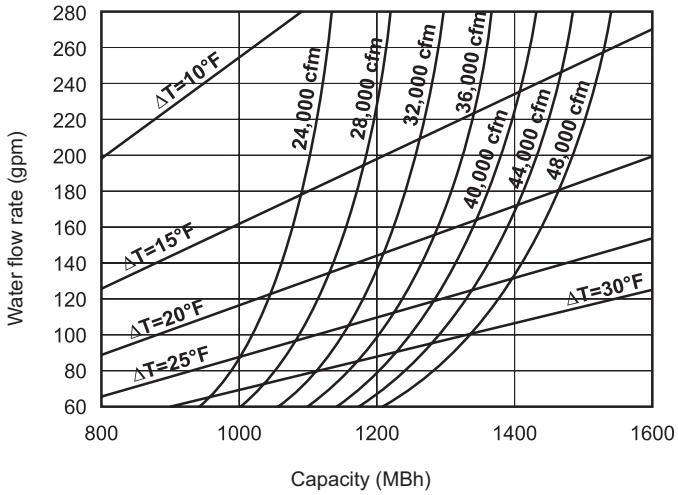


Figure 46: Hot Water Coil, High Capacity, 080D to 140D

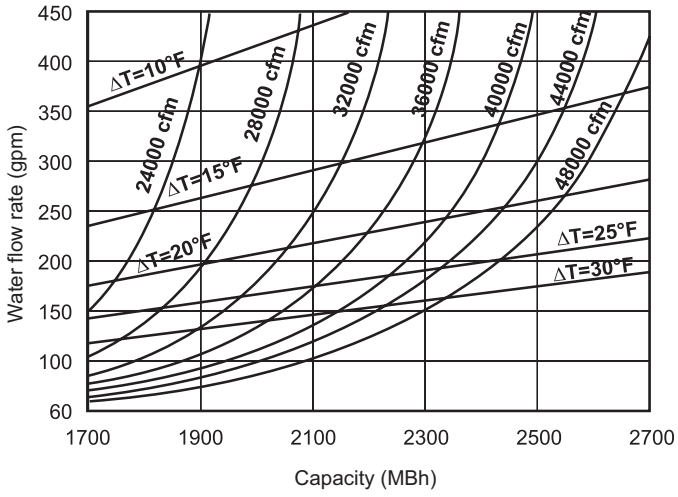


Figure 47: Hot Water Coil Pressure Drop (headers included, does not include valve and valve piping), 045D to 140D

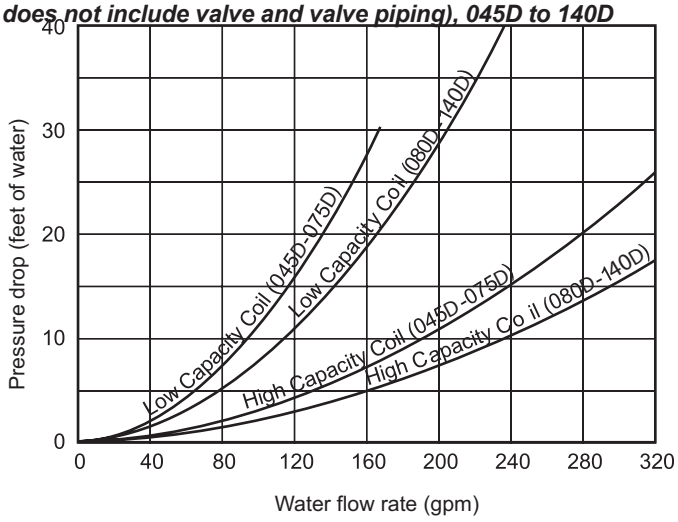


Figure 48: Hot Water Valve Pressure Drop (does not include piping and coil), RPS and RFS 045D to 140D

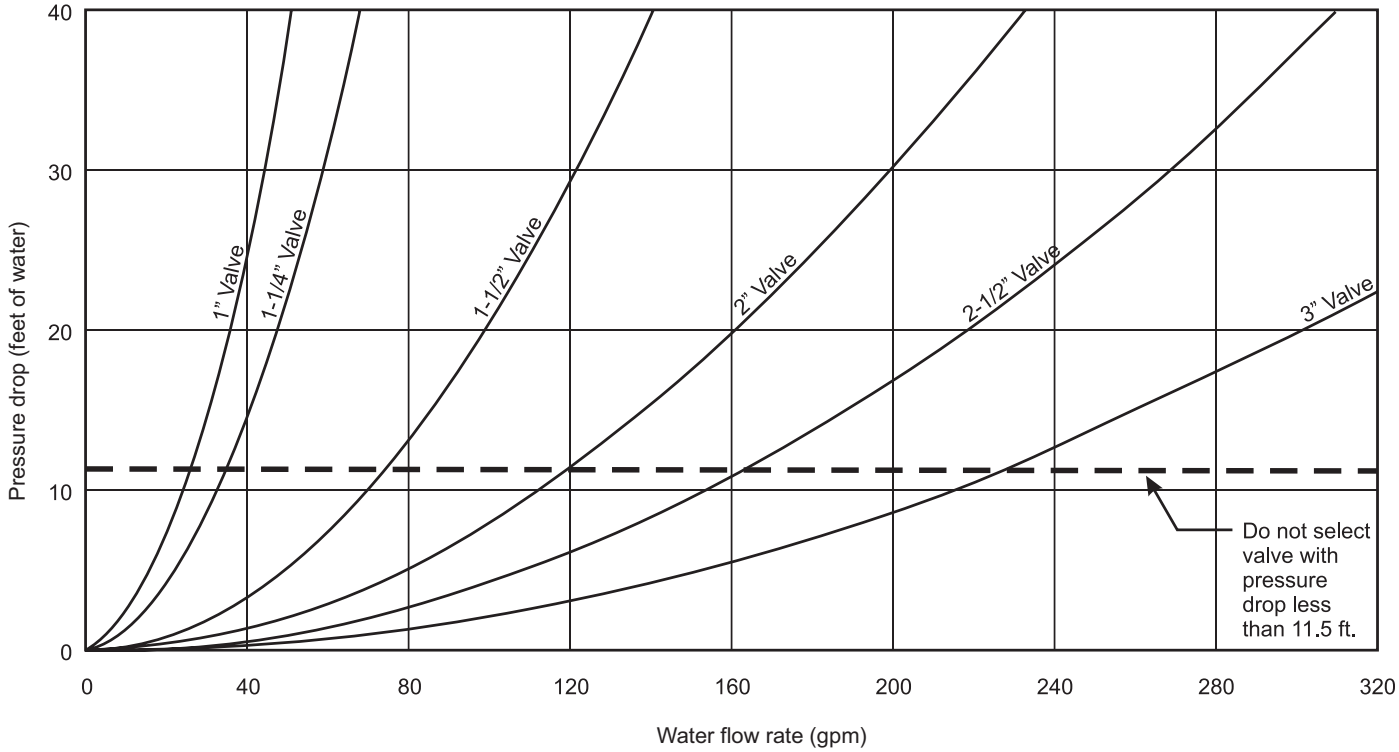
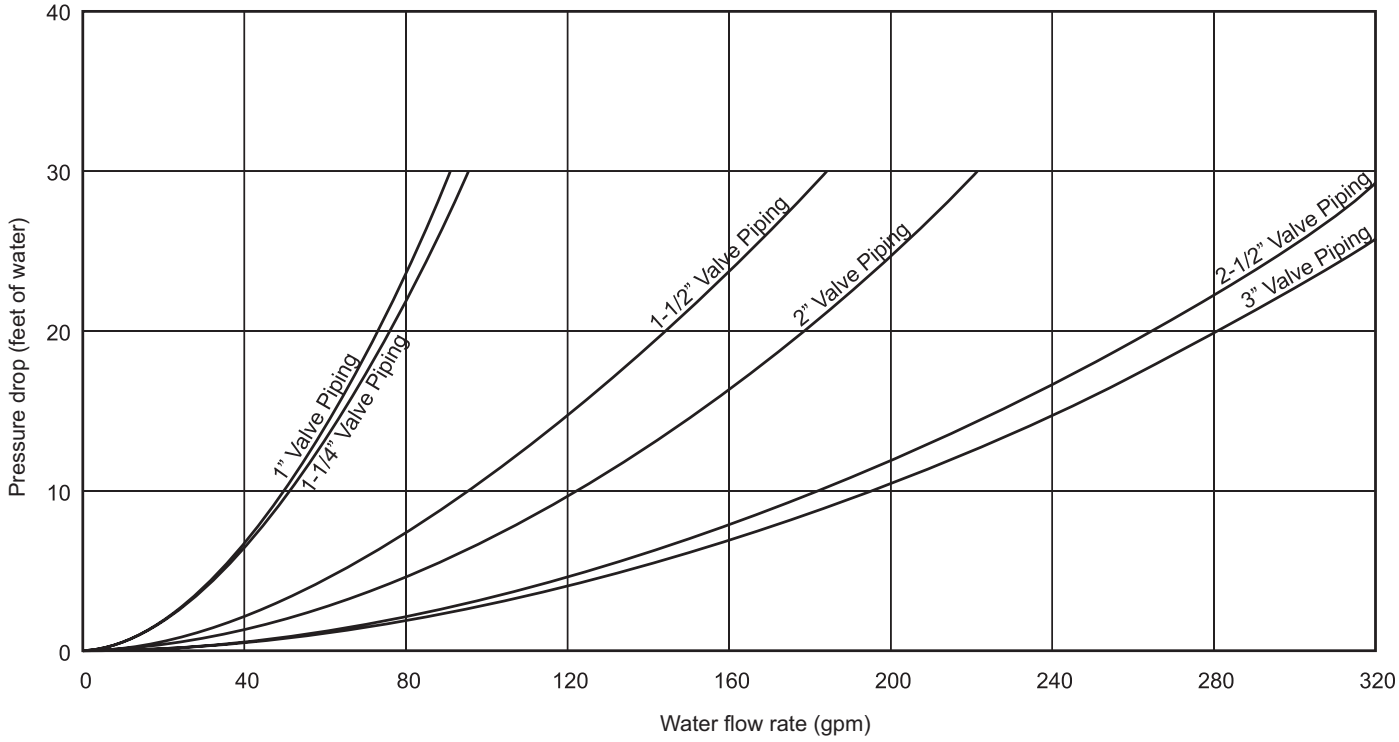


Figure 49: Hot Water Piping Pressure Drop (does not include valve and coil), RPS and RFS 045D to 140D



Steam Heat

RPS, RFS, RDT 015D to 042D

Figure 50: Steam Coil, Low Capacity, 015D to 042D

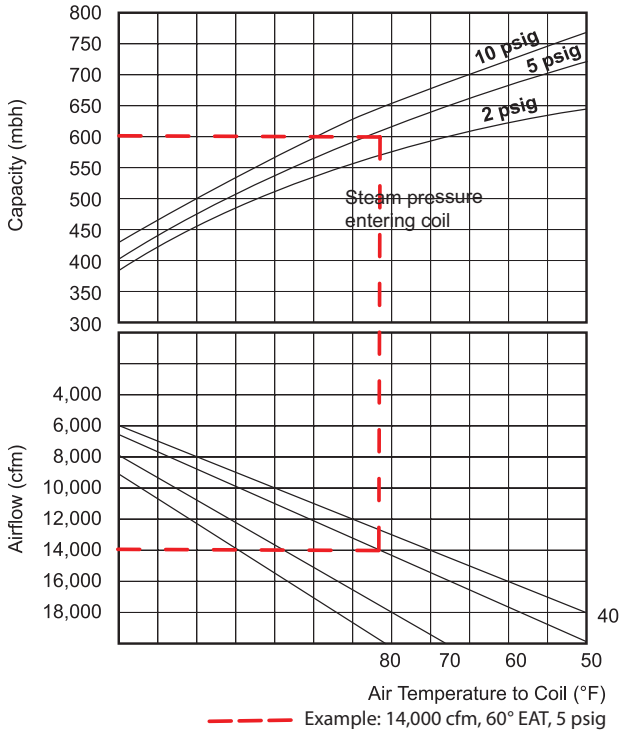


Figure 51: Steam Coil, High Capacity, 015D to 042D

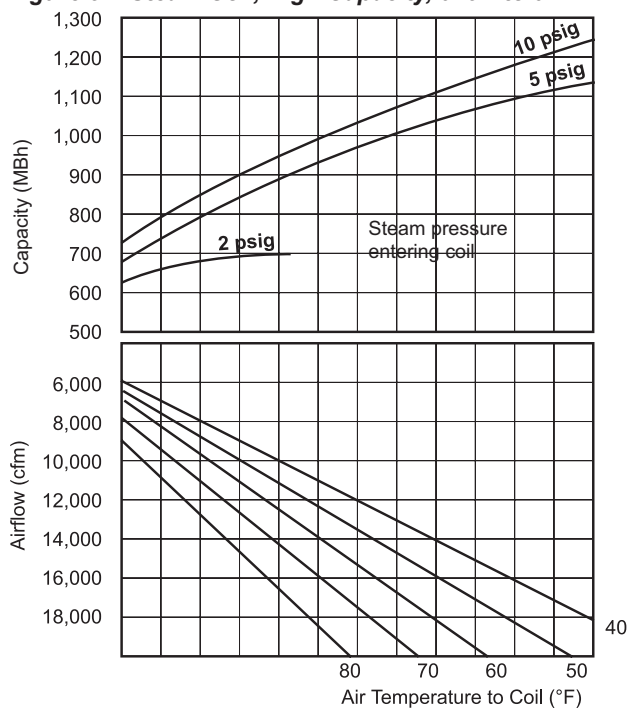


Figure 52: Steam Coil, Low Capacity, 045D to 079D

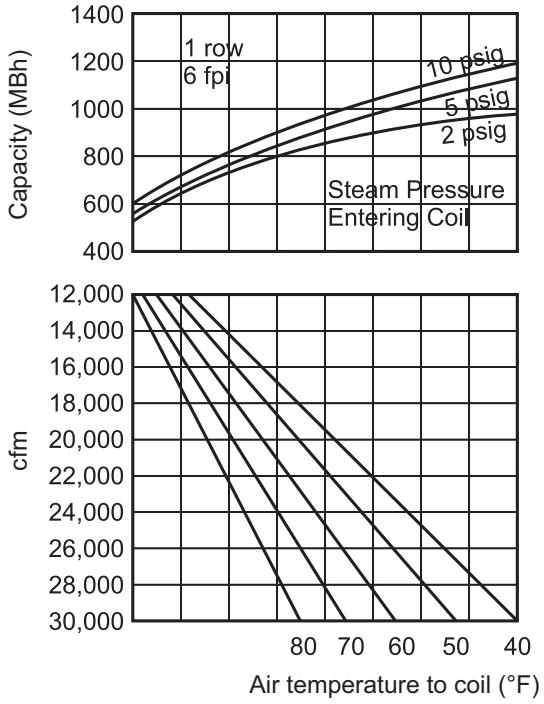


Figure 53: Steam Coil, High Capacity, 045D to 079D

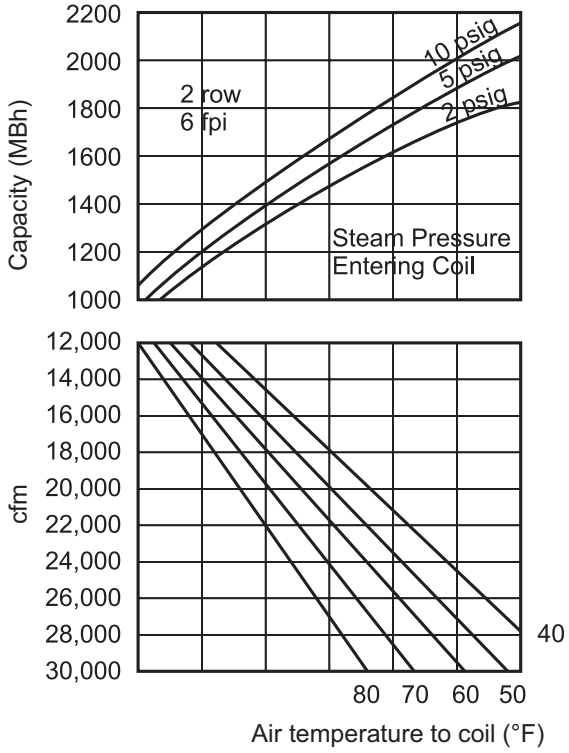


Figure 54: Steam Coil, Medium Capacity, 045D to 079D

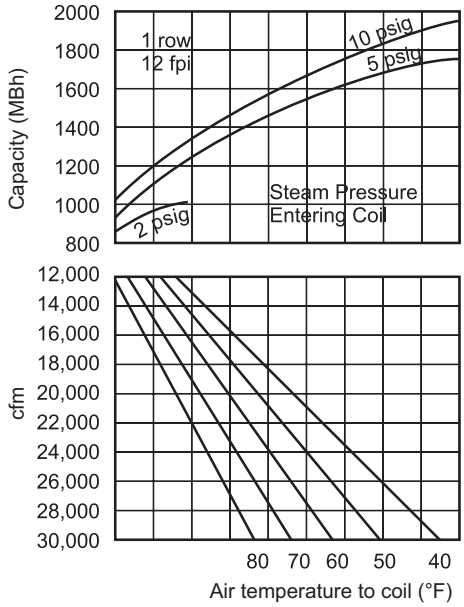


Figure 55: Steam Coil, Medium Capacity, 080D to 140D

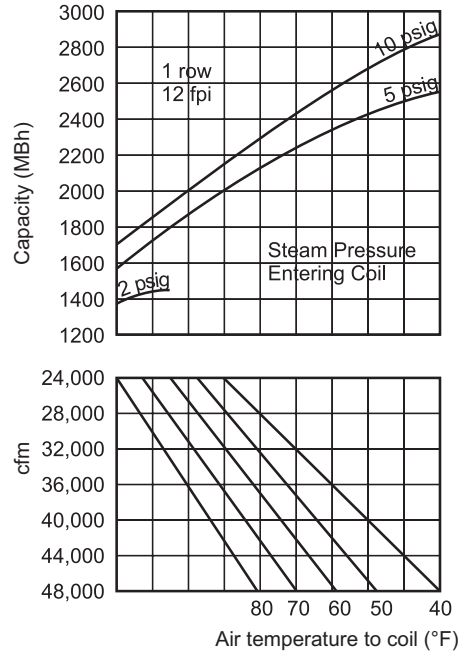


Table 20: Steam Valve Selection Chart

Valve size (inches)	Condensate rate, lb./hr. Steam supply pressure			
	5 psig	10 psig	15 psig	25 psig
1	196–260	301–380	391–480	571–650
1 1/4	261–380	381–560	481–700	651–940
1 1/2	381–600	561–870	701–1090	940–1470
2	601–950	871–1390	1091–1750	1471–2350
2 1/2	951–1330	1391–1940	1751–2450	2351–3290
3	1331–2020	1941–2950	2451–3716	—

Figure 56: Steam Coil, Low Capacity, 080D to 140D

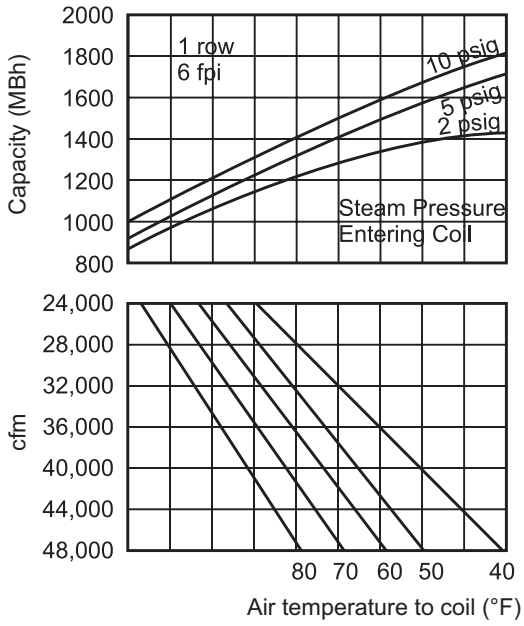


Figure 57: Steam Coil, High Capacity, 080D to 140D

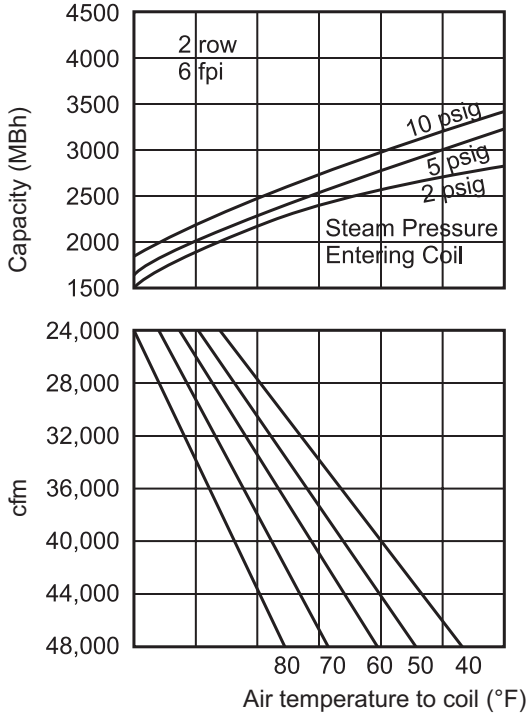


Table 21: Saturated Steam Properties

Pressure (psig)	Temperature (°F)	Latent heat (btu/lb.)
2	218.5	966.1
5	227.1	960.6
10	239.4	952.6
15	249.7	945.7
25	266.8	934.0

Table 22: RPS and RFS 015D to 042D (in. w.g.)

Unit Airflow (cfm)	Filter				Evaporator Coils[a]					
	Angular Rack	Flat Rack			018D –020D			025D –042D		
	30% Pleated	Pre-filters	65% Cartridge	95% Cartridge	5-row 8 fpi	5-row 10 fpi	5-row 12 fpi	5-row 8 fpi	5-row 10 fpi	5-row 12 fpi
4,000	0.02	0.06	0.08	0.12	0.16	0.19	0.23	—	—	—
5,000	0.03	0.08	0.12	0.17	0.22	0.27	0.33	—	—	—
6,000	0.04	0.10	0.16	0.23	0.30	0.35	0.42	0.17	0.20	0.24
7,000	0.05	0.13	0.20	0.29	0.37	0.44	0.53	0.21	0.25	0.30
8,000	0.07	0.16	0.25	0.35	0.45	0.54	0.64	0.26	0.31	0.37
9,000	0.08	0.19	0.31	0.42	0.54	0.64	0.75	0.31	0.36	0.43
10,000	0.09	0.22	0.36	0.49	0.63	0.74	0.87	0.36	0.42	0.50
11,000	0.10	0.25	0.43	0.56	0.72	0.84	0.99	0.41	0.49	0.58
12,000	0.12	0.28	0.49	0.64	0.81	0.95	—	0.46	0.55	0.65
13,000	0.13	0.32	0.56	0.72	—	—	—	0.54	0.64	0.75
14,000	0.14	0.35	0.63	0.81	—	—	—	0.60	0.71	0.84
15,000	0.16	0.39	0.71	0.89	—	—	—	0.67	0.79	0.92
16,000	0.18	0.43	0.79	0.98	—	—	—	0.73	0.86	1.01
17,000	0.19	0.47	0.87	1.07	—	—	—	0.80	0.94	—
18,000	0.21	0.50	0.95	1.17	—	—	—	—	—	—

a. Pressure drop is for wet coil

Table 23: RPS and RFS 015D to 042D (in. w.g.)

Unit Airflow (cfm)	Coils				Economizer Return Damper	100% O.A. Hood withDampers
	Hot Water		Steam			
	Low Capacity	High Capacity	Low Capacity	High Capacity		
4,000	0.03	0.05	0.02	0.04	0.01	0.01
5,000	0.04	0.08	0.03	0.06	0.02	0.01
6,000	0.06	0.11	0.04	0.07	0.03	0.01
7,000	0.08	0.14	0.05	0.09	0.04	0.02
8,000	0.09	0.18	0.06	0.11	0.05	0.02
9,000	0.12	0.22	0.07	0.13	0.07	0.03
10,000	0.14	0.27	0.08	0.14	0.08	0.03
11,000	0.17	0.31	0.09	0.16	0.10	0.04
12,000	0.20	0.36	0.10	0.18	0.12	0.05
13,000	0.22	0.41	0.11	0.20	0.15	0.06
14,000	0.26	0.46	0.12	0.23	0.17	0.06
15,000	0.29	0.53	0.13	0.25	0.20	0.07
16,000	0.32	0.60	0.15	0.27	0.23	0.08
17,000	0.36	0.66	0.16	0.30	0.26	0.09
18,000	0.40	0.74	0.17	0.32	0.29	0.10

Table 24: RFS and RDT 045D to 079D

Component		Airflow (cfm)								
		14,000	16,000	18,000	20,000	22,000	24,000	26,000	28,000	30,000
Outdoor/ Return Air Options[a, b]	0–30% outside air hood w/damper	0.06	0.08	0.10	0.12	0.15	0.18	0.21	0.24	0.28
	100% outside air hood w/damper	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06
	0–100% economizer, w/o RAF	0.08	0.10	0.13	0.16	0.19	0.23	0.27	0.31	0.36
	0–100% economizer, w/RAF	0.21	0.25	0.29	0.33	0.38	0.43	0.48	0.54	0.59
Filter Options	30% pleated	0.08	0.10	0.12	0.14	0.16	0.18	0.20	0.25	0.27
	Prefilter, standard flow	0.17	0.20	0.24	0.28	0.32	0.37	0.41	—	—
	Prefilter, medium flow	0.13	0.15	0.18	0.21	0.25	0.28	0.32	0.35	0.39
	65% cartridge, standard flow	0.27	0.34	0.41	0.49	0.57	0.66	0.76	—	—
	65% cartridge, medium flow	0.20	0.25	0.31	0.36	0.43	0.49	0.56	0.63	0.71
	95% cartridge, standard flow	0.38	0.46	0.55	0.64	0.74	0.84	0.95	—	—
	95% cartridge, medium flow	0.29	0.35	0.42	0.49	0.56	0.64	0.72	0.81	0.89
Plenum Options	Return, isolation damper	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	Discharge, isolation damper	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Cooling Options[c, d, e]	DX, low airflow, 5-row, 10 fpi	0.41	0.50	0.59	0.69	0.79	0.89	—	—	—
	DX, low airflow, 5-row, 12 fpi	0.49	0.59	0.70	0.81	0.93	—	—	—	—
	DX, high airflow, 5-row, 10 fpi	—	0.38	0.45	0.52	0.60	0.68	0.79	0.88	0.98
	DX, high airflow, 5-row, 12 fpi	—	0.45	0.54	0.62	0.71	0.80	0.93	1.04	—
	Cooling diffuser	0.04	0.05	0.06	0.08	0.10	0.11	0.13	0.15	0.18
Heating Options[b]	Hot water, 1-row	0.12	0.15	0.19	0.22	0.26	0.30	0.35	0.39	0.44
	Hot water, 2-row	0.24	0.30	0.37	0.44	0.52	0.61	0.69	0.78	0.88
	Steam, 1-row, 6 fpi	0.10	0.12	0.15	0.18	0.21	0.24	0.27	0.31	0.35
	Steam, 1-row, 12 fpi	0.16	0.20	0.24	0.28	0.33	0.38	0.43	0.48	0.54
	Steam, 2-row, 6 fpi	0.19	0.24	0.30	0.35	0.41	0.48	0.55	0.62	0.70
	Electric heat	0.07	0.10	0.12	0.15	0.18	0.22	0.25	0.29	0.34
	Gas heat	See Table 27: Furnace Pressure Drop (in. w.c.), RPS and RFS 015D to 140D on page 59.								

a. Pressure drop through hood and damper is based on 30% of listed airflow.
b. Pressure drop through the economizer assumes that the majority of air is passing through the return air dampers. If large quantities of outside air are required, pressure drops increase, causing airflow to decrease.
c. Pressure drop of cooling coils not shown can be found in the Daikin Applied Selection Program output.
d. DX coil pressure drops are based on wet coils.
e. A cooling diffuser is provided on units with blow-through cooling only.

Table 25: RPS, RFS, RDT 080D to 140D

Component		Airflow (cfm)								
		18,000	22,000	26,000	30,000	34,000	38,000	42,000	46,000	50,000
Outdoor/ Return Air Options[a, b]	0-30% outside air hood w/damper	0.05	0.08	0.11	0.14	0.18	0.23	0.28	0.34	0.40
	100% outside air hood w/damper	0.01	0.02	0.03	0.03	0.04	0.06	0.07	0.08	0.09
	Economizer, w/o RAF	0.06	0.10	0.15	0.20	0.26	0.32	0.39	0.46	0.54
	Economizer, w/RAF	0.16	0.22	0.29	0.36	0.44	0.52	0.61	0.70	0.80
Filter Options	2" throwaway	0.15	0.07	0.09	0.11	0.13	—	—	—	—
	30% pleated	0.06	0.08	0.11	0.13	0.15	0.18	0.21	0.24	0.27
	Prefilter, standard flow	0.15	0.20	0.24	0.31	0.37	—	—	—	—
	Prefilter, medium flow	0.12	0.16	0.21	0.25	0.31	0.36	—	—	—
	Prefilter, high flow	0.09	0.12	0.15	0.18	0.22	0.26	0.30	0.34	0.39
	65% cartridge, standard flow	0.24	0.33	0.43	0.55	0.68	—	—	—	—
	65% cartridge, medium flow	0.19	0.27	0.35	0.44	0.54	0.65	—	—	—
	65% cartridge, high flow	0.13	0.18	0.24	0.31	0.38	0.45	0.53	0.62	0.71
	95% cartridge, standard flow	0.33	0.45	0.57	0.71	0.85	—	—	—	—
	95% cartridge, medium flow	0.27	0.37	0.47	0.58	0.70	0.83	—	—	—
	95% cartridge, high flow	0.19	0.26	0.34	0.42	0.50	0.59	0.69	0.79	0.89
Plenum Options	Return, isolation damper	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	Discharge, isolation damper	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Cooling Options[c, d, e]	Cooling diffuser	0.04	0.05	0.07	0.10	0.13	0.16	0.19	0.23	0.28
	Cooling coils	See Table 26: Cooling Coil Air Pressure Drops, RPS, RFS, RDT 080D to 140D on page 59.								
Heating Options[d]	Hot water, 1-row	0.10	0.14	0.19	0.24	0.30	0.36	0.43	0.50	0.58
	Hot water, 2-row	0.20	0.28	0.38	0.48	0.60	0.72	0.86	1.00	1.16
	Steam, 1-row, 6 fpi	0.10	0.12	0.15	0.19	0.24	0.29	0.34	0.40	0.46
	Steam, 1-row, 12 fpi	0.14	0.19	0.25	0.31	0.37	0.45	0.52	0.60	0.69
	Steam, 2-row, 6 fpi	0.16	0.23	0.30	0.39	0.48	0.58	0.68	0.80	0.92
	Electric heat	0.07	0.10	0.14	0.19	0.24	0.30	0.37	0.45	0.53
	Gas heat	See Table 27: Furnace Pressure Drop (in. w.c.), RPS and RFS 015D to 140D on page 59.								

a. Pressure drop through hood and damper is based on 30% of listed airflow.
b. Pressure drop through the economizer assumes that the majority of air is passing through the return air dampers. If large quantities of outside air are required, pressure drops increase, causing airflow to decrease.
c. Pressure drop of cooling coils not shown can be found in the Daikin Applied Selection Program output.
d. DX coil pressure drops are based on wet coils.
e. A cooling diffuser is provided on units with blow-through cooling only

Table 26: Cooling Coil Air Pressure Drops, RPS, RFS, RDT 080D to 140D

Unit Size	Cooling Coil	Airflow (cfm)											
		28000	30000	32000	34000	36000	38000	40000	42000	44000	46000	48000	50000
080D to 090D	DX, low airflow, 5-row, 10 fpi	0.72	0.78	0.87	0.95	—	—	—	—	—	—	—	—
	DX, low airflow, 5-row, 12 fpi	0.85	0.92	1.02	—	—	—	—	—	—	—	—	—
	DX, high airflow, 5-row, 10 fpi	0.60	0.65	0.72	0.79	0.86	0.93	—	—	—	—	—	—
	DX, high airflow, 5-row, 12 fpi	0.71	0.77	0.85	0.93	1.01	—	—	—	—	—	—	—
100D to 140D	DX, low airflow, 5-row, 10 fpi	0.60	0.67	0.74	0.81	0.88	0.95	—	—	—	—	—	—
	DX, low airflow, 5-row, 12 fpi	0.72	0.80	0.87	0.95	1.04	—	—	—	—	—	—	—
	DX, high airflow, 5-row, 10 fpi	0.43	0.48	0.53	0.58	0.63	0.68	0.73	0.78	0.84	0.89	0.95	1.01
	DX, high airflow, 5-row, 12 fpi	0.52	0.57	0.62	0.68	0.74	0.80	0.86	0.92	0.98	1.05	—	—

DX oil pressure drops are based on wet coils.
Pressure drop of cooling coils not shown can be found in the Daikin Applied selection program output.

Table 27: Furnace Pressure Drop (in. w.c.), RPS and RFS 015D to 140D

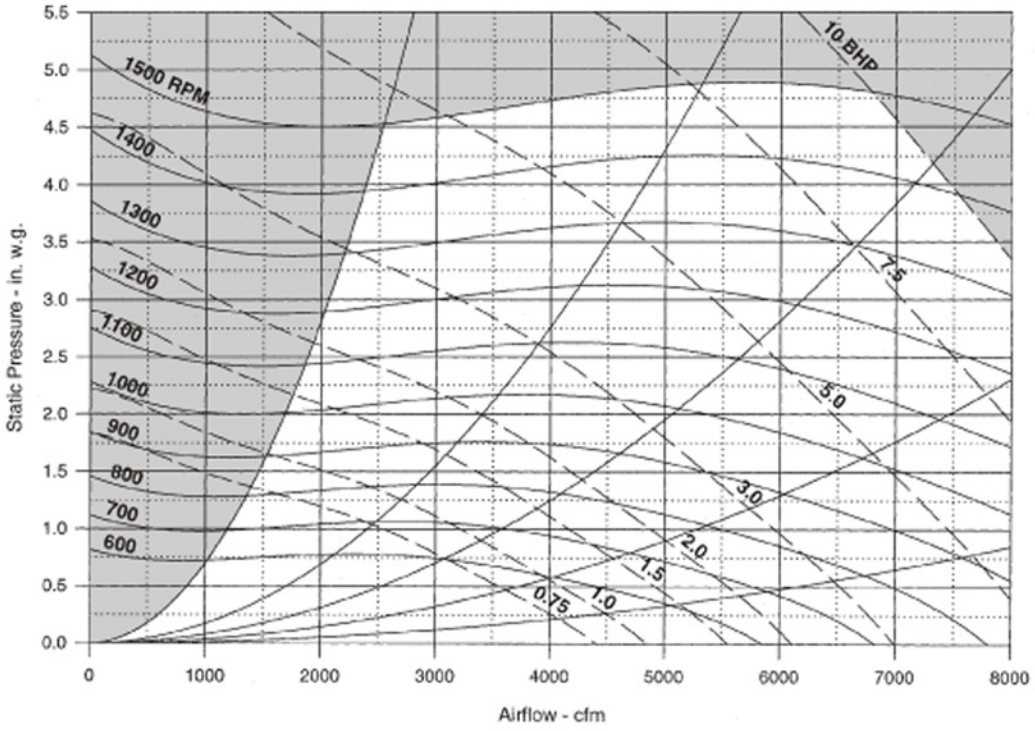
Airflow (cfm)	Column Number, See Table 11 on page 47									
	1	2	3	4	5	6	7	8	9	10
4000	0.06	0.05	—	—	—	—	—	—	—	—
6000	0.13	0.1	—	—	—	—	—	—	—	—
8000	0.24	0.17	0.14	0.08	0.07	—	—	—	—	—
10000	0.37	0.27	0.22	0.12	0.11	0.09	0.08	—	—	—
12000	0.53	0.39	0.32	0.17	0.16	0.13	0.12	0.09	0.08	—
14000	0.72	0.54	0.44	0.24	0.21	0.18	0.16	0.12	0.1	0.1
16000	0.94	0.7	0.57	0.31	0.28	0.24	0.2	0.15	0.13	0.12
18000	1.19	0.89	0.72	0.39	0.35	0.3	0.26	0.19	0.17	0.16
20000	—	1.09	0.89	0.48	0.43	0.37	0.32	0.24	0.21	0.2
22000	—	—	1.08	0.58	0.52	0.44	0.39	0.29	0.25	0.24
24000	—	—	—	0.69	0.62	0.53	0.46	0.34	0.3	0.28
26000	—	—	—	0.81	0.73	0.62	0.54	0.4	0.35	0.33
28000	—	—	—	0.94	0.85	0.72	0.63	0.47	0.41	0.38
30000	—	—	—	1.08	0.97	0.83	0.72	0.54	0.47	0.44
32000	—	—	—	1.23	1.11	0.94	0.82	0.61	0.53	0.5
34000	—	—	—	—	1.25	1.06	0.92	0.69	0.6	0.56
36000	—	—	—	—	—	1.19	1.04	0.77	0.68	0.63
38000	—	—	—	—	—	—	1.15	0.86	0.75	0.7
40000	—	—	—	—	—	—	—	0.95	0.84	0.78
42000	—	—	—	—	—	—	—	1.05	0.92	0.86
44000	—	—	—	—	—	—	—	1.15	1.01	0.94
46000	—	—	—	—	—	—	—	—	1.11	1.03
48000	—	—	—	—	—	—	—	—	1.2	1.12
50000	—	—	—	—	—	—	—	—	—	1.22

Table 28: Gravity Relief Damper Air Pressure Drop, 0 to 100% Economizer

Exhaust cfm	5000	10000	15000	20000	25000	30000	35000	40000
Size 015D to 042D	—	.25	.54	—	—	—	—	—
Size 045D to 079D	—	—	.36	.61	1.00	—	—	—
Size 080D to 140D	—	—	—	.25	.35	.48	.66	.85

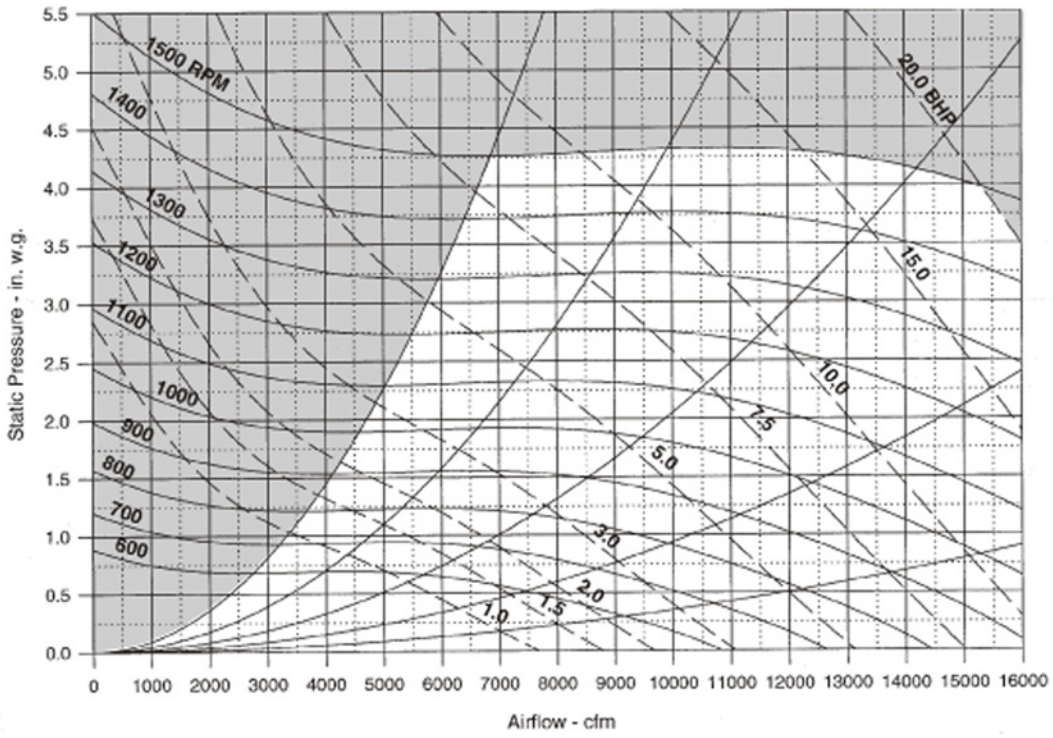
NOTE:
If all exhaust must occur through the economizer gravity relief damper, and no return or exhaust fan is provided, then the building may be pressurized by the sum of the return duct pressure drop plus the gravity relief pressure.

Figure 58: RPS/RFS 015D to 031D (2) 15 in. × 6 in. Forward Curved Supply Fan



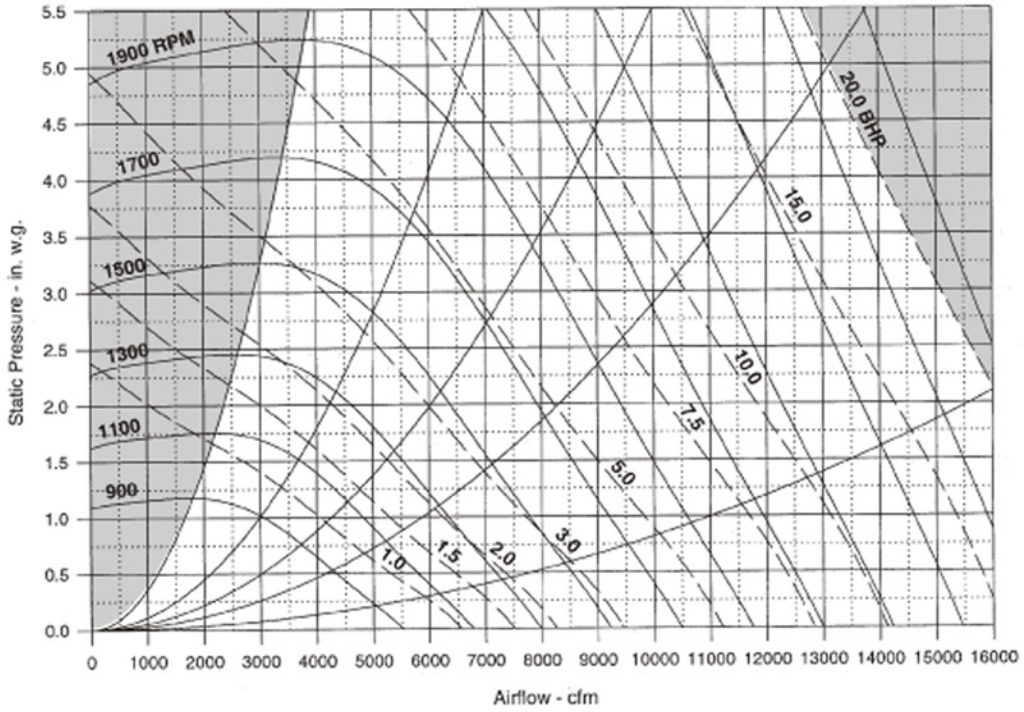
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 59: RPS/RFS 015D to 031D (2) 15 in. × 15 in. Forward Curved Supply Fan



NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

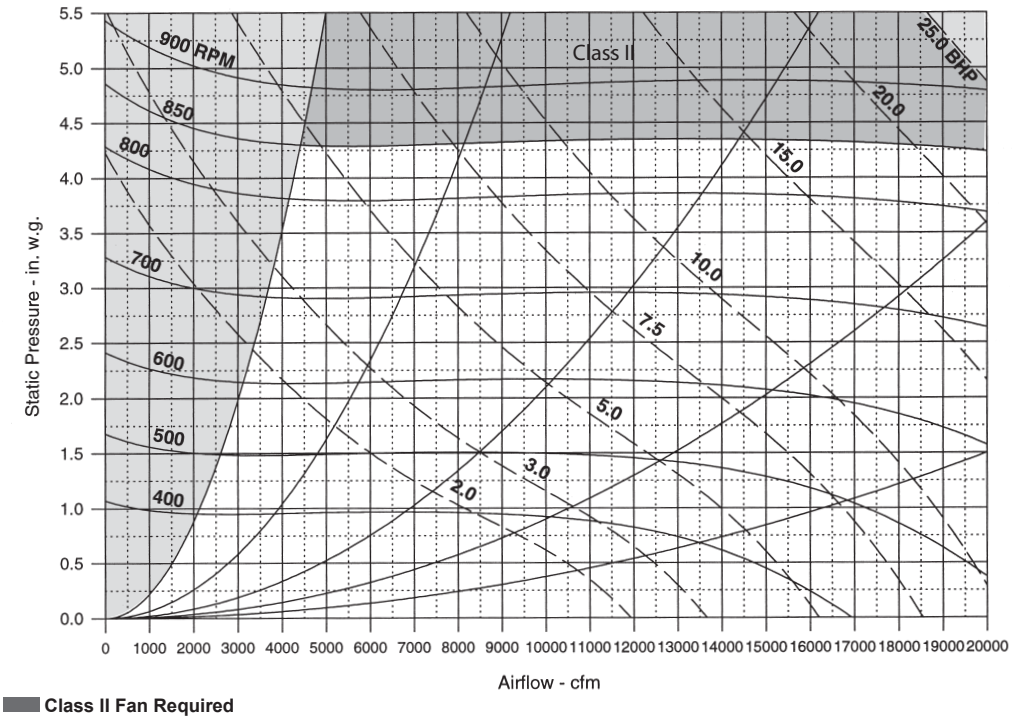
Figure 60: RPS/RFS 015D to 031D 20 in. Airfoil Supply Fan



Do Not Select

NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

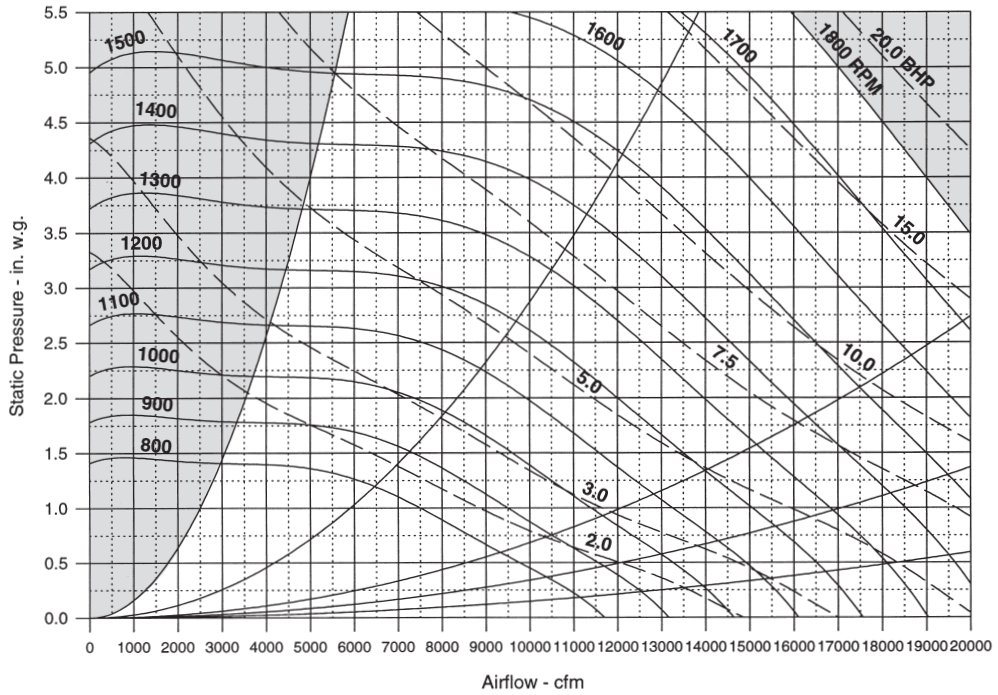
Figure 61: RPS/RFS 035D to 042D 24 in. Forward Curve Supply Fan



Do Not Select Class II Fan Required

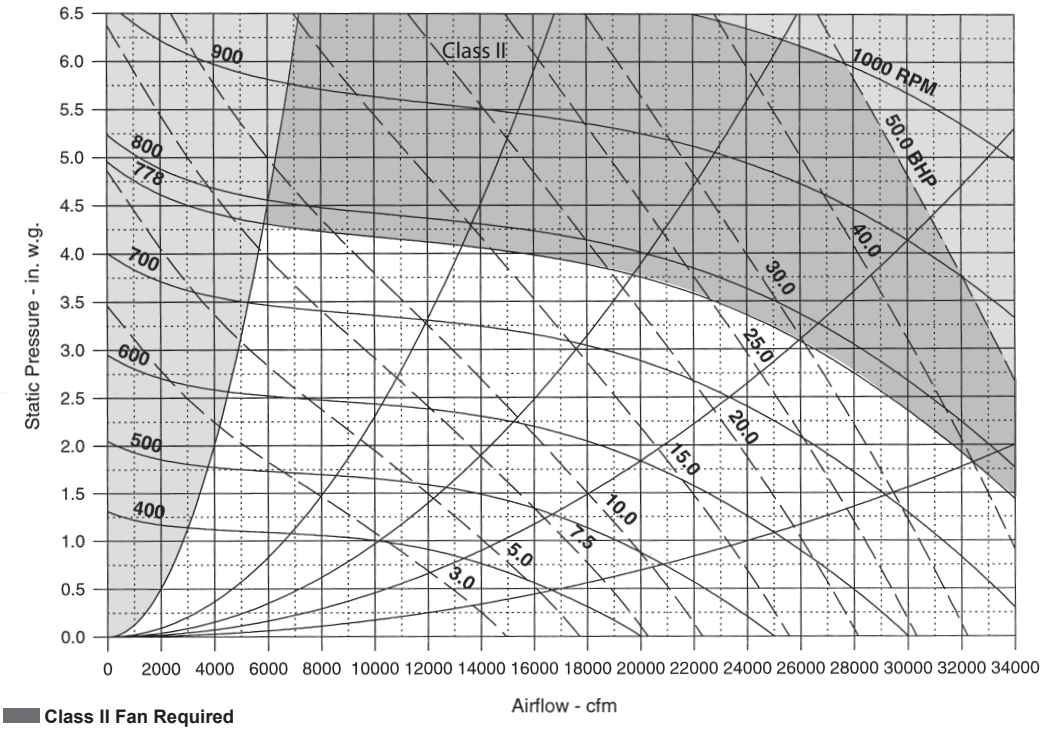
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 62: RPS/RFS 035D to 042D 24 in. Airfoil Supply Fan



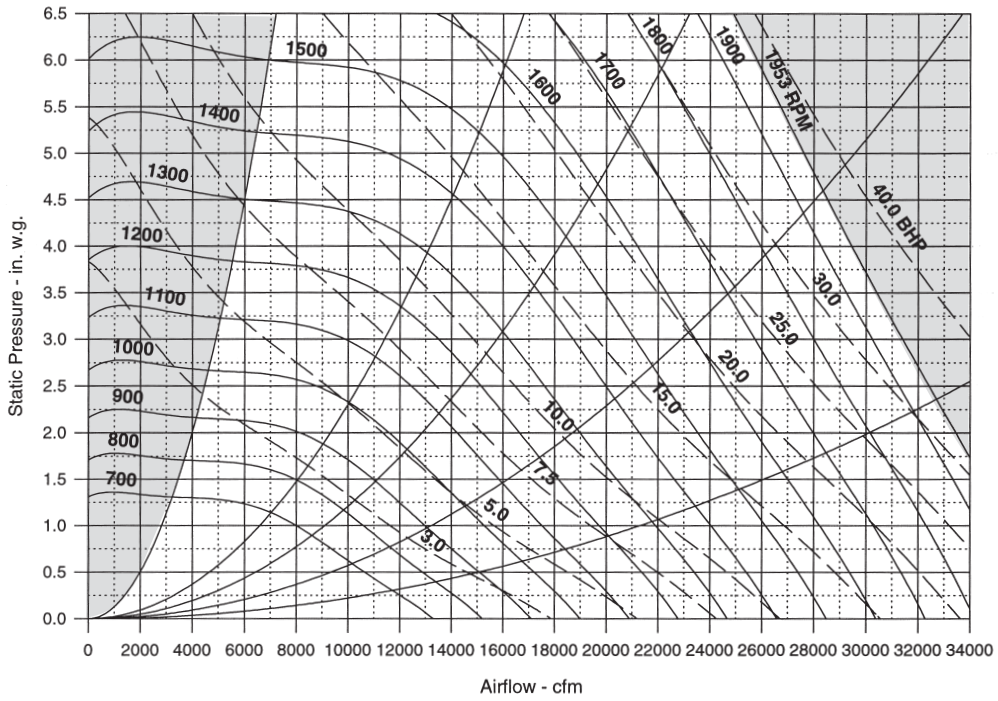
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 63: RPS/RFS 045D to 050D 27 in. Forward Curved Supply Fan



NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

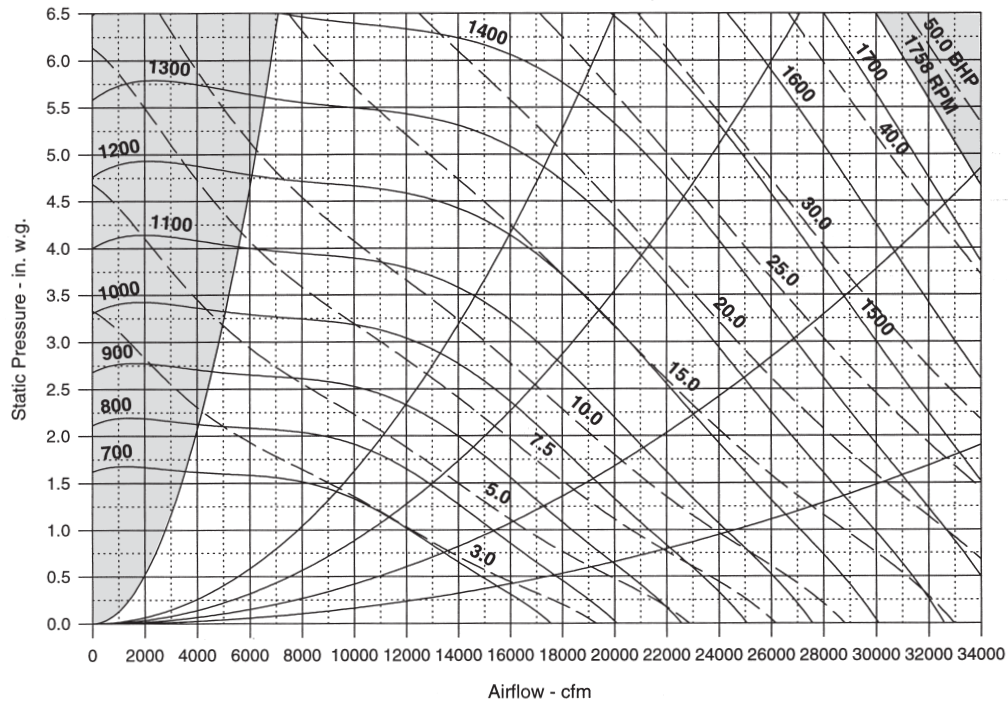
Figure 64: RPS/RFS 045D to 050D 27 in. Airfoil Supply Fan



Do Not Select

NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

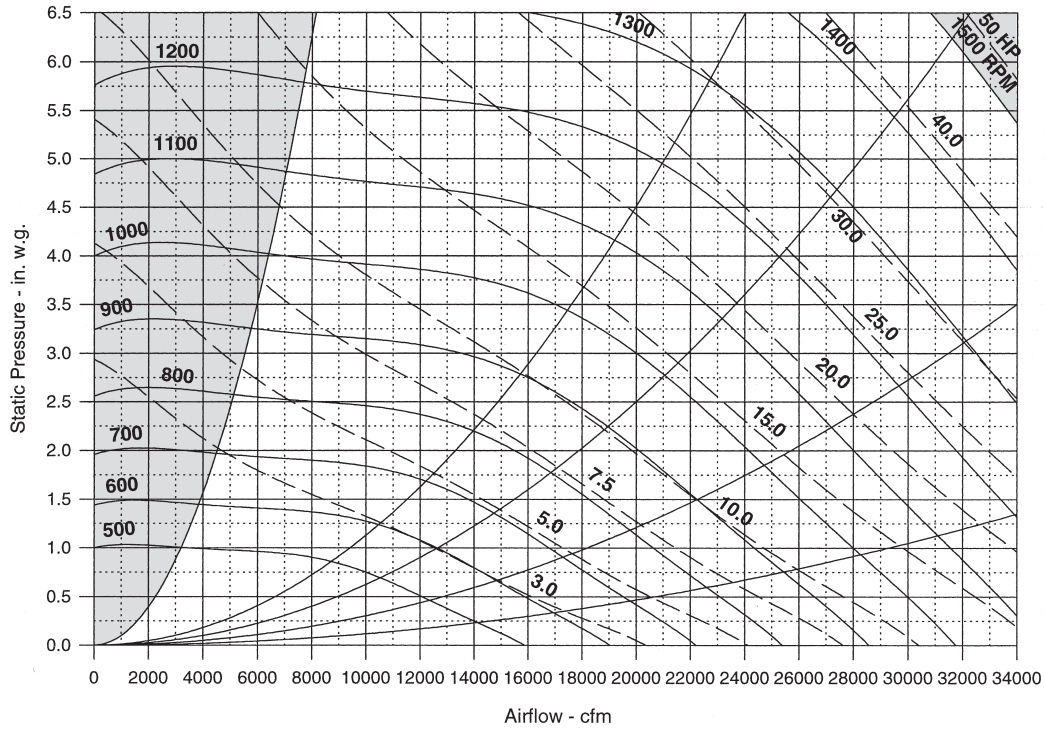
Figure 65: RPS/RFS 045D to 079D 30 in. Airfoil Supply Fan



Do Not Select

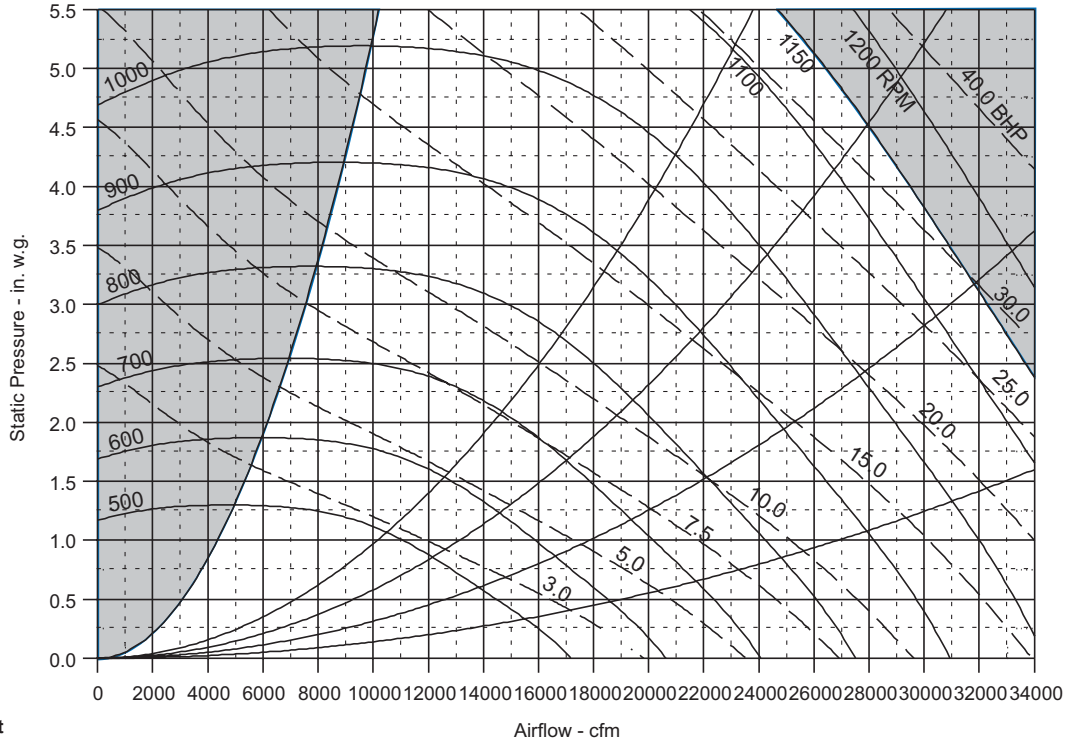
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 66: RPS/RFS 060D to 079D 33 in. Airfoil Supply Fan



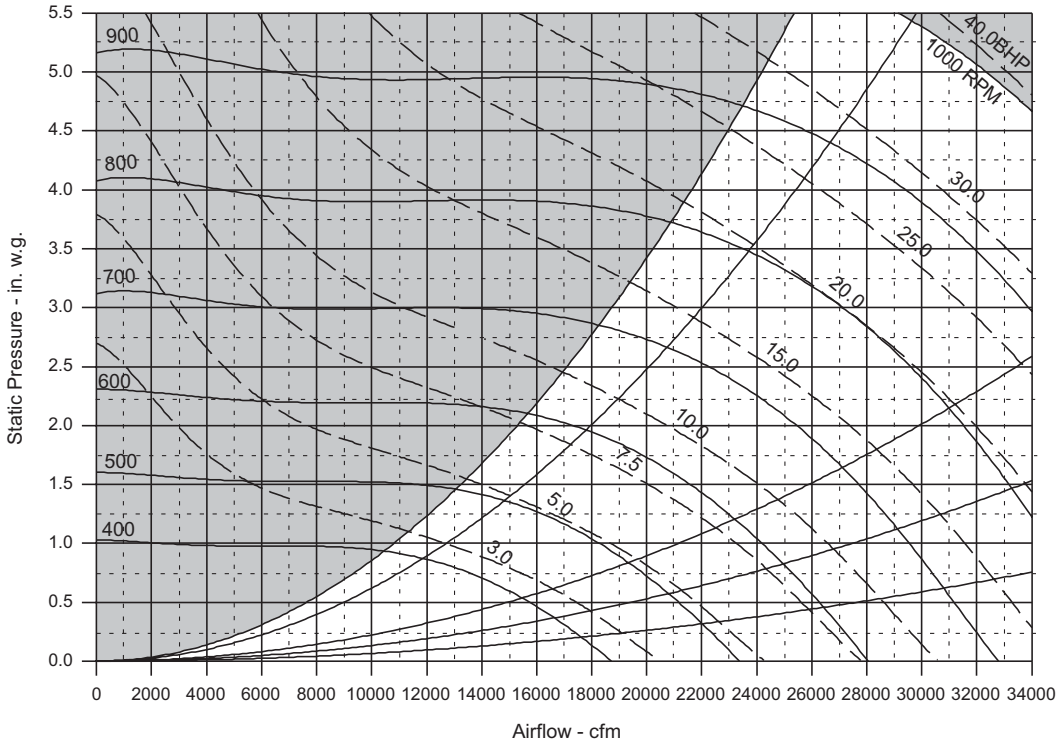
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 67: RDT 045D to 079D 40 in. SWSI Airfoil Supply Fan



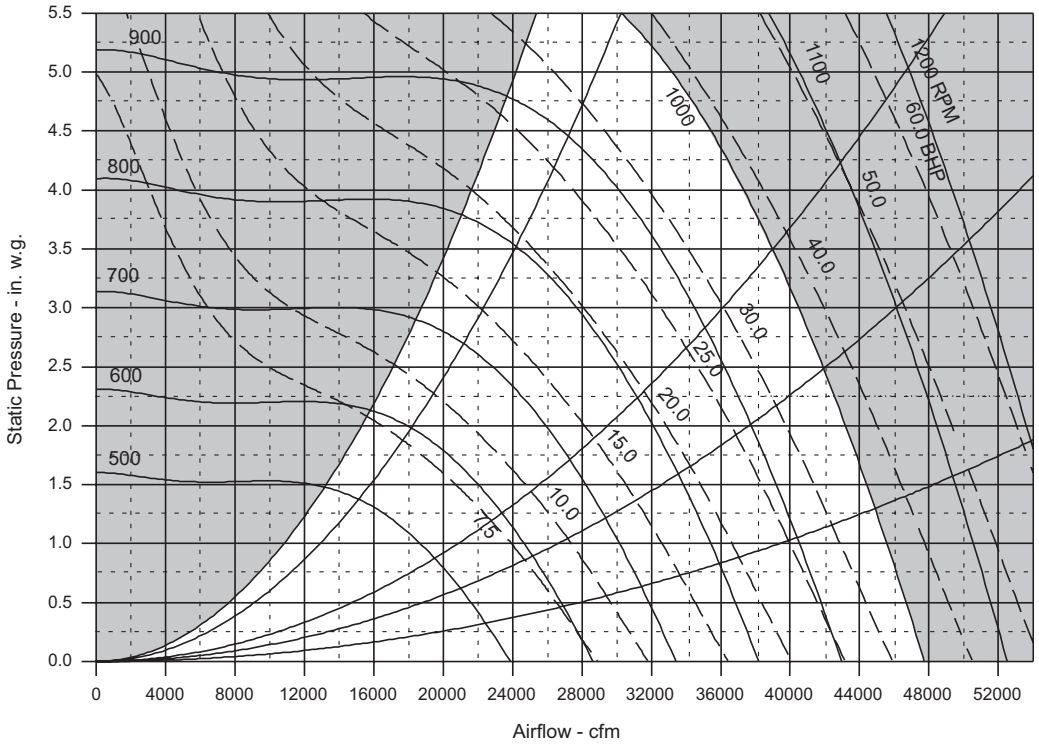
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 68: RDT 045D to 079D 44 in. SWSI Airfoil Supply Fan



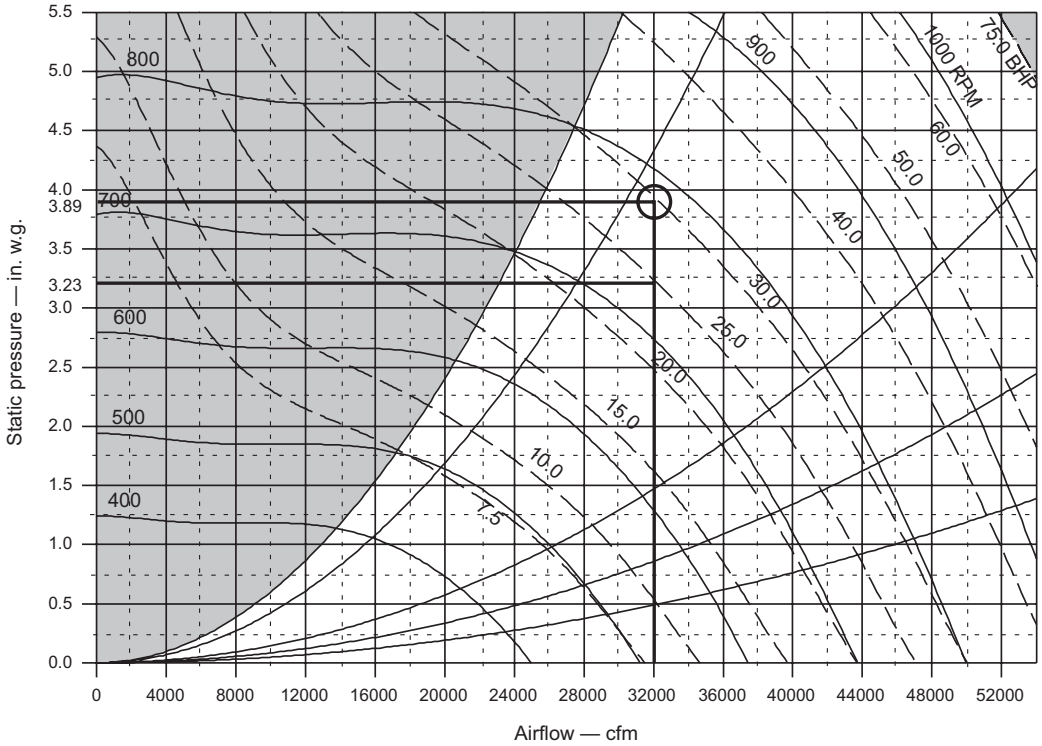
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 69: RDT 080D to 140D 44 in. SWSI Airfoil Supply Fan



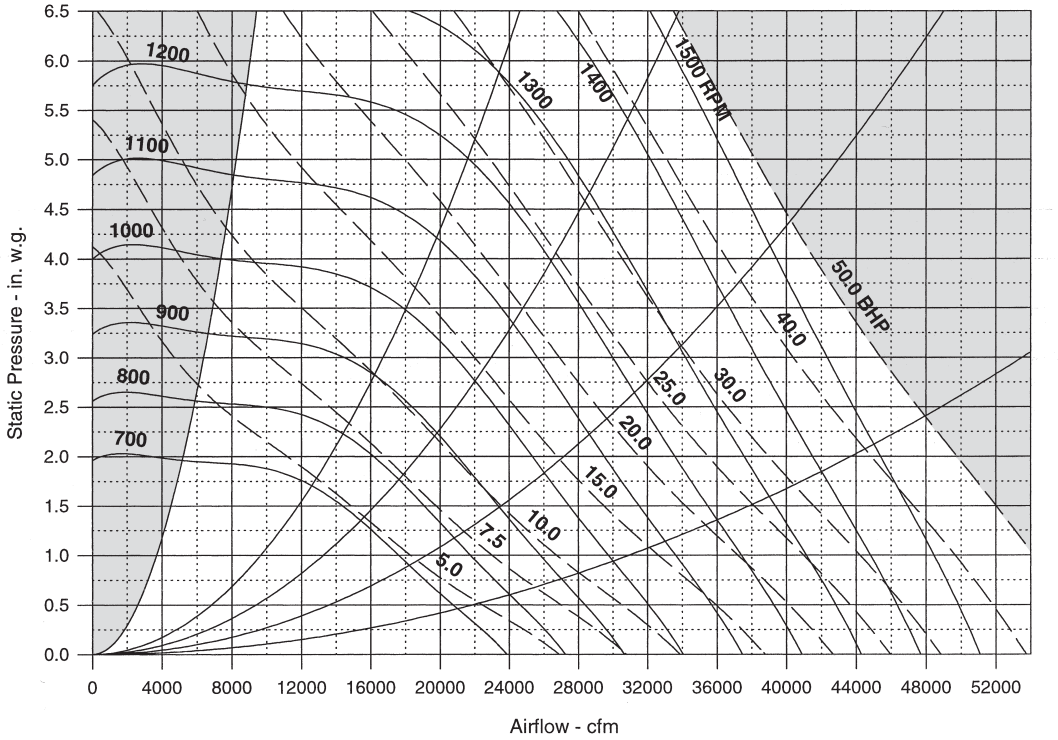
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 70: RDT 080D to 140D 49 in. SWSI Airfoil Supply Fan



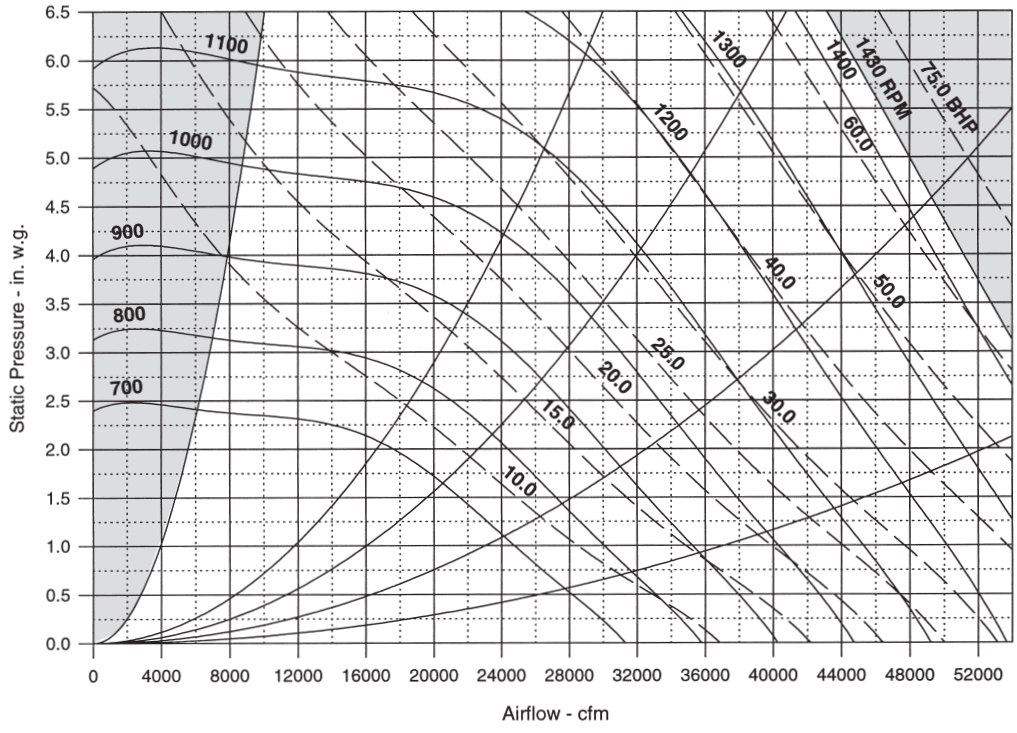
NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 71: RPS/RFS 080D to 105D 33 in. Airfoil Supply Fan



NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

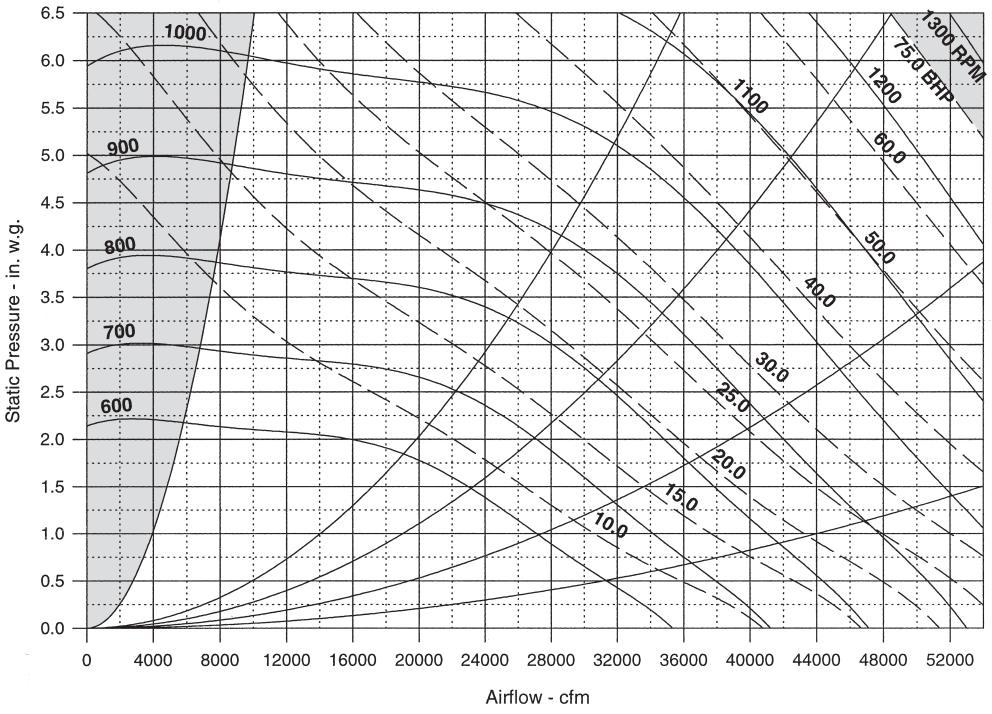
Figure 72: RPS/RFS 080D to 140D 36 in. Airfoil Supply Fan



Do Not Select

NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 73: RPS/RFS 080D to 140D 40 in. Airfoil Supply Fan



Do Not Select

NOTE: Maximum allowable static pressure at fan bulkhead is 5.0 in. (i.e., ESP plus blow-through component pressure drops cannot exceed 5.0 in).

Figure 74: RPS/RFS/RDT 045D to 140D (1) 36 in. Propeller Exhaust Fan

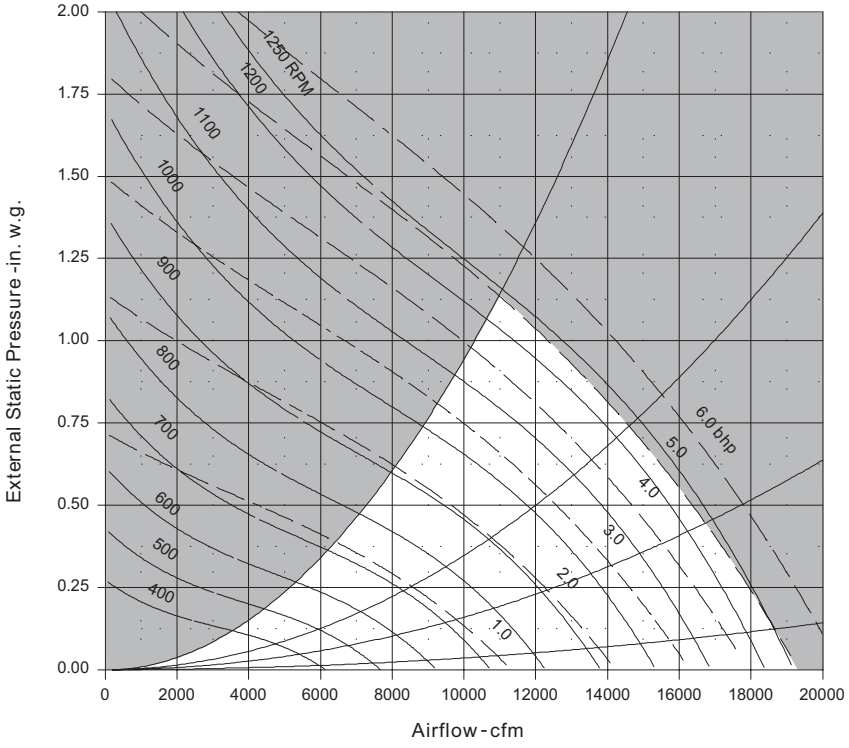


Figure 75: RPS/RFS/RDT 045D to 140D (2) 36 in. Propeller Exhaust Fan

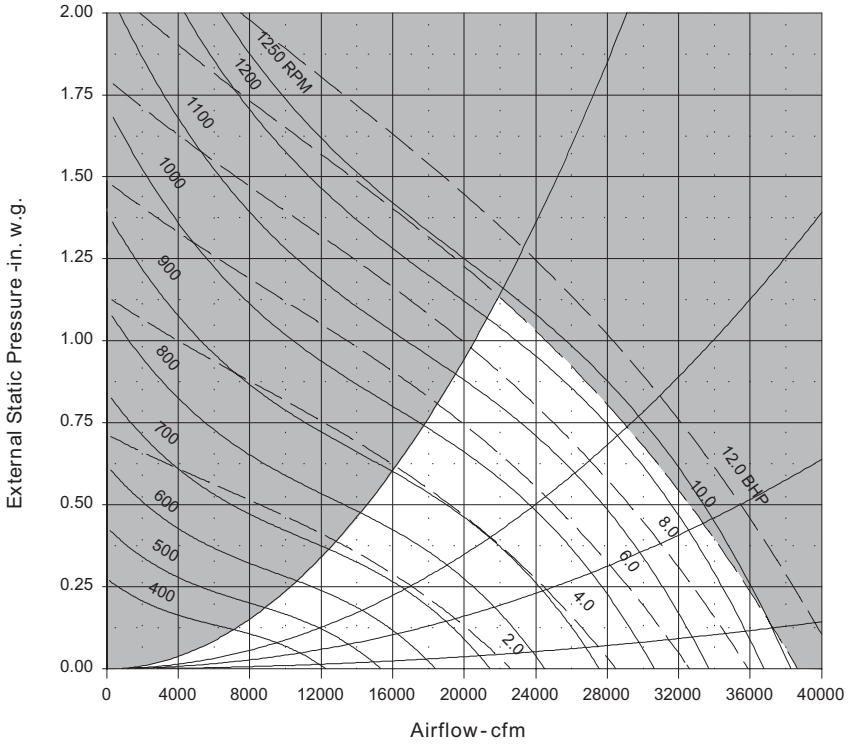


Figure 76: RPS/RFS/RDT 080D to 140D (3) 36 in. Propeller Exhaust Fan

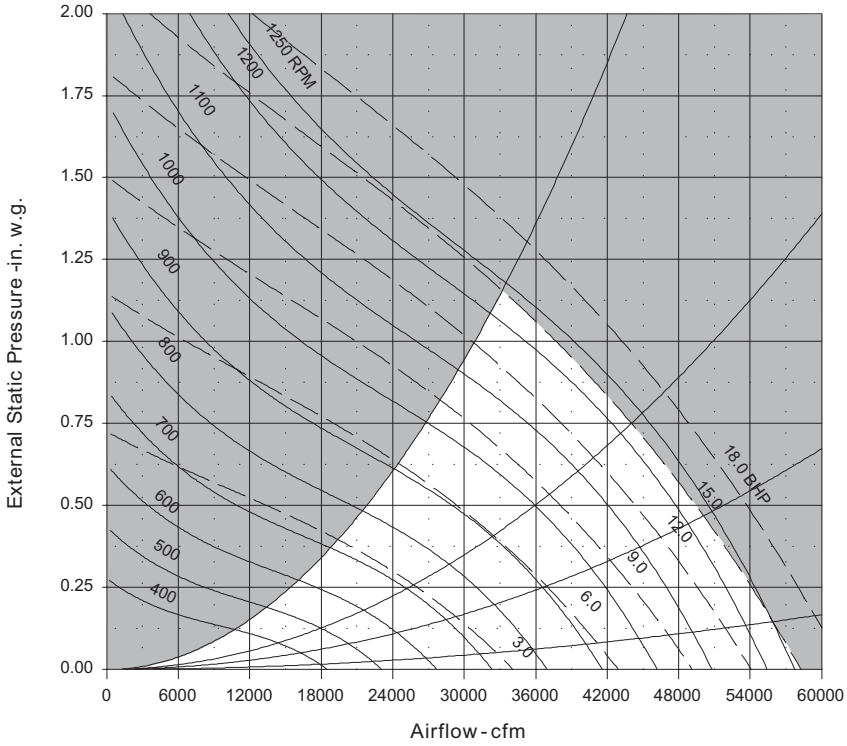
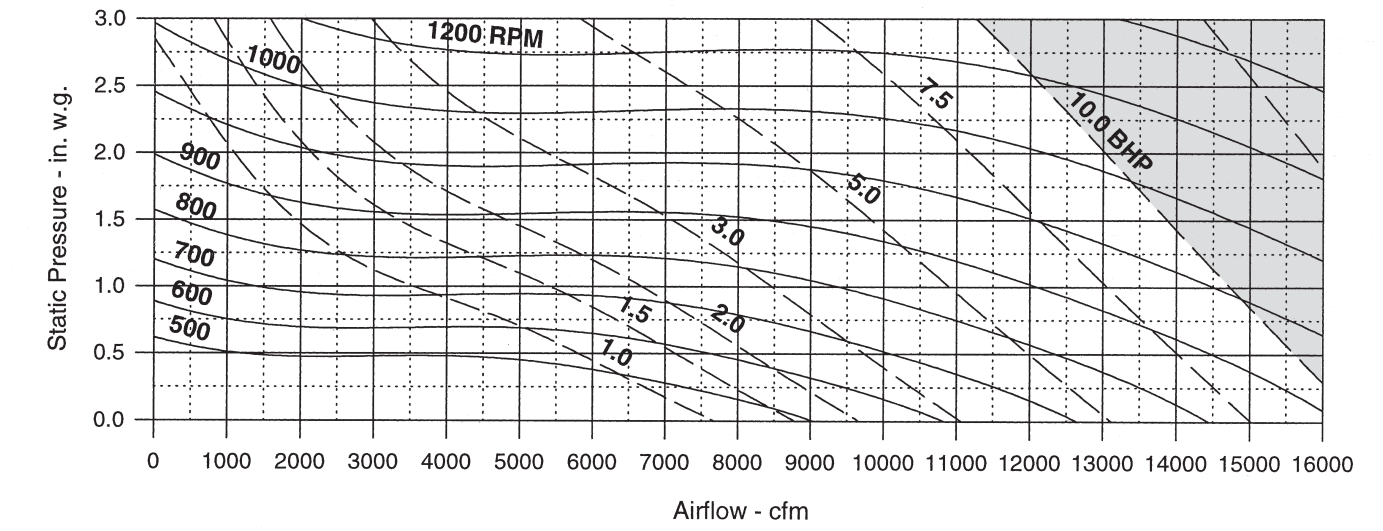
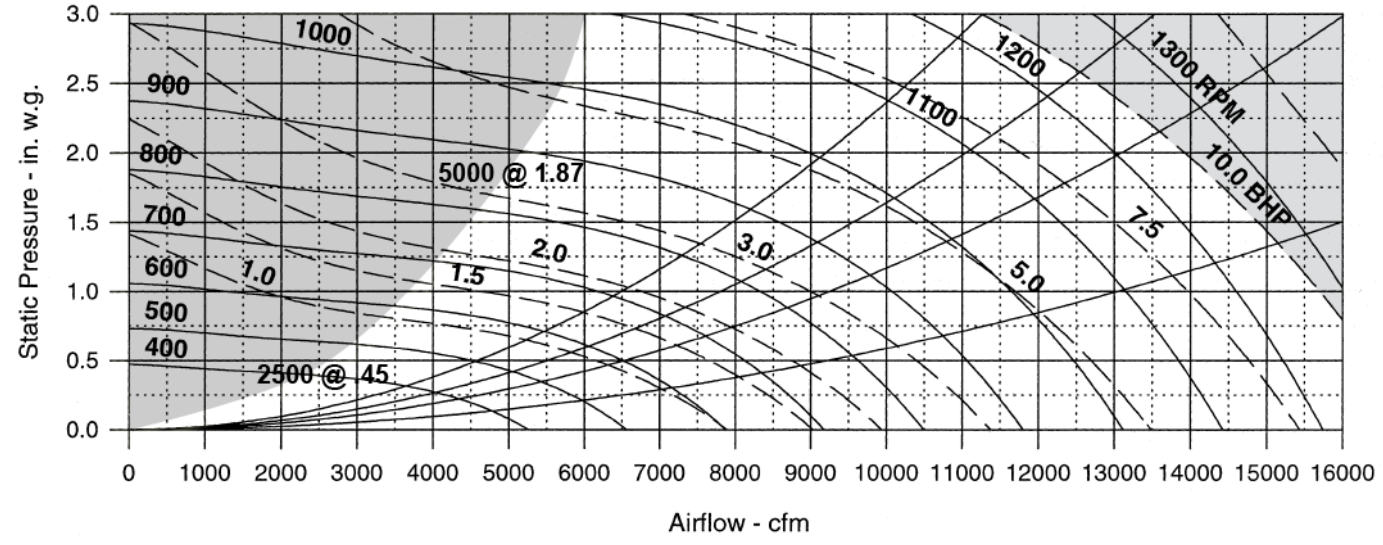


Figure 77: RPS/RFS 015D to 031D, (2) 15 in. × 15 in. Forward Curved Return Fan



Do Not Select

*Figure 78: RPS/RFS 015D to 042D, 30 in. SWSI Airfoil Return Fan**



Do Not Select

*Fan curve applicable for bottom return. Back return corrections are listed below.

Back Return Performance Correction

For 30 in. airfoil fan with back return, add the following static pressure drop to the design return duct static pressure drop. Enter Figure 78 at this greater static pressure and the design airflow to determine actual back return performance.

Table 29: Additional Back Return Static Pressure, 30 in. Airfoil Return Fan

Airflow (cfm)	4,000	6,000	8,000	10,000	12,000	14,000
Back return SP (in. W.G.)	0.05	0.12	0.21	0.33	0.48	0.65

Figure 79: RPS/RFS/RDT 035D to 042D, 40 in. SWSI Airfoil Return Fan (Bottom Return Only)

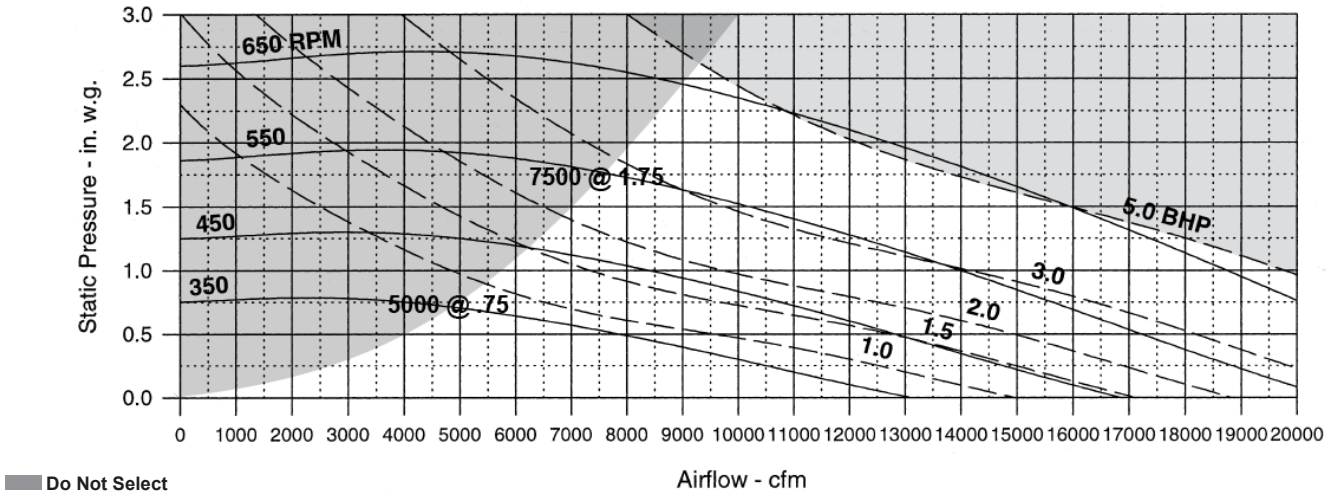


Figure 80: RPS/RFS/RDT 045D to 079D, 40 in. SWSI Airfoil Return Fan

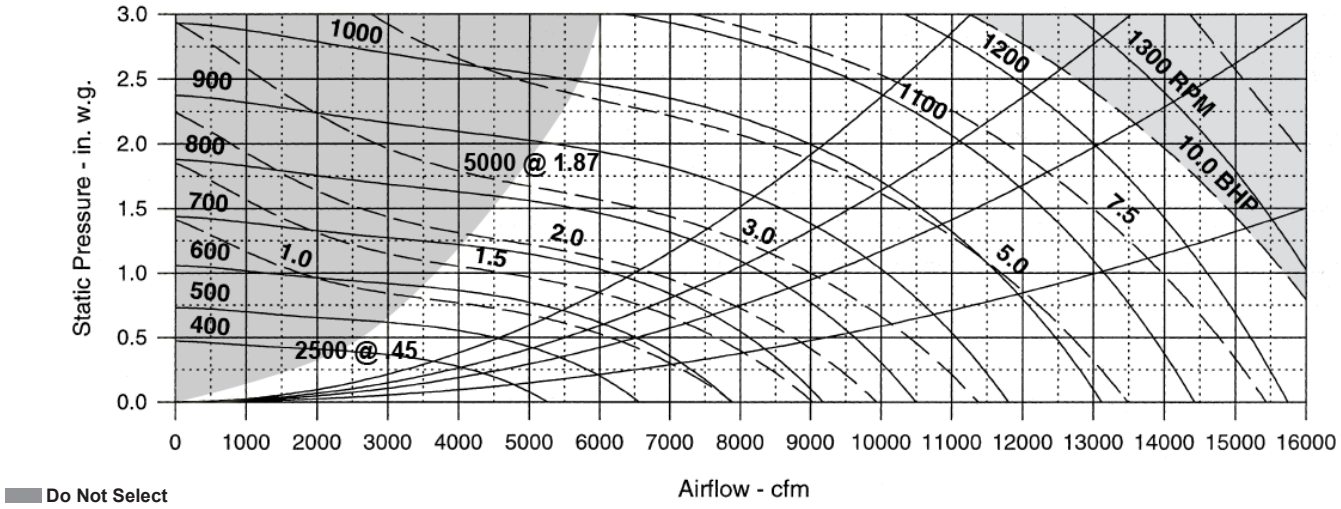
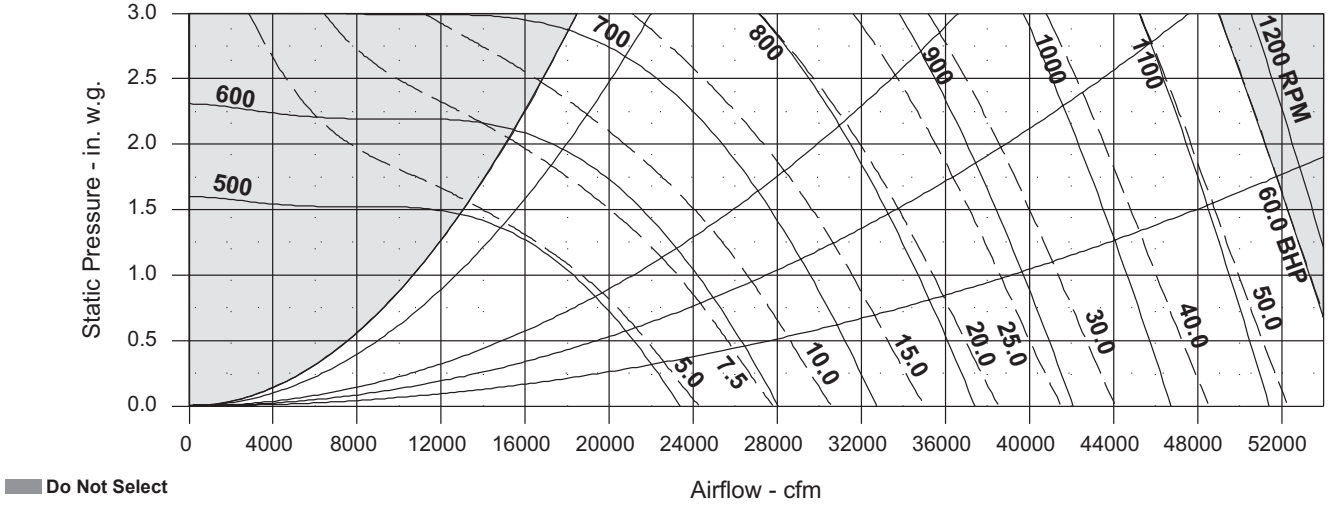


Figure 81: RPS/RFS/RDT 080D to 140D, 44 in. SWSI Airfoil Return Fan



Section Options and Locations

Figure 82—Figure 90 show section options, curb lengths, and relative positions. Curb lengths (in inches) are shown below each icon.

Figure 82: RPS/RFS/RCS 015D to 031D, Draw-Through Coil Section

Position A Outdoor/ Return Air Mandatory	**Position B** Filter Mandatory	**Position C** Blank (Optional)	**Position E** Blank (Optional)	**Position F** Draw-through Clg/Supply Air Fan Mandatory	**Position G** Heat/Blank (Optional)	**Position H** Blank (Optional)	**Position I** Blank w/Drain Pan (Optional)	**Position J** Final Filter (Optional)	**Position K** Discharge Plenum Mandatory	**Position L** Blank Compartment (Optional)	**Position M** Air-Cooled Condenser
OA Hood 0 Plenum 40 30% OA 40 Economizer 40 Economizer w/ (2) 15"x15" FC Return Fan 62 Economizer with 30" AF Return Fan 52	Angular 22 Cartridge 24 sq. ft. 28 Blank Access 22 Blank Access 28 Blender & Angular Filter 74 Blender & Cartridge Filter 80	Blank Access 40 Blank Access 52 VFD Section 52	Blank Access 40	(2) 15" FC with DX Coil 18.5 sq. ft. 015-020 27.0 sq. ft. 025-030 40 20" AF with DX Coil 18.5 sq. ft. 015-020 27.0 sq. ft. 025-030 52	Steam/ Hot Water 20.3 sq.ft. 40 Electric 40 Gas 200-1000 mbh 40 Blank Access 40	Blank Access 40 Blank Access 52 Sound Attenuator 52	Drain Pan Only 40	W/Cig Only, Steam or Hot Water Heat 24 sq.ft. 28 W/ Gas or Electric Heat 24 sq.ft. 52 Blank Access 28 Blank Access 52	Discharge Plenum 40	Compartment (out of airstream) 40	Air-Cooled Condenser 61 (015-025) (Does not affect curb length) 83 (030) (Does not affect curb length) 106 (016, 021, 026, 031)

Figure 83: RPS/RFS/RCS 035D and 042D, Blow-Through Coil Section (NA Final Filters)

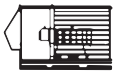
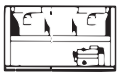
Position A Outdoor/ Return Air Mandatory	**Position B** Filter Mandatory	**Position C** Blank Optional	**Position D** Blank w/Drain Pan Optional	**Position E** Blank Optional	**Position F** Supply Air Fan Mandatory	**Position G** Heat/Blank Mandatory	**Position H** Blank Optional	**Position I** DX Coil Mandatory	**Position J** Blank Optional	**Position K** Discharge Plenum Mandatory	**Position L** Blank Compartment Optional	**Position M** Air-cooled Condenser
OA Hood  0 Plenum  52 30% OA  52 Economizer  52 Economizer w/ 30" AF Return Fan  52 Economizer w/ 40" AF Return Fan  80	Angular  22 Cartridge 24 sq. Ft  28 Blank Access  22 Blank Access  28 Blender & Angular Filter  74 Blender & Cartridge Filter  80	Blank Access  40 Blank Access  52 VFD Section  52	Drain Pan Only  40	Blank Access  40	24" Dia  62	Steam/ Hot Water  40 Electric  40 Gas  40 Blank Access  40	Blank Access  40 Blank Access  52 Sound Attenuator  52	DX Coil 27.0 sq. Ft.  22	Blank Access  28 Blank Access  52	Discharge Plenum  40	Compartment (out of airstream)  40	Air-cooled Condenser  83 (Does Not Affect Curb Length)  106 (042)

Figure 84: RPS/RFS/RCS 035D and 042D, Draw-Through Coil Section

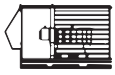
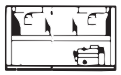
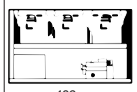
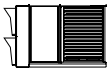
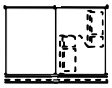
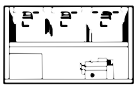
Position A Outdoor/ Return Air Mandatory	**Position B** Filter Mandatory	**Position C** Blank Optional	**Position D** DX Coil Mandatory	**Position E** Blank Optional	**Position F** Supply Air Fan Mandatory	**Position G** Heat/Blank Optional	**Position H** Blank Optional	**Position I** Blank w/Drain Pan Optional	**Position J** Final Filter Optional	**Position K** Discharge Plenum Mandatory	**Position L** Blank Compartment Optional	**Position M** Air-cooled Condenser
OA Hood  0 Plenum  52 30% OA  52 Economizer  52 Economizer w/ 30" AF Return Fan  52 Economizer w/ 40" AF Return Fan  80	Angular  22 Cartridge 24 sq. Ft  28 Blank Access  22 Blank Access  28 Blender & Angular Filter  74 Blender & Cartridge Filter  80	Blank Access  40 Blank Access  52 VFD Section  52	DX Coil 27.0 sq. Ft. 22	Blank Access  40	24" Dia  62	Steam/ Hot Water 20.3 sq. Ft  40 Electric  40 Gas 200-1000 mbh  40 Blank Access  40	Blank Access  40 Blank Access  52 Sound Attenuator  52	Drain Pan Only  40	W/Cig Only, Steam or Hot Water Heat 24 sq. Ft.  28 W/ Gas or Elec. Heat 24 sq. Ft.  52 Blank Access  28 Blank Access  52	Discharge Plenum  40	Compartment (out of airstream)  40	Air-cooled Condenser  83 (Does Not Affect Curb Length)  106 (042)

Figure 85: RPS/RFS/RCS 045D to 079D, Blow-Through Coil Section (NA Final Filters)

Position A Outdoor/ Return Air Mandatory	Position B Filter Mandatory	Position C Blank Optional	Position F Supply Air Fan Mandatory	Position G Heat Mandatory	Position H Blank Optional	Position I DX Coil Mandatory	Position K Discharge Plenum Mandatory	Position L Blank Compartment Optional	Position M Air-cooled Condensing Unit
Outdoor Air Hood  0 Plenum  48 30% Outside Air  48 Economizer  72 Economizer w/ Return Air Fan  72 Econ w/ Prop. Exh. Fans, Bottom or Back Ret. Fans  72 Econ w/ Prop. Exh. & Side Ret. Fans  120	Angular  24 Cartridge (40 sq. Ft)  24 Cartridge (48 sq. Ft.)  48 Blender & Angular or 40 sq ft Cartridge  72 Blender & 48 sq ft Cartridge  96 Blank  24 or 48	Blank  48 VFD Section  48	27" & 30" Dia  72 30" Dia  72 33"Dia  96	Steam/Hot Water  48 Electric  48 Gas  48 Blank  48	Blank  48 Sound Attenuator  48 Sound Attenuator*  72	(39.5 sq. ft.)  24 (47.1 sq. ft.)  48	Discharge Plenum  48	Blank Compartment  72	050D-068D Air-cooled Condenser  83 (Does not affect curb length) 051, 063, 070 thru 079D Air-cooled Condenser  106 (Does not affect curb length)

NOTE: Exhaust fan section dimensions do not include hood.

Figure 86: RPS/RFS/RCS 045D to 079D, Draw-Through Coil Section

Position A Outdoor/ Return Air Mandatory	Position B Filter Mandatory	Position C Blank Optional	Position D DX Coil Mandatory	Position F Supply Air Fan Mandatory	Position G Heat Mandatory	Position H Blank Optional	Position J Final Filter Optional	Position K Discharge Plenum Mandatory	Position L Blank Compartment Optional	Position M Air-cooled Condensing Unit
Outdoor Air Hood 0 Plenum 48 30% Outside Air 48 Economizer 72 Economizer w/ Return Air Fan 72 Econ w/ Prop. Exh. Fans, Bottom or Back Ret. 72 Econ w/ Prop. Exh. & Side Ret. 120	Angular 24 Cartridge (40 sq. ft.) 24 Cartridge (48 sq. ft.) 48 Blender & Angular or 40 sq ft Cartridge 72 Blender & 48 sq ft Cartridge 96 Blank 24 or 48	Blank 48 VFD Section 48	(39.5 sq. ft.) 24 (47.1 sq. ft.) 48	27" & 30" Dia 72 30" Dia 72 33" Dia 96	Steam/ Hot Water 48 Electric 48 Gas 48 Blank 48	Blank 48 Cooling Only, Steam or Hot Water Sound Attenuator 48 Gas or Electric Heat Sound Attenuator* 72	(40 sq. ft.) 48 72 Blank 48 Blank 72	Discharge Plenum 48	Blank Compartment 72	050D-068D Air-cooled Condenser 83 (Does not affect curb length) 051, 063, 070 thru 079D Air-cooled Condenser 106 (Does not affect curb length)

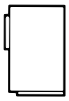
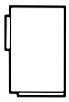
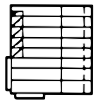
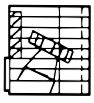
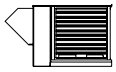
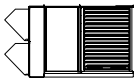
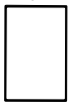
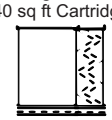
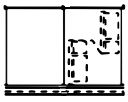
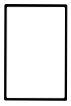
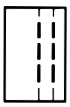
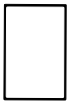
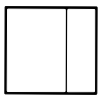
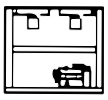
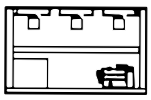
NOTE: Exhaust fan section dimensions do not include hood.
Some final filter lengths can not be reduced (consult the factory).

Example: RPS 050D with draw-through coil section

Section Description	Length (in.)
Economizer With Return Air Fan =	72
Angular Filters =	24
Cooling Coil =	24
Supply Fan =	72
Gas Heat =	48
Final Filter, Standard Flow =	48
Discharge Plenum =	48
Air Cooled Condensing Unit =	83
Total Air Handler Length =	336
Total Unit Length (including Condensing Unit) =	**419**

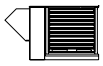
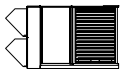
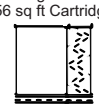
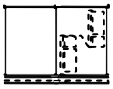
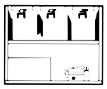
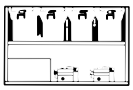
For a custom certified drawing of your specific requirements, consult your local Daikin Applied sales representative.

Figure 87: RDT 045D to 079D, Draw-Through Coil Section

Position A Exhaust/Return Air	Position B Filter	Position C Optional Blank	Position D DX Coil	Position E Optional Heat	Position F Supply Air Fan	Position L Optional Blank Compartment	Position M Air-Cooled Condensing Unit
OA Hood  Plenum  48 in. 30% OA  48 in. Economizer  72 in. Econ./RA  72 in. Econ w/ Prop. Exh. Fans, Bottom or Back Ret. Fans  72 Econ w/ Prop. Exh. & Side Ret. Fans  120	TA/30  24 in. 65/95 40 ft²  24 in. 65/95 48 ft²  48 in. Blank  48 in. Blank  24 in. Blender & Angular or 40 sq ft Cartridge  72 Blender & 48 sq ft Cartridge  96	Blank  48 in. VFD Section  48	40.1 ft²  24 in. 47.4 ft²  48 in.	S&HW  48 in. Blank  48 in.	40 in. or 44 in. Dia  72 in.	 72 in.	050D-068D  83 in. 051, 063, 070 thru 079D  106 in.

NOTE: Exhaust fan section dimensions do not include hood.

Figure 88: RPS/RFS/RCS 080D to 140D, Blow-Through Coil Section (NA Final Filters)

Position A Outdoor/ Return Air Mandatory	Position B Filter Mandatory	Position C Blank Optional	Position F Supply Air Fan Mandatory	Position G Heat Mandatory	Position H Blank Optional	Position I DX Coil Mandatory	Position K Discharge Plenum Mandatory	Position L Blank Compartment Optional	Position M Air-cooled Condensing Unit
Outdoor Air Hood  0 Plenum  72 30% Outside Air  72 Economizer  96 Economizer w/ Return Air Fan  96 Econ w/Prop. Exh. Fans, Back Ret.  72 Econ w/Prop. Exh. & Side Ret.  120 Econ w/Prop. Exh. Fans & Bottom Return  96	Angular  24 Cartridge (56 sq. ft.) (080D-090D only)  24 Cartridge (64 sq. ft.) (080D-140D only)  48 Cartridge (80 sq. ft.) (100D-140D only)  72 Blender & Angular or 56 sq ft Cartridge  72 Blender & 64 sq ft Cartridge  96 Blank  24 or 48	Blank  48 VFD Section  48	33” Dia  72 36” Dia  96 36” & 40” Dia  96	Steam/ Hot Water  48 Electric  48 Gas  48 Blank  48	Blank  48 Sound Attenuator  48 Sound Attenuator*  72	080D-090D (53.9 sq. ft.)  24 (60.8 sq. ft.)  48 100D-120D (60.8 sq. ft.)  48 (76.0 sq. ft.)  72 120D-140D (76.0 sq. ft.)  72	Discharge Plenum  48	Blank Compartment  72	080D-105D Air-cooled Condenser  106 (Does not affect curb length) 081, 091, 101, 110 thru 140D Air-cooled Condenser  139 (Does not affect curb length)

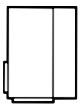
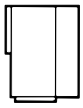
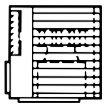
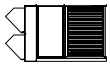
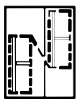
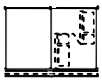
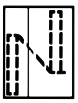
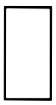
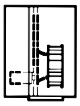
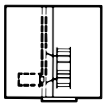
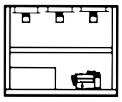
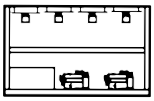
NOTE: Exhaust fan section dimensions do not include hood.

Figure 89: RPS/RFS/RCS 080D to 140D, Draw-Through Coil Section

Position A Outdoor/ ReturnAir Mandatory	Position B Filter Mandatory	Position C Blank Optional	Position D DX Coil Mandatory	Position F Supply Air Fan Mandatory	Position G Heat Mandatory	Position H Blank Optional	Position J Final Filter Optional	Position K Discharge Plenum Mandatory	Position L Blank Compartment Optional	Position M Air-cooled Condensing Unit
Outdoor Air Hood 0 Plenum 72 30% Outside Air 72 Economizer 96 Economizer w/ Return Air Fan 96 Econ w/Prop. Exh. Fans, Back Ret. 72 Econ w/Prop. Exh. & Side Ret. 120 Econ w/ Prop. Exh. Fans & Bottom Return 96	Angular 24 Cartridge (56 sq. ft.) (080D-090D only) 24 Cartridge (64 sq. ft.) (080D-140D only) 48 Cartridge (80 sq. ft.) (100D-140D only) 72 Blender & Angular or 56 sq ft Cartridge 72 Blender & 64 sq ft Cartridge 96 Blank 24 or 48	Blank 48 VFD Section 48	080D-090D (53.9 sq. ft.) 24 (60.8 sq. ft.) 48 100D-120D (60.8 sq. ft.) 48 (76.0 sq. ft.) 72 120D-140D (76.0 sq. ft.) 72	33" Dia 72 36" Dia 96 36" & 40" Dia 96	Steam/ Hot Water 48 Electric 48 Gas 48 Blank 48	Blank 48 Cooling Only, Steam or Hot Water Sound Attenuator 48 Gas or Electric Heat Sound Attenuator* 72	(56 sq. ft.) (080D-090D only) 48 (64 sq. ft.) 72 (80 sq. ft.) (100D-140D only) 96 Blank 48 Blank 72	080D-090D Discharge Plenum 48 100D-140D 72	Blank Compartment 72	080D-105D Air-cooled Condenser 108 (Does not affect curb length) 081, 091, 101, 110 thru 140D Air-cooled Condenser 139 (Does not affect curb length)

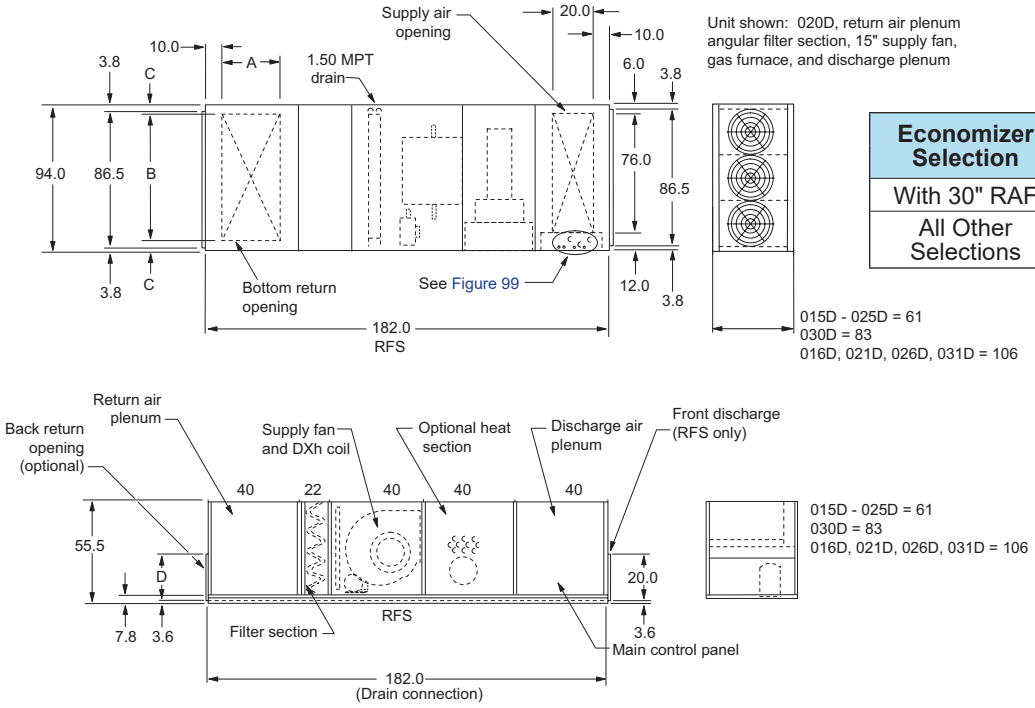
NOTE: Exhaust fan section dimensions do not include hood.
Some final filter lengths can not be reduced (consult the factory).

Figure 90: RDT 080D to 140D

Positon A Exhaust/Return Air	Positon B Filter	Positon C Optional Blank	Positon D DX Coil	Positon E Optional Heat	Positon F Supply Air Fan	Positon L Optional Blank Compartment	Positon M Air-Cooled Condensing Unit
OA/Hood  Plenum  72 in. 30% OA  72 in. Economizer  96 in. Econ/RAF  96 in. Econ w/ Prop. Exh. Fans, Bottom or Back Ret. Fans  72 Econ w/ Prop. Exh. & Side Ret. Fans  120	TA/30  24 in. 65/95 56 ft²  24 in. 65/95 64 ft²  48 in. Blank  48 in. Blank  24 in. 65/95 80 ft²  72 in. Blender & Angular or 56 sq ft Cartridge  72 Blender & 64 sq ft Cartridge  96	Blank  48 in. VFD Section  48	54.7 ft²  24 in. 62 ft²  48 in. 76.6 ft²  72 in.	S&HW  48 in. Blank  48 in.	44 in. Dia  72 in. 49 in. Dia  96 in.	72 in.	080D-105D  106 in. 081, 091, 101, 110 thru 140D  139 in.

NOTE: Exhaust fan section dimensions do not include hood.

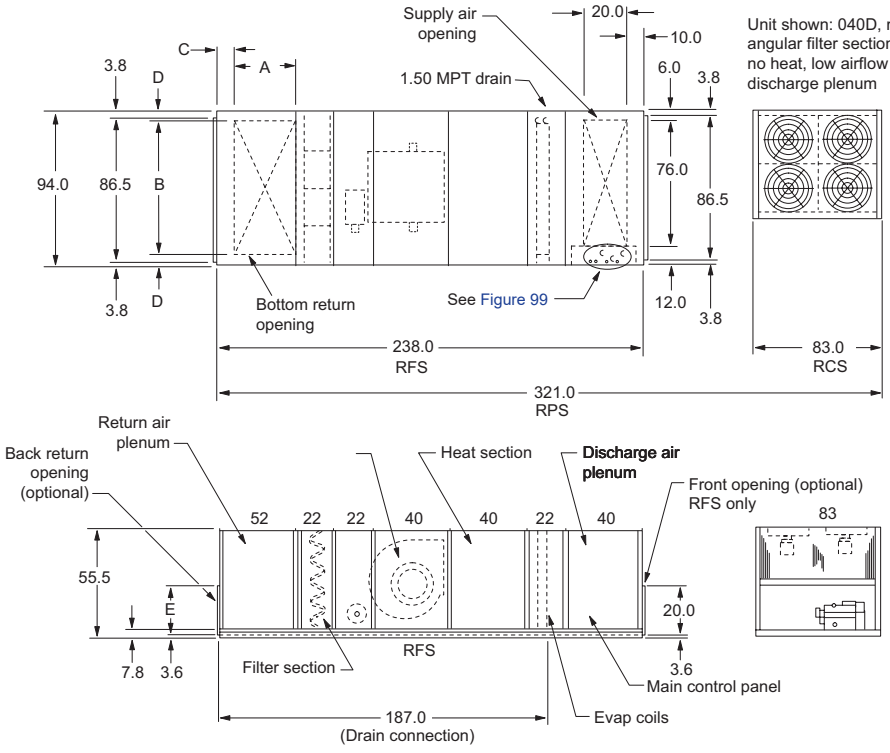
Figure 91: RPS/RFS/RCS 015D to 031D, Basic Configuration



1. Unit length varies depending on the configuration (sections and options ordered). See Figure 82 for air handler section lengths.
2. Figures illustrate an RFS/RCS configuration. An RPS is a single piece.

Economizer Selection	(inches)			
	A	B	C	D
With 30" RAF	30	76	9	16
All Other Selections	24	82	6	20

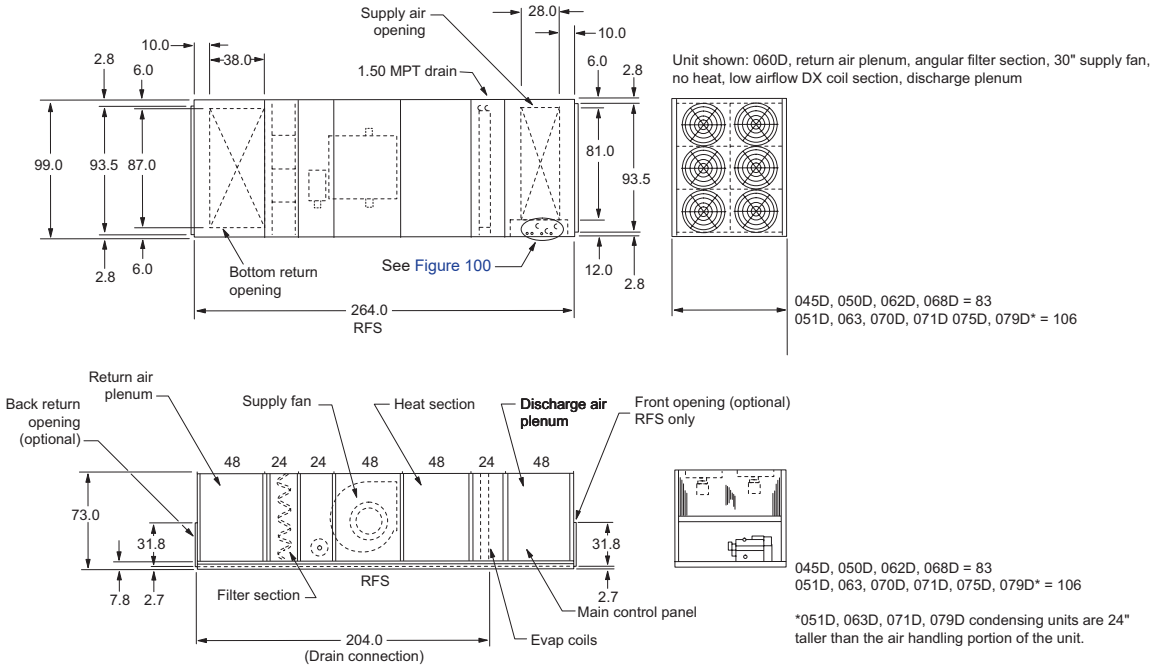
Figure 92: RPS/RFS/RCS 035D to 042D, Basic Configuration



1. Unit length varies depending on the configuration (sections and options ordered). See Figure 83 and Figure 84 for air handler section lengths.
2. Figures illustrate an RFS/RCS configuration. An RPS is a single piece.

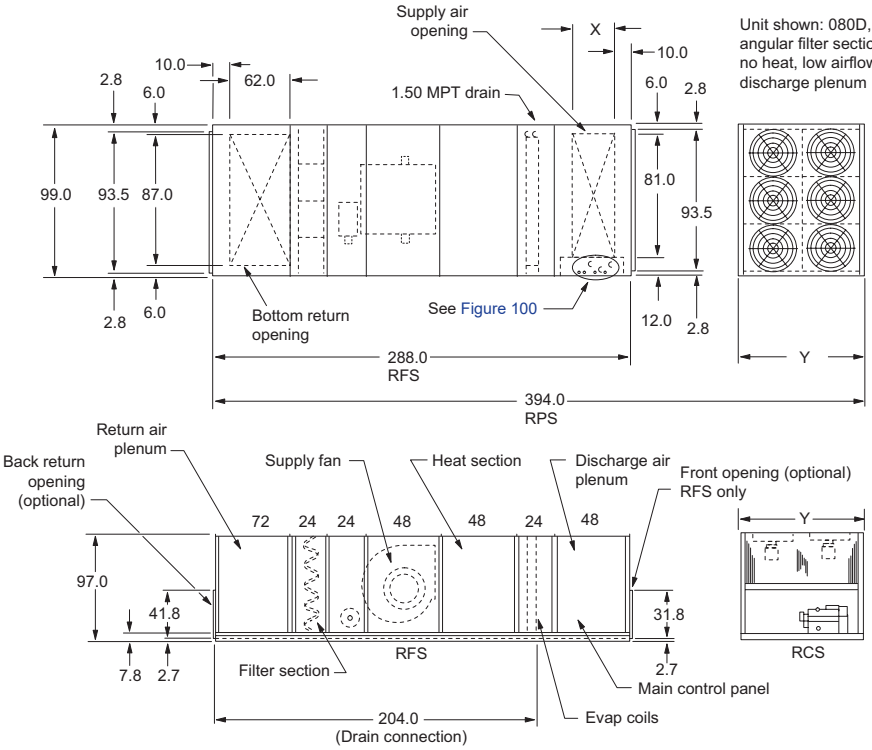
Return Fan	(inches)				
	A	B	C	D	E
None	24	82	10	6	20
With 30" AF	30	76	10	9	16
With 40" AF	36	78	18	8	N/A

Figure 93: RPS/RFS/RCS 045D to 079D



1. Unit length varies depending on the configuration (sections and options ordered). See Figure 84 through Figure 86 for air handler section lengths.
2. Figures illustrate an RFS/RCS configuration. An RPS is a single piece.

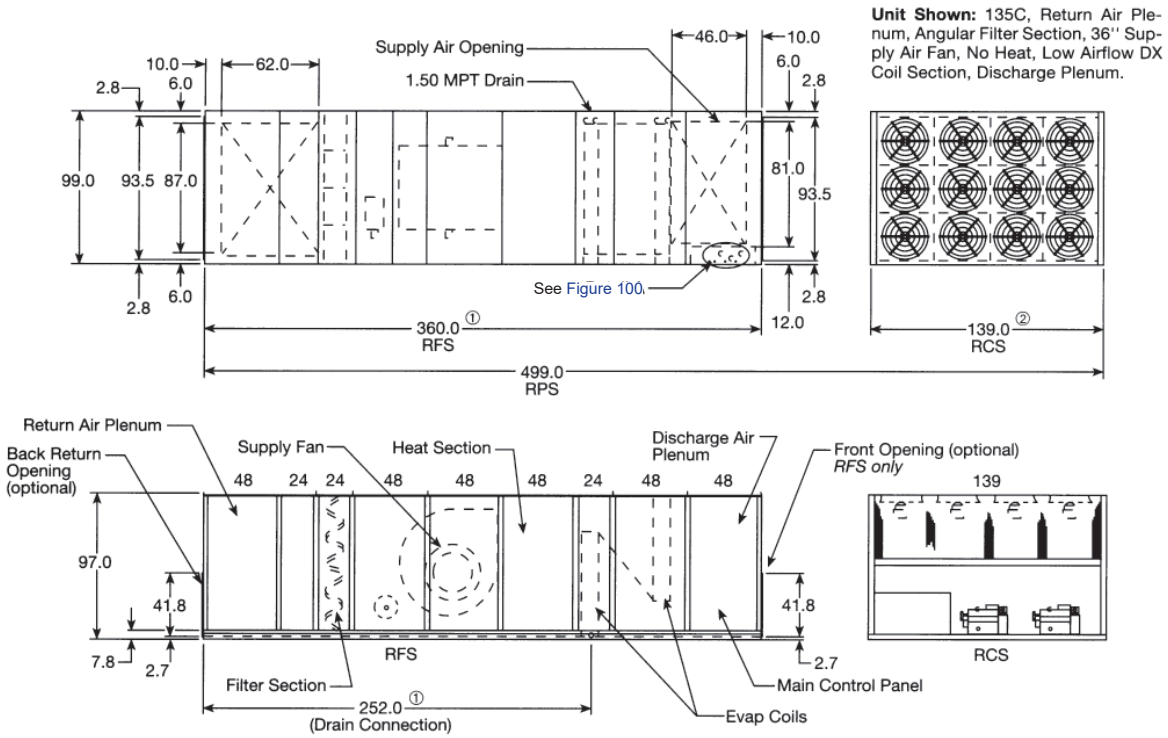
Figure 94: RPS/RFS/RCS 080D to 105D



Unit Size	(inches)	
	X	Y
080D, 085D, 090D	38	106
100D, 105D	46	106
081D, 091D	38	139
101D	46	139

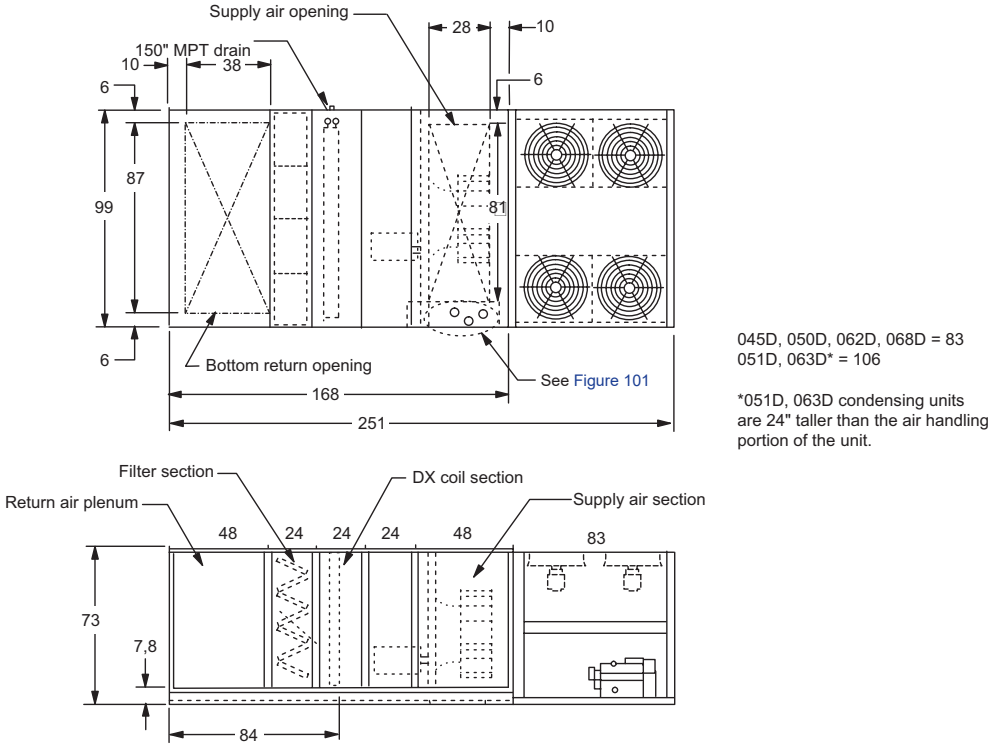
1. Unit length varies depending on the configuration (sections and options ordered). See Figure 88 through Figure 90 for air handler section lengths.
2. Figures illustrate an RFS/RCS configuration. An RPS is a single piece.

Figure 95: RPS/RFS/RCS 110D to 140D



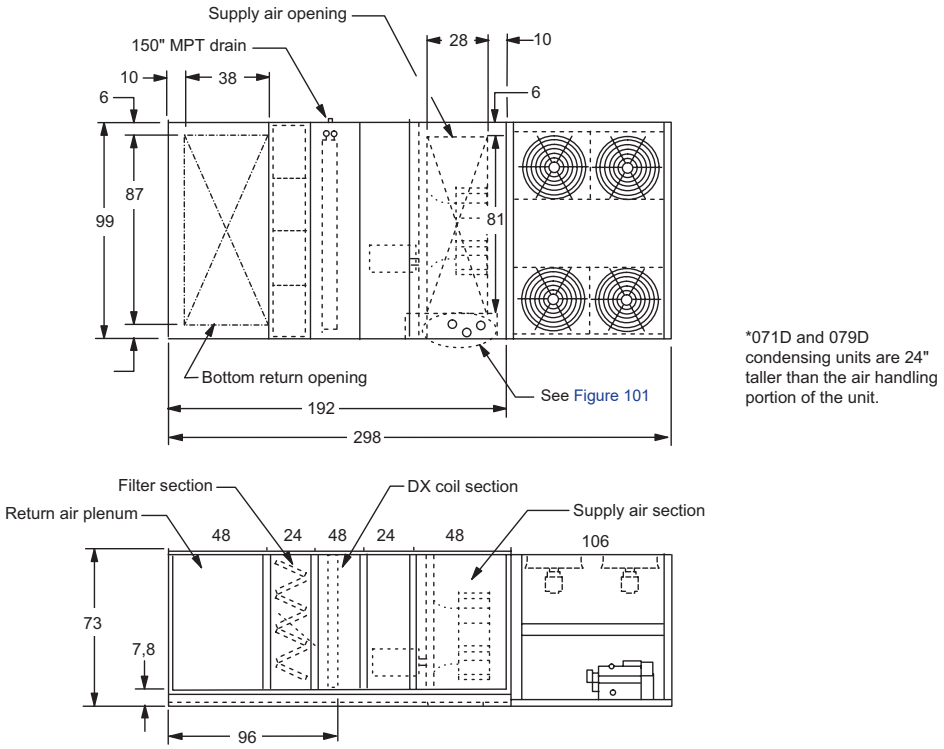
1. Unit length varies depending on the configuration (sections and options ordered). See Figure 88 through Figure 90 for air handler section lengths.
2. Figures illustrate an RFS/RCS configuration. An RPS is a single piece.

Figure 96: RDT 045D to 068D



1. Unit length varies depending on the configuration (sections and options ordered). See Figure 88 through Figure 90 for air handler section lengths.
2. Figures illustrate an RFS/RCS configuration. An RPS is a single piece.

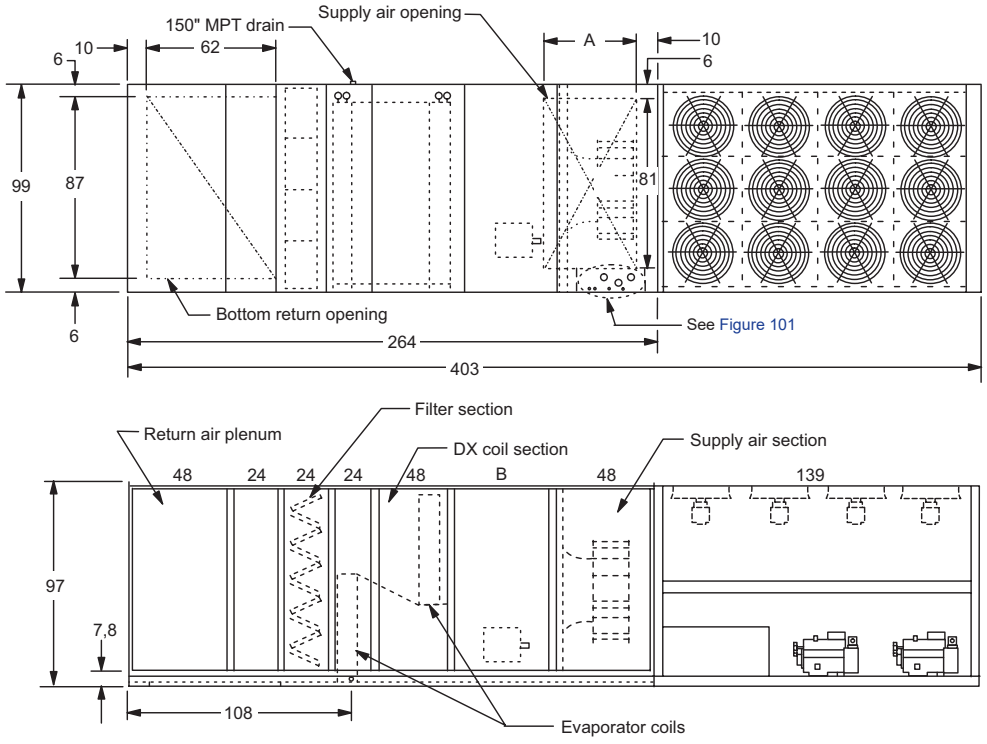
Figure 97: RDT 070D to 079D



*071D and 079D condensing units are 24" taller than the air handling portion of the unit.

1. Unit length varies depending on the configuration (sections and options ordered). See Figure 88 through Figure 90 for air handler section lengths.
2. Figures illustrate an RFS/RCS configuration. An RPS is a single piece.

Figure 98: RDT 080D to 140D



Unit Size	(inches)		
	A	B	C
44" SAF	38	24	—
49" SAF	46	48	—
080D, 085D, 090D, 100D, 105D	—	—	106
081D, 091D, 101D, 110D–140D	—	—	139

1. Unit length varies depending on the configuration (sections and options ordered). See Figure 88 through Figure 90 for air handler section lengths.
2. Figures illustrate an RFS/RCS configuration. An RPS is a single piece.

Electrical Knockout Locations

Figure 99: Main Control Panel/Discharge Plenum, RPS/ RFS/RDT 015D to 042D

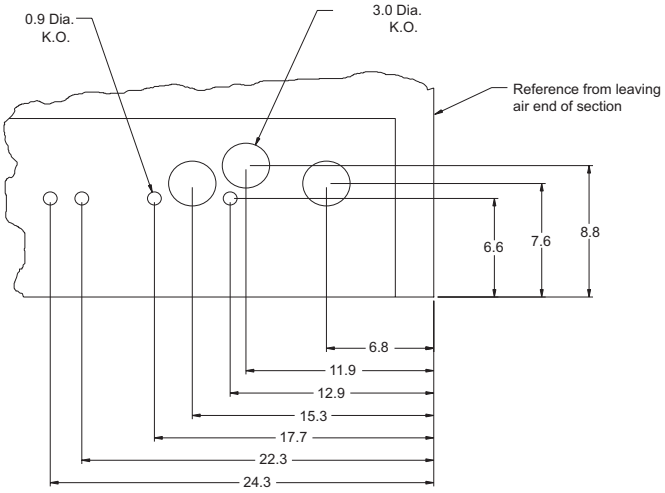


Figure 100: Main Control Panel/Discharge Plenum, RPS/ RFS/RDT 045D to 140D

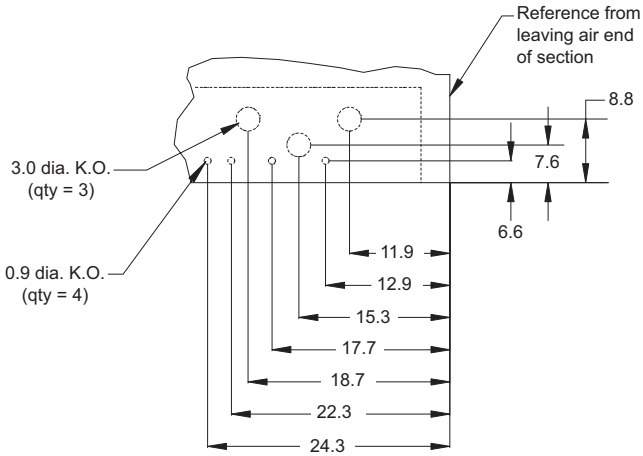
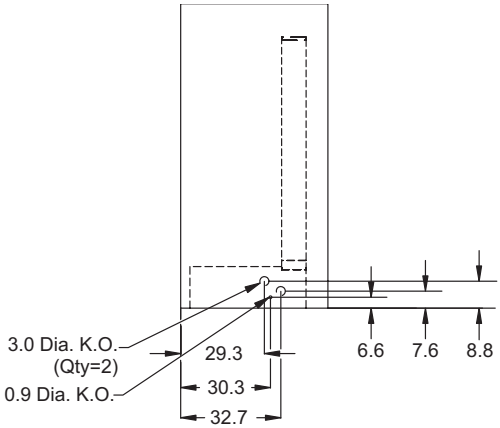
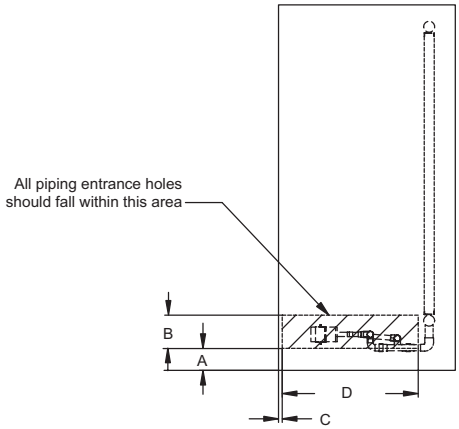


Figure 101: Electric Heat/Heat Section



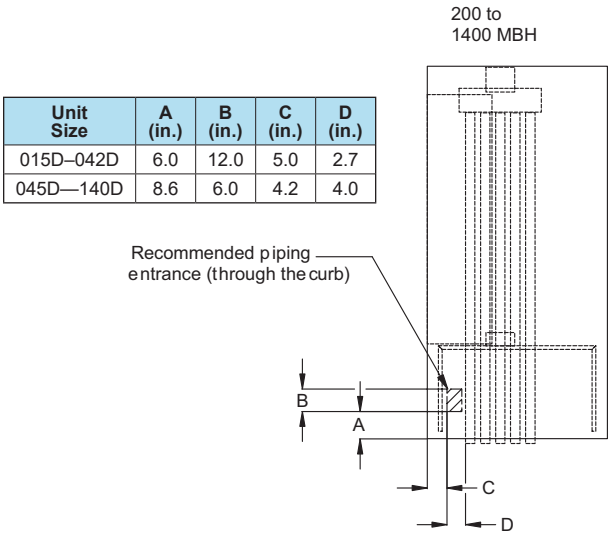
Piping Entrance Locations

Figure 102: Steam and Hot Water Heat/Heat Section



Unit Size	A (in.)	B (in.)	C (in.)	D (in.)
015D–042D	6.0	6.5	1.0	29.0
045D—140D	6.0	9.0	1.0	37.0

Figure 103: 200 to 1400 MBh Gas Heat/Heat Section



Unit Size	A (in.)	B (in.)	C (in.)	D (in.)
015D–042D	6.0	12.0	5.0	2.7
045D—140D	8.6	6.0	4.2	4.0

Figure 104: 1500 to 2000 MBh Gas Heat/Heat Section

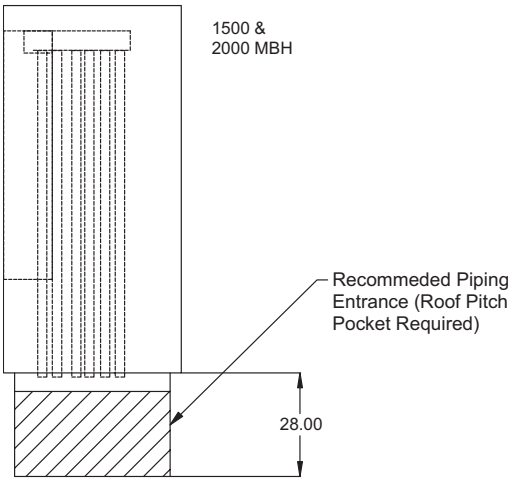
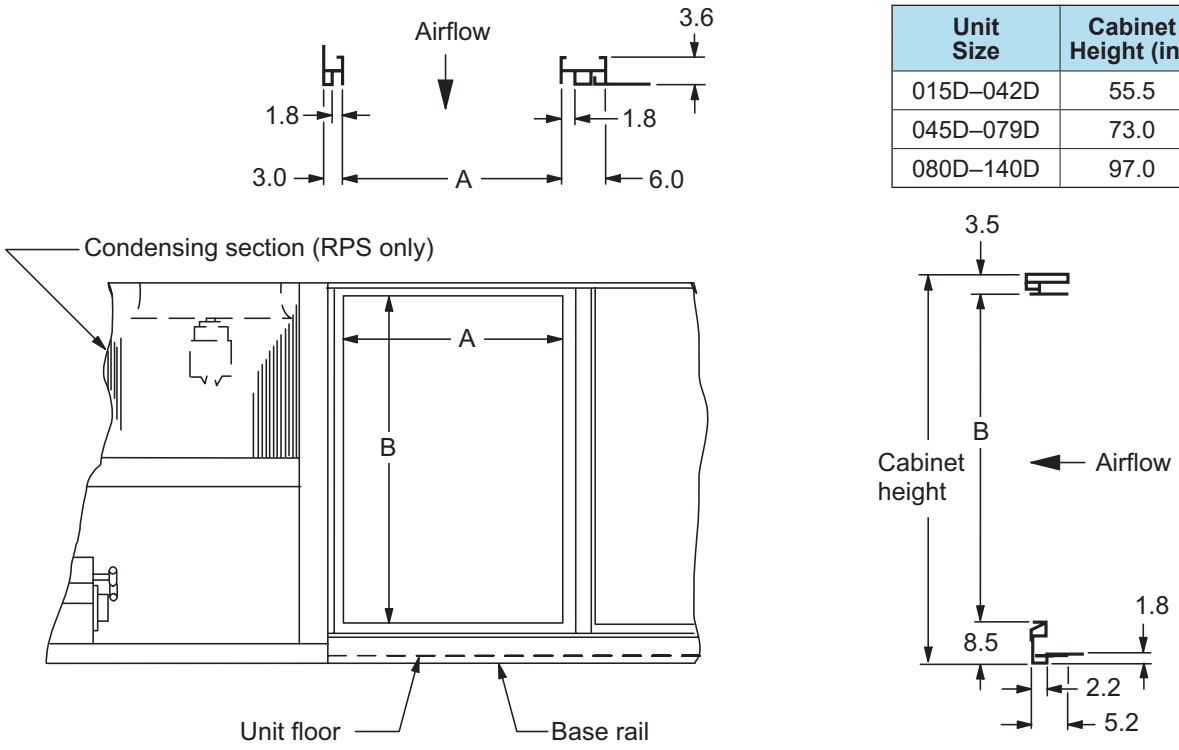
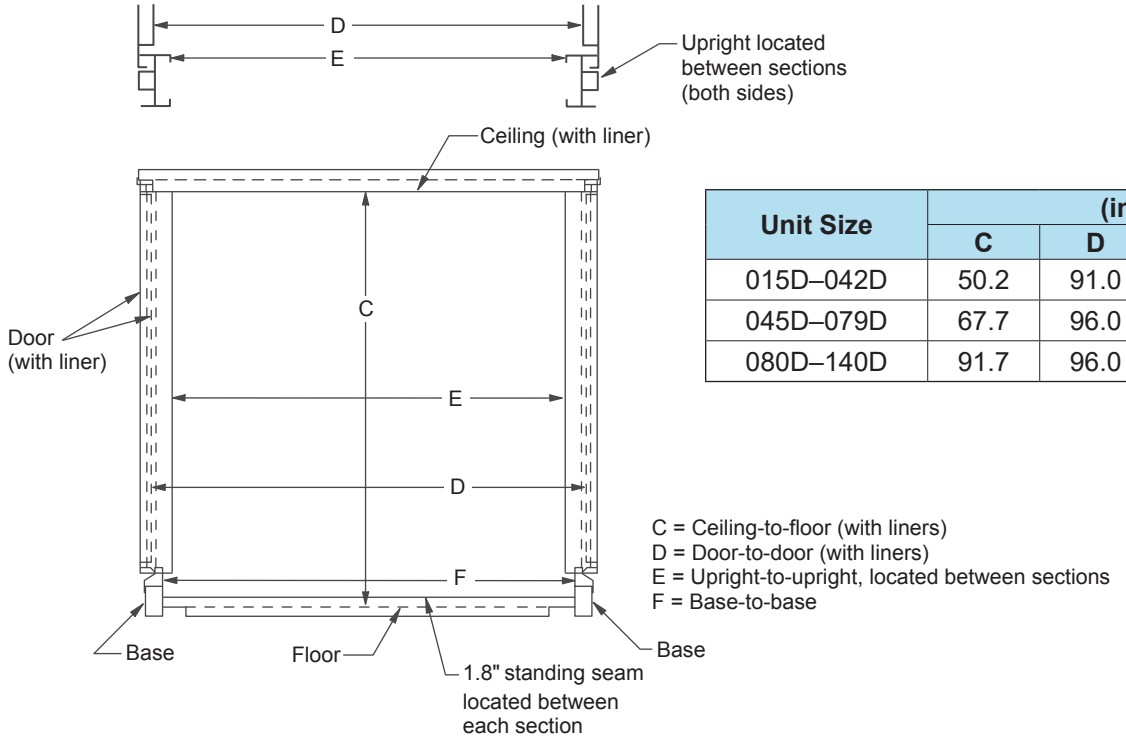


Figure 105: Side Discharge



Unit Size	Cabinet Height (in.)	Door Opening	
		A (in.)	B (in.)
015D–042D	55.5	34.0	43.5
045D–079D	73.0	42.0	61.0
080D–140D	97.0	42.0	85.0

Figure 106: Internal Cabinet Clearance, Air Toward Face



Unit Size	(inches)			
	C	D	E	F
015D–042D	50.2	91.0	86.8	90.0
045D–079D	67.7	96.0	91.8	95.0
080D–140D	91.7	96.0	91.8	95.0

C = Ceiling-to-floor (with liners)
D = Door-to-door (with liners)
E = Upright-to-upright, located between sections
F = Base-to-base

Figure 107: RPS/RFS/RDT 045D to 079D, Back Return Propeller Exhaust Fans (2 Shown, Dimensions in inches)

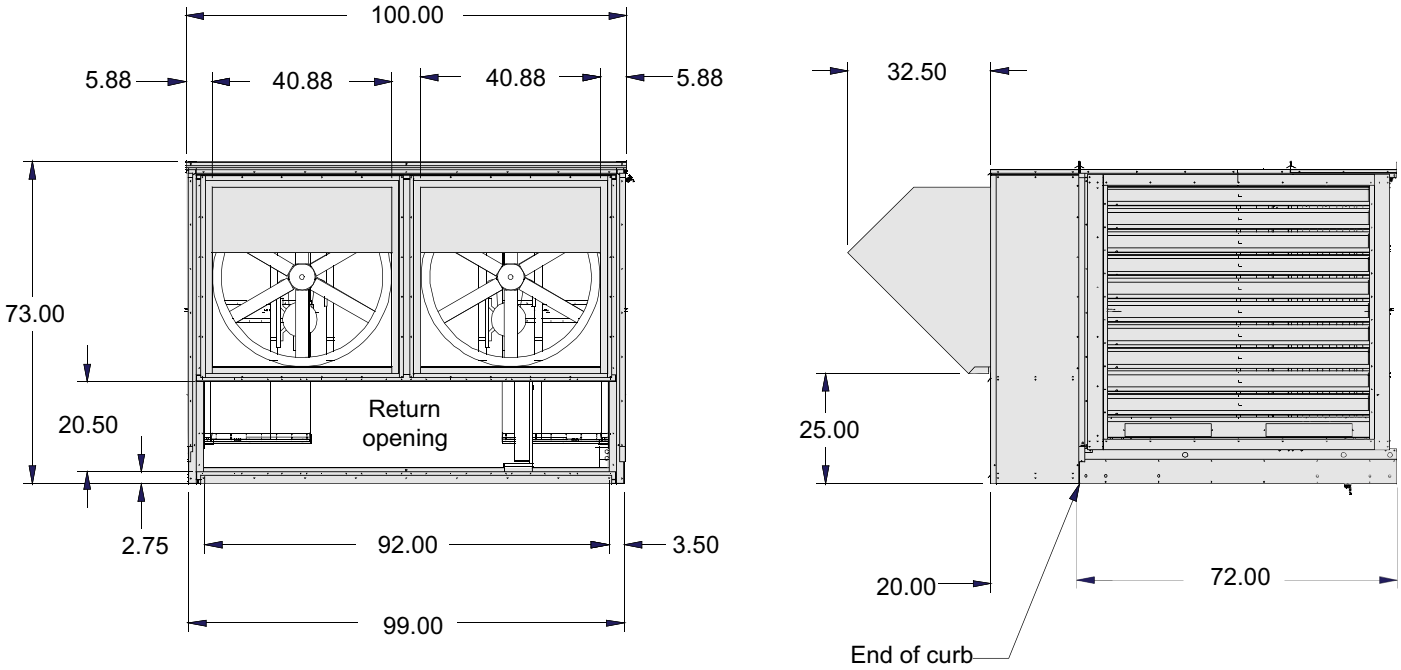
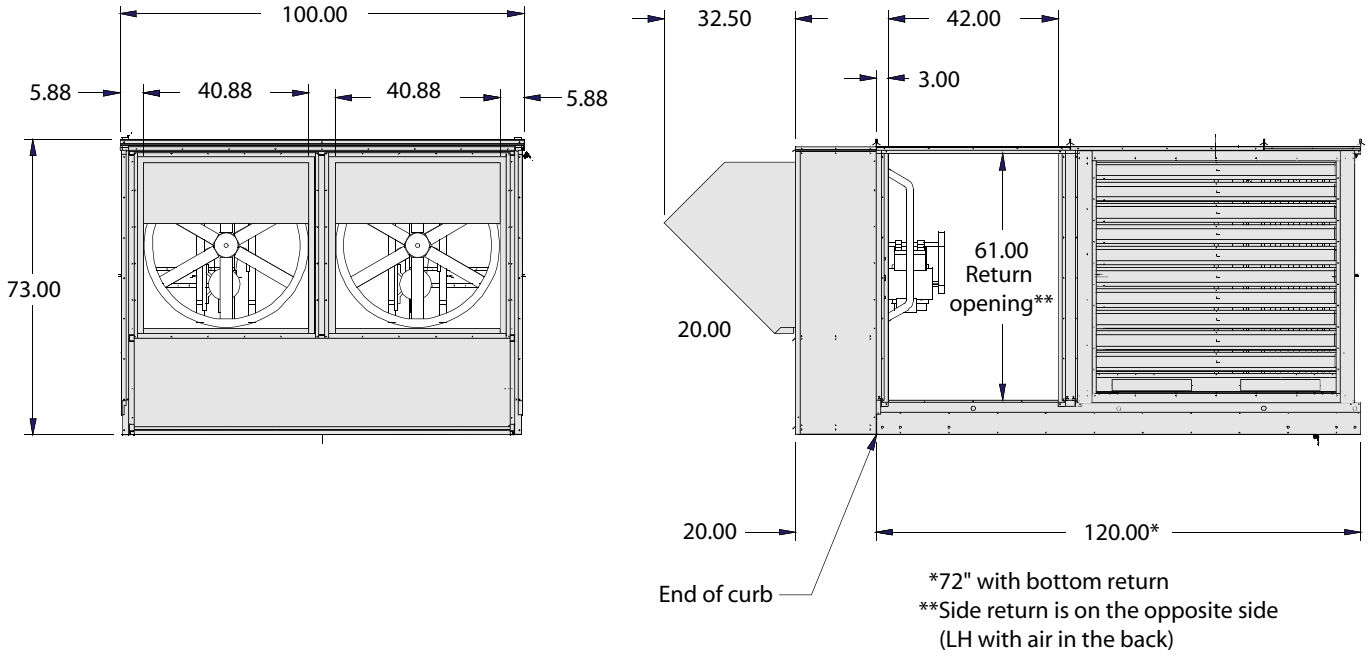


Figure 108: RPS/RFS/RDT 045D to 079D, Side Return Propeller Exhaust Fans (Dimensions in inches)



See Figures 91–95 on pages 96–98 for back return without exhaust fans.

