Final Investment Grade Audit

Prepared for

Town of Sudbury, Massachusetts

May 6, 2014

AMERESCO
Green • Clean • Sustainable

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Town of Sudbury, Massachusetts

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Final Investment Grade Audit

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Executive Summary

The Metropolitan Area Planning Council (MAPC) issued a Request for Qualifications (RFQ) to Energy Service Companies (ESCos) to provide for Comprehensive Energy Management Services for 14 of its member communities. Ameresco submitted a proposal and was subsequently awarded the contract.

The program utilizes a multiple step design/development process beginning with a Preliminary Energy Audit (PEA) and followed by a refined and detailed Investment Grade Audit (IGA). This IGA is a key step in developing a successful energy savings and infrastructure improvement project focusing on the exact needs and desires of the Town. The purpose of the IGA is to analyze and quantify the feasibility of installing certain improvements or energy conservation measures (ECMs) throughout the Town of Sudbury. The IGA will form the basis for the subsequent Energy Services Agreement (ESA) which will enable the design and construction phase.

This IGA quantifies how the Town will be able to reduce utility costs by nearly $83,000 annually, through the acquisition of $1 million dollars in capital improvements. This investment however, will be budget-neutral to the Town. The Town will achieve these improvements via a Performance Contact designed to extract energy inefficiencies in the current utility operating budgets to self-fund the project from future energy savings. Payment will be made over time utilizing Ameresco's guaranteed annual energy savings for security.

Table ES.1

Total Project Cost	$1,093,073
Estimated Utility Rebates	$118,928
Net Project Cost	$974,145
Financing Term (after construction)	15 years
Estimated Tax-exempt Interest Rate	3.25%
Guaranteed Cost Savings / Year 1	$82,598
Net Excess Cumulative Cash Flow	$97,350

In collaboration with and by direction of the Town, Ameresco has conducted an IGA on the buildings below. The table provides the square footage for each building analyzed, along with the energy performance of each building, in terms of fossil fuel and electricity usage per square foot. Energy performance is the ratio of yearly energy use by square footage and is a good indicator of how well a building performs.

Facility Name	Gross Square Feet	Fuel MBTU / g.s.f.	Electric MBTU / g.s.f.	Total EUI MBTU / g.s.f.
DPW Highway[1]	7,154	147.5	-	147.5
DPW Offices	28,274	42.3	22.9	65.2
Flynn Building	14,750	48.1	38.8	86.9
Town Hall[2]	13,705	110.9	11.1	122.1
Fairbank Community Center	40,341	154.7	48.9	203.6
Public Library	34,364	40.4	31.7	72.1
Fire Department Headquarters	10,055	66.2	32.7	98.9
Fire Department South	3,286	102.2	17.7	119.8
Fire Department North	3,286	81.9	19.4	101.3
Curtis Middle School	155,789	37.8	25.2	63.0
Loring Elementary School	78,451	40.8	19.0	59.8
Noyes Elementary School	82,502	52.7	15.0	67.8
Haynes Elementary School	62,565	61.5	18.1	79.7
Nixon Elementary School	57,902	54.7	18.3	73.0
Total/Averages	**592,424**	**57.1**	**23.2**	**80.3**

Ameresco developed a comprehensive baseline for each facility, the details of which can be found in Section 1. The total amount of utility usage for the Fiscal Year 2011 was 4,025,852 kWh of electricity, 338,293 Therms of natural gas, and 5,203 kgallons of water.

A wide-range of energy conservation measures (ECMs) were identified, evaluated, and presented for consideration. The comprehensive development process of the IGA included input from Town personnel in order to refine the ECMs and overall scope of the project to match the infrastructure need of the facilities. This IGA outlines and describes 11 distinct ECMs across all facilities as listed in the matrix on the following page. The subsequent page lists the cost and savings for each of the measures across all facilities.

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[1] Receives electricity from the DPW Office Building

[2] Not included in project, with the exception to PC Load Management

Table ES.2: ECM Matrix

Town of Sudbury Energy Conservation Measures (ECMs)	Lighting System Improvements	Integrated and New Energy Management System	Programmable Thermostats	PC Load Management	Demand Control Ventilation	Variable Frequency Drives	Vending Machine Controls	Weatherization	Pipe Insulation	Efficient Showerheads	Replace Transformers	
Facility	**1**	**3**	**4**	**5**	**6**	**7**	**9**	**11**	**22**	**25**	**29**	
DPW Highway	X		X	X			X					
DPW Offices				X								
Flynn Building	X			X								
Town Hall				X								
Police Department												
Fairbank Community Center (Including Pool)				X			X			X		
Public Library	X			X		X						
Fire Dept Headquarters	X			X			X	X		X		
Fire Dept South				X			X		X			
Fire Dept North				X			X	X	X			
Curtis Middle School	X				X						X	
Loring Elementary	X	X					X				X	
Noyes Elementary		X					X					
Haynes Elementary	X	X			X		X	X				
Nixon Elementary	X	X					X					

Table ES.3: Cost and Savings by Measure

Ecm #	ECM Name	Annual kW	Total kWh	Natural Gas (Therms)	Water (kGallons)	Sewer (kGallons)	Energy Savings	O&M Savings	Total Project Savings	Total Project Costs	SPB
1	Lighting System Improvements	671	209,268	(1,597)	-	-	$ 33,272	$ 3,174	$ 36,446	$ 350,467	9.62
3	Integrated and New Energy Management System	-	9,227	11,938	-	-	$ 14,769	$ -	$ 14,769	$ 392,039	26.54
4	Programmable Thermostats	-	637	1,400	-	-	$ 1,782	$ -	$ 1,782	$ 9,174	5.15
5	PC Load Management	-	15,369	(244)	-	-	$ 1,260	$ -	$ 1,260	$ 5,526	4.38
6	Demand Control Ventilation	-	33,827	414	-	-	$ 3,455	$ -	$ 3,455	$ 52,327	15.15
7	Variable Frequency Drives	-	15,564	-	-	-	$ 1,551	$ -	$ 1,551	$ 30,123	19.42
9	Vending Machine Controls	-	16,801	(282)	-	-	$ 1,529	$ -	$ 1,529	$ 7,272	4.76
11	Weatherization	-	33	1,312	-	-	$ 1,549	$ -	$ 1,549	$ 17,941	11.58
22	Pipe Insulation	-	-	389	-	-	$ 526	$ -	$ 526	$ 6,251	11.88
25	Efficient Showerheads	-	-	708	200	200	$ 1,543	$ -	$ 1,543	$ 582	0.38
29	Replace Transformers	219	129,218	-	-	-	$ 15,782	$ -	$ 15,782	$ 221,372	14.03
		890	**429,944**	**14,039**	**200**	**200**	**$ 77,018**	**$ 3,174**	**$ 80,192**	**$ 1,093,073**	**13.63**

Table ES.4: Project Pro-Forma

Town of Sudbury - Pro-Forma

Initial Project Costs:		
Implementation costs	$	1,093,073
Total Initial Project Costs	**$**	**1,093,073**
Utility Rebates	$	118,928
Total Rebates	**$**	**118,928**
Net Project Costs after rebates	**$**	**974,146**

Financial Assumptions	
Term of Project {yrs}	15.0 yrs
Term of Financing {yrs}	15.0 yrs
Estimated Financing Rate	3.25%
Payments per year (frequency)	12
Discount Rate	3.25%
Average Energy escalation rate {annual}	3.00%
Project Simple Payback	13.63

Pro-forma			***Year***									
		Initial Values	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	Annual energy costs without improvements	$ 1,093,162	$ 1,125,957	$ 1,159,736	$ 1,194,528	$ 1,230,364	$ 1,267,275	$ 1,305,293	$ 1,344,452	$ 1,384,785	$ 1,426,329	$ 1,469,119
2	Annual energy costs with improvements	$ 1,016,144	$ 1,046,629	$ 1,078,027	$ 1,110,368	$ 1,143,679	$ 1,177,990	$ 1,213,329	$ 1,249,729	$ 1,287,221	$ 1,325,838	$ 1,365,613
3	Annual energy cost savings (1-2)	$ 77,018	$ 79,329	$ 81,709	$ 84,160	$ 86,685	$ 89,285	$ 91,964	$ 94,723	$ 97,564	$ 100,491	$ 103,506
4	O&M Savings	$ 3,174	$ 3,269	$ 3,367	$ 3,468	$ 3,572	$ 3,679	$ 3,790	$ 3,903	$ 4,020	$ 4,141	$ 4,265
5	Total Project Savings	$ 80,192	$ 82,598	$ 85,076	$ 87,628	$ 90,257	$ 92,964	$ 95,753	$ 98,626	$ 101,585	$ 104,632	$ 107,771
6	Payments for financing equipment		$ 68,546	$ 70,797	$ 73,115	$ 75,503	$ 77,963	$ 80,496	$ 83,106	$ 85,793	$ 88,562	$ 91,413
7	Payments for Ongoing Services	$ -	$ 7,568	$ 7,795	$ 8,029	$ 8,270	$ 8,518	$ 8,773	$ 9,036	$ 9,307	$ 9,587	$ 9,874
8	Net annual benefits		$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484
9	Cumulative cash flow	**$ 97,260**	$ 6,484	$ 12,968	$ 19,452	$ 25,936	$ 32,420	$ 38,904	$ 45,388	$ 51,872	$ 58,356	$ 64,840
10	**Net Present Value of cash flow**	**$ 76,024**										
11	Interest Rate	3.25%										
12	Discount Rate	3.25%										

Line #	**11**	**12**	**13**	**14**	**15**	**Totals**
1	$ 1,513,192	$ 1,558,588	$ 1,605,346	$ 1,653,506	$ 1,703,111	$ 20,941,583
2	$ 1,406,581	$ 1,448,779	$ 1,492,242	$ 1,537,009	$ 1,583,120	$ 19,466,155
3	$ 106,611	$ 109,810	$ 113,104	$ 116,497	$ 119,992	$ 1,475,429
4	$ 4,393	$ 4,525	$ 4,661	$ 4,801	$ 4,945	$ 60,800
5	$ 111,004	$ 114,335	$ 117,765	$ 121,298	$ 124,936	$ 1,536,228
6	$ 94,350	$ 97,375	$ 100,491	$ 103,700	$ 107,005	$ 1,298,215
7	$ 10,171	$ 10,476	$ 10,790	$ 11,114	$ 11,447	$ 140,753
8	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 97,260
9	$ 71,324	$ 77,808	$ 84,292	$ 90,776	$ 97,260	
10						
11						
12						

Notes:

1 This Proforma Cash Flow reflects an estimated financing rate of 3.25%. The actual rate will increase or decrease based on market conditions and customer credit rating at the time of funding.

2 Savings are based on current utility rate structures and usage information provided for purposes of this project.

Energy Conservation Measures

The following ECM descriptions are intended to provide a high level overview. In general the ECMs are designed to deliver many technical, financial, and environmental benefits to the Town of Sudbury that include:

- Better learning and working environment for students and staff;
- Improved energy efficiency and operation of existing systems;
- New energy efficient equipment and systems;
- Performance Guarantee of energy savings; and
- Reduction of Greenhouse gasses and emissions.

ECM 1: Lighting System Improvements

Figure 1.1:.New lamps and ballasts will improve aesthetics and provide substantial energy savings.

Ameresco proposes to install a state-of-the-art lighting system to benefit the building occupants of the Town. The project replaces or upgrades existing fixtures and will enhance the quality, consistency, and color rendering of the lighting system, while meeting all applicable codes and standards.

We identified over 130 different lamp/ballast/fixture combinations, the majority of which are linear fluorescent, which provide general lighting in key areas such as classrooms, offices, & halls.

Ameresco standardized the lighting system where practical, reducing the number of different products the Town must stock and maintain. Most fixtures replaced or retrofitted with 4' T8 lamps will receive 28-watt "energy-efficient" lamps and instant-start ballasts. This premium combination consumes less energy while matching the light output of standard T8's. The 28-watt lamp also maintains light output better than T12 and typical T8 lamps.

ECM 3: Integrated and New Energy Management Systems

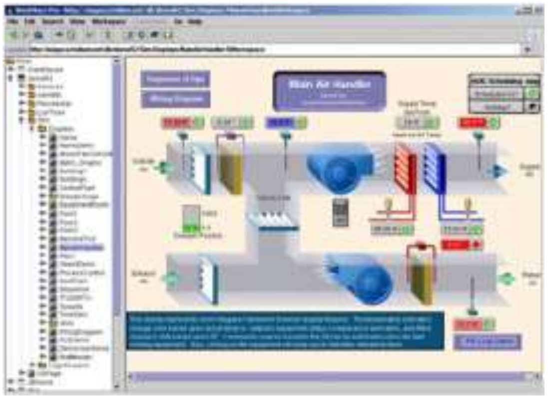

Figure 3.1: Ameresco proposes to expand and recommission the existing EMS.

Ameresco proposes to replace and/or integrate the different existing EMS systems installed in Loring Elementary School, Noyes Elementary School, Haynes Elementary School and Nixon Elementary School.

The proposed EMS would be "open protocol" and "interoperable" with other manufacturer's products. This feature would allow products from any vendor to be installed as the system is maintained or expanded in the future. The recommended EMS would be accessible from any Internet-enabled personal computer with web browsing software and would provide reduced energy consumption, increase system reliability and improve occupant comfort for the Town. The proposed EMS will provide dynamic systems control and utility consumption reporting capabilities for the entire Town.

Under the proposed EMS, Ameresco would install a new EMS that would be installed on top of existing controls for the air handling units and other control valves, as well as exhaust fans and circulator pumps. All existing pneumatic logic controllers will be removed as well as existing pneumatic thermostats controlling unit ventilators and cabinet heaters.

ECM 4: Programmable Thermostats

Ameresco proposes to install new local programmable thermostats at the DPW Highway Building to control the existing infrared heaters serving the garage bays. The new programmable thermostats will be installed in each of the three existing zones to monitor space temperature and provide control of the existing infrared heaters according to occupancy schedules and setpoint temperatures.

Figure 4.1: Ameresco proposes to replace the existing T87 thermostats at the DPW Highway Building with new programmable thermostats.

ECM 5: PC Load Management

Ameresco proposes to install a client/server software application that will manage the power consumption of computers located throughout the Town buildings. Ameresco identified 149 personal computers (PCs) of various models located at a number of Town buildings. This software will save energy and money by reducing the time the computers spend in high power modes while not in use. These packages are easy-to-deploy software utilities that address network energy waste and reduce operating costs without impacting computer users. The applications manage and minimize the energy consumed by the network's clients through one centralized interface.

Figure 5.1: These are typical computers found at the DPW Offices and throughout the other Town buildings as well.

ECM 6: Demand Control Ventilation

Ameresco identified energy saving opportunities at the Curtis Middle School and Haynes Elementary School through the installation of demand control ventilation (DCV). DCV controls modulate the amount of outdoor air supplied to a space to maintain a required ventilation rate (CFM/person) based on the actual occupancy at that time. This strategy saves energy by reducing the amount of outdoor air that is conditioned during low occupancy periods.

Figure 6.1: Existing constant air volume system serving the gymnasium at the Haynes Elementary School.

ECM 7: Variable Frequency Drives

Ameresco proposes to install variable frequency drives (VFD) for the HVAC fans located at the Goodnow Library. The VFDs will be integrated to the new Energy Management System. The installation of VFDs and controls will allow the fans to modulate with varying load more efficiently than the existing inlet guide vane method of control, which will reduce energy consumption and to improve system efficiency.

Figure 7.1: Existing belt driven fan with inlet guide vanes inside RTU-1.

ECM 9: Vending Machine Controls

Ameresco proposes to install occupancy sensing, plug load controllers to reduce the unnecessary operation of the Town's vending machines during unoccupied periods. Each vending machine controller will save energy used by the refrigerated vending machine during unoccupied hours without compromising product quality. The controller will use a sensor to detect when the space is unoccupied and turn off the vending machine. Existing non-refrigerated snack machines will also be controlled.

Figure 9.1: Soda and drink vending machines will be controlled and temperature set back, resulting in electrical savings.

ECM 11: Weatherization

The infiltration of outdoor air can be a significant load on a building's central heating and cooling systems. There are many sources of infiltration in a building's exterior envelope that can be considerably reduced with proper weather-stripping and air sealing methods. The major sources of infiltration are exterior doors, windows, walls and roof-wall intersections.

Ameresco evaluated the exterior of each building and found many areas that were in need of proper weather-stripping. The majority of the doors recommended for weather-

Figure 11.1: By reducing infiltration through leaky windows at the Fairbank Community Center, energy savings will be achieved through reduced heating and cooling loads.

stripping replacement had worn weather-stripping and door sweeps causing large gaps between the door jam and door.

Ameresco proposes to perform a number of infiltration reduction measures at a number of buildings throughout the Town. Exterior doors, windows, roof-wall intersections, soffit overhangs, and wall penetrations at the identified buildings have many gaps that allow outside air to infiltrate the building. The new weather-stripping and sealants will greatly reduce heat loss as well as increase occupant comfort due to fewer drafts.

ECM 22: Pipe Insulation

Ameresco proposes to insulate hot water piping at the Fire Station North and Fire Station South where insulation is absent or insufficient. The areas that lack insulation include the boiler header and hot water supply piping. Replacing insufficient insulation and insulating bare pipes will improve the overall efficiency of each system and alleviate over heating due to heat loss from exposed piping. Cost savings from the reduction of natural gas usage will result from the implementation of this measure.

Figure 22.1: Existing bare pipe at Fire Station North and Fire Station South will be insulated.

ECM 25: Efficient Showerheads

Ameresco proposes to reduce domestic water consumption at the Fairbank Community Center and Fire Department Headquarters by replacing standard flow showerhead fixtures with low flow showerhead fixtures. The low-flow water fixtures will enhance facility operations by reducing water usage.

Figure 25.1: Standard flow showerhead fixtures like the one shown above at the Fire Department Headquarters will be replaced with low consumption models.

ECM 29: Replace Transformers

Most transformers in the Town are estimated to be loaded at about 5% - 15% of their total capacity which is typical of other buildings. Operating at low levels for normal transformers is inefficient. Commercial transformer specifications rarely require a minimum efficiency. As one would expect, building a less efficient transformer is cheaper than building a more efficient one, so a typical low-first-cost transformer will have a low up-front cost but high operating cost, with the lifetime cost of the operating losses exceeding the purchase cost many times over.

Ameresco proposes to replace existing step-down transformers with new energy-efficient transformers at Curtis Middle School and Loring Elementary School. All of the transformers are dry-type indoor transformers that step-down 480 volt power to 208Y/120 volt power. Ameresco

Figure29.1: Existing standard efficiency transformers like the one pictured above at the Curtis Middle School will be replaced in this measure.

proposes to replace these transformers with new premium efficiency units that will reduce the electric losses and lower the cooling load of some of the equipment rooms

Summary

Ameresco has presented a complete and comprehensive IGA that addresses the needs of the Town and provides realistic solutions. The ECMs identified present very viable and needed solutions for the continued effective operations of the Town and School facilities. The final accepted IGA will form the basis for the scope-of-work under the subsequent ESA, whereby Ameresco will provide design, acquisition, installation, modification, commissioning and training for the ECMs as presented herein.

This is an important project for the Town and one that requires an Energy Services Company (ESCo) with significant expertise. The Ameresco team has extensive experience with Performance Contracting projects in municipalities and school districts in the Boston metropolitan area, throughout the Commonwealth and North America. We have the proven commitment, experience, resources, technical expertise and financial capability out of our corporate headquarters in nearby Framingham, to successfully execute this project over the full contract term. We are ready and eager to begin implementation so that the Town may secure current low cost financing and realize the overall benefit of improved facilities within the next 12 months.

Section 1: Baseline

Overview

Ameresco performed an Investment Grade Audit (IGA) for the Town of Sudbury, Massachusetts. The Town of Sudbury is located in Middlesex County, west of Boston. The Town buildings are comprised of schools, fire and police stations, library, senior center, community center, public works buildings, and the Town Hall.

Ameresco performed a Preliminary Energy Audit (PEA) for the Town of Sudbury on fifteen (15) buildings throughout the Town, including five (5) school buildings and ten (10) Town facilities. The total area of building space audited was approximately 598,880 square feet. After review of the facilities with Town personnel, the Town narrowed down the list to fourteen (14) facilities to focus on during the Investment Grade Audit (IGA) phase. The Police Department was removed entirely from the project due to potential future plans for this building. The list of buildings included in the IGA phase consisted of five (5) school buildings and eight (9) Town facilities. The area of building space audited during the IGA phase was approximately 592,424 square feet.

As part of the IGA, Ameresco developed a baseline model for each facility that was audited during the IGA phase. The baseline developed for each building is based on fiscal year 2011 (FY11) utility data. The total amount of utility usage for the Fiscal Year 2011 was 4,025,852 kWh of electricity, 338,293 Therms of natural gas, and 5,203 kgallons of water. The total utility cost for this time period was $1,433,237.