Figure 109: RPS/RFS/RDT 080D to 140D, Back Return Propeller Exhaust Fans (Dimensions in inches)

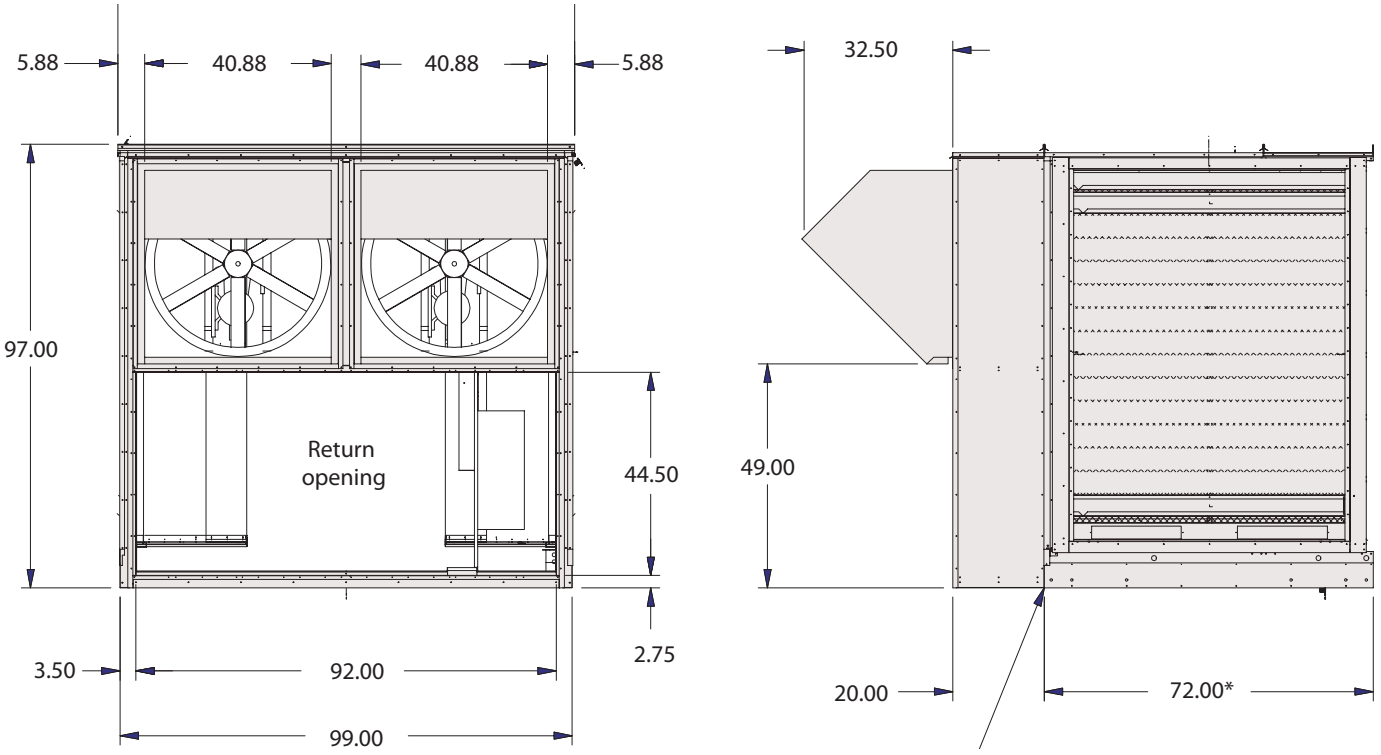


Figure 110: RPS/RFS/RDT 080D to 140D, Side Return Propeller Exhaust Fans (Dimensions in inches)

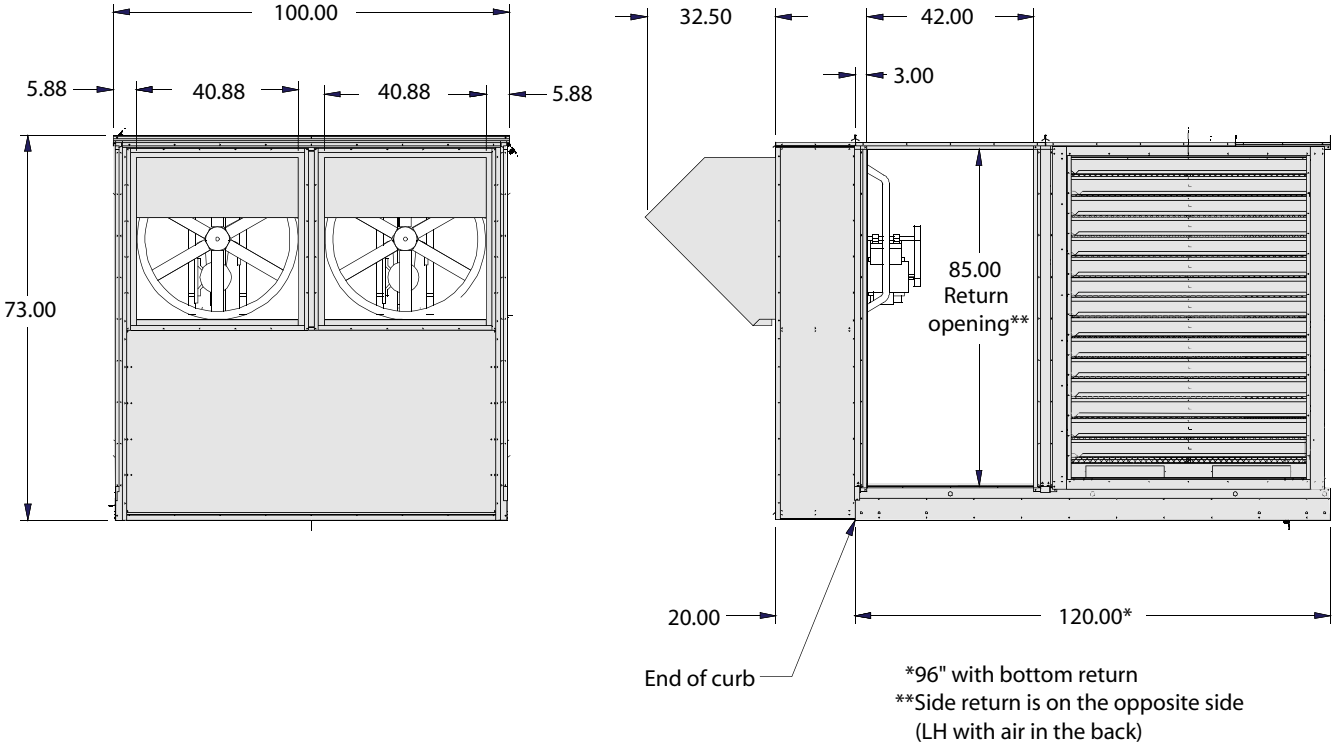
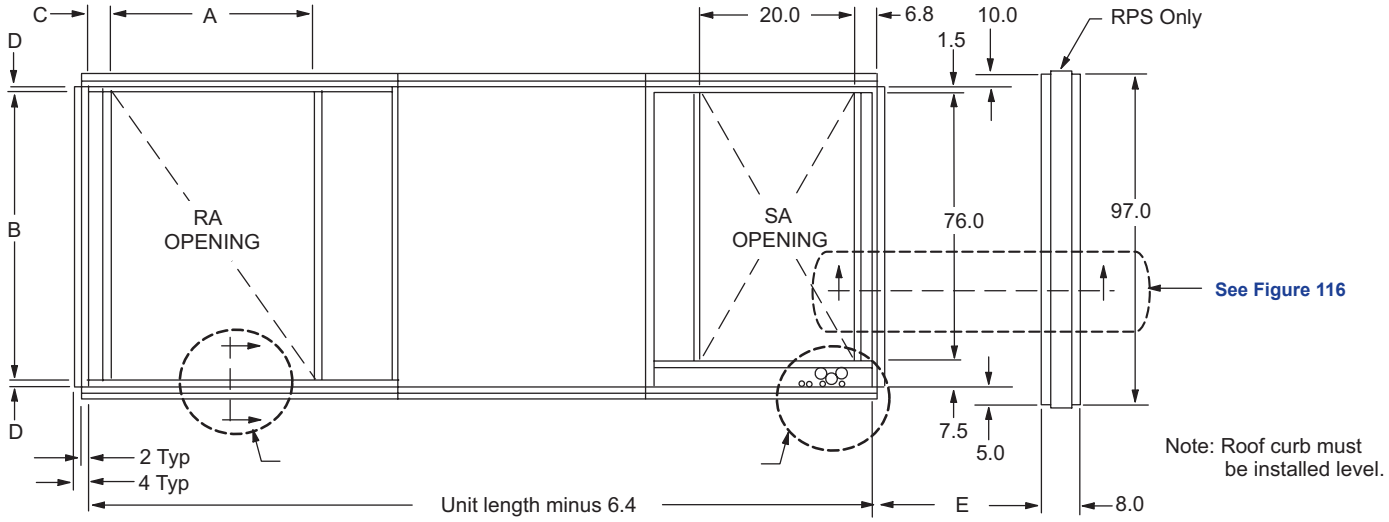
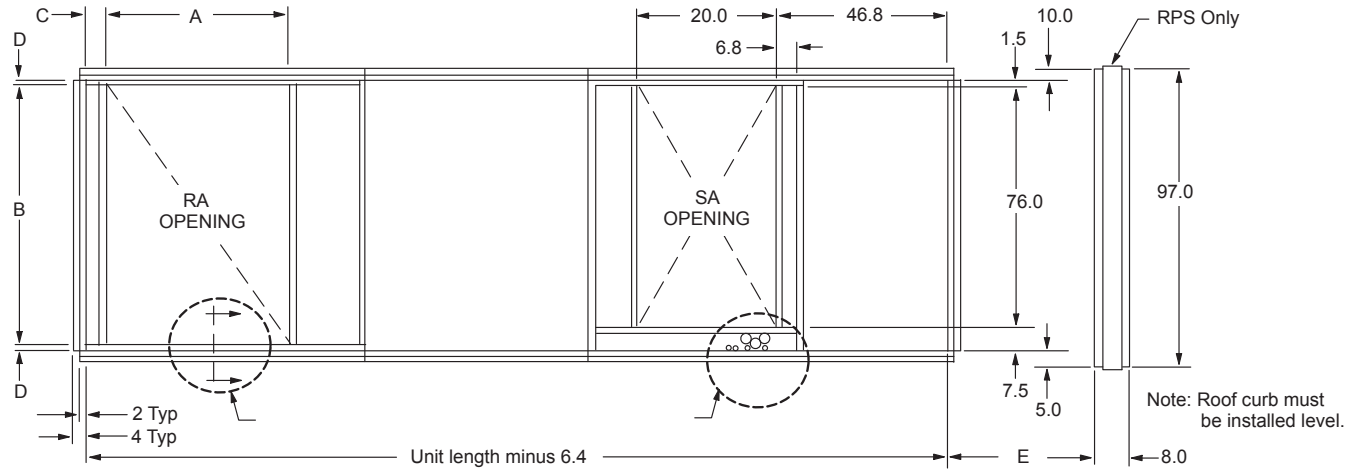


Figure 111: Roof Curb, RPS/RFS/RDT 015D to 042D (without Blank Compartment)



NOTE: Dimensions are approximate. Use certified drawings for actual construction.

Figure 112: Roof Curb, RPS/RFS/RDT 015D to 042D (with Blank Compartment)



NOTE: Dimensions are approximate. Use certified drawings for actual construction.

Table 30: RPS/RFS 015D to 040D Roof Curb Dimensions

Model	Return fan	A (in.)	B (in.)	C (in.)	D (in.)
015D to 031D	None	24	82	6.8	1.5
	(2) 15 in. FC	24	82	6.8	1.5
	30 in. AF	30	76	6.8	4.5
035D to 042D	None	24	82	6.8	1.5
	30 in. AF	30	76	6.8	4.5
	40 in. AF	36	78	14.8	3.5

Table 31: Table 65: Rail Locations

Model	E (in.)
015D, 020D, 025D	53.6
030D	56.2
035D	57.3
016D, 021D, 026D, 031D, 042D	74

Figure 113: Roof Curb, RPS/RFS/RDT 045D to 140D (without Blank Compartment)

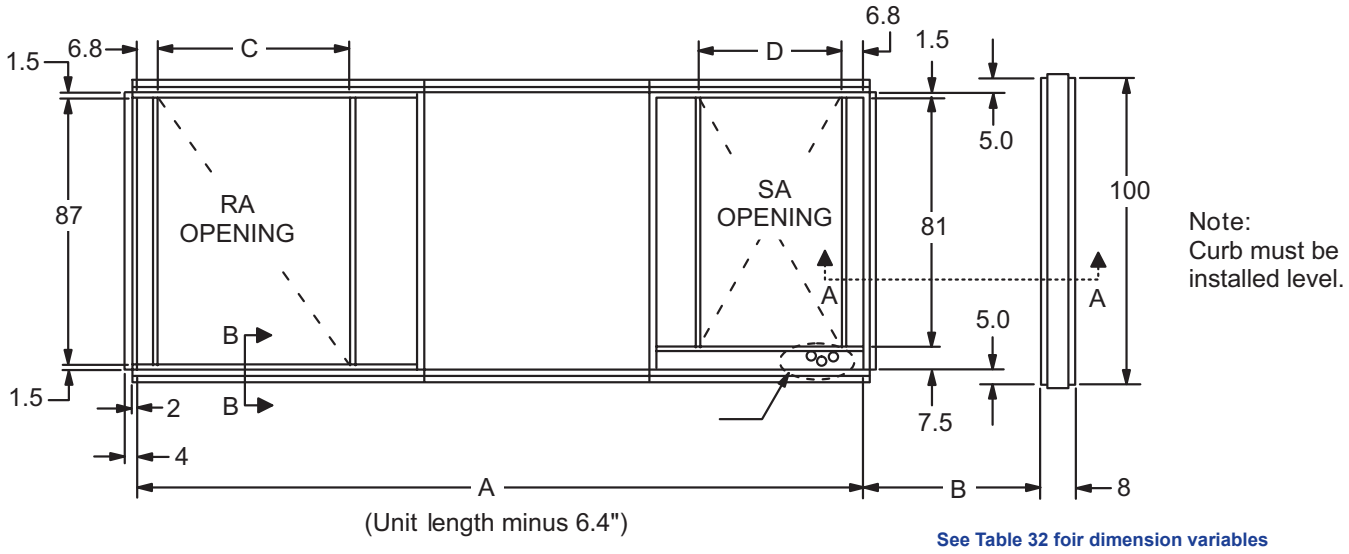


Figure 114: Roof Curb, RPS/RFS/RDT 045D to 140D (with Blank Compartment)

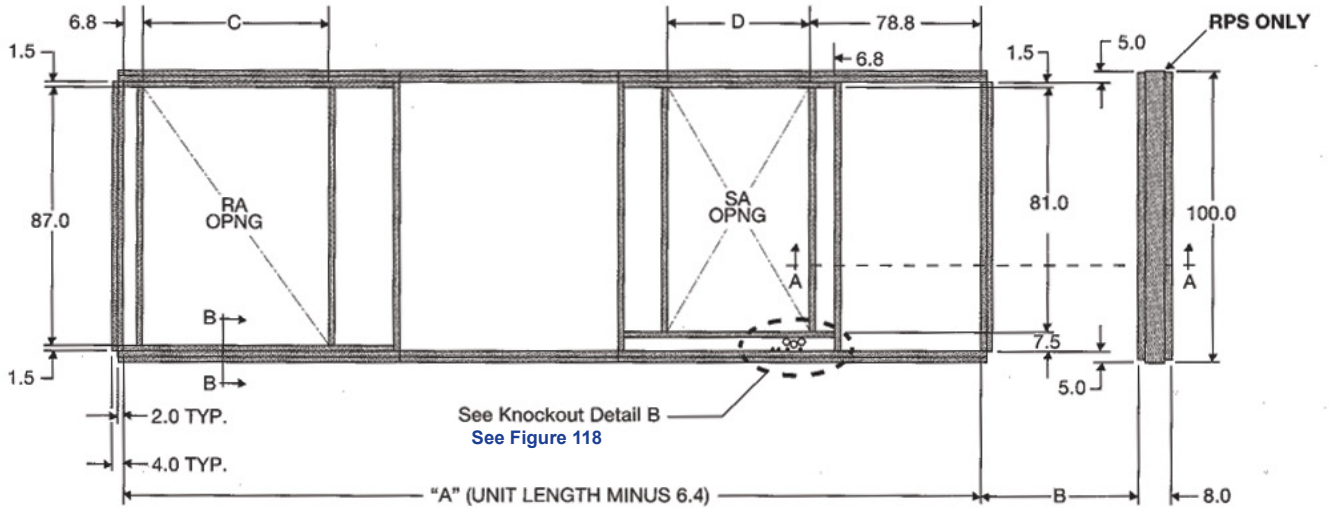


Table 32: RPS/RFS 045D to 140D Variable Dimensions

Model	Size	D Supply Air Opening	C Return Air Opening	B
RPS	045D, 050D, 061D, 068D	28	38	61
	051D, 063D, 070D, 071D, 075D, 079D	28	38	74
	080D, 085D, 090D	38	62	74
	081D, 091D	38	62	99
	101D	46	62	99
	100D, 105D	46	62	74
	110D through 140D	46	62	99

Figure 115: Curb Cross Section

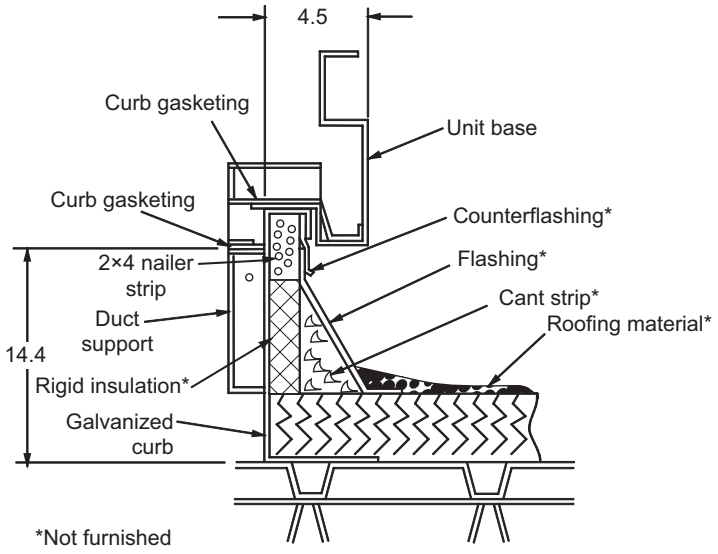
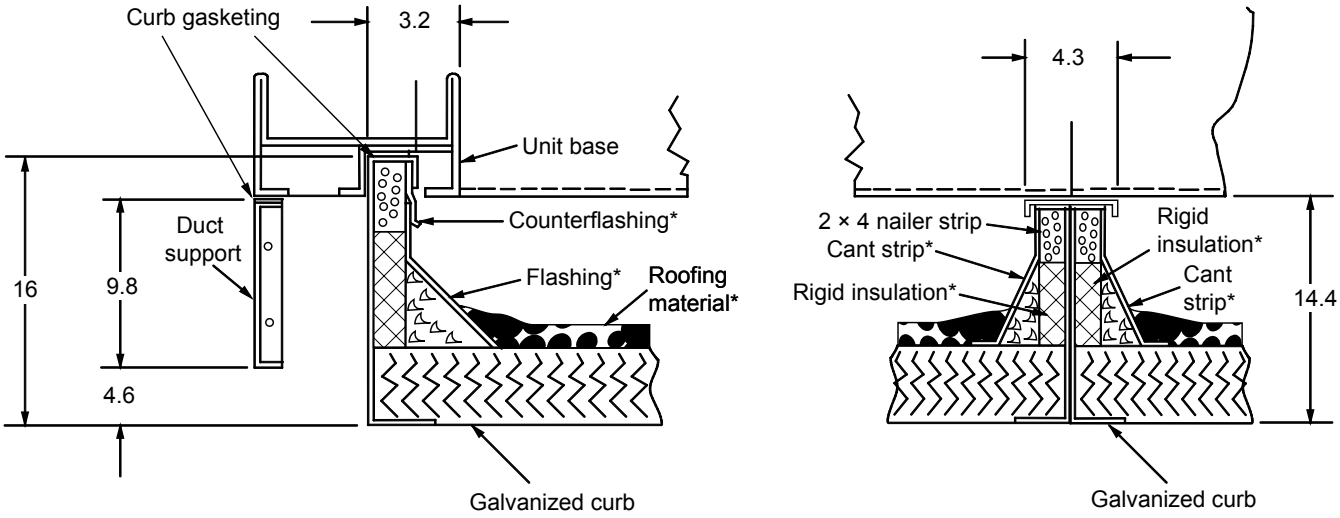


Figure 116: Curb Cross Section



*Not furnished

Figure 117: Knockout Detail, 025D to 042D

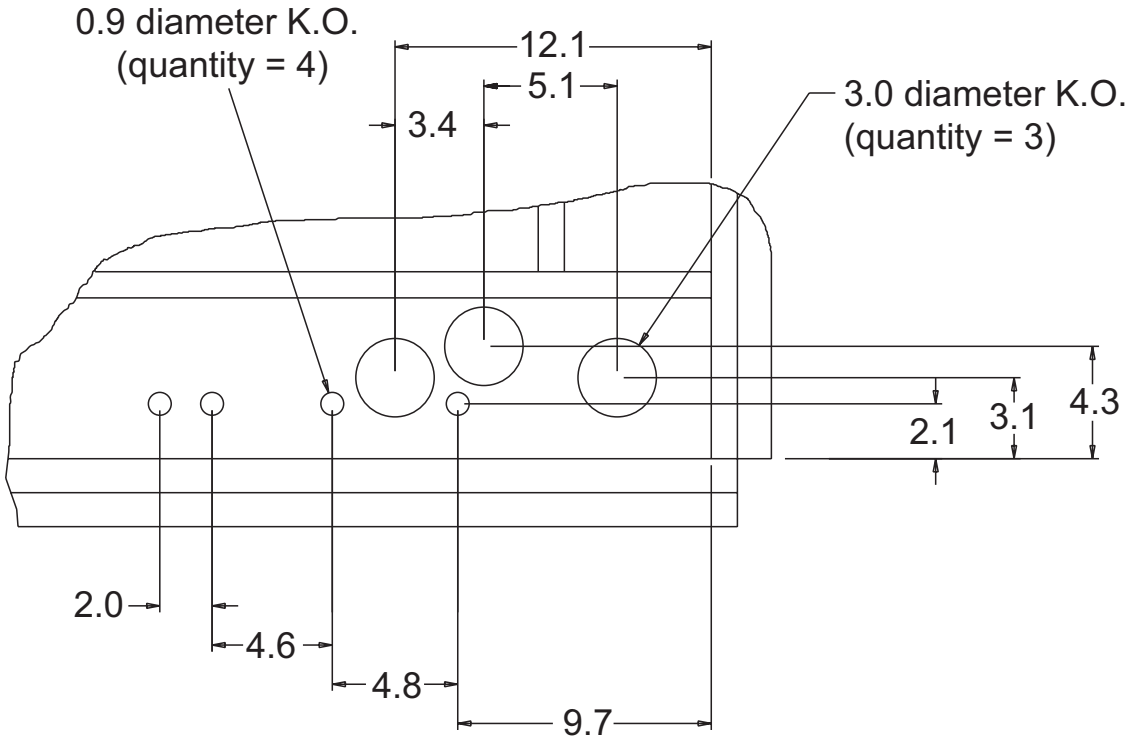
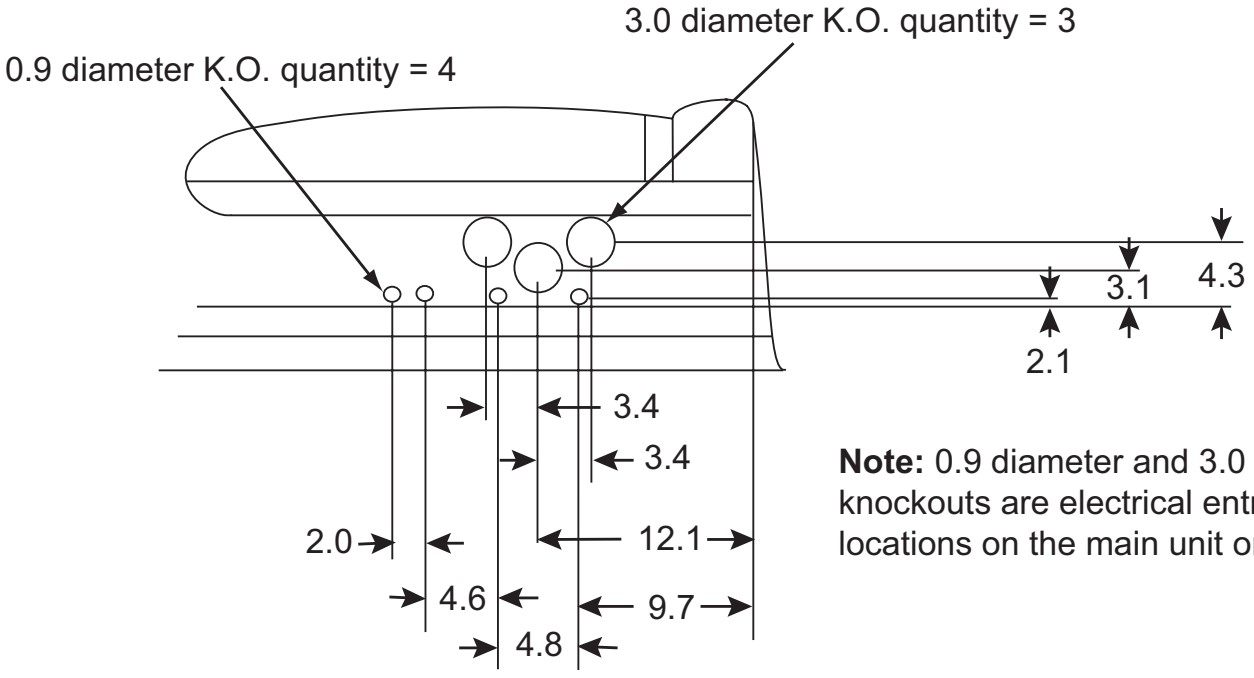
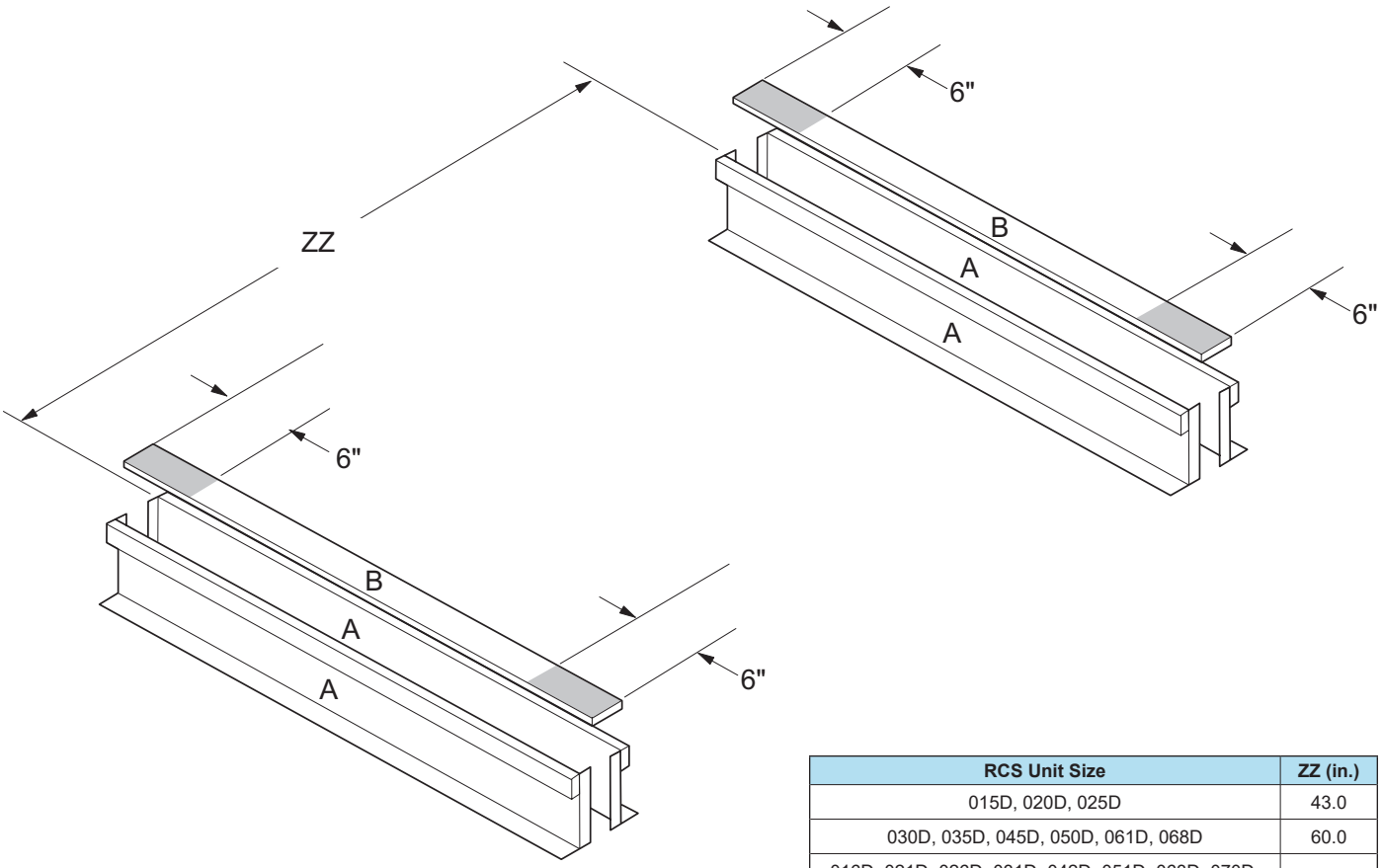


Figure 118: Knockout Detail, 045D to 140D



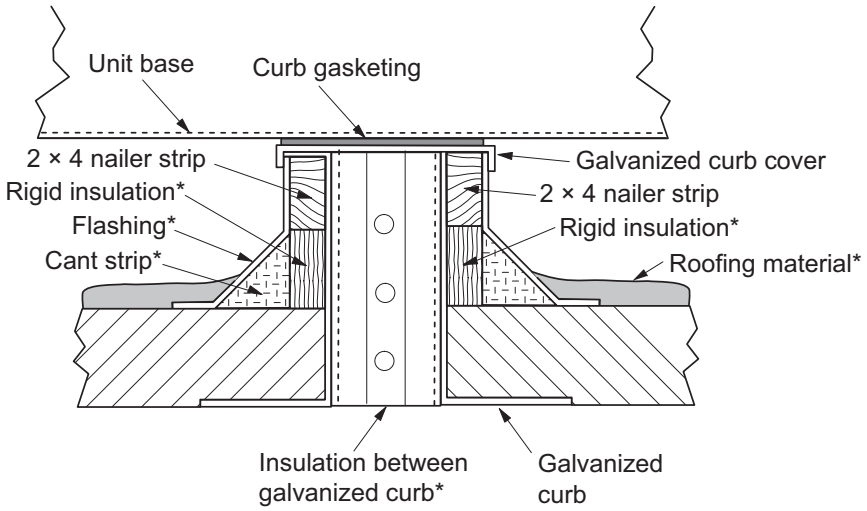
Note: 0.9 diameter and 3.0 diameter knockouts are electrical entrance locations on the main unit only.

Figure 119: RCS Roof Installation



RCS Unit Size	ZZ (in.)
015D, 020D, 025D	43.0
030D, 035D, 045D, 050D, 061D, 068D	60.0
016D, 021D, 026D, 031D, 042D, 051D, 063D, 070D, 071D, 075D, 079D, 080D, 085D, 090D, 100D, 105D	83.0
081D, 091D, 101D, 110D—140D	116.0

RCS rail cross section



*Not furnished

Piping Connections, RFS/RCS Units

Figure 120: Refrigerant Piping Connection Locations Example

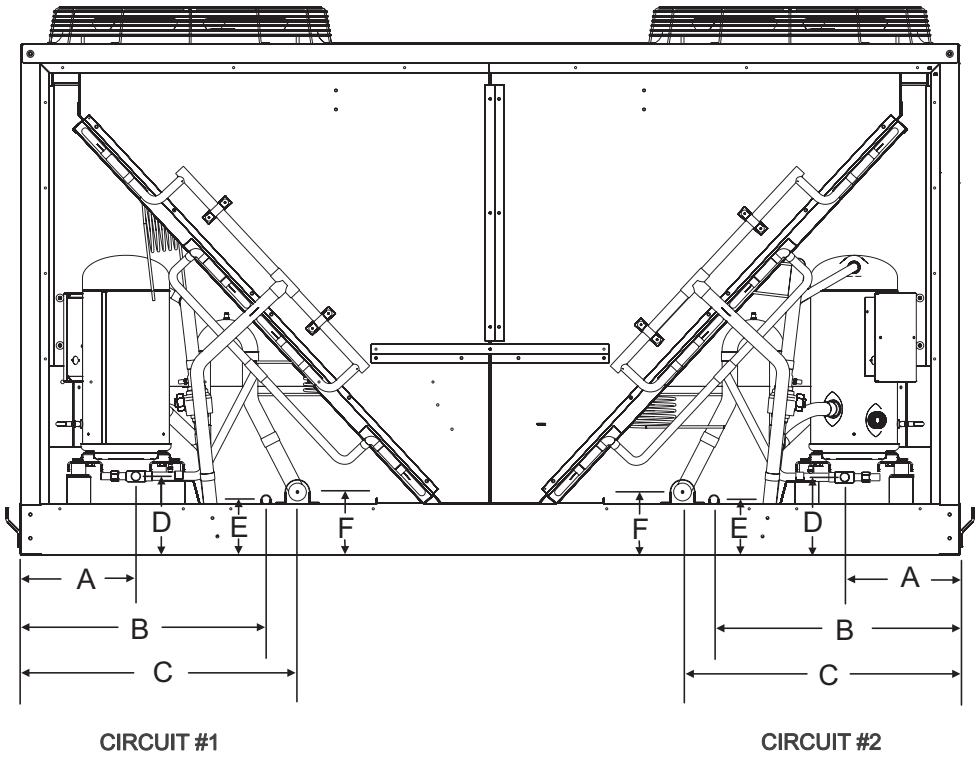


Table 33: 015D – 140D Connection Sizes and Locations

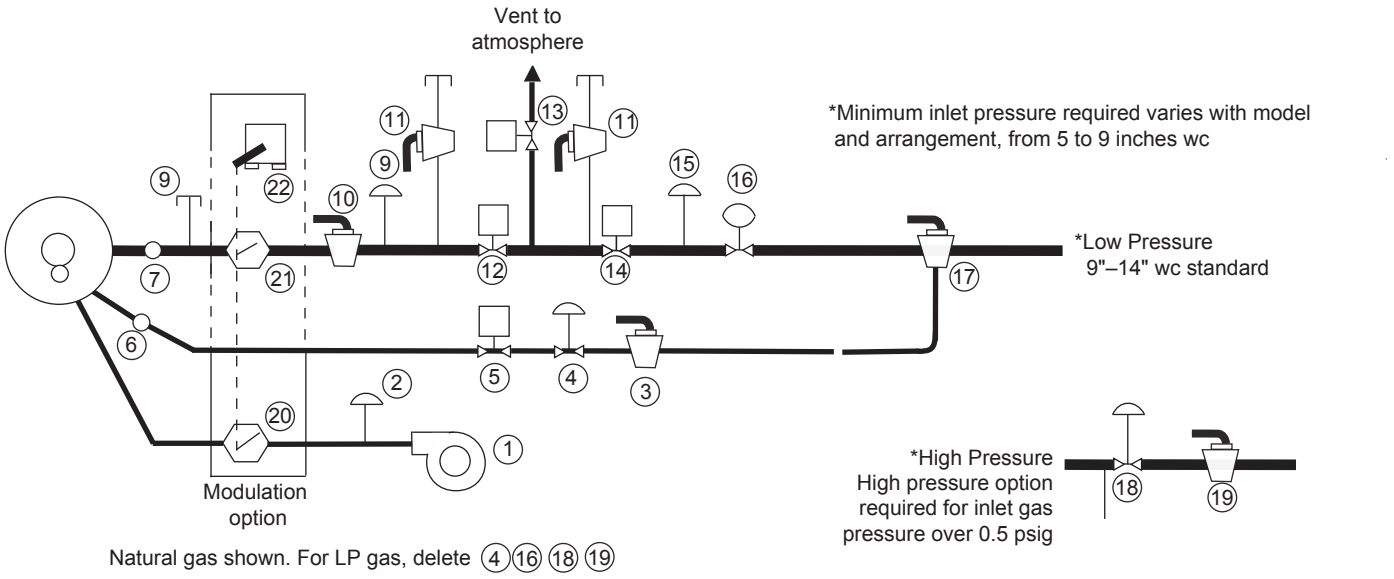
Dimension	Component	Circuit	Piping Dimension (inches)					
			015D–026D	030D–042D	045D–068D	070D–079D	080D–105D	110D–140D
A	Liquid Line #1 / #2	Circuit 1 & 2	16.7	12.9	12.0	13.5	11.2	20.8
B	HGBP Line #1 / #2	Circuit 1 & 2	24.0	25.4	25.9	25.9	28.1	25.9
C	Suction Line #1 / #2	Circuit 1 & 2	32.7	29.3	29.4	32.3	32.3	32.4
D	Liquid Line #1 / #2	Circuit 1 & 2	8.38	8.38	8.38	8.38	8.38	8.38
E	HGBP Line #1 / #2	Circuit 1 & 2	6.02	6.02	6.02	6.02	6.02	6.02
F	Suction Line #1 / #2	Circuit 1 & 2	6.62	6.62	6.62	6.62	6.62	6.62

Table 34: 015D – 140D Piping Diameter

Component	Circuit	Piping Diameter (inches)									
		015/016D	020/021D	025/026D	030/031D	035D	042D	045D	050/051D	061/063D	068D
Liquid Line #1 / #2	Circuit 1 & 2	5/8	5/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
HGBP Line #1 / #2	Circuit 1 & 2	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
Suction Line #1 / #2	Circuit 1 & 2	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
Component	**Circuit**	**Piping Diameter (inches)**									
		070/071D	**075/079D**	**080/085D**	**090/091D**	**100/101D**	**105D**	**110D**	**120D**	**125D**	**130/140D**
Liquid Line #1 / #2	Circuit 1 & 2	7/8	7/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8	1-1/8
HGBP Line #1 / #2	Circuit 1 & 2	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
Suction Line #1 / #2	Circuit 1 & 2	2-5/8	2-5/8	2-5/8	2-5/8	2-5/8	2-5/8	2-5/8	2-5/8	2-5/8	2-5/8

Gas Piping Schematic

Figure 121: Gas Piping Schematic

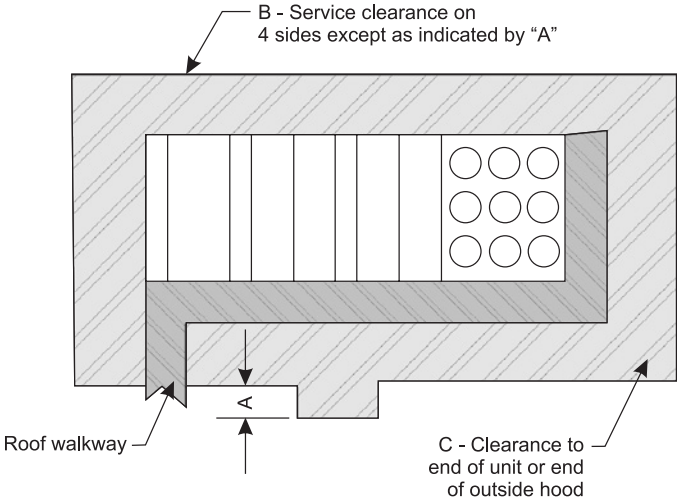


Item	Description	FM/ETL/UL		FM/ETL-C		IRI
		Thru 400 MBh	Over 400 MBh	Thru 400 MBh	Over 400 MBh	400–2000 MBh
1	Forced draft blower	Standard	Standard	Standard	Standard	Standard
2	Combination air switch	Standard	Standard	Standard	Standard	Standard
3	Pilot cock	Standard	Standard	Standard	Standard	Standard
4	Pilot pressure regulator	Standard	Standard	Standard	Standard	Standard
5	Pilot gas valve	Standard	Standard	Standard	Standard	Standard
6	Pilot orifice	Standard	Standard	Standard	Standard	Standard
7	Main gas orifice	Standard	Standard	Standard	Standard	Standard
8	Manifold pressure tap	Standard	Standard	Standard	Standard	Standard
9	High pressure switch	—	—	—	Standard	—
10	Test cock	Standard	Standard	Standard	Standard	Standard
11	Leak test tap cock	—	—	—	—	Standard
12	Safety shutoff valve	Combination redundant valve and pressure regulator	Standard	Combination redundant valve and pressure regulator	—	Standard
13	Vent to atmosphere valve, N/O	—	—	—	—	Standard
14	Safety shutoff valve	Combination redundant valve and pressure regulator	Standard	Combination redundant valve and pressure regulator	Safety shut off valve	Safety shut off valve with proof of closure switch
15	Low pressure switch	—	—	—	—	Standard
16	Main pressure regulator	Combination redundant valve and pressure regulator	Standard	Combination redundant valve and pressure regulator	Standard	Standard
17	Main gas shutoff cock	Standard	Standard	Standard	Standard	Standard
18	High pressure regulator	Optional	Optional	Optional	Optional	Optional
19	Lubricated shutoff cock	Optional	Optional	Optional	Optional	Optional
20	Combustion air butterfly valve	Standard	Standard	Standard	Standard	Standard
21	Main gas butterfly valve	Standard	Standard	Standard	Standard	Standard
22	Modulating operator	Standard	Standard	Standard	Standard	Standard

Service Clearance

Allow recommended service clearances shown in Figure 122. Provide a roof walkway along two sides of the unit for service and access to most controls.

Figure 122: Service Clearances



Cooling Coil, Heat and Supply Fan Service Clearance

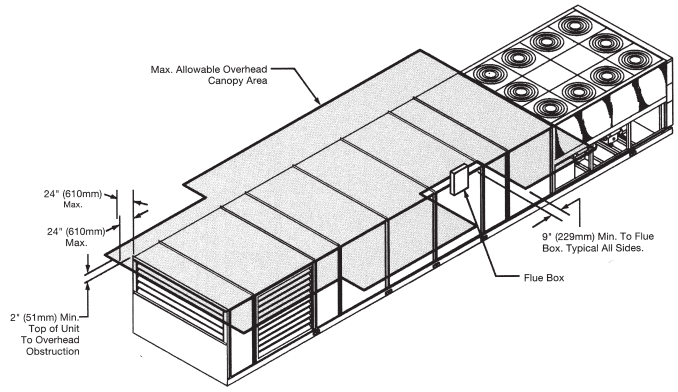
Additional clearance, A, is recommended adjacent to the cooling coil, heat, and supply fan sections. See Figure 82 on page 72 through Figure 90 on page 80 to identify these sections.

Table 35: Service Clearance

Unit Size	A	B	C*
015D to 042D	30	60	60
045D to 140D	24	72	72

* Condenser coil placement is simplified if the following temporary access clearances can be arranged: 030D - 062D = 83”, 070D - 100D = 106”

Figure 123: Ventilation Clearances



Overhead Clearance

1. Unit(s) surrounded by screens or solid walls must have no overhead obstructions over any part of the unit.
2. Area above condenser must be unobstructed in all installations to allow vertical air discharge.
3. For overhead obstructions above the air handler section, observe the following restrictions:
    a. No overhead obstructions above the furnace flue, or within 9 in. of the flue box.
    b. Any overhead obstruction not within 2 in. of the top of the unit.
    c. Service canopy not to protrude more than 24 in. beyond the unit in the area of the outside air and exhaust dampers.

Ventilation Clearance

Unit(s) surrounded by a screen or a fence:

1. The bottom of the screen should be a minimum of 1 ft. above the roof surface.
2. Minimum distance, unit to screen—same as service clearance (Table 35).
3. Minimum distance, unit to unit—120 in.

Unit(s) surrounded by solid walls:

1. Minimum distance, unit to wall—96 in., all sizes.
2. Minimum distance, unit to unit—120 in.
3. Wall height restrictions:
    a. Wall on one side only or on two adjacent side—no restrictions.
    b. Walls on more than two adjacent sides—wall height not to exceed unit height.

Do not locate outside air intakes near exhaust vents or other sources of contaminated air.

If the unit is installed where windy conditions are common, install wind screens around the unit, maintaining the clearances specified above. This is particularly important to prevent blowing snow from entering outside air intakes and to maintain adequate head pressure control when mechanical cooling is required at low outdoor air temperatures. SpeedTrol, required for compressor operation below 45°F, maintains proper head pressure in calm wind conditions.

Table 36: RPS/RFS/RCS/RDT Rated Load Amps[a]

Model	Voltage	Circuit 1		Circuit 2	
		RLA/Comp	Comp Qty	RLA/Comp	Comp Qty
015D	208-60-3	27.6	1	27.6	2
	230-60-3	25		25	
	460-60-3	12.2		12.2	
	575-60-3	9.4		9.4	
020D	208-60-3	37.6	1	19.3	2
	230-60-3	34		17.4	
	460-60-3	19.2		8.6	
	575-60-3	12.9		6.5	
021D	208-60-3	37.6	1	19.3	2
	230-60-3	34		17.4	
	460-60-3	19.2		8.6	
	575-60-3	12.9		6.5	
025D/026D	208-60-3	53.2	1	24.8	2
	230-60-3	48.1		22.4	
	460-60-3	18.6		10.6	
	575-60-3	14.7		7.7	
030D	208-60-3	56.7	1	25.7	2
	230-60-3	51.3		23.2	
	460-60-3	23.1		11.2	
	575-60-3	19.9		8.2	
035D	208-60-3	31.6	2	31.6	2
	230-60-3	28.6		28.6	
	460-60-3	14.5		14.5	
	575-60-3	11.6		11.6	
042D	208-60-3	33.7	2	33.7	2
	230-60-3	30.5		30.5	
	460-60-3	15.8		15.8	
	575-60-3	12.2		12.2	
045D	208-60-3	37.6	2	37.6	2
	230-60-3	34		34	
	460-60-3	19.2		19.2	
	575-60-3	12.9		12.9	
050D/051D	208-60-3	53.2	2	53.2	2
	230-60-3	48.1		48.1	
	460-60-3	18.6		18.6	
	575-60-3	14.7		14.7	
061D	208-60-3	56.7	2	56.7	2
	230-60-3	51.3		51.3	
	460-60-3	23.1		23.1	
	575-60-3	19.9		19.9	
063D	208-60-3	56.7	2	56.7	2
	230-60-3	51.3		51.3	
	460-60-3	23.1		23.1	
	575-60-3	19.9		19.9	
068D	208-60-3	61.7	2	61.7	2
	230-60-3	55.8		55.8	
	460-60-3	26.9		26.9	
	575-60-3	23.7		23.7	
070D/071D	208-60-3	36.8	3	36.8	3
	230-60-3	33.3		33.3	
	460-60-3	17.9		17.9	
	575-60-3	12.8		12.8	
075D	208-60-3	53.2	3	53.2	3
	230-60-3	48.1		48.1	
	460-60-3	18.6		18.6	
	575-60-3	14.7		14.7	
079D	208-60-3	53.2	3	56.7	3
	230-60-3	48.1		51.3	
	460-60-3	18.6		23.1	
	575-60-3	14.7		19.9	
080D/081D	208-60-3	53.2	3	53.2	3
	230-60-3	48.1		48.1	
	460-60-3	18.6		18.6	
	575-60-3	14.7		14.7	
085D	208-60-3	56.7	3	56.7	3
	230-60-3	51.3		51.3	
	460-60-3	23.1		23.1	
	575-60-3	19.9		19.9	
090D/091D	208-60-3	56.7	3	56.7	3
	230-60-3	51.3		51.3	
	460-60-3	23.1		23.1	
	575-60-3	19.9		19.9	
100D/101D	208-60-3	56.7	3	61.7	3
	230-60-3	51.3		55.8	
	460-60-3	23.1		26.9	
	575-60-3	19.9		23.7	
105D	208-60-3	61.7	3	61.7	3
	230-60-3	55.8		55.8	
	460-60-3	26.9		26.9	
	575-60-3	23.7		23.7	
110D	208-60-3	61.7	3	61.7	3
	230-60-3	55.8		55.8	
	460-60-3	26.9		26.9	
	575-60-3	23.7		23.7	
120D	208-60-3	61.7	3	81.7	3
	230-60-3	55.8		73.9	
	460-60-3	26.9		34.8	
	575-60-3	23.7		24.6	
125D	208-60-3	81.7	3	81.7	3
	230-60-3	73.9		73.9	
	460-60-3	34.8		34.8	
	575-60-3	24.6		24.6	
130D	208-60-3	81.7	3	81.7	3
	230-60-3	73.9		73.9	
	460-60-3	34.8		34.8	
	575-60-3	24.6		24.6	
140D	208-60-3	81.7	3	99.6	3
	230-60-3	73.9		90.1	
	460-60-3	34.8		45.1	
	575-60-3	24.6		34.7	

a. VFD compressor units in RPS and RDT only

b. Compressor information for units with variable speed inverter compressor.

Table 37: Variable Speed Inverter Compressor Rated Load Amps

Model	Voltage	Circuit 1		Circuit 2	
		RLA/Comp	Comp Quantity	RLA/Comp	Comp Quantity
016D[a]	208-60-3	27.6	1	47.0	1
	230-60-3	25.0		42.5	
	460-60-3	12.2		22.9	
020D[a]	208-60-3	37.6	1	47.0	1
	230-60-3	34		42.5	
	460-60-3	19.2		22.9	
021D[a]	208-60-3	37.6	1	47.0	1
	230-60-3	34		42.5	
	460-60-3	19.2		22.9	
025D[a]	208-60-3	53.2	1	47.0	1
	230-60-3	48.1		42.5	
	460-60-3	18.6		22.9	
026D[a]	208-60-3	53.2	1	47.0	1
	230-60-3	48.1		42.5	
	460-60-3	18.6		22.9	
031D[a]	208-60-3	56.7	2	61.7	1
	230-60-3	51.3		55.8	
	460-60-3	23.1		30.1	
035D[a]	208-60-3	31.6	2	61.7	1
	230-60-3	28.6		55.8	
	460-60-3	14.5		30.1	
042D[a]	208-60-3	33.7	2	61.7	1
	230-60-3	30.5		55.8	
	460-60-3	15.8		30.1	
045D[a]	208-60-3	37.6	2	76.1	1
	230-60-3	34		68.8	
	460-60-3	19.2		37.2	
050D[a]	208-60-3	53.2	2	81.4	1
	230-60-3	48.1		73.6	
	460-60-3	18.6		39.7	
051D[a]	208-60-3	53.2	2	86.8	1
	230-60-3	48.1		78.5	
	460-60-3	18.6		42.5	
063D[a]	208-60-3	56.7	2	92.5	1
	230-60-3	51.3		83.7	
	460-60-3	23.1		45.2	
074D[a]	208-60-3	56.7	2	92.5	1
	230-60-3	51.3		83.7	
	460-60-3	23.1		45.2	

a - Base unit with variable speed inverter compressor

Table 38: Condenser Fan Quantity

RPS/RCS Model	Quantity Fans
015D–026D	2
030D–051D	4
061D–071D, 080D–085D	6
075D, 079D, 090D, 091D, 105D, 110D	8
100D, 101D, 120D	9
125D	10
130D, 140D	12

Table 39: Condenser Fan Amps (each)

Voltage	Standard Fan		Quiet Fan	
	FLA	LRA	FLA	LRA
208	4.2	20.8	3.4	20.8
230	4.0	19.8	3.1	19.8
460	2.0	9.9	1.6	9.9
575	1.7	9.6	1.2	9.6

Table 40: Supply, Exhaust and Return Fan Motors, RPS/RFS/RDT 015D to 140D

Fan motor			208/60/3		230/60/3		460/60/3[a]		575/60/3	
HP	Efficiency		FLA	LRA	FLA	LRA	FLA	LRA	FLA	LRA
1	High	ODP	3.9	26	2.8	20	1.4	10.5	1.15	9
	High	TEFC	4	27	2.8	21	1.4	10.5	1.2	9
	Premium	ODP	—	—	3	19.2	1.5	15	1.1	7.7
	Premium	TEFC	3.3	27	3	28	1.5	14	1.3	10
1.5	High	ODP	4.5	39	4.2	32	2.1	16	1.7	12.8
	High	TEFC	6.2	39	4.2	32	2.1	16	1.7	12.8
	Premium	ODP	4.8	40.3	4.2	25	2.1	14	1.7	14
	Premium	TEFC	—	—	4.2	40	2.1	20	1.7	16
2	High	ODP	7.1	47	5.6	42	2.8	21	2.2	16.8
	High	TEFC	7	50.6	5.6	48	2.8	24	2.2	17
	Premium	ODP	6.1	43.2	5.8	37.6	2.9	26.5	2.1	15
	Premium	TEFC	—	—	5.6	44	2.8	22	2.2	17
3	High	ODP	9.9	79	9	64.6	4.5	32.3	3.4	26.1
	High	TEFC	9.6	81	8.2	77.2	4.1	38.6	3.4	30.9
	Premium	ODP	9.3	74	8.2	64	4.1	32	3.1	25.6
	Premium	TEFC	9.4	80	8.2	71	4.1	35.5	3.3	29
5	High	ODP	16.1	106	14	94	7	47	5.3	38
	High	TEFC	15.2	126	13.4	102.4	6.7	51.2	5.4	39
	Premium	ODP	15.7	110	13.6	96	6.8	48	5.2	38.4
	Premium	TEFC	15	124	13	96	6.5	48	5.2	38
7.5	High	ODP	25	137	21.6	148.4	10.8	74.2	8.2	49
	High	TEFC	24.8	175.3	20.4	145.2	10.2	72.6	8.2	58
	Premium	ODP	22.3	185	20	122	10	80	7.4	52
	Premium	TEFC	22	177	20	141	10	70.5	8	56
10	High	ODP	33	290	28	180	14	94	11	72
	High	TEFC	29.5	228	28.4	200	14.2	100	11.4	80
	Premium	ODP	29	247	25.8	192	12.9	106	10.3	76.6
	Premium	TEFC	28.5	209	25	182	12.5	91	10	67
15	High	ODP	44.8	368	40.6	301	20.3	150.5	16.2	120
	High	TEFC	43.7	310	38.8	272	19.4	136	15.5	109
	Premium	ODP	43.4	271	37.8	233.6	18.9	117	14.1	94
	Premium	TEFC	42.4	282	37	246	18.5	123	14	89
20	High	ODP	61	342	50	350	25	175	20	135
	High	TEFC	60	465	48	320	24	160	19.1	123
	Premium	ODP	57	373	49	322	24.5	160.8	18.9	130
	Premium	TEFC	56	403	48	350	24	175	18.8	138
25	High	ODP	74	427	62	382	31	191	24.3	151
	High	TEFC	73	416	60	380	30	190	24.2	152
	Premium	ODP	70	438	61	380	30.5	190	24.2	125
	Premium	TEFC	68.4	431	61	376	30.5	188	22.8	148
30	High	ODP	86.5	560	75	460	37.5	230	30	177
	High	TEFC	87	448	72	460	36	230	28.6	184
	Premium	ODP	83.3	514	72.4	448	36.2	224	29.8	179
	Premium	TEFC	84	566	69	428	34.5	214	27.6	178
40	High	ODP	117	660	102	630	51	315	40	251
	High	TEFC	114	590	95	544	47.5	272	38	214
	Premium	ODP	110	730	96	630	48	315	38	245
	Premium	TEFC	106	734	94	650	47	325	37	213
50	High	ODP	140	832	124	770	62	385	49.2	303
	High	TEFC	136	840	118	744	59	372	48	266
	Premium	ODP	137	877	120	752	60	376	47.5	332
	Premium	TEFC	131	897	118	778	59	389	46	237
60	High	ODP	154	991	144	872	72	442	57.4	355
	High	TEFC	—	—	140	1022	70	511	56	409
	Premium	ODP	160	1125	140	912	70	456	56	345
	Premium	TEFC	—	—	140	1200	70	600	54	403
75	High	ODP	189	1240	176	1108	88	553	71	505
	High	TEFC	—	—	172	1132	86	566	68	447
	Premium	ODP	195	1240	170	1044	85	553	65.5	444
	Premium	TEFC	—	—	168	1186	84	593	66	504

a. For 380/50/3 applications, 460/60/3 motors are used. Derate nameplate by 0.85 to obtain actual horsepower.

Table 41: Electric Heat, RPS/RFS 015D to 042D

Model	208/60/3				240/60/3				480/60/3				600/60/3			
	kW	FLA	Steps	Stages[b]	kW	FLA	Steps[a]	Stages[b]	kW	FLA	Steps[a]	Stages[b]	kW	FLA	Steps[a]	Stages[b]
20	14.4	41.4	2	2	19.8	47.6	2	2	19.8	23.8	2	2	19.8	19.0	2	2
40	29.9	83.0	2	2	39.8	95.7	2	2	39.8	47.8	2	2	39.8	38.3	2	2
60	45.1	124.9	4	3	60.0	144.3	4	3	60.0	72.2	2	2	60.0	57.7	2	2
80	59.8	166.0	4	3	79.6	191.5	4	3	79.6	94.7	2	2	79.6	76.6	2	2
100	74.7	207.4	6	3	99.5	239.3	6	3	99.5	119.7	4	3	99.5	95.7	4	3
120	89.7	249.3	6	3	119.4	287.2	6	3	119.4	143.6	4	3	119.4	114.9	4	3
140	—	—	—	—	—	—	—	—	139.1	167.3	4	3	139.1	133.8	4	3
160	—	—	—	—	—	—	—	—	159.2	191.5	4	3	159.2	153.2	4	3
180	—	—	—	—	—	—	—	—	179.1	215.4	6	3	179.1	172.3	6	3
200	—	—	—	—	—	—	—	—	199.0	239.4	6	3	199.0	191.5	6	3
220	—	—	—	—	—	—	—	—	218.7	263.0	6	3	218.7	210.4	6	3
240	—	—	—	—	—	—	—	—	238.8	287.2	6	3	238.8	229.8	6	3

a. Number of fused circuits
b. Number of controlled heat stages from MicroTech III solid-state control system; additional fused circuits controlled by time delay relays.
See Table 14 on page 48 through Table 17 on page 49 for electric heat availability by unit size.*

Table 42: Electric Heat, RPS/RFS 045D to 140D

Model	208/60/3			240/60/3			480/60/3			600/60/3		
	kW	FLA	Stages	kW	FLA	Stages	kW	FLA	Stages	kW	FLA	Stages
40	29.9	83.0	2	39.8	95.7	2	39.8	47.9	2	39.8	38.3	2
60	45.1	124.9	2	60.0	144.3	2	60.0	72.2	2	60.0	57.7	2
80	59.8	166.0	4	79.6	191.5	4	79.6	95.7	4	79.6	76.6	4
100	74.7	207.4	4	99.5	239.4	4	99.5	119.7	4	99.5	95.7	4
120	89.7	249.3	4	119.4	287.2	4	119.4	143.6	4	119.4	114.9	4
160	119.7	332.0	4	159.2	383.0	4	159.2	191.5	4	159.2	153.2	4
—	—	—	—	—	—	—	199.0	239.4	4	199.0	191.5	4
—	—	—	—	—	—	—	238.8	287.2	6	238.8	229.8	6
—	—	—	—	—	—	—	278.6	335.1	4	278.6	268.1	4
—	—	—	—	—	—	—	318.4	383.0	4	318.4	306.4	4

See Table 18 on page 50 through Table 18 on page 50 for electric heat availability by unit size.

Supply Power Wiring

Table 43: RPS/RFS/RCS/RDT Recommended Power Wiring

Ampacity	Number of Power Wires per Phase	Number of Conduits	Wire Gauge	Insulation Rating (0°C)
30	1	1	10	60
40	1	1	8	60
55	1	1	6	60
70	1	1	4	60
85	1	1	3	60
95	1	1	2	60
130	1	1	1	75
150	1	1	1/0	75
175	1	1	2/0	75
200	1	1	3/0	75
230	1	1	4/0	75
255	1	1	250	75
285	1	1	300	75
310	1	1	350	75
335	1	1	400	75
380	1	1	500	75
400	2	2	3/0	75
460	2	2	4/0	75
510	2	2	250	75
570	2	2	300	75
620	2	2	350	75
670	2	2	400	75
760	2	2	500	75
765	3	3	250	75
855	3	3	300	75
930	3	3	350	75

1. Units require three-phase power supply.
2. Allowable voltage tolerances:
   a. 60 Hertz
      – Nameplate 208V: Min. 187V, Max. 229V
      – Nameplate 230V: Min. 207V, Max. 253V
      – Nameplate 460V: Min. 414V, Max. 506V
      – Nameplate 575V: Min. 518V, Max. 633V
   b. 50 Hertz
      – Nameplate 380V: Min. 360V, Max. 418V
3. Minimum Circuit Ampacity (MCA) Calculation:

NOTE: If a unit is provided with multiple power connections, each must be considered alone in selecting power wiring components.

The MCA is calculated based on the following formulas:

1. Units with cooling and all heating except electric heat
   MCA = 1.25 × largest load + sum of all other loads
2. On units with electric heat, the MCA is computed both in the cooling mode and the heating mode and the greater of the two values is used.
   a. Heating Mode
      – Electric heat less than or equal to 50 kW
      MCA = 1.25 (heater FLA + largest motor loads) + (the rest of the loads)
      – Electric heat greater than or equal to 50 kW
      MCA = 1.25 (largest motor load) + (the rest of the loads) + heater FLA

NOTE: The compressor and condenser are not included in this heating mode calculation.

   b. Cooling Mode
      – MCA = 1.25 × largest load + sum of all the other loads
3. Size wires in accordance with Table 310-16 or 310-19 of the National Electrical Code.
4. Wires should be sized for a maximum of 3% voltage drop.
5. There are two options for the convenience outlet and light circuit power connections.
   a. Separate Field Power, 120 V, 15 amps minimum
   This option provides optimal service and maintenance flexibility. Control circuit ampacity need not be considered in MCA calculations.

NOTE: If the unit is provided with one or more fan section lights, they are powered from the separate 15 amp (minimum), 120V supply required by the NEC for the unit convenience outlet.

   b. Unit Powered – This option provides lowest installed cost. Control circuit ampacity must be added to unit ampacity if lights are ordered. Consult factory for details.

Table 44: RPS/RFS/RCS 015D to 040D (lbs)

Components	Unit Size					
	015/016D	020/021D	025/026D	030/031D	035D	042D/42D
Unit Configuration						
RPS basic unit	3762/4052	3852/4182	3862/4198	4264/4407	5308	5733
RFS basic unit[a]	2290	2290	2298	2298	3126	3526
RCS basic unit	1499/1827	1613/1981	1848/2222	1899/2061	2548	3239
Unit Configuration – RPS Unit Model[f]	**016D[f]**	**020D[f]/021D[f]**	**025D[f]/026D[f]**	**031D[f]**	**035D[f]**	**042D[f]**
RPS basic unit with Inverter Compressor	4204	4259	4302	4539	5317	5690
Outdoor/Return Air Options						
Return air plenum	Included in basic unit weight					
0%–30% O A hood with damper	145	145	145	145	145	145
100% O A hood with damper (deduct)	(338)	(338)	(338)	(338)	(449)	(449)
Economizer	515	515	515	515	637	637
Economizer with 30" RAF	637	637	637	637	637	637
Economizer with (2) 15" RAF	692	692	692	692	—	—
Economizer with 40" RAF	—	—	—	—	845	845
Blender (low cfm)[c]	540	540	540	540	540	540
Blender (high cfm)[c]	548	548	548	548	548	548
Filter Options—Draw-Through Section						
30% pleated	9	9	9	9	9	9
65% cartridge with prefilter	146	146	146	146	146	146
95% cartridge with prefilter	154	154	154	154	154	154
Filter Options—Blow-Through Section (Final Filters, 95% Cartridge)						
With cooling only, steam, or hot water heat	625	625	625	625	625	625
With gas or electric heat	794	794	794	794	794	794
Supply Air Fan Assembly						
(2) 15" × 6" diameter forward curved	345	345	345	345	—	—
(2) 15" × 15" diameter forward curved	375	375	375	375	—	—
20" diameter airfoil	556	556	556	556	—	—
24" diameter forward curved—LP	—	—	—	—	539	539
24" diameter forward curved—MP	—	—	—	—	569	569
24" diameter airfoil	—	—	—	—	574	574
Return Air Fan Assembly						
15" × 15" diameter forward curved	350	350	350	350	—	—
30" diameter airfoil	385	385	385	385	385	385
40" diameter airfoil	—	—	—	—	512	512
Evaporator Coils						
4-row, 10 Fpi	198	198	292	292	292	300
5-row, 10 Fpi	235	235	348	348	348	356
5-row, 12 Fpi	252	252	372	372	372	380
Hot Water Heat						
Low capacity	580	580	580	580	580	580
High capacity	630	630	630	630	630	630
Steam Heat						
Low capacity	575	575	575	575	575	575
High Capacity	605	605	605	605	605	605
Electric Heat						
20 kW	656	656	656	656	656	656
40 kW	664	664	664	664	664	664
60 kW	668	668	668	668	668	668
80 kW	696	696	696	696	696	696
100 kW	769	769	769	769	769	769
120 kW	777	777	777	777	777	777
140 kW	811	811	811	811	811	811
160 kW	819	819	819	819	819	819
180 kW	841	841	841	841	841	841
200 kW	849	849	849	849	849	849
Gas Furnace						
200, 250, 320, 400 MBh	964	964	964	964	964	964
500, 640 MBh	1041	1041	1041	1041	1041	1041
650, 790 MBh	1155	1155	1155	1155	1155	1155
800, 1000 MBh	1237	1237	1237	1237	1237	1237
Blank Section						
40", unlined	405	405	405	405	405	405
52", unlined	512	512	512	512	512	512
Accessory Items						
Variable frequency drive—SAF	150	150	150	150	150	150
Variable frequency drive RAF[c]	100	100	100	100	100	100
Insulation and Liners						
Weight per foot of unit length	24	24	24	24	24	24

a. Basic unit consists of return air plenum, angular filter section with 2" throwaway filters, supply fan section without fan or motor, cooling section without coil, discharge plenum, and condensing unit (RPS only) For RPS 015C to 30C and RPS 018C to 30C, cooling section is incorporated in the supply fan section
b. Final filter option includes liners in final filter and discharge plenum sections.
c. Does not include weight of blank section
d. Nominal 2", 1 5 lbs density solid liners, excluding condensing unit section and blank compartment
Weights shown are sufficient for both reciprocating and scroll compressor units.
e. Does not include RAF and motor - must also include the weights listed below
f. Base unit with inverter compressor

Base Unit Weights

Table 45: Base Unit Weights (Less Options)

Unit Size	Unit Weight (lbs)				
	RCS	RFS	RDT	RPS	RPS[a]
045D/045D[a]	2455	3779	5420	6159	6226
050D/050D[a], 051D[a]	2511/3315	3779	5469/6239	6215/6985	6336/7106
061D/063D[a]	2671/3441	3779	5581/6347	6342/7108	7207
068D	2575	3779	5592	6354	6354
070D/071D	3307/4000	3849	6297/7000	7156/7860	—
074D[a]	—	3849	6368	7236	8647
075D	3387	3849	6368	7236	7236
080D/081D	3603/4171	4682	6697/7266	8097/8666	8097/8666
085D	3615	4682	6716	8116	8116
090D/091D	3708/4278	4682	6816/7386	8216/8786	8216/8786
100D/101D	3764/4334	4974	7178/7738	8578/9158	8578/9158
105D	3726	4974	7147	8547	8547
110D	4277	4974	7706	9106	9106
120D	4858	5361	8687	10,087	10,087
125D	5439	5361	9275	10,675	10,675
130D	5532	5361	9275	10,675	10,675
140D	5619	5361	9476	10876	10876

a - Base unit with inverter compressor

Fan Motor Weights

Table 46: Supply, Exhaust and Return Fan Motors (All Size Units)

Motor HP	Weight (lbs)	
	Open Drip-Proof	Totally Enclosed
1	39	40
1.5	48	49
2	48	49
3	71	72
5	82	85
7.5	124	140
10	144	170
15	185	235
20	214	300
25	266	330
30	310	390
40	404	510
50	452	570
60	620	850
75	680	910

Option Weights

Table 47: RPS/RFS/RCS/RDT 050D to 140D (lbs)

Options	Unit Size		
	050D—079D	080D—091D	100D—140D
Outdoor/Return Air Options			
Return air plenum	Included in basic unit weight		
0%–30% O A hood	222	262	262
Economizer	1065	1266	1266
100% O A hood (deduct)	(139)	(71)	(71)
Blender Assembly			
Blender (low cfm)[a]	628	632	632
Blender (height cfm)[a]	632	731	731
Filter Options—Draw-Thru Section			
30% pleated	4	6	6
65% cartridge — std. flow	57	69	—
Med. flow	538	589	589
High flow	—	—	1100
95% cartridge — std. flow	67	83	—
Med. flow	550	605	605
High flow	—	—	1120
Filter Options—Blow-Thru Section (Final Filters)b			
95% cartridge — std. flow	1083	1296	—
Med. flow	1509	1760	1760
High flow	—	—	2275
Supply Air Fan Assembly			
27" diameter forward curved — LP	919	—	—
27" diameter forward curved — MP	942	—	—
27" diameter airfoil	868	—	—
30" diameter airfoil	965	—	—
33" diameter airfoil	—	989	—
36" diameter airfoil	—	1719	1719
40" diameter airfoil	—	—	1728
Return Air Fan Assembly			
40" diameter airfoil	629	—	—
44" diameter airfoil	—	971	971
Condenser Coil Options			
Copper fins	435	649	724
Coil guards	15	23	32
Evaporator Coils—Aluminum Fins, Standard Airflow Face Area			
3-row, 8 Fpi	370	487	792
3-row, 10 Fpi	395	520	830
3-row, 12 Fpi	419	553	867
4-row, 8 Fpi	445	588	905
4-row, 10 Fpi	478	632	955
4-row, 12 Fpi	510	676	1005
5-row, 8 Fpi	518	689	1022
5-row, 10 Fpi	559	744	1085
5-row, 12 Fpi	600	799	1147

a. Does not included the required 4' blank section weight
b. Final filter option includes liners in final filter and discharge plenum sectors.

Roof Curb Weights

Calculate the weight of the unit curb using one of the following equations and adding additional weights accordingly.

Unit Size	Weight Formula
050C–140C	Base curb wt. (lb.) = 0.74 [170 + 2 × curb length (in.)]

NOTE: Curb length does not include condenser length.

Additional Weights

1. For blank compartment out of airstream, add 30 lbs.
2. Cross supports:
   - For curb length greater than 144 in., add 30 lbs.
   - For curb length greater than 288 in., add 60 lbs.
   - For curb length greater than 432 in., add 90 lbs.
   - For curb length greater than 576 in., add 120 lbs.
3. For condenser section support rail (RPS only), add 139 lbs.

Example: RPS 090D

Component	Lbs
Basic unit	8,216
Economizer	1,266
30% efficiency filters	6
Burglar bars, supply	69
Burglar bars, return	114
36" airfoil supply fan	1,719
44" airfoil return fan	971
DX coil—5-row 12 fpi, high airflow aluminum fins	1,528
Gas heat—1000 MBh	650
SAF motor—40 hp	404
RAF motor —15 hp	185
Curb length greater than 288	60
Liners	900
	16,088

Liner calculations	ft
Section	
Economizer	8
Filter	+ 2
Supply fan	+ 8
Heat	+ 4
DX coil	+ 4
Discharge plenum	+ 4
	= 30
	× 30 lbs.
	per ft.
	= 900 lbs

Example: RPS 090D

Component	Lbs
Basic unit	7,492
Economizer	1,266
30% efficiency filters	6
44" airfoil supply fan with VIV	1,437
44” airfoil return fan with VIV	1,122
DX coil—5-row 12 FPI, high airflow aluminum fins	1,528
SAF motor—40 hp	404
RAF motor —15 hp	185
Liners	600
	14,040 lbs

Liner calculations	ft
Section	
Economizer	8
Filter	2
Supply fan	8
Heat	4
DX coil	4
Discharge plenum	4
	= 30
	× 30 lbs. per ft
	= **600 lbs**

NOTE: For structural purposes, consider roof curb weight.

Part 1: General

1 01 Section includes:

A. Semi-custom packaged rooftop air conditioners.

1 02 References

A. AFBMA 9—Load Ratings and Fatigue Life for Ball Bearings.

B. AMCA 99—Standards Handbook.

C. AMCA 210—Laboratory Methods of Testing Fans for Rating Purposes.

D. AMCA 300—Test Code for Sound Rating Air Moving Devices.

E. AMCA 500—Test Methods for Louver, Dampers, and Shutters.

F. ANSI/AHRI—Standard 340/360—Large Unitary Equipment.

G. NEMA MG1—Motors and Generators.

H. NFPA 70—National Electrical Code.

I. SMACNA—HVAC Duct Construction Standards—Metal and Flexible.

J. UL 900—Test Performance of Air Filter Units.

1 03 Submittals

A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements. A computer generated psychometric chart shall be submitted for each cooling coil with design points and final operating point clearly noted.

B. B. Product Data:

1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, and electrical characteristics and connection requirements.
2. Provide data on filter media, filter performance, filter assembly, and filter frames.
3. Provide computer generated fan curves with specified operating point clearly plotted.

C. Manufacturer's Installation Instructions.

1 04 Operation and Maintenance Data

A. Maintenance Data: Provide instructions for installation, maintenance and service

1.05 Qualifications

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.

B. Startup must be done by trained personnel experienced with rooftop equipment.

C. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.

1 06 Delivery, Storage, and Handling

A. Deliver, store, protect and handle products to site.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

Part 2: Products

2 01 Manufacturers

A. The following manufacturers will be considered provided they comply with contract documents. No substitutions will be permitted.

1. Daikin
2. Mammoth
3. Engineered Air
4. Seasons 4
5. Energy Labs
6. Governaire

2 02 General Description

A. Furnish as shown on plans, Daikin RoofPak™ Singlezone Heating and Cooling Unit(s) model [RPS] [RFS] [RCS] [RDT]. Unit performance and electrical characteristics shall be per the job schedule.

B. Configuration: Fabricate as detailed on prints and drawings:

1. Return fan/economizer section
2. [Air blender]
3. Filter section
4. Blow-through supply fan section
5. Heating coil section
6. Access section
7. Cooling coil section
8. [Draw-through supply fan section]
9. Diffuser
10. [Sound attenuator]
11. [Final filters]
12. Discharge plenum
13. Condensing unit section

C. The complete unit shall be [ETL/MEA] [ETL-Canada] listed. The burner and gas train for the unit furnace shall be [IRI/FIA] approved.

D. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Units shall be of a modular design with factory installed access sections available to provide maximum design flexibility. Each unit shall be [completely factory assembled and shipped in one piece] [split (045D–140D) at the condensing section] and/or [split between the supply fan section and the heat section]. Packaged units shall be shipped fully charged with Refrigerant R410A. RFS/RCS split systems and all units split between the evaporator and the condensing section are shipped with a nitrogen holding charge only.

E. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply [and return] fan assemblies, a refrigeration circuit run test, a unit control system operations checkout, [test and adjustment of the gas furnace], a unit refrigerant leak test and a final unit inspection.

F. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

G. The Rooftop unit shall be designed, manufactured, tested, rated, and certified to meet the seismic standards of the 2009 International Building Code.

Clear installation instructions shall be provided including all accessory components.

H. Performance: All scheduled capacities and face areas are minimum accepted values. All scheduled amps, kW, and hp are maximum accepted values that allow scheduled capacity to be met. I. Warranty: The manufacturer shall provide 12-month parts only warranty. [The manufacturer will provide extended 48-month, parts only, warranty on the compressor.] Defective parts will be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

2 03 Cabinet, Casing and Frame

A. Standard double-wall construction for all side wall access doors and floor areas shall be provided with 22-gauge, solid galvanized steel inner liners to protect insulation during service and maintenance. Insulation shall be a minimum of 1” thick, 3/4-lb. density neoprene-coated glass fiber. Unit cabinet shall be designed to operate at total static pressures up to [5.5 inches w.g. unit sizes 015-042D] [6.5 inches w.g. unit sizes 045–140D]. Insulation on ceiling and end panels shall be secured with adhesive and mechanical fasteners. [Heavy gauge solid galvanized steel liners shall be provided throughout, allowing no exposed insulation within the air stream. All cabinet insulation, except floor panels, shall be a nominal 2” thick, 1½-lb. density, R6.5, glass fiber.] [A combination of solid and perforated galvanized steel liners shall be provided throughout. Perforated liners to be used in the supply and return air plenums to provide improved sound attenuation. All cabinet insulation, except floor panels, shall be a nominal 2” thick, 1½-lb. density, R6.5, glass fiber.] All floor panels shall include [double wall construction and include a nominal 2” thick, 1½ lb. density, R6.5 glass fiber insulation.] [a minimum 1” thick, 3-lb. density, R4.2 glass fiber glass insulation.]

B. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished surface to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance. Service doors shall be provided on both sides of each section in order to provide user access to all unit components. Service doors shall be constructed of heavy gauge galvanized steel with a gauge, galvanized steel interior liner. All service doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system that is operated by a single, flush-mounted handle. The latch system shall feature a staggered engagement for ease of operation. Removable panels, or doors secured by multiple, mechanical fasteners are not acceptable.

C. The unit base frame shall be constructed of [15-gauge (015D–040D)] [13-gauge (045D–140D)] pre-painted galvanized steel. The unit base shall overhang the roof curb for positive water runoff and shall have a formed recess that seats on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base with lifting holes to accept cable or chain hooks.

2 04 Supply and Return Fans

A. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease-lubricated ball bearings shall be used. Bearings shall be sized to provide an L-50 life at 200,000 hours. The entire fan assembly shall be isolated from the fan bulkhead and mounted on [rubber-in-shear isolators] [spring isolators] [spring isolators with seismic restraints]. [Fixed] [Adjustable] pitch V-belt drives with matching belts shall be provided. V-belt drives shall be selected at [the manufacturer's standard service factor] [1.5 times fan brake horsepower].

B. Fan motors shall be heavy-duty 1800 rpm [open drip-proof (ODP)] [totally enclosed TEFC] type with grease-lubricated ball bearings. [Motors shall be high efficiency and meet applicable EPACT requirements.] [Motors shall be premium efficiency.] Motors shall be mounted on an adjustable base that provides for proper alignment and belt tension adjustment.

C. Airfoil supply fans

1. RPS and RFS supply fans shall be double width, double inlet (DWDI) airfoil centrifugal fan. All fans shall be mounted using shafts and hubs with mating keyways. Fans shall be Class II type and fabricated from heavy-gauge aluminum. Fan blades shall be continuously welded to the back plate and end rim.
2. RDT supply fan shall be single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades continuously welded to the back plate and end rim. Fans shall be mounted using shafts and hubs with mating keyways.

D. Forward curved supply fans

RPS and RFS supply fan shall be double width, double inlet forward curved centrifugal fan. All fans shall be mounted using shafts and hubs with mating keyways. The forward curved fan wheel and housing shall be fabricated form galvanized steel and shall be [Class I] [Class II] construction to satisfy the specified application.

E. Airfoil return fans

A single width, single inlet (SWSI) airfoil centrifugal return air fan shall be provided. The fan wheel shall be Class II construction and fabricated from heavy-gauge aluminum with fan blades continuously welded to the back plate and end rim. The fan shall be mounted using shafts and hubs with mating keyways. Exhaust fans are not acceptable.

F. Forward curved return fans

Double width, double inlet (DWDI) forward curved centrifugal return air fans shall be provided. Fans shall be mounted using shafts and hubs with mating keyways. The fan wheels and housings shall be fabricated from painted steel and shall be Class I construction to satisfy the specified application. Exhaust fans are not acceptable.

G. [The supply air fan and return air fan sections shall be provided with an expanded metal belt guard.]

2 05 Propeller Exhaust Fans (No Energy Recovery Wheel)

A. Belt drive propeller exhaust fans shall be provided. Propellers shall be constructed with fabricated steel, and shall be securely attached to fan shafts. All propellers shall be statically and dynamically balanced. Motors shall be permanently lubricated, heavy-duty type, carefully matched to the fan load. Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speeds. Drives shall be sized for a minimum of 105 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to wheel and motor shafts. Motor sheaves shall be adjustable for system balancing. Drive frame and panel assemblies shall be galvanized steel. Drive frames shall be formed channels and panels shall be welded construction. The axial exhaust fans shall bear the AMCA Certified Ratings Seals for both sound and air performance. Return fans are not acceptable.

B. The exhaust fans shall be controlled by a variable frequency drive.

C. [The exhaust air fan sections shall be provided with an expanded metal belt guard.]

2 06 Variable Air Volume Control

A. An electronic variable frequency drive shall be provided for the supply [and return] air fan. [Two independent drives, one per fan, shall be provided.] Each drive shall be factory installed downstream of the filters in a manner that the drive(s) are directly cooled by the filtered, mixed air stream. Drives shall meet UL Standard 95-5V and the variable frequency drive manufacturer shall have specifically approved them for plenum duty application. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly complete with a single handle latch mechanism. Mounting arrangements that expose drives to high temperature, unfiltered ambient air is not acceptable.

B. The unit manufacturer shall install all power/control wiring. [A manual bypass contactor arrangement shall be provided. The arrangement will allow fan operation at full design cfm, even if the drive has been removed for service]. [Line reactors shall be factory installed for each drive].

C. The supply air fan drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel. [The supply and return/exhaust fan drive outputs shall be independently controlled in order to provide the control needed to maintain building pressure control. Supply and return/exhaust air fan drives that are slaved off of a common control output are not acceptable.]

D. All drives shall be factory run tested prior to unit shipment.

2 06 Electrical

A. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with unit shall be numbered and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a [single] [dual] point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115volt control circuit transformer and fuse, system switches, high temperature sensor, and a 115-volt receptacle with a separate electrical connection shall also be provided with unit.

B. Each compressor and condenser fan motor shall be furnished with contactors, current sensing manual motor and short circuit protection, and inherent thermal overload protection. Supply and return fan motors shall have [contactors and external overload protection without VFDs] [Circuit breakers and built in overload protection with VFDs]. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance. All 115–600 voltage wire shall be protected from damage by raceways or conduit.

C. [A factory installed and wired marine service light, with switch and receptacle, shall be provided in the supply air and return/exhaust fan section. The separate, main unit service receptacle electrical circuit shall also power the light circuit.]

D. [A factory installed and wired 115 volt power supply shall be provided for the GFI receptacle. The power supply shall be wired to the line side of the disconnect so the receptacle is powered when the main unit disconnect is off. This option shall include a weather proof transformer and disconnect for the 115 volt GFI. The 115 volt GFI electrical circuit shall complete with primary fused short circuit protection.

E. [Phase failure and under voltage protection on three-phase motors shall be provided to prevent damage from single phasing, phase reversal, and low voltage conditions.]

F. [Ground fault protection shall be provided to protect against arcing ground faults.]

G. Further options

1. Factory-mounted smoke detectors shall be factory installed in the [supply air opening] [supply and return air openings]. Smoke detectors to be ionization type, which responds to invisible products of combustion without requiring the sensing of heat, flame or visible smoke. Upon sensing smoke, the unit shall provide a control output for use by building management system.
2. Unit to have factory-mounted UV lights located on the leaving air side of the cooling coil. Unit to have view port to allow for visual indication of operation through UV resistant glass. Unit to have door interlocks on each door accessing UV light. Interlock to kill power to UV light when door is opened.

   Lamp and fixture to consist of a housing, power source, lamp sockets, and lamp. All components are to be constructed to withstand typical HVAC environments and are UL/C-UL listed. Housings are to be constructed of type 304 stainless steel and are to be equipped with both male and female power plugs with one type at each end to facilitate simple fixture-to-fixture plug-in for AC power.

   Power source shall be an electric, rapid-type with overload protections and is to be designed to maximize radiance and reliability at UL/C-UL listed temperatures of 55°F–135°F. Power source will include RF and EMI suppression.

   Sockets shall be medium bi-pin, single click safety, twist lock type and are to constructed of a UVC-resistant polycarbonate.

   Lamp shall be a high output, hot cathode, T8 diameter, medium bi-pin that produces UVGI of 254 nm. Each tube produces the specified output at 500 fpm and air temperatures of 55°F–135°F.
3. A [single] [dual] non-fused disconnect switch[es] shall be provided for disconnecting electrical power at the unit. [The second switch will service the condensing section.] Disconnect switches shall be mounted internally to the control panel and operated by an externally-mounted handle. Externally-mounted handle is designed to prohibit opening of the control panel door without the use of a service tool.

2 07 Heating and Cooling Sections

Cooling

A. [The cooling coil section shall be installed in a blow-through configuration, downstream of the supply air fan. A factory-tested diffuser shall be used in order to provide air distribution across the cooling coil. A blow-through coil is specified to minimize the impact of fan motor heat.] [The cooling coil section shall be installed in a draw through configuration, upstream of the supply air fan.] The coil section shall be complete with factory piped cooling coil and sloped drain pan. Hinged access doors on both sides of the section shall provide convenient access to the cooling coil and drain pan for inspection and cleaning.

   Submittals must demonstrate that scheduled unit leaving air temperature (LAT) is met, that fan and motor heat temperature rise (TR) have been considered, and scheduled entering air temperature (EAT) equals mixed air temperature (MAT).

   Draw-through cooling—Scheduled EAT equals cooling coil EAT and scheduled unit LAT equals cooling coil LAT plus TR.

   Blow-through cooling—Cooling coil EAT equals scheduled EAT plus TR and scheduled unit LAT equals cooling coil LAT.

   Direct expansion (DX) cooling coils shall be fabricated of seamless 1/2” diameter high efficiency copper tubing that is mechanically expanded into high efficiency [aluminum] [copper] plate fins. Coils shall be a multi-row, staggered tube design with a minimum of [3] [4] [5] rows and a maximum of [8] [10] [12] fins per inch. All units shall have two independent refrigerant circuits and shall use an interlaced coil circuiting that keeps the full coil face active at all load conditions.

   All coils shall be factory leak tested with high pressure air under water.

B. A [painted galvanized steel,] [stainless steel,] positively sloped drain pan shall be provided with the cooling coil. The drain pan shall extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall be connected to a threaded drain connection extending through the unit base. Units with stacked cooling coils shall be provided with a secondary drain pan piped to the primary drain pan.

Hot Water Heating Option

C. [A factory installed three-way modulating control valve and spring return valve actuator shall provide control of the hot water coil. The valve actuator shall be controlled by the factory installed main unit control system] A [1] [2] row hot water heating coil shall be factory installed in the unit heat section. Coils shall be fabricated of seamless 5/8" diameter copper tubing that is mechanically expanded into high efficiency HI-F rippled and corrugated aluminum plate fins. All coil vents and drains shall be factory installed. [The hot water heat section shall be installed downstream (RFS/RPS) of the supply air fan. A factory-tested diffuser shall be used in order to provide air distribution across the coil.] [The hot water heat section shall be installed upstream (RDT) of the supply air fan.] Hinged access doors shall provide convenient access to the coil and valve for inspection and cleaning.

[[Ethylene glycol] [propylene glycol] shall be added to the hot water circuit to protect against coil freeze-up.]

[A factory installed, non-averaging type freezestat shall be factory installed to provide some protection against coil freeze-up.]

Coils shall be factory leak tested with high pressure air under water.

Steam Heating Option

D. A [1 row, 6 fin per inch] [1 row, 12 fin per inch] [2 row, 6 fin per inch] fin per inch team heating coil shall be factory installed in the unit heat section. Coils shall be fabricated of seamless 5/8" diameter copper tubing that is mechanically expanded into high efficiency HI-F rippled and corrugated aluminum plate fins. Steam coils shall be of the jet distributing type. [The steam heat section shall be installed downstream (RFS/RPS) of the supply air fan. A factory-tested diffuser shall be used in order to provide air distribution across the coil.] [The steam heat section shall be installed upstream (RDT) of the supply air fan.] Hinged access doors shall provide convenient access to the coil and valve for inspection and cleaning.

[A factory installed two-way modulating control valve and spring return valve actuator shall provide control of the steam coil. The valve actuator shall be controlled by the factory installed main unit control system]

[A factory installed, non-averaging type freezestat shall be factory installed to provide some protection against coil freeze-up.]

Coils shall be factory leak tested with high pressure air under water.

Gas Heating Option

E. A natural gas fired furnace shall be installed in the unit heat section. The heat exchanger shall include a type 321 stainless steel cylindrical primary combustion chamber, a type 321 stainless steel header, type 321 stainless steel] secondary tubes and type 321stainless steel turbulators. Carbon and aluminized steel heat exchanger surfaces are not acceptable. The heat exchanger shall have a condensate drain. Clean out of the primary heat exchanger and secondary tubes shall be accomplished without removing casing panels or passing soot through the supply air passages. The furnace section shall be positioned downstream of the supply air fan.

[The furnace will be supplied with a modulating forced draft burner. The burner shall be controlled for low fire start. The burner shall be capable of continuous modulation between 33% and100% of rated capacity and shall operate efficiently at all firing rates.]

[The furnace shall be supplied with a Daikin SuperMod™ forced draft burner capable of continuous modulation between 5% and 100% of rated capacity, without steps. The burner shall operate efficiently at all firing rates. The burner shall have proven open damper low-high-low pre-purge cycle, and proven low fire start. The combustion air control damper shall be in the closed position during the off cycle to reduce losses.]

The burner shall be specifically designed to burn natural gas and shall include a microprocessor based flame safeguard control, combustion air proving switch, pre-purge timer and spark ignition. The gas train shall include redundant gas valves, [maximum 0.5psi pressure regulator] [2–3psi high pressure regulator] [5–10psi high pressure regulator], shutoff cock, pilot gas valve, pilot pressure regulator, and pilot cock. The burner shall be rated for operation and full modulation capability at inlet gas pressures down to [7.0. W.C. (models 200–650)] [8.0 in. W.C. (models 790, 800, 1100, 1400, 1500)] [9.0 in. W.C. (models 100 and 2000)].

The gas burner shall be controlled by the factory installed main unit control system.

The burner shall be fired, tested and adjusted at the factory. Final adjustments shall be made in the field at initial start-up by a qualified service technician to verify that installation and operation of the burner is according to specifications.

Electric Heating Option

F. Staged electric heating coils shall be factory installed in the unit heat section. Heating coils shall be constructed of a low watt density, high nickel-chromium alloy resistance wire, mechanically stacked and heli-arc welded to corrosion resistant terminals. A corrosion resistant heavy gauge rack shall support the elements. Safety controls shall include automatic reset high limit control for each heater element with manual reset backup line break protection in each heater element branch circuit (Note: Manual reset not provided when ETL-Canada label is provided). Heating element branch circuits shall be individually fused to maximum of 48 Amps per NEC requirements. The electric heat section shall be positioned downstream of the supply air fan.

   The electric heat elements shall be controlled by the factory installed main unit control system.

2 08 Filters

Draw-through Filters

A. Unit shall be provided with a draw-through filter section. The filter section shall be supplied complete with the filter rack as an integral part of the unit. The draw-through filter section shall be provided with [panel] [cartridge] filters.

B. 2" thick AmericanAirFilter [MERV 8, 30%] [MERV 13, 85%] efficient pleated panel filters shall be provided. Filters shall be frame mounted and shall slide into galvanized steel racks contained within the unit. Filters shall be installed in an angular arrangement to maximize filter area and minimize filter face velocity. Filters shall be accessible from both sides of the filter section.

C. 12" deep [MERV 11, 60-65%] [MERV 14, 90-95%] efficient, UL Std. 900, Class 1, AmericanAirFilter cartridge filters shall be provided. 2" panel, 30% efficient pre-filters shall be included. Cartridge filters shall consist of filter media permanently attached to a metal frame and shall slide into a gasketed, extruded aluminum rack contained within the unit. The filter rack shall have secondary gasketed, hinged end panels to insure proper sealing. Filters shall be accessible from both sides of the filter section.

D. [30% efficient pleated] [60-65% efficient cartridge] [90–95% efficient cartridge] filters shall be provided with INTERSEPT® antimicrobial treatment.

Final Filters Option

E. Final Filters—Unit shall be provided with a final filter section downstream of the supply fan. Unit to have 40" of unit length between the fan discharge and the final filters to allow for proper air distribution. The final filter section shall be supplied complete with the filter rack as an integral part of the unit. The final filter section shall be provided with cartridge filters.

F. 12" deep 90–95% efficient, UL Std. 900, Class 1, AmericanAirFilter cartridge filters shall be provided. [For units with gas or electric heat, AmericanAirFilter High Temperature cartridge filters rated for 500º F shall be used.] Cartridge filters shall consist of filter media permanently attached to a metal frame and shall slide into a gasketed, extruded aluminum rack contained within the unit. The filter rack shall have secondary gasketed, hinged end panels to insure proper sealing. Filters shall be accessible from both sides of the filter section.

G. [Filters shall be provided with INTERSEPT antimicrobial treatment.]

2 09 Outdoor / Return Air Section

Return Air Plenum

A. Unit shall be provided with a return air plenum for handling 100% re-circulated air. The 100% return air plenum shall allow return air to enter from the [bottom] [back] of the unit.

Return Air Plenum with 0 to 30% Outdoor Air Hood

B. A return air plenum shall be provided with a 0 to 30% outdoor air hood. The hood shall allow outdoor air to enter at the back of the return air plenum. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream. The return air plenum shall allow return air to enter from the [bottom] [back] of the unit.

C. Daikin UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged horizontally in the hood. Damper leakage shall be less than 1.5 cfm per ft^2 of damper area at 1" static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. [Control of the dampers shall be from a factory installed, two-position actuator.]

0%–100% Outdoor Air Economizer (no energy recovery)

D. Unit shall be provided with an outdoor air economizer section. The 0 to 100% outside air economizer section shall include outdoor, return, and exhaust air dampers. Outdoor air shall enter from both sides of the economizer section through horizontal, louvered intake panels complete with rain lip and bird screen. The floor of the outdoor air intakes shall provide for water drainage. The economizer section shall allow return air to enter from the [bottom] [back] of the unit.

The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be opposed sets of parallel blades, arranged vertically to converge the return air and outdoor air streams in multiple, circular mixing patterns. Daikin UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed. Damper leakage shall be less than 1.5 cfm per ft^2 of damper area at 1" static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers.

A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. [An electric actuator shall provide positive closure of the exhaust damper.] A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with urethane gasketing on contact edges.

Control of the dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating, spring return type. [An adjustable enthalpy control shall be provided to sense the dry-bulb temperature and relative humidity of the outdoor air stream to determine if outdoor air is suitable for “free” cooling.] [A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for “free” cooling.] If outdoor air is suitable for “free” cooling, the outdoor air dampers shall modulate in response to the unit’s temperature control system.

DesignFlow Minimum Ventilation Air Control Option

E. Daikin DesignFlow precision ventilation control system shall be provided as an integral part of the 0–100% outdoor air economizer system. It shall directly measure the total mass volume of air flowing through the outdoor air intakes. The unit’s control panel shall automatically adjust the outdoor damper position to maintain minimum outdoor air cfm. The airflow station shall be capable of accurately measuring minimum outdoor air volume within 5% to continuously satisfy the requirements of ASHRAE 62–1999. Third party verification of measurement accuracy shall be verified by a nationally recognized independent testing agency.

100% OA Hood Option

F. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.

G. Daikin UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 cfm per ft^2 of damper area at 1" static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. [Control of the dampers shall be from a factory installed, two-position actuator.]

Energy Recovery Option

H. Unit shall be provided with [a modulating outdoor air economizer section with] an ARI certified energy recovery wheel. [The economizer section shall include outdoor, return and return exhaust air control. Bypass dampers and damper actuators shall be included that automatically bypass outdoor air around the wheel during economizer operation.] Outdoor air shall enter at the back of the section through a factory-installed hood capable of handling 100% outdoor air. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same prepainted finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign material and a rain lip to drain water away from the entering air stream. Return air shall enter through the bottom of the unit. The entire section shall be double-wall construction.

I. The entalphy wheel shall be constructed of corrugated synthetic fibrous media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated, bonded, or synthesized onto the media are not acceptable due to delamination or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized (±0.032 in.) in order to minimize wear on inner seal surfaces and to minimize cross leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for airflow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by airflow are unacceptable due to the possibility of channeling, internal bypass or leakage, and performance degradation. The media shall be in accordance with NFPA or UL guidelines. The desiccant material shall be a molecular sieve, specifically a 4A or smaller molecular sieve to minimize cross contamination. The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment. The wheel seals shall be brush seals, neoprene bulb seals, or equivalent. Seals should be easily adjustable. Cassettes shall be fabricated of heavy duty reinforced galvanized steel. Cassettes shall have a built-in adjustable purge section minimizing cross contamination of supply air. Bearings shall be in board, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged bearings. Drive systems shall consist of fractional horsepower A.C.drive motors with multilink drive belts. The wheel shall be tested in accordance with NFPA or UL guidelines and shall be UL recognized or equivalent. The wheel capacity, air pressure drop, and efficiency shall be ARI certified by ARI and its testing agencies. Alternative independent performance testing must be pre-approved to be accepted. [Wheel shall be provided with variable speed control for frost protection.]

J. The wheel recovers energy from the factory-supplied return exhaust section and includes an SWSI airfoil fan and motor in accordance with construction already specified. Gravity relief dampers and foldout exhaust hood shall be provided. All necessary exhaust fan motors, branch short circuit protection, and wiring [and controls] shall be provided. Two-inch, 30% pleated filters shall be provided in both air inlets to protect the wheel from dust and dirt in both the outdoor and return/exhaust air paths. Dampers to be Daikin UltraSeal, low-leak type, and shall be provided on outdoor or return dampers. Damper blades shall be fully gasketed and side sealed and arranged horizontally in the hood. Damper leakage shall be less than 0.2% at 1.5 inches static pressure differential. Leakage rate to be tested in accordance with AMC Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers.

2 11 Access Section Option

A. Unit shall be provided with factory installed access sections located [upstream] [downstream] [upstream and downstream] of the supply air fan, as shown on the unit drawing. Access sections shall have hinged access doors on both sides of the section and shall have the same construction features as the rest of the unit.

Blank Compartment

B. An insulated, blank compartment shall be provided. The section shall be located after the discharge plenum and will be out of the air stream. The section shall be complete with insulation, double wall construction [and a service light].

2 12 Static Air Mixer (Air Blender) Option

A. A static air mixing device shall be factory installed between the outside/return air section and the filter section. The static air mixer shall be installed with proper upstream and downstream distances. The mixing device shall perform at face velocities from 500 fpm through 2500 fpm with no loss in mixing performance. The mixing device shall provide mixing and distribution of the outside and return air streams to minimize the threat of coil freeze-up during operation and to improve temperature control. Acceptable manufacturers are Blender Products or Kees.

2 13 Sound Attenuator Option

A. A section shall be provided by the air handling unit manufacturer as an integral part of the unit to attenuate fan noise at the source. Variable range of splitter thickness and air passages provided to optimize acoustic performance and energy conservation. The attenuators shall have perforated double-wall construction and be located downstream of the supply fan. Hinged access doors shall be provided on both sides of the section and shall have the same construction as the rest of the unit. [Sound attenuator shall have Tedlar coating for moisture protection]. Combustion rating for the silencer acoustic fill shall not be greater than the following UL fire hazard classification:

Flame Spread 15

Fuel Contributed 0

Smoke Developed 0

Tested in accordance with UL Test Procedure 723.

B. The attenuator rating shall be determined using the duct-to-reverberant room test method which provides for airflow in both directions through the attenuator in accordance with latest version of ASTM specification E-477. Insertion Loss Ratings (ILR) shall be:

Octave Band at Center Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000
ILR (no Tedlar)	7	9	22	28	29	29	18	12
ILR (Tedlar coating)	6	10	20	16	14	18	13	12

C. Manufacturer shall provide certified test data on dynamic insertion loss, self-generated sound power levels, and aerodynamic performance for reverse and forward flow test conditions to the design professional in writing as least 10 days prior to the bid.

2 14 Discharge And Return Plenum Accessories

A. A supply air discharge plenum shall be provided. [The plenum section shall be lined with a perforated acoustic liner to enhance sound attenuation.] The plenum section shall have a [bottom] [side] [front (RFS only)] discharge opening.

B. A combination burglar bar/safety grate shall be provided in the [bottom return air opening] [bottom supply air opening] [bottom return and supply air openings]. Burglar bar/safety grate shall be made of 3/4" diameter ground and polished steel shaft welded to a galvanized steel frame.

C. Isolation dampers shall be provided in the [bottom return air opening] [bottom supply air opening] [bottom return and supply air openings]. [A two-position actuator shall be provided to close the dampers when the fans are not running.]

2 15 Condensing Unit

A. The condensing section shall be open on the sides and bottom to provide access and to allow airflow through the coils. Condenser coils shall be multi-row and fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.

B. Condenser fans shall be direct drive, propeller type designed for low tip speed and vertical air discharge. [Condenser fan rpm shall be 1140 rpm maximum. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield][Special quiet condenser fans shall consist of seven aerodynamic, airfoil blades with serrated trailing edges and special blade tips to break up turbulence and noise. Compressor sound blankets shall also be provided.]

C. Each circuit shall have fan cycling of at least one condenser fan to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45º F.

D. Liquid tight conduit shall be provided on exposed condensing section wiring.

Fixed Speed Scroll Compressors

E. Each unit shall have multiple, heavy-duty Copeland® scroll compressors. Each compressor shall be complete with crankcase heater, sight-glass, anti-slug protection, current sensing and motor temperature sensing, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.

Variable Speed Inverter Compressors

F. Each unit shall have a variable speed inverter compressor on one circuit and [(016 through 031) one compliant fixed speed scroll compressor] on others, [multiple compliant fixed speed scroll compressors]. All compressors shall be isolated with resilient rubber isolators to decrease noise transmission.

The lead compressor shall be driven by variable frequency drive to control compressor speed. The compressor speed shall dynamically vary to match the space load. Inverter driven compressor shall be able to modulate from 25 Hertz to a maximum of 100 Hz. The minimum unit capacity shall be [(size 16) –20%] [(size021& 026–15%] [(size 031–17%)] [(size 042) –13%] [(size045& 051–16%] [(size 063–14%)] [(size 074–11%)] of full load. The variable speed inverter compressor motor shall be a brushless permanent magnet type, to provide higher efficiency at all speeds. Oil injection system shall be provided to ensure optimal efficiencies. Gearotor oil pump shall be provided for exceptional bearing lubrication at all compressor speed. Oil Strainer shall be provided to control the risk of system debris in the oil injection circuit. Each variable speed inverter compressor shall be engineered with an appropriate sized VFD to control compressor motor speed and to provide compressor protection functions. Each variable speed compressor shall include a crankcase heater (done via a DC holding current through the motor windings or external, sight-glass, current sensing & motor temperature sensing, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure.

Each fixed speed compressor shall include crankcase heater, sight-glass, anti-slug protection, current sensing and motor temperature sensing, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure.

Refrigeration Controls for Fixed Speed Scroll Compressors

G. Each unit shall have two independent refrigeration circuits. Each circuit shall be complete with low pressure control, filter-drier, liquid moisture indicator/ sight-glass, solenoid, thermal expansion valve, liquid line shutoff valve with charging port, discharge line shutoff valve, a manual reset high pressure safety switch and high pressure relief device. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation. Each circuit shall be dehydrated and leak tested.

Refrigeration Controls for Variable Speed Inverter Compressors

H. Each unit shall have two independent refrigeration circuits. Each circuit shall be completed with low pressure control, filter-drier, liquid moisture indicator/ sight-glass, solenoid, thermal expansion valve, liquid line shutoff valve with charging port, discharge line shutoff valve, a manual reset high pressure safety switch and high pressure relief device. The thermal expansion valve shall be capable of modulation from [(100% to [(size 16) –20%] [(size021& 026–15%] [(size 031–17%)] [(size 042)–13%] [(size 045& 051–16%] [(size 063–14%)] [(size 074–11%)] of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation. Each circuit shall be dehydrated and leak tested.

Capacity Control for Fixed Speed Scroll Compressors

I. Refrigeration capacity control shall be accomplished by staging of the unit's multiple compressors. To maintain desired temperature control, the unit shall have a minimum of [two (size 15)][four (size 20–68] [six (size 70–140)] steps of capacity control.

J. All compressor capacity control staging shall be controlled by the factory installed main unit control system.

Capacity Control for Variable Speed Inverter Compressors

K. Refrigeration capacity control shall be accomplished by modulating & staging of the unit's multiple compressors. To maintain desired temperature control, the unit shall have one variable speed compressor plus a minimum of [one (sizes 16, 21, 25, 31)][two (sizes 42, 45, 51, 63] [three (size 74)] steps of capacity control for fixed speed compressor(s). The unit shall modulate the inverter compressor speed and stage the fixed compressors to deliver the desired set point temperature with the minimum amount of energy.

L. All compressor capacity control modulating & staging shall be controlled by the factory installed main unit control system.

Options for Fixed Speed Scroll Compressors

M. Hot gas bypass control shall be factory installed on one [both] refrigerant circuits. Hot gas bypass control shall include a modulating hot gas bypass control valve, all associated piping and be automatically operated by the units microprocessor control.

N. Modulating hot gas reheat shall be provided on the lead circuit complete with modulating valves, micro-channel refrigerant reheat coil, and dehumidification control. Controls shall maintain ± 0.5ºF control of the reheat coil leaving air temperature.

O. A vandal protection screen shall be provided on the condensing section. It will be constructed from PVC coated, 12-gauge steel wire.

Options for Variable Speed Inverter Compressors

P. Hot gas bypass control shall be factory installed only on the fixed compressor refrigerant circuits. Hot gas bypass control shall include a modulating hot gas bypass control valve and all associated piping and shall be automatically operated.

Q. Modulating hot gas reheat shall be provided on the lead circuit complete with modulating valves, micro-channel refrigerant reheat coil, and dehumidification control. Controls shall maintain ± 0.5ºF control of the reheat coil leaving air temperature.

R. A vandal protection screen shall be provided on the condensing section. It will be constructed from PVC coated, 12-gauge steel wire.

2 16 Roof Curb

A. A prefabricated 12-gauge galvanized steel, mounting curb, designed and manufactured by the unit manufacturer, shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and rail support of the condensing section. Supply and return opening duct frames shall be provided as part of the curb structure allowing duct connections to be made directly to the curb prior to unit arrival. The curb shall be a minimum of 16" high and include a nominal 2" × 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

2 17 Controls

A. Each unit shall be equipped with a complete MicroTech III microprocessor based control system. The unit control system shall include all required temperature and pressure sensors, input/output boards, main microprocessor and operator interface. The unit control system shall perform all unit control functions including scheduling,], unit diagnostics and safeties. Control sequences shall include [constant air volume, zone temperature control (CAV-ZTC)] [constant air volume, discharge temperature control (CAV-DTC)] [variable air volume, cooling only discharge temperature control (VAV-DTC)] [variable air volume, cooling/modulating heating discharge temperature control (VAV-DTC)] [duct static pressure control], [supply/return air fan tracking control] and [building static pressure control. All boards shall be individually replaceable for ease of service. All microprocessors, boards, and sensors shall be factory mounted, wired and tested.

B. The microprocessor shall be a stand-alone DDC controller not dependent on communications with any on-site or remote PC or master control panel. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.

C. An optional [BACnet IP] [BACnet MS/TP] [LonWorks] communication module shall be provided for direct interface to the BAS network.

D. All digital inputs and outputs shall be protected against damage from transients or wrong voltages. The status of each input and output can be read on the display. All field wiring shall be terminated at a separate, clearly marked terminal strip.

E. The microprocessor memory shall be protected from all voltage fluctuations as well as any extended power failures. The microprocessor shall maintain existing set points and operate stand alone if the rooftop loses either direct connect or network communications.

F. The microprocessor shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to ten holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.

G. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:

1. Zone sensor with tenant override switch.
2. #1 above plus a heating and cooling set point adjustment. (CAV-ZTC only)

H. The display character format shall be 22 characters × 5 lines. The character font shall be a 5 × 8 dot matrix. The display shall be a supertwist liquid crystal display (LCD) with black characters on yellow background providing high visibility. The display form shall be in plain English coded formats. Lookup tables are not acceptable

I. Adjustments and readings shall be made through a push/pull navigational wheel. All control settings shall be password protected from changes by unauthorized personnel.

J. [Both a unit-mounted and remote-mounted UI shall be provided. Up to eight units can be connected to a remote UI. Both the unit-mounted and remote-mounted UI are always operable. The control contractor is responsible for wiring between the unit and the remote UI. The maximum wiring distance to the remote UI is 700 meters. Optical isolation shall protect the main unit controller from remote UI wiring problems. The remote UI shall be provided with the same navigational wheel and keypad/display and have comparable functionality to the unit-mounted UI.]

K. The display shall provide the following information as required by selected unit options:
   1. Unit status showing number of stages or percent capacity for heating, cooling, and economizer
   2. Supply, return, outdoor, and space air temperature
   3. Duct and building static pressure; the control contractor is responsible for providing and installing sensing tubes
   4. Supply fan and return fan status and airflow verification
   5. Supply and return VFD speed
   6. Outside air damper position and economizer mode
   7. Cooling and heating changeover status
   8. Occupied, unoccupied, and dirty filter status
   9. Date and time schedules
   10. Up to ten current alarms and 25 previous alarms with time and date

L. The push/pull navigation wheel shall allow the following set points as a minimum as required by selected unit options:
   1. Six control modes including off manual, auto, heat/cool, cool only, heat only, and fan only
   2. Four occupancy modes including auto, occupied, unoccupied and bypass (tenant override with adjustable duration)
   3. Control changeover based on return air temperature, outdoor air temperature, or space temperature
   4. Primary cooling and heating set point temperature based on supply or space temperature
   5. Night setback and setup space temperature
   6. Cooling and heating control differential (or dead band)
   7. Cooling and heating supply temperature reset options based on one of the following: Return air temperature, outdoor air temperature, space temperature, airflow, or external (1–5 VDC) signal
   8. Reset schedule temperature
   9. High supply, low supply, and high return air temperature alarm limits
   10. Ambient compressor and heat lockout temperatures
   11. Compressor interstage timers duration
   12. Duct and building static pressure
   13. Return fan tracking (VaneTrol) settings that include minimum/maximum VFD speed
   14. Minimum outdoor airflow reset based on external reset (1–5 VFD) percent of cfm capacity, and fixed outdoor damper position
   15. Economizer changeover based on enthalpy, dry bulb or network signal
   16. Current time and date
   17. Occupied/unoccupied time schedules with allowances for holiday/event dates and duration
   18. Three types of service modes including timers normal (all time delays), timers fast (all time delays 20 seconds), and normal
   19. Tenant override time

M. Open Communication Protocol—The unit control system shall have the ability to communicate to an independent Building Management System (BMS) through a direct [BACnet IP] [BACnet MS/TP] [LonWorks] communication connection. The independent BMS system shall have access to [quantity from specification] “read only” variables and [quantity from specification] “read & and write” variables. Communications shall not require field mounting of any additional sensors or devices at the unit. [The communications protocol shall be LonMark 3.4 certified under the [Discharge Air] [Space Comfort] functional profiles.]

   The BMS system shall be capable of interacting with the individual rooftop controllers in the following ways:

   1. Monitor controller inputs, outputs, set points, parameters and alarms
   2. Set controller set points and parameters
   3. Clear alarms
   4. Reset the cooling and heating discharge air temperature set point (VAV and CAV-DTC units)
   5. Reset the duct static pressure set point (VAV units)
   6. Set the heat/cool changeover temperature (VAV and CAV-DTC units)
   7. Set the representative zone temperature (CAVZTC units)

N. It will be the responsibility of the Systems Integrating Contractor to integrate the rooftop data into the BMS control logic and interface stations.

Part 3: Execution

3 01 Installation

A. Install in accordance with manufacturer’s instructions.

Daikin Applied Training and Development

Now that you have made an investment in modern, efficient Daikin equipment, its care should be a high priority. For training information on all Daikin HVAC products, please visit us at www.DaikinApplied.com and click on Training, or call 540-248-9646 and ask for the Training Department.

Warranty

All Daikin equipment is sold pursuant to its standard terms and conditions of sale, including Limited Product Warranty. Consult your local Daikin Applied Representative for warranty details. To find your local Daikin Applied Representative, go to www.DaikinApplied.com.

Aftermarket Services

To find your local parts office, visit www.DaikinApplied.com or call 800-37PARTS (800-377-2787). To find your local service office, visit www.DaikinApplied.com or call 800-432-1342.

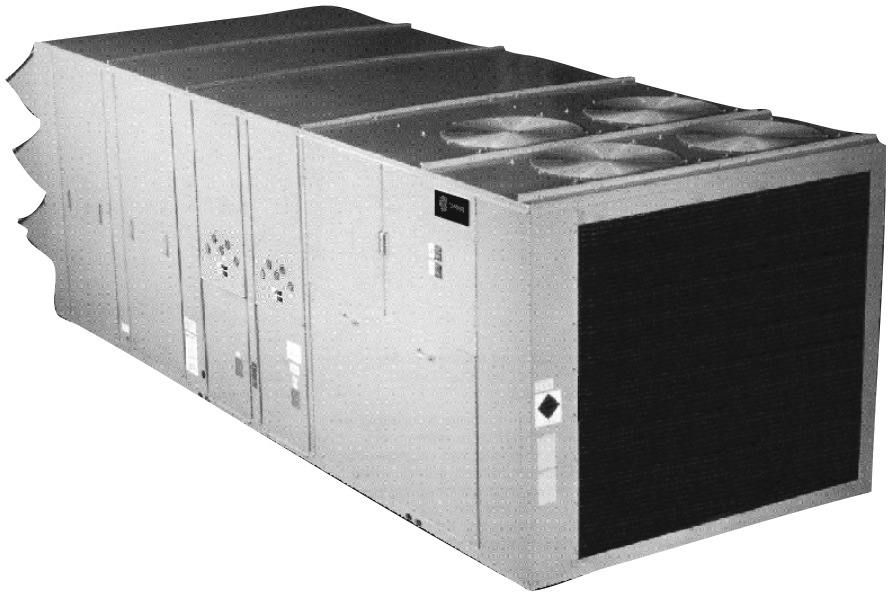
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Packaged Rooftop Air Conditioners

27½ to 50 Ton - 60 Hz
23 to 42 Ton (81-148 kW) - 50 Hz
Voyager™ Commercial with ReliaTel™ Controls



September 2004

RT-PRC007-EN

Introduction

Packaged Rooftop Air Conditioners

Through the years, Trane has designed and developed the most complete line of Packaged Rooftop products available in the market today. Trane was the first to introduce the Micro—microelectronic unit controls—and has continued to improve and revolutionalize this design concept.

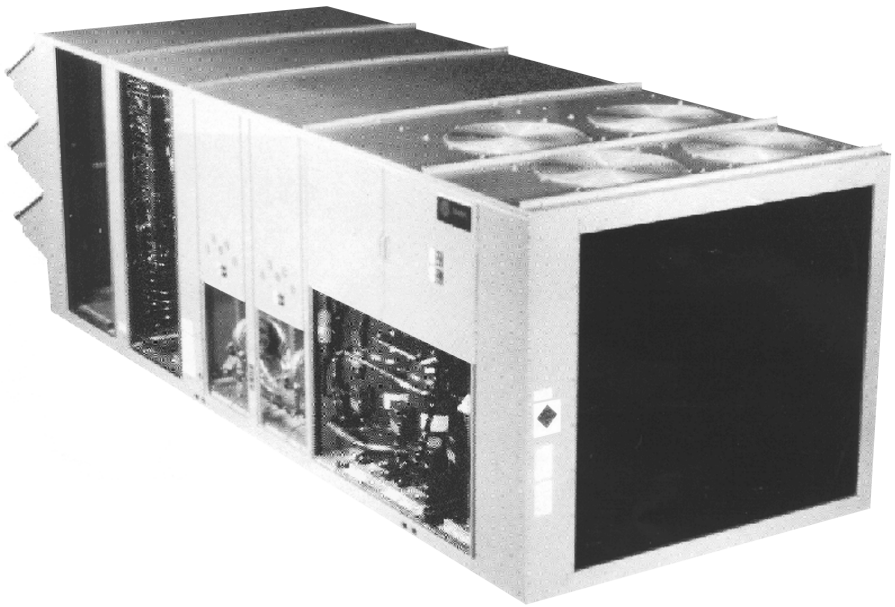
The ReliaTel control platform offers the same great features and functionality as the original Micro, with additional benefits for greater application flexibility.

The Voyager Commercial line offers 27½ to 50 ton 60 Hz and 23 to 42 ton 50 Hz models. Both 50 and 60 Hz models come in a choice of five sizes to meet the changing demands of the commercial rooftop market.

Trane customers demand products that provide exceptional reliability, meet stringent performance requirements, and are competitively priced. Trane delivers with Voyager Commercial.

Voyager Commercial features cutting edge technologies: reliable 3-D™ Scroll compressors, Trane engineered ReliaTel controls, computer-aided run testing, and Integrated Comfort™ Systems. So, whether you're the contractor, the engineer, or the owner you can be certain Voyager Commercial Products are built to meet your needs.

It's Hard To Stop A Trane.®



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Features and Benefits

Standard Features
- Factory installed and commissioned ReliaTel™ controls
- Trane 3-D™ Scroll Compressors
- Dedicated downflow or horizontal configuration
- CV or VAV control
- Frostat™ coil frost protection on all units
- Supply air overpressurization protection on VAV units
- Supply airflow proving
- Emergency stop input
- Compressor lead-lag
- Occupied-Unoccupied switching
- Timed override activation
- FC supply fans
- UL and CSA listing on standard options
- Two inch standard efficiency filters
- Finish exceeds salt spray requirements of ASTM B117
- Sloped condensate drain pan
- Cleanable, IAQ-enhancing, foil faced insulation on all interior surfaces exposed to the unit air stream

Optional Features
- Electric heat
- Natural gas heat
- LP gas heat (kit only)
- Power Exhaust
- Barometric Relief
- High Efficiency 2" Throwaway Filters
- High Efficiency 4" Throwaway Filters
- High Efficiency supply fan motors
- Manual fresh air damper
- Economizer with dry bulb control
- Economizer with reference enthalpy control
- Economizer with differential (comparative) enthalpy control
- Inlet guide vanes on VAV units
- Variable frequency drives on VAV units (with or without bypass)
- Service Valves
- Through-the-base electrical provision
- Factory mounted disconnect with external handle (non-fused)
- Factory powered 15A GFI convenience outlet
- Field powered 15A GFI convenience outlet
- Trane Communication Interface (TCI)
- Ventilation Override
- Hinged Service Access
- Factory installed condenser coil guards
- Black epoxy pre-coated condenser coil
- Sloped stainless steel evaporator coil drain pans
- CO_2 sensors for space comfort control (SCC) or discharge air control (DAC)
- LonTalk® Communication Interface (LCI-R)
- Clogged filter switch
- Discharge air temperature sensor (CV only)

Features and Benefits

Trane 3-D™ Scroll Compressor

Simple Design with 70% Fewer Parts

Fewer parts than an equal capacity reciprocating compressor means significant reliability and efficiency benefits. The single orbiting scroll eliminates the need for pistons, connecting rods, wrist pins and valves. Fewer parts lead to increased reliability. Fewer moving parts, less rotating mass and less internal friction means greater efficiency than reciprocating compressors.

The Trane 3-D Scroll provides important reliability and efficiency benefits. The 3-D Scroll allows the orbiting scrolls to touch in all three dimensions, forming a completely enclosed compression chamber which leads to increased efficiency. In addition, the orbiting scrolls only touch with enough force to create a seal; there is no wear between the scroll plates. The fixed and orbiting scrolls are made of high strength cast iron which results in less thermal distortion, less leakage, and higher efficiencies. The most outstanding feature of the 3-D Scroll compressor is that slugging will not cause failure. In a reciprocating compressor, however, the liquid or dirt can cause serious damage.

Low Torque Variation

The 3-D Scroll compressor has a very smooth compression cycle; torque variations are only 30 percent of that produced by a reciprocating compressor. This means that the scroll compressor imposes very little stress on the motor resulting in greater reliability. Low torque variation reduces noise and vibration.

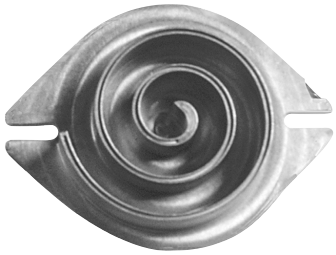
Suction Gas Cooled Motor

Compressor motor efficiency and reliability is further optimized with the latest scroll design. Cool suction gas keeps the motor cooler for longer life and better efficiency.

Proven Design Through Testing and Research

With over twenty years of development and testing, Trane 3-D Scroll compressors have undergone more than 400,000 hours of laboratory testing and field operation. This work combined with over 25 patents makes Trane the worldwide leader in air conditioning scroll compressor technology.





One of two matched scroll plates — the distinguishing feature of the scroll compressor.

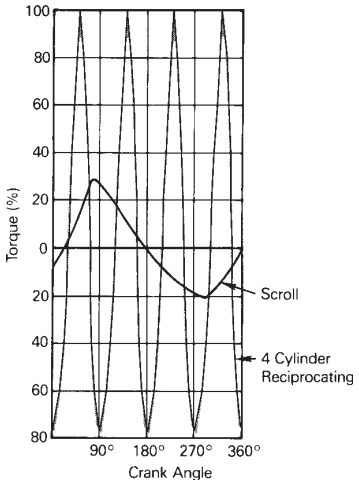
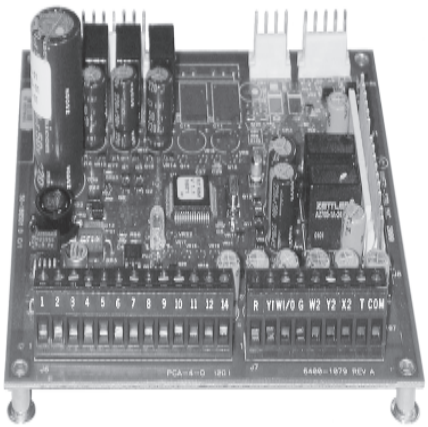


Chart illustrates low torque variation of 3-D Scroll compressor vs reciprocating compressor.

Features and Benefits

Quality and Reliability



Easy to Install, Service and Maintain

Because today's owners are very cost-conscious when it comes to service and maintenance, the Trane Voyager was designed with direct input from service contractors. This valuable information helped to design a product that would get the serviceman off the job quicker and save the owner money. Voyager does this by offering:

ReliaTel™ Controls (LCI-R)

ReliaTel controls provide unit control for heating, cooling and ventilating utilizing input from sensors that measure outdoor and indoor temperature.

Quality and Reliability are enhanced through ReliaTel control and logic:

- prevents the unit from short cycling, considerably improving compressor life.
- ensures that the compressor will run for a specific amount of time which allows oil to return for better lubrication, enhancing the reliability of the commercial compressor.

Voyager with ReliaTel reduces the number of components required to operate the unit, thereby reducing possibilities for component failure.

ReliaTel Makes Installing and Servicing Easy

ReliaTel eliminates the need for field installed anti-shortcycle timer and time delay relays. ReliaTel controls provide these functions as an integral part of the unit. The contractor no longer has to purchase these controls as options and pay to install them.

The wiring of the low voltage connections to the unit and the zone sensors is as easy as 1-1, 2-2, and 3-3. This simplified system makes it easier for the installer to wire.

ReliaTel Makes Testing Easy

Reliael requires no special tools to run the Voyager unit through its paces. Simply place a jumper between Test 1 and Test 2 terminals on the Low Voltage Terminal Board and the unit will walk through its operational steps automatically.

— The unit automatically returns control to the zone sensor after stepping through the test mode a single time, even if the jumper is left on the unit.

As long as the unit has power and the "system on" LED is lit, ReliaTel is operational. The light indicates that the controls are functioning properly.

ReliaTel features expanded diagnostic capabilities when utilized with Trane Integrated Comfort™ Systems.

Some Zone Sensor options have central control panel lights which indicate the mode the unit is in and possible diagnostic information (dirty filters for example).

Other ReliaTel Benefits

The ReliaTel built-in anti-shortcycle timer, time delay relay and minimum "on" time control functions are factory tested to assure proper operation.

ReliaTel softens electrical "spikes" by staging on fans, compressors and heaters.

Intelligent Fallback is a benefit to the building occupant. If a component goes astray, the unit will continue to operate at predetermined temperature setpoint.

Intelligent Anticipation is a standard ReliaTel feature. It functions continuously as ReliaTel and zone sensor(s) work together in harmony to provide much tighter comfort control than conventional electro-mechanical thermostats.

Features and Benefits

Trane Communication Interface (TCI)

The TCI is available factory or field installed. When applied with ReliaTel, this module easily interfaces with the Trane Integrated Comfort™ System.

Interoperability with LonTalk® (LCI-R)

The LonTalk Communication (LCI-R) for Voyager Commercial offers a building automation control system with outstanding interoperability benefits. LonTalk, which is an industry standard, is an open, secure and reliable network communication protocol for controls, created by Echelon Corporation and adopted by the LonMark Interoperability Association. It has been adopted by several standards, such as: EIA-709.1, the Electronic Industries Alliance (EIA) Control Network Protocol Specification and ANSI/ ASHRAE 135, part of the American Society of Heating, Refrigeration, and Air-Conditioning Engineer's BACnet control standard for buildings.

Interoperability allows application or project engineers to specifiy the best products of a given type, rather than one individual supplier's entire system. It reduces product training and installation costs by standardizing communications across products.

Interoperable systems allow building managers to monitor and control Voyager Commercial equipment with a Trane Tracer Summit™ or a 3rd party building automation system.

It enables integration with many different building controls such as access/intrusion monitoring, lighting, fire and smoke devices, energy management, and a wide variety of sensors for temperature, pressure, humidity and occupancy CO_2.

For additional information on LonMark, visit www.lonmark.org or Echelon, www.echelon.com.

Variable Frequency Drives (VFD)

Variable Frequency Drives are factory installed and tested to provide supply fan motor speed modulation. VFD's, as compared to inlet guide vanes or discharge dampers, are quieter, more efficient, and are eligible for utility rebates. The VFD's are available with or without a bypass option. Bypass control will simply provide full nominal airflow in the event of drive failure.

VariTrac™ changeover-bypass VAV

For light commercial applications, Trane offers constant volume (CV) Voyager Commercial models with a changeover-bypass VAV system.

For the most advanced comfort management systems, count on Trane.



Delivered VAV

Trane provides true pressure independent variable air volume with Voyager Commercial delivered VAV. The system is auto-configured to reduce programming and set-up time on the job. Generally available only on sophisticated larger models, this Voyager Commercial system can economically handle comfort requirements for any zone in the facility.

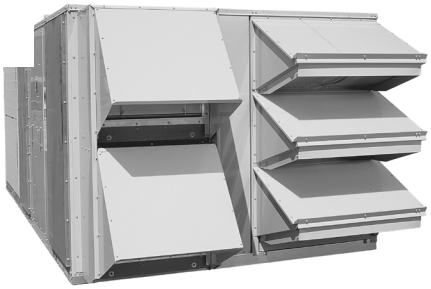
The system consists of:

- Voyager™ Commercial VAV packaged rooftops
- Up to 32 VariTrane™ VAV boxes with DDC (direct digital controls)
- VariTrac™ Central Control Panel (CCP) with Operator Display (OD)

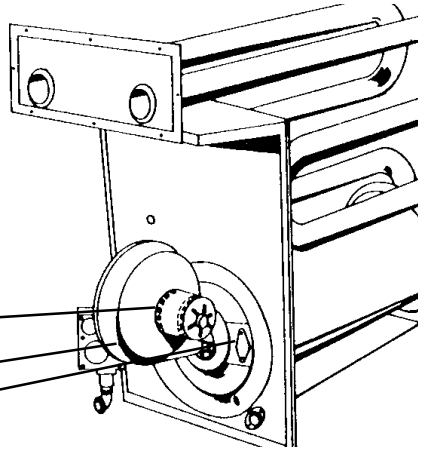
The VariTrac Central Control Panel acts as a communications hub by coordinating the actions of the VAV rooftop and the VAV boxes. Single duct or fan powered VAV boxes are available, along with an option for factory-installed local heat. For more details, see VAV-SLM003-EN.

Downflow and Horizontal Economizers

The economizers come with three control options dry bulb, enthalpy and differential enthalpy. (Photo below shows the three fresh air hoods on the Horizontal Discharge Configuration).



Features and Benefits



Drum and Tube Heat Exchanger

Outstanding Standard and Optional Components

Drum and Tube Heat Exchanger

The drum and tube heat exchanger is designed for increased efficiency and reliability and utilizes the same technology that has been incorporated into large commercial roof top units for over 20 years.

The heat exchanger is manufactured using optional stainless, or standard aluminized, steel with stainless steel components for maximum durability. The requirement for cycle testing of heat exchangers is 10,000 cycles by ANSI Z21.47. This is the standard required by both UL and AGA for cycle test requirements. Trane requires the design to be tested to 2½ times this current standard. The drum and tube design has been tested and passed over 150,000 cycles which is over 15 times the current ANSI cycling requirements.

The negative pressure gas valve will not allow gas flow unless the combustion blower is operating. This is one of the unique safety features of Voyager Commercial.

The forced combustion blower supplies pre-mixed fuel through a single stainless steel burner screen into a sealed drum where ignition takes place. It is more reliable to operate and maintain than a multiple burner system.

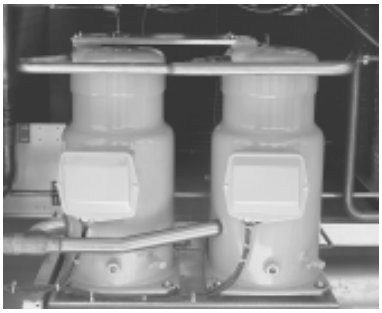
The hot surface ignitor is a gas ignition device which doubles as a safety device utilizing a continuous test to prove the flame. The design is cycle tested at the factory for quality and reliability.

All the gas/electric rooftops exceed all California seasonal efficiency requirements. They also perform better than required to meet the California NOx emission requirements.

Excellent Part-Load Efficiency

The unique design of the scroll compressor allows it to be applied in a passive parallel manifolded piping scheme, something that a "recip" just doesn't do very well.

When the unit begins stage back at part load it still has the full area and circuitry of its evaporator and condenser coils



available to transfer heat. In simple terms this means superior part-load efficiencies (IPLV) and lower unit operating costs.

Rigorous Testing

All of Voyager's designs were rigorously rain tested at the factory to ensure water integrity.

Actual shipping tests are performed to determine packaging requirements. Units are test shipped around the country. Factory shake and drop tested as part of the package design process to help assure that the unit will arrive at your job site in top condition.

Rigging tests include lifting a unit into the air and letting it drop one foot, assuring that the lifting lugs and rails hold up under stress.

We perform a 100% coil leak test at the factory. The evaporator and condenser coils are leak tested at 200 psig and pressure tested to 450 psig.

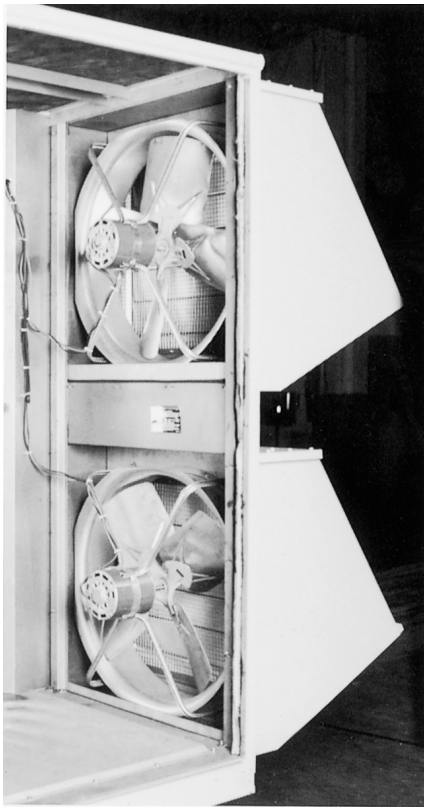
All parts are inspected at the point of final assembly. Sub-standard parts are identified and rejected immediately.

Every unit receives a 100% unit run test before leaving the production line to make sure it lives up to rigorous Trane requirements.

Features and Benefits

Power Exhaust Option

Provides exhaust of the return air when using an economizer to maintain proper building pressurization. Great for relieving most building overpressurization problems.



Horizontal Discharge with Power Exhaust Option

Easy to Install

Contractors look for lower installation (jobsite) costs. Voyager's conversionless units provide many time and money saving features.

Conversionless Units

The dedicated design units (either downflow or horizontal) require no panel removal or alteration time to convert in the field — a major cost savings during installation.

Improved Airflow

U-shaped airflow allows for improved static capabilities. The need for high static motor conversion is minimized and saves the time normally spent changing to high static oversized motors.

Single Point Power

A single electrical connection powers the unit.

Trane factory built roof curbs

Available for all units.

Added Efficiency

Low Ambient Cooling

All Voyager Commercial units have cooling capabilities down to 0 F as standard.

FC Fans with Inlet Guide Vanes

Trane's forward-curved fans with inlet guide vanes pre-rotate the air in the direction of the fan wheel, decreasing static pressure and horsepower, essentially unloading the fan wheel. The unloading characteristics of a Trane FC fan with inlet guide vanes result in superior part load performance.



One of Our Finest Assets

Trane Commercial Sales Engineers are a support group that can assist you with:

— Product
— Application
— Service
— Training
— Special Applications
— Specifications
— Computer Programs and more

Application Considerations 60 Hz

Exhaust Air Options

When is it necessary to provide building exhaust?

Whenever an outdoor air economizer is used, a building generally requires an exhaust system. The purpose of the exhaust system is to exhaust the proper amount of air to prevent over or under-pressurization of the building.

A building may have all or part of its exhaust system in the rooftop unit. Often, a building provides exhaust external to the air conditioning equipment. This external exhaust must be considered when selecting the rooftop exhaust system.

Voyager Commercial rooftop units offer two types of exhaust systems:

1

Power exhaust fan.

2

Barometric relief dampers.

Application Recommendations

Power Exhaust Fan

The exhaust fan option is a dual, nonmodulating exhaust fan with approximately half the air-moving capabilities of the supply fan system. It is Trane's experience that a non-modulating exhaust fan selected for 40 to 50 percent of nominal supply cfm can be applied successfully.

The power exhaust fan generally should not be selected for more than 40 to 50 percent of design supply airflow. Since it is an on/off nonmodulating fan, it does not vary exhaust cfm with the amount of outside air entering the building. Therefore, if selected for more than 40 to 50 percent of supply airflow, the building may become underpressurized when economizer operation is allowing lesser amounts of outdoor air into the building. If, however, building pressure is not of a critical nature, the non-modulating exhaust fan may be sized for more than 50 percent of design supply airflow. Consult Table PD-16 for specific exhaust fan capabilities with Voyager Commercial units.

Barometric Relief Dampers

Barometric relief dampers consist of gravity dampers which open with increased building pressure. As the building pressure increases, the pressure in the unit return section also increases, opening the dampers and relieving air. Barometric relief may be used to provide relief for single story buildings with no return ductwork and exhaust requirements less than 25 percent.

Altitude Corrections

The rooftop performance tables and curves of this catalog are based on standard air (.075 lbs/ft). If the rooftop airflow requirements are at other than standard conditions (sea level), an air density correction is needed to project accurate unit performance.

Figure PD-1 shows the air density ratio at various temperatures and elevations. Trane rooftops are designed to operate between 40 and 90 degrees Fahrenheit leaving air temperature.

The procedure to use when selecting a supply or exhaust fan on a rooftop for elevations and temperatures other than standard is as follows:

1

First, determine the air density ratio using Figure PD-1.

2

Divide the static pressure at the nonstandard condition by the air density ratio to obtain the corrected static pressure.

3

Use the actual cfm and the corrected static pressure to determine the fan rpm and bhp from the rooftop performance tables or curves.

4

The fan rpm is correct as selected.

5

Bhp must be multiplied by the air density ratio to obtain the actual operating bhp.

In order to better illustrate this procedure, the following example is used:

Consider a 30 ton rooftop unit that is to deliver 11,000 actual cfm at 1.50 inches total static pressure (tsp), 55 F leaving air temperature, at an elevation of 5,000 ft.

1

From Figure PD-1, the air density ratio is 0.86.

2

Tsp=1.50 inches/0.86=1.74 inches tsp.

3

From the performance tables: a 30 ton rooftop will deliver 11,000 cfm at 1.74 inches tsp at 668 rpm and 6.93 bhp.

4

The rpm is correct as selected — 668 rpm.

5

Bhp = 6.93 x 0.86 = 5.96 .

Compressor MBh, SHR, and kw should be calculated at standard and then converted to actual using the correction factors in Table PD-2. Apply these factors to the capacities selected at standard cfm so as to correct for the reduced mass flow rate across the condenser.

Heat selections other than gas heat will not be affected by altitude. Nominal gas capacity (output) should be multiplied by the factors given in Table PD-3 before calculating the heating supply air temperature.

Application Considerations 50 Hz

Exhaust Air Options

When is it necessary to provide building exhaust?

Whenever an outdoor air economizer is used, a building generally requires an exhaust system. The purpose of the exhaust system is to exhaust the proper amount of air to prevent over or under-pressurization of the building.

A building may have all or part of its exhaust system in the rooftop unit. Often, a building provides exhaust external to the air conditioning equipment. This external exhaust must be considered when selecting the rooftop exhaust system.

Voyager™ Commercial rooftop units offer two types of exhaust systems:

1

Power exhaust fan

2

Barometric relief dampers

Application Recommendations

Power Exhaust Fan

The exhaust fan option is a dual, non-modulating exhaust fan with approximately half the air-moving capabilities of the supply fan system. The experience of Trane is that a non-modulating exhaust fan selected for 40 to 50 percent of nominal supply cfm can be applied successfully.

The power exhaust fan generally should not be selected for more than 40 to 50 percent of design supply airflow. Since it is an on/off non-modulating fan, it does not vary exhaust cfm with the amount of outside air entering the building. Therefore, if selected for more than 40 to 50 percent of supply airflow, the building may become under-pressurized when economizer operation is allowing lesser amounts of outdoor air into the building. If, however, building pressure is not of a critical nature, the non-modulating exhaust fan may be sized for more than 50 percent of design supply airflow.

Barometric Relief Dampers

Barometric relief dampers consist of gravity dampers which open with increased building pressure. As the building pressure increases, the pressure in the unit return section also increases, opening the dampers and relieving air. Barometric relief may be used to provide relief for single story buildings with no return ductwork and exhaust requirements less than 25 percent.

Altitude Corrections

The rooftop performance tables and curves of this catalog are based on standard air (.075 lb/ft) (.034 kg/cm). If the rooftop airflow requirements are at other than standard conditions (sea level), an air density correction is needed to project accurate unit performance.

Figure PD-1 shows the air density ratio at various temperatures and elevations. Trane rooftops are designed to operate between 40 and 90°F (4.4 and 32.2°C) leaving air temperature.

The procedure to use when selecting a supply or exhaust fan on a rooftop for elevations and temperatures other than standard is as follows:

1

First, determine the air density ratio using Figure PD-1.

2

Divide the static pressure at the nonstandard condition by the air density ratio to obtain the corrected static pressure.

3

Use the actual cfm and the corrected static pressure to determine the fan rpm and bhp from the rooftop performance tables or curves.

4

The fan rpm is correct as selected.

5

Bhp must be multiplied by the air density ratio to obtain the actual operating bhp.

In order to better illustrate this procedure, the following example is used:

Consider a 29-ton (105 kW) rooftop unit that is to deliver 9,160 actual cfm (4323 L/s) at 1.50 inches total static pressure (tsp) (38 mm, 373 Pa), 55°F (12.8°C) leaving air temperature, at an elevation of 5,000 ft (1524 m).

1

From Figure PD-1, the air density ratio is 0.86.

2

Tsp = 1.50 inches/0.86 = 1.74 inches tsp. 374/.86 = 434 Pa.

3

From the performance tables: a 29-ton (105 kW) rooftop will deliver 9,160 cfm at 1.74 inches tsp 4323 L/s at 434 Pa) at 651 rpm and 5.51 bhp (4.11 kW).

4

The rpm is correct as selected – 651 rpm.

5

Bhp = 5.51 x 0.86 = 4.74 bhp actual.
kW = 4.11 x 0.86 = 3.5 kW

Compressor MBh, SHR, and kW should be calculated at standard and then converted to actual using the correction factors in Table PD-2. Apply these factors to the capacities selected at standard cfm so as to correct for the reduced mass flow rate across the condenser.

Heat selections other than gas heat will not be affected by altitude. Nominal gas capacity (output) should be multiplied by the factors given in Table PD-3 before calculating the heating supply air temperature.

Application Considerations 50/60 Hz

Acoustical Considerations

Proper placement of rooftops is critical to reducing transmitted sound levels to the building. The ideal time to make provisions to reduce sound transmissions is during the design phase. And the most economical means of avoiding an acoustical problem is to place the rooftop(s) away from acoustically critical areas. If possible, rooftops should not be located directly above areas such as: offices, conference rooms, executive office areas and classrooms. Instead, ideal locations might be over corridors, utility rooms, toilets or other areas where higher sound levels directly below the unit(s) are acceptable.

Several basic guidelines for unit placement should be followed to minimize sound transmission through the building structure:

1

Never cantilever the compressor end of the unit. A structural cross member must support this end of the unit.

2

Locate the unit center of gravity which is close to, or over, a column or main support beam.

3

If the roof structure is very light, roof joists must be replaced by a structural shape in the critical areas described above.

4

If several units are to be placed on one span, they should be staggered to reduce deflection over that span.

It is impossible to totally quantify the effect of building structure on sound transmission, since this depends on the response of the roof and building members to the sound and vibration of the unit components. However, the guidelines listed above are experience-proven guidelines which will help reduce sound transmissions.

Clearance Requirements

The recommended clearances identified with unit dimensions should be maintained to assure adequate serviceability, maximum capacity and peak operating efficiency. A reduction in unit clearance could result in condenser coil starvation or warm condenser air recirculation. If the clearances shown are not possible on a particular job, consider the following:

Do the clearances available allow for major service work such as changing compressors or coils?

Do the clearances available allow for proper outside air intake, exhaust air removal and condenser airflow?

If screening around the unit is being used, is there a possibility of air recirculation from the exhaust to the outside air intake or from condenser exhaust to condenser intake?

Actual clearances which appear inadequate should be reviewed with a local Trane sales engineer.

When two or more units are to be placed side by side, the distance between the units should be increased to 150 percent of the recommended single unit clearance. The units should also be staggered for two reasons:

1

To reduce span deflection if more than one unit is placed on a single span. Reducing deflection discourages sound transmission.

2

To assure proper diffusion of exhaust air before contact with the outside air intake of adjacent unit.

Duct Design

It is important to note that the rated capacities of the rooftop can be met only if the rooftop is properly installed in the field. A well designed duct system is essential in meeting these capacities.

The satisfactory distribution of air throughout the system requires that there be an unrestricted and uniform airflow from the rooftop discharge duct. This discharge section should be straight for at least several duct diameters to allow the conversion of fan energy from velocity pressure to static pressure.

However, when job conditions dictate elbows be installed near the rooftop outlet, the loss of capacity and static pressure may be reduced through the use of guide vanes and proper direction of the bend in the elbow. The high velocity side of the rooftop outlet should be directed at the outside radius of the elbow rather than the inside.

Selection Procedure 60 Hz

Selection ofTrane commercial air conditioners is divided into five basic areas:

1

Cooling capacity

2

Heating capacity

3

Air delivery

4

Unit electrical requirements

5

Unit designation

Factors Used In Unit Cooling Selection:

1

Summer design conditions — 95 DB/

76 WB, 95 F entering air to condenser.

2

Summer room design conditions — 76 DB/66 WB.

3

Total peak cooling load — 321 MBh (27.75 tons).

4

Total peak supply cfm — 12,000 cfm.

5

External static pressure — 1.0 inches.

6

Return air temperatures — 80 DB/66 WB.

7

Return air cfm — 4250 cfm.

8

Outside air ventilation cfm and load — 1200 cfm and 18.23 MBh (1.52 tons).

9

Unit accessories include:

a

Aluminized heat exchanger — high heat module.

b

2″ Hi-efficiency throwaway filters.

c

Exhaust fan.

d

Economizer cycle.

Step 1 — A summation of the peak cooling load and the outside air ventilation load shows: 27.75 tons + 1.52 tons = 29.27 required unit capacity. From Table 18-2, 30-ton unit capacity at 80 DB/ 67 WB, 95 F entering the condenser and 12,000 total peak supply cfm, is 30.0 tons. Thus, a nominal 30-ton unit is selected.

Step 2 — Having selected a nominal 30-ton unit, the supply fan and exhaust fan motor bhp must be determined.

Supply Air Fan:

Determine unit static pressure at design supply cfm:

External static pressure	1.20 inches
Heat exchanger (Table PD-14)	.14 inches
High efficiency filter 2″ (Table PD-14)	.09 inches
Economizer (Table PD-14)	.076 inches
Unit total static pressure	1.50 inches

Using total cfm of 12,000 and total static pressure of 1.50 inches, enter Table PD-12. Table PD-12 shows 7.27 bhp with 652 rpm.

Step 3 — Determine evaporator coil entering air conditions. Mixed air dry bulb temperature determination.

Using the minimum percent of OA (1,200 cfm ÷ 12,000 cfm = 10 percent), determine the mixture dry bulb to the evaporator. RADB + %OA (OADB - RADB) = 80 + (0.10) (95 - 80) = 80 + 1.5 = 81.5F

Approximate wet bulb mixture temperature:

RAWB + OA (OAWB - RAWB) = 66 + (0.10) (76-66) = 68 + 1 = 67 F.

A psychrometric chart can be used to more accurately determine the mixture temperature to the evaporator coil.

Step 4 — Determine total required unit cooling capacity:

Required capacity = total peak load + O.A. load + supply air fan motor heat.

From Figure SP-1, the supply air fan motor heat for 7.27 bhp = 20.6 MBh.

Capacity = 321 + 18.23 + 20.6 = 359.8 MBh (30 tons)

Step 5 — Determine unit capacity:

From Table PD-4 unit capacity at 81.5 DB. 67 WB entering the evaporator, 12000 supply air cfm, 95 F entering the condenser is 361 MBh (30.1 tons) 279 sensible MBh.

Step 6 — Determine leaving air temperature:

Unit sensible heat capacity, corrected for supply air fan motor heat 279 - 20.6 = 258.4 MBh.

Supply air dry bulb temperature difference = 258.4 MBh ÷ (1.085 x 12,000 cfm) = 19.8 F.

Supply air dry bulb: 81.5 - 19.8 = 61.7.

Unit enthalpy difference = 361 ÷ (4.5 x 12,000) = 6.7

Btu/lb leaving enthalpy = h (ent WB) = 31.62

Leaving enthalpy = 31.62 Btu/lb - 6.7 Btu/lb = 24.9 Btu/lb.

From Table PD-1, the leaving air wet bulb temperature corresponding to an enthalpy of 24.9 Btu/lb = 57.5.

Leaving air temperatures = 61.7 DB/57.5 WB

Selection Procedure 60 Hz

Heating capacity selection:

1

Winter outdoor design conditions—5 F.

2

Total return air temperature — 72 F.

3

Winter outside air minimum ventilation load and cfm — 1,200 cfm and 87.2 MBh.

4

Peak heating load 225 MBh.

Utilizing unit selection in the cooling capacity procedure.

Mixed air temperature = RADB + %O.A. (OADB - RADB) = 72
+ (0.10) (0-72) = 64.8 F.

Supply air fan motor heat temperature rise = 20,600 BTU ÷ (1.085 x 12,000) cfm = 1.6 F.

Mixed air temperature entering heat module = 64.8 + 1.6 = 66.4 F.

Total winter heating load = peak heating + ventilation load - total fan motor heat = 225 + 87.2 - 20.6 = 291.6 MBh.

Electric Heating System

Unit operating on 480/60/3 power supply. From Table PD-9, kw may be selected for a nominal 30-ton unit operating on 480-volt power. The high heat module — 90 KW or 307 MBh will satisfy the winter heating load of 291.6 MBh.

Table PD-9 also shows an air temperature rise of 23.6 F for 12,000 cfm through the 90 kw heat module.

Unit supply temperature at design heating conditions = mixed air temperature + air temperature rise = 66.4 + 23.6 = 90 F.

Natural Gas Heating System

Assume natural gas supply — 1000 Btu/ft^3. From Table PD-11, select the high heat module (486 MBh output) to satisfy 291.6 at unit cfm.

Table PD-11 also shows air temperature rise of 37.3 F for 12,000 cfm through heating module.

Unit supply temperature design heating conditions = mixed air temperature + air temperature rise = 66.4 + 37.3 = 103.7 F.

Air Delivery Procedure

Supply air fan bhp and rpm selection. Unit supply air fan performance shown in Table PD-12 includes pressure drops for dampers and casing losses. Static pressure drops of accessory components such as heating systems, and filters if used, must be added to external unit static pressure for total static pressure determination.

The supply air fan motor selected in the previous cooling capacity determination example was 7.27 bhp with 652 rpm. Thus, the supply fan motor selected is 7.5 hp.

To select the drive, enter Table PD-15 for a 30-ton unit. Select the appropriate drive for the applicable rpm range. Drive selection letter C with a range of 650 rpm, is required for 652 rpm. Where altitude is significantly above sea level, use Table PD-2 and PD-3, and Figure PD-1 for applicable correction factors.

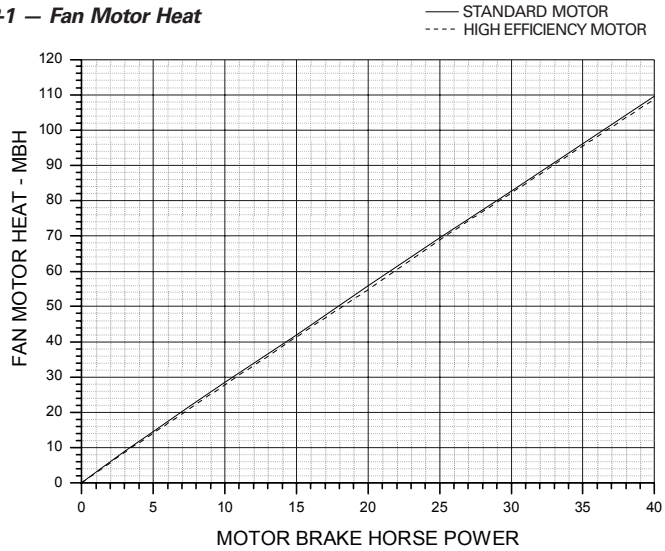
Unit Electrical Requirements

Selection procedures for electrical requirements for wire sizing amps, maximum fuse sizing and dual element fuses are given in the electrical service selection of this catalog.

Unit Designation

After determining specific unit characteristics utilizing the selection procedure and additional job information, the complete unit model number can be developed using the model number nomenclature page.

Figure SP-1 — Fan Motor Heat



Selection Procedure 50 Hz

Selection ofTrane commercial air conditioners is divided into five basic areas:

1
Cooling capacity

2
Heating capacity

3
Air delivery

4
Unit electrical requirements

5
Unit designation

Factors Used In Unit Cooling Selection:

1
Summer design conditions – 95 DB/ 76 WB (35/24.4°C), 95°F (35°C) entering air to condenser.

2
Summer room design conditions – 76 DB/66 WB (24.4/18.9°C).

3
Total peak cooling load – 270 MBh (79 kW) (22.5 tons).

4
Total peak supply cfm – 10,000 cfm (4720 L/s).

5
External static pressure – 1.0 inches wc (249 Pa).

6
Return air temperatures – 80 DB/66°F WB (26.7/18.9°C).

7
Return air cfm – 3540 cfm (1671 L/s).

8
Outside air ventilation cfm and load – 1000 cfm and 15.19 MBh (1.27 tons or 4.45 kW) 472 L/s.

9
Unit accessories include:

a
Aluminized heat exchanger – high heat module.

b
2″ Hi-efficiency throwaway filters.

c
Exhaust fan.

d
Economizer cycle.

Step 1 – A summation of the peak cooling load and the outside air ventilation load shows: 22.5 tons + 1.27 tons = 23.77 (79 kW + 4.45 kW = 83.45) required unit capacity. From Table PD-18, 25 ton (89 kW) unit capacity at 80 DB/67 WB (27/ 19°C), 95°F entering the condenser and 10,000 total peak supply cfm (4720 L/s), is YC/TC/TE*305.

Step 2 – Having selected the correct unit, the supply fan and exhaust fan motor bhp must be determined.

Supply Air Fan:
Determine unit static pressure at design supply cfm:

External static pressure	1.24 inches (310 Pa)
Heat exchanger (Table PD-27)	.12 inches (30 Pa)
High efficiency filter 2″ (25 mm) (Table PD-27)	.07 inches (17 Pa)
Economizer (Table PD-27)	.07 inches (17 Pa)
Unit total static pressure	1.50 inches (374 Pa)

Using total cfm of 10,000 (4720 L/s) and total static pressure of 1.50 inches (38 mm), enterTable PD-25.Table PD-25 shows 5.35 bhp (4 kW) with 616 rpm.

Step 3 – Determine evaporator coil entering air conditions. Mixed air dry bulb temperature determination.

Using the minimum percent of OA (1,000 cfm ÷ 10,000 cfm = 10 percent), determine the mixture dry bulb to the evaporator. RADB + % OA (OADB - RADB) = 80 + (0.10) (95 - 80) = 80 + 1.5 = 81.5°F [26.7 + 1.5 = 28°C).

Approximate wet bulb mixture temperature:

RAWB + OA (OAWB - RAWB) = 66 + (0.10) (76-66) = 68 + 1 = 67°F.

A psychrometric chart can be used to more accurately determine the mixture temperature to the evaporator coil.

Step 4 – Determine total required unit cooling capacity:
Required capacity = total peak load + O.A. load + supply air fan motor heat.

From Chart SP-1, the supply air fan motor heat for 5.35 bhp = 15 MBh.

Capacity = 270 + 15 + 15 = 300 MBh (89 kW)

Step 5 – Determine unit capacity:
From Table PD-18 unit capacity at 81.5 DB/67 WB entering the evaporator, 10,000 supply air cfm, 95°F (35°C) entering the condenser about 304 MBh (89 kW) with 235 MBh (68.8 kW) sensible.

Step 6 – Determine leaving air temperature:
Unit sensible heat capacity, corrected for supply air fan motor heat 235 - 15 = 220 MBh (64.4 kW).

Supply air dry bulb temperature difference = 220 MBh ÷ (1.085 x 10,000 cfm) = 20.2°F (-6.6°C)

Supply air dry bulb: 81.5-20.2 = 61.3 (16.3°C)

Unit enthalpy difference = 305.6 ÷ (4.5 x 10,000) = 6.76
Btu/lb leaving enthalpy = h (ent WB) = 31.62
Leaving enthalpy = 31.62 Btu/lb - 6.76 Btu/lb = 24.86 Btu/lb.

From Table PD-1, the leaving air wet bulb temperature corresponding to an enthalpy of 24.8 Btu/lb = 57.5.
Leaving air temperatures = 61.3 DB/57.5 WB (16.3/14.2°C).

Selection Procedure 50 Hz

1
Winter outdoor design conditions – 0°F (17.7°C).
2
Total return air temperature – 72°F (22.2°C).
3
Winter outside air minimum ventilation load and cfm – 1,000 cfm and 87.2 MBh.
4
Peak heating load 150 MBh.

Utilizing unit selection in the cooling capacity procedure.
Mixed air temperature = RADB + % O.A. (OADB - RADB) = 72 + (0.10) (0-72) = 64.8°F.
Supply air fan motor heat temperature rise = 20,600 Btu ÷ (1.085 x 10,000) cfm = 1.9°F.
Mixed air temperature entering heat module = 64.8 + 1.9 = 66.7°F.
Total winter heating load = peak heating + ventilation load - total fan motor heat = 150 + 87.2 - 15 = 222.2 MBh.

Electric Heating System
Unit operating on 415 power supply. From Table PD-22, kW may be selected for TC*305 unit to satisfy the winter heating load. The 67 kW module will do the job.

Table PD-22 also shows an air temperature rise of 21.2°F for 10,000 cfm through the 67 kW heat module.

Unit supply temperature at design heating conditions = mixed air temperature + air temperature rise = 66.7 + 21.2 = 87.9°F.

Natural Gas Heating System
Assume natural gas supply – 1000 Btu/ft^3. From Table PD-24, select the low heat module (243 MBh output) to satisfy 222 at unit cfm.

Table PD-25 also shows air temperature rise of 37.3°F for 10,000 cfm through heating module.

Unit supply temperature design heating conditions = mixed air temperature + air temperature rise = 66.7 + 37.3 = 104.0°F.

Air Delivery Procedure
Supply air fan bhp and rpm selection. Unit supply air fan performance shown in Table PD-25 includes pressure drops for dampers and casing losses. Static pressure drops of accessory components such as heating systems, and filters if used, must be added to external unit static pressure for total static pressure determination.

The supply air fan motor selected in the previous cooling capacity determination example was 5.35 bhp with 616 rpm. Thus, the supply fan motor selected is 7.5 hp.

To select the drive, enter Table PD-28 for a 305 unit. Select the appropriate drive for the applicable rpm range. Drive selection letter E with a range of 625 rpm, is required for 616 rpm. Where altitude is significantly above sea level, use Table PD-2 and PD-3, and Figure PD-1 for applicable correction factors.

Unit Electrical Requirements
Selection procedures for electrical requirements for wire sizing amps, maximum fuse sizing and dual element fuses are given in the electrical service selection of this catalog.

Unit Designation
After determining specific unit characteristics utilizing the selection procedure and additional job information, the complete unit model number can be developed using the model number nomenclature page.

Model Number Description

60 Hz

YCD	4	8	0	A	4	H	A	1	A	4	A	D	1	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R[5]
1,2,3,	4,	5,	6,	7,	8,	9,	10,	11,	12,	13,	14,	15,	16,	17,	18,	19,	20,	21,	22,	23,	24,	25,	26,	27,	28,	29,	30,	31

Digit 1, 2 — Unit Function
TC = DX Cooling, No Heat
TE = DX Cooling, Electric Heat
YC = DX Cooling, Natural Gas Heat

Digit 3 — Unit Airflow Design
D = Downflow Configuration
H = Horizontal Configuration

Digit 4, 5, 6 — Nominal Cooling Capacity
330 = 27½ Tons
360 = 30 Tons
420 = 35 Tons
480 = 40 Tons
600 = 50 Tons

Digit 7 — Major Development Sequence
A = First

Digit 8 — Power Supply (See Note 1)
E = 208/60/3
F = 230/60/3
4 = 460/60/3
5 = 575/60/3

Digit 9 — Heating Capacity (See Note 4)
0 = No Heat (TC only)
L = Low Heat (YC only)
H = High Heat (YC only)
J = Low Heat-Stainless Steel Gas Heat Exchangers (YC only)
K = High Heat-Stainless Steel Gas Heat Exchanger (YC only)
Note: When second digit is "E" for Electric Heat, the following values apply in the ninth digit.
A = 36 KW
B = 54 KW
C = 72 KW
D = 90 KW
E = 108 KW

Digit 10 Design Sequence
A = First

Digit 11 — Exhaust
0 = None
1 = Barometric Relief
(Available w/Economizer only)
2 = Power Exhaust Fan
(Available w/Economizer only)

Digit 12 — Filter
A = Standard 2" Throwaway Filters
B = High Efficiency 2" Throwaway Filters
C = High Efficiency 4" Throwaway Filters

Digit 13 — Supply Fan Motor, HP
1 = 7.5 Hp Std. Eff.
2 = 10 Hp Std. Eff.
3 = 15 Hp Std. Eff.
4 = 20 Hp Std. Eff.
5 = 7.5 Hp Hi. Eff.
6 = 10 Hp Hi. Eff.
7 = 15 Hp Hi. Eff.
8 = 20 Hp Hi. Eff.

Digit 14 — Supply Air Fan Drive Selections (See Note 3)
A = 550 RPM
B = 600 RPM
C = 650 RPM
D = 700 RPM
E = 750 RPM
F = 790 RPM
G = 800 RPM
H = 500 RPM
J = 525 RPM
K = 575 RPM
L = 625 RPM
M = 675 RPM
N = 725 RPM

Digit 15 — Fresh Air Selection
A = No Fresh Air
B = 0-25% Manual Damper
C = 0-100% Economizer, Dry Bulb Control
D = 0-100% Economizer, Reference Enthalpy Control
E = 0-100% Economizer, Differential Enthalpy Control
F = "C" Option and Low Leak Fresh Air Damper
G = "D" Option and Low Leak Fresh Air Damper
H = "E" Option and Low Leak Fresh Air Damper

Digit 16 — System Control
1 = Constant Volume
2 = VAV Supply Air Temperature Control w/o Inlet Guide Vanes
3 = VAV Supply Air Temperature Control w/Inlet Guide Vanes
4 = VAV Supply Air Temperature Control w/Variable Frequency Drive w/o Bypass
5 = VAV Supply Air Temperature Control w/Variable Frequency Drive and Bypass
Note: Zone sensors are not included with option and must be ordered as a separate accessory.

Digit 17 - 31 — Miscellaneous
A = Service Valves (See Note 2)
B = Through the Base Electrical Provision
C = Non-Fused Disconnect Switch with External Handle
D = Factory-Powered 15A GFI Convenience Outlet and Non-Fused Disconnect Switch with External Handle
E = Field-Powered 15A GFI Convenience Outlet
F = Trane Communication Interface (TCI)
H = Hinged Service Access
J = Condenser Coil Guards
K = LCI (LonTalk)
L = Unused digit
M = Stainless Steel Drain Pans
N = Black Epoxy Pre-Coated Condenser Coil
P = Discharge Temperature Sensor
R = Clogged Filter Switch

Notes:
1. All voltages are across the line starting only.
2. Option includes Liquid, Discharge, Suction Valves.
3. Supply air fan drives A thru G are used with 27½-35 ton units only and drives H thru N are used with 40 & 50 ton units only.
4. Electric Heat KW ratings are based upon voltage ratings of 240/480/600 V. Voltage offerings are as follows (see table PD-9 for additional information):

		KW				
Tons	Voltage	36	54	72	90	108
27½ to 35	240	x	x			
	480	x	x	x	x	
	600		x	x	x	
40 and 50	240		x			
	480		x	x	x	x
	600		x	x	x	x

5. The service digit for each model number contains 31 digits; all 31 digits must be referenced.

Model Number Description 50 Hz

YCD	5	0	0	A	C	H	A	1	A	4	A	D	1	A	0	0	0	0	0	0	0	0	0	0	0	0	0[5]
1,2,	3,	4,	5,	6,	7,	8,	9,	10,	11,	12,	13,	14,	15,	16,	17,	18,	19,	20,	21,	22,	23,	24,	25,	26,	27,	28,	29,	30,	31

Digits 1, 2 – Unit Function
TC = DX Cooling, No Heat
TE = DX Cooling, Electric Heat
YC = DX Cooling, Natural Gas Heat

Digit 3 – Unit Airflow Design
D = Downflow Configuration
H = Horizontal Configuration

Digits 4, 5, 6 – Nominal Cooling Capacity
275 = 22.9 Tons (82 kW)
305 = 25.4 Tons (89 kW)
350 = 29.2 Tons (105 kW)
400 = 33.3 Tons (120 kW)
500 = 41.7 Tons (148 kW)

Digit 7 – Major Development Sequence
A = First
B = Second, Etc.

Digit 8 – Power Supply (See Note 1)
C = 380/50/3
D = 415/50/3

Digit 9 – Heating Capacity (See Note 4)
0 = No Heat (TC only)
L = Low Heat (YC only)
H = High Heat (YC only)
Note: When second digit is "E" for Electric Heat, the following values apply in the ninth digit.

	380V	415V	
A =	23	27	kW
B =	34	40	kW
C =	45	54	kW
D =	56	67	kW
E =	68	81	kW

Digit 10 – Design Sequence
A = First

Digit 11 – Exhaust
0 = None
1 = Barometric Relief
(Available w/Economizer only)
2 = Power Exhaust Fan
(Available w/Economizer only)

Digit 12 – Filter
A = Standard 2" (51 mm) Throwaway Filters
B = High Efficiency 2" (51 mm) Throwaway Filters
C = High Efficiency 4" (102 mm) Throwaway Filters

Digit 13 – Supply Fan Motor, HP
1 = 7.5 Hp Std. Eff. (5.6 kW)
2 = 10 Hp Std. Eff. (7.5 kW)
3 = 15 Hp Std. Eff. (11.2 kW)
4 = 20 Hp Std. Eff. (14.9 kW)

Digit 14 – Supply Air Fan Drive Selections
(See Note 3)

A = 458	H = 417
B = 500	J = 437
C = 541	K = 479
D = 583	L = 521
E = 625	M = 562
F = 658	N = 604
G = 664	

Digit 15 – Fresh Air Selection
A = No Fresh Air
B = 0-25% Manual Damper
C = 0-100% Economizer, Dry Bulb Control
D = 0-100% Economizer, Reference Enthalpy Control
E = 0-100% Economizer, Differential Enthalpy Control
F = "C" Option and Low Leak Fresh Air Damper
G = "D" Option and Low Leak Fresh Air Damper
H = "E" Option and Low Leak Fresh Air Damper

Digit 16 – System Control
1 = Constant Volume
2 = VAV Supply Air Temperature Control w/o Inlet Guide Vanes
3 = VAV Supply Air Temperature Control w/Inlet Guide Vanes
Note: Zone sensors are not included with option and must be ordered as a separate accessory.

Digit 17-31 – Miscellaneous
A = Service Valves (See Note 2)
B = Through the Base Electrical Provision
C = Non-Fused Disconnect Switch with External Handle
D = Factory-Powered 15A GFI Convenience Outlet and Non-Fused Disconnect Switch with External Handle
E = Field-Powered 15A GFI Convenience Outlet
F = Trane Communication Interface (TCI)
G = Ventilation Override
H = Hinged Service Access
J = Condenser Coil Guards
K = Special
L = Unused digit
M = Stainless Steel Drain Pans
N = Black Epoxy Pre-Coated Condenser Coil
P = Discharge Temperature Sensor
R = Clogged Filter Switch

Notes:
1. All voltages are across-the-line starting only.
2. Option includes Liquid, Discharge, Suction Valves.
3. Supply air fan drives A thru G are used with 22.9-29.2 ton (82-105 kW) units only and drives H thru N are used with 33.3 and 41.7 ton (120-148 kW) units only.
4. Electric Heat kW ratings are based upon voltage ratings of 380/415 V. Heaters A, B, C, D are used with 22.9-29.2 ton (82-105 kW) units only and heaters B, C, D, E are used with 33.3-41.7 ton (120-148 kW) units only.
5. The service digit for each model number contains 31 digits; all 31 digits must be referenced.

General Data 60 Hz

Table GD-1 — General Data — 27½ - 30 Tons

	27½Ton		30Ton	
Cooling Performance[1]				
Nominal Gross Capacity	329,000		363,000	
Natural Gas Heat[2]	Low	High	Low	High
Heating Input (BTUH)	350,000	600,000	350,000	600,000
First Stage	250,000	425,000	250,000	425,000
Heating Output (BTUH)	283,500	486,000	283,500	486,000
First Stage	202,500	344,500	202,500	344,500
Steady State Efficiency (%)[3]	81.00	81.00	81.00	81.00
No. Burners	1	2	1	2
No. Stages	2	2	2	2
Gas Supply Pressure (in. w.c.)				
Natural or LP (minimum/maximum)	2.5/14.0	2.5/14.0	2.5/14.0	2.5/14.0
Gas Connection Pipe Size (in.)	3/4	1	3/4	1
Electric Heat				
KW Range[5]		27-90[5]		27-90[5]
Capacity Steps:		2		2
Compressor				
Number/Type		2/Scroll		2/Scroll
Size (Nominal)		10/15		15
Unit Capacity Steps (%)		100/40		100/50
Motor RPM		3450		3450
Outdoor Coil — Type		Lanced		Lanced
Tube Size (in.) OD		3/8		3/8
Face Area (sq. ft.)		51.33		51.33
Rows/Fins Per Inch		2/16		2/16
Indoor Coil — Type		Hi-Performance		Hi-Performance
Tube Size (in.) OD		1/2		1/2
Face Area (sq. ft.)		31.67		31.67
Rows/Fins Per Foot		2/180		2/180
Refrigerant Control		TXV		TXV
No. of Circuits		1		1
Drain Connection No./Size (in)		1/1.25		1/1.25
Type		PVC		PVC
Outdoor FanType		Propeller		Propeller
No. Used/Diameter		3/28.00		3/28.00
DriveType/No. Speeds		Direct/1		Direct/1
CFM		24,800		24,800
No. Motors/HP/RPM		3/1.10/1125		3/1.10/1125
Indoor FanType		FC		FC
No. Used		1		1
Diameter/Width (in)		22.38/22.00		22.38/22.00
DriveType/No. Speeds		Belt/1		Belt/1
No. Motors/HP		1/7.50/10.00		1/7.50/10.00
Motor RPM		1760		1760
Motor Frame Size		213/215T		213/215T
Exhaust FanType		Propeller		Propeller
No. Used/Diameter (in)		2/26.00		2/26.00
DriveType/No. Speeds/Motors		Direct/2/2		Direct/2/2
Motor HP/RPM		1.0/1075		1.0/1075
Motor Frame Size		48		48
Filters — Type Furnished		Throwaway		Throwaway
No./ Recommended Size (in)[6]		16/16 x 20 x 2		16/16 x 20 x 2
Refrigerant Charge (Lbs of R-22)[4]		46.00		46.60
Minimum Outside AirTemperature For Mechanical Cooling		0 F		0 F

Notes:
1. Cooling Performance is rated at 95 F ambient, 80 F entering dry bulb, 67 F entering wet bulb. Gross capacity does not include the effect of fan motor heat. Rated and tested in accordance with the Unitary Large Equipment certification program, which is based on ARI Standard 340/360-93.
2. Heating Performance limit settings and rating data were established and approved under laboratory test conditions using American National Standards Institute standards. Ratings shown are for elevations up to 4,500 feet.
3. Steady State Efficiency is rated in accordance with DOE test procedures.
4. Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.
5. Maximum KW @ 208V = 41, @ 240V = 54. For Electric heat KW range per specific voltage, see table PD-10.
6. Filter dimensions listed are nominal. For actual filter and rack sizes see the Unit Installation, Operation, Maintenance Guide.

General Data 60 Hz

Table GD-2— General Data — 35-40 Ton

	35Ton		40Ton	
Cooling Performance[1]				
Nominal Gross Capacity	417,000		513,000	
Natural Gas Heat[2]	Low	High	Low	High
Heating Input (BTUH)	350,000	600,000	400,000	800,000
First Stage	250,000	425,000	300,000	600,000
Heating Output (BTUH)	283,500	486,000	324,000	648,000
First Stage	202,500	344,500	243,000	486,000
Steady State Efficiency (%)[3]	81.00	81.00	81.00	81.00
No. Burners	1	2	1	2
No. Stages	2	2	2	2
Gas Supply Pressure (in. w.c.)				
Natural or LP (minimum/maximum)	2.5/14.0	2.5/14.0	2.5/14.0	2.5/14.0
Gas Connection Pipe Size (in.)	3/4	1	3/4	1
Electric Heat				
KW Range[5]	27-90[5]		41-108[5]	
Capacity Steps:	2		2	
Compressor				
Number/Type	2/Scroll		3/Scroll	
Size (nominal)	15		15/15/10	
Unit Capacity Steps (%)	100/50		100/60/40	
Motor RPM	3450		3450	
Outdoor Coil — Type	Lanced		Lanced	
Tube Size (in.) OD	3/8		3/8	
Face Area	51.33		69.79	
Rows/Fins Per Inch	2/16		2/16	
Indoor Coil — Type	Hi-Performance		Hi-Performance	
Tube Size (in.) OD	1/2		1/2	
Face Area (sq. ft.)	31.67		37.50	
Rows/Fins Per Foot	3/180		3/180	
Refrigerant Control	TXV		TXV	
No. of Circuits	1		2	
Drain Connection No./Size (in)	1/1.25		1/1.25	
Type	PVC		PVC	
Outdoor Fan Type	Propeller		Propeller	
No. Used/Diameter	3/28.00		4/28.00	
Drive Type/No. Speeds	Direct/1		Direct/1	
CFM	24,800		31,700	
No. Motors/HP/RPM	3/1.10/1125		4/1.10/1125	
Indoor Fan Type	FC		FC	
No. Used	1		1	
Diameter/Width (in)	22.38/22.00		25.00/25.00	
Drive Type/No. Speeds	Belt/1		Belt/1	
No. Motors/HP	1/7.50/10.00/15.00		1/10.00/15.00	
Motor RPM	1760		1760	
Motor Frame Size	213/215/254T		215/254T	
Exhaust Fan Type	Propeller		Propeller	
No. Used/Diameter (in)	2/26.00		2/26.00	
Drive Type/No. Speeds/Motors	Direct/2/2		Direct/2/2	
Motor HP/RPM	1.0/1075		1.0/1075	
Motor Frame Size	48		48	
Filters — Type Furnished	Throwaway		Throwaway	
No./Recommended Size (in)[6]	16/16 x 20 x 2		17/16 x 20 x 2	
Refrigerant Charge (Lbs of R-22)[4]	51.50		26.00/47.10 per circuit	
Minimum Outside Air Temperature For Mechanical Cooling	0 F		0 F	

Notes:
1. Cooling Performance is rated at 95 F ambient, 80 F entering dry bulb, 67 F entering wet bulb. Gross capacity does not include the effect of fan motor heat. Rated and tested in accordance with the Unitary Large Equipment certification program, which is based on ARI Standard 340/360-93.
2. Heating Performance limit settings and rating data were established and approved under laboratory test conditions using American National Standards Institute standards. Ratings shown are for elevations up to 4,500 feet.
3. Steady State Efficiency is rated in accordance with DOE test procedures.
4. Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.
5. Maximum KW @ 208V = 41, @ 240V = 54. For Electric heat KW range per specific voltage, see table PD-10.
6. Filter dimensions listed are nominal. For actual filter and rack sizes see the Unit Installation, Operation, Maintenance Guide.

General Data 60 Hz

Table GD-3— General Data — 50 Ton

	50Ton	
Cooling Performance[1]		
Nominal Gross Capacity	616,000	
Natural Gas Heat[2]	Low	High
Heating Input (BTUH)	400,000	800,000
First Stage	300,000	600,000
Heating Output (BTUH)	324,000	648,000
First Stage	243,000	486,000
Steady State Efficiency (%)[3]	81.00	81.00
No. Burners	1	2
No. Stages	2	2
Gas Supply Pressure (in. w.c.) Natural or LP (minimum/maximum)	2.5/14.0	2.5/14.0
Gas Connection Pipe Size (in.)	3/4	1
Electric Heat		
KW Range[5]	41-108[5]	
Capacity Steps:	2	
Compressor		
Number/Type	3/Scroll	
Size (nominal)	14	
Unit Capacity Steps (%)	100/67/33	
Motor RPM	3450	
Outdoor Coil —Type	Lanced	
Tube Size (in.) OD	3/8	
Face Area (sq. ft.)	69.79	
Rows/Fins Per Inch	2/16	
Indoor Coil —Type	Hi-Performance	
Tube Size (in.) OD	1/2	
Face Area (sq. ft.)	37.50	
Rows/Fins Per Foot	4/164	
Refrigerant Control	TXV	
No. of Circuits	2	
Drain Connection No./Size (in)	1/1.25	
Type	PVC	
Outdoor FanType	Propeller	
No. Used/Diameter	4/28.00	
DriveType/No. Speeds	Direct/1	
CFM	31,700	
No. Motors/HP/RPM	4/1.10/1125	
Indoor FanType	FC	
No. Used	1	
Diameter/Width (in)	25.00/25.00	
DriveType/No. Speeds	Belt/1	
No. Motors/HP	1/10.00/15.00/20.00	
Motor RPM	1760	
Motor Frame Size	215/254/256T	
Exhaust FanType	Propeller	
No. Used/Diameter (in)	2/26.00	
DriveType/No. Speeds/Motors	Direct/2/2	
Motor HP/RPM	1.0/1075	
Motor Frame Size	48	
Filters —Type Furnished	Throwaway	
No./Recommended Size (in)[6]	17/16 x 20 x 2	
Refrigerant Charge (Lbs of R-22)[4]	25.70/54.30 per circuit	
Minimum Outside Air Temperature For Mechanical Cooling	0 F	

Table GD-4 — Economizer Outdoor Air Damper Leakage (Of Rated Airflow)

	ΔP Across Dampers (In. WC)	
	0.5 (In.)	1.0 (In.)
Standard	1.5 %	2.5 %
Optional "Low Leak"	0.5 %	1.0 %

Note: Above data based on tests completed in accordance with AMCA Standard 575.

Notes:
1. Cooling Performance is rated at 95 F ambient, 80 F entering dry bulb, 67 F entering wet bulb. Gross capacity does not include the effect of fan motor heat. Rated and tested in accordance with the Unitary Large Equipment certification program, which is based on ARI Standard 340/360-93.
2. Heating Performance limit settings and rating data were established and approved under laboratory test conditions using American National Standards Institute standards. Ratings shown are for elevations up to 4,500 feet.
3. Steady State Efficiency is rated in accordance with DOE test procedures.
4. Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.
5. Maximum KW @ 208V = 41, @ 240V = 54. For Electric heat KW range per specific voltage, see table PD-10.
6. Filter dimensions listed are nominal. For actual filter and rack sizes see the Unit Installation, Operation, Maintenance Guide.

General Data 50 Hz

Table GD-5 – General Data – 23-25 Tons

	TC/YC/TE*275 (23 Tons)		TC/YC/TE*305 (25 Tons)	
Cooling Performance[1]				
Nominal Gross Capacity - Btu (kW)	277,000 (81.1)		303,000 (88.7)	
System Power - kW	24.9		28.6 kW	
Compressor				
Number/Type	2/Scroll		2/Scroll	
Size (Nominal Tons)	10/15		15/15	
Unit Capacity Steps (%)	100/40		100/50	
Motor rpm	2875		2875	
Natural Gas Heat[2]	Low	High	Low	High
Heating Input - Btu (kW)	290,000 (85.0)	500,000 (147)	290,000 (85.0)	500,000 (147)
First Stage	250,000 (73.3 kW)	425,000 (125 kW)	250,000 (73.3 kW)	425,000 (125 kW)
Heating Output - Btu (kW)	243,000 (69.0)	405,000 (119)	243,000 (69.0)	405,000 (119)
First Stage	202,500 (59.4 kW)	344,250 (101 kW)	202,500 (59.4 kW)	344,250 (101 kW)
Steady State Efficiency(%) [3]	81		81	
No. Burners/No. Stages	1/2		1/2	
Gas Connect Pipe Size - in. (mm)	0.75 (19)		0.75 (19)	
Outdoor Coil - Type	Lanced		Lanced	
Tube Size OD - in. (mm)	0.375 (10)		0.375 (10)	
Face Area - sq ft (sq m)	51.3 (4.8)		51.3 (4.8)	
Rows/Fins Per Inch	2/16		2/16	
Indoor Coil - Type-Performance	Hi Performance		Hi Performance	
Tube Size OD - in. (mm)	0.500 (13)		0.500 (13)	
Face Area - sq ft (sq m)	31.7 (2.9)		31.7 (2.9)	
Rows/Fins Per Foot	2/180		2/180	
Refrigerant Control	TXV		TXV	
PVC Drain Connect No./Size - in. (mm)	1/1.25 (1/32)		1/1.25 (1/32)	
Outdoor Fan Type	Propeller		Propeller	
No. Used	3		3	
Diameter - in. (mm)	28.0 (711)		28.0 (711)	
Drive Type/No. Speeds	Direct/1		Direct/1	
cfm (L/s)	20,450 (9650)		20,450 (9650)	
No. Motors (rpm)	3 (940)		3 (940)	
Motor- hp (kW)	0.75 (0.56)		0.75 (0.56)	
Indoor Fan Type/No. Used	FC/1		FC/1	
Diameter - in. (mm)	22.4 (568)		22.4 (568)	
Width - in. (mm)	22.0 (559)		22.0 (559)	
Drive Type	Belt		Belt	
No. Speeds/No. Motors	1/1		1/1	
Motor - hp (kW)	7.5 (5.6)		7.5 (5.6)	
Motor rpm/Frame Size	1460/213T		1460/213T	
Filters - Type	Throwaway		Throwaway	
Furnished/No.	Yes/16		Yes/16	
Recommended Size - in. (mm)	16X 20 X2 (406X 508 X51)		16x20x2 (406X 508x51)	
Refrigerant Type	R-22		R-22	
Factory Charge - lb (kg) [4]	44.5 (20.2)		45 (20.4)	

Notes:
1. Cooling Performance is rated at 95°F (35°C) ambient, 80°F (27°C) entering dry bulb, 67°F (19°C) entering wet bulb. Gross capacity does not include the effect of fan motor heat.
2. Heating Performance Limit settings and ratings data were established and approved under laboratory test conditions using American National Standards.
3. Steady State Efficiency is rated in accordance with DOE test procedures.
4. Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.

General Data 50 Hz

Table GD-6 – General Data – 29-33 Tons

	TC/YC/TE*350 (29Tons)		TC/YC/TE*400 (33Tons)	
Cooling Performance[1]				
Nominal Gross Capacity(Btu)	353,000 (103.4 kW)		435,000 (127.4 kW)	
System Power - kW	32.55		42.6	
Compressor				
Number/Type	2/Scroll		3/Scroll	
Size (Nominal Tons)	15/15		15/15/10	
Unit Capacity Steps (%)	100/50		100/60/40	
Motor rpm	2875		2875	
Natural Gas Heat[2]	Low	High	Low	High
Heating Input - Btu (kW)	290,000 (85.0)	500,000 (147)	335,000 (98.2)	670,000 (196)
First Stage	250,000 (73.3 kW)	425,000 (125 kW)	300,000 (87.9 kW)	600,000 (176 kW)
Heating Output - Btu (kW)	243,000 (69.0)	405,000 (119)	271,350 (80.0)	542,700 (159)
First Stage	202,500 (59.4 kW)	344,250 (101 kW)	243,500 (71.4 kW)	486,000 (166 kW)
Steady State Efficiency(%)[3]	81		81	
No. Burners/No. Stages	1/2		1/2	
Gas Connect Pipe Size - in. (mm)	0.75 (19)		0.75 (19)	
Outdoor Coil - Type	Lanced		Lanced	
Tube Size OD - in. (mm)	0.375 (10)		0.375 (10)	
Face Area - sq ft (sq m)	51.3 (4.8)		69.8 (6.5)	
Rows/Fins Per Inch	2/16		2/16	
Indoor Coil - Type	Hi-Performance		Hi-Performance	
Tube Size - in. (mm) OD	0.500 (13)		0.500 (13)	
Face Area - sq ft (sq m)	31.7 (2.9)		37.5 (3.5)	
Rows/Fins Per Foot	2/180		3/180	
Refrigerant Control	TXV		TXV	
PVC Drain Connect No./Size - in. (mm)	1/1.25 (1/32)		1/1.25 (1/32)	
Outdoor Fan Type	Propeller		Propeller	
No. Used	3		4	
Diameter - in. (mm)	28.0 (711)		28.0 (711)	
Drive Type/No. Speeds	Direct/1		Direct/1	
cfm (L/s)	20,400 (9650)		26,200 (12,400)	
No. Motors (rpm)	3 (940)		4 (940)	
Motor - hp (kW)	0.75 (0.56)		0.75 (0.56)	
Indoor Fan Type/No. Used	FC/1		FC/1	
Diameter - in. (mm)	22.4 (568)		25.0 (635)	
Width - in. (mm)	22.0 (559)		25.0 (635)	
Drive Type	Belt		Belt	
No. Speeds/No. Motors	1/1		1/1	
Motor - hp (kW)	7.5 (5.6)		10.0 (7.5)	
Motor rpm/Frame Size	1460/213T		1460/215T	
Filters - Type	Throwaway		Throwaway	
Furnished/No.	Yes/16		Yes/17	
Recommended Size - in. (mm)	16x20x2 (406x508x51)		16X 20 X2 (406X 508 X51)	
Refrigerant Type	R-22		R-22	
Factory Charge Circuit 1 - lb (kg) [4]	50 (22.7)		26.4 (12)	
Factory Charge Circuit 2 - lb (kg)	–		47.8 (21.7)	

Notes:
1. Cooling Performance is rated at 95°F (35°C) ambient, 80°F (27°C) entering dry bulb, 67°F (19°C) entering wet bulb. Gross capacity does not include the effect of fan motor heat.
2. Heating Performance Limit settings and ratings data were established and approved under laboratory test conditions using American National Standards.
3. Steady State Efficiency is rated in accordance with DOE test procedures.
4. Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.

General Data 50 Hz

Table GD-7 – General Data – 43 Tons

	TC/YC/TE*500 (42Tons)	
Cooling Performance [1]		
Nominal Gross Capacity - Btu (kW)	520,000 (152)	
System Power - kW	50.9	
Compressor		
Number/Type	3/Scroll	
Size (Nominal Tons)	14/14/14	
Unit Capacity Steps (%)	100/67/33	
Motor rpm	2875	
Natural Gas Heat[2]	Low	High
Heating Input - Btu (kW)	335,000 (98.2)	670,000 (196)
First Stage	300,000 (87.9 kW)	600,000 (176 kW)
Heating Output - Btu (kW)	271,350 (79.5)	542,700 (159)
First Stage	243,500 (71.4 kW)	486,000 (166 kW)
Steady State Efficiency(%)[3]	81	
No. Burners/No. Stages	1/2	
Gas Connect Pipe Size - in. (mm)	0.75 (19)	
Outdoor Coil - Type	Lanced	
Tube Size OD - in. (mm)	0.375 (10)	
Face Area - sq ft (sq m)	69.8 (6.5)	
Rows/Fins Per Inch	2/16	
Indoor Coil - Type	Hi-Performance	
Tube Size OD - in. (mm)	0.500 (13)	
Face Area - sq ft (sq m)	37.5 (3.5)	
Rows/Fins Per Foot	4/164	
Refrigerant Control	TXV	
PVC Drain Connect No./Size - in. (mm)	1/1.25 (1/32)	
Outdoor Fan Type	Propeller	
No. Used	4	
Diameter - in. (mm)	28.0 (711)	
Drive Type/No. Speeds	Direct/1	
cfm (L/s)	26,200 (12,400)	
No. Motors (rpm)	4 (940)	
Motor - hp (kW)	0.75 (0.56)	
Indoor Fan Type/No. Used	FC/1	
Diameter - in. (mm)	25.0 (635)	
Width - in. (mm)	25.0 (635)	
Drive Type	Belt	
No. Speeds/No. Motors	1/1	
Motor hp	10.0 (7.5 kW)	
Motor rpm/Frame Size	1460/215T	
Filters - Type	Throwaway	
Furnished/No.	Yes/17	
Recommended Size - in. (mm)	16x20x2 (406x508x51)	
Refrigerant Type	R-22	
Factory Charge Circuit 1 - lb (kg) [4]	26.0 (11.8)	
Factory Charge Circuit 1 - lb (kg)	53.2 (24.1)	

Notes:
1. Cooling Performance is rated at 95°F (35°C) ambient, 80°F (27°C) entering dry bulb, 67°F (19°C) entering wet bulb. Gross capacity does not include the effect of fan motor heat.
2. Heating Performance Limit settings and ratings data were established and approved under laboratory test conditions using American National Standards.
3. Steady State Efficiency is rated in accordance with DOE test procedures.
4. Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.

Table GD-8 – Economizer Outdoor Air Damper Leakage (Of Rated Airflow)

	ΔP Across Dampers (In. wc) (Pa)	
	0.5 In. (124.5 Pa)	1.0 In. (249 Pa)
Standard	1.5%	2.5%
Optional "Low Leak"	0.5%	1.0%

Note: Above data based on tests completed in accordance with AMCA Standard 575.

Performance Adjustment Factors

Table PD-1 – Enthalpy of Saturated Air

Wet Bulb Temperature °F	°C	Btu Per lb
40	4.4	15.23
41	5.0	15.70
42	5.5	16.17
43	6.1	16.66
44	6.7	17.15
45	7.2	17.65
46	7.8	18.16
47	8.3	18.68
48	8.9	19.21
49	9.4	19.75
50	10.0	20.30
51	10.6	20.86
52	11.1	21.44
53	11.7	22.02
54	12.2	22.62
55	12.8	23.22
56	13.3	23.84
57	13.9	24.48
58	14.4	25.12
59	15.0	25.78
60	15.6	26.46
61	16.1	27.15
62	16.7	27.85
63	17.2	28.57
64	17.8	29.31
65	18.3	30.06
66	18.9	30.83
67	19.4	31.62
68	20.0	32.42
69	20.6	33.25
70	21.1	34.09
71	21.7	34.95
72	22.2	35.83
73	22.8	36.74
74	23.3	37.66
75	23.9	38.61

Figure PD-1 – Air Density Ratios

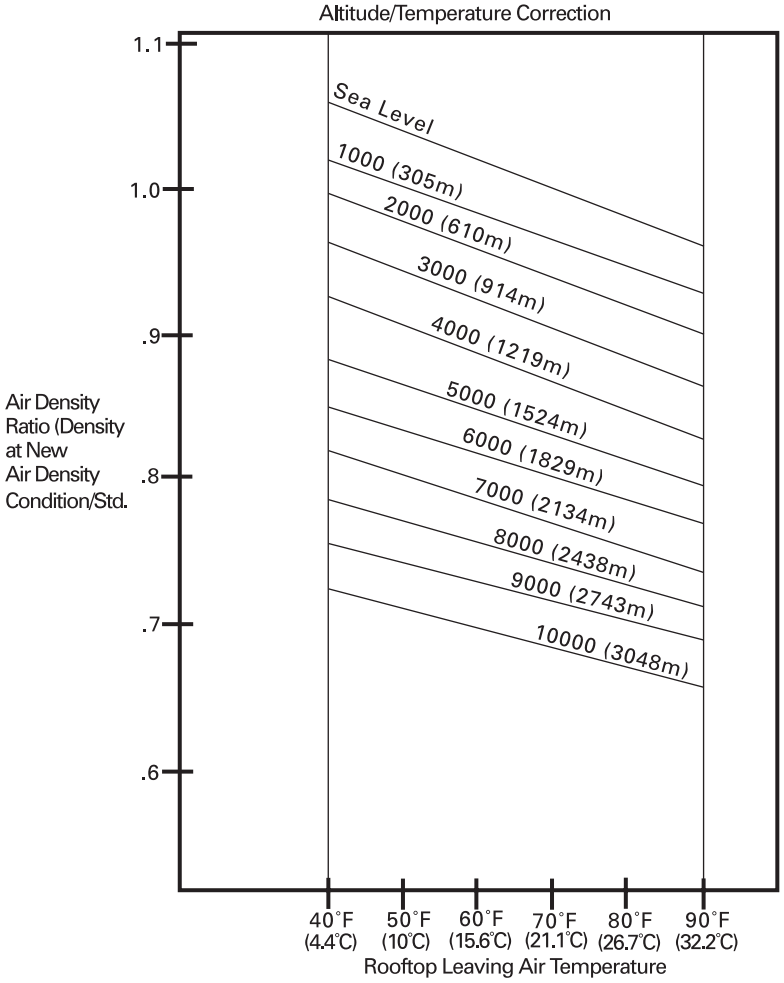


Table PD-2 – Cooling Capacity Altitude Correction Factors

	Altitude ft. (m)							
	Sea Level	1000 (304.8)	2000 (609.6)	3000 (914.4)	4000 (1219.2)	5000 (1524.0)	6000 (1828.8)	7000 (2133.6)
Cooling Capacity Multiplier	1.00	0.99	0.99	0.98	0.97	0.96	0.95	0.94
KW Correction Multiplier (Compressors)	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07
SHR Correction Multiplier	1.00	.98	.95	.93	.91	.89	.87	.85
Maximum Condenser Ambient	115°F (46.1°C)	114°F (45.6°C)	113°F (45.0°C)	112°F (44.4°C)	111°F (43.9°C)	110°F (43.3°C)	109°F (42.8°C)	108°F (42.2°C)

Note:
SHR = Sensible Heat Ratio

Table PD-3 – Gas Heating Capacity Altitude Correction Factors

	Altitude ft. (m)						
	Sea Level To 2000 (Sea Level To 609.6)	2000 To 2500 (609.9 To 762.0)	2501 To 3500 (762.3 To 1066.8)	3501 To 4500 (1067.1 To 1674.4)	4501 To 5500 (1371.9 To 1675.4)	5501 To 6500 (1676.7 To 1981.2)	6501 To 7500 (1981.5 To 2286.0)
Capacity Multiplier	1.00	.92	.88	.84	.80	.76	.72

Note:
Correction factors are per AGA Std 221.30 – 1964, Part VI, 6.12. Local codes may supersede.

Performance Data 60 Hz

Table PD-4 — 27½ Ton Gross Cooling Capacities (MBh)

		Ambient Temperature — Deg F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature — Deg F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
CFM	(F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	291	228	323	185	358	130	278	221	309	174	343	123	265	213	295	167	327	116	251	206	279	159	310	109
8000	80	294	268	324	220	359	171	281	261	310	212	343	164	268	253	296	205	327	157	255	246	280	197	311	149
	85	301	301	325	258	360	210	290	290	311	251	344	203	278	278	297	243	329	196	266	266	282	236	312	188
	90	317	317	328	297	361	248	306	306	315	290	345	241	294	294	301	283	330	234	282	282	286	275	313	226
	75	299	242	331	189	367	133	285	235	316	182	351	126	272	227	301	175	334	119	257	219	286	168	316	112
9000	80	302	286	332	232	367	178	290	279	318	225	351	171	276	272	303	217	335	164	261	261	287	209	317	157
	85	314	314	334	275	368	221	302	302	319	268	352	215	290	290	305	260	336	208	277	277	289	252	319	201
	90	331	331	338	319	369	264	319	319	324	312	354	256	306	306	310	304	337	249	293	293	293	293	320	241
	75	305	255	337	197	373	136	292	248	322	190	357	129	277	240	307	183	339	122	263	232	291	176	322	115
10000	80	310	304	339	244	374	185	297	297	324	237	358	178	283	283	308	229	341	171	270	270	292	221	323	164
	85	325	325	341	291	375	233	313	313	326	284	359	226	300	300	311	276	342	219	287	287	295	268	324	212
	90	343	343	346	340	376	279	330	330	332	332	360	271	317	317	317	317	343	264	304	304	303	303	326	256
	75	311	268	343	205	379	139	297	260	327	198	362	132	282	253	311	191	344	125	268	245	295	183	326	117
11000	80	316	316	344	255	380	192	304	304	329	248	363	185	291	291	313	240	345	178	278	278	297	232	327	170
	85	335	335	347	307	381	245	322	322	332	300	364	237	309	309	317	292	347	230	295	295	301	284	329	220
	90	353	353	353	353	383	293	340	340	340	340	366	286	327	327	327	327	349	278	313	313	312	312	331	270
	75	316	281	348	223	384	142	302	274	332	216	366	135	287	266	316	208	348	128	272	258	299	200	330	121
12100	80	325	325	349	268	385	199	312	312	334	260	368	192	299	299	318	252	350	185	285	285	301	244	331	176
	85	344	344	353	324	387	254	331	331	338	317	369	246	317	317	322	309	352	239	303	303	306	301	333	231
	90	364	364	363	363	388	309	350	350	350	350	372	301	336	336	336	336	354	294	321	321	321	321	336	286

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Table PD-5— 30 Ton Gross Cooling Capacities (Mbh)

		Ambient Temperature — Deg F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature — Deg F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
CFM	(F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	323	255	358	207	397	144	309	247	343	194	380	137	295	239	327	186	362	129	279	230	310	178	344	122
9000	80	326	299	359	245	398	190	313	291	344	237	381	182	298	283	328	229	363	175	284	275	311	221	345	167
	85	335	335	361	288	399	234	323	323	346	280	382	227	310	310	330	272	364	219	297	297	313	264	345	210
	90	352	352	364	332	400	276	340	340	349	324	383	269	327	327	334	316	365	261	313	313	318	308	347	252
	75	331	268	366	210	405	147	316	260	350	202	387	140	301	252	333	194	369	132	286	243	316	186	350	125
10000	80	335	317	367	257	406	197	321	309	351	249	388	189	306	301	335	241	370	182	290	290	318	232	351	174
	85	347	347	369	304	407	246	334	334	353	296	389	238	321	321	337	288	371	230	307	307	320	280	352	222
	90	366	366	374	353	408	292	353	353	358	345	391	284	339	339	342	337	372	276	325	325	324	324	353	267
	75	337	281	372	218	411	150	322	273	356	210	393	143	307	265	339	202	374	135	291	256	321	194	355	127
11000	80	343	335	374	269	412	204	328	327	357	261	394	196	312	312	340	252	375	188	298	298	323	244	356	180
	85	358	358	376	321	413	257	345	345	360	312	395	249	331	331	343	304	377	241	316	316	326	296	357	233
	90	378	378	382	374	415	306	364	364	367	366	397	298	350	350	349	349	378	290	335	335	334	334	359	282
	75	343	294	378	225	417	153	328	285	361	218	398	145	312	277	343	210	379	138	295	268	325	201	359	129
12000	80	348	348	379	280	418	210	334	334	362	272	399	203	321	321	345	263	380	195	306	306	327	255	360	187
	85	368	368	382	336	419	268	354	354	366	328	401	260	340	340	349	320	382	252	325	325	331	311	362	244
	90	388	388	388	388	421	321	374	374	374	374	402	313	359	359	359	359	383	304	343	343	343	343	364	296
	75	349	308	383	246	422	156	333	300	366	238	403	149	317	291	348	229	383	141	300	283	329	221	363	133
13200	80	357	357	385	293	423	218	343	343	368	285	405	210	329	329	350	276	385	202	314	314	332	268	365	194
	85	378	378	389	354	425	278	364	364	372	346	406	270	349	349	355	338	387	261	333	333	337	329	366	253
	90	399	399	399	399	427	337	384	384	384	384	408	329	369	369	369	369	389	321	353	353	352	352	369	312

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

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Table PD-6 — 35 Ton Gross Cooling Capacities (Mbh)

		Ambient Temperature — Deg F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature — Deg F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
CFM	(F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	377	310	416	240	459	166	361	301	398	231	438	158	343	291	379	223	417	150	325	282	359	214	396	141
10500	80	383	367	417	296	460	224	366	359	399	287	439	216	350	349	380	278	418	207	332	332	360	268	397	198
	85	398	398	420	351	461	281	383	383	402	343	440	272	368	368	383	333	419	263	352	352	364	324	397	254
	90	419	419	426	409	462	336	404	404	408	400	442	327	388	388	388	388	421	317	371	371	371	371	399	308
	75	387	332	425	258	468	171	370	322	406	249	447	162	352	313	387	240	425	154	334	303	366	231	403	145
12000	80	393	393	427	315	469	236	378	378	408	306	448	227	362	362	388	297	426	218	346	346	368	288	404	209
	85	415	415	431	379	470	300	399	399	412	370	449	290	383	383	393	361	427	281	366	366	373	351	405	271
	90	437	437	437	437	472	361	421	421	421	421	451	352	404	404	404	404	430	342	386	386	386	386	408	333
	75	393	346	430	261	473	173	375	337	411	253	452	165	357	327	391	244	429	156	339	317	370	234	406	147
13000	80	402	402	432	328	475	243	387	387	413	319	453	234	370	370	393	310	430	225	353	353	372	300	408	216
	85	425	425	437	397	476	312	409	409	418	388	454	303	392	392	399	378	432	294	374	374	379	369	409	285
	90	448	448	448	448	478	377	431	431	431	431	457	368	413	413	413	413	435	359	395	395	395	395	412	349
	75	398	360	435	270	478	176	380	351	415	261	456	167	362	341	395	252	433	159	343	331	373	243	410	150
14000	80	410	410	437	341	479	250	394	394	417	332	457	241	378	378	397	322	434	232	360	360	376	312	411	223
	85	434	434	443	414	480	324	417	417	423	405	458	315	400	400	404	396	436	306	381	381	381	381	413	297
	90	458	458	457	457	484	393	440	440	440	440	462	384	422	422	422	422	440	375	403	403	403	403	417	365
	75	400	365	436	272	479	177	382	356	416	263	457	168	364	346	396	254	434	160	345	337	375	244	411	151
14400	80	413	413	439	346	481	253	397	397	419	336	459	244	380	380	399	327	436	235	363	363	378	317	412	226
	85	437	437	445	421	482	326	420	420	426	412	460	317	402	402	406	402	437	308	384	384	384	384	414	298
	90	461	461	461	461	486	400	443	443	443	443	464	390	425	425	425	425	442	381	406	406	406	406	419	371

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Table PD-7 — 40 Ton Gross Cooling Capacities (Mbh)

		Ambient Temperature — Deg F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature — Deg F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
CFM	(F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	460	365	510	288	565	202	439	353	486	276	539	190	416	340	462	263	512	178	393	327	436	250	484	166
12000	80	466	432	511	351	566	269	445	419	487	338	540	257	423	406	463	325	513	244	401	393	438	312	486	232
	85	480	480	515	415	567	333	461	461	491	402	541	322	441	441	467	390	515	309	421	421	442	376	487	297
	90	506	506	521	480	568	398	487	487	498	468	543	385	467	467	475	455	517	373	445	445	450	442	489	360
	75	476	396	525	304	580	208	453	383	500	291	553	196	430	370	474	279	525	184	406	357	448	266	496	172
14000	80	484	473	526	378	581	284	463	461	502	365	554	272	438	438	477	352	526	260	417	417	450	339	497	248
	85	506	506	532	453	582	359	486	486	508	440	556	347	465	465	482	427	528	335	443	443	457	414	499	321
	90	535	535	541	529	585	432	514	514	518	517	559	420	492	492	492	492	531	407	470	470	469	469		
	75	482	411	530	317	586	211	459	398	505	305	558	199	436	385	479	292	530	187	411	371	452	279		
15000	80	489	489	533	391	587	292	469	469	508	379	560	280	448	448	482	366	531	268	426	426	456	352		
	85	518	518	539	471	588	372	497	497	514	458	561	360	475	475	489	445	533	346	453	453	463	432		
	90	547	547	546	546	591	449	525	525	525	525	565	437	503	503	503	503	537	424	480	480	480	480		
	75	488	425	536	321	591	213	465	412	510	309	563	202	441	399	484	296	534	189	416	385	456	282		
16000	80	499	499	539	405	592	299	478	478	513	392	565	287	457	457	487	379	536	275	434	434	460	365		
	85	528	528	546	489	593	383	507	507	521	477	566	371	485	485	495	463	538	358	461	461	469	450		
	90	558	558	558	558	597	466	536	536	536	536	571	453	513	513	513	513	543	440	489	489	489	489		
	75	497	448	543	335	598	217	473	435	517	322	570	206	449	422	490	308	541	193	424	408	462	295		
17600	80	513	513	547	425	599	311	491	491	521	412	572	299	469	469	495	399	543	286	446	446	467	385		
	85	543	543	555	518	601	401	521	521	530	505	574	389	498	498	504	492	545	376	474	474	474	474		
	90	574	574	574	574	606	492	551	551	551	551	579	479	527	527	527	527	551	466						

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Performance Data 60 Hz

Table PD-8 — 50 Ton Gross Cooling Capacities (MBh)

		Ambient Temperature — Deg F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature — Deg F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
CFM	(F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	556	459	614	356	679	244	529	444	585	342	647	230	502	429	555	327	614	216	475	414	524	312		
15000	80	565	547	616	439	680	331	539	533	588	424	649	318	511	511	558	409	616	303	487	487	527	394		
	85	590	590	622	524	682	417	567	567	593	509	651	403	542	542	564	494	618	389	517	517	534	479		
	90	623	623	631	611	684	500	599	599	604	597	654	486	574	574	574	574	622	471	547	547	547	547		
	75	570	491	627	373	691	250	543	476	597	359	659	236	515	460	566	344	625	222	486	445	533	328		
17000	80	581	581	630	468	693	348	557	557	601	453	661	334	532	532	570	437	627	320	506	506	538	422		
	85	615	615	637	564	694	443	590	590	608	549	662	429	565	565	578	534	629	414	538	538	547	518		
	90	650	650	649	649	698	536	624	624	624	624	667	522	597	597	597	597	634	507						
	75	576	506	633	386	696	252	548	491	602	371	663	239	520	476	570	356	629	224	491	460	538	340		
18000	80	591	591	636	482	698	355	566	566	606	467	666	342	541	541	575	451	632	327	514	514	543	436		
	85	626	626	644	583	699	455	601	601	615	568	668	441	574	574	584	553	634	426	547	547	553	537		
	90	661	661	661	661	703	554	635	635	635	635	673	540	608	608	607	607	640	525						
	75	581	522	638	391	701	255	554	507	607	377	668	241	525	491	575	362	633	227	496	475	542	345		
19000	80	600	600	642	495	702	363	575	575	611	480	670	350	549	549	580	465	636	335	522	522	547	449		
	85	636	636	651	602	704	467	610	610	621	587	673	453	583	583	590	572	639	438	555	555	559	556		
	90	671	671	671	671	709	571	645	645	645	645	678	557	617	617	617	617	645	543						
	75	587	537	642	400	705	257	559	522	611	386	672	244	530	506	579	371	637	230	501	490	545	353		
20000	80	609	609	647	509	707	371	583	583	616	494	674	357	557	557	584	478	640	343	529	529	551	463		
	85	645	645	657	621	708	479	619	619	627	606	677	465	591	591	596	591	643	450	563	563	562	562		
	90	681	681	681	681	714	589	654	654	654	654	683	575	626	626	626	626	650	560						

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

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Table PD-9 — Electric Heat Air Temperature Rise

KW	Total	Cfm												
Input	MBH	8000	9000	10000	11000	12000	13000	14000	15000	16000	17000	18000	19000	20000
36	123	14.2	12.6	11.3	10.3	9.4	8.7	8.1	7.6	—	—	—	—	—
54	184	21.2	18.9	17.0	15.4	14.2	13.1	12.1	11.3	10.6	10.0	9.4	8.9	8.5
72	246	28.3	25.2	22.6	20.6	18.9	17.4	16.2	15.1	14.2	13.3	12.6	11.9	11.3
90	307	35.4	31.5	28.3	25.7	23.6	21.8	20.2	18.9	17.7	16.7	15.7	14.9	14.2
108	369	—	—	—	—	28.3	26.1	24.3	22.6	21.2	20.0	18.9	17.9	17.0

Notes:
1. Air temperature rise = (KW x 3413)/(scfm x 1.085).
2. All heaters on constant volume units provide 2 increments of capacity. All VAV units provide 1 step of heating capacity.
3. Air temperature rise in this table are based on heater operating at 240, 480 or 600 volts.

Table PD-10 — Available Electric Heat KW Ranges

Nominal Unit Size	Nominal Voltage			
Tons	208	240	480	600
27½	27-41	36-54	36-90	54-90
30.0	27-41	36-54	36-90	54-90
35.0	27-41	36-54	36-90	54-90
40.0	41	54	54-108	54-108
50.0	41	54	54-108	54-108

Notes:
1. KW ranges in this table are based on heater operating at 208, 240, 480, and 600 volts.
2. For other than rated voltage, KW = $\left(\frac{\text{Applied Voltage}}{\text{Rated Voltage}}\right)^2$ x Rated KW.
3. Electric heaters up to 54 KW are single element heaters, those above 54 KW are dual element heaters.

Table PD-11 — Natural Gas Heating Capacities

Tons	Unit Model No.	Heat Input MBH (See Note 1)	Heating Output MBH (See Note 1)	Air Temp. Rise, F
27½-35	YCD/YCH330**L YCD/YCH360**L YCD/YCH420**L	350,000/250,000	283,500/202,500	10-40
27½-35	YCD/YCH330**H YCD/YCH360**H YCD/YCH420**H	600,000/425,000	486,000/344,500	25-55
40-50	YCD/YCH480**L YCD/YCH600**L	400,000/300,000	324,000/243,000	5-35
40-50	YCD/YCH480**H YCD/YCH600**H	800,000/600,000	648,000/486,000	20-50

Note:
1. Second stage is total heating capacity. Second Stage/First Stage.

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Table PD-12 — Supply Fan Performance — 27½ - 35 Ton

	Static Pressure (in. wg)[1]																	
	0.25		0.50		0.75		1.00		1.25		1.50		1.75		2.00		2.25	
SCFM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
8000	308	1.17	372	1.62	427	2.09	475	2.55	525	3.11	574	3.75	620	4.42	661	5.09	701	5.77
8500	317	1.33	381	1.82	436	2.33	480	2.77	528	3.34	574	3.97	620	4.66	662	5.36	702	6.08
9000	326	1.51	391	2.04	443	2.55	489	3.08	532	3.58	577	4.22	620	4.91	663	5.64	703	6.40
9500	337	1.72	401	2.28	451	2.80	498	3.39	537	3.87	580	4.50	621	5.18	663	5.93	703	6.70
10000	349	1.96	411	2.54	459	3.09	506	3.69	545	4.25	584	4.81	624	5.48	664	6.23	703	7.02
10500	363	2.22	421	2.82	468	3.40	513	3.98	555	4.65	589	5.17	628	5.84	666	6.56	703	7.34
11000	376	2.52	430	3.11	479	3.74	521	4.33	563	5.03	598	5.63	633	6.22	670	6.95	706	7.73
11500	390	2.83	438	3.41	489	4.10	530	4.72	570	5.38	607	6.11	639	6.68	674	7.37	709	8.14
12000	404	3.18	447	3.74	499	4.48	538	5.13	578	5.79	615	6.56	648	7.22	679	7.83	713	8.59
12500	417	3.55	457	4.10	509	4.88	549	5.58	586	6.24	623	7.00	657	7.78	687	8.42	718	9.10
13000	431	3.95	468	4.50	518	5.30	559	6.04	594	6.73	630	7.45	665	8.30	696	9.04	724	9.69
13500	445	4.39	479	4.92	526	5.73	569	6.53	604	7.26	638	7.98	673	8.82	705	9.68	733	10.38
14000	459	4.85	490	5.39	535	6.19	579	7.04	614	7.81	647	8.56	680	9.35	713	10.26	742	11.09
14500	473	5.35	503	5.90	544	6.68	588	7.59	624	8.40	656	9.18	688	9.96	720	10.86	751	11.78

Table PD-12 — Supply Fan Performance — 27½ - 35 Ton Continued

	Static Pressure (in. wg)[1]					
	2.50		2.75		3.00	
SCFM	RPM	BHP	RPM	BHP	RPM	BHP
8000	738	6.48	773	7.18	805	7.88
8500	739	6.82	774	7.54	807	8.28
9000	740	7.16	775	7.92	809	8.70
9500	740	7.48	776	8.30	810	9.12
10000	742	7.86	777	8.68	812	9.54
10500	742	8.20	777	9.05	812	9.94
11000	741	8.56	777	9.43	812	10.35
11500	743	8.95	777	9.83	812	10.78
12000	747	9.43	780	10.30	812	11.21
12500	750	9.90	783	10.79	814	11.70
13000	755	10.45	786	11.30	817	12.22
13500	760	11.04	790	11.88	821	12.81
14000	768	11.79	795	12.52	824	13.39
14500	778	12.59	803	13.30	829	14.10

Notes:
1. Supply fan performance table includes internal resistance of rooftop. For total static pressure determination, system external static must be added to appropriate component static pressure drops, (evaporator coil, filters, optional economizer, optional heating system, optional roof curb).
2. The pressure drop from the supply fan to the space cannot exceed 2.25".
3. Maximum air flow for 27½ ton — 12,100 cfm, 30 ton — 13,200 cfm, 35 ton — 14,400 cfm.
4. Maximum motor horsepower for 27½ ton — 10 hp, 30 ton — 10 hp, 35 ton — 15 hp.

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Table PD-13 — Supply Fan Performance — 40 and 50 Ton

	Static Pressure (in. wg)[1]																	
	0.25		0.50		0.75		1.00		1.25		1.50		1.75		2.00		2.25	
SCFM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
12000	307	2.29	353	2.86	394	3.45	436	4.11	471	4.75	509	5.43	543	6.14	575	6.89	606	7.63
13000	324	2.79	368	3.40	407	4.06	446	4.73	482	5.43	515	6.13	550	6.87	582	7.65	612	8.44
14000	341	3.35	384	4.03	422	4.74	457	5.42	494	6.19	525	6.93	556	7.69	589	8.49	619	9.32
15000	359	3.99	401	4.77	437	5.48	471	6.24	504	6.99	537	7.82	566	8.62	595	9.42	625	10.27
16000	376	4.72	418	5.60	452	6.32	485	7.14	515	7.92	548	8.77	578	9.65	604	10.49	632	11.36
17000	394	5.53	434	6.50	468	7.26	500	8.12	529	8.97	558	9.79	589	10.73	616	11.65	641	12.54
18000	413	6.42	451	7.48	485	8.34	515	9.18	544	10.11	571	10.99	598	11.89	628	12.88	654	13.87
19000	431	7.42	469	8.55	501	9.53	530	10.37	559	11.34	585	12.29	611	13.22	637	14.17	665	15.24
20000	449	8.52	486	9.72	518	10.83	547	11.69	573	12.66	600	13.69	625	14.70	648	15.64	675	16.71

Table PD-13 — Supply Fan Performance — 40 and 50 Ton Continued

	Static Pressure (in. wg)[1]									
	2.50		2.75		3.00		3.25		3.50	
SCFM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
12000	640	8.45	670	9.25	700	10.03	727	10.81	755	11.61
13000	640	9.23	671	10.12	701	10.98	729	11.85	756	12.69
14000	647	10.16	674	11.04	700	11.89	729	12.85	757	13.79
15000	653	11.14	680	12.05	706	12.97	731	13.89	757	14.86
16000	659	12.23	687	13.16	713	14.14	738	15.10	762	16.10
17000	666	13.45	694	14.42	719	15.37	744	16.39	768	17.39
18000	677	14.81	700	15.76	726	16.78	751	17.77	774	18.81
19000	690	16.29	711	17.27	734	18.29	758	19.34	782	20.41
20000	701	17.83	724	18.91	745	19.94	765	20.99	788	22.12

Notes:
1. Supply fan performance table includes internal resistance of rooftop. For total static pressure determination, system external static must be added to appropriate component static pressure drops, (evaporator coil, filters, optional economizer, optional heating system, optional roof curb).
2. The pressure drop from the supply fan to the space cannot exceed 2.50".
3. Maximum air flow for 40 ton — 17,600 cfm, 50 ton — 20,000 cfm.
4. Maximum motor horsepower for 40 ton — 15 hp, 50 ton — 20 hp.

Performance Data

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Figure PD-2 — Supply Fan Performance — 27½ - 35 Ton

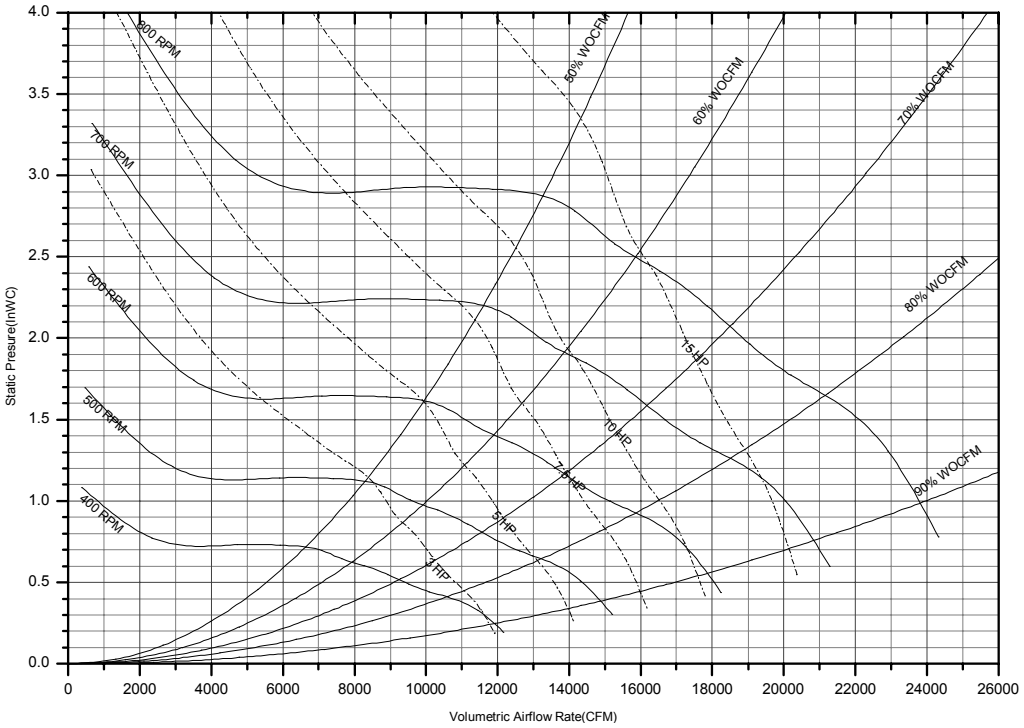


Figure PD-3 — Supply Fan Performance — 40 and 50 Ton

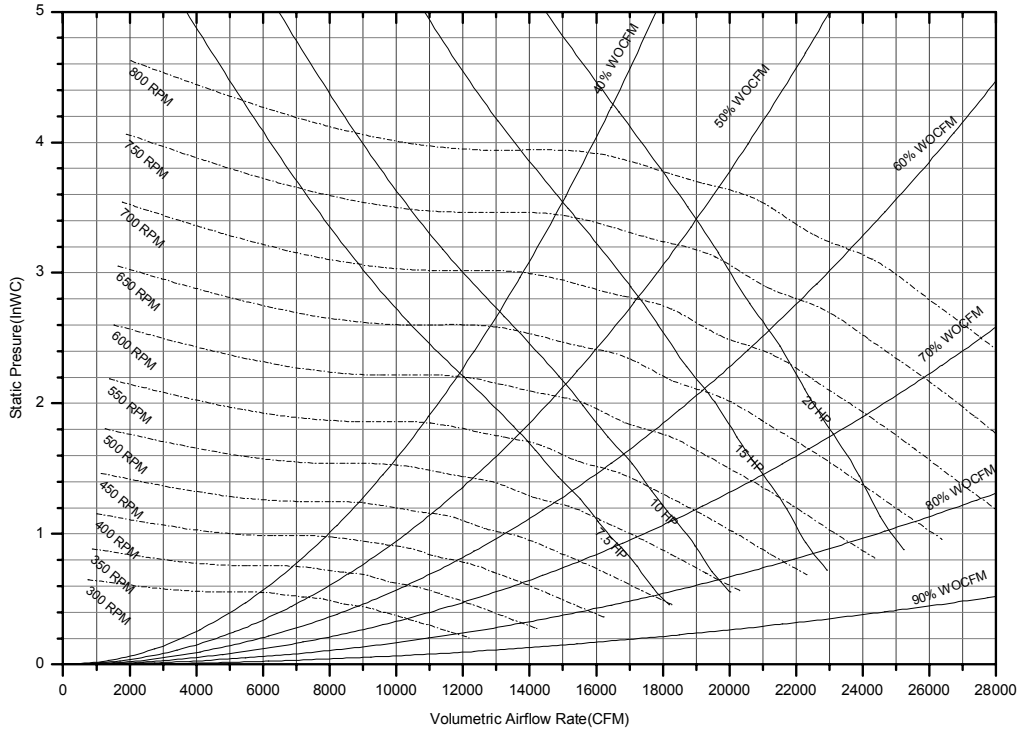


Table PD-14 — Component Static Pressure Drops (in. W.G.)[1]

Nominal Tons	CFM Std Air	Heating System: Gas Heat Low	Gas Heat High	Electric Heat[3] 1 Element	Electric Heat[3] 2 Element	ID Coil Dry	ID Coil Wet	Filters[2]: Throwaway 2"	High Eff. Filters 2"	High Eff. Filters 4"	Inlet Guide Vanes	Economizer
	8000	0.08	0.06	0.05	0.06	0.09	0.11	0.08	0.12	0.11	0.05	0.04
	9000	0.1	0.08	0.07	0.07	0.11	0.14	0.09	0.14	0.13	0.07	0.04
27½	10000	0.13	0.1	0.08	0.09	0.13	0.17	0.1	0.16	0.15	0.08	0.05
	11000	0.15	0.12	0.1	0.11	0.16	0.19	0.12	0.2	0.17	0.1	0.06
	12000	0.18	0.14	0.12	0.13	0.18	0.22	0.13	0.21	0.2	0.12	0.07
	9000	0.1	0.08	0.07	0.07	0.11	0.14	0.09	0.14	0.13	0.07	0.04
	10000	0.13	0.1	0.08	0.09	0.13	0.17	0.1	0.16	0.15	0.08	0.05
30	11000	0.15	0.12	0.1	0.11	0.16	0.19	0.12	0.2	0.17	0.1	0.06
	12000	0.18	0.14	0.12	0.13	0.18	0.22	0.14	0.23	0.21	0.12	0.07
	13000	0.21	0.16	0.14	0.15	0.2	0.25	0.15	0.26	0.23	0.14	0.09
	10500	0.14	0.11	0.09	0.1	0.22	0.27	0.11	0.18	0.16	0.09	0.06
	11500	0.17	0.13	0.11	0.12	0.25	0.31	0.13	0.21	0.19	0.11	0.07
35	12500	0.2	0.15	0.13	0.14	0.29	0.35	0.14	0.24	0.21	0.13	0.08
	13500	0.23	0.18	0.15	0.16	0.32	0.4	0.15	0.26	0.23	0.15	0.1
	14500	0.26	0.2	0.18	0.19	0.36	0.45	0.17	0.3	0.27	0.18	0.11
	12000	0.01	0.03	0.08	0.13	0.2	0.25	0.1	0.19	0.17	0.04	0.07
	13000	0.01	0.04	0.1	0.15	0.23	0.29	0.12	0.23	0.2	0.05	0.08
	14000	0.02	0.05	0.11	0.18	0.26	0.33	0.13	0.25	0.22	0.05	0.09
40	15000	0.02	0.05	0.13	0.2	0.29	0.36	0.14	0.28	0.24	0.06	0.1
	16000	0.02	0.06	0.15	0.23	0.32	0.4	0.15	0.31	0.27	0.07	0.11
	17000	0.02	0.07	0.17	0.26	0.36	0.44	0.17	0.35	0.3	0.08	0.12
	15000	0.02	0.05	0.13	0.2	0.39	0.48	0.14	0.28	0.24	0.06	0.1
	16000	0.02	0.06	0.15	0.23	0.43	0.54	0.15	0.31	0.27	0.07	0.11
50	17000	0.02	0.07	0.17	0.26	0.48	0.59	0.17	0.35	0.3	0.08	0.12
	18000	0.03	0.08	0.19	0.29	0.52	0.65	0.18	0.38	0.33	0.09	0.14
	19000	0.03	0.08	0.21	0.32	0.57	0.74	0.19	0.42	0.35	0.1	0.16
	20000	0.03	0.09	0.23	0.36	0.62	0.77	0.2	0.45	0.38	0.11	0.18

Notes:
1. Static pressure drops of accessory components must be added to external static pressure to enter fan selection tables.
2. Throwaway filter option limited to 300 ft/min face velocity.
3. Electric Heaters 36-54 KW contain 1 element; 72-108 KW 2 elements.

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Table PD-15 — Supply Air Fan Drive Selections

	7.5 HP		10 HP		15 HP		20 HP	
Nominal Tons	RPM	Drive No	RPM	Drive No	RPM	Drive No	RPM	Drive No
	550	A						
	600	B						
27½T	650	C						
	700		700	D				
	750		750*	E				
	550	A						
	600	B						
30T	650	C						
	700		700	D				
	750		750	E				
	600	B						
	650		650	C				
35T	700		700	D				
	790				790**	F		
	800				800*	G		
	500		500	H				
	525		525	J				
	575		575	K				
40T	625				625	L		
	675				675	M		
	725				725	N		
	525		525	J				
	575		575	K				
50T	625				625	L		
	675				675	M		
	725						725	N

Note:
*For YC gas/electrics only.
**For TC and TE Cooling only and with electric heat units only.

Performance Data 60 Hz

Table PD-16— Power Exhaust Fan Performance

Exhaust Airflow (Cfm)	External Static Pressure — Inches of Water		
	High Speed ESP	Med Speed ESP	Low Speed ESP
3500	0.900	—	—
4000	0.860	—	—
4500	0.820	—	—
5000	0.780	—	0.400
5500	0.745	—	0.380
6000	0.700	—	0.360
6500	0.660	—	0.330
7000	0.610	0.400	0.300
7500	0.560	0.365	0.260
8000	0.505	0.330	0.215
8500	0.445	0.300	0.170
9000	0.385	0.255	0.120
9500	0.320	0.210	0.070
10000	0.255	0.165	0.020
10500	0.190	0.125	—
11000	0.125	0.060	—
11500	0.065	0.000	—
12000	0.005	—	—

Notes:
1. Performance in table is with both motors operating.
2. High speed = both motors on high speed. Medium speed is one motor on high speed and one on low speed. Low speed is both motors on low speed.
3. Power Exhaust option is not to be applied on systems that have more return air static pressure drop than the maximum shown in the table for each motor speed tap.

Performance Data 50 Hz

Table PD-17 – 23 Ton Gross Cooling Capacities (MBh) (I-P)

		Ambient Temperature – °F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature – °F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
cfm	(°F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	247	195	274	158	304	110	235	188	262	152	290	104	224	182	249	146	276	98	211	175	235	139	261	91
6900	80	249	229	275	187	304	145	238	223	263	181	291	139	227	216	250	174	277	133	214	209	236	167	262	126
	85	256	256	276	221	305	179	247	247	264	215	292	173	236	236	251	208	278	167	225	225	237	201	263	160
	90	270	270	279	255	306	212	260	260	267	249	293	206	250	250	254	242	279	199	239	239	241	235	264	193
	75	251	203	279	164	309	112	240	197	266	158	295	106	228	190	253	152	280	100	215	183	239	145	265	93
7500	80	254	241	280	195	310	150	243	235	267	189	296	144	232	228	254	182	281	137	218	218	240	175	266	131
	85	264	264	281	231	310	186	254	254	269	225	297	180	243	243	256	218	282	173	232	232	242	211	267	166
	90	279	279	284	269	311	222	268	268	272	262	298	216	257	257	260	255	283	209	246	246	246	246	268	202
	75	255	210	282	168	313	113	243	204	269	162	298	107	231	197	256	155	283	101	218	190	241	149	267	95
8000	80	259	250	283	201	313	153	247	244	271	195	299	147	235	235	257	188	284	141	223	223	243	181	269	134
	85	270	270	285	240	314	192	260	260	272	233	300	186	249	249	259	227	285	179	237	237	245	219	270	172
	90	285	285	289	279	315	230	274	274	277	273	301	223	263	263	263	263	287	217	251	251	251	251	271	210
	75	261	224	288	171	319	116	249	217	275	165	304	110	236	210	261	159	289	104	223	203	246	152	272	97
9000	80	265	265	289	213	320	161	255	255	276	207	305	154	243	243	262	200	290	148	231	231	247	193	274	141
	85	281	281	292	257	321	203	270	270	279	250	306	198	258	258	265	243	291	192	246	246	251	236	275	182
	90	297	297	296	296	322	245	285	285	285	285	308	238	274	274	0	0	293	232	261	261	261	261	277	225
	75	266	236	293	179	324	119	254	230	280	173	309	113	241	223	265	166	293	106	227	215	250	159	276	99
10000	80	274	274	295	225	325	167	263	263	281	218	310	161	251	251	267	211	294	155	239	239	252	204	278	148
	85	290	290	298	273	326	216	279	279	285	266	311	207	267	267	271	259	296	200	254	254	256	252	279	193
	90	307	307	306	306	328	260	295	295	295	295	313	253	282	282	282	282	298	246	269	269	269	269	281	239

Notes:
1.Il capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Table PD-17a – 82 kW (23 Tons) Gross Cooling Capacity (kW) (SI)

		Ambient Temperature – °C																					
		29.4						35.0						40.6						46.1			
	Ent	Entering Wet Bulb Temperature – °C																					
	DB	16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8	
L/s	(°C)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	23.9	72.4	57.1	80.3	46.3	89.1	32.2	68.9	55.1	76.8	44.5	85.0	30.5	65.6	53.3	73.0	42.8	80.9	28.6	61.8	51.3	68.9	40.7	76.5	26.8
3260	26.7	73.0	67.1	80.6	54.8	89.1	42.5	69.8	65.4	77.1	53.0	85.3	40.7	66.5	63.3	73.3	51.0	81.2	39.0	62.7	61.3	69.2	48.9	76.8	36.9
	29.4	75.0	75.0	80.9	64.8	89.4	52.5	72.4	72.4	77.4	63.0	85.6	50.7	69.2	69.2	73.6	61.0	81.5	48.9	65.9	65.9	69.5	58.9	77.1	46.9
	32.2	79.1	79.1	81.8	74.7	89.7	62.1	76.2	76.2	78.2	73.0	85.9	60.4	73.3	73.3	74.4	70.9	81.8	58.3	70.0	70.0	70.6	68.9	77.4	56.6
	23.9	73.6	59.5	81.8	48.1	90.6	32.8	70.3	57.7	78.0	46.3	86.5	31.1	66.8	55.7	74.1	44.5	82.1	29.2	63.0	53.6	70.0	42.5	77.7	27.3
3540	26.7	74.4	70.6	82.1	57.1	90.9	44.0	71.2	68.9	78.2	55.4	86.7	42.2	68.0	66.8	74.4	53.3	82.4	40.2	63.9	63.9	70.3	51.3	78.0	38.4
	29.4	77.4	77.4	82.4	67.7	90.9	54.5	74.4	74.4	78.8	65.9	87.0	52.8	71.2	71.2	75.0	63.9	82.6	50.7	68.0	68.0	70.9	61.8	78.2	48.6
	32.2	81.8	81.8	83.2	78.8	91.1	65.1	78.5	78.5	79.7	76.8	87.3	63.3	75.3	75.3	76.2	74.7	82.9	61.3	72.1	72.1	72.1	72.1	78.5	59.2
	23.9	74.7	61.5	82.6	49.2	91.7	33.1	71.2	59.8	78.8	47.5	87.3	31.4	67.7	57.7	75.0	45.4	82.9	29.6	63.9	55.7	70.6	43.7	78.2	27.7
3780	26.7	75.9	73.3	82.9	58.9	91.7	44.8	72.4	71.5	79.4	57.1	87.6	43.1	68.9	68.9	75.3	55.1	83.2	41.3	65.4	65.4	71.2	53.0	78.8	39.3
	29.4	79.1	79.1	83.5	70.3	92.0	56.3	76.2	76.2	79.7	68.3	87.9	54.5	73.0	73.0	75.9	66.5	83.5	52.5	69.5	69.5	71.8	64.2	79.1	50.4
	32.2	83.5	83.5	84.7	81.8	92.3	67.4	80.3	80.3	81.2	80.0	88.2	65.4	77.1	77.1	77.1	77.1	84.1	63.6	73.6	73.6	73.6	73.6	79.4	61.5
	23.9	76.5	65.6	84.4	50.1	93.5	34.0	73.0	63.6	80.6	48.4	89.1	32.2	69.2	61.5	76.5	46.6	84.7	30.5	65.4	59.5	72.1	44.5	79.7	28.5
4250	26.7	77.7	77.7	84.7	62.4	93.8	47.2	74.7	74.7	80.9	60.7	89.4	45.1	71.2	71.2	76.8	58.6	85.0	43.4	67.7	67.7	72.4	56.6	80.3	41.3
	29.4	82.4	82.4	85.6	75.3	94.1	59.5	79.1	79.1	81.8	73.3	89.7	58.0	75.6	75.6	77.7	71.2	85.3	56.3	72.1	72.1	73.6	69.2	80.6	53.3
	32.2	87.0	87.0	86.7	86.7	94.4	71.8	83.5	83.5	83.5	83.5	90.3	69.8	80.3	80.3	0.0	0.0	85.9	68.0	76.5	76.5	76.5	76.5	81.2	65.9
	23.9	78.0	69.2	85.9	52.5	95.0	34.9	74.4	67.4	82.1	50.7	90.6	33.1	70.6	65.4	77.7	48.6	85.9	31.1	66.5	63.0	73.3	46.6	80.9	29.1
4720	26.7	80.3	80.3	86.5	65.9	95.2	48.9	77.1	77.1	82.4	63.9	90.9	47.2	73.6	73.6	78.2	61.8	86.2	45.4	70.0	70.0	73.9	59.8	81.5	43.4
	29.4	85.0	85.0	87.3	80.0	95.5	63.3	81.8	81.8	83.5	78.0	91.1	60.7	78.2	78.2	79.4	75.9	86.7	58.6	74.4	74.4	75.0	73.9	81.8	56.6
	32.2	90.0	90.0	89.7	89.7	96.1	76.2	86.5	86.5	86.5	86.5	91.7	74.1	82.6	82.6	82.6	82.6	87.3	72.1	78.8	78.8	78.8	78.8	82.4	70.0

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Performance Data 50 Hz

Table PD-18 – 25 Ton Gross Cooling Capacities (MBh) (I-P)

		Ambient Temperature – °F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature – °F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
cfm	(°F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	270	212	300	172	332	120	258	205	286	166	318	114	245	198	272	159	302	107	231	190	257	152	285	100
7500	80	273	249	301	204	333	158	261	243	287	197	318	152	248	235	273	190	303	145	235	228	258	183	286	138
	85	280	280	302	240	334	195	269	269	289	233	319	189	258	258	275	226	304	182	246	246	260	218	287	174
	90	295	295	304	277	335	231	284	284	292	270	320	224	272	272	278	263	305	217	260	260	264	255	288	209
	75	274	219	304	177	336	122	262	212	290	171	321	115	248	205	276	164	305	109	234	197	260	157	289	102
8000	80	277	259	305	210	337	162	265	252	291	203	322	155	252	245	277	196	306	149	239	237	261	189	289	141
	85	286	286	306	249	338	201	275	275	293	242	323	194	264	264	278	234	307	187	251	251	263	227	290	179
	90	302	302	309	288	339	239	291	291	296	281	324	232	279	279	282	274	308	224	266	266	268	266	292	217
	75	281	233	311	187	344	125	268	226	297	181	328	118	254	218	281	174	311	112	240	210	266	167	294	105
9000	80	285	277	312	223	344	169	273	270	298	216	329	163	259	259	283	208	312	156	246	246	267	200	295	148
	85	298	298	314	265	345	212	287	287	300	258	330	205	274	274	285	251	314	198	261	261	270	243	296	190
	90	314	314	318	309	347	254	303	303	305	302	331	247	290	290	290	290	315	240	277	277	277	277	298	232
	75	287	246	316	197	349	128	274	238	302	189	333	121	260	231	286	181	316	114	245	223	270	174	298	107
10000	80	291	291	318	234	350	176	280	280	303	227	334	169	267	267	288	220	318	162	254	254	272	212	300	155
	85	308	308	320	281	351	223	296	296	306	274	336	216	283	283	291	267	319	208	270	270	275	259	301	200
	90	325	325	325	325	353	269	313	313	313	313	337	262	300	300	300	300	321	254	286	286	286	286	303	246
	75	292	258	321	204	354	130	279	251	306	197	338	124	264	243	290	190	320	117	249	235	274	182	302	110
11000	80	300	300	323	246	355	183	288	288	308	238	339	176	275	275	292	231	322	169	261	261	276	223	303	161
	85	317	317	326	297	357	233	305	305	312	290	340	226	291	291	296	282	323	218	277	277	280	275	305	210
	90	335	335	335	335	358	283	322	322	322	322	342	276	309	309	308	308	325	268	294	294	294	294	308	261

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Table PD-18a – 89 kW (25 Tons) Gross Cooling Capacity (kW) (SI)

		Ambient Temperature – °C																					
		29.4						35.0						40.6						46.1			
	Ent	Entering Wet Bulb Temperature – °C																					
	DB	16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8	
L/s	(°C)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	23.9	79.1	62.1	87.9	50.4	97.3	35.2	75.6	60.1	83.8	48.6	93.2	33.4	71.8	58.0	79.7	46.6	88.5	31.4	67.7	55.7	75.3	44.5	83.5	29.3
3540	26.7	80.0	73.0	88.2	59.8	97.6	46.3	76.5	71.2	84.1	57.7	93.2	44.5	72.7	68.9	80.0	55.7	88.8	42.5	68.9	66.8	75.6	53.6	83.8	40.4
	29.4	82.1	82.1	88.5	70.3	97.9	57.1	78.8	78.8	84.7	68.3	93.5	55.4	75.6	75.6	80.6	66.2	89.1	53.3	72.1	72.1	76.2	63.9	84.1	51.0
	32.2	86.5	86.5	89.1	81.2	98.2	67.7	83.2	83.2	85.6	79.1	93.8	65.6	79.7	79.7	81.5	77.1	89.4	63.6	76.2	76.2	77.4	74.7	84.4	61.3
	23.9	80.3	64.2	89.1	51.9	98.5	35.8	76.8	62.1	85.0	50.1	94.1	33.7	72.7	60.1	80.9	48.1	89.4	31.9	68.6	57.7	76.2	46.0	84.7	29.9
3780	26.7	81.2	75.9	89.4	61.5	98.8	47.5	77.7	73.9	85.3	59.5	94.4	45.4	73.9	71.8	81.2	57.4	89.7	43.7	70.0	69.5	76.5	55.4	84.7	41.3
	29.4	83.8	83.8	89.7	73.0	99.1	58.9	80.6	80.6	85.9	70.9	94.7	56.9	77.4	77.4	81.5	68.6	90.0	54.8	73.6	73.6	77.1	66.5	85.0	52.5
	32.2	88.5	88.5	90.6	84.4	99.4	70.0	85.3	85.3	86.7	82.4	95.0	68.0	81.8	81.8	82.6	80.3	90.3	65.6	78.0	78.0	78.5	78.0	85.6	63.6
	23.9	82.4	68.3	91.1	54.8	100.8	36.6	78.5	66.2	87.0	53.0	96.1	34.6	74.4	63.9	82.4	51.0	91.1	32.8	70.3	61.5	78.0	48.9	86.2	30.8
4250	26.7	83.5	81.2	91.4	65.4	100.8	49.5	80.0	79.1	87.3	63.3	96.4	47.8	75.9	75.9	82.9	61.0	91.4	45.7	72.1	72.1	78.2	58.6	86.5	43.4
	29.4	87.3	87.3	92.0	77.7	101.1	62.1	84.1	84.1	87.9	75.6	96.7	60.1	80.3	80.3	83.5	73.6	92.0	58.0	76.5	76.5	79.1	71.2	86.7	55.7
	32.2	92.0	92.0	93.2	90.6	101.7	74.4	88.8	88.8	89.4	88.5	97.0	72.4	85.0	85.0	85.0	85.0	92.3	70.3	81.2	81.2	81.2	81.2	87.3	68.0
	23.9	84.1	72.1	92.6	57.7	102.3	37.5	80.3	69.8	88.5	55.4	97.6	35.5	76.2	67.7	83.8	53.0	92.6	33.4	71.8	65.4	79.1	51.0	87.3	31.4
4720	26.7	85.3	85.3	93.2	68.6	102.6	51.6	82.1	82.1	88.8	66.5	97.9	49.5	78.2	78.2	84.4	64.5	93.2	47.5	74.4	74.4	79.7	62.1	87.9	45.4
	29.4	90.3	90.3	93.8	82.4	102.9	65.4	86.7	86.7	89.7	80.3	98.5	63.3	82.9	82.9	85.3	78.2	93.5	61.0	79.1	79.1	80.6	75.9	88.2	58.6
	32.2	95.2	95.2	95.2	95.2	103.5	78.8	91.7	91.7	91.7	91.7	98.8	76.8	87.9	87.9	87.9	87.9	94.1	74.4	83.8	83.8	83.8	83.8	88.8	72.1
	23.9	85.6	75.6	94.1	59.8	103.7	38.1	81.8	73.6	89.7	57.7	99.1	36.3	77.4	71.2	85.0	55.7	93.8	34.3	73.0	68.9	80.3	53.3	88.5	32.2
5190	26.7	87.9	87.9	94.7	72.1	104.0	53.6	84.4	84.4	90.3	69.8	99.4	51.6	80.6	80.6	85.6	67.7	94.4	49.5	76.5	76.5	80.9	65.4	88.8	47.2
	29.4	92.9	92.9	95.5	87.0	104.6	68.3	89.4	89.4	91.4	85.0	99.6	66.2	85.3	85.3	86.7	82.6	94.7	63.9	81.2	81.2	82.1	80.6	89.4	61.5
	32.2	98.2	98.2	98.2	98.2	104.9	82.9	94.4	94.4	94.4	94.4	100.2	80.9	90.6	90.6	90.3	90.3	95.2	78.5	86.2	86.2	86.2	86.2	90.3	76.5

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Performance Data 50 Hz

Table PD-19 – 29 Ton Gross Cooling Capacities (MBh) (I-P)

		Ambient Temperature – °F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature – °F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
cfm	(°F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	318	260	352	204	389	141	304	252	336	197	371	133	288	244	319	189	352	125	272	235	301	181	332	118
8750	80	323	309	353	249	389	189	309	301	337	241	372	182	294	293	320	233	353	174	278	278	302	224	333	166
	85	336	336	355	296	390	237	323	323	339	288	373	229	309	309	322	280	354	221	294	294	305	271	334	212
	90	353	353	359	344	391	283	340	340	344	336	374	275	326	326	328	328	355	267	311	311	311	311	336	258
	75	320	264	354	207	391	141	306	256	337	199	372	134	290	248	320	192	353	126	273	239	302	183	334	118
9000	80	325	314	354	252	391	191	311	306	338	244	373	184	295	295	321	236	354	176	280	280	303	227	335	168
	85	339	339	357	301	392	240	326	326	341	293	374	232	312	312	324	284	355	224	297	297	306	276	335	215
	90	357	357	362	350	393	287	344	344	346	342	376	279	329	329	329	329	357	271	314	314	314	314	337	262
	75	327	279	360	217	397	144	312	271	343	209	378	137	296	263	326	201	359	129	279	254	307	193	338	121
10000	80	332	332	361	266	398	199	319	319	345	258	380	191	304	304	327	249	360	183	289	289	309	241	340	175
	85	351	351	364	319	399	252	337	337	348	311	380	244	322	322	331	303	361	236	307	307	313	294	341	227
	90	370	370	370	370	401	305	356	356	355	355	382	296	340	340	340	340	363	288	325	325	324	324	343	279
	75	333	294	365	227	402	147	318	286	348	219	383	139	301	277	330	211	363	132	284	268	311	203	342	124
11000	80	341	341	367	279	404	207	328	328	350	271	385	199	313	313	332	262	365	191	297	297	313	254	344	183
	85	361	361	371	338	405	264	347	347	354	330	386	256	332	332	337	321	366	248	316	316	319	312	345	239
	90	381	381	381	381	407	321	366	366	366	366	388	313	350	350	350	350	369	305	334	334	334	334	348	296
	75	338	308	370	236	407	150	322	300	352	228	387	142	306	291	334	220	367	134	288	282	314	210	346	126
12000	80	350	350	372	292	408	214	336	336	354	284	389	206	320	320	336	275	369	198	304	304	317	266	347	190
	85	370	370	377	356	410	276	355	355	360	347	390	268	340	340	342	339	370	259	323	323	323	323	349	250
	90	391	391	391	391	413	338	376	376	375	375	394	330	359	359	359	359	374	321	342	342	342	342	353	312

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Table PD-19a – 105 kW (29 Ton) Gross Cooling Capacity (kW) (SI)

		Ambient Temperature – °C																					
		29.4						35.0						40.6						46.1			
	Ent	Entering Wet Bulb Temperature – °C																					
	DB	16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8	
L/s	(°C)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	23.9	93.2	76.2	103.2	59.8	114.0	41.3	89.1	73.9	98.5	57.7	108.7	39.0	84.4	71.5	93.5	55.4	103.2	36.6	79.7	68.9	88.2	53.0	97.3	34.6
4130	26.7	94.7	90.6	103.5	73.0	114.0	55.4	90.6	88.2	98.8	70.6	109.0	53.3	86.2	85.9	93.8	68.3	103.5	51.0	81.5	81.5	88.5	65.6	97.6	48.6
	29.4	98.5	98.5	104.0	86.7	114.3	69.5	94.7	94.7	99.4	84.4	109.3	67.1	90.6	90.6	94.4	82.1	103.7	64.8	86.2	86.2	89.4	79.4	97.9	62.1
	32.2	103.5	103.5	105.2	100.8	114.6	82.9	99.6	99.6	100.8	98.5	109.6	80.6	95.5	95.5	96.1	96.1	104.0	78.2	91.1	91.1	91.1	91.1	98.5	75.6
	23.9	93.8	77.4	103.7	60.7	114.6	41.3	89.7	75.0	98.8	58.3	109.0	39.3	85.0	72.7	93.8	56.3	103.5	36.9	80.0	70.0	88.5	53.6	97.9	34.6
4250	26.7	95.2	92.0	103.7	73.9	114.6	56.0	91.1	89.7	99.1	71.5	109.3	53.9	86.5	86.5	94.1	69.2	103.7	51.6	82.1	82.1	88.8	66.5	98.2	49.2
	29.4	99.4	99.4	104.6	88.2	114.9	70.3	95.5	95.5	99.9	85.9	109.6	68.0	91.4	91.4	95.0	83.2	104.0	65.6	87.0	87.0	89.7	80.9	98.2	63.0
	32.2	104.6	104.6	106.1	102.6	115.2	84.1	100.8	100.8	101.4	100.2	110.2	81.8	96.4	96.4	96.4	96.4	104.6	79.4	92.0	92.0	92.0	92.0	98.8	76.8
	23.9	95.8	81.8	105.5	63.6	116.3	42.2	91.4	79.4	100.5	61.3	110.8	40.2	86.7	77.1	95.5	58.9	105.2	37.8	81.8	74.4	90.0	56.6	99.1	35.5
4720	26.7	97.3	97.3	105.8	78.0	116.6	58.3	93.5	93.5	101.1	75.6	111.4	56.0	89.1	89.1	95.8	73.0	105.5	53.6	84.7	84.7	90.6	70.6	99.6	51.3
	29.4	102.9	102.9	106.7	93.5	116.9	73.9	98.8	98.8	102.0	91.1	111.4	71.5	94.4	94.4	97.0	88.8	105.8	69.2	90.0	90.0	91.7	86.2	99.9	66.5
	32.2	108.4	108.4	108.4	108.4	117.5	89.4	104.3	104.3	104.0	104.0	112.0	86.7	99.6	99.6	99.6	99.6	106.4	84.4	95.2	95.2	95.0	95.0	100.5	81.8
	23.9	97.6	86.2	107.0	66.5	117.8	43.1	93.2	83.8	102.0	64.2	112.2	40.7	88.2	81.2	96.7	61.8	106.4	38.7	83.2	78.5	91.1	59.5	100.2	36.3
5190	26.7	99.9	99.9	107.6	81.8	118.4	60.7	96.1	96.1	102.6	79.4	112.8	58.3	91.7	91.7	97.3	76.8	107.0	56.0	87.0	87.0	91.7	74.4	100.8	53.6
	29.4	105.8	105.8	108.7	99.1	118.7	77.4	101.7	101.7	103.7	96.7	113.1	75.0	97.3	97.3	98.8	94.1	107.3	72.7	92.6	92.6	93.5	91.4	101.1	70.0
	32.2	111.7	111.7	111.7	111.7	119.3	94.1	107.3	107.3	107.3	107.3	113.7	91.7	102.6	102.6	102.6	102.6	108.1	89.4	97.9	97.9	97.9	97.9	102.0	86.7
	23.9	99.1	90.3	108.4	69.2	119.3	44.0	94.4	87.9	103.2	66.8	113.4	41.6	89.7	85.3	97.9	64.5	107.6	39.3	84.4	82.6	92.0	61.5	101.4	36.9
5660	26.7	102.6	102.6	109.0	85.6	119.6	62.7	98.5	98.5	103.7	83.2	114.0	60.4	93.8	93.8	98.5	80.6	108.1	58.0	89.1	89.1	92.9	78.0	101.7	55.7
	29.4	108.4	108.4	110.5	104.3	120.2	80.9	104.0	104.0	105.5	101.7	114.3	78.5	99.6	99.6	100.2	99.4	108.4	75.9	94.7	94.7	94.7	94.7	102.3	73.3
	32.2	114.6	114.6	114.6	114.6	121.0	99.1	110.2	110.2	109.9	109.9	115.5	96.7	105.2	105.2	105.2	105.2	109.6	94.1	100.2	100.2	100.2	100.2	103.5	91.4

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Performance Data

50 Hz

Table PD-20 – 33 Ton Gross Cooling Capacities (MBh) (I-P)

		Ambient Temperature – °F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature – °F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
cfm	(°F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	389	307	433	242	480	171	370	296	412	231	457	160	350	284	390	220	433	149	328	272	366	208	407	138
10000	80	394	362	434	295	481	227	375	351	413	284	458	216	355	339	391	272	434	205	334	327	368	260	409	193
	85	405	405	436	349	482	281	389	389	416	338	460	271	371	371	394	326	436	259	352	352	371	314	410	248
	90	428	428	441	404	483	335	411	411	421	393	461	324	393	393	400	381	437	312	373	373	377	369	412	300
	75	398	323	441	252	488	174	378	311	419	241	465	163	357	299	397	230	440	152	335	287	373	218	414	141
11000	80	404	384	442	309	490	235	384	372	421	298	466	224	364	361	398	286	441	213	342	342	374	274	415	201
	85	420	420	446	369	491	295	402	402	425	357	468	284	384	384	402	345	443	272	364	364	379	333	417	261
	90	444	444	452	429	492	353	426	426	431	418	469	342	407	407	410	406	445	330	387	387	386	386	419	318
	75	405	338	448	262	495	177	385	327	426	251	471	166	364	315	403	240	446	155	341	302	378	228	419	144
12000	80	413	405	450	323	497	243	391	391	428	312	473	232	372	372	405	300	448	221	352	352	380	288	421	209
	85	433	433	454	388	498	308	415	415	432	376	474	297	396	396	410	364	449	285	375	375	386	352	422	272
	90	457	457	462	454	500	370	439	439	439	439	477	359	419	419	419	419	452	347	398	398	398	398	426	335
	75	412	353	454	272	501	180	391	342	432	261	477	169	370	329	408	249	451	158	347	317	383	237	424	146
13000	80	419	419	456	337	503	251	401	401	434	325	479	240	382	382	410	313	453	228	361	361	386	301	426	217
	85	445	445	461	407	503	320	426	426	439	395	480	308	406	406	416	383	454	297	385	385	392	370	428	284
	90	470	470	470	470	507	387	450	450	450	450	483	376	430	430	430	430	458	364	408	408	408	408	432	352
	75	421	377	462	287	509	184	400	365	439	276	484	173	378	353	415	264	458	162	355	340	389	252	430	150
14600	80	434	434	465	358	510	263	415	415	442	346	486	252	395	395	418	334	460	240	374	374	393	322	432	229
	85	461	461	472	436	512	339	441	441	449	424	488	327	420	420	426	412	462	315	398	398	401	399	434	303
	90	487	487	487	487	516	414	467	467	467	467	492	403	445	445	445	445	466	391	423	423	423	423	440	379

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Table PD-20a – 120 kW (33 Ton) Gross Cooling Capacity (kW) (SI)

		Ambient Temperature – °C																					
		29.4						35.0						40.6						46.1			
	Ent	Entering Wet Bulb Temperature – °C																					
	DB	16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8	
L/s	(°C)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	23.9	114.0	90.0	126.9	70.9	140.7	50.1	108.4	86.7	120.7	67.7	133.9	46.9	102.6	83.2	114.3	64.5	126.9	43.7	96.1	79.7	107.3	61.0	119.3	40.4
4720	26.7	115.5	106.1	127.2	86.5	141.0	66.5	109.9	102.9	121.0	83.2	134.2	63.3	104.0	99.4	114.6	79.7	127.2	60.1	97.9	95.8	107.9	76.2	119.9	56.6
	29.4	118.7	118.7	127.8	102.3	141.3	82.4	114.0	114.0	121.9	99.1	134.8	79.4	108.7	108.7	115.5	95.5	127.8	75.9	103.2	103.2	108.7	92.0	120.2	72.7
	32.2	125.4	125.4	129.2	118.4	141.6	98.2	120.5	120.5	123.4	115.2	135.1	95.0	115.2	115.2	117.2	111.7	128.1	91.4	109.3	109.3	110.5	108.1	120.7	87.9
	23.9	116.6	94.7	129.2	73.9	143.0	51.0	110.8	91.1	122.8	70.6	136.3	47.8	104.6	87.6	116.3	67.4	129.0	44.5	98.2	84.1	109.3	63.9	121.3	41.3
5190	26.7	118.4	112.5	129.5	90.6	143.6	68.9	112.5	109.0	123.4	87.3	136.6	65.6	106.7	105.8	116.6	83.8	129.2	62.4	100.2	100.2	109.6	80.3	121.6	58.9
	29.4	123.1	123.1	130.7	108.1	143.9	86.5	117.8	117.8	124.6	104.6	137.2	83.2	112.5	112.5	117.8	101.1	129.8	79.7	106.7	106.7	111.1	97.6	122.2	76.5
	32.2	130.1	130.1	132.5	125.7	144.2	103.5	124.8	124.8	126.3	122.5	137.5	100.2	119.3	119.3	120.2	119.0	130.4	96.7	113.4	113.4	113.1	113.1	122.8	93.2
	23.9	118.7	99.1	131.3	76.8	145.1	51.9	112.8	95.8	124.8	73.6	138.0	48.6	106.7	92.3	118.1	70.3	130.7	45.4	99.9	88.5	110.8	66.8	122.8	42.2
5660	26.7	121.0	118.7	131.9	94.7	145.7	71.2	114.6	114.6	125.4	91.4	138.6	68.0	109.0	109.0	118.7	87.9	131.3	64.8	103.2	103.2	111.4	84.4	123.4	61.3
	29.4	126.9	126.9	133.1	113.7	145.9	90.3	121.6	121.6	126.6	110.2	138.9	87.0	116.1	116.1	120.2	106.7	131.6	83.5	109.9	109.9	113.1	103.2	123.7	79.7
	32.2	133.9	133.9	135.4	133.1	146.5	108.4	128.7	128.7	128.7	128.7	139.8	105.2	122.8	122.8	122.8	122.8	132.5	101.7	116.6	116.6	116.6	116.6	124.8	98.2
	23.9	120.7	103.5	133.1	79.7	146.8	52.8	114.6	100.2	126.6	76.5	139.8	49.5	108.4	96.4	119.6	73.0	132.2	46.3	101.7	92.9	112.2	69.5	124.3	42.8
6140	26.7	122.8	122.8	133.6	98.8	147.4	73.6	117.5	117.5	127.2	95.2	140.4	70.3	112.0	112.0	120.2	91.7	132.8	66.8	105.8	105.8	113.1	88.2	124.8	63.6
	29.4	130.4	130.4	135.1	119.3	147.4	93.8	124.8	124.8	128.7	115.8	140.7	90.3	119.0	119.0	121.9	112.2	133.1	87.0	112.8	112.8	114.9	108.4	125.4	83.2
	32.2	137.7	137.7	137.7	137.7	148.6	113.4	131.9	131.9	131.9	131.9	141.6	110.2	126.0	126.0	126.0	126.0	134.2	106.7	119.6	119.6	119.6	119.6	126.6	103.2
	23.9	123.4	110.5	135.4	84.1	149.2	53.9	117.2	107.0	128.7	80.9	141.8	50.7	110.8	103.5	121.6	77.4	134.2	47.5	104.0	99.6	114.0	73.9	126.0	44.0
6890	26.7	127.2	127.2	136.3	104.9	149.5	77.1	121.6	121.6	129.5	101.4	142.4	73.9	115.8	115.8	122.5	97.9	134.8	70.3	109.6	109.6	115.2	94.4	126.6	67.1
	29.4	135.1	135.1	138.3	127.8	150.1	99.4	129.2	129.2	131.6	124.3	143.0	95.8	123.1	123.1	124.8	120.7	135.4	92.3	116.6	116.6	117.5	116.9	127.2	88.8
	32.2	142.7	142.7	142.7	142.7	151.2	121.3	136.9	136.9	136.9	136.9	144.2	118.1	130.4	130.4	130.4	130.4	136.6	114.6	124.0	124.0	124.0	124.0	129.0	111.1

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

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Table PD-21 – 42 Ton Gross Cooling Capacities (MBh) (I-P)

		Ambient Temperature – °F																					
		85						95						105						115			
	Ent	Entering Wet Bulb Temperature – °F																					
	DB	61		67		73		61		67		73		61		67		73		61		67		73	
cfm	(°F)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	469	385	519	298	574	206	446	372	494	286	546	193	421	358	467	272	517	180	395	344	438	259	486	167
12500	80	476	459	521	369	576	279	454	446	495	355	548	267	428	428	469	342	519	254	406	406	441	328	488	240
	85	498	498	525	440	578	351	477	477	500	427	550	338	455	455	474	413	521	325	432	432	446	399	489	311
	90	526	526	533	513	580	421	504	504	508	500	552	408	482	482	481	481	523	394	458	458	458	458	493	380
	75	476	402	526	309	582	209	453	388	500	296	553	196	428	374	472	283	523	183	401	360	444	269	491	170
13500	80	485	481	528	383	583	288	462	462	502	370	555	275	440	440	475	356	525	262	416	416	447	342	—	—
	85	511	511	533	460	585	365	489	489	508	447	556	351	467	467	481	433	526	338	443	443	453	419	—	—
	90	540	540	543	539	588	440	518	518	517	517	560	427	494	494	494	494	530	413	470	470	469	469	—	—
	75	483	418	532	319	588	211	459	404	506	306	558	199	434	390	478	293	528	186	407	375	448	279	—	—
14500	80	494	494	535	398	590	296	472	472	509	384	561	283	449	449	481	371	530	270	425	425	452	356	—	—
	85	523	523	541	480	591	378	501	501	515	467	562	364	477	477	488	453	532	351	453	453	459	439	—	—
	90	553	553	552	552	595	458	530	530	530	530	567	445	506	506	506	506	537	431	480	480	480	480	—	—
	75	489	433	538	329	593	214	465	420	511	316	563	202	439	406	482	302	532	189	412	391	452	289	—	—
15500	80	504	504	541	412	595	304	482	482	514	399	566	291	458	458	486	385	535	278	434	434	457	370	—	—
	85	534	534	548	500	597	390	511	511	522	487	568	377	487	487	494	473	537	363	462	462	465	458	—	—
	90	564	564	564	564	602	476	541	541	541	541	573	463	516	516	516	516	542	449	490	490	490	490	—	—
	75	495	449	543	339	598	217	470	435	515	326	568	204	444	421	486	312	536	191	417	406	456	295	—	—
16500	80	513	513	546	426	600	312	491	491	519	413	570	299	467	467	491	399	539	286	441	441	461	384	—	—
	85	544	544	554	520	603	403	521	521	528	506	573	390	496	496	500	492	542	376	470	470	470	470	—	—
	90	575	575	575	575	608	494	551	551	551	551	578	481	526	526	526	526	548	467	—	—	—	—	—	—

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Table PD-21a – 148 kW (42 Ton) Gross Cooling Capacity (kW) (SI)

		Ambient Temperature – °C																					
		29.4						35.0						40.6						46.1			
	Ent	Entering Wet Bulb Temperature – °C																					
	DB	16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8		16.1		19.4		22.8	
L/s	(°C)	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC	TGC	SHC
	75	137	113	152	87	168	60	131	109	145	84	160	57	123	105	137	80	152	53	116	101	128	76	142	49
5900	80	140	135	153	108	169	82	133	131	145	104	161	78	125	125	137	100	152	74	119	119	129	96	143	70
	85	146	146	154	129	169	103	140	140	147	125	161	99	133	133	139	121	153	95	127	127	131	117	143	91
	90	154	154	156	150	170	123	148	148	149	147	162	120	141	141	141	141	153	115	134	134	134	134	144	111
	75	140	118	154	91	171	61	133	114	147	87	162	57	125	110	138	83	153	54	118	106	130	79	144	50
6370	80	142	141	155	112	171	84	135	135	147	108	163	81	129	129	139	104	154	77	122	122	131	100	—	—
	85	150	150	156	135	171	107	143	143	149	131	163	103	137	137	141	127	154	99	130	130	133	123	—	—
	90	158	158	159	158	172	129	152	152	152	152	164	125	145	145	145	145	155	121	138	138	137	137	—	—
	75	142	123	156	93	172	62	135	118	148	90	164	58	127	114	140	86	155	55	119	110	131	82	—	—
6840	80	145	145	157	117	173	87	138	138	149	113	164	83	132	132	141	109	155	79	125	125	132	104	—	—
	85	153	153	159	141	173	111	147	147	151	137	165	107	140	140	143	133	156	103	133	133	135	129	—	—
	90	162	162	162	162	174	134	155	155	155	155	166	130	148	148	148	148	157	126	141	141	141	141	—	—
	75	143	127	158	96	174	63	136	123	150	93	165	59	129	119	141	89	156	55	121	115	132	85	—	—
7320	80	148	148	159	121	174	89	141	141	151	117	166	85	134	134	142	113	157	81	127	127	134	108	—	—
	85	156	156	161	147	175	114	150	150	153	143	166	110	143	143	145	139	157	106	135	135	136	134	—	—
	90	165	165	165	165	176	140	159	159	159	159	168	136	151	151	151	151	159	132	144	144	144	144	—	—
	75	145	132	159	99	175	64	138	127	151	96	166	60	130	123	142	91	157	56	122	119	134	86	—	—
7790	80	150	150	160	125	176	91	144	144	152	121	167	88	137	137	144	117	158	84	129	129	135	113	—	—
	85	159	159	162	152	177	118	153	153	155	148	168	114	145	145	147	144	159	110	138	138	138	138	—	—
	90	169	169	169	169	178	145	161	161	161	161	169	141	154	154	154	154	161	137	—	—	—	—	—	—

Notes:
1. All capacities shown are gross and have not considered indoor fan heat. To obtain net cooling, subtract indoor fan heat.
2. TGC = Total gross capacity.
3. SHC = Sensible heat capacity.

Performance Data 50 Hz

Table PD-22 – Electric Heat Air Temperature Rise (°F) (I-P)

Heater	Total	CFM										
Input (kW)	MBh	7000	8000	9000	10000	11000	12000	13000	14000	15000	16000	17000
26.9	92	12.1	10.6	9.4	8.5	7.7	7.1	–	–	–	–	–
40.4	138	18.2	15.9	14.1	12.7	11.6	10.6	9.8	9.1	8.5	7.9	7.5
53.8	184	24.2	21.2	18.8	16.9	15.4	14.1	13.0	12.1	11.3	10.6	10.0
67.3	230	30.2	26.5	23.5	21.2	19.2	17.6	16.3	15.1	14.1	13.2	12.5
80.7	276	–	–	–	25.4	23.1	21.2	19.5	18.1	16.9	15.9	14.9

Notes:
1. Air temperature rise = (kW x 3413)/(scfm x 1.085).
2. All heaters on constant volume units provide 2 increments of capacity.
3. Air temperature rise in this table are based on heater operating at 415 volts.

Table PD-22a – Electric Heat Air Temperature Rise (Degrees Celsius) (SI)

Heater	L/s										
Input (kW)	3300	3780	4250	4720	5190	5660	6140	6610	7080	7550	8020
26.9	6.8	5.9	5.3	4.7	4.3	4.0	—	—	—	—	—
40.4	10.2	8.9	7.9	7.1	6.5	5.9	5.5	5.1	4.8	4.5	4.2
53.8	13.6	11.9	10.5	9.5	8.6	7.9	7.3	6.8	6.3	5.9	5.6
67.3	17.0	14.8	13.2	11.9	10.8	9.9	9.1	8.5	7.9	7.4	7.0
80.7	—	—	—	14.2	13.0	11.9	11.0	10.2	9.5	8.9	8.4

Notes:
1. Air temperature rise in this table are based on heater operating at 415 volts.
2. All heaters on constant volume units provide 2 increments of capacity.

Table PD-23 – Available Electric Heat kW Ranges

Nominal Unit Size Tons	Nominal Voltage (V)	
	380	415
22.9	23-56	27-67
25.0	23-56	27-67
29.2	23-56	27-67
33.3	34-68	40-81
42.7	34-68	40-81

Notes:
1. kW ranges in this table are based on heater operating at nominal voltages 380 or 415.

Table PD-24 – Natural Gas Heating Capacities

Tons	Unit Model No.	Heat Input MBh (kW) (See Note 1)	Heating Output MBh (kW) (See Note 1)	Air Temp. Rise, °F (°C)
22.9-29.2	YCD/YCH275**L YCD/YCH300**L YCD/YCH350**L	290,000 (85)	243,000 (69)	10-40 (-12.2 , 4.4)
22.9-29.2	YCD/YCH275**H YCD/YCH300**H YCD/YCH350**H	500,000 (147)	405,000 (119)	25-55 (-3.9 , 12.8)
33.3-42.7	YCD/YCH400**L YCD/YCH500**L	335,000 (98)	271,350 (80)	5-35 (-15 , 1.6)
33.3-42.7	YCD/YCH400**H YCD/YCH500**H	670,000 (196)	542,700 (159)	20-50 (-6.7 , 10)

Note:
1. Total heating capacity.

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Table PD-25 – Supply Fan Performance – 23-29 Ton (I-P)

	Static Pressure (in. wg)																	
	0.25		0.50		0.75		1.00		1.25		1.50		1.75		2.00		2.25	
scfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
6670	283	0.80	351	1.18	410	1.58	469	2.08	524	2.63	573	3.20	617	3.78	659	4.37	696	4.96
7085	291	0.90	358	1.31	413	1.70	469	2.21	524	2.78	574	3.37	619	3.98	660	4.59	698	5.22
7500	299	1.02	364	1.43	418	1.86	472	2.35	524	2.92	574	3.55	619	4.18	661	4.82	699	5.46
7915	306	1.14	371	1.58	425	2.05	475	2.51	524	3.08	574	3.72	620	4.38	661	5.04	701	5.73
8330	313	1.27	378	1.75	433	2.25	478	2.69	527	3.26	574	3.89	620	4.58	662	5.27	702	5.99
8745	321	1.42	386	1.93	439	2.43	484	2.92	530	3.45	574	4.08	620	4.79	663	5.51	702	6.24
9160	330	1.58	394	2.12	445	2.62	492	3.18	533	3.67	577	4.30	620	4.99	664	5.74	703	6.50
9575	339	1.76	403	2.32	452	2.84	499	3.44	538	3.93	580	4.53	622	5.22	663	5.96	703	6.76
9990	349	1.95	411	2.54	459	3.08	505	3.68	545	4.24	583	4.80	624	5.49	663	6.21	703	7.02
10405	360	2.17	419	2.77	467	3.34	511	3.92	552	4.57	588	5.09	628	5.77	665	6.49	703	7.28
10820	371	2.41	426	3.00	475	3.62	518	4.20	560	4.90	595	5.46	631	6.07	668	6.80	705	7.59
11235	383	2.66	434	3.25	483	3.90	525	4.50	566	5.19	603	5.85	634	6.41	671	7.13	707	7.90
11650	394	2.93	441	3.51	492	4.21	532	4.83	572	5.51	610	6.25	642	6.84	675	7.50	710	8.26
12065	405	3.23	449	3.79	500	4.53	540	5.18	578	5.83	616	6.61	649	7.30	680	7.90	714	8.67

Table PD-25 – Supply Fan Performance – 23-29 Ton (I-P) Continued

	Static Pressure (in. wg)					
	2.50		2.75		3.00	
scfm	rpm	bhp	rpm	bhp	rpm	bhp
6670	733	5.60	767	6.23	800	6.88
7085	735	5.86	769	6.52	802	7.18
7500	736	6.13	771	6.82	803	7.49
7915	737	6.40	772	7.10	806	7.83
8330	739	6.70	773	7.41	807	8.16
8745	740	6.99	775	7.73	808	8.49
9160	740	7.25	776	8.06	809	8.83
9575	740	7.54	777	8.38	810	9.17
9990	741	7.83	776	8.65	811	9.51
10405	742	8.14	777	8.99	812	9.86
10820	741	8.41	777	9.31	812	10.21
11235	742	8.74	778	9.63	812	10.55
11650	745	9.11	778	9.96	812	10.89
12065	747	9.47	779	10.34	811	11.24

Table PD-25a – Supply Fan Performance – 82-105 kW (SI)

	Static Pressure (Pascals)																	
	62.9		124.1		186.2		248.3		310.4		372.5		434.6		496.7		558.8	
(L/s)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)
3148	283	0.59	351	0.88	410	1.17	469	1.55	524	1.96	573	2.39	617	2.82	659	3.26	696	3.70
3344	291	0.67	358	0.98	413	1.27	469	1.65	524	2.07	574	2.52	619	2.97	660	3.42	698	3.89
3539	299	0.76	364	1.07	418	1.39	472	1.75	524	2.18	574	2.64	619	3.12	661	3.59	699	4.07
3735	306	0.85	371	1.18	425	1.53	475	1.87	524	2.29	574	2.77	620	3.26	661	3.76	701	4.27
3931	313	0.95	378	1.30	433	1.68	478	2.01	527	2.43	574	2.90	620	3.41	662	3.93	702	4.46
4127	321	1.06	386	1.44	439	1.81	484	2.18	530	2.58	574	3.04	620	3.57	663	4.11	702	4.65
4323	330	1.18	394	1.58	445	1.95	492	2.37	533	2.74	577	3.21	620	3.72	664	4.28	703	4.84
4519	339	1.31	403	1.73	452	2.12	499	2.56	538	2.93	580	3.38	622	3.89	663	4.45	703	5.04
4715	349	1.45	411	1.89	459	2.30	505	2.74	545	3.17	583	3.58	624	4.09	663	4.63	703	5.23
4910	360	1.62	419	2.06	467	2.49	511	2.93	552	3.40	588	3.79	628	4.31	665	4.84	703	5.43
5106	371	1.80	426	2.24	475	2.70	518	3.13	560	3.65	595	4.07	631	4.53	668	5.07	705	5.66
5302	383	1.98	434	2.42	483	2.91	525	3.36	566	3.87	603	4.37	634	4.78	671	5.32	707	5.89
5498	394	2.19	441	2.62	492	3.14	532	3.60	572	4.11	610	4.66	642	5.10	675	5.59	710	6.16
5694	405	2.41	449	2.83	500	3.38	540	3.87	578	4.35	616	4.93	649	5.44	680	5.89	714	6.46

Notes:
1. Supply fan performance table includes internal resistance of rooftop. For total static pressure determination, system external static must be added to appropriate component static pressure drops, (evaporator coil, filters, optional economizer, optional heating system, optional roof curb).
2. The pressure drops from the supply fan to the space should not exceed 2.25" (558.8 Pa) positive.
3. Maximum air flow 23 ton (80 kW) is 4756 L/s, 25 ton is 5190 L/s, 29 ton is 5663 L/s
4. Maximum motor kW for 23 ton unit is 7.5 (10 hp), 25 ton is 7.5 kW (10 hp), 29 ton is 11.2 kW (15 hp).

Continued on the following page.

Figure PD-4 — Supply Fan Performance — 23-29 Ton

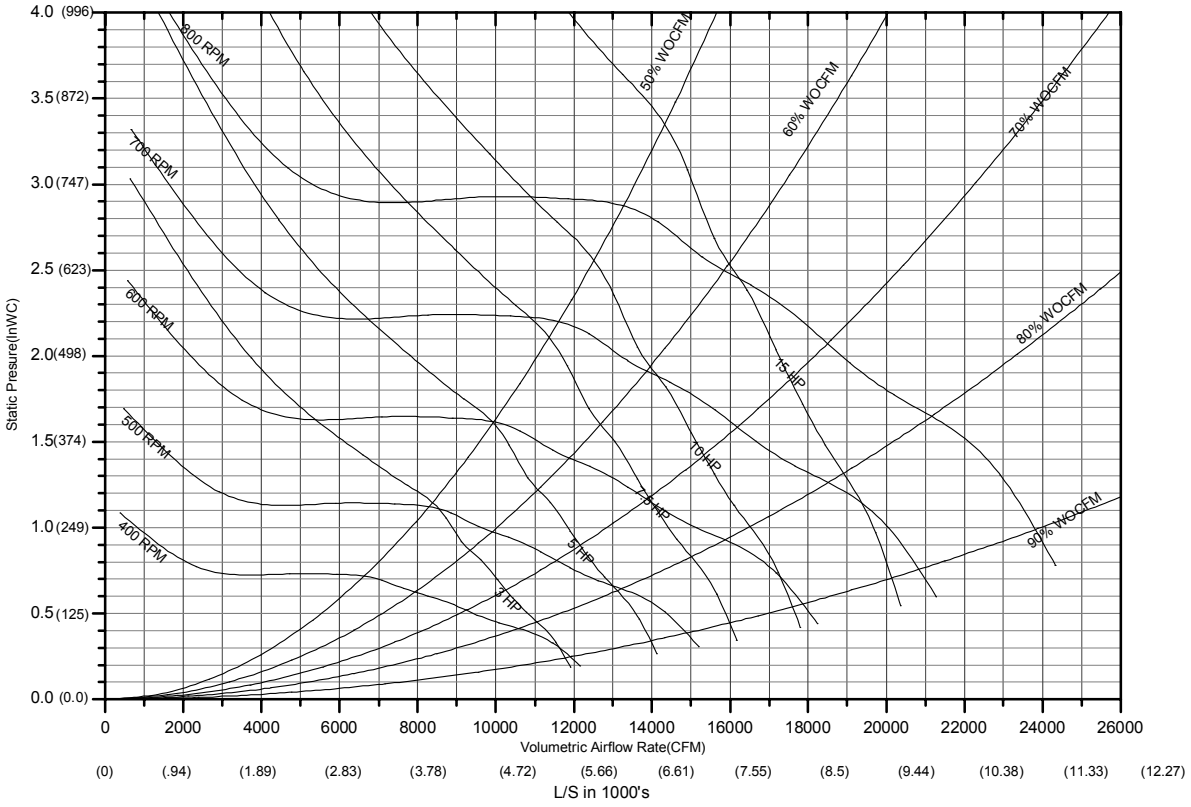


Table PD-25a – Supply Fan Performance – 23-29 Ton kW (SI) Continued

	Static Pressure (Pascals)					
	620.9		683.0		745.1	
(L/s)	rpm	(kW)	rpm	(kW)	rpm	(kW)
3148	733	4.18	767	4.65	800	5.13
3344	735	4.37	769	4.86	802	5.36
3539	736	4.57	771	5.08	803	5.58
3735	737	4.77	772	5.29	806	5.84
3931	739	5.00	773	5.53	807	6.08
4127	740	5.21	775	5.76	808	6.33
4323	740	5.41	776	6.01	809	6.58
4519	740	5.62	777	6.25	810	6.84
4715	741	5.84	776	6.45	811	7.09
4910	742	6.07	777	6.70	812	7.35
5106	741	6.27	777	6.94	812	7.62
5302	742	6.52	778	7.18	812	7.87
5498	745	6.79	778	7.43	812	8.12
5694	747	7.06	779	7.71	811	8.38

Performance Data 50 Hz

Table PD-26 – Supply Fan Performance – 33 and 42 Ton (I-P)

	Static Pressure (in. wg)																			
	0.25		0.50		0.75		1.00		1.25		1.50		1.75		2.00		2.25		2.50	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
9996	273	1.46	324	1.95	372	2.49	417	3.04	458	3.64	495	4.25	535	4.92	572	5.59	605	6.23	636	6.90
10829	287	1.78	336	2.30	383	2.87	422	3.44	464	4.06	501	4.71	535	5.38	572	6.11	606	6.81	638	7.53
11662	301	2.14	348	2.69	390	3.27	432	3.91	469	4.53	506	5.21	541	5.91	573	6.64	607	7.41	639	8.17
12495	315	2.53	360	3.12	401	3.74	442	4.41	476	5.07	512	5.76	546	6.49	578	7.24	609	8.03	639	8.82
13328	329	2.96	373	3.60	412	4.27	450	4.94	486	5.67	518	6.38	551	7.12	584	7.91	614	8.71	642	9.52
14161	344	3.45	387	4.14	424	4.85	459	5.55	495	6.31	527	7.08	557	7.83	589	8.62	619	9.45	648	10.31
14994	358	3.99	401	4.77	437	5.48	470	6.23	503	6.98	538	7.83	565	8.61	594	9.41	625	10.27	653	11.13
15827	373	4.58	415	5.45	449	6.17	482	6.98	513	7.75	546	8.61	576	9.46	602	10.30	630	11.14	659	12.04
16660	388	5.24	429	6.19	463	6.93	495	7.78	525	8.61	554	9.43	586	10.36	613	11.26	637	12.13	664	13.04

Table PD-26 – Supply Fan Performance – 33 and 42 Ton (I-P) Continued

	Static Pressure (in. wg)							
	2.75		3.00		3.25		3.50	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
9996	665	7.63	691	8.35	717	9.10	743	9.87
10829	669	8.24	697	8.99	722	9.77	748	10.57
11662	671	8.97	699	9.73	727	10.47	751	11.26
12495	670	9.66	700	10.49	728	11.33	755	12.13
13328	671	10.38	700	11.27	729	12.17	756	13.04
14161	674	11.16	702	12.08	730	13.01	757	13.96
14994	680	12.03	706	12.96	731	13.87	757	14.88
15827	686	12.99	711	13.92	737	14.90	761	15.87
16660	691	13.97	717	14.94	742	15.96	765	16.94

Table PD-26a – Supply Fan Performance – 105-148 kW (SI)

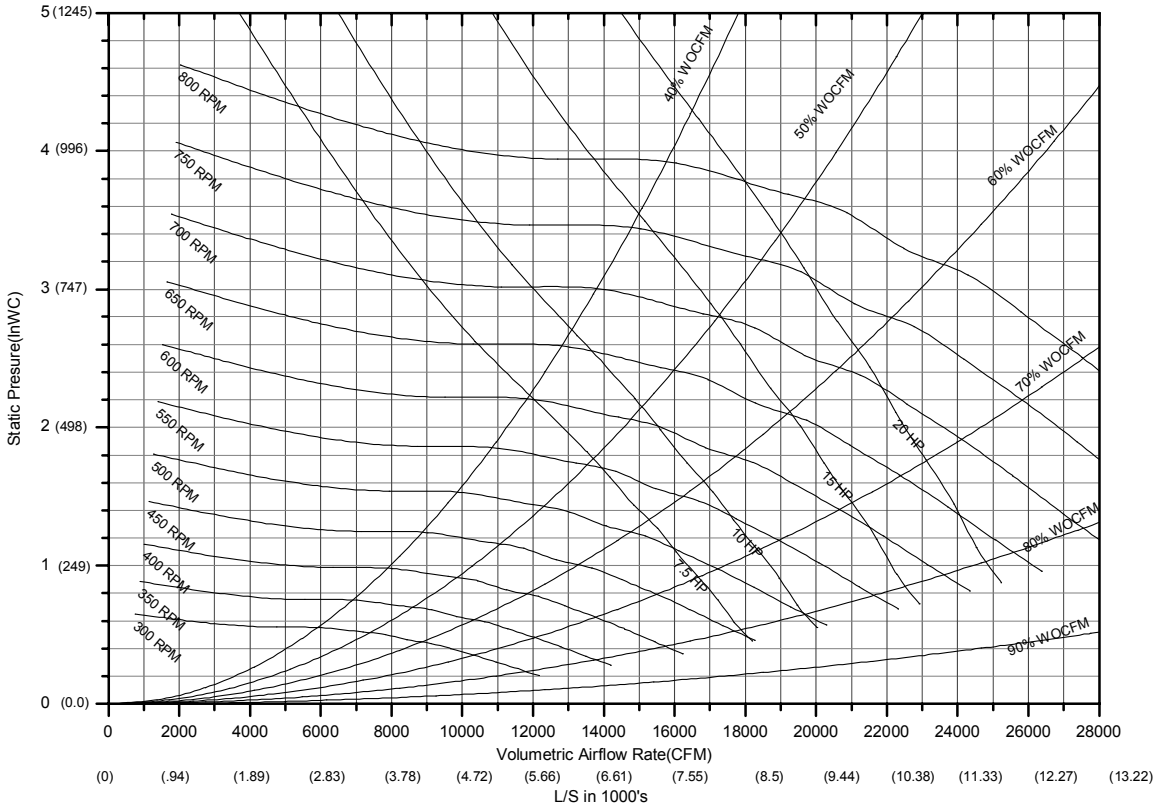
	Static Pressure (Pascals)																			
	62.1		124,2		186.3		248.1		310.4		372.5		434.6		496.7		558.8		620.9	
(L/s)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)
4717	273	1.09	324	1.46	372	1.86	417	2.27	458	2.72	495	3.17	535	3.67	572	4.17	605	4.64	636	5.14
5111	287	1.33	336	1.72	383	2.14	422	2.57	464	3.03	501	3.51	535	4.01	572	4.55	606	5.08	638	5.62
5504	301	1.59	348	2.00	390	2.44	432	2.91	469	3.38	506	3.88	541	4.41	573	4.95	607	5.52	639	6.09
5897	315	1.88	360	2.33	401	2.79	442	3.29	476	3.78	512	4.30	546	4.84	578	5.40	609	5.99	639	6.57
6290	329	2.21	373	2.68	412	3.19	450	3.69	486	4.23	518	4.76	551	5.31	584	5.90	614	6.49	642	7.10
6683	344	2.57	387	3.09	424	3.62	459	4.14	495	4.70	527	5.28	557	5.84	589	6.43	619	7.05	648	7.69
7076	358	2.97	401	3.56	437	4.09	470	4.65	503	5.21	538	5.84	565	6.42	594	7.02	625	7.66	653	8.30
7469	373	3.42	415	4.07	449	4.60	482	5.20	513	5.78	546	6.42	576	7.06	602	7.68	630	8.31	659	8.98
7862	388	3.91	429	4.61	463	5.17	495	5.80	525	6.42	554	7.03	586	7.73	613	8.40	637	9.05	664	9.72

Table PD-26a – Supply Fan Performance – 105-148 kW (SI) Continued

	Static Pressure (Pascals)							
	683.0		745.1		807.2		869.3	
(L/s)	rpm	(kW)	rpm	(kW)	rpm	(kW)	rpm	(kW)
4717	665	5.69	691	6.22	717	6.78	743	7.36
5111	669	6.14	697	6.70	722	7.28	748	7.88
5504	671	6.69	699	7.25	727	7.81	751	8.40
5897	670	7.20	700	7.83	728	8.45	755	9.05
6290	671	7.74	700	8.41	729	9.07	756	9.72
6683	674	8.32	702	9.01	730	9.71	757	10.41
7076	680	8.97	706	9.66	731	10.35	757	11.10
7469	686	9.69	711	10.38	737	11.11	761	11.84
7862	691	10.42	717	11.14	742	11.90	765	12.63

Notes:
1. Supply fan performance table includes internal resistance of rooftop. For total static pressure determination, system external static must be added to appropriate component static pressure drops, (evaporator coil, filters, optional economizer, optional heating system, optional roof curb).
2. The pressure drops from the supply fan to the space should not exceed 2.5" wg (620.9 Pa) positive.
3. Max cfm for 33 ton unit 6825 L/s, 42 ton -7860 L/s
4. Max motor hp for 33 ton unit-11.2 kW (15 hp), 42 ton 14.9 kW (20 hp)

Figure PD-5 – Supply Fan Performance – 33 and 42 Ton (I-P)



Performance Data 50 Hz

Table PD-27 – Component Static Pressure Drops — in. wg (I-P)

Nominal Std Tons (kW)	CFM Std Air	Heating System				ID Coil		Filters			Inlet Guide Vanes	Economizer
		Gas Heat		Electric Heat				Throwaway	High Eff. Filters			
		Low	High	1 Element	2 Element	Dry	Wet	2"	2"	4"		
	6670	0.07	0.05	0.04	0.05	0.07	0.09	0.05	0.08	0.07	0.04	0.331
	7500	0.08	0.07	0.06	0.06	0.08	0.1	0.07	0.11	0.1	0.06	0.04
23 (80)	8330	0.1	0.08	0.07	0.08	0.09	0.12	0.08	0.13	0.12	0.07	0.049
	9170	0.13	0.1	0.08	0.09	0.12	0.14	0.09	0.15	0.14	0.08	0.059
	10000	0.15	0.12	0.1	0.11	0.13	0.17	0.11	0.18	0.16	0.1	0.07
	7500	0.08	0.07	0.06	0.06	0.08	0.1	0.07	0.11	0.1	0.06	0.04
	8330	0.1	0.08	0.07	0.08	0.09	0.12	0.08	0.13	0.12	0.07	0.049
25 (88)	9170	0.13	0.1	0.08	0.09	0.12	0.14	0.09	0.15	0.14	0.08	0.059
	10000	0.15	0.12	0.1	0.11	0.13	0.17	0.11	0.18	0.17	0.12	0.07
	8750	0.11	0.09	0.08	0.08	0.16	0.2	0.09	0.15	0.13	0.08	0.054
29 (103)	9580	0.14	0.11	0.09	0.1	0.18	0.23	0.1	0.17	0.16	0.11	0.065
	11200	0.19	0.15	0.13	0.14	0.24	0.3	0.12	0.21	0.19	0.13	0.077
	12100	0.22	0.17	0.15	0.16	0.27	0.33	0.13	0.22	0.21	0.15	0.091
	10000	0.01	0.03	0.07	0.11	0.15	0.19	0.11	0.18	0.16	0.03	70
	10800	0.01	0.03	0.08	0.13	0.17	0.22	0.12	0.21	0.18	0.04	0.076
	11700	0.01	0.04	0.1	0.15	0.2	0.24	0.13	0.23	0.2	0.04	0.085
33 (118)	12500	0.01	0.04	0.11	0.17	0.22	0.27	0.14	0.26	0.23	0.05	0.096
	13300	0.02	0.05	0.12	0.19	0.24	0.3	0.15	0.28	0.25	0.06	0.107
	14200	0.02	0.06	0.14	0.22	0.27	0.33	0.17	0.32	0.28	0.07	0.12
	12500	0.01	0.04	0.11	0.17	0.29	0.36	0.14	0.26	0.23	0.05	0.095
	13300	0.02	0.05	0.12	0.19	0.32	0.4	0.15	0.28	0.25	0.06	0.108
42 (146)	14200	0.02	0.06	0.16	0.24	0.36	0.44	0.17	0.34	0.29	0.07	0.12
	15800	0.02	0.07	0.18	0.27	0.42	0.53	0.19	0.38	0.34	0.08	0.136
	16700	0.03	0.08	0.2	0.3	0.46	0.57	0.2	0.41	0.36	0.09	0.155

Note:
1. Static pressure drops of accessory components must be added to external static pressure to enter fan performance tables.

Performance Data 50 Hz

Table PD-27a – Component Static Pressure Drops — Pa (SI)

Nominal Std Tons (kW)	L/s Std Air	Heating System				ID Coil		Filters			Inlet Guide Vanes	Economizer
		Gas Heat		Electric Heat				Throwaway	High Eff. Filters			
		Low	High	1 Element	2 Element	Dry	Wet	Adder	50 mm	100 mm		
80 (23)	3150	17	13	11	12	17	22	12	19	17	11	0.05
	3540	21	16	14	15	19	24	17	26	24	14	0.07
	3930	26	20	17	19	22	29	19	31	29	17	0.08
	4320	31	24	21	23	29	34	22	36	34	21	0.1
	4720	37	29	25	27	31	41	26	43	38	25	0.12
88 (25)	3540	21	16	14	15	19	24	17	26	24	14	0.07
	3930	26	20	17	19	22	29	19	31	29	17	0.08
	4320	31	24	21	23	29	34	22	36	34	25	0.12
	5120	44	34	29	32	31	41	26	43	41	29	0.14
103 (29)	4130	29	22	19	21	38	48	22	36	31	19	0.09
	4520	34	27	23	25	43	55	24	41	38	23	0.11
	4920	41	32	27	29	58	72	29	50	46	27	0.13
	5310	47	37	32	34	65	79	31	53	50	32	0.15
118 (33)	4720	2	7	18	27	36	46	26	43	38	8	0.12
	5120	3	8	21	32	41	53	29	50	43	10	0.14
	5510	3	10	24	37	48	58	31	55	48	11	0.16
	5900	4	11	27	42	53	65	34	62	55	13	0.18
	6290	4	12	31	48	58	72	36	67	60	15	0.21
	6680	5	14	35	54	65	79	41	77	67	16	0.24
146 (42)	5900	4	11	27	42	70	86	34	62	55	13	0.18
	6290	4	12	31	48	77	96	36	67	60	15	0.21
	6680	5	14	35	54	86	106	41	82	72	16	0.24
	7070	5	16	39	60	101	127	46	91	82	18	0.27
	7470	6	18	44	67	110	137	48	98	86	21	0.3

Note:
1. Static pressure drops of accessory components must be added to external static pressure to enter fan performance tables.

Performance Data 50 Hz

Table PD-28 – Supply Air Fan Drive Selections

Nominal Tons (kW)	5 hp rpm	5 hp Drive No	7.5 hp rpm	7.5 hp Drive No	10 hp rpm	10 hp Drive No	15 hp rpm	15 hp Drive No
23 (80)	458	A						
	500	B						
	541	C						
	583		583	D				
	625		625*	E				
25 (88)	458	A						
	500	B						
	541	C						
	583		583	D				
	625		625	E				
29 (103)	500	B						
	541		541	C				
	583		583	D				
	658				658**	F		
	664				664*	G		
33 (118)	417		417	H				
	437		437	J				
	479		479	K				
	521				521	L		
	562				562	M		
	604				604	N		
42 (146)	437		437	J				
	479		479	K				
	521				521	L		
	562				562	M		
	604						604	N

Note:
*For YC gas/electrics only.
**For TC and TE Cooling only and with electric Heat units only.

Table PD-29 – Power Exhaust Fan Performance (I-P)

Exhaust Airflow (cfm)	External Static Pressure – Inches of Water: High Speed ESP	Med Speed ESP	Low Speed ESP
1000	0.800	–	–
1500	0.780	–	–
2000	0.750	–	0.400
2500	0.720	–	0.380
3000	0.680	–	0.370
3500	0.650	0.420	0.360
4000	0.610	0.380	0.340
4500	0.560	0.360	0.320
5000	0.520	0.330	0.300
5500	0.460	0.310	0.280
6000	0.420	0.290	0.250
6500	0.360	0.270	0.230
7000	0.310	0.240	0.190
7500	0.250	0.200	0.150
8000	0.200	0.160	0.120
8500	0.150	0.120	0.070
9000	0.100	0.060	0.000
9500	0.040	0.000	–
10000	0.000	–	–

Table PD-29a – Power Exhaust Fan Performance (SI)

Exhaust Airflow (L/s)	External Static Pressure – Pa: High Speed ESP	Med Speed ESP	Low Speed ESP
470	199.3	–	–
710	194.3	–	–
940	186.8	–	99.6
1180	179.4	–	94.7
1420	169.4	–	92.2
1650	161.9	104.6	89.7
1890	152.0	94.7	84.7
2120	139.5	89.7	79.7
2360	129.5	82.2	74.7
2600	114.6	77.2	69.7
2830	104.6	72.2	62.3
3070	89.7	67.3	57.3
3300	77.2	59.8	47.3
3540	62.3	49.8	37.4
3780	49.8	39.9	29.9
4010	37.4	29.9	17.4
4250	24.9	14.9	0.0
4480	10.0	0.0	–
4720	0.0	–	–

Notes:
1. Performance in table is with both motors operating.
2. High speed = both motors on high speed. Medium speed is one motor on high speed and one on low speed. Low speed is both motors on low speed.
3. Power Exhaust option is not to be applied on systems that have more return air static pressure drop than the maximum shown in the table for each motor speed tap.

Controls

VAV Units Only

Sequence of Operation

1

Supply Air Pressure Control

Inlet Guide Vane Control

Inlet guide vanes are driven by a modulating 2-10 vdc signal from the VAV Module. A pressure transducer measures duct static pressure, and the inlet guide vanes are modulated to maintain the supply air static pressure within an adjustable user-defined range. The range is determined by the supply air pressure setpoint and supply air pressure deadband, which are set through a unit mounted potentiometer.

Inlet guide vane assemblies installed on the supply fan inlets regulate fan capacity and limit horsepower at lower system air requirements. When in any position other than full open, the vanes pre-spin intake air in the same direction as supply fan rotation. As the vanes approach the full-closed position, the amount of "spin" induced by the vanes increases at the same time that intake airflow and fan horsepower diminish. The inlet guide vanes will close when the supply fan is shut down.

Supply Air Static Pressure Limit

The opening of the inlet guide vanes and VAV boxes are coordinated, with respect to time, during unit start up and transition to/from Occupied/Unoccupied modes to prevent overpressurization of the supply air ductwork. However, if for any reason the supply air pressure exceeds the fixed supply air static pressure limit of 3.5" W.C., the supply fan is shut down and the inlet guide vanes are closed. The unit is then allowed to restart three times. If the overpressurization condition occurs on the fourth time, the unit is shut down and a manual reset diagnostic is set and displayed at any of the remote panels with LED status lights or communicated to the Integrated Comfort system.

Variable Frequency Drives (VFD) Control

Variable frequency drives are driven by a modulating 2-10 vdc signal from the VAV module. A pressure transducer measures duct static pressure, and the VFD is modulated to maintain the supply air static pressure within an adjustable user-defined range. The range is determined by the supply air pressure setpoint and supply air pressure deadband, which are set through a unit mounted potentiometer. Variable frequency drives provide supply fan motor speed modulation. The drive will accelerate or decelerate as required to maintain the supply static pressure setpoint. When subjected to high ambient return conditions the VFD shall reduce its output frequency to maintain operation. Bypass control is offered to provide full nominal airflow in the event of drive failure.