The baseline utility cost shown in the proforma located in Section 4 is based on current utility rates and does not include customer charges. Further, most of the rate tariffs the buildings receive electricity, natural gas and water under include block rate structures. These structures charge different rates depending on how much is used. Ameresco is only including rates that reflect blocks that will be affected by the ECMs. These rates are shown in Section 7 in the Utility Rate Table. The baseline utility cost shown in the proforma located in Section 4 is the product of the baseline utility energy units multiplied by the utility rates shown in Section 7.

Table 1 gives the square footage for each facility analyzed, along with the energy performance of each building, in terms of fossil fuel and electricity usage per square foot. Energy performance is the ratio of yearly energy use by square footage and is a good indicator of how well a building performs. The energy performance of each Town and school buildings was calculated from the utility information provided by Town personnel and directly from the utility companies.

The total mbtu/gsf represents the total energy usage for the entire facility on a square foot basis. The total energy usage for the entire facility on a square foot basis is the addition of both electrical and fossil fuel (mbtu/gsf) if applicable. In most of the buildings evaluated, the primary source for space heating is natural gas. Supplemental electric heating is used at a few locations. Electric cooling is utilized to varying degree in all Town buildings, mostly through DX split-systems and local air conditioners. Buildings with larger central cooling systems operate at a higher annual electrical mbtu/gsf.

Table 1: List of Audited Buildings and Energy Performance

Facility Name	Gross Square Feet	Fuel MBTU / g.s.f.	Electric MBTU / g.s.f.	Total EUI MBTU / g.s.f.
DPW Highway[1]	7,154	147.5	-	147.5
DPW Offices	28,274	42.3	22.9	65.2
Flynn Building	14,750	48.1	38.8	86.9
Town Hall[2]	13,705	110.9	11.1	122.1
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Haynes Elementary School	62,565	61.5	18.1	79.7
Nixon Elementary School	57,902	54.7	18.3	73.0
Total/Averages	**592,424**	**57.1**	**23.2**	**80.3**

Using information from the energy performance table along with investigating the existing conditions of equipment and systems, Ameresco has identified several key opportunities to reduce utility costs for each facility. Many of those savings opportunities have been captured in the Energy Conservation Measures (ECM) and are detailed in Section 3.

Baseline Information

The baseline utility data for this Investment Grade Audit is based on the Fiscal 2011 energy data (*July 2010 through June 2011*). Fiscal Year 2011's annual heating degree days (HDD) closely matched the 30-year average weather conditions for Sudbury, Massachusetts. Fiscal 2012 energy data was also available; however, Fiscal 2011 was used as we believe it still closely represents current operational conditions. For annual energy usage see the table at the end of this section.

Utilities are supplied through a number of different providers. At present, NSTAR provides delivery services while TransCanada provides commodity (supply) for electricity. Natural Gas is delivered by National Grid

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[1] Receives electricity from the DPW Office Building

[2] Not included in project, with the exception to PC Load Management

and supplied by Direct Energy. Water is supplied to the buildings by the Town of Sudbury. For annual energy usage at each facility, see Table 2.

Table 2: Annual Energy Use by Facility

Facility Name	Natural Gas Usage (Therms)	Electric Usage (kWh)	Annual Electric Demand (kW)
DPW Highway	10,554	0	0
DPW Offices	11,963	189,927	632.0
Flynn Building	7,090	167,776	378.8
Town Hall	15,204	44,680	113.2
Fairbank Community Center	62,395	578,160	1,242.8
Public Library	13,886	319,200	1,024.0
Fire Department Headquarters	6,659	96,280	204.4
Fire Department South	3,357	17,017	0
Fire Department North	2,691	18,716	0
Curtis Middle School	58,861	1,150,680	5,261.6
Loring Elementary School	31,984	436,720	1,827.6
Noyes Elementary School	43,508	363,200	1,780.0
Haynes Elementary School	38,481	332,616	1,394.8
Nixon Elementary School	31,660	310,880	1,249.6
Totals	**338,293**	**4,025,852**	**15,108.8**

Each ECM presented in this audit was explicitly "baselined" by a "temperature bin" analysis for temperature variant loads and by a fixed baseline for constant loads. Straightforward electrical saving ECMs such as lighting retrofits and motor replacements were analyzed by a combination of known operating hours, field measurements and engineering calculations. The baseline operating hours for each location or a portion thereof was determined from information from the Town and review of metered data acquired during the Investment Grade Audit. Energy cost savings for each ECM was calculated with the energy rates outlined in this section.

Electricity

The buildings receive electricity supply from TransCanada at an average price of $0.10379 per kWh. NSTAR electricity delivery is charged according to three delivery rates; G-1, G-2, and T-2. NSTAR rates vary between seasons (winter and summer). Ameresco analyzed the winter and summer rates and developed a blended rate structure as well. These rates were applied to each energy conservation measure (ECM) as appropriate. A blended rate was applied to an ECM if the savings occurred in both seasons. For ECMs that only provided savings during the summer period (cooling related ECMs), the summer rate was applied. Section 7 of the IGA outlines the exact rate used in determining the cost savings for each building. Each delivery rate plus the supply cost is displayed in Table 3.

Table 3: Electric Rates (includes Supply and Delivery)

Electricity Charges	Winter On-Peak (kWh)	Winter Off-Peak (kWh)	Winter Electric Demand (kW)	Summer On-Peak (kWh)	Summer Off-Peak (kWh)	Summer Electric Demand (kW)
General Service – G-1	$0.1935	$0.1935	$0.00	$0.2215	$0.2215	$0.00
General Service – G-2	$0.1428	$0.1428	$9.43	$0.1527	$0.1527	$20.22
Time of Use – T-2	$0.1202	$0.1202	$11.43	$0.1202	$0.1202	$19.88

Table 4: Electric Rates by Building

Facility	G-1	G-2	T-2
DPW Highway		X	
DPW Offices		X	
Flynn Building		X	
Town Hall		X	
Fairbank Community Center		X	
Public Library		X	
Fire Department Headquarters		X	
Fire Department South	X		
Fire Department North	X		
Curtis Middle School			X
Loring Elementary School			X
Noyes Elementary School		X	
Haynes Elementary School			X
Nixon Elementary School		X	

Natural Gas

The buildings receive natural gas supply from Direct Energy at an average price of $1.273 per therm. National Grid natural gas delivery is charged under four different rate structures; G-41, G-42, G-43, and G-44. Each delivery rate plus the supply cost is displayed in Table 5.

Table 5: Natural Gas Rates (includes Supply and Delivery)

Natural Gas Charges	Delivery ($/Therm)	Supply ($/Therm)	Total Cost
G-41 – Commercial Heat	$0.6722	$1.273	$1.9452
G-42 – Commercial Heat	$0.5455	$1.273	$1.8185
G-43 – Commercial Heat	$0.4796	$1.273	$1.7526
G-43 – Commercial Heat	$0.3636	$1.273	$1.6366

Table 6: Gas Rates by Building

Facility	G-41	G-42	G-43	G-44
DPW Highway		X		
DPW Offices			X	
Flynn Building			X	
Town Hall		X		
Fairbank Community Center				X
Public Library			X	
Fire Department Headquarters			X	
Fire Department South	X			
Fire Department North	X			
Curtis Middle School			X	
Loring Elementary School			X	
Noyes Elementary School			X	
Haynes Elementary School			X	
Nixon Elementary School			X	

Water & Sewer Usage

Water and sewer service is provided to the Town and School buildings by the Town. Water consumption is recorded quarterly. For calculating a cost savings for the water conservation measures, Ameresco utilized the current water rate of $4.00 per kgallon. This rate was used for Town and School buildings.

End-Use Breakdown

A baseline model was developed for each audited building. Fiscal year 2011 utility data as previously described was used to calibrate the model(s). The energy end-use breakdown for natural gas and electricity was calculated from inventoried equipment ratings, local bin weather data, operational characteristics obtained from personnel, and building envelope characteristics. Where equipment data could not be obtained, engineering experience and judgment was used. The major fuel heating end-uses found in the Town and school buildings audited includes space heating, (which consist of mechanical ventilation, conduction, and infiltration), domestic hot water usage, and cooking. Electrical usage includes lighting, space cooling, HVAC fan/pumps, kitchen equipment (includes cooking appliances, refrigeration, etc.), and office equipment (includes computers, copiers, etc.). The remaining energy was placed in the category of "Miscellaneous Loads" and includes other plug loads.

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End-Use Graphs

End-Use Information

DPW Highway

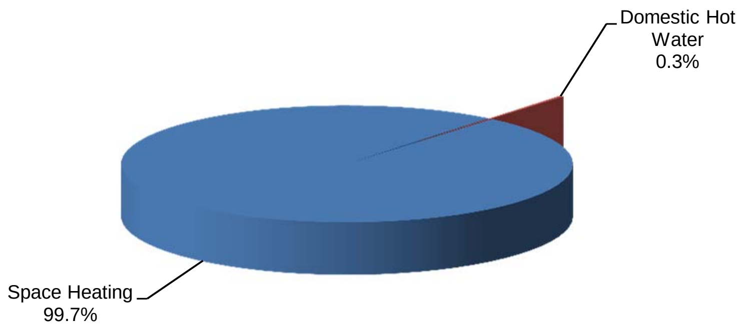
Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50216-10240

Fiscal Year 2011 Natural Gas Consumption:	10,554	Therms
Incremental Consumption:	147.5	MBTU / SF

Fiscal Year 2011 Cost:	$	18,470	
Fiscal Year 2011 Blended Rate:	$	1.750	/ Therms

Natural Gas End-Use



End-Use Information

DPW Offices

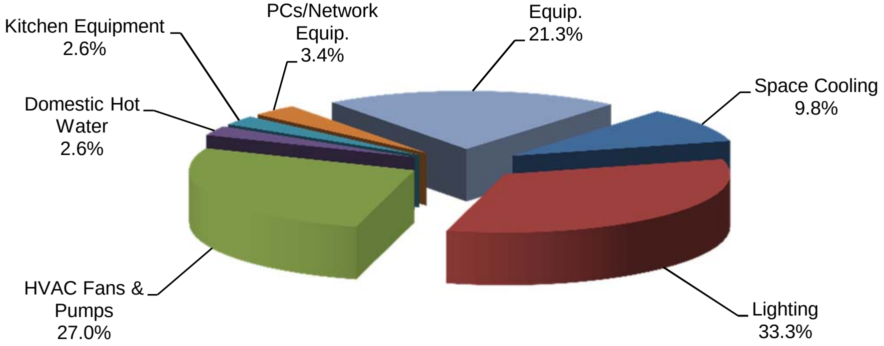
Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-687-1007

Fiscal Year 2011 Electrical Demand Consumption:		632	kW
Fiscal Year 2011 Electrical Energy Consumption:		189,927	kWh On-Peak
	+	N/A	kWh Off-Peak
		189,927	kWh Total

Most Recent Fiscal Year Cost:	$	38,810	
Most Recent Year Blended Rate:	$	0.204	/ kWh

Electricity End-Use



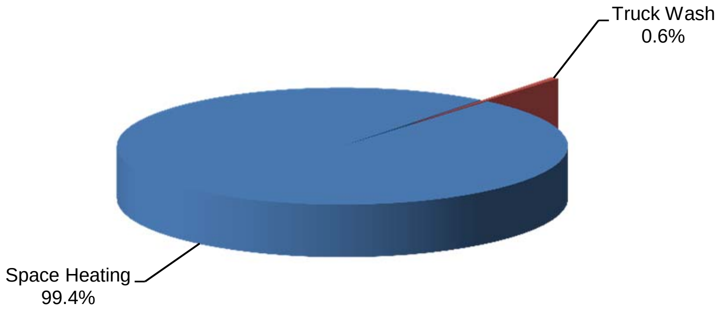
Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50216-10250

Fiscal Year 2011 Natural Gas Consumption:	11,963	Therms
Incremental Consumption:	42.3	MBTU / SF

Fiscal Year 2011 Cost:	$	20,867	
Fiscal Year 2011 Blended Rate:	$	1.744	/ Therms

Natural Gas End-Use



End-Use Information

Flynn Building

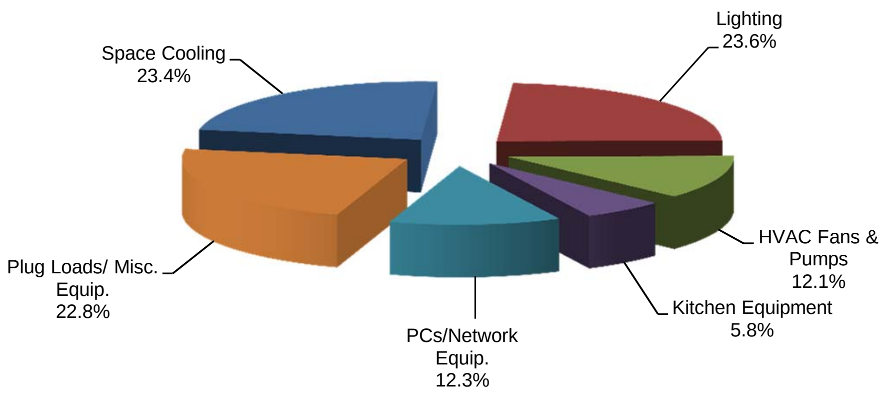
Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-316-1006

Fiscal Year 2011 Electrical Demand Consumption:		379	kW
Fiscal Year 2011 Electrical Energy Consumption:		167,776	kWh On-Peak
	+	N/A	kWh Off-Peak
		167,776	kWh Total

Most Recent Fiscal Year Cost:	$	30,904	
Most Recent Year Blended Rate:	$	0.184	/ kWh

Electricity End-Use



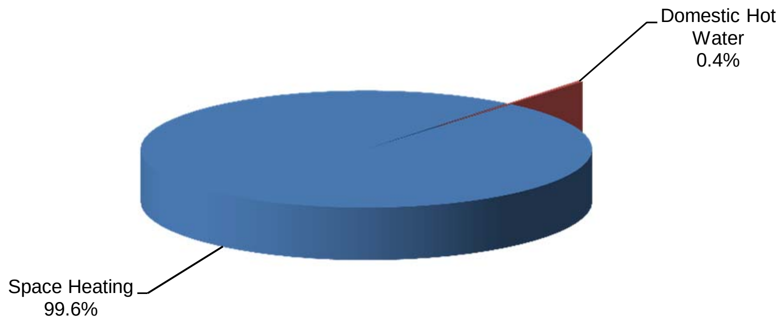
Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50216-19360

Fiscal Year 2011 Natural Gas Consumption:	7,090	Therms
Incremental Consumption:	48.1	MBTU / SF

Fiscal Year 2011 Cost:	$	12,530	
Fiscal Year 2011 Blended Rate:	$	1.767	/ Therms

Natural Gas End-Use



End-Use Information

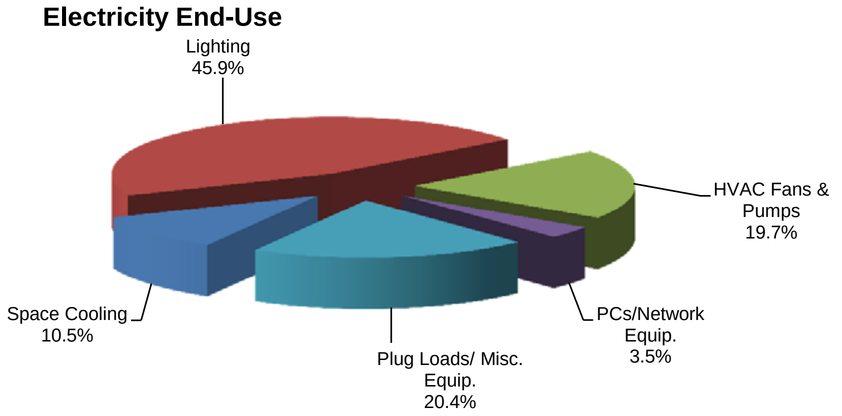
Town Hall

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-321-1009

Fiscal Year 2011 Electrical Demand Consumption:		113	kW
Fiscal Year 2011 Electrical Energy Consumption:		44,680	kWh On-Peak
	+	N/A	kWh Off-Peak
		44,680	kWh Total

Most Recent Fiscal Year Cost:	$	8,051	
Most Recent Year Blended Rate:	$	0.180	/ kWh

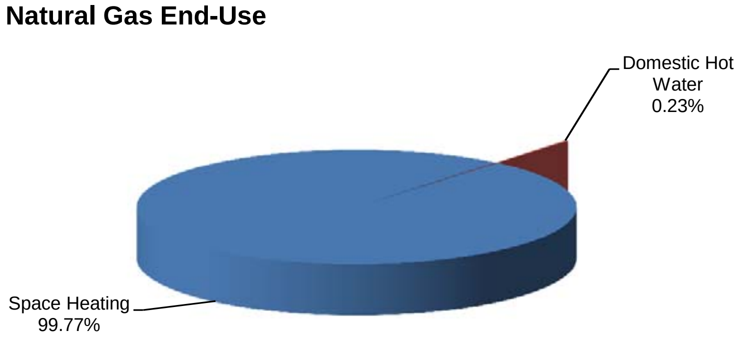


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	5021420330

Fiscal Year 2011 Natural Gas Consumption:	15,204	/ Therms
Incremental Consumption:	110.9	MBTU / SF

Fiscal Year 2011 Cost:	$	26,104	
Fiscal Year 2011 Blended Rate:	$	1.717	/ Therms



End-Use Information

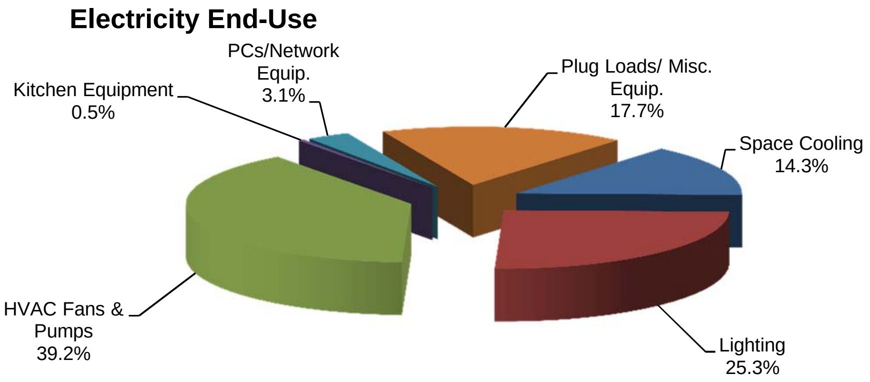
Fairbank Community Center (Including Pool)

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-615-1004, 2599-615-1004

Fiscal Year 2011 Electrical Demand Consumption:		1,243	kW
Fiscal Year 2011 Electrical Energy Consumption:		578,160	kWh On-Peak
	+	N/A	kWh Off-Peak
		578,160	kWh Total

Most Recent Fiscal Year Cost:	$	105,613	
Most Recent Year Blended Rate:	$	0.183	/ kWh

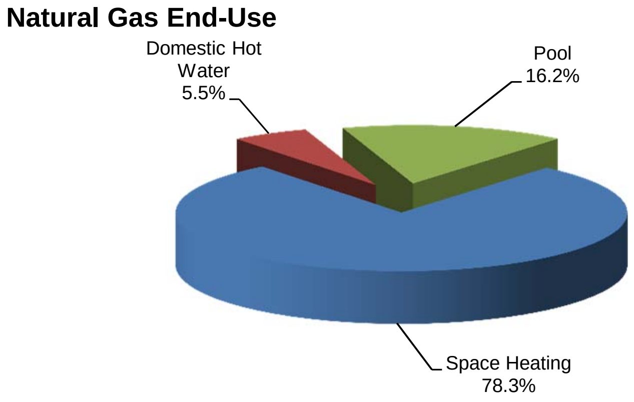


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50224-15340

Fiscal Year 2011 Natural Gas Consumption:	62,395	Therms
Incremental Consumption:	154.7	MBTU / SF

Fiscal Year 2011 Cost:	$	100,852	
Fiscal Year 2011 Blended Rate:	$	1.616	/ Therms



End-Use Information

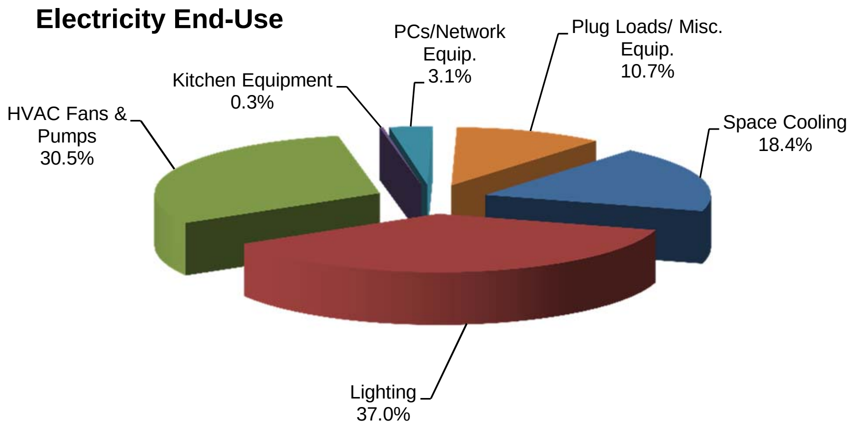
Public Library

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-197-1000

Fiscal Year 2011 Electrical Demand Consumption:		1,024	kW
Fiscal Year 2011 Electrical Energy Consumption:		319,200	kWh On-Peak
	+	N/A	kWh Off-Peak
		319,200	kWh Total