2

Supply Air Temperature Controls

Cooling/Economizer

During occupied cooling mode of operation, the economizer (if available) and primary cooling are used to control the supply air temperature. The supply air temperature setpoint is user-defined at the unit mounted VAV Setpoint Potentiometer or at the remote panel. If the enthalpy of the outside air is appropriate to use "free cooling," the economizer will be used first to attempt to satisfy the supply setpoint.

On units with economizer, a call for cooling will modulate the fresh air dampers open. The rate of economizer modulation is based on deviation of the discharge temperature from setpoint, i.e., the further away from setpoint, the faster the fresh air damper will open. Note that the economizer is only allowed to function freely if ambient conditions are below the enthalpy control setting or below the return air enthalpy if unit has comparative enthalpy installed. If outside air is not suitable for "economizing," the fresh air dampers drive to the minimum open position. A field adjustable potentiometer on the Economizer Actuator, Tracer™, or a remote potentiometer can provide the input to establish the minimum damper position.

At outdoor air conditions above the enthalpy control setting, primary cooling only is used and the fresh air dampers remain at minimum position.

If the unit does not include an economizer, primary cooling only is used to satisfy cooling requirements.

Supply Air Setpoint Reset

Supply air reset can be used to adjust the supply air temperature setpoint on the basis of a zone temperature, return air temperature, or on outdoor air temperature. Supply air reset adjustment is available on the unit mounted VAV Setpoint Potentiometer for supply air cooling control.

a

Reset Based on Outdoor Air Temperature

Outdoor air cooling reset is sometimes used in applications where the outdoor temperature has a large effect on building load. When the outside air temperature is low and the building cooling load is low, the supply air setpoint can be raised, thereby preventing subcooling of critical zones. This reset can lower usage of primary cooling and result in a reduction in primary cooling energy usage.

There are two user-defined parameters that are adjustable through the VAV Setpoint Potentiometer: reset temperature setpoint and reset amount. The amount of reset applied is dependent upon how far the outdoor air temperature is below the supply air reset setpoint. The amount is zero where they are equal and increases linearly toward the value set at the reset amount input. The maximum value is 20 F. If the outdoor

Controls

air temperature is more than 20 F below the reset temperature setpoint the amount of reset is equal to the reset amount setpoint.

b

Reset Based On Zone Or Return Temperature

Zone or return reset is applied to the zone(s) in a building that tend to overcool or overheat. The supply air temperature setpoint is adjusted based on the temperature of the critical zone(s) or the return air temperature. This can have the effect of improving comfort and/or lowering energy usage. The user-defined parameters are the same as for outdoor air reset.

Logic for zone or return reset control is the same except that the origins of the temperature inputs are the zone sensor or return sensor respectively. The amount of reset applied is dependent upon how far the zone or return air temperature is below the supply air reset setpoint. The amount is zero where they are equal and increases linearly toward the value set at the reset amount potentiometer on the VAV Setpoint potentiometer. The maximum value is 3 F. If the return or zone temperature is more than 3 F below the reset temperature setpoint the amount of reset is equal to the reset amount setpoint.

3

Zone Temperature Control

Unoccupied Zone Heating and Cooling

During Unoccupied mode, the unit is operated as a CV unit. Inlet guide vanes and VAV boxes are driven full open. The unit controls zone temperature to the Unoccupied zone cooling and heating (heating units only) setpoints.

Daytime Warm-up

During occupied mode, if the zone temperature falls to a temperature three degrees below the Morning Warm-up setpoint, Daytime Warm-up is initiated. The system changes to CV heating (full unit airflow), the VAV boxes are fully opened and the CV heating algorithm is in control until the Morning Warm-up setpoint is reached. The unit is then returned to VAV cooling mode. The Morning Warm-up setpoint is set at the unit mounted VAV Setpoint potentiometer or at a remote panel.

Morning Warm-up (MWU)

Morning warm-up control (MWU) is activated whenever the unit switches from unoccupied to occupied and the zone temperature is at least 1.5 F below the MWU setpoint. When MWU is activated the VAV box output will be energized for at least 6 minutes to drive all boxes open, the inlet guide vanes are driven full open, and all stages of heat (gas or electric) are energized. When MWU is activated the economizer damper is driven fully closed. When the zone temperature meets or exceeds the MWU setpoint minus 1.5 F, the heat will be staged down. When the zone temperature meets or exceeds the MWU setpoint then MWU will be terminated and the unit will switch over to VAV cooling.

CV Units Only

Sequence of Operation

1

Occupied Zone Temperature Control

Cooling/Economizer

During occupied cooling mode, the economizer (if provided) and primary cooling are used to control zone temperature. If the enthalpy of outside air is appropriate to use "free cooling", the economizer will be used first to attempt to satisfy the cooling zone temperature setpoint; then primary cooling will be staged up as necessary.

On units with economizer, a call for cooling will modulate the fresh air dampers open. The rate of economizer modulation is based on deviation of the zone temperature from setpoint, i.e., the further away from setpoint, the faster the fresh air damper will open. First stage of cooling will be allowed to start after the economizer reaches full open.

Note that the economizer is allowed to function freely only if ambient conditions are below the enthalpy control setting or below the return air enthalpy if unit has comparative enthalpy. If outside air is not suitable for "economizing," the fresh air dampers drive to the minimum open position. A field adjustable potentiometer on the Economizer Actuator, Tracer or a remote potentiometer can provide the input to establish the minimum damper position.

At outdoor air temperatures above the enthalpy control setting, primary cooling only is used and the outdoor air dampers remain at minimum position.

If the unit does not include an economizer, primary cooling only is used to satisfy cooling requirements.

Heating

Gas Heating

When heating is required the RTRM initiates the heating cycle through the ignition control module(s) (IGN). The IGN relay brings on the combustion fan motor. The ignition control module(s) begin the ignition process by preheating the hot surface ignitor(s). After the hot surface ignitor is preheated the gas valve is opened to ignite first stage. If ignition does not take place the IGN(s) will attempt to ignite 2 more times before locking out. When ignition does occur the hot surface ignitor is deenergized and then functions as a flame sensor. The RTRM will energize the supply fan contactor 45 seconds after the initiation of the heat cycle. If more capacity is needed to satisfy the heating setpoint, the RTRM will call for the second stage of heat by driving the combustion blower motor to high speed.

When the space temperature rises above the heating setpoint, the RTRM terminates the heat cycle.

Electric Heating

When heat is required, the RTRM initiates first stage heating by energizing the first stage electric heat contactor. The first stage electric heater bank(s) will be energized if the appropriate limits are closed. The RTRM will cycle first stage heat on and off as required to maintain zone temperature. If first stage cannot satisfy the requirement, the RTRM will energize the second stage electric heat contactor(s) if the appropriate limits are

Controls

closed. The RTRM will cycle second stage on and off as required while keeping stage one energized.

The supply fan is energized approximately 1 second before the electric heat contactors. When the space temperature rises above the heating setpoint, the RTRM deenergizes the supply fan and all electric heat contactors.

Supply Air Tempering

This feature is available only with Tracer™ or with systems using programmable zone sensors (CV only with economizer). For gas and electric heat units in the Heat mode but not actively heating, if the supply air temperature drops to 10 F below the occupied zone heating temperature setpoint, one stage of heat will be brought on to maintain a minimum supply air temperature. The heat stage is dropped if the supply air temperature rises to 10 F above the occupied zone heating temperature setpoint.

Auto Changeover

When the System Mode is "Auto," the mode will change to cooling or heating as necessary to satisfy the zone cooling and heating setpoints. The zone cooling and heating setpoints can be as close as 2 F apart.

Unoccupied Zone Temperature Control Cooling and Heating

Both cooling or heating modes can be selected to maintain Unoccupied zone temperature setpoints. For Unoccupied periods, heating or primary cooling operation can be selectively locked out at the remote panels or TRACER.

Conventional Thermostat Interface

Conventional Thermostat Interface (CTI) is a standard part of the RTRM. The CTI will allow only two steps of heating or cooling. The CTI provides zone temperature control only and is mutually exclusive of the Trane Communications Interface (TCI).

Control Sequences of Operation Common to Both VAV and CV Units

Ventilation override (VOM)

Applying 24 volts to one of the three Ventilation Override inputs manually activates ventilation override. One input is provided to request the pressurize mode, the second input to request the purge mode, and the third input to request the exhaust mode.

If more than one mode is requested at the same time, the pressurize request will have priority followed by purge. When any ventilation override mode is active, all heating and cooling is turned off. For the case where the unit is required to turn off, the emergency stop input is used. The ICS can also initiate any ventilation override mode.

Affected Function	Mode and Priority		
	Pressurize	Purge	Exhaust
	1	2	3
Heat/Cool	off	off	off
IGV/VFD	open/full speed	open/full speed	open/full speed
Supply Fan	on	on	off
Exhaust Fan	off	on	on
Economizer	open	open	closed
VAV Boxes	forced open	forced open	normal operation

Controls

Coil Freeze Protection FROSTAT™

The FROSTAT system eliminates the need for hot gas bypass and adds a suction line surface temperature sensor to determine if the coil is in a condition of impending frost. If impending frost is detected primary cooling capacity is shed as necessary to prevent icing. All compressors are turned off after they have met their minimum 3 minute on times. The supply fan is forced on until the FROSTAT device no longer senses a frosting condition or for 60 seconds after the last compressor is shut off, whichever is longer.

Occupied/Unoccupied Switching

There are 3 ways to switch Occupied/ Unoccupied:

1

NSB Panel

2

Electronic time clock or field-supplied contact closure

3

TRACER

Night Setback Sensors

Trane's night setback sensors are programmable with a time clock function that provides communication to the rooftop unit through a 2-wire communications link. The desired transition times are programmed at the night setback sensor and communicated to the unit.

Night setback (unoccupied mode) is operated through the time clock provided in the sensors with night setback. When the time clock switches to night setback operation, the outdoor air dampers close and heating/cooling can be enabled or disabled. As the building load changes, the night setback sensor communicates the need for the rooftop heating/cooling (if enabled) function and the evaporator fan. The rooftop unit will cycle through the evening as heating/cooling (if enabled) is required in the space. When the time clock switches from night setback to occupied mode, all heating/cooling functions begin normal operation.

When using the night setback options with a VAV heating/cooling rooftop, airflow must be maintained through the rooftop unit. This can be accomplished by electrically tying the VAV boxes to the VAV heat relay contacts on the Low voltage terminal board or by using changeover thermostats. Either of these methods will assure adequate airflow through the unit and satisfactory temperature control of the building.

Timed override Activation—ICS

When this function is initiated by pushing the override button on the ICS sensor, TRACER will switch the unit to the occupied mode. Unit operation (occupied mode) during timed override is terminated by a signal from TRACER.

Timed override Activation—Non-ICS

When this function is initiated by the push of an override button on the programmable zone sensor, the unit will switch to the occupied mode. Automatic Cancellation of the Timed override Mode occurs after three hours of operation.

Comparative Enthalpy Control of Economizer

The Economizer Actuator receives inputs from optional return air humidity and temperature sensors and determines whether or not it is feasible to economize. If the outdoor air enthalpy is greater than the return air enthalpy then it is not feasible to economize and the economizer damper will not open past its minimum position.

Fan Failure Switch

The fan failure switch will disable all unit functions and "flash" the Service LED on the zone sensor.

Emergency Stop Input

A binary input is provided on the RTRM for installation of field provided switch or contacts for immediate shutdown of all unit functions. The binary input is brought out to Low Voltage Terminal Board One (LTB1).

Electrical Data

Electrical Service Sizing

To correctly size electrical service wiring for your unit, find the appropriate calculations listed below. Each type of unit has its own set of calculations for MCA (Minimum Circuit Ampacity), MOP (Maximum Overcurrent Protection), and RDE (Recommended Dual Element fuse size). Read the load definitions that follow and then find the appropriate set of calculations based on your unit type.

Set 1 is for cooling only and cooling with gas heat units, and set 2 is for cooling with electric heat units.

Load Definitions: (To determine load values, see the Electrical Service Sizing Data Tables.)

LOAD1 = CURRENT OF THE LARGEST MOTOR (COMPRESSOR OR FAN MOTOR)

LOAD2 = SUM OF THE CURRENTS OF ALL REMAINING MOTORS

LOAD3 = CURRENT OF ELECTRIC HEATERS

LOAD4 = ANY OTHER LOAD RATED AT 1 AMP OR MORE

Set 1. Cooling Only Rooftop Units and Cooling with Gas Heat Rooftop Units

MCA = (1.25 x LOAD1) + LOAD2 + LOAD4

MOP = (2.25 x LOAD1) + LOAD2 + LOAD4

Select a fuse rating equal to the MOP value. If the MOP value does not equal a standard fuse size as listed in NEC 240-6, select the next lower standard fuse rating. NOTE: If selected MOP is less than the MCA, then reselect the lowest standard maximum fuse size which is equal to or larger than the MCA, provided the reselected fuse size does not exceed 800 amps.

RDE = (1.5 x LOAD1) + LOAD2 + LOAD4

Select a fuse rating equal to the RDE value. If the RDE value does not equal a standard fuse size as listed in NEC 240-6, select the next higher standard fuse rating. NOTE: If the selected RDE is greater than the selected MOP value, then reselect the RDE value to equal the MOP value.

(Keep in mind when determining LOADS that crankcase heaters are disabled in the cooling mode).

DSS = 1.15 x (LOAD1 + LOAD2 + LOAD4)

Select a disconnect switch size equal to or larger than the DSS value calculated.

Set 2. Rooftop units with Electric Heat

To arrive at the correct MCA, MOP, and RDE values for these units, you must perform two sets of calculations. First calculate the MCA, MOP, and RDE values as if the unit was in cooling mode (use the equations given in Set 1). Then calculate the MCA, MOP, and RDE values as if the unit was in the heating mode as follows.

(Keep in mind when determining LOADS that the compressors and condenser fans don't run while the unit is in the heating mode and crankcase heaters are disabled in the cooling mode.)

For units using heaters less than 50 kw.

MCA = 1.25 x (LOAD1 + LOAD2 + LOAD4) + (1.25 x LOAD3)

For units using heaters equal to or greater than 50 kw.

MCA = 1.25 x (LOAD1 + LOAD2 + LOAD4) + LOAD3

The nameplate MCA value will be the larger of the cooling mode MCA value or the heating mode MCA value calculated above.

MOP = (2.25 x LOAD1) + LOAD2 + LOAD3 + LOAD4

The selection MOP value will be the larger of the cooling mode MOP value or the heating mode MOP value calculated above.

Select a fuse rating equal to the MOP value. If the MOP value does not equal a standard fuse size as listed in NEC 240-6, select the next lower standard fuse rating. NOTE: If selected MOP is less than the MCA, then reselect the lowest standard maximum fuse size which is equal to or larger than the MCA, provided the reselected fuse size does not exceed 800 amps.

RDE = (1.5 x LOAD1) + LOAD2 + LOAD3 + LOAD4

The selection RDE value will be the larger of the cooling mode RDE value or the heating mode RDE value calculated above.

Select a fuse rating equal to the RDE value. If the RDE value does not equal a standard fuse size as listed in NEC 240-6, select the next higher standard fuse rating. NOTE: If the selected RDE is greater than the selected MOP value, then reselect the RDE value to equal the MOP value.

DSS = 1.15 x (LOAD1 + LOAD2 + LOAD3 + LOAD4)

NOTE: Keep in mind when determining LOADS that the compressors and condenser fans don't run while the unit is in the heating mode.

The selection DSS value will be the larger of the cooling mode DSS or the heating mode DSS calculated above.

Select a disconnect switch size equal to or larger than the DSS value calculated.

Table ED-1 — Electrical Service Sizing Data — Electric Heat Module (Electric Heat Only)

		Models: TED/TEH 330 thru 600 Electric Heat FLA				
Nominal Unit Size (Tons)	Nominal Unit Voltage	KW Heater				
		36	54	72	90	108
		FLA	FLA	FLA	FLA	FLA
27½	208	74.9	112.4	—	—	—
30.0	230	86.6	129.9	—	—	—
35.0	460	43.3	65.0	86.6	108.3	—
	575	—	52.0	69.3	86.6	—
40.0	208	—	112.4	—	—	—
50.0	230	—	129.9	—	—	—
	460	—	65.0	86.6	108.3	129.9
	575	—	52.0	69.3	86.6	103.9

Notes:
1. All FLA in this table are based on heater operating at 208, 240, 480, and 600 volts.

Electrical Data 60 Hz

Table ED-2 — 27½-50 Ton Electrical Service Sizing Data[1]

			Compressor			Fan Motors							
						Supply		Condenser			Exhaust		
Model	Electrical Characteristics	Allowable Voltage Range	No/Ton	RLA (Ea.)	LRA (Ea.)	HP	Standard/ Hi-Efficiency FLA	No.	HP	FLA (Ea.)	No.	HP	FLA (Ea.)
TC/TE/YC*330	208/60/3	187-229	1/10,1/15	41.9/62.8	269/409	7.5	22.3/21.5	3	1.1	7.0	2	1.0	6.7
						10.0	29.7/29.0						
	230/60/3	207-253		41.9/62.8	247/376	7.5	19.6/18.8			7.0			6.7
						10.0	26.4/25.2						
	460/60/3	414-506		18.1/27.3	95/142	7.5	9.8/9.4			3.5			2.9
						10.0	13.2/12.6						
	575/60/3	517-633		14.6/21.8	76/114	7.5	7.8/7.5			2.8			2.3
						10.0	10.3/10.1						
TC/TE/YC*360	208/60/3	187-229	2/15	62.8	409	7.5	22.3/21.5	3	1.1	7.0	2	1.0	6.7
						10.0	29.7/29.0						
	230/60/3	207-253		62.8	376	7.5	19.6/18.8			7.0			6.7
						10.0	26.4/25.2						
	460/60/3	414-506		27.3	142	7.5	9.8/9.4			3.5			2.9
						10.0	13.2/12.6						
	575/60/3	517-633		21.8	114	7.5	7.8/7.5			2.8			2.3
						10.0	10.3/10.1						
TC/TE/YC*420	208/60/3	187-229	2/15	62.8	409	7.5	22.3/21.5	3	1.1	7.0	2	1.0	6.7
						10.0	29.7/29.0						
						15.0	44.4/41.5						
	230/60/3	207-253		62.8	376	7.5	19.6/18.8			7.0			6.7
						10.0	26.4/25.2						
						15.0	38.6/36.0						
	460/60/3	414-506		27.3	142	7.5	9.8/9.4			3.5			2.9
						10.0	13.2/12.6						
						15.0	19.3/18.0						
	575/60/3	517-633		21.8	114	7.5	7.8/7.5			2.8			2.3
						10.0	10.3/10.1						
						15.0	15.4/14.5						
TC/TE/YC*480	208/60/3	187-229	2/15,1/10	62.8/62.8/41.9	409/409/269	10.0	29.7/29.0	4	1.1	7.0	2	1.0	6.7
						15.0	44.4/41.5						
	230/60/3	207-253		62.8/62.8/41.9	376/376/247	10.0	26.4/25.2			7.0			6.7
						15.0	38.6/36.0						
	460/60/3	414-506		27.3/27.3/18.1	142/142/95	10.0	13.2/12.6			3.5			2.9
						15.0	19.3/18.0						
	575/60/3	517-633		21.8/21.8/14.6	114/114/76	10.0	10.3/10.1			2.8			2.3
						15.0	15.4/14.5						
TC/TE/YC*600	208/60/3	187-229	3/15	62.8	409	10.0	29.7/29.0	4	1.1	7.0	2	1.0	6.7
						15.0	44.4/41.5						
						20.0	58.7/56.1						
	230/60/3	207-253		62.8	376	10.0	26.4/25.2			7.0			6.7
						15.0	38.6/36.0						
						20.0	51.0/49.4						
	460/60/3	414-506		27.3	142	10.0	13.2/12.6			3.5			2.9
						15.0	19.3/18.0						
						20.0	25.5/24.7						
	575/60/3	517-633		21.8	114	10.0	10.3/10.1			2.8			2.3
						15.0	15.4/14.5						
						20.0	20.4/19.6						

Notes:
1. All customer wiring and devices must be installed in accordance with local and national electrical codes.

Table ED-3 — Electrical Service Sizing Data — Crankcase Heaters — Heating Mode Only)

Nominal Unit Size (Tons)	FLA Add Unit Voltage 200	230	460	575
27½ - 35	2	2	1	1
40, 50	3	3	2	2

Electrical Data 50 Hz

Table ED-4 – Electrical Service Sizing Data

Model	Electrical[2] Characteristics	Compressor No/Ton	Compressor RLA (Ea.)	Compressor LRA (Ea.)	Fan Motors Supply HP	Fan Motors Supply FLA	Fan Motors Condenser No.	Fan Motors Condenser HP	Fan Motors Condenser FLA (Ea.)	Fan Motors Exhaust No.	Fan Motors Exhaust HP	Fan Motors Exhaust FLA (Ea.)	MCA*	Max. Fuse Size
TC/TE/YC*275	380-415/50/3	1/10, 1/15	18.1/27.3	110/174	5	13.1	3	.75	4.4	2	.75	2.9	79	100
TC/TE/YC*305	380-415/50/3	2/15	27.3	174	5	13.1	3	.75	4.4	2	.75	2.9	93	110
TC/TE/YC*350	380-415/50/3	2/15	27.3	174	5	13.1	3	.75	4.4	2	.75	2.9	93	110
TC/TE/YC*400	380-415/50/3	2/15, 1/10	27.3 18.1	174 110	7.5	16.6	4	.75	4.4	2	.75	2.9	119	125
TC/TE/YC*500	380-415/50/3	3/15	27.3	174	7.5	16.6	4	.75	4.4	2	.75	2.9	128	150

Notes:
1. All customer wiring and devices must be installed in accordance with local and national electrical codes.
2. Allowable voltage range for the 380V unit is 342-418V, allowable voltage range for the 415V unit is 373-456.
* Minimum Circuit Ampacity.

Table ED-5 – Electrical Service Sizing Data – Electric Heat Module (Electric Heat Units Only)

Models: TED/TEH 275 thru 500
Electric Heat FLA

Nominal Unit Size (Tons)	Nominal Unit Voltage	KW Heater (380/415V) 23/27	34/40	45/54	56/67	68/81
23-29	380	34.5	51.1	68.9	85.5	–
	415	37.6	55.6	–	–	–
33, 42	380	–	51.1	68.9	85.5	103.4
	415	–	55.6	75.1	93.2	112.7

Notes:
1. All FLA in this table are based on heater operating at 380 or 415 volts as shown above.

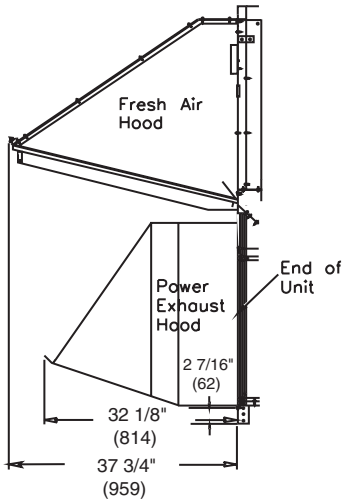
Table ED-6— Electrical Service Sizing Data — Crankcase Heaters — Heating Mode Only)

Nominal Unit Size (Tons)	FLA Add Unit Voltage 380	415
23 - 29	1	1
33 - 42	2	2

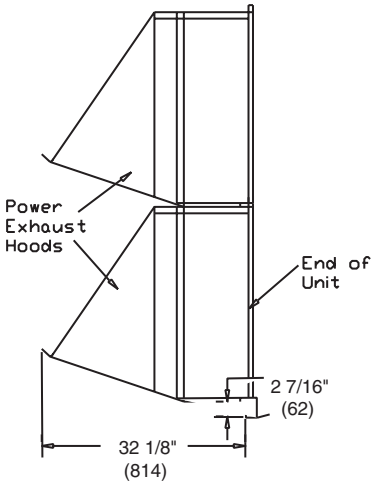
Dimensional Data 60/50 Hz

Figure DD-1— Fresh Air, Power Exhaust Hoods

SIDE VIEW SHOWING
FRESH AIR AND
POWER EXHAUST HOODS
FOR DOWNFLOW CONFIGURATION



SIDE VIEW SHOWING
POWER EXHAUST HOODS
FOR HORIZONTAL CONFIGURATION

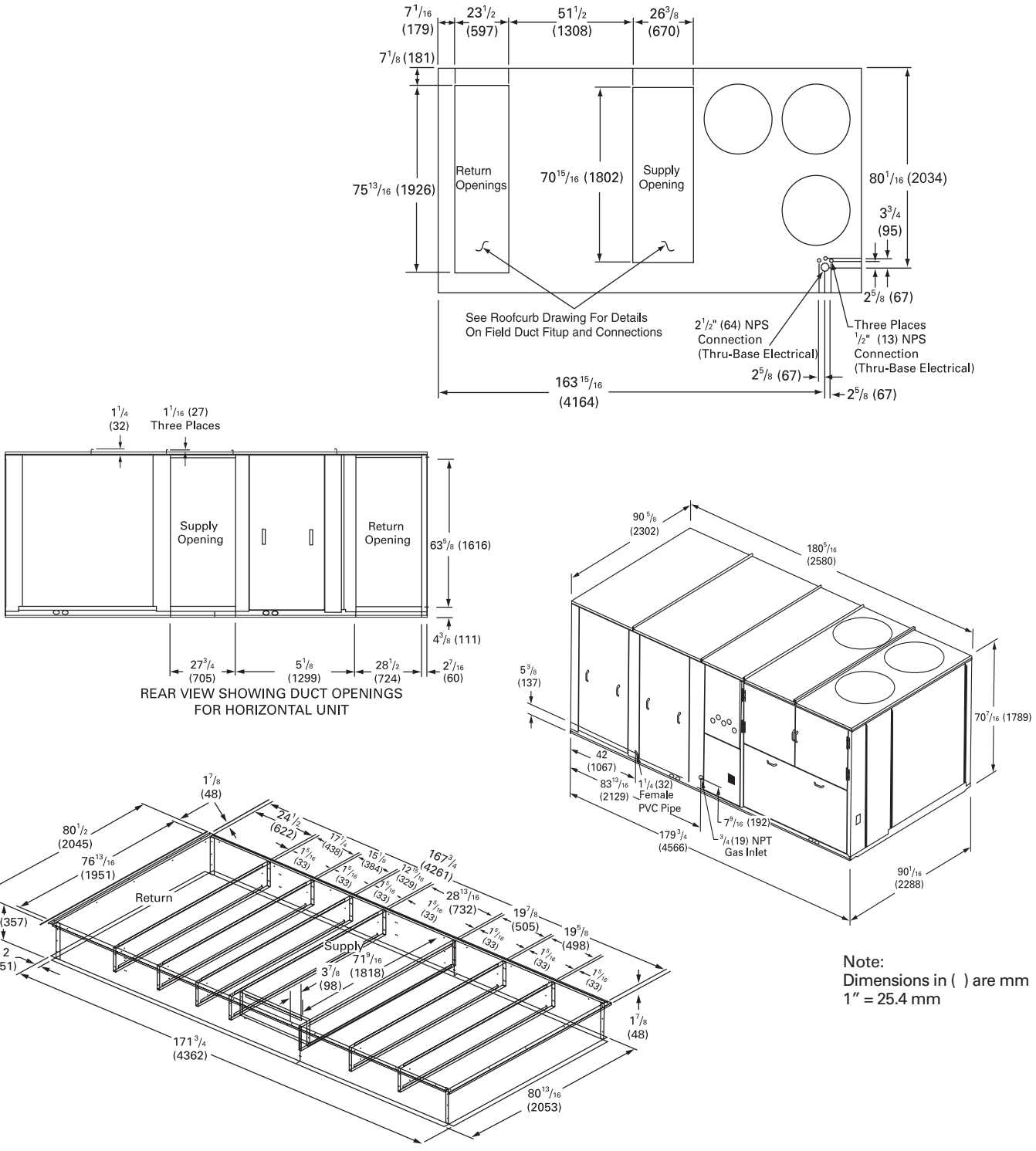


NOTE: The Two Horizontal Power Exhaust Hoods and the three Horizontal Fresh Air Hoods are located side by side. The Fresh Air Hoods (not shown) extend only 23 15/16" from the end of the unit.

Dimensional Data

60/50 Hz

Figure DD-2 – 60 Hz 27½-35, 50 Hz 23-29 Tons (TC, TE, YC Low Heat)

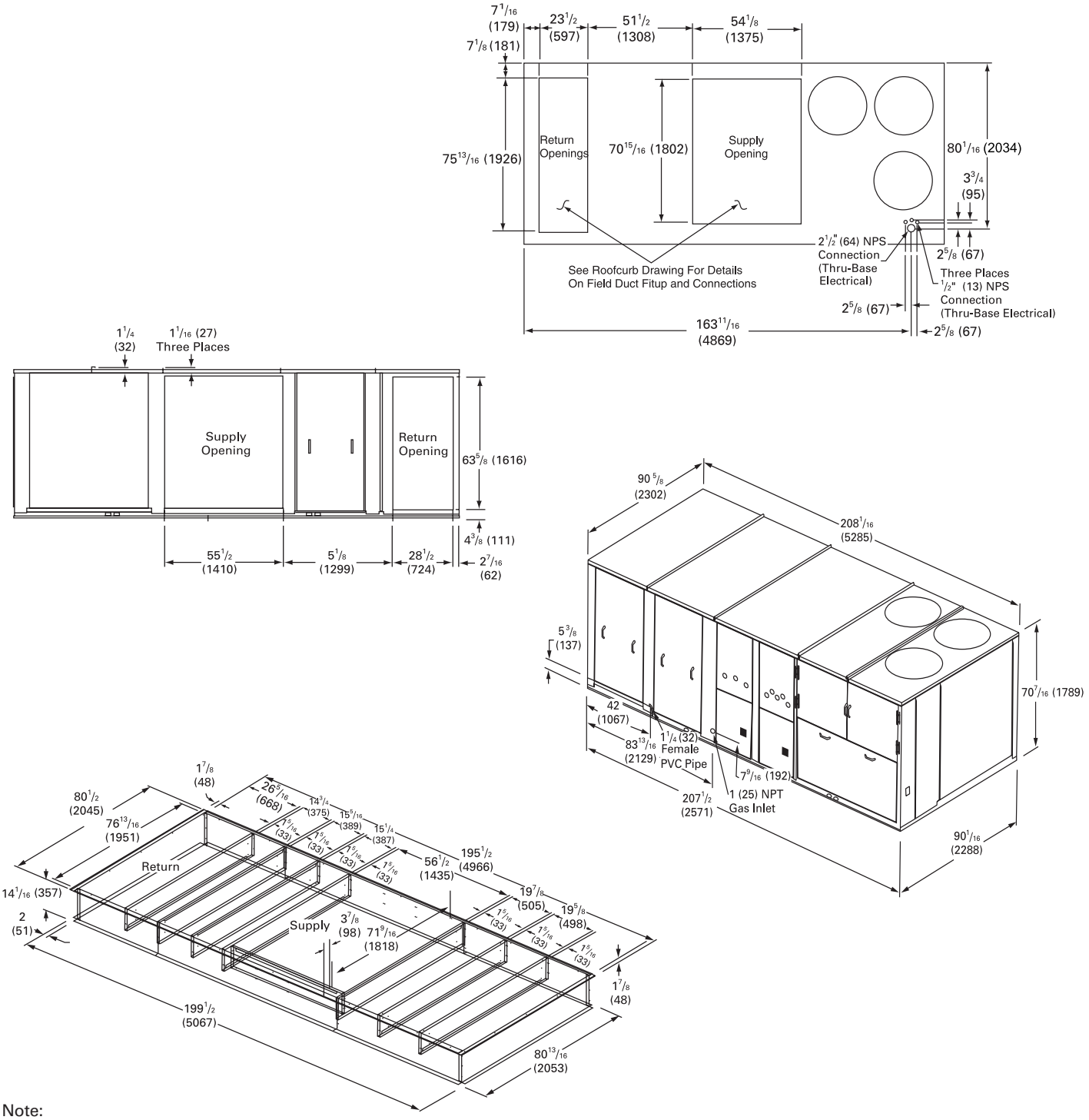


Note:
Dimensions in ( ) are mm
1″ = 25.4 mm

Dimensional Data

60/50 Hz

Figure DD-3– 60 Hz 27½-35, 50 Hz 23-29 Tons (YC High Heat)

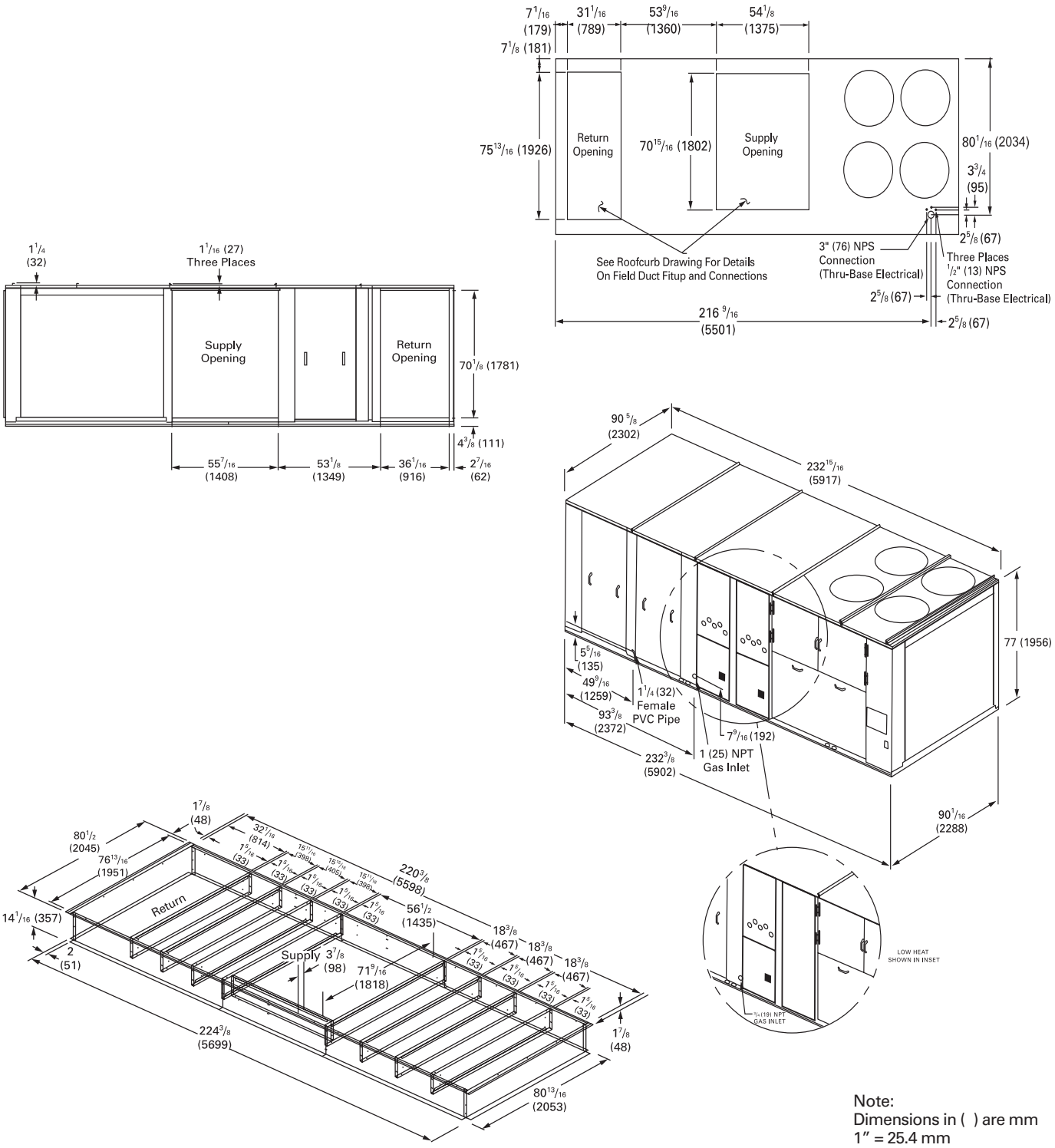


Note:
Dimensions in ( ) are mm
1″ = 25.4 mm

Dimensional Data

60/50 Hz

Figure DD-4 – 60 Hz 40-50, 50 Hz 33-42 Tons (TC, TE, YC Low & High Heat)

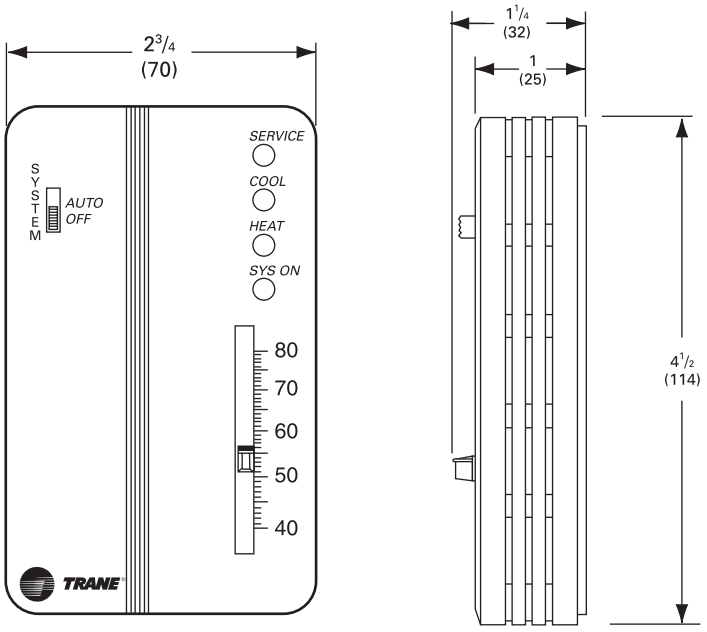


Note:
Dimensions in ( ) are mm
1″ = 25.4 mm

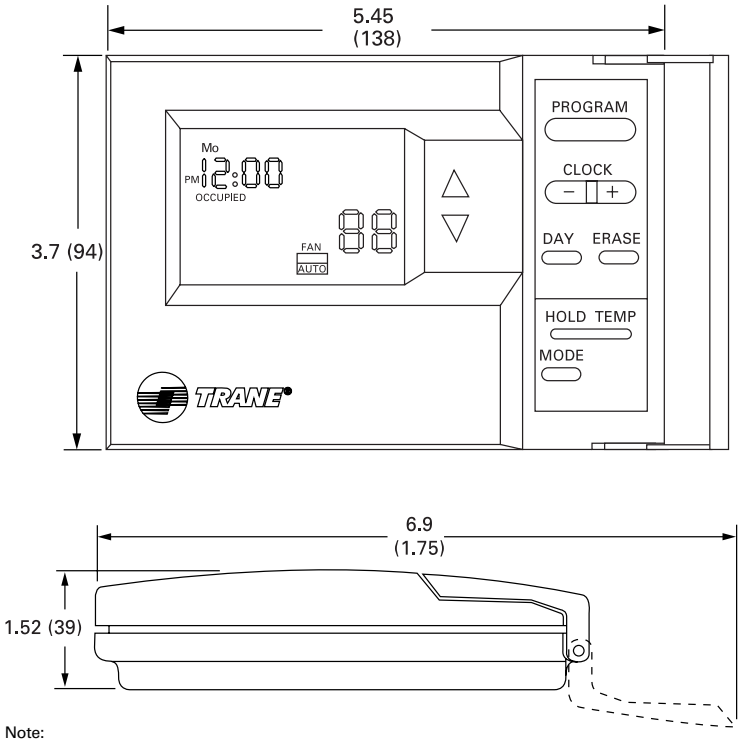
Dimensional Data (Variable Air Volume VAV)

Field Installed Sensors

SINGLE SETPOINT SENSOR WITH SYSTEM FUNCTION LIGHTS (BAYSENS021*)



PROGRAMMABLE NIGHT-SETBACK SENSOR (BAYSENS020*)

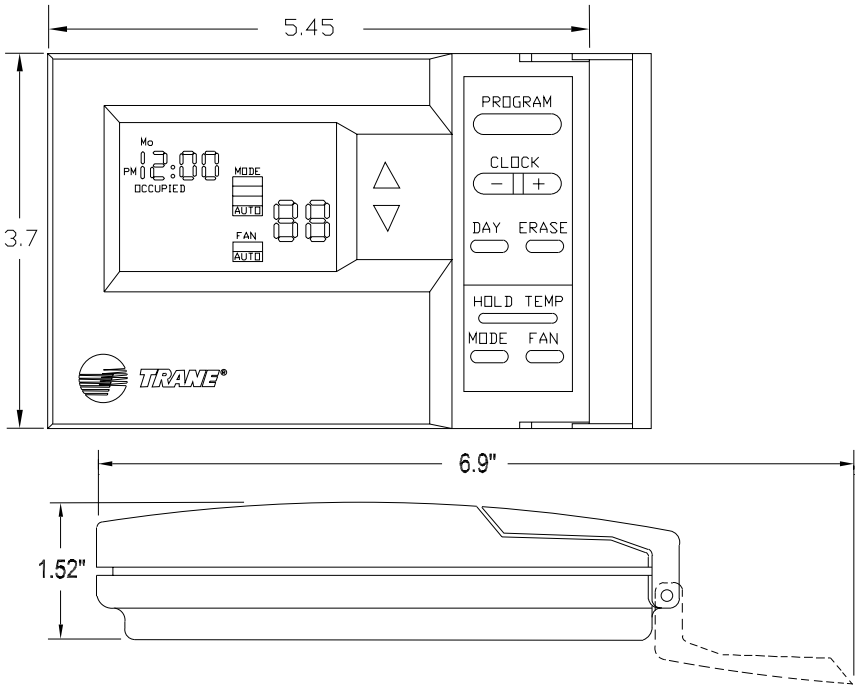


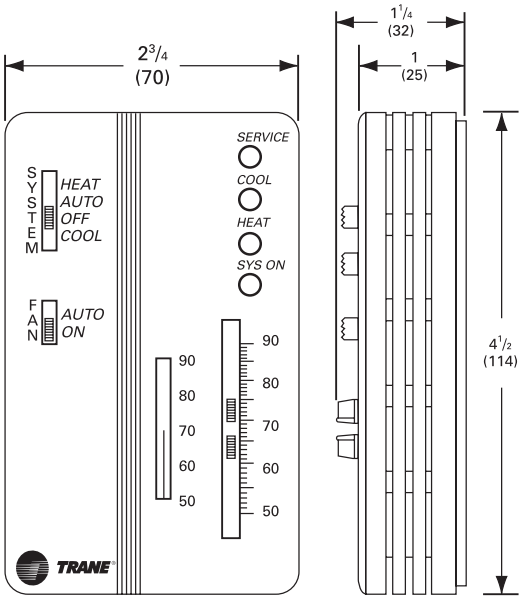
Note:
1. Remote sensors are available for use with all zone sensors to provide remote sensing capabilities.

Dimensional Data (Constant Volume CV)

Field Installed Sensors

PROGRAMMABLE NIGHT-SETBACK SENSOR (BAYSENS019*)





DUAL SETPOINT, MANUAL/AUTOMATIC CHANGEOVER SENSOR WITH SYSTEM FUNCTION LIGHTS (BAYSENS010*)

WITHOUT LED STATUS INDICATORS (BAYSENS008*)

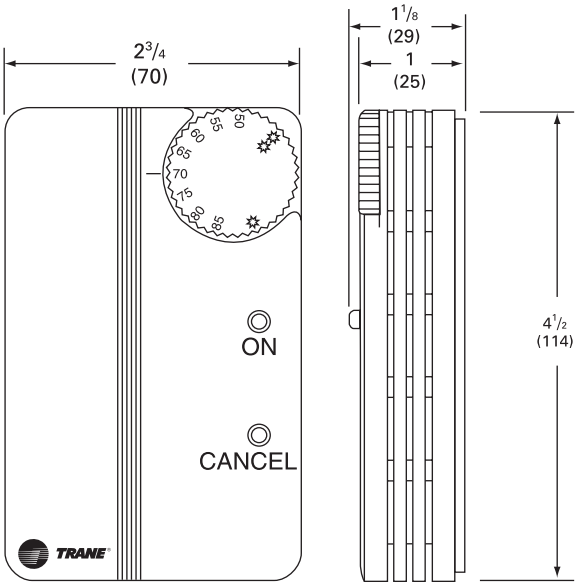
SINGLE SETPOINT WITHOUT LED STATUS INDICATORS (BAYSENS006*)

Note:
1. Remote sensors are available for use with all zone sensors to provide remote sensing capabilities.

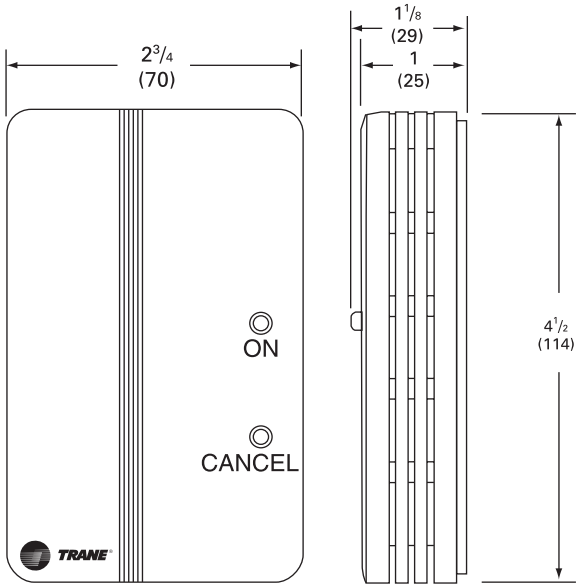
Dimensional Data (CV and VAV)

Integrated Comfort™ System Sensors

ZONE TEMPERATURE SENSOR W/TIMED OVERRIDE BUTTON AND LOCAL SETPOINT ADJUSTMENT (BAYSENS014)[1]



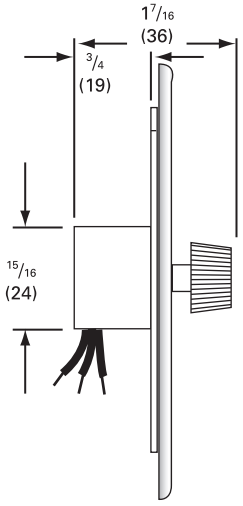
ZONE TEMPERATURE SENSOR W/TIMED OVERRIDE BUTTONS (BAYSENS013*) ALSO AVAILABLE SENSOR ONLY (BAYSENS017*)

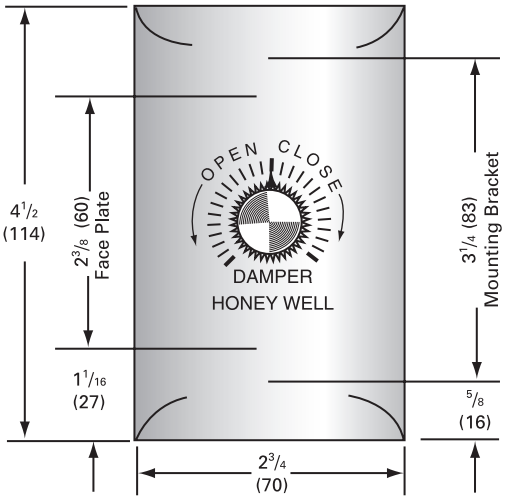


TEMPERATURE SENSOR (BAYSENS016*)



REMOTE MINIMUM POSITION POTENTIOMETER CONTROL (BAYSTAT023*)





Note:
1. Remote sensors are available for use with all zone sensors to provide remote sensing capabilities.

Dimensional Data and Weights

WALL-MOUNTED CO_2 SENSOR (BAYCO2K005*)
DUCT-MOUNTED CO_2 SENSOR (NOT PICTURED) (BAYC02K006*)

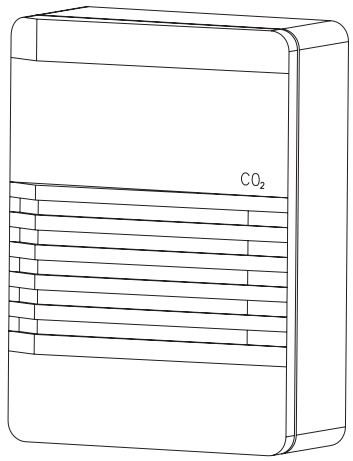


Table W-1 — Approximate Operating Weights — Lbs.[2]

	Basic Unit Weights[1]			
Unit Model	YC Low Heat	YC High Heat	TC	TE
**D330/275	3650	4012	3520	3553
**H330/275	3650	4077	3565	3598
**D360/305	3730	4092	3600	3633
**H360/305	3730	4142	3600	3633
**D420/350	3815	4177	3685	3718
**H420/350	3815	4227	3685	3718
**D480/400	4765	4885	4540	4575
**H480/400	4790	4915	4540	4575
**D600/500	4935	5055	4710	4745
**H600/500	4960	5085	4710	4745

Table W-1a — Approximate Operating Weights — kg

	Basic Unit Weights[1]			
Unit Model	YC Low Heat	YC High Heat	TC	TE
**D330/275	1656	1820	1597	1612
**H330/275	1656	1849	1617	1632
**D360/305	1692	1856	1633	1648
**H360/305	1692	1879	1633	1648
**D420/350	1731	1895	1672	1687
**H420/350	1731	1895	1672	1687
**D480/400	2161	2216	2059	2075
**H480/400	2161	2216	2059	2075
**D600/500	2239	2293	2137	2152
**H600/500	2239	2293	2137	2152

Notes
1. Basic unit weight includes minimum HP Supply Fan motor.
2. Optional high static and high efficiency motor weights are in addition to the standard motor weight included in the basic unit weight.
3. Point Loading is identified with corner A being the corner with the compressors. As you move clockwise around the unit as viewed from the top, mid-point B, corner C, corner D, mid-point E and corner F.
4. Point load calculations provided are based on the unit weight for YC high heat models. To calculate point loads for a specific model, multiply the percentages given in Table W-5 by the unit weight listed in table W-1.

Table W-2 — Point Loading Average Weight[3,4] — lbs.

Model	A	B	C	D	E	F
**D330/275	843	883	481	642	682	481
**H330/275	856	897	489	652	693	489
**D360/305	859	900	491	655	696	491
**H360/305	870	911	497	663	704	497
**D420/350	877	919	501	668	710	501
**H420/350	888	930	507	676	719	507
**D480/400	1026	1075	586	782	830	586
**H480/400	1032	1081	590	786	836	590
**D600/500	1062	1112	607	809	859	607
**D600/500	1068	1119	610	814	864	610

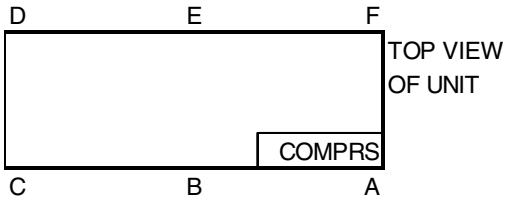
Table W-2a— Point Loading Average Weight[3,4] — kg.

Model	A	B	C	D	E	F
**D330/275	382.38	400.53	218.18	291.21	309.36	218.18
**H330/275	388.28	406.88	221.81	295.75	314.34	221.81
**D360/305	389.64	408.24	222.72	297.11	315.71	222.72
**H360/305	394.63	413.23	225.44	300.74	319.33	225.44
**D420/350	397.81	416.86	227.25	303.00	322.06	227.25
**H420/350	402.80	421.85	229.98	306.63	326.14	229.98
**D480/400	465.39	487.62	265.81	354.72	376.49	265.81
**H480/400	468.12	490.34	267.62	356.53	379.21	267.62
**D600/500	481.72	504.40	275.34	366.96	389.64	275.34
**H600/500	484.44	507.58	276.70	369.23	391.91	276.70

Table W-3— Point Loading Percentages of Total Unit Weight[1]

A	B	C	D	E	F
21%	22%	12%	16%	17%	12%

1. To calculate point loads for a specific model, multiply percentages by unit weight listed in table Table W-1.



Weights

Table W-4— Approximate Operating Weights — lb — Weight of Optional Components

Unit Model	Baro. Relief	Power Exhaust	Hi-Stat/ Hi Eff. Sup Fan Motor[2]	0-25% Man Damper	Econ.	Inlet Guide Vanes	Var. Freq. Drives (VFD's) W/O Bypass	Var. Freq. Drives (VFD's) With Bypass	Serv Valves	Thru-the base Elec.	Non-Fused Discon. Switch	Fact. GFI with Discon. Switch	Roof Curb Lo/Hi
**D330/275	110	165	120	50	260	55	85	115	11	6	30	85	310/330
**H330/300	145	200	120	50	285	55	85	115	11	6	30	85	310/330
**D360/305	110	165	120	50	260	55	85	115	11	6	30	85	310/330
**H330/305	145	200	120	50	285	55	85	115	11	6	30	85	310/330
**D420/350	110	165	120	50	260	55	115	150	11	6	30	85	310/330
**H420/350	145	200	120	50	285	55	115	150	11	6	30	85	310/330
**D480/400	110	165	125	50	290	70	115	150	18	6	30	85	365/368
**H480/400	145	200	125	50	300	70	115	150	18	6	30	85	365/365
**D600/500	110	165	125	50	290	70	115	150	18	6	30	85	365/365
**H600/500	145	200	125	50	300	70	115	150	18	6	30	85	365/365

Table W-4a — Approximate Operating Weights — kg — Weight of Optional Components

Unit Model	Baro. Relief	Power Exhaust	Hi-Stat/ Hi Eff. Sup Fan Motor[2]	0-25% Man Damper	Econ.	Inlet Guide Vanes	Var. Freq. Drives (VFD's) W/O Bypass	Var. Freq. Drives (VFD's) With Bypass	Serv Valves	Thru-the base Elec.	Non-Fused Discon. Switch	Fact. GFI with Discon. Switch	Roof Curb Lo/Hi
**D275	50	74	54	23	117	25	38.6	52.2	5	3	14	38	141/150
**H275	65	90	54	23	128	25	38.6	52.2	5	3	14	38	141/150
**D305	50	74	54	23	117	25	38.6	52.2	5	3	14	38	141/150
**H305	65	90	54	23	128	25	38.6	52.2	5	3	14	38	141/150
**D350	50	74	54	23	117	25	52.2	68.04	5	3	14	38	141/150
**H350	65	90	54	23	128	25	52.2	68.04	5	3	14	38	141/150
**D400	50	74	56	23	131	32	52.2	68.04	8	3	14	38	169
**H400	65	90	56	23	135	32	52.2	68.04	8	3	14	38	169
**D500	50	74	56	23	131	32	52.2	68.04	8	3	14	38	169
**H500	65	90	56	23	135	32	52.2	68.04	8	3	14	38	169

Notes:
1. Basic unit weight includes minimum hp Supply Fan Motor.
2. Optional high static and high efficiency motor weights are in addition to the standard motor weight included in the basic unit weight.

Table W-5— Minimum Operating Clearances for Unit Installation

	Econo / Exhaust End	Condenser Coil[2] End / Side	Service Side Access
Single Unit[1]	6 Feet (1.82 m)	8 Feet / 4 Feet (2.43/1.21 m)	4 Feet (1.21 m)
Multiple Unit[1,3]	12 Feet (3.65 m)	16 Feet / 8 Feet (4.87/2.43 m)	8 Feet (2.43 m)

Notes:
1. Horizontal and Downflow Units, all sizes.
2. Condenser coil is located at the end and side of the unit.
3. Clearances on multiple unit installations are distances between units.

Mechanical Specifications

General

The units shall be dedicated downflow or horizontal airflow. The operating range shall be between 115 F and 0 F in cooling as standard from the factory for all units. Cooling performance shall be rated in accordance with ARI testing procedures. All units shall be factory assembled, internally wired, fully charged with HCFC-22 and 100% run tested to check cooling operation, fan and blower rotation and control sequence before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be UL listed and labeled, classified in accordance to UL 1995/CAN/CSA No. 236-M90 for Central Cooling Air Conditioners. Canadian units shall be CSA Certified.

Casing

Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. All components shall be mounted in a weather resistant steel cabinet with a painted exterior. Where top cover seams exist, they shall be double hemmed and gasket sealed to prevent water leakage. Cabinet construction shall allow for all maintenance on one side of the unit. Service panels shall have handles and shall be removable while providing a water and air tight seal. Control box access shall be hinged. The indoor air section shall be completely insulated with fire resistant, permanent, odorless, foil faced glass fiber material. The base of the unit shall have provisions for crane lifting.

Filters

Two inch, throwaway filters shall be standard on all size units. Two inch "high efficiency", and four inch "high efficiency" filters shall be optional.

Compressors

Trane 3-D™ Scroll compressors have a simple mechanical design with only three major moving parts. Scroll type compression provides inherently low vibration. The 3-D Scroll provides a completely enclosed compression chamber which leads to increased efficiency. Exhaustive testing on the 3-D Scroll, including start up with the shell full of liquid, has proven that slugging does not fail involutes. Direct-drive, 3600 rpm, suction gas-cooled hermetic motor. Trane 3-D Scroll compressor includes centrifugal oil pump, oil level sightglass and oil charging valve. Each compressor shall have crankcase heaters installed, properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

Refrigerant Circuits

Each refrigerant circuit shall have independent thermostatic expansion devices, service pressure ports and refrigerant line filter driers factory-installed as standard. An area shall be provided for replacement suction line driers.

Evaporator and Condenser Coils

Condenser coils shall have $^{3}/_{8}$" copper tubes mechanically bonded to lanced aluminum plate fins. Evaporator coils shall be $^{1}/_{2}$" internally finned copper tubes mechanically bonded to high performance aluminum plate fins. All coils shall be leak tested at the factory to ensure pressure integrity. All coils shall be leak tested to 200 psig and pressure tested to 450 psig. All dual circuit evaporator coils shall be of intermingled configuration. Sloped condensate drain pans are standard.

Outdoor Fans

The outdoor fan shall be direct-drive, statically and dynamically balanced, draw through in the vertical discharge position. The fan motor(s) shall be permanently lubricated and have built-in thermal overload protection.

Indoor Fan

Units shall have belt driven, FC, centrifugal fans with fixed motor sheaves. All motors shall be circuit breaker protected. All indoor fan motors meet the U.S. Energy Policy Act of 1992 (EPACT).

Electric Heaters

Electric heat shall be available for factory installation within basic unit. Electric heater elements shall be constructed of heavy-duty nickel chromium elements internally delta connected for 240 volt, wye connected for 480 and 600 volt. Staging shall be achieved through the rooftop refrigeration module (RTRM). Each heater package shall have automatically reset high limit control operating through heating element contactors. All heaters shall be individually fused from factory, where required, and meet all NEC and CEC requirements. Power assemblies shall provide single-point connection. Electric heat shall be UL listed or CSA certified.

Gas Heating Section

The heating section shall have a drum and tube heat exchanger(s) design with primary and secondary surfaces of corrosion resistant aluminized steel or optional stainless steel.

A forced combustion blower shall supply premixed fuel to a single burner ignited by a pilotless hot surface ignition system. In order to provide reliable operation, a negative pressure gas valve shall be used that requires blower operation to initiate gas flow. On an initial call for heat, the combustion blower shall purge the heat exchanger(s) 45 seconds before ignition. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset at the thermostat. Units shall be suitable for use with natural gas or propane (field installed kit) and also comply with California requirements for low NOx emissions. All units shall have two stage heating.

Controls

Unit shall be completely factory wired with necessary controls and terminal block for power wiring. Units shall provide an external location for mounting fused disconnect device. ReliaTel controls

Mechanical Specifications

shall be provided for all 24 volt control functions. The resident control algorithms shall make all heating, cooling and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, minimizes drift from set point and provides better building comfort. ReliaTel controls shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.

Control Options

Inlet Guide Vanes shall be installed on each fan inlet to regulate capacity and limit horsepower at lower system requirements. When in any position other than full open they shall pre-spin intake air in the same direction as fan rotation. The inlet guide vanes shall close when supply fan is off, except in night setback.

The inlet guide vane actuator motor shall be driven by a modulating dc signal from the unit controls. A pressure transducer shall measure duct static pressure and modulate the inlet guide vanes to maintain the required supply air static pressure within a predetermined range.

Variable Frequency Drives (VFDs)

VFDs shall be factory installed and tested to provide supply fan motor speed modulation. The VFD shall receive a 2-10 VDC signal from the unit controls based upon supply static pressure and shall cause the drive to accelerate or decelerate as required to maintain the supply static pressure setpoint. When subjected to high ambient return conditions the VFD shall reduce its output frequency to maintain operation. Bypass control to provide full nominal air flow in the event of drive failure shall be optional.

Ventilation Override

Ventilation Override shall allow a binary input from the fire/life safety panel to cause the unit to override standard operation and assume one of two factory preset ventilation sequences, exhaust or pressurization. The two sequences shall be selectable based open a binary select input.

Trane Communication Interface (TCI)

Shall be provided to interface with the Trane Integrated Comfort™ System and shall be available field or factory-installed. The TCI shall allow control and monitoring of the rooftop unit via a two-wire communication link.

The following alarm and diagnostic information shall be available:

RTRM Originated Data

- Unit operating mode
- Unit failure status
  - Cooling failure
  - Heating failure
  - Emergency service stop indication
  - Supply fan proving
  - Timed override activation
  - High temperature thermostat status
- Zone temperature
- Supply air temperature
- Cooling status (all stages)
- Stage activated or not
- Stage locked out by RTRM
- HPC status for that stage
- Compressor disable inputs
- Heating status
- Number of stages activated
- High temperature limit status
- Economizer status
- Enthalpy favorability status
- Requested minimum position
- Damper position
- Dry bulb/enthalpy input status
- Outside air temperature
- Outside relative humidity
- Sensor Failure
  - Humidity sensor
  - OAT sensor
  - SAT sensor
  - RAT sensor
  - Zone temperature sensor
  - Mode input
  - Cooling/heating setpoints from sensors
  - Static pressure transducer
  - Unit mounted potentiometer
  - SAT from potentiometer
  - Air reset setpoint from potentiometer
- Unit Configuration data
  - Gas or electric heat
  - Economizer present
- High temp input status
- Local setpoint
- Local mode setting
- Inlet Guide Vane position
- Clogged filter service indicator
- CO_2 setpoint
- CO_2 value

Tracer Originated Data

- Command operating mode
- Host controllable functions:
  - Supply fan
  - Economizer
  - Cooling stages enabled
  - Heating stages enabled
  - Emergency shutdown
- Minimum damper position
- Heating setpoint
- Cooling setpoint
- Supply air tempering enable/disable
- Slave mode (CV only)
- Tracer/Local operation
- SAT setpoint
- Reset setpoint
- Reset amount
- MWU setpoint
- MWU enable/disable
- SAT Reset type select
- Static pressure setpoint
- Static pressure deadband
- Daytime warm-up enable/disable
- Power exhaust setpoint

LonTalk Communication Interface (LCI-R)

The field or factory-installed ReliaTel® LonTalk Communication Interface (LCI-R) will be provided to interface with the Trane Integrated Comfort System or LonTalk capable third party building management networks. The LCI-R will allow control and monitoring of the rooftrop unit via a two-wire communication link.

Outside Air

Manual Outside Air

A manually controllable outside air damper shall be adjustable for up to 25 percent outside air. Manual damper is set at desired position at unit start up.

Economizer

Economizer shall be factory installed. The assembly includes: fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness, and fixed dry bulb control. Solid state enthalpy and differential enthalpy control shall be a factory or field installed option.

Mechanical Specifications

Exhaust Air

Barometric Relief

The barometric relief damper shall be optional with the economizer. Option shall provide a pressure operated damper for the purpose of space pressure equalization and be gravity closing to prohibit entrance of outside air during the equipment "off" cycle.

Power Exhaust Fan

Power exhaust shall be available on all units and shall be factory installed. It shall assist the barometric relief damper in maintaining building pressurization.

Unit Options

Service Valves

Service valves shall be provided factory installed and include suction, liquid, and discharge 3-way shutoff valves.

Through-The-Base Electrical Provision

An electrical service entrance shall be provided which allows access to route all high and low voltage electrical wiring inside the curb, through the bottom of the outdoor section of the unit and into the control box area.

Non-Fused Disconnect Switch

A factory installed non-fused disconnect switch with external handle shall be provided and shall satisfy NEC requirements for a service disconnect. The non-fused disconnect shall be mounted inside the unit control box.

GFI Convenience Outlet (Factory Powered)

A 15A, 115V Ground Fault Interrupter convenience outlet shall be factory installed. It shall be wired and powered from a factory mounted transformer. Unit mounted non-fused disconnect with external handle shall be furnished with factory powered outlet.

GFI Convenience Outlet (Field Powered)

A 15A, 115V Ground Fault Interrupter convenience outlet shall be factory installed and shall be powered by customer provided 115V circuit.

Hinged Service Access

Filter access panel and supply fan access panel shall be hinged for ease of unit service.

Condenser Coil Guards

Factory installed condenser vinyl coated wire mesh coil guards shall be available to provide full area protection against debris and vandalism.

Stainless Steel Drain Pans

Sloped stainless steel evaporator coil drain pans are durable, long-lasting and highly corrosion resistant.

Black Epoxy Pre-Coated Condenser Coil

A thermoset vinyl coating is bonded to the aluminum fin stock prior to the fin stamping process. The pre-coated coils are an economical option for protection in mildly corrosive environments.

Discharge Air Sensing

Provides true discharge air sensing in heating and cooling models. This sensor is a status indicator readable through Tracer, Tracker or LCI-R. Discharge air sensing is standard with Variable Air Volume (VAV) units, optional with Constant Volume (CV) units.

Clogged Filter Indication

This optional factory installed differential pressure switch allows dirty filter indication at the zone sensor with service LED. When closed, the dirty filter switch will light the service LED on the zone sensor and allow the unit to continue normal operation.

Roof Curb

The roof curb shall be designed to mate with the unit and provide support and a water tight installation when installed properly. The roof curb design shall allow field-fabricated rectangular supply/return ductwork to be connected directly to the curb when used with downflow units. Curb design shall comply with NRCA requirements. Curb shall ship knocked down for field assembly and include wood nailer strips.

Zone Sensors

Shall be provided to interface with the ReliaTel unit controls and shall be available in either manual, automatic programmable with night setback, with system malfunction lights or remote sensor options.

Remote Potentiometer

A remote potentiometer shall be available to remotely adjust the unit economizer minimum position.

High Temperature Thermostats

Field installed, manually resettable high temperature thermostats shall provide input to the unit controls to shut down the system if the temperature sensed at the return is 135 F or at the discharge 240 F.

Reference Enthalpy Kit

Field installed enthalpy kit shall provide inputs for economizer control based upon comparison of the outside air stream to a definable enthalpy reference point. May also be factory installed.

Comparative Enthalpy Kit

Field installed enthalpy kit shall provide inputs for economizer control based upon comparison of the enthalpies of the return and outdoor air streams. Also available factory installed.

LP Conversion Kit

Field installed conversion kit shall provide orifice(s) for simplified conversion to liquefied propane gas. No change of gas valve shall be required.

BAYCO2K005* — Wall-mounted CO_2 sensor has the ability to monitor space occupancy levels within the building by measuring the parts per million of CO_2 (Carbon Dioxide) in the air. As the CO_2 levels increase, the outside air damper modulates to meet the CO_2 space ventilation requirements.

BAYCO2K006* — Duct-mounted CO_2 sensor has the ability to monitor space occupancy levels within the building by measuring the parts per million of CO_2 (Carbon Dioxide) in the air. As the CO_2 levels increase, the outside air damper modulates to meet the CO_2 space ventilation requirements.

Mechanical Specifications

BAYICSI004* — Field-installed Trane Communication Interface (TCI).

BAYLTCI001* — Field-installed LonTalk Communication Interface (LCI-R) for Constant Volume (CV) units.

BAYLTCI004* — Field-installed LonTalk Communication Interface (LCI-R) for Variable Air Volume (VAV) units.

BAYSENS006* — Zone Sensor has one temperature setpoint lever, heat, off or cool system switch, fan auto or fan on switch. Manual changeover. These sensors are for CV units only.

BAYSENS008* — Zone Sensor has two temperature setpoint levers, heat, auto, off, or cool system switch, fan auto or fan on switch. Auto changeover. These sensors are used with CV units.

BAYSENS010* — Zone Sensor has two temperature set point levers, heat, auto, off, or cool system switch, fan auto or fan on switch. Status indication LED lights, System on, Heat, Cool, and Service are provided. These sensors are used with CV units.

BAYSENS013* — Zone temperature sensor with timed override buttons used with Tracer™ Integrated Comfort system.

BAYSENS014* — Zone temperature sensor with local temperature adjustment control and timed override buttons used with Tracer Integrated Comfort system. May also be used for Morning Warm-up setpoint and sensor.

BAYSENS016* — Temperature Sensor is a bullet or pencil type sensor that could be used for temperature input such as return air duct temperature.

BAYSENS017* — Remote Sensor can be used for remote zone temperature sensing capabilities when zone sensors are used as remote panels or as a morning warm-up sensor for use with VAV units or as a zone sensor with Tracer Integrated Comfort system.

BAYSENS019* and BAYSENS020* — Electronic programmable sensors with auto or manual changeover with seven day programming. Keyboard selection of heat, cool, auto fan or on. All programmable sensors have System on, Heat, Cool, Service LED/LCD indicators as standard. Night setback sensors have two occupied, and two unoccupied programs per day. Sensors are available for CV zone temperature control and VAV zone temperature control.

BAYSENS021* — Zone Sensor with supply air single temperature setpoint and AUTO/OFF system switch. Status indication LED lights, System ON, Heat, Cool, and Service are provided. Sensors are available to be used with VAV units.

BAYSTAT023* — Remote Minimum Position Potentiometer is used to remotely specify the minimum economizer position.

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Trane has a policy of continuous product and product data improvement and reserves the right to change design and specifications without notice.

Product Catalog

Packaged Rooftop Air Conditioners
Precedent™ with eFlex™ Technology — Cooling and Gas/Electric

3 to 10 Tons — 60 Hz



January 2019

RT-PRC053F-EN

Introduction

Trane® customers demand products that provide exceptional reliability, meet stringent performance requirements, and are competitively priced. Trane® delivers with Precedent™.

Precedent™ features cutting edge technologies: reliable compressors, Trane® engineered ReliaTel™ controls, computer-aided run testing, and Integrated Comfort™ Systems. So, whether you're the contractor, the engineer, or the owner you can be certain Precedent products are built to meet your needs.

Through the years, Trane® has designed and developed the complete line of Packaged Rooftop products available in the market today. Trane® was the first to introduce the Micro—microelectronic unit controls—and has continued to improve and revolutionize this design concept.

All units utilize ReliaTel™ controls. These are standard for variable staged cooling Precedent™ products.

The ReliaTel™ control platform offers the same great features and functionality as the original Micro, with additional benefits for greater application flexibility.

With its sleek, compact cabinet, Precedent™ continues to provide the highest standards in quality and reliability, comfort, ease of service, and the performance of Trane® light commercial products.

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Revision History

Updates to performance data tables and electrical data tables.

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Features and Benefits

Standard Features

- 5-year limited compressor warranty
- 5-year limited heat exchanger warranty
- 1-year limited parts warranty
- Anti-short cycle timer (standard with ReliaTel™)
- Colored and numbered wiring
- Condensing temperature thermistor[1]
- Convertible airflow
- Crankcase heaters
- Discharge air temperature sensor
- Easy access low voltage terminal board (LTB)
- eFlex™ technology - variable speed compressor, variable speed outdoor fan, variable speed indoor fan
- eDrive™ technology - direct drive indoor fan
- Enhanced dehumidification functionality
- Evaporating temperature thermistor[1]
- Filters are standard on all units
- Foil-faced and edge captured Insulation
- Frostat™
- High pressure control
- IAQ dual sloped, plastic, removable, reversible drain pan
- Liquid line refrigerant drier
- Low ambient cooling to 0°F
- Low pressure control
- Microchannel coils[2]
- Operating charge of R-410A
- Phase loss protection
- Phase reversal protection
- Progressive tubular aluminized steel heat exchanger
- Provisions for through-the-base gas and condensate drain connections
- Quick access panels
- ReliaTel™ microprocessor controls
- Scroll compressors
- Single point power
- Single side service access
- Single zone variable air volume (SZVAV)
- Standardized components

[1] Thermistor is standard for T/YZC072-120F models
[2] Microchannel condenser coil is standard for T/YZC048F models

- Thermal expansion valve
- Voltage imbalance protection

Options[1]

Factory Installed Options

- Air-Fi™ Wireless Communication Interface
- 2-inch MERV 8 filters or 2-inch MERV 13 filters with filter removal tool
- Black epoxy pre-coated coils
- CO_2 sensor (wiring only)
- CompleteCoat™ condenser coil
- Condensate overflow switch
- Fault detection and diagnostics (FDD); Meets CA Title 24 requirements
- Hinged access doors
- Human interface – 5-inch color touchscreen
- Modulating gas heat
- Multiple-zone variable air volume (MZVAV)
- Powered[2] or unpowered convenience outlet
- Stainless steel drain pan
- Stainless steel heat exchanger with 10 year warranty
- Supply, return or plenum[3] air smoke detector
- Through-the-Base electrical access
- Through-the-Base electrical with circuit breaker
- Through-the-Base electrical with disconnect switch

Factory or Field Installed Options

- Barometric relief
- Clogged filter/fan failure switch
- Discharge air temperature sensing kit
- Economizer: Standard and low leak
- Electric heaters
- LonTalk® Communications Interface (LCI)
- BACnet® Communications Interface (BCI)
- Reference or comparative enthalpy
- Hail guards

Field Installed Options

- CO_2 Sensor[4]
- Dual thermistor remote zone sensor
- Economizer: Low leak

[1] Refer to Model Number Description for option availability
[2] Powered convenience outlet not available on 460V units
[3] Plenum smoke detector not available on T/YZC072-120 models
[4] CO_2 sensor always field installed; associated with demand control ventilation

- High altitude kit
- High static drive
- Humidity sensor
- LP conversion kit
- Powered exhaust
- Quick adapt curbs
- Quick start kit
- Remote potentiometer
- Roof curb
- Ventilation override accessory
- Wireless zone sensor
- Zone sensor

Other Benefits

- Cabinet design ensures water integrity
- Ease of service, installation and maintenance
- Mixed model build enables “fastest in the industry” ship cycle times
- Outstanding airflow distribution
- ReliaTel™ controls
- Unmatched Product Support is one of our finest assets. Trane Sales Representatives are a support group that can assist you with:
  - Product
  - Application
  - Service
  - Training
  - Special applications
  - Specifications
  - Computer programs and much more

Standard Features

Anti-Short Cycle Timer (Standard with ReliaTel)™

Provides a 3 minute minimum “ON” time and 3 minute “OFF” time for compressors to enhance compressor reliability by assuring proper oil return.

Colored and Numbered Wiring

Save time and money tracing wires and diagnosing the unit.

Condenser Coil



Precedent™ boasts a patent-pending 1+1+1 condenser coil, permanently gapped for easy cleaning.

Controls – ReliaTel™

ReliaTel™ microprocessor controls provide unit control for heating, cooling and ventilating utilizing input from sensors that measure indoor and outdoor temperature and other zone sensors. ReliaTel™ also provides outputs for building automation systems and expanded diagnostics. For a complete list of ReliaTel™ offerings, refer to the "Other Benefits" section within the Features and Benefits section of this catalog.

Convertible Units



The units ship in a downflow configuration. They can be easily converted to horizontal by simply moving two panels.

Units come complete with horizontal duct flanges so the contractor doesn't have to field fabricate them. These duct flanges are a time and cost saver.

Crankcase Heaters

These band heaters provide improved compressor reliability by warming the oil to prevent migration during off-cycles or low ambient conditions.

Discharge Air Temperature Sensor

Provides true discharge air temperature sensing in heating and cooling mode.

eFlex™ Variable Speed Scroll Compressor

Precedent™ eFlex™ variable speed scroll compressors are matched with a specially designed variable frequency drive that allows a modulating ratio of up to 4:1. This allows for unmatched control of leaving air temperatures to meet space loads. The eFlex™ compressors also include brushless permanent magnet motors designed to operate at higher efficiency resulting in significant part load energy savings. This makes units with eFlex™ compressors the most efficient products in their class at part load.

Easy Access Low Voltage Terminal Board

Precedent's low voltage terminal board is external to the electrical control cabinet. It is extremely easy to locate and attach the thermostat wire and test operation of all unit functions. This is another cost and time saving installation feature.

Foil Faced Insulation

All panels in the evaporator section of the unit have cleanable foil-faced insulation. All edges are either captured or sealed to ensure no insulation fibers get into the airstream.

eDrive™ Indoor Fan Motor

The eDrive™ direct drive indoor fan motor provides superior efficiencies at a wide range of operating conditions and speeds. These direct drive motors are over 20% more efficient than typical permanent split capacitor motors. They also eliminate the need for routine maintenance associated with belts.

Frostat™

This capillary bulb embedded in the face of the evaporator coil monitors coil temperature to prevent evaporator icing and protect the compressor. Recommended for applications with low leaving air temperatures, low airflow and or high latent load applications.

Heat Exchanger

The compact cabinet features a progressive tubular heat exchanger in low, medium and high heat capacities.

The heat exchanger is fabricated using corrosion-resistant aluminized steel tubes and burners as standard on all models. It has an induced draft blower to pull the gas mixture through the burner tubes. The heater has a direct spark ignition system which doubles as a safety device to prove the flame.

High Pressure Control

All units include high pressure control as standard.

IAQ Dual Sloped, Plastic, Removable, Reversible Drain Pans



Every Precedent™ unit has a plastic, removable, dual-sloped drain pan that's easy to clean and reversible to allow installation of drain trap on either side of the unit.

Low Ambient Cooling

All Precedent™ microprocessor units have cooling capabilities down to 0°F as standard.

Low Voltage Connections

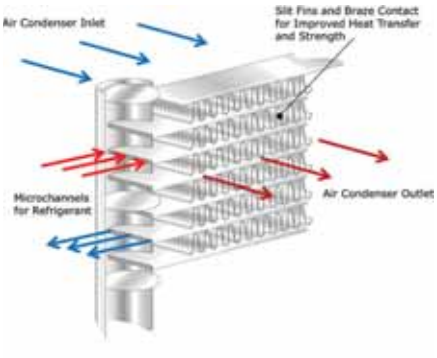
The wiring of the low voltage connections to the unit and the zone sensors is as simple as 1-1, 2-2, and 3-3. This simplified system makes it easy for the installer to wire.

Phase Monitoring Protection

Note: *Available on 3 to 5 ton units only.*

Precedent™ units with are equipped with phase monitoring protection as standard. The phase monitor protects motors by preventing unit operation when there is a phase loss, phase imbalance or phase reversal condition. An illuminated green LED indicates proper phase operation, and an illuminated red LED indicates there is a fault.

Microchannel Condenser Coils[a]



Due to flat streamlined tubes with small ports, and metallurgical tube-to-fin bond, microchannel coil has better heat transfer performance. Microchannel condenser coil can reduce system refrigerant charge by up to 50% because of smaller internal volume, which leads to better compressor reliability. Compact all-aluminum microchannel coils also help to reduce the unit weight. These all aluminum coils are recyclable. Galvanic corrosion is also minimized due to all aluminum construction. Strong aluminum brazed structure provides better fin protection. In addition, flat streamlined tubes also make microchannel coils more dust resistant and easier to clean.

(a) The microchannel type condenser coil is standard for T/YZC048F models.

Quick-Access Panels

Remove two screws for access to the standardized internal components and wiring.

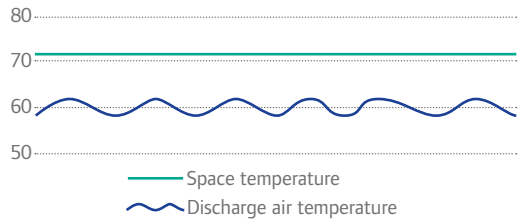
Single Point Power

A single electrical connection powers the unit.

Single Side Service

Single side service is standard on all units.

Single Zone Variable Air Volume



Single Zone VAV control offers full supply fan modulation across the available airflow range. In addition to full supply fan modulation, the unit controls the discharge air temperature to a varying discharge air temperature setpoint in order to maintain space temperature.

Standardized Components

Components are placed in the same location on all Precedent™ units.

Due to standardized components throughout the Precedent™ line, contractors/owners can stock fewer parts.

Thermal Expansion Valve

This feature is standard on all units.

Through-the-Base Condensate

Every unit includes provisions for through-the-base condensate drain connections. This allows the drain to be connected through the roof curb instead of a roof penetration.

Variety of Options

Factory Installed Options[1]

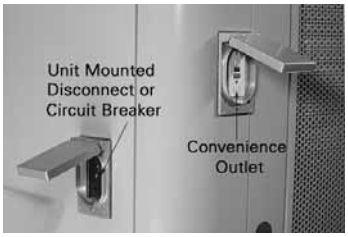
Trane® Air-Fi™ Wireless

Trane® Air-Fi™ wireless communication is a reliable, flexible solution that frees you from the hassles associated with wired components for your building controls system. With Air-Fi™ wireless, you get easy problem solving, efficient performance, and cost savings over the life of the equipment.

Black Epoxy Pre-Coated Coils

The pre-coated coils are an economical option for protection in mildly corrosive environments.

Circuit Breaker (Available on units equipped with Through-the-Base Electrical)



This option is a factory installed thermal magnetic, molded case, HACR circuit breaker with provisions for through the base electrical connections.

Hinged Access Doors



These doors permit easy access to the filter, fan/heat and compressor/control sections. They reduce the potential roof damage from screws or sharp access door corners.

CO_2 Sensor Wiring

Factory-installed $C0_2$ sensor wiring saves time and ensures proper unit connections for the field installed $C0_2$ sensor kits.

CompleteCoat™ Condenser Coil[2]

These coils provide excellent corrosion resistance as well as uniformity of coverage and coating thickness.

Condensate Overflow Switch

A condensate overflow switch is available to shut the unit down in the event that the condensate drain line becomes clogged.This option protects the unit from water overflowing from the drain pan and entering the base of the units.

Disconnect Switch (Available on units equipped with Through-the-Base Electrical)

Factory installed 3-pole, molded case, disconnect switch for through-the-base electrical connections.

Codes require a method of assured unit shutdown for servicing. Field-installed disconnects sometimes interfere with service access. Factory installation of unit disconnects reduces costs, assures proper mounting and provides the opportunity to upgrade to unit circuit breaker protection.

[1] Refer to Model Number Description for option availability.
[2] This option is available for both fin-tube and microchannel condenser coils.

Fault Detection and Diagnostics (FDD)

This offering meets the mandatory requirement of CA Title 24 of fully configurable diagnostics allowing fault history and reading fault codes at the unit. This option provides detection of the following faults: air temperature sensor failure/fault and notification of acceptable economizer mode. The FDD system shall be certified by the Energy Commission as meeting the requirements.

High Efficiency Filtration

Precedent™ units offer a variety of high efficiency filtration options. MERV 8 and MERV 13 filters provide additional filtration beyond the capabilities of typical 2-inch throwaway filters. Also, when MERV 8 or MERV 13 filters are ordered, units come equipped with a filter removal tool.

Human Interface - 5-inch Color Touchscreen

The 5-inch color touchscreen Human Interface provides an intuitive user interface to the rooftop unit that speeds up unit commissioning, shortens unit troubleshooting times, and enhances preventative maintenance measures. The human interface includes several features.



- Data trending capabilities by means of time series graphs
- Historical alarm messages
- Real-time sensor measurements
- On board system setpoints
- USB port that enables the downloading of component runtime information as well as trended historical sensor data
- Customized reports

Note: *Refer to RT-SVX49*-EN for additional information.*

Multiple-Zone VAV Control

A multiple-zone VAV (MZVAV) system consists of a packaged rooftop unit that serves several individually controlled zones. Each zone is equipped with a VAV terminal unit that varies the quantity of air delivered to maintain the desired temperature in that zone. The rooftop unit controller varies the speed of the indoor fan to maintain the static pressure in the supply ductwork at a setpoint, ensuring all zones receive the necessary quantity of air. In addition, cooling capacity is cycled to maintain the supply air temperature at the desired setpoint.

For decades, Trane has been an industry leader in rooftop VAV systems. Now, multiple-zone VAV control is available in Trane's light commercial rooftop platform (3 to 25 tons).

Convenience Outlet



This option is a GFCI, 120V/15amp, 2 plug, convenience outlet, either powered or unpowered. This option can only be ordered when through-the-base electrical with either the disconnect switch or circuit breaker option is ordered.

Note: Powered convenience outlet not available on 460V units.

Stainless Steel Heat Exchanger

The optional stainless steel heat exchanger is constructed of 409 stainless steel tubes and 439 stainless steel burners. It is resistant to corrosion and oxidation and easy to clean. The high strength to weight ratio allows for high ventilation rates with gas units. It is an excellent option to compliment enhanced dehumidification as a high outside air ventilation unit. With this option, a 10-year stainless steel heat exchanger warranty is standard.

Stainless Steel Drain Pan

For excellent corrosion and oxidation resistance, the optional stainless steel drain pan provides a cleanable surface that complement other IAQ solutions such as high efficiency filtration (MERV 8 or 13), demand control ventilation (CO_2).

Supply, Return, and Plenum Air Smoke Detector



With this option installed, if smoke is detected, all unit operation will be shut down. Reset will be manual at the unit. In order for the supply air smoke detector or return air smoke detector to properly sense smoke in the supply air stream or the return air stream, the air velocity entering the smoke detector unit must be between 500 - 4000 feet per minute. Equipment covered in this manual will develop an airflow velocity that falls within these limits over the entire airflow range specified in the evaporator fan performance table. Supply and/or return smoke detectors may not be used with the plenum smoke detector.

Through-the-Base Electrical Utility Access



An electrical service entrance shall be provided allowing electrical access for both control and main power connections inside the curb and through the base of the unit. Option will allow for field installation of liquid-tight conduit and an external field installed disconnect switch.



Factory provided through the base openings simplify wiring and piping. Because these utility openings frequently minimize the number of roof penetrations, the integrity of roofing materials is enhanced.

Factory or Field Installed Options[1]

BACnet® Communications Interface

This interface allows the unit to communicate directly with a generic open protocol BACnet® MS/TP Network Building Automation System Controls.

Barometric Relief

Designed to be used on downflow units, barometric relief is an unpowered means of relieving excess building pressure.

Clogged Filter/Fan Failure Switch

A dedicated differential pressure switch is available to achieve active fan failure indication and/or clogged filter indication.

These sensors allow a zone sensor service light or Integrated Comfort System to indicate a dirty filter or a fan that's not working. The field installation charges for these feedback devices often eliminate them from consideration. Factory installation can make such features a good investment.

Economizer (Standard)

This accessory shall be available with or without barometric relief. The assembly includes fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness with plug, spring return actuator and fixed dry bulb control. The barometric relief shall provide a pressure operated damper that shall be gravity closing and shall prohibit entrance of outside air during the equipment "off" cycle. Optional solid state or differential enthalpy control shall be available for either factory or field installation. The economizer arrives in the shipping position and shall be moved to the operating position by the installing contractor.

Electric Heaters

Electric heat modules are available within the basic unit. If ordering the through-the-base electrical option with an electric heater, the heater must be factory installed.

Fresh Air Options – Dampers and Economizer

Economizers are equipped with either dry bulb or reference or comparative enthalpy sensing. These economizers provide free cooling as the outdoor temperature and/or humidity decreases. Correctly installed, they offer a valuable energy savings. Factory-installed economizers save time and ensure proper installation.

The economizers come with three control options — dry bulb is standard, enthalpy and differential enthalpy are optional.

Low Leak Economizer

This accessory meets low leak requirements for ASHRAE 90.1, IECC, and CA Title 24 standards (3 cfm/ft^2@1" wg exterior air, 4 cfm/ft^2@1" wg return air). This option allows 100% outdoor air supply from 0-100% modulating dampers and is standard with barometric relief. It can be paired with powered exhaust for additional building pressure relief. This option can be paired with or without fault detection and diagnostics (FDD) to meet current mandatory CA Title 24 requirements. Available on downflow units only.

The economizers come with three control options, dry bulb and reference or comparative enthalpy (optional).

LonTalk® Communications Interface

This interface allows the unit to communicate as a Tracer® LCI-V device or directly with the generic LonTalk® Network Building Automation System Controls.

[1] Refer to Model Number Description for option availability.

Reference or Comparative Enthalpy

Measures and communicates humidity while maximizing comfort control.

Hail Guards

Hail protection quality coil guards protects the condenser coil from vandalism and/or hail damage.

Field Installed Options[1]

CO_2 Sensor - Demand Control Ventilation (DCV)

Demand-controlled ventilation (DCV) is a control strategy that responds to the actual demand (need) for ventilation by regulating the rate at which the HVAC system brings outdoor air into the building. A CO_2 sensor measures the concentration (parts per million, ppm) of CO_2 (carbon dioxide) in the air. As the CO_2 concentration changes, the outside air damper modulates to meet the current ventilation needs of the zone.The CO_2 sensor kit is available as a field installed accessory.Two field installed kits are offered; CO_2 sensor and wiring or CO_2 sensor only.The CO_2 sensor only kit should be ordered with factory installed CO_2 sensor wiring. Factory installed CO_2 sensor wiring saves set-up time and ensures proper unit connections for the CO_2 sensor.

Economizer - Low Leak (0-100%)

Meets all leakage requirements for ASHRAE and IECC. With additional fault detection and diagnostics (FDD) complies with California Title 24 requirements.

High Altitude Kit

Previously a Canadian Agency requirement for units applied above 2000 feet, it is not required by the U.S. Domestic contractors should consult with local authority on best practice. Derates gas orifices by 10%.

LP Conversion Kit

Provided for field conversion of gas/electric units from Natural gas to Propane.

Quick Adapt Curbs

Enables easy conversion of existing Voyager™ 3-5 ton units to Precedent™ units on replacement jobs.

Quick Start Kits

Single phase equipment to enable startup and prevent building lighting dimming during low voltage.

Roof Curbs

Available for downflow units. Only two roof curbs for the entire line simplifies curb selection.

Remote Potentiometer

When properly installed in the economizer control circuitry, this accessory provides a remote variable resistance to enable the operator to adjust the minimum damper position.

Ventilation Override Accessory

With the ventilation override accessory installed, the unit can be set to transition to up to 3 different pre-programmed sequences for smoke purge, pressurization, and exhaust. The transition occurs when a binary input on the RTOM is closed (shorted). This would typically be a hard wired relay output from a smoke detector or fire control panel. The ventilation override kit is available as a field installed accessory.

[1] Refer to Model Number Description for option availability.

Zone Sensors

Available in programmable, automatic and manual styles.

Other Benefits

Easy to Install, Service and Maintain

Because today's owners are very cost-conscious when it comes to service and maintenance, the Precedent™ was designed with direct input from service contractors. This valuable information helped to design a product that would get the service person off the job quicker and save the owner money. Precedent™ offers outstanding standard features enhanced by a variety of factory and field installed options, multiple control options, rigorously tested proven designs and superior product and technical support.

Airflow Distribution

Airflow is outstanding. Precedent™ can replace an older machine with old ductwork and, in many cases, improve the comfort through better air distribution.

Cabinet Integrity



For added water integrity, Precedent™ has a raised 1 1/8" lip around the supply and return of the downflow units to prevent water from blowing into the ductwork.

Flexibility

Precedent™ offers ultimate flexibility. Units are built to order in our standard "shortest in the industry" ship cycle time.

Unit Cabinet

The compact cabinet with rounded corners takes up less room and is less costly to ship. The beveled and ribbed top is not only aesthetically pleasing, it is designed to prevent water from pooling.

Rigorous Testing

All of Precedent's designs were rigorously rain tested at the factory to ensure water integrity.

Actual shipping tests were performed to determine packaging requirements. Units were test shipped around the country to determine the best packaging. Factory shake and drop tests were used as part of the package design process to help assure that the unit arrives at the job site in top condition.

Rigging tests include lifting a unit into the air and letting it drop one foot, assuring that the lifting lugs and rails hold up under stress.

We perform a 100% coil leak test at the factory. The evaporator and condenser coils are leak tested at 600 psig. The assembled unit is leak tested to 465 psig.

All parts are inspected at the point of final assembly. Sub-standard parts are identified and rejected immediately.

Every unit receives a 100% unit run test before leaving the production line to make sure it lives up to rigorous Trane requirements.

ReliaTel™ Controls

ReliaTel™ controls provide unit control for heating, cooling and ventilating utilizing input from sensors that measure outdoor and indoor temperature.

ReliaTel™ control logic enhances quality and reliability

- prevents the unit from short cycling, considerably improving compressor life.
- ensures that the compressor will run for a specific amount of time which allows oil to return for better lubrication, enhancing the reliability of the compressor.

Precedent™ units with ReliaTel™ reduces the number of components required to operate the unit, thereby reducing possibilities for component failure.

ReliaTel™ Makes Installing and Servicing Easy

ReliaTel™ eliminates the need for field installed anti-shortcycle timer and time delay relays. ReliaTel controls provide these functions as an integral part of the unit. The contractor no longer has to purchase these controls as options and pay to install them.

The wiring of the low voltage connections to the unit and the zone sensors is as easy as 1-1, 2-2, and 3-3. This simplified system makes wiring easier for the installer.

ReliaTel™ Makes Testing Easy

ReliaTel requires no special tools to run the Precedent™ unit through its paces. Simply place a jumper between Test 1 and Test 2 terminals on the low voltage terminal board and the unit will walk through its operational steps automatically.

The unit automatically returns control to the zone sensor after stepping through the test mode a single time, even if the jumper is left on the unit.

As long as the unit has power and the “system on” LED is lit, ReliaTel™ is operational. The light indicates that the controls are functioning properly.

ReliaTel™ features expanded diagnostic capabilities when utilized with Trane® Integrated Comfort™ Systems.

Some zone sensor options have central control panel lights which indicate the mode the unit is in and possible diagnostic information (dirty filters for example).

Other ReliaTel™ Benefits

The ReliaTel™ built-in anti-shortcycle timer, time delay relay and minimum “on” time control functions are factory tested to assure proper operation.

ReliaTel™ softens electrical “spikes” by staging on fans, compressors and heaters.

Intelligent Fallback is a benefit to the building occupant. If a component fails, the unit will continue to operate at predetermined temperature setpoint.

Intelligent Anticipation is a standard ReliaTel™ feature. It functions continuously as ReliaTel™ and zone sensor(s) work together in harmony to provide much tighter comfort control than conventional electro-mechanical thermostats.

The same ReliaTel™ board fits all packaged gas/electric and cooling with electric heat models. This provides standardization of parts for contractors. Less money is tied up in inventory with ReliaTel™.

Application Considerations

Application of this product should be within the cataloged airflow and cooling considerations.

Barometric Relief

This product line offers an optional barometric relief damper for use in conjunction with economizer option. This accessory consists of gravity dampers which open with increased pressure. As the building air pressure increases, the pressure in the unit return air section also increases, opening the dampers and relieving the conditioned space.

Note: *The effectiveness of barometric relief damper during economizing operation is system related. Pressure drop of the return air system should be considered to control building pressurization.*

Black Epoxy Coil

The coils are manufactured with a thermoset, vinyl coating that is bonded to the aluminum fin stock prior to the fin stamping process. These coils are an economical option for protection in mildly corrosive environments.

Note: *Not to be used where seacoast applications exist.*

Note: *Not available on microchannel condenser coils.*

Clearance Requirements

The recommended clearances identified with unit dimensions should be maintained to assure adequate service maximum capacity and peak operating efficiency. Actual clearances which appear inadequate should be reviewed with the local Trane® sales personnel.

Model Number	Clearance required from duct to combustible surfaces (inches)
TZC036E	0
TZC048F	0
TZC060E	0
TZC072F	1
TZC090F	1
TZC102F	1
TZC120F	1

CompleteCoat™ Condenser Coil

The coils provide protection from corrosive environments and are ideal for seacoast applications.

Condensate Trap

The evaporator is a draw-thru configuration. A trap must be field provided prior to start-up on the cooling cycle.

Heating Operation

The heat exchanger is manufactured with aluminized steel. To prevent condensation within the heat exchanger, do not exceed 50% outside air or a minimum mixed air temperature of 40°F.

Low Ambient Cooling

The Precedent™ line features, with ReliaTel™ microprocessor controls, low ambient cooling down to 0°F. The following features or options need to be included/considered when low ambient applications are required: continuous fan operation, crankcase heaters, thermal expansion valves, Frostat™.

Contact a local Trane® Representative for more assistance with low ambient cooling applications.

Optional Stainless Steel Heat Exchanger

The optional stainless steel heat exchanger is manufactured with 409 stainless steel tubes and 439 stainless steel burners. To prevent corrosion and prolong heat exchanger reliability, the minimum mixed air temperature allowed across the heat exchanger is 20°F.

The stainless steel heat exchanger option is an excellent option that compliments the dehumidification package. Whenever high outside air or outside applications exist, these options should be utilized.

Unit Pitch

These units have reversible sloped condensate drain pans. Units must be installed level. Any unit slope must be toward the side of unit where condensate drain is connected.

Sequence of Operation

General Standby Mode

During normal occupied periods, when there is no space cooling or heating demands, the user will be able to choose constant or cycling supply fan operation. During this period, if the supply fan is operating due to a constant fan mode selection or due to a ventilation request, the supply fan will operate at 50% of the user selected, application specific, maximum airflow. The unit controls will be compatible with BACnet® and LonTalk® Building Automation System communication interfaces.

Cooling Operation

Default Operation

During cooling operation, the control will monitor the space temperature and space cooling setpoint and with a PI control algorithm determine if active cooling capacity is required. As the space temperature deviates from the space cooling setpoint, the unit controller will calculate an active discharge air cooling setpoint that the economizer (if installed) and compressor and outdoor fan outputs will be modulated to meet. This active discharge air cooling setpoint will be calculated between the space cooling setpoint and a user adjustable minimum [65°F default for Single Zone Variable Air Volume (SZVAV)]. Once the control determines that a discharge air temperature equal to the user selected minimum (65°F default) is required to meet the space cooling demand, if the space demand continues to increase, the supply fan speed will be allowed to increase above its minimum speed proportionally to meet the additional demand.

Alternate Economizer Operation

Under the default operation, as described above, the supply fan speed will remain at minimum speed, as determined by the active cooling stages, until the space demand requires an increase in supply airflow. The customer will have the ability to choose to allow the supply fan speed to increase when the economizer is enthalpy enabled in order to realize the maximum cooling capacity of the economizer, prior to energizing compressor outputs, when the space requires active cooling capacity. All cooling capacity demand decisions will function as described in the “Default Operation” section above with the exception of the supply fan speed when the unit has an active cooling demand and the economizer is enthalpy enabled.

Heating Operation

During heating operation, the control will monitor the space temperature and space heating setpoint and with a PI control algorithm determine if active heating capacity is required. As the space temperature deviates from the space heating setpoint, the unit controller will increase the supply airflow up to the user selected, application specific, maximum airflow and begin to energize the heating (gas or electric) to meet space demand. The customer will also have the ability to enable supply air tempering control which will allow the unit to bring on one stage of heating when the

discharge air temperature falls below the space heating setpoint - 10°F and the unit is operating in a minimum ventilation state with the supply fan running (not actively heating or cooling). The supply fan output will increase to the user selected, application specific, maximum airflow during supply air tempering operation.

Enhanced Dehumidification

Enhanced dehumidification will be available on all units equipped with a space humidity sensor. Once the space humidity value exceeds the dehumidification setpoint and dehumidification is enabled the unit will maintain the compressor operation and reduce the indoor fan airflow to increase latent capacity. If the space humidity value exceeds the dehumidification setpoint during no active call for cooling, the unit will energize the compressor and fans to an optimum capacity for dehumidification. If during active enhanced dehumidification the space humidity falls below the dehumidification setpoint - 2%, dehumidification will be terminated and the unit will transition back to normal cooling or heating control.

Selection Procedure

Cooling Capacity

Note: *Cooling Capacity Procedure is the same for electric heat (TZC) and gas heat (YZC).*

1. Calculate the building's total and sensible cooling loads at design conditions. Use the Trane® calculation methods or any other standard accepted method.

Factors used in unit selection:

- Packaged Cooling with Optional Electric Heat
- Total Cooling Load: 44 MBh
- Sensible Cooling Load: 35 MBh
- Airflow: 1600 cfm
- Electrical Characteristics: 460/60/3
- Summer Design Conditions: Entering Evaporator Coil: 80 DB
- 67WB Outdoor Ambient: 95
- External Static Pressure: 0.36 in. wg
- Downflow Configuration
- Efficiency: Ultra High
- Economizer

2. A rough determination must be made of the size of the unit. The final selection will be made after examining the performance at the given conditions. Divide the total cooling load by nominal Btu/h per ton (12 MBh per ton); then round up to the nearest unit size.

44 MBh / 12 MBh = approx. 4 tons

3. Table 7, p. 37 shows that a TZC048F4 has a **gross** cooling capacity of 46.27 MBh and 37.21 MBh sensible capacity at 1600 cfm and 95 DB outdoor ambient with 80 DB, 67 WB air entering the evaporator.

To Find Capacity at Intermediate Conditions not in the table.

When the design conditions are between two numbers that are in the capacity table, interpolation is required to approximate the capacity.

Note: *Extrapolation outside of the table conditions is not recommended.*

In order to select the correct unit which meets the building's requirements, the fan motor heat must be deducted from the gross cooling capacity. The amount of heat that the fan motor generates is dependent on the effort by the motor - cfm and static pressure.

4. Determine the total unit static pressure:

External Static Duct System	0.36 wg
Standard Filter from Table 46, p. 82	0.03 wg
Economizer from Table 46, p. 82 (100% Outside Air) *worst case	0.09 wg
Electric Heater Size 6 kW from Table 46, p. 82 (reference "Heating Capacity" section on this page for determination of heater size)	0.02 wg
Total Static Pressure	0.50 wg

Note: *The evaporator fan performance Table 16, p. 53 has deducted the pressure drop for a filter already in the unit (see note below Table 16, p. 53).Therefore, the actual total static pressure is 0.50 - 0.03 (from Table 46, p. 82) = 0.47 in. wg.*

With 1600 cfm and 0.5 in. wg.

Table 46, p. 82 shows 0.43 bhp for this unit.

Note: *Below the table is the formula to calculate fan motor heat*

2.9245 x bhp + 0.055 = MBh.

2.9245 x 0.43 + 0.055 = 1.3 MBh.

Now subtract the fan motor heat from the gross cooling capacity of the unit:

Net Total Cooling Capacity

= 46.27 MBh - 1.3 = 44.97 MBh

Net Sensible Cooling Capacity

= 37.21 MBh - 1.3 = 35.91 MBh

Subtracting Sensible from Total Capacity to find Latent Capacity

Net Latent Capacity

= 44.97 - 35.91 = 9.06MBh

5. Compare your resulting capacities to the building load. If the performance will not meet the required load of the building's total or sensible cooling load, try a selection at the next higher size unit.

Heating Capacity

Note: *Heating capacity procedure DIFFERS for electric heat (TZC) and gas heat (YZC) units*

1. Calculate the building heating load using the Trane® calculation form or other standard accepted method.
2. Size the system heating capacity to match the calculated building heating load. The following are building heating requirements:

Total heating load of 15 MBh

1600 cfm

TZC units with optional electric heat: 460V/3 phase Power Supply

The electric heat accessory capacities are listed in Table 49, p. 84. From the table, a 6kW heater will deliver 20.48 MBh at 480 volts. In order to determine capacity at 460 volts, the heater voltage correction factor from Table 50, p. 85 must be used. Therefore, 20.48 MBh x 0.918 (voltage correction factor) = 18.8 MBh

YZC units with gas heat: Fuel- natural gas.

60 MBh, 80MBh and 120MBh input models shown in Table 48, p. 84. The output capacities of these furnaces are 48 MBh, 64 MBh and 96 MBh respectively. The low heat model with 48 MBh best matches the building requirements.

Air Delivery Selection

Note: *Air delivery procedure is the same for electric heat and gas heat units.)*

External static pressure drop through the air distribution system has been calculated to be 0.5 inches of water. Enter Table 16, p. 53 for a TZC048F4 at 1600 cfm and 0.5 static pressure. The standard direct drive motor will give the desired airflow at a rated bhp of 0.43 and 761 rpm.

Model Number Descriptions

Digit 1 - Unit Type
T DX Cooling
Y DX Cooling, Gas Heat

Digit 2 - Efficiency
Z Ultra High Efficiency

Digit 3 - Airflow
C Convertible

Digit 4,5,6 - Nominal Gross Cooling Capacity (MBh)
036 3 Ton
048 4 Ton
060 5 Ton
072 6 Ton
090 7.5Ton
102 8.5 Ton
120 10 Ton

Digit 7 - Major Design Sequence
E R-410A Refrigerant
F Microchannel Type Condenser Coils with R-410A Refrigerant[11]

Digit 8 - Voltage Selection
3 208-230/60/3
4 460/60/3
W 575/60/3

Digit 9 - Unit Controls
R ReliaTel™ Microprocessor

Digit 10 - Heating Capacity

Note: *Applicable to Digit 1, T models only*
0 No Electric Heat
B 6 kW (3 phase)
C 9 kW (3 phase)
E 12 kW (3 phase)
G 18 kW (1 and 3 phase)
J 23 kW (3 phase)
K 27 kW (3 phase)
N 36 kW (3 phase)
P 54 kW (3 phase)

Note: *Applicable to Digit 1, Y models only*
L Low Heat
M Medium Heat
H High Heat
X Low Heat, Stainless Steel Heat Exchanger
Y Medium Heat, Stainless Steel Heat Exchanger
Z High Heat, Stainless Steel Heat Exchanger
V Modulating Gas Heat

Digit 11 - Minor Design Sequence
A First Sequence

Digit 12,13 - Service Sequence
** Factory Assigned

Digit 14 - Fresh Air Selection
0 No Fresh Air
C Economizer, Dry Bulb 0-100% without Barometric Relief[2]
D Economizer, Dry Bulb 0-100% with Barometric Relief[2]
E Economizer, Reference Enthalpy 0-100% without Barometric Relief[2]
F Economizer, Reference Enthalpy 0-100% with Barometric Relief[2]
G Economizer, Comparative Enthalpy 0-100% without Barometric Relief[2]
H Economizer, Comparative Enthalpy 0-100% with Barometric Relief[2]
K Low Leak Economizer with Barometric Relief
M Low Leak Economizer with Reference Enthalpy with Barometric Relief
P Low Leak Economizer with Comparative Enthalpy with Barometric Relief

Digit 15 - Supply Fan/Drive Type/ Motor
6 Single Zone VAV[10]
E VAV Supply Air Temperature Control - Standard Motor

Digit 16 - Hinged Service Access/ Filters
0 Standard Panels/Standard Filters
A Hinged Access Panels/Standard Filters
B Standard Panels/2" MERV 8 Filters
C Hinged Access Panels/2" MERV 8 Filters
D Standard Panels/2" MERV 13 Filters
E Hinged Access Panels/2" MERV 13 Filters

Digit 17 - Condenser Coil Protection
0 Standard Coil
1 Standard Coil with Hail Guard
2 Black Epoxy Pre-Coated Condenser Coil[12]
3 Black Epoxy Pre-Coated Condenser Coil with Hail Guard[12]
4 CompleteCoat™ Condenser Coil
5 CompleteCoat™ Condenser Coil with Hail Guard

Digit 18 - Through the Base Provisions
0 No Through-the-Base Provisions
A Through-the-Base Electric[3]
B Through-the-Base Gas Piping[7]
C Through-the-Base Electric and Gas Piping[7]

Digit 19 - Disconnect/Circuit Breaker (three-phase only)
0 No Disconnect/No Circuit Breaker
1 Unit Mounted Non-Fused Disconnect[3]
2 Unit Mounted Circuit Breaker[3]

Digit 20 - Convenience Outlet
0 No Convenience Outlet
A Unpowered Convenience Outlet
B Powered Convenience Outlet (three-phase only)[4]

Digit 21 - Communications Options
0 No Communications Interface
2 LonTalk® Communications Interface
6 BACnet® Communications Interface
7 Air-Fi™ Wireless Communications[16]

Digit 22 - Refrigeration System Option
0 Standard Refrigeration System[5]

Digit 23 - Refrigeration Controls
0 Without Refrigeration Controls[1]

Digit 24 - Smoke Detector[8]
0 No Smoke Detector
A Return Air Smoke Detector[6]
B Supply Air Smoke Detector
C Supply and Return Air Smoke Detectors[6]
D Plenum Smoke Detector

Digit 25 - System Monitoring Controls[14]
0 Standard Monitoring System
1 Clogged Filter Switch
2 Fan Failure Switch
4 Clogged Filter Switch and Fan Failure Switch
A Condensate Drain Pan Overflow Switch
B Clogged Filter Switch and Condensate Drain Pan Overflow Switch
C Fan Failure Switch and Condensate Drain Pan Overflow Switch
E Clogged Filter Switch, Fan Failure Switch and Condensate Drain Pan Overflow Switch

Digit 26 - System Monitoring Controls
0 No Monitoring Controls
A Demand Control Ventilation (CO_2)[9,13]
B Low Leak Economizer with FDD (Fault Detection and Diagnostics)
C FDD (Fault Detection and Diagnostics) with DCV (Demand Control Ventilation)

Digit 27 - Unit Hardware Enhancements

0 No Enhancements
1 Stainless Steel Drain Pan

Digit 31 - Advanced Unit Controls

0 Standard Unit Controls
1 Human Interface

Model Number Notes

1. Standard on all eFlex™ and eDrive™ units.
2. Economizer with Barometric Relief is for downflow configured units only. Order Economizer without Barometric Relief for horizontal configuration. Barometric Relief for horizontal configured units must be ordered as field installed accessory.
3. Through the base electric required when ordering disconnect/circuit breaker options.
4. Requires use of Disconnect or Circuit Breaker.
5. Standard metering devices are TXVs.
6. The return air smoke detector may not fit up or work properly on the Precedent units when used in conjunction with 3rd party accessories such as bolt on heat wheels, economizers and power exhaust. Do not order the return air smoke detectors when using this type of accessory.
7. Includes gas piping and shutoff (field assembly required).
8. Not available with high temperature duct sensor accessory.
9. Demand Control Ventilation Option includes wiring only. The CO_2 sensor is a field-installed only option.
10. Discharge Air Temperature Sensor is also standard equipment on units with Single Zone.
11. Standard on T/YZC 4 ton models.
12. Epoxy coil and epoxy with hail guard option not available for units with microchannel condenser coil.
13. Requires selection of 2″ pleated filters (option B or C) for Digit 16.
14. Discharge Air Sensing Tube is standard.
15. Field installed only.
16. Must be used with BACnet® open protocol.

General Data

Table 1. General data - 3 to 5 tons with eFlex™ and eDrive™ technology (208/230 volt)

	3 Tons	4 Tons	5 Tons
	T/YZC036E3	**T/YZC048F3**	**T/YZC060E3**
Cooling Performance[a]			
Gross Cooling Capacity - Full Load	36,600	46,000	60,500
EER/SEER[b]	13.0/20.1	13.6/19.4	12.9/19.6
Nominal cfm/AHRI Rated cfm	1,200/1,100	1,600/1,350	2,000/1,900
AHRI Net Cooling Capacity - Full Load	35,800	44,500	59,000
System Power (kW)	2.75	3.27	4.58
Compressor			
Number/Type	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)
Sound			
Outdoor Sound Rating (dB)[c]	81	87	87
Outdoor Coil - Type	Tube-Fin	Microchannel	Tube-Fin
Tube Size (in.) OD	0.3125	—	0.3125
Coil Width (in.)	—	0.71	—
Face Area (sq. ft.)	17.0	17.5	17.0
Rows/FPI	3/16	1/20	3/16
Indoor Coil - Type	Lanced	Lanced	Lanced
Tube Size (in.) ID	0.3125	0.3125	0.3125
Face Area (sq. ft.)	7.71	9.27	9.89
Rows/FPI	3/16	3/16	4/16
Refrigerant Control	Thermal Expansion Valve	Thermal Expansion Valve	Thermal Expansion Valve
Drain Connection Number/Size (in.)	1¾ NPT	1¾ NPT	1¾ NPT
Outdoor Fan - Type	Propeller	Propeller	Propeller
Number Used/Diameter (in.)	1/22	1/26	1/26
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable
cfm	3,064	3,982	3,953
Motor hp	0.33	0.5	0.5
Motor rpm	1,100	1,100	1,100
Indoor Fan - Type	FC Centrifugal	FC Centrifugal	FC Centrifugal
Number Used/Diameter (in.)/Width (in.)	1/11x11	1/11x11	1/11x11
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable
Number Motors	1	1	1
Motor hp (Standard/Oversized)	0.75	1.0	1.0
Motor Frame Size (Standard/Oversized)	48	48	48
Filters[d]			
Type Furnished	Throwaway	Throwaway	Throwaway
Number Size Recommended	(2) 20x30x2	(4) 16x25x2	(4) 16x25x2
Refrigerant Charge[e]			
Pounds of R-410A	7.8	6.0	11.9

continued on next page

Table 1. General data - 3 to 5 tons with eFlex™ and eDrive™ technology (208/230 volt) (continued)

	3 Tons	4 Tons	5 Tons
	T/YZC036E3	T/YZC048F3	T/YZC060E3
Heating Performance[f]			
(Gas/Electric Only)			
Heating Input			
Low Heat Input (Btu)	60,000	60,000	60,000
Mid Heat Input (Btu)	80,000	80,000	80,000
High Heat Input (Btu)	100,000	120,000	130,000
Heating Output			
Low Heat Input (Btu)	48,000	49,000	49,000
Mid Heat Input (Btu)	64,000	64,000	64,000
High Heat Input (Btu)	80,000	96,000	104,000
AFUE% [g]			
Low Heat Input (Btu)	78	80	80
Mid Heat Input (Btu)	78	79	79
High Heat Input (Btu)	78	79	80
Steady State Efficiency%			
Low Heat Input (Btu)	80	81	81
Mid Heat Input (Btu)	80	80	80
High Heat Input (Btu)	81	81	80
No. Burners			
Low Heat Input (Btu)	2	2	2
Mid Heat Input (Btu)	2	2	2
High Heat Input (Btu)	3	3	3
No. Stages			
Low Heat Input (Btu)	1	1	1
Mid Heat Input (Btu)	1	1	1
High Heat Input (Btu)	1	1	1
Gas Supply Line Pressure			
Natural (minimum/maximum)	4.5/14.0	4.5/14.0	4.5/14.0
LP (minimum/maximum)	11.0/14.0	11.0/14.0	11.0/14.0
Gas Connection Pipe Size (in)			
Low Heat	1/2	1/2	1/2
Mid Heat	1/2	1/2	1/2
High Heat	1/2	1/2	1/2

(a) High Stage Cooling Performance is rated at 95°F ambient, 80°F entering dry bulb, 67°F entering wet bulb. Gross capacity does not include the effect of fan motor heat. AHRI capacity is net and includes the effect of fan motor heat. Units are suitable for operation to ±20% of nominal cfm. Units are certified in accordance with the Unitary Air-Conditioner Equipment certification program, which is based on AHRI standard 210/240.
(b) EER and/or SEER are rated at AHRI conditions and in accordance with DOE test procedures.
(c) Outdoor Sound Rating shown is tested in accordance with AHRI Standard 270. For additional information reference the outdoor sound power level data in the performance section.
(d) Optional 2" MERV 8 and MERV 13 filters also available.
(e) Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.
(f) Heating performance limit settings and rating data were established and approved under laboratory test conditions using American National Standards Institute standards. Ratings shown are for elevations up to 2000 feet. For elevations above 2000 feet, ratings should be reduced at the rate of 4% for each 1000 feet above sea level. Applicable to Gas/Electric units only.
(g) AFUE is rated in accordance with DOE test procedures.

Table 2. General data - 6 to 10 tons with eFlex™ and eDrive™ technology (208/230 volt)

	6 Tons	7.5 Tons	8.5 Tons	10 Tons
	T/YZC072F3	T/YZC090F3	T/YZC102F3	T/YZC120F3
Cooling Performance[a]				
Gross Cooling Capacity - Full Load	71,000	92,000	103,000	117,000
EER/IEER[b]	12.8/23.2	12.8/22.4	12.6/22.5	12.1/23.0
Nominal cfm/AHRI Rated cfm	2,400/2,400	3,000/2,850	3,400/2,975	4,000/4,000
AHRI Net Cooling Capacity - Full Load	70,000	90,000	99,000	114,000
System Power (kW)	5.47	7.03	7.86	9.42
Compressor				
Number/Type	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)
Sound				
Outdoor Sound Rating (dB)[c]	89	89	89	89
Outdoor Coil - Type	Microchannel	Microchannel	Microchannel	Microchannel
Coil Width (in.)	0.8	1.0	1.0	1.0
Face Area (sq. ft.)	20.8	20.9	20.9	26.7
Rows/FPI	1/23	1/20	1/20	1/20
Indoor Coil - Type	Lanced	Lanced	Lanced	Lanced
Tube Size (in.) ID	0.3125	0.3125	0.3125	0.3125
Face Area (sq. ft.)	12.4	12.4	12.4	16.7
Rows/FPI	5/16	4/16	4/16	4/16
Refrigerant Control	Thermal Expansion Valve	Thermal Expansion Valve	Thermal Expansion Valve	Thermal Expansion Valve
Drain Connection Number/Size (in.)	1¾ NPT	1¾ NPT	1¾ NPT	1¾ NPT
Outdoor Fan - Type	Propeller	Propeller	Propeller	Propeller
Number Used/Diameter (in.)	1/26	1/26	1/26	1/30
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable	Direct/Variable
cfm	5,865	6,806	6,770	7,611
Motor hp	0.75	0.75	0.75	0.75
Motor rpm (max.)	1,200	1,200	1,200	1,200
Indoor Fan - Type	EBM	EBM	EBM	EBM
Number Used/Diameter (in.)	1/23.03	1/23.03	1/23.03	1/23.03
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable	Direct/Variable
Number Motors	1	1	1	1
Motor hp (Standard/Oversized)	2.75	2.75	2.75	2.75
Filters[d]				
Type Furnished	Throwaway	Throwaway	Throwaway	Throwaway
Number Size Recommended	(4) 2x20x25	(4) 2x20x25	(4) 2x20x25	(3) 2x20x25 (2) 2x20x30
Refrigerant Charge[e]				
Pounds of R-410A	8.3	8.7	8.9	10.5

continued on next page

Table 2. General data - 6 to 10 tons with eFlex™ and eDrive™ technology (208/230 volt) (continued)

	6 Tons	7.5 Tons	8.5 Tons	10 Tons
	T/YZC072F3	T/YZC090F3	T/YZC102F3	T/YZC120F3
Heating Performance[f]				
(Gas/Electric Only)				
Heating Input				
Low Heat Input (Btu)	80,000	120,000	120,000	150,000
Mid Heat Input (Btu)	120,000	150,000	150,000	200,000
High Heat Input (Btu)	150,000	200,000	200,000	250,000
Modulating Heat Input (Btu)	150,000	200,000	200,000	250,000
Heating Output				
Low Heat Input (Btu)	64,800	97,200	97,200	121,500
Mid Heat Input (Btu)	97,200	121,500	121,500	162,000
High Heat Input (Btu)	121,500	162,000	162,000	202,500
Modulating Heat (Btu)	121,500	162,000	162,000	202,500
Steady State Efficiency%				
Low Heat Input (Btu)	81	81	81	81
Mid Heat Input (Btu)	81	81	81	81
High Heat Input (Btu)	81	81	81	81
Modulating Heat (Btu)	81	81	81	81
No. Burners				
Low Heat Input (Btu)	3	3	3	3
Mid Heat Input (Btu)	3	3	3	4
High Heat Input (Btu)	3	5	5	5
Modulating Heat (Btu)	3	5	5	5
No. Stages				
Low Heat Input (Btu)	1	1	1	2
Mid Heat Input (Btu)	1	2	2	2
High Heat Input (Btu)	2	2	2	2
Modulating Heat (Btu)	2.5:1 Modulating	2.5:1 Modulating	2.5:1 Modulating	2.5:1 Modulating
Gas Supply Line Pressure (w.c.)				
Natural (minimum/maximum) Low/Mid/High	4.5/14.0	4.5/14.0	4.5/14.0	4.5/14.0
Natural (minimum/maximum) Mod Heat	5.5/14.0	5.5/14.0	5.5/14.0	5.5/14.0
LP (minimum/maximum)	11.0/14.0	11.0/14.0	11.0/14.0	11.0/14.0
Gas Connection Pipe Size (in)				
Low Heat	1/2	1/2	1/2	3/4
Mid Heat	1/2	3/4	3/4	3/4
High Heat	3/4	3/4	3/4	3/4
Modulating Heat	3/4	3/4	3/4	3/4

(a) High stage cooling performance is rated at 95°F ambient, 80°F entering dry bulb, 67°F entering wet bulb. Gross capacity does not include the effect of fan motor heat. AHRI capacity is net and includes the effect of fan motor heat. Units are suitable for operation to ±20% of nominal cfm. Units are certified in accordance with the Unitary Air-Conditioner Equipment certification program, which is based on AHRI standard 340/360.
(b) EER and/or IEER are rated at AHRI conditions and in accordance with DOE test procedures.
(c) Outdoor Sound Rating shown is tested in accordance with AHRI Standard 270. For additional information reference the outdoor sound power level data in the performance section.
(d) Optional 2" MERV 8 and MERV 13 filters also available.
(e) Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.
(f) Heating performance limit settings and rating data were established and approved under laboratory test conditions using American National Standards Institute standards. Ratings shown are for elevations up to 2000 feet. For elevations above 2000 feet, ratings should be reduced at the rate of 4% for each 1000 feet above sea level. Applicable to gas/electric units only.

Table 3. General data - 3 to 5 tons with eFlex™ and eDrive™ technology (460 volt)

	3 Tons	4 Tons	5 Tons
	T/YZC036E4	**T/YZC048F4**	**T/YZC060E4**
Cooling Performance[a]			
Gross Cooling Capacity - Full Load	36,600	46,000	58,500
EER/SEER[b]	12.9/19.5	13.3/18.5	12.5/18.4
Nominal cfm/AHRI Rated cfm	1,200/1,100	1,600/1,350	2,000/1,900
AHRI Net Cooling Capacity - Full Load	35,800	44,500	57,000
System Power (kW)	2.78	3.35	4.56
Compressor			
Number/Type	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)
Sound			
Outdoor Sound Rating (dB)[c]	81	87	87
Outdoor Coil - Type	Tube-Fin	Microchannel	Tube-Fin
Tube Size (in.) OD	0.3125	—	0.3125
Coil Width (in.)	—	0.71	—
Face Area (sq. ft.)	10.96	17.5	17.0
Rows/FPI	3/16	1/20	3/16
Indoor Coil - Type	Lanced	Lanced	Lanced
Tube Size (in.) ID	0.3125	0.3125	0.3125
Face Area (sq. ft.)	7.71	9.27	9.89
Rows/FPI	3/16	3/16	4/16
Refrigerant Control	Thermal Expansion Valve	Thermal Expansion Valve	Thermal Expansion Valve
Drain Connection Number/Size (in.)	1¾ NPT	1¾ NPT	1¾ NPT
Outdoor Fan - Type	Propeller	Propeller	Propeller
Number Used/Diameter (in.)	1/22	1/26	1/26
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable
cfm	3,064	3,982	3,953
Motor hp	0.33	0.5	0.5
Motor rpm	1,100	1,100	1,100
Indoor Fan - Type (Optional)	FC Centrifugal	FC Centrifugal	FC Centrifugal
Number Used/Diameter (in.)/Width (in.)	1/11x11	1/11x11	1/11x11
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable
Number Motors	1	1	1
Motor hp (Standard/Oversized)	0.75	1.0	1.0
Motor Frame Size (Standard/Oversized)	48	48	48
Filters[d]			
Type Furnished	Throwaway	Throwaway	Throwaway
Number Size Recommended	(2) 20x30x2	(4) 16x25x2	(4) 16x25x2
Refrigerant Charge[e]			
Pounds of R-410A	7.8	6.0	12.0

continued on next page

Table 3. General data - 3 to 5 tons with eFlex™ and eDrive™ technology (460 volt) (continued)

	3 Tons	4 Tons	5 Tons
	YZC036E4	YZC048F4	YZC060E4
Heating Performance[f]			
(Gas/Electric Only)			
Heating Input			
Low Heat Input (Btu)	60,000	60,000	60,000
Mid Heat Input (Btu)	80,000	80,000	80,000
High Heat Input (Btu)	100,000	120,000	130,000
Heating Output			
Low Heat Input (Btu)	48,000	49,000	49,000
Mid Heat Input (Btu)	64,000	64,000	64,000
High Heat Input (Btu)	80,000	96,000	104,000
Steady State Efficiency%			
Low Heat Input (Btu)	80	81	81
Mid Heat Input (Btu)	80	80	80
High Heat Input (Btu)	81	81	80
No. Burners			
Low Heat Input (Btu)	2	2	2
Mid Heat Input (Btu)	2	2	2
High Heat Input (Btu)	3	3	3
No. Stages			
Low Heat Input (Btu)	1	1	1
Mid Heat Input (Btu)	1	1	1
High Heat Input (Btu)	1	1	1
Gas Supply Line Pressure			
Natural (minimum/maximum)	4.5/14.0	4.5/14.0	4.5/14.0
LP (minimum/maximum)	11.0/14.0	11.0/14.0	11.0/14.0
Gas Connection Pipe Size (in)			
Low Heat	1/2	1/2	1/2
Mid Heat	1/2	1/2	1/2
High Heat	1/2	1/2	1/2

(a) High Stage Cooling Performance is rated at 95°F ambient, 80°F entering dry bulb, 67°F entering wet bulb. Gross capacity does not include the effect of fan motor heat. AHRI capacity is net and includes the effect of fan motor heat. Units are suitable for operation to ±20% of nominal cfm. Units are certified in accordance with the Unitary Air-Conditioner Equipment certification program, which is based on AHRI standard 210/240.
(b) EER and/or SEER are rated at AHRI conditions and in accordance with DOE test procedures.
(c) Outdoor Sound Rating shown is tested in accordance with AHRI Standard 270. For additional information reference the outdoor sound power level data in the performance section.
(d) Optional 2" MERV 8 and MERV 13 filters also available.
(e) Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.
(f) Heating performance limit settings and rating data were established and approved under laboratory test conditions using American National Standards Institute standards. Ratings shown are for elevations up to 2000 feet. For elevations above 2000 feet, ratings should be reduced at the rate of 4% for each 1000 feet above sea level. Applicable to Gas/Electric units only.

Table 4. General data - 6 to 10 tons with eFlex™ and eDrive™ technology (460 volt)

	6 Tons	7.5 Tons	8.5 Tons	10 Tons
	T/YZC072F4	T/YZC090F4	T/YZC102F4	T/YZC120F4
Cooling Performance[a]				
Gross Cooling Capacity - Full Load	71,000	92,000	103,000	117,000
EER/IEER[b]	12.6/23.2	12.8/22.4	12.6/22.5	12.2/23.0
Nominal cfm/AHRI Rated cfm	2,400/2,400	3,000/2,850	3,400/2,975	4,000/4,000
AHRI Net Cooling Capacity - Full Load	70,000	90,000	99,000	114,000
System Power (kW)	5.56	7.03	7.86	9.34
Compressor				
Number/Type	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)
Sound				
Outdoor Sound Rating (dB)[c]	89	89	89	89
Outdoor Coil - Type	Microchannel	Microchannel	Microchannel	Microchannel
Coil Width (in.)	0.8	1.0	1.0	1.0
Face Area (sq. ft.)	20.8	20.9	20.9	26.7
Rows/FPI	1/23	1/20	1/20	1/20
Indoor Coil - Type	Lanced	Lanced	Lanced	Lanced
Tube Size (in.) ID	0.3125	0.3125	0.3125	0.3125
Face Area (sq. ft.)	12.4	12.4	12.4	16.7
Rows/FPI	5/16	4/16	4/16	4/16
Refrigerant Control	Thermal Expansion Valve	Thermal Expansion Valve	Thermal Expansion Valve	Thermal Expansion Valve
Drain Connection Number/Size (in.)	1¾ NPT	1¾ NPT	1¾ NPT	1¾ NPT
Outdoor Fan - Type	Propeller	Propeller	Propeller	Propeller
Number Used/Diameter (in.)	1/26	1/26	1/26	1/30
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable	Direct/Variable
cfm	5,864	6,806	6,771	7,613
Motor hp	0.75	0.75	0.75	0.75
Motor rpm	1,200	1,200	1,200	1,200
Indoor Fan - Type (Optional)	EBM	EBM	EBM	EBM
Number Used/Diameter (in.)	1/23.03	1/23.03	1/23.03	1/23.03
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable	Direct/Variable
Number Motors	1	1	1	1
Motor hp (Standard/Oversized)	2.75	2.75	2.75	2.75
Filters[d]				
Type Furnished	Throwaway	Throwaway	Throwaway	Throwaway
Number Size Recommended	(4) 2x20x25	(4) 2x20x25	(4) 2x20x25	(3) 2x20x25 (2) 2x20x30
Refrigerant Charge[e]				
Pounds of R-410A	8.3	8.7	8.9	10.5

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Table 4. General data - 6 to 10 tons with eFlex™ and eDrive™ technology (460 volt) (continued)

	6 Tons	7.5 Tons	8.5 Tons	10 Tons
	T/YZC072F4	T/YZC090F4	T/YZC102F4	T/YZC120F4
Heating Performance(f)				
(Gas/Electric Only)				
Heating Input				
Low Heat Input (Btu)	80,000	120,000	120,000	150,000
Mid Heat Input (Btu)	120,000	150,000	150,000	200,000
High Heat Input (Btu)	150,000	200,000	200,000	250,000
Modulating Heat Input (Btu)	150,000	200,000	200,000	250,000
Heating Output				
Low Heat Input (Btu)	64,800	97,200	97,200	121,500
Mid Heat Input (Btu)	97,200	121,500	121,500	162,000
High Heat Input (Btu)	121,500	162,000	162,000	202,500
Modulating Heat Input (Btu)	121,500	162,000	162,000	202,500
Steady State Efficiency%				
Low Heat Input (Btu)	81	81	81	81
Mid Heat Input (Btu)	81	81	81	81
High Heat Input (Btu)	81	81	81	81
Modulating Heat Input (Btu)	81	81	81	81
No. Burners				
Low Heat Input (Btu)	3	3	3	3
Mid Heat Input (Btu)	3	3	3	4
High Heat Input (Btu)	3	5	5	5
Modulating Heat Input (Btu)	3	5	5	5
No. Stages				
Low Heat Input (Btu)	1	1	1	2
Mid Heat Input (Btu)	1	2	2	2
High Heat Input (Btu)	2	2	2	2
Modulating Heat Input (Btu)	2.5:1 Modulating	2.5:1 Modulating	2.5:1 Modulating	2.5:1 Modulating
Gas Supply Line Pressure (w.c.)				
Natural (minimum/maximum) Low/Mid/High	4.5/14.0	4.5/14.0	4.5/14.0	4.5/14.0
Natural (minimum/maximum) Mod Heat	5.5/14.0	5.5/14.0	5.5/14.0	5.5/14.0
LP (minimum/maximum)	11.0/14.0	11.0/14.0	11.0/14.0	11.0/14.0
Gas Connection Pipe Size (in)				
Low Heat	1/2	1/2	1/2	3/4
Mid Heat	1/2	3/4	3/4	3/4
High Heat	3/4	3/4	3/4	3/4
Modulating Heat	3/4	3/4	3/4	3/4

(a) High stage cooling performance is rated at 95°F ambient, 80°F entering dry bulb, 67°F entering wet bulb. Gross capacity does not include the effect of fan motor heat. AHRI capacity is net and includes the effect of fan motor heat. Units are suitable for operation to ±20% of nominal cfm. Units are certified in accordance with the Unitary Air-Conditioner Equipment certification program, which is based on AHRI standard 340/360.
(b) EER and/or IEER are rated at AHRI conditions and in accordance with DOE test procedures.
(c) Outdoor Sound Rating shown is tested in accordance with AHRI Standard 270. For additional information reference the outdoor sound power level data in the performance section.
(d) Optional 2" MERV 8 and MERV 13 filters also available.
(e) Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.
(f) Heating performance limit settings and rating data were established and approved under laboratory test conditions using American National Standards Institute standards. Ratings shown are for elevations up to 2000 feet. For elevations above 2000 feet, ratings should be reduced at the rate of 4% for each 1000 feet above sea level. Applicable to gas/electric units only.

Table 5. General data - 6 to 10 tons with eFlex™ and eDrive™ technology (575 volt)

	6 Tons	7.5 Tons	8.5 Tons	10 Tons
	T/YZC072FW	T/YZC090FW	T/YZC102FW	T/YZC120FW
Cooling Performance[a]				
Gross Cooling Capacity - Full Load	71,000	92,000	103,000	117,000
EER/IEER[b]	12.5/22.6	12.8/21.5	12.6/21.5	12.1/22.5
Nominal cfm/AHRI Rated cfm	2,400/2,400	3,000/2,850	3,400/2,975	4,000/4,000
AHRI Net Cooling Capacity - Full Load	70,000	90,000	99,000	114,000
System Power (kW)	5.60	7.03	7.86	9.42
Compressor				
Number/Type	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)	1/Scroll (Variable Speed)
Sound				
Outdoor Sound Rating (dB)[c]	89	89	89	89
Outdoor Coil - Type	Microchannel	Microchannel	Microchannel	Microchannel
Coil Width (in.)	0.8	1.0	1.0	1.0
Face Area (sq. ft.)	20.8	20.9	20.9	26.7
Rows/FPI	1/23	1/20	1/20	1/20
Indoor Coil - Type	Lanced	Lanced	Lanced	Lanced
Tube Size (in.) ID	0.3125	0.3125	0.3125	0.3125
Face Area (sq. ft.)	12.4	12.4	12.4	16.7
Rows/FPI	5/16	4/16	4/16	4/16
Refrigerant Control	Thermal Expansion Valve	Thermal Expansion Valve	Thermal Expansion Valve	Thermal Expansion Valve
Drain Connection Number/Size (in.)	1¾ NPT	1¾ NPT	1¾ NPT	1¾ NPT
Outdoor Fan - Type	Propeller	Propeller	Propeller	Propeller
Number Used/Diameter (in.)	1/26	1/26	1/26	1/30
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable	Direct/Variable
cfm	5,864	6,806	6,771	7,612
Motor hp	0.75	0.75	0.75	0.75
Motor rpm	1,200	1,200	1,200	1,200
Indoor Fan - Type (Optional)	EBM	EBM	EBM	EBM
Number Used/Diameter (in.)	1/23.03	1/23.03	1/23.03	1/23.03
Drive Type/No. Speeds	Direct/Variable	Direct/Variable	Direct/Variable	Direct/Variable
Number Motors	1	1	1	1
Motor hp (Standard/Oversized)	2.75	2.75	2.75	2.75
Filters[d]				
Type Furnished	Throwaway	Throwaway	Throwaway	Throwaway
Number Size Recommended	(4) 2x20x25	(4) 2x20x25	(4) 2x20x25	(3) 2x20x25 (2) 2x20x30
Refrigerant Charge[e]				
Pounds of R-410A	8.3	8.7	8.9	10.5

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Table 5. General data - 6 to 10 tons with eFlex™ and eDrive™ technology (575 volt) (continued)

	6 Tons	7.5 Tons	8.5 Tons	10 Tons
	T/YZC072FW	T/YZC090FW	T/YZC102FW	T/YZC120FW
Heating Performance[f]				
(Gas/Electric Only)				
Heating Input				
Low Heat Input (Btu)	80,000	120,000	120,000	150,000
Mid Heat Input (Btu)	120,000	150,000	150,000	200,000
High Heat Input (Btu)	150,000	200,000	200,000	250,000
Modulating Heat Input (Btu)	150,000	200,000	200,000	250,000
Heating Output				
Low Heat Input (Btu)	64,800	97,200	97,200	121,500
Mid Heat Input (Btu)	97,200	121,500	121,500	162,000
High Heat Input (Btu)	121,500	162,000	162,000	202,500
Modulating Heat Input (Btu)	121,500	162,000	162,000	202,500
Steady State Efficiency%				
Low Heat Input (Btu)	81	81	81	81
Mid Heat Input (Btu)	81	81	81	81
High Heat Input (Btu)	81	81	81	81
Modulating Heat Input (Btu)	81	81	81	81
No. Burners				
Low Heat Input (Btu)	3	3	3	3
Mid Heat Input (Btu)	3	3	3	4
High Heat Input (Btu)	3	5	5	5
Modulating Heat Input (Btu)	3	5	5	5
No. Stages				
Low Heat Input (Btu)	1	1	1	2
Mid Heat Input (Btu)	1	2	2	2
High Heat Input (Btu)	2	2	2	2
Modulating Heat Input (Btu)	2.5:1 Modulating	2.5:1 Modulating	2.5:1 Modulating	2.5:1 Modulating
Gas Supply Line Pressure (w.c.)				
Natural (minimum/maximum) Low/Mid/High	4.5/14.0	4.5/14.0	4.5/14.0	4.5/14.0
Natural (minimum/maximum) Mod Heat	5.5/14.0	5.5/14.0	5.5/14.0	5.5/14.0
LP (minimum/maximum)	11.0/14.0	11.0/14.0	11.0/14.0	11.0/14.0
Gas Connection Pipe Size (in)				
Low Heat	1/2	1/2	1/2	3/4
Mid Heat	1/2	3/4	3/4	3/4
High Heat	3/4	3/4	3/4	3/4
Modulating Heat	3/4	3/4	3/4	3/4

(a) High stage cooling performance is rated at 95°F ambient, 80°F entering dry bulb, 67°F entering wet bulb. Gross capacity does not include the effect of fan motor heat. AHRI capacity is net and includes the effect of fan motor heat. Units are suitable for operation to ±20% of nominal cfm. Units are certified in accordance with the Unitary Air-Conditioner Equipment certification program, which is based on AHRI standard 340/360.
(b) EER and/or IEER are rated at AHRI conditions and in accordance with DOE test procedures.
(c) Outdoor Sound Rating shown is tested in accordance with AHRI Standard 270. For additional information reference the outdoor sound power level data in the performance section.
(d) Optional 2" MERV 8 and MERV 13 filters also available.
(e) Refrigerant charge is an approximate value. For a more precise value, see unit nameplate and service instructions.
(f) Heating performance limit settings and rating data were established and approved under laboratory test conditions using American National Standards Institute standards. Ratings shown are for elevations up to 2000 feet. For elevations above 2000 feet, ratings should be reduced at the rate of 4% for each 1000 feet above sea level. Applicable to gas/electric units only.

Performance Data

Table 6. Gross cooling capacities 3 tons with eFlex™ and eDrive™ technology - three phase T/YZC036E3,4

Air Flow	Ent DB	Ambient Temperature 85 Entering Wet Bulb 61		67		73		Ambient Temperature 95 Entering Wet Bulb 61		67		73		Ambient Temperature 105 Entering Wet Bulb 61		67		73	
cfm	(F)	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC
600	75	29.27	22.35	32.98	17.67	36.39	8.66	27.33	20.92	30.84	16.53	34.03	8.07	25.31	19.42	28.60	15.35	31.59	7.46
600	80	29.75	25.54	33.10	22.57	36.51	15.89	27.83	23.98	30.98	21.16	34.18	14.88	25.83	22.33	28.77	19.71	31.76	13.84
600	85	30.65	28.08	33.22	26.26	36.63	21.79	28.76	26.46	31.12	24.68	34.32	20.46	26.78	24.76	28.94	23.03	31.93	19.08
600	90	31.98	29.94	33.77	29.09	37.18	26.66	30.11	28.35	31.70	27.42	34.90	25.10	28.16	26.66	29.54	25.67	32.53	23.49
720	75	30.92	24.24	34.44	19.24	37.65	9.93	28.89	22.71	32.20	18.01	35.21	9.27	26.77	21.11	29.87	16.74	32.67	8.59
720	80	31.56	27.70	34.73	24.42	37.94	17.43	29.55	26.03	32.51	22.93	35.52	16.34	27.46	24.29	30.21	21.37	33.01	15.21
720	85	32.63	30.47	35.01	28.38	38.23	23.62	30.65	28.75	32.82	26.70	35.83	22.19	28.58	26.94	30.55	24.95	33.34	20.72
720	90	34.13	32.50	35.73	31.45	38.95	28.76	32.17	30.82	33.56	29.69	36.57	27.11	30.13	29.03	31.31	27.83	34.11	25.39
840	75	32.37	25.98	36.12	20.96	40.28	11.60	30.24	24.35	33.79	19.64	37.38	10.76	28.04	22.66	31.37	18.29	34.76	10.01
840	80	33.17	29.69	36.15	26.15	40.30	19.44	31.08	27.93	33.84	24.56	37.44	18.09	28.89	26.08	31.45	22.91	34.83	16.88
840	85	34.41	32.68	36.60	30.35	40.41	25.83	32.34	30.87	34.32	28.58	37.92	24.32	30.18	28.96	31.95	26.73	35.34	22.75
840	90	36.08	34.89	37.49	33.65	40.51	30.73	34.03	33.11	35.23	31.79	38.04	28.99	31.89	31.23	32.89	29.83	35.49	27.17
960	75	33.61	27.56	37.17	22.31	41.06	12.76	31.40	25.84	34.75	20.91	38.43	11.95	29.10	24.04	32.24	19.47	35.71	11.13
960	80	34.59	31.50	37.37	27.73	41.33	20.82	32.40	29.64	34.97	26.05	38.72	19.56	30.12	27.69	32.48	24.30	36.03	18.26
960	85	35.99	34.70	37.99	32.16	41.60	27.42	33.83	32.79	35.62	30.29	39.02	25.82	31.57	30.79	33.16	28.34	36.35	24.16
960	90	37.82	37.07	39.04	35.66	41.87	32.54	35.68	35.20	36.69	33.70	39.32	30.70	33.46	33.23	34.26	31.65	36.67	28.78
1080	75	34.65	28.96	38.02	23.52	42.57	14.13	32.35	27.15	35.51	22.04	39.85	13.26	29.96	25.25	32.91	20.51	37.04	12.36
1080	80	35.80	33.12	38.38	29.14	42.58	22.30	33.52	31.16	35.89	27.37	39.89	20.96	31.15	29.11	33.32	25.52	37.10	19.57
1080	85	37.37	36.52	39.18	33.78	42.60	28.87	35.11	34.51	36.71	31.81	39.92	27.17	32.77	32.40	34.16	29.76	37.16	25.41
1080	90	39.37	39.04	40.40	37.48	43.03	34.18	37.14	37.08	37.96	35.42	40.39	32.24	34.82	34.82	35.43	33.27	37.65	30.22
1200	75	35.50	30.17	38.67	24.58	43.03	15.14	33.10	28.26	36.07	23.02	40.22	14.19	30.61	26.27	33.37	21.39	37.31	13.22
1200	80	36.81	34.53	39.20	30.37	43.21	23.42	34.43	32.47	36.62	28.51	40.42	22.00	31.97	30.32	33.95	26.56	37.54	20.53
1200	85	38.55	38.11	40.16	35.20	43.39	30.14	36.20	36.01	37.60	33.14	40.62	28.36	33.76	33.76	34.96	30.98	37.77	26.50
1200	90	40.71	40.71	41.55	39.08	43.99	35.63	38.39	38.39	39.02	36.93	41.25	33.60	35.98	35.98	36.40	34.68	38.43	31.48
1320	75	36.13	31.18	39.12	25.47	43.29	16.01	33.65	29.17	36.42	23.82	40.38	15.00	31.07	27.08	33.64	22.11	37.39	13.96
1320	80	37.61	35.71	39.82	31.41	43.63	24.38	35.15	33.56	37.14	29.45	40.75	22.88	32.60	31.31	34.38	27.42	37.78	21.33
1320	85	39.52	39.47	40.94	36.41	43.98	31.23	37.08	37.08	38.29	34.25	41.12	29.36	34.56	34.56	35.56	32.00	38.18	27.41
1320	90	41.86	41.86	42.50	40.46	44.75	36.87	39.44	39.44	39.88	38.21	41.92	34.75	36.94	36.94	37.17	35.86	39.00	32.53
1440	75	36.57	31.96	39.36	26.18	43.77	16.92	33.99	29.87	36.57	24.45	40.54	15.76	31.32	27.68	33.70	22.65	37.46	14.65
1440	80	38.22	36.66	40.23	32.24	43.85	25.17	35.66	34.42	37.46	30.20	40.88	23.60	33.02	32.07	34.61	28.06	37.82	21.96
1440	85	40.29	40.29	41.52	37.39	44.37	32.12	37.76	37.76	38.78	35.14	41.42	30.16	35.15	35.15	35.96	32.79	38.38	28.13
1440	90	42.80	42.80	43.25	41.59	45.31	37.90	40.29	40.29	40.53	39.26	42.38	35.68	37.70	37.70	37.73	36.81	39.37	33.37

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Table 6. Gross cooling capacities 3 tons with eFlex™ and eDrive™ technology - three phase T/YZC036E3,4 (continued)

Air Flow cfm	Ent DB (F)	Ambient Temperature 115 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 120 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
600	75	23.20	17.85	26.28	14.13	29.06	6.85	22.11	17.04	25.09	13.50	27.76	6.54
600	80	23.74	20.61	26.47	18.19	29.26	12.76	22.67	19.71	25.29	17.40	27.97	12.22
600	85	24.72	22.96	26.67	21.31	29.45	17.65	23.65	22.03	25.50	20.42	28.18	16.92
600	90	26.12	24.88	27.29	23.84	30.07	21.80	25.07	23.95	26.14	22.89	28.81	20.93
720	75	24.57	19.44	27.46	15.43	30.83	8.10	23.43	18.57	26.22	14.75	29.49	7.75
720	80	25.28	22.46	27.82	19.75	31.19	14.41	24.16	21.51	26.60	18.92	29.86	13.82
720	85	26.43	25.04	28.18	23.12	31.55	19.68	25.32	24.06	26.97	22.18	30.24	18.89
720	90	28.00	27.15	28.98	25.89	31.56	23.60	26.90	26.17	27.77	24.89	30.26	22.68
840	75	25.74	20.88	28.87	16.88	31.62	9.12	24.56	19.96	27.58	16.15	30.93	8.93
840	80	26.62	24.14	28.97	21.19	32.15	15.63	25.45	23.14	27.70	20.30	31.12	15.16
840	85	27.93	26.95	29.50	24.79	32.68	21.12	26.78	25.91	28.24	23.79	31.31	20.28
840	90	29.67	29.25	30.46	27.78	32.85	25.27	28.53	28.22	29.21	26.72	31.50	24.29
960	75	26.71	22.16	29.64	17.96	32.90	10.28	25.48	21.19	28.31	17.19	31.47	9.85
960	80	27.76	25.65	29.91	22.47	33.25	16.92	26.55	24.59	28.60	21.53	31.83	16.23
960	85	29.24	28.68	30.61	26.30	33.60	22.43	28.04	27.58	29.31	25.24	32.19	21.54
960	90	31.15	31.15	31.74	29.50	33.94	26.78	29.96	29.96	30.44	28.38	32.54	25.75
1080	75	27.48	23.27	30.22	18.91	34.15	11.44	26.21	22.25	28.84	18.09	32.67	10.97
1080	80	28.69	26.96	30.66	23.59	34.23	18.14	27.44	25.85	29.29	22.60	32.76	17.40
1080	85	30.34	30.19	31.52	27.62	34.31	23.59	29.09	29.04	30.17	26.51	32.86	22.65
1080	90	32.42	32.42	32.82	31.01	34.83	28.12	31.18	31.18	31.48	29.84	33.39	27.04
1200	75	28.04	24.19	30.59	19.70	34.33	12.22	26.73	23.11	29.17	18.84	32.80	11.71
1200	80	29.43	28.07	31.20	24.54	34.58	19.00	28.12	26.91	29.79	23.50	33.07	18.22
1200	85	31.24	31.24	32.23	28.74	34.83	24.58	29.95	29.95	30.83	27.58	33.33	23.59
1200	90	33.49	33.49	33.69	32.32	35.51	29.27	32.21	32.21	32.31	31.10	34.02	28.13
1320	75	28.41	24.90	30.77	20.33	34.51	12.96	27.05	23.77	29.30	19.42	32.94	12.41
1320	80	29.96	28.96	31.54	25.29	34.73	19.72	28.61	27.74	30.08	24.20	33.17	18.89
1320	85	31.94	31.94	32.74	29.65	35.15	25.39	30.61	30.61	31.30	28.43	33.60	24.35
1320	90	34.35	34.35	34.37	33.40	36.00	30.22	32.60	32.60	32.94	32.12	34.46	29.03
1440	75	28.57	25.40	30.94	20.92	34.69	13.65	27.16	24.22	29.42	19.95	33.07	13.06
1440	80	30.29	29.62	31.68	25.84	34.87	20.38	28.90	28.35	30.18	24.70	33.27	19.50
1440	85	32.44	32.44	33.05	30.34	35.26	26.01	31.06	31.06	31.56	29.07	33.67	24.92
1440	90	34.59	34.59	34.84	34.25	36.28	30.96	33.22	33.22	33.37	32.92	34.70	29.72

Notes:

1. All capacities shown are gross and have not considered indoor fan heat. To obtain **NET** cooling capacity subtract indoor fan heat. For indoor fan heat formula, refer to appropriate airflow table notes.
2. MBh = Total Gross Capacity
3. SHC = Sensible Heat Capacity

Table 7. Gross cooling capacities 4 tons with eFlex™ and eDrive™ technology - three phase T/YZC048F3,4

Air Flow cfm	Ent DB (F)	Ambient Temperature 85 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 95 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 105 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
800	75	37.22	29.31	41.86	23.37	46.17	11.63	35.20	27.92	39.60	22.36	43.68	11.30	33.10	26.44	37.26	21.27	41.10	10.92
800	80	37.86	33.23	42.03	29.52	46.35	20.84	35.88	31.68	39.81	28.20	43.89	20.03	33.81	30.05	37.51	26.80	41.34	19.15
800	85	39.09	36.35	42.21	34.12	46.53	28.37	37.14	34.74	40.02	32.60	44.10	27.18	35.11	33.03	37.75	30.98	41.59	25.91
800	90	40.90	38.63	42.97	37.68	47.28	34.61	38.99	37.02	40.82	36.03	44.89	33.15	36.99	35.33	38.58	34.29	42.42	31.60
960	75	39.06	31.56	43.46	25.31	47.53	13.29	36.95	30.07	41.11	24.20	44.95	12.87	34.75	28.48	38.67	23.01	42.27	12.40
960	80	39.92	35.80	43.85	31.79	47.93	22.81	37.84	34.14	41.53	30.37	45.37	21.90	35.68	32.39	39.13	28.85	42.73	20.92
960	85	41.36	39.19	44.24	36.71	48.32	30.65	39.32	37.47	41.96	35.07	45.80	29.36	37.19	35.65	39.59	33.33	43.19	27.98
960	90	43.38	41.68	45.21	40.54	49.29	37.22	41.37	39.97	42.97	38.78	46.81	35.65	39.28	38.16	40.64	36.92	44.24	33.99
1120	75	40.68	33.65	45.42	27.48	50.67	15.47	38.48	32.04	42.98	26.27	47.99	14.98	36.19	30.34	40.46	24.98	45.22	14.44
1120	80	41.75	38.17	45.45	33.90	50.81	25.42	39.59	36.41	43.04	32.37	48.16	24.42	37.33	34.55	40.55	30.75	45.43	23.35
1120	85	43.41	41.83	46.05	39.11	50.94	33.49	41.28	40.00	43.68	37.36	48.33	32.09	39.06	38.07	41.22	35.51	45.63	30.61
1120	90	45.65	44.52	47.24	43.21	51.08	39.68	43.55	42.71	44.90	41.34	48.50	37.99	41.36	40.79	42.48	39.37	45.84	36.21
1280	75	42.09	35.53	46.60	29.14	51.60	17.00	39.80	33.82	44.06	27.83	48.83	16.42	37.41	32.01	41.44	26.44	45.97	15.78
1280	80	43.38	40.34	46.83	35.83	51.95	27.16	41.12	38.46	44.33	34.19	49.21	26.07	38.77	36.49	41.75	32.46	46.39	24.89
1280	85	45.25	44.25	47.65	41.31	52.30	35.49	43.02	42.30	45.19	39.45	49.60	33.99	40.71	40.26	42.63	37.48	46.81	32.39
1280	90	47.70	47.13	49.05	45.67	52.66	41.94	45.51	45.21	46.62	43.68	49.98	40.14	43.23	43.18	44.11	41.59	47.23	38.24
1440	75	43.29	37.20	47.55	30.63	52.32	18.40	40.90	35.38	44.92	29.22	50.62	18.15	38.42	33.46	42.21	27.73	47.66	17.43
1440	80	44.79	42.27	48.00	37.56	52.88	28.75	42.43	40.28	45.41	35.81	50.63	27.87	39.99	38.19	42.73	33.96	47.72	26.60
1440	85	46.87	46.42	49.04	43.29	53.45	37.30	44.55	44.36	46.48	41.31	50.65	35.69	42.15	42.15	43.83	39.23	47.77	33.98
1440	90	49.54	49.49	50.65	47.89	54.02	43.99	47.25	47.25	48.13	45.79	51.25	42.08	44.88	44.88	45.52	43.58	48.40	40.06
1600	75	44.27	38.64	48.29	31.93	53.99	20.09	41.78	36.71	45.57	30.42	51.02	19.34	39.22	34.68	42.76	28.82	47.98	18.52
1600	80	45.98	43.95	48.96	39.06	54.18	30.49	43.53	41.85	46.27	37.21	51.26	29.19	41.00	39.65	43.50	35.25	48.25	27.81
1600	85	48.28	48.28	50.21	45.03	54.38	38.91	45.87	45.87	47.55	42.94	51.49	37.19	43.37	43.37	44.82	40.75	48.51	35.37
1600	90	51.16	51.16	52.04	49.85	55.16	45.81	48.78	48.78	49.42	47.64	52.30	43.79	46.32	46.32	46.72	45.32	49.36	41.66
1760	75	45.03	39.84	48.82	33.02	54.27	21.21	42.46	37.80	46.00	31.41	51.22	20.37	39.80	35.66	43.10	29.70	48.08	19.46
1760	80	46.96	45.37	49.70	40.34	54.69	31.71	44.42	43.16	46.92	38.37	51.67	30.31	41.79	40.85	44.05	36.31	48.56	28.83
1760	85	49.48	49.48	51.16	46.51	55.10	40.29	46.97	46.97	48.42	44.31	52.11	38.46	44.38	44.38	45.59	42.01	49.04	36.53
1760	90	52.57	52.57	53.21	51.55	56.09	47.39	50.10	50.10	50.50	49.23	53.14	45.25	47.54	47.54	47.70	46.80	50.11	43.00
1920	75	45.58	40.77	49.13	33.89	54.93	22.39	42.91	38.63	46.22	32.18	51.41	21.32	40.16	36.39	43.23	30.37	48.18	20.32
1920	80	47.73	46.51	50.23	41.36	54.97	32.72	45.09	44.20	47.35	39.29	51.86	31.23	42.37	41.77	44.39	37.12	48.66	29.64
1920	85	50.45	50.45	51.90	47.73	55.60	41.43	47.85	47.85	49.06	45.42	52.52	39.49	45.17	45.17	46.14	43.00	49.36	37.46
1920	90	53.76	53.76	54.16	52.97	56.81	48.70	51.20	51.20	51.36	50.53	53.76	46.45	47.97	47.97	48.47	47.99	50.64	44.09

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Table 7. Gross cooling capacities 4 tons with eFlex™ and eDrive™ technology - three phase T/YZC048F3,4 (continued)

Air Flow cfm	Ent DB (F)	Ambient Temperature 115 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 120 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
800	75	30.91	24.87	34.83	20.11	38.39	10.47	29.79	24.05	33.59	19.50	37.07	10.24
800	80	31.66	28.31	35.11	25.31	38.67	18.18	30.55	27.41	33.89	24.54	37.37	17.70
800	85	32.99	31.22	35.39	29.26	38.94	24.56	31.90	30.28	34.18	28.37	37.66	23.85
800	90	34.90	33.53	36.26	32.44	39.86	29.96	33.83	32.59	35.06	31.49	38.54	29.11
960	75	32.47	26.80	36.11	21.75	40.52	12.16	31.30	25.92	34.86	21.08	39.16	11.90
960	80	33.44	30.55	36.65	27.26	41.01	20.38	32.28	29.58	35.38	26.42	39.67	19.83
960	85	34.98	33.73	37.14	31.50	41.56	27.21	33.84	32.73	35.89	30.55	40.18	26.44
960	90	37.11	36.25	38.22	34.96	41.58	32.23	35.99	35.26	36.98	33.94	40.22	31.32
1120	75	33.82	28.55	37.84	23.61	42.32	13.79	32.60	27.62	36.51	22.90	40.91	13.50
1120	80	34.99	32.58	37.97	29.03	42.56	22.20	33.79	31.56	36.65	28.14	41.17	21.59
1120	85	36.75	36.03	38.68	33.56	42.85	29.04	35.57	34.97	37.37	32.55	41.43	28.22
1120	90	39.09	38.77	39.97	37.29	43.09	34.33	37.93	37.72	38.68	36.21	41.69	33.36
1280	75	34.95	30.10	38.73	24.97	42.97	15.04	33.68	29.11	37.35	24.20	41.52	14.70
1280	80	36.34	34.41	39.08	30.63	43.42	23.63	35.09	33.33	37.71	29.68	41.99	22.97
1280	85	38.31	38.10	40.00	35.41	43.93	30.71	37.08	36.98	38.65	34.34	42.46	29.83
1280	90	40.87	40.87	41.50	39.39	44.39	36.25	39.65	39.65	40.17	38.26	42.93	35.21
1440	75	35.86	31.44	39.41	26.15	44.57	16.63	34.55	30.39	37.98	25.32	43.07	16.21
1440	80	37.47	36.00	39.97	32.02	44.71	25.24	36.17	34.86	38.55	31.02	43.18	24.53
1440	85	39.66	39.66	41.10	37.05	44.80	32.18	38.38	38.38	39.71	35.92	43.28	31.25
1440	90	42.43	42.43	42.82	41.27	45.47	37.95	41.17	41.17	41.44	40.07	43.97	36.85
1600	75	36.56	32.55	39.87	27.13	44.79	17.64	35.20	31.45	38.39	26.25	43.25	17.17
1600	80	38.38	37.34	40.64	33.20	45.15	26.35	37.04	36.15	39.18	32.13	43.57	25.58
1600	85	40.78	40.78	41.99	38.45	45.45	33.45	39.46	39.46	40.55	37.25	43.89	32.46
1600	90	43.77	43.77	43.93	42.89	46.33	39.42	42.46	42.46	42.50	41.63	44.79	38.26
1760	75	37.05	33.42	40.12	27.91	44.80	18.48	35.64	32.26	38.60	26.98	43.43	18.05
1760	80	39.08	38.43	41.10	34.14	45.37	27.26	37.70	37.17	39.60	33.02	43.74	26.44
1760	85	41.70	41.70	42.67	39.59	45.89	34.50	40.33	40.33	41.18	38.34	44.28	33.45
1760	90	44.32	44.32	44.82	44.25	46.99	40.65	42.96	42.96	43.34	42.93	45.39	39.43
1920	75	37.32	34.04	40.15	28.47	44.81	19.22	35.87	32.82	38.80	27.64	43.60	18.86
1920	80	39.57	39.24	41.35	34.84	45.38	27.97	38.13	37.93	39.80	33.66	43.92	27.22
1920	85	42.40	42.40	43.13	40.47	46.11	35.31	40.98	40.98	41.59	39.17	44.45	34.20
1920	90	45.23	45.23	45.49	45.33	47.42	41.62	43.83	43.83	43.97	43.96	45.78	40.34

Notes:

1. All capacities shown are gross and have not considered indoor fan heat. To obtain **NET** cooling capacity subtract indoor fan heat. For indoor fan heat formula, refer to appropriate airflow table notes.
2. MBh = Total Gross Capacity
3. SHC = Sensible Heat Capacity

Table 8. Gross cooling capacities 5 tons with eFlex™ and eDrive™ technology - three phase T/YZC060E3

Air Flow	Ent DB	Ambient Temperature 85 Entering Wet Bulb 61		67		73		Ambient Temperature 95 Entering Wet Bulb 61		67		73		Ambient Temperature 105 Entering Wet Bulb 61		67		73	
cfm	(F)	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC
1000	75	49.03	37.99	55.10	30.37	61.63	15.90	46.28	35.99	52.25	28.90	58.52	15.16	43.38	33.87	49.01	27.21	54.98	14.31
1000	80	49.66	42.97	55.31	38.24	61.70	27.63	46.95	40.79	52.26	36.26	58.54	26.32	44.09	38.48	49.05	34.19	54.99	24.85
1000	85	50.96	46.80	55.42	44.01	61.90	37.17	48.29	44.56	52.41	41.80	58.55	35.31	45.48	42.18	49.25	39.47	55.04	33.36
1000	90	52.94	49.45	56.21	48.32	62.01	44.38	50.31	47.26	53.24	45.99	58.70	42.21	47.53	44.91	50.12	43.53	55.23	39.93
1200	75	51.48	40.87	57.54	32.95	64.31	18.12	48.57	38.71	54.53	31.34	61.05	17.28	45.51	36.42	51.12	29.51	57.34	16.33
1200	80	52.37	46.26	57.76	41.10	64.39	30.30	49.50	43.91	54.54	38.97	61.06	28.87	46.48	41.42	51.17	36.73	57.35	27.25
1200	85	53.94	50.45	58.13	47.28	64.60	40.19	51.11	48.03	54.96	44.91	61.08	38.17	48.12	45.47	51.63	42.40	57.40	36.07
1200	90	56.18	53.36	59.18	51.95	64.72	47.65	53.39	51.00	56.05	49.45	61.24	45.31	50.44	48.48	52.76	46.81	57.60	42.86
1400	75	53.65	43.54	59.69	35.37	66.71	20.30	50.57	41.20	56.53	33.63	63.29	19.36	47.34	38.74	52.95	31.65	59.41	18.28
1400	80	54.80	49.31	59.91	43.77	66.79	32.86	51.77	46.79	56.53	41.48	63.31	31.30	48.58	44.12	53.00	39.08	59.43	29.54
1400	85	56.63	53.83	60.55	50.33	67.01	43.04	53.63	51.25	57.21	47.78	63.32	40.88	50.48	48.50	53.72	45.10	59.48	38.61
1400	90	59.13	57.01	61.86	55.34	67.13	50.71	56.17	54.48	58.56	52.67	63.48	48.21	53.06	51.78	55.11	49.85	59.68	45.58
1600	75	55.53	45.96	61.56	37.62	68.56	22.30	52.28	43.46	57.97	35.58	64.88	21.22	48.89	40.82	54.23	33.45	60.94	20.07
1600	80	56.94	52.09	61.78	46.22	68.64	35.14	53.74	49.39	58.24	43.77	65.00	33.45	50.38	46.55	54.53	41.20	60.96	31.55
1600	85	59.03	56.94	62.68	53.13	68.87	45.54	55.87	54.18	59.18	50.41	65.01	43.21	52.55	51.25	55.52	47.55	61.01	40.78
1600	90	61.79	60.38	64.26	58.47	69.25	53.55	58.67	57.68	60.79	55.62	65.44	50.88	55.40	54.81	57.17	52.62	61.48	48.08
1800	75	57.11	48.11	62.87	39.51	70.13	24.19	53.70	45.45	59.12	37.32	66.28	23.00	50.14	42.64	55.21	35.04	62.18	21.73
1800	80	58.79	54.59	63.36	48.42	70.21	37.24	55.42	51.71	59.65	45.81	66.41	35.42	51.90	48.69	55.78	43.07	62.20	33.38
1800	85	61.14	59.75	64.52	55.66	70.44	47.81	57.81	56.81	60.85	52.77	66.42	45.33	54.33	53.70	57.03	49.73	62.25	42.73
1800	90	64.16	63.43	66.36	61.30	71.08	56.13	60.88	60.56	62.73	58.28	67.11	53.29	57.44	57.44	58.94	55.10	62.98	50.32
2000	75	58.41	49.99	63.90	41.16	71.40	25.93	54.84	47.15	59.98	38.83	67.14	24.54	51.11	44.17	55.91	36.40	62.87	23.15
2000	80	60.35	56.77	64.65	50.36	71.49	39.15	56.82	53.73	60.77	47.58	67.26	37.05	53.13	50.52	56.74	44.67	62.89	34.86
2000	85	62.96	62.23	66.08	57.90	71.72	49.83	59.47	59.12	62.24	54.84	67.54	47.19	55.82	55.82	58.25	51.62	63.20	44.44
2000	90	66.25	66.16	68.17	63.83	72.63	58.44	62.80	62.80	64.38	60.64	68.49	55.43	59.19	59.19	60.43	57.28	64.19	52.28
2200	75	59.42	51.56	64.64	42.57	72.13	27.40	55.68	48.56	60.56	40.09	67.70	25.90	51.79	45.41	56.32	37.50	63.27	24.40
2200	80	61.62	58.64	65.66	52.01	72.22	40.68	57.92	55.42	61.61	49.07	67.83	38.44	54.07	52.03	57.41	45.99	63.29	36.11
2200	85	64.50	64.37	67.34	59.83	72.72	51.58	60.84	60.84	63.34	56.59	68.37	48.79	57.03	57.03	59.18	53.20	63.86	45.87
2200	90	68.04	68.04	69.70	66.03	73.88	60.45	64.43	64.43	65.74	62.67	69.58	57.27	60.66	60.66	61.62	59.13	65.12	53.95
2400	75	60.14	52.82	65.09	43.71	72.58	28.69	56.24	49.65	60.84	41.08	67.98	27.07	52.18	46.32	56.44	38.34	63.38	25.45
2400	80	62.61	60.16	66.37	53.36	72.66	41.97	58.74	56.77	62.16	50.26	68.11	39.59	54.72	53.20	57.80	47.02	63.40	37.12
2400	85	65.74	65.74	68.31	61.43	73.42	53.05	61.92	61.92	64.15	58.03	68.91	50.10	57.94	57.94	59.82	54.46	64.24	47.02
2400	90	69.55	69.55	70.93	67.89	74.85	62.14	65.77	65.77	66.81	64.35	70.38	58.81	61.83	61.83	62.53	60.64	65.75	55.31

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Table 8. Gross cooling capacities 5 tons with eFlex™ and eDrive™ technology - three phase T/YZC060E3 (continued)

Air Flow cfm	Ent DB (F)	Ambient Temperature 115 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 120 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
1000	75	40.33	31.62	45.61	25.44	51.37	13.46	38.74	30.45	43.86	24.53	47.77	12.57
1000	80	41.08	36.03	45.70	32.00	51.38	23.35	39.52	34.74	43.96	30.87	49.64	22.62
1000	85	42.51	39.63	45.93	37.00	51.38	31.31	40.96	38.30	44.22	35.72	49.74	30.40
1000	90	44.60	42.40	46.84	40.92	51.61	37.52	43.08	41.08	45.15	39.55	49.74	36.27
1200	75	42.29	34.00	47.56	27.59	53.56	15.36	40.62	32.74	45.72	26.59	49.81	14.34
1200	80	43.30	38.78	47.65	34.38	53.57	25.61	41.66	37.41	45.83	33.16	51.75	24.82
1200	85	44.99	42.74	48.15	39.75	53.58	33.86	43.36	41.32	46.35	38.38	51.86	32.87
1200	90	47.35	45.79	49.32	44.01	53.82	40.28	45.74	44.39	47.54	42.56	51.87	38.94
1400	75	43.96	36.15	49.22	29.58	55.47	17.20	42.21	34.80	47.30	28.50	51.32	15.98
1400	80	45.23	41.30	49.31	36.55	55.48	27.75	43.50	39.83	47.41	35.24	53.32	26.76
1400	85	47.18	45.59	50.07	42.27	55.49	36.23	45.47	44.07	48.19	40.81	53.43	35.00
1400	90	49.80	48.92	51.50	46.87	55.73	42.83	48.12	47.42	49.64	45.32	53.70	41.40
1600	75	45.34	38.05	50.33	31.22	56.75	18.84	43.51	36.62	48.33	30.07	52.55	17.52
1600	80	46.87	43.54	50.68	38.50	56.76	29.57	45.06	41.98	48.70	37.10	54.60	28.54
1600	85	49.09	48.16	51.70	44.55	56.85	38.24	47.29	46.55	49.74	42.99	54.71	36.93
1600	90	51.97	51.76	53.40	49.46	57.36	45.14	50.20	50.17	51.46	47.82	55.24	43.62
1800	75	46.43	39.69	51.15	32.65	57.82	20.37	44.51	38.16	49.07	31.42	53.50	18.93
1800	80	48.23	45.50	51.76	40.20	57.83	31.25	46.33	43.84	49.70	38.71	55.59	30.15
1800	85	50.70	50.42	53.05	46.55	57.93	40.02	48.83	48.72	51.00	44.89	55.71	38.62
1800	90	53.85	53.85	55.01	51.76	58.70	47.21	51.99	51.99	52.98	50.02	56.50	45.59
2000	75	47.23	41.05	51.69	33.85	58.35	21.67	45.23	39.43	49.52	32.53	53.93	20.12
2000	80	49.29	47.15	52.56	41.63	58.36	32.58	47.31	45.39	50.41	40.05	56.03	31.40
2000	85	52.03	52.03	54.10	48.25	58.71	41.56	50.07	50.07	51.97	46.51	56.41	40.07
2000	90	55.43	55.43	56.32	53.75	59.74	48.99	53.50	53.50	54.21	51.92	57.46	47.29
2200	75	47.74	42.10	51.93	34.80	58.58	22.79	45.66	40.39	49.68	33.40	54.07	21.13
2200	80	50.07	48.47	53.06	42.78	58.59	33.68	48.01	46.62	50.83	41.11	56.19	32.42
2200	85	53.06	53.06	54.87	49.65	59.21	42.82	51.02	51.02	52.66	47.81	56.83	41.25
2200	90	56.73	56.73	57.35	55.42	60.50	50.48	54.71	54.71	55.16	53.49	58.14	48.69
2400	75	47.97	42.84	52.14	35.66	58.79	23.82	45.80	41.04	49.81	34.18	54.19	22.07
2400	80	50.55	49.46	53.28	43.63	58.80	34.69	48.41	47.52	50.96	41.87	56.31	33.35
2400	85	53.81	53.81	55.35	50.73	59.42	43.81	51.69	51.69	53.05	48.79	56.95	42.15
2400	90	57.74	57.74	58.09	56.74	60.97	51.66	55.64	55.64	55.82	54.72	58.53	49.78

Notes:

1. All capacities shown are gross and have not considered indoor fan heat. To obtain **NET** cooling capacity subtract indoor fan heat. For indoor fan heat formula, refer to appropriate airflow table notes.
2. MBh = Total Gross Capacity
3. SHC = Sensible Heat Capacity

Table 9. Gross cooling capacities 5 tons with eFlex™ and eDrive™ technology - three phase T/YZC060E4

Air Flow cfm	Ent DB (F)	Ambient Temperature 85 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 95 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 105 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
1000	75	48.15	37.49	53.82	29.73	59.94	15.08	45.62	35.67	51.00	28.32	56.86	14.44	42.95	33.74	48.03	26.83	53.81	13.81
1000	80	49.02	42.63	53.96	37.62	60.15	27.05	46.50	40.64	51.16	35.86	57.06	25.85	43.84	38.52	48.20	33.99	53.82	24.58
1000	85	50.58	46.64	54.28	43.59	60.28	36.71	48.08	44.59	51.49	41.59	57.20	35.08	45.43	42.38	48.55	39.46	53.98	33.34
1000	90	52.84	49.44	55.30	48.11	60.32	44.01	50.35	47.42	52.52	45.99	57.26	42.06	47.72	45.25	49.60	43.73	54.05	40.00
1200	75	50.38	40.33	56.00	32.34	62.35	17.42	47.70	38.35	53.04	30.78	59.13	16.67	44.89	36.25	49.94	29.14	55.95	15.92
1200	80	51.51	45.87	56.15	40.49	62.58	29.81	48.85	43.72	53.21	38.57	59.34	28.47	46.05	41.42	50.12	36.53	55.96	27.05
1200	85	53.34	50.24	56.74	46.85	62.71	39.80	50.69	48.01	53.81	44.68	59.49	38.00	47.91	45.63	50.73	42.38	56.13	36.11
1200	90	55.86	53.31	58.03	51.73	62.75	47.31	53.24	51.13	55.11	49.44	59.55	45.20	50.46	48.79	52.05	47.00	56.20	42.96
1400	75	52.34	42.94	57.93	34.77	64.24	19.60	49.52	40.80	54.83	33.07	60.88	18.73	46.56	38.54	51.58	31.28	57.57	17.86
1400	80	53.73	48.87	58.08	43.14	64.47	32.30	50.93	46.54	55.00	41.05	61.10	30.81	47.99	44.07	51.76	38.85	57.58	29.25
1400	85	55.83	53.57	58.94	49.87	64.61	42.52	53.05	51.17	55.87	47.54	61.25	40.56	50.12	48.62	52.65	45.06	57.74	38.50
1400	90	58.62	56.91	60.49	55.10	64.92	50.39	55.86	54.56	57.43	52.64	61.58	48.11	52.94	52.05	54.23	50.02	58.09	45.69
1600	75	54.03	45.29	59.33	36.84	65.87	21.66	51.08	42.99	56.08	34.99	62.37	20.66	47.98	40.56	52.70	33.05	58.92	19.67
1600	80	55.70	51.58	59.75	45.54	66.11	34.60	52.76	49.08	56.52	43.30	62.59	32.97	49.67	46.44	53.15	40.93	58.93	31.26
1600	85	58.06	56.61	60.87	52.63	66.25	45.00	55.14	54.04	57.66	50.12	62.75	42.89	52.06	51.32	54.30	47.47	59.10	40.66
1600	90	61.12	60.21	62.69	58.19	66.83	53.22	58.21	57.70	59.49	55.55	63.34	50.76	55.16	55.02	56.15	52.76	59.71	48.17
1800	75	55.47	47.36	60.46	38.67	67.24	23.55	52.37	44.90	57.08	36.67	63.59	22.43	49.13	42.30	53.55	34.58	60.01	21.33
1800	80	57.40	53.98	61.15	47.68	67.48	36.69	54.32	51.32	57.79	45.27	63.82	34.92	51.09	48.51	54.27	42.74	60.02	33.05
1800	85	60.03	59.33	62.54	55.09	67.62	47.23	56.96	56.59	59.19	52.42	63.98	44.96	53.75	53.70	55.69	49.59	60.19	42.57
1800	90	63.36	63.18	64.63	60.96	68.47	55.76	60.31	60.31	61.29	58.16	64.84	53.13	57.11	57.11	57.80	55.19	61.07	50.37
2000	75	56.64	49.13	61.34	40.23	68.08	25.16	53.40	46.50	57.81	38.09	64.29	23.92	50.02	43.74	54.14	35.85	60.57	22.70
2000	80	58.83	56.06	62.29	49.52	68.32	38.39	55.61	53.23	58.78	46.95	64.52	36.48	52.24	50.25	55.13	44.26	60.58	34.46
2000	85	61.73	61.70	63.95	57.23	68.74	49.18	58.52	58.52	60.46	54.39	64.95	46.75	55.17	55.17	56.81	51.40	61.02	44.20
2000	90	65.33	65.33	66.30	63.40	69.85	57.99	62.14	62.14	62.82	60.43	66.08	55.20	58.80	58.80	59.20	57.29	62.16	52.26
2200	75	57.54	50.57	61.95	41.52	68.66	26.55	54.16	47.79	58.28	39.24	64.73	25.20	50.64	44.87	54.47	36.84	60.87	23.86
2200	80	60.01	57.80	63.17	51.04	68.90	39.83	56.65	54.80	59.52	48.32	64.96	37.77	53.14	51.65	55.72	45.47	60.88	35.61
2200	85	63.17	63.17	65.10	59.04	69.58	50.82	59.83	59.83	61.46	56.03	65.66	48.24	56.33	56.33	57.68	52.87	61.59	45.52
2200	90	67.04	67.04	67.72	65.48	70.96	59.89	63.70	63.70	64.09	62.34	67.05	56.93	60.22	60.22	60.33	59.03	63.00	53.83
2400	75	58.19	51.67	62.30	42.51	68.97	27.72	54.67	48.74	58.49	40.09	64.91	26.24	51.00	45.66	54.54	37.55	60.90	24.79
2400	80	60.92	59.17	63.79	52.24	69.22	40.97	57.42	56.01	60.00	49.37	65.14	38.78	53.77	52.70	56.06	46.36	60.91	36.48
2400	85	64.35	64.35	65.98	60.49	70.17	52.14	60.86	60.86	62.20	57.32	66.10	49.41	57.23	57.23	58.28	54.00	61.89	46.54
2400	90	68.48	68.48	68.87	67.19	71.82	61.44	65.01	65.01	65.10	63.89	67.76	58.32	61.10	61.10	61.19	60.41	63.57	55.05

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Table 9. Gross cooling capacities 5 tons with eFlex™ and eDrive™ technology - three phase T/YZC060E4 (continued)

Air Flow cfm	Ent DB (F)	Ambient Temperature 115 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 120 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
1000	75	40.12	31.68	44.92	25.25	50.26	13.05	38.66	30.60	43.31	24.42	47.44	12.39
1000	80	41.03	36.25	45.11	32.00	50.44	23.22	39.57	35.06	43.50	30.96	48.69	22.52
1000	85	42.64	40.02	45.47	37.19	50.61	31.50	41.19	38.78	43.88	36.01	48.87	30.54
1000	90	44.94	42.91	46.54	41.31	50.70	37.80	43.50	41.68	44.95	40.04	48.96	36.65
1200	75	41.92	34.02	46.68	27.40	52.25	15.02	40.38	32.86	45.00	26.50	49.32	14.26
1200	80	43.10	38.98	46.88	34.37	52.44	25.55	41.57	37.70	45.20	33.25	50.62	24.76
1200	85	44.97	43.10	47.51	39.94	52.62	34.10	43.45	41.77	45.84	38.66	50.80	33.05
1200	90	47.54	46.28	48.84	44.40	52.70	40.58	46.03	44.96	47.18	43.04	50.90	39.34
1400	75	43.46	36.14	48.18	29.38	53.72	16.83	41.85	34.89	46.43	28.40	50.69	15.96
1400	80	44.90	41.45	48.38	36.53	53.91	27.59	43.30	40.08	46.64	35.32	52.02	26.73
1400	85	47.04	45.91	49.28	42.44	54.09	36.32	45.45	44.49	47.55	41.07	52.21	35.19
1400	90	49.88	49.37	50.88	47.24	54.45	43.14	48.30	47.97	49.15	45.79	52.57	41.81
1600	75	44.73	37.99	49.16	31.00	54.92	18.50	43.05	36.66	47.34	29.94	51.80	17.53
1600	80	46.44	43.64	49.63	38.44	55.12	29.45	44.77	42.19	47.81	37.14	53.16	28.51
1600	85	48.85	48.43	50.79	44.68	55.31	38.32	47.18	46.92	48.99	43.22	53.35	37.10
1600	90	51.95	51.95	52.66	49.80	55.93	45.44	50.30	50.30	50.86	48.26	53.98	44.02
1800	75	45.74	39.57	49.87	32.38	55.87	20.02	43.99	38.14	47.98	31.23	52.65	18.95
1800	80	47.72	45.54	50.61	40.08	56.07	31.09	45.98	43.99	48.72	38.70	54.04	30.08
1800	85	50.39	50.39	52.04	46.62	56.26	40.05	48.66	48.66	50.16	45.07	54.24	38.75
1800	90	53.77	53.77	54.17	52.06	57.15	47.46	52.04	52.04	52.30	50.42	55.13	45.95
2000	75	46.49	40.84	50.32	33.50	56.29	21.26	44.67	39.34	48.36	32.28	52.99	20.10
2000	80	48.73	47.11	51.33	41.43	56.49	32.36	46.92	45.48	49.37	39.96	54.39	31.26
2000	85	51.67	51.67	53.03	48.25	56.95	41.51	49.87	49.87	51.08	46.62	54.85	40.13
2000	90	55.31	55.31	55.43	53.98	58.10	49.18	53.38	53.38	53.48	52.26	56.02	47.58
2200	75	46.97	41.80	50.51	34.34	56.44	22.29	45.08	40.21	48.48	33.05	53.08	21.05
2200	80	49.48	48.34	51.78	42.48	56.65	33.36	47.60	46.62	49.75	40.93	54.48	32.19
2200	85	52.69	52.69	53.75	49.55	57.37	42.68	50.82	50.82	51.73	47.83	55.21	41.21
2200	90	56.32	56.32	56.41	55.55	58.79	50.57	54.31	54.31	54.40	53.74	56.64	48.88
2400	75	47.19	42.44	50.70	35.09	56.60	23.21	45.23	40.77	48.60	33.72	53.17	21.88
2400	80	49.97	49.22	51.97	43.21	56.81	34.24	48.02	47.42	49.87	41.58	54.57	33.00
2400	85	53.45	53.45	54.21	50.51	57.53	43.54	51.50	51.50	52.12	48.71	55.30	41.98
2400	90	57.06	57.06	57.14	56.76	59.22	51.63	54.98	54.98	55.06	54.87	57.00	49.86

Notes:

1. All capacities shown are gross and have not considered indoor fan heat. To obtain **NET** cooling capacity subtract indoor fan heat. For indoor fan heat formula, refer to appropriate airflow table notes.
2. MBh = Total Gross Capacity
3. SHC = Sensible Heat Capacity

Table 10. Gross cooling capacities 6 tons with eFlex™ and eDrive™ technology - three phase T/YZC072F3,4,W

Air Flow cfm	Ent DB (F)	Ambient Temperature 85 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 95 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 105 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
1200	75	57.0	41.7	64.7	34.3	73.2	26.5	54.1	40.0	61.6	32.6	69.8	24.8	51.5	38.5	58.6	31.0	66.4	23.2
1200	80	57.0	48.3	64.7	40.9	73.2	33.2	54.2	46.6	61.7	39.3	69.9	31.6	51.6	45.1	58.6	37.6	66.5	29.9
1200	85	56.9	54.7	64.7	47.5	73.3	39.9	53.9	53.0	61.7	45.9	69.9	38.2	51.2	51.2	58.7	44.3	66.6	36.6
1200	90	55.8	55.8	64.8	54.1	73.3	46.5	53.2	53.2	61.8	52.5	70.0	44.9	51.3	51.3	58.7	50.8	66.6	43.3
1440	75	59.8	45.9	67.8	36.9	76.6	27.5	56.7	44.2	64.5	35.2	73.0	25.7	53.8	42.5	61.2	33.4	69.2	24.0
1440	80	59.9	53.8	67.8	44.8	76.7	35.5	56.8	52.1	64.6	43.1	73.0	33.8	53.9	50.4	61.2	41.4	69.3	32.0
1440	85	59.6	59.6	67.9	52.7	76.7	43.5	56.4	56.4	64.6	51.1	73.1	41.8	53.4	53.4	61.3	49.3	69.4	40.1
1440	90	60.7	60.7	67.9	60.6	76.8	51.5	58.3	58.3	64.7	59.0	73.2	49.8	55.9	55.9	61.4	57.2	69.4	48.0
1680	75	62.0	50.0	70.2	39.3	79.3	28.3	58.8	48.2	66.7	37.5	75.4	26.5	55.6	46.4	63.1	35.7	71.3	24.7
1680	80	62.1	59.2	70.3	48.6	79.3	37.7	58.8	57.4	66.8	46.8	75.4	35.9	55.6	55.6	63.2	45.0	71.4	34.0
1680	85	61.9	61.9	70.3	57.8	79.4	47.0	58.9	58.9	66.8	56.1	75.5	45.2	56.4	56.4	63.3	54.3	71.4	43.4
1680	90	65.1	65.1	70.4	67.0	79.4	56.3	62.5	62.5	66.9	65.3	75.6	54.5	59.9	59.9	63.3	63.3	71.5	52.7
1920	75	63.7	54.0	72.1	41.7	81.3	29.0	60.3	52.1	68.4	39.8	77.2	27.2	56.9	50.2	64.6	38.0	72.9	25.3
1920	80	63.8	63.8	72.2	52.3	81.4	39.7	60.4	60.4	68.5	50.4	77.3	37.9	57.0	57.0	64.7	48.6	73.0	36.0
1920	85	65.0	65.0	72.3	62.8	81.5	50.4	62.3	62.3	68.6	61.0	77.4	48.6	59.5	59.5	64.8	59.1	73.1	46.7
1920	90	68.9	68.9	72.3	72.3	81.5	61.0	66.1	66.1	68.6	68.6	77.5	59.2	63.3	63.3	64.9	64.9	73.2	57.3
2160	75	65.2	57.8	73.7	44.0	83.0	29.7	61.6	55.9	69.8	42.1	78.7	27.8	58.0	54.0	65.8	40.1	74.3	25.8
2160	80	65.3	65.3	73.8	55.9	83.1	41.8	61.8	61.8	69.8	54.0	78.8	39.9	58.4	58.4	65.9	52.1	74.4	37.9
2160	85	68.1	68.1	73.9	67.8	83.2	53.8	65.2	65.2	70.0	65.9	78.9	51.9	62.1	62.1	66.0	64.0	74.4	49.9
2160	90	72.3	72.3	74.0	74.0	83.2	65.7	69.2	69.2	70.2	70.2	79.0	63.8	66.2	66.2	66.5	66.5	74.5	61.9
2400	75	66.3	61.7	75.0	46.2	84.4	30.3	62.7	59.7	70.9	44.2	79.9	28.4	58.9	57.7	66.8	42.3	75.3	26.4
2400	80	66.8	66.8	75.1	59.5	84.5	43.7	63.3	63.3	71.0	57.5	80.0	41.8	60.3	60.3	66.9	55.5	75.4	39.8
2400	85	70.8	70.8	75.2	72.7	84.5	57.1	67.6	67.6	71.1	70.7	80.1	55.1	64.4	64.4	67.1	67.1	75.5	53.1
2400	90	75.2	75.2	75.7	75.7	84.6	70.3	72.0	72.0	72.0	72.0	80.2	68.4	68.7	68.7	68.7	68.7	75.6	66.4
2640	75	67.3	65.4	76.1	48.4	85.5	30.9	63.5	63.4	71.9	46.4	81.0	28.9	59.7	59.7	67.6	44.4	76.2	26.9
2640	80	68.4	68.4	76.2	63.0	85.6	45.7	65.4	65.4	72.0	61.0	81.1	43.7	62.1	62.1	67.7	58.9	76.3	41.6
2640	85	73.1	73.1	76.3	76.3	85.7	60.3	69.8	69.8	72.2	72.2	81.2	58.4	66.5	66.5	68.0	68.0	76.4	56.3
2640	90	77.8	77.8	77.6	77.6	85.8	74.9	74.4	74.4	74.5	74.5	81.3	73.0	70.8	70.8	70.9	70.9	76.6	70.9
2880	75	68.2	68.2	77.0	50.6	86.5	31.5	64.3	64.3	72.7	48.5	81.8	29.5	60.4	60.4	68.3	46.4	76.9	27.4
2880	80	70.5	70.5	77.1	66.5	86.6	47.6	67.2	67.2	72.8	64.5	81.9	45.6	63.7	63.7	68.4	62.3	77.1	43.5
2880	85	75.3	75.3	77.3	77.3	86.7	63.6	71.8	71.8	73.1	73.1	82.0	61.6	68.2	68.2	68.8	68.8	77.2	59.5
2880	90	80.1	80.1	80.2	80.2	86.8	79.5	76.5	76.5	76.6	76.6	82.2	77.5	72.8	72.8	72.9	72.9	77.3	75.4

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Table 10. Gross cooling capacities 6 tons with eFlex™ and eDrive™ technology - three phase T/YZC072F3,4,W (continued)

Air Flow	Ent DB	Ambient Temperature 115 Entering Wet Bulb						Ambient Temperature 120 Entering Wet Bulb					
		61		67		73		61		67		73	
cfm	(F)	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC
1200	75	49.7	37.4	56.1	29.6	63.3	21.7	49.1	36.9	55.2	29.1	61.9	21.0
1200	80	49.8	44.0	56.2	36.3	63.3	28.4	49.1	43.5	55.3	35.7	62.0	27.7
1200	85	49.4	49.4	56.3	42.9	63.4	35.1	48.7	48.7	55.4	42.4	62.1	34.4
1200	90	49.9	49.9	56.3	49.5	63.5	41.7	49.3	49.3	55.4	49.0	62.1	41.1
1440	75	51.7	41.3	58.3	31.9	65.7	22.3	51.0	40.8	57.2	31.3	64.1	21.6
1440	80	51.8	49.1	58.4	39.9	65.8	30.4	51.0	48.6	57.3	39.3	64.2	29.6
1440	85	51.4	51.4	58.5	47.8	65.8	38.4	50.6	50.6	57.4	47.2	64.3	37.7
1440	90	54.1	54.1	58.5	55.7	65.9	46.4	53.4	53.4	57.4	55.1	64.3	45.7
1680	75	53.2	45.0	60.0	34.1	67.5	22.9	52.3	44.5	58.7	33.4	65.7	22.1
1680	80	53.2	53.2	60.0	43.4	67.5	32.3	52.3	52.3	58.8	42.7	65.8	31.5
1680	85	54.4	54.4	60.1	52.7	67.6	41.7	53.6	53.6	58.9	52.0	65.9	40.9
1680	90	57.6	57.6	60.1	60.1	67.7	51.0	56.8	56.8	58.8	58.8	66.0	50.2
1920	75	54.3	48.7	61.2	36.2	68.8	23.4	53.4	48.1	59.8	35.5	66.9	22.6
1920	80	54.4	54.4	61.3	46.9	68.9	34.2	53.5	53.5	59.9	46.1	67.0	33.3
1920	85	57.1	57.1	61.4	57.4	69.0	44.8	56.2	56.2	60.0	56.7	67.1	44.0
1920	90	60.6	60.6	61.5	61.5	69.1	55.5	59.6	59.6	60.2	60.2	67.2	54.6
2160	75	55.2	52.4	62.2	38.3	69.8	23.9	54.2	51.7	60.7	37.6	67.8	23.0
2160	80	55.7	55.7	62.3	50.3	69.9	36.0	54.7	54.7	60.8	49.5	67.9	35.1
2160	85	59.5	59.5	62.4	62.2	70.0	48.0	58.4	58.4	60.9	60.9	68.0	47.1
2160	90	63.2	63.2	63.1	63.1	70.1	60.0	62.0	62.0	62.0	62.0	68.1	59.1
2400	75	55.9	55.9	63.0	40.4	70.7	24.4	54.8	54.8	61.4	39.6	68.6	23.4
2400	80	57.6	57.6	63.1	53.7	70.8	37.8	56.6	56.6	61.5	52.8	68.7	36.8
2400	85	61.5	61.5	63.3	63.3	70.9	51.1	60.2	60.2	61.7	61.7	68.8	50.2
2400	90	65.5	65.5	65.6	65.6	71.0	64.4	64.0	64.0	64.1	64.1	68.9	63.5
2640	75	56.5	56.5	63.6	42.4	71.4	24.8	55.3	55.3	62.0	41.6	69.1	23.8
2640	80	59.2	59.2	63.8	57.0	71.5	39.6	58.0	58.0	62.1	56.2	69.2	38.6
2640	85	63.3	63.3	64.1	64.1	71.6	54.2	61.9	61.9	62.4	62.4	69.4	53.3
2640	90	67.4	67.4	67.5	67.5	71.8	68.9	65.8	65.8	65.9	65.9	69.5	67.9
2880	75	57.1	57.1	64.2	44.4	72.0	25.3	55.8	55.8	62.4	43.6	69.6	24.2
2880	80	60.6	60.6	64.3	60.4	72.1	41.3	59.3	59.3	62.5	59.5	69.7	40.3
2880	85	64.8	64.8	64.9	64.9	72.3	57.4	63.3	63.3	63.2	63.2	69.8	56.3
2880	90	69.1	69.1	69.2	69.2	72.4	72.4	67.4	67.4	67.5	67.5	70.0	70.0

Notes:

1. All capacities shown are gross and have not considered indoor fan heat. To obtain **NET** cooling capacity subtract indoor fan heat. For indoor fan heat formula, refer to appropriate airflow table notes.
2. MBh = Total Gross Capacity
3. SHC = Sensible Heat Capacity

Table 11. Gross cooling capacities 7.5 tons with eFlex™ and eDrive™ technology - three phase T/YZC090F3,4,W

Air Flow cfm	Ent DB (F)	Ambient Temperature 85 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 95 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 105 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
1500	75	75.3	54.5	84.7	44.8	94.8	34.6	72.2	52.6	81.3	42.9	90.8	32.6	69.1	50.8	77.7	41.0	86.7	30.7
1500	80	75.4	62.8	84.8	53.2	94.8	43.0	72.4	61.0	81.4	51.3	90.9	41.1	69.2	59.1	77.8	49.4	86.8	39.1
1500	85	75.5	71.0	84.9	61.5	94.9	51.4	72.4	68.9	81.5	59.7	91.0	49.5	69.3	66.9	78.0	57.7	86.9	47.5
1500	90	75.8	75.8	85.1	69.8	95.0	59.8	73.4	73.4	81.7	68.0	91.1	57.9	70.9	70.9	78.1	66.1	87.0	55.9
1800	75	79.0	59.8	88.6	48.0	98.5	35.5	75.6	57.8	84.8	46.0	94.2	33.5	72.2	55.8	80.9	44.0	89.6	31.4
1800	80	79.2	69.8	88.7	58.0	98.6	45.7	75.9	67.8	85.0	56.1	94.3	43.6	72.4	65.8	81.1	54.0	89.7	41.5
1800	85	79.6	79.2	88.9	68.0	98.7	55.7	76.3	76.3	85.2	66.1	94.4	53.7	72.9	72.9	81.3	64.0	89.9	51.6
1800	90	82.5	82.5	89.1	78.0	98.8	65.8	79.8	79.8	85.4	76.0	94.5	63.8	76.8	76.8	81.5	74.0	90.1	61.7
2100	75	81.8	64.9	91.4	51.0	101.1	36.3	78.2	62.8	87.4	48.9	96.5	34.2	74.5	60.7	83.1	46.7	91.6	32.0
2100	80	82.2	76.5	91.7	62.7	101.2	48.1	78.6	73.9	87.6	60.6	96.6	46.0	74.9	71.8	83.4	58.5	91.7	43.8
2100	85	83.3	83.3	91.9	74.4	101.4	59.9	80.4	80.4	87.9	72.3	96.8	57.8	77.2	77.2	83.7	70.2	91.9	55.6
2100	90	88.1	88.1	92.2	86.0	101.6	71.6	84.9	84.9	88.2	83.3	96.9	69.5	81.6	81.6	84.1	81.1	92.1	67.3
2400	75	84.1	69.8	93.6	53.8	103.1	37.0	80.2	67.7	89.3	51.6	98.1	34.8	76.3	65.5	84.8	49.4	93.0	32.5
2400	80	84.7	82.5	93.9	67.2	103.2	50.5	80.9	80.3	89.6	65.0	98.3	48.3	77.0	77.0	85.1	62.8	93.2	46.0
2400	85	87.7	87.7	94.2	80.5	103.4	63.9	84.4	84.4	89.9	78.4	98.5	61.7	81.0	81.0	85.5	76.2	93.4	59.4
2400	90	92.7	92.7	94.8	93.1	103.5	77.3	89.2	89.2	90.6	90.6	98.6	75.1	85.5	85.5	86.3	86.3	93.5	72.8
2700	75	85.9	74.6	95.4	56.6	104.5	37.6	81.8	72.4	90.8	54.3	99.4	35.4	77.7	70.2	86.1	52.0	94.0	33.0
2700	80	86.9	86.9	95.7	71.6	104.7	52.8	83.0	83.0	91.2	69.4	99.6	50.5	79.1	79.1	86.5	67.1	94.2	48.2
2700	85	91.4	91.4	96.0	86.7	104.9	67.9	87.8	87.8	91.6	83.6	99.7	65.6	84.0	84.0	86.9	81.2	94.4	63.3
2700	90	96.5	96.5	97.1	97.1	105.0	82.9	92.7	92.7	92.8	92.8	99.9	80.6	88.6	88.6	88.8	88.8	94.5	78.3
3000	75	87.4	79.4	96.7	59.3	105.7	38.3	83.2	77.1	92.0	57.0	100.4	35.9	78.9	73.8	87.2	54.6	94.8	33.6
3000	80	89.1	89.1	97.1	76.0	105.9	55.1	85.5	85.5	92.4	73.7	100.5	52.8	81.7	81.7	87.5	71.3	95.0	50.4
3000	85	94.5	94.5	97.6	91.7	106.0	71.8	90.6	90.6	93.0	89.3	100.7	69.5	86.6	86.6	88.2	86.8	95.1	67.1
3000	90	99.6	99.6	99.6	99.6	106.1	88.5	95.5	95.5	95.6	95.6	100.8	86.2	91.1	91.1	91.2	91.2	95.2	83.8
3300	75	88.7	83.1	97.9	62.0	106.6	38.9	84.4	80.7	93.0	59.6	101.2	36.5	80.0	78.1	88.0	57.1	95.5	34.1
3300	80	91.7	91.7	98.2	80.4	106.8	57.4	87.8	87.8	93.4	78.0	101.3	55.0	83.7	83.7	88.3	75.5	95.6	52.5
3300	85	97.1	97.1	98.9	97.4	106.9	75.8	93.0	93.0	94.2	94.2	101.4	73.4	88.6	88.6	89.2	89.2	95.7	70.9
3300	90	102.2	102.2	102.3	102.3	107.2	94.1	97.7	97.7	97.8	97.8	101.6	91.7	93.0	93.0	93.1	93.1	95.9	87.8
3600	75	89.9	87.6	98.8	64.6	107.4	39.5	85.4	85.0	93.8	62.2	101.8	37.1	80.9	80.9	88.6	59.7	96.0	34.6
3600	80	93.9	93.9	99.2	84.7	107.6	59.6	89.8	89.8	94.1	82.2	101.9	57.2	85.5	85.5	89.0	78.4	96.1	54.7
3600	85	99.3	99.3	100.2	100.2	107.7	79.7	94.9	94.9	95.3	95.3	102.0	77.2	90.3	90.3	90.3	90.3	96.1	74.7
3600	90	104.3	104.3	104.4	104.4	108.1	99.8	99.6	99.6	99.6	99.6	102.4	95.7	94.5	94.5	94.6	94.6	96.5	93.0

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Table 11. Gross cooling capacities 7.5 tons with eFlex™ and eDrive™ technology - three phase T/YZC090F3,4,W (continued)

Air Flow	Ent DB	Ambient Temperature 115 Entering Wet Bulb						Ambient Temperature 120 Entering Wet Bulb					
		61		67		73		61		67		73	
cfm	(F)	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC
1500	75	65.8	48.9	74.0	39.0	82.4	28.6	64.2	47.9	72.1	38.0	80.0	27.5
1500	80	66.0	57.2	74.1	47.4	82.4	37.1	64.4	56.2	72.2	46.4	80.1	36.0
1500	85	66.1	65.0	74.3	55.8	82.6	45.5	64.5	64.0	72.4	54.8	80.2	44.4
1500	90	68.3	68.3	74.5	64.1	82.7	53.9	66.9	66.9	72.5	63.1	80.4	52.8
1800	75	68.6	53.8	76.8	41.9	84.8	29.2	66.8	52.8	74.6	40.8	82.2	28.1
1800	80	68.9	63.8	77.0	51.9	84.9	39.3	67.1	62.3	74.9	50.9	82.3	38.2
1800	85	69.8	69.8	77.2	62.0	85.1	49.4	68.2	68.2	75.1	60.9	82.5	48.3
1800	90	73.8	73.8	77.4	71.9	85.2	59.5	72.2	72.2	75.3	70.9	82.7	58.3
2100	75	70.7	58.6	78.7	44.5	86.4	29.7	68.7	57.5	76.4	43.4	83.7	28.5
2100	80	71.1	69.6	79.0	56.3	86.6	41.5	69.2	68.5	76.7	55.1	83.8	40.3
2100	85	73.9	73.9	79.3	68.0	86.8	53.3	72.2	72.2	77.0	66.8	84.0	52.1
2100	90	78.2	78.2	79.7	78.9	86.9	65.0	76.3	76.3	77.5	77.5	84.1	63.8
2400	75	72.2	63.3	80.2	47.1	87.6	30.2	70.1	62.1	77.7	45.9	84.6	28.9
2400	80	73.1	73.1	80.5	60.5	87.7	43.7	71.1	71.1	78.0	59.3	84.8	42.4
2400	85	77.3	77.3	80.8	73.9	87.9	57.1	75.4	75.4	78.4	72.7	84.9	55.8
2400	90	81.6	81.6	81.8	81.8	88.0	70.4	79.5	79.5	79.5	79.5	85.0	69.2
2700	75	73.5	67.0	81.2	49.7	88.4	30.6	71.3	65.8	78.7	48.4	85.4	29.4
2700	80	75.5	75.5	81.6	64.7	88.5	45.8	73.5	73.5	79.0	63.5	85.5	44.5
2700	85	80.0	80.0	82.1	78.7	88.6	60.8	77.9	77.9	79.5	77.4	85.6	59.5
2700	90	84.3	84.3	84.4	84.4	88.7	75.8	81.9	81.9	82.0	82.0	85.6	74.5
3000	75	74.5	71.3	82.1	52.2	89.0	31.1	72.3	70.0	79.4	50.9	85.9	29.8
3000	80	77.7	77.7	82.4	68.9	89.1	47.9	75.5	75.5	79.7	67.6	86.0	46.5
3000	85	82.2	82.2	83.1	83.1	89.2	64.6	79.9	79.9	80.5	80.5	86.0	63.2
3000	90	86.3	86.3	86.4	86.4	89.2	81.2	83.7	83.7	83.8	83.8	86.0	78.5
3300	75	75.4	75.4	82.7	54.6	89.5	31.5	73.1	73.1	79.9	53.3	86.3	30.2
3300	80	79.4	79.4	83.0	73.0	89.6	49.9	77.2	77.2	80.3	70.4	86.3	48.6
3300	85	84.0	84.0	84.1	84.1	89.5	68.3	81.4	81.4	81.4	81.4	86.2	66.9
3300	90	87.8	87.8	87.9	87.9	89.8	85.0	85.0	85.0	85.0	85.0	86.5	83.5
3600	75	76.3	76.3	83.2	57.1	89.9	32.0	73.9	73.9	80.3	55.7	86.7	30.6
3600	80	80.9	80.9	83.6	75.6	89.9	52.0	78.5	78.5	80.7	74.2	86.5	50.6
3600	85	85.3	85.3	85.4	85.4	89.8	72.0	82.6	82.6	82.7	82.7	86.5	70.6
3600	90	89.1	89.1	89.1	89.1	90.2	90.1	86.1	86.1	86.1	86.1	86.9	86.9

Notes:

1. All capacities shown are gross and have not considered indoor fan heat. To obtain **NET** cooling capacity subtract indoor fan heat. For indoor fan heat formula, refer to appropriate airflow table notes.
2. MBh = Total Gross Capacity
3. SHC = Sensible Heat Capacity

Table 12. Gross cooling capacities 8.5 tons with eFlex™ and eDrive™ technology - three phase T/YZC102F3,4,W

Air Flow cfm	Ent DB (F)	Ambient Temperature 85 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 95 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 105 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
1700	75	84.0	61.5	94.5	50.3	105.9	38.5	80.5	59.4	90.6	48.2	101.4	36.3	76.8	57.3	86.4	46.0	96.7	34.1
1700	80	84.2	71.2	94.7	60.0	106.0	48.3	80.7	69.1	90.7	57.9	101.5	46.1	77.0	67.0	86.6	55.7	96.8	43.9
1700	85	84.3	80.8	94.8	69.7	106.0	58.0	80.9	78.2	90.9	67.6	101.6	55.9	77.3	76.1	86.8	65.4	96.9	53.7
1700	90	85.5	85.5	95.0	79.4	106.2	67.8	82.7	82.7	91.1	77.2	101.7	65.6	79.7	79.7	87.0	75.1	97.1	63.4
2040	75	88.0	67.6	98.7	53.9	110.0	39.6	84.1	65.4	94.3	51.7	105.1	37.3	80.1	63.1	89.8	49.3	99.9	34.9
2040	80	88.3	79.2	98.9	65.6	110.1	51.3	84.4	77.0	94.6	63.3	105.2	49.0	80.4	74.7	90.1	61.0	100.0	46.7
2040	85	88.9	88.9	99.2	77.2	110.3	63.0	85.2	85.2	94.9	75.0	105.4	60.8	81.5	81.5	90.4	72.7	100.2	58.4
2040	90	92.9	92.9	99.4	88.8	110.5	74.7	89.6	89.6	95.1	86.6	105.6	72.4	86.2	86.2	90.7	84.3	100.5	70.1
2380	75	91.0	73.4	101.8	57.3	112.9	40.5	86.9	71.1	97.1	55.0	107.6	38.1	82.5	68.7	92.2	52.5	102.1	35.6
2380	80	91.5	87.0	102.1	71.0	113.0	54.2	87.4	83.9	97.4	68.6	107.8	51.8	83.2	81.5	92.6	66.2	102.3	49.3
2380	85	93.6	93.6	102.4	84.5	113.3	67.9	90.1	90.1	97.8	82.2	108.0	65.5	86.5	86.5	93.0	79.7	102.6	63.0
2380	90	99.0	99.0	102.9	98.1	113.5	81.5	95.3	95.3	98.3	94.9	108.3	79.1	91.5	91.5	93.6	92.4	102.8	76.6
2720	75	93.4	79.1	104.2	60.6	115.1	41.3	89.0	76.7	99.2	58.1	109.5	38.8	84.4	74.2	94.1	55.6	103.7	36.2
2720	80	94.3	93.7	104.6	76.2	115.3	57.0	90.0	90.0	99.6	73.7	109.7	54.5	85.6	85.6	94.5	71.2	103.9	51.9
2720	85	98.4	98.4	104.9	91.7	115.5	72.6	94.5	94.5	100.0	89.2	110.0	70.1	90.5	90.5	95.0	86.7	104.2	67.5
2720	90	104.0	104.0	105.8	105.8	115.8	88.1	100.0	100.0	101.1	101.1	110.3	85.6	95.8	95.8	96.2	96.2	104.5	83.1
3060	75	95.4	84.7	106.1	63.8	116.7	42.1	90.7	82.2	100.9	61.3	110.9	39.5	86.0	78.6	95.5	58.6	104.8	36.8
3060	80	96.8	96.8	106.5	81.3	117.0	59.7	92.4	92.4	101.3	78.8	111.2	57.1	88.2	88.2	96.0	76.2	105.2	54.5
3060	85	102.4	102.4	107.0	98.8	117.2	77.2	98.2	98.2	101.9	95.1	111.5	74.7	93.9	93.9	96.7	92.4	105.5	72.0
3060	90	108.2	108.2	108.5	108.5	117.5	94.7	103.8	103.8	103.8	103.8	111.7	92.1	99.2	99.2	99.4	99.4	105.7	89.5
3400	75	97.0	89.1	107.6	67.0	118.0	42.8	92.2	86.4	102.2	64.3	112.0	40.1	87.3	83.6	96.7	61.6	105.7	37.4
3400	80	99.5	99.5	108.1	86.4	118.3	62.4	95.4	95.4	102.7	83.8	112.3	59.7	91.0	91.0	97.2	81.1	106.1	57.0
3400	85	105.8	105.8	108.8	104.5	118.6	81.8	101.3	101.3	103.5	101.7	112.6	79.2	96.7	96.7	98.1	98.1	106.4	76.5
3400	90	111.7	111.7	111.8	111.8	118.8	101.2	107.0	107.0	107.1	107.1	112.8	98.6	102.0	102.0	102.1	102.1	106.6	95.9
3740	75	98.5	94.3	108.9	70.1	119.1	43.5	93.5	91.5	103.3	67.4	112.9	40.8	88.5	88.5	97.6	64.6	106.4	38.0
3740	80	102.4	102.4	109.4	91.5	119.4	65.0	97.9	97.9	103.8	88.7	113.3	62.3	93.2	93.2	98.1	86.0	106.8	59.5
3740	85	108.7	108.7	110.3	110.3	119.7	86.4	103.9	103.9	104.9	104.9	113.5	83.7	99.0	99.0	99.4	99.4	107.1	80.9
3740	90	114.6	114.6	114.7	114.7	119.9	107.7	109.6	109.6	109.7	109.7	113.8	103.4	104.3	104.3	104.4	104.4	107.4	100.4
4080	75	99.8	99.5	109.9	73.2	120.0	44.2	94.7	94.7	104.2	70.4	113.6	41.4	89.5	89.5	98.3	67.5	107.0	38.6
4080	80	104.8	104.8	110.4	96.5	120.3	67.7	100.1	100.1	104.7	93.7	114.0	64.9	95.1	95.1	98.8	89.1	107.4	62.0
4080	85	111.1	111.1	111.8	111.8	120.5	91.0	106.1	106.1	106.3	106.3	114.2	88.2	100.9	100.9	100.7	100.7	107.6	85.3
4080	90	117.0	117.0	117.1	117.1	120.9	112.3	111.7	111.7	111.8	111.8	114.5	109.4	106.0	106.0	106.1	106.1	107.9	106.3

continued on next page

Table 12. Gross cooling capacities 8.5 tons with eFlex™ and eDrive™ technology - three phase T/YZC102F3,4,W (continued)

Air Flow	Ent DB	Ambient Temperature 115 Entering Wet Bulb						Ambient Temperature 120 Entering Wet Bulb					
		61		67		73		61		67		73	
cfm	(F)	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC
1700	75	73.1	55.1	82.2	43.7	91.8	31.8	71.2	54.1	80.0	42.6	89.2	30.6
1700	80	73.3	64.8	82.4	53.5	91.9	41.6	71.4	63.7	80.2	52.4	89.3	40.4
1700	85	73.6	73.6	82.6	63.2	92.0	51.4	71.8	71.8	80.5	62.1	89.4	50.2
1700	90	76.7	76.7	82.8	72.9	92.2	61.1	75.1	75.1	80.7	71.7	89.6	59.9
2040	75	76.0	60.8	85.2	47.0	94.5	32.5	74.0	59.7	82.7	45.8	91.6	31.2
2040	80	76.4	72.4	85.5	58.7	94.6	44.2	74.4	70.6	83.1	57.5	91.8	43.0
2040	85	78.1	78.1	85.8	70.3	94.9	56.0	76.4	76.4	83.4	69.1	92.0	54.7
2040	90	82.7	82.7	86.1	82.0	95.1	67.7	80.9	80.9	83.7	80.0	92.2	66.4
2380	75	78.2	66.3	87.3	50.0	96.3	33.1	76.0	65.1	84.7	48.8	93.2	31.7
2380	80	78.9	78.9	87.6	63.7	96.5	46.8	76.7	76.7	85.1	62.4	93.4	45.4
2380	85	82.7	82.7	88.0	77.3	96.8	60.5	80.7	80.7	85.4	76.0	93.7	59.1
2380	90	87.5	87.5	88.8	88.8	97.0	74.1	85.4	85.4	86.2	86.2	93.9	72.7
2720	75	79.8	71.7	88.8	53.0	97.6	33.6	77.5	70.4	86.1	51.7	94.3	32.2
2720	80	81.2	81.2	89.3	68.6	97.9	49.3	79.1	79.1	86.5	67.3	94.6	47.9
2720	85	86.3	86.3	89.8	83.1	98.1	64.9	84.1	84.1	87.0	81.7	94.9	63.5
2720	90	91.3	91.3	91.3	91.3	98.4	80.4	88.9	88.9	89.1	89.1	95.1	79.0
3060	75	81.2	75.8	90.0	56.0	98.5	34.1	78.7	74.4	87.1	54.6	95.1	32.7
3060	80	84.1	84.1	90.5	73.5	98.8	51.7	81.8	81.8	87.6	72.1	95.4	50.3
3060	85	89.3	89.3	91.2	89.6	99.1	69.3	86.9	86.9	88.3	88.1	95.6	67.8
3060	90	94.3	94.3	94.5	94.5	99.3	86.7	91.7	91.7	91.8	91.8	95.8	85.3
3400	75	82.3	80.8	90.9	58.9	99.2	34.6	79.8	79.3	87.9	57.4	95.7	33.2
3400	80	86.4	86.4	91.4	78.3	99.5	54.2	84.0	84.0	88.4	76.9	96.0	52.7
3400	85	91.7	91.7	92.5	92.5	99.7	73.6	89.1	89.1	89.5	89.5	96.2	72.1
3400	90	96.7	96.7	96.8	96.8	100.0	91.4	93.8	93.8	93.9	93.9	96.4	89.8
3740	75	83.3	83.3	91.6	61.7	99.7	35.1	80.7	80.7	88.5	60.2	96.1	33.6
3740	80	88.4	88.4	92.2	81.5	100.1	56.6	85.8	85.8	89.0	79.9	96.4	55.1
3740	85	93.7	93.7	93.7	93.7	100.2	78.0	90.9	90.9	90.7	90.7	96.5	76.5
3740	90	98.5	98.5	98.6	98.6	100.5	97.2	95.3	95.3	95.4	95.4	96.8	95.5
4080	75	84.3	84.3	92.2	64.6	100.1	35.6	81.6	81.6	89.0	63.0	96.4	34.1
4080	80	90.0	90.0	92.8	85.9	100.5	59.0	87.2	87.2	89.6	84.3	96.7	57.5
4080	85	95.3	95.3	95.4	95.4	100.5	82.3	92.3	92.3	92.4	92.4	96.7	80.8
4080	90	99.9	99.9	99.9	99.9	100.9	100.9	96.5	96.5	96.5	96.5	97.1	97.1

Notes:

1. All capacities shown are gross and have not considered indoor fan heat. To obtain **NET** cooling capacity subtract indoor fan heat. For indoor fan heat formula, refer to appropriate airflow table notes.
2. MBh = Total Gross Capacity
3. SHC = Sensible Heat Capacity

Table 13. Gross cooling capacities 10 tons with eFlex™ and eDrive™ technology - three phase T/YZC120F3,4,W

Air Flow cfm	Ent DB (F)	Ambient Temperature 85 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 95 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC	Ambient Temperature 105 Entering Wet Bulb 61 MBh	61 SHC	67 MBh	67 SHC	73 MBh	73 SHC
2000	75	95.9	70.5	107.7	57.5	120.2	43.8	92.1	68.3	103.5	55.3	115.4	41.5	88.2	66.1	99.1	53.0	110.4	39.2
2000	80	96.0	81.4	107.8	68.5	120.2	54.9	92.3	79.3	103.5	66.3	115.4	52.7	88.4	77.0	99.1	64.1	110.4	50.4
2000	85	95.9	92.2	107.8	79.5	120.2	66.0	92.1	90.0	103.6	77.3	115.5	63.8	88.2	87.3	99.2	75.1	110.5	61.5
2000	90	95.8	95.8	107.9	90.5	120.3	77.1	92.9	92.9	103.8	88.3	115.5	74.9	89.8	89.8	99.4	86.1	110.5	72.6
2400	75	100.4	77.4	112.4	61.6	124.7	45.0	96.3	75.1	107.7	59.3	119.5	42.7	92.0	72.8	102.9	56.9	114.0	40.2
2400	80	100.6	90.6	112.4	74.9	124.8	58.4	96.4	88.3	107.8	72.6	119.5	56.0	92.2	85.9	103.0	70.2	114.1	53.6
2400	85	100.6	100.6	112.6	88.1	124.8	71.7	96.6	96.6	108.0	85.8	119.6	69.4	92.5	92.5	103.2	83.4	114.2	67.0
2400	90	104.1	104.1	112.7	101.3	124.9	85.0	100.7	100.7	108.1	99.0	119.7	82.7	97.2	97.2	103.3	96.6	114.3	80.3
2800	75	103.8	84.1	115.8	65.5	127.9	46.1	99.4	81.7	110.8	63.1	122.4	43.6	94.8	79.3	105.7	60.7	116.6	41.1
2800	80	104.0	99.4	115.9	81.0	128.0	61.7	99.6	97.1	111.0	78.6	122.4	59.2	95.1	93.9	105.9	76.1	116.6	56.7
2800	85	105.1	105.1	116.1	96.4	128.1	77.2	101.5	101.5	111.2	94.0	122.5	74.8	97.7	97.7	106.1	91.6	116.8	72.3
2800	90	110.9	110.9	116.3	111.8	128.2	92.7	107.1	107.1	111.4	109.4	122.7	90.3	103.2	103.2	106.4	106.0	116.9	87.8
3200	75	106.5	90.6	118.4	69.3	130.4	47.0	101.8	88.1	113.2	66.8	124.5	44.5	97.0	85.6	107.8	64.3	118.4	41.9
3200	80	106.9	106.9	118.6	87.0	130.4	64.8	102.3	102.3	113.4	84.5	124.6	62.4	97.7	97.7	108.1	82.0	118.5	59.8
3200	85	110.5	110.5	118.9	104.6	130.6	82.6	106.5	106.5	113.7	102.1	124.8	80.1	102.4	102.4	108.3	99.6	118.7	77.6
3200	90	116.5	116.5	119.3	119.3	130.7	100.3	112.4	112.4	114.2	114.2	124.9	97.8	108.1	108.1	109.0	109.0	118.8	95.3
3600	75	108.6	97.0	120.5	73.0	132.2	47.9	103.8	94.5	115.1	70.4	126.2	45.4	98.8	91.9	109.5	67.8	119.9	42.7
3600	80	109.5	109.5	120.8	92.9	132.3	68.0	104.9	104.9	115.4	90.3	126.3	65.4	100.2	100.2	109.8	87.7	120.0	62.8
3600	85	115.0	115.0	121.0	112.7	132.5	87.9	110.7	110.7	115.6	110.1	126.4	85.4	106.3	106.3	110.1	107.5	120.1	82.8
3600	90	121.2	121.2	122.0	122.0	132.6	107.8	116.7	116.7	116.9	116.9	126.6	105.3	112.0	112.0	112.0	112.0	120.3	102.7
4000	75	110.4	103.4	122.2	76.6	133.7	48.8	105.4	100.7	116.6	74.0	127.5	46.2	100.2	98.1	110.8	71.3	121.0	43.5
4000	80	112.2	112.2	122.5	98.7	133.9	71.0	108.0	108.0	116.9	96.1	127.6	68.5	103.4	103.4	111.1	93.4	121.1	65.8
4000	85	118.8	118.8	122.8	120.7	134.0	93.2	114.3	114.3	117.3	116.8	127.8	90.6	109.5	109.5	111.6	111.6	121.3	88.0
4000	90	125.1	125.1	125.0	125.0	134.1	115.3	120.3	120.3	120.5	120.5	127.9	112.7	115.3	115.3	115.4	115.4	121.4	110.1
4400	75	112.0	109.6	123.7	80.2	135.0	49.6	106.8	105.7	117.9	77.5	128.6	47.0	101.5	101.5	111.9	74.8	121.9	44.3
4400	80	115.4	115.4	123.9	104.5	135.1	74.1	110.8	110.8	118.2	101.8	128.7	71.5	106.1	106.1	112.2	99.1	122.0	68.8
4400	85	122.0	122.0	124.5	124.5	135.2	98.5	117.2	117.2	118.8	118.8	128.8	95.9	112.2	112.2	113.0	113.0	122.2	93.1
4400	90	128.4	128.4	128.5	128.5	135.3	122.8	123.3	123.3	123.4	123.4	128.9	120.1	118.0	118.0	118.1	118.1	122.3	117.4
4800	75	113.4	113.4	124.9	83.8	136.0	50.5	108.1	108.1	118.9	81.0	129.5	47.8	102.7	102.7	112.8	78.3	122.6	45.0
4800	80	118.1	118.1	125.1	110.2	136.1	77.2	113.3	113.3	119.2	107.5	129.6	74.5	108.3	108.3	113.1	104.7	122.8	71.7
4800	85	124.8	124.8	126.0	126.0	136.3	103.8	119.7	119.7	120.3	120.3	129.7	101.1	114.5	114.5	114.5	114.5	122.9	98.3
4800	90	131.2	131.2	131.3	131.3	136.3	130.2	125.8	125.8	125.9	125.9	129.8	127.6	120.2	120.2	120.3	120.3	123.0	122.8

continued on next page

Table 13. Gross cooling capacities 10 tons with eFlex™ and eDrive™ technology - three phase T/YZC120F3,4,W (continued)

Air Flow	Ent DB	Ambient Temperature 115 Entering Wet Bulb						Ambient Temperature 120 Entering Wet Bulb					
		61		67		73		61		67		73	
cfm	(F)	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC	MBh	SHC
2000	75	84.3	63.8	94.5	50.7	105.1	36.8	82.3	62.7	92.2	49.5	102.2	35.5
2000	80	84.4	74.8	94.6	61.8	105.1	48.0	82.4	73.7	92.3	60.6	102.3	46.7
2000	85	84.2	84.2	94.7	72.8	105.2	59.1	82.2	82.2	92.4	71.6	102.3	57.8
2000	90	86.6	86.6	94.9	83.8	105.3	70.2	85.0	85.0	92.5	82.6	102.4	68.9
2400	75	87.7	70.4	97.9	54.5	108.2	37.7	85.5	69.2	95.3	53.2	105.1	36.4
2400	80	87.8	83.6	98.1	67.8	108.3	51.1	85.6	82.4	95.5	66.5	105.2	49.8
2400	85	88.6	88.6	98.3	81.0	108.4	64.5	86.8	86.8	95.7	79.7	105.3	63.1
2400	90	93.5	93.5	98.4	94.1	108.5	77.8	91.6	91.6	95.8	92.9	105.4	76.4
2800	75	90.2	76.8	100.4	58.1	110.4	38.5	87.8	75.6	97.6	56.8	107.1	37.1
2800	80	90.5	90.5	100.6	73.6	110.5	54.1	88.2	88.2	97.8	72.3	107.2	52.8
2800	85	93.8	93.8	100.8	89.0	110.6	69.7	91.8	91.8	98.0	87.7	107.3	68.3
2800	90	99.0	99.0	101.1	101.1	110.8	85.2	96.8	96.8	98.4	98.4	107.4	83.8
3200	75	92.2	83.1	102.2	61.7	112.0	39.3	89.6	81.8	99.3	60.3	108.5	37.9
3200	80	93.0	93.0	102.5	79.3	112.1	57.1	90.6	90.6	99.5	78.0	108.6	55.7
3200	85	98.1	98.1	102.7	97.0	112.2	74.9	95.8	95.8	99.8	95.6	108.7	73.5
3200	90	103.5	103.5	103.7	103.7	112.4	92.6	101.0	101.0	101.0	101.0	108.9	91.2
3600	75	93.7	89.3	103.6	65.1	113.2	40.0	91.1	87.9	100.6	63.7	109.5	38.6
3600	80	95.9	95.9	103.9	85.0	113.3	60.1	93.6	93.6	100.8	83.6	109.7	58.6
3600	85	101.6	101.6	104.3	103.6	113.4	80.0	99.1	99.1	101.2	101.2	109.8	78.6
3600	90	107.0	107.0	107.1	107.1	113.6	99.9	104.3	104.3	104.4	104.4	109.9	98.5
4000	75	95.0	94.2	104.8	68.6	114.1	40.7	92.3	92.3	101.6	67.1	110.4	39.3
4000	80	98.7	98.7	105.1	90.7	114.2	63.0	96.2	96.2	101.9	89.2	110.5	61.5
4000	85	104.4	104.4	105.7	105.7	114.4	85.2	101.7	101.7	102.6	102.6	110.6	83.7
4000	90	109.9	109.9	110.0	110.0	114.4	107.3	106.9	106.9	107.0	107.0	110.7	105.8
4400	75	96.2	96.2	105.7	72.0	114.8	41.4	93.4	93.4	102.4	70.5	111.0	39.9
4400	80	101.1	101.1	106.0	96.3	115.0	65.9	98.4	98.4	102.7	94.8	111.1	64.4
4400	85	106.8	106.8	107.0	107.0	115.0	90.3	103.9	103.9	103.9	103.9	111.2	88.8
4400	90	112.2	112.2	112.2	112.2	115.2	114.6	109.0	109.0	109.0	109.0	111.3	111.1
4800	75	97.3	97.3	106.4	75.4	115.4	42.2	94.5	94.5	103.0	73.9	111.6	40.6
4800	80	103.0	103.0	106.7	101.9	115.5	68.8	100.2	100.2	103.3	100.4	111.6	67.3
4800	85	108.8	108.8	108.6	108.6	115.6	95.4	105.7	105.7	105.8	105.8	111.6	93.9
4800	90	114.0	114.0	114.1	114.1	115.8	115.8	110.6	110.6	110.7	110.7	111.9	111.9

Notes:

1. All capacities shown are gross and have not considered indoor fan heat. To obtain **NET** cooling capacity subtract indoor fan heat. For indoor fan heat formula, refer to appropriate airflow table notes.
2. MBh = Total Gross Capacity
3. SHC = Sensible Heat Capacity

Evaporator Fan Performance

Table 14. Direct drive evaporator fan performance - 3 ton with eFlex™ and eDrive™ technology- T/YZC036E3, E4 downflow airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
960	—	—	615	0.15	655	0.18	695	0.22	735	0.26	775	0.29	815	0.33	855	0.37	896	0.41	936	0.44
1080	599	0.16	639	0.20	680	0.24	720	0.27	760	0.31	800	0.35	840	0.38	880	0.42	920	0.46	960	0.49
1200	624	0.21	664	0.25	704	0.29	744	0.32	784	0.36	824	0.40	865	0.43	905	0.47	945	0.51	985	0.54
1320	649	0.26	689	0.30	729	0.34	769	0.37	809	0.41	849	0.45	889	0.49	929	0.52	969	0.56	1009	0.60
1440	673	0.31	713	0.35	753	0.39	793	0.43	834	0.46	874	0.50	914	0.54	954	0.57	994	0.61	1034	0.65

Continued

	External Static Pressure (Inches of Water)									
	1.10		1.20		1.30		1.40		1.50	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
960	976	0.48	1016	0.52	1056	0.55	1096	0.59	1136	0.63
1080	1000	0.53	1040	0.57	1081	0.60	1121	0.64	—	—
1200	1025	0.58	1065	0.62	1105	0.66	—	—	—	—
1320	1050	0.63	1090	0.67	—	—	—	—	—	—
1440	1074	0.68	—	—	—	—	—	—	—	—

Notes:
1. For Constant CFM Direct Drive Fan, reference the applicable table in the fan performance section for voltage vs. cfm setting.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct Drive Fan Motor Heat (MBH) = 2.9245 x fan bhp + 0.055
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 15. Direct drive evaporator fan performance - 3 ton with eFlex™ and eDrive™ technology - T/YZC036E3,E4 horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
960	596	0.11	634	0.15	673	0.18	711	0.22	750	0.26	788	0.29	827	0.33	865	0.36	904	0.40	942	0.44
1080	618	0.16	656	0.20	695	0.23	733	0.27	772	0.31	810	0.34	849	0.38	887	0.42	926	0.45	964	0.49
1200	640	0.21	678	0.25	717	0.29	755	0.32	794	0.36	832	0.40	871	0.43	909	0.47	948	0.51	986	0.54
1320	662	0.27	700	0.30	739	0.34	777	0.38	816	0.41	854	0.45	893	0.49	931	0.52	970	0.56	1008	0.59
1440	684	0.32	722	0.36	761	0.39	799	0.43	838	0.46	876	0.50	915	0.54	953	0.57	992	0.61	1030	0.65

Continued

	External Static Pressure (Inches of Water)									
	1.10		1.20		1.30		1.40		1.50	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
960	981	0.47	—	—	—	—	—	—	—	—
1080	—	—	—	—	—	—	—	—	—	—
1200	—	—	—	—	—	—	—	—	—	—
1320	—	—	—	—	—	—	—	—	—	—
1440	—	—	—	—	—	—	—	—	—	—

Notes:
1. For Constant CFM Direct Drive Fan, reference the applicable table in the fan performance section for voltage vs. cfm setting.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct Drive Fan Motor Heat (MBH) = 2.9245 x fan bhp + 0.055
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Table 16. Direct drive evaporator fan performance - 4 ton with eFlex™ and eDrive™ technology - T/YZC048F3, F4 downflow airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1280	541	0.07	585	0.12	628	0.18	672	0.23	715	0.28	759	0.33	802	0.39	846	0.44	889	0.49	933	0.55
1440	564	0.15	608	0.20	651	0.25	695	0.30	738	0.36	782	0.41	825	0.46	869	0.51	912	0.57	956	0.62
1600	587	0.22	631	0.27	674	0.33	718	0.38	761	0.43	805	0.48	848	0.54	892	0.59	935	0.64	979	0.70
1760	610	0.30	654	0.35	697	0.40	741	0.45	784	0.51	828	0.56	871	0.61	915	0.66	958	0.72	1002	0.77
1920	634	0.37	677	0.42	721	0.48	764	0.53	808	0.58	851	0.63	895	0.69	938	0.74	982	0.79	1025	0.85

Continued

	External Static Pressure (Inches of Water)									
	1.10		1.20		1.30		1.40		1.50	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1280	976	0.60	1020	0.65	1063	0.70	1107	0.76	1150	0.81
1440	999	0.67	1043	0.73	1086	0.78	1130	0.83	1173	0.88
1600	1022	0.75	1066	0.80	1109	0.85	1153	0.91	1196	0.96
1760	1045	0.82	1089	0.88	1132	0.93	1176	0.98	1219	1.03
1920	1069	0.90	1112	0.95	1156	1.00	1199	1.06	1243	1.11

Notes:
1. For Constant CFM Direct Drive Fan, reference the applicable table in the fan performance section for voltage vs. cfm setting.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct Drive Fan Motor Heat (MBH) = 2.9245 x fan bhpP + 0.055
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 17. Direct drive evaporator fan performance - 4 ton with eFlex™ and eDrive™ technology - T/YZC048F3, F4 horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1280	591	0.10	632	0.15	674	0.20	715	0.26	756	0.31	798	0.36	839	0.41	880	0.47	922	0.52	963	0.57
1440	621	0.19	663	0.24	704	0.30	745	0.35	787	0.40	828	0.45	869	0.51	911	0.56	952	0.61	993	0.66
1600	652	0.28	693	0.33	734	0.39	776	0.44	817	0.49	858	0.55	900	0.60	941	0.65	982	0.70	1023	0.76
1760	682	0.37	723	0.43	765	0.48	806	0.53	847	0.58	889	0.64	930	0.69	971	0.74	1012	0.80	1054	0.85
1920	712	0.47	754	0.52	795	0.57	836	0.62	878	0.68	919	0.73	960	0.78	1001	0.83	1043	0.89	1084	0.94

Continued

	External Static Pressure (Inches of Water)									
	1.10		1.20		1.30		1.40		1.50	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1280	1004	0.62	1045	0.68	1087	0.73	1128	0.78	1169	0.83
1440	1034	0.72	1076	0.77	1117	0.82	1158	0.87	1200	0.93
1600	1065	0.81	1106	0.86	1147	0.91	1189	0.97	1230	1.02
1760	1095	0.90	1136	0.95	1178	1.01	1219	1.06	1260	1.11
1920	1125	0.99	1167	1.05	1208	1.10	1249	1.15	1291	1.20

Notes:
1. For Constant CFM Direct Drive Fan, reference the applicable table in the fan performance section for voltage vs. cfm setting.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct Drive Fan Motor Heat (MBH) = 2.9245 x fan bhp + 0.055
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Table 18. Direct drive evaporator fan performance - 5 ton with eFlex™ and eDrive™ technology - T/YZC060E3,E4 downflow airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1600	618	0.13	656	0.18	693	0.23	731	0.28	769	0.33	806	0.38	844	0.43	881	0.48	919	0.53	957	0.58
1800	651	0.24	689	0.29	727	0.34	764	0.39	802	0.44	839	0.49	877	0.54	915	0.59	952	0.64	990	0.69
2000	685	0.35	722	0.40	760	0.45	798	0.50	835	0.55	873	0.60	910	0.65	948	0.70	986	0.75	1023	0.80
2200	718	0.46	756	0.51	793	0.56	831	0.61	869	0.66	906	0.71	944	0.76	981	0.81	1019	0.86	1057	0.91
2400	752	0.57	789	0.62	827	0.67	864	0.72	902	0.77	940	0.82	977	0.87	1015	0.92	1052	0.97	1090	1.02

Continued

	External Static Pressure (Inches of Water)									
	1.10		1.20		1.30		1.40		1.50	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1600	994	0.63	1032	0.68	1069	0.73	1107	0.79	1145	0.84
1800	1027	0.74	1065	0.79	1103	0.84	1140	0.89	—	—
2000	1061	0.85	1098	0.90	1136	0.95	—	—	—	—
2200	1094	0.96	1132	1.01	—	—	—	—	—	—
2400	—	—	—	—	—	—	—	—	—	—

Notes:
1. For Constant CFM Direct Drive Fan, reference the applicable table in the fan performance section for voltage vs. cfm setting.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct Drive Fan Motor Heat (MBH) = 2.9245 x fan bhp + 0.055
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 19. Direct drive evaporator fan performance - 5 ton with eFlex™ and eDrive™ technology - T/YZC060E3,E4 horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1600	680	0.14	717	0.19	753	0.25	790	0.31	827	0.36	864	0.42	901	0.47	937	0.53	974	0.59	1011	0.64
1800	716	0.27	753	0.32	789	0.38	826	0.44	863	0.49	900	0.55	937	0.61	973	0.66	1010	0.72	1047	0.78
2000	752	0.40	789	0.46	825	0.51	862	0.57	899	0.63	936	0.68	973	0.74	1009	0.80	1046	0.85	1083	0.91
2200	788	0.53	825	0.59	861	0.65	898	0.70	935	0.76	972	0.82	1009	0.87	1045	0.93	1082	0.99	1119	1.04
2400	824	0.67	861	0.72	897	0.78	934	0.84	971	0.89	1008	0.95	1045	1.01	1081	1.06	1118	1.12	1155	1.18

Continued

	External Static Pressure (Inches of Water)									
	1.10		1.20		1.30		1.40		1.50	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1600	—	—	—	—	—	—	—	—	—	—
1800	—	—	—	—	—	—	—	—	—	—
2000	—	—	—	—	—	—	—	—	—	—
2200	—	—	—	—	—	—	—	—	—	—
2400	—	—	—	—	—	—	—	—	—	—

Notes:
1. For Constant CFM Direct Drive Fan, reference the applicable table in the fan performance section for voltage vs. cfm setting.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct Drive Fan Motor Heat (MBH) = 2.9245 x fan bhp + 0.055
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Table 20. Direct drive evaporator fan performance - 6 ton with eFlex™ and eDrive™ technology - TZC072F3,F4,FW downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1200*	431	0.04	494	0.06	547	0.09	593	0.12	635	0.15	672	0.18	708	0.21	741	0.25	772	0.28	802	0.32
1440*	490	0.06	549	0.09	599	0.12	643	0.15	683	0.18	720	0.21	755	0.25	787	0.29	818	0.33	848	0.37
1680*	551	0.08	606	0.11	653	0.15	695	0.18	734	0.22	770	0.26	804	0.29	835	0.33	865	0.38	894	0.42
1920	613	0.11	664	0.15	709	0.18	749	0.22	786	0.26	821	0.30	854	0.34	884	0.39	914	0.43	942	0.48
2160	676	0.15	724	0.19	766	0.23	805	0.27	841	0.31	874	0.36	906	0.40	936	0.45	965	0.50	992	0.55
2400	740	0.19	785	0.23	825	0.28	862	0.32	896	0.37	929	0.42	959	0.47	988	0.52	1017	0.57	1043	0.62
2640	805	0.24	847	0.29	885	0.34	920	0.39	953	0.44	985	0.49	1014	0.54	1042	0.60	1069	0.65	1096	0.71
2880	871	0.31	910	0.36	947	0.41	980	0.46	1012	0.52	1041	0.57	1070	0.63	1098	0.69	1124	0.75	1149	0.81

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1200*	830	0.36	858	0.40	884	0.44	909	0.48	934	0.52	958	0.56	980	0.61	1002	0.65	1024	0.70	1045	0.74
1440*	876	0.41	902	0.45	928	0.49	953	0.53	977	0.58	1001	0.63	1023	0.67	1045	0.72	1067	0.77	1088	0.82
1680*	921	0.46	948	0.51	974	0.55	998	0.60	1022	0.65	1045	0.70	1068	0.74	1089	0.79	1110	0.85	1131	0.90
1920	969	0.52	995	0.57	1020	0.62	1044	0.67	1068	0.72	1091	0.77	1113	0.82	1135	0.88	1156	0.93	1176	0.99
2160	1019	0.60	1043	0.65	1068	0.70	1092	0.75	1115	0.81	1138	0.86	1159	0.91	1180	0.97	1202	1.03	1222	1.09
2400	1069	0.68	1093	0.73	1117	0.78	1141	0.84	1163	0.90	1186	0.96	1208	1.01	1229	1.07	1249	1.13	1269	1.19
2640	1121	0.77	1145	0.82	1169	0.88	1192	0.94	1214	1.00	1235	1.06	1257	1.12	1277	1.19	1298	1.25	1317	1.31
2880	1174	0.87	1198	0.93	1220	0.99	1243	1.05	1264	1.11	1286	1.18	1306	1.24	1326	1.31	1347	1.38	1367	1.44

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (Mbh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1200, 1440, and 1680 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 21. Direct drive evaporator fan performance - 6 ton with eFlex™ and eDrive™ technology - TZC072F3,F4,FW horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1200*	430	0.05	501	0.08	562	0.12	614	0.15	660	0.19	703	0.23	743	0.27	779	0.32	815	0.36	848	0.41
1440*	487	0.08	550	0.11	608	0.15	659	0.19	704	0.23	746	0.28	785	0.32	822	0.37	856	0.42	889	0.47
1680*	547	0.10	604	0.15	657	0.19	705	0.23	750	0.28	791	0.33	829	0.38	864	0.43	899	0.48	932	0.54
1920	609	0.14	660	0.19	708	0.23	754	0.28	797	0.34	837	0.39	874	0.44	909	0.50	943	0.56	974	0.62
2160	672	0.19	719	0.24	763	0.29	805	0.35	846	0.40	885	0.46	922	0.52	956	0.58	988	0.64	1020	0.71
2400	735	0.24	780	0.30	820	0.36	859	0.42	896	0.48	934	0.54	969	0.60	1003	0.67	1035	0.74	1066	0.80
2640	800	0.31	841	0.38	880	0.44	916	0.51	950	0.57	984	0.63	1019	0.70	1051	0.77	1082	0.84	1113	0.91
2880	865	0.39	904	0.46	940	0.53	974	0.60	1007	0.67	1038	0.74	1069	0.81	1101	0.88	1131	0.96	1161	1.04

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1200*	880	0.46	910	0.50	939	0.55	967	0.61	995	0.66	1021	0.71	1047	0.77	1071	0.82	1094	0.88	1119	0.94
1440*	920	0.52	950	0.57	979	0.63	1007	0.68	1034	0.74	1060	0.80	1085	0.85	1110	0.92	1134	0.98	1156	1.03
1680*	962	0.59	992	0.65	1021	0.71	1047	0.77	1074	0.83	1101	0.89	1125	0.95	1150	1.02	1173	1.08	1196	1.14
1920	1006	0.68	1034	0.74	1063	0.80	1090	0.86	1116	0.93	1142	0.99	1167	1.06	1190	1.12	1215	1.20	1237	1.26
2160	1049	0.77	1078	0.83	1106	0.90	1133	0.97	1158	1.03	1184	1.11	1209	1.18	1233	1.25	1255	1.32	1278	1.39
2400	1094	0.87	1123	0.94	1150	1.01	1177	1.08	1203	1.16	1227	1.23	1253	1.31	1275	1.38	1299	1.46	1321	1.54
2640	1141	0.99	1169	1.06	1196	1.14	1223	1.22	1247	1.29	1272	1.37	1297	1.45	1319	1.53	1342	1.61	1364	1.69
2880	1189	1.12	1216	1.19	1243	1.28	1269	1.36	1293	1.44	1317	1.52	1341	1.60	1364	1.69	1387	1.77	1409	1.86

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (Mbh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1200, 1440, and 1680 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 22. Direct drive evaporator fan performance - 6 ton with eFlex™ and eDrive™ technology - YZC072F3,F4,FW low and medium gas heat downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1920	613	0.11	662	0.15	705	0.19	745	0.23	781	0.27	815	0.31	847	0.35	877	0.39	907	0.44	933	0.48
2160	676	0.15	722	0.19	763	0.23	801	0.28	836	0.32	869	0.36	899	0.41	929	0.46	957	0.50	984	0.55
2400	741	0.20	784	0.24	823	0.29	858	0.33	892	0.38	924	0.43	954	0.48	982	0.53	1009	0.58	1036	0.63
2640	806	0.25	846	0.30	883	0.35	917	0.40	949	0.45	980	0.50	1008	0.56	1036	0.61	1062	0.66	1088	0.72
2880	871	0.32	910	0.37	944	0.42	977	0.48	1007	0.53	1037	0.59	1065	0.65	1091	0.70	1117	0.76	1142	0.82

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1920	960	0.53	985	0.58	1010	0.62	1034	0.67	1057	0.72	1079	0.77	1101	0.83	1123	0.88	1143	0.93	1163	0.99
2160	1010	0.60	1035	0.65	1059	0.70	1082	0.76	1105	0.81	1127	0.87	1148	0.92	1169	0.98	1189	1.03	1209	1.09
2400	1060	0.68	1085	0.74	1108	0.79	1131	0.85	1154	0.91	1176	0.96	1196	1.02	1217	1.08	1237	1.14	1257	1.20
2640	1113	0.78	1137	0.84	1160	0.89	1182	0.95	1204	1.01	1225	1.07	1246	1.13	1266	1.20	1286	1.26	1305	1.32
2880	1166	0.88	1189	0.94	1212	1.00	1234	1.07	1256	1.13	1276	1.19	1296	1.26	1316	1.32	1335	1.39	1355	1.46

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 23. Direct drive evaporator fan performance - 6 ton with eFlex™ and eDrive™ technology - YZC072F3,F4,FW high gas heat downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1200*	438	0.04	504	0.07	558	0.10	606	0.12	650	0.16	689	0.19	726	0.22	760	0.26	792	0.29	823	0.33
1440*	497	0.06	559	0.09	611	0.12	657	0.16	698	0.19	737	0.22	773	0.26	806	0.30	839	0.34	869	0.38
1680*	558	0.09	615	0.12	665	0.16	709	0.19	749	0.23	787	0.27	821	0.31	854	0.35	886	0.39	915	0.43
1920	622	0.12	674	0.16	721	0.20	763	0.24	802	0.28	838	0.32	872	0.36	904	0.41	934	0.45	964	0.50
2160	686	0.16	734	0.20	778	0.24	819	0.29	856	0.33	891	0.38	924	0.43	955	0.47	985	0.52	1013	0.57
2400	752	0.21	796	0.25	838	0.30	876	0.35	912	0.40	946	0.45	978	0.50	1008	0.55	1037	0.60	1064	0.66
2640	819	0.27	859	0.32	898	0.37	935	0.42	969	0.47	1002	0.53	1032	0.58	1062	0.64	1090	0.69	1117	0.75
2880	886	0.34	923	0.39	959	0.45	994	0.50	1027	0.56	1059	0.62	1089	0.68	1117	0.74	1144	0.79	1171	0.86

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1200*	853	0.37	881	0.41	908	0.45	934	0.49	960	0.53	985	0.57	1008	0.62	1031	0.66	1053	0.71	1075	0.75
1440*	898	0.42	925	0.46	952	0.50	978	0.55	1004	0.60	1027	0.64	1051	0.69	1073	0.73	1096	0.79	1117	0.83
1680*	944	0.48	971	0.52	998	0.57	1023	0.62	1047	0.67	1072	0.72	1095	0.77	1118	0.82	1139	0.87	1162	0.92
1920	992	0.55	1019	0.60	1044	0.65	1070	0.70	1094	0.75	1118	0.80	1140	0.85	1163	0.91	1185	0.96	1207	1.02
2160	1041	0.63	1067	0.68	1093	0.73	1117	0.78	1141	0.84	1165	0.89	1187	0.95	1209	1.01	1232	1.07	1252	1.13
2400	1092	0.71	1117	0.77	1143	0.83	1166	0.88	1191	0.94	1212	1.00	1235	1.06	1257	1.12	1279	1.18	1300	1.24
2640	1144	0.81	1169	0.87	1194	0.93	1217	0.99	1240	1.05	1263	1.12	1284	1.18	1305	1.24	1327	1.31	1347	1.37
2880	1196	0.92	1221	0.98	1245	1.05	1269	1.11	1291	1.18	1314	1.24	1335	1.31	1356	1.38	1376	1.44	1396	1.51

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1200, 1440, and 1680 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 24. Direct drive evaporator fan performance - 6 ton with eFlex™ and eDrive™ technology - YZC072F3,F4,FW low and medium gas heat horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1920	618	0.15	670	0.20	718	0.25	764	0.30	808	0.35	847	0.41	884	0.47	920	0.53	953	0.59	985	0.65
2160	681	0.20	730	0.26	774	0.31	816	0.37	858	0.42	896	0.48	932	0.55	967	0.61	999	0.67	1031	0.74
2400	746	0.26	791	0.32	832	0.39	872	0.45	909	0.51	946	0.57	982	0.64	1015	0.70	1047	0.77	1078	0.85
2640	811	0.34	854	0.40	892	0.47	929	0.54	964	0.61	999	0.67	1032	0.74	1065	0.81	1097	0.89	1127	0.96
2880	877	0.42	917	0.49	954	0.57	988	0.65	1021	0.72	1053	0.79	1085	0.86	1116	0.93	1146	1.01	1176	1.09

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1920	1015	0.72	1045	0.79	1073	0.85	1100	0.92	1128	1.00	1153	1.07	1178	1.15	1201	1.22	1225	1.30	1249	1.38
2160	1061	0.81	1089	0.88	1118	0.96	1144	1.03	1171	1.11	1196	1.18	1220	1.26	1244	1.34	1268	1.42	1292	1.51
2400	1107	0.92	1136	0.99	1163	1.07	1190	1.15	1216	1.23	1240	1.30	1264	1.38	1289	1.47	1312	1.56	1334	1.64
2640	1155	1.04	1183	1.12	1210	1.20	1237	1.28	1262	1.36	1286	1.44	1310	1.53	1334	1.62	1357	1.71	1378	1.79
2880	1205	1.18	1232	1.26	1258	1.34	1283	1.42	1308	1.51	1332	1.60	1357	1.69	1380	1.78	1402	1.87	1424	1.96

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 25. Direct drive evaporator fan performance - 6 ton with eFlex™ and eDrive™ technology - YZC072F3,F4,FW high gas heat horizontal airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1200*	436	0.06	507	0.09	567	0.13	619	0.17	665	0.20	708	0.24	747	0.27	784	0.31	819	0.34	852	0.38
1440*	495	0.08	558	0.12	615	0.17	666	0.21	711	0.25	752	0.29	791	0.34	827	0.38	861	0.42	894	0.47
1680*	556	0.11	613	0.16	666	0.21	714	0.26	758	0.31	799	0.36	836	0.41	872	0.46	906	0.51	938	0.56
1920	619	0.16	671	0.21	719	0.26	764	0.32	807	0.38	847	0.43	883	0.49	918	0.55	951	0.60	983	0.66
2160	683	0.21	731	0.26	775	0.32	817	0.38	857	0.45	896	0.51	932	0.58	965	0.64	998	0.71	1029	0.77
2400	748	0.27	792	0.33	833	0.39	873	0.46	910	0.53	946	0.60	981	0.67	1015	0.75	1046	0.82	1077	0.89
2640	814	0.34	855	0.41	893	0.48	930	0.55	965	0.62	999	0.70	1033	0.78	1065	0.86	1096	0.94	1126	1.02
2880	881	0.43	919	0.51	955	0.58	989	0.66	1022	0.73	1055	0.82	1085	0.90	1117	0.99	1146	1.07	1176	1.16

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1200*	883	0.41	913	0.45	943	0.48	970	0.52	997	0.55	1024	0.59	1049	0.63	1074	0.66	1097	0.70	1121	0.74
1440*	925	0.51	955	0.55	984	0.59	1011	0.64	1038	0.68	1064	0.72	1090	0.76	1114	0.81	1137	0.85	1160	0.89
1680*	969	0.61	998	0.66	1026	0.71	1053	0.76	1079	0.81	1106	0.86	1131	0.91	1154	0.96	1178	1.01	1201	1.06
1920	1013	0.72	1042	0.78	1070	0.83	1097	0.89	1122	0.94	1148	1.00	1173	1.06	1198	1.12	1220	1.17	1243	1.23
2160	1059	0.84	1088	0.90	1115	0.96	1142	1.03	1167	1.09	1193	1.16	1217	1.22	1241	1.28	1264	1.35	1287	1.41
2400	1106	0.96	1134	1.03	1162	1.11	1188	1.18	1213	1.25	1238	1.32	1262	1.39	1285	1.46	1308	1.53	1330	1.60
2640	1154	1.10	1182	1.18	1209	1.26	1234	1.33	1259	1.41	1284	1.49	1307	1.57	1331	1.65	1353	1.73	1376	1.81
2880	1204	1.25	1230	1.33	1257	1.42	1282	1.50	1307	1.59	1331	1.68	1354	1.76	1377	1.85	1400	1.93	1422	2.02

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1200, 1440, and 1680 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 26. Direct drive evaporator fan performance - 7.5 ton with eFlex™ and eDrive™ technology - TZC090F3,F4,FW downflow airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1500*	494	0.06	552	0.09	602	0.13	646	0.16	686	0.20	723	0.24	757	0.28	789	0.33	820	0.37	849	0.42
1800*	568	0.09	621	0.13	667	0.17	709	0.21	747	0.25	783	0.29	816	0.34	848	0.39	878	0.44	907	0.49
2100*	644	0.13	693	0.17	736	0.21	776	0.26	812	0.31	846	0.36	878	0.41	909	0.46	938	0.51	965	0.57
2400	722	0.18	767	0.23	807	0.27	844	0.32	879	0.38	912	0.43	943	0.48	972	0.54	1000	0.60	1027	0.66
2700	801	0.24	842	0.29	880	0.35	915	0.40	948	0.46	979	0.52	1009	0.58	1037	0.64	1064	0.70	1090	0.76
3000	881	0.32	919	0.37	954	0.43	987	0.49	1018	0.55	1048	0.62	1077	0.68	1104	0.75	1130	0.81	1155	0.88
3300	961	0.41	996	0.47	1030	0.53	1061	0.60	1090	0.67	1119	0.73	1146	0.80	1172	0.87	1197	0.94	1222	1.02
3600	1043	0.51	1075	0.58	1106	0.65	1135	0.72	1164	0.80	1191	0.87	1217	0.94	1242	1.02	1266	1.09	1290	1.17

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1500*	878	0.47	904	0.51	930	0.57	955	0.62	980	0.67	1002	0.72	1025	0.78	1047	0.84	1069	0.90	1090	0.95
1800*	934	0.54	960	0.59	985	0.65	1010	0.70	1033	0.76	1057	0.82	1079	0.87	1100	0.93	1122	1.00	1143	1.06
2100*	992	0.62	1018	0.68	1042	0.74	1066	0.79	1090	0.86	1112	0.92	1134	0.98	1156	1.04	1176	1.11	1197	1.17
2400	1053	0.72	1077	0.78	1102	0.84	1125	0.90	1148	0.97	1171	1.04	1192	1.10	1213	1.17	1234	1.24	1254	1.31
2700	1115	0.83	1139	0.89	1163	0.96	1186	1.03	1208	1.09	1229	1.16	1251	1.24	1272	1.31	1292	1.38	1312	1.45
3000	1179	0.95	1203	1.02	1226	1.09	1248	1.16	1270	1.24	1291	1.31	1312	1.38	1332	1.46	1352	1.54	1371	1.62
3300	1246	1.09	1268	1.17	1291	1.24	1312	1.32	1334	1.39	1355	1.47	1374	1.55	1394	1.63	1413	1.71	1432	1.80
3600	1313	1.25	1335	1.33	1357	1.41	1378	1.49	1399	1.57	1419	1.66	1439	1.74	1458	1.82	1477	1.91	1495	1.99

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1500, 1800, and 2100 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Evaporator Fan Performance

Table 27. Direct drive evaporator fan performance - 7.5 ton with eFlex™ and eDrive™ technology - TZC090F3,F4,FW horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1500*	488	0.07	550	0.11	604	0.15	652	0.19	695	0.24	734	0.28	771	0.33	806	0.38	838	0.42	869	0.48
1800*	559	0.11	615	0.15	666	0.20	711	0.25	752	0.29	791	0.34	827	0.40	861	0.45	892	0.50	923	0.56
2100*	634	0.16	685	0.20	730	0.26	773	0.31	813	0.37	850	0.42	884	0.48	917	0.54	949	0.60	978	0.66
2400	711	0.22	756	0.27	798	0.33	837	0.39	876	0.45	911	0.51	944	0.57	976	0.64	1006	0.70	1035	0.77
2700	789	0.29	828	0.35	870	0.41	905	0.48	940	0.55	974	0.62	1006	0.69	1037	0.76	1067	0.83	1095	0.90
3000	868	0.39	904	0.45	941	0.52	976	0.59	1008	0.67	1039	0.74	1070	0.82	1100	0.90	1129	0.97	1156	1.05
3300	947	0.50	981	0.57	1013	0.65	1047	0.72	1079	0.80	1107	0.88	1135	0.97	1164	1.05	1192	1.14	1218	1.22
3600	1027	0.63	1059	0.71	1088	0.79	1118	0.87	1150	0.95	1178	1.04	1204	1.13	1230	1.23	1256	1.32	1282	1.41

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1500*	899	0.53	927	0.58	955	0.64	981	0.69	1007	0.75	1031	0.81	1056	0.87	1078	0.93	1102	0.99	1124	1.06
1800*	952	0.62	980	0.68	1007	0.74	1033	0.80	1058	0.86	1082	0.92	1106	0.99	1130	1.05	1152	1.12	1175	1.19
2100*	1007	0.72	1034	0.78	1061	0.85	1087	0.92	1111	0.98	1135	1.05	1159	1.12	1182	1.19	1204	1.26	1226	1.34
2400	1064	0.84	1090	0.91	1116	0.98	1142	1.05	1166	1.12	1190	1.19	1213	1.27	1235	1.34	1257	1.42	1278	1.50
2700	1122	0.97	1149	1.05	1174	1.12	1199	1.20	1223	1.28	1246	1.36	1268	1.44	1291	1.52	1312	1.60	1334	1.68
3000	1182	1.13	1207	1.21	1233	1.29	1257	1.37	1280	1.45	1303	1.54	1325	1.62	1348	1.71	1368	1.79	1390	1.88
3300	1244	1.30	1269	1.39	1293	1.47	1317	1.56	1340	1.65	1362	1.74	1383	1.83	1405	1.92	1426	2.01	1446	2.10
3600	1307	1.50	1331	1.59	1354	1.68	1378	1.78	1400	1.87	1423	1.97	1444	2.06	1465	2.16	1485	2.25	1505	2.35

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1500, 1800, and 2100 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 28. Direct drive evaporator fan performance - 7.5 ton with eFlex™ and eDrive™ technology - YZC090F3,F4,FW low and medium gas heat downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2400	757	0.26	799	0.32	842	0.38	882	0.44	919	0.51	955	0.57	987	0.64	1018	0.70	1049	0.77	1077	0.84
2700	841	0.36	880	0.42	916	0.48	955	0.56	991	0.63	1024	0.70	1056	0.77	1086	0.84	1115	0.92	1142	0.99
3000	925	0.47	962	0.54	994	0.61	1028	0.68	1064	0.77	1096	0.85	1126	0.92	1155	1.00	1183	1.08	1210	1.17
3300	1010	0.61	1045	0.69	1076	0.76	1105	0.84	1136	0.93	1169	1.02	1198	1.10	1226	1.19	1253	1.28	1279	1.36
3600	1095	0.77	1128	0.86	1158	0.94	1185	1.02	1211	1.11	1241	1.21	1271	1.31	1298	1.40	1324	1.49	1349	1.59

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2400	1105	0.91	1131	0.98	1157	1.05	1182	1.13	1206	1.20	1229	1.28	1252	1.35	1275	1.43	1297	1.51	1318	1.59
2700	1170	1.07	1195	1.14	1220	1.22	1245	1.30	1268	1.38	1291	1.46	1314	1.55	1336	1.63	1357	1.71	1377	1.80
3000	1236	1.25	1261	1.33	1285	1.41	1309	1.50	1332	1.59	1354	1.67	1377	1.76	1398	1.85	1420	1.94	1440	2.03
3300	1304	1.45	1328	1.54	1352	1.63	1375	1.72	1397	1.81	1419	1.91	1442	2.00	1462	2.10	1483	2.19	1503	2.29
3600	1374	1.68	1397	1.78	1421	1.88	1443	1.97	1465	2.07	1487	2.17	1507	2.27	1528	2.37	1548	2.47	1568	2.58

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 29. Direct drive evaporator fan performance - 7.5 ton with eFlex™ and eDrive™ technology - YZC090F3,F4,FW low and medium gas heat horizontal airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2400	734	0.23	780	0.29	823	0.35	862	0.41	899	0.47	934	0.53	966	0.60	998	0.66	1027	0.73	1056	0.79
2700	815	0.32	856	0.38	895	0.44	932	0.51	968	0.58	1001	0.65	1033	0.72	1062	0.79	1092	0.86	1119	0.93
3000	896	0.42	933	0.48	970	0.55	1005	0.63	1039	0.71	1070	0.78	1100	0.86	1130	0.93	1157	1.01	1184	1.09
3300	979	0.54	1013	0.61	1046	0.69	1079	0.77	1111	0.85	1140	0.94	1169	1.02	1198	1.10	1224	1.18	1251	1.27
3600	1061	0.69	1093	0.77	1124	0.85	1154	0.93	1185	1.02	1213	1.11	1240	1.20	1267	1.29	1293	1.38	1318	1.47

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2400	1083	0.86	1110	0.93	1135	1.00	1160	1.07	1184	1.15	1208	1.22	1231	1.30	1253	1.37	1273	1.45	1295	1.52
2700	1146	1.00	1171	1.08	1196	1.15	1220	1.23	1244	1.31	1267	1.39	1290	1.47	1311	1.55	1332	1.63	1354	1.72
3000	1210	1.17	1235	1.25	1259	1.33	1282	1.41	1305	1.49	1329	1.58	1350	1.67	1371	1.75	1392	1.84	1412	1.93
3300	1275	1.35	1300	1.44	1323	1.53	1347	1.62	1368	1.70	1391	1.80	1413	1.89	1434	1.98	1454	2.07	1474	2.17
3600	1342	1.56	1367	1.66	1389	1.75	1412	1.84	1434	1.94	1456	2.04	1476	2.13	1497	2.23	1517	2.33	1536	2.43

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Table 30. Direct drive evaporator fan performance - 7.5 ton with eFlex™ and eDrive™ technology - YZC090F3,F4,FW high gas heat downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1500*	515	0.09	577	0.13	630	0.17	677	0.21	718	0.26	758	0.31	794	0.36	828	0.41	861	0.46	892	0.52
1800*	593	0.13	649	0.18	698	0.22	742	0.27	783	0.33	820	0.38	855	0.43	889	0.49	920	0.55	951	0.61
2100*	673	0.19	723	0.24	769	0.29	811	0.35	850	0.41	885	0.47	920	0.53	951	0.59	982	0.66	1012	0.72
2400	756	0.26	801	0.32	842	0.38	882	0.44	918	0.51	953	0.57	986	0.64	1017	0.71	1047	0.78	1075	0.85
2700	839	0.35	880	0.42	919	0.48	955	0.56	990	0.63	1023	0.70	1054	0.77	1085	0.85	1113	0.92	1141	1.00
3000	924	0.47	960	0.54	997	0.61	1031	0.69	1063	0.77	1095	0.85	1124	0.93	1154	1.01	1181	1.09	1208	1.17
3300	1010	0.60	1043	0.68	1076	0.76	1108	0.84	1139	0.93	1167	1.02	1197	1.10	1224	1.19	1252	1.28	1277	1.37
3600	1096	0.76	1126	0.85	1156	0.94	1186	1.03	1216	1.12	1243	1.21	1270	1.31	1297	1.40	1322	1.50	1348	1.59

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1500*	921	0.57	950	0.63	976	0.69	1003	0.75	1029	0.81	1053	0.87	1077	0.94	1101	1.00	1124	1.07	1146	1.14
1800*	980	0.67	1007	0.73	1034	0.80	1060	0.87	1085	0.93	1110	1.00	1133	1.07	1157	1.14	1179	1.21	1200	1.28
2100*	1040	0.79	1067	0.86	1094	0.93	1119	1.00	1143	1.07	1167	1.14	1190	1.22	1213	1.29	1235	1.37	1257	1.45
2400	1103	0.93	1130	1.00	1155	1.07	1179	1.15	1205	1.23	1227	1.31	1250	1.39	1272	1.47	1295	1.55	1316	1.63
2700	1167	1.08	1193	1.16	1218	1.24	1243	1.32	1266	1.41	1289	1.49	1312	1.58	1333	1.66	1355	1.75	1376	1.84
3000	1234	1.26	1259	1.35	1283	1.43	1307	1.52	1330	1.61	1353	1.70	1375	1.79	1396	1.88	1416	1.97	1437	2.07
3300	1302	1.46	1326	1.55	1350	1.64	1374	1.74	1396	1.84	1418	1.93	1439	2.03	1460	2.13	1481	2.23	1501	2.33
3600	1372	1.69	1395	1.79	1419	1.89	1441	1.99	1463	2.09	1484	2.19	1505	2.29	1526	2.40	1545	2.50	1565	2.61

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1500, 1800, and 2100 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Evaporator Fan Performance

Table 31. Direct drive evaporator fan performance - 7.5 ton with eFlex™ and eDrive™ technology - YZC090F3,F4,FW high gas heat horizontal airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1500*	506	0.08	569	0.12	622	0.17	670	0.22	712	0.26	752	0.32	788	0.37	824	0.43	856	0.49	887	0.55
1800*	581	0.12	638	0.17	688	0.22	733	0.27	774	0.33	813	0.39	848	0.45	882	0.51	913	0.57	944	0.64
2100*	659	0.17	710	0.23	757	0.28	799	0.34	839	0.41	876	0.47	910	0.53	942	0.60	973	0.67	1003	0.74
2400	739	0.24	785	0.30	828	0.37	868	0.43	905	0.50	941	0.57	974	0.64	1005	0.71	1036	0.79	1064	0.86
2700	821	0.33	861	0.39	902	0.47	939	0.53	974	0.61	1008	0.68	1040	0.76	1071	0.84	1099	0.92	1127	1.00
3000	903	0.44	940	0.50	977	0.58	1012	0.67	1045	0.74	1077	0.82	1108	0.90	1138	0.99	1165	1.07	1193	1.16
3300	986	0.57	1020	0.64	1053	0.72	1087	0.81	1118	0.90	1149	0.98	1178	1.06	1206	1.15	1233	1.25	1259	1.34
3600	1070	0.73	1101	0.81	1132	0.88	1162	0.97	1193	1.08	1221	1.17	1249	1.26	1276	1.35	1302	1.45	1328	1.55

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1500*	917	0.61	945	0.67	973	0.74	999	0.80	1025	0.87	1050	0.94	1073	1.01	1097	1.08	1121	1.16	1143	1.23
1800*	974	0.71	1001	0.77	1028	0.84	1055	0.92	1080	0.99	1104	1.06	1128	1.14	1151	1.22	1174	1.30	1195	1.37
2100*	1032	0.82	1059	0.89	1086	0.97	1112	1.04	1136	1.12	1160	1.20	1184	1.28	1207	1.37	1228	1.45	1251	1.53
2400	1092	0.94	1120	1.02	1145	1.10	1170	1.18	1194	1.27	1218	1.35	1241	1.44	1263	1.53	1285	1.62	1308	1.71
2700	1155	1.09	1181	1.17	1206	1.26	1230	1.35	1255	1.44	1278	1.53	1301	1.62	1322	1.71	1345	1.81	1365	1.91
3000	1219	1.25	1244	1.34	1269	1.44	1293	1.53	1316	1.63	1339	1.72	1361	1.82	1383	1.92	1404	2.02	1424	2.12
3300	1285	1.44	1309	1.54	1334	1.64	1357	1.74	1380	1.84	1402	1.94	1423	2.04	1446	2.15	1465	2.25	1485	2.36
3600	1352	1.65	1377	1.76	1399	1.86	1423	1.97	1444	2.07	1466	2.18	1488	2.29	1508	2.40	1529	2.52	1548	2.63

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1500, 1800, and 2100 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 32. Direct drive evaporator fan performance - 8.5 ton with eFlex™ and eDrive™ technology - TZC102F3,F4,FW downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1700*	543	0.08	598	0.12	645	0.15	688	0.19	727	0.23	763	0.28	797	0.32	828	0.37	858	0.41	887	0.46
2040*	629	0.12	678	0.16	722	0.20	762	0.25	799	0.29	834	0.34	866	0.39	896	0.44	926	0.50	953	0.55
2380*	717	0.17	762	0.22	802	0.27	840	0.32	874	0.37	907	0.42	938	0.48	967	0.53	995	0.59	1023	0.65
2720	806	0.24	847	0.30	885	0.35	919	0.41	953	0.46	984	0.52	1013	0.58	1041	0.64	1068	0.71	1095	0.77
3060	897	0.33	934	0.39	969	0.45	1002	0.51	1033	0.58	1062	0.64	1090	0.70	1117	0.77	1143	0.84	1168	0.91
3400	988	0.44	1022	0.51	1055	0.57	1085	0.64	1115	0.71	1143	0.78	1169	0.85	1196	0.92	1220	0.99	1244	1.07
3740	1081	0.57	1112	0.64	1142	0.72	1171	0.79	1199	0.86	1225	0.94	1250	1.01	1275	1.09	1299	1.17	1323	1.25
4080	1174	0.72	1202	0.81	1230	0.88	1257	0.96	1283	1.04	1308	1.12	1333	1.21	1357	1.29	1379	1.37	1401	1.46

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1700*	915	0.51	941	0.56	966	0.62	991	0.67	1015	0.73	1038	0.78	1061	0.84	1083	0.90	1104	0.96	1125	1.02
2040*	980	0.60	1006	0.66	1031	0.72	1055	0.78	1078	0.84	1102	0.90	1123	0.96	1145	1.02	1165	1.08	1187	1.15
2380*	1049	0.71	1074	0.77	1098	0.83	1121	0.89	1144	0.96	1167	1.03	1188	1.09	1209	1.16	1230	1.23	1250	1.30
2720	1120	0.83	1144	0.90	1167	0.97	1190	1.04	1213	1.10	1235	1.18	1255	1.25	1276	1.32	1296	1.39	1316	1.46
3060	1193	0.98	1216	1.05	1239	1.12	1261	1.19	1283	1.27	1304	1.34	1324	1.42	1344	1.49	1364	1.57	1384	1.65
3400	1268	1.14	1290	1.22	1313	1.30	1335	1.37	1355	1.45	1376	1.53	1396	1.61	1416	1.70	1435	1.78	1454	1.86
3740	1345	1.33	1367	1.41	1388	1.50	1408	1.58	1429	1.66	1449	1.75	1469	1.83	1488	1.92	1507	2.01	1524	2.09
4080	1424	1.55	1445	1.63	1465	1.72	1486	1.81	1505	1.90	1524	1.99	1544	2.08	1562	2.17	1580	2.26	1598	2.36

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1700, 2040, and 2380 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Evaporator Fan Performance

Table 33. Direct drive evaporator fan performance - 8.5 ton with eFlex™ and eDrive™ technology - TZC102F3,F4,FW horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1700*	535	0.10	593	0.14	645	0.18	691	0.23	733	0.27	772	0.32	807	0.37	841	0.42	874	0.48	905	0.53
2040*	618	0.15	671	0.19	717	0.25	760	0.30	801	0.35	838	0.40	873	0.46	906	0.52	937	0.58	967	0.64
2380*	706	0.21	752	0.27	793	0.32	833	0.39	871	0.44	907	0.51	941	0.57	972	0.63	1002	0.70	1031	0.76
2720	795	0.30	833	0.36	875	0.42	910	0.49	944	0.56	978	0.63	1011	0.70	1041	0.77	1070	0.84	1099	0.91
3060	884	0.41	919	0.48	955	0.54	990	0.61	1022	0.69	1052	0.77	1083	0.85	1113	0.93	1141	1.00	1168	1.08
3400	974	0.54	1007	0.62	1038	0.69	1071	0.77	1102	0.85	1130	0.93	1157	1.02	1185	1.11	1213	1.19	1240	1.28
3740	1065	0.70	1096	0.79	1124	0.87	1152	0.95	1183	1.04	1211	1.12	1237	1.22	1262	1.32	1287	1.41	1312	1.50
4080	1156	0.90	1185	0.99	1212	1.08	1237	1.17	1264	1.26	1292	1.35	1318	1.44	1342	1.55	1365	1.66	1387	1.76

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1700*	935	0.59	963	0.64	989	0.70	1016	0.76	1041	0.82	1065	0.88	1089	0.95	1112	1.01	1136	1.08	1157	1.14
2040*	996	0.70	1024	0.76	1050	0.83	1075	0.89	1100	0.95	1125	1.02	1148	1.09	1172	1.16	1193	1.23	1215	1.30
2380*	1060	0.83	1086	0.90	1112	0.97	1138	1.04	1162	1.11	1186	1.18	1209	1.26	1232	1.33	1253	1.41	1275	1.48
2720	1126	0.98	1152	1.06	1178	1.13	1203	1.21	1226	1.29	1250	1.37	1272	1.45	1294	1.53	1316	1.61	1337	1.69
3060	1194	1.16	1219	1.24	1245	1.33	1269	1.41	1292	1.49	1315	1.58	1336	1.66	1358	1.75	1379	1.83	1400	1.92
3400	1265	1.37	1289	1.45	1314	1.54	1337	1.63	1360	1.72	1382	1.81	1403	1.90	1425	2.00	1446	2.09	1466	2.18
3740	1337	1.60	1361	1.69	1384	1.79	1407	1.88	1429	1.98	1451	2.08	1472	2.18	1493	2.28	1513	2.38	1533	2.48
4080	1411	1.86	1434	1.97	1456	2.07	1479	2.17	1500	2.27	1521	2.38	1541	2.48	1562	2.59	1581	2.69	-	-

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1700, 2040, and 2380 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 34. Direct drive evaporator fan performance - 8.5 ton with eFlex™ and eDrive™ technology - YZC102F3,F4,FW low and medium gas heat downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2720	847	0.36	885	0.42	921	0.49	960	0.56	996	0.64	1029	0.71	1060	0.78	1090	0.85	1119	0.92	1147	1.00
3060	942	0.49	979	0.57	1011	0.64	1043	0.71	1078	0.80	1110	0.88	1140	0.96	1169	1.04	1197	1.12	1224	1.20
3400	1039	0.66	1073	0.74	1103	0.82	1131	0.90	1161	0.98	1193	1.08	1222	1.17	1250	1.26	1276	1.35	1302	1.44
3740	1135	0.85	1168	0.95	1196	1.04	1223	1.12	1249	1.21	1275	1.30	1304	1.41	1332	1.51	1358	1.61	1383	1.70
4080	1233	1.09	1263	1.20	1290	1.30	1316	1.39	1340	1.48	1363	1.57	1388	1.68	1414	1.79	1440	1.90	1464	2.01

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2720	1173	1.08	1199	1.15	1224	1.23	1248	1.31	1272	1.40	1295	1.48	1318	1.56	1340	1.64	1361	1.73	1383	1.82
3060	1249	1.29	1274	1.37	1298	1.46	1322	1.54	1345	1.63	1368	1.72	1389	1.81	1411	1.90	1432	1.99	1453	2.08
3400	1327	1.53	1351	1.62	1374	1.71	1397	1.80	1420	1.90	1442	1.99	1463	2.09	1483	2.18	1504	2.28	1524	2.38
3740	1407	1.80	1430	1.90	1453	2.00	1475	2.10	1496	2.20	1518	2.30	1538	2.40	1560	2.51	1579	2.62	1598	2.72
4080	1487	2.11	1510	2.22	1533	2.33	1554	2.44	1575	2.54	1595	2.65	-	-	-	-	-	-	-	-

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 35. Direct drive evaporator fan performance - 8.5 ton with eFlex™ and eDrive™ technology - YZC102F3,F4,FW low and medium gas heat horizontal airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2720	820	0.32	861	0.38	901	0.45	937	0.52	972	0.59	1005	0.65	1037	0.72	1067	0.80	1095	0.87	1123	0.94
3060	913	0.44	949	0.51	985	0.58	1020	0.65	1052	0.73	1084	0.81	1114	0.89	1143	0.96	1170	1.04	1197	1.12
3400	1006	0.59	1039	0.66	1072	0.74	1104	0.82	1135	0.90	1165	0.99	1193	1.08	1220	1.16	1247	1.25	1273	1.33
3740	1100	0.76	1131	0.85	1160	0.93	1190	1.01	1219	1.10	1247	1.20	1274	1.29	1300	1.39	1326	1.48	1351	1.58
4080	1195	0.97	1223	1.07	1251	1.16	1277	1.24	1304	1.34	1331	1.44	1357	1.54	1382	1.65	1406	1.75	1430	1.86

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2720	1150	1.02	1175	1.09	1200	1.17	1225	1.25	1248	1.32	1271	1.40	1293	1.48	1315	1.57	1336	1.65	1357	1.73
3060	1223	1.20	1248	1.29	1273	1.37	1296	1.45	1319	1.54	1341	1.62	1363	1.71	1384	1.80	1404	1.88	1425	1.97
3400	1298	1.42	1322	1.51	1345	1.60	1368	1.69	1390	1.78	1412	1.87	1433	1.96	1454	2.06	1475	2.15	1495	2.25
3740	1374	1.67	1398	1.77	1420	1.86	1442	1.96	1465	2.06	1486	2.15	1506	2.25	1527	2.36	1547	2.46	1566	2.56
4080	1453	1.95	1475	2.06	1498	2.16	1519	2.27	1540	2.37	1560	2.47	1581	2.58	1601	2.69	-	-	-	-

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Table 36. Direct drive evaporator fan performance - 8.5 ton with eFlex™ and eDrive™ technology - YZC102F3,F4,FW high gas heat downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1700*	567	0.11	624	0.16	675	0.20	720	0.25	761	0.30	799	0.35	835	0.41	868	0.46	900	0.52	930	0.58
2040*	657	0.17	708	0.22	754	0.28	797	0.33	836	0.39	872	0.45	907	0.51	939	0.57	970	0.63	999	0.70
2380*	750	0.25	795	0.31	837	0.37	877	0.44	914	0.50	949	0.57	981	0.63	1013	0.70	1042	0.77	1071	0.84
2720	845	0.36	885	0.43	924	0.49	960	0.56	995	0.64	1028	0.71	1059	0.78	1089	0.86	1118	0.94	1145	1.01
3060	941	0.49	977	0.57	1012	0.64	1046	0.72	1078	0.80	1109	0.88	1139	0.96	1168	1.04	1195	1.13	1222	1.21
3400	1038	0.65	1070	0.74	1102	0.82	1134	0.90	1164	0.99	1192	1.08	1221	1.17	1248	1.26	1275	1.35	1301	1.44
3740	1136	0.85	1165	0.94	1194	1.03	1223	1.12	1252	1.22	1279	1.31	1306	1.41	1331	1.51	1356	1.61	1381	1.71
4080	1234	1.09	1261	1.19	1288	1.29	1314	1.39	1341	1.48	1367	1.58	1392	1.69	1416	1.79	1440	1.91	1463	2.01

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1700*	960	0.64	988	0.70	1015	0.76	1042	0.83	1066	0.89	1090	0.96	1114	1.02	1138	1.10	1160	1.16	1183	1.24
2040*	1027	0.76	1055	0.83	1081	0.90	1106	0.97	1132	1.04	1156	1.12	1179	1.19	1201	1.26	1224	1.34	1246	1.42
2380*	1098	0.91	1126	0.99	1151	1.06	1175	1.14	1201	1.22	1223	1.29	1246	1.37	1268	1.45	1291	1.54	1312	1.62
2720	1172	1.09	1198	1.17	1223	1.26	1247	1.34	1270	1.42	1293	1.50	1315	1.59	1337	1.68	1358	1.76	1380	1.85
3060	1247	1.30	1272	1.38	1297	1.47	1320	1.56	1343	1.65	1366	1.74	1387	1.84	1409	1.93	1429	2.02	1449	2.11
3400	1325	1.53	1350	1.63	1373	1.72	1396	1.82	1417	1.91	1439	2.01	1462	2.12	1482	2.21	1502	2.31	1522	2.42
3740	1405	1.81	1428	1.91	1451	2.01	1473	2.11	1495	2.22	1515	2.32	1536	2.43	1557	2.54	1577	2.64	1597	2.75
4080	1486	2.12	1509	2.23	1530	2.33	1552	2.45	1573	2.56	1593	2.67	-	-	-	-	-	-	-	-

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1700, 2040, and 2380 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Evaporator Fan Performance

Table 37. Direct drive evaporator fan performance - 8.5 ton with eFlex™ and eDrive™ technology - YZC102F3,F4,FW high gas heat horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1700*	556	0.11	615	0.15	666	0.20	712	0.25	754	0.31	792	0.36	828	0.42	862	0.48	894	0.54	925	0.61
2040*	643	0.16	696	0.22	743	0.27	786	0.33	826	0.39	863	0.45	898	0.52	930	0.58	962	0.65	991	0.72
2380*	734	0.24	780	0.30	823	0.36	864	0.42	901	0.49	936	0.56	969	0.63	1001	0.70	1032	0.78	1060	0.85
2720	826	0.34	867	0.40	907	0.48	944	0.54	979	0.61	1012	0.69	1044	0.77	1075	0.85	1104	0.93	1132	1.01
3060	920	0.47	956	0.53	992	0.61	1027	0.70	1059	0.77	1091	0.85	1122	0.93	1151	1.02	1179	1.11	1206	1.20
3400	1014	0.62	1047	0.69	1080	0.77	1112	0.86	1143	0.96	1172	1.04	1201	1.12	1229	1.22	1256	1.31	1282	1.41
3740	1109	0.81	1139	0.89	1169	0.97	1198	1.06	1228	1.17	1256	1.27	1283	1.36	1309	1.45	1335	1.55	1360	1.65
4080	1204	1.03	1233	1.12	1260	1.21	1287	1.30	1314	1.40	1341	1.52	1367	1.64	1391	1.73	1416	1.83	1439	1.93

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
1700*	955	0.67	983	0.74	1009	0.81	1036	0.88	1062	0.95	1086	1.02	1110	1.10	1134	1.17	1156	1.25	1178	1.33
2040*	1019	0.79	1048	0.87	1074	0.94	1099	1.01	1124	1.09	1149	1.17	1172	1.25	1196	1.33	1217	1.42	1240	1.50
2380*	1088	0.93	1116	1.01	1141	1.09	1166	1.17	1190	1.26	1214	1.34	1237	1.43	1260	1.52	1282	1.61	1303	1.70
2720	1159	1.10	1184	1.18	1210	1.27	1235	1.36	1259	1.45	1282	1.54	1304	1.63	1327	1.73	1348	1.82	1368	1.92
3060	1232	1.29	1257	1.38	1281	1.47	1306	1.57	1329	1.67	1352	1.76	1373	1.86	1395	1.97	1416	2.07	1437	2.17
3400	1307	1.51	1331	1.61	1355	1.71	1379	1.81	1401	1.91	1424	2.02	1444	2.12	1465	2.23	1487	2.34	1507	2.45
3740	1384	1.76	1408	1.87	1431	1.97	1453	2.08	1475	2.19	1496	2.30	1518	2.42	1538	2.53	1558	2.65	1577	2.76
4080	1462	2.04	1486	2.16	1508	2.27	1529	2.39	1551	2.51	1572	2.63	1592	2.74	-	-	-	-	-	-

Notes:

1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 1700, 2040, and 2380 cfm, unit application below 320 cfm/ton are only applicable on T_C models and modulating gas. See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 38. Direct drive evaporator fan performance - 10 ton with eFlex™ and eDrive™ technology - TZC120F3,F4,FW downflow airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2000*	593	0.12	650	0.18	702	0.23	748	0.29	791	0.35	831	0.40	868	0.46	904	0.52	938	0.59	970	0.65
2400*	699	0.20	732	0.24	785	0.31	827	0.38	870	0.45	907	0.51	942	0.58	976	0.65	1009	0.72	1040	0.80
2800*	800	0.30	830	0.34	873	0.41	913	0.49	947	0.56	987	0.65	1022	0.73	1053	0.80	1083	0.88	1113	0.96
3200	901	0.42	941	0.50	952	0.52	1001	0.63	1037	0.72	1065	0.79	1098	0.88	1133	0.98	1163	1.07	1192	1.16
3600	1005	0.57	1040	0.66	1065	0.72	1072	0.74	1124	0.89	1158	1.00	1184	1.08	1209	1.17	1240	1.27	1272	1.39
4000	1108	0.77	1141	0.86	1173	0.96	1185	1.00	1191	1.01	1242	1.19	1276	1.33	1300	1.42	1323	1.52	1346	1.61
4400	1213	1.00	1243	1.10	1272	1.21	1298	1.31	1305	1.33	1310	1.35	1356	1.53	1391	1.70	1416	1.83	1437	1.93
4800	1317	1.28	1346	1.39	1372	1.50	1399	1.62	1418	1.71	1424	1.73	1429	1.75	1464	1.91	1502	2.12	1530	2.28

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2000*	1001	0.72	1030	0.78	1059	0.85	1086	0.92	1113	0.99	1139	1.07	1165	1.14	1189	1.21	1212	1.29	1235	1.37
2400*	1070	0.87	1099	0.94	1127	1.02	1153	1.09	1180	1.17	1206	1.25	1230	1.33	1254	1.41	1277	1.49	1300	1.58
2800*	1142	1.05	1170	1.13	1197	1.21	1224	1.29	1249	1.38	1274	1.47	1298	1.55	1322	1.64	1345	1.73	1367	1.82
3200	1218	1.25	1244	1.34	1271	1.44	1295	1.52	1321	1.62	1345	1.71	1368	1.80	1392	1.90	1414	2.00	1437	2.10
3600	1299	1.49	1325	1.59	1348	1.69	1372	1.79	1396	1.89	1419	1.99	1441	2.10	1464	2.20	1486	2.30	1508	2.42
4000	1374	1.73	1403	1.86	1430	1.98	1453	2.09	1476	2.20	1497	2.31	1519	2.42	1540	2.53	1561	2.65	1582	2.77
4400	1458	2.03	1478	2.14	1504	2.27	1530	2.40	1556	2.54	1579	2.67	1600	2.79	1620	2.91	-	-	-	-
4800	1550	2.40	1570	2.51	1589	2.63	1607	2.74	1629	2.87	-	-	-	-	-	-	-	-	-	-

Notes:

1. For direct drive evaporator fan speed (rpm), refer to the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in commercial equipment, are definite purpose motors, specifically designed and tested to operate reliably and continuously at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 2000, 2400, and 2800 cfm, unit application below 320 cfm/ton are only applicable on T_C models only (no gas heat). See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Evaporator Fan Performance

Table 39. Direct drive evaporator fan performance - 10 ton with eFlex™ and eDrive™ technology - TZC120F3,F4,FW horizontal airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2000*	573	0.11	626	0.16	680	0.21	727	0.26	770	0.32	815	0.38	857	0.44	896	0.51	933	0.58	968	0.65
2400*	666	0.17	712	0.22	756	0.28	802	0.34	844	0.41	881	0.47	917	0.53	955	0.61	991	0.68	1025	0.76
2800*	762	0.25	803	0.31	841	0.37	879	0.43	919	0.51	956	0.58	991	0.66	1022	0.73	1052	0.81	1085	0.89
3200	857	0.35	897	0.42	931	0.49	964	0.56	997	0.63	1032	0.72	1065	0.80	1099	0.89	1128	0.97	1156	1.05
3600	954	0.47	991	0.56	1023	0.63	1054	0.71	1082	0.79	1111	0.87	1142	0.96	1172	1.06	1202	1.16	1232	1.25
4000	1051	0.63	1086	0.72	1117	0.81	1145	0.89	1172	0.98	1198	1.06	1225	1.16	1251	1.25	1278	1.36	1306	1.46
4400	1149	0.81	1182	0.92	1212	1.02	1239	1.11	1264	1.21	1288	1.30	1311	1.39	1335	1.49	1360	1.59	1384	1.70
4800	1247	1.04	1279	1.15	1307	1.26	1333	1.36	1357	1.47	1380	1.57	1402	1.67	1424	1.77	1446	1.88	1467	1.98

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
2000*	1001	0.72	1033	0.79	1064	0.87	1094	0.94	1123	1.02	1150	1.10	1178	1.18	1204	1.27	1230	1.35	1255	1.44
2400*	1058	0.84	1090	0.92	1120	1.00	1150	1.08	1179	1.17	1206	1.25	1233	1.34	1259	1.43	1284	1.52	1309	1.62
2800*	1118	0.98	1149	1.06	1178	1.15	1208	1.24	1236	1.33	1263	1.42	1290	1.52	1315	1.62	1340	1.71	1365	1.81
3200	1182	1.14	1209	1.22	1238	1.32	1267	1.42	1294	1.51	1321	1.61	1347	1.71	1374	1.82	1398	1.92	1422	2.03
3600	1259	1.34	1285	1.44	1309	1.53	1332	1.63	1356	1.73	1383	1.83	1408	1.94	1433	2.05	1457	2.16	1481	2.28
4000	1333	1.58	1360	1.68	1385	1.78	1409	1.88	1432	1.99	1453	2.09	1475	2.20	1495	2.31	1518	2.42	1541	2.54
4400	1410	1.82	1434	1.94	1459	2.06	1483	2.18	1507	2.29	1530	2.41	1552	2.52	1572	2.63	1592	2.75	1611	2.86
4800	1490	2.10	1512	2.22	1535	2.35	1558	2.48	1581	2.61	1603	2.74	1626	2.87	-	-	-	-	-	-

Notes:

1. For direct drive evaporator fan speed (rpm), refer to the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in commercial equipment, are definite purpose motors, specifically designed and tested to operate reliably and continuously at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

* For 2000, 2400, and 2800 cfm, unit application below 320 cfm/ton are only applicable on T_C models only (no gas heat). See below for restrictions.
* For electric heat applications, minimum airflow is set to 320 cfm/ton, unless specified otherwise, values found in electric heat temperature rise table.
* Dehumidification (hot gas reheat) or TXV with Frostat™ and crankcase heaters are required on applications below 320 cfm/ton.

Table 40. Direct drive evaporator fan performance - 10 ton with eFlex™ and eDrive™ technology - YZC120F3,F4,FW low and medium gas heat downflow airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
3200	892	0.39	929	0.47	964	0.54	998	0.62	1031	0.70	1064	0.78	1095	0.86	1124	0.94	1153	1.02	1181	1.10
3600	994	0.54	1028	0.63	1060	0.71	1090	0.79	1120	0.87	1151	0.97	1180	1.06	1209	1.15	1236	1.24	1262	1.33
4000	1096	0.72	1128	0.81	1158	0.91	1186	1.00	1213	1.09	1240	1.18	1267	1.28	1294	1.38	1321	1.49	1346	1.59
4400	1199	0.93	1230	1.04	1257	1.14	1284	1.24	1309	1.34	1333	1.44	1358	1.54	1383	1.65	1407	1.77	1432	1.88
4800	1302	1.19	1332	1.30	1357	1.42	1382	1.53	1406	1.64	1429	1.75	1451	1.85	1474	1.97	1496	2.08	1519	2.20

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
3200	1208	1.19	1234	1.27	1260	1.35	1285	1.44	1308	1.52	1333	1.61	1355	1.70	1377	1.79	1399	1.88	1420	1.97
3600	1287	1.42	1312	1.51	1337	1.60	1361	1.69	1384	1.79	1407	1.88	1429	1.97	1451	2.07	1472	2.17	1493	2.27
4000	1371	1.69	1395	1.79	1417	1.89	1440	1.99	1462	2.09	1484	2.19	1506	2.29	1527	2.40	1548	2.50	1569	2.61
4400	1455	1.99	1479	2.10	1501	2.21	1523	2.33	1544	2.43	1564	2.54	1584	2.65	-	-	-	-	-	-
4800	1542	2.33	1564	2.45	1586	2.58	1607	2.70	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
1. For direct drive fan speed, reference the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine additional static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in equipment, are definite purpose motors, specifically designed and tested to operate at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 41. Direct drive evaporator fan performance - 10 ton with eFlex™ and eDrive™ technology - YZC120F3,F4,FW low and medium gas heat horizontal airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
3200	853	0.34	896	0.42	935	0.50	970	0.57	1004	0.65	1037	0.73	1070	0.81	1101	0.90	1130	0.98	1160	1.07
3600	950	0.47	988	0.55	1025	0.64	1058	0.72	1089	0.81	1120	0.89	1149	0.98	1180	1.08	1209	1.17	1235	1.26
4000	1049	0.63	1081	0.71	1116	0.81	1148	0.91	1177	1.00	1206	1.09	1233	1.19	1260	1.28	1286	1.38	1314	1.49
4400	1148	0.81	1176	0.90	1208	1.01	1239	1.12	1267	1.22	1294	1.33	1320	1.42	1344	1.53	1369	1.63	1394	1.74
4800	1247	1.04	1273	1.14	1301	1.24	1330	1.36	1357	1.48	1384	1.59	1408	1.70	1432	1.81	1455	1.92	1478	2.04

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
3200	1191	1.16	1221	1.25	1248	1.35	1275	1.44	1300	1.53	1325	1.62	1349	1.72	1373	1.81	1396	1.91	1418	2.01
3600	1261	1.36	1287	1.45	1315	1.55	1342	1.66	1367	1.76	1394	1.87	1417	1.97	1441	2.08	1463	2.18	1484	2.28
4000	1339	1.60	1364	1.70	1388	1.80	1411	1.90	1435	2.01	1460	2.12	1484	2.24	1508	2.36	1530	2.47	1553	2.59
4400	1419	1.86	1443	1.98	1466	2.09	1489	2.20	1510	2.31	1532	2.43	1553	2.54	1575	2.65	1597	2.78	1619	2.90
4800	1500	2.16	1523	2.28	1546	2.40	1567	2.52	1589	2.65	1611	2.78	1631	2.90	-	-	-	-	-	-

Notes:
1. For direct drive evaporator fan speed (rpm), refer to the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in commercial equipment, are definite purpose motors, specifically designed and tested to operate reliably and continuously at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Table 42. Direct drive evaporator fan performance - 10 ton with eFlex™ and eDrive™ technology - YZC120F3,F4,FW high gas heat downflow airflow

	External Static Pressure (Inches of Water)																			
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
3200	900	0.42	939	0.50	972	0.57	1004	0.64	1037	0.72	1069	0.80	1099	0.88	1127	0.95	1155	1.03	1184	1.12
3600	1005	0.58	1037	0.66	1071	0.74	1099	0.82	1128	0.90	1157	0.99	1186	1.08	1214	1.17	1240	1.26	1265	1.35
4000	1110	0.77	1138	0.86	1170	0.96	1198	1.05	1223	1.13	1249	1.22	1275	1.32	1302	1.42	1327	1.52	1352	1.62
4400	1215	1.01	1241	1.10	1268	1.20	1297	1.31	1321	1.41	1344	1.50	1367	1.60	1391	1.71	1415	1.82	1439	1.93
4800	1321	1.29	1345	1.39	1369	1.49	1395	1.61	1420	1.73	1442	1.83	1463	1.94	1484	2.04	1506	2.16	1529	2.28

Continued

	External Static Pressure (Inches of Water)																			
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
3200	1212	1.21	1239	1.29	1266	1.38	1291	1.47	1316	1.56	1342	1.65	1367	1.75	1392	1.84	1415	1.94	1438	2.03
3600	1290	1.44	1316	1.53	1341	1.63	1365	1.72	1390	1.82	1414	1.92	1436	2.02	1459	2.12	1482	2.22	1506	2.33
4000	1375	1.72	1398	1.81	1420	1.91	1443	2.01	1466	2.12	1488	2.23	1511	2.33	1534	2.45	1554	2.55	1575	2.66
4400	1462	2.03	1485	2.15	1506	2.25	1527	2.36	1548	2.47	1567	2.57	1588	2.69	1609	2.80	1631	2.93	-	-
4800	1550	2.39	1572	2.51	1593	2.63	1614	2.75	1634	2.87	-	-	-	-	-	-	-	-	-	-

Notes:
1. For direct drive evaporator fan speed (rpm), refer to the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in commercial equipment, are definite purpose motors, specifically designed and tested to operate reliably and continuously at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Evaporator Fan Performance

Table 43. Direct drive evaporator fan performance - 10 ton with eFlex™ and eDrive™ technology - YZC120F3,F4,FW high gas heat horizontal airflow

External Static Pressure (Inches of Water)																				
	.10		.20		.30		.40		.50		.60		.70		.80		.90		1.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
3200	868	0.37	906	0.44	943	0.51	980	0.59	1014	0.67	1046	0.74	1078	0.82	1109	0.91	1139	0.99	1168	1.08
3600	969	0.50	1001	0.58	1035	0.66	1068	0.74	1100	0.83	1131	0.92	1160	1.01	1189	1.10	1217	1.19	1244	1.28
4000	1070	0.67	1098	0.75	1129	0.84	1159	0.93	1188	1.02	1218	1.12	1245	1.22	1272	1.32	1298	1.41	1324	1.52
4400	1172	0.87	1197	0.96	1224	1.06	1251	1.16	1279	1.26	1306	1.36	1332	1.46	1358	1.57	1383	1.68	1407	1.79
4800	1274	1.12	1297	1.21	1321	1.31	1346	1.42	1371	1.53	1396	1.64	1421	1.75	1445	1.86	1469	1.98	1493	2.10

Continued

External Static Pressure (Inches of Water)																				
	1.10		1.20		1.30		1.40		1.50		1.60		1.70		1.80		1.90		2.00	
cfm	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp	rpm	bhp
3200	1196	1.16	1225	1.25	1254	1.34	1280	1.43	1306	1.52	1330	1.61	1355	1.71	1378	1.80	1400	1.89	1424	1.99
3600	1271	1.37	1297	1.47	1323	1.57	1347	1.66	1374	1.77	1398	1.86	1423	1.97	1447	2.07	1470	2.17	1492	2.27
4000	1349	1.62	1375	1.72	1399	1.83	1422	1.93	1445	2.03	1468	2.14	1491	2.25	1514	2.36	1538	2.48	1561	2.59
4400	1431	1.90	1455	2.01	1478	2.12	1499	2.23	1523	2.35	1544	2.46	1565	2.57	1587	2.69	1608	2.81	1629	2.92
4800	1515	2.21	1537	2.33	1559	2.45	1581	2.57	1602	2.69	1623	2.82	1643	2.94	-	-	-	-	-	-

Notes:
1. For direct drive evaporator fan speed (rpm), refer to the applicable table in the fan performance section.
2. Data includes pressure drop due to standard filters and wet coils.
3. To determine static pressure drop due to other options/accessories, refer to the applicable table in the fan performance section.
4. Direct drive fan motor heat (MBh) = 2.7912 x fan bhp + 0.1388
5. Factory supplied motors, in commercial equipment, are definite purpose motors, specifically designed and tested to operate reliably and continuously at all cataloged conditions. Using the full horsepower range of our fan motors as shown in our tabular data will not result in nuisance tripping or premature motor failure. Our product's warranty will not be affected.

Fan Performance

Table 44. Voltage vs. cfm table

T/YZC036E, T/YZC048F, T/YZC060E		
PWM% Value	**Potentiometer Voltage (Vdc)**	**CFM/Ton**
70	<0.1	320
75	0.7	347
80	1.25	373
85	1.65	400
90	1.95	427
95	2.17	453
100	>2.4	480

Table 45. Direct drive plenum fan settings (rpm vs. voltage)

T/YZC072F, T/YZC090F, T/YZC102F, T/YZC120F	
Potentiometer	**Motor RPM**
1.25	0
1.5	0
1.75	0
2.0	0
2.25	325
2.50	402
2.75	465
3.00	544
3.25	630
3.50	716
3.75	775
4.00	845
4.25	912
4.50	976
4.75	1044
5.00	1115
5.25	1203
5.50	1253
5.75	1312
6.00	1368
6.25	1425
6.50	1475
6.75	1533
7.00	1581
7.25	1615
7.50	1615

Note: See fan tables for unit rpm and cfm units.

Note: Factory setting is 5V.