Most Recent Fiscal Year Cost:	$	66,996	
Most Recent Year Blended Rate:	$	0.210	/ kWh

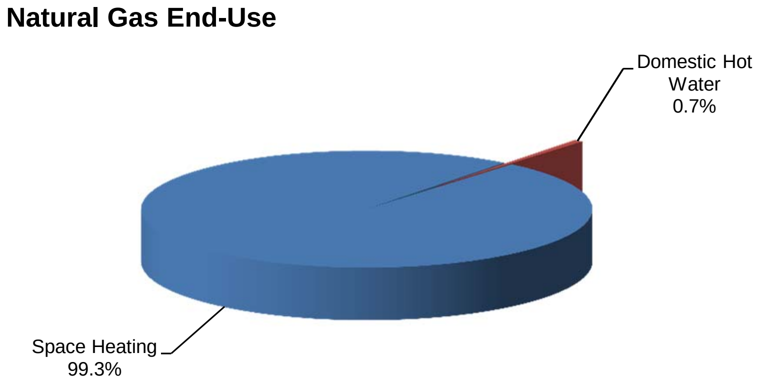


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50214-18520

Fiscal Year 2011 Natural Gas Consumption:	13,886	Therms
Incremental Consumption:	40.4	MBTU / SF

Fiscal Year 2011 Cost:	$	23,860	
Fiscal Year 2011 Blended Rate:	$	1.718	/ Therms



End-Use Information

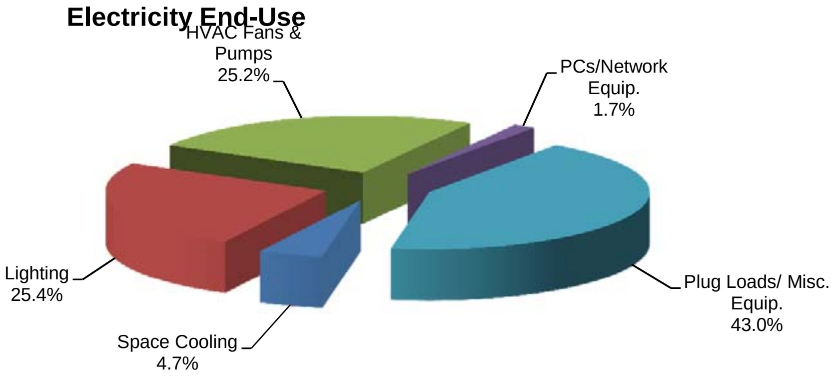
Fire Dept Headquarters

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-715-1003

Fiscal Year 2011 Electrical Demand Consumption:		204	kW
Fiscal Year 2011 Electrical Energy Consumption:		96,280	kWh On-Peak
	+	N/A	kWh Off-Peak
		96,280	kWh Total

Most Recent Fiscal Year Cost:	$	17,171	
Most Recent Year Blended Rate:	$	0.178	/ kWh

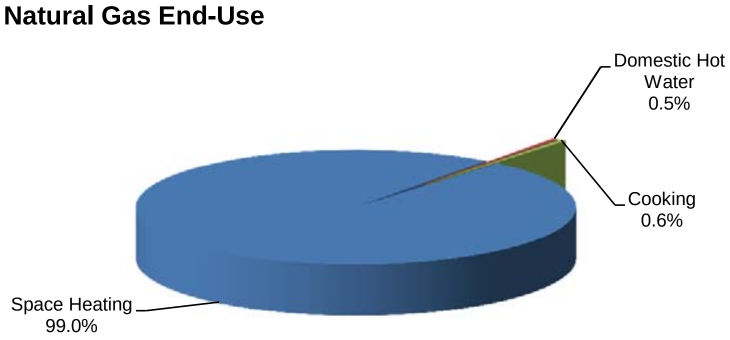


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50224-16630

Fiscal Year 2011 Natural Gas Consumption:	6,659	Therms
Incremental Consumption:	66.2	MBTU / SF

Fiscal Year 2011 Cost:	$	12,131	
Fiscal Year 2011 Blended Rate:	$	1.822	/ Therms



End-Use Information

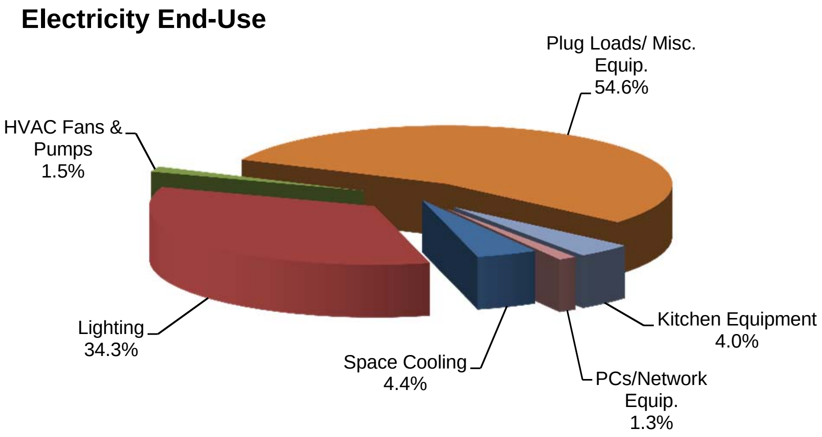
Fire Dept South

Electricity

Electricity Delivery: National Grid
Electricity Supply: TransCanada
Electricity Accounts: 2599-803-1006

Fiscal Year 2011 Electrical Demand Consumption:	N/A	kW
Fiscal Year 2011 Electrical Energy Consumption:	17,017	kWh On-Peak
	+ N/A	kWh Off-Peak
	17,017	kWh Total

Most Recent Fiscal Year Cost:	$	3,517	
Most Recent Year Blended Rate:	$	0.207	/ kWh

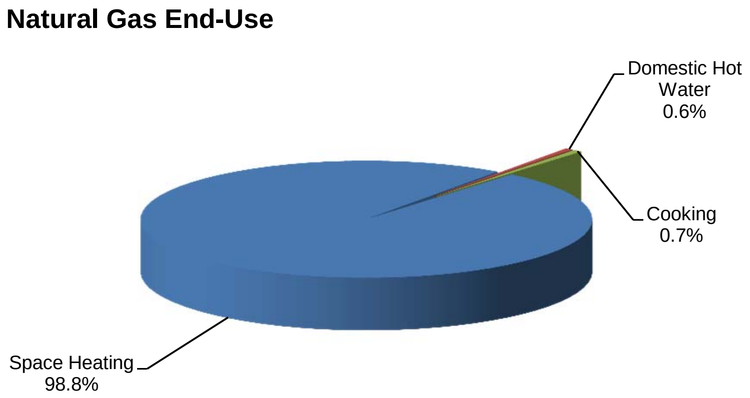


Natural Gas

Natural Gas Delivery Provider: National Grid
Natural Gas Supplier: Direct Energy
Natural Gas Accounts: 50220-17620

Fiscal Year 2011 Natural Gas Consumption:	3,357	Therms
Incremental Consumption:	102.2	MBTU / SF

Fiscal Year 2011 Cost:	$	6,355	
Fiscal Year 2011 Blended Rate:	$	1.893	/ Therms



End-Use Information

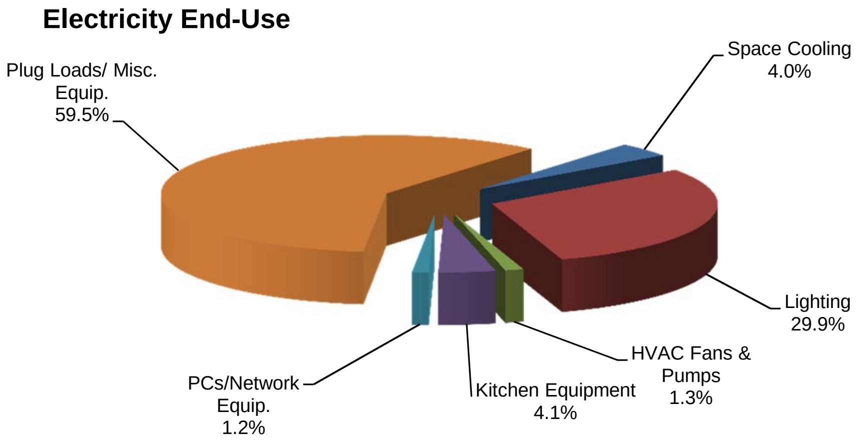
Fire Dept North

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-432-1005

Fiscal Year 2011 Electrical Demand Consumption:		N/A	kW
Fiscal Year 2011 Electrical Energy Consumption:		18,716	kWh On-Peak
	+	N/A	kWh Off-Peak
		18,716	kWh Total

Most Recent Fiscal Year Cost:	$	3,829	
Most Recent Year Blended Rate:	$	0.205	/ kWh

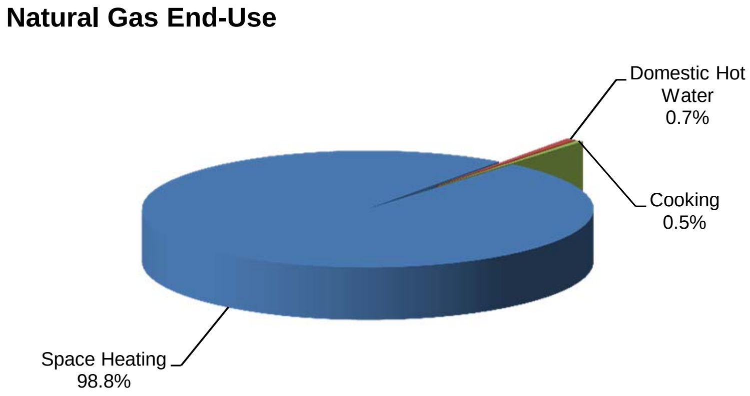


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50218-11230

Fiscal Year 2011 Natural Gas Consumption:	2,691	Therms
Incremental Consumption:	81.9	MBTU / SF

Fiscal Year 2011 Cost:	$	5,183	
Fiscal Year 2011 Blended Rate:	$	1.926	/ Therms



End-Use Information

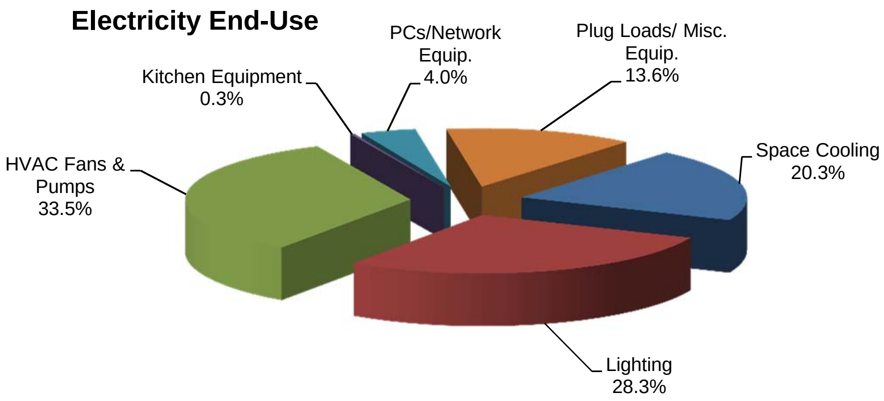
Curtis Middle School

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-677-1009

Fiscal Year 2011 Electrical Demand Consumption:		5,262	kW
Fiscal Year 2011 Electrical Energy Consumption:		1,150,680	kWh On-Peak
	+	N/A	kWh Off-Peak
		1,150,680	kWh Total

Most Recent Fiscal Year Cost:	$	263,419	
Most Recent Year Blended Rate:	$	0.229	/ kWh

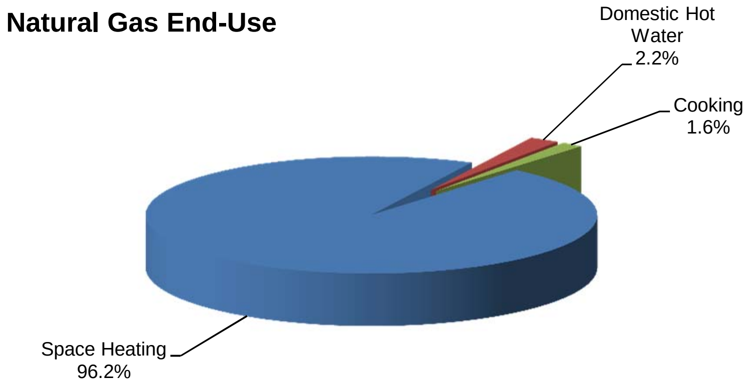


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50230-19870

Fiscal Year 2011 Natural Gas Consumption:	58,861	Therms
Incremental Consumption:	37.8	MBTU / SF

Fiscal Year 2011 Cost:	$	97,811	
Fiscal Year 2011 Blended Rate:	$	1.662	/ Therms



End-Use Information

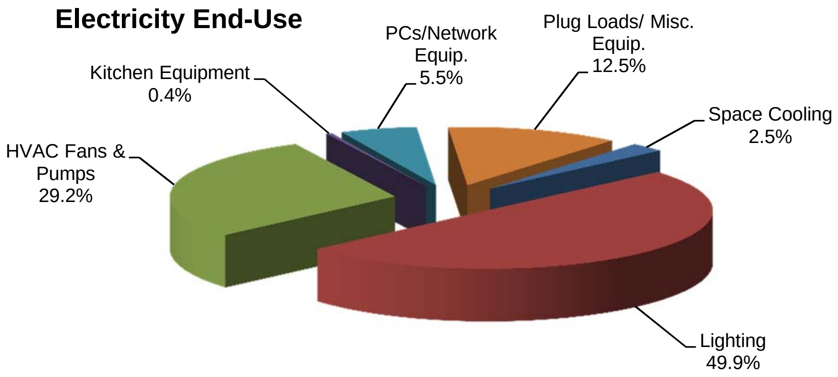
Loring Elementary

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-059-1007

Fiscal Year 2011 Electrical Demand Consumption:		1,828	kW
Fiscal Year 2011 Electrical Energy Consumption:		436,720	kWh On-Peak
	+	N/A	kWh Off-Peak
		436,720	kWh Total

Most Recent Fiscal Year Cost:	$	93,741	
Most Recent Year Blended Rate:	$	0.215	/ kWh

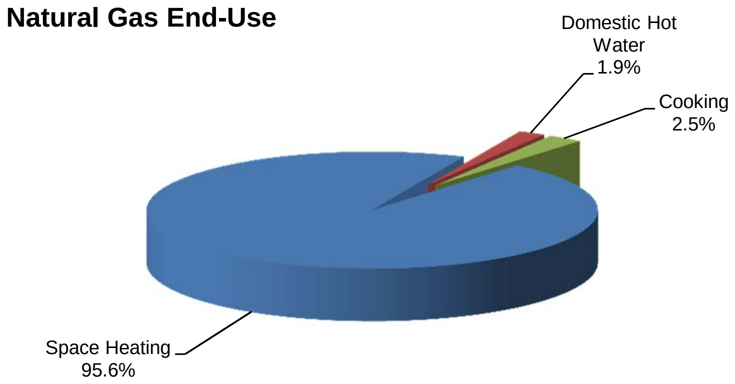


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50216-18760

Fiscal Year 2011 Natural Gas Consumption:	31,984	Therms
Incremental Consumption:	40.8	MBTU / SF

Fiscal Year 2011 Cost:	$	53,716	
Fiscal Year 2011 Blended Rate:	$	1.679	/ Therms



End-Use Information

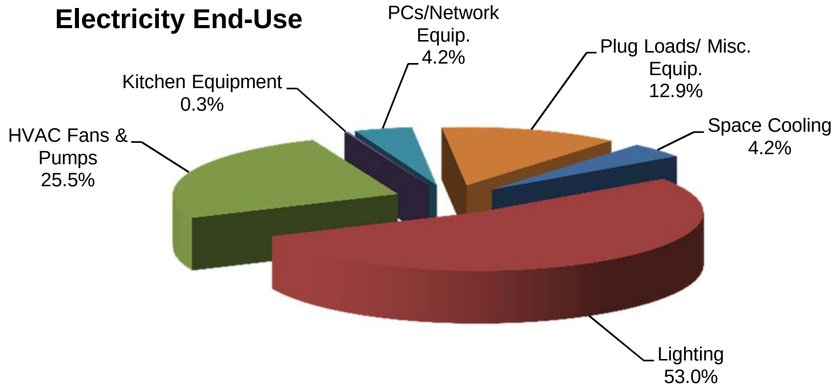
Noyes Elementary

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-317-1005

Fiscal Year 2011 Electrical Demand Consumption:		1,780	kW
Fiscal Year 2011 Electrical Energy Consumption:		363,200	kWh On-Peak
	+	N/A	kWh Off-Peak
		363,200	kWh Total

Most Recent Fiscal Year Cost:	$	82,558	
Most Recent Year Blended Rate:	$	0.227	/ kWh

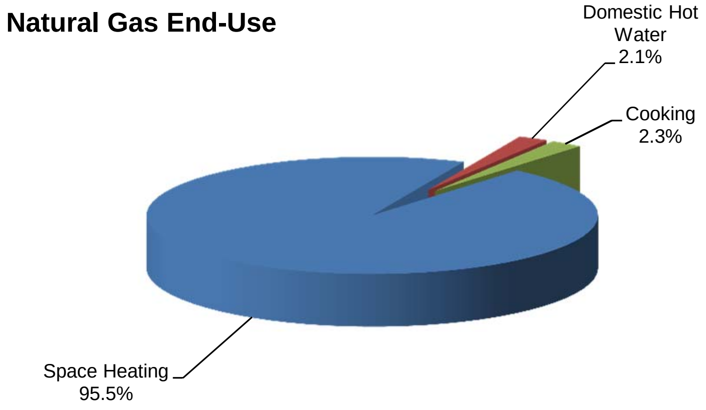


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50216-17500

Fiscal Year 2011 Natural Gas Consumption:	43,508	Therms
Incremental Consumption:	52.7	MBTU / SF

Fiscal Year 2011 Cost:	$	73,719	
Fiscal Year 2011 Blended Rate:	$	1.694	/ Therms



End-Use Information

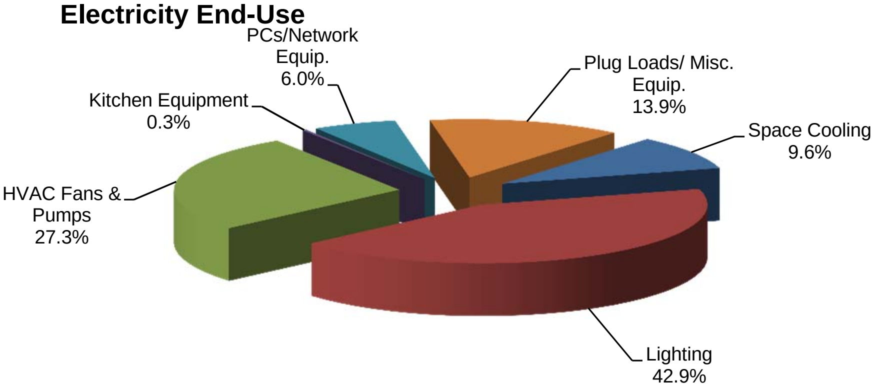
Haynes Elementary

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-474-1004

Fiscal Year 2011 Electrical Demand Consumption:		1,395	kW
Fiscal Year 2011 Electrical Energy Consumption:		332,616	kWh On-Peak
	+	N/A	kWh Off-Peak
		332,616	kWh Total

Most Recent Fiscal Year Cost:	$	68,208	
Most Recent Year Blended Rate:	$	0.205	/ kWh

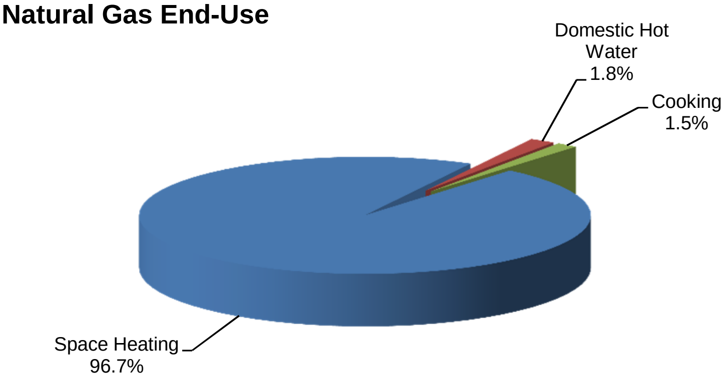

Electricity End-Use

Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50218-17320

Fiscal Year 2011 Natural Gas Consumption:	38,481	Therms
Incremental Consumption:	61.5	MBTU / SF