Table 46. Static pressure drop through accessories (inches water column) - 3 to 10 tons

Tons	Unit Model Number	cfm	Standard Filters[a]	2" MERV 8 Filter	2" MERV 13 Filter	Economizer with OA/RA Dampers[b]						Electric Heater Accessory (kW)[c],[d]			
						100% OA	100% RA	100% OA	100% RA	100% OA	100% RA				
						Downflow		Low Leak[e]		Horizontal		5-6	9-18	23-36	54
3	T/YZC036E3,4	600	0.01	0.02	0.03	0.03	0.01	0.04	0.01	0.03	0.01	—	—	—	—
3	T/YZC036E3,4	960	0.01	0.03	0.04	0.04	0.01	0.11	0.04	0.04	0.01	0.01	0.01	0.01	—
3	T/YZC036E3,4	1200	0.02	0.04	0.05	0.06	0.01	0.17	0.07	0.06	0.01	0.02	0.02	0.02	—
3	T/YZC036E3,4	1440	0.03	0.05	0.06	0.08	0.02	0.23	0.09	0.08	0.01	0.02	0.03	0.03	—
4	T/YZC048F3,4	800	0.01	0.03	0.04	0.06	0.00	0.02	0.03	0.03	0.01	—	—	—	—
4	T/YZC048F3,4	1280	0.02	0.04	0.03	0.08	0.00	0.08	0.04	0.04	0.01	0.01	0.00	0.01	—
4	T/YZC048F3,4	1600	0.03	0.06	0.05	0.09	0.01	0.13	0.08	0.05	0.02	0.02	0.01	0.02	—
4	T/YZC048F3,4	1920	0.05	0.08	0.07	0.10	0.01	0.20	0.09	0.07	0.02	0.02	0.01	0.03	—
5	T/YZC060E3,4	1000	0.01	0.04	0.03	0.06	0.01	0.04	0.03	0.06	0.01	—	—	—	—
5	T/YZC060E3,4	1600	0.03	0.06	0.08	0.09	0.01	0.14	0.08	0.05	0.01	0.02	0.01	0.02	—
5	T/YZC060E3,4	2000	0.05	0.08	0.11	0.11	0.01	0.22	0.10	0.07	0.02	0.02	0.02	0.03	—
5	T/YZC060E3,4	2400	0.07	0.10	0.13	0.12	0.03	0.31	0.11	0.09	0.04	0.03	0.02	0.04	—
6	T/YZC072F	1920	0.03	0.04	0.10	0.09	0.01	0.13	0.08	0.06	0.01	—	0.01	0.01	—
6	T/YZC072F	2400	0.04	0.06	0.12	0.11	0.02	0.20	0.11	0.08	0.02	—	0.01	0.01	—
6	T/YZC072F	2880	0.06	0.08	0.13	0.13	0.04	0.29	0.18	0.11	0.04	—	0.01	0.02	—
7.5	T/YZC090F	1500	0.02	0.03	0.08	0.07	0.01	0.07	0.05	0.04	0.01	—	—	—	—
7.5	T/YZC090F	2400	0.04	0.06	0.12	0.11	0.02	0.20	0.11	0.08	0.02	—	0.01	0.01	—
7.5	T/YZC090F	3000	0.06	0.09	0.13	0.14	0.05	0.31	0.20	0.12	0.05	—	0.01	0.02	—
7.5	T/YZC090F	3600	0.09	0.13	0.15	0.21	0.07	0.46	0.30	0.25	0.08	—	0.02	0.03	—
8.5	T/YZC102F	1700	0.02	0.05	0.11	0.07	0.01	0.16	0.09	0.05	0.02	—	—	—	—
8.5	T/YZC102F	2720	0.05	0.08	0.13	0.12	0.03	0.42	0.18	0.09	0.04	—	0.01	0.02	—
8.5	T/YZC102F	3400	0.08	0.11	0.14	0.19	0.06	0.63	0.21	0.18	0.06	—	0.02	0.02	—
8.5	T/YZC102F	4080	0.12	0.16	0.16	0.30	0.07	0.91	0.34	0.31	0.09	—	0.03	0.03	—
10	T/YZC120F	2000	0.03	0.06	0.11	0.08	0.03	0.22	0.10	0.07	0.02	—	—	—	—
10	T/YZC120F	3200	0.07	0.10	0.14	0.17	0.05	0.57	0.20	0.14	0.05	—	0.02	0.03	0.05
10	T/YZC120F	4000	0.11	0.15	0.16	0.26	0.07	0.87	0.33	0.30	0.08	—	0.02	0.03	0.05
10	T/YZC120F	4800	0.16	0.20	0.18	0.34	0.09	1.23	0.49	0.35	0.10	—	0.03	0.04	0.06

(a) Tested with standard filters. Difference in pressure drop should be considered when utilizing optional 2" MERV 8 and MERV 13 filters.
(b) OA = Outside Air and RA = Return Air.
(c) Nominal kW ratings at 240 and 480 volts. Heaters only available on T units.
(d) Electric heaters restricted on applications below 320 cfm/Ton.
(e) Low Leak - downflow only.

Table 47. Outdoor sound power level - dB (ref. 10 - 12 W)

	Unit Model				Octave Center Frequency					Overall
Tons	Number	63	125	250	500	1000	2000	4000	8000	dBA
3	T/YZC036E	79	85	79	79	77	71	67	58	81
4	T/YZC048F	80	86	84	85	83	79	73	67	87
5	T/YZC060E	80	86	84	85	83	79	73	67	87
6[(a)]	T/YZC072F	91	95	90	87	84	79	75	68	89
7.5	T/YZC090F	93	91	89	89	85	80	76	72	90
8.5	T/YZC102F	93	91	89	89	85	80	76	72	90
10	T/YZC120F	91	92	89	86	83	78	75	71	88

(a) Tested in accordance with AHRI270-2015. Sound data for T/YZ072 are estimates.

Heat Performance

Table 48. Gas fired heating capacities

Tons	Unit Model Number	Heating Input MBh	Heating Output MBh	Air Temp. Rise, F
3	YZC036E	60	48	25-55
3	YZC036E	80	64	35-65
3	YZC036E	100	80	55-85
4	YZC048F	60	48	10-40
4	YZC048F	80	64	20-50
4	YZC048F	120	96	40-70
5	YZC060E	60	48	10-40
5	YZC060E	80	64	15-45
5	YZC060E	130	104	35-65
6	YZC072F	80	64.8	15-45
6	YZC072F	120	97.2	20-50
6	YZC072F	150	121.5	25-55
7.5	YZC090F	120	97.2	20-50
7.5	YZC090F	150	121.5	20-50
7.5	YZC090F	200	162	35-65
8.5	YZC102F	120	97.2	20-50
8.5	YZC102F	150	121.5	20-50
8.5	YZC102F	200	162	35-65
10	YZC120F	150	121.5	20-50
10	YZC120F	200	162	25-55
10	YZC120F	250	202.5	35-65

Note: Ratings shown are for elevations up to 2,000 ft. For higher elevations, reduce ratings at a rate of 4% per 1,000 ft. elevation.

Table 49. Auxiliary electric heat capacity

Tons	Unit Model Number	Total[a]			Stage1		Stage 2	
		kW Input[b]	MBh Output	No. of Stages	kW Input	MBh Output	kW Input	MBh Output
3	TZC036E3,4	6.00	20.48	1	6.00	20.48	—	—
3	TZC036E3,4	12.00	40.97	2	6.00	20.48	6.00	20.48
3	TZC036E3,4	17.40	59.40	2	8.70	29.70	8.70	29.70
4	TZC048F3,4	6.00	20.48	1	6.00	20.48	—	—
4	TZC048F3,4	12.00	40.97	2	6.00	20.48	6.00	20.48
4	TZC048F3,4	17.40	59.40	2	8.70	29.70	8.70	29.70
5	TZC060E3,4	6.00	20.48	1	6.00	20.48	—	—
5	TZC060E3,4	12.00	40.97	2	6.00	20.48	6.00	20.48
5	TZC060E3,4	17.40	59.40	2	8.70	29.70	8.70	29.70
5	TZC060E3,4	23.00	78.52	2	8.70	29.70	14.30	48.82
6	TZC072F3,4	9.00	30.73	1	9.00	30.73	—	—
6	TZC072F3,4,W	18.00	61.45	1	18.00	61.45	—	—
6	TZC072F3,4	27.00	92.18	2	18.00	61.45	9.00	30.73
6	TZC072F3,4,W	36.00	122.90	2	18.00	61.45	18.00	61.45
7.5	TZC090F3,4	9.00	30.73	1	9.00	30.73	—	—

Table 49. Auxiliary electric heat capacity (continued)

Tons	Unit Model Number	Total[a]			Stage1		Stage 2	
		kW Input[b]	MBh Output	No. of Stages	kW Input	MBh Output	kW Input	MBh Output
7.5	TZC090F3,4,W	18.00	61.45	1	18.00	61.45	—	—
7.5	TZC090F3,4	27.00	92.18	2	18.00	61.45	9.00	30.73
7.5	TZC090F3,4,W	36.00	122.90	2	18.00	61.45	18.00	61.45
8.5	TZC102F3,4,	9.00	30.73	1	9.00	30.73	—	—
8.5	TZC102F3,4,W	18.00	61.45	1	18.00	61.45	—	—
8.5	TZC102F3,4,	27.00	92.18	2	18.00	61.45	9.00	30.73
8.5	TZC102F3,4,W	36.00	122.90	2	18.00	61.45	18.00	61.45
10	TZC120F3,4,W	18.00	61.45	1	18.00	61.45	—	—
10	TZC120F3,4	27.00	92.18	2	18.00	61.45	9.00	30.73
10	TZC120F3,4,W	36.00	122.90	2	18.00	61.45	18.00	61.45
10	TZC120F3,4,W	54.00	184.36	2	36.00	122.90	18.00	61.45

(a) Heaters are rated at 240V and 480V. For other than rated voltage, CAP= (voltage/rated voltage)^2 x rated cap.
(b) All input/output does not include indoor fan power or heat.

Table 50. Electric heater voltage correction factors (applicable to auxiliary heat capacity)

Nominal Voltage	Distribution Voltage	Capacity Multiplier
240	208	0.751
240	230	0.918
240	240	1.000
480	440	0.840
480	460	0.918
480	480	1.000
600	540	0.810
600	575	0.918
600	600	1.000

Table 51. Air temperature rise across electric heaters (°F) - 3 to 5 tons

kW	Stages	3 Tons[a]	4 Tons	5 Tons
		1200 cfm	1600 cfm	2000 cfm[b]
		Three Phase TZC036E3,4	Three Phase TZC048F3,4	Three Phase TZC060E3,4
6.00	1	18.5	10.5	11.4
12.00	2	36.2	22.3	21.5
17.40	2	48.2	33.0	30.0
23.0	2	—	—	38.8

Notes:
1. For minimum design airflow, see airflow performance table for each unit.
2. To calculate temp rise at different airflow, use the following formula: Temp. rise across Electric Heater = kWx3414/1.08xCFM.

(a) The minimum allowable airflow for a 3 ton with a 17.4 kW heater is 1080 cfm.
(b) The minimum allowable airflow for a 5 ton unit with a 23.0 kW heater is 1900 cfm.

Heat Performance

Table 52. Air temperature rise across electric heaters (°F) - 6 to 10 tons

kW	Stages	6 Tons 2000 cfm TZC072F3,4,W	7.5 tons 3000 cfm TZC090F3,4,W	8.5 tons 3400 cfm TZC102F3,4,W	10 Tons 4000 cfm[a] TZC120F3,4,W
9.0	1	14.2	9.5	8.4	—
18.0	1	28.5	19.0	16.7	14.2
27.0	2	42.7	28.5	25.1	21.3
36.0	2	56.9	37.9	33.5	28.5
54.0	2	—	—	—	42.7

Notes:
1. For minimum design airflow, see airflow performance table for each unit.
2. To calculate temp rise at different airflow, use the following formula: Temp. rise across Electric Heater = kWx3414/1.08xCFM.

(a) The minimum allowable airflow with a 54 kW heater for TZC120F is 3400 cfm.

Controls

ReliaTel™ Controlled Units

Zone Sensors are the building occupant's comfort control devices. The following zone sensor options are available for Precedent units with ReliaTel control:

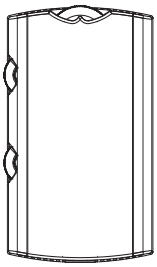
Differential Enthalpy

Differential Enthalpy replaces the standard dry bulb control with two enthalpy sensors that compare total heat content of the indoor air and outdoor air to determine the most efficient air source. This control option offers the highest level of comfort control, plus energy efficiency, available.

Differential Pressure Switches

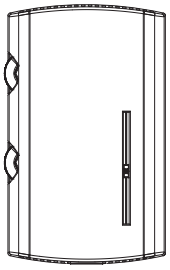
This factory or field-installed option allows individual fan failure and dirty filter indication. The fan failure switch will disable all unit functions and "flash" the Service LED on the zone sensor. The dirty filter switch will light the Service LED on the zone sensor and will allow continued unit operation.

Manual Changeover



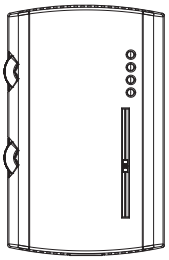
Heat, Cool or Off System Switch. Fan Auto or Off Switch. One temperature setpoint lever.

Manual/Automatic Changeover



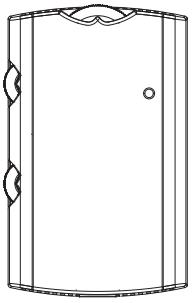
Auto, Heat, Cool or Off System Switch. Fan Auto or Off Switch. Two temperature setpoint levers.

Manual/Automatic Changeover



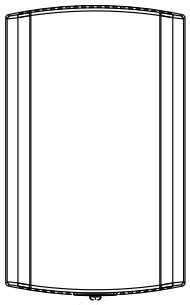
Auto, Heat, Cool or Off System Switch. Fan Auto or Off Switch. Two temperature setpoint levers. Status Indication LED lights, System On, Heat, Cool, or Service.

Manual/Automatic Changeover



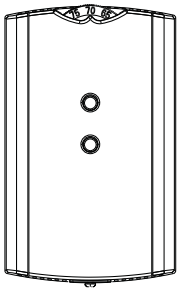
Auto, Heat, Cool or Off System Switch. Fan Auto or Off Switch. Two temperature setpoint levers.

Remote Sensor



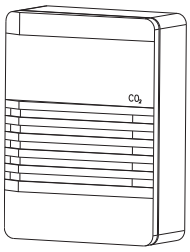
Sensor(s) available for all zone sensors to provide remote sensing capabilities.

Integrated Comfort™ System



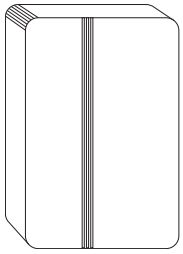
Sensor(s) available with optional temperature adjustment and override buttons to provide central control through a Trane Integrated Comfort™ system.

CO_2 Sensing



The CO_2 sensor shall have the ability to monitor the concentration (parts per million, ppm) of CO_2 (Carbon Dioxide) in the air. As the CO_2 concentration changes, the outside air damper modulates to meet the current ventilation needs of the zone.

Humidity Sensor



Field installed, wall-mounted or duct-mounted humidity sensor is used to control activation of the enhanced dehumidification option. The humidity sensor can be set for humidity levels between 40% and 60% relative humidity by adjusting the ReliaTel Options Module.

Economizer Controls

The standard equipment offering is a fixed dry bulb changeover control. In addition, there are two optional controls, Enthalpy and Differential Enthalpy Control.

Enthalpy Control

Replaces the dry bulb control with a wet bulb changeover controller which has a fully adjustable setpoint. Enthalpy control offers a higher level of comfort control, along with energy savings potential, than the standard dry bulb control. This is due to the additional wet bulb sensing capability.

RA Remote Sensor

Return Air Remote Sensor which can be mounted in the return air duct to report return air temperature.

Room Remote Sensor

Space Remote Sensor which can be mounted on the wall to report/control from a remote location in the space.

Remote Potentiometer

Minimum position setting of economizer can be remotely adjusted with this accessory.

Trane® Communication Interface (TCI)

This factory or field-installed micro-processor interface allows the unit to communicate to Trane's Integrated Comfort™ system. TCI communication is only for constant volume units. Multi-speed and VAV units require either a BACnet® or LON communication if a BAS is used for control.

BACnet® Communication Interface

This option shall be provided to allow the unit to communicate directly with a generic open protocol BACnet MS/TP Network Building Automation System Controls.

Electrical Data

Table 53. Unit wiring with cooling (no electric heat) - 3 to 10 tons

Tons	Unit Model Number	Unit Operating Voltage Range	Standard Indoor Motor	
			MCA	Max Fuse Size or Max Circuit Breaker
3	TZC036E3	208-230	14	20
	TZC036E4	460	7	15
4	TZC048F3	208-230	18	25
	TZC048F4	460	9	15
5	TZC060E3	208-230	26	40
	TZC060E4	460	11	15
6	TZC072F3	187-253	39	50
	TZC072F4	414-506	22	30
	TZC072FW	517-633	20	30
7.5	TZC090F3	187-253	40	60
	TZC090F4	414-506	23	35
	TZC090FW	517-633	21	30
8.5	TZC102F3	187-253	42	60
	TZC102F4	414-506	24	35
	TZC102FW	517-633	22	30
10	TZC120F3	187-253	53	80
	TZC120F4	414-506	31	45
	TZC120FW	517-633	28	40

Table 54. Unit wiring with gas heat - 3 to 10 tons

Tons	Unit Model Number	Unit Operating Voltage Range	Standard Indoor Motor	
			MCA	Max Fuse Size or Max Circuit Breaker
3	YZC036E3	230	14	20
	YZC036E4	460	7	15
4	YZC048F3	230	18	25
	YZC048F4	460	9	15
5	YZC060E3	230	26	40
	YZC060E4	460	11	15
6	YZC072F3	187-253	39	50
	YZC072F4	414-506	22	30
	YZC072FW	517-633	20	30
7.5	YZC090F3	187-253	40	60
	YZC090F4	414-506	23	35
	YZC090FW	517-633	21	30
8.5	YZC102F3	187-253	42	60
	YZC102F4	414-506	24	35
	YZC102FW	517-633	22	30
10	YZC120F3	187-253	53	80
	YZC120F4	414-506	31	45
	YZC120FW	517-633	28	40

Table 55. Unit wiring with electric heat (single point connection) - 3 to 10 tons

Tons	Unit Model Number	Heater Model Number	Heater kW Rating[a]	Control Stages	Heater Amps	Standard Indoor Motor	
						MCA	Max Fuse Size or Max Circuit Breaker
208/230 Volts Three Phase							
3	TZC036E3	BAYHTRE306*	4.5/6.0	1	12.5/14.4	20/22	20/25
	TZC036E3	BAYHTRE312*	9.0/12.0	2	25.0/28.9	36/40	40/40
	TZC036E3	BAYHTRE318*	13.1/17.4	2	36.3/41.9	50/57	50/60
4	TZC048F3	BAYHTRX306*	4.5/6.0	1	12.5/14.4	21/24	25/25
	TZC048F3	BAYHTRX312*	9.0/12.0	2	25.0/28.9	37/42	40/45
	TZC048F3	BAYHTRX318*	13.1/17.4	2	36.3/41.9	51/58	60/60
5	TZC060E3	BAYHTRX306*	4.5/6.0	1	12.5/14.4	26/26	40/40
	TZC060E3	BAYHTRX312*	9.0/12.0	2	25.0/28.9	37/42	40/45
	TZC060E3	BAYHTRX318*	13.1/17.4	2	36.3/41.9	51/58	60/60
	TZC060E3	BAYHTRX323*	17.3/23.0	2	48.0/55.3	66/75	70/80
6	TZC072F3	BAYHTRA309*	6.8/9	1	18.8/21.7	39/39	50/50
	TZC072F3	BAYHTRZ318*	13.5/18	1	37.5/43.3	58/65	60/70
	TZC072F3	BAYHTRA327*	20.3/27	2	56.3/65.0	81/92	90/100
	TZC072F3	BAYHTRZ336*	27/36	2	75.1/86.6	104/119	110/125
7.5	TZC090F3	BAYHTRA309*	6.8/9	1	18.8/21.7	40/40	60/60
	TZC090F3	BAYHTRZ318*	13.5/18	1	37.5/43.3	58/65	60/70
	TZC090F3	BAYHTRA327*	20.3/27	2	56.3/65.0	81/92	90/100
	TZC090F3	BAYHTRZ336*	27/36	2	75.1/86.6	104/119	110/125
8.5	TZC102F3	BAYHTRA309*	6.8/9	1	18.8/21.7	42/42	60/60
	TZC102F3	BAYHTRZ318*	13.5/18	1	37.5/43.3	58/65	60/70
	TZC102F3	BAYHTRA327*	20.3/27	2	56.3/65.0	81/92	90/100
	TZC102F3	BAYHTRZ336*	27/36	2	75.1/86.6	104/119	110/125
10	TZC120F3	BAYHTRD318*	13.5/18	1	37.5/43.3	58/65	80/80
	TZC120F3	BAYHTRD327*	20.3/27	2	56.3/65.0	81/92	90/100
	TZC120F3	BAYHTRZ337*	27/36	2	75.1/86.6	104/119	110/125
	TZC120F3	BAYHTRZ354*	40.6/54	2	112.6/129.9	151/141	175/175
460 Volts Three Phase							
3	TZC036E4	BAYHTRE406*	6.0	1	7.2	12	15
	TZC036E4	BAYHTRE412*	12.0	2	14.4	21	25
	TZC036E4	BAYHTRE418*	17.4	2	20.9	29	30
4	TZC048F4	BAYHTRX406*	6.0	1	7.2	12	15
	TZC048F4	BAYHTRX412*	12.0	2	14.4	21	25
	TZC048F4	BAYHTRX418*	17.4	2	20.9	29	30
5	TZC060E4	BAYHTRX406*	6.0	1	7.2	13	15
	TZC060E4	BAYHTRX412*	12.0	2	14.4	22	25
	TZC060E4	BAYHTRX418*	17.4	2	20.9	30	30
	TZC060E4	BAYHTRX423*	23.0	2	27.7	38	40

Table 55. Unit wiring with electric heat (single point connection) - 3 to 10 tons (continued)

Tons	Unit Model Number	Heater Model Number	Heater kW Rating[a]	Control Stages	Heater Amps	Standard Indoor Motor	
						MCA	Max Fuse Size or Max Circuit Breaker
6	TZC072F4	BAYHTRA409*	9	1	10.8	22	30
	TZC072F4	BAYHTRA418*	18	1	21.7	33	35
	TZC072F4	BAYHTRA427*	27	2	32.5	47	50
	TZC072F4	BAYHTRA436*	36	2	43.3	60	60
7.5	TZC090F4	BAYHTRA409*	09	1	10.8	23	35
	TZC090F4	BAYHTRA418*	18	1	21.7	33	35
	TZC090F4	BAYHTRA427*	27	2	32.5	47	50
	TZC090F4	BAYHTRA436*	36	2	43.3	60	60
8.5	TZC102F4	BAYHTRA409*	09	1	10.8	24	35
	TZC102F4	BAYHTRA418*	18	1	21.7	33	35
	TZC102F4	BAYHTRA427*	27	2	32.5	47	50
	TZC102F4	BAYHTRA436*	36	2	43.3	60	60
10	TZC120F4	BAYHTRD418*	18	1	21.7	33	45
	TZC120F4	BAYHTRD427*	27	2	32.5	47	50
	TZC120F4	BAYHTRZ436*	36	2	43.3	60	60
	TZC120F4	BAYHTRZ454*	54	2	65.0	71	90
575 Volts Three Phase							
6	TZC072FW	BAYHTRAW18*	18	1	17.3	28	30
	TZC072FW	BAYHTRAW36*	36	2	34.6	49	50
7.5	TZC090FW	BAYHTRAW18*	18	1	17.3	28	30
	TZC090FW	BAYHTRAW36*	36	2	34.6	49	50
8.5	TZC102FW	BAYHTRAW18*	18	1	17.3	28	30
	TZC102FW	BAYHTRAW36*	36	2	34.6	49	50
10	TZC120FW	BAYHTRBW18*	18	1	17.3	28	40
	TZC120FW	BAYHTRZW36*	36	2	34.6	49	50
	TZC120FW	BAYHTRZW54*	54	2	52.0	58	70

(a) Heater kW ratings are at 208/240V for 208/230V units, 480V for 460V units.

Table 56. Electrical characteristics - compressor motor - variable frequency drive

Ton	Unit Model Number	Volts	Phase	VFD Input Amps
3	T/YZC036E3	208-230	3	8.0
	T/YZC036E4	460	3	4.0
4	T/YZC048F3	208-230	3	9.0
	T/YZC048F4	460	3	4.5
5	T/YZC060E3	208-230	3	16.0
	T/YZC060E4	460	3	6.0
6	T/YZC072F3	187-253	3	20.8
	T/YZC072F4	414-506	3	12.2
	T/YZC072FW	517-633	3	10.5
7.5	T/YZC090F3	187-253	3	21.5
	T/YZC090F4	414-506	3	12.9
	T/YZC090FW	517-633	3	11.3

Table 56. Electrical characteristics - compressor motor - variable frequency drive (continued)

Ton	Unit Model Number	Volts	Phase	VFD Input Amps
8.5	T/YZC102F3	187-253	3	22.6
	T/YZC102F4	414-506	3	13.6
	T/YZC102FW	517-633	3	11.9
10	T/YZC120F3	187-253	3	31.3
	T/YZC120F4	414-506	3	18.8
	T/YZC120FW	517-633	3	16.5

Table 57. Electrical characteristics - condenser fan motor - 60 cycle

Ton	Unit Model Number	Volts	Hz	Motor Phase	Nameplate Rating	
					FLA	bhp
3	T/YZC036E3	208-230	60	1	1.0	0.33
	T/YZC036E4	460[a]	60	1	0.5	0.33
4	T/YZC048F3	208-230	60	1	2.9	0.50
	T/YZC048F4	460[a]	60	1	1.3	0.50
5	T/YZC060E3	208-230	60	1	2.4	0.50
	T/YZC060E4	460[a]	60	1	1.2	0.50
6	T/YZC072F3	187-253	60	1-PWM	5.7	0.75
	T/YZC072F4	414-506	60	1-PWM	3.1	0.75
	T/YZC072FW	517-633	60	1-PWM	3.1	0.75
7.5	T/YZC090F3	187-253	60	1-PWM	5.7	0.75
	T/YZC090F4	414-506	60	1-PWM	3.1	0.75
	T/ZC090FW	517-633	60	1-PWM	3.1	0.75
8.5	T/ZC102F3	187-253	60	1-PWM	5.7	0.75
	T/ZC102F4	414-506	60	1-PWM	3.1	0.75
	T/ZC102FW	517-633	60	1-PWM	3.1	0.75
10	T/ZC120F3	187-253	60	1-PWM	5.7	0.75
	T/ZC120F4	414-506	60	1-PWM	3.1	0.75
	T/ZC120FW	517-633	60	1-PWM	3.1	0.75

(a) Precedent™ models with 460V supply power will utilize a high efficiency 208-230V powered evaporator and condenser fan motor. Power will be adapted for the fan motors with a 460V/230V autotransformer

Table 58. Electrical characteristics - evaporator fan motor - 60 cycle

Ton	Unit Model Number	Volts	Hz	Motor Phase	Nameplate Rating	
					FLA	bhp
3	T/YZC036E3	208-230	60	1	2.3	0.75
	T/YZC036E4	460[a]	60	1	1.0	0.75
4	T/YZC048F3	208-230	60	1	3.3	1.00
	T/YZC048F4	460[a]	60	1	1.4	1.00
5	T/YZC060E3	208-230	60	1	3.3	1.00
	T/YZC060E4	460[a]	60	1	1.8	1.00
6	T/YZC072F3	187-253	60	3 DC	7.3	2.7
	T/YZC072F4	414-506	60	3 DC	3.6	2.7
	T/YZC072FW	517-633	60	3 DC	3.6	2.7

Table 58. Electrical characteristics - evaporator fan motor - 60 cycle (continued)

Ton	Unit Model Number	Volts	Hz	Motor Phase	Nameplate Rating	
					FLA	bhp
7.5	T/YZC090F3	187-253	60	3 DC	7.3	2.7
	T/YZC090F4	414-506	60	3 DC	3.6	2.7
	T/YZC090FW	517-633	60	3 DC	3.6	2.7
8.5	T/YZC102F3	187-253	60	3 DC	7.3	2.7
	T/YZC102F4	414-506	60	3 DC	3.6	2.7
	T/YZC102FW	517-633	60	3 DC	3.6	2.7
10	T/YZC120F3	187-253	60	3 DC	7.3	2.7
	T/YZC120F4	414-506	60	3 DC	3.6	2.7
	T/YZC120FW	517-633	60	3 DC	3.6	2.7

(a) Precedent™ models with 460V supply power will utilize a high efficiency 208-230V powered evaporator and condenser fan motor. Power will be adapted for the fan motors with a 460V/230V autotransformer.

Table 59. Electrical characteristics - power exhaust (cooling and gas/electric)

Ton	Volts	Motor Phase	hp	rpm	FLA	LRA
3-5	208-230	1	0.33	1075	2.2	5.5
3-5	460	1	0.33	1075	1.1	2.8
6-10	208-230	1	0.87	1075	5.7	13.6
6-10	460	1	0.87	1075	3.3	6.8
6-10	575	1	0.87	1075	2.3	5.4

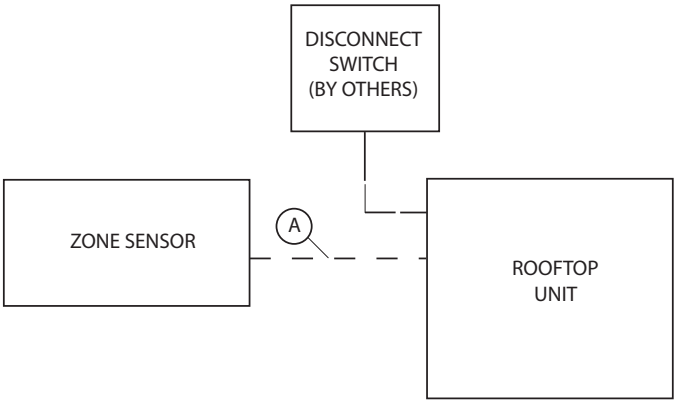
Table 60. Electrical characteristics - inducer motor

Ton	Stage	hp	rpm	Volts	Motor Phase	LRA
3-5	1	1/35	3000	208-230	1	0.6
6-10	208-230	1	1/15	3350/2800	0.42/0.5	1.25

Jobsite Connections

Table 61. Typical Number of Wires

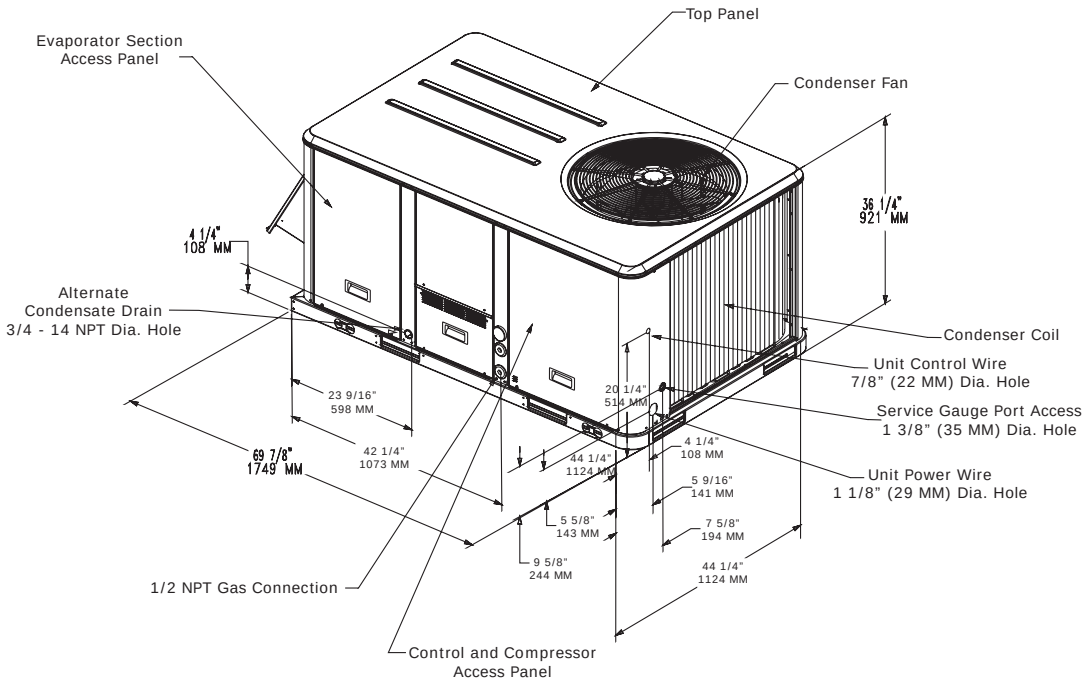
	Zone Sensors	
A	Manual Changeover.....	4
	Manual/Auto Changeover.....	5
	Manual/Auto Changeover with Status Indication LED's.....	10
	Programmable Night Setback with Status Indication LED's.....	7



For specific wiring information, see the installation instructions.
All wiring except power wire is low voltage.
All customer supplied wiring to be copper and must conform to applicable electrical codes (such as NEC or CEC) and local electric codes. Wiring shown dotted is to be furnished and installed by the customer.

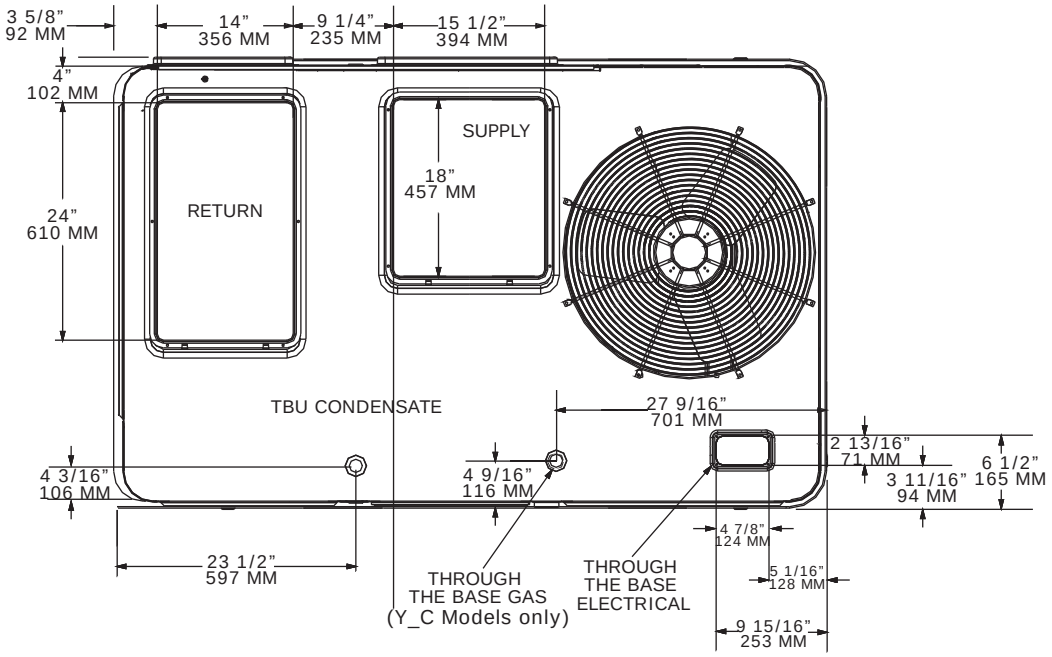
Dimensional Data

Figure 1. Cooling and gas/electric - 3 tons ultra high efficiency[a],[b]



(a) All dimensions are in inches/millimeters.
(b) ½ NPT Gas Connection = (Y_C Models only); 2" Electrical Connection: Single Point Power When Heat Installed (T_C Models only.)

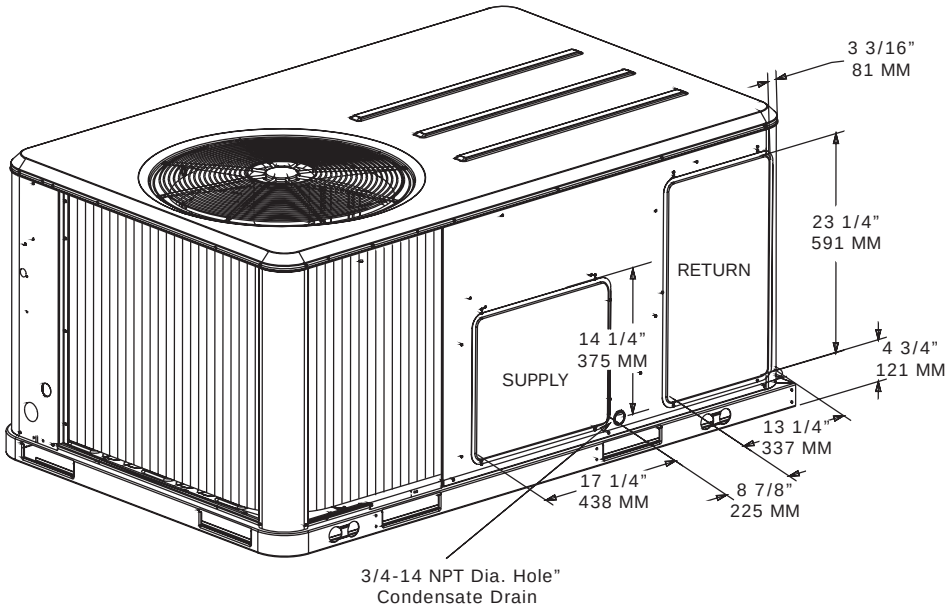
Figure 2. Cooling and gas/electric - 3 tons - downflow airflow supply/return - through-the-base utilities[a]



(a) All dimensions are in inches/millimeters.

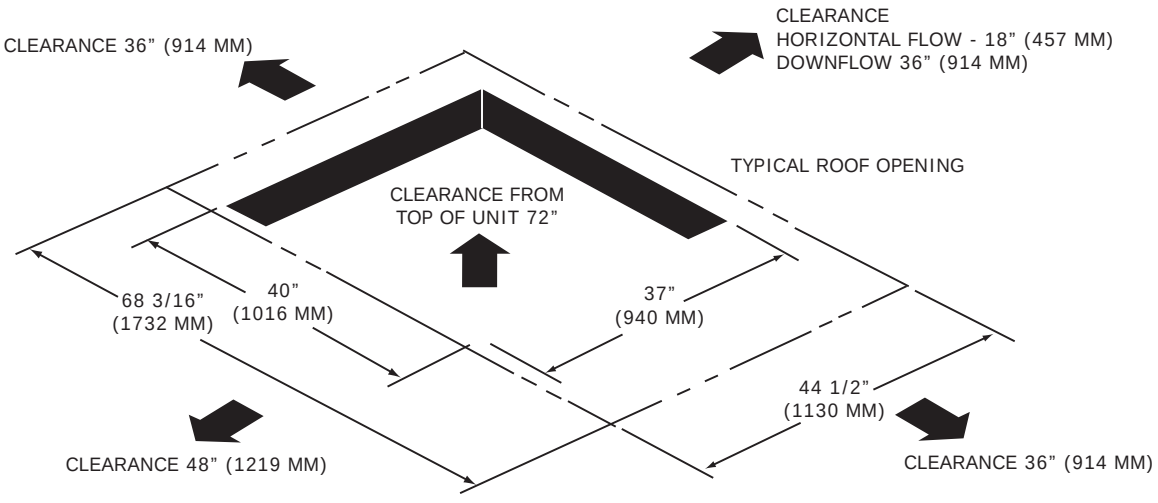
Dimensional Data

Figure 3. Cooling and gas/electric - 3 tons - horizontal airflow supply/return[a]



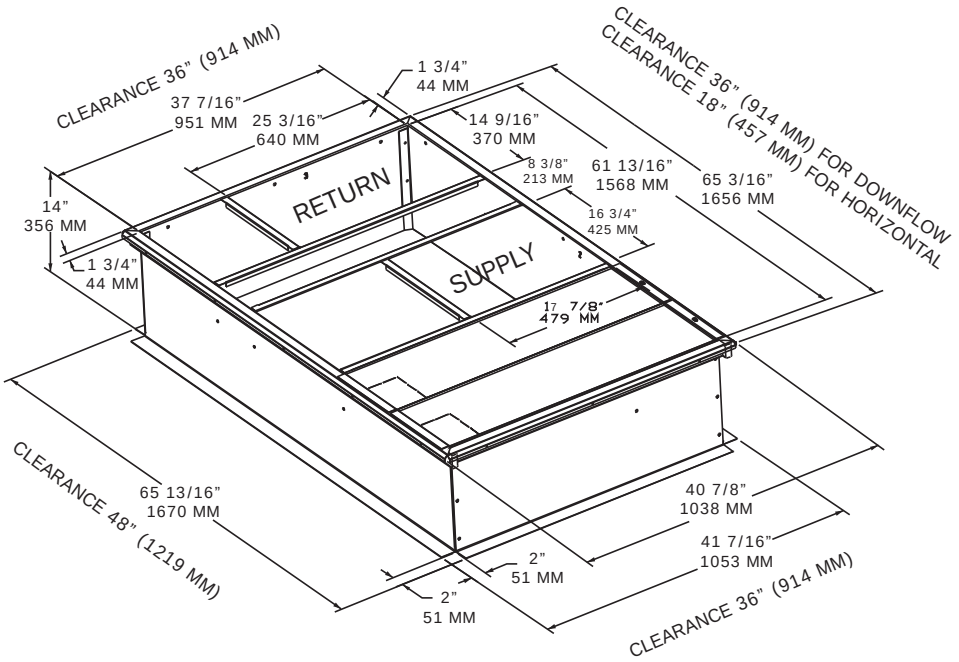
(a) All dimensions are in inches/millimeters.

Figure 4. Cooling and gas/electric - 3 tons ultra high efficiency - unit clearance and roof opening[a]



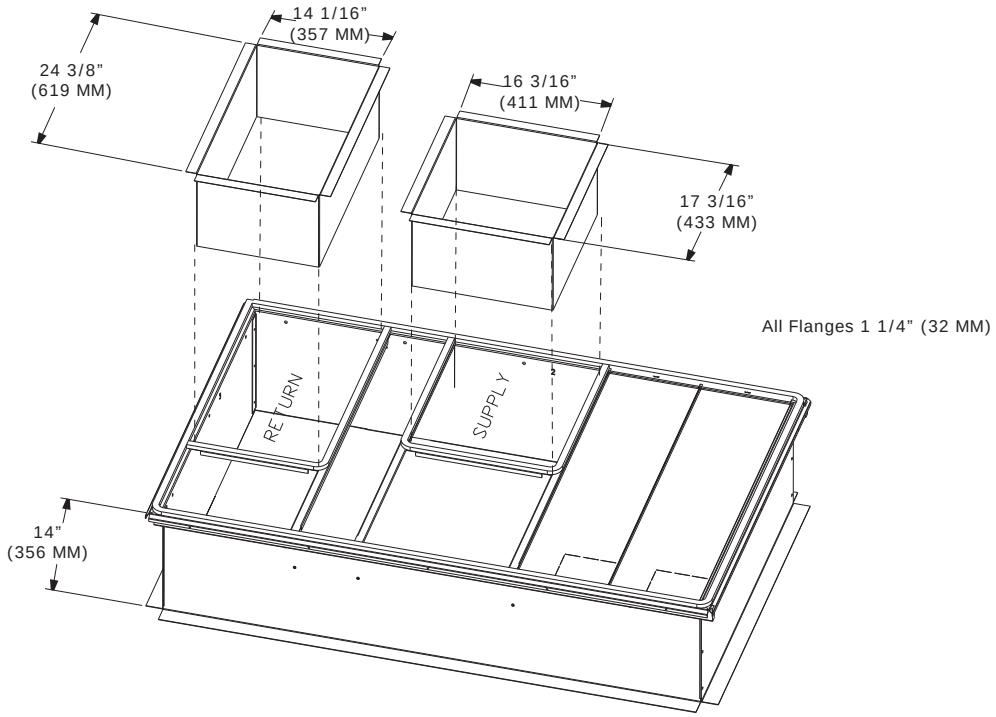
(a) All dimensions are in inches/millimeters.

Figure 5. Cooling and gas/electric - 3 tons ultra high efficiency - roof curb[(a)]



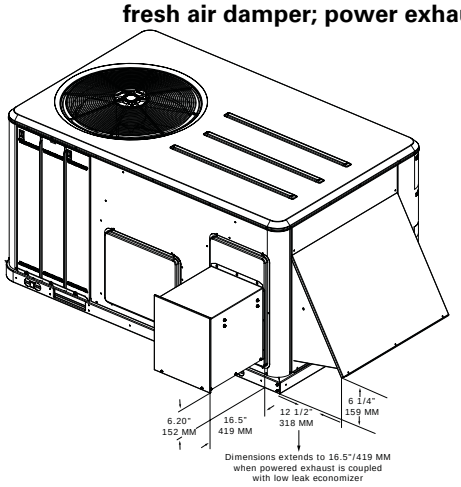
(a) All dimensions are in inches/millimeters.

Figure 6. Cooling and gas/electric - 3 tons ultra high efficiency - downflow duct connections - field fabricated[(a)]



(a) All dimensions are in inches/millimeters.

Figure 7. Cooling and gas/electric - 3 tons ultra high efficiency- economizer, manual or motorized fresh air damper; power exhaust[a]



(a) All dimensions are in inches/millimeters.

Figure 8. Cooling and gas/electric - 3 tons ultra high efficiency- economizer and barometric relief damper hood[a]

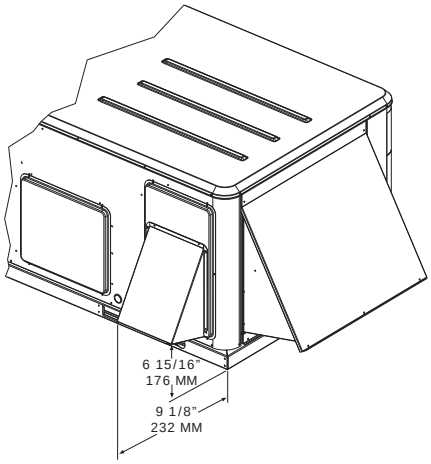
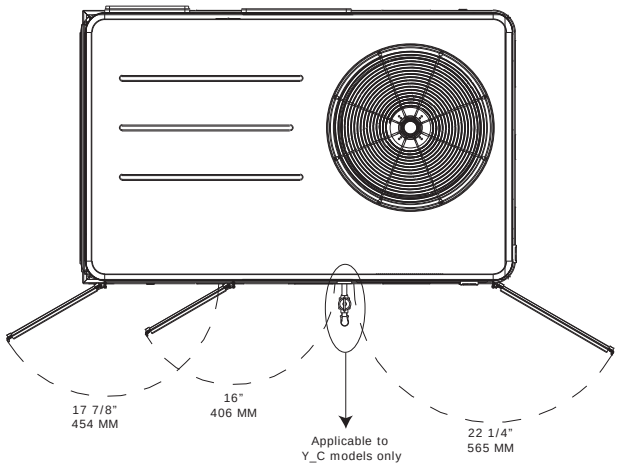


Figure 9. Cooling and gas/electric models - 3 tons ultra high efficiency- swing diameter for hinged door(s) option[a]



(a) All dimensions are in inches/millimeters.

Figure 10. Gas/electric models - 3 tons ultra high efficiency- height of gas pipe required from inside base of unit to gas shut off assembly (factory provided) - Y_C models only

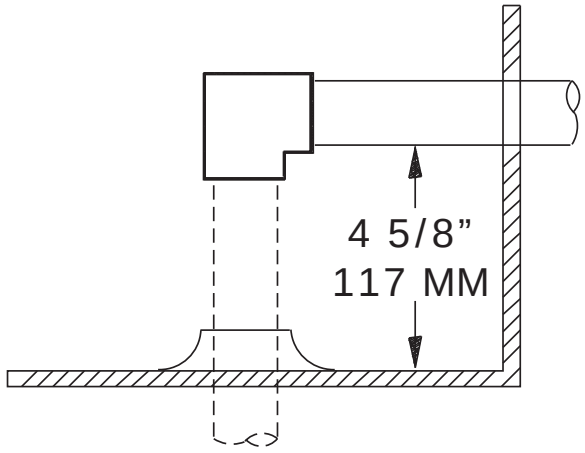
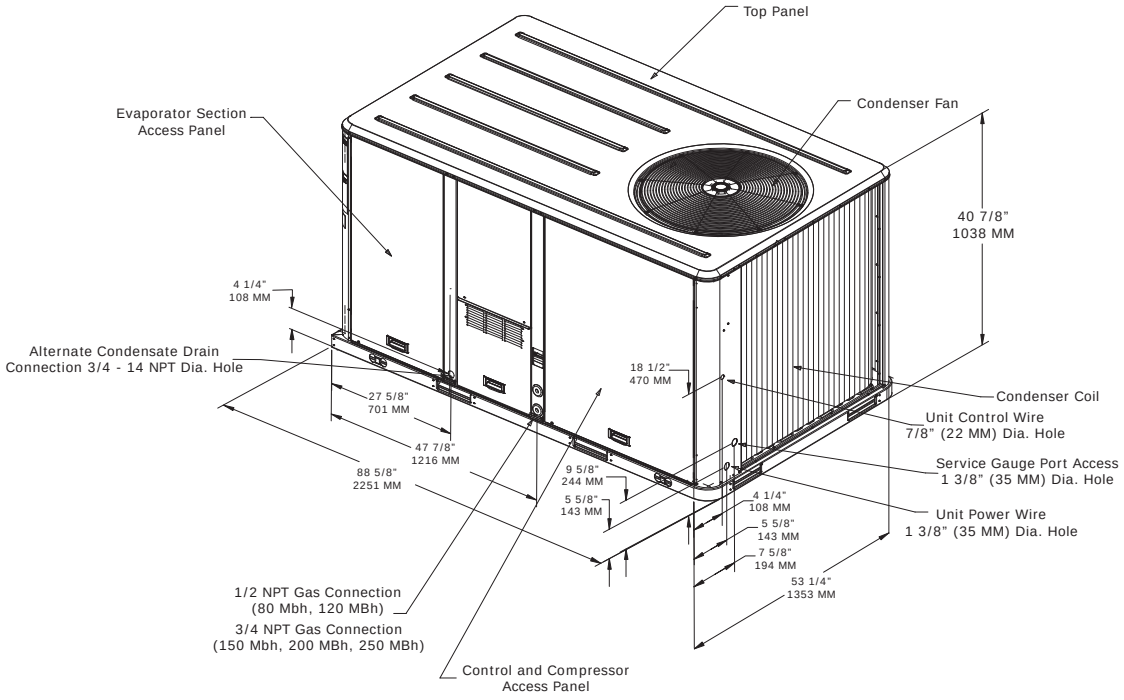
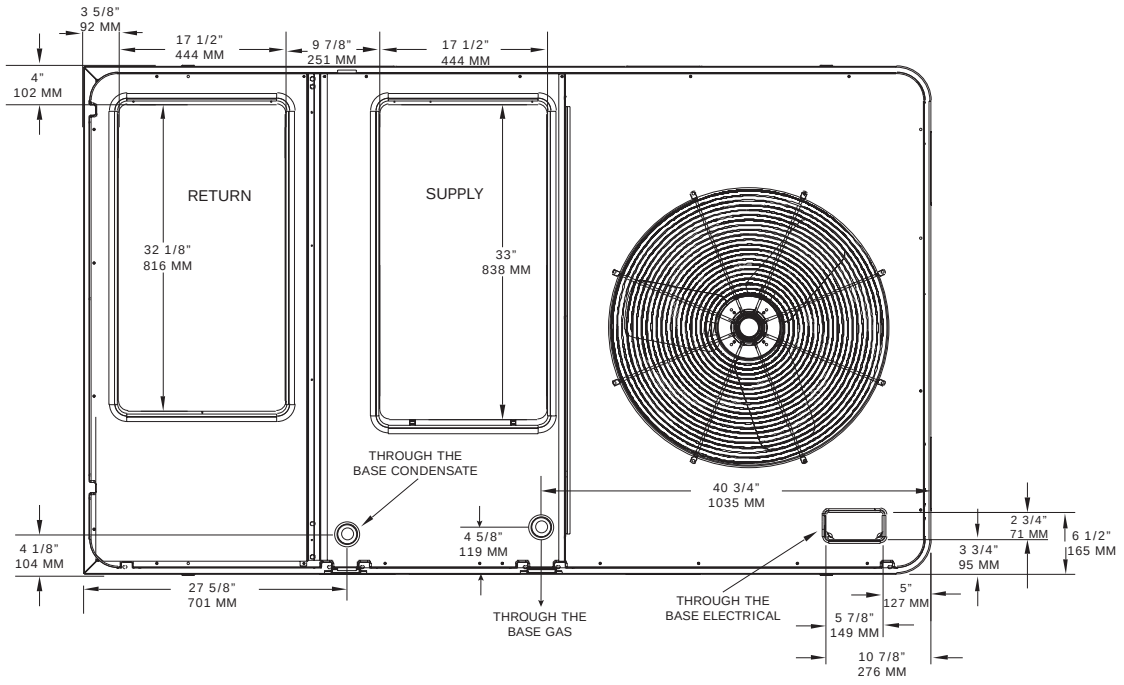


Figure 11. Cooling and gas/electric - 4 to 5 tons ultra high efficiency[a]



(a) All dimensions are in inches/millimeters.

Figure 12. Cooling and gas/electric - 4 to 5 tons ultra high efficiency- downflow airflow supply/return - through-the-base utilities[a]



(a) All dimensions are in inches/millimeters.

Figure 13. Cooling and gas/electric - 4 to 5 tons ultra high efficiency- horizontal airflow supply and return

Note: All dimensions are in inches/millimeters.

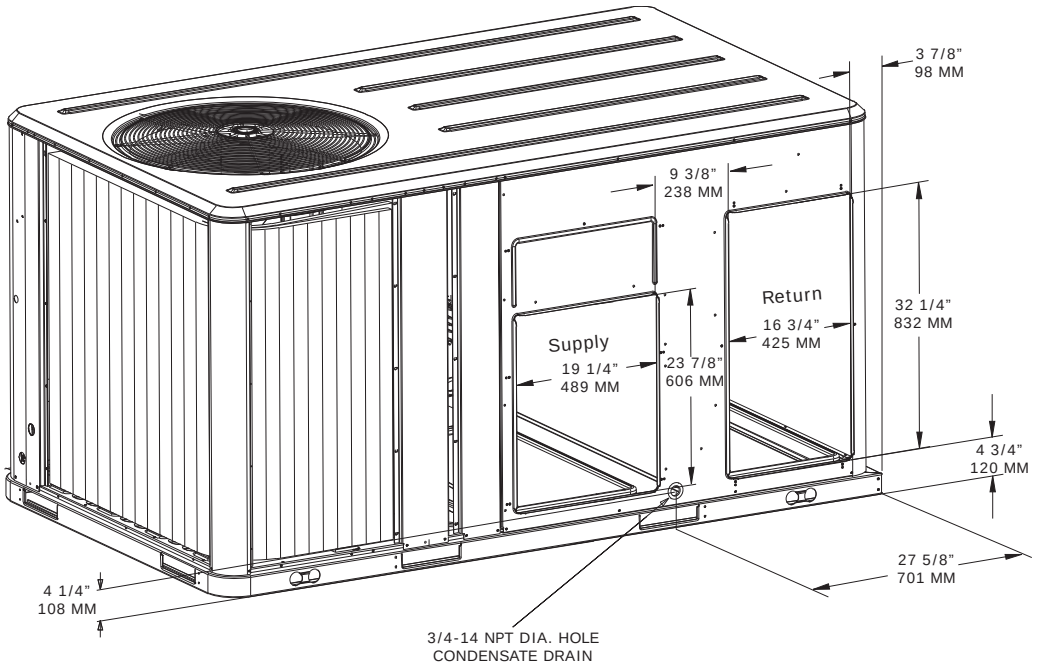


Figure 14. Cooling and gas/electric - 4 to 5 tons ultra high efficiency- unit clearance and roof opening

Note: All dimensions are in inches/millimeters.

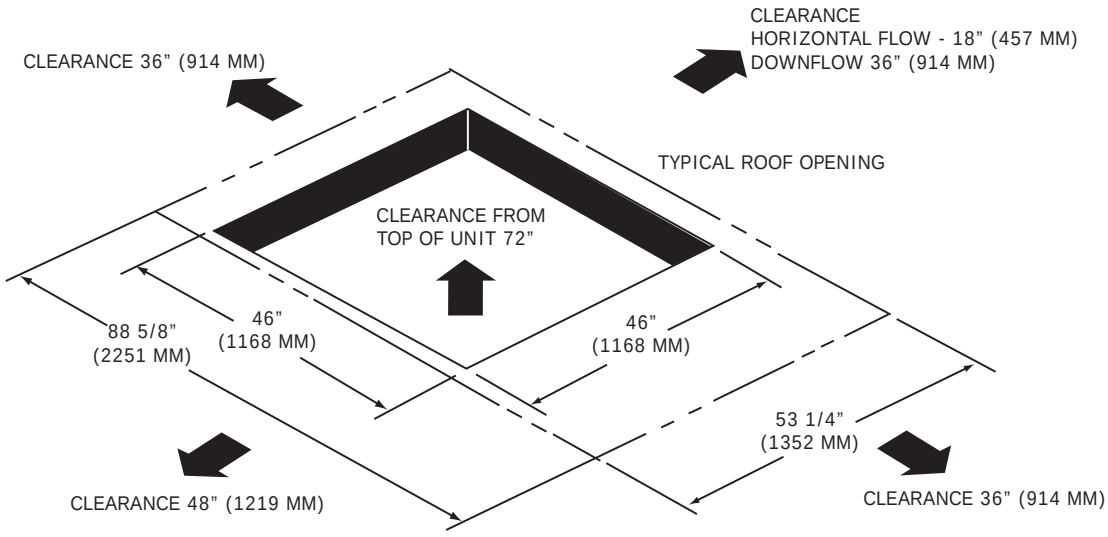
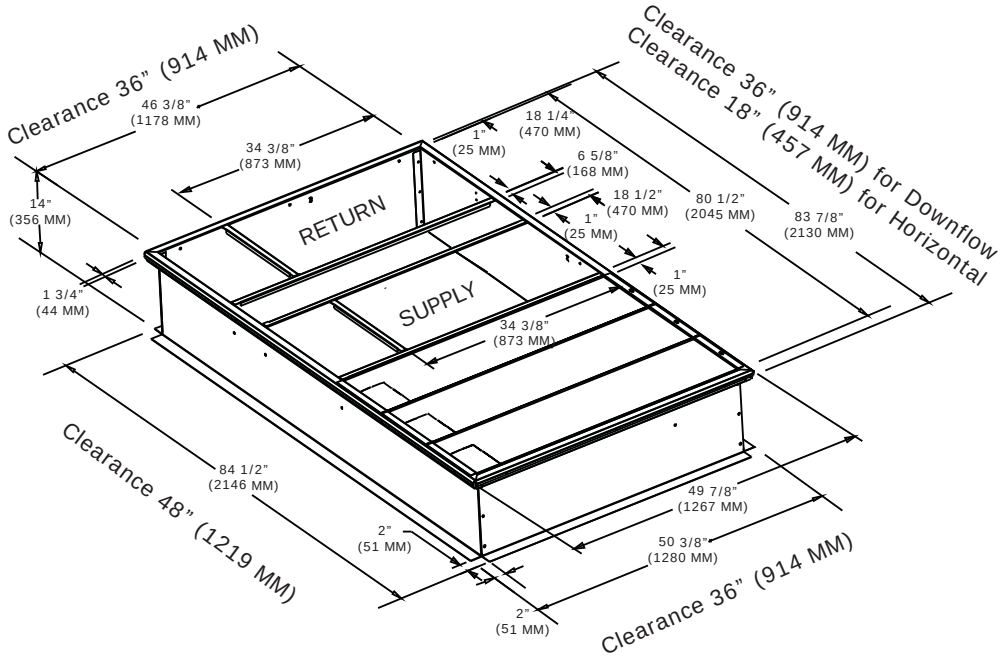
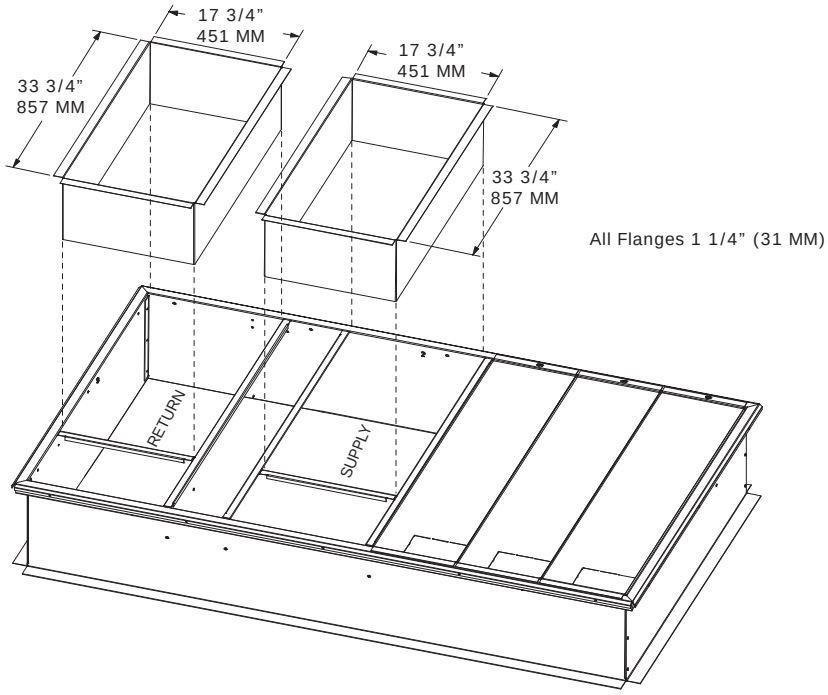


Figure 15. Cooling and gas/electric - 4 to 5 tons ultra high efficiency - roof curb[a]



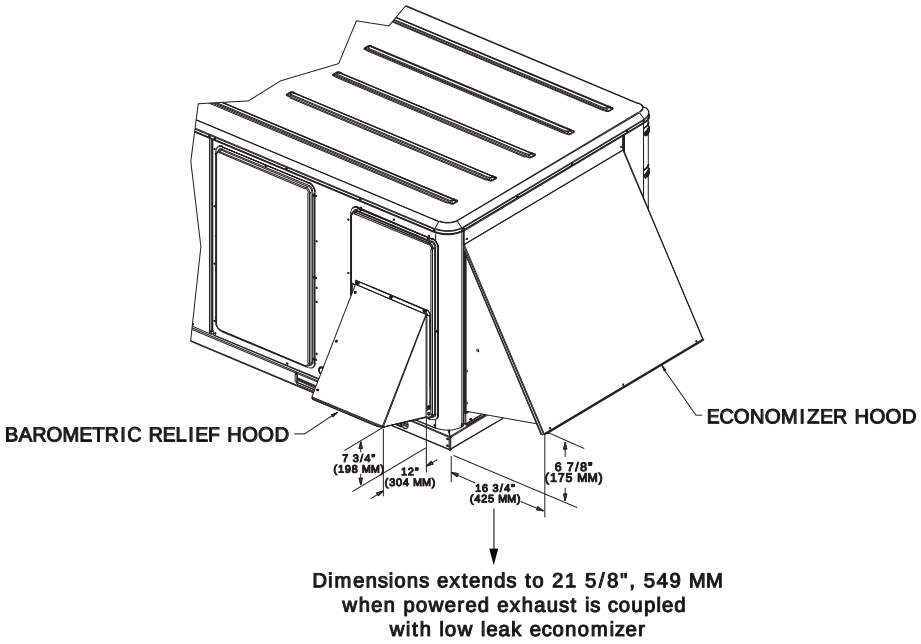
(a) All dimensions are in inches/millimeters.

Figure 16. Cooling and gas/electric - 4 to 5 tons ultra high efficiency- downflow duct connections field fabricated[a],[b]



(a) All dimensions are in inches/millimeters.
(b) See the clearance requirement table in the Application Consideration chapter for duct clearance to combustible materials.

Figure 17. Cooling and gas/electric - 4 to 5 tons ultra high efficiency - economizer, manual or motorized fresh air damper[(a)]



(a) All dimensions are in inches/millimeters.

Figure 18. Cooling and gas/electric - 4 to 5 tons ultra high efficiency- swing diameter for hinged door(s) option

Note: All dimensions are in inches/millimeters.

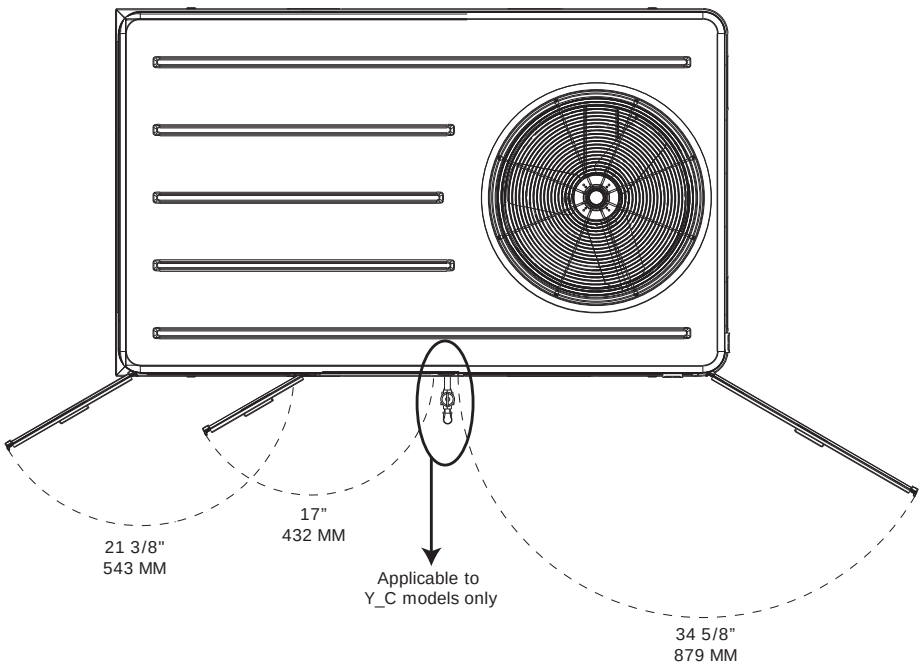


Figure 19. Cooling and gas/electric - 6 to 8.5 tons ultra high efficiency

Note: All dimensions are in inches/millimeters.

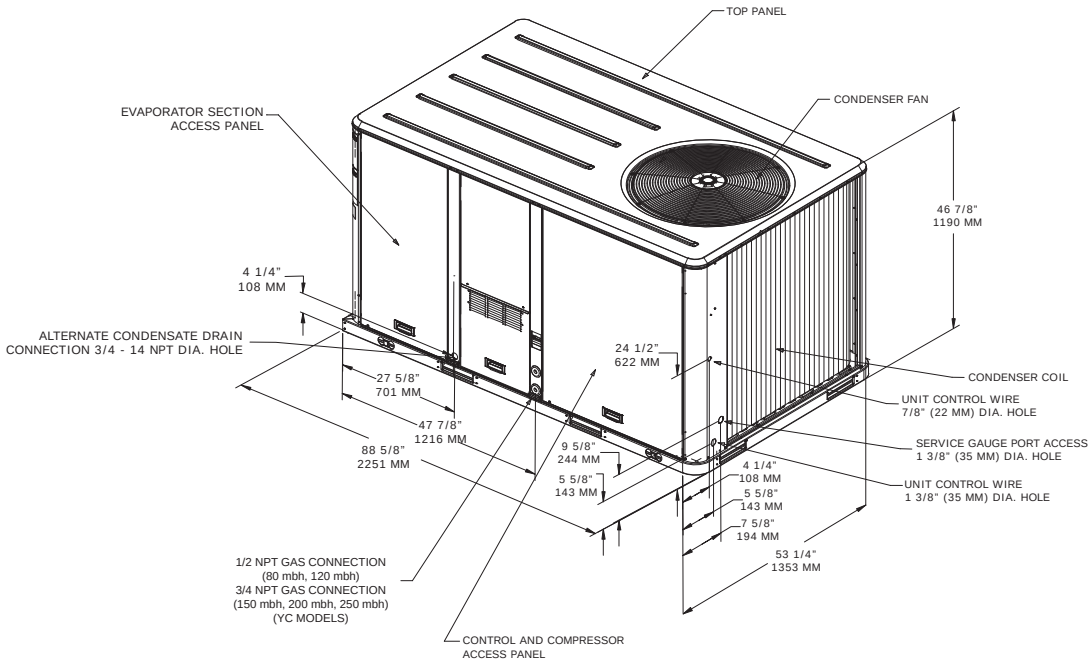


Figure 20. Cooling and gas/electric - 6 to 8.5 tons ultra high efficiency - downflow supply/return through-the-base utilities

Note: All dimensions are in inches/millimeters.

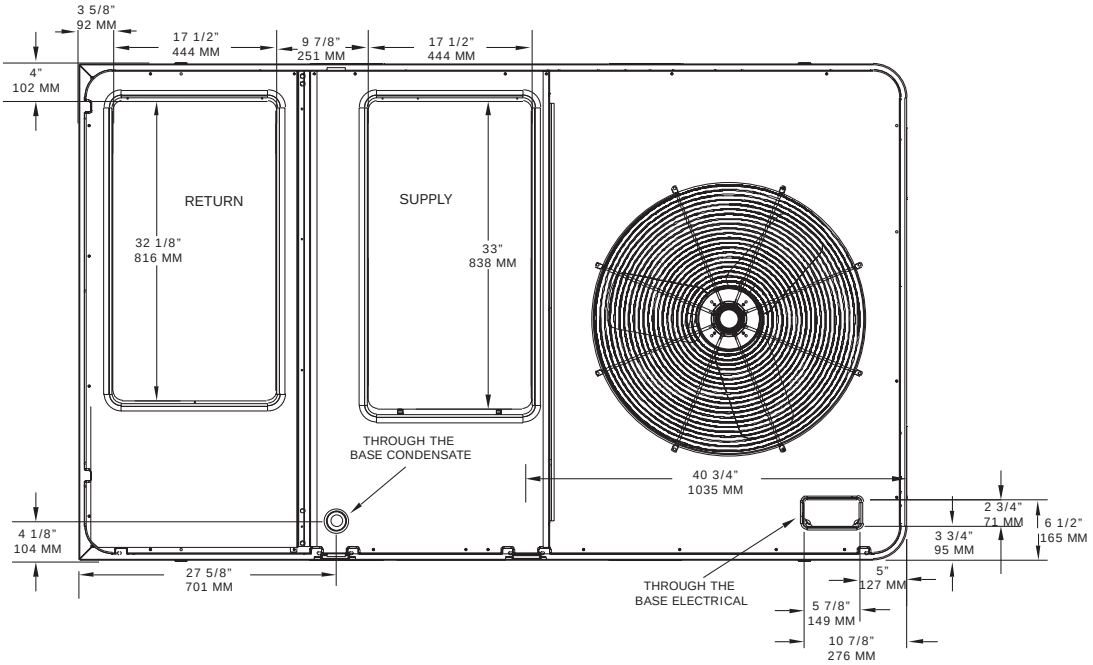


Figure 21. Cooling and gas/electric - 6 to 10 tons ultra high efficiency - horizontal airflow supply and return

Note: All dimensions are in inches/millimeters.

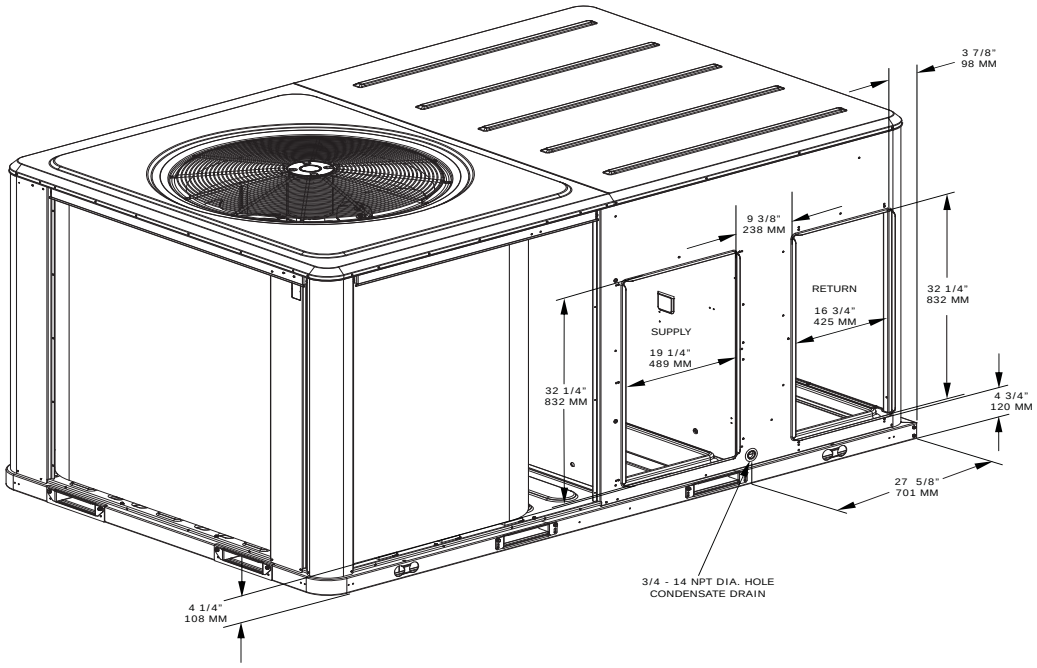


Figure 22. Cooling and gas/electric - 6 to 8.5 tons ultra high efficiency - unit clearance and roof opening

Note: All dimensions are in inches/millimeters.

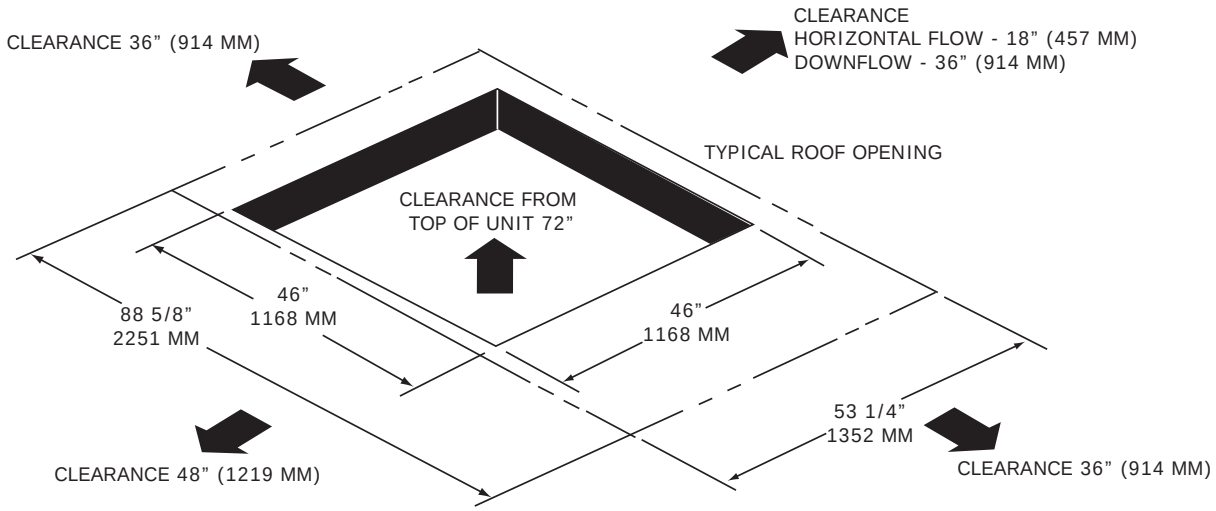


Figure 23. Cooling and gas/electric - 6 to 8.5 tons ultra high efficiency - roof curb

Note: All dimensions are in inches/millimeters.

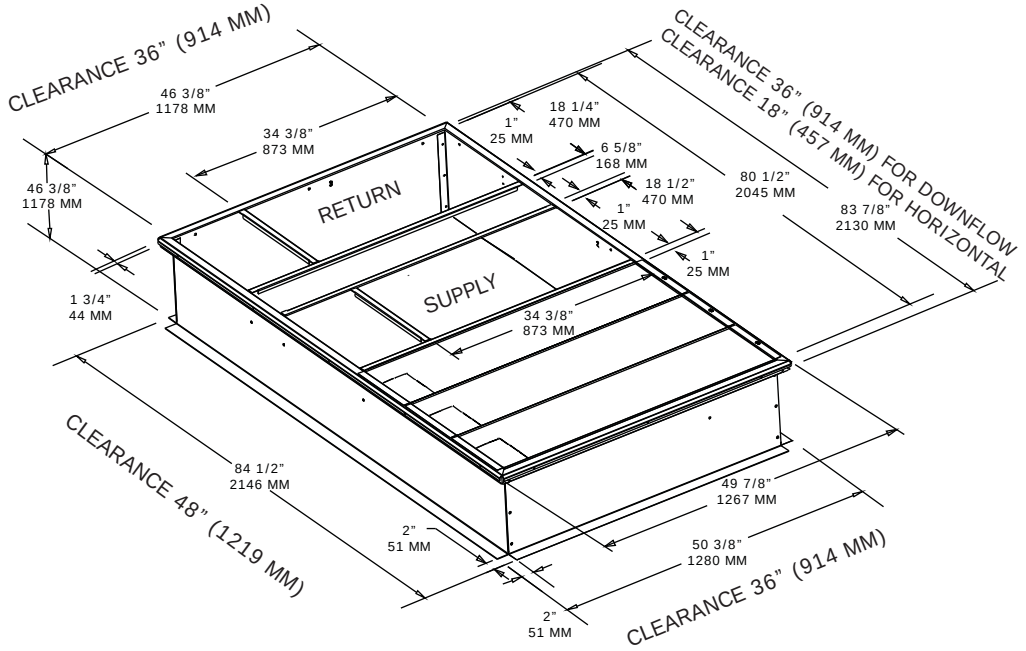


Figure 24. Cooling and gas/electric - 6 to 10 tons ultra high efficiency - duct connections field fabricated

Note: All dimensions are in inches/millimeters.

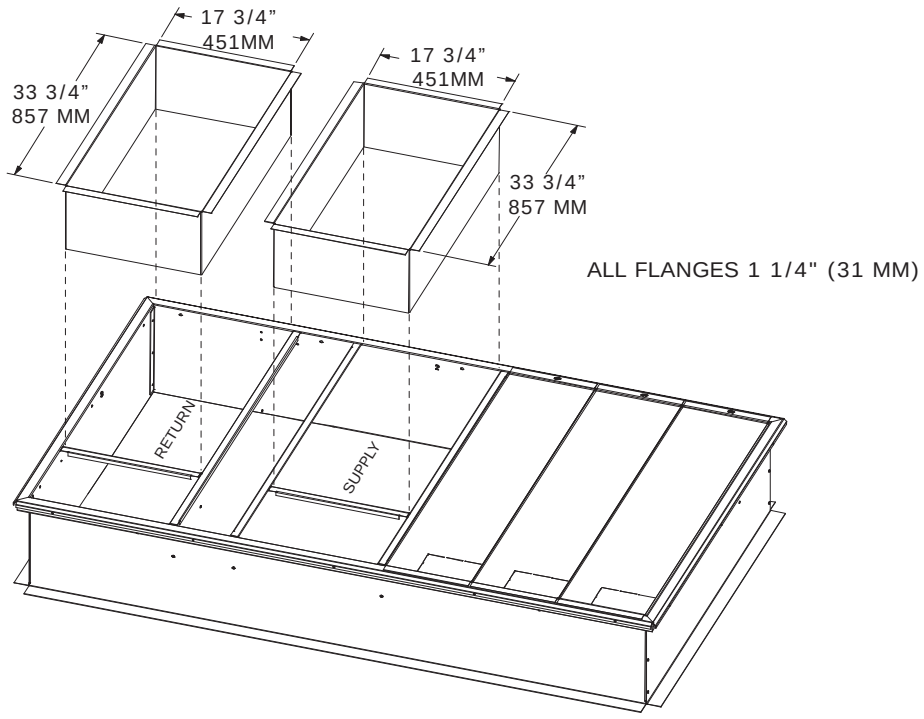


Figure 25. Cooling and gas/electric - 6 to 8.5 tons ultra high efficiency - power exhaust

Note: All dimensions are in inches/millimeters.

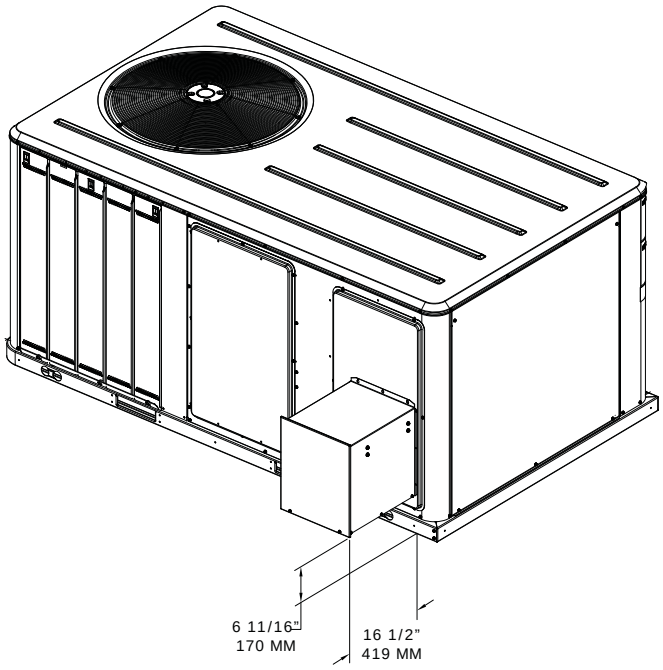


Figure 26. Cooling and gas/electric - 6 to 8.5 tons ultra high efficiency - swing diameter for hinged door(s) option

Note: All dimensions are in inches/millimeters.

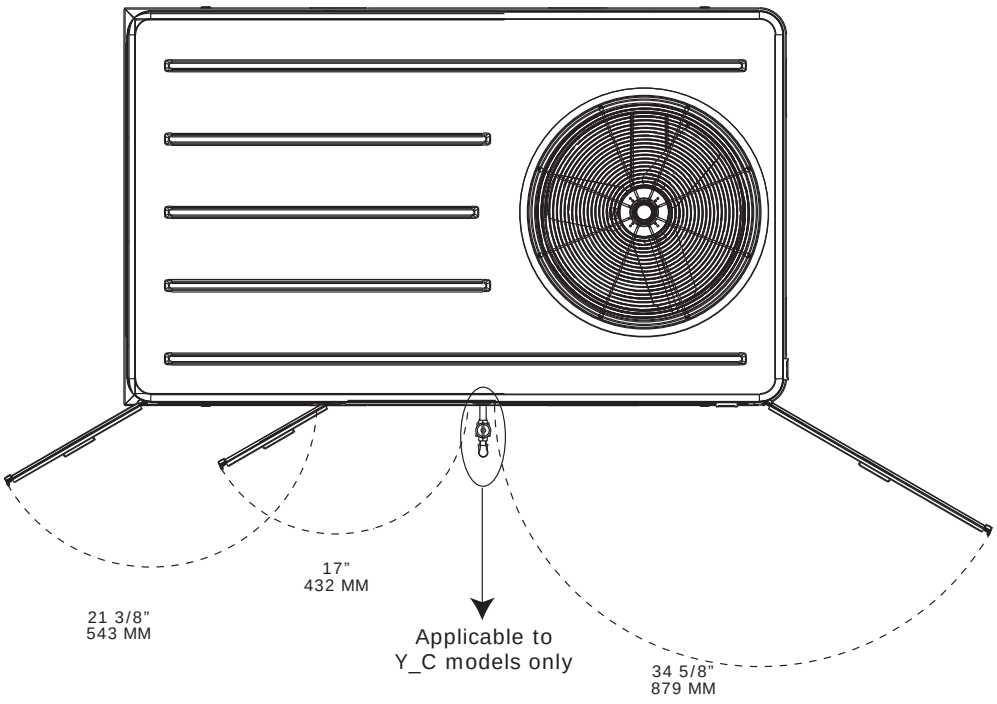


Figure 27. Cooling and gas/electric - 6 to 10 tons ultra high efficiency - economizer, manual or motorized fresh air damper

Note: All dimensions are in inches/millimeters.

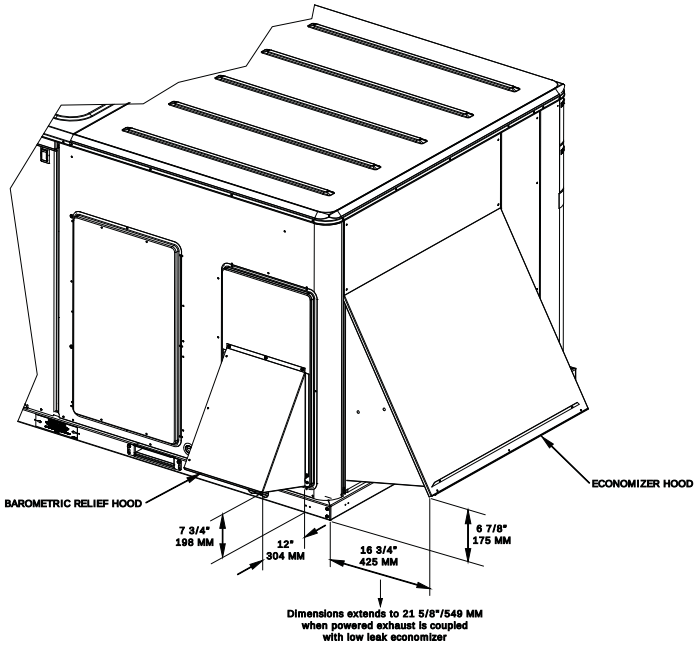
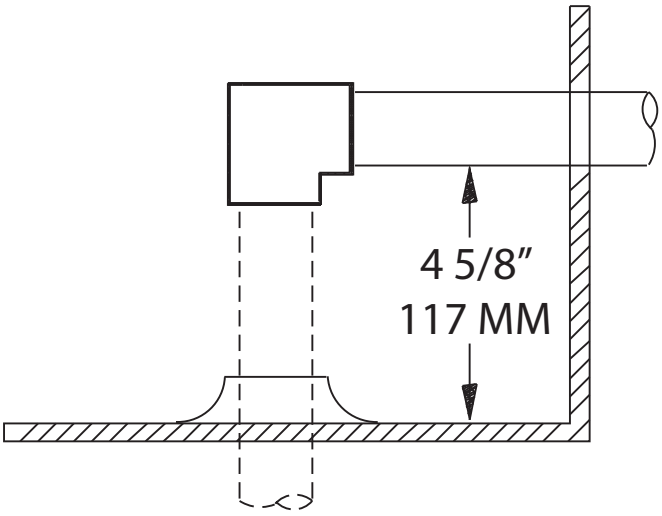


Figure 28. Gas/electric - 6 to 10 tons ultra high efficiency - height of gas pipe required from inside of base of unit to gas shut-off assembly (factory provided) YZC models only

Note: All dimensions are in inches/millimeters.



Dimensional Data

Figure 29. Cooling and gas/electric - 10 tons ultra high efficiency

Note: All dimensions are in inches/millimeters.

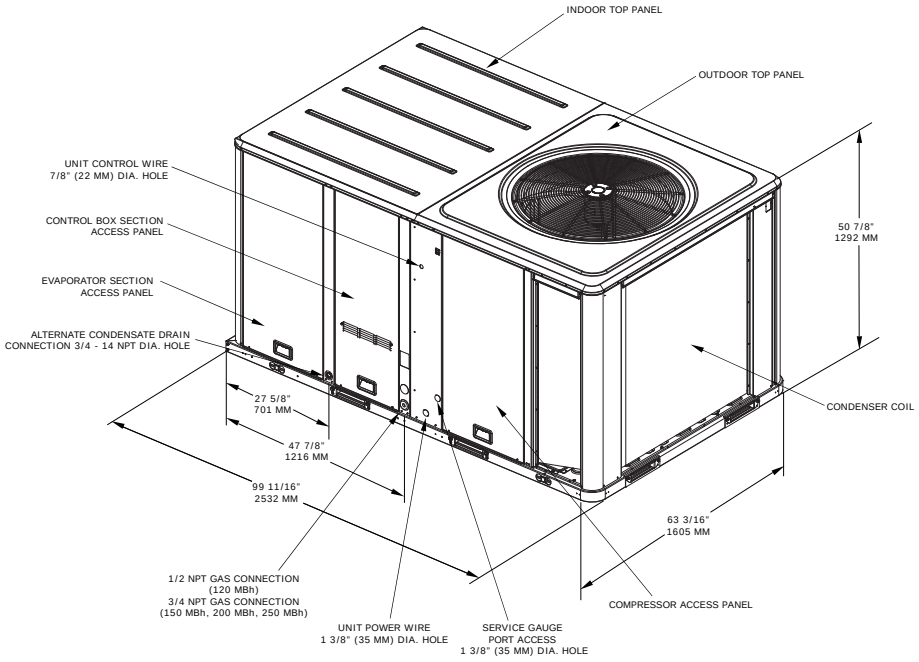


Figure 30. Cooling and gas/electric - 10 tons ultra high efficiency - downflow airflow supply/return, through-the-base utilities

Note: All dimensions are in inches/millimeters.

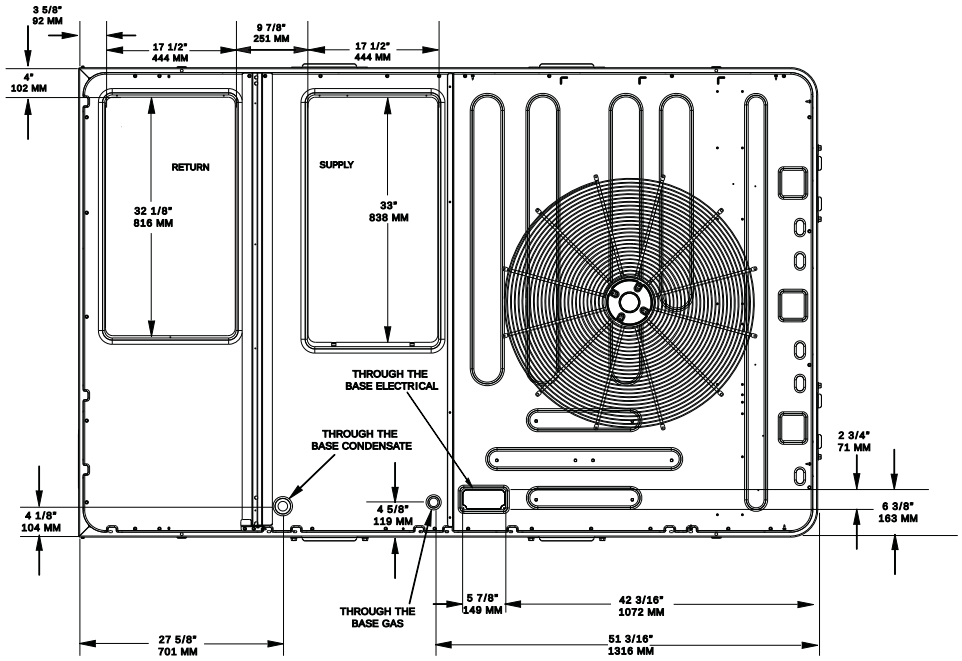


Figure 31. Cooling and gas/electric - 10 tons ultra high efficiency - unit clearance and roof opening

Note: All dimensions are in inches/millimeters.

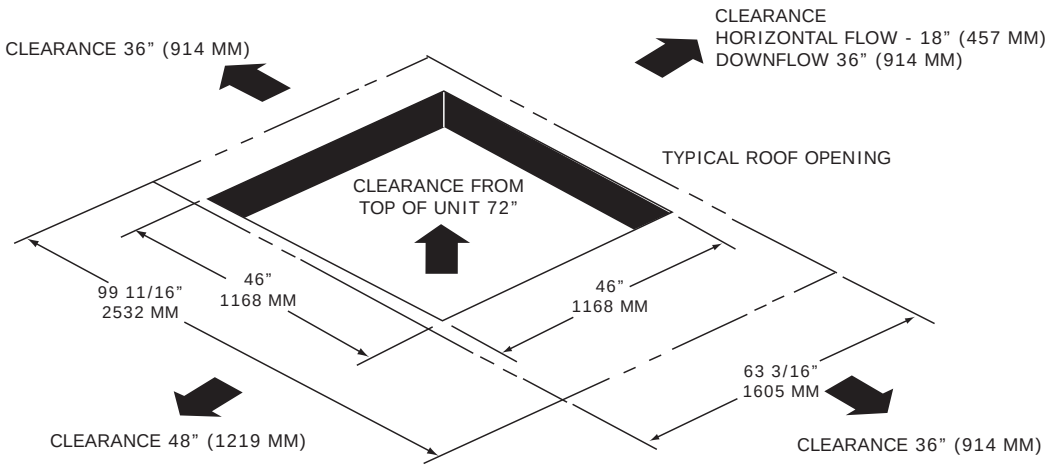


Figure 32. Cooling and gas/electric - 10 tons ultra high efficiency - roof curb

Note: All dimensions are in inches/millimeters.

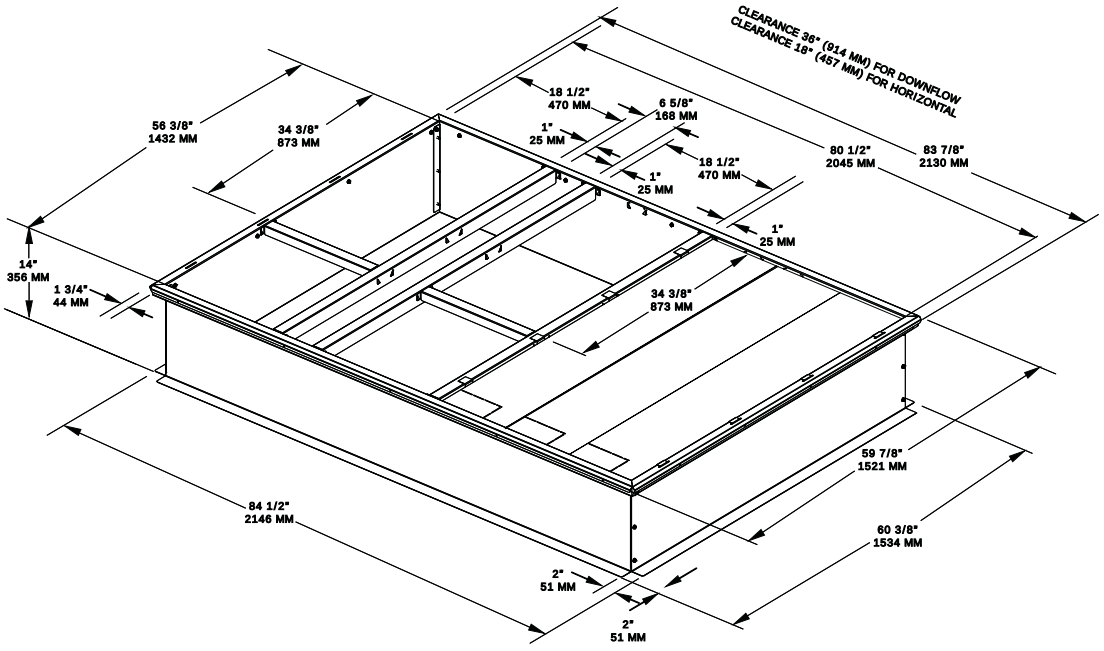


Figure 33. Cooling and gas/electric - 10 tons ultra high efficiency - power exhaust

Note: All dimensions are in inches/millimeters.

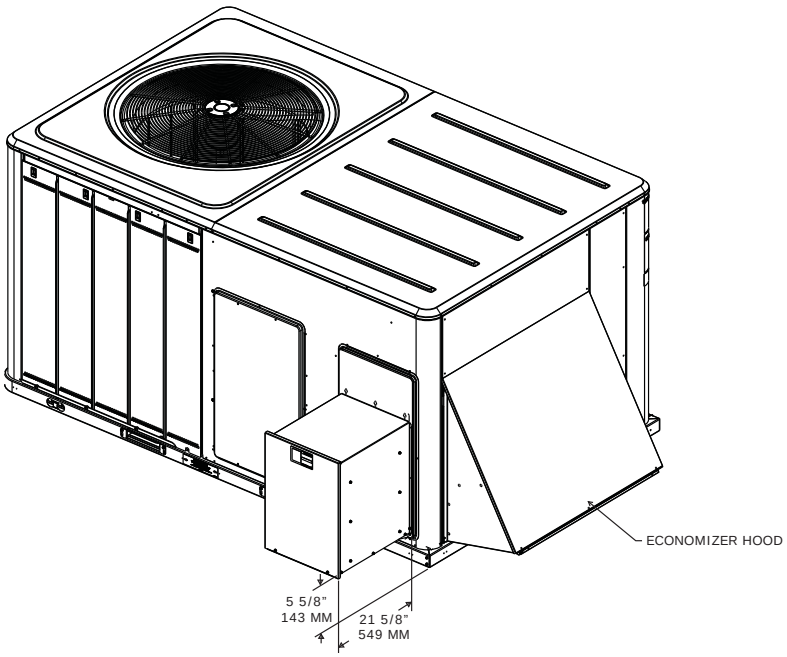
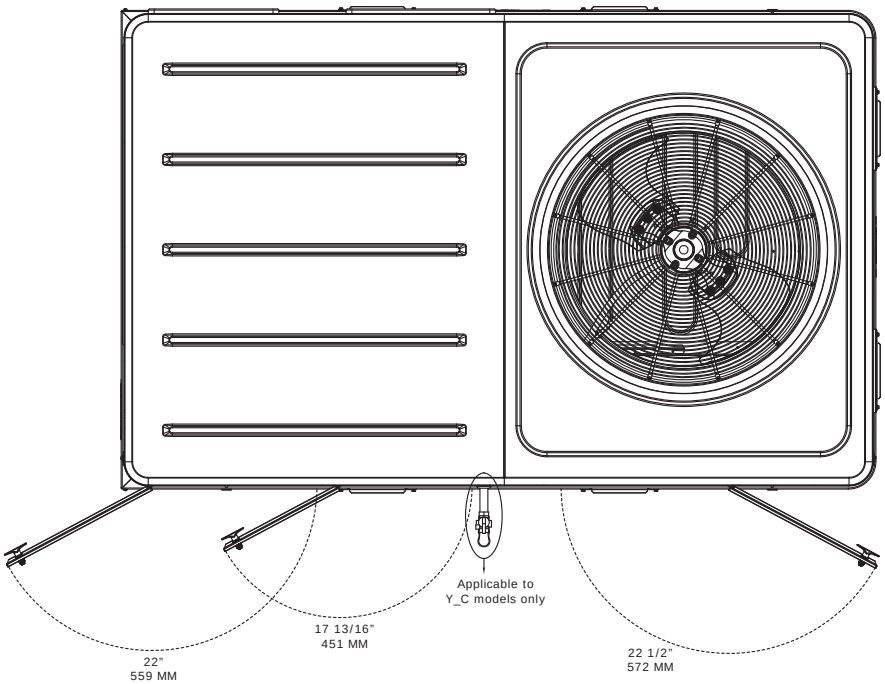


Figure 34. Cooling and gas/electric - 10 tons ultra high efficiency - swing diameter for hinged door(s) option

Note: All dimensions are in inches/millimeters.



Weights

Table 62. Maximum base unit and corner weights (lbs) and center of gravity dimensions (in.) - cooling models

Tons	Unit Model No.	Maximum Base Model Weights[a]		Corner Weights[b]				Center of Gravity (in.)	
		Shipping	Net	A	B	C	D	Length	Width
3	TZC036E	628	553	133	183	61	176	32	18
4	TZC048F	777	682	176	238	112	156	39	22
5	TZC060E	873	778	181	274	102	221	39	22
6	TZC072F	893	795	300	165	242	88	65	22
7.5	TZC090F	908	810	223	186	235	166	52	26
8.5	TZC102F	908	810	223	186	235	166	52	26
10	TZC120F	1302	1108	316	299	275	218	56	28

(a) Weight are approximate for 1st 10 digit model number.
(b) Corner weights are given for information only.

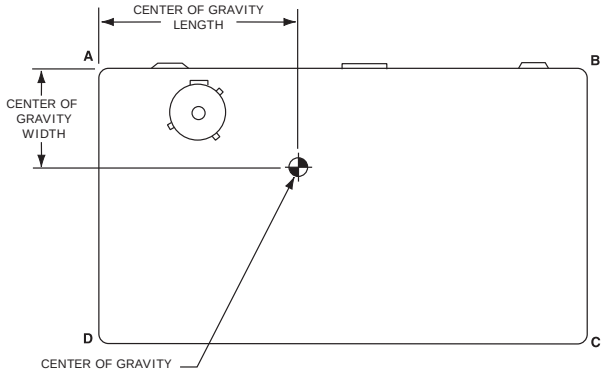


Table 63. Maximum base unit and corner weights (lbs) and center of gravity dimensions (in.) - gas/electric models

Tons	Unit Model No.	Maximum Base Model Weights[a]		Corner Weights[b]				Center of Gravity (in.)	
		Shipping	Net	A	B	C	D	Length	Width
3	YZC036E	690	615	154	196	73	192	33	19
4	YZC048F	848	753	196	258	126	173	40	23
5	YZC060E	949	854	200	293	121	240	40	23
6	YZC072F	966	868	321	184	262	101	64	22
7.5	YZC090F	1007	909	248	210	261	190	51	26
8.5	YZC102F	1007	909	248	210	261	190	51	26
10	YZC120F	1428	1234	346	344	306	238	56	28

(a) Weight are approximate for 1st 10 digit model number.
(b) Corner weights are given for information only.

Weights

Table 64. Factory installed options (fiops)/accessory net weights (lbs)[a],[b]

Accessory	T/YZC036E Net Weight 3 Tons	T/YZC048F-060E Net Weight 4 to 5 Tons	T/YZC072F Net Weight 6 Tons	T/YZC090-102F Net Weight 7.5 to 8.5 Tons	T/YZC120F Net Weight 10 Tons
Barometric Relief	7	10	10	10	10
Coil Guards	12	20	20	20	30
Economizer	26	36	36	36	36
Electric Heaters[c]	15	30	30	44	50
Hinged Doors	10	12	12	12	12
Low Leak Economizer	68	93	93	93	93
Powered Convenience Outlet[d]	38	38	38	38	50
Powered Exhaust	40	40	80	80	80
Roof Curb	61	78	78	78	89
Smoke Detector, Supply	5	5	5	5	5
Smoke Detector, Return	7	7	7	7	7
Stainless Steel Heat Exchanger[e]	4	6	6	6	6
Through-the-Base Electrical	8	13	13	13	13
Through-the-Base Gas	5	5	5	5	5
Unit Mounted Circuit Breaker	5	5	5	5	5
Unit Mounted Disconnect	5	5	5	5	5

(a) Weights for options not listed are <5 lbs.
(b) Net weight should be added to unit weight when ordering factory-installed accessories.
(c) Applicable to cooling units only.
(d) Applicable for 208-230V 3-10 Ton units and 460V 6-10 Ton units only.
(e) Applicable to gas/electric units only.

Mechanical Specifications

General

The units shall be convertible airflow. The operating range shall be between 120°F and 0°F in cooling as standard from the factory. Cooling performance shall be rated in accordance with AHRI testing procedures. All units shall be factory assembled, internally wired, fully charged with R-410A, and 100 percent run tested to check cooling operation, fan and blower rotation, and control sequence before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be cULus listed and labeled, classified in accordance for Central Cooling Air Conditioners.

Casing

Unit casing shall be constructed of zinc coated, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 672 hours in a salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all maintenance on one side of the unit. Service panels shall have lifting handles and be removed and reinstalled by removing two fasteners while providing a water and air tight seal. All exposed vertical panels and top covers in the indoor air section shall be insulated with a cleanable foil-faced, fire-retardant permanent, odorless glass fiber material. The base of the unit shall be insulated with 1/8 inch, foil-faced, closed-cell insulation. All insulation edges shall be either captured or sealed. The unit's base pan shall have no penetrations within the perimeter of the curb other than the raised 1 1/8 inch high downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The base of the unit shall have provisions for forklift and crane lifting, with forklift capabilities on three sides of the unit.

Compressors

The eFlex™ variable speed compressor shall be capable of speed modulation from 15Hz to a maximum of 60 Hz. The minimum unit capacity shall be 25% of full load or less. The compressor motor shall be a permanent magnet type. Each variable speed compressor shall be matched with a specially designed, refrigerant-cooled, variable frequency drive which modulates the speed of the compressor motor and provides several compressor protection functions. Control of the variable speed compressor and inverter control, as well as tandem direct-drive, scroll type compressors, shall be integrated with the ReliaTel™ unit controller to ensure optimal equipment reliability and efficiency. Each compressor shall have a crankcase heater installed, properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

Variable speed compressors are outstanding for humidity control and light load cooling conditions.

Controls

Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Unit shall provide an external location for mounting a fused disconnect device.

Microprocessor controls provide for all 24V control functions. The resident control algorithms shall make all heating, cooling, and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, minimizes drift from set point, and provides better building comfort. A centralized microprocessor shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection.

Enhanced Dehumidification

Enhanced dehumidification will be available on all units equipped with a space humidity sensor. Humidity levels are decreased while increasing the comfort level in an air space through advanced controls of compressor and indoor fan operation.

Evaporator and Condenser Coils

Internally finned, 5/16" copper tubes are mechanically bonded to a configured aluminum plate fin. The microchannel type condenser coil uses flat streamlined tubes with small ports, and metallurgical tube-to-fin bond. This allows the microchannel coil better heat transfer performance. Microchannel condenser coil can reduce system refrigerant charge by up to 50% because of smaller internal volume, which leads to better compressor reliability. Compact all-aluminum microchannel coils also help to reduce the unit weight. These all aluminum coils are recyclable. Galvanic corrosion is also minimized due to all aluminum construction. Strong aluminum brazed structure provides better fin protection. In addition, flat streamlined tubes also make microchannel coils more dust resistant and easier to clean. Coils shall be leak tested at the factory to ensure the pressure integrity. The evaporator coil and condenser coil shall be leak tested to 600 psig. The assembled unit shall be leak tested to 465 psig. The plate fin condenser coil shall have a patent pending 1+1+1 hybrid coil designed with slight gaps for ease of cleaning. A plastic, dual-sloped, removable and reversible condensate drain pan with through-the-base condensate drain is standard.

Filters

Throwaway filters shall be standard on all units. Optional 2-inch MERV 8 and MERV 13 filters shall also be available.

Frostat™

This option is to be utilized as a safety device. The Frostat™ opens when temperatures on the evaporator coil fall below 10°F. The temperature will need to rise to 50°F before closing. This feature should be utilized in low airflow or high outside air applications (cooling only).

Gas Heating Section

The heating section hasa progressive tubular heat exchanger design using corrosion resistant steel throughout. An induced draft combustion blower pulls the combustion products through the firing tubes. The heater uses a direct spark ignition (DSI) system. On initial call for heat, the combustion blower will purge the heat exchanger for 20 seconds before ignition. After three unsuccessful ignition attempts, the entire heating system will be locked out until manually reset at the thermostat/zone sensor.

(3 to 5 tons only) For installation in SCAQMD only: This furnace does not meet the SCAQMD Rule 1111 14 ng/J NOx emission limit, and thus is subject to a mitigation fee of up to $450. This furnace is not eligible for the Clean Air Furnace Rebate Program: www.cleanairfurnacerebate.com

High Pressure Control

All units include high pressure cutout as standard.

Indoor Fan

All units have variable speed, direct drive motors. All motors shall be thermally protected. All indoor fan motors meet the U.S. Energy Policy Act of 1992 (EPACT).

Outdoor Fans

The outdoor fan shall be direct-drive, statically balanced, draw-through in the vertical discharge position. The fan motor shall be permanently lubricated and shall have built-in thermal overload protection.

Phase Monitoring Protection

Precedent™ units with 3-phase power are equipped with phase monitoring protection as standard. These devices protect motors and compressors against problems caused by phase loss, phase imbalance and phase reversal indication.

Refrigerant Circuits

Each refrigerant circuit offer thermal expansion valve as standard. Service pressure ports, and refrigerant line filter driers are factory-installed as standard. An area shall be provided for replacement suction line driers.

Unit Top

The top cover shall be one piece construction or where seams exist, it shall be outside the indoor air-conditioned section. The ribbed top adds extra strength and prevents water from pooling on unit top.

Factory Installed Options

Black Epoxy Pre-Coated Coils

The black epoxy coils have a thermoset vinyl coating that is bonded to the aluminum fin stock prior to the fin-stamping process. The pre-coated coils are an economical option for protection in mildly corrosive environments.

CO_2 Sensor Wiring

The unit wiring for field installed $C0_2$ sensors. Factory-installed $C0_2$ sensor wiring saves time and ensures proper unit connections for the field installed $C0_2$ sensor kits.

Condensate Overflow Switch

This option shall shut the unit down in the event that a clogged condensate drain line prevents proper condensate removal from the unit.

CompleteCoat™ Coils

The cathodic epoxy type electrodisposition coating is formulated for high edge build to plate fin and tube heat exchangers. The coating is selected to provide excellent resistance and durability to corrosive effects of alkalies, acids, alcohols, petroleum, seawater, salt air and corrosive environments.

Fault Detection and Diagnostics (FDD)

This offering meets the mandatory requirement of CA Title 24 of fully configurable diagnostics allowing fault history and reading fault codes at the unit. This option provides detection of the following faults: Air temperature sensor failure/fault and notification of acceptable economizer mode. The FDD system shall be certified by the Energy Commission as meeting the requirements.

Heat Exchanger

The compact cabinet features a tubular heat exchanger in low, medium and high heat capacities.

The heat exchanger is fabricated using corrosion-resistant aluminized steel tubes and burners as standard on all models. It has an induced draft blower to pull the gas mixture through the burner tubes. The heater has a direct spark ignition system which doubles as a safety device to prove the flame.

Hinged Access Doors

Sheet metal hinges are available on the filter/evaporator, supply fan/heat, and the compressor/ control access doors.

Human Interface

The Human Interface shall have a 5-inch color touchscreen display that conforms to FCC Part 15 Class B with an Ingress Protection Rating of IP24. The display text shall be readable by a person with 20/20 vision at a distance of 3 feet and 60° angle at lighting levels ranging from 100 lux - 25,000 lux. Also, the display shall operate at temperatures of -40° C to 70° C. Firmware will be restored via a USB storage device.

Multiple-Zone VAV Control

Multiple-zone VAV (MZVAV) control shall vary the speed of the indoor fan to maintain the duct static pressure at a setpoint. In cooling mode, the compressors shall be cycled (or economizer modulated) to maintain the supply air temperature (SAT) at the desired setpoint. In heating mode, the indoor fan shall operate at maximum speed whenever the heater is operating.

Powered or Unpowered Convenience Outlet

This is a GFCI, 120V/15amp, 2 plug, convenience outlet, either powered or unpowered. When the convenience outlet is powered, a service receptacle disconnect will be available. The convenience outlet is powered from the line side of the disconnect or circuit breaker, and therefore will not be affected by the position of the disconnect or circuit breaker. This option can only be ordered when the through-the-base electrical with either the disconnect switch or circuit breaker option is ordered.

Single Zone Variable Air Volume

Single zone VAV control offers full supply fan modulation across the available airflow range based on zone conditions. In addition to full supply fan modulation, the unit controls the discharge air temperature to a varying discharge air temperature setpoint in order to maintain space temperature.

Stainless Steel Drain Pan

This option provides excellent corrosion and oxidation resistance. The drain pan is reversible and constructed of 304 stainless steel.

Stainless Steel Heat Exchanger

The optional stainless steel heat exchanger is constructed of 409 stainless steel tubes and 439 stainless steel burners. It is resistant to corrosion and oxidation and easy to clean.

The high strength to weight ratio allows for high ventilation rates with gas units. It is an excellent option to compliment the dehumidification option as a high outside air ventilation unit.

With this option, a 10-year stainless steel heat exchanger warranty is standard.

Supply, Return, and Plenum Air Smoke Detector

With this option installed, if smoke is detected, all unit operation will be shut down. Reset will be manual at the unit. In order for the supply air smoke detector or return air smoke detector to properly sense smoke in the supply air stream or the return air stream, the air velocity entering the smoke detector unit must be between 500 - 4000 feet per minute. Equipment covered in this manual will develop an airflow velocity that falls within these limits over the entire airflow range specified in the evaporator fan performance table. Supply and/or return smoke detectors may not be used with the plenum smoke detector.

Thermal Expansion Valve

Thermal expansion valve is standard for all models.

Through-the-Base Electrical Access

An electrical service entrance shall be provided allowing electrical access for both control and main power connections inside the curb and through the base of the unit. Option will allow for field installation of liquid-tight conduit and an external field-installed disconnect switch.

Through-the-Base Electrical with Circuit Breaker

This option is a thermal magnetic, molded case, HACR Circuit Breaker with provisions for through the base electrical connections. The circuit breaker will be installed in a water tight enclosure in the unit with access through a swinging door. Wiring will be provided from the switch to the unit high voltage terminal block. The circuit breaker will provide overcurrent protection, be sized per NEC and cULus guidelines, and be agency recognized by cULus.

Through-the-Base Electrical with Disconnect Switch

This 3-pole, molded case, disconnect switch with provisions for through the base electrical connections are available. The disconnect switch will be installed in the unit in a water tight enclosure with access through a swinging door. Wiring will be provided from the switch to the unit high voltage terminal block. The switch will be cULus agency recognized.

Note: *The disconnect switch will be sized per NEC and cULus guidelines but will not be used in place of unit overcurrent protection.*

Through-the-Base Gas Piping

The unit shall include a standard through the base gas provision. This option shall have all piping necessary including, black steel, manual gas shut-off valve, elbows, and union. The manual shut-off valve shall include a 1/8" NPT pressure tap. This assembly will require minor field labor to install (gas/electric only).

Trane® Air-Fi™ Wireless

Trane® Air-Fi™ wireless communication shall be factory installed and pre-wired. Air-Fi must also be Zigbee® Building Automation certified and the system communicates using standard BACnet® open protocol.

Two-Inch Filters

Two-inch MERV 8 and MERV 13 media filters shall be available on all models.

Factory or Field Installed Options

Clogged Filter/Fan Failure Switch

A dedicated differential pressure switch is available to achieve active fan failure indication and/or clogged filter indication. These indications will be registered with either a zone sensor with status indication lights or an Integrated Comfort™ System. This option is available for microprocessor controlled units.

Differential Pressure Switches

These sensors allow individual fan failure and dirty filter indication for microprocessor controlled units. The fan failure switch will disable all unit functions and "flash" the Service LED on the zone sensor. The dirty filter switch will light the Service LED on the zone sensor and will allow continued unit operation.

Economizer (Standard)

This accessory shall be available with or without barometric relief. The assembly includes fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness with plug, spring return actuator and fixed dry bulb control. The barometric relief shall provide a pressure operated damper that shall be gravity closing and shall prohibit entrance of outside air during the equipment "off" cycle. Optional solid state or differential enthalpy control shall be available for either factory or field installation. The economizer arrives in the shipping position and shall be moved to the operating position by the installing contractor.

Electric Heaters

Electric heat modules shall be available for installation within basic unit. Electric heater elements shall be constructed of heavy-duty nickel chromium elements internally delta connected for 240V, wye connected for 480V and 600 V. Staging shall be achieved through ReliaTel™. Each heater package shall have automatically reset high limit control operating through heating element contactors. All heaters shall be individually fused from the factory, where required, and shall meet all NEC and CEC requirements when properly installed. Power assemblies shall provide single-point connection. Electric heat modules shall be cULus listed.

LonTalk® Communication Interface

This option shall be provided to allow the unit to communicate as a Tracer® LCI-R device or directly with generic LonTalk® Network Building Automation System Controls.

Low Leak Economizer

This accessory meets low leak requirements for ASHRAE 90.1, IECC, and CA Title 24 standards (3 cfm/ft^2@1" wg exterior air, 4 cfm/ft^2@1" wg return air). This option allows 100% outdoor air supply from 0-100% modulating dampers and is standard with barometric relief. It can be paired with powered exhaust for additional building pressure relief. This option can be paired with or without Fault Detection and Diagnostics (FDD) to meet current mandatory CA Title 24 requirements. Available on downflow units only.

BACnet® Communication Interface

This option shall be provided to allow the unit to communicate directly with a generic open protocol BACnet® MS/TP Network Building Automation System Controls.

Reference or Comparative Enthalpy

Reference enthalpy is used to measure and communicate outdoor humidity. The unit receives and uses this information to provide improved comfort cooling while using the economizer. comparative enthalpy measures and communicates humidity for both outdoor and return air conditions, and return air temperature. The unit receives and uses this information to maximize use of economizer cooling, and to provide maximum occupant comfort control. Reference or comparative enthalpy option shall be available when a factory or field installed downflow economizer is ordered. This option is available on all downflow models.

Hail Guards

Hail protection quality coil guards are available for condenser coil protection.

Field Installed Options

CO_2 Sensor

The CO_2 sensor shall have the ability to monitor the concentration (parts per million, ppm) of CO_2 (Carbon Dioxide) in the air. As the CO_2 concentration changes, the outside air damper modulates to meet the current ventilation needs of the zone.

Two field installed kits are offered; CO_2 sensor and wiring or CO_2 sensor only. The CO_2 sensor only kit should be ordered with factory installed CO_2 sensor wiring. Factory installed CO_2 sensor wiring saves set-up time and ensures proper unit connections for the CO_2 sensor.

Low Leak Economizer

This accessory meets low leak requirements for ASHRAE 90.1, IECC, and CA Title 24 standards (3 cfm/ft^2@1" wg exterior air, 4 cfm/ft^2@1" wg return air). This option allows 100% outdoor air supply from 0-100% modulating dampers and is standard with barometric relief. It can be paired with powered exhaust for additional building pressure relief. Available on downflow units only.

Powered Exhaust

The powered exhaust, available for 3 to 5 ton units, shall provide exhaust of return air, when using an economizer, to maintain better building pressurization.

Programmable Night Setback

Auto or manual changeover with seven-day programming. Keyboard selection of heat, cool, fan, auto, or on. All programmable sensors have system on, heat, cool, service LED/indicators as standard. Night setback sensors have one (1) occupied, one (1) un-occupied, and one (1) override program per day.

Remote Potentiometer

The minimum position setting of the economizer shall be adjusted with this accessory.

Roof Curb

The roof curb shall be designed to mate with the unit's downflow supply and return and provide support and a water tight installation when installed properly. The roof curb design shall allow field-fabricated rectangular supply/return ductwork to be connected directly to the curb. Curb shall be shipped knocked down for field assembly and shall include wood nailer strips.

Ventilation Override Accessory

With the ventilation override accessory installed, the unit can be set to transition up to 3 different pre-programmed sequences for smoke purge, pressurization, and exhaust. The transition occurs when a binary input on the RTOM is closed (shorted). This would typically be a hard wired relay output from a smoke detector or fire control panel. The ventilation override accessory shall be available as field installed.

Wireless Zone Sensor

LCD display that provides heat, cool, auto or off. Includes two temperature setpoints and a lockable setting with °F or °C indicators.

Zone Sensor

This control shall be provided to interface with the Micro equipped units and shall be available in either manual, automatic programmable with night setback, with system malfunction lights, or remote sensor options.

Ingersoll Rand (NYSE:IR) advances the quality of life by creating comfortable, sustainable and efficient environments. Our people and our family of brands—including Club Car®, Ingersoll Rand®, Thermo King® and Trane®—work together to enhance the quality and comfort of air in homes and buildings; transport and protect food and perishables; and increase industrial productivity and efficiency. We are a global business committed to a world of sustainable progress and enduring results.

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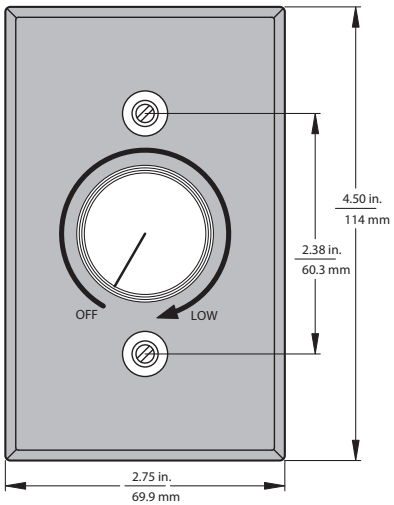
RT-PRC053F-EN 14 Jan 2019
Supersedes RT-PRC053E-EN (Jan 2017)

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TRIAC-120-5 SPEED CONTROL SUBMITTAL

CONTROL OF SINGLE OR MULTIPLE SHADED POLE/PSC MOTOR

MODEL	VOLTAGE	AMPS
TRIAC-120-5	120V	5



PROJECT	
ENGINEER	
ARCHITECT	
CONTRACTOR	
SUBMITTED BY	
DATE	
QUANTITY	

PART NUMBER & QUANTITY

☐ TRIAC-120-5 Qty. _____

Note: Expect the fan to hum at the lower to middle speed where the sine-wave chopping is most severe. Fan control works best when fully loaded

TRIAC SPEED CONTROL DESCRIPTION

Airius speed controls are used to vary the speed of shaded pole (SP) or permanent split capacitor (PSC) motors. Speed controls for EC motors: refer to the potentiometer submittal. Speed control for EL fans: refer to the FanCenter submittal.

ATTRIBUTES AND CHARACTERISTICS

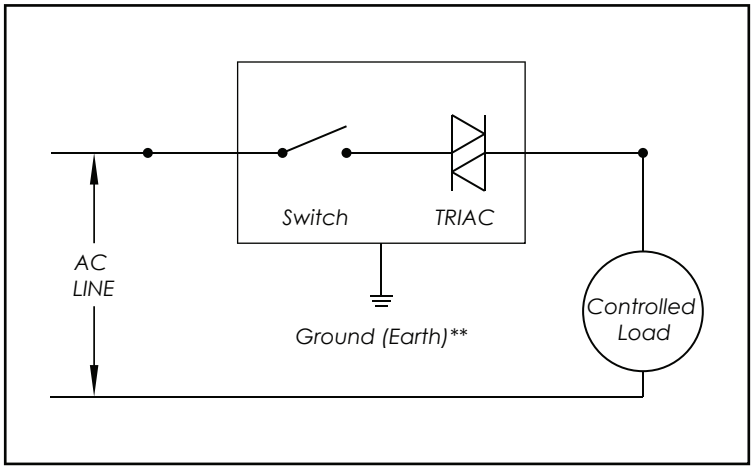
- *Built-in On/Off AC line switch*
- *Minimum speed trimpot*
- *RFI filter (provides RFI and EMI suppression)*
- *All models mount in a standard 2" x 4" electrical wall box*
- *Faceplate (4.5" x 2.75"), knob, screws and wire nuts included*
- *Simple installation by a qualified electrician*
- *Adjust top 50% RPM*
- *Can control multiple fans on a single dedicated circuit*

CODE APPROVAL

- *UL listing/recognition*
- *CSA certified*

WARRANTY

- *Warranty - 1 - years parts and workmanship*



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811 South Sherman Street, Longmont, Colorado 80501, Phone: 303.772.2633, Fax: 303.772.8276, info@airiusfans.com, www.airiusfans.com

May be covered by one or more of the following United States Patents: 7,381,129 B2; D514688 and other patents pending

Typical Data Needed for Preliminary/Feasibility Analysis (ROM)

1. Facility Information – needed to estimate costs

IDEALLY: plans or drawings showing actual fixtures (or total fixture counts)

MINIMUM: building list with names, age and square footage (and use if not obvious)

NICE (but not required): any pictures of fixtures or flushometers, make/model numbers or flow rates, comments about performance issues or other problems.

2. Water History – needed to estimate savings

IDEALLY: 2-3 years of individual bills showing volume and cost. This allows us to study both the rate structure and also make allowances for seasonal differences.
Note; broken out by building if the cost and savings is to be shown by building.

MINIMUM: we need annual spend (dollars) and volume (units)

NICE (but not required): Any information as to non-domestic consumption on the bills
Irrigation (metered separately or on main meter, areas irrigated)
Laundry (discuss opportunities, to be developed during detailed site visit)
Building Heat or Cooling Towers (provide tonnage data)
Swimming Pools
Any other (water cooled equipment, wash bays, etc.)
Other water comments (RO water, etc.)

3. Occupancy – needed to estimate savings

IDEALLY: The number of staff (full time and part time), visitors, and all other occupant types (patients, students, or inmates, whatever is appropriate) and hours of occupancy.
Note; broken out by building if the cost and savings is to be shown by building.

MINIMUM: for K12 schools we can typically get data from their web sites. All other market segments will need to at least have the total full time occupants of all combined buildings. We can estimate numbers of visitors for the ROM and verify during the audit.

NICE (but not required): Any detail on the visitors, contractors or other part time occupants such as number of days or number of hours per part time occupant.

NOTE: Due to our vast industry experience, we are able to work with whatever data you have available. The more detailed the data is, the higher level of confidence we can provide for the cost and savings represented on the ROM. Missing data can be identified and confirmed during this preliminary process – we will attempt to get all the facility data required during our site audit and will confirm the other data provided.

Confidential and Proprietary Information of HydraMetrics

VendingMiser®

ENERGY MANAGEMENT SYSTEM
For Refrigerated Vending Machines

Improve the profitability of your existing cold drink machines. Vending Miser® puts you on a cost-effective refresher course for energy savings and conservation.



VendingMiser cuts energy costs down to size

VendingMiser incorporates its innovative energy-saving technology into a small, plug-and-play powerhouse that installs in minutes either on the wall or on the vending machine. It's that easy.

With VendingMiser there's no need to have new machines to achieve maximum energy savings resulting in a reduction in operating costs and greenhouse gas emissions. When equipped with the VendingMiser, refrigerated beverage vending machines use less energy and are comparable in daily energy performance to new ENERGY STAR® qualified machines.

Power play

Compatible with all types of cold drink vending machines, the VendingMiser uses a Passive Infrared Sensor (PIR) to power down the machine when the area surrounding it is vacant. Then it monitors the room's temperature and automatically re-powers the cooling system at one- to three-hour intervals, independent of sales, to ensure that the product stays cold.

This Miser runs the bank

For a series of up to four machines, VendingMiser can use its embedded Sensor Repeater, which allows it to be controlled from the PIR sensor of any other Miser in the bank.

Refresher course

VendingMiser's microcontroller will never power down the machine while the compressor is running, eliminating compressor short-cycling. In addition, when the machine is powered up, the cooling cycle is allowed to finish before again powering down. This reduces the wear and tear on your machines, extending the lifespan and prolonging your profitability. Maintenance savings is generated through reduced running time of vendor components – estimated at $40 - $80 per year, per machine. The VendingMiser has been tested and accepted for use by major bottlers.

VendingMiser reduces energy consumption an average of 46%—typically $150 per machine.

Vending Miser offers...

- A quick, inexpensive solution to energy savings and conservation
- Longer machine lifespan
- Early return on investment
- Environmental benefits

VendingMiser can also control other cooled product vending machines, such as refrigerated candy machines.

VendingMiser Technical Specifications

Electrical Specifications
Input Voltage: 115 Volts
Input Frequency: 50/60 Hz
Maximum Load: 12 Amps (Steady-State)
Power Consumption: Less than 1 Watt (Standby)

Environmental Specifications
Operating Temp: -15°C to 75°C
Storage Temp: -40°C to 85°C
Relative Humidity: 95% Maximum (Non-Condensing)

Compatibility
Vending Machines: Any machine, except those containing perishable goods such as dairy products

Inactivity Timeouts
Occupancy Timeout: 15 minutes
Auto Re-power: One to three hours, dynamically adjusted, based on ambient temperature

Dimensions
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2.2 lbs. (includes power cable)

Regulatory Approvals
Safety: UL/C-UL Listed
Information Technology Equipment (ITE) 9T79

Other energy-saving products offered by USA Technologies include VM2IQ™, CoolerMiser™, SnackMiser™ and PlugMiser™.

GSA Schedule Contract GS-35F-0031R

ENERGY STAR PARTNER

USA TECHNOLOGIES

Frequently Asked Questions

Will VendingMiser® keep my drinks cold?
Absolutely - VendingMiser® has been tested and accepted for use by both major bottlers.

Is the VendingMiser® easy to install?
Yes! VendingMiser® is a simple external plug-and-play product. The VendingMiser® can be installed on the wall with simple hand tools or it can be attached to the vending machine without tools using the new Easy-Install system. The Easy-Install System allows quick installation in 5 minutes.

Is VendingMiser® safe for all machines?
Yes! VendingMiser® is compatible with all types of cold drink vending machines. In fact, by reducing run time of the machines, VendingMiser® reduces maintenance costs.

Has VendingMiser® been field tested?
Tens of thousands of VendingMisers® are operational in the field. Typical energy savings have been independently documented to be between 35% and 45%. Measurement and verification test results as well as testimonials are available on the website.

Are there any locations not appropriate for VendingMiser®?
VendingMiser's® savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings. Our VM2IQ is more appropriate for this type of location and will typically save up to 35% energy use.

Technical Specifications

ELECTRICAL SPECIFICATIONS

Input Voltage:	115 Volts (230 Volts available)
Input Frequency:	50/60 Hz
Maximum Load:	12 Amps (Steady-State)
Power Consumption:	Less than 1 Watt (Standby)

ENVIRONMENTAL SPECIFICATIONS

Operating Temp:	-15°C to 75°C
Storage Temp:	-40°C to 85°C
Relative Humidity:	95% Maximum (Non-Condensing)

COMPATIBILITY

Vending Machines:	Any machine, except those containing perishable goods such as dairy products.

INACTIVITY TIMEOUTS

Occupancy Timeout:	15 minutes
Auto Repower:	One to three hours, dynamically adjusted, based on ambient temperature

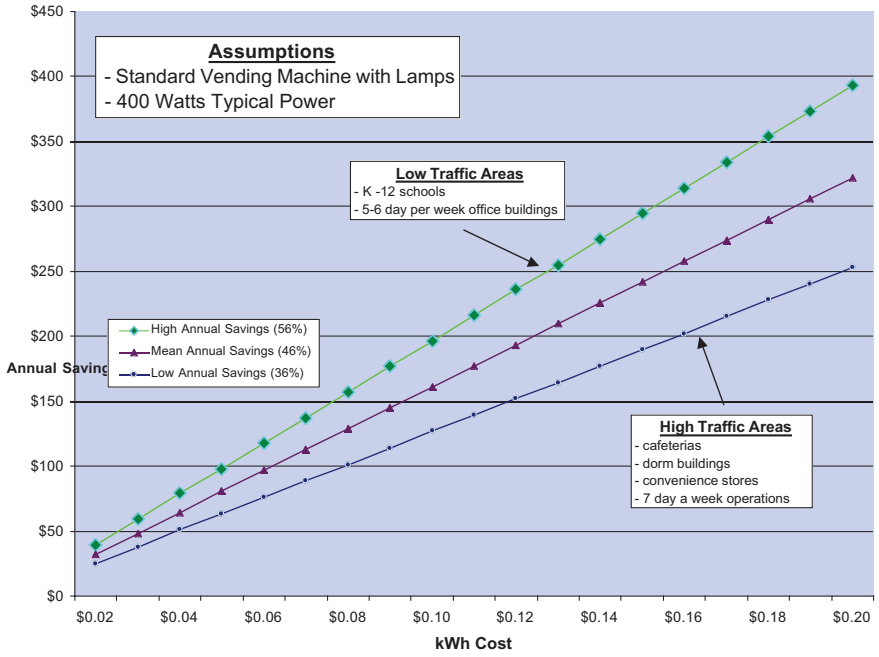
DIMENSIONS

Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

Typical Saving Generated with VendingMiser®



VendingMiser® Products

VM150	VendingMiser® with PIR Sensor
VM151	VendingMiser® only
VM160	Weatherproof VendingMiser® with PIR Sensor
VM161	Weatherproof VendingMiser® only
VM170	Easy-Install VendingMiser® with PIR Sensor
VM171	Easy-Install VendingMiser® only
VM180	Weatherproof Easy-Install VendingMiser w/PIR sensor
VM181	Weatherproof Easy-Install VendingMiser only

SmartVFD HVAC and BYPASS

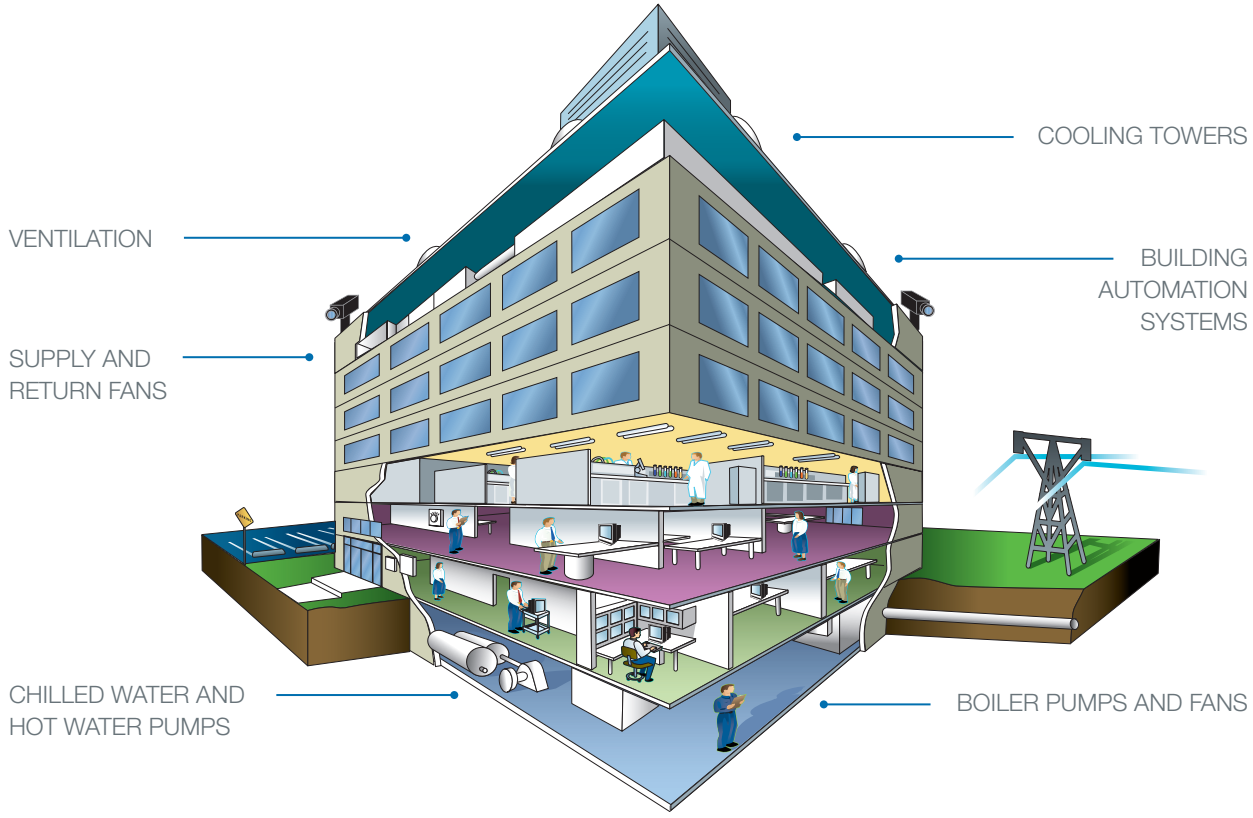
Honeywell



The Smart Choice for Energy Savings.

Saving Energy the Smart Way

Buildings consume more than 70 percent of the electricity produced in North America — and roughly half of that is used to circulate air and water. Honeywell SmartVFD HVAC, BYPASS and COMPACT variable frequency drives maximize energy savings by modulating the speed of fans and pumps. VFDs achieve these savings by operating within a building's control system or independently through its internal PID capabilities. Additionally, Honeywell's VFDs are loaded with labor-saving features such as startup wizards, PC programming, and an intuitive graphical interface that allows for faster, more accurate commissioning and reliable maintenance over the life of the drive.



BACKED BY HONEYWELL

Already among the leading names in HVAC variable frequency drives, Honeywell is pleased to deliver the SmartVFD HVAC line — the third generation of Honeywell VFDs. Designed specifically for commercial applications and backed by more than a century of Honeywell's control expertise, you can count on Honeywell's SmartVFD HVAC and BYPASS to deliver long-term service and energy savings for your customer. You simply can't find a commercial building control name with a more proven record than Honeywell.

The Smart Choice for Efficient Investment

It's a common myth that any VFD can easily be applied in a commercial application, but many VFDs are not the right tool for the job. The Honeywell SmartVFD HVAC and BYPASS are designed specifically for commercial buildings to deliver the energy savings that building owners and facility managers need with 98 percent energy efficiency, minimal labor and a fast ROI.



SMARTVFD HVAC – SMART INSTALLATION, SMART COMMISSIONING AND SMART COMMUNICATION

The Honeywell SmartVFD HVAC meets UL and cUL standards which makes installation and commissioning easy for you and energy savings easy for your customers:

Easy Communication

- Start-up Wizards — Set the clock and tell the VFD whether you have a pump or a fan, enter nominal motor information, and you are up and running. PID and multi-pumps wizards are also built in.
- PC Software Wizards — Commissioning, programming and troubleshooting are all a snap with the PC Software Wizards.
- Graphic Interface — The easy-to-use keypad and interface deliver menu-driven programming and monitoring for fast, uniform commissioning. It's also easy for the building owner or manager to learn and use, helping to reduce service calls. Every parameter has a built-in help feature to provide assistance while programming.
- Built-In Communications — With BACnet®, N2 and Modbus built in, your customers will enjoy a lower total installed cost and reliable communications with the building management system.
- Built-In PLC — PC based tools eliminate the need for an expensive external controller.

Built-in Protection

- DC Choke for harmonic protection.
- Standard RFI Filter — Ensures that EMC/RFI requirements are met.
- Bypass Options — Meet specifications and system critical applications with a comprehensive bypass offering.

Smart Software

- Real-Time Clock — Battery included.
- Fire Mode to improve fire safety in the building.
- Motor Switch Ride-Through — Easy, fault-free maintenance.
- Hand-Off-Auto (HOA) control built into the keypad.
- Plenum rated for install flexibility.
- 100 KA Short Circuit Current Rating (SCCR) rated.



Smart Benefits with Easy Commissioning

Honeywell SmartVFD HVAC doesn't just work in the laboratory — it works in the field. From the variety of network protocols that make integration easy, to the guided Startup and PID wizards, the design and technology of SmartVFDs make them true HVAC drives. Intuitive menus assist with commissioning, programming, troubleshooting and overall operation.

COMMUNICATION STANDARD



Integrating Honeywell SmartVFD HVAC into a building management system is a breeze. There's no need for extra cards because it offers a wide range of communications protocols right out of the box, including:

- RS485 – BACnet®, Modbus and N2
- Ethernet – BACnet/IP and Modbus/TCP
- Available options – LonWorks® and DeviceNet

HIGH-RESOLUTION GRAPHIC DISPLAY



It's not just easy on the eyes, it's also easy to use. The menu driven display shows the minimum, maximum and actual values for all parameters and allows easy uploading and downloading of parameters, and has multiple help functions and the manual built-in. In addition, there is a Local/Remote button on the keypad for built in HOA control.

DETERMINE ROOT CAUSE OF FAULTS



With the SmartVFD HVAC, troubleshooting involves very little trouble. The built in, diagnostic screen provides a description for every fault, and the actual values and references are stored at the time of the fault for easy review and problem resolution.

MONITOR SYSTEM PERFORMANCE



The data needed to analyze usage and make adjustments for maximum energy savings is right at your fingertips. Actual electricity consumption in kWh can be monitored using the VFD PC Wizard, and can be conveniently displayed in bar graphs. At any time, the user can see the actual power consumption currently in use — a great tool for managing energy savings.

Smart Configurations

For system critical applications, you must be able to select a bypass that meets the requirements of the specification. The SmartVFD BYPASS is easy to specify, select, install and commission. The SmartVFD BYPASS is UL certified and is the perfect complement to the advanced capabilities of the SmartVFD family — a combination that is both simple and smart.

SMARTVFD BYPASS CONFIGURATIONS

Our five configurations make it easy for you to select the right bypass to complete your drive package. All bundles are available in NEMA 1, NEMA 12 and ventilated NEMA 3R HOA (HAND OFF AUTO).



SmartVFD Disconnect Only

- Adds a fused disconnect to the VFD.

SmartVFD 2-Contactor Bypass

Provides an economical means of bypassing the VFD.

- Freeze/Fire/Smoke Interlock

SmartVFD 3-Contactor Bypass

Commission, service or replace the VFD without affecting the operation of the motor.

- Fused Disconnect
- Freeze/Fire/Smoke Interlock
- VFD is isolated from power with motor running in BYPASS mode
- TEST position powers the VFD without sending power to the motor

SmartVFD 3-Contactor Bypass with Auto-Bypass

The package adds the control capabilities below to the standard three contactor bypass.

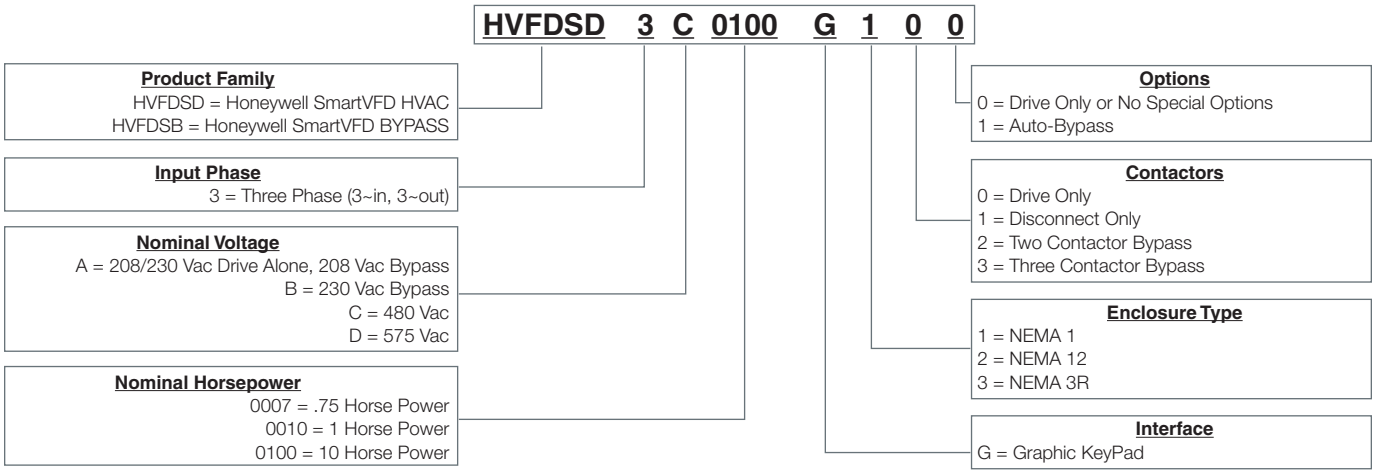
- Any VFD fault will automatically send the bypass to BYPASS mode
- A contact closure sends the bypass to BYPASS mode
- Dry contacts indicate when the bypass is in BYPASS mode, alerting the building management system

SLEEKER. SMALLER. SMARTER.

As the latest evolution of the Honeywell VFD line, the SmartVFD BYPASS is sleeker, smaller, lighter and less expensive.



Smart Selection



PICK THE RIGHT VFD FOR THE APPLICATION

- Drives are typically sized to match the horsepower rating of the motor, which will be accurate 95 percent of the time. But for the greatest accuracy, drives should be sized based upon the Full Load Amps or current draw of the motor. The VFD must have a slightly larger current rating maximum.
- The environment the drive will operate in is critical for selection. Honeywell offers NEMA 1, NEMA 12 (for dusty, dirtier environments) and NEMA 3R enclosures (for falling water or rain situations).
- Because of the complexity of VFDs, a clean, conditioned space with temperatures between 14° F and 104° F provides an environment for ideal operation. Heaters are an option in order to keep your VFD at its recommended temperature.
- Honeywell SmartVFD HVAC has a model range from 1.5-250 HP for 460 Vac, 0.75-125 HP for 208/230 Vac.
- Honeywell SmartVFD offers a standard 3-year warranty from the date of purchase.

Find all SmartVFD selection information on the following pages

SmartVFD HVAC Drive Alone

	HP	AMPS	Frame	NEMA 1 Drive Alone	NEMA 12 Drive Alone	NEMA 3R Drive Alone
460 Vac	1.5	3.4	4	HVFDSD3C0015G100	HVFDSD3C0015G200	HVFDSD3C0015G300
	2	4.8	4	HVFDSD3C0020G100	HVFDSD3C0020G200	HVFDSD3C0020G300
	3	5.6	4	HVFDSD3C0030G100	HVFDSD3C0030G200	HVFDSD3C0030G300
	4	8	4	HVFDSD3C0040G100	HVFDSD3C0040G200	HVFDSD3C0040G300
	5	9.6	4	HVFDSD3C0050G100	HVFDSD3C0050G200	HVFDSD3C0050G300
	7.5	12	4	HVFDSD3C0075G100	HVFDSD3C0075G200	HVFDSD3C0075G300
	10	16	5	HVFDSD3C0100G100	HVFDSD3C0100G200	HVFDSD3C0100G300
	15	23	5	HVFDSD3C0150G100	HVFDSD3C0150G200	HVFDSD3C0150G300
	20	31	5	HVFDSD3C0200G100	HVFDSD3C0200G200	HVFDSD3C0200G300
	25	38	6	HVFDSD3C0250G100	HVFDSD3C0250G200	HVFDSD3C0250G300
	30	46	6	HVFDSD3C0300G100	HVFDSD3C0300G200	HVFDSD3C0300G300
	40	61	6	HVFDSD3C0400G100	HVFDSD3C0400G200	HVFDSD3C0400G300
	50	72	7	HVFDSD3C0500G100	HVFDSD3C0500G200	HVFDSD3C0500G300
	60	87	7	HVFDSD3C0600G100	HVFDSD3C0600G200	HVFDSD3C0600G300
	75	105	7	HVFDSD3C0750G100	HVFDSD3C0750G200	HVFDSD3C0750G300
	100	140	8	HVFDSD3C1000G100	HVFDSD3C1000G200	HVFDSD3C1000G300
	125	170	8	HVFDSD3C1250G100	HVFDSD3C1250G200	HVFDSD3C1250G300
	150	205	8	HVFDSD3C1500G100	HVFDSD3C1500G200	HVFDSD3C1500G300
	200	261	9	HVFDSD3C2000G100	HVFDSD3C2000G200	-
	250	310	9	HVFDSD3C2500G100	HVFDSD3C2500G200	-
	HP	AMPS	Frame	NEMA 1 Drive Alone	NEMA 12 Drive Alone	NEMA 3R Drive Alone
208/ 230 Vac	.75	3.7	4	HVFDSD3A0007G100	HVFDSD3A0007G200	HVFDSD3A0007G300
	1	4.8	4	HVFDSD3A0010G100	HVFDSD3A0010G200	HVFDSD3A0010G300
	1.5	6.6	4	HVFDSD3A0015G100	HVFDSD3A0015G200	HVFDSD3A0015G300
	2	8	4	HVFDSD3A0020G100	HVFDSD3A0020G200	HVFDSD3A0020G300
	3	11	4	HVFDSD3A0030G100	HVFDSD3A0030G200	HVFDSD3A0030G300
	5	18	5	HVFDSD3A0050G100	HVFDSD3A0050G200	HVFDSD3A0050G300
	7.5	24	5	HVFDSD3A0075G100	HVFDSD3A0075G200	HVFDSD3A0075G300
	10	31	5	HVFDSD3A0100G100	HVFDSD3A0100G200	HVFDSD3A0100G300
	15	48	6	HVFDSD3A0150G100	HVFDSD3A0150G200	HVFDSD3A0150G300
	20	62	6	HVFDSD3A0200G100	HVFDSD3A0200G200	HVFDSD3A0200G300
	25	75	7	HVFDSD3A0250G100	HVFDSD3A0250G200	HVFDSD3A0250G300
	30	88	7	HVFDSD3A0300G100	HVFDSD3A0300G200	HVFDSD3A0300G300
	40	105	7	HVFDSD3A0400G100	HVFDSD3A0400G200	HVFDSD3A0400G300
	50	140	8	HVFDSD3A0500G100	HVFDSD3A0500G200	HVFDSD3A0500G300
	60	170	8	HVFDSD3A0600G100	HVFDSD3A0600G200	HVFDSD3A0600G300
	75	205	8	HVFDSD3A0750G100	HVFDSD3A0750G200	HVFDSD3A0750G300
	100	261	9	HVFDSD3A1000G100	HVFDSD3A1000G200	-
	125	310	9	HVFDSD3A1250G100	HVFDSD3A1250G200	-

SmartVFD HVAC NEMA 1 Disconnect and SmartVFD BYPASS

	HP	AMPS	Frame	NEMA 1 Fused Disconnect	NEMA 1 2-Contactor Bypass	NEMA 1 3-Contactor Bypass	NEMA 1 3-Cont. Bypass + Auto-Bypass
460 Vac	1.5	3.4	4	HVFDSB3C0015G110	HVFDSB3C0015G120	HVFDSB3C0015G130	HVFDSB3C0015G131
	2	4.8	4	HVFDSB3C0020G110	HVFDSB3C0020G120	HVFDSB3C0020G130	HVFDSB3C0020G131
	3	5.6	4	HVFDSB3C0030G110	HVFDSB3C0030G120	HVFDSB3C0030G130	HVFDSB3C0030G131
	4	8	4	HVFDSB3C0040G110	HVFDSB3C0040G120	HVFDSB3C0040G130	HVFDSB3C0040G131
	5	9.6	4	HVFDSB3C0050G110	HVFDSB3C0050G120	HVFDSB3C0050G130	HVFDSB3C0050G131
	7.5	12	4	HVFDSB3C0075G110	HVFDSB3C0075G120	HVFDSB3C0075G130	HVFDSB3C0075G131
	10	16	5	HVFDSB3C0100G110	HVFDSB3C0100G120	HVFDSB3C0100G130	HVFDSB3C0100G131
	15	23	5	HVFDSB3C0150G110	HVFDSB3C0150G120	HVFDSB3C0150G130	HVFDSB3C0150G131
	20	31	5	HVFDSB3C0200G110	HVFDSB3C0200G120	HVFDSB3C0200G130	HVFDSB3C0200G131
	25	38	6	HVFDSB3C0250G110	HVFDSB3C0250G120	HVFDSB3C0250G130	HVFDSB3C0250G131
	30	46	6	HVFDSB3C0300G110	HVFDSB3C0300G120	HVFDSB3C0300G130	HVFDSB3C0300G131
	40	61	6	HVFDSB3C0400G110	HVFDSB3C0400G120	HVFDSB3C0400G130	HVFDSB3C0400G131
	50	72	7	HVFDSB3C0500G110	HVFDSB3C0500G120	HVFDSB3C0500G130	HVFDSB3C0500G131
	60	87	7	HVFDSB3C0600G110	HVFDSB3C0600G120	HVFDSB3C0600G130	HVFDSB3C0600G131
	75	105	7	HVFDSB3C0750G110	HVFDSB3C0750G120	HVFDSB3C0750G130	HVFDSB3C0750G131
	100	140	8	HVFDSB3C1000G110	HVFDSB3C1000G120	HVFDSB3C1000G130	HVFDSB3C1000G131
	125	170	8	HVFDSB3C1250G110	HVFDSB3C1250G120	HVFDSB3C1250G130	HVFDSB3C1250G131
	150	205	8	HVFDSB3C1500G110	HVFDSB3C1500G120	HVFDSB3C1500G130	HVFDSB3C1500G131
	HP	AMPS	Frame	NEMA 1 Fused Disconnect	NEMA 1 2-Contactor Bypass	NEMA 1 3-Contactor Bypass	NEMA 1 3-Cont. Bypass + Auto-Bypass
208 Vac	.75	3.7	4	HVFDSB3A0007G110	HVFDSB3A0007G120	HVFDSB3A0007G130	HVFDSB3A0007G131
	1	4.8	4	HVFDSB3A0010G110	HVFDSB3A0010G120	HVFDSB3A0010G130	HVFDSB3A0010G131
	1.5	6.6	4	HVFDSB3A0015G110	HVFDSB3A0015G120	HVFDSB3A0015G130	HVFDSB3A0015G131
	2	8	4	HVFDSB3A0020G110	HVFDSB3A0020G120	HVFDSB3A0020G130	HVFDSB3A0020G131
	3	11	4	HVFDSB3A0030G110	HVFDSB3A0030G120	HVFDSB3A0030G130	HVFDSB3A0030G131
	5	18	5	HVFDSB3A0050G110	HVFDSB3A0050G120	HVFDSB3A0050G130	HVFDSB3A0050G131
	7.5	24	5	HVFDSB3A0075G110	HVFDSB3A0075G120	HVFDSB3A0075G130	HVFDSB3A0075G131
	10	31	5	HVFDSB3A0100G110	HVFDSB3A0100G120	HVFDSB3A0100G130	HVFDSB3A0100G131
	15	48	6	HVFDSB3A0150G110	HVFDSB3A0150G120	HVFDSB3A0150G130	HVFDSB3A0150G131
	20	62	6	HVFDSB3A0200G110	HVFDSB3A0200G120	HVFDSB3A0200G130	HVFDSB3A0200G131
	25	75	7	HVFDSB3A0250G110	HVFDSB3A0250G120	HVFDSB3A0250G130	HVFDSB3A0250G131
	30	88	7	HVFDSB3A0300G110	HVFDSB3A0300G120	HVFDSB3A0300G130	HVFDSB3A0300G131
	40	105	7	HVFDSB3A0400G110	HVFDSB3A0400G120	HVFDSB3A0400G130	HVFDSB3A0400G131
	50	140	8	HVFDSB3A0500G110	HVFDSB3A0500G120	HVFDSB3A0500G130	HVFDSB3A0500G131
	60	170	8	HVFDSB3A0600G110	HVFDSB3A0600G120	HVFDSB3A0600G130	HVFDSB3A0600G131
	75	205	8	HVFDSB3A0750G110	HVFDSB3A0750G120	HVFDSB3A0750G130	HVFDSB3A0750G131
	HP	AMPS	Frame	NEMA 1 Fused Disconnect	NEMA 1 2-Contactor Bypass	NEMA 1 3-Contactor Bypass	NEMA 1 3-Cont. Bypass + Auto-Bypass
230 Vac	.75	3.7	4	HVFDSB3B0007G110	HVFDSB3B0007G120	HVFDSB3B0007G130	HVFDSB3B0007G131
	1	4.8	4	HVFDSB3B0010G110	HVFDSB3B0010G120	HVFDSB3B0010G130	HVFDSB3B0010G131
	1.5	6.6	4	HVFDSB3B0015G110	HVFDSB3B0015G120	HVFDSB3B0015G130	HVFDSB3B0015G131
	2	8	4	HVFDSB3B0020G110	HVFDSB3B0020G120	HVFDSB3B0020G130	HVFDSB3B0020G131
	3	11	4	HVFDSB3B0030G110	HVFDSB3B0030G120	HVFDSB3B0030G130	HVFDSB3B0030G131
	5	18	5	HVFDSB3B0050G110	HVFDSB3B0050G120	HVFDSB3B0050G130	HVFDSB3B0050G131
	7.5	24	5	HVFDSB3B0075G110	HVFDSB3B0075G120	HVFDSB3B0075G130	HVFDSB3B0075G131
	10	31	5	HVFDSB3B0100G110	HVFDSB3B0100G120	HVFDSB3B0100G130	HVFDSB3B0100G131
	15	48	6	HVFDSB3B0150G110	HVFDSB3B0150G120	HVFDSB3B0150G130	HVFDSB3B0150G131
	20	62	6	HVFDSB3B0200G110	HVFDSB3B0200G120	HVFDSB3B0200G130	HVFDSB3B0200G131
	25	75	7	HVFDSB3B0250G110	HVFDSB3B0250G120	HVFDSB3B0250G130	HVFDSB3B0250G131
	30	88	7	HVFDSB3B0300G110	HVFDSB3B0300G120	HVFDSB3B0300G130	HVFDSB3B0300G131
	40	105	7	HVFDSB3B0400G110	HVFDSB3B0400G120	HVFDSB3B0400G130	HVFDSB3B0400G131
	50	140	8	HVFDSB3B0500G110	HVFDSB3B0500G120	HVFDSB3B0500G130	HVFDSB3B0500G131
	60	170	8	HVFDSB3B0600G110	HVFDSB3B0600G120	HVFDSB3B0600G130	HVFDSB3B0600G131
	75	205	8	HVFDSB3B0750G110	HVFDSB3B0750G120	HVFDSB3B0750G130	HVFDSB3B0750G131

Smart Selection

SmartVFD HVAC NEMA 12 Disconnect and SmartVFD BYPASS

	HP	AMPS	Frame	NEMA 12 Fused Disconnect	NEMA 12 2-Contactor Bypass	NEMA 12 3-Contactor Bypass	NEMA 12 3-Cont. Bypass + Auto-Bypass
460 Vac	1.5	3.4	4	HVFDSB3C0015G210	HVFDSB3C0015G220	HVFDSB3C0015G230	HVFDSB3C0015G231
	2	4.8	4	HVFDSB3C0020G210	HVFDSB3C0020G220	HVFDSB3C0020G230	HVFDSB3C0020G231
	3	5.6	4	HVFDSB3C0030G210	HVFDSB3C0030G220	HVFDSB3C0030G230	HVFDSB3C0030G231
	4	8	4	HVFDSB3C0040G210	HVFDSB3C0040G220	HVFDSB3C0040G230	HVFDSB3C0040G231
	5	9.6	4	HVFDSB3C0050G210	HVFDSB3C0050G220	HVFDSB3C0050G230	HVFDSB3C0050G231
	7.5	12	4	HVFDSB3C0075G210	HVFDSB3C0075G220	HVFDSB3C0075G230	HVFDSB3C0075G231
	10	16	5	HVFDSB3C0100G210	HVFDSB3C0100G220	HVFDSB3C0100G230	HVFDSB3C0100G231
	15	23	5	HVFDSB3C0150G210	HVFDSB3C0150G220	HVFDSB3C0150G230	HVFDSB3C0150G231
	20	31	5	HVFDSB3C0200G210	HVFDSB3C0200G220	HVFDSB3C0200G230	HVFDSB3C0200G231
	25	38	6	HVFDSB3C0250G210	HVFDSB3C0250G220	HVFDSB3C0250G230	HVFDSB3C0250G231
	30	46	6	HVFDSB3C0300G210	HVFDSB3C0300G220	HVFDSB3C0300G230	HVFDSB3C0300G231
	40	61	6	HVFDSB3C0400G210	HVFDSB3C0400G220	HVFDSB3C0400G230	HVFDSB3C0400G231
	50	72	7	HVFDSB3C0500G210	HVFDSB3C0500G220	HVFDSB3C0500G230	HVFDSB3C0500G231
	60	87	7	HVFDSB3C0600G210	HVFDSB3C0600G220	HVFDSB3C0600G230	HVFDSB3C0600G231
	75	105	7	HVFDSB3C0750G210	HVFDSB3C0750G220	HVFDSB3C0750G230	HVFDSB3C0750G231
	100	140	8	HVFDSB3C1000G210	HVFDSB3C1000G220	HVFDSB3C1000G230	HVFDSB3C1000G231
	125	170	8	HVFDSB3C1250G210	HVFDSB3C1250G220	HVFDSB3C1250G230	HVFDSB3C1250G231
	150	205	8	HVFDSB3C1500G210	HVFDSB3C1500G220	HVFDSB3C1500G230	HVFDSB3C1500G231
	HP	AMPS	Frame	NEMA 12 Fused Disconnect	NEMA 12 2-Contactor Bypass	NEMA 12 3-Contactor Bypass	NEMA 12 3-Cont. Bypass + Auto-Bypass
208 Vac	.75	3.7	4	HVFDSB3A0007G210	HVFDSB3A0007G220	HVFDSB3A0007G230	HVFDSB3A0007G231
	1	4.8	4	HVFDSB3A0010G210	HVFDSB3A0010G220	HVFDSB3A0010G230	HVFDSB3A0010G231
	1.5	6.6	4	HVFDSB3A0015G210	HVFDSB3A0015G220	HVFDSB3A0015G230	HVFDSB3A0015G231
	2	8	4	HVFDSB3A0020G210	HVFDSB3A0020G220	HVFDSB3A0020G230	HVFDSB3A0020G231
	3	11	4	HVFDSB3A0030G210	HVFDSB3A0030G220	HVFDSB3A0030G230	HVFDSB3A0030G231
	5	18	5	HVFDSB3A0050G210	HVFDSB3A0050G220	HVFDSB3A0050G230	HVFDSB3A0050G231
	7.5	24	5	HVFDSB3A0075G210	HVFDSB3A0075G220	HVFDSB3A0075G230	HVFDSB3A0075G231
	10	31	5	HVFDSB3A0100G210	HVFDSB3A0100G220	HVFDSB3A0100G230	HVFDSB3A0100G231
	15	48	6	HVFDSB3A0150G210	HVFDSB3A0150G220	HVFDSB3A0150G230	HVFDSB3A0150G231
	20	62	6	HVFDSB3A0200G210	HVFDSB3A0200G220	HVFDSB3A0200G230	HVFDSB3A0200G231
	25	75	7	HVFDSB3A0250G210	HVFDSB3A0250G220	HVFDSB3A0250G230	HVFDSB3A0250G231
	30	88	7	HVFDSB3A0300G210	HVFDSB3A0300G220	HVFDSB3A0300G230	HVFDSB3A0300G231
	40	105	7	HVFDSB3A0400G210	HVFDSB3A0400G220	HVFDSB3A0400G230	HVFDSB3A0400G231
	50	140	8	HVFDSB3A0500G210	HVFDSB3A0500G220	HVFDSB3A0500G230	HVFDSB3A0500G231
	60	170	8	HVFDSB3A0600G210	HVFDSB3A0600G220	HVFDSB3A0600G230	HVFDSB3A0600G231
	75	205	8	HVFDSB3A0750G210	HVFDSB3A0750G220	HVFDSB3A0750G230	HVFDSB3A0750G231
	HP	AMPS	Frame	NEMA 12 Fused Disconnect	NEMA 12 2-Contactor Bypass	NEMA 12 3-Contactor Bypass	NEMA 12 3-Cont. Bypass + Auto-Bypass
230 Vac	.75	3.7	4	HVFDSB3B0007G210	HVFDSB3B0007G220	HVFDSB3B0007G230	HVFDSB3B0007G231
	1	4.8	4	HVFDSB3B0010G210	HVFDSB3B0010G220	HVFDSB3B0010G230	HVFDSB3B0010G231
	1.5	6.6	4	HVFDSB3B0015G210	HVFDSB3B0015G220	HVFDSB3B0015G230	HVFDSB3B0015G231
	2	8	4	HVFDSB3B0020G210	HVFDSB3B0020G220	HVFDSB3B0020G230	HVFDSB3B0020G231
	3	11	4	HVFDSB3B0030G210	HVFDSB3B0030G220	HVFDSB3B0030G230	HVFDSB3B0030G231
	5	18	5	HVFDSB3B0050G210	HVFDSB3B0050G220	HVFDSB3B0050G230	HVFDSB3B0050G231
	7.5	24	5	HVFDSB3B0075G210	HVFDSB3B0075G220	HVFDSB3B0075G230	HVFDSB3B0075G231
	10	31	5	HVFDSB3B0100G210	HVFDSB3B0100G220	HVFDSB3B0100G230	HVFDSB3B0100G231
	15	48	6	HVFDSB3B0150G210	HVFDSB3B0150G220	HVFDSB3B0150G230	HVFDSB3B0150G231
	20	62	6	HVFDSB3B0200G210	HVFDSB3B0200G220	HVFDSB3B0200G230	HVFDSB3B0200G231
	25	75	7	HVFDSB3B0250G210	HVFDSB3B0250G220	HVFDSB3B0250G230	HVFDSB3B0250G231
	30	88	7	HVFDSB3B0300G210	HVFDSB3B0300G220	HVFDSB3B0300G230	HVFDSB3B0300G231
	40	105	7	HVFDSB3B0400G210	HVFDSB3B0400G220	HVFDSB3B0400G230	HVFDSB3B0400G231
	50	140	8	HVFDSB3B0500G210	HVFDSB3B0500G220	HVFDSB3B0500G230	HVFDSB3B0500G231
	60	170	8	HVFDSB3B0600G210	HVFDSB3B0600G220	HVFDSB3B0600G230	HVFDSB3B0600G231
	75	205	8	HVFDSB3B0750G210	HVFDSB3B0750G220	HVFDSB3B0750G230	HVFDSB3B0750G231

SmartVFD HVAC NEMA 3R Disconnect and SmartVFD BYPASS

	HP	AMPS	Frame	NEMA 3R Fused Disconnect	NEMA 3R 2-Contactor Bypass	NEMA 3R 3-Contactor Bypass	NEMA 3R 3-Cont. Bypass + Auto-Bypass
460 Vac	1.5	3.4	4	HVFDSB3C0015G310	HVFDSB3C0015G320	HVFDSB3C0015G330	HVFDSB3C0015G331
	2	4.8	4	HVFDSB3C0020G310	HVFDSB3C0020G320	HVFDSB3C0020G330	HVFDSB3C0020G331
	3	5.6	4	HVFDSB3C0030G310	HVFDSB3C0030G320	HVFDSB3C0030G330	HVFDSB3C0030G331
	4	8	4	HVFDSB3C0040G310	HVFDSB3C0040G320	HVFDSB3C0040G330	HVFDSB3C0040G331
	5	9.6	4	HVFDSB3C0050G310	HVFDSB3C0050G320	HVFDSB3C0050G330	HVFDSB3C0050G331
	7.5	12	4	HVFDSB3C0075G310	HVFDSB3C0075G320	HVFDSB3C0075G330	HVFDSB3C0075G331
	10	16	5	HVFDSB3C0100G310	HVFDSB3C0100G320	HVFDSB3C0100G330	HVFDSB3C0100G331
	15	23	5	HVFDSB3C0150G310	HVFDSB3C0150G320	HVFDSB3C0150G330	HVFDSB3C0150G331
	20	31	5	HVFDSB3C0200G310	HVFDSB3C0200G320	HVFDSB3C0200G330	HVFDSB3C0200G331
	25	38	6	HVFDSB3C0250G310	HVFDSB3C0250G320	HVFDSB3C0250G330	HVFDSB3C0250G331
	30	46	6	HVFDSB3C0300G310	HVFDSB3C0300G320	HVFDSB3C0300G330	HVFDSB3C0300G331
	40	61	6	HVFDSB3C0400G310	HVFDSB3C0400G320	HVFDSB3C0400G330	HVFDSB3C0400G331
	50	72	7	HVFDSB3C0500G310	HVFDSB3C0500G320	HVFDSB3C0500G330	HVFDSB3C0500G331
	60	87	7	HVFDSB3C0600G310	HVFDSB3C0600G320	HVFDSB3C0600G330	HVFDSB3C0600G331
	75	105	7	HVFDSB3C0750G310	HVFDSB3C0750G320	HVFDSB3C0750G330	HVFDSB3C0750G331
	100	140	8	HVFDSB3C1000G310	HVFDSB3C1000G320	HVFDSB3C1000G330	HVFDSB3C1000G331
	125	170	8	HVFDSB3C1250G310	HVFDSB3C1250G320	HVFDSB3C1250G330	HVFDSB3C1250G331
	150	205	8	HVFDSB3C1500G310	HVFDSB3C1500G320	HVFDSB3C1500G330	HVFDSB3C1500G331
	HP	AMPS	Frame	NEMA 3R Fused Disconnect	NEMA 3R 2-Contactor Bypass	NEMA 3R 3-Contactor Bypass	NEMA 3R 3-Cont. Bypass + Auto-Bypass
208 Vac	.75	3.7	4	HVFDSB3A0007G310	HVFDSB3A0007G320	HVFDSB3A0007G330	HVFDSB3A0007G331
	1	4.8	4	HVFDSB3A0010G310	HVFDSB3A0010G320	HVFDSB3A0010G330	HVFDSB3A0010G331
	1.5	6.6	4	HVFDSB3A0015G310	HVFDSB3A0015G320	HVFDSB3A0015G330	HVFDSB3A0015G331
	2	8	4	HVFDSB3A0020G310	HVFDSB3A0020G320	HVFDSB3A0020G330	HVFDSB3A0020G331
	3	11	4	HVFDSB3A0030G310	HVFDSB3A0030G320	HVFDSB3A0030G330	HVFDSB3A0030G331
	5	18	5	HVFDSB3A0050G310	HVFDSB3A0050G320	HVFDSB3A0050G330	HVFDSB3A0050G331
	7.5	24	5	HVFDSB3A0075G310	HVFDSB3A0075G320	HVFDSB3A0075G330	HVFDSB3A0075G331
	10	31	5	HVFDSB3A0100G310	HVFDSB3A0100G320	HVFDSB3A0100G330	HVFDSB3A0100G331
	15	48	6	HVFDSB3A0150G310	HVFDSB3A0150G320	HVFDSB3A0150G330	HVFDSB3A0150G331
	20	62	6	HVFDSB3A0200G310	HVFDSB3A0200G320	HVFDSB3A0200G330	HVFDSB3A0200G331
	25	75	7	HVFDSB3A0250G310	HVFDSB3A0250G320	HVFDSB3A0250G330	HVFDSB3A0250G331
	30	88	7	HVFDSB3A0300G310	HVFDSB3A0300G320	HVFDSB3A0300G330	HVFDSB3A0300G331
	40	105	7	HVFDSB3A0400G310	HVFDSB3A0400G320	HVFDSB3A0400G330	HVFDSB3A0400G331
	50	140	8	HVFDSB3A0500G310	HVFDSB3A0500G320	HVFDSB3A0500G330	HVFDSB3A0500G331
	60	170	8	HVFDSB3A0600G310	HVFDSB3A0600G320	HVFDSB3A0600G330	HVFDSB3A0600G331
	75	205	8	HVFDSB3A0750G310	HVFDSB3A0750G320	HVFDSB3A0750G330	HVFDSB3A0750G331
	HP	AMPS	Frame	NEMA 3R Fused Disconnect	NEMA 3R 2-Contactor Bypass	NEMA 3R 3-Contactor Bypass	NEMA 3R 3-Cont. Bypass + Auto-Bypass
230 Vac	.75	3.7	4	HVFDSB3B0007G310	HVFDSB3B0007G320	HVFDSB3B0007G330	HVFDSB3B0007G331
	1	4.8	4	HVFDSB3B0010G310	HVFDSB3B0010G320	HVFDSB3B0010G330	HVFDSB3B0010G331
	1.5	6.6	4	HVFDSB3B0015G310	HVFDSB3B0015G320	HVFDSB3B0015G330	HVFDSB3B0015G331
	2	8	4	HVFDSB3B0020G310	HVFDSB3B0020G320	HVFDSB3B0020G330	HVFDSB3B0020G331
	3	11	4	HVFDSB3B0030G310	HVFDSB3B0030G320	HVFDSB3B0030G330	HVFDSB3B0030G331
	5	18	5	HVFDSB3B0050G310	HVFDSB3B0050G320	HVFDSB3B0050G330	HVFDSB3B0050G331
	7.5	24	5	HVFDSB3B0075G310	HVFDSB3B0075G320	HVFDSB3B0075G330	HVFDSB3B0075G331
	10	31	5	HVFDSB3B0100G310	HVFDSB3B0100G320	HVFDSB3B0100G330	HVFDSB3B0100G331
	15	48	6	HVFDSB3B0150G310	HVFDSB3B0150G320	HVFDSB3B0150G330	HVFDSB3B0150G331
	20	62	6	HVFDSB3B0200G310	HVFDSB3B0200G320	HVFDSB3B0200G330	HVFDSB3B0200G331
	25	75	7	HVFDSB3B0250G310	HVFDSB3B0250G320	HVFDSB3B0250G330	HVFDSB3B0250G331
	30	88	7	HVFDSB3B0300G310	HVFDSB3B0300G320	HVFDSB3B0300G330	HVFDSB3B0300G331
	40	105	7	HVFDSB3B0400G310	HVFDSB3B0400G320	HVFDSB3B0400G330	HVFDSB3B0400G331
	50	140	8	HVFDSB3B0500G310	HVFDSB3B0500G320	HVFDSB3B0500G330	HVFDSB3B0500G331
	60	170	8	HVFDSB3B0600G310	HVFDSB3B0600G320	HVFDSB3B0600G330	HVFDSB3B0600G331
	75	205	8	HVFDSB3B0750G310	HVFDSB3B0750G320	HVFDSB3B0750G330	HVFDSB3B0750G331

Smart Selection

VFD Pricing/Job Estimating Tools

For additional tools you can use for the selection and pricing of VFDs, click on the "Commercial Components Estimating Tools" link at ***customer.honeywell.com.***

NEMA 1

Frame Size	HP And Voltage		Configuration	Dimensions (in)			Weight (lb)
	208/230 VAC	460 VAC		W	H	D	
4	0.75-3 HP	1.5-7.5 HP	Drive alone	5	12.9	7.5	13.2
			Disconnect	8.9	31.9	10.3	33
			2-Contactor	8.9	31.9	9.6	38
			3-Contactor	8.9	38.9	10.3	44
			3-Contactor with Auto-Bypass	8.9	38.9	10.3	46
5	5 HP 7.5 HP 10 HP	10 HP 15 HP 20 HP	Drive alone	5.7	16.5	8.4	22
			Disconnect	8.9	34.7	10.3	43
			2-Contactor	8.9	34.7	9.6	48/50/50
			3-Contactor	8.9	41.7	10.3/10.3/10.8	55.5/57/59.5
			3-Contactor with Auto-Bypass	8.9	41.7	10.3/10.3/10.8	56/57.5/60
6	15 HP 20 HP	25 HP 30 HP 40 HP	Drive alone	7.7	21.9	9	44.1
			Disconnect	12.4	45.1	11.3	50
			2-Contactor	12.4	45.1	10.1	55/59
			3-Contactor	12.4	55.2	11.3	94.5/98.5/105.5
			3-Contactor with Auto-Bypass	12.4	55.2	11.3	96.5/100.5/107.5
7	25 HP 30 HP 40 HP	50 HP 60 HP 75 HP	Drive alone	9.3	25.4	10.2	82.7
			Disconnect	20.8	51.5	13.2	100
			2-Contactor	20.8	51.5	12.2	169/179/189
			3-Contactor	20.8	59	13.2	175/184/195
			3-Contactor with Auto-Bypass	20.8	59	13.2	177/186/197
8	50 HP 60 HP 75 HP	100 HP 125 HP 150 HP	Drive alone	11.4	38	13.5	154.3
			Disconnect	25	60	16.2	200
			2-Contactor	25	60	15.2	250/265/280
			3-Contactor	25	70	16.2	285/295/331
			3-Contactor with Auto-Bypass	25	70	16.2	287/297/333
9	100-125 HP	200-250 HP	Drive alone	18.9	45.3	14.4	238.1

NEMA 12

Frame Size	HP And Voltage		Configuration	208/230 Vac Dimensions (in) & Weight (lb)				460 Vac Dimensions (in) & Weight (lb)			
	208/230 VAC	460 VAC		W	H	D	lb	W	H	D	lb
4	0.75-3 HP	1.5HP-7.5 HP	Drive alone	5	12.9	7.5	13.2	5	12.9	7.5	13.2
			Disconnect	12	37.5	11	40	12	37.5	11	40
			2-Contactor	16	37.5	11	55	16	37.5	11	53
			3-Contactor	16	37.5	11	55	16	37.5	11	53
			3-Contactor with Auto-Bypass	16	37.5	11	55	16	37.5	11	53
5	5-10 HP	10 HP 15 HP 20 HP	Drive alone	5.7	16.5	8.4	22	5.7	16.5	8.4	22
			Disconnect	12	41	11	72	12	41	11	72
			2-Contactor	16	41/41/45	11	70/70/84	16	41/41/45	11	64/64/76
			3-Contactor	16	41/41/45	11	70/70/84	16	41/41/45	11	64/64/76
			3-Contactor with Auto-Bypass	16	41/41/45	11	70/70/84	16	41/41/45	11	64/64/76
6	15-20 HP	25 HP 30 HP 40 HP	Drive alone	7.7	21.9	9	44.1	7.7	21.9	9	44.1
			Disconnect	12	46.5	13	120	12/12/16	46.5	13	120/120/136
			2-Contactor	16/20	50.5/54.5	13	125/140	16/16/20	50.5/50.5/54.5	13	120/120/136
			3-Contactor	16/20	50.5/54.5	13	125/140	16/16/20	50.5/50.5/54.5	13	120/120/136
			3-Contactor with Auto-Bypass	16/20	50.5/54.5	13	125/140	16/16/20	50.5/50.5/54.5	13	120/120/136
7	25-40 HP	50 HP 60 HP 75 HP	Drive alone	9.3	25.4	10.2	82.7	9.3	25.4	10.2	82.7
			Disconnect	16	50.5	13.5	145/160/175	16	50.5	13.5	145/160/175
			2-Contactor	20/24/30	58.5/65.5/70.5	13.5	160/175/200	20/24/30	58.5/65.5/70.5	13.5	150/165/193
			3-Contactor	20/24/30	58.5/65.5/70.5	13.5	160/175/200	20/24/30	58.5/65.5/70.5	13.5	150/165/193
			3-Contactor with Auto-Bypass	20/24/30	58.5/65.5/70.5	13.5	160/175/200	20/24/30	58.5/65.5/70.5	13.5	150/165/193
8	50-75 HP	100 HP 125 HP 150 HP	Drive alone	11.4	38	13.5	154.3	11.42	38.03	13.5	154.3
			Disconnect	Contact Customer Care				Contact Customer Care			
			2-Contactor								
			3-Contactor								
			3-Contactor with Auto-Bypass								
9	100-125 HP	180-220 HP	Drive alone	18.9	45.3	14.4	238.1	14.37	45.27	18.9	238.1

NEMA 3R

Frame Size	HP And Voltage		Configuration	Dimensions (in)			Weight (lb)
	208/230 VAC	460 VAC		W	H	D	
4	0.75-3 HP	1.5-7.5 HP	Drive alone	20.5	20	10.5	39
			Disconnect	20.5	20	12	43
			2-Contactor	24.5	24	10.5	49
			3-Contactor	24.5	24	12	54
			3-Contactor with Auto-Bypass	24.5	24	12	54
5	5-10 HP	10-20 HP	Drive alone	20.5	24	10.5	58
			Disconnect	20.5	24	12	61
			2-Contactor	24.5	24	10.5	72
			3-Contactor	28.5	30	12	78
			3-Contactor with Auto-Bypass	28.5	30	12	78
6	15-20 HP	25-40 HP	Drive alone	28.5	36	10.5	80
			Disconnect	28.5	36	12	88
			2-Contactor	28.5	36	10.5	118
			3-Contactor	34.5	36	12	124
			3-Contactor with Auto-Bypass	34.5	36	12	124
7	25-40 HP	50-75 HP	Drive alone	28.5	48	12.5	130
			Disconnect	28.5	48	14	149
			2-Contactor	28.5	48	12.5	185
			3-Contactor	40.5	48	14	193
			3-Contactor with Auto-Bypass	40.5	48	14	193
8	50-75 HP	100-150 HP	Drive alone	40.5	60	12.5	299
			Disconnect	40.5	60	14	340
			2-Contactor	40.5	60	12.5	430
			3-Contactor	40.5	60	14	440
			3-Contactor with Auto-Bypass	40.5	60	14	440

Honeywell SmartVFD HVAC and SmartVFD BYPASS are smaller, sleeker and require a smaller footprint than other manufacturers. They are specifically designed for your HVAC application.

Smart Accessories

SmartVFD Accessories

Accessory	Description	Drive Used with
32006630-001/U	LON Communication Card (NXOPTC4)	SMART
HVFDSDOPT1AI2AO/U	1 x AI, 2 x AO (isolated, D- and E- slot compatible)	SMART
HVFDSDOPT1RO5DI/U	1 x RO, 5 x DI (42-240 VAC, D- and E- slot compatible)	SMART
HVFDSDREP2RO1T/U	2 x RO + Thermistor (B- slot compatible)	SMART
HVFDSDOPT2RO1T/U	2 x RO + Thermistor (D- and E- slot compatible)	SMART
HVFDSDOPT3RO/U	3 x RO (D- and E- slot compatible)	SMART
HVFDSDBATTERY/U	Battery Package, 5 pcs, for Real Time Clock	SMART
HVFDSDREP3RO/U	3 x RO (B- slot compatible)	SMART
HVFDSDOPT6DI/U	6 x DI / DO Programmable (D- and E- slot compatible)	SMART
HVFDSDTRAINER/U	SmartVFD HVAC Training Demonstration Kit	SMART
HVFDSDGRAPHICKP/U	SmartVFD HVAC Replacement Graphical Keypad	SMART
HVFDSDMOUNTKIT/U	SmartVFD HVAC Panel Mount Kit for NEMA 12 Install 3 Meter Cable	SMART
HVFDSDNEMA12FR4/U	SmartVFD HVAC NEMA 12 Kit Frame 4	SMART
HVFDSDNEMA12FR5/U	SmartVFD HVAC NEMA 12 Kit Frame 5	SMART
HVFDSDNEMA12FR6/U	SmartVFD HVAC NEMA 12 Kit Frame 6	SMART
HVFDSDFLANGEFR4/U	SmartVFD HVAC Flange Mounting Kit for Frame 4	SMART
HVFDSDFLANGEFR5/U	SmartVFD HVAC Flange Mounting Kit for Frame 5	SMART
HVFDSDFLANGEFR6/U	SmartVFD HVAC Flange Mounting Kit for Frame 6	SMART
HVFDSDFLANGEFR7/U	SmartVFD HVAC Flange Mounting Kit for Frame 7	SMART
HVFDSDFANFR4/U	SmartVFD HVAC Frame 4 Replacement Fan	SMART
HVFDSDFANFR5/U	SmartVFD HVAC Frame 5 Replacement Fan	SMART
HVFDSDFANFR6/U	SmartVFD HVAC Frame 6 Replacement Fan	SMART
HVFDSDFANFR7/U	SmartVFD HVAC Frame 7 Replacement Fan	SMART
HVFDSDINSTALLFR4/U	SmartVFD HVAC Replacement Installation Accessories Frame 4	SMART
HVFDSDINSTALLFR5/U	SmartVFD HVAC Replacement Installation Accessories Frame 5	SMART
HVFDSDINSTALLFR6/U	SmartVFD HVAC Replacement Installation Accessories Frame 6	SMART
HVFDCABLE/U	SmartVFD Compact Commissioning Cable and USB Adaptor	COMPACT & SMART

See the Big Picture

With an optional Micro Communication Adapter (MCA), you can turn your computer into a window to easily setup, operate, monitor and diagnose your SmartVFD drives. Just download the free PC Tool software from customer.honeywell.com, then use the adapter to connect to the drive.

PROGRAMMING AND COMMISSIONING

You'll have it all at your fingertips:

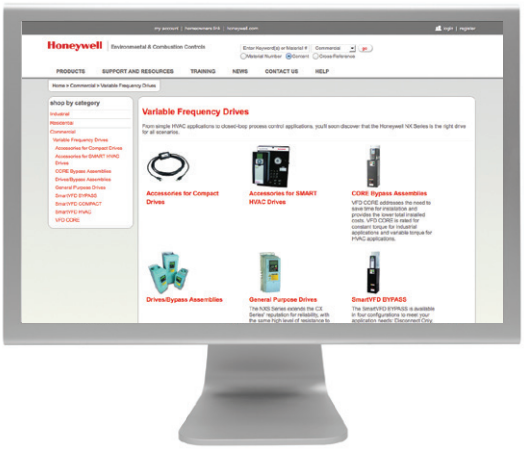
- Upload and download parameters to the SmartVFD drive for viewing and editing with maximum, minimum and default values for each parameter
- Directly control the drive to run it through its paces
- Save parameters for offline editing
- Directly control the drive speed in real time

MONITORING AND DIAGNOSTICS

See it all onscreen:

- Monitor parameters in real time
- Save screen shots and export values to a spreadsheet
- Pause a real-time monitoring window to capture accurate data
- For diagnostic assistance, view detailed active faults, the fault history (up to 40 stored faults), and I/O states

Smart Contacts and Websites



Honeywell Take-Off Service

1. Submit your information in one of the following ways:
   a) E-mail to takeoff.service@honeywelll.com (preferred)
   b) Fax toll-free to 1-877-880-3386
2. Include your desired turn-around time
3. Take-Off Service staff will send you a confirmation that your e-mail or fax was received. We always attempt to have your request finished as soon as possible. Please note, however, that the quality of the submitted information largely determines the turn-around time. We will work closely with you to ensure that we have enough information to move forward as quickly as possible.
4. Following take-off completion, a final product schedule spreadsheet will be returned to you that includes:
   - Complete product schedule
   - Base Price
   - Directions on how to order Honeywell products
   - Links to product submittals
   - Quote identification number

Main VFD Website
customer.honeywell.com/VFD

VFD Technical Hotline
763-954-6464 or
888-516-9347 option 4
techmail@honeywell.com

VFD for Consulting Engineer Site
specifyhoneywell.com/product.resources

Literature Ordering for VFD
literature.honeywell.com

Honeywell Promotional Materials
honeywell.promocollection.com

Buildings University Online and Face-to-Face Training
customer.honeywell.com/buildingsuniversity

New Product and Programs Website
beyondinnovation.honeywell.com

Learn More
For more information on Honeywell Variable Frequency Drives, contact your local Honeywell distributor, your Honeywell sales representative, call 1-800-466-3993 or visit **customer.honeywell.com/VFD**.

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Product Catalog

Variable Refrigerant Flow (VRF)
Air Source Heat Pump and Heat Recovery
Outdoor Units
4TVH*/4TVR*



February 2015

VRF-PRC008B-EN

Introduction

Trane® VRF variable refrigerant systems are efficient, effective, reliable heating and cooling solutions you can trust. When VRF is the right solution for your application, Trane® will help you ensure it's the best solution. VRF is well suited for historic buildings without existing ductwork, as well as schools and mid-rise office buildings with multiple interior spaces and diverse occupancy rates.

Trane® VRF systems are designed for exceptional energy efficiency, offering industry leading performance up to 33 IEER and 32 SCHE. Trane® VRF utilizes inverter compressors (some model feature dual compressors) with vapor injection for improved performance and comfort.

Systems are available for both heat pump and simultaneous heating and cooling operation. Both feature individual zone control to provide individual occupant comfort. The simultaneous heating and cooling models offer the ability to heat and cool adjacent zones, intelligently exchanging energy between them through strategically located mode control units.

Indoor units are available in a wide variety of configurations and capacities, allowing architects the flexibility to satisfy almost any design requirement.

Trane® offers a complete line-up of controls to complete your VRF installation. These range from easy to use individual zone controls, to centralized systems for building monitoring and control, as well as optional BACnet® connectivity for centralized Trane® Tracer™ integration.

Best of all, your Trane® VRF™ system is supported by the Trane® nationwide network of sales and service offices.

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Revision History

VRF-PRC008B-EN (17 February 2015)

- AHRI-1230 ratings updated and now include larger capacity systems previously not covered.
- Low ambient heating range expanded from -4°F to -13°F.

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System Features

- Individual modules are available as standard heat pump or simultaneous heating and cooling (heat recovery) configuration; units can be combined as double or triple modules for larger capacity requirements.
- 3rd generation compressor technology features all inverter compressors for superior efficiency and reliability
- Asymmetric scroll is designed to minimize frictional loss
- Dual inverter compressors (available in many models) are designed to equally share load for higher reliability
- Improved vapor injection system increases refrigerant flow rate up to 20% for superior heating performance
- Intercooler uses a plate heat exchanger for improved heating and cooling efficiency
- 8,400 RPM (maximum speed) compressor assures quick start cooling and heating performance
- Auto oil balancing eliminates the need for an oil balancing pipe
- Compressor inverter drives are liquid cooled for improved reliability
- Longer pipe lengths are the result of large oil storage capacity and low oil circulation rate
- Total harmonic distortion is reduced through adaptive sine wave control
- Refrigerant pump down and pump out facilitates maintenance and repair
- Automatic refrigerant balancing between indoor units optimize refrigerant distribution for better comfort and performance
- Optional quiet operation mode for reduced sound levels at night
- Auto snow blowing function removes accumulated snow when conditions require it
- Special hydrophilic heat exchanger coating minimizes frost build up on the outdoor coils and facilitates the defrost cycle.
- Anti-corrosion finish provides added protection in harsh environments
- Four and six port mode control units are light and compact. Distributed installation flexibility provides superior performance during simultaneous heating and cooling operation.
- Trane® VRF systems feature self-diagnosis, including system monitoring and error code reporting

Model Number Descriptions

4	T	V	R	0	0	9	6	B	3	0	0	N	B
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Digit 1 — Refrigerant
4 = R-410A

Digit 2 — Brand Name
T = Trane

Digit 3 — System Type
V = Variable Refrigerant Flow

Digit 4 — Functional Type Outdoor Unit
H = Heat Pump, DC Inverter (VRF)
R = Heat Recovery (three pipe), DC Inverter

Digit 5 — Special Application
0 = Standard

Digit 6,7,8 — Nominal Capacity
Important: *Btuh x1,000*
072 = 72,000 Btuh
096 = 96,000 Btuh
120 = 120,000 Btuh
144 = 144,000 Btuh

Digit 9 — Major Development Sequence
B = Second Development Sequence

Digit 10 — Electric Power Supply Characteristics
3 = 208–230/60/3
4 = 460/60/3

Digit 11 — Reserved for Future Use
0 = Not currently used

Digit 12 — Reserved for Future Use
0 = Not currently used

Digit 13 — Region of Sale
N = North America (UL or ETL)

Digit 14 — Minor Design Sequence
B = Second Design Sequence

System Combination Line-up

	Tons	4TVH/R0072B	4TVH/R0096B	4TVH/R0120B	4TVH/R0144B
Single Module	6	1			
	8		1		
	10			1	
	12				1
Double Module	14	1	1		
	16	1		1	
	18	1			1
	20			2	
	22			1	1
	24				2
Triple Module	26	1	1		1
	28	1		1	1
	30	1			2
	32			2	1
	34			1	2
	36				3

Products

Table 1. Application matrix

		Capacity													
		7.5 MBh	9.0 MBh	9.5 MBh	12 MBh	18 MBh	20 MBh	24 MBh	30 MBh	36 MBh	42 MBh	48 MBh	60 MBh	76.8 MBh	96 MBh
Type															
Slim one way cassette		x		x	x										
Four way cassette			x		x	x		x	x	x		x			
Mini four way cassette				x	x	x	x								
Slim duct		x		x	x	x		x	x	x		x			
MSP duct						x		x	x	x		x			
HSP duct										x		x		x	x
Ceiling						x		x							
High Wall		x		x	x	x	x	x							
Convertible AHU								x	x	x	x	x	x		

Controls

Table 2. Controls for VRF Products

Family	Description	Model Number
Zone Controllers	VRF Wireless Remote Control	TVCTRLTRDH00UT
	VRF Simple Wired Remote Control	TVCTRLWR001T
	VRF Wired Remote Control	TVCTRLTWRWD01T
	VRF Duct Signal Receiver & Wire	TVCTRLTRKA10N0
Centralized Control Systems	VRF Central On/Off Control	TVCTRLTCMA202D
	VRF Touch Screen Control	TVCTRLTCMA300T
	VRF Mode Select Switch	TVCTRLTCMC2000
Integrated System Management	VRF System Controller	TVCTRLTIMD00A0
	VRF Enterprise Management Software	TVCTRLTSTP3P00
	VRF Power Meter Interface Mod.	TVCTRLTIMB16A0
Building Management System Gateways	VRF System Controller + BACnet	TVCTRLTIMB17A0
	VRF System Controller + LonTalk™	TVCTRLTIMB18A0
Interface Modules	VRF External Contact Interface Module	TVCTRLTIMB14A0
	VRF Multi Function Control	TVCTRLTC210N00
	VRF MFC Enclosure	TVCTRLTC210BOX
	Required control box for 4TVM air handling unit	4TVCTRLAU001
Sensors	VRF Ext. Room Temp Sensor	TVCTRLTRWTA000
	VRF Motion Sensor Mini 4Way	MOTIONSEN4TVB
Commissioning and Utility Kits	VRF Technician Utilities Tool	TVCTRLTIMC0300
	VRF Auto-Commissioning Tool	TVCTRLTIMC1000

Accessories

Table 3. Accessories for VRF Products

Family	Description	Model Number
Refrigeration Joints	VRF Y-joint <51MBh	4YDK1509B0051A
	VRF Y-joint 51-138MBh	4YDK2512B0138A
	VRF Y-joint 138-160MBh	4YDK2812B0160A
	VRF Y-joint 160-240MBh	4YDK2815B0240A
	VRF Y-joint 240-336MBh	4YDK3419B0336A
	VRF Y-joint 336-468MBh	4YDK4119B0468A
	VRF Y-joint >468MBh	4YDK4422B0999A
	VRF Y-joint HR <80MBh	4YDK1500B0080A
	VRF Y-joint HR 80-240MBh	4YDK2500B0240A
	VRF Y-joint HR 240-468MBh	4YDK3100B0468A
	VRF Y-joint HR >468MBh	4YDK3800B0999A
	VRF T-joint >468MBh	4TDK3800B0999A
	VRF T-joint <468MBh	4TDK3819B0000A
	VRF T-joint HR <468MBh	4TDK3100B0000A
	VRF T-joint HR >468MBh	4TDK4422B0999A
Header Joints	VRF Header Joint 4Units<160MBh	4HJK2512B0159A
	VRF Header Joint 8Units 240MBh	4HJK3115B0241A
	VRF Header Joint 8Units<160MBh	4HJK3819B0998A
EEV Kits (For Floor/Ceiling and Selected High Wall Indoor Units	VRF EEV Kit 1Unit 7-15.5MBh	4EEVEVA24SA000
	VRF EEV Kit 1Unit 17-31MBh	4EEVEVA32SA000
	VRF EEV 1x 7-15.5& 1x 17-31MBh	4EEVXDA24K132A
	VRF EEV Kit 2Unit 7-15.5MBh	4EEVXDA24K200A
	VRF EEV 2x 7-15.5& 1x 17-31MBh	4EEVXDA24K232A
	VRF EEV Kit 2Unit 17-31MBh	4EEVXDA32K200A
	VRF EEV 1x 7-15.5& 2x 17-31MBh	4EEVXDA32K224A
	VRF EEV Kit 3Unit 7-15.5MBh	4EEVXDA24K300A
	VRF EEV Kit 3Unit 17-31MBh	4EEVXDA32K300A
AHU Kits	VRF AHU Kit 24-30MBh	4EEVAKA40K1025
	VRF AHU Kit 48-60MBh	4EEVAKA40K1050
	VRF AHU Kit 72-90MBh	4EEVAKA64K1075
	VRF AHU Kit 96-112MBh	4EEVAKA64K1100

Table 3. Accessories for VRF Products (continued)

Family	Description	Model Number
Condensate Pumps	VRF Drain Pump High Wall and Floor/Ceiling	CONDPUMPAHWB01
	VRF Drain Pump Slim Duct	CONDPUMPXVLB01
	VRF Drain Pump MSP 18/24MBh	CONDPUMPXVMB01
	VRF Drain Pump MSP 30/36MBh	CONDPUMPXVMB02
	VRF Drain Pump MSP48/ HSP3648MBh	CONDPUMPXVDB01
	VRF Drain Pump HSP 76.8/96MBh	CONDPUMPXVHB01
Mode Control Units (for Simultaneous Heating and Cooling Applications)	VRF MCU Kit up to 4 IDU	4MCUCUY4NCE000
	VRF MCU Kit up to 6 IDU	4MCUCUY6NCE000
	VRF MCU Kit 2 IDU 36 MBh +	4MCUCUY2NCE000
Ball Valves	1/2" Ball Valve Flare	BVALVE12FLARE1
	1/4" Ball Valve Flare	BVALVE14FLARE1
	3/8" Ball Valve Flare	BVALVE38FLARE1
	5/8" Ball Valve Flare	BVALVE58FLARE1
Cassette Panels	VRF Cass. Panel Sliding 1Way	TVEPANPC1NUAET
	VRF Cass. Panel Slim 1Way	TVEPANPC1NUSET
	VRF Cass. Panel 4Way	TVEPANPC4NUSET
	VRF Cass. Panel Mini 4Way	TVEPANPC4SUSET
Pressure Differential Module (for high rise applications)	Pressure Diff Module 6/8/10 Ton	MXD-A12K2A
	Pressure Diff Module 12 Ton	MXD-A38K2A
Hail Guards	Hail Guard 4TVH/TVR0072B	TVRGARD001A
	Hail Guard 4TVH/TVR0096-0144B	TVRGARD002A
	Hail Guard 4TVH0036-0053B	TVRGARD003A

Product Specifications

Outdoor Units

Table 4. 208-230V Heat Pump Single Modules

Model Name				4TVH0072B300NB		4TVH0096B300NB		4TVH0120B300NB		4TVH0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			6.0		8.0		10.0		12.0	
	System Type			Ducted	Non-ducted	Ducted	Non-ducted	Ducted	Non-ducted	Ducted	Non-ducted
	Capacity (Nominal)[a]	Cooling	Btuh	72,000	72,000	96,000	96,000	120,000	120,000	144,000	144,000
		Heating	Btuh	81,000	81,000	108,000	108,000	135,000	135,000	162,000	162,000
	Capacity (Rated)[b]	Cooling	Btuh	69,000	69,000	92,000	92,000	114,000	114,000	138,000	138,000
		High Temp Heating	Btuh	77,000	77,000	103,000	103,000	129,000	129,000	154,000	154,000
		Low Temp Heating	Btuh	51,000	51,000	67,000	67,000	84,000	84,000	100,000	100,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	11.50	12.90	11.60	13.80	11.10	12.50	10.80	11.20
		IEER	-	22.50	33.00	23.00	31.00	21.80	26.70	21.10	24.50
		COP @ 47°F	-	3.46	4.15	3.60	4.23	3.43	3.97	3.54	3.64
		COP @ 17°F	-	2.49	2.75	2.47	2.90	2.45	2.62	2.23	2.40
		SCHE	-	-	-	-	-	-	-	-	-
Power	MCA		A	28		37.8		43		52.6	
	MOP		A	35		50		50		70	
	SCCR		kA	-		-		-		5.0	
Compressor	Type (Qty.)		-	SSC SCROLL (1)		SSC SCROLL (2)		SSC SCROLL (2)		SSC SCROLL (2)	
	Model Name		-	DS-GB052FBVASG		DS-GB052FBVASG (2)		DS-GB052FBVASG (2)		DS-GB052FBVASG (2)	
	Output		kW each	4.96		4.96		4.96		4.96	
	Oil	Type	-	PVE		PVE		PVE		PVE	
	Initial Charge		fl. oz.	77.8		155.5		155.5		155.5	
Fan	Type (Qty.)		-	Propeller (1)		Propeller (2)		Propeller (2)		Propeller (2)	
	Output (Each)		W	400		620		620		620	
	Airflow Rate		CFM	7,240		9,180		9,180		9,535	
	External Static Pressure		In. WG	0.31		0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/8" Braze		3/8" Braze		1/2" Braze		1/2" Braze	
	Gas Pipe		Ø inch	3/4" Braze		7/8" Braze		1 1/8" Braze		1 1/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	N/A		N/A		N/A		N/A	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	12		16		20		25	
	Total Capacity		-	50 To 130% Of Total Outdoor Unit Capacity							
Refrigerant	Type		-	R-410A		R-410A		R-410A		R-410A	
	Factory Charge		lbs.	12.1		16.3		16.3		19.18	
Sound[e]	Sound Pressure		dB(A)	60.0		61.0		61.0		62.0	
	Sound Power		dB(A)	81		81		81		83	
External Dimensions	Net Weight		lbs.	425		624		624		657	
	Shipping Weight		lbs.	461		666		666		699	
	Net Dimensions (WXHXD)		inches	34.65 X 66.73 X 30.12		50.98 X 66.73 X 30,12		50.98 X 66.73 X 30,12		50.98 X 66.73 X 30.12	
	Shipping Dimensions (WXHXD)		inches	37.32 X 75.28 X 32.76		53.66 X 75.28 X 32.76		53.66 X 75.28 X 32.76		53.66 X 75.28 X 32.76	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75		-13 ~ 75	

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB

(b) Rated per AHRI-1230 Standard conditions.

(c) Actual length (equivalent length in parenthesis).

(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. (If the height difference exceeds 164 ft., request engineering support from Trane). If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.

(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 5. 208~230V Heat Pump Dual Modules I

Model Name				4TVH0168B300NB + 4TVH0072B300NB + 4TVH0096B300NB		4TVH0192B300NB + 4TVH0072B300NB + 4TVH0120B300NB		4TVH0216B300NB + 4TVH0072B300NB + 4TVH0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			14.0		16.0		18.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	168,000	168,000	192,000	192,000	216,000	216,000
		Heating	Btuh	189,000	189,000	216,000	216,000	243,000	243,000
	Capacity (Rated)[b]	Cooling	Btuh	160,000	160,000	184,000	183,000	206,000	206,000
		High Temp Heating	Btuh	180,000	180,000	206,000	206,000	230,000	230,000
		Low Temp Heating	Btuh	118,000	118,000	134,000	134,000	150,000	150,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	11.40	12.10	10.90	11.40	10.60	10.80
		IEER	-	20.80	25.90	21.50	24.10	20.50	22.40
		COP @ 47°F	-	3.46	3.94	3.34	3.83	3.34	3.63
		COP @ 17°F	-	2.43	2.65	2.42	2.59	2.31	2.52
		SCHE	-	-	-	-	-	-	-
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (3)		SSC Scroll (3)		SSC Scroll (3)	
	Model Name		-	DS-GB052FBVASG x 3		DS-GB052FBVASG x 3		DS-GB052FBVASG x 3	
	Output		kW each	4.96 x 3		4.96 x 3		4.96 x 3	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	233.3		233.3		233.3	
Fan	Type (Qty.)		-	Propeller (3)		Propeller (3)		Propeller (3)	
	Output (Each)		W	400 + 620 x 2		400 + 620 x 2		400 + 620 x 2	
	Airflow Rate		CFM	7,240 + 9,180		7,240 + 9,180		7,240 + 9,535	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	5/8" Braze		5/8" Braze		5/8" Braze	
	Gas Pipe		Ø inch	1 1/8" Braze		1 1/8" Braze		1 1/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	N/A		N/A		N/A	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	29		33		37	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R-410A		R-410A		R-410A	
	Factory Charge		lbs.	28.4		28.4		31.3	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	425 + 624		425 + 624		425 + 657	
	Shipping Weight		lbs.	461 + 666		461 + 666		461 + 699	
	Net Dimensions (WXHXD)		inches	34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12		34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12		34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12	
	Shipping Dimensions (WXHXD)		inches	37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76		37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76		37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires 4TDK3819B0000A outdoor unit T-joint connection

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference; Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 6. 208~230V Heat Pump Dual Modules II

Model Name				4TVH0240B300NB		4TVH0264B300NB		4TVH0288B300NB	
				2x 4TVH0120B300NB		4TVH0120B300NB + 4TVH0144B300NB		2x 4TVH0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			20.0		22.0		24.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	240,000	240,000	264,000	264,000	288,000	288,000
		Heating	Btuh	270,000	270,000	297,000	297,000	324,000	324,000
	Capacity (Rated)[b]	Cooling	Btuh	228,000	228,000	252,000	252,000	276,000	276,000
		High Temp Heating	Btuh	258,000	258,000	282,000	282,000	308,000	308,000
		Low Temp Heating	Btuh	168,000	168,000	184,000	184,000	200,000	200,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	10.60	11.10	10.10	10.50	10.00	9.50
		IEER	-	19.10	21.80	18.60	21.50	18.60	21.00
		COP @ 47°F	-	3.24	3.65	3.25	3.45	3.25	3.26
		COP @ 17°F	-	2.40	2.54	2.26	2.41	2.12	2.29
		SCHE	-	-	-	-	-	-	-
Power	MCA		A	28		37.8		43	
	MOP		A	35		50		50	
	SCCR		kA	-		-		-	
Compressor	Type (Qty.)		-	SSC Scroll (1)		SSC Scroll (2)		SSC Scroll (2)	
	Model Name		-	DS-GB052FBVASG		DS-GB052FBVASG x 2		DS-GB052FBVASG x 2	
	Output		kW each	4.96 x 4		4.96 x 4		4.96 x 4	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	311.1		311.1		311.1	
Fan	Type (Qty.)		-	Propeller (4)		Propeller (4)		Propeller (4)	
	Output (Each)		W	620 x 4		620 x 4		620 x 4	
	Airflow Rate		CFM	9180 x 2		9,180 + 9,535		9535 x 2	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	5/8" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 1/8" Braze		1 3/8" Braze		1 3/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	N/A		N/A		N/A	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	41		45		49	
	Total Capacity		-	50 to 130% of total outdoor unit cooling capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	32.6		35.5		38.4	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	624 x 2		624 + 657		657 x 2	
	Shipping Weight		lbs.	699 x 2		665 + 699		699 x 2	
	Net Dimensions (WXHXD)		inches	(50.98 x 66.73 x 30.12) x 2		(50.98 x 66.73 x 30.12) x 2		(50.98 x 66.73 x 30.12) x 2	
	Shipping Dimensions (WXHXD)		inches	(53.66 x 75.28 x 32.76) x 2		(53.66 x 75.28 x 32.76) x 2		(53.66 x 75.28 x 32.76) x 2	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires 4TDK3819B0000A outdoor unit T-joint connection

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 7. 208-230V Heat Pump Triple Modules I

Model Name				4TVH0312B300NB 4TVH0072B300NB + 4TVH0096B300NB + 4TVH0144B300NB		4TVH0336B300NB 4TVH0072B300NB + 4TVH0120B300NB + 4TVH0144B300NB		4TVH0360B300NB 4TVH0072B300NB + 2x 4TVH0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			26.0		28.0		30.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	312,000	312,000	336,000	336,000	360,000	360,000
		Heating	Btuh	351,000	351,000	378,000	378,000	405,000	405,000
	Capacity (Rated)[b]	Cooling	Btuh	298,000	298,000	320,000	320,000	344,000	344,000
		High Temp Heating	Btuh	334,000	334,000	360,000	360,000	386,000	386,000
		Low Temp Heating	Btuh	218,000	218,000	234,000	234,000	250,000	250,000
	AHRI -1230 Efficiency Ratings[2]	EER	-	10.30	10.50	10.00	10.20	9.80	9.80
		IEER	-	18.30	21.20	17.10	20.50	16.60	20.00
		COP @ 47°F	-	3.20	3.38	3.20	3.27	3.20	3.22
		COP @ 17°F	-	2.25	2.54	2.21	2.39	2.11	2.31
		SCHE	-	-	-	-	-	-	-
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (5)		SSC Scroll (5)		SSC Scroll (5)	
	Model Name		-	DS-GB052FBVASG (5)		DS-GB052FBVASG (5)		DS-GB052FBVASG (5)	
	Output		kW each	4.96 x 5		4.96 x 5		4.96 x 5	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	388.9		388.9		388.9	
Fan	Type (Qty.)		-	Propeller (5)		Propeller (5)		Propeller (5)	
	Output (Each)		W	400 + 620 x 4		400 + 620 x 4		400 + 620 x 4	
	Airflow Rate		CFM	7,240 + 9,180 + 9,535		7,240 + 9,180 + 9,535		7,240 + (9,535 x2)	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/4" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 3/8" Braze		1 3/8" Braze		1 5/8" Braze	
	High Pressure Gas Pipe (For Hr)		Ø inch	N/A		N/A		N/A	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	54		58		62	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	47.6		47.6		50.5	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	425 + 624 + 657		425 + 624 + 657		425 + (657 x2)	
	Shipping Weight		lbs.	461 + 666 + 699		461 + 666 + 699		461 + (699 x2)	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2		34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2		34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2		7.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2		37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires two 4TDK3819B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions (published ratings apply to systems ≤ 300,000 Btuh).
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft..
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 8. 208-230V Heat Pump Triple Modules II

Model Name				4TVH0384B300NB		4TVH0408B300NB		4TVH0432B300NB	
				2x 4TVH0120B300NB + 4TVH0144B300NB		4TVH0120B300NB + 2x 4TVH0144B300NB		3x 4TVH0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			32.0		34.0		36.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	384,000	384,000	408,000	408,000	432,000	432,000
		Heating	Btuh	432,000	432,000	459,000	459,000	486,000	486,000
	Capacity (Rated)[b]	Cooling	Btuh	366,000	366,000	390,000	390,000	415,000	415,000
		High Temp Heating	Btuh	410,000	410,000	435,000	435,000	460,000	460,000
		Low Temp Heating	Btuh	268,000	268,000	284,000	284,000	300,000	300,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	9.50	9.50	9.50	9.50	9.50	9.50
		IEER	-	16.50	19.50	16.40	19.10	16.30	19.10
		COP @ 47°F	-	3.20	3.20	3.20	3.20	3.20	3.20
		COP @ 17°F	-	2.05	2.10	2.05	2.05	2.05	2.05
		SCHE	-	-	-	-	-	-	-
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (6)		SSC Scroll (6)		SSC Scroll (6)	
	Model Name		-	DS-GB052FBVASG (6)		DS-GB052FBVASG (6)		DS-GB052FBVASG (6)	
	Output		kW each	4.96 x 6		4.96 x 6		4.96 x 6	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	466.6		466.6		466.6	
Fan	Type (Qty.)		-	Propeller (6)		Propeller (6)		Propeller (6)	
	Output (Each)		W	620 x 6		620 x 6		620 x 6	
	Airflow Rate		CFM	(9,180 x2) + 9535		9,180 + (2x 9,535)		9535 x 3	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/4" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 5/8" Braze		1 5/8" Braze		1 5/8" Braze	
	High Pressure Gas Pipe (For Hr)		Ø inch	N/A		N/A		N/A	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	64		64		64	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	51.8		54.7		57.5	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	(624 x 2) + 657		624 + (657 x2)		657 x 3	
	Shipping Weight		lbs.	(666 x2) + 699		666 + (699 x2)		699 x 3	
	Net Dimensions (WxHxD)		inches	(50.98 x 66.73 x 30.12) x 3		(50.98 x 66.73 x 30.12) x 3		(50.98 x 66.73 x 30.12) x 3	
	Shipping Dimensions (WxHxD)		inches	(53.66 x 75.28 x 32.76) x 3		(53.66 x 75.28 x 32.76) x 3		(53.66 x 75.28 x 32.76) x 3	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires two 4TDK3819B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions (published ratings apply to systems ≤ 300,000 Btuh).
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions

Table 9. 208-230V Heat Recovery Single Modules

Model Name				4TVR0072B300NB		4TVR0096B300NB		4TVR0120B300NB		4TVR0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			6.0		8.0		10.0		12.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	72,000	72,000	96,000	96,000	120,000	120,000	144,000	144,000
		Heating	Btuh	81,000	81,000	108,000	108,000	135,000	135,000	162,000	162,000
	Capacity (Rated)[b]	Cooling	Btuh	69,000	69,000	92,000	92,000	114,000	114,000	138,000	138,000
		High Temp Heating	Btuh	77,000	77,000	103,000	103,000	129,000	129,000	154,000	154,000
		Low Temp Heating	Btuh	51,000	51,000	67,000	67,000	84,000	84,000	100,000	100,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	11.50	12.90	11.60	13.80	11.10	12.50	10.80	11.20
		IEER	-	22.50	33.00	23.00	31.00	21.80	26.70	21.10	24.50
		COP @ 47°F	-	3.46	4.15	3.60	4.23	3.43	3.97	3.54	3.64
		COP @ 17°F	-	2.49	2.75	2.47	2.90	2.45	2.62	2.23	2.40
		SCHE	-	26.00	28.00	26.50	32.00	25.50	31.00	25.00	27.50
Power	MCA		A	28		37.8		43		52.6	
	MOP		A	35		50		50		70	
	SCCR		kA	-		-		-		5.0	
Compressor	Type (Qty.)		-	SSC Scroll (1)		SSC Scroll (2)		SSC Scroll (2)		SSC Scroll (2)	
	Model Name		-	DS-GB052FBVASG		DS-GB052FBVASG x 2		DS-GB052FBVASG x 2		DS-GB052FBVASG x 2	
	Output		kW each	4.96		4.96 x 2		4.96 x 2		4.96 x 2	
	Oil	Type	-	PVE		PVE		PVE		PVE	
		Initial Charge	fl. oz.	77.8		155.5		155.5		155.5	
Fan	Type (Qty.)		-	Propeller (1)		Propeller (2)		Propeller (2)		Propeller (2)	
	Output (Each)		W	400		620		620		620	
	Airflow Rate		CFM	7,240		9,180		9,180		9,535	
	External Static Pressure		in. WG	0.31		0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/8" Braze		3/8" Braze		1/2" Braze		1/2" Braze	
	Gas Pipe		Ø inch	3/4" Braze		7/8" Braze		1 1/8" Braze		1 1/8" Braze	
	High Pressure Gas Pipe (For Hr)		Ø inch	5/8" Braze		3/4" Braze		7/8" Braze		7/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	12		16		20		25	
	Total Capacity		-	50 to 130% of total outdoor unit capacity							
Refrigerant	Type		-	R410A		R410A		R410A		R410A	
	Factory Charge		lbs.	12.1		16.3		16.3		19.18	
Sound[e]	Sound Pressure		dB(A)	60.0		61.0		61.0		62.0	
	Sound Power		dB(A)	81		81		81		83	
External Dimensions	Net Weight		lbs.	430		637		637		672	
	Shipping Weight		lbs.	465		679		679		714	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12		50.98 x 66.73 x 30,12		50.98 x 66.73 x 30,12		50.98 x 66.73 x 30.12	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76		53.66 x 75.28 x 32.76		53.66 x 75.28 x 32.76		53.66 x 75.28 x 32.76	
Operating Temp Range	Cooling[f]		°F	5 ~ 120		5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75		-13 ~ 75	

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 10. 208-230V Heat Recovery Dual Modules I

Model Name				4TVR0168B300NB + 4TVR0072B300NB + 4TVR0096B300NB		4TVR0192B300NB + 4TVR0072B300NB + 4TVR0120B300NB		4TVR0216B300NB + 4TVR0072B300NB + 4TVR0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			14.0		16.0		18.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	168,000	168,000	192,000	192,000	216,000	216,000
		Heating	Btuh	189,000	189,000	216,000	216,000	243,000	243,000
	Capacity (Rated)[b]	Cooling	Btuh	160,000	160,000	184,000	184,000	206,000	206,000
		High Temp Heating	Btuh	180,000	180,000	206,000	206,000	230,000	230,000
		Low Temp Heating	Btuh	118,000	118,000	134,000	134,000	150,000	150,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	11.40	12.10	10.90	11.40	10.60	10.80
		IEER	-	20.80	25.90	21.50	24.10	20.50	22.40
		COP @ 47°F	-	3.46	3.94	3.34	3.83	3.34	3.63
		COP @ 17°F	-	2.43	2.65	2.42	2.59	2.31	2.52
		SCHE	-	23.50	27.00	23.50	26.50	23.00	25.50
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (3)		SSC Scroll (3)		SSC Scroll (3)	
	Model Name		-	DS-GB052FBVASG x 3		DS-GB052FBVASG x 3		DS-GB052FBVASG x 3	
	Output		kW each	4.96 x 3		4.96 x 3		4.96 x 3	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	233.3		233.3		233.3	
Fan	Type (Qty.)		-	Propeller (3)		Propeller (3)		Propeller (3)	
	Output (Each)		W	400 + 620 x 2		400 + 620 x 2		400 + 620 x 2	
	Airflow Rate		CFM	7,240 + 9,180		7,240 + 9,180		7,240 + 9,535	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	5/8" Braze		5/8" Braze		5/8" Braze	
	Gas Pipe		Ø inch	1 1/8" Braze		1 1/8" Braze		1 1/8" Braze	
	High Pressure Gas Pipe (For Hr)		Ø inch	7/8" Braze		1 1/8" Braze		1 1/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	29		33		37	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	28.4		28.4		31.3	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	430 + 637		430 + 637		430 + 672	
	Shipping Weight		lbs.	465 + 479		465 + 479		465 + 714	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12		34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12		34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76		37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76		37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76	
Operating Temp Range	Cooling[f]		°F	5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires 4TDK3819B0000A and 4TDK3100B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 11. 208~230V Heat Recovery Dual Modules II

Model Name				4TVR0240B300NB		4TVR0264B300NB		4TVR0288B300NB	
				2x 4TVR0120B300NB		4TVR0120B300NB + 4TVR0144B300NB		2x 4TVR0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			20.0		22.0		24.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	240,000	240,000	264,000	264,000	288,000	288,000
		Heating	Btuh	270,000	270,000	297,000	297,000	324,000	324,000
	Capacity (Rated)[b]	Cooling	Btuh	228,000	228,000	252,000	252,000	276,000	276,000
		High Temp Heating	Btuh	258,000	258,000	282,000	282,000	308,000	308,000
		Low Temp Heating	Btuh	168,000	168,000	184,000	184,000	200,000	200,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	10.60	11.10	10.10	10.50	10.00	9.50
		IEER	-	19.10	21.80	18.60	21.50	18.60	21.00
		COP @ 47°F	-	3.24	3.65	3.25	3.45	3.25	3.26
		COP @ 17°F	-	2.40	2.54	2.26	2.41	2.12	2.29
		SCHE	-	22.50	25.50	22.00	24.50	21.50	23.50
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (4)		SSC Scroll (4)		SSC Scroll (4)	
	Model Name		-	DS-GB052FBVASG x 4		DS-GB052FBVASG x 4		DS-GB052FBVASG x 4	
	Output		kW each	4.96 x 4		4.96 x 4		4.96 x 4	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	311.1		311.1		311.1	
Fan	Type (Qty.)		-	Propeller (4)		Propeller (4)		Propeller (4)	
	Output (Each)		W	620 x 4		620 x 4		620 x 4	
	Airflow Rate		CFM	9180 x 2		9,180 + 9,535		9535 x 2	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	5/8" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 1/8" Braze		1 3/8" Braze		1 3/8" Braze	
	High Pressure Gas Pipe (For Hr)		Ø inch	1 1/8" Braze		1 1/8" Braze		1 1/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	41		45		49	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R-410A		R410A		R410A	
	Factory Charge		lbs.	32.6		32.6		35.5	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	637 x 2		637 x 2		637 + 672	
	Shipping Weight		lbs.	714 x 2		679 x 2		679 + 714	
	Net Dimensions (WxHxD)		inches	(50.98 x 66.73 x 30.12) x 2		(50.98 x 66.73 x 30.12) x 2		(50.98 x 66.73 x 30.12) x 2	
	Shipping Dimensions (WxHxD)		inches	(53.66 x 75.28 x 32.76) x 2		(53.66 x 75.28 x 32.76) x 2		(53.66 x 75.28 x 32.76) x 2	
Operating Temp Range	Cooling[f]		°F	23 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-4 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires 4TDK3819B0000A and 4TDK3100B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 12. 208-230V Heat Recovery Triple Modules I

Model Name				4TVR0312B300NB 4TVR0072B300NB + 4TVR0096B300NB + 4TVR0144B300NB		4TVR0336B300NB 4TVR0072B300NB + 4TVR0120B300NB + 4TVR0144B300NB		4TVR0360B300NB 4TVR0072B300NB + 2x 4TVR0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			26.0		28.0		30.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	312,000	312,000	336,000	336,000	360,000	360,000
		Heating	Btuh	351,000	351,000	378,000	378,000	405,000	405,000
	Capacity (Rated)[b]	Cooling	Btuh	298,000	298,000	320,000	320,000	344,000	344,000
		High Temp Heating	Btuh	334,000	334,000	360,000	360,000	386,000	386,000
		Low Temp Heating	Btuh	218,000	218,000	234,000	234,000	250,000	250,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	10.30	10.50	10.00	10.20	9.80	9.80
		IEER	-	18.30	21.20	17.10	20.50	16.60	20.00
		COP @ 47°F	-	3.20	3.38	3.20	3.27	3.20	3.22
		COP @ 17°F	-	2.25	2.54	2.21	2.39	2.11	2.31
		SCHE	-	20.50	23.50	20.50	23.10	20.00	22.40
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (5)		SSC Scroll (5)		SSC Scroll (5)	
	Model Name		-	DS-GB052FBVASG x 5		DS-GB052FBVASG x 5		DS-GB052FBVASG x 5	
	Output		kW each	4.96 x 5		4.96 x 5		4.96 x 5	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	388.9		388.9		388.9	
Fan	Type (Qty.)		-	Propeller (5)		Propeller (5)		Propeller (5)	
	Output (Each)		W	400 + 620 x 4		400 + 620 x 4		400 + 620 x 4	
	Airflow Rate		CFM	7,240 + 9,180 + 9,535		7,240 + 9,180 + 9,535		7,240 + (9,535 x2)	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/4" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 3/8" Braze		1 3/8" Braze		1 5/8" Braze	
	High Pressure Gas Pipe (For Hr)		Ø inch	1 1/8" Braze		1 1/8" Braze		1 3/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	54		58		62	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	47.6		47.6		50.5	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	430 + 637 + 672		430 + 637 + 672		430 + (672 x 2)	
	Shipping Weight		lbs.	465 + 679 + 714		465 + 679 + 714		465 + (714 x 2)	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12 +(50.98 x 66.73 x 30.12) x2		34.65 x 66.73 x 30.12 +(50.98 x 66.73 x 30.12) x2		34.65 x 66.73 x 30.12 +(50.98 x 66.73 x 30.12) x2	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2		37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2		37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2	
Operating Temp Range	Cooling[f]		°F	5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires two each 4TDK3819B0000A and 4TDK3100B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions (published ratings apply to systems ≤ 300,000 Btuh).
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 13. 208-230V Heat Recovery Triple Modules II

Model Name				4TVR0384B300NB		4TVR0408B300NB		4TVR0432B300NB	
				2x 4TVR0120B300NB + 4TVR0144B300NB		4TVR0120B300NB + 2x 4TVR0144B300NB		3x 4TVR0144B300NB	
Power Supply				208-230/60/3		208-230/60/3		208-230/60/3	
Performance	Nominal Tons			32.0		34.0		36.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	384,000	384,000	408,000	408,000	432,000	432,000
		Heating	Btuh	432,000	432,000	459,000	459,000	486,000	486,000
	Capacity (Rated)[b]	Cooling	Btuh	366,000	366,000	390,000	390,000	415,000	415,000
		High Temp Heating	Btuh	410,000	410,000	435,000	435,000	460,000	460,000
		Low Temp Heating	Btuh	268,000	268,000	284,000	284,000	300,000	300,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	9.50	9.50	9.50	9.50	9.50	9.50
		IEER	-	16.50	19.50	16.40	19.10	16.30	19.10
		COP @ 47°F	-	3.20	3.20	3.20	3.20	3.20	3.20
		COP @ 17°F	-	2.05	2.10	2.05	2.05	2.05	2.05
		SCHE	-	16.50	23.00	19.00	22.00	19.00	21.50
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (6)		SSC Scroll (6)		SSC Scroll (6)	
	Model Name		-	DS-GB052FBVASG x 6		DS-GB052FBVASG x 6		DS-GB052FBVASG x 6	
	Output		kW each	4.96 x 6		4.96 x 6		4.96 x 6	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	466.6		466.6		466.6	
Fan	Type (Qty.)		-	Propeller (6)		Propeller (6)		Propeller (6)	
	Output (Each)		W	620 x 6		620 x 6		620 x 6	
	Airflow Rate		CFM	(9,180 x2) + 9535		9,180 + (2x 9,535)		9535 x 3	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/4" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 5/8" Braze		1 5/8" Braze		1 5/8" Braze	
	High Pressure Gas Pipe (For Hr)		Ø inch	1 3/8" Braze		1 3/8" Braze		1 3/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	64		64		64	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	51.8		54.7		57.5	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	(637 x 2) + 672		(637 x 2) + 672		672 x 2	
	Shipping Weight		lbs.	(679 x 2) + 714		(679 x2) + 714		714 x 2	
	Net Dimensions (WxHxD)		inches	(50.98 x 66.73 x 30.12) x 3		(50.98 x 66.73 x 30.12) x 3		(50.98 x 66.73 x 30.12) x 3	
	Shipping Dimensions (WxHxD)		inches	(53.66 x 75.28 x 32.76) x 3		(53.66 x 75.28 x 32.76) x 3		(53.66 x 75.28 x 32.76) x 3	
Operating Temp Range	Cooling[f]		°F	5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires two each 4TDK3819B0000A and 4TDK3100B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions (published ratings apply to systems ≤ 300,000 Btuh).
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 14. 460V Heat Pump Single Modules

Model Name				4TVH0072B400NB		4TVH0096B400NB		4TVH0120B400NB		4TVH0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			6.0		8.0		10.0		12.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal) (a)	Cooling	Btuh	72,000	72,000	96,000	96,000	120,000	120,000	144,000	144,000
		Heating	Btuh	81,000	81,000	108,000	108,000	135,000	135,000	162,000	162,000
	Capacity (Rated)(b)	Cooling	Btuh	69,000	69,000	92,000	92,000	114,000	114,000	138,000	138,000
		High Temp Heating	Btuh	77,000	77,000	103,000	103,000	129,000	129,000	154,000	154,000
		Low Temp Heating	Btuh	51,000	51,000	67,000	67,000	84,000	84,000	100,000	100,000
	AHRI -1230 Efficiency Ratings(b)	EER	-	11.50	12.90	11.50	13.90	11.10	12.40	10.80	11.20
		IEER	-	22.50	33.00	22.40	29.60	21.20	27.10	21.10	24.50
		COP @ 47°F	-	3.46	4.15	3.56	4.23	3.43	3.97	3.54	3.64
		COP @ 17°F	-	2.49	2.75	2.45	2.81	2.44	2.53	2.23	2.40
		SCHE	-	-	-	-	-	-	-	-	-
Power	MCA		A	16.4		19		21.7		26.4	
	MOP		A	20		25		30		40	
	SCCR		kA	-		-		-		-	
Compressor	Type (Qty.)		-	SSC Scroll (1)		SSC Scroll (1)		SSC Scroll (1)		SSC Scroll (2)	
	Model Name		-	DS-GB052FAVASG		DS-GB066FAVASG		DS-GB066FAVASG		DS-GB052FAVASG	
	Output		kW	4.96		6.13		6.13		4.96 x 2	
	Oil	Type	-	PVE		PVE		PVE		PVE	
		Initial Charge	fl. oz.	77.8		77.8		77.8		155.5	
Fan	Type (Qty.)		-	Propeller (1)		Propeller (2)		Propeller (2)		Propeller (2)	
	Output (Each)		W	400		620		620		620	
	Airflow Rate		CFM	7,240		9,180		9,180		9,535	
	External Static Pressure		in. WG	0.31		0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/8" Braze		3/8" Braze		1/2" Braze		1/2" Braze	
	Gas Pipe		Ø inch	3/4" Braze		7/8" Braze		1 1/8" Braze		1 1/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	N/A		N/A		N/A		N/A	
	Installation Limits	Max Length(c)	ft.	656 (722)		656 (722)		656 (722)		656 (722)	
		Max Height(d)	ft.	361 (131)		361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	12		16		20		25	
	Total Capacity		-	50 to 130% of total outdoor unit capacity							
Refrigerant	Type		-	R-410A		R-410A		R-410A		R-410A	
	Factory Charge		lbs.	12.1		16.3		16.3		19.18	
Sound(e)	Sound Pressure		dB(A)	60.0		61.0		61.0		62.0	
	Sound Power		dB(A)	81		81		81		83	
External Dimensions	Net Weight		lbs.	437		540		540		672	
	Shipping Weight		lbs.	472		582		582		714	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12		50.98 x 66.73 x 30,12		50.98 x 66.73 x 30,12		50.98 x 66.73 x 30.12	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76		53.66 x 75.28 x 32.76		53.66 x 75.28 x 32.76		53.66 x 75.28 x 32.76	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75		-13 ~ 75	

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 15. 460V Heat Pump Dual Modules I

Model Name				4TVH0168B400NB 4TVH0072B400NB + 4TVH0096B400NB		4TVH0192B400NB 4TVH0072B400NB + 4TVH0120B400NB		4TVH0216B400NB 4TVH0072B400NB + 4TVH0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			14.0		16.0		18.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)(a)	Cooling	Btuh	168,000	168,000	192,000	192,000	216,000	216,000
		Heating	Btuh	189,000	189,000	216,000	216,000	243,000	243,000
	Capacity (Rated)(b)	Cooling	Btuh	160,000	160,000	184,000	184,000	206,000	206,000
		High Temp Heating	Btuh	180,000	180,000	206,000	206,000	230,000	230,000
		Low Temp Heating	Btuh	118,000	118,000	134,000	134,000	150,000	150,000
	AHRI -1230 Efficiency Ratings(b)	EER	-	11.30	12.10	10.90	11.20	10.60	10.80
		IEER	-	20.50	25.30	21.50	24.20	20.50	22.40
		COP @ 47°F	-	3.44	3.94	3.34	3.83	3.34	3.63
		COP @ 17°F	-	2.43	2.65	2.42	2.59	2.31	2.52
		SCHE	-	-	-	-	-	-	-
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (2)		SSC Scroll (2)		SSC Scroll (2)	
	Model Name		-	DS-GB052FAVASG + DS-GB066FAVASG		DS-GB052FAVASG + DS-GB066FAVASG		DS-GB052FAVASG x 2	
	Output		kW	4.96 + 6.13		4.96 + 6.13		4.96 x 3	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	155.5		155.5		233.3	
Fan	Type (Qty.)		-	Propeller (3)		Propeller (3)		Propeller (3)	
	Output (Each)		W	400 + 620 x 2		400 + 620 x 2		400 + 620 x 2	
	Airflow Rate		CFM	7,240 + 9,180		7,240 + 9,180		7,240 + 9,535	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	5/8" Braze		5/8" Braze		5/8" Braze	
	Gas Pipe		Ø inch	1 1/8" Braze		1 1/8" Braze		1 1/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	N/A		N/A		N/A	
	Installation Limits	Max Length(c)	ft.	656 (722)		656 (722)		656 (722)	
		Max Height(d)	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	29		33		37	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	28.4		28.4		31.3	
Sound(e)	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	436 + 540		436 + 540		436 + 672	
	Shipping Weight		lbs.	472 + 582		472 + 582		472 + 714	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12		34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12		34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76		37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76		37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	'-13 ~ 75		'-13 ~ 75		'-13 ~ 75	

Note: Requires 4TDK3819B0000A outdoor unit T-joint connection

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 16. 460V Heat Pump Dual Modules II

Model Name				4TVH0240B400NB		4TVH0264B400NB		4TVH0288B400NB	
				2x 4TVH0120B400NB		4TVH0120B400NB + 4TVH0144B400NB		2x 4TVH0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			20.0		22.0		24.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	240,000	240,000	264,000	264,000	288,000	288,000
		Heating	Btuh	270,000	270,000	297,000	297,000	324,000	324,000
	Capacity (Rated)[b]	Cooling	Btuh	228,000	228,000	252,000	252,000	276,000	276,000
		High Temp Heating	Btuh	258,000	258,000	282,000	282,000	308,000	308,000
		Low Temp Heating	Btuh	168,000	168,000	184,000	184,000	200,000	200,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	10.60	10.70	10.10	10.10	10.00	9.90
		IEER	-	18.50	22.10	18.50	21.50	18.60	21.00
		COP @ 47°F	-	3.24	3.65	3.25	3.45	3.25	3.26
		COP @ 17°F	-	2.40	2.54	2.26	2.41	2.12	2.29
		SCHE	-	-	-	-	-	-	-
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (2)		SSC Scroll (3)		SSC Scroll (4)	
	Model Name		-	DS-GB066FAVASG x 2		DS-GB052FAVASG x 2 + DS-GB066FAVASG		DS-GB052FAVASG x 4	
	Output		kW	6.13 x 2		(4.96 x 2) + 6.13		4.96 x 4	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	155.5		233.3		311.1	
Fan	Type (Qty.)		-	Propeller (4)		Propeller (4)		Propeller (4)	
	Output (Each)		W	620 x 4		620 x 4		620 x 4	
	Airflow Rate		CFM	9180 x 2		9,180 + 9,535		9535 x 2	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	5/8" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 1/8" Braze		1 3/8" Braze		1 3/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	N/A		N/A		N/A	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	41		45		49	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	32.6		35.5		38.4	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	540 x 2		540 + 672		672 x 2	
	Shipping Weight		lbs.	582 x 2		582 + 714		714 x 2	
	Net Dimensions (WxHxD)		inches	(50.98 x 66.73 x 30.12) x 2		(50.98 x 66.73 x 30.12) x 2		(50.98 x 66.73 x 30.12) x 2	
	Shipping Dimensions (WxHxD)		inches	(53.66 x 75.28 x 32.76) x 2		(53.66 x 75.28 x 32.76) x 2		(53.66 x 75.28 x 32.76) x 2	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires 4TDK3819B0000A outdoor unit T-joint connection

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.

(b) Rated per AHRI-1230 Standard conditions.

(c) Actual length (equivalent length in parenthesis).

(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.

(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 17. 460V Heat Pump Triple Modules I

Model Name				4TVH0312B400NB		4TVH0336B400NB		4TVH0360B400NB	
				4TVH0072B400NB + 4TVH0096B400NB + 4TVH0144B400NB		4TVH0072B400NB + 4TVH0120B400NB + 4TVH0144B400NB		4TVH0072B400NB + 2x 4TVH0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			26.0		28.0		30.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	312,000	312,000	336,000	336,000	360,000	360,000
		Heating	Btuh	351,000	351,000	378,000	378,000	405,000	405,000
	Capacity (Rated)[b]	Cooling	Btuh	298,000	298,000	320,000	320,000	344,000	344,000
		High Temp Heating	Btuh	334,000	334,000	360,000	360,000	386,000	386,000
		Low Temp Heating	Btuh	218,000	218,000	234,000	234,000	250,000	250,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	10.30	10.60	10.00	10.20	9.80	9.80
		IEER	-	18.10	20.90	17.00	20.50	16.60	20.00
		COP @ 47°F	-	3.20	3.38	3.20	3.27	3.20	3.22
		COP @ 17°F	-	2.25	2.51	2.21	2.39	2.11	2.31
		SCHE	-	-	-	-	-	-	-
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (4)		SSC Scroll (4)		SSC Scroll (5)	
	Model Name		-	DS-GB052FAVASG x 3 + DS-GB066FAVASG		DS-GB052FAVASG x 3 + DS-GB066FAVASG		DS-GB052FAVASG x 5	
	Output		kW	(4.96 x 3) + 6.13		(4.96 x 3) + 6.13		4.96 x 5	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	311.1		311.1		388.9	
Fan	Type (Qty.)		-	Propeller (5)		Propeller (5)		Propeller (5)	
	Output (Each)		W	400 + 620 x 4		400 + 620 x 4		400 + 620 x 4	
	Airflow Rate		CFM	7,240 + 9,180 + 9,535		7,240 + 9,180 + 9,535		7,240 + (9,535 x2)	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/4" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 3/8" Braze		1 3/8" Braze		1 5/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	N/A		N/A		N/A	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	54		58		62	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R-410A		R-410A		R-410A	
	Factory Charge		lbs.	47.6		47.6		50.5	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	437 + 540 + 672		437 + 540 + 672		437 + (672 x2)	
	Shipping Weight		lbs.	472 + 582 + 714		472 + 582 + 714		472 + (714 x2)	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2		34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2		34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2		37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2		37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires two 4TDK3819B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions (published ratings apply to systems < 300,000 Btuh).
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 18. 460V Heat Pump Triple Modules II

Model Name				4TVH0384B400NB		4TVH0408B400NB		4TVH0432B400NB	
				2x 4TVH0120B400NB + 4TVH0144B400NB		4TVH0120B400NB + 2x 4TVH0144B400NB		3x 4TVH0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			32.0		34.0		36.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	384,000	384,000	408,000	408,000	432,000	432,000
		Heating	Btuh	432,000	432,000	459,000	459,000	486,000	486,000
	Capacity (Rated)[b]	Cooling	Btuh	366,000	366,000	390,000	390,000	415,000	415,000
		High Temp Heating	Btuh	410,000	410,000	435,000	435,000	460,000	460,000
		Low Temp Heating	Btuh	268,000	268,000	284,000	284,000	300,000	300,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	9.50	9.50	9.50	9.50	9.50	9.50
		IEER	-	16.20	19.50	16.30	19.10	16.30	19.10
		COP @ 47°F	-	3.20	3.20	3.20	3.20	3.20	3.20
		COP @ 17°F	-	2.05	2.10	2.05	2.05	2.05	2.05
		SCHE	-	-	-	-	-	-	-
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (4)		SSC Scroll (5)		SSC Scroll (6)	
	Model Name		-	DS-GB052FAVASG x 2 + DS-GB066FAVASG x 2		DS-GB052FAVASG x 4 + DS-GB066FAVASG		DS-GB052FAVASG x 6	
	Output		kW	(4.96 x 2) + (6.13 x 2)		(4.96 x 4) + 6.13		4.96 x 6	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	311.1		388.9		466.6	
Fan	Type (Qty.)		-	Propeller (6)		Propeller (6)		Propeller (6)	
	Output (Each)		W	620 x 6		620 x 6		620 x 6	
	Airflow Rate		CFM	(9,180 x2) + 9535		9,180 + (2x 9,535)		9535 x 3	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/4" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 5/8" Braze		1 5/8" Braze		1 5/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	N/A		N/A		N/A	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	64		64		64	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R410A		R410A		R410A	
	Factory Charge		lbs.	51.8		54.7		57.5	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	(540 x 2) + 672		540 + (672 x 2)		672 x 3	
	Shipping Weight		lbs.	(582 x 2) + 714		582 + (714 x 2)		714 x 3	
	Net Dimensions (WxHxD)		inches	(50.98 x 66.73 x 30.12) x 3		(50.98 x 66.73 x 30.12) x 3		(50.98 x 66.73 x 30.12) x 3	
	Shipping Dimensions (WxHxD)		inches	(53.66 x 75.28 x 32.76) x 3		(53.66 x 75.28 x 32.76) x 3		(53.66 x 75.28 x 32.76) x 3	
Operating Temp Range	Cooling		°F	23 ~ 120		23 ~ 120		23 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires two 4TDK3819B0000A outdoor unit T-joint connections.

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions (published ratings apply to systems ≤ 300,000 Btuh).
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.

Table 19. 460V Heat Recovery Single Modules

Model Name				4TVR0072B400NB		4TVR0096B400NB		4TVR0120B400NB		4TVR0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			6.0		8.0		10.0		12.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	72,000	72,000	96,000	96,000	120,000	120,000	144,000	144,000
		Heating	Btuh	81,000	81,000	108,000	108,000	135,000	135,000	162,000	162,000
	Capacity (Rated)[b]	Cooling	Btuh	69,000	69,000	92,000	92,000	114,000	114,000	138,000	138,000
		High Temp Heating	Btuh	77,000	77,000	103,000	103,000	129,000	129,000	154,000	154,000
		Low Temp Heating	Btuh	51,000	51,000	67,000	67,000	84,000	84,000	100,000	100,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	11.50	12.90	11.50	13.90	11.10	12.40	10.80	11.20
		IEER	-	22.50	33.00	22.40	29.60	21.20	27.10	21.10	24.50
		COP @ 47°F	-	3.46	4.15	3.56	4.23	3.43	3.97	3.54	3.64
		COP @ 17°F	-	2.49	2.75	2.45	2.81	2.44	2.53	2.23	2.40
		SCHE	-	26.00	28.00	26.50	31.50	25.50	30.00	25.00	27.50
Power	MCA		A	16.4		19		21.7		26.4	
	MOP		A	20		25		30		40	
	SCCR		kA	-		-		-		-	
Compressor	Type (Qty.)		-	SSC Scroll (1)		SSC Scroll (1)		SSC Scroll (1)		SSC Scroll (2)	
	Model Name		-	DS-GB052FAVASG		DS-GB066FAVASG		DS-GB066FAVASG		DS-GB052FAVASG	
	Output		kW	4.96		6.13		6.13		4.96 x 2	
	Oil	Type	-	PVE		PVE		PVE		PVE	
		Initial Charge	fl. oz.	77.8		77.8		77.8		155.5	
Fan	Type (Qty.)		-	Propeller (1)		Propeller (2)		Propeller (2)		Propeller (2)	
	Output (Each)		W	400		620		620		620	
	Airflow Rate		CFM	7,240		9,180		9,180		9,535	
	External Static Pressure		in. WG	0.31		0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/8" Braze		3/8" Braze		1/2" Braze		1/2" Braze	
	Gas Pipe		Ø inch	3/4" Braze		7/8" Braze		1 1/8" Braze		1 1/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	5/8" Braze		3/4" Braze		7/8" Braze		7/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	12		16		20		25	
	Total Capacity		-	50 to 130% of total outdoor unit capacity							
Refrigerant	Type		-	R-410A		R-410A		R-410A		R-410A	
	Factory Charge		lbs.	12.1		16.3		16.3		19.18	
Sound[e]	Sound Pressure		dB(A)	60.0		61.0		61.0		62.0	
	Sound Power		dB(A)	81		81		81		83	
External Dimensions	Net Weight		lbs.	445		553		553		692	
	Shipping Weight		lbs.	481		595		595		734	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12		50.98 x 66.73 x 30,12		50.98 x 66.73 x 30,12		50.98 x 66.73 x 30.12	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76		53.66 x 75.28 x 32.76		53.66 x 75.28 x 32.76		53.66 x 75.28 x 32.76	
Operating Temp Range	Cooling[f]		°F	5 ~ 120		5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75		-13 ~ 75	

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 20. 460V Heat Recovery Dual Modules I

Model Name				4TVR0168B400NB + 4TVR0072B400NB + 4TVR0096B400NB		4TVR0192B400NB + 4TVR0072B400NB + 4TVR0120B400NB		4TVR0216B400NB + 4TVR0072B400NB + 4TVR0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			14.0		16.0		18.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	168,000	168,000	192,000	192,000	216,000	216,000
		Heating	Btuh	189,000	189,000	216,000	216,000	243,000	243,000
	Capacity (Rated)[b]	Cooling	Btuh	160,000	160,000	184,000	184,000	206,000	206,000
		High Temp Heating	Btuh	180,000	180,000	206,000	206,000	230,000	230,000
		Low Temp Heating	Btuh	118,000	118,000	134,000	134,000	150,000	150,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	11.30	12.10	10.90	11.20	10.60	10.80
		IEER	-	20.50	25.30	21.50	24.20	20.50	22.40
		COP @ 47°F	-	3.44	3.94	3.34	3.83	3.34	3.63
		COP @ 17°F	-	2.43	2.65	2.42	2.59	2.31	2.52
		SCHE	-	23.50	27.00	23.50	26.50	23.00	25.50
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (2)		SSC Scroll (2)		SSC Scroll (2)	
	Model Name		-	DS-GB052FAVASG + DS-GB066FAVASG		DS-GB052FAVASG + DS-GB066FAVASG		DS-GB052FAVASG x 2	
	Output		kW	4.96 + 6.13		4.96 + 6.13		4.96 x 3	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	155.5		155.5		233.3	
Fan	Type (Qty.)		-	Propeller (3)		Propeller (3)		Propeller (3)	
	Output (Each)		W	400 + 620 x 2		400 + 620 x 2		400 + 620 x 2	
	Airflow Rate		CFM	7,240 + 9,180		7,240 + 9,180		7,240 + 9,535	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	5/8" Braze		5/8" Braze		5/8" Braze	
	Gas Pipe		Ø inch	1 1/8" Braze		1 1/8" Braze		1 1/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	7/8" Braze		1 1/8" Braze		1 1/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	29		33		37	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R-410A		R-410A		R-410A	
	Factory Charge		lbs.	28.4		28.4		31.3	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	445 + 553		445 + 553		445 + 692	
	Shipping Weight		lbs.	481 + 595		481 + 595		481 + 734	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12		34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12		34.65 x 66.73 x 30.12 + 50.98 x 66.73 x 30.12	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76		37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76		37.32 x 75.28 x 32.76 + 53.66 x 75.28 x 32.76	
Operating Temp Range	Cooling[f]		°F	5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires 4TDK3819B0000A and 4TDK3100B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 21. 460V Heat Recovery Dual Modules II

Model Name				4TVR0240B400NB		4TVR0264B400NB		4TVR0288B400NB	
				2x 4TVR0120B400NB		4TVR0120B400NB + 4TVR0144B400NB		2x 4TVR0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			20.0		22.0		24.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	240,000	240,000	264,000	264,000	288,000	288,000
		Heating	Btuh	270,000	270,000	297,000	297,000	324,000	324,000
	Capacity (Rated)[b]	Cooling	Btuh	228,000	228,000	252,000	252,000	276,000	276,000
		High Temp Heating	Btuh	258,000	258,000	282,000	282,000	308,000	308,000
		Low Temp Heating	Btuh	168,000	168,000	184,000	184,000	200,000	200,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	10.60	10.70	10.10	10.10	10.00	9.90
		IEER	-	18.50	22.10	18.50	21.50	18.60	21.00
		COP @ 47°F	-	3.24	3.65	3.25	3.45	3.25	3.26
		COP @ 17°F	-	2.40	2.54	2.26	2.41	2.12	2.29
		SCHE	-	22.50	25.50	22.00	24.50	21.50	23.50
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (2)		SSC Scroll (3)		SSC Scroll (4)	
	Model Name		-	DS-GB066FAVASG x 2		DS-GB052FAVASG x 2 + DS-GB066FAVASG		DS-GB052FAVASG x 4	
	Output		kW	6.13 x 2		(4.96 x 2) + 6.13		4.96 x 4	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	155.5		233.3		311.1	
Fan	Type (Qty.)		-	Propeller (4)		Propeller (4)		Propeller (4)	
	Output (Each)		W	620 x 4		620 x 4		620 x 4	
	Airflow Rate		CFM	9180 x 2		9,180 + 9,535		9535 x 2	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	5/8" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 1/8" Braze		1 3/8" Braze		1 3/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	1 1/8" Braze		1 1/8" Braze		1 1/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	41		45		49	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R-410A		R-410A		R-410A	
	Factory Charge		lbs.	32.6		35.5		38.4	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	553 x 2		553 + 692		692 x 2	
	Shipping Weight		lbs.	595 x 2		595 + 734		734 x 2	
	Net Dimensions (WxHxD)		inches	(50.98 x 66.73 x 30.12) x 2		(50.98 x 66.73 x 30.12) x 2		(50.98 x 66.73 x 30.12) x 2	
	Shipping Dimensions (WxHxD)		inches	(53.66 x 75.28 x 32.76) x 2		(53.66 x 75.28 x 32.76) x 2		(53.66 x 75.28 x 32.76) x 2	
Operating Temp Range	Cooling[f]		°F	5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires 4TDK3819B0000A and 4TDK3100B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 22. 460V Heat Recovery Triple Modules I

Model Name				4TVR0312B400NB 4TVR0072B400NB + 4TVR0096B400NB + 4TVR0144B400NB		4TVR0336B400NB 4TVR0072B400NB + 4TVR0120B400NB + 4TVR0144B400NB		4TVR0360B400NB 4TVR0072B400NB + 2x 4TVR0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			26.0		28.0		30.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)(a)	Cooling	Btuh	312,000	312,000	336,000	336,000	360,000	360,000
		Heating	Btuh	351,000	351,000	378,000	378,000	405,000	405,000
	Capacity (Rated)(b)	Cooling	Btuh	298,000	298,000	320,000	320,000	344,000	344,000
		High Temp Heating	Btuh	334,000	334,000	360,000	360,000	386,000	386,000
		Low Temp Heating	Btuh	218,000	218,000	234,000	234,000	250,000	250,000
	AHRI -1230 Efficiency Ratings(b)	EER	-	10.30	10.60	10.00	10.20	9.80	9.80
		IEER	-	18.10	20.90	17.00	20.50	16.60	20.00
		COP @ 47°F	-	3.20	3.38	3.20	3.27	3.20	3.22
		COP @ 17°F	-	2.25	2.51	2.21	2.39	2.11	2.31
		SCHE	-	20.50	23.50	20.50	23.10	20.00	22.40
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (4)		SSC Scroll (4)		SSC Scroll (5)	
	Model Name		-	DS-GB052FAVASG x 3 + DS-GB066FAVASG		DS-GB052FAVASG x 3 + DS-GB066FAVASG		DS-GB052FAVASG x 5	
	Output		kW	(4.96 x 3) + 6.13		(4.96 x 3) + 6.13		4.96 x 5	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	311.1		311.1		388.9	
Fan	Type (Qty.)		-	Propeller (5)		Propeller (5)		Propeller (5)	
	Output (Each)		W	400 + 620 x 4		400 + 620 x 4		400 + 620 x 4	
	Airflow Rate		CFM	7,240 + 9,180 + 9,535		7,240 + 9,180 + 9,535		7,240 + (9,535 x2)	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/4" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 3/8" Braze		1 3/8" Braze		1 5/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	1 1/8" Braze		1 1/8" Braze		1 3/8" Braze	
	Installation Limits	Max Length(c)	ft.	656 (722)		656 (722)		656 (722)	
		Max Height(d)	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	54		58		62	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R-410A		R-410A		R-410A	
	Factory Charge		lbs.	47.6		47.6		50.5	
Sound(e)	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	445 + 553 + 692		445 + 553 + 692		445 + (692 x 2)	
	Shipping Weight		lbs.	481 + 595 + 734		481 + 595 + 734		481 + (734 x 2)	
	Net Dimensions (WxHxD)		inches	34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2		34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2		34.65 x 66.73 x 30.12 + (50.98 x 66.73 x 30.12) x2	
	Shipping Dimensions (WxHxD)		inches	37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2		37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2		37.32 x 75.28 x 32.76 + (53.66 x 75.28 x 32.76) x2	
Operating Temp Range	Cooling(f)		°F	5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires two each 4TDK3819B0000A and 4TDK3100B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions (published ratings apply to systems < 300,000 Btuh).
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

Table 23. 460V Heat Recovery Triple Modules II

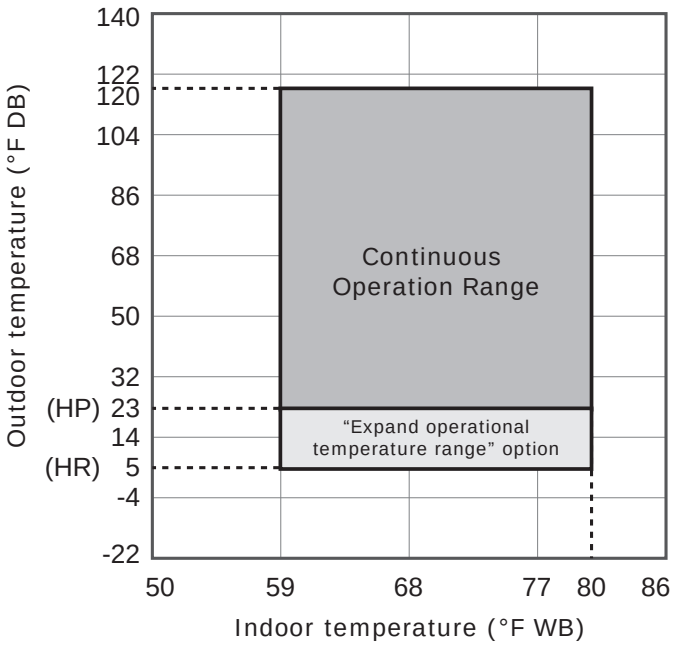
Model Name				4TVR0384B400NB		4TVR0408B400NB		4TVR0432B400NB	
				2x 4TVR0120B400NB + 4TVR0144B400NB		4TVR0120B400NB + 2x 4TVR0144B400NB		3x 4TVR0144B400NB	
Power Supply				460/60/3		460/60/3		460/60/3	
Performance	Nominal Tons			32.0		34.0		36.0	
	System Type			Ducted	Non-Ducted	Ducted	Non-Ducted	Ducted	Non-Ducted
	Capacity (Nominal)[a]	Cooling	Btuh	384,000	384,000	408,000	408,000	432,000	432,000
		Heating	Btuh	432,000	432,000	459,000	459,000	486,000	486,000
	Capacity (Rated)[b]	Cooling	Btuh	366,000	366,000	390,000	390,000	415,000	415,000
		High Temp Heating	Btuh	410,000	410,000	435,000	435,000	460,000	460,000
		Low Temp Heating	Btuh	268,000	268,000	284,000	284,000	300,000	300,000
	AHRI -1230 Efficiency Ratings[b]	EER	-	9.50	9.50	9.50	9.50	9.50	9.50
		IEER	-	16.20	19.50	16.30	19.10	16.30	19.10
		COP @ 47°F	-	3.20	3.20	3.20	3.20	3.20	3.20
		COP @ 17°F	-	2.05	2.10	2.05	2.05	2.05	2.05
		SCHE	-	19.50	23.00	19.00	22.00	19.00	21.50
Power	MCA		A	Each individual outdoor unit requires a separate electrical connection. Reference electrical data for each individual outdoor unit.					
	MOP		A						
	SCCR		kA						
Compressor	Type (Qty.)		-	SSC Scroll (4)		SSC Scroll (5)		SSC Scroll (6)	
	Model Name		-	DS-GB052FAVASG x 2 + DS-GB066FAVASG x 2		DS-GB052FAVASG x 4 + DS-GB066FAVASG		DS-GB052FAVASG x 6	
	Output		kW	(4.96 x 2) + (6.13 x 2)		(4.96 x 4) + 6.13		4.96 x 6	
	Oil	Type	-	PVE		PVE		PVE	
		Initial Charge	fl. oz.	311.1		388.9		466.6	
Fan	Type (Qty.)		-	Propeller (6)		Propeller (6)		Propeller (6)	
	Output (Each)		W	620 x 6		620 x 6		620 x 6	
	Airflow Rate		CFM	(9,180 x2) + 9535		9,180 + (2x 9,535)		9535 x 3	
	External Static Pressure		in. WG	0.31		0.31		0.31	
Piping Connections	Liquid Pipe		Ø inch	3/4" Braze		3/4" Braze		3/4" Braze	
	Gas Pipe		Ø inch	1 5/8" Braze		1 5/8" Braze		1 5/8" Braze	
	High Pressure Gas Pipe (For HR)		Ø inch	1 3/8" Braze		1 3/8" Braze		1 3/8" Braze	
	Installation Limits	Max Length[c]	ft.	656 (722)		656 (722)		656 (722)	
		Max Height[d]	ft.	361 (131)		361 (131)		361 (131)	
Indoor Unit Connections	Number Of Connectable Indoor Units		-	64		64		64	
	Total Capacity		-	50 to 130% of total outdoor unit capacity					
Refrigerant	Type		-	R-410A		R-410A		R-410A	
	Factory Charge		lbs.	51.8		54.7		57.5	
Sound[e]	Sound Pressure		dB(A)	-		-		-	
	Sound Power		dB(A)	-		-		-	
External Dimensions	Net Weight		lbs.	553 + (692 x 2)		553 + (692 x 2)		692 x 3	
	Shipping Weight		lbs.	595 + (734 x 2)		595 + (734 x 2)		734 x 3	
	Net Dimensions (WxHxD)		inches	(50.98 x 66.73 x 30.12) x 3		(50.98 x 66.73 x 30.12) x 3		(50.98 x 66.73 x 30.12) x 3	
	Shipping Dimensions (WxHxD)		inches	(53.66 x 75.28 x 32.76) x 3		(53.66 x 75.28 x 32.76) x 3		(53.66 x 75.28 x 32.76) x 3	
Operating Temp Range	Cooling[f]		°F	5 ~ 120		5 ~ 120		5 ~ 120	
	Heating		°F	-13 ~ 75		-13 ~ 75		-13 ~ 75	

Note: Requires two each 4TDK3819B0000A and 4TDK3100B0000A outdoor unit T-joint connections

(a) Nominal capacity based on 25 ft. of equivalent refrigerant piping with 0 ft. level difference. Cooling: Indoor temperature 80°F DB, 67°F WB/Outdoor temperature 95°F DB, 75°F WB. Heating: Indoor temperature 70°F DB, 60°F WB/Outdoor temperature 47°F DB, 43°F WB.
(b) Rated per AHRI-1230 Standard conditions.
(c) Actual length (equivalent length in parenthesis).
(d) If the outdoor unit is installed above the indoor units, the allowable height difference to the furthest indoor unit is 361 ft. If the outdoor unit is installed below the below the indoor units, the allowable height difference is 131 ft.
(e) Sound pressure was acquired in a dead room. Actual noise level may be different depending on installation conditions.
(f) Cooling operation between 23° F and 5° F requires mixed mode condition (at least 50% of the indoor units must be in heating mode).

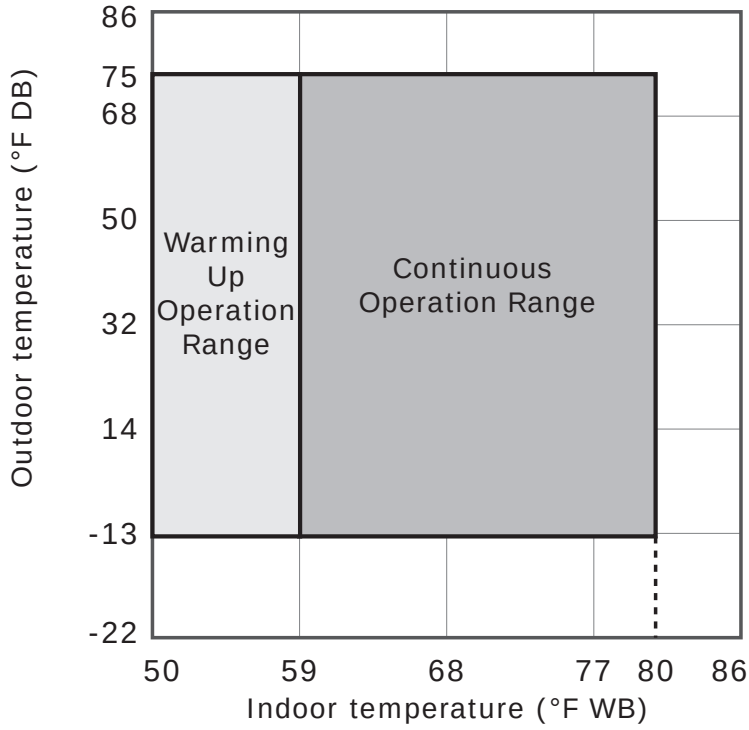
Operation Limit - Outdoor Units

Figure 1. Cooling[a]



(a)Extend operational temperature range applies to heat recovery systems in mixed mode condition (at least 50% of the indoor units must be in heating mode).

Figure 2. Heating

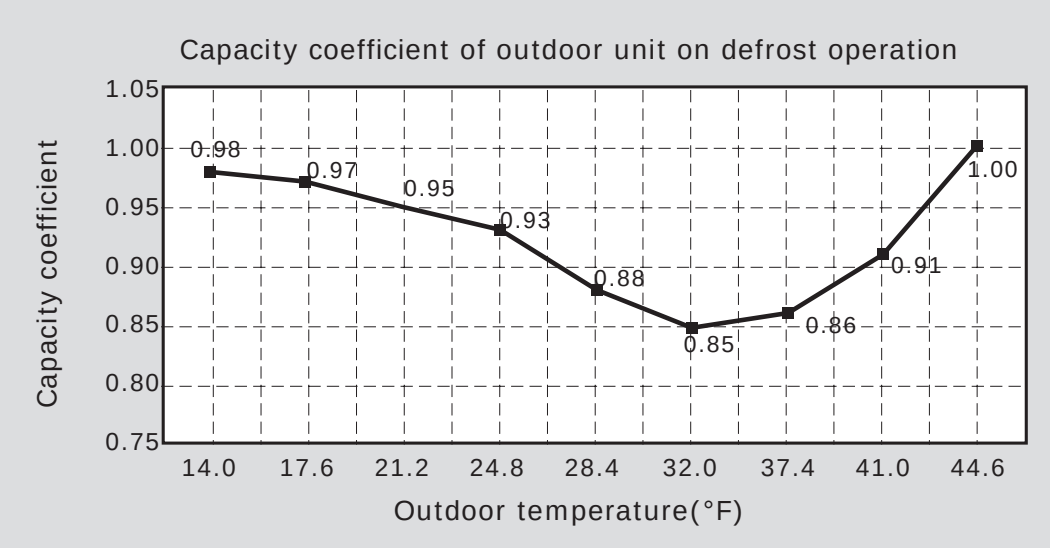


Defrosting Correction Factor

In heating operation, frost can be formed on heat exchanger according to outdoor temperature. (frost on heat exchanger results in decreasing the performance.)To remove frost on heat exchanger of outdoor unit, defrost operation is carried out periodically. During defrost operation, capacity of outdoor unit may decrease. The decrement is not considered to the individual capacity tables.

Outdoor temperature (°F, WB)	14.0	17.6	21.2	24.8	28.4	32.0	37.4	41.0	44.6
Capacity coefficient	0.98	0.97	0.95	0.93	0.88	0.85	0.86	0.91	1.00

Figure 3. Corrected Heating Capacity = Heating Capacity x Capacity coefficient



Electrical Wiring Diagrams - Outdoor Units

Figure 4. Heat Pump - 4TVH0072B300NB, 4TVH0072B400NB

Note 1: Resistance value at 25°C (77°F)

Note 5: Input voltage 460V: Does not apply
Input voltage 208-230V: Apply

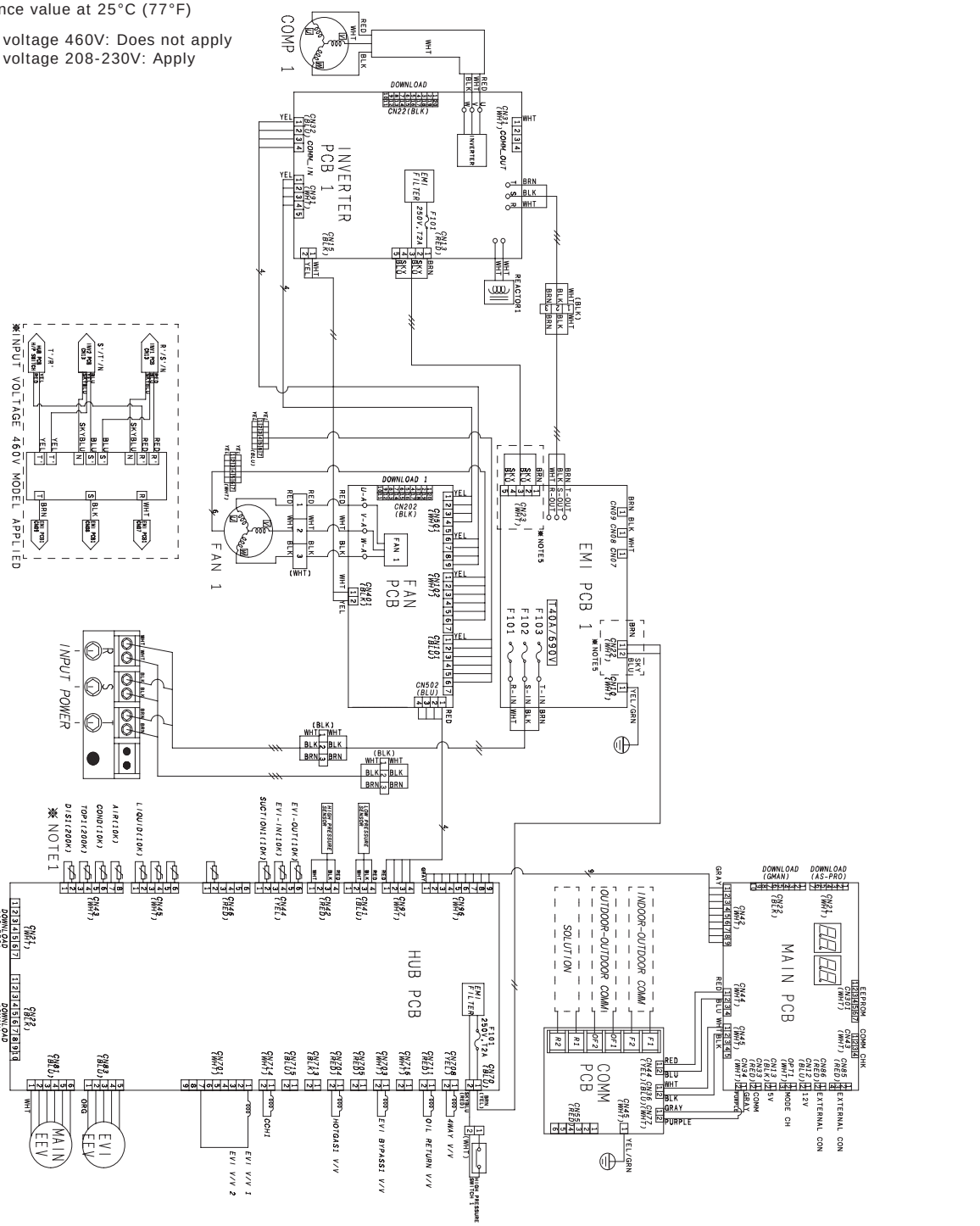


Figure 5. Heat Pump - 4TVH0096B400NB, 4TVH0120B400NB

Note 1: Resistance value at 25°C (77°F)

Note 2: 1 Fan: Does not apply
2 Fan: Apply

Note 5: Input voltage 460V: Does not apply
Input voltage 208-230V: Apply

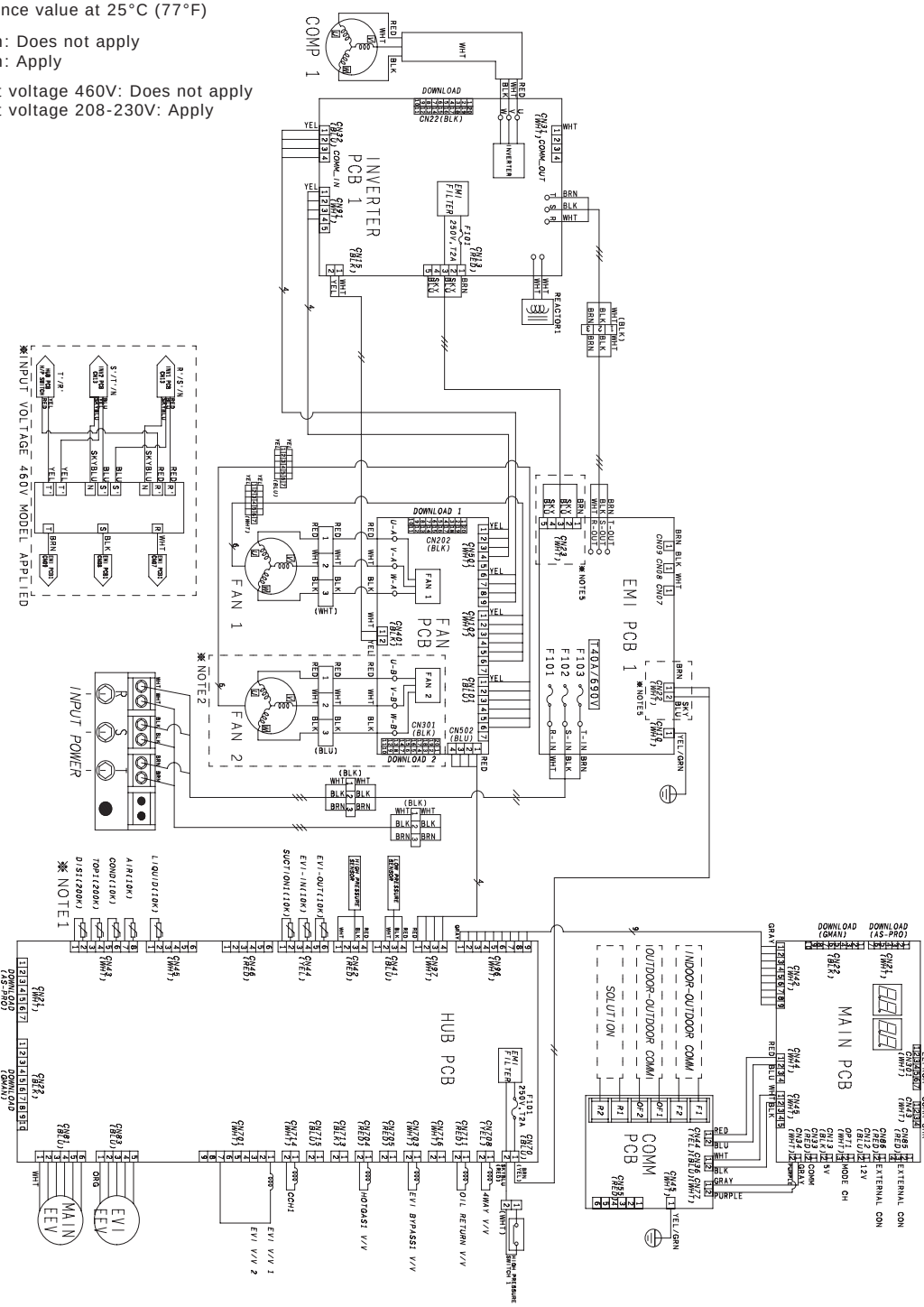


Figure 6. Heat Pump - 4TVH0096B300NB, 4TVH0120B300NB, 4TVH0144B300NB, 4TVH0144B400NB

Note 1: Resistance value at 25°C (77°F)

Note 2: 1 Fan: Does not apply
2 Fan: Apply

Note 3: 1 Comp: Does not apply
2 Comp: Apply

Note 5: Input voltage 460V: Does not apply
Input voltage 208-230V: Apply

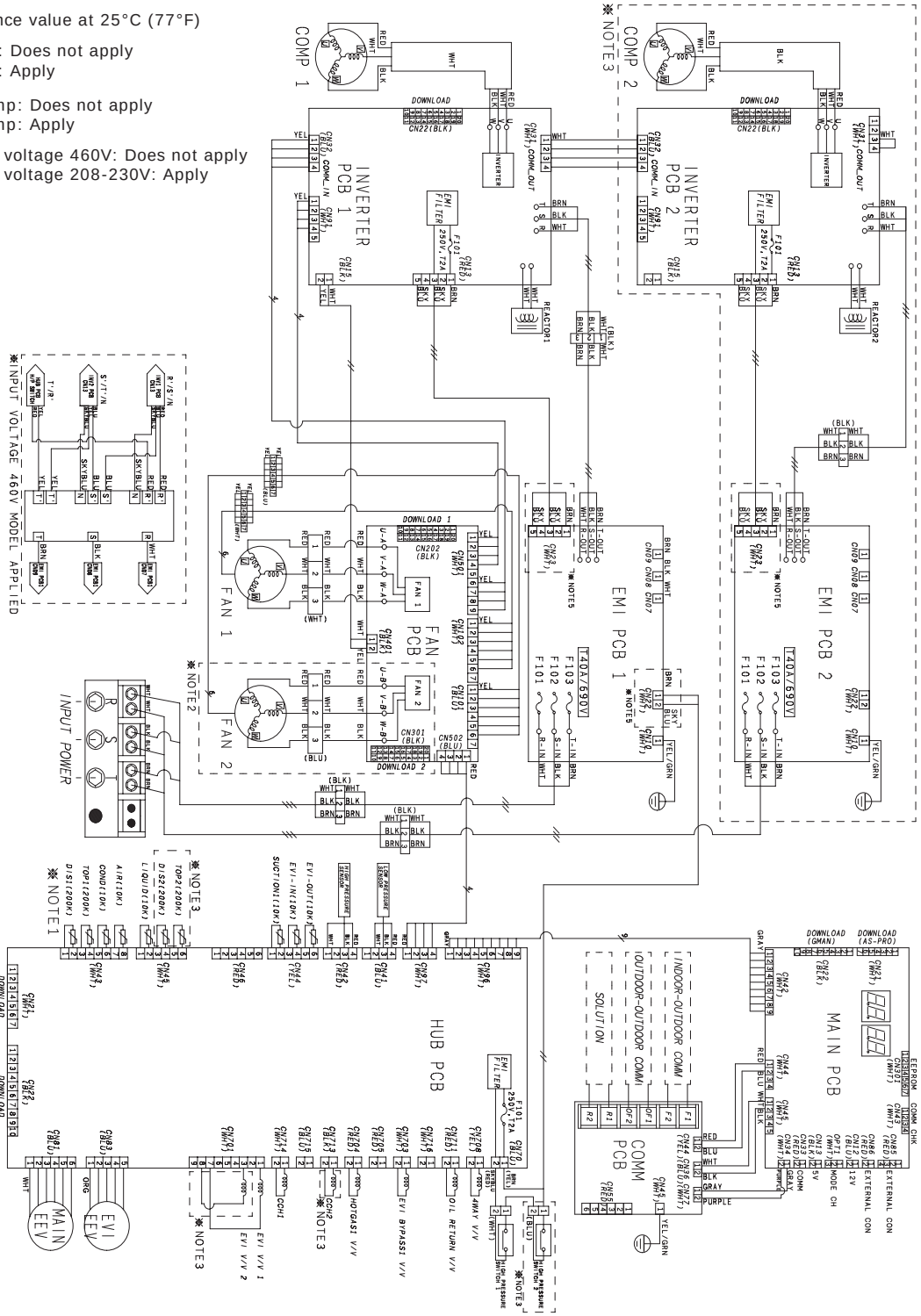


Figure 7. Heat Recovery - 4TVR0072B300NB, 4TVR0072B400NB

Note 1: Resistance value at 25°C (77°F)

Note 4: Heat Pump: Does not apply
Heat Recovery: Apply

Note 5: Input voltage 460V: Does not apply
Input voltage 208-230V: Apply

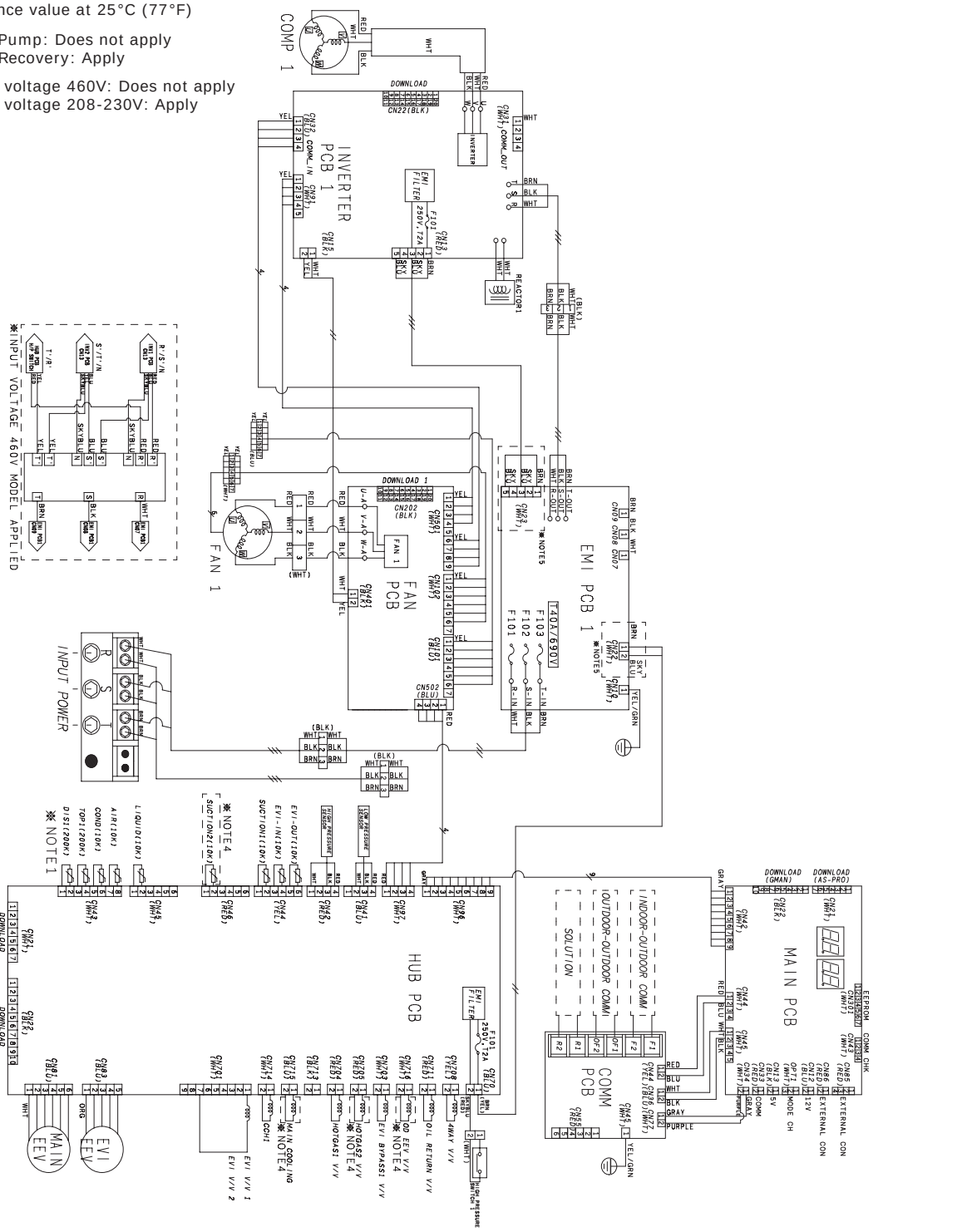


Figure 8. Heat Recovery - 4TVR0096B400NB, 4TVR0120B400NB

Note 1: Resistance value at 25°C (77°F)

Note 2: 1 Fan: Does not apply
2 Fan: Apply

Note 4: Heat Pump: Does not apply
Heat Recovery: Apply

Note 5: Input voltage 460V: Does not apply
Input voltage 208-230V: Apply

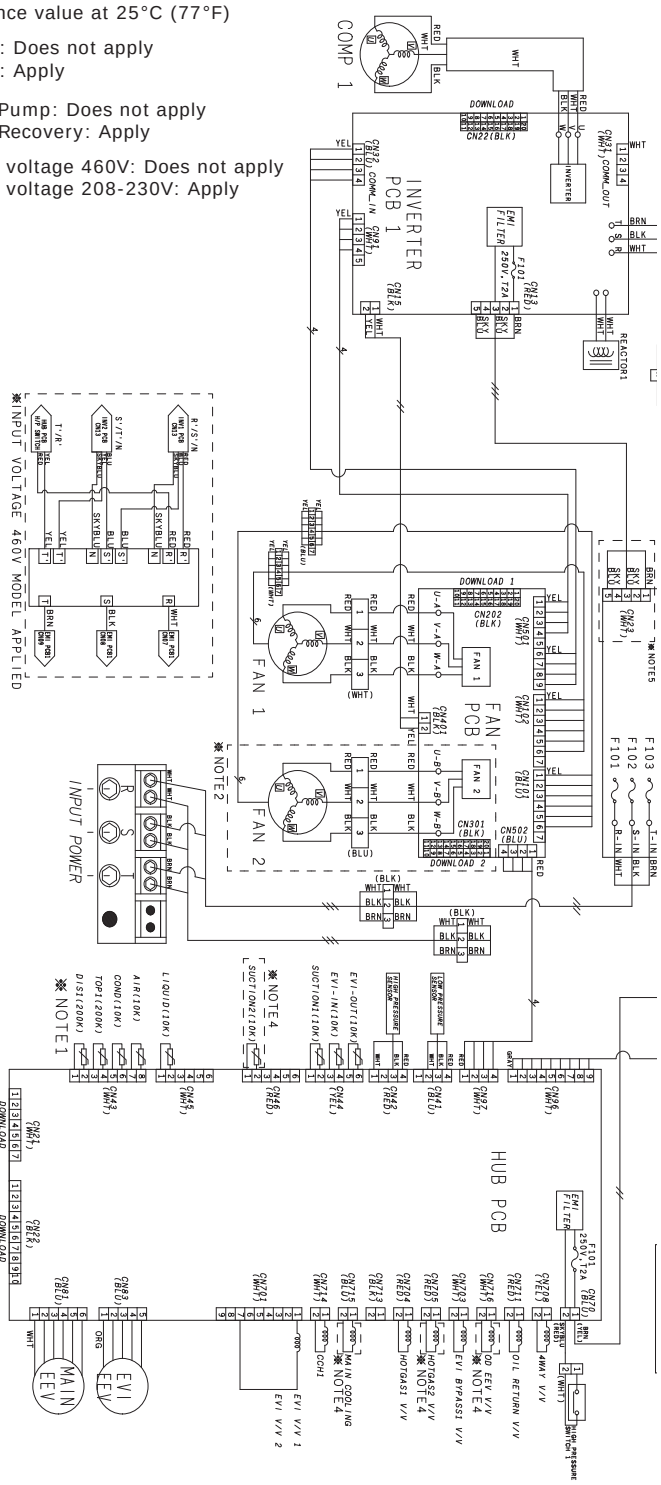


Figure 9. Heat Recovery - 4TVR0096B300NB, 4TVR0120B300NB, 4TVR0144B300NB, 4TVR0144B400NB

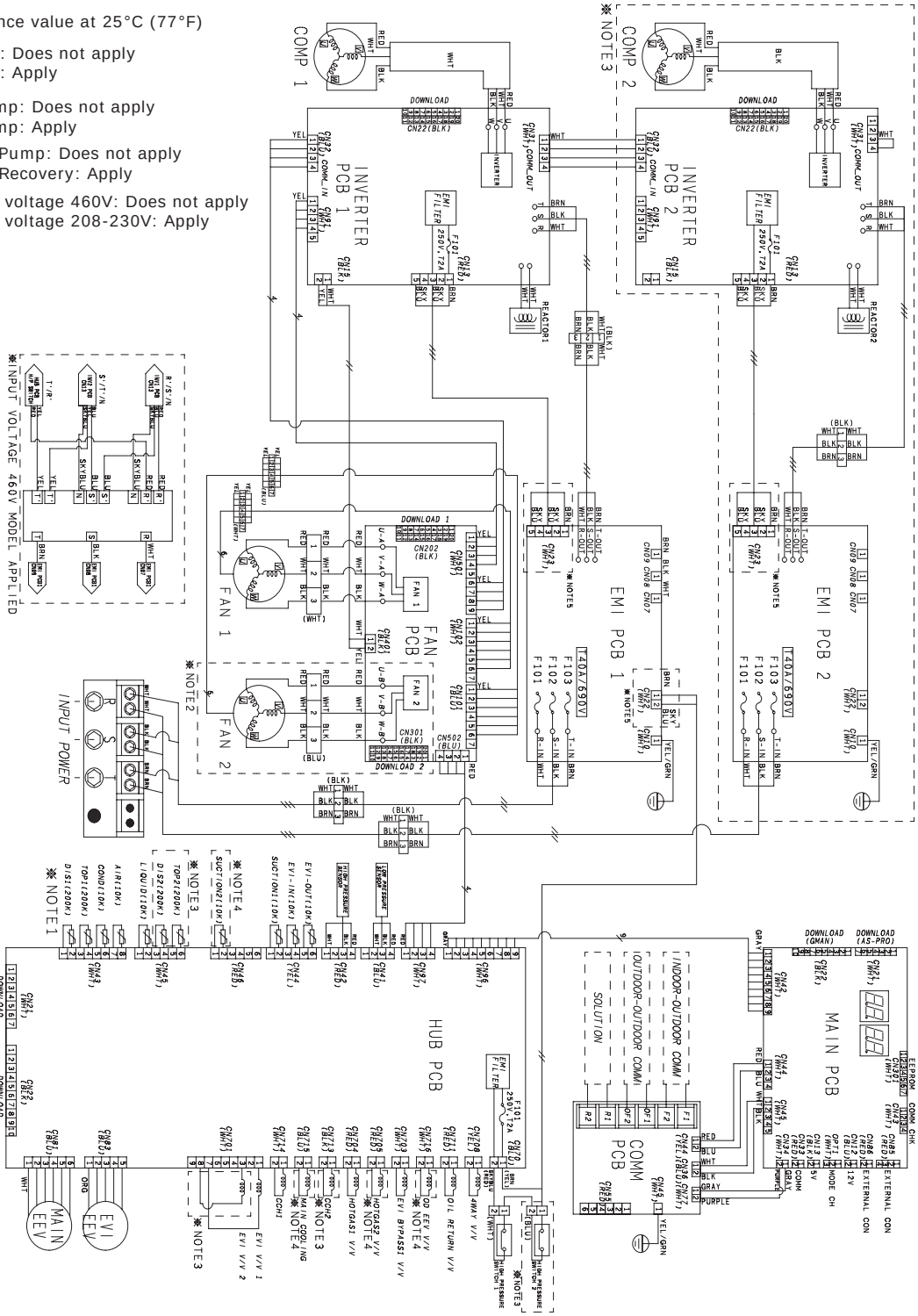
Note 1: Resistance value at 25°C (77°F)

Note 2: 1 Fan: Does not apply
2 Fan: Apply

Note 3: 1 Comp: Does not apply
2 Comp: Apply

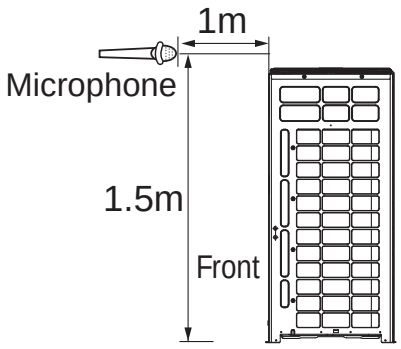
Note 4: Heat Pump: Does not apply
Heat Recovery: Apply

Note 5: Input voltage 460V: Does not apply
Input voltage 208-230V: Apply



Sound Levels - Outdoor Units

Figure 10. Sound Pressure Level



Unit: dB(A)

Model	Pressure
4TVH/R0072B3, 4TVH/R0072B4	60
4TVH/R0096B3, 4TVH/R0120B3	61
4TVH/R0096B4, 4TVH/R0120B4	61
4TVH/R0072B3, 4TVH/R0072B4	60

Notes:

- *Measuring place: Anechoic chamber (conversion value)*
- *These operation values were obtained in an anechoic room. Sound pressure level will vary depending on a range of factors such as the construction of the particular room where the equipment is installed.*
- *Operation sound level may differ depending on operation and ambient conditions.*

NC Curves

Figure 11. 4TVH/R0072B3, 4TVH/R0072B4

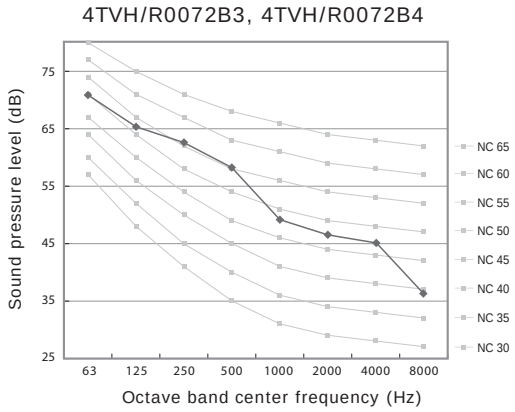


Figure 12. 4TVH/R0096B3, 4TVH/R0120B3

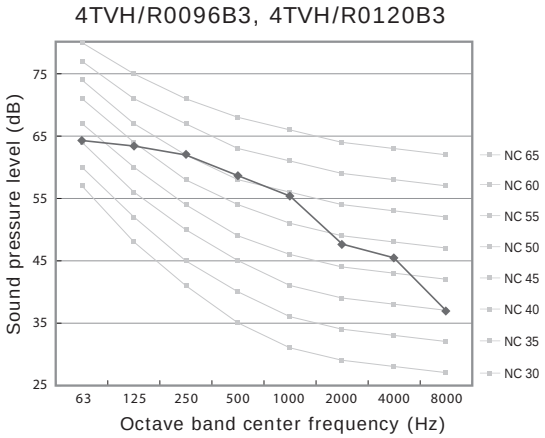


Figure 13. 4TVH/R0096B4, 4TVH/R0120B4

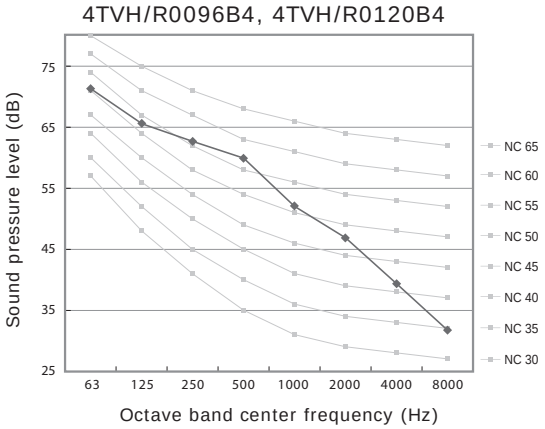
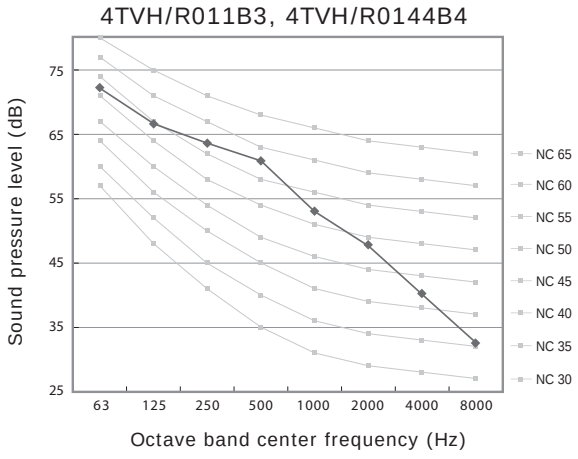


Figure 14. 4TVH/R0144B3, 4TVH/R0144B4



Sound Power

Notes:

- *dBA = A-weighted sound power level.*
- *Reference power: 1pW*
- *Measured according to ISO 3741.*

Unit: dB(A)

Model	Power
4TVH/R0072B3, 4TVH/R0072B4	81
4TVH/R0096B3, 4TVH/R0120B3	81
4TVH/R0096B4, 4TVH/R0120B4	81
4TVH/R0144B3, 4TVH/R0144B4	83

NR Curves

Figure 15. 4TVH/R0072B3, 4TVH/R0072B4

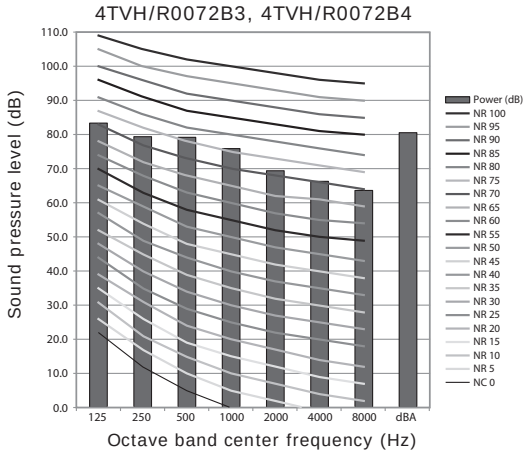


Figure 16. 4TVH/R0096B3, 4TVH/R0120B3

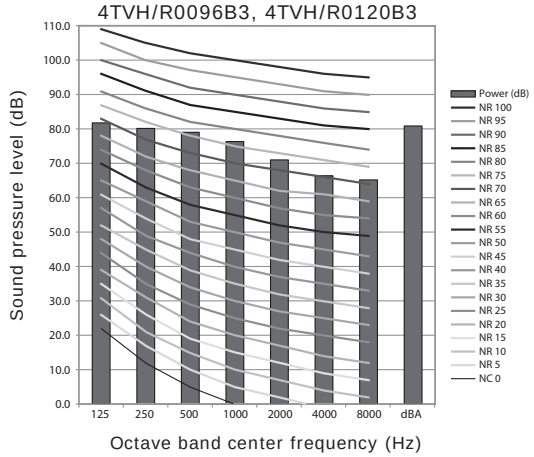


Figure 17. 4TVH/R0096B4, 4TVH/R0120B4

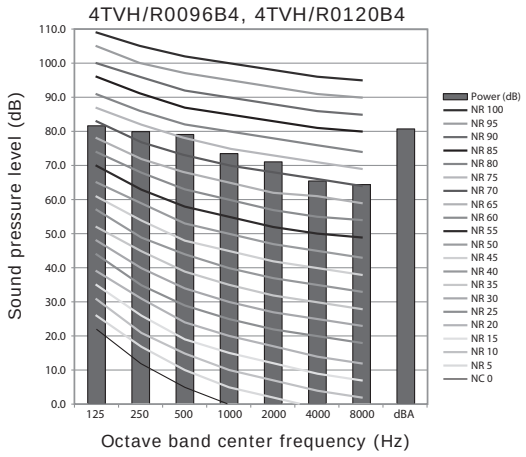
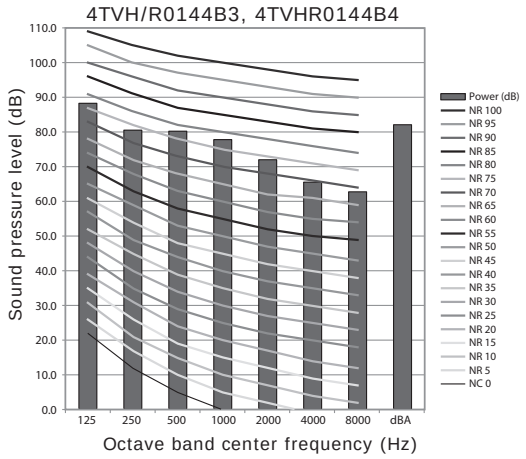


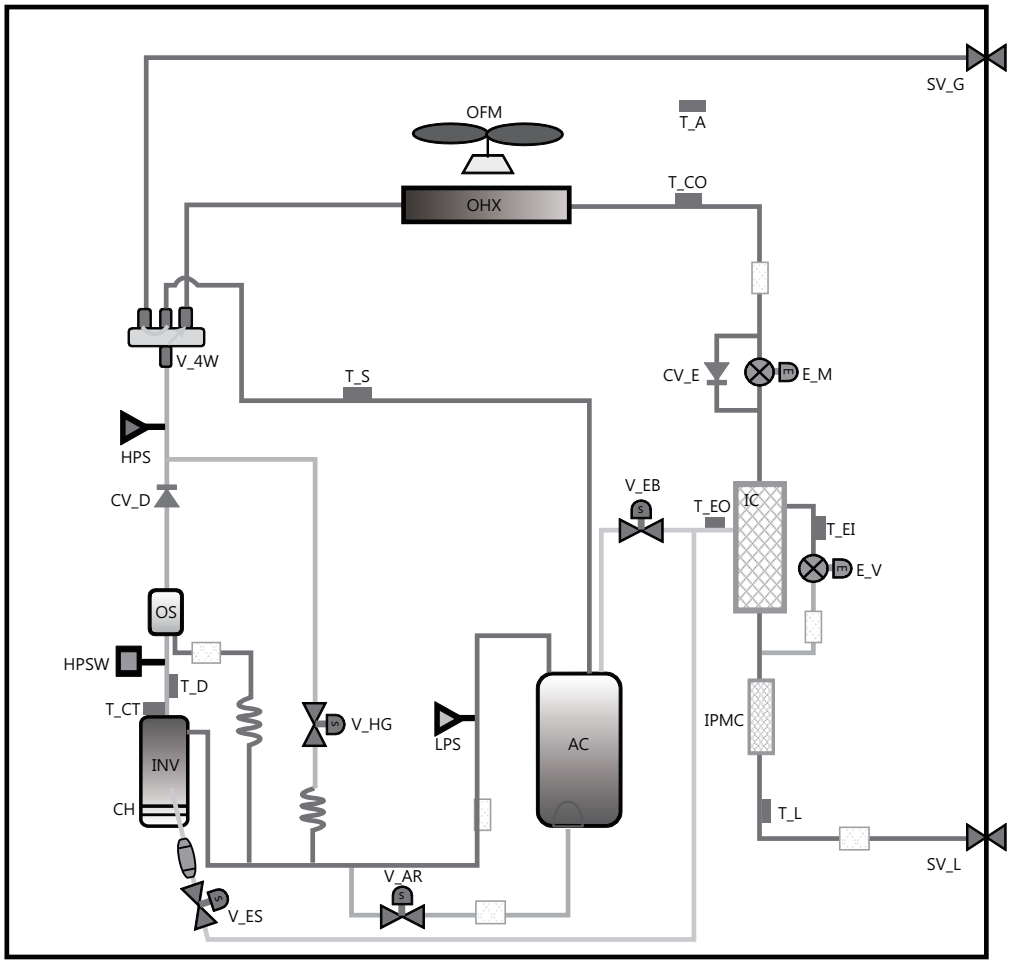
Figure 18. 4TVH/R0144B3, 4TVH/R0144B4



Cycle Diagrams

Parts of Outdoor Unit (HP)