Fiscal Year 2011 Cost:	$	64,359	
Fiscal Year 2011 Blended Rate:	$	1.672	/ Therms


Natural Gas End-Use

End-Use Information

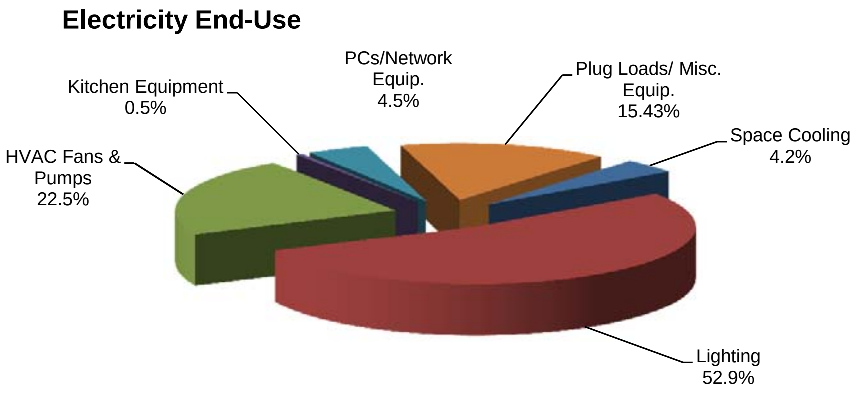
Nixon Elementary

Electricity

Electricity Delivery:	National Grid
Electricity Supply:	TransCanada
Electricity Accounts:	2599-368-1003

Fiscal Year 2011 Electrical Demand Consumption:		1,250	kW
Fiscal Year 2011 Electrical Energy Consumption:		310,880	kWh On-Peak
	+	N/A	kWh Off-Peak
		310,880	kWh Total

Most Recent Fiscal Year Cost:	$	65,284	
Most Recent Year Blended Rate:	$	0.210	/ kWh

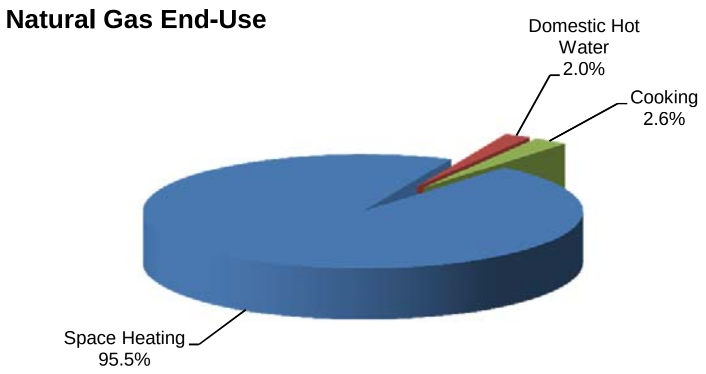


Natural Gas

Natural Gas Delivery Provider:	National Grid
Natural Gas Supplier:	Direct Energy
Natural Gas Accounts:	50216-15670

Fiscal Year 2011 Natural Gas Consumption:	31,660	Therms
Incremental Consumption:	54.7	MBTU / SF

Fiscal Year 2011 Cost:	$	53,190	
Fiscal Year 2011 Blended Rate:	$	1.680	/ Therms



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IGA Baseline Information

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MAPC - Sudbury

Utility Data Summary

Fiscal 2011

		Cost		*Annual Electric*						*Annual Fossil Fuel*			*Performance*			*Water & Sewer (Annual 2011)*		
Facility Name	**GSF Area (SF)**	**Annual Cost ($)**	**Unit Cost ($/SF)**	**Demand (kW)**	**Energy Consump (Peak kWh)**	**Peak Energy Cost $**	**Total Cost**	**W/Sqft**	**kWh/Sqft**	**Natural Gas (Therms)**	**Natural Gas Cost $**	**Total MMbtu**	**kWh/Sqft**	**Fossil Fuel (Mbtu/Sqft)**	**Annual EUI (Mbtu/Sqft)**	**Water (kGallons)**	**Water Cost $**	**Gal/Sqft**
DPW Highway	7,154	$18,727	$2.62				$0	0.0	0.0	10,554	$18,470	1,055	0.0	147.5	147.5	79	$257	11.0
DPW Offices	28,274	$59,901	$2.12	632.0	189,927	$38,810	$38,810	1.9	6.7	11,963	$20,867	1,196	6.7	42.3	65.2	68	$224	2.4
Flynn Building	14,750	$43,684	$2.96	378.8	167,776	$30,904	$30,904	2.1	11.4	7,090	$12,530	709	11.4	48.1	86.9	77	$251	5.2
Town Hall	13,705	$34,319	$2.50	113.2	44,680	$8,051	$8,051	0.7	3.3	15,204	$26,104	1,520	3.3	110.9	122.1	48	$164	3.5
Fairbank Community Center (Includir	40,341	$213,717	$5.30	1,242.8	578,160	$105,613	$105,613	2.6	14.3	62,395	$100,852	6,240	14.3	154.7	203.6	2,404	$7,252	59.6
Public Library	34,364	$91,187	$2.65	1,024.0	319,200	$66,996	$66,996	2.5	9.3	13,886	$23,860	1,389	9.3	40.4	72.1	104	$332	3.0
Fire Dept Headquarters	10,055	$29,673	$2.95	204.4	96,280	$17,171	$17,171	1.7	9.6	6,659	$12,131	666	9.6	66.2	98.9	117	$371	11.6
Fire Dept South	3,286	$9,976	$3.04		17,017	$3,517	$3,517	0.0	5.2	3,357	$6,355	336	5.2	102.2	119.8	28	$104	8.5
Fire Dept North	3,286	$9,182	$2.79		18,716	$3,829	$3,829	0.0	5.7	2,691	$5,183	269	5.7	81.9	101.3	50	$170	15.2
Curtis Middle School	155,789	$363,127	$2.33	5,261.6	1,150,680	$263,419	$263,419	2.8	7.4	58,861	$97,811	5,886	7.4	37.8	63.0	619	$1,897	4.0
Loring Elementary	78,451	$148,947	$1.90	1,827.6	436,720	$93,741	$93,741	1.9	5.6	31,984	$53,716	3,198	5.6	40.8	59.8	490	$1,490	6.2
Noyes Elementary	82,502	$157,739	$1.91	1,780.0	363,200	$82,558	$82,558	1.8	4.4	43,508	$73,719	4,351	4.4	52.7	67.8	474	$1,462	5.7
Haynes Elementary	62,565	$133,444	$2.13	1,394.8	332,616	$68,208	$68,208	1.9	5.3	38,481	$64,359	3,848	5.3	61.5	79.7	279	$877	4.5
Nixon Elementary	57,902	$119,612	$2.07	1,249.6	310,880	$65,284	$65,284	1.8	5.4	31,660	$53,190	3,166	5.4	54.7	73.0	366	$1,138	6.3
Totals	**592,424**	**$1,433,237**	**$2.42**	**15,108.8**	**4,025,852**	**$848,101**	**$848,101**	**2.1**	**6.8**	**338,293**	**$569,147**	**33,829**	**6.8**	**57.1**	**80.3**	**5,203**	**$15,989**	**8.8**

Utility Baseline Backup Information

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MAPC - Sudbury

Utility Data Summary - All Facilities

Fiscal Year 2011

	Weather	*Electric*						*Natural Gas*			*Total*	*Water & Sewer (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Off-Peak kWh	Total kWh	Total $	$/kWh Blended	Therms	$	$/Therm	MMBtu	kGal water	Total $	$/kGal Total	$
Jul-10	6	1,261	239,042	79,572	318,614	$76,522	$0.2402	1,849	5,207	2.8159	185	0	$0	$0.00	$81,729
Aug-10	16	1,043	223,021	64,957	287,978	$69,926	$0.2428	1,688	4,546	2.6932	169	1,328	$4,079	$3.07	$78,551
Sep-10	103	1,535	247,453	81,184	328,637	$89,022	$0.2709	3,140	7,839	2.4967	314	0	$0	$0.00	$96,862
Oct-10	455	1,519	274,081	71,481	345,562	$73,770	$0.2135	8,831	14,976	1.6959	883	0	$0	$0.00	$88,746
Nov-10	731	1,226	281,687	63,036	344,723	$64,728	$0.1878	27,079	44,516	1.6439	2,708	1,414	$4,337	$3.07	$113,581
Dec-10	1,181	1,172	284,573	75,166	359,739	$65,491	$0.1821	44,669	74,522	1.6683	4,467	0	$0	$0.00	$140,013
Jan-11	1,330	1,274	274,652	76,535	351,187	$65,632	$0.1869	75,537	125,214	1.6577	7,554	0	$0	$0.00	$190,846
Feb-11	1,114	1,202	299,544	74,154	373,698	$69,757	$0.1867	64,051	105,759	1.6512	6,405	1,176	$3,623	$3.08	$179,139
Mar-11	948	1,167	278,552	73,362	351,914	$66,806	$0.1898	56,417	93,483	1.6570	5,642	0	$0	$0.00	$160,289
Apr-11	521	1,103	257,496	57,434	314,930	$61,203	$0.1943	39,715	66,231	1.6677	3,972	0	$0	$0.00	$127,434
May-11	259	1,229	254,645	48,217	302,862	$62,074	$0.2050	10,634	18,161	1.7078	1,063	1,285	$3,950	$3.07	$84,185
Jun-11	89	1,552	274,164	71,844	346,008	$83,170	$0.2404	4,683	8,692	1.8560	468	0	$0	$0.00	$91,862
Totals	**6,753**	**15,281**	**3,188,910**	**836,942**	**4,025,852**	**$848,101**	**$0.2107**	**338,293**	**$569,147**	**$1.6824**	**33,829**	**5,203**	**$15,989**	**$3.07**	**$1,433,237**

Town of Sudbury

Utility Data Summary - DPW Highway

Fiscal Year 2011

	Weather	*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	0	$0	$0.00	0	0	$0	$0.00	$0
Aug-10	16	11	$125	$11.40	1	19	$62	$3.26	$187
Sep-10	103	7	$69	$9.79	1	0	$0	$0.00	$69
Oct-10	455	170	$310	$1.82	17	0	$0	$0.00	$310
Nov-10	731	934	$1,589	$1.70	93	22	$71	$3.23	$1,660
Dec-10	1,181	1,454	$2,521	$1.73	145	0	$0	$0.00	$2,521
Jan-11	1,330	2,477	$4,287	$1.73	248	0	$0	$0.00	$4,287
Feb-11	1,114	2,274	$3,931	$1.73	227	23	$74	$3.22	$4,005
Mar-11	948	1,837	$3,183	$1.73	184	0	$0	$0.00	$3,183
Apr-11	521	984	$1,715	$1.74	98	0	$0	$0.00	$1,715
May-11	259	332	$583	$1.76	33	15	$50	$3.33	$633
Jun-11	89	74	$157	$2.12	7	0	$0	$0.00	$157
Totals	**6,753**	**10,554**	**$18,470**	**$1.75**	**1,055**	**79**	**$257**	**$3.25**	**$18,727**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - DPW Offices

Fiscal Year 2011

	Weather	*Electric*							*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	70	16,188	16,188	$2,448	$1,482	$3,930	$0.24	3	$176	$58.83	0	0	$0	$0.00	$4,106
Aug-10	16	52	16,186	16,186	$2,224	$1,757	$3,982	$0.25	3	$137	$45.73	0	12	$41	$3.42	$4,160
Sep-10	103	56	12,913	12,913	$2,246	$1,766	$4,012	$0.31	10	$177	$17.72	1	0	$0	$0.00	$4,189
Oct-10	455	54	12,080	12,080	$1,236	$1,457	$2,693	$0.22	89	$262	$2.95	9	0	$0	$0.00	$2,956
Nov-10	731	38	13,440	13,440	$921	$1,348	$2,269	$0.17	397	$749	$1.89	40	19	$62	$3.26	$3,080
Dec-10	1,181	45	17,280	17,280	$1,122	$1,462	$2,583	$0.15	874	$1,489	$1.70	87	0	$0	$0.00	$4,073
Jan-11	1,330	64	21,280	21,280	$1,412	$1,842	$3,254	$0.15	3,249	$5,428	$1.67	325	0	$0	$0.00	$8,682
Feb-11	1,114	60	21,680	21,680	$1,546	$2,231	$3,778	$0.17	3,447	$5,740	$1.67	345	22	$71	$3.23	$9,589
Mar-11	948	53	16,800	16,800	$1,299	$2,281	$3,580	$0.21	2,613	$4,368	$1.67	261	0	$0	$0.00	$7,949
Apr-11	521	45	15,680	15,680	$1,150	$1,790	$2,940	$0.19	1,035	$1,757	$1.70	104	0	$0	$0.00	$4,697
May-11	259	42	13,440	13,440	$1,038	$1,696	$2,734	$0.20	200	$413	$2.06	20	15	$50	$3.33	$3,197
Jun-11	89	52	12,960	12,960	$1,578	$1,477	$3,055	$0.24	43	$170	$3.94	4	0	$0	$0.00	$3,224
Totals	**6,753**	**632**	**189,927**	**189,927**	**$18,220**	**$20,589**	**$38,810**	**$0.20**	**11,963**	**$20,867**	**$1.74**	**1,196**	**68**	**$224**	**$3.29**	**$59,901**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Flynn Building

Fiscal Year 2011

	Weather	*Electric*							*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	50	15,712	15,712	$1,776	$1,699	$3,475	$0.22	4	$173	$43.27	0	0	$0	$0.00	$3,649
Aug-10	16	37	15,835	15,835	$1,694	$1,720	$3,414	$0.22	1	$134	$134.17	0	16	$53	$3.31	$3,601
Sep-10	103	37	13,670	13,670	$1,635	$1,519	$3,154	$0.23	2	$155	$77.66	0	0	$0	$0.00	$3,309
Oct-10	455	39	13,478	13,478	$954	$1,474	$2,427	$0.18	148	$364	$2.46	15	0	$0	$0.00	$2,792
Nov-10	731	24	14,943	14,943	$752	$1,599	$2,351	$0.16	640	$1,105	$1.73	64	23	$74	$3.22	$3,530
Dec-10	1,181	25	13,826	13,826	$738	$1,495	$2,234	$0.16	1,004	$1,671	$1.66	100	0	$0	$0.00	$3,905
Jan-11	1,330	32	13,150	13,150	$715	$1,431	$2,145	$0.16	1,715	$2,823	$1.65	172	0	$0	$0.00	$4,968
Feb-11	1,114	23	14,454	14,454	$794	$1,568	$2,362	$0.16	1,341	$2,204	$1.64	134	18	$59	$3.28	$4,625
Mar-11	948	23	12,288	12,288	$725	$1,340	$2,065	$0.17	1,165	$1,934	$1.66	117	0	$0	$0.00	$3,998
Apr-11	521	23	13,114	13,114	$749	$1,435	$2,184	$0.17	705	$1,198	$1.70	71	0	$0	$0.00	$3,382
May-11	259	25	13,465	13,465	$792	$1,470	$2,262	$0.17	263	$512	$1.95	26	20	$65	$3.25	$2,840
Jun-11	89	43	13,841	13,841	$1,348	$1,482	$2,830	$0.20	102	$256	$2.51	10	0	$0	$0.00	$3,085
Totals	**6,753**	**379**	**167,776**	**167,776**	**$12,671**	**$18,232**	**$30,904**	**$0.18**	**7,090**	**$12,530**	**$1.77**	**709**	**77**	**$251**	**$3.26**	**$43,684**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Town Hall

Fiscal Year 2011

	Weather	*Electric*							*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	16	4,480	4,480	$352	$480	$832	$0.19	3	$172	$57.20	0	0	$0	$0.00	$1,004
Aug-10	16	6	3,840	3,840	$351	$420	$772	$0.20	2	$136	$67.84	0	18	$59	$3.28	$966
Sep-10	103	6	4,040	4,040	$370	$442	$812	$0.20	3	$157	$52.28	0	0	$0	$0.00	$969
Oct-10	455	15	3,640	3,640	$236	$396	$633	$0.17	350	$671	$1.92	35	0	$0	$0.00	$1,304
Nov-10	731	6	3,760	3,760	$221	$403	$624	$0.17	1,186	$1,991	$1.68	119	9	$32	$3.56	$2,647
Dec-10	1,181	9	3,600	3,600	$256	$389	$645	$0.18	1,934	$3,243	$1.68	193	0	$0	$0.00	$3,888
Jan-11	1,330	15	3,720	3,720	$208	$401	$609	$0.16	3,538	$5,906	$1.67	354	0	$0	$0.00	$6,515
Feb-11	1,114	6	3,760	3,760	$237	$408	$645	$0.17	2,923	$4,875	$1.67	292	12	$41	$3.42	$5,560
Mar-11	948	6	3,400	3,400	$220	$368	$588	$0.17	2,645	$4,422	$1.67	265	0	$0	$0.00	$5,011
Apr-11	521	4	3,520	3,520	$201	$384	$585	$0.17	2,029	$3,403	$1.68	203	0	$0	$0.00	$3,988
May-11	259	6	3,080	3,080	$210	$341	$551	$0.18	562	$987	$1.76	56	9	$32	$3.56	$1,569
Jun-11	89	17	3,840	3,840	$346	$411	$757	$0.20	29	$141	$4.88	3	0	$0	$0.00	$898
Totals	**6,753**	**113**	**44,680**	**44,680**	**$3,207**	**$4,844**	**$8,051**	**$0.18**	**15,204**	**$26,104**	**$1.72**	**1,520**	**48**	**$164**	**$3.42**	**$34,319**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Fairbank Community Center (Including Pool)

Fiscal Year 2011

	Weather	*Electric*								*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	152	53,520	53,520	$5,809	$5,808	$11,617	$0.22	1,466	$2,873	$1.96	147	0	$0	$0.00	$14,489
Aug-10	16	136	56,400	56,400	$6,076	$6,117	$12,193	$0.22	1,409	$2,633	$1.87	141	621	$1,873	$3.02	$16,699
Sep-10	103	112	42,680	42,680	$4,902	$4,816	$9,718	$0.23	2,246	$3,796	$1.69	225	0	$0	$0.00	$13,514
Oct-10	455	123	44,400	44,400	$3,266	$4,891	$8,157	$0.18	3,566	$5,516	$1.55	357	0	$0	$0.00	$13,673
Nov-10	731	83	48,160	48,160	$2,478	$5,199	$7,677	$0.16	5,536	$8,858	$1.60	554	614	$1,852	$3.02	$18,387
Dec-10	1,181	83	48,560	48,560	$2,488	$5,253	$7,741	$0.16	6,423	$10,549	$1.64	642	0	$0	$0.00	$18,290
Jan-11	1,330	101	49,320	49,320	$2,627	$5,330	$7,957	$0.16	9,839	$15,609	$1.59	984	0	$0	$0.00	$23,566
Feb-11	1,114	87	53,600	53,600	$2,902	$5,783	$8,685	$0.16	8,370	$12,911	$1.54	837	625	$1,885	$3.02	$23,481
Mar-11	948	80	46,480	46,480	$2,600	$5,032	$7,631	$0.16	8,882	$14,060	$1.58	888	0	$0	$0.00	$21,691
Apr-11	521	72	46,400	46,400	$2,476	$5,075	$7,550	$0.16	6,957	$11,335	$1.63	696	0	$0	$0.00	$18,885
May-11	259	81	44,240	44,240	$2,540	$4,864	$7,403	$0.17	5,070	$8,265	$1.63	507	544	$1,642	$3.02	$17,310
Jun-11	89	133	44,400	44,400	$4,500	$4,785	$9,285	$0.21	2,631	$4,447	$1.69	263	0	$0	$0.00	$13,732
Totals	**6,753**	**1,243**	**578,160**	**578,160**	**$42,662**	**$62,951**	**$105,613**	**$0.18**	**62,395**	**$100,852**	**$1.62**	**6,240**	**2,404**	**$7,252**	**$3.02**	**$213,717**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Public Library

Fiscal Year 2011

	Weather	*Electric*							*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	125	34,320	34,320	$4,718	$3,742	$8,460	$0.25	13	$192	$14.74	1	0	$0	$0.00	$8,652
Aug-10	16	111	30,840	30,840	$4,528	$3,376	$7,905	$0.26	9	$146	$16.25	1	24	$77	$3.21	$8,128
Sep-10	103	115	28,680	28,680	$4,592	$3,195	$7,786	$0.27	13	$172	$13.23	1	0	$0	$0.00	$7,958
Oct-10	455	92	27,840	27,840	$2,268	$3,089	$5,357	$0.19	411	$763	$1.86	41	0	$0	$0.00	$6,121
Nov-10	731	81	25,680	25,680	$1,852	$2,829	$4,682	$0.18	1,428	$2,373	$1.66	143	20	$65	$3.25	$7,119
Dec-10	1,181	55	23,880	23,880	$1,427	$2,663	$4,090	$0.17	1,835	$3,080	$1.68	184	0	$0	$0.00	$7,170
Jan-11	1,330	64	20,640	20,640	$1,402	$2,323	$3,725	$0.18	2,864	$4,790	$1.67	286	0	$0	$0.00	$8,514
Feb-11	1,114	54	23,160	23,160	$1,491	$2,603	$4,095	$0.18	2,349	$3,924	$1.67	235	37	$116	$3.14	$8,135
Mar-11	948	58	23,760	23,760	$1,578	$2,642	$4,220	$0.18	2,250	$3,770	$1.68	225	0	$0	$0.00	$7,990
Apr-11	521	70	25,680	25,680	$1,809	$2,864	$4,672	$0.18	1,631	$2,743	$1.68	163	0	$0	$0.00	$7,415
May-11	259	74	25,680	25,680	$1,861	$2,838	$4,699	$0.18	953	$1,604	$1.68	95	23	$74	$3.22	$6,377
Jun-11	89	125	29,040	29,040	$4,234	$3,071	$7,305	$0.25	130	$303	$2.33	13	0	$0	$0.00	$7,608
Totals	**6,753**	**1,024**	**319,200**	**319,200**	**$31,760**	**$35,236**	**$66,996**	**$0.21**	**13,886**	**$23,860**	**$1.72**	**1,389**	**104**	**$332**	**$3.19**	**$91,187**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Fire Dept Headquarters

Fiscal Year 2011

	Weather	*Electric*							*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	30	9,320	9,320	$936	$1,008	$1,943	$0.21	33	$217	$6.57	3	0	$0	$0.00	$2,160
Aug-10	16	16	8,760	8,760	$810	$958	$1,769	$0.20	24	$169	$7.04	2	30	$95	$3.17	$2,033
Sep-10	103	13	7,040	7,040	$674	$796	$1,470	$0.21	27	$193	$7.15	3	0	$0	$0.00	$1,663
Oct-10	455	23	6,160	6,160	$462	$695	$1,157	$0.19	59	$232	$3.93	6	0	$0	$0.00	$1,388
Nov-10	731	7	5,760	5,760	$284	$646	$930	$0.16	313	$617	$1.97	31	32	$101	$3.16	$1,648
Dec-10	1,181	12	7,360	7,360	$399	$805	$1,204	$0.16	1,039	$1,762	$1.70	104	0	$0	$0.00	$2,966
Jan-11	1,330	24	9,440	9,440	$496	$1,008	$1,504	$0.16	2,032	$3,414	$1.68	203	0	$0	$0.00	$4,918
Feb-11	1,114	18	12,600	12,600	$666	$1,321	$1,987	$0.16	1,417	$2,383	$1.68	142	26	$83	$3.19	$4,453
Mar-11	948	18	9,080	9,080	$556	$969	$1,526	$0.17	1,041	$1,770	$1.70	104	0	$0	$0.00	$3,296
Apr-11	521	12	7,160	7,160	$413	$791	$1,204	$0.17	584	$1,037	$1.78	58	0	$0	$0.00	$2,241
May-11	259	8	5,840	5,840	$322	$661	$983	$0.17	51	$176	$3.46	5	29	$92	$3.17	$1,252
Jun-11	89	24	7,760	7,760	$661	$835	$1,496	$0.19	39	$160	$4.11	4	0	$0	$0.00	$1,656
Totals	**6,753**	**204**	**96,280**	**96,280**	**$6,679**	**$10,492**	**$17,171**	**$0.18**	**6,659**	**$12,131**	**$1.82**	**666**	**117**	**$371**	**$3.17**	**$29,673**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Fire Dept South

Fiscal Year 2011

	Weather	*Electric*								*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	0	1,473	1,473	$165	$164	$330	$0.22	44	$104	$2.36	4	0	$0	$0.00	$433
Aug-10	16	0	1,604	1,604	$180	$178	$358	$0.22	36	$83	$2.31	4	8	$29	$3.63	$471
Sep-10	103	0	1,230	1,230	$140	$142	$282	$0.23	52	$115	$2.22	5	0	$0	$0.00	$397
Oct-10	455	0	1,251	1,251	$115	$142	$257	$0.21	80	$152	$1.90	8	0	$0	$0.00	$409
Nov-10	731	0	1,237	1,237	$106	$138	$244	$0.20	257	$469	$1.83	26	7	$26	$3.71	$739
Dec-10	1,181	0	1,582	1,582	$134	$171	$304	$0.19	462	$870	$1.88	46	0	$0	$0.00	$1,174
Jan-11	1,330	0	1,953	1,953	$170	$209	$379	$0.19	712	$1,334	$1.87	71	0	$0	$0.00	$1,713
Feb-11	1,114	0	1,805	1,805	$160	$195	$354	$0.20	597	$1,116	$1.87	60	6	$23	$3.83	$1,493
Mar-11	948	0	1,447	1,447	$130	$159	$288	$0.20	537	$1,009	$1.88	54	0	$0	$0.00	$1,297
Apr-11	521	0	1,367	1,367	$123	$153	$276	$0.20	361	$683	$1.89	36	0	$0	$0.00	$958
May-11	259	0	973	973	$90	$113	$203	$0.21	152	$287	$1.89	15	7	$26	$3.71	$515
Jun-11	89	0	1,095	1,095	$123	$118	$242	$0.22	67	$134	$1.99	7	0	$0	$0.00	$375
Totals	**6,753**	**0**	**17,017**	**17,017**	**$1,636**	**$1,881**	**$3,517**	**$0.21**	**3,357**	**$6,355**	**$1.89**	**336**	**28**	**$104**	**$3.71**	**$9,976**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Fire Dept North

Fiscal Year 2011

	Weather	*Electric*							*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	0	1,809	1,809	$201	$197	$398	$0.22	11	$50	$4.50	1	0	$0	$0.00	$447
Aug-10	16	0	1,641	1,641	$184	$178	$363	$0.22	11	$44	$3.97	1	11	$38	$3.45	$444
Sep-10	103	0	1,266	1,266	$144	$143	$287	$0.23	11	$48	$4.33	1	0	$0	$0.00	$335
Oct-10	455	0	1,289	1,289	$118	$144	$263	$0.20	24	$66	$2.76	2	0	$0	$0.00	$329
Nov-10	731	0	1,507	1,507	$128	$163	$290	$0.19	187	$349	$1.87	19	15	$50	$3.33	$689
Dec-10	1,181	0	1,533	1,533	$130	$165	$295	$0.19	361	$682	$1.89	36	0	$0	$0.00	$977
Jan-11	1,330	0	1,742	1,742	$152	$187	$339	$0.19	657	$1,232	$1.88	66	0	$0	$0.00	$1,571
Feb-11	1,114	0	1,867	1,867	$165	$199	$364	$0.19	549	$1,028	$1.87	55	12	$41	$3.42	$1,433
Mar-11	948	0	1,501	1,501	$134	$163	$297	$0.20	468	$881	$1.88	47	0	$0	$0.00	$1,177
Apr-11	521	0	1,547	1,547	$138	$169	$307	$0.20	288	$548	$1.90	29	0	$0	$0.00	$855
May-11	259	0	1,374	1,374	$123	$151	$274	$0.20	101	$197	$1.95	10	12	$41	$3.42	$512
Jun-11	89	0	1,640	1,640	$181	$172	$353	$0.22	23	$59	$2.55	2	0	$0	$0.00	$411
Totals	**6,753**	**0**	**18,716**	**18,716**	**$1,799**	**$2,030**	**$3,829**	**$0.20**	**2,691**	**$5,183**	**$1.93**	**269**	**50**	**$170**	**$3.40**	**$9,182**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Curtis Middle School

Fiscal Year 2011

	Weather	*Electric*								*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Off-Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	466	46,347	51,813	98,160	$13,873	$11,442	$25,315	$0.26	52	$250	$4.82	5	0	$0	$0.00	$25,565
Aug-10	16	381	36,613	42,227	78,840	$11,420	$9,300	$20,720	$0.26	41	$195	$4.75	4	168	$514	$3.06	$21,429
Sep-10	103	614	54,420	49,710	104,130	$18,047	$11,938	$29,985	$0.29	386	$755	$1.96	39	0	$0	$0.00	$30,740
Oct-10	455	566	63,639	44,721	108,360	$13,146	$12,277	$25,423	$0.23	1,952	$3,091	$1.58	195	0	$0	$0.00	$28,514
Nov-10	731	420	56,760	34,980	91,740	$9,045	$10,288	$19,333	$0.21	4,659	$7,591	$1.63	466	216	$658	$3.05	$27,582
Dec-10	1,181	369	57,819	43,251	101,070	$8,188	$11,353	$19,540	$0.19	7,080	$11,757	$1.66	708	0	$0	$0.00	$31,298
Jan-11	1,330	360	52,781	47,389	100,170	$8,343	$11,286	$19,629	$0.20	13,590	$22,522	$1.66	1,359	0	$0	$0.00	$42,151
Feb-11	1,114	369	53,249	43,171	96,420	$8,552	$10,897	$19,450	$0.20	11,085	$18,375	$1.66	1,109	78	$244	$3.13	$38,069
Mar-11	948	364	61,842	45,468	107,310	$8,612	$12,105	$20,716	$0.19	9,194	$15,254	$1.66	919	0	$0	$0.00	$35,970
Apr-11	521	337	41,981	31,009	72,990	$7,603	$8,518	$16,120	$0.22	9,611	$15,939	$1.66	961	0	$0	$0.00	$32,059
May-11	259	454	51,869	28,621	80,490	$9,935	$9,268	$19,203	$0.24	757	$1,287	$1.70	76	157	$481	$3.06	$20,970
Jun-11	89	561	66,576	44,424	111,000	$15,929	$12,055	$27,984	$0.25	454	$796	$1.75	45	0	$0	$0.00	$28,780
Totals	**6,753**	**5,262**	**643,896**	**506,784**	**1,150,680**	**$132,693**	**$130,726**	**$263,419**	**$0.23**	**58,861**	**$97,811**	**$1.66**	**5,886**	**619**	**$1,897**	**$3.06**	**$363,127**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Loring Elementary

Fiscal Year 2011

	Weather	*Electric*								*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Off-Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	105	9,842	15,838	25,680	$3,236	$3,020	$6,255	$0.24	43	$237	$5.51	4	0	$0	$0.00	$6,492
Aug-10	16	107	7,778	12,062	19,840	$3,252	$2,410	$5,661	$0.29	19	$161	$8.49	2	104	$317	$3.05	$6,140
Sep-10	103	174	17,001	17,579	34,580	$5,240	$3,875	$9,116	$0.26	76	$282	$3.71	8	0	$0	$0.00	$9,397
Oct-10	455	169	24,491	13,909	38,400	$4,012	$4,218	$8,230	$0.21	457	$818	$1.79	46	0	$0	$0.00	$9,048
Nov-10	731	165	27,262	14,138	41,400	$3,662	$4,441	$8,103	$0.20	2,465	$4,034	$1.64	247	120	$365	$3.04	$12,502
Dec-10	1,181	160	24,808	17,832	42,640	$3,581	$4,578	$8,160	$0.19	4,808	$7,997	$1.66	481	0	$0	$0.00	$16,157
Jan-11	1,330	162	22,036	16,784	38,820	$3,711	$4,174	$7,886	$0.20	7,175	$11,919	$1.66	718	0	$0	$0.00	$19,805
Feb-11	1,114	163	25,177	18,223	43,400	$3,824	$4,664	$8,488	$0.20	6,499	$10,786	$1.66	650	115	$350	$3.04	$19,624
Mar-11	948	157	25,527	15,993	41,520	$3,693	$4,461	$8,154	$0.20	5,829	$9,689	$1.66	583	0	$0	$0.00	$17,842
Apr-11	521	149	22,330	15,230	37,560	$3,477	$4,118	$7,595	$0.20	3,667	$6,110	$1.67	367	0	$0	$0.00	$13,705
May-11	259	158	24,301	11,819	36,120	$3,622	$3,947	$7,569	$0.21	713	$1,225	$1.72	71	151	$458	$3.03	$9,252
Jun-11	89	159	20,347	16,413	36,760	$4,689	$3,837	$8,526	$0.23	233	$457	$1.96	23	0	$0	$0.00	$8,983
Totals	**6,753**	**1,828**	**250,900**	**185,820**	**436,720**	**$45,999**	**$47,742**	**$93,741**	**$0.21**	**31,984**	**$53,716**	**$1.68**	**3,198**	**490**	**$1,490**	**$3.04**	**$148,947**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Noyes Elementary

Fiscal Year 2011

	Weather	*Electric*							*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	84	19,600	19,600	$2,991	$2,206	$5,197	$0.27	55	$250	$4.55	6	0	$0	$0.00	$5,447
Aug-10	16	62	18,000	18,000	$2,570	$2,063	$4,633	$0.26	33	$183	$5.53	3	121	$373	$3.08	$5,189
Sep-10	103	158	28,400	28,400	$6,013	$3,089	$9,102	$0.32	90	$1,288	$14.31	9	0	$0	$0.00	$10,390
Oct-10	455	172	31,600	31,600	$4,084	$3,357	$7,441	$0.24	514	$919	$1.79	51	0	$0	$0.00	$8,359
Nov-10	731	166	34,400	34,400	$3,293	$3,595	$6,888	$0.20	3,210	$5,225	$1.63	321	133	$409	$3.08	$12,521
Dec-10	1,181	158	36,000	36,000	$3,218	$3,763	$6,982	$0.19	6,665	$11,066	$1.66	667	0	$0	$0.00	$18,048
Jan-11	1,330	184	33,600	33,600	$3,491	$3,529	$7,021	$0.21	10,795	$17,906	$1.66	1,080	0	$0	$0.00	$24,927
Feb-11	1,114	170	37,600	37,600	$3,600	$3,937	$7,537	$0.20	9,058	$15,019	$1.66	906	91	$283	$3.11	$22,839
Mar-11	948	158	30,400	30,400	$3,215	$3,210	$6,425	$0.21	7,574	$12,573	$1.66	757	0	$0	$0.00	$18,998
Apr-11	521	162	34,000	34,000	$3,379	$3,587	$6,965	$0.20	4,701	$7,822	$1.66	470	0	$0	$0.00	$14,787
May-11	259	142	28,800	28,800	$2,936	$3,083	$6,019	$0.21	574	$1,005	$1.75	57	129	$397	$3.08	$7,421
Jun-11	89	164	30,800	30,800	$5,157	$3,191	$8,348	$0.27	239	$463	$1.94	24	0	$0	$0.00	$8,811
Totals	**6,753**	**1,780**	**363,200**	**363,200**	**$43,948**	**$38,610**	**$82,558**	**$0.23**	**43,508**	**$73,719**	**$1.69**	**4,351**	**474**	**$1,462**	**$3.08**	**$157,739**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Haynes Elementary

Fiscal Year 2011

	Weather	*Electric*								*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Off-Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	63	6,751	11,921	18,672	$1,933	$1,995	$3,928	$0.21	41	$224	$5.46	4	0	$0	$0.00	$4,152
Aug-10	16	61	6,324	10,668	16,992	$1,869	$1,821	$3,690	$0.22	27	$173	$6.42	3	76	$238	$3.13	$4,101
Sep-10	103	121	11,953	13,895	25,848	$3,609	$2,695	$6,304	$0.24	89	$287	$3.22	9	0	$0	$0.00	$6,591
Oct-10	455	123	17,653	12,851	30,504	$2,884	$3,145	$6,029	$0.20	570	$1,003	$1.76	57	0	$0	$0.00	$7,033
Nov-10	731	123	20,858	13,918	34,776	$2,702	$3,521	$6,223	$0.18	3,772	$6,124	$1.62	377	81	$253	$3.12	$12,600
Dec-10	1,181	140	19,205	14,083	33,288	$3,023	$3,392	$6,415	$0.19	6,226	$10,340	$1.66	623	0	$0	$0.00	$16,756
Jan-11	1,330	133	16,990	12,362	29,352	$2,958	$2,997	$5,954	$0.20	9,084	$15,076	$1.66	908	0	$0	$0.00	$21,030
Feb-11	1,114	130	19,232	12,760	31,992	$2,956	$3,268	$6,224	$0.19	7,413	$12,299	$1.66	741	42	$136	$3.24	$18,659
Mar-11	948	133	19,947	11,901	31,848	$3,001	$3,254	$6,255	$0.20	6,590	$10,946	$1.66	659	0	$0	$0.00	$17,201
Apr-11	521	119	16,717	11,195	27,912	$2,693	$2,885	$5,578	$0.20	3,866	$6,444	$1.67	387	0	$0	$0.00	$12,021
May-11	259	127	17,423	7,777	25,200	$2,803	$2,616	$5,419	$0.22	424	$758	$1.79	42	80	$250	$3.13	$6,427
Jun-11	89	122	15,225	11,007	26,232	$3,497	$2,692	$6,188	$0.24	379	$684	$1.81	38	0	$0	$0.00	$6,873
Totals	**6,753**	**1,395**	**188,278**	**144,338**	**332,616**	**$33,927**	**$34,281**	**$68,208**	**$0.21**	**38,481**	**$64,359**	**$1.67**	**3,848**	**279**	**$877**	**$3.14**	**$133,444**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Town of Sudbury

Utility Data Summary - Nixon Elementary

Fiscal Year 2011

	Weather	*Electric*							*Natural Gas*			*Total*	*Water & Sewer* (Annual 2011)*			*Total*
Date	HDD	kW	Peak kWh	Total kWh	Deliv $	Sup $	Total $	$/kWh Blended	Therm	$	$/Therm	MMBtu	kGal water	Water $	$/kGal Water	$
Jul-10	6	77	19,680	19,680	$2,755	$2,088	$4,843	$0.25	81	$289	$3.57	8	0	$0	$0.00	$5,132
Aug-10	16	56	19,200	19,200	$2,416	$2,052	$4,467	$0.23	62	$226	$3.65	6	100	$310	$3.10	$5,004
Sep-10	103	114	24,160	24,160	$4,449	$2,545	$6,994	$0.29	128	$346	$2.70	13	0	$0	$0.00	$7,339
Oct-10	455	122	26,560	26,560	$2,948	$2,755	$5,702	$0.21	441	$809	$1.83	44	0	$0	$0.00	$6,511
Nov-10	731	105	27,920	27,920	$2,254	$2,859	$5,113	$0.18	2,095	$3,442	$1.64	210	103	$319	$3.10	$8,874
Dec-10	1,181	107	29,120	29,120	$2,308	$2,990	$5,298	$0.18	4,504	$7,493	$1.66	450	0	$0	$0.00	$12,790
Jan-11	1,330	116	28,000	28,000	$2,352	$2,879	$5,231	$0.19	7,810	$12,969	$1.66	781	0	$0	$0.00	$18,200
Feb-11	1,114	112	31,360	31,360	$2,572	$3,217	$5,789	$0.18	6,729	$11,168	$1.66	673	69	$217	$3.14	$17,174
Mar-11	948	108	26,080	26,080	$2,370	$2,690	$5,061	$0.19	5,792	$9,626	$1.66	579	0	$0	$0.00	$14,686
Apr-11	521	102	28,000	28,000	$2,334	$2,893	$5,227	$0.19	3,296	$5,498	$1.67	330	0	$0	$0.00	$10,725
May-11	259	103	24,160	24,160	$2,233	$2,524	$4,757	$0.20	482	$860	$1.78	48	94	$292	$3.11	$5,909
Jun-11	89	128	26,640	26,640	$4,053	$2,749	$6,803	$0.26	240	$465	$1.94	24	0	$0	$0.00	$7,267
Totals	**6,753**	**1,250**	**310,880**	**310,880**	**$33,042**	**$32,241**	**$65,284**	**$0.21**	**31,660**	**$53,190**	**$1.68**	**3,166**	**366**	**$1,138**	**$3.11**	**$119,612**

**Water usage based on annual 2011 utility data, Jan-11 to Dec-11.*

Section 2:
Existing Conditions

DPW Highway

Building Characteristics

The DPW Highway building is a 7,154 ft² building that was constructed in 1956. It is utilized by the Department of Public Works, Monday through Friday from 6:30 AM to 3:30 PM, and consists of offices, three garage bays, and a dormitory. The building has a concrete masonry unit (CMU) construction throughout the first level and a steel frame roof system with a flat rubber top coat. The second story addition above the offices that houses the dormitory has a wood frame construction with vinyl siding and a sloped roof with asphalt shingles. Windows throughout the building are mostly double pane glazing in vinyl frames, with the exception of the few garage bay windows which are single pane glazing in metal frames. There are 12 overhead doors that account for much of the building's exterior surface.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The DPW Highway garages are heated by eight gas-fired Vantage II infrared heaters that are mounted from the ceiling. Each of the infrared heaters has a minimum gas input capacity of 100 MBH. The offices and dormitory are conditioned by a Carrier Weather Maker central heating and cooling system located in the first floor mechanical closet. The unit has a 100 MBH gas input capacity and a 5 ton cooling capacity

Energy Management Systems

The infrared heaters are each controlled by their own individual T87 style Honeywell thermostat. The furnace serving the offices and dormitory is controlled by an antiquated White Rodgers programmable thermostat.

Domestic Hot Water Systems

Domestic hot water is provided by an AO Smith Gas III gas-fired water heater with a gas input capacity of 30 MBH and a tank storage capacity of 30 gallons.

Lighting Systems

Shops employ efficient 4' T8 28w strips, standard T8 strips, MH bay fixtures. Storage areas have standard T8 strips, MH surface fixtures. The parking garage employs MH bay fixtures. Building mounted fixtures use MH exterior fixtures, HPS floods.

DPW Offices

Building Characteristics

The DPW Offices building is a 28,274 ft² building that was constructed in 2001. It is utilized by the Department of Public Works, Monday through Friday from 8:00 AM to 4:00 PM, and consists of offices and a large garage bay. The office section of the building has a CMU construction and a metal and wood frame roof system with a sloped ashpalt shingle roof. There is sufficient insulation installed between the rafters of the office section attic. The garage bay portion of the building has an insulated metal panel wall and metal panel sloped roof system with metal framing throughout. There are 2 over-sized overhead doors that serve the garage bay. Windows throughout the building are double pane glazing in aluminum frames.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The DPW Offices building is conditioned by a number of heating, cooling and ventilation units. The garage bay is heated by four gas-fired Reznor heating and ventilation (H&V) units that are hung from the ceiling. The two large units have an output capacity of 648 MBH and the two small units have an output capacity of 240 MBH. There are a number of exhaust fans that serve the garage bay and remove vehicle emissions. The office section of the building is heated and cooled by six Reznor HVAC units located in the attic with associated condensing units located on the rooftop. Each unit has a heating output capacity of 98 MBH and a cooling capacity ranging from 3 to 6 tons. These units serve six office zones and provide the conditioned air through an overhead distribution system and diffusers mounted in the dropped ceiling. A number of exhaust fans serve the common areas and electric rooms.

Energy Management Systems

The H&V units serving the garage bay are controlled by Honeywell thermostats that provide basic control of on/off function and temperature setpoint. The exhaust fans are controlled by a Vulcain system that monitors the emissions level in the space. Each of the HVAC units serving the office zones is controlled by a Robert Shaw 7-day programmable thermostat. The thermostats are programmed to operate during the hours of 8:00 AM and 5:00 PM.

Domestic Hot Water Systems

Domestic hot water for the office section is provided by a small on-demand electric water heater and 20 gallon electric water heater. A gas-fired water heater with an input capacity of 395 MBH serves the truck washing load of the garage bay.

Lighting Systems

Offices use efficient 4' T8 28w troffers, compact fluorescent cans, incandescent cans, standard T8 troffers. Halls have standard T8 troffers, efficient 4' T8 28w wraps. The parking garage employs T5 bay fixtures. Storage areas use efficient 4' T8 28w troffers. Baths have compact fluorescent cans, standard T8 valances. The kitchen uses efficient 4' T8 28w troffers. Building mounts use HPS squares, exterior fixtures, and MH exterior fixtures. The parking lot utilizes MH parking/roadway fixtures.

Flynn Building

Building Characteristics

The Flynn building is a 14,750 ft^2 two story building with basement that was constructed in 1898 and renovated in 1968. It is utilized by many Town Departments including the Assessors Office, Engineering, and Treasurer, Monday through Friday from 7:00 AM to 8:00 PM. The building has a wood frame wall and roof construction with wood siding. The original front wing of the building has a sloped ashpalt shingle roof and the remaining section has a flat rubber roof. There is a minimal amount of blown-in fiberglass insulation in the attic space of the sloped roof sections. Windows throughout the building are mostly double pane glazing in vinyl frames, with the exception of a few single pane, architectural wood frame windows.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The Flynn Building is provided with heating hot water by a PK Thermific SN-1200 gas-fired boiler located in the basement boiler room. The boiler has an output capacity of 1,020 MBH and the heating hot water is distributed throughout the building to terminal units by two 3 HP pumps. All of the occupied spaces are heated by fourteen finned tube baseboard radiators that wrap around the entire perimeter of the building. Three split-system AC units with a combined cooling capacity of 7 tons provide cooling to the IT server room. There are also a number of window AC units of various sizes that provide cooling to offices.

Energy Management Systems

The PK Thermific boiler is controlled by a Tekmar 256 controller that operates the boiler using outdoor temperature reset. The building's finned tube radiators are controlled by fourteen Honeywell T87 style thermostats with basic temperature setpoint control. There are fourteen associated hot water zone valves that open and close with the space heating demand.

Domestic Hot Water Systems

Domestic hot water is provided by an electric AO Smith water heater with a storage capacity of 30 gallons.

Lighting Systems

Offices have standard T8 wraps, troffers, strips, old surface fixtures, incandescent cans. Storage areas have standard T8 strips, wraps, old surface fixtures, incandescent surface fixtures, T12 strips. Halls employ standard T8 wraps, strips. Baths have standard T8 wraps, T12 valances. The kitchen uses standard T8 troffers.

Town Hall

Building Characteristics

The Town Hall building is a 12,789 ft^2 two story building that was constructed in 1931 with an addition completed in the 1950s. The building consists of offices and meeting spaces and is utilized by Town Departments including the Town Clerk, Sudbury Historical Society and Verterans' Agent, Monday through Friday from 9:00 AM to 5:00 PM. The building has a concrete and brick wall construction and Greek-style architectural details at the front entrance. The cross gable style roof has a steel frame structure with a wood deck and exterior asphalt shingles. There is no insulation installed in the attic space or walls of the building. The windows throughout the first level are double-hung, double pane glazing in vinyl frames. The second level windows are the original double-hung, single pane glazing in wood frames which are a major source of heat loss. Doors throughout are insulated slabs with sufficient weatherstripping.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The Town Hall is provided with low pressure steam by a Weil-McLain 688 boiler located in the basement boiler room. The boiler has an input capacity of 1,703 MBH and distributes steam to the original building terminal units including radiators, convectors, and air-handling units. The radiators throughout the building are 1-pipe and 2-pipe, floor and wall mounted. Condensate from the steam distribution system is returned to condensate pump located in the boiler room. The boiler also provides steam to an Everhot steam-to-hot water heat exchanger that generates hot water for the building addition terminal units. The hot water is distributed throughout the building by a fractional horsepower circulator pump. The addition is provided with ventilation and cooling by a rooftop unit that distributes conditioned air through an overhead ductwork system. Four unit ventilators serve the Auditorium and second floor Historical Society.

Energy Management Systems

The steam boiler operates on outdoor air temperature and system pressure. Steam zones in the original building have little to no control. The hot water heating zones are controlled by local thermostats inside each occupied space. These thermostats control basic open/close operation of Taco zone valves. The air conditioning unit and unit ventilators are controlled by Robert Shaw programmable thermostats that provide scheduling and occupied/unoccupied setpoint temperature control.

Domestic Hot Water Systems

Domestic hot water is provided primarily by an A.O. Smith ProMax water heater with a 40 gallon tank capacity and an input rating of 38 MBH. Additional domestic hot water is provided to the office area restrooms by a small electric heater.

Fairbank Community Center

Building Characteristics

The Fairbank Community Center is a 40,341 ft² building consisting of the Atkinson Pool, Senior Center, and School Administration offices. The original single story building that was constructed in 1959 first served as an elementary school but is now utilized by School Adminstration. This section has a masonry block construction and a built-up roof with rubber top coat. The Senior Center addition was constructed in 1989 and has a masonry block construction and metal frame roof and metal deck with asphalt shingles. The Atkinson Pool addition was constructed in 1989 and also has a masonry block construction and metal frame roof system with asphalt shingles. The roof above the pool has an interior wood frame and wood deck. Windows in the 1959 wing are majority single pane glazing in aluminum frames with lower 1/3 sections of unibsulated panel. The remaining windows throughout the building are double pane windows in aluminum frames. The occupied hours vary but on average the Fairbank Community Center is occupied from 7:00 AM to 7:00 PM.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The Senior Center and School Administration wings are primarily heated by two PK Thermific SN-2000 gas-fired boilers, each with output capacity of 1,700 MBH. Two 5 HP pumps serve the primary hot water loop and distribute the water to the secondary hot water loop. In the secondary hot water loop the heating hot water is distributed by three sets of pumps to three zones; Senior Center, School Department, and Parks and Recreation. The School Administration is still heated by the original baseboard radiators located along the perimeter of the building. Various window mounted AC units provide cooling to the School department offices. The Senior Center is primarily conditioned by two Trane Climate Changer rooftop units that provide heating and cooling to the spaces through an overhead distribution system. Perimeter hot water baseboard provides supplementary heat to the spaces. The Video Game room and TV Lounge are provided with cooling by two Sanyo split-systems. A number of roof and wall mounted exhaust fans serve the common areas of the Senior Center and Administration wings.

A set of Raypack P-0514 gas-fired boilers located in the Atkinson Pool boiler room serves the heating load of the pool water. The lap pool boiler has an input capacity of 800 MBH and the diving pool boiler has an input capacity of 512 MBH. The water is heated, treated, and filtered before being pumped to the lap pool by two 10 HP pumps and also pumped to the diving pool by a 5 HP pump. The Atkinson Pool lobby area and locker rooms are conditioned by a York gas-fired rooftop unit that provides heating and cooling to the spaces through an overhead distribution system. The pool area is conditioned by a gas-fired rooftop unit as well. The rooftop units and boilers serving the Atkinson Pool are currently in the process of being replaced. A number of roof and wall mounted exhaust fans serve the common areas of the pool building.

Energy Management Systems

A majority of the HVAC equipment located in the Senior Center boiler room is controlled and monitored by a Johnson Controls Facility Explorer (FX) energy management system (EMS). The FX system provides hot water loop temperature and occupancy schedule adjustments for the three zones being served by the heating hot water system. A number of Johnson Control sensors located in the Senior Center meeting spaces communicate with the rooftop units to provide the necessary heating or cooling. The nine baseboard radiators in the Senior Center are controlled by Honeywell T87 style thermostats located within each occupied space. The Administration offices baseboard heat is controlled by thermostatic radiator valves installed directly on each of the eighteen sections of baseboard. The pool boiler plant is controlled by an antiquated independent control system. There is a 6.1 kW solar PV array installed on the Senior Center to offset the electric utility costs. This solar array is tied into a Wattmetrics system for real-time monitoring online.

Domestic Hot Water Systems

Domestic hot water for the Fairbank Community Center including the pool shower rooms is primarily provided by two PVI 40P gas-fired water heaters. These water heaters each have a tank capacity of 90 gallons and a gas input capacity of 400 MBH. Supplementary domestic hot water is provided by a twelve panel solar mechanical array on the Senior Center that is tied into the domestic water distribution system.

Lighting Systems

Offices employ efficient 4' T8 30w troffers, standard T8 troffers. Baths have standard T8 troffers, valances, compact fluorescent exterior fixtures, efficient 4' T8 30w troffers, vanities. Halls employ standard T8 troffers, efficient 4' T8 30w troffers, compact fluorescent cans. Classrooms use standard T8 troffers, efficient 4' T8 30w troffers, and incandescent cans. The pool utilizes T5 bay fixtures. Storage areas use efficient 4' T8 30w wraps. The kitchen has standard T8 troffers. The gym use T5 bay fixtures. The auditorium uses efficient 4' T8 30w wraps. Building mounts have compact fluorescent exterior fixtures, cans, led exterior fixtures, MH floods. The parking lot use HPS parking/roadway fixtures.

Goodnow Library

Building Characteristics

The Goodnow Library is a 34,364 ft² two story building that underwent a major renovation and addition in 1997. It is utilized by Town of Sudbury residents and staff Monday through Thursday 9:00 AM to 9:00 PM, Friday and Saturday 9:00 AM to 5:00 PM, and Sunday 2:00 PM to 5:00 PM. The occupied space consists of two levels of open study space, a private study area, meeting room , and offices. The building has a brick and masonry block wall construction with thermal pane windows in aluminum frames throughout the addition and wood frame windows in the original section. The original building has a hipped roof with slate shingles and the addition has a metal roof system with a combination of asphalt shingles on the sloped section and a rubber membrane on the flat section. The addition was constructed with batt insulation in the wall cavities and rigid insulation built in the roof system. The building has both wood slab and aluminum frame doors.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The Goodnow Library is provided with heating hot water by a Smith Series 28A-5 gas-fired boiler with an output capacity of 1,014 MBH. Two 3 HP pumps distribute the hot water supply to baseboard radiators, VAV boxes, and two rooftop units. The two Trane Model YCD rooftop units provide heating, cooling, and ventilation to the entire library through an overhead variable air volume (VAV) distribution system. Air is distributed to each zone through 31 VAV boxes equipped with air dampers that modulate the amount of conditioned air supplied to each space based on the demand for heating or cooling. The VAV boxes are also equipped with hot water reheat coils to temper the supply air if necessary. Baseboard radiators along the perimeter walls provide additional heat as well. A handful of roof exhaust fans serve the Library common areas.

Energy Management Systems

The boiler is controlled by a Honeywell T775 controller that operates the boiler using basic outdoor temperature reset. The Trane rooftop units are controlled by Trane programmable thermostats that allow programming of setpoint temperatures and occupied schedules. Each VAV box is controlled by a KMC thermostat with basic setpoint temperature control located within the occupied space being served. The thermostat communicates with the VAV box to open/close dampers and modulate the hot water valve to meet space temperature requirements. The baseboard radiators are also equipped with the same KMC thermostats that control the hot water valves supplying the units. All of the HVAC equipment currently operates independently of each other.

Domestic Hot Water Systems

Domestic hot water for the building is provided by a State SSX gas-fired water heater with a tank capacity of 50 gallons and an input capacity of 52 MBH.

Lighting Systems

The library uses compact fluorescent cans, standard T8 troffers, T5 "biax" decorative fixtures, incandescent cans. Offices use standard T8 troffers, indirects, compact fluorescent cans, and T5 "biax" decorative fixtures. Halls employ compact fluorescent cans, incandescent cans, MH cans. Classrooms have compact fluorescent cans, incandescent cans, and standard T8 troffers. Storage areas use standard T8 wraps, strips, T12 wraps, strips. Baths use standard T8 strips. Building mounts use incandescent cans, compact fluorescent exterior fixtures. The parking lot uses HPS parking/roadway fixtures.

Fire Department Headquarters

Building Characteristics

The Fire Department Headquarters is a 10,055 ft^2 two story building that was constructed in 1991. It is utilized by the Sudbury Fire Department and provides 24/7 fire safety and emergency medical response services. The occupied space consists of a large apparatus bay, offices, conference room, dispatch, dormitories, kitchen, and fitness center. The building has a wood frame wall and roof construction with exterior vinyl siding and an asphalt shingle roof. Fiberglass batt insulation is installed within the wall cavities and blown-in fiberglass inulation is installed in attic space. The double hung windows throughout the building are double pane glazing in vinyl frames.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The office wing of the Fire Station Headquarters is heated by two Central Environmental Systems gas-fired furnaces located in the attic, each with an output of 105 MBH. The conditioned air is distributed through an overhead system and diffusers mounted in the dropped-ceiling. Each of these units also provides 5 tons of cooling through a DX split-system. Electric unit heaters provide heat to those common spaces that are not conditioned by the overhead system. A few exhaust roof mounted and ceiling hung exhaust fans serve the restrooms, locker rooms, kitchen, and conference room.

The apparatus bay of the Fire Station Headquarters is heated by two ceiling mounted gas-fired unit heaters, each with an output capacity of 200 MBH. There is a Plymovent exhaust system as well as wall mounted exhaust fans installed in the apparatus bay to remove vehicle emissions.

Energy Management Systems

The office wing of the Fire Station Headquarters has two zones; 1st floor and 2nd floor. A Honeywell thermostat located in the 1st floor dispatch room controls Furnace-2 serving the 1st floor zone. A Honeywell thermostat located in the 2nd floor hall controls Furnace-1 serving the 2nd floor zone. These heat/cool thermostats control the on/off operation of the fan, heat/cool function of the units, and setpoint temperature. The apparatus bay unit heaters are controlled by T87 style thermostats with basic on/off and setpoint temperature control.

Domestic Hot Water Systems

Domestic hot water for the building is provided by a Rheem-Ruud gas-fired water heater with a tank capacity of 85 gallons and input capacity of 300 MBH.

Lighting Systems

Offices use standard T8 troffers. The parking garage has standard T8 strips. Halls use standard T8 troffers, wraps. Baths employ compact fluorescent cans, standard T8 old wall mounted fixtures, troffers, T12 vanities. Storage areas use standard T8 troffers, strips. Bedrooms use standard T8 troffers. The gym uses standard T8 troffers. Classrooms use standard T8 troffers. Building mounts use incandescent decorative fixtures, MH floods.

Fire Department South (Fire Department 2)

Building Characteristics

The Fire Department South is a 3,286 ft^2 building that was constructed in 1988. It is utilized by the Sudbury Fire Department and provides 24/7 fire safety and emergency medical response services. The occupied space consists of a large apparatus bay, offices, a dormitory, kitchen, and lounge. The building has a brick and concrete wall construction and a cross gable steel frame roof covered in asphalt shingles. There are three large overhead doors that serve the apparatus bay. The double hung windows throughout the building are single pane glazing in wood frames.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The two zones of the building are heated by a Burnham 208NCL gas-fired boiler with an input capacity of 232 MBH. The low efficiency boiler is gravity-vented and equipped with an automatic vent damper. Two zone pumps in the boiler room distribute the hot water supply to the apparatus bay zone and the common area zone (kitchen, dormitory, offices). The apparatus bay is heated by two ceiling hung unit heaters equipped with hot water coils. A Plymovent exhaust system is installed in the apparatus bay to exhaust vehicle emissions. The common area spaces are heated by baseboard radiators that wrap along the perimeter of the wing. Cooling for the office wing is provided by window air conditioners of various sizes.

Energy Management Systems

The two heating zones of the building have Honeywell T87 thermostats that control the zone pump for their respective zone. The thermostats provide basic setpoint temperature control of the spaces and the boiler operates to meet the required heating demand.

Domestic Hot Water Systems

Domestic hot water is provided by a 50-gallon Burnham indirect water heater located in the boiler room. The Burnham 208NCL gas-fired boiler provides the hot water and a zone pump delivers the hot water to the indirect water heater.

Fire Department North (Fire Department 3)

Building Characteristics

The Fire Department North is a 3,286 ft^2 building that was constructed in 1988. The building is a mirror image of Fire Station South, with a few minor differences. It is utilized by the Sudbury Fire Department and provides 24/7 fire safety and emergency medical response services. The occupied space consists of a large apparatus bay, offices, a dormitory, kitchen, and lounge. The building has a brick and concrete wall construction and a steel frame roof covered in a rubber membrane. There are three large overhead doors that serve the apparatus bay. The original double hung windows throughout the building have been replaced with double pane, vinyl frame

windows.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The two zones of the building are heated by a Burnham P-209A gas-fired boiler with an input capacity of 266 MBH. The low efficiency boiler is gravity-vented and equipped with an automatic vent damper. Two zone pumps in the boiler room distribute the hot water supply to the apparatus bay zone and the common area zone (kitchen, dormitory, offices). The apparatus bay is heated by two ceiling hung unit heaters equipped with hot water coils. A Plymovent exhaust system is installed in the apparatus bay to exhaust vehicle emissions. The common area spaces are heated by baseboard radiators that wrap along the perimeter of the wing. Cooling for the office wing is provided by window air conditioners of various sizes.

Energy Management Systems

The two heating zones of the building have Honeywell thermostats that control the zone pump for their respective zone. The thermostats provide basic setpoint temperature control of the spaces and the boiler operates to meet the required heating demand.

Domestic Hot Water Systems

Domestic hot water for the building is provided by a gas-fired water heater in the boiler room with a 40 gallon tank capacity and 40 MBH input capacity.

Curtis Middle School

Building Characteristics

The Curtis Middle School is a 155,000 ft^2 building that was constructed in 1998. It is utilized by teachers, staff, and students from approximately 7:30 AM to 3:00 PM through the school year, with some activities taking place during the evening and summer months. The building consists of three wing; A, B, and C. Three story A-Wing houses most of the classrooms and science labs. The two story B-Wing houses the cafeteria, main office, library, guidance offices, art rooms, and computer labs. The single story C-Wing houses the gym, auditorium, and music rooms. The building has a masrонry block wall construction and numerous flat sections of metal frame and deck roof with rubber membrane top coats. A formed metal panel system covers various wall sections of the west, south, and east facing exterior walls. Windows throughout the building are double hung and fixed style with insulated glass in aluminum frames. Exterior doors are insulated metal slabs with minimal glazing.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The Curtis Middle School is provided with heating hot water by three Burnham Model KV1123 WML gas-fired boilers, each with a gross output capacity of 4,551 MBH. Two 40 HP premium efficiency pumps distribute the hot water supply throughout the building. The two pumps share a Square D Econoflex adjustable speed drive controller that operates the pumps in a lead/lag strategy and varies the pumps output based on the hot water loop system pressure. The heating hot water is distributed to terminal units throughout the building including 14 rooftop units, 51 VAV boxes, 8 unit ventilators, and approximately 47 baseboard radiators.

The fourteen rooftop units provide a majority of the heating, cooling, and ventilation to the various zones of the building through risers and overhead ductwork systems. The following table provides a list of the rooftop units and the areas served by each.

Designation	Service	Supply Fan HP	Return Fan HP	Supply and Return CFM
RTU-1	A-Wing Science Prep Rooms	1.5	-	1,260
RTU-2 (HRU-1)	A-Wing Interior Classrooms	30	15	16,260
RTU-3 (HRU-2)	A-Wing Perimeter Classrooms	15	10	11,275
RTU-4 (HRU-3)	A-Wing Perimeter Classrooms	7.5	7.5	9,150
RTU-5	B-Wing Guidance Office	10	7.5	8,645
RTU-6	B-Wing Kitchen	7.5	3	6,050
RTU-7	B-Wing Library	15	7.5	10,350
RTU-8	B-Wing Cafeteria	7.5	5	6,400
RTU-9	B-Wing Main Office & Nurse	7.5	5	4,950
RTU-10	C-Wing Gym	7.5	3	7,000
RTU-11 (HRU-4)	C-Wing Locker Rooms	1.5	1.5	1,150
RTU-12	C-Wing Auditorium	15	7.5	12,000
RTU-13	C-Wing Orchestra & Music	3	2	2,650
RTU-14 (HRU-5)	C-Wing Orchestra & Music	3	3	2,700

Each of the rooftop units is equipped with a hot water heating coil and outside air dampers which modulate to provide varying amounts of ventilation air. All of the rooftop units except RTU-2, RTU-6, RTU-10, RTU-11 are equipped with DX cooling coils and air cooled condensing units. The supply and return fans of RTU-2, RTU-5, and RTU-9 are equipped with variable frequency drives (VFD) that modulate the fan output based on system pressure. These units serve VAV boxes equipped with reheat coils and dampers that modulate to meet the heating or cooling loads of their respective zone. The A-Wing science classrooms are provided with heating, cooling, and ventilation by ceiling hung unit ventilators. These units operate in conjunction with the fume hoods in each science classroom to ensure adequate ventilation. Hot water baseboard radiators are located throughout the building classrooms along the perimeter walls to supplement the overhead heating system. Heat recover units (HRU) provide ventilation air to the classrooms. Hot water cabinet unit heaters are located in common areas including stairways, corridors, and vestibules to condition those spaces. There are 29 Greenheck rooftop exhaust fans that serve the classrooms, restrooms, kitchen, and storage spaces.

Energy Management Systems

A Delta Controls Energy Management System (EMS) was installed to control all the HVAC equipment in the building. The fully digital control system consists of DDC actuators and valves on all HVAC equipment, Delta DAC controllers, Delta temperature sensors in all spaces, CO2 sensors for Demand Controlled Ventilation (DCV), and web accessible front end running on ORCAweb software. ORCAweb allows the operator to easily monitor HVAC equipment status, alarms or adjust temperature setpoints and operation schedules. Most of the Delta controllers are V2 models, except for the Delta V3 controllers operating the Science Room unit ventilators. The V2 controllers are not compatible with the new V3 controllers which have caused some communication issues. The V2 controllers may also present an issue with integrating the existing EMS into a town-wide network.

The following table contains the summer and winter operation schedules of the fourteen building zones and auxiliary terminal units. RTU-8, 10, and 12 are occasionally operated on the weekends and their schedules are modified on a weekly basis to accommodate changing activities.

Schedule	Cooling Season		Heating Season	
	On (AM)	Off (PM)	On (AM)	Off (PM)
A, B, C-Wings (FTR+CUH)	7:00	16:00	3:40	16:00
A, B, C-Wing (VAV)	7:03	16:00	4:37	16:00
A-Wing Science Rooms (UVs)	7:15	15:00	6:01	15:00
RTU-1	7:16	16:30	7:16	16:30
RTU-2 (HRU-1)	4:25	16:00	5:05	16:00
RTU-3 (HRU-2)	4:30	16:00	5:10	16:00
RTU-4 (HRU-3)	4:15	16:00	5:15	16:00
RTU-5	5:00	16:50	5:25	16:50
RTU-6	6:53	14:30	5:20	14:30
RTU-7	7:05	16:00	6:05	16:00
RTU-8	5:50	16:00	5:20	16:00
RTU-9	6:45	16:00	4:45	17:00
RTU-10	6:56	15:00	5:56	15:00
RTU-11 (HRU-4)	6:40	16:00	5:50	15:00
RTU-12	8:00	13:00	6:34	12:00
RTU-13	6:59	16:00	3:45	18:00
RTU-14 (HRU-5)	7:35	16:00	5:30	15:00

Domestic Hot Water Systems

Domestic hot water for the building is provided by two PVI Turbopower 750N gas-fired water heaters with input capacities of 600 MBH and an additional Takagi instantaneous gas-fired water heater with an input capacity of 380 MBH. A 15 kW Hatco booster water heater provides additional water heating for the kitchen domestic water load.

Lighting Systems

Classrooms use standard T8 indirects, wallwash, troffers, compact fluorescent cans. Halls have standard T8 troffers, coves, valances, compact fluorescent cans. Offices use standard T8 troffers, indirects, compact fluorescent cans. Baths employ standard T8 troffers, valances, strips, compact fluorescent cans. The cafeteria uses compact fluorescent cans, standard T8 troffers, and MH sconces. Storage areas use standard T8 troffers, strips. The library uses standard T8 troffers, MH decorative fixtures, indirects, compact fluorescent sconces. The auditorium has compact fluorescent cans, sconces, standard T8 troffers. Labs use standard T8 indirects. The gym employs T5 bay fixtures. The kitchen uses standard T8 troffers, compact fluorescent wall mounted fixtures. Building mounts use MH exterior fixtures, indirects, squares, led exterior fixtures.

Loring Elementary School

Building Characteristics

The Loring Elementary School is a 81,654 ft² building that was constructed in 1998. It is utilized by teachers, staff, and students from approximately 8:00 AM to 3:00 PM through the school year, with some activities taking place during the evening and summer months. The two story building consists of kindergarten through grade 5 classrooms, gymnasium, library, cafetorium, and office space. The building has an insulated brick and masronry block wall construction . Sections of the building have a standing seam metal roofing system while a majority of the building has an EPDM membrane roofing system with a metal deck. Windows throughout the building are double hung and fixed style with double pane glazing in aluminum frames. Building entrances have aluminum store front window systems and all exterior doors are insulated metal slabs with varying amounts of glazing.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The Loring Elementary School is provided with heating hot water by two Burnham V1117W gas-fired boilers, each with a gross output of 3,353 MBH. The heating hot water is distributed throughout the building by two 15 HP Taco pumps to terminal units including 8 rooftop units, 11 fan-powered VAV boxes, and approximately 59 hot water finned tube radiators. The two pumps share a Square D Econoflex adjustable speed drive controller that operates the pumps in a lead/lag strategy and varies the pumps output based on the hot water loop system pressure.

RTU-1 serving the library provides heating, cooling, and ventilation and is equipped with a hot water heating coil, DX cooling coil, and economizer. The fans are equipped with VFDs for optimum fan start/stop and speed control. RTUs 2 through 8 provide heating and ventilation to the remaining areas of the building including the gym, classrooms, kitchen, and cafeteria. These units are equipped with hot water coils and economizers and distribute the conditioned air through an overhead ductwork system. The fan-powered VAV boxes serve the main office, library, and computer lab and are equipped with hot water reheat coils to provide additional heat to the spaces. Perimeter baseboard radiators are located throughout classrooms and common spaces to provide additional heat along the exterior walls and windows of those spaces. Fourteen roof mounted exhaust fans of fractional horsepower serve the restroom, classrooms, and general spaces.

Energy Management Systems

The Loring Elementary School originally had a Johnson Controls Metasys EMS and Tekmar boiler controller installed to control all the HVAC equipment and boiler plant. The EMS was recently upgraded with a new Johnson Controls Facility Explorer EMS consisting of some new Facility Explorer field controllers and front end software. An FX60 Supervisory Controller was installed to manage all the existing Metasys and new Facility Explorer field controllers and provides web accessibility of the EMS front end software. All of the HVAC equipment is controlled and monitored by the Facility Explorer EMS which provides hot water loop temperature and occupancy schedule adjustments. Metasys temperature sensors in each occupied zone communicate with the FX system and provide control of the rooftop units, VAV boxes, and finned tube radiators.

Domestic Hot Water Systems

Domestic hot water for the building is provided by two PVI 40N gas-fired water heaters with input capacities of 400 MBH each. A 24 kW Hatco booster water heater provides additional water heating for the kitchen domestic water load.

Lighting Systems

Classrooms have T5 indirects, standard T8 troffers, and tubes. Halls use standard T8 troffers, boxes, strips, compact fluorescent cans, MH cans. The library uses T5 indirects. Baths use standard T8 valances, troffers, compact fluorescent cans. The cafeteria uses standard T8 troffers, bay fixtures, compact fluorescent cans. Offices use standard T8 troffers, strips, and T5 indirects. Labs have T5 indirects. The gym uses T5 bay fixtures. Storage areas employ standard T8 troffers, strips, compact fluorescent drums. The kitchen uses standard T8 troffers. Mechanical areas use standard T8 strips. The auditorium uses standard T8 strips. Building mounts use led exterior fixtures, MH exterior fixtures, standard T8 vapor tights, compact fluorescent exterior fixtures, drums. The parking lot employs MH parking/roadway fixtures.

Noyes Elementary School

Building Characteristics

The Noyes Elementary School is a 82,502 ft^2 building that was originally constructed in 1948 with an addition constructed in 1972 and renovations completed in 2000 and 2011. It is utilized by teachers, staff, and students from approximately 8:30 AM to 3:30 PM through the school year, with some activities taking place during the evening and summer months. The two story building consists of kindergarten through grade 5 classrooms, gymnasium, library, cafeteria, and office space. The building has a brick and masronry block wall construction and a steel frame roof system with flat white PVC membrane. Windows throughout the building are hopper and fixed style with insulated glass in aluminum frames. Building entrances have insulated metal slab doors with varying amounts of glazing.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The Noyes Elementary School is provided with heating hot water by three Thermal Solutions EVCA 1500BN2 gas-fired boilers, each with a gross output capacity of 1,420 MBH. Three 2 HP pumps distribute the hot water supply through the primary loop. A pair of 3 HP pumps and a pair of 5 HP pumps distribute the water through the secondary loop to terminal units including 37 unit ventilators, 9 finned tube radiators, 5 VAV boxes, 6 fan-powered boxes, 2 rooftop units, and 5 air handling units. All pumps are equipped with high efficiency motors.

The majority of the school is heated and ventilated by the 37 Nesbitt unit ventilators located in classrooms along perimeter walls. These units are equipped with hot water coils, face/bypass dampers, and outside air dampers that vary the amount of outside air provided to the space. The remaining spaces are conditioned by rooftop equipment. All of the rooftop units are equipped with hot water coils and outside air dampers, and distribute the conditioned air through overhead ductwork systems. RTU-1 and RTU-2 provide heating to the Speech and Guidance area through a VAV system. The VAV boxes in these two zones are equipped with hot water reheat coils and automatic dampers. AHUs 1 through 5 provide heating to the administration & computer lab, library, kitchen, cafeteria, and gym respectively. The fan-powered boxes serving the administration & computer lab and the library are equipped with hot water reheat coils. AHU-1 and AHU-2 are also equipped with DX coils and outdoor condensing units and provide cooling to their zones. The finned tube radiators provide additional heat to a number of classrooms and administration area.

Energy Management Systems

A Johnson Controls Facility Explorer EMS was installed to control the building HVAC equipment. An FX60 Supervisory Controller was installed to manage all the existing Honeywell and new Facility Explorer field controllers and provides web accessibility of the EMS front end software. Most of the equipment in renovated areas is equipped with Facility Explorer field controllers, sensors, valves, and actuators, including the boiler plant, some unit ventilators, and finned tube radiators. Much of the building HVAC equipment is being controlled by the previously existing Honeywell field controllers including the remaining unit ventilators, rooftop units, and fan boxes. All of the HVAC equipment is controlled and monitored by the Facility Explorer EMS which provides hot water loop temperature and occupancy schedule adjustments. Honeywell and Johnson Controls temperature sensors in each occupied zone communicate with the FX system and provide control of the terminal units. A small roof-mounted solar array was installed to offset the electric utility costs. The output can be monitored by a Solren View internet data monitoring system.

Domestic Hot Water Systems

Domestic hot water for the building is provided by a Stat Model SUF gas-fired water heater with a 130 gallon tank capacity and a 300 MBH input capacity.

Haynes Elementary School

Building Characteristics

The Hayness Elementary School is a 62,565 ft² building that was constructed in 1998. It is utilized by teachers, staff, and students from approximately 8:30 AM to 3:30 PM through the school year, with some activities taking place during the evening and summer months. The single story building consists of kindergarten through grade 5 classrooms, gymnasium, library, cafeteria, auditorium, and office space. The building has an insulated brick and masronry block wall construction and an insulated steel frame roof system with a flat EPDM membrane top coat. Windows throughout the building are double-hung and fixed style with double pane glazing in aluminum frames. Building entrances have insulated metal slab doors with varying amounts of glazing.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The Haynes Elementary School is provided with heating hot water by 18 Hydrotherm Multi-temp modular boilers, grouped into three sections containing 6 modules each. Each section has a gross output capacity of 1,440 MBH. The low efficiency boilers are gravity-vented and equipped with automatic vent dampers. Two 7.5 HP pumps distribute the hot water supply throughout the building to terminal units including unit ventilators and rooftop units. The two pumps share a Square D Econoflex adjustable speed drive controller that operates the pumps in a lead/lag strategy and varies the pumps output based on the hot water loop system pressure.

Four McQuay Model RDS rooftop units, HV-1 through 4, equipped with hot water coils provide heating and ventilation to the library, cafeteria, auditorium, and gym. These units distribute the conditioned air through an overhead ductwork system. Three air conditioning units, AC-1 through 3, equipped with DX coils provide cooling to the head end room, computer room, and administration offices. AC-2 serving the computer room is also equipped with a gas-fired heat exchanger that provides heating the space. The remaining areas of the building including classrooms, the lobby and teacher's lounge are heated and ventilated by 35 AAF unit ventilators equipped with hot water coils, face/bypass dampers, and outside air dampers. Approximately 30 rooftop exhaust fans serve the gymnasium, classrooms, restrooms, and kitchen.

Energy Management Systems

A Honeywell Excel 15B Building Management System (BMS) was installed to control the HVAC equipment at Haynes Elementary School. The Honeywell BMS allows facility staff to monitor HVAC equipment operation and modify temperature setpoint temperatures and operation schedules. A Honeywell Excel 15B Building Manager operator interface was installed to connect the system to the internet and allow for web accessibility. Honeywell field controllers are installed on equipment throughout the building including the boiler plant and rooftop units. The controllers communicate with the Honeywell wall sensors located within each occupied space to monitor temperature and operate the associate equipment to meet space heating or cooling loads. The Honeywell BMS has full control of the rooftop units and boiler plant but only limited control of the exhaust fans and the AAF unit ventilators. The exhaust fans and unit ventilators are controlled through the BMS by RIB relays that provide basic on/off operation of the equipment. The unit ventilators are controlled by MicroTech 325 controllers that operate the units based on integral thermostats. The MicroTech controllers allow adjustment of minimum outside air damper position and heating setpoint. The stand-alone UV controllers operate independently of each other and do not communicate with the BMS.

Domestic Hot Water Systems

Domestic hot water for the building is provided by a gas-fired PVI Turbopower 750P water heater with a 250 gallon tank capacity and a 600 MBH input capacity. Domestic hot water is distributed to points of use by two fractional horsepower pumps.

Lighting Systems

Classrooms have standard T8 indirects, strips, wraps. Halls use compact fluorescent cans, sconces, standard T8 tubes, valances, troffers. The cafeteria uses compact fluorescent decorative fixtures. Offices use standard T8 troffers, indirects, strips, vapor tights, compact fluorescent cans. The kitchen employs standard T8 troffers. The gym uses T5 bay fixtures. Baths use standard T8 strips, vapor tights, compact fluorescent cans. Labs have standard T8 troffers. The auditorium uses standard T8 wraps. Mechanical areas use standard T8 strips. Storage areas employ standard T8 strips, troffers. Building mounts use led exterior fixtures, MH exterior fixtures, compact fluorescent cans. The parking lot uses MH parking/roadway fixtures.

Nixon Elementary School

Building Characteristics

The Nixon Elementary School is a 57,902 ft^2 building that was originally constructed in 1960 with an addition completed in 1994 that nearly doubled the square footage. It is utilized by teachers, staff, and students from approximately 8:30 AM to 3:30 PM through the school year, with some activities taking place during the evening and summer months. The single story building consists of kindergarten through grade 5 classrooms, gymnasium, library, cafeteria, and office space. The building has an insulated brick and masronry block wall construction and an insulated steel frame roof system with a flat EPDM membrane top coat. Windows throughout the building are hopper and fixed style with insulated glazing in aluminum frames. Building entrances have insulated metal slab doors with varying amounts

of glazing.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

Heating hot water is provided by three Patterson-Kelly Thermific B-1200 gas-fired boilers, each with an output capacity of 1,020. Two 10 HP pumps distribute the hot water supply to terminal units including 2 rooftop units, 37 unit ventilators, 18 finned tube radiators, and 8 cabinet unit heaters.

The gym is provided with heating and ventilation by RTU-1, equipped with a hot water coil and outside air damper. A similar unit, RTU-2, serves the library and rotunda and provides the spaces with heating and ventilation. RTU-2 is equipped with a DX coil to provide cooling to the space in addition to heating. Both of the rooftop units distribute the conditioned air through an exposed overhead ductwork system.

Classrooms in the original section of the building are heated and ventilated by Nesbitt unit ventilators and classrooms in the addition are heated and ventilated by MSI unit ventilators. Both models are practically the same in function and appearance. These units are floor mounted along the perimeter walls and are equipped with hot water coils and face and bypass dampers. Finned tube radiators are located in the administration area and the two corridors that connect the classroom wings to the administration area. Cabinet unit heaters serve the vestibules and interior corridors. Nine rooftop exhaust fans serve the restroom and common areas.

Energy Management Systems

A Johnson Controls Facility Explorer EMS was installed to control the boiler plant and rooftop units with intentions of expanding the EMS to control the remaining HVAC equipment in the future. The HVAC equipment is being controlled by the previously existing Honeywell field controllers. An FX60 Supervisory Controller was installed to manage all the existing Honeywell field controllers and provides web accessibility of the EMS front end software. The HVAC equipment is controlled and monitored by the Facility Explorer EMS which provides hot water loop temperature and occupancy schedule adjustments. Honeywell and Johnson Controls temperature sensors in each occupied zone communicate with the FX system and provide control of the rooftop units. The unit ventilators, cabinet unit heaters, and finned tube radiators are still being controlled by an antiquated pneumatic control system. Air compressors in the boiler room provide the required amount of air for the system and distribute it throughout the building through a tubing network. Pneumatic thermostats in each of the zones provide a signal to the associated terminal unit's pneumatic valves and dampers to open/close when there is demand for heat or when the space setpoint temperature is satisfied. The EMS has minimal control of the exhaust fans and unit ventilators by the use of numerous RIB relays that provide basic on/off operation of the equipment.

Domestic Hot Water Systems

Domestic hot water for the building is provided by a Rheem-Ruud G65 gas-fired water heater with a 60 gallon tank capacity and an input capacity of 360 MBH.

Lighting Systems

Classrooms have standard T8 boxes. Halls use standard T8 boxes, strips, compact fluorescent wall mounted fixtures, cans. Offices use standard T8 boxes, troffers, wraps, compact fluorescent cans, and surface fixtures.

The library uses standard T8 boxes, strips, compact fluorescent cans. Baths employ standard T8 vanities, boxes, strips. The cafeteria uses T5 bay fixtures. The kitchen has standard T8 troffers. Storage areas use standard T8 boxes, strips. The gym uses T5 bay fixtures. The auditorium uses standard T8 troffers. Mechanical areas employ compact fluorescent surface fixtures. Building mounts use compact fluorescent wall mounted fixtures, squares, exterior fixtures, MH wraps, led exterior fixtures. The parking lot uses MH parking/roadway fixtures.

Section 3:
Energy Conservation Measures

Table 1: Recommended Measures Index

ECM No.	Title	Tab
1	Lighting System Improvements	1
3	Integrated and New Energy Managements System	3
4	Programmable Thermostats	4
5	PC Load Management	5
6	Demand Control Ventilation	6
7	Variable Frequency Drives	7
9	Vending Machine Controls	9
11	Weatherization	11
22	Pipe Insulation	22
25	Efficient Showerheads	25
29	Replace Transformers	29

Maintenance Requirements per ECM

For the majority of measures included in this project, O&M is expected to be approximately equal to what the Town currently incurs for overall operations and maintenance, therefore O&M can continue to be performed as is. Town personnel will receive training on the proper operation and maintenance of the new equipment once equipment commissioning is complete. The Town will be expected to perform maintenance on a scheduled basis and repair/replacement of failed components in a timely manner, all in accordance with manufacturer's standards and/or Ameresco O&M manuals for the measures installed under this Performance Contract. If the Town is unable to perform these tasks, Ameresco can provide these services for an additional fee and/or the Town shall outsource to a qualified service provider. Failure of the Town to carry out the aforementioned during the term of the contract may require Ameresco to adjust the savings guarantee.

The following table describes the general maintenance requirements that will need to be carried out in order to ensure the persistence of savings for the term of the contract. Final operational and maintenance tasks will be developed in detail once these ECMs are commissioned. Ameresco will provide the Town with a set of O&M manuals that will detail these tasks.

Energy Conservation Measures	Required Maintenance	Town Responsibility	Ameresco Responsibility
ECM-1: Lighting System Improvements	Replace failed lamps and ballasts with the same or similarly rated components.	✓	
ECM-3: Integrated and New Energy Management System	Calibrate sensors periodically to maintain accuracy. Replace or repair failed components.	✓	
ECM-4: Programmable Thermostats	Calibrate sensors periodically to maintain accuracy. Replace or repair failed components.	✓	
ECM-5: PC Load Management	Maintain energy saving profiles for existing and future computers	✓	
ECM-6: Demand Control Ventilation	Calibrate sensors periodically to maintain accuracy. Replace or repair failed components.	✓	
ECM-7: Variable Frequency Drives	Clean filters as required	✓	
ECM-9: Vending Machine Controls	Transfer controls to any replacement machines	✓	
ECM-11: Weatherization	Replace or repair failed components.	✓	
ECM- 22: Pipe Insulation	Replace insulation if removed for maintenance of other systems.	✓	
ECM-25: Efficient Showerheads	No maintenance required.	✓	
ECM-29: Replace Transformers	No maintenance required.	✓	

Warranty and Maintenance Response

Warranty

Ameresco will warrant the labor and material for each ECM for a period of one year from the issuance of substantial completion for each ECM. After the one year period, any remaining manufacturer's warranties will be passed on to the Town.

Maintenance Response

To the extent that any Ameresco maintenance services are included in the final project, all operations and services will be coordinated through the Ameresco corporate office located in Framingham, Massachusetts and through local area contractors. This will provide the Town with a local, single point of contact. Kevin Sullivan, Operations Manager, will serve as the single point of contact for the Town throughout the entire operations phase of the project.

Savings Summary

Ecm #	ECM Name	Annual kW	Total kWh	Natural Gas (Therms)	Water (kGallons)	Sewer (kGallons)	Energy Savings	O&M Savings	Total Project Savings	Total Project Costs	SPB
1	Lighting System Improvements	671	209,268	(1,597)	-	-	$ 33,272	$ 3,174	$ 36,446	$ 350,467	9.62
3	Integrated and New Energy Management System	-	9,227	11,938	-	-	$ 14,769	$ -	$ 14,769	$ 392,039	26.54
4	Programmable Thermostats	-	637	1,400	-	-	$ 1,782	$ -	$ 1,782	$ 9,174	5.15
5	PC Load Management	-	15,369	(244)	-	-	$ 1,260	$ -	$ 1,260	$ 5,526	4.38
6	Demand Control Ventilation	-	33,827	414	-	-	$ 3,455	$ -	$ 3,455	$ 52,327	15.15
7	Variable Frequency Drives	-	15,564	-	-	-	$ 1,551	$ -	$ 1,551	$ 30,123	19.42
9	Vending Machine Controls	-	16,801	(282)	-	-	$ 1,529	$ -	$ 1,529	$ 7,272	4.76
11	Weatherization	-	33	1,312	-	-	$ 1,549	$ -	$ 1,549	$ 17,941	11.58
22	Pipe Insulation	-	-	389	-	-	$ 526	$ -	$ 526	$ 6,251	11.88
25	Efficient Showerheads	-	-	708	200	200	$ 1,543	$ -	$ 1,543	$ 582	0.38
29	Replace Transformers	219	129,218	-	-	-	$ 15,782	$ -	$ 15,782	$ 221,372	14.03
		890	**429,944**	**14,039**	**200**	**200**	**$ 77,018**	**$ 3,174**	**$ 80,192**	**$ 1,093,073**	**13.63**

ECM Matrix

Town of Sudbury Energy Conservation Measures (ECMs)	Lighting System Improvements	Integrated and New Energy Management System	Programmable Thermostats	PC Load Management	Demand Control Ventilation	Variable Frequency Drives	Vending Machine Controls	Weatherization	Pipe Insulation	Efficient Showerheads	Replace Transformers	
Facility	**1**	**3**	**4**	**5**	**6**	**7**	**9**	**11**	**22**	**25**	**29**	
DPW Highway	X		X	X			X					
DPW Offices				X								
Flynn Building	X			X								
Town Hall				X								
Police Department												
Fairbank Community Center (Including Pool)				X			X			X		
Public Library	X			X		X						
Fire Dept Headquarters	X			X			X	X		X		
Fire Dept South				X			X		X			
Fire Dept North				X			X	X	X			
Curtis Middle School	X				X						X	
Loring Elementary	X	X					X				X	
Noyes Elementary		X					X					
Haynes Elementary	X	X			X		X	X				
Nixon Elementary	X	X					X					

Existing and Proposed EUIs

Building	Square Feet	Baseline mbtu/sqft	Proposed mbtu/sqft	Overall Reduction
DPW Highway	7,154	147.5	124.7	15%
DPW Offices	28,274	65.2	65.1	0%
Flynn Building	14,750	86.9	84.6	3%
Town Hall	13,705	122.1	122.0	0%
Fairbank Community Center (In	40,341	203.6	201.7	1%
Public Library	34,364	72.1	67.5	6%
Fire Dept Headquarters	10,055	98.9	92.5	7%
Fire Dept South	3,286	119.8	113.6	5%
Fire Dept North	3,286	101.3	92.1	9%
Curtis Middle School	155,789	63.0	58.8	7%
Loring Elementary	78,451	59.8	56.2	6%
Noyes Elementary	82,502	67.8	64.9	4%
Haynes Elementary	62,565	79.7	68.7	14%
Nixon Elementary	57,902	73.0	65.1	11%
	592,424	**80.3**	**75.4**	**6%**

ECM 1:
Lighting System Improvements

ECM Overview

Ameresco will install a state-of-the-art lighting system to benefit the building occupants of the Town of Sudbury, MA. Our project replaces or upgrades approximately **3,259** existing fixtures and will enhance the quality, consistency, and color rendering of the lighting system, while meeting all applicable codes and standards.

Our in-house lighting experts completed a detailed survey of your facilities. Ameresco has eliminated the middle-man, and having implemented projects at hundreds of facilities with similar needs, is fully capable and responsible for meeting your lighting needs.

Figure 1.1:.New lamps and ballasts will improve aesthetics and provide substantial energy savings.

ECM Detail

Existing System

- *General Information about the Existing System at All Sites*

We identified over 130 different lamp/ballast/fixture combinations, the majority of which are linear fluorescent, which provide general lighting in key areas such as classrooms, offices, & halls.

Approximately 79% of linear fluorescent fixtures use standard-grade T8s on electronic ballasts on standard series normal ballast factor ballasts. An additional 5.5% of linear fluorescent fixtures employ energy efficient 28w or 30w lamps with a mixture of ballast factors. For example the acrylic troffers found at the Fairbank Community Center were found to have 30w lamps running on energy efficient low ballast factor ballasts. Parabolic troffers at the DPW Offices building however, wer found to have existing 28w lamps running on standard series normal ballast factor ballasts. There are T5 lamps used in 15% of total fluorescent fixtures. T12s on magnetic ballasts. The remaining .5% of linear fluorescent fixtures use T12s on magnetic ballasts.

High-intensity discharge (HID) lamps are used in libraries, parking garages and storage areas as well as for the exterior. Color rendition is fair to poor depending on lamp quality and age, which unfortunately can be a characteristic of HID lamps.

Incandescent lamps are installed in 2% of fixtures. Compact fluorescents comprise 18% of the existing fixture total.

Although the lighting system is generally performing as designed, improvements are possible. Light levels are appropriate in the majority of areas. Most fixtures are in good condition.

Specific Information about the Existing System

The detailed description provided below is representative of our proposed scope, with predominant areas and fixtures mentioned first. We then proceed in descending order, with each subsequent area representing a smaller portion of the scope.

DPW Highway: Shops employ efficient 4' T8 28w strips, standard T8 strips, MH bay fixtures. Storage areas have standard T8 strips, MH surface fixtures. The parking garage employs MH bay fixtures. Building mounted fixtures use MH exterior fixtures, HPS floods.

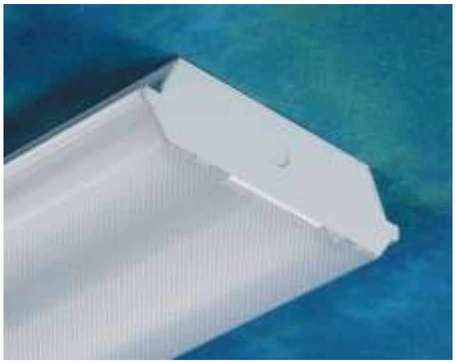
Flynn Building: Offices have standard T8 wraps, troffers, strips, old surface fixtures, incandescent cans. Storage areas have standard T8 strips, wraps, old surface fixtures, incandescent surface fixtures, T12 strips. Halls employ standard T8 wraps, strips. Baths have standard T8 wraps, T12 valances. The kitchen use standard T8 troffers.

Public Library: The library use compact fluorescent cans, standard T8 troffers, T5 "biax" decorative fixtures, incandescent cans. Offices use standard T8 troffers, indirects, compact fluorescent cans, and T5 "biax" decorative fixtures. Halls employ compact fluorescent cans, incandescent cans, MH cans. Classrooms have compact fluorescent cans, incandescent cans, and standard T8 troffers. Storage areas use standard T8 wraps, strips, T12 wraps, strips. Baths use standard T8 strips. Building mounts use incandescent cans, compact fluorescent exterior fixtures. The parking lot use HPS parking/roadway fixtures.

Fire Dept. Headquarters: Offices use standard T8 troffers. The parking garage has standard T8 strips. Halls use standard T8 troffers, wraps. Baths employ compact fluorescent cans, standard T8 old wall mounted fixtures, troffers, T12 vanities. Storage areas use standard T8 troffers, strips. Bedrooms use standard T8 troffers. The gym use standard T8 troffers. Classrooms use standard T8 troffers. Building mounts use incandescent decorative fixtures, MH floods.

Curtis Middle School: Classrooms use standard T8 indirects, wallwash, troffers, compact fluorescent cans. Halls have standard T8 troffers, coves, valances, compact fluorescent cans. Offices use standard T8 troffers, indirects, compact fluorescent cans. Baths employ standard T8 troffers, valances, strips, compact fluorescent cans. The cafeteria use compact fluorescent cans, standard T8 troffers, and MH sconces. Storage areas use standard T8 troffers, strips. The library use standard T8 troffers, MH decorative fixtures, indirects, compact fluorescent sconces. The auditorium has compact fluorescent cans, sconces, standard T8 troffers. Labs use standard T8 indirects. The gym employs T5 bay fixtures. The kitchen use standard T8 troffers, compact fluorescent wall mounted fixtures. Building mounts use MH exterior fixtures, indirects, squares, led exterior fixtures.

Loring Elementary: Classrooms have T5 indirects, standard T8 troffers, and tubes. Halls use standard T8 troffers, boxes, strips, compact fluorescent cans, MH cans. The library use T5 indirects. Baths use standard T8 valances, troffers, compact fluorescent cans. The cafeteria uses standard T8 troffers, bay fixtures, compact fluorescent cans. Offices use standard T8 troffers, strips, and T5 indirects. Labs have T5 indirects. The gym use T5 bay fixtures. Storage areas employ standard T8 troffers, strips, compact fluorescent drums. The kitchen use standard T8 troffers. Mechanical areas use standard T8 strips. The auditorium use standard T8 strips. Building mounts use led exterior fixtures, MH exterior fixtures, standard T8 vapor tights, compact fluorescent exterior fixtures, drums. The parking lot employs MH parking/roadway fixtures.



Haynes Elementary: Classrooms have standard T8 indirects, strips, wraps. Halls use compact fluorescent cans, sconces, standard T8 tubes, valances, troffers. The cafeteria use compact fluorescent decorative fixtures. Offices use standard T8 troffers, indirects, strips, vapor tights, compact fluorescent cans. The kitchen employs standard T8 troffers. The gym use T5 bay fixtures. Baths use standard T8 strips, vapor tights, compact fluorescent cans. Labs have standard T8 troffers. The auditorium use standard T8 wraps. Mechanical areas use standard T8 strips. Storage areas employ standard T8 strips, troffers. Building mounts use led exterior fixtures, MH exterior fixtures, compact fluorescent cans. The parking lot use MH parking/roadway fixtures.

Nixon Elementary: Classrooms have standard T8 boxes. Halls use standard T8 boxes, strips, compact fluorescent wall mounted fixtures, cans. Offices use standard T8 boxes, troffers, wraps, compact fluorescent cans, and surface fixtures. The library use standard T8 boxes, strips, compact fluorescent cans. Baths employ standard T8 vanities, boxes, strips. The cafeteria use T5 bay fixtures. The kitchen has standard T8 troffers. Storage areas use standard T8 boxes, strips. The gym use T5 bay fixtures. The auditorium use standard T8 troffers. Mechanical areas employ compact fluorescent surface fixtures. Building mounts use compact fluorescent wall mounted fixtures, squares, exterior fixtures, MH wraps, led exterior fixtures. The parking lot use MH parking/roadway fixtures.

Proposed System

- *General Information about the Proposed System*

Ameresco standardized the lighting system where practical, reducing the number of different products the Town of Sudbury must purchase, stock and maintain. Most fixtures replaced or retrofitted with 4’ T8 lamps will receive **28**-watt “energy-efficient” lamps and instant-start ballasts. This premium combination yields maximum energy savings without sacrificing light output or quality. These **28**-watt lamps use a superior mix of phosphors that allow them to consume less energy while matching the light output of standard T8’s. The **28**-watt lamp also maintains light output better than T12 and typical T8 lamps.

Ballast outputs were tailored to deliver optimum light levels in each room. The new lighting system is designed to maintain lighting levels, while meeting IESNA standards in affected areas. All recommendations were made with the intent to optimize energy savings without compromising the quality and the level of light output.

Our project replaces or upgrades **3,259** existing fixtures. We consider two adjoining fixtures sharing a ballast to be a single fixture. This method provides a more precise assessment of energy consumption and material inventory, but sometimes results in a lower apparent fixture count.

Following are highlights of the proposed scope, with predominant applications presented first. We then proceed in descending order, with each subsequent item representing a smaller portion of the scope. Please refer to the "Lighting System Analysis" in Appendix I, as this is a complete list of work to be performed.

- *Specific Information about the Proposed System, by Strategy*

- **Existing fixtures will receive T8 lamps and electronic ballasts** in **3,152** existing fixtures. **484** of those fixtures will also receive new reflectors designed to improve fixture efficiency.

- **A new LED shoebox shall replace 14** existing exterior fixtures.

- **Compact fluorescent lamps will be installed in 25** existing exterior fixtures.

- **New industrials shall replace 23** existing fixtures.

- **A new LED wall pack shall replace 2** existing exterior fixtures.

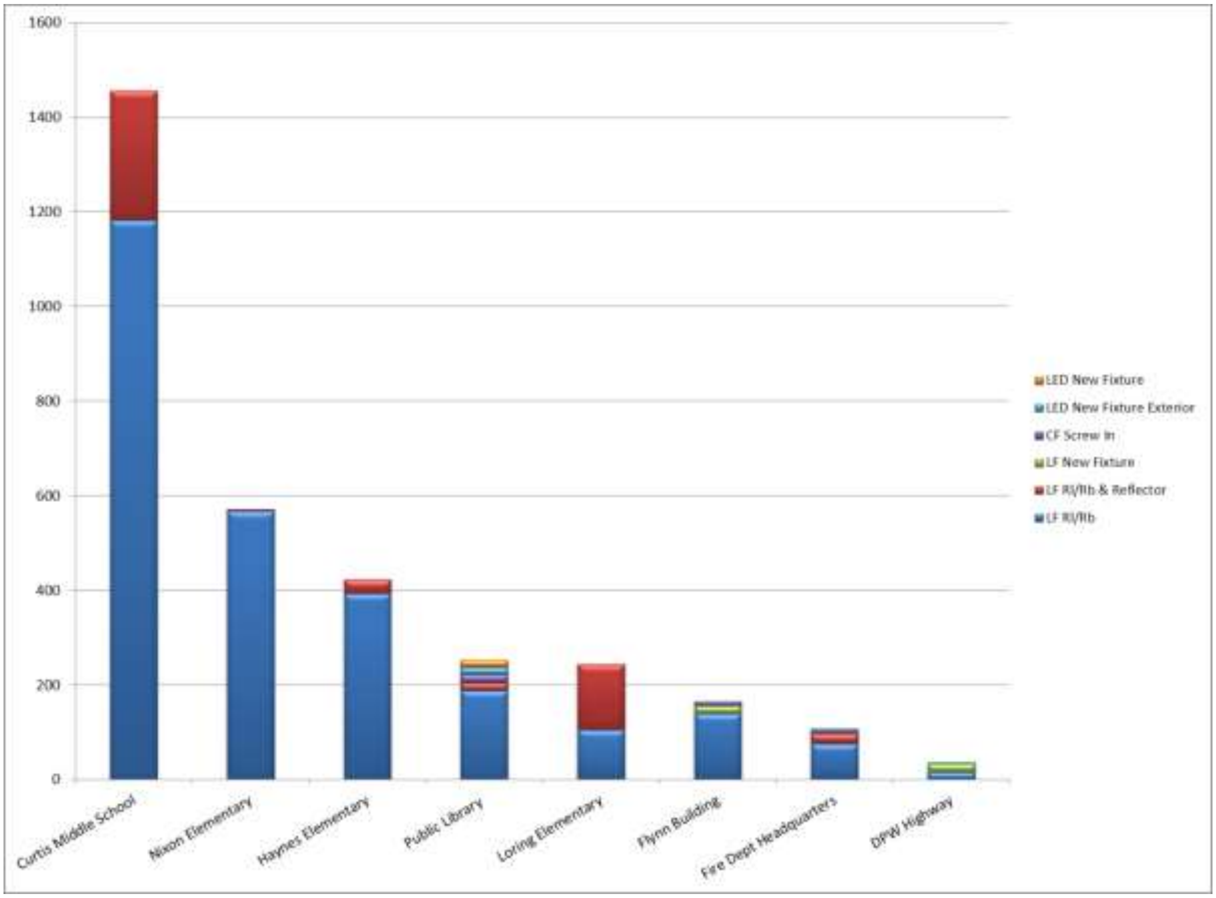
- **Compact fluorescent lamps will be installed** in **10** existing interior fixtures.

- **A new LED track head shall replace 16** existing fixtures.

- **New vapor tight high-bays shall replace 7** existing fixtures.

- **New wraps shall replace 7** existing fixtures.

- **A new LED flood shall replace 3** existing exterior fixtures.



- *Specific Information about the Proposed System, by Building*

DPW Highway: Existing fixtures will receive T8 lamps and electronic ballasts in for shops. New industrials shall replace existing fixtures in storage areas, for shops. New vapor tight high-bays shall replace fixtures in the parking garage, for shops. New LED wall packs shall replace existing building mounted fixtures.

Flynn Building: Existing fixtures will receive T8 lamps and electronic ballasts in for offices, for storage areas, for halls, for baths, for the kitchen. New industrials shall replace existing fixtures in offices, for halls. Compact fluorescent lamps will be installed in storage areas and offices. New wraps shall replace existing fixtures for offices and storage areas.

Public Library: Existing fixtures will receive T8 lamps and electronic ballasts in for the library, offices, storage areas and bathrooms. Existing recessed fixtures will receive T8 lamps, electronic ballasts, and reflectors in offices and classrooms. New LED track heads shall replace some existing hallway lighting. Compact fluorescent lamps will be installed for building mounted fixtures. New LED shoeboxes shall replace existing parking lot fixtures.

Fire Department Headquarters: Existing fixtures will receive T8 lamps and electronic ballasts in the parking garage, offices, bedrooms, the gym, classrooms, storage areas, halls and bathrooms existing recessed fixtures will receive T8 lamps, electronic ballasts, and reflectors in halls, offices, storage areas, and bathrooms. New wraps shall replace existing fixtures in bathrooms. Compact fluorescent lamps will be installed in building mounted exterior fixtures. A new LED flood shall replace existing building mounted flood lights.

Curtis Middle School: Existing fixtures will receive T8 lamps and electronic ballasts in classrooms, halls, offices, storage areas, baths, labs, the