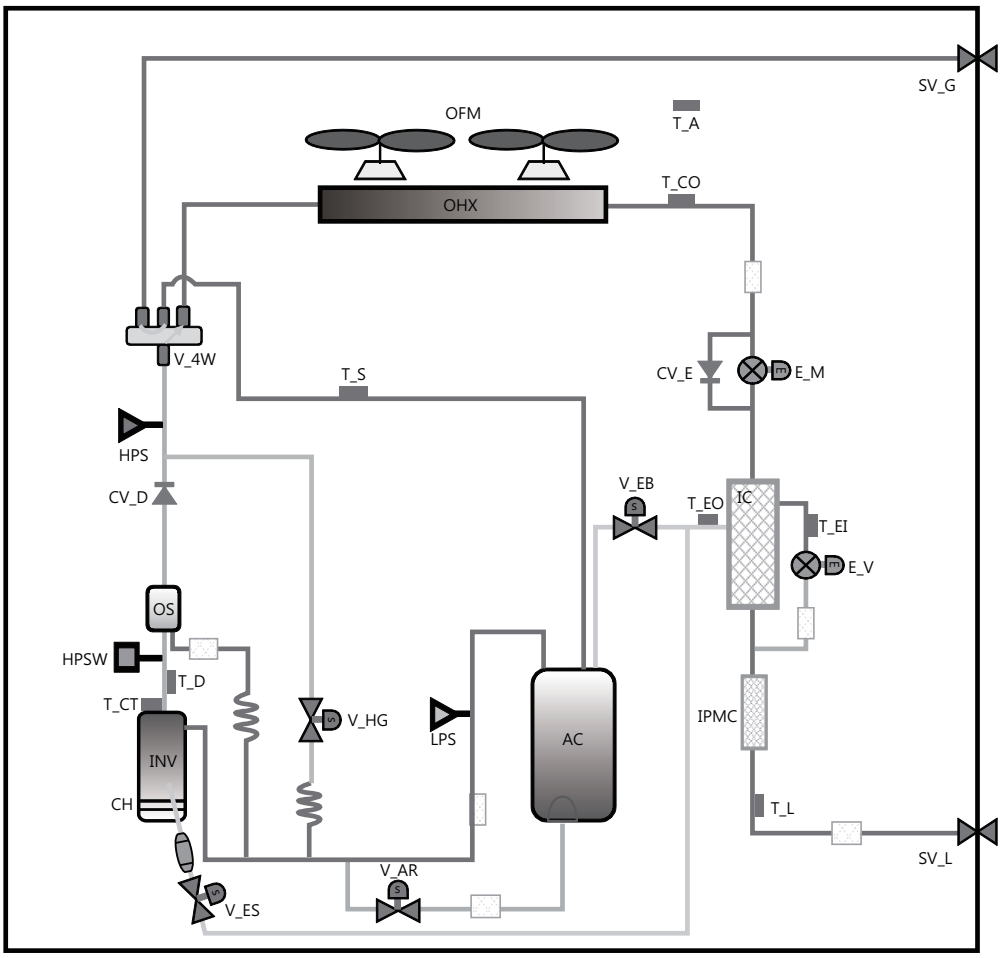
Figure 19. 4TVH0072B300NB, 4TVH0072B400NB



Classification	Description
INV	Inverter Compressor
OFM	Outdoor Fan Motor
OHX	Outdoor Heat Exchanger
AC	Accumulator
OS	Oil Separator
IC	Intercooler
IPMC	IPM Cooler
CH	Crank Case Heater
HPS	High Pressure Sensor
LPS	Low Pressure Sensor
HPSW	High Pressure Switch
E_M	Main EEV
E_EV	EVI EEV
V_ES	EVI Solenoid Valve
V_EB	EVI Bypass Valve

Classification	Description
V_HG	Hot Gas Bypass Valve
V_4W	4way Valve
V_AR	Accumulator Oil Return Valve
CV_E	EEV Bypass Check Valve
CV_D	Discharge Check Valve
T_D	Discharge Temperature Sensor
T_S	Suction Temperature Sensor
T_CO	Condenser Out Temperature Sensor
T_EI	EVI In Temperature Sensor
T_EO	EVI Out Temperature Sensor
T_L	Liquid Tube Temperature Sensor
T_CT	Compressor Top Temperature Sensor
T_A	Ambient Temperature Sensor
SV_G	Gas Pipe Service Valve
SV_L	Liquid Pipe Service Valve

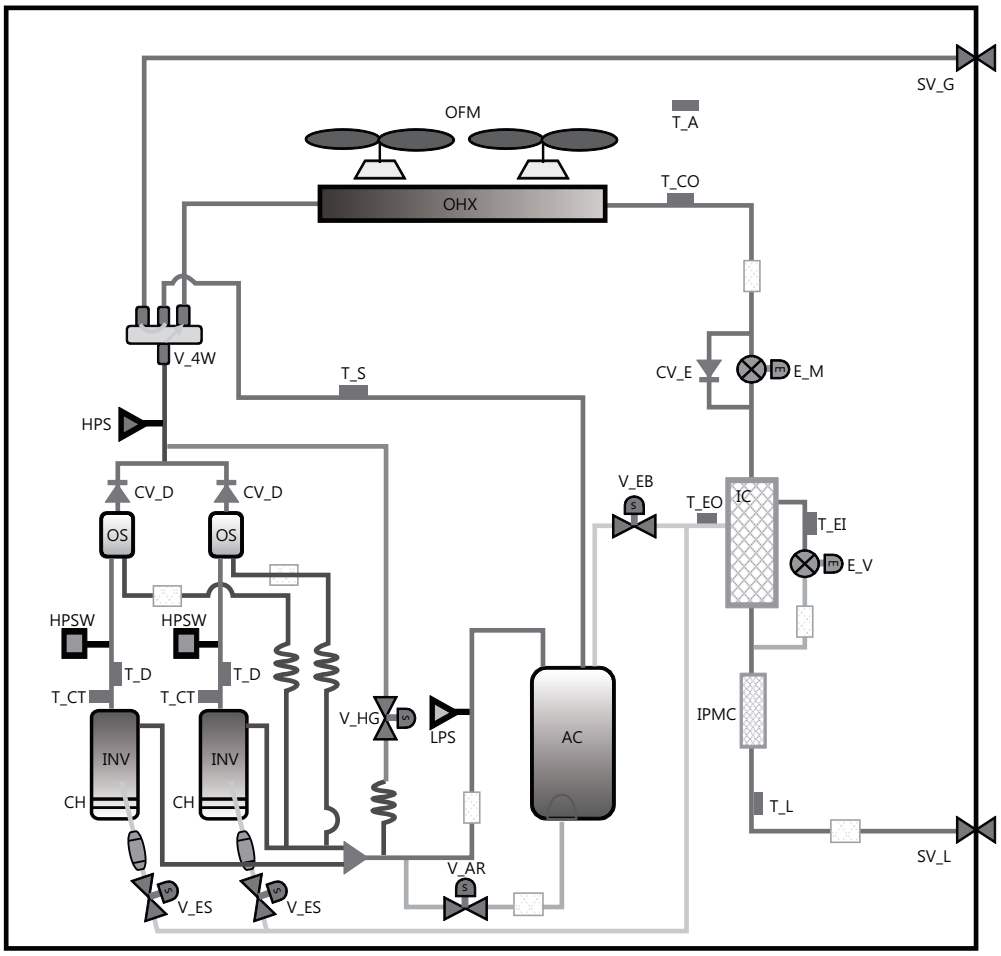
Figure 20. 4TVH0096B400NB, 4TVH0120B400NB



Classification	Description
INV	Inverter Compressor
OFM	Outdoor Fan Motor
OHX	Outdoor Heat Exchanger
AC	Accumulator
OS	Oil Separator
IC	Intercooler
IPMC	IPM Cooler
CH	Crank Case Heater
HPS	High Pressure Sensor
LPS	Low Pressure Sensor
HPSW	High Pressure Switch
E_M	Main EEV
E_EV	EVI EEV
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T_CO	Condenser Out Temperature Sensor
T_EI	EVI In Temperature Sensor
T_EO	EVI Out Temperature Sensor
T_L	Liquid Tube Temperature Sensor
T_CT	Compressor Top Temperature Sensor
T_A	Ambient Temperature Sensor
SV_G	Gas Pipe Service Valve
SV_L	Liquid Pipe Service Valve

Figure 21. 4TVH0096B300NB, 4TVH0120B300NB, 4TVH0144B300NB, 4TVH0144B400NB

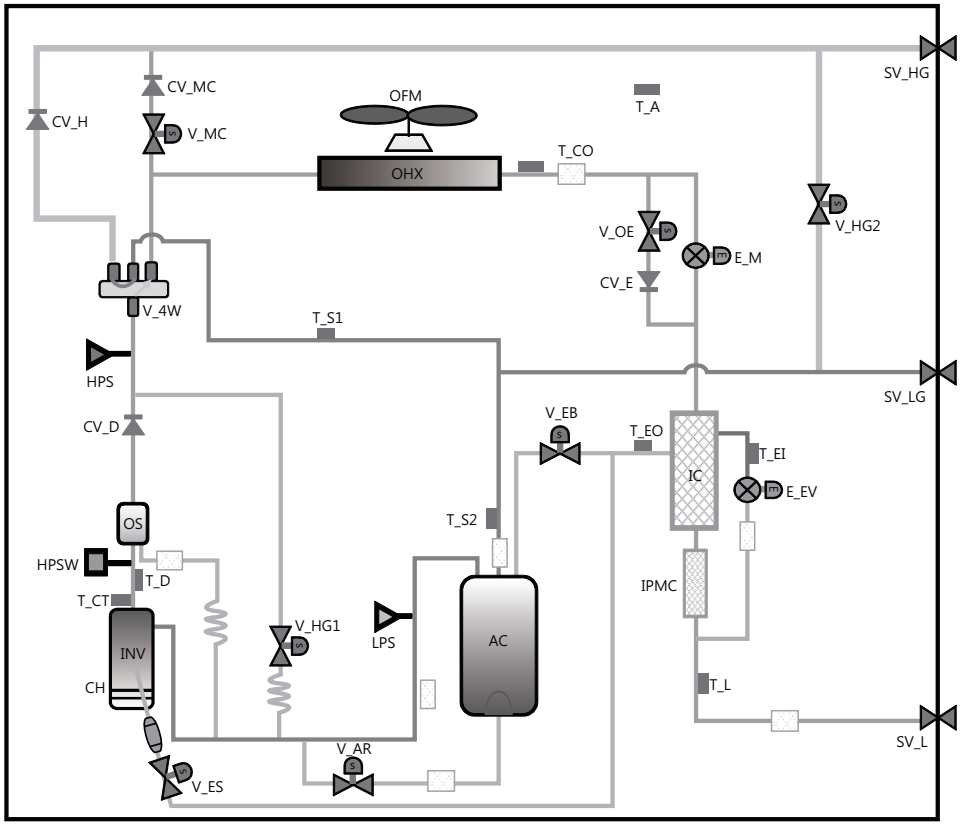


Classification	Description
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T_CO	Condenser Out Temperature Sensor
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T_EO	EVI Out Temperature Sensor
T_L	Liquid Tube Temperature Sensor
T_CT	Compressor Top Temperature Sensor
T_A	Ambient Temperature Sensor
SV_G	Gas Pipe Service Valve
SV_L	Liquid Pipe Service Valve

Parts of Outdoor Unit (HR)

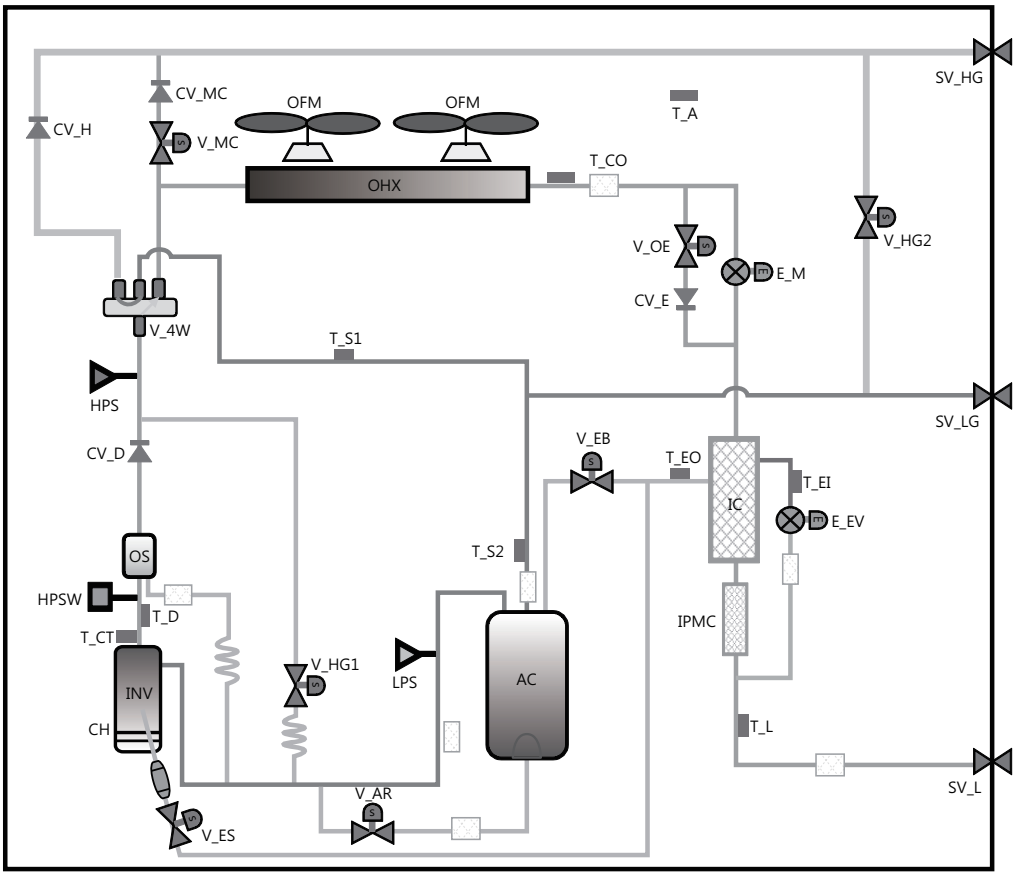
Figure 22. 4TVR0072B300NB, 4TVR0072B400NB



Classification	Description
INV	Inverter Compressor
OFM	Outdoor Fan Motor
OHX	Outdoor Heat Exchanger
AC	Accumulator
OS	Oil Separator
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T_CT	Compressor Top Temperature Sensor
T_A	Ambient Temperature Sensor
SV_G	Gas Pipe Service Valve
SV_L	Liquid Pipe Service Valve

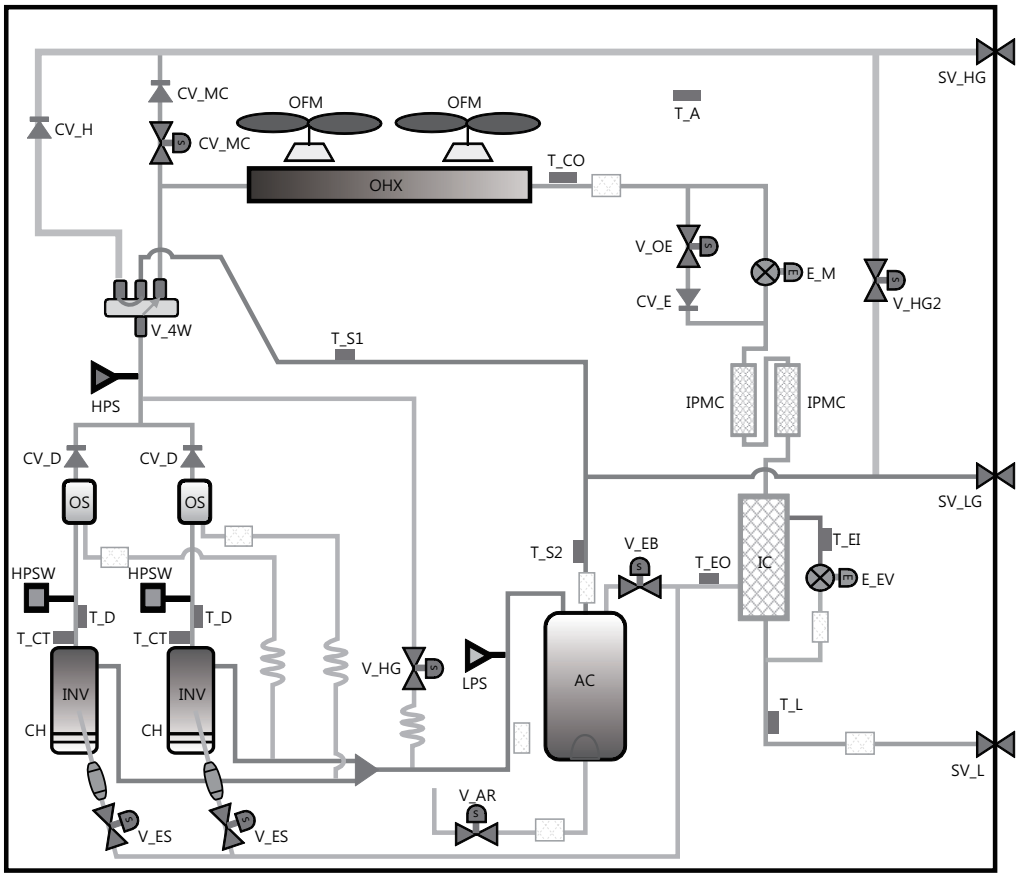
Figure 23. 4TVR0096B400NB, 4TVR0120B400NB



Classification	Description
INV	Inverter Compressor
OFM	Outdoor Fan Motor
OHX	Outdoor Heat Exchanger
AC	Accumulator
OS	Oil Separator
IC	Intercooler
IPMC	IPM Cooler
CH	Crank Case Heater
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T_L	Liquid Tube Temperature Sensor
T_CT	Compressor Top Temperature Sensor
T_A	Ambient Temperature Sensor
SV_G	Gas Pipe Service Valve
SV_L	Liquid Pipe Service Valve

Figure 24. 4TVR0096B300NB, 4TVR0120B300NB, 4TVR0144B300NB, 4TVR0144B400NB



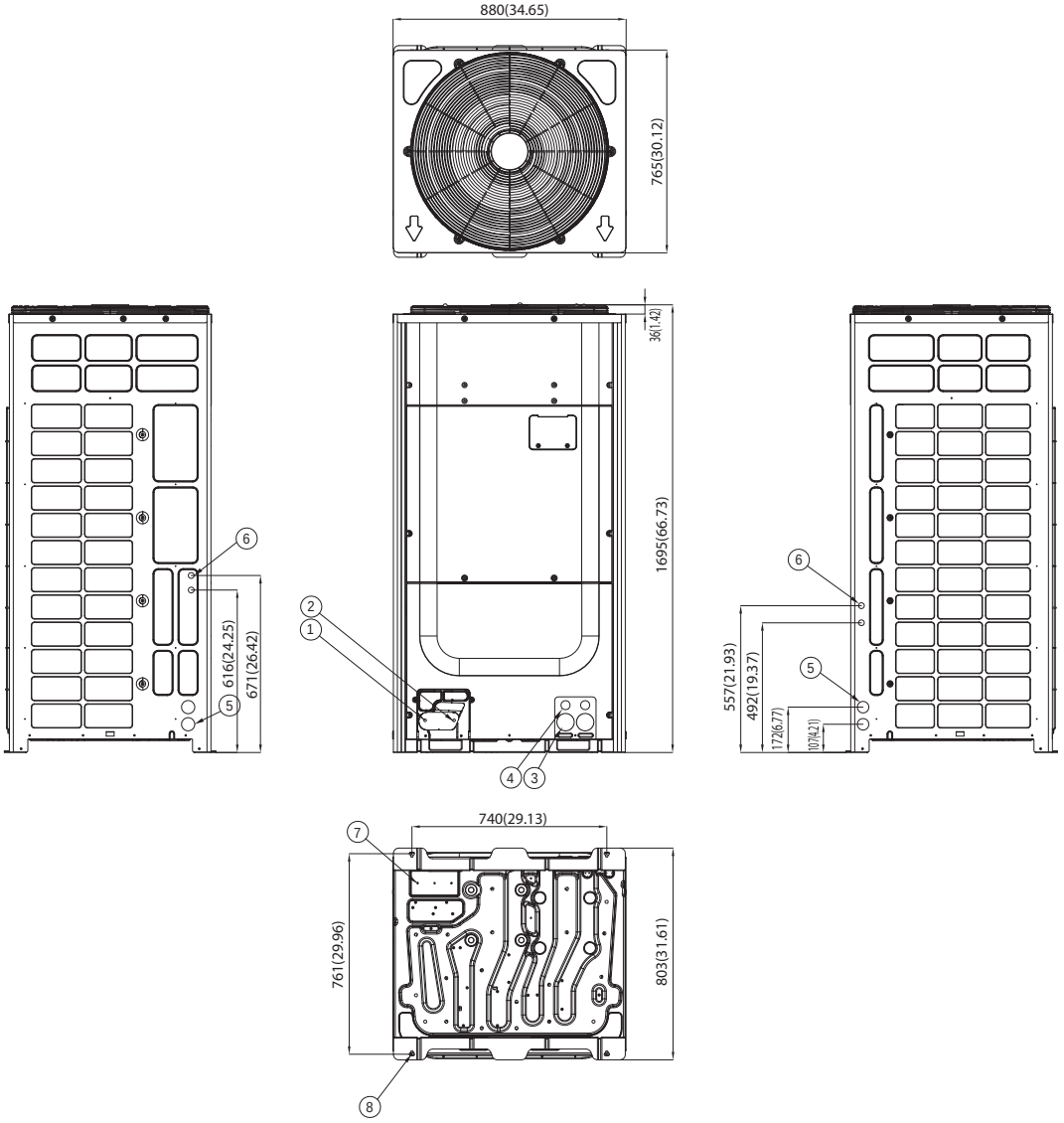
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T_EO	EVI Out Temperature Sensor
T_L	Liquid Tube Temperature Sensor
T_CT	Compressor Top Temperature Sensor
T_A	Ambient Temperature Sensor
SV_G	Gas Pipe Service Valve
SV_L	Liquid Pipe Service Valve

Dimensional Drawings

Heat Pump/Heat Recovery

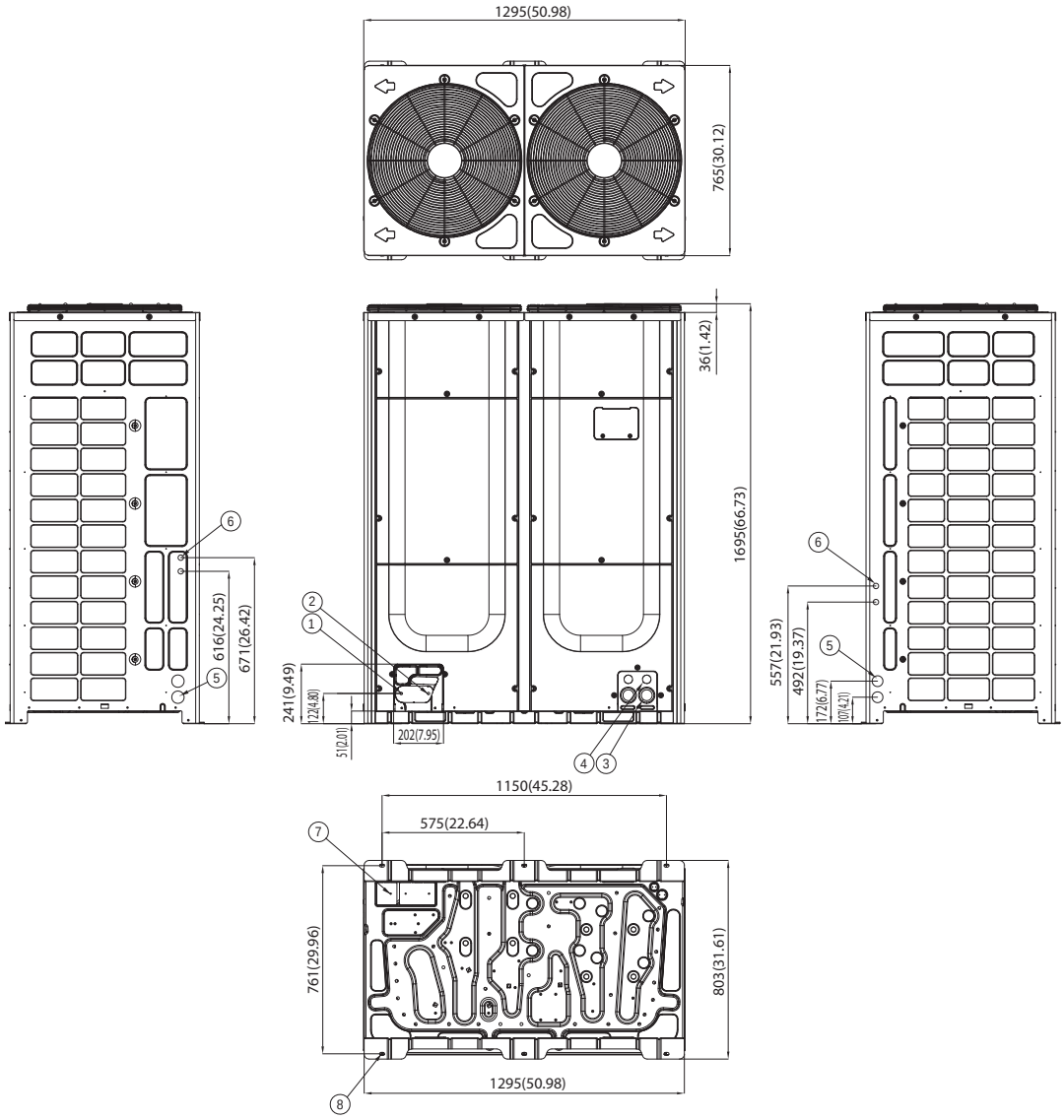
Figure 25. 4TVH/R0072B***(a)**



(a) Unit: mm (inch)

No.	Name	Description	No.	Name	Description
1	Gas Ref. Pipe	-	5	Power Wiring Conduit	4(0.16") - Ø43.7(1.72")
2	Liquid Ref. Pipe	-	6	Communication Wiring Conduit	8(0.31") - Ø22.0(0.87")
3	Power Wiring Conduit	2(0.08") - Ø43.7(1.72")	7	Knock-out Hole for Ref. Piping	178 x 76(7" x 3")
4	Communication Wiring Conduit	2(0.08") - Ø34.5(1.36")	8	Anchor Bolt Hole	4(0.16") - Ø12(0.47")

Figure 26. 4TVH/R0096B***, 4TVH/R120B*****, 4TVH/R0144B*****(a)**



(a) Unit: mm (inch)

No.	Name	Description	No.	Name	Description
1	Gas Ref. Pipe	-	5	Power Wiring Conduit	4(0.16") - Ø43.7(1.72")
2	Liquid Ref. Pipe	-	6	Communication Wiring Conduit	8(0.31") - Ø22.0(0.87")
3	Power Wiring Conduit	2(0.08") - Ø43.7(1.72")	7	Knock-out Hole for Ref. Piping	178 x 76(7" x 3")
4	Communication Wiring Conduit	2(0.08") - Ø34.5(1.36")	8	Anchor Bolt Hole	4(0.16") - Ø12(0.47")





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Supersedes VRF-PRC008-EN (31 July 2013)

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APPENDIX 4 SAFETY MANAGEMENT PLAN

SEE ATTACHED USB DRIVE

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HSE Safety Management Plan

Prepared by:	Wyatt Ferguson
Signature:	
Date:	10/24/2019
HSE Manager:	Sharon Arents
Signature:	
Date:	
Customer:	Middlesex County VO-Tech
Signature:	
Date:	

NOTE: A SIGNED AND ACCEPTED COPY IS TO BE KEPT ON SITE AND ON CONTRACT FILE.

INTRODUCTION

The Health, Safety & Environmental (HSE) Site Management Plan is an integral part of all work and site specific procedures for all Honeywell operations. Honeywell is committed to developing safety systems which ensure the highest standard of health and safety for all employees. We aim to continually improve the systems of work and strive for best practice in the area of health, safety and environment. Honeywell aims to control risk through the implementation of an effective HSE Site Management Plan and Program.

The objective of this document is to establish a plan for implementing the company safe operations management program. The plan is intended to minimize losses, meet regulatory compliance requirements and to implement site health, safety and environmental regulations established by the Customer.

Honeywell demonstrates its commitment to health and safety by making all levels of management accountable for all health and safety issues. We attribute the success of effective safety systems to the ability to communicate the agreed standards of performance between employees and management. Honeywell's commitment to health, safety and the environment can be viewed at **Attachment 1: Honeywell HSE Commitment Statements**.

1. Plan Deployment

The HSE Plan is one component of Honeywell's Safe Operations Management (SOM) program. The HSE Plan, and its relevant components and references specific to this project, should be reviewed with the Customer, Honeywell representatives and subcontractors/contractors to ensure effective deployment of the SOM program. This includes:

(1) On-site meeting between Customer and Honeywell representative(s) and subcontractors.
(2) Customer and Honeywell representative(s) and subcontractors are briefed and understand the Safety Management Plan:
    a) Site information,
    b) Hazard and risk assessments,
    c) HSE training,
    d) Activity schedules,
    e) Measures of HSE performance.
(3) Plan is to be reviewed on a quarterly basis to ensure Management of Change.
(4) Plan shall be maintained to ensure that relevant information is available to employees, contractors, customers, clients and the public concerning the effects of the Company's activities and materials on the safety and health of people and impact on the environment.
(5) Communication and management systems shall be developed, implemented and maintained throughout each site to facilitate continuous improvement in performance.

(6) Active consultation and communication with employees and contractors in the improvement of health, safety and environmental work.

Honeywell Management Systems are the property of Honeywell and must be maintained in accordance with Honeywell Information Security guidelines. Clients wishing to view any components of the Honeywell Operating System (external to Safe Operations Management) can request to do so by contacting the Honeywell Project Manager, who will assess the request and where deemed appropriate, arrange for viewing of the relevant Honeywell information.

2. Revision Sheet

When changes are made to this document, the revision sheet must be revised and all controlled copies of the document updated and distributed per the Distribution List.

Revision	Date	Description
Initial Draft	10/24/19	Initial document

3. Distribution List

One hard copy will be maintained for the assigned contract on site. Electronic copy can be distributed, upon request.

Copy	Name	Organization & Title	Email Address
1	Salvatore Corcione	Honeywell Project Manager	Salvatore.Corcione@honeywell.com
2	Sharon Arents	Honeywell HSE Leader	Sharon.Arents@Honeywell.com
3	Robert Letso	Honeywell PM Leader	Robert.letso@Honeywell.com
4	Francis Cap	Customer Project Manager	capf@mail.mcvts.net
5		Customer HSE Leader	

4. Contents

Introduction
Section 1 Site Information
Section 2 Site Hazards and Safety Management Plan
Section 3 Site Requirements
Section 4 Site HSE Activity Schedule
Section 5 Site HSE Performance
Section 6 Contract Form and Attachments

SECTION 1 – SITE INFORMATION & HSE ADMINISTRATION

5. Contract – Scope of Work Description

Project name:	Middlesex County VO-Tech BOE
Customer name and address:	112 Rues Lane, East Brunswick, NJ 08816
Scope of work (summary):	Lighting, Mechanical, Controls, Building Envelope, Solar
Start Date:	1/15/2020
Completion Date:	6/25/2021

6. Key Project Contacts (List all Honeywell Employees & Contractors)

Honeywell Project Manager	Salvatore Corcione	Salvatore.Corcione@Honeywell.com
Honeywell Project Administrator	Wyatt Ferguson	908-655-1906 Wyatt.Ferguson@Honeywell.com
Honeywell Branch Project Manager	NA	NA
Honeywell Regional HSE Leader	Sharon Arents	Sharon.Arents@Honeywell.com
Customer Project Manager	Francis Cap	capf@mail.mcvts.net
Customer HSE Leader		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		
Subcontractor Project Manager		

7. Customer HSE Reporting

Honeywell will report HSE performance to the Customer, if required, as defined in the scope of work and/or contract. Reporting topics may include:

- Customer requested HSE metrics at customer request,
- Incidents/injuries, Safety Observation System events,
- Summary of HSE Project Manager site reviews/audits, Contractor audit results

8. Cardinal Rules – Unacceptable Behaviors & Attitudes

The Cardinal Rules shall be displayed at all Honeywell locations, including field offices and also at designated Honeywell offices within the Customer site. All employees are to adhere to the Cardinal Rules which can be viewed at **Attachment 2: Honeywell Cardinal Rules**.

9. Responsibilities, Authority & Resources

Management & Resources

The Honeywell Project Manager is responsible for the implementation of the Honeywell Health, Safety and Environment Plan requirements and shall maintain and monitor programs aimed at continuous improvement of HSE performance. Appropriate health, safety and environmental support and resources shall be available to assist project and service managers to discharge their responsibilities.

Honeywell Project Manager Responsibilities

Each PM is accountable for implementation of Honeywell's HSE Policy. Specific responsibilities are:

- Supports and promotes jobsite safety through leadership and example.
- Becomes involved in task safety analysis in order to identify any hazards and manage the associated risks prior to work being done.
- Ensures the completion of job hazard analysis prior to the beginning of any work including review and approval.
- Insist upon employee's and subcontractor's compliance with established safety rules, correcting any unsafe acts or conditions, and implementing corrective or disciplinary actions as necessary for the effective functioning of the safety program.
- Ensure all team members are trained in safe work procedures.
- Ensure regular hazard inspections are carried out within areas under their control.
- Verify that employees and subcontractors implement the designated site safe work procedures/systems.
- Ensure approved Honeywell employee protective equipment is issued and proper instruction given as to its use, maintenance and storage.
- Be involved in formal as well as informal safety audits and monitor contractor and site safety performance on a regular basis.
- Ensure that all accidents and injuries are reported and investigated.
- Identify cause of non-compliance and investigate/document actions to correct safe work method deficiencies or rectify inappropriate workplace behaviors, including consultation, counselling, training and/or disciplinary action.
- Preparation and regular review of work procedures.

All Honeywell Employee Responsibilities

Employees have a duty to cooperate in the achievement of a safe and accident free workplace, through:

- Cooperating in fulfilment of the obligations placed on Honeywell International.
- Identify all tasked and prepare risk assessments.
- Working with care for their own safety and that of others who may be affected by their actions
- Reporting unsafe conditions and behaviours.
- Wear and maintain any issued personal protective equipment (PPE) when necessary.
- Assisting in the investigation of any accidents with the objective to prevent recurrence.
- Maintain a safe working environment for all Honeywell/Contractor employees that may be utilized for this project.
- Report all safety issues or events directly to the Honeywell Project Manager.

Subcontractors shall be responsible for complying with all Subcontractor Responsibilities

Subcontractors shall be responsible for complying with all statutory obligations and shall exercise all possible care for the health and safety of their personnel and other persons at the workplace who may be affected by their activities. Subcontractors shall at all times comply with Honeywell's HSE policy and procedures. As a condition of employment all employees are expected to work in a safe and responsible manner. The employee is ultimately responsible for his or her own safety. All contractors shall provide the employee with all the necessary training and PPE, but the employee must make the proper choices when performing an assigned task. Any issues not covered by this Safety Plan should be communicated to the relevant Honeywell representative. The Contractor's personnel will have responsibilities, which include but may not be limited to the following:

- Establishing safety responsibilities for their site personnel including their subcontractors.
- Insisting and ensuring correct and safe practices are used at all times.
- Providing adequate resources, personnel, equipment, time and funds to ensure the objectives of the safety plan are met.
- Completing the required work authorization forms and safety permits for each activity.

- Following safety rules and verbal instructions. Ask superintendent questions when any uncertainty exists.
- Ensuring their site personnel are suitably trained to effectively carry out their HSE responsibilities.
- Using tools in a safe and appropriate manner in accordance with their design; inspecting them for damage prior to each use.
- Ensuring safety auditing and performance reporting requirements specified by Honeywell are met.
- Reporting any unsafe acts or conditions, correcting them whenever possible.
- Reporting all injuries, incidents and near misses immediately, no matter how minor.

Project Employee/Contractor List

The Honeywell Project Manager will maintain the **Attachment 3 Site Project Contractor/Employee List**. All Contractors and Honeywell Employees working on site, listed or not, have a duty to cooperate in the achievement of a safe and accident free workplace.

10. Site Facilities

Honeywell Designated Areas

All designated Honeywell areas, if any, at the customer site must be maintained by Honeywell staff to ensure these facilities are kept in a clean and hygienic condition for the duration of the contract. At a minimum, these areas are to be inspected weekly to identify any workplace hazards or risks and to ensure minimum standards are maintained. If there is a Honeywell office you are required to post the Honeywell Commitment Statement and Cardinal Safety Rules. Depending on local or federal requirements ensure regulatory postings are current.

Security

Honeywell employees must meet all customer security requirements. This may include visitor badges, access training, appropriate regulatory and/or customer documentation, background checks, registry upon arrival and departure, etc. Badges are to be worn above the waist and in a visible position at all times while on site.

11. Honeywell Staff Training

Training needs shall be identified and training delivered to ensure that the project and service managers have the appropriate health, safety and environmental management skills. Honeywell employees shall be instructed in safe systems of work to ensure they work with proper regard for the safety, health, and protection of themselves, others and the environment. The Honeywell Project Manager is responsible for identifying the specific training requirements of their team members and ensuring the required training is undertaken. This training may be either Honeywell internal training, or training specific to the project location provided by the customer, provided the minimum content requirements are met. The minimum required training for the project scope of work is listed in Section 3 of this safety management plan.

12. Contractor Work Authorization & Permits

Contractor Sign-in & Work Authorization

Contractors must complete the Contractor Safety Declaration and Work Authorization Form with required risk assessments and permits prior to commencing work. Low risk work can be undertaken by contractors without direct authorization given that the relevant Honeywell Project Manager is aware of the:

1) Scope of work.
2) Time the work is to be undertaken.
3) Workers performing the work.

Attachment 4: Contractor Safety Declaration & Work Authorization Form
Attachment 5: Safety Permit Applications

13. Accident / Incident Events

Reporting of Accident / Incident Events

Honeywell Employees & Contractors must adhere to the following reporting requirements,

(1) Globally contact the Honeywell Project Manager
(2) Honeywell employees only - Call the HSE Hotline at 1-866-466-1765
(3) Honeywell Project Manager will contact the customer safety manager if required.
(4) The Honeywell HSE Manager must be contacted should any of these events occur.
    a. All injuries and incident events
    b. Release of dangerous goods or hazardous substances to the environment
(5) Certain incidents must also be reported to the relevant local workplace safety or environmental

protection authorities in accordance with local legislation.

Incident Investigation of Accident / Incident Events

Honeywell Representative must follow the following criteria after an accident or incident occurs.

(1) Conduct an incident investigation in accordance with Honeywell injury and incident investigation requirements in consultation with the regional HSE manager and affected employee(s).
(2) Ensure implementation and close out of short and/or long-term corrective actions to prevent re-occurrence.
(3) Present to Honeywell Project Management Leader and HSE Manager all planned corrective actions.

Attachment 6: Incident Investigation Report

14. Safety Observation System Events

Safety Observations must be submitted to the Honeywell Project Manager by any Honeywell employee using the **Attachment 7 Safety Observation Form**. Safety Observation is an unplanned event or condition that could have reasonably resulted in personal injury or illness, equipment or property damage, an environmental excursion, or when a safety control measure is challenged or ignored.

15. Site Evacuation Procedures

The Honeywell site specific **Emergency Response Plan, Attachment 17** shall be prepared, if a customer equivalent response plan is not available. The Honeywell Project Manager shall review and incorporate the emergency response plan into the Safety Management Plan. Either the Honeywell or Customer site specific emergency response plan shall be followed and this plan shall be communicated to all Honeywell employees, contractors, and visitors prior to working at the project site. For any Honeywell-occupied spaces such as a job trailer, leased office space or warehouse used during the course of a project, Honeywell shall complete a Honeywell site specific Emergency Risk Assessment by checking the appropriate boxes, then complete a site specific Emergency Response Plan as explained in the Emergency Response Procedure.

SECTION 2 – SITE RISK ASSESSMENT TOOLS

16. Hazard Reporting

It is the responsibility of all employees to immediately report any unsafe act or condition to the Honeywell Project Manager. Honeywell actively encourages all employees and contractors to report hazards. The strength of our Health, Safety Management Plan relies on the ability of Honeywell employees and contractors to report hazards. At each site, all hazards that are identified by employees or contractors shall be communicated immediately to the Honeywell Project Manager. In the event that the hazard is considered significant, it must be reported immediately to the appropriate Customer representative.

17. Site Assessment Tools

Identify Site Hazards

Hazards associated with contracted scope of work shall be identified and documented in the **Attachment 8 hazard assessment site inventory**. The Hazard Assessment Site Inventory should include all identified hazards for the scope of work on this contract. The Hazard Assessment is used to prepare task and generic risk assessments or contractor authorizations.

Risk Assessment & Contractor Work Authorization Forms

Each hazard must be assessed according to the risk calculator listed on the **Attachment 9 Risk Assessment Form** to ensure the hazards are categorized as low, medium or high risks. Risk exposure to hazards in the work environment is determined by consequence and severity resulting in a low, medium or high risk level. **[**Click **HERE** for sample Risk Assessments / Safe Work Procedures.**]**

Risk assessments and contractor work authorization forms include a list of control measures which need to be developed and made readily available for the duration of the work. Hazards shall be controlled to ensure that consequent risks are eliminated or reduced as far as is reasonably practicable. Control measures shall be reviewed and monitored for their effectiveness. Continuous consultation should occur with all employees and contractors on site to ensure that hazards are identified and controls implemented.

Control measures will be selected in accordance with both established Field Risk Assessment Forms and the “Hierarchy of Control Measures” aimed at eliminating the hazard or hazardous activity. The most desirable

control measure must be selected using the control hierarchy, in this order, elimination, substitution, engineering control, administrative control and personal protective equipment.

Tasks assessed as a high risk will require notifying the Honeywell Project Manager prior to commencement of work. The Honeywell Project Manager will evaluate the task for personal safety issues. All relevant activity check sheets and permits shall be completed in advance, and applicable guidelines, procedures, and/or work instructions will be reviewed and followed prior to and during the performance of the tasks.

Both contract and site specific data should be reviewed for inclusion in the orientation process to ensure key hazards/risks and any expectations in relation to the hazard elimination/risk management are communicated to the relevant employees and contractors.

The Honeywell Project Manager shall ensure that risk assessment and contractor authorization forms are implemented where required and ensure a quality standard of service is provided. Honeywell has developed a list of safety procedures for site work that facilitate compliance to legislative requirements. After the contractor completes the work authorization form the contractor may use previously completed Honeywell and/or the customer field risk assessment forms, provided that the contractor understands the procedure and takes ownership of the field risk assessment forms. All field risk assessment forms need to be reviewed by each employee prior to commencement of work.

Field Risk Assessment Forms identified are assessed for any potential risks of personal injury or injury to others, and property damage or environmental damage. Risk Assessments are separated into generic and task specific functions. The following are only examples and do not include all tasks that may apply at the customer or Honeywell location,

- Generic Field Risk Assessment Forms include common steps that are prepared once and can be used at multiple locations,
  - Climbing a ladder, working from a scaffold, scissor lifts, aerial lifts, man lift, etc.
  - Safe driving to/from customer locations
  - Personnel safety at customer locations, including walking on site
  - Roof Work
  - Mobilization of personnel, equipment or heavy components
  - Working on operating equipment
- Task Specific Field Risk Assessment Forms are prepared for a unique task at the customer site,
  - Equipment specific Lock Out / Tag Out, of electrical, mechanical, hydraulic, pneumatic, gravity, gas tie-ins, refrigerant servicing, etc.
  - Working from heights involving fall protection
  - Demolition of Electrical Cabling, equipment, etc.
  - Working in areas (e.g., installation, demolition) with live power or active control / fiber-optic cable, including junction boxes, where there is a substantial possibility of interrupting a live circuit.

18. Site Specific Field Risk Assessment Form Inventory

The Project Manager is responsible for keeping an inventory of the completed risk assessments and contractor work authorizations for the scope of work of this contract using the table provided in the hazard assessment site survey Attachment 8. This includes specific Field Risk Assessment Forms identified as a result of the completed Risk Assessments and Contractor Work Authorization Forms. All contract personnel are required to be familiar with the procedures and when they are to be used. These procedures must be followed at all times when the identified major risk activity is performed. Full records are to be kept for every major risk activity performed.

SECTION 3 – Site Requirements, HSE Training, Licenses and Competency

19. Customer Site Orientation

General Requirements

All Honeywell employees and contractors working on the customers sites will complete the customer site orientation, if required by the customer. Honeywell contractor orientations shall be managed by the Honeywell Project Manager to ensure that all orientations, including site safety management plan requirements are received and accepted by contractors and Honeywell staff, documented as being completed, and maintained in this plan for all contract personnel as required by Honeywell.

Orientation Schedule

The following orientations must be completed:

Orientation	Orientation Frequency	Key Contact(s)
Contractor Orientation	Prior to commencement of work. Complete **Site Orientation Form Attachment 10** with contractors & their employees Prior to commencement of work. Complete **Attachment 12 Field Safety Checklist** which document potential hazards. Review Contractor Work Authorization Forms with required safety permits.	Salvatore Corcione Wyatt Ferguson
Honeywell Employee Orientation	1. Prior to commencement of work and annually. Complete required monthly training modules per **Attachment 11 Training Register**. 2. Document employee having completed Risk Assessment Forms with required safety permits.	Salvatore Corcione Wyatt Ferguson

20. HSE Training, Licenses & Certificate of Competency

Honeywell Staff, Contractors and Sub-contractors

Both Honeywell Staff and contractors are required to complete the Attachment 11 Training Register as proof of completion of the required training. Honeywell employees are required to complete **Attachment 15 Vehicle, Tool, & PPE Inspection Checklist**. Additional training requirements may be required by local regulations. If applicable, this must be verified as completed before commencing work at the site. Training must be completed prior to performing site specific task or activities. All contractors and Honeywell employees are required to be currently licensed in accordance with state and local requirements to perform the work and activities associated with the contract scope of work.

SECTION 4 – Site HSE Activity Schedule

21. Honeywell Project Manager HSE Activity Schedule

1) Conduct Safety Inspections:
    a) Attachment 12 Field Safety Checklist – Project Manager to complete prior to starting work onsite and annually.
    b) **Attachment 13 Behavioural Observation Checklist** – Project Manager to complete periodically to assess Honeywell field employees during scheduled construction.
    c) **Attachment 14 Contractor Safety Checklist** – Project Manager to complete periodically to assess Contractor safety compliance.
2) Attend Customer safety meetings and audits, as scheduled.
3) Report Safety Observations to the HSE Manager and Customer.
4) Document and approve all Risk Assessments, Contractor Work Authorizations and required safety permits.

SECTION 5 – Site HSE Performance

22. HSE Metrics

The following HSE metrics will be documented and maintained during project construction,

- Attendance at weekly contractor safety meetings.
- Number of safety audits performed and completed.
- Number (and %) of safety audit items in conformance with requirements.
- Number and types of injuries, illnesses, and safety observation events noted during the project.

SECTION 6 – Contract Forms and Tools

23. Contract Forms and Tools

Contracts Forms, Tools and Procedures

The following list includes all pertinent safety forms for the use of initiating and maintaining safe work practices as described in this Safety Management Plan. These forms are also included in the following pages of this section.

Attachment No.	Document Name	Time to Complete:	Frequency	Responsible to Complete
–	Safety Management Plan (SMP)	Start of contract	Once for each phase/contract	Honeywell PM
1	HSE Commitment Statements	Start of contract	Once with SMP	Honeywell PM (Post on-site)
2	HSE Cardinal Rules	Start of contract	Once with SMP	Honeywell PM (Post on-site)
3	Site Employee/Contractor list	Booking Date – Before Installation	Update as needed throughout project duration	Honeywell PM
4	Contractor Work Authorization Form	Booking Date – Before Installation	Update as needed throughout project duration	All Subcontractors
5	Safety Permit Applications	Before performing task that requires it.	As required throughout installation	Contractor / Honeywell Field Employees
6	Incident Investigation Report Form	Within 24 hours of incident.	As required throughout project duration	Honeywell PM
7	Safety Observation Form	Throughout Project Duration	Monthly	All Honeywell Employees
8	Hazard Assessment Site Inventory	Booking Date – Before Installation	Update as needed throughout project duration	Honeywell PM
9	Risk Assessment Form	Booking Date – Before Installation	Update as needed throughout project duration	Honeywell Field Employees
10	Site Orientation Form	Booking Date – Before Installation	Once with SMP	Honeywell PM
11	Training Register	Booking Date – Before Installation	Once with SMP	Honeywell PM
12	Field Safety Checklist	Booking Date – Before Installation	Done once for each trade, Update as needed throughout project duration	Honeywell PM
13	Behavioral Observation Checklist	Throughout installation	Monthly while Honeywell field employees are working	Honeywell PM
14	Contractor Safety Checklist	Throughout installation	Monthly while subcontractors are working	Honeywell PM
15	Vehicle, Tool, & PPE Inspection Checklist	Throughout project duration	Quarterly	Honeywell PM/Employees
16	Site Specific Emergency Plan	Booking Date – Before Install	Once with SMP	Honeywell PM

Honeywell
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Sustainable Opportunity Policy
Honeywell's Commitment to Health, Safety and the Environment

By integrating health, safety and environmental considerations into all aspects of our business, we protect our employees, our communities and the environment, achieve sustainable growth and accelerated productivity, drive compliance with all applicable regulations and develop technologies that expand the sustainable capacity of our world. Our health, safety and environmental management systems reflect our values and help us meet our business objectives.

- We protect the safety and health of our employees, and minimize the environmental footprint of our operations through efforts to prevent illness, injury and pollution.
- We actively promote and develop opportunities for expanding sustainable capacity by increasing energy and water efficiency, improving security and safety, and reducing emissions of harmful pollutants.
- We are committed to compliance with all of our health, safety, environmental and legal requirements everywhere we operate.
- Our commitment to health, safety and the environment is an integral aspect of our design of products, processes and services, and of the lifecycle management of our products.
- Our management systems apply a global standard that provides protection of both human health and the environment during normal and emergency situations.
- We identify, control and endeavor to reduce emissions, waste and inefficient use of resources, including energy and water.
- We are open with stakeholders and work within our communities to advance laws, regulation and practices that safeguard the public.
- We abide by the company's own strict standards in cases where local laws are less stringent.
- Our senior leadership and individual employees are accountable for their role in meeting our commitments.
- We measure and periodically review our progress and strive for continuous improvement.

These are our commitments to health, safety, and the environment, and to creating Sustainable Opportunity everywhere we operate.

Darius Adamczyk
CEO

John Rajchert
President HBS
March 1, 2018

Honeywell
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HBS - HEALTH, SAFETY, ENVIRONMENTAL & REMEDIATION - CARDINAL RULES

No employee shall:

1. Engage in horseplay or conduct that endangers or injures employees, risk damage or actually does damage to company property or the environment.

2. Bring into any customer site, company-owned and/or company-operated facility and all company-sponsored events and meetings, or have in his/her possession: firearms, explosives or weapons of any type.

3. Bypass or operate equipment without guards, safety devices, or control equipment without following company established procedures and protocols.

4. Disassemble, enter or perform servicing, changeover or maintenance on equipment without properly de-energizing and safeguarding all power sources according to the applicable lock-out/tag-out policy.

5. Violate a life safety permit procedure (confined space, hot work, line breaking, fall protection).

6. Knowingly place her/himself or another person in physical danger, conceal a safety hazard or unlawful chemical release to the environment, or fail to promptly obtain attention to a personal injury or chemical spill.

7. Possess or under the influence of illegal drugs (not prescribed by a Physician of for their own use) or alcohol while on a customer site, company-owned and/or company-operated facility.

The actions listed above have been found to have such great potential for serious injury or damage that any employee that engages in such action may be subject to discipline, up to and including termination from the company regardless of previous performance. This policy is intended to protect the employee and his/her co-workers.

All employees are expected to understand and adhere to these Cardinal Rules and to request assistance in questionable situations. Further, all employees are encouraged to question the safety and environmental performance of all operations and become involved in improving them.

_____

Site Leader

Honeywell Internal

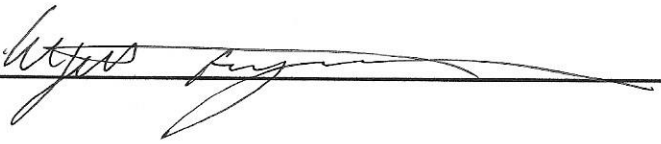
SMP Attachment 2: Honeywell Cardinal Rules

No Employee/Contractor may:

1. Engage in horseplay or conduct that endangers or injures employees, risks damage or actually does damage to company and/or customer property or the environment.
2. Bring into any company and/or customer site: firearms, explosives, or weapons of any type.
3. Bypass or operate equipment without guards, safety devices, or control equipment without following company and/or customer established procedures and protocols.
4. Disassemble, enter or perform servicing, changeover or maintenance on equipment without properly de-energizing and safeguarding all power sources according to the applicable lock-out/tag-out policy.
5. Violate a life safety permit procedure (confined space, hot work, line breaking and fall protection).
6. Knowingly place her/himself or another person in physical danger, conceal a safety hazard or unlawful chemical release to the environment, or fail to promptly obtain attention for a personal injury or chemical spill.
7. Possess or be under the influence of illegal drugs (not prescribed by a Physician of for their own use) or alcohol while on a customer site, company-owned and/or company-operated facility.

The actions listed above have been found to have such great potential for serious injury or damage that any employee that engages in such actions may be subject to discipline, up to and including termination from the company or removal from the project site, regardless of previous performance. This policy is intended to protect the employee and his/her co-workers.

All employees are expected to understand and adhere to these Cardinal Rules and to request assistance in questionable situations. Further, all employees are encouraged to question the safety and environmental performance of all operations and become involved in improving them.

Project Manager Signature: 

SMP Attachment 3: Site Employee Contractor List

Badge #	Employer	Name	Phone Number	Supervisor

SMP Attachment 4: Contractor Safety Declaration & Work Authorization Form

Contractor Safety Declaration

As a duly authorized and designated representative and agent of _____ , hereafter called "Contractor/Subcontractor", I hereby certify and agree for myself and for and on behalf of Contractor /Subcontractor:

I have visited the project site MCVT BOE _____ and visually inspected the general and local conditions which could affect the Contractor /Subcontractor Work. Any failure of the Contractor /Subcontractor to reasonably ascertain from a visual inspection of the site, the general and local conditions which could affect the Contractor /Subcontractor Work, will not relieve the Contractor/Subcontractor from its responsibility to properly complete the Contractor /Subcontractor Work without additional expense to Honeywell. In addition, I have read and agree to comply with all the Terms and Conditions as specified in the written contract.

1. I have already instructed or will immediately instruct all such agents and employees with respect to such conditions and/or hazards and the proper safety precautions to be observed in regard there to;

2. I certify that all necessary, adequate and operative protective clothing and equipment have been or will be immediately issued to all such agents and employees, together with full instructions and training for their use at Contractor's cost;

3. I certify that all Honeywell Safety and Work Specific procedures as specified in the Honeywell Contractors Safety Guide, including those addressing employee personal protective equipment (PPE), Life Critical Tasks and tool and equipment requirements will be put into effect; and that all such agents and employees will be properly supervised to insure compliance in the use of PPE, procedures and equipment and in the strict observance of safety rules and regulations;

4. I certify that all such agents and employees have completed the identified and required training and that proof of such training has been submitted to Honeywell representative. If such identified training has not been completed I agree to complete such training as identified and required to a standard equivalent or exceeding Honeywell standards.

5. I certify that I will participate in the Honeywell program to observe and monitor all such agents and employees for compliance to specified Safety Procedures and work practices as defined or required by any and all governmental regulations and laws.

6. At a minimum, I certify that Contractor /Subcontractor employees have been trained and/or briefed for the following applicable programs (identified with x), in accordance with local laws/regulations,

- ☑ General safety rules and regulations
- ☑ Specific safety requirements
- ☐ Confined space entry
- ☑ Eye and face protection
- ☐ Hearing protection
- ☐ Burning, welding and cutting
- ☐ Utility line hazards/precautions
- ☐ Chemical line hazards/precautions
- ☐ Workplace chemical hazards
- ☐ other (specify)

- ☑ General protective clothing and equipment requirements
- ☑ Lockout and tagout
- ☐ Line breaking
- ☐ Excavation
- ☐ Respiratory protection
- x Honeywell Contractor HSE Guide
- _____
- _____
- _____

Date: _____ _____
Signature of Contractor's/Subcontractor's Representative

Date: _____ _____
Signature of Honeywell Representative

Honeywell Use Only: **HID #:**

PRELIMINARY SAFETY DETAILS								*Honeywell Use Only: Work Authorisation Form Expiry : (Max 12 months) HSE Signed:*
Site		Contractor		Phone				
Name (PM responsible for the work)			Job / PO / SR Number					
Names of other workers			Honeywell Project Manager					
Scope of Work			Project Duration					
Location of Work	East Brunswick BOE							
1. Will you be using sub-contractors?	Yes □	No □	*You must inform the Honeywell Works Supervisor of all sub-contractors you intend to use.*					
2. Are all workers inducted to site & aware of first aid & emergency procedures?			Yes □	No □→	*If **No**, Do Not Proceed. Contact The Honeywell Project Manager*			
3. Are workers familiar with the work area and specific hazards in the work area(s)?			Yes □	No □→				
4. Are tools, plant and equipment in good order (plant maintained, electrical equip. tagged, etc)?	No Plant/Tools□		Yes □	No □→				
5. Are workers aware of the safety requirements for the job & licensed where required?			Yes □	No □→				

If the Scope of Works changes Honeywell must be contacted prior to undertaking the new works

HAZARD ID, RISK ASSESSMENT & CONTROLS

Identify the Hazards ✓ **applicable**	**Assess the Risk** ✓ **applicable**	When assessing risks use these risk levels: Minor Potential for minor injury / first aid treatment; Moderate Potential for lost time injury / medical treatment; Major Potential for death or serious injury	
		Detail Risk Control Measures to Be Used	**Responsible Person**
□ Exposure to live electrical circuit	**Major*** □	List controls to eliminate or minimize risks.	List who is responsible for ensuring the controls are in place and are
□ Fall > 1.8m	**Moderate*** □	Refer to relevant procedure or JSA.	
□ Line Breaking	**Minor** □		
□ Confined Space Entry			
□ Asbestos	** Detail Risk Controls & Responsibilities. Direct Authorisation required from the Honeywell Work Supervisor prior to commencing works.*		
□ Traffic / Mobile Plant			
□ Chemicals / Fumes / Dusts			
□ Noise / Vibration			
□ Public exposure to hazards			
□ Spill to Environment			
OTHER			

MANDATORY SAFETY PERMITS & SYSTEM ISOLATIONS
Safety Permits must be obtained and approved before commencing the following works. If not listed below use "other" section. (✓ applicable):

Other (not listed) — List any Risk Control Safety permits not listed below here.

□ Hot Works	□ Live Electrical	□ Confined Space Access	□ Line Breaking	□ Roof/Ceiling Access	□ Equipment Isolation	□ Fire / EVAC Impairment	□ Penetration in fire rating material

6. Will the work cause interruption/isolation of site utilities (water, gas, electricity)?	No □	Yes □→	*If **Yes**, contact the Honeywell Works Supervisor*
7. Will you need to isolate systems or services (medical gas, UPS, security, comms, etc)?	No □	Yes □→	
If Yes to Q7 or Q8, what is the extent and impact of the isolation(s) / interruption?			

CONTRACTOR DECLARATION

I confirm that all necessary Health, Safety and Environment protection measures and precautions as detailed in this form will be taken to ensure the health and safety of workers and others who may be affected by the work. I also confirm the workers undertaking this work are competent, and where required, licensed to carry out the tasks.

Contractor Signature		**Date**	

SMP Attachment 5: Safety Permit Applications (Contractor & Honeywell Employee)

The permits listed below are required when called for by a risk assessment or contractor work authorization and must be documented and kept with the SMP. Permits not included or shown below may still be applicable, as determined by the Honeywell PM. Contractors may also use their own permits if approved and accepted by Honeywell PM.

Line Breaking, roof/ceiling access, Equipment Isolation, Fire/EVAC Impairment, Penetration in Fire Rated Material, Others

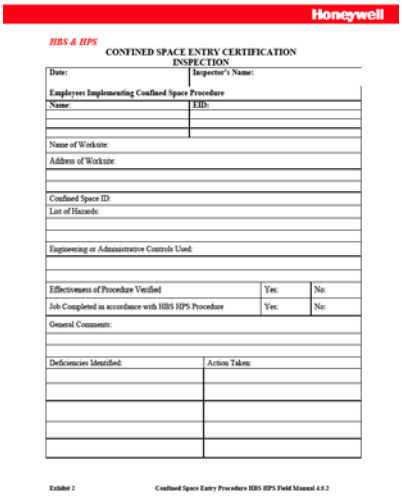
(Click on images below for PDF file attachment)

Hot Work Permit


HONEYWELL HOT WORK PERMIT

WARNING! HOT WORK IN PROGRESS WATCH FOR FIRE!

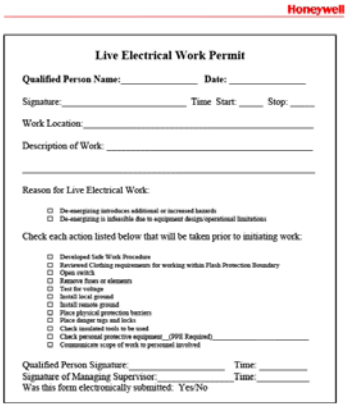
Confined Space Permit & Cert.


Honeywell

HBS & HPS

CONFINED SPACE ENTRY CERTIFICATION INSPECTION

Live Electrical Permit


Honeywell

Live Electrical Work Permit

Qualified Person Name:_____ Date: _____

Signature:_____ Time Start: ____ Stop: ____

Work Location:_____

Description of Work: _____

Reason for Live Electrical Work:

- ☐ De-energizing introduces additional or increased hazards
- ☐ De-energizing is infeasible due to equipment design/operational limitations

Check each action listed below that will be taken prior to initiating work:

- ☐ Developed Safe Work Procedure
- ☐ Reviewed Clothing requirements for working within Flash Protection Boundary
- ☐ Open switch
- ☐ Remove fuses or elements
- ☐ Test for voltage
- ☐ Install local ground
- ☐ Install remote ground
- ☐ Place physical protection barriers
- ☐ Place danger tags and locks
- ☐ Check insulated tools to be used
- ☐ Check personal protective equipment (PPE Required)_____
- ☐ Communicate scope of work to personnel involved

Qualified Person Signature:_____ Time: _____

Signature of Managing Supervisor:_____ Time:_____

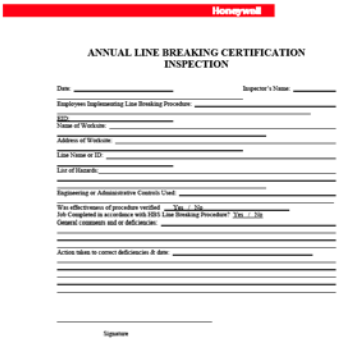
Was this form electronically submitted: Yes/No

Lockout/Tagout Permit


Honeywell

Multi Energy Source Equipment Specific Lockout\Tagout Procedure

Line Breaking Permit & Cert.


Honeywell

ANNUAL LINE BREAKING CERTIFICATION INSPECTION

SMP Attachment 6: Incident Investigation Report – Filed per Occurrence

Part 1: BASIC INFORMATION (Complete and return to HBS HSE Hotline within 24 hours)		
Name of person reporting (if not the Supervisor)	Date of report	
Name and address of location	Region/Business Site Code (LID)	Supervisor's name Supervisor's telephone number

Claimant / Accident Information			
Full Name of injured party Employee ID #	Address of injured party Home phone: Work phone:		Is the injured party ☐ Male ☐ Female
	Employee's typical work schedule:		
Date of Hire Job title Employment status	Days worked ☐ Mon ☐ Tue ☐ Wed ☐ Thu ☐ Fri ☐ Sat ☐ Sun	Time begins/ends to work	Contractor? ☐ Yes ☐ No If YES, please complete: Name and address of Temporary Agency/ Contractor: Contact: Phone number:

Date of accident Time of Accident ☐AM☐ PM	Employer notified on what date	Name of place where incident occurred Address where incident occurred	Was there lost time? ☐ Yes ☐ No If yes, Last day worked
Briefly describe the incident			
Were authorities contacted? (police, fire, ambulance) ☐ Yes ☐ No If YES, who		Was a report number given? ☐ Yes ☐ No If YES, list number	
Were any safeguards provided? ☐ Yes ☐ No Were they in use at the time of the incident? ☐ Yes ☐ No			
NATURE OF INCIDENT:			
TYPE OF INCIDENT:			
PART OF BODY:			

Medical Care Information	
Name and address of treating physician	Name and address of treating hospital/clinic
Phone number of treating physician	Phone number of treating hospital/clinic
Date employee first visited the doctor	What treatment was given (please check)
Describe diagnosis / medical treatment the doctor provided (List prescribed medications if any)	
Physical restrictions noted by the medical provider during the initial visit?	

Witness Information	
Name and address of a witness to the incident	Phone number where witness can be reached
Comments from witness N° 1	
Name and address of a witness to the incident	Phone number where witness can be reached
Comments from witness N° 2	
Anything related to the incident you would like to add	

Part 2: INCIDENT INVESTIGATION (Complete & return to the HBS Regional HSE Leader within 5 days)	
Root Cause Analysis	
Why did the incident happen? (Direct Cause)	
Why did this occur? (Contributing Cause)	
Why did that occur? (Contributing Cause)	
ADDITIONAL COMMENTS:	
PRIMARY ROOT CAUSE:	
SECONDARY/CONTRIBUTING ROOT CAUSE(S)	
Please explain or if additional information is meaningful, please describe:	

List corrective and preventative actions:

Corrective Action	Responsible Person	Target Date	Completion Date

SMP Attachment 7: Safety Observation Form

SAFE OBSERVATION SYSTEM (SOS) REPORT FORM

A SOS is an unplanned event or condition that could have reasonably resulted in personal injury or illness, equipment or property damage, or an environmental excursion. Some examples include: Unsafe Conditions, Unsafe behavior, Events where injury could have occurred but did not, Events where property damage resulted or could have resulted, Events where a control measure was challenged or ignored.

1	SOS Title:						
2	Reporting Employee Name:			Employee EID:			
3	Name of Person responsible for closure:			Employee EID:			
4	Supervisor name:			Supervisor EID:			
5	Name of Contract	Contract Number		6	Address:		
7	Describe the SOS (what happened) / (Do *not use individual names if you have seen an unsafe practice)*:						
8	Honeywell HBS	9	Country: America	10	Region:	11	State:
12	Date SOS Observed:	DD/MM/YYYY					
13	Or select only one recommended time period for closing corrective action:	☐ One week ☐ Two weeks ☐ One month ☐ Three months ☐ Six months ☐ Twelve months					
14	Describe the corrective action:						
15	Date SOS to be closed (meet AOP goal):	DD/MM/YYYY					
16	Consequence of occurrence (select only one):	☐ Catastrophic (fatality) ☐ Major (hospitalisation) ☐ Serious (medical treatment/recordable) ☐ Minor (first aid) ☐ Negligible		17	Likelihood of Recurrence (select only one):	☐ Almost certain (>2 times/year) ☐ Highly likely (once per year ☐ Likely (once every three years) ☐ Unlikely (once every five years) ☐ Remote (once every ten years)	
18	Type of Hazard: (select only one):	☐ Contact in / between / under ☐ Contact with electricity ☐ Contact with sharp object ☐ Exposure to chemical (gas, dust, fume) ☐ Exposure to extreme temp. (hot/cold) ☐ Exposure to noise ☐ Exposure to low oxygen			☐ Fall from elevation ☐ Lifting / Repetitive Motion / Ergonomic exposure ☐ Liquid Splash / Contact struck against ☐ Slip / Trip / Fall (same level) ☐ Struck by ☐ Vehicle ☐ Another kind of hazard		
19	Type of SOS (select only one):	☐ Unsafe Behavior	☐ Unsafe Condition	☐ Incident with property damage		☐ Incident without property damage	
20	Location of Safety Observation (select only one):	☐ Manufacturing plant / Mill ☐ Honeywell Office ☐ Customer Office ☐ Hospital ☐ School ☐ Mechanical Room			☐ Laboratory ☐ Residence ☐ Warehouse ☐ Roof ☐ Computer Room / Control Room ☐ Vehicle ☐ Other		
21	Honeywell Risk Calculator (select only one):	☐ Major		☐ Moderate		☐ Minor	
22	Status:	☐ Open		☐ Closed			
23	Manager / Lead Signature:			Date:	DD/MM/YYYY		
	REMEMBER SAFETY IS EVERYONE'S RESPONSIBILITY						

SMP Attachment 8: Hazard Assessment Site Inventory

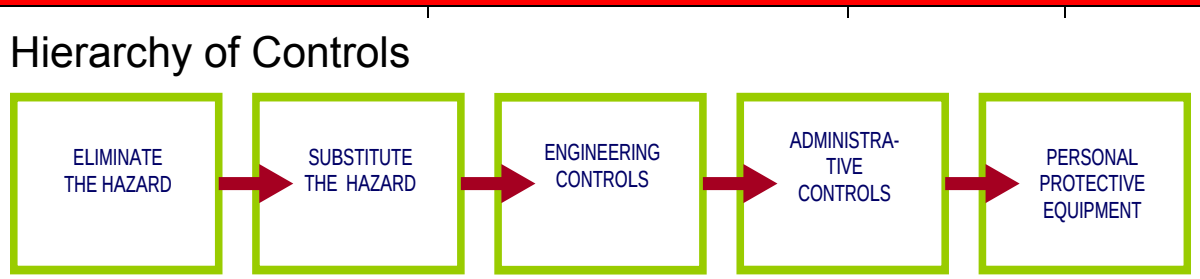
The following table lists each of the completed contractor work authorization forms and risk assessments for the scope of work of this contract.

HID#	Description of Hazard, Location, Safety Permits Required	Original Date	Check which is applicable below		Review Date
			Contractor Authorization Form	Risk Assessment Form	
1	Crane Lift	8/16/18			
2	General Site PPE	8/16/18	X	X	
3	Hand and Power Tools	8/16/18	X	X	
4	Ladder Use	8/16/18	X	X	
5	Line Breaking	8/16/18	X	X	
6	Live Electrical Work	8/16/18			
7	Lockout Tagout	8/16/18	X	X	
8	Rigging	8/16/18	X	X	
9	Slips, Trips, Falls	8/16/18	X	X	
10	Storage of Materials Onsite	8/16/18	X	X	
11	Vehicle Use	8/16/18	X	X	
12	Walking Through a Construction Site	8/16/18	X	X	
13	Roofwork	8/16/18	x	x	
14	Installing/Replacing Luminaries	8/16/18			
15	Hot Work	8/16/18	X	X	
16	Mobile Working Platforms	8/16/18			
17	Lifting	8/16/18	X	X	
18	Non-permit Confined Space	8/16/18			
19	Industrial Vehicles	8/16/18	X	X	
20	Emergency Response	8/16/18	X	X	
21					
22					
23					
24					
25					

Honeywell

SMP Attachment 9: Field Risk Assessment Form

FIELD RISK ASSESSMENT FORM CRITERIA / CALCULATOR



HONEYWELL RISK ASSESSMENT CALCULATOR

SEVERITY / CONSEQUENCE

PROBABILITY / LIKELIHOOD	1. Negligible	2. Minor	3. Serious	4. Major	5. Catastrophic
5. Almost Certain	Medium	High	High	High	High
4. Highly Likely	Medium	Medium	Medium	High	High
3. Likely	Low	Low	Medium	Medium	High
2. Unlikely	Low	Low	Low	Medium	High
1. Remote	Low	Low	Low	Medium	Medium

Severity / Consequence Criteria	Probability / Likelihood Criteria
Catastrophic ❑ Injury: Fatality of employees, contractors or the public. (Tier 1) ❑ Environment/Assets: Irreversible contamination of environment; Significant damage to building/equipment integrity. ❑ Public Relations: Significant public interest, national and/or international media involvement or significant impact on business reputation. ❑ Law and Permits: Federal regulatory intervention and/or regulatory fines greater then $5M to the company/unit; Government withdrawal of permits to operate the entire Honeywell unit or project.	**Almost Certain** 5. Occurred or likely to occur many times.
Major ❑ Injury: Extensive injury or Hospitalization of employees, contractors or the public. (Tier 2) ❑ Environment/Assets: Reversible contamination of environment; Moderate damage to building/equipment integrity. ❑ Public Relations: Moderate public interest, regional media involvement or moderate impact on business reputation. ❑ Law and Permits: Regional/District/State regulatory intervention and or regulatory fines greater then $1M to the company/unit; Government suspension of permits to operate a project.	**Highly Likely** 4. Occurred or likely to occur several times.
Serious ❑ Injury: Medical treatment of employees, contractors or the public. (Tier 2) ❑ Environment/Assets: Reversible small contamination of environment; Minor damage to building/equipment integrity. ❑ Public Relations: Some public interest, local media involvement or some impact on business reputation. ❑ Law and Permits: Local regulatory intervention and/or fines less then $1M to the company/unit; Customer suspension of some permits to a daily operation or written warning to Honeywell or project management.	**Likely** 3. Occurred or likely to occur once.
Minor ❑ Injury: First-aid treatment or Safety Observation of an employee, contractor or a member of the public. (Tier 3) ❑ Environment/Assets: No contamination of environment, no breach of law and no damage to building/equipment integrity. ❑ Public Relations: Little public interest, local media involvement or little impact on business reputation. ❑ Law and Permits: No suspension of permits to operate, continue daily operations, verbal warning to Honeywell or project management.	**Unlikely** 2. Might occur or likely to occur.
Negligible ❑ Injury: No injury. ❑ Environment/Assets: No impact. ❑ Public Relations: No public interest, local media involvement or no impact on business reputation. ❑ Law and Permits: No impact.	**Remote** 1. Rarely occurs.

RISK ASSESSMENT GUIDELINES

In most instances, moderate and major risks to health and safety can be adequately managed using site specific safe systems of work. For example, if a safety harness is specified as the control measure for working at height the risk assessment form should specify the pre-use inspections, selection of proper anchorage points, training of wearers, rescue of a suspended worker, etc.

For work with plant and substances consideration must be given to any safety recommendations of the manufacturer (e.g. the MSDS).

The actual workers performing the task should participate in all steps of the risk assessment process. It is crucial that the workers involved in the activity have input in the development and review of the safety measures.

Remember.
1. The risk assessment provides a written record of the process to be used to carry out a task safely. To demonstrate mutual understanding, it should be signed off by the parties who have responsibility for the tasks.
2. Management processes must be in place to ensure workers are competent and have the skills to complete the job and that there is a required level of supervision to ensure the tasks are completed as documented.
3. The risk assessment should be completed by all employees involved in the activity, not just the principal contractor or supervisor.

Describe the Site and the Scope of Work (Job Task)

The risk assessment should contain a brief description of the scope of work, location, supervisor, contractors, date & revision date where relevant.
Details of the specific area where the work is to be performed should also be included with the site details (e.g., building 1, phase 1 etc)

Document the Hazards that Make up the Scope of Work (Job Task)

In consultation with the persons performing the work, write down the hazards required to perform the scope of work/job task in the order to be carried out.
Details of the equipment and tools to be used should also be included. (e.g., fixing cabling to metal frame in roof space using an explosive powered ramset gun).

Identify Harm from Exposure to the Hazard

For each hazard, identify the harm/injury that may be caused from exposure to the hazard (s) to those engaged in the task or to others in the vicinity. For example, the main hazards from drilling concrete include exposure to hazardous silica dust, flying debris, high torque of tools and noise. The respective consequences would typically include respiratory damage, hearing damage, eye damage, sprains or cuts.
Pay particular attention to the use of plant and power tools to ensure that all safety hazards are identified.
For mobile plant check the general plant risk assessment record/Work instructions, as this will provide specific information on potential hazards associated with the plant.

Document all the Existing Risk Control Measures Associated with the Hazard to Eliminate / Reduce Risk

List all the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures). Control measures include training, instructions, information and supervision. For each hazard assess the foreseeable level of risk using the Honeywell risk assessment calculator.

Also include cross reference in the control measure column to any other risk assessments undertaken as part of the task, by referring to relevant hazard assessed (i.e. manual handling of ladders).

Risk Control Measures

Risk control measures should be selected in consultation with the relevant workers, making reference to the Honeywell HSE procedures where applicable. It may be necessary to seek advice from persons with safety training, working experience & the relevant Safety Advisor to identify the most appropriate control measure.
When selecting control measures consider:

- All persons that may be affected by the hazard, not just those involved in performing the task.
- The actual work practices on site.
- How often and for how long people are exposed to the hazard.
- The experience of workers doing the task.
- Safe work methods available and their effectiveness.
- The degree of safety training & instruction required (e.g. Safety inductions, safe work procedures, PPE use, use of MSDS's or the amount of supervision required).

Document Risk Level

Using the Risk Calculator, perform a risk assessment: evaluate the potential severity and probability (1, 2, 3, 4 or 5) of an incident for each hazard associated with the task.

Use the Risk Matrix to establish the risk ranking for each Task and Hazard; based on the Severity and Probability of an event, determine Low, Medium or High risk
Low Risk (green): Adhere to current hazard controls
Medium Risk (yellow): Control plan requires cell supervisor approval. Task should only proceed once the controls are in place
High Risk (red): Control plan must be reviewed and approved by the supervisor and site HSE. Work should not proceed until all the controls are in place and verified.
High risk tasks must also be added to site Risk Assessment tool. Activities should take place to lower risk classification.

List in priority order any additional control measures required to eliminate or reduce the hazard to the lowest exposure level possible relevant to the Hierarchy of Control.

Hierarchy of Risk Control Measures

Select control measures from the highest level practicable in levels 1 to 5 below, e.g., first try to eliminate the hazard, as this gives the best result. The measures at the lower levels are less effective and require training of workers plus frequent review of the hazards and systems of work. In some situations a combination of control measures may need to be used.

1 - Eliminate the hazard
Discontinue the activity or stop using the plant, tool or substance where practicable.
2 - Substitute the hazard
Use something safer or change the system of work
3 - Engineering controls
Use guards, fencing, safety screens, etc to separate workers from the hazard, use dust extractors on tools or exhaust ventilation to reduce dust
4 - Administrative controls.
e.g. specific worker instructions or procedures.
5 - Personal protective equipment (PPE).
Only when level 1 - 4 control measures have been considered and applied to the highest extent practicable, any remaining risk may be reduced by using PPE such as safety harness, eye protection, hearing protection, etc.

Any specific training, permits and information needed to carry out the task safely should also be noted (e.g. work at height training).

Identify Who Is Responsible

Document the names of the person's responsible for implementing the control plan (additional controls/information) to lower the risk level.

Monitor and Review the Risk Assessment

Make sure the work is supervised to ensure that the work is carried out as documented in the risk assessment.
Review the risk assessment if conditions, location, etc of the work change or after an appropriate length of time. Consider also:

- Whether the control measures are suitable for the task.
- The degree of support it has amongst the employees concerned.
- The effectiveness of control measures.

Designated Major Risk Tasks

Major risk work includes, but is not limited to:

- Unprotected work at heights >1.8 meters / 6 feet, particularly on roofs.
- Working on ladders above 1.8 meters / 6 feet.
- Entering confined spaces.
- Live electrical works.
- Working with mobile plant and machinery.
- Working near power lines.
- Working with elevating work platforms and cranes.
- Trenching and excavation.
- Work on or near gas mains or electricity supplies.
- Working with/near asbestos or lead or their removal.
- Demolition.
- Using certain hazardous substances including carcinogens.

Assessing and Reviewing Subcontractor Risk Assessments

The team leader/project manager or their delegated representative should ensure that the adequacy of subcontractor risk assessments and any associated safety documents and instructions are assessed prior to commencing work. In assessing subcontractor risk assessments consider the following:

- Compliance with Honeywell's policies and procedures.
- Has the recommended process been followed to develop the risk assessment?
- Are foreseeable significant hazards and risks to health and safety identified in relation to the nature of the works, including plant, tools and equipment used?
- Are risk control measures adequate and in line with the hierarchy of controls?
- Are all legislative requirements satisfied?
- Has the subcontractors inducted their workers into their own risk assessment?
- Is there adequate provision for supervision to ensure control?

[CLICK HERE FOR LINK TO PRE-POPULATED RISK ASSESSMENTS/SAFE WORK PROCEDURES]

FIELD RISK ASSESSMENT FORM

ASSESSMENT NO:

SITE LOCATION:

SCOPE OF WORK (JOB TASK):

PERMIT TO WORK REQUIRED? Yes ☐ No ☐

PERSON POTENTIALLY EXPOSED:				DURATION OF EXPOSURE:				FREQUENCY OF JOB:	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
	STAFF MEMBER PERFORMING JOB ONLY		VISITORS		16-30 MINUTES		31-45 MINUTES		NO OF TIMES PER WEEK
	MEMBERS OF THE PUBLIC		OTHER (SPECIFY)		46 MINS -1 HOUR		1 HOUR OR MORE		NO OF TIMES PER MONTH

HONEYWELL RISK ASSESSMENT CALCULATOR

Probability/ Likelihood \ Severity / Consequence	1. Negligible	2. Minor	3. Serious	4. Major
5. Almost Certain	Medium	High	High	High
4. Highly Likely	Medium	Medium	Medium	High
3. Likely	Low	Low	Medium	Medium
2. Unlikely	Low	Low	Low	Medium
1. Remote	Low	Low	Low	Medium

JOB HAZARD EXPOSURE OR DETAILED HAZARD AND HARM *List each of the hazards associated with the scope of work in the sequence they are encountered including possible harm and effects.*	RISK LOW / MEDIUM /HIGH *Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard*	RISK CONTROL MEASURES / SPECIAL PERMIT REQUIREMENTS *List the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures)*	RISK LOW / MEDIUM /HIGH *Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard*	ASSIGN RESPONSIBILITY *Write the name of the person responsible (supervisor or above): implement the control measures identified.*

I have read and understood the content of this RISK ASSESSMENT and agree to follow the requirements as outlined or alternatively contact the responsible Honeywell supervisor to revise the agreement

This risk assessment is written and approved at an administrative level. This approval does not imply that the risk assessment is a comprehensive and accurate document. Any subsequent use of the risk assessment makes it implicit upon the user to verify the accurate sequence of events, potential hazards, risks and controls.	RISK ASSESSMENT AUTHOR (PRINT NAME)	AUTHOR'S SIGNATURE	ASSESSMENT DATE
	MANAGERS NAME (PRINT NAME)	MANAGER'S SIGNATURE	ASSESSMENT REVIEW DATE

EMPLOYEE SIGNATURES

EMPLOYEE NAME (PRINT NAME)	EMPLOYEE SIGNATURE	DATE

EMPLOYEE NAME (PRINT NAME)	EMPLOYEE SIGNATURE	DATE

SMP Attachment 10: Orientation Form (Completed at Project Construction Kick-off)

Employee/Contractor:…… Contract: …… Date……...

Honeywell Representative: Wyatt Ferguson ……

Please tick ✓	Yes	No	Comments
• Honeywell/Customer HSE Policy	☐	☐	
• Discuss (or provide copies) of relevant Honeywell and/or Customer HSE procedures	☐	☐	
• Discuss/provide copy of Contractor HSE guidelines	☐	☐	
• First Aid arrangements	☐	☐	
• Location of hazardous materials listed in Hazardous Materials Register	☐	☐	
• Emergency Procedures	☐	☐	
• Evacuation Procedures	☐	☐	
• HSE Risk Assessment Worksheet	☐	☐	
• Reviewed Health and Safety Plan	☐	☐	
• Site Entry/Access requirements	☐	☐	
• Specific Training for special Area/Tasks (list below)	☐	☐	
• Works Authorization Form requirements	☐	☐	
	☐	☐	
	☐	☐	

I have completed the Orientation & Training as required for this Contract and agree to follow the guidelines and procedures as outlined in these courses.

Name	Signature	Name	Signature
Salvatore Corcione			
Wyatt Ferguson			

SMP Attachment 10: (Completed by ALL Contractor/HW Employees prior to construction start)

I have read and understand the Risk Assessments, completed Site Orientation & Safety training as required for this Contract at (enter project name) and agree to follow all guidelines to work safely			
Print Name	Signature	Company	Date

SMP Attachment 10: (Completed by ALL Contractor/HW Employees prior to construction start)

I have read and understand the Risk Assessments, completed Site Orientation & Safety training as required for this Contract at (enter project name) and agree to follow all guidelines to work safely			
Print Name	Signature	Company	Date

SMP Attachment 11: Training Register

The following table lists the Site Specific training requirements that must be completed prior to working on the project site. These training procedures were identified as a result of the completed hazard and risk assessments observed at the contract site. All employees and contractors must be familiar with the required training for this project and agree to follow these procedures for the entire duration of the project.

Training Register				
#	Training Requirement	Contract Required (yes or no)	Who is to Complete	Comments
1	Customer orientation	Yes	Honeywell Employees	
2	Honeywell Safety Awareness / Orientation	Yes	Honeywell Employees	
3	Asbestos Awareness	Yes	Honeywell Employees	
4	Bloodborne Pathogen Awareness			
5	Canine Awareness			
6	Cold Weather Safety			
7	Compressed Gas Awareness			
8	Confined Space Awareness	Yes	Honeywell Employees	
9	Confined Space Entry – advanced training required	Yes	Honeywell Employees	
10	Cranes & Slings	Yes	Honeywell Employees	
11	Driver Safety	Yes	Honeywell Employees	
12	Electrical Arc Flash Awareness	Yes	Honeywell Employees	
13	Electrical Safety General Awareness	Yes	Honeywell Employees	
14	Emergency Preparedness Plan (Customer)			
15	Environmental Hazard	Yes	Honeywell Employees	
16	Eye & Face Protection	Yes	Honeywell Employees	
17	Fall Protection	Yes	Honeywell Employees	
18	Fire Extinguisher Usage	Yes	Honeywell Employees	
19	Hand & Power Tool	Yes	Honeywell Employees	
20	Hazard Communication	Yes	Honeywell Employees	
21	Hearing Protection	Yes	Honeywell Employees	
22	Hot Work Permit	Yes	Honeywell Employees	
23	Ladder Safety	Yes	Honeywell Employees	
24	Laser Safety			
25	Lead Safety	Yes	Honeywell Employees	
26	Line Breaking	Yes	Honeywell Employees	
27	Lock Out/Tag Out	Yes	Honeywell Employees	
28	Machine Safeguarding			
29	Management of Change	Yes	Honeywell Employees	
30	Manual Material Handling / Back Safety	Yes	Honeywell Employees	
31	Office Ergonomics	Yes	Honeywell Employees	
32	Personal Protective Equipment	Yes	Honeywell Employees	
33	Powered Industrial Trucks	Yes	Honeywell Employees	
34	Process Safety Management			
35	Refrigerant Management	Yes	Honeywell Employees	
36	Respiratory Protection	Yes	Honeywell Employees	
37	Safety Observation System (SOS)	Yes	Honeywell Employees	
38	Safe Operations Management (SOM)Training	Yes	Honeywell Employees	
Below list other customer specific training requirements, if applicable.				
1				
2				

SMP Attachment 12: Field Safety Checklist

Form completed by _____ Date _____

Honeywell requires a Field HSE Check List be maintained onsite for all current or new projects. It is to be performed prior to starting work during the initial site visit. Hazards identified are to be communicated to all personnel working at the site and referenced during future visits.

Original Date: _____ Revision Date: _____
Contractor(s): _____
Customer Name: _____ Customer Contact: _____ Address: _____
Telephone No: _____ Customer HSE Rep: _____ Phone: _____

1. Scope of work summary:

2. Personal protective equipment required on site?

	NO		YES (Honeywell)		YES (Contractor)
Fall Protection?	☐		☐		☐
Hard Hat?	☐		☐		☐
Safety Glasses?	☐		☐		☐
Hearing Protection?	☐		☐		☐
Safety Shoes?	☐		☐		☐
Protective Clothing? (specify)	☐		☐		☐
Respiratory protection? Explain:	☐		☐		☐

3. Safety hazards encountered at customer's facility (Check and explain plans for addressing the hazard).

Check for Yes	Safety Hazard	Name of Contractor / Personnel Performing Work	Plans to Address: Risk Assessment or Contractor Work Authorization
☐	Construction environment		
☐	High or low temperature materials or equipment		
☐	Welding		
☐	Laser equipment		
☐	Confined space or isolated work area		
☐	Overhead operations		
☐	Work at heights requiring a ladder, lift platform or basket; who provides the equipment and has appropriate training been completed?		
☐	Are there areas where the following conditions are present: Oxygen deficient atmosphere, toxic gases, vapors, fumes, mists, dusts, lead, mercury?		
☐	Known or suspected carcinogens including asbestos		
☐	Potential exposure to biohazards		
☐	Explosive or highly combustible materials		
☐	Excessive noise levels (signage identifies area)		
☐	High voltage (480 volts or greater) in the work area		
☐	Radiation sources		
☐	Ergonomics: excessive bending/stooping, cramped space		
☐	Slippery surfaces		
☐	Open pits, vats, trenches		
☐	Material handling requiring hoists, cranes, rigging, forklifts?		
☐	Raw or partially treated sewage		
☐	High pressure equipment		
☐	Unguarded machinery		
☐	Hot work permits required		
☐	Lockout/tagout permits required		
☐	Emergency evacuation		
☐	Special parking or security requirements		
☐	Customer hazard communication requirements		
☐	Process safety management requirements		
☐	Applicable MSDS's available; if no, who obtains them		
☐	Other hazards		

4. Specific safety considerations necessary to abide with customer's safety procedures. _____

5. Have all employees been briefed on the customer's site emergency response and evacuation plans & how will employees be accounted for in the event of an emergency? _____

6. Does the customer have a drug/alcohol policy for contractors and does it include drug testing? _____

7. Have the employees assigned to this project received appropriate safety training to prepare them for safety issues identified? _____

Complete, Sign and review on first visit or after work order changes. Revise annually. Review, sign & date:

Honeywell Manager	Employee\Contractor	Customer Representative (Optional)

SMP Attachment 13: Behavioral Observation Checklist (HW Employee Monitoring)

Utilize the Behavior Observation Checklist to identify both safe and at risk conditions in the work environment. After observation provide feedback to the employee for both safe and at risk observations. All at risk observations must have comments to identify corrective action or explanation. Only respond to questions that apply to the task

1. Observer

Report Observer Name

Observer EID

2. Observed

Observed Name

Observed EID

3.Task performed by Employee:_____

(4) Select SBU: HBS or HPS	(5) Select Pole (Americas or EMEA or AP):	(6) Region within Pole:	(7) State/District /Branch within Region:

(8) Location of Behavior Observation (select only one):

- ☐ Manufacturing plant / Mill
- ☐ Honeywell Office
- ☐ Customer Office
- ☐ Hospital
- ☐ School
- ☐ Mechanical Room
- ☐ Laboratory
- ☐ Residence
- ☐ Warehouse
- ☐ Roof
- ☐ Computer Room / Control Room
- ☐ Vehicle
- ☐ Other

(9) Date BOC Observed: DD/MM/YYYY

SAFE PATH OF TRAVEL			
Uses designated walkways to access work area	SAFE	AT RISK	N/A
Has clear view of path to travel	SAFE	AT RISK	N/A
PERSONAL PROTECTIVE EQUIPMENT (PPE)			
Head Protection	SAFE	AT RISK	N/A
Eye/Face Protection	SAFE	AT RISK	N/A
Hand Protection	SAFE	AT RISK	N/A
Foot Protection	SAFE	AT RISK	N/A
Respiratory Protection	SAFE	AT RISK	N/A
Electrical Protection	SAFE	AT RISK	N/A
Personal gas detector	SAFE	AT RISK	N/A
SAFE MOTOR VEHICLE OPERATION			
Does not use any mobile device while driving	SAFE	AT RISK	N/A
Secures equipment for safe transport	SAFE	AT RISK	N/A
Vehicle properly maintained	SAFE	AT RISK	N/A
Parking brake engaged when parked	SAFE	AT RISK	N/A
BODY POSITIONING DURING TASK			
Uses knees to lift not back	SAFE	AT RISK	N/A
Use knee pads when kneeling	SAFE	AT RISK	N/A
Watches hand placement / Keeps eyes on task	SAFE	AT RISK	N/A
Avoids pinch points or “line of fire” hazards	SAFE	AT RISK	N/A
Note: Line of fire: Struck by/against, caught in /between/under			
LADDERS			
Properly stores ladder on vehicle	SAFE	AT RISK	N/A
Ladders inspected prior to use	SAFE	AT RISK	N/A
Right ladder (step/extension) for the job	SAFE	AT RISK	N/A
Three points of contact at all times	SAFE	AT RISK	N/A
Does not use ladders in wet conditions	SAFE	AT RISK	N/A
Uses tool belt/back pack to carry tools	SAFE	AT RISK	N/A
PRE-JOB PLANNING			

Identifies all hazards in the work environment	SAFE	AT RISK	N/A
Conducts risk assessment using the risk calculator for	SAFE	AT RISK	N/A
Low / Medium or High Risks	SAFE	AT RISK	N/A
Obtains Work Permit where required	SAFE	AT RISK	N/A
Implements controls prior to starting work	SAFE	AT RISK	N/A
Communicates job activities with customer or team	SAFE	AT RISK	N/A
TOOLS			
Tools properly maintained	SAFE	AT RISK	N/A
Lock out, tag out properly applied	SAFE	AT RISK	N/A
Verifies zero energy after lock out	SAFE	AT RISK	N/A
Proper use of tools/ Uses right tool for the job	SAFE	AT RISK	N/A
Inspects tools before use	SAFE	AT RISK	N/A
INCLEMENT WEATHER			
Drinking plenty of fluids	SAFE	AT RISK	N/A
Taking rest breaks	SAFE	AT RISK	N/A
Uses ice cleats for icy conditions	SAFE	AT RISK	N/A
WORK ENVIRONMENT			
Keeps work area clean / free of trip hazards	SAFE	AT RISK	N/A
Checks work area for bees, wasps, snakes, etc	SAFE	AT RISK	N/A
HAZARD/INCIDENT REPORTING			
Reports Safety Observations	SAFE	AT RISK	N/A
Knows how to report injuries	SAFE	AT RISK	N/A
OTHER CRITICAL BEHAVIORS OBSERVED			
_____	SAFE	AT RISK	N/A
_____	SAFE	AT RISK	N/A

Describe At Risk Behavior:

Describe Safe Behavior:

Corrective action entered into SOS: Yes: **No:** **SOS Number:**

Manager / Lead Signature **Date** DD/MM/YYYY

SMP Attachment 14: Contractor Performance Safety Checklist (Contractor Audits)

Contractor Performance Safety Checklist					
Site location:	MCVT BOE	**Location of work**			
Auditor:		**Date and time**	**Date**	**Time**	
Details of work being undertaken					
Contract Number or Name					
Name of contractor					

Observed health and safety standards			**Comments**
(i) Have all contractor and sub contractor staff attended a site safety orientation course and received required HSE training?	Yes	No	
(ii) Have all contractor and sub contractor staff aware of the sites emergency procedures?	Yes	No	
(iii) Have all contractor and sub contractor staff been aware of what to do in the event of an accident and/or safety observation? (speak to contractor staff)	Yes	No	
(iv) Has the contractor made adequate first aid provision?	Yes	No	
(v) Have safety observations been submitted to Honeywell on a periodic basis?	Yes	No	
(vi) Are the contractor and sub contractor risk assessments, safe work procedures, method statements, HSE procedures, and permits to work being followed?	Yes	No	
(vii) Has required PPE, e.g. hard hats, safety boots, etc. been provided according to the risk assessment and is it being worn?	Yes	No	
(viii) Has the contractor implemented life critical control measures for fall protection, electrical safety, arc flash, and permit confined spaces?	Yes	No	
(ix) Where applicable are the contractor works securely fenced off or otherwise protected from the public, staff, etc?	Yes	No	
(x) Is the contractor maintaining a safe work area and implementing good housekeeping standards, including safe egress to roads, aisles, stairs, etc.?	Yes	No	
(xi) Is the contractor holding regular tool box talks with employees?	Yes	No	
(xii) Other observations			

Auditor: *I hereby declare that I have completed health and safety monitoring on the contractor named above*

Name (capitals)		Signature			
Job Title		Time		Date	
Contractors representatives name		Signature		Date	
Site managers name		Signature		Date	

SMP Attachment 15: Vehicle, Tool, & PPE Inspection Checklist (Honeywell Employees)

EMPLOYEE NAME: Wyatt Ferguson	VEHICLE #: N/A
SUPERVISOR NAME: Bob Letso	VEHICLE MILEAGE: N/A
LOCATION ID# VEHICLE ASSIGNED: N/A	INSPECTION DATE (MM/DD/YY): 06-11-2019

	Insp	Test	Items	OK	DEV	N/A	Deviations: Enter a brief description of deviation, action taken, and date corrected
VEHICLE SAFETY ITEMS	x		**Housekeeping -** vehicle, tools, and equipment are neat and orderly, items in driver compartment are adequately secured	X			
	x		**Ladder racks** - in good condition, hardware intact, operates easily, ladders secure			X	
	x		**Exterior/Body damage** - exterior clean and in good condition (note all damage including scratches, dents, etc.)	X			
	x	x	**Lights** visible and operational - headlights (low & high beam), tail lights, brake lights, emergency flashers, other lights	X			
	x	x	**Windshield washer system/wipers/fluid** - operating properly, good condition, appropriate fluid level	X			
	x	x	**Seatbelt** - available and in good condition	X			
	x		**Glass & mirrors** - clean, no cracks or pits in areas that obstruct driver's view, mirrors securely mounted, properly positioned	X			
	x	x	**Tire Condition and Pressure** - appropriate tire wear and pressure (including spare)	X			
	x	x	**Fluid levels -** verify that oil is full, no fluid leaks	X			
	x	x	**Tire Condition and Pressure** - adequate tread depth and appropriate tire wear, proper pressure (including spare)	X			
	x	x	**Brakes** - operating properly (per driver's verbal report), verify that emergency brake operates properly	X			
	x	x	**Doors & locks** - door catches and handles work properly, locks work properly and can be secured	X			
	x		**Fire extinguisher** - mounted within vehicle, gauge needle in "green" zone or otherwise indicates "full"	X			
	x		**First aid kit** - vehicle kit available and adequately stocked	X			
	x		**Chocks and cones -** available, as needed			X	
	x		**Vehicle registration, insurance card, driver's license, Honeywell driver's guide, fuel card** -present, current, available for appropriate vehicle	X			
LADDERS & FALL	x		**Ladders** - Rungs, rails, hardware, rope in good condition. Appropriate ladder size and type available (non-conductive ladder available when electricity could be encountered)			X	
	x		**Fall protection equipment** - harness, lanyard, anchoring equipment inspected and in good condition. Complete system from same manufacturer. Harness and lanyard stored properly (without twisting, bending, away from chemicals and direct sunlight). Replaced according to manufacturer guidance.			X	
PPE	x		**Eye protection** - readily available, clean, in good condition	X			
	x	x	**Hard hat** – in good condition, no cracks or dents. Cradle system intact and in good condition. Clean surface.	X			
	x		**Hand and foot protection** - available and in good condition	X			
	x		**Hearing protection** – appropriately selected, clean, in good condition, stored properly	X			

	x	x	**Respiratory protection** - appropriately selected, in good condition, stored properly			X	
TOOLS & EQUIPMENT	x		**Power tools** - in good condition; cords, plugs, prongs present and good condition; grounded or double insulated; no broken pads; guards in place; removed from service/replaced promptly if poor condition detected			X	
	x		**Pneumatic tools** - hose/whip secured to tool by positive means (to prevent tool from being accidentally disconnected); safety clips or retainers used on impact/percussion tools			X	
	x		**Hand tools** - Good condition, no mushroomed heads, no broken or cracked parts; removed from service/replaced promptly if poor condition			X	
	x		**Fuel-powered tools/equipment** - good condition; stored so as to prevent spilling of fuel during transport; when in use in enclosed spaces, measures are taken to prevent build-up of gases and fumes; stopped for refueling, service, and maintenance			X	
ELECTRICAL	x		**Extension cords** - cord and plugs in good condition (no cracks, cuts, or tape), prongs intact, cord is grounded or double-insulated (and/or GFI available)			X	
	x		**Lockout/Tagout** - appropriate devices available (locks, tags, hasps, etc.), appropriate variety available for job conditions			X	
	x	x	**Amp Meter** - clean, no damage, proper storage, good working order, test battery			X	
COMPRESSED	x		**Torches, hoses, regulators** - fittings in good condition, no leaks, auto shut-off tested, hoses & connections designed for pressure and service to which subjected; equipped with backflow prevention or flash arrestor			X	
	x		**Gas cylinders** - turned off, stored upright with caps in place, secured (to prevent tipping), properly labeled, used with appropriate PPE, regulators and torches removed and/or disconnected from cylinders when not used			X	
	x		**Personal Protective Equipment for Hot Work** (i.e. face shield, body protection, etc.) - protective equipment available and in good condition			X	
MISCELLANEOUS	x		**Outdoor/inclement weather supplies & equipment** - appropriate supplies available for hazards encountered (i.e. drinking water/fluids, snow/ice management equipment {sand, shovels, etc.], insect spray [di-electric spray required if working near electricity], sunscreen, etc.)			X	
	x		**Chemicals** - only "approved" chemicals used, all containers properly labeled, containers stored properly (secured). Material Safety Data Sheets (MSDS) on file at HON office. If refrigerant is distributed, logs are available and up-to-date.			X	
	x		**Hand lines and ropes** - no cuts, abrasions, decay, burns, signs of wear			X	
	x		**Portable blowers** - in good condition, proper ratings on blower, proper set-up and use (test)			X	
	x	x	**Air monitoring equipment (for confined space entry)** - appropriate for job conditions and hazards potentially encountered, in good condition and functioning properly, test/calibrate equipment according to requirements, appropriate calibration gases and test kit available			X	
	x	x	**Electrical insulating gloves (for electrical hot work) -** if used and available, ensure appropriate class/type for use, verify current inspection/test date stamp rubber protective layer (w/in past 9 mos.), stored in bag with fingers upright, stored away from direct sunlight in dedicated bag			X	
	x		**Electrical mats/barriers** - Mats and barriers in good condition, no tears, rips or holes. Appropriate for hazards encountered.			X	
	x		**Gasoline** - stored in approved flammable liquid container with self-closing lid, flame/flash arrestor. Stored to prevent tipping. Maximum capacity stored less than 5 gallons.			X	
	x		**Heaters** – equipped with proper shut-off (tip over protection), use only approved heaters in good condition.			X	
	x		**Permits** - verify adequate supply of required permits (Hot Work, Live Electrical, Permit-Required Confined Space Entry, etc.)	X			

SMP Attachment 17: Emergency Response Plan

HBS & HPS Facilities Emergency Response Plan

Honeywell Business Unit:	EES-Customer Site - MCVT BOE
Street Address:	112 Rues Lane
City, State, Zip:	East Brunswick NJ, 08816
Date of ERP Review:	6/11/2019



Emergency Response Preparedness (ERP) Checklist: ***(Click on PDF)***



SMP Attachment 17: Emergency Response Plan

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1. EMERGENCY PREPAREDNESS PLAN SCOPE:

Honeywell International Inc. (Honeywell) will provide a safe and healthy work environment. Consistent with policy, the following emergency action plan is developed for this site and will guide the actions taken by employees, management, and emergency coordinators. Emergency events addressed by this plan include building evacuation, fires, severe weather, medical emergencies, Bomb Threats or other facility-related emergencies that could endanger employees and/or visitors to this Honeywell location.

2. HSE HOTLINE REPORTING GUIDANCE:

Report all Injuries and Illnesses and Emergency Events addressed within this reporting procedure to the **Honeywell Hotline at (866-466-1765).** Early Post Injury Reporting with Immediate First Aid measures can reduce Injury Severity & Eliminate the need for Future Medical Care (Recordable Injuries).

3. DRILLS/TEST OF EMERGENCY PREPAREDNESS PLAN:

Familiarity with responsibilities and procedures must be thorough so that response to the plan is automatic. Each location is responsible for accomplishing at least one emergency situation drill every twelve (12) months. After accomplishing the emergency situations drill it must be documented on the Emergency Preparedness Drill Critique.

4. FACILITY IDENTIFICATION, DESCRIPTION, GENERAL INFORMATION:

Office Name/LID	Customer Site, MSVT BOE
Address	112 Rues Lane East Brunswick NJ
Description of Bldg, Usage	School / Administrative Building
Location Description, Cross Streets, Directions	
Facility Utilities, Nearby Buildings	

5. EMERGENCY COORDINATOR INFORMATION

THE EMERGENCY COORDINATOR HAS PRIMARY RESPONSIBILITY FOR ASSURING THE IMPLEMENTATION OF THIS EMERGENCY PREPAREDNESS PLAN AND REQUIREMENTS STATED HEREIN. WHEN EMERGENCIES OCCUR, THE EMERGENCY COORDINATOR MAINTAINS PRIMARY RESPONSIBILITY FOR APPROPRIATE NOTIFICATIONS TO EMPLOYEES, HONEYWELL MANAGEMENT, MUNICIPAL EMERGENCY SERVICES (I.E. FIRE AND/OR POLICE DEPARTMENTS), AND OTHER AGENCIES OR SERVICES THAT MAY ASSIST IN MANAGEMENT OF THE EMERGENCY.

The alternate Emergency Coordinator serves in place of the Emergency Coordinator when the primary coordinator is unavailable. (It is recommended that these positions be filled with employees who are typically in the building for the majority of the workday.)

A. THE PRIMARY EMERGENCY COORDINATOR FOR THIS FACILITY IS:

Name	Wyatt Ferguson
Title	Project Supervisor
Office Phone	
Pager or Cell	908-655-1906
Alternate Phone	

B. THE ALTERNATE EMERGENCY COORDINATOR FOR THIS FACILITY IS:

Name	Francis Cap
Title	Facilities Manager
Office Phone	215-588-5747
Pager or Cell	
Alternate Phone	

6. HONEYWELL CRISIS COMMUNICATION:

Major crisis situations often generate interest from the news media and require effective internal communications to address employee concerns. As soon as possible following a major crisis event, contact the Communications Leader to discuss the situation so appropriate internal and external communications plans and tools can be developed. Examples of such times where crisis reporting should be accomplished include the following:

a. Catastrophic facility damage caused by fires, storms, explosions, or earthquakes, tsunamis, accidents that may result in severe injury and threats or acts of violence or terrorism

b. Other unexpected events that have the potential to cause harm to Honeywell's employees, reputation, competitive positioning, or financial viability.

I. INTERNAL RESOURCE NUMBERS: It is always appropriate to contact the local site leader if they are not on-site at the time of the incident. Additionally, based on the nature of the event/injury it may also be necessary to contact other Honeywell personnel listed below:

	Name	Office Phone	Cell Phone
Local Site Leader(s)	Wyatt Ferguson		908-655-1906
HSE Leader	Steve Serian	603-930-0222	603-930-0222
Facilities Manager			
HR Leader			
ACS Security Director	Jeff Soholt	763-954-6123	952-303-1648

- **Additional Links**
  - Corporate Communication Policy
  - Corporate Communication Contacts

II. EXTERNAL RESOURCES / EMERGENCY PHONE NUMBERS:

	Name	Phone
Police Department		911
Fire & Ambulence		911
Building Landlord/Manager		
Other		

7. EMERGENCY EVACUATION SYSTEM:

A fire alarm will be used to alert employees within the building of fire or severe weather emergency or other need to evacuate the building or to seek shelter in place. In buildings that are not equipped with audible emergency alarms, employees will be alerted to other emergencies through direct verbal communication from the Emergency Coordinator(s) and/or designated alternate.

The Emergency Coordinator or designated alternate will make physical contact with employees who have sight or hearing disabilities to ensure that they are aware of the emergency.

a. BUILDING EVACUATION:

Evacuation of employees to a rally point outside of the building or to a refuge area within the building will be enacted whenever there is a threat to their safety or health because of an emergency condition. The refuge area shall be a safe area within the building away from windows where employees can gather, for example, in severe weather. The Emergency Coordinator is authorized to enact the evacuation of a particular room, floor, or the building.

- ✓ The designated rally point is:
  Specify: Front of building, parking lot, or main entrance
  If the designated rally point is involved in the emergency, the alternate rally point will be:
  Specify: Parking lot.
- ✓ The designated (indoor) refuge area is:
  Specify: vaires by building.
- ✓ The Emergency Coordinator and Team will be responsible for accounting for all employees, visitors and contractors. If personnel are unaccounted for after conducting the headcount at the rally point, the Emergency Coordinator will be the designated person responsible for communicating with emergency services.
- ✓ Re-entry to the building will be coordinated through emergency services and the Emergency Coordinator. In the event of an incident preventing re-entry, the Emergency Coordinator will work with senior management, Facilities, and Health, Safety, Environmental (HSE) departments to assure the safety of the building and personnel.
- ✓ Injured personnel will receive medical care through the municipality's emergency response system.
- ✓ In the event an unplanned evacuation results from an actual site emergency, the Emergency Coordinator shall ensure appropriate notifications are made to site leadership.
- ✓ A diagram or description of the evacuation routes, exit doors, rally points and refuge areas are posted:
  Specify: See evacuation routes posted on walls.
  The designated exit doors for this facility are (list exit doors).
- ✓ Know the locations of your building evacuation route, outdoor rally point, and indoor refuge area before an emergency occurs by reviewing the posted/attached instructions and/or evacuation map.

8. MEDICAL EMERGENCY:

Remember to report all injuries no matter how minor to your manager and HSE leader immediately and the **Honeywell Hotline at (866-466-1765).** *Never enter into a medical emergency area unless you are sure there are no hazards present. Scan the area visually, overhead as well, to ensure that there are no physical dangers present. We do not want to delay the initial medical emergency response nor do we want to provide additional responses to would-be rescuers. Never move or attempt to render any assistance that could impact greater injury to the already injured victim.*

The following steps to be taken in the event of an on-site medical emergency:

a. *Immediately contact First Aid personnel and dial 9-911 for assistance, such as loss of consciousness, uncontrolled bleeding, potential heart attack or stroke and give exact location and nature of the emergency.*

b. *Remember, when First Aid arrives, they are in charge. Persons in the immediate area should be limited to only those identified by the First Aid Attendant. The First Aid Person will provide direction and course of action.*

c. *If further medical assistance is required, the First Aid Attendant or designate will contact dial 911 and request an ambulance be dispatched*

9. FIRE EMERGENCY (Evacuate and call 9-911):

To protect yourself, it is important to understand the basic characteristics of fire. Fire spreads quickly so there is no time to gather valuables or make a phone call. In just two minutes, a fire can become life-threatening. In five minutes, a residence can be engulfed in flames. Heat and smoke from fire can be more dangerous than the flames. Inhaling the super-hot air can sear your lungs. Fire produces poisonous gases that make you disoriented and drowsy. Asphyxiation is the leading cause of fire deaths, exceeding burns by a three-to-one ratio.

a. Protective Measures for Fires:

- ✓ Insure smoke alarms are installed, tested and cleaned in accordance with applicable instructions.
- ✓ Ensure Fire Suppression Systems are maintained and tested in accordance with applicable instructions.
- ✓ Ensure Fire extinguishers are in place and serviceable.
- ✓ Accomplish Annual Emergency Fire Drills to prepare employees.

b. Escaping the Fire:

- ✓ Review escape routes with personnel and practice escaping from each room.
- ✓ Ensure security doors and other antitheft mechanisms that could block outside window entry are easily opened from the inside.
- ✓ Remain low to the floor (where the air is safer in a fire) when escaping from a fire.
- ✓ Clean out storage areas. Never allow trash, old newspapers, boxes or magazines to accumulate.

c. Flammable Items:

- ✓ Never use gasoline, benzene, naphtha, or similar flammable liquids indoors.
- ✓ Store flammable liquids in approved containers in well-ventilated storage areas.

d. Fire sources and smoking:

- ✓ Never smoke near flammable liquids
- ✓ Smoke only in designated smoking areas as described below:

Specify: None, No smoking on site.

Provide deep sturdy ashtrays or outdoor approved cigarette/cigar disposal cans.

e. Heating Sources

- ✓ Be careful when using portable heating sources.
- ✓ Ensure space heaters are at least three feet (1 meter) away from combustible materials.
- ✓ Ensure Portable heating devices have a tilt shutoff as well as a timer shutoff.
- ✓ Always unplug Portable Heating Devices when not in use.

f. Electrical Wiring:

- ✓ Ensure electrical wiring is not exposed.
- ✓ Never Daisy Chain extension cords.
- ✓ Inspect extension cords for frayed or exposed wires or loose plugs.
- ✓ Make sure outlets have cover plates and no exposed wiring.
- ✓ Make sure wiring does not run under rugs, over nails, or across high-traffic areas.
- ✓ Do not overload extension cords or outlets. If you need to plug in two or three appliances, get a UL-approved unit with built-in circuit breakers to prevent sparks and short circuits.

g. During a Fire If your clothes catch on fire:

- ✓ Stop, drop, and roll until the fire is extinguished.

10. TERROIST / BOMB / BIOLOGICAL / CHEMICAL / RADIOLOGICALTHREAT EMERGENCY:

a. Remain calm, listen carefully and record the following details:

- ✓ *Time the call was received,*
- ✓ *Details of the threat (Where is the bomb or When it is expected to explode),*
- ✓ *Details of the caller (voice tone – angry, joking, sarcastic, quiet, business-like),*
- ✓ *Background noise (car noise, street noise, television, radio),*
- ✓ *Time the call ended*

c. Notify Local Police Department, Honeywell Management and Security immediately.

Bomb, Chemical and/or Biological Threat Guideline

Detailed DESCRIPTION OF CALLER'S VOICE	***Ask the below EXACT WORDS upon BOMB THREAT***
Male _____ Female_____ Young _____ Middle Aged _____ Older_____ _____ Calm _____ Nasal _____ Angry _____ Stutter _____ Excited _____ Lisp _____ Slow _____ Raspy _____ Rapid _____ Deep _____ Soft _____ Cleared Throat _____ Loud _____ Deep Breathing _____ Laughter _____ Cracked Voice _____ Crying _____Accent _____ Normal _____Familiar _____ Slurred _____Disguised BACKGROUND SOUNDS _____ Street _____ Factory _____ Animal _____ Clear _____ Voices _____PA System _____ House _____Traffic _____ Other *THREAT LANGUAGE* _____*Well spoken* _____ *Incoherent* _____Foul/ Irrational _____ Read Message?	*1. Where is the device right now?* *2. What does it look like?* *3. What kind of a device is it?* *4. Why are you doing this?* *5. What is your name?* 6. Are you part of an organization? *7. Why are you warning us?* 8. What will cause it to activate?
*Person receiving call*_____ *Time Caller hung up*_____ *Phone number at which call was received*_____ *Date*_____	

11. HAZARDOUS CHEMICALS:

If applicable, identify and list below all hazardous chemical quantities stored on site. Otherwise state "Not Applicable" to this location.

✓ **Inside and/or outside locations:**
✓ **Quantities of hazardous materials:**
✓ **Physical and/or chemical hazards, i.e., asphyxiation hazards**
✓ **Hazardous material properties, i.e. flammability, toxicity. Reference location of Safety Data Sheets**

12. INTERNAL HAZARD / CONTROL MEASURES:

Include in this section any process operations that may fail during an emergency event.

Possible Failures	**Emergency Control Measure Description**

The following are examples of process operations that are addressed in the procedure, but do not need to be part of this section if not applicable to your location: *(Truck/railcar deliveries, transfer of materials, utilities, pollution control devices, control rooms, pipelines, control valves, ventilation systems, boilers, pressure vessels, security access controls, fire protection systems, identify existing engineering control measures to avoid release of hazardous materials).* However, if applicable, prepare emergency control measures for each potential failed process that may apply to your location.

13. EMERGENCY DRILL REQUIREMENTS

a. *Annual Emergency Evacuation Drills*

- ✓ *Drills must be accomplished annually and include different types of Emergency Scenarios as outlined in this Emergency Preparedness Plan*
- ✓ *Upon completion of the Emergency Evacuation Drill use the Critique Form to Document Drill.*
- ✓ *In accordance with Corporate Policy,* once the Emergency Evacuation Drill is complete, forward the Critique Form to regional HSE Manager for entry into the Corporate Event Tracking System.

b. *Annual AED Emergency Drill*

- ✓ *If a location has more than 200 employees an AED is required.* Before making the determination to purchase an AED, contact your Regional Safety Manager.
- ✓ Locations with AEDs must conduct AED drills at least annually on all shifts where AED trained personnel are present. These drills must be documented and must measure the actual response time.
- ✓ When AED drill response times are greater than or equal to 5 minutes, the organization must create a corrective action plan to reduce the response time to less than 5 minutes. *This action plan must be documented in the Corporate Event Tracking System by the HSE Manager*. Corrective actions must include a mechanism for ensuring the response time of 5 minutes or less is met.

14. NATURAL DISASTERS:

a. TORNADO EMERGENCY:

I. Tornado Terms:

- ✓ **Tornado Watch:** Means Tornadoes are possible. Remain alert for approaching storms. Watch the sky and stay tuned to NOAA Weather Radio, commercial radio, or television for information.
- ✓ **Tornado Warning:** A tornado has been sighted or indicated by weather radar. Take shelter immediately.

II. Protective Measures before and during a Tornado:

- ✓ Listen to NOAA Weather Radio or to commercial radio or television newscasts for the latest information & remain alert.
- ✓ Look for approaching danger signs such as a dark greenish sky or dark low-lying cloud with rotation or evidence of large hail.
- ✓ Listen for a loud roar, similar to a freight train.
- ✓ If you see approaching storms or any of the danger signs, be prepared to take shelter immediately or if you're under a tornado WARNING, seek shelter immediately!
- ✓ If inside an enclosed structure such as a small building, school, nursing home, hospital, factory, shopping center or high-rise building, go to a pre-designated shelter area such as a safe room, basement, storm cellar, or the lowest building level. If there is no basement, go to the center of an interior room on the lowest level (closet, interior hallway) away from corners, windows, doors, and outside walls. Put as many walls as possible between you and the outside. Get under a sturdy table and use your arms to protect your head and neck. Do not open windows.
- ✓ If outside with no shelter lie flat in a nearby ditch or depression and cover your head with your hands.
- ✓ Watch out for flying debris. Flying debris from tornadoes causes most fatalities and injuries.

b. HURRICANE/CYCLONE EMERGENCY:

I. Hurricanes Terms:

- ✓ **Hurricane/Cyclone and Tropical Storm Watch**: Hurricane/tropical storm conditions are possible in the specified area, usually within 36 hours. Tune in to NOAA Weather Radio, commercial radio, or television for information.
- ✓ **Hurricane/Cyclone and Tropical Storm Warning**: Hurricane/tropical storm conditions are expected in the specified area, usually within 24 hours.

II. Hurricane/Cyclone Protective Measures before and during a Hurricane:

- ✓ Make plans to secure property by closing all windows, doors and roof vents if possible.
- ✓ Determine a safe room / location for shelter.
- ✓ Listen to the radio or TV for information.
- ✓ Turn off utilities if instructed to do so.
- ✓ Evacuate building if directed by local authorities and be sure to follow their instructions.

c. EARTHQUAKE EMERGENCY:

I. Protective Measures before and during an Earthquake:

- ✓ *Keep your cool, avoid panic and confusion and ride out the motion.*
- ✓ *Take cover under a sturdy desk, table, or bench or against an inside wall, and hold on. If there isn't a table or desk near you, cover your face and head with your arms and crouch in an inside corner of the building.*
- ✓ *Stay away from glass, windows, outside doors and walls, and anything that could fall, such as lighting fixtures or furniture.*
- ✓ *Use a doorway for shelter only if it is in close proximity to you and if you know it is a strongly supported, load bearing doorway.*
- ✓ *Remain inside until shaking stops and it is safe to go outside. Most injuries during earthquakes occur when people are hit by falling objects when entering into or exiting from buildings.*
- ✓ *Be aware that the electricity may go out or the sprinkler systems or fire alarms may turn on.*
- ✓ *Do not use elevators during an Earthquake.*

II. Post Earthquake Protective Measures: *Being prepared for aftershocks are extremely important. Even though secondary shockwaves are usually less violent, they can be strong enough to cause additional damage to already weekend structures.*

- ✓ *Check for injuries amongst those around you. Notify First Aid of injured persons as soon as safe to do so. Do not move the seriously injured unless they are in immediate danger. Try and keep the injured warm.*
- ✓ *Contact local emergency resource centers such as the hospital or fire department as required for injuries or fire concerns or call 9-911.*
- ✓ *Stay away from damaged areas unless your assistance has been specifically requested by police, fire, or relief organizations*
- ✓ *Listen for sounds or smell of leaking gas and exit building if the smell of gas apparent.*
- ✓ *Be aware of possible tsunamis if you live in coastal areas. These are also known as seismic sea waves (mistakenly called "tidal waves"). When local authorities issue a tsunami warning, assume that a series of dangerous waves is on the way. Stay away from the beach.*
- ✓ *Always open cabinets cautiously as objects may have shifted causing falling hazards.*
- ✓ *Never leave the worksite area unless you have advised your Site Manager. You may be jeopardizing your safety (bridge or road damage, et cetera) as well as create traffic congestion for emergency vehicles.*
- ✓ *If evacuation is ordered, leave by the nearest emergency exit and report directly to your designated assembly/rally point.*

d. VOLCANO EMERGENCY:

I. Protective Measures before and during a Volcanic Eruption:

- ✓ Monitor local radio stations and News Broadcasts

- ✓ Ensure the building / office ventilation system is turned off. This will keep ash particulates from entering building.
- ✓ Cover sensitive equipment with plastic sheets to keep ash particulates from entering parts.
- ✓ Evacuate immediately from the volcano area to avoid flying debris, hot gases, lateral blast and lava flow.
- ✓ Wear long-sleeved shirts and long pants.
- ✓ Use goggles and war eyeglasses instead of contact lenses.
- ✓ Use a dust mask or hold a damp cloth over your face to help with breathing.
- ✓ Stay away from areas downwind from the volcano to avoid volcanic ash.
- ✓ Stay indoors until the ash has settled unless there is a danger of the roof collapsing.
- ✓ Close doors, windows and turn off all ventilation systems.

e. TSUNAMI EMERGENCY:

I. Understanding Tsunamis Terms:

- ✓ Advisory: An earthquake has occurred in the Pacific basin, which might generate a tsunami.
- ✓ Watch: A tsunami was or may have been generated, but is at least two hours travel time to the area in Watch status.
- ✓ Warning: A tsunami was, or may have been generated, which could cause damage; therefore, people in the warned area are strongly advised to evacuate.

II. Tsunami Protective measures before and during a tsunami event:

- ✓ Turn on your radio to learn if there is a tsunami warning if an earthquake occurs and you are in a coastal area.
- ✓ Move inland to higher ground immediately and stay there.
- ✓ **Visual Indication of Imminent Tsunami** - Strong Earthquake lasting 20 seconds or more where it is difficult to stand or walk or the water level at the beach begins receding / being pulled back into the ocean.

15. Insert PDF of Building Evacuation Map and Location of Fire Extinguishers on Following Page

Insert PDF map on here or on next page

See evacuation plans posted on walls of buildings.

OSHA's Form 300A (Rev. 01/2004)

Summary of Work-Related Injuries and Illnesses

Year 2018

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

All establishments covered by Part 1904 must complete this Summary page, even if no work-related injuries or illnesses occurred during the year. Remember to review the Log to verify that the entries are complete and accurate before completing this summary.

Using the Log, count the individual entries you made for each category. Then write the totals below, making sure you've added the entries from every page of the Log. If you had no cases, write "0."

Employees, former employees, and their representatives have the right to review the OSHA Form 300 in its entirety. They also have limited access to the OSHA Form 301 or its equivalent. See 29 CFR Part 1904.35, in OSHA's recordkeeping rule, for further details on the access provisions for these forms.

Number of Cases

Total number of deaths	Total number of cases with days away from work	Total number of cases with job transfer or restriction	Total number of other recordable cases
0	0	0	0
(G)	(H)	(I)	(J)

Number of Days

Total number of days away from work	Total number of days of job transfer or restriction
0	0
(K)	(L)

Injury and Illness Types

Total number of...	(M)		(M)
(1) Injuries	0	(4) Poisonings	0
		(5) Hearing loss	0
(2) Skin disorders	0	(6) All other illnesses	0
(3) Respiratory conditions	0		

Post this Summary page from February 1 to April 30 of the year following the year covered by the form.

Public reporting burden for this collection of information is estimated to average 58 minutes per response, including time to review the instructions, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any other aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistical Analysis, Room N-3644, 200 Constitution Avenue, NW, Washington, DC 20210. Do not send the completed forms to this office.

Establishment information

Your establishment name: HESG Field Ops- HSEMS (US & Canada)

Street: NA

City: _____ State: _____ ZIP: _____

Industry description (*e.g., Manufacture of motor truck trailers*)

Standard Industrial Classification (SIC), if known (*e.g., 3715*)

OR

North American Industrial Classification (NAICS), if known (e.g., 336212)

238210

Employment information *(If you don't have these figures, see the Worksheet on the back of this page to estimate.)*

Annual average number of: 208

Total hours worked by all employees last: 445222

Sign here

Knowingly falsifying this document may result in a fine.

I certify that I have examined this document and that to the best of my knowledge the entries are true, accurate, and complete.

VP/GM Project Financing & Energy

Company executive — Title

(973) 727-2667 — 2/1/2019

Phone — Date

GENERIC RISK ASSESSMENTS –

The enclosed risk assessments are only a sample of typical risk assessments used on EES projects. For a full listing of current generic risk assessments for use on your project, please visit:

EES Safe Work Procedures

Honeywell

HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO	UK34

SITE LOCATION	SCOPE OF WORK (JOB TASK)	PERMIT TO WORK REQUIRED
	REPLACING WINDOWS	Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
	STAFF MEMBER PERFORMING JOB ONLY		VISITORS		16-30 MINUTES		31-45 MINUTES		NO OF TIMES PER WEEK
	MEMBERS OF THE PUBLIC		OTHER (SPECIFY)		46 MINS -1 HOUR		1 HOUR OR MORE		NO OF TIMES PER MONTH

HONEYWELL RISK ASSESSMENT CALCULATOR

Probability \ Severity	1. Negligible	2. Minor	3. Serious	4. Major	5. Catastrophic
5. Almost Certain	Medium	High	High	High	High
4. Highly Likely	Medium	Medium	Medium	High	High
3. Likely	Low	Low	Medium	Medium	High
2. Unlikely	Low	Low	Low	Medium	High
1. Remote	Low	Low	Low	Medium	Medium

JOB HAZARD EXPOSURE/DETAILED HAZARD *List each of the hazards associated with the scope of work in the sequence they are carried out.*	POSSIBLE HARM AND EFFECTS *Detail the harm that can result as a result of exposure to the hazard*	EXISTING CONTROL MEASURES *List the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures)*	*Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard* S 12345	P 12345	R L/M/H	RECOMMENDED ADDITIONAL CONTROLS / INFORMATION (IN PRIORITY ORDER) *Detail additional control measures to eliminate or reduce the hazard to the lowest exposure level possible. Use Control Hierarchy to further eliminate or minimise risks. (consider local legal and HON requirements) .*	ASSIGN RESPONSIBILITY *Write the name of the person responsible (supervisor or above): implement the control measures identified.*
Exposure to glass if broken	Damage to property or equipment	A pre-start survey carried out to check route, manpower, equipment required and foreseen hazards	3	2	L	Ensure **ALL** existing control measures are in place prior to commencement of task	
Fall of materials	Fall of person(s)	All work to be planned in advance	3	2	L		
Fragile roof	Fall of material(s)	Liaison with person in charge of premise to ensure area is free from others	3	2	L		
Horseplay	Injury to person(s)	Lone working to be avoided	3	2	L		
Manual handling	Ladder slipping	Manual handling to be reduced as far as practicably possible by provision of mechanical aids	3	2	L	Tasks presenting significant risk to have it's own specific risk assessment.	
Moving materials	Muscular – skeletal injuries	Planning of work to ensure that maximum safety is provided by access equipment to prevent falls from height or falling objects	3	2	L		
Ricochets/ Splintering	Striking persons below	Relevant 'Work at Height' risk assessment referred to and appropriate measures put in place	3	2	L		
Unstable structure	Trapping between fixture and load	Work is planned to ensure a safe means of access is provided	3	2	L		
		Remove and dispose of all broken glass before attempting to board up window	3	2	L		
		Correct angle of ladders is 75 degrees or base: height ratio 1:4	3	2	L		
		PPE to be worn including eye and hearing protection, gloves and safety shoes	3	2	L		
		Ground conditions taken into account i.e. soft ground, height restrictions and obstructions	3	2	L		

	MANAGERS NAME (PRINT NAME)	MANAGER'S SIGNATURE	ASSESSMENT REVIEW DATE

Each risk assessment, including generic risk assessment's must be reviewed to ensure they are site specific.
All workers must be consulted, and should sign off to verify that they understand all the requirements of the risk assessment.

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HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO	UK38

SITE LOCATION	SCOPE OF WORK (JOB TASK)	PERMIT TO WORK REQUIRED
	USE OF VEHICLE	Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
	STAFF MEMBER PERFORMING JOB ONLY		VISITORS		16-30 MINUTES		31-45 MINUTES		NO OF TIMES PER WEEK
	MEMBERS OF THE PUBLIC		OTHER (SPECIFY)		46 MINS -1 HOUR		1 HOUR OR MORE		NO OF TIMES PER MONTH

HONEYWELL RISK ASSESSMENT CALCULATOR

Probability \ Severity	1. Negligible	2. Minor	3. Serious	4. Major	5. Catastrophic
5. Almost Certain	Medium	High	High	High	High
4. Highly Likely	Medium	Medium	Medium	High	High
3. Likely	Low	Low	Medium	Medium	High
2. Unlikely	Low	Low	Low	Medium	High
1. Remote	Low	Low	Low	Medium	Medium

JOB HAZARD EXPOSURE/DETAILED HAZARD *List each of the hazards associated with the scope of work in the sequence they are carried out.*	POSSIBLE HARM AND EFFECTS *Detail the harm that can result as a result of exposure to the hazard*	EXISTING CONTROL MEASURES *List the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures)*	*Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard* S 12345	P 12345	R L/M/H	RECOMMENDED ADDITIONAL CONTROLS / INFORMATION (IN PRIORITY ORDER) *Detail additional control measures to eliminate or reduce the hazard to the lowest exposure level possible. Use Control Hierarchy to further eliminate or minimise risks. (consider local legal and HON requirements) .*	ASSIGN RESPONSIBILITY *Write the name of the person responsible (supervisor or above): implement the control measures identified.*
Contact with other vehicles/road users	Death	All vehicles to be inspected before use	3	2	L	Ensure **ALL** existing control measures are in place prior to commencement of task	
Mechanical failure	Injury to person(s)	All routes to be planned in advance	3	2	L		
Road traffic	Fire/explosion	Banksman is to be used where the operator's vision is impaired	3	2	L	Tasks presenting significant risk to have it's own specific risk assessment.	
Striking equipment or materials	Striking persons	Vehicle to be checked before use	3	2	L		
	Overturning	Vehicles not to be left running when unattended	3	2	L		
		Vehicles maintained to legal standards and checked to ensure that it is in good order	3	2	L		
		Operatives must hold a recognised licence	3	2	L		

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	MANAGERS NAME (PRINT NAME)	MANAGER'S SIGNATURE	ASSESSMENT REVIEW DATE

SAFE WORK PROCEDURE - CHECKLIST

Part 2 of 2

Each risk assessment, including generic risk assessment's must be reviewed to ensure they are site specific.
All workers must be consulted, and should sign off to verify that they understand all the requirements of the risk assessment.

Honeywell

HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO	UK36

SITE LOCATION	SCOPE OF WORK (JOB TASK)	PERMIT TO WORK REQUIRED
	ROOF WORK	Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
	STAFF MEMBER PERFORMING JOB ONLY		VISITORS		16-30 MINUTES		31-45 MINUTES		NO OF TIMES PER WEEK
	MEMBERS OF THE PUBLIC		OTHER (SPECIFY)		46 MINS -1 HOUR		1 HOUR OR MORE		NO OF TIMES PER MONTH

HONEYWELL RISK ASSESSMENT CALCULATOR

Probability \ Severity	1. Negligible	2. Minor	3. Serious	4. Major	5. Catastrophic
5. Almost Certain	Medium	High	High	High	High
4. Highly Likely	Medium	Medium	Medium	High	High
3. Likely	Low	Low	Medium	Medium	High
2. Unlikely	Low	Low	Low	Medium	High
1. Remote	Low	Low	Low	Medium	Medium

JOB HAZARD EXPOSURE/DETAILED HAZARD *List each of the hazards associated with the scope of work in the sequence they are carried out.*	POSSIBLE HARM AND EFFECTS *Detail the harm that can result as a result of exposure to the hazard*	EXISTING CONTROL MEASURES *List the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures)*	*Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard* S 12345	P 12345	R L/M/H	RECOMMENDED ADDITIONAL CONTROLS / INFORMATION (IN PRIORITY ORDER) *Detail additional control measures to eliminate or reduce the hazard to the lowest exposure level possible. Use Control Hierarchy to further eliminate or minimise risks. (consider local legal and HON requirements) .*	ASSIGN RESPONSIBILITY *Write the name of the person responsible (supervisor or above): implement the control measures identified.*
Electrocution	Death	A pre-start survey carried out to check route, manpower, equipment required and foreseen hazards	3	2	L	Ensure **ALL** existing control measures are in place prior to commencement of task	
Fall of materials	Damage to property or equipment	Lone working to be avoided	3	2	L		
Fragile roof	Fall of person(s)	**Permit to Work system required**	3	2	L		
Moving materials	Fall of material(s)	Planning of work to ensure that maximum safety is provided by access equipment to prevent falls from height or falling objects	3	2	L	Tasks presenting significant risk to have it's own specific risk assessment.	
Overhead cables	Injury to person(s)	Relevant 'Work at Height' risk assessment referred to and appropriate measures put in place	3	2	L		
Structural elements	Ladder slipping	Separate assessments for use of ladders, scaffolding, MEWP and mobile towers	3	2	L		
Unstable structure	Striking persons below	Edge protection at all openings or edges	3	2	L		
Edge of roof/mezzanine floor	Striking overhead obstructions	Safety harness worn where no edge protection	3	2	L		
		Towers should not be used in the vicinity of overhead power lines	3	2	L		
		Management to ensure that employees have received adequate information	3	2	L		
		Only authorised, trained operatives to carry out task	3	2	L		
		Training and instruction provided in use of harness including inspection before use	3	2	L		

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Honeywell

HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO	UK20

SITE LOCATION	SCOPE OF WORK (JOB TASK)	PERMIT TO WORK REQUIRED
	USE OF PORTABLE ELECTRICAL EQUIPMENT	Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
	STAFF MEMBER PERFORMING JOB ONLY		VISITORS		16-30 MINUTES		31-45 MINUTES		NO OF TIMES PER WEEK
	MEMBERS OF THE PUBLIC		OTHER (SPECIFY)		46 MINS -1 HOUR		1 HOUR OR MORE		NO OF TIMES PER MONTH

HONEYWELL RISK ASSESSMENT CALCULATOR

Probability \ Severity	1. Negligible	2. Minor	3. Serious	4. Major	5. Catastrophic
5. Almost Certain	Medium	High	High	High	High
4. Highly Likely	Medium	Medium	Medium	High	High
3. Likely	Low	Low	Medium	Medium	High
2. Unlikely	Low	Low	Low	Medium	High
1. Remote	Low	Low	Low	Medium	Medium

JOB HAZARD EXPOSURE/DETAILED HAZARD *List each of the hazards associated with the scope of work in the sequence they are carried out.*	POSSIBLE HARM AND EFFECTS *Detail the harm that can result as a result of exposure to the hazard*	EXISTING CONTROL MEASURES *List the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures)*	*Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard* S 12345	P 12345	R L/M/H	RECOMMENDED ADDITIONAL CONTROLS / INFORMATION (IN PRIORITY ORDER) *Detail additional control measures to eliminate or reduce the hazard to the lowest exposure level possible. Use Control Hierarchy to further eliminate or minimise risks. (consider local legal and HON requirements) .*	ASSIGN RESPONSIBILITY *Write the name of the person responsible (supervisor or above): implement the control measures identified.*
Electrocution	Injury to person(s)	All equipment subject to PPM	3	2	L	Ensure **ALL** existing control measures are in place prior to commencement of task Tasks presenting significant risk to have it's own specific risk assessment	
Fire	Damage to equipment	Equipment used fit for purpose and task being carried out	3	2	L		
	Damage to property	Only authorised, trained person(s) to operate tool	3	2	L		
		Inspection of equipment before use	3	2	L		
		Only equipment operating at 110v to be used	3	2	L		
		If 240v only available, use of RCD mandatory	3	2	L		
		Leads and extension leads routed to avoid trip and obstruction hazards	3	2	L		
		Only trained and competent persons test, repair equipment	3	2	L		
		Identification of first aiders trained in electric shock treatment	3	2	L		

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	MANAGERS NAME (PRINT NAME)	MANAGER'S SIGNATURE	ASSESSMENT REVIEW DATE

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Honeywell

HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO: Generic

SITE LOCATION:

SCOPE OF WORK (JOB TASK): **USE OF MOBILE SCAFFOLD TOWERS**

PERMIT TO WORK REQUIRED: Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
	STAFF MEMBER PERFORMING JOB ONLY		VISITORS		16-30 MINUTES		31-45 MINUTES		NO OF TIMES PER WEEK
	MEMBERS OF THE PUBLIC		OTHER (SPECIFY)		46 MINS -1 HOUR		1 HOUR OR MORE		NO OF TIMES PER MONTH

HONEYWELL RISK ASSESSMENT CALCULATOR

Probability \ Severity	1. Negligible	2. Minor	3. Serious	4. Major	5. Catastrophic
5. Almost Certain	Medium	High	High	High	High
4. Highly Likely	Medium	Medium	Medium	High	High
3. Likely	Low	Low	Medium	Medium	High
2. Unlikely	Low	Low	Low	Medium	High
1. Remote	Low	Low	Low	Medium	Medium

JOB HAZARD EXPOSURE/DETAILED HAZARD *List each of the hazards associated with the scope of work in the sequence they are carried out.*	POSSIBLE HARM AND EFFECTS *Detail the harm that can result as a result of exposure to the hazard*	EXISTING CONTROL MEASURES *List the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures)*	*Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard* S 12345	P 12345	R L/M/H	RECOMMENDED ADDITIONAL CONTROLS / INFORMATION (IN PRIORITY ORDER) *Detail additional control measures to eliminate or reduce the hazard to the lowest exposure level possible. Use Control Hierarchy to further eliminate or minimise risks. (consider local legal and HON requirements) .*	ASSIGN RESPONSIBILITY *Write the name of the person responsible (supervisor or above): implement the control measures identified.*
Access Working at height Unstable structure Fall of materials Overloading	Fall of person(s) Fall of material(s) Collapse Overturning of tower Injury to person(s) Damage to property or equipment	Only authorised persons will erect, modify or dismantle scaffolding Towers should not be used in the vicinity of overhead power lines Ground conditions taken into account i.e. soft ground, height restrictions and obstructions Towers erected by competent person(s) in accordance with manufacturers instructions Maximum height to base ratios not exceeded i.e. 3.5:1 inside and 3:1 outside (without ties) All tower platforms to be boarded and fitted with toe boards Personnel and material removed before tower is moved Maximum loadings to be adhered to After alterations, adverse weather or after 7 days, scaffolding to be inspected by competent person Scaffolds checked regularly to ensure correct use and for unauthorised adaptations Hard hats and protective boots worn				Ensure **ALL** existing control measures are in place prior to commencement of task Tasks presenting significant risk to have it's own specific risk assessment	

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RISK ASSESSMENT AUTHOR (PRINT NAME)	AUTHOR'S SIGNATURE	ASSESSMENT DATE
MANAGERS NAME (PRINT NAME)	MANAGER'S SIGNATURE	ASSESSMENT REVIEW DATE

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Honeywell

HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO	UK13

SITE LOCATION	SCOPE OF WORK (JOB TASK)	PERMIT TO WORK REQUIRED
	LIFTING OPERATIONS USING MOBILE CRANES	Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
	STAFF MEMBER PERFORMING JOB ONLY		VISITORS		16-30 MINUTES		31-45 MINUTES		NO OF TIMES PER WEEK
	MEMBERS OF THE PUBLIC		OTHER (SPECIFY)		46 MINS -1 HOUR		1 HOUR OR MORE		NO OF TIMES PER MONTH

HONEYWELL RISK ASSESSMENT CALCULATOR

Probability \ Severity	1. Negligible	2. Minor	3. Serious	4. Major	5. Catastrophic
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2. Unlikely	Low	Low	Low	Medium	High
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JOB HAZARD EXPOSURE/DETAILED HAZARD *List each of the hazards associated with the scope of work in the sequence they are carried out.*	POSSIBLE HARM AND EFFECTS *Detail the harm that can result as a result of exposure to the hazard*	EXISTING CONTROL MEASURES *List the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures)*	*Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard* S 12345	P 12345	R L/M/H	RECOMMENDED ADDITIONAL CONTROLS / INFORMATION (IN PRIORITY ORDER) *Detail additional control measures to eliminate or reduce the hazard to the lowest exposure level possible. Use Control Hierarchy to further eliminate or minimise risks. (consider local legal and HON requirements) .*	ASSIGN RESPONSIBILITY *Write the name of the person responsible (supervisor or above): implement the control measures identified.*
Fall of load	Injury to person(s)	All lifting equipment will be under the control of an appointed person	4	2	M		
Overturning of crane	Fall of material(s)	Operations to be planned to ensure maximum safety of personnel and property	4	2	M	Ensure **ALL** existing control measures are in place prior to commencement of task	
	Damage to property or equipment	Lifting equipment subject to PPM	4	2	M		
	Trapping between fixture and load	Only authorised and trained persons to carry out task	4	2	M	Tasks presenting significant risk to have it's own specific risk assessment	
		Cranes will be positioned on firm ground with stabilisers extended	4	2	M		
		No persons permitted in working area radius	4	2	M		
		Loads must not be slewed over personnel or vehicles	4	2	M		
		A trained banks man/ slingers is to be used	4	2	M		
		Lifting equipment to be on firm level base	4	2	M		
		All personnel associated with slinging will wear safety helmets, gloves and footwear	4	2	M		
		Lifting to be supervised to ensure the stability of load	4	2	M		
		SWL of equipment established and marked on equipment before use	4	2	M		

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Honeywell

HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO	UK24

SITE LOCATION	SCOPE OF WORK (JOB TASK)	PERMIT TO WORK REQUIRED
	WORK ON ELECTRICAL SYSTEMS	Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
	STAFF MEMBER PERFORMING JOB ONLY		VISITORS		16-30 MINUTES		31-45 MINUTES		NO OF TIMES PER WEEK
	MEMBERS OF THE PUBLIC		OTHER (SPECIFY)		46 MINS -1 HOUR		1 HOUR OR MORE		NO OF TIMES PER MONTH

HONEYWELL RISK ASSESSMENT CALCULATOR

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JOB HAZARD EXPOSURE/DETAILED HAZARD *List each of the hazards associated with the scope of work in the sequence they are carried out.*	POSSIBLE HARM AND EFFECTS *Detail the harm that can result as a result of exposure to the hazard*	EXISTING CONTROL MEASURES *List the control measures required to eliminate or minimise the risk of injury from the identified hazard (Refer to relevant Honeywell HSE Procedures)*	*Using the Honeywell Hazard & Risk Matrix list the risk level against each hazard* S 12345	P 12345	R L/M/H	RECOMMENDED ADDITIONAL CONTROLS / INFORMATION (IN PRIORITY ORDER) *Detail additional control measures to eliminate or reduce the hazard to the lowest exposure level possible. Use Control Hierarchy to further eliminate or minimise risks. (consider local legal and HON requirements) .*	ASSIGN RESPONSIBILITY *Write the name of the person responsible (supervisor or above): implement the control measures identified.*
Electrocution	Injury to person(s)	Live working **will not** be permitted unless unavoidable, and then only after detailed risk assessment and Permit to Work	4	2	M	**All circuits to be worked on will be treated as live until verified dead. There are no exceptions to this requirement**	
Fire	Damage to property	Written 'Safe System of Work' required	4	2	M		
Arc Flash	Damage to equipment	Electrical work is only to be carried out by authorised competent electricians under direct supervision	4	2	M	Ensure **ALL** existing control measures are in place prior to commencement of task	
Explosions		Access to live conductors to be controlled and appropriate signs to be in place	4	2	M		
		Clear access of 1m rubber gloves and matting to be provided for 'live' work	4	2	M	Tasks presenting significant risk to have it's own specific risk assessment	
		Lone working to be avoided	4	2	M		
		Adequate PPE, and qualified first aid are to be available where live work is to be done	4	2	M		
		Periodic management inspection of the work area to ensure compliance	4	2	M		

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Honeywell

HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO

SITE LOCATION

SCOPE OF WORK (JOB TASK)

USE OF LADDERS

PERMIT TO WORK REQUIRED
Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
	ALL STAFF		CONTRACTORS		UNDER 5 MINUTES		6-15 MINUTES		CONTINUOUS/ ONGOING
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Access Working at height Unstable structure Fall of materials Overloading	Fall of person(s) Fall of material(s) Ladder slipping Injury to person(s) Damage to property or equipment	Ladders checked to ensure correct length, type and condition before use Ladders subject to PPM Work restricted to that which can be carried out using one hand only Ground base firm and level Ladder to be sufficient length to extend 1 m above platform to provide handhold Correct angle of ladders is 75 degrees or base: height ration 1:4 Ladders secured against slipping by tying at the top or bottom. Ladder to be footed as minimum Over-reaching from ladder prohibited Use of ladders monitored regularly Staff trained in safe use and hazards to be avoided				Ensure **ALL** existing control measures are in place prior to commencement of task Tasks presenting significant risk to have it's own specific risk assessment	

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HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO	UK25

SITE LOCATION	SCOPE OF WORK (JOB TASK)	PERMIT TO WORK REQUIRED
	INSTALLING/REPLACING LUMINARIES	Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
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Falls from height	Injury to person(s)	Planning of work to ensure that maximum safety is provided by access equipment to prevent falls from height or falling objects	3	2	L	Ensure **ALL** existing control measures are in place prior to commencement of task	
Falling objects	Damage to property or equipment	Liaison with person in charge of premise to ensure area is free from others	3	2	L		
Exposure to contents if broken	Illness	Isolate power supply before replacing luminaries, if possible locked off	3	2	L	Tasks presenting significant risk to have it's own specific risk assessment	
Electrocution		Warning signs displayed	3	2	L		
Exposure to dust		Lamps must be kept whole where possible to prevent escape of contents and broken glass	3	2	L		
		Operatives **must** be trained in the use and assembly of access equipment	3	2	L		
		Operatives to clean/vacuum dust where possible	3	2	L		
		Eye protection worn where applicable	3	2	L		

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SAFE WORK PROCEDURE - CHECKLIST

Part 2 of 2

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HONEYWELL HEALTH AND SAFETY RISK ASSESSMENT FORM

Part 1 of 2

ASSESSMENT NO	UK18

SITE LOCATION	SCOPE OF WORK (JOB TASK)	PERMIT TO WORK REQUIRED
	USE OF HAND TOOLS	Yes ☐ *(Detail in Part 2)* No ☐

PERSON POTENTIALLY EXPOSED				DURATION OF EXPOSURE				FREQUENCY OF JOB	
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Horseplay	Injury to person(s)	Only tools that have been purchased through risk assessment are to be used	3	2	L	Ensure **ALL** existing control measures are in place prior to commencement of task Tasks presenting significant risk to have it's own specific risk assessment	
Failure	Damage to property	Tools should be suitable for the task	3	2	L		
	Damage to equipment	Eye protection is to be provided where there is a risk of injury i.e. chisels, drills etc	3	2	L		
		Open bladed knives, screw drivers and other sharp tools to be carried as not to cause injury to others	3	2	L		
		Non-ferrous (spark free) tools to be used in flammable atmospheres	3	2	L		
		Insulated tools must be used where there a possibility of live electrical work	3	2	L		
		All tools to be inspected before use	3	2	L		
		Tools subject to periodic management inspections checking for damage	3	2	L		
		Operatives to be instructed in correct method of use if not part of trade training	3	2	L		
		Tool box talk – hand tools,	3	2	L		

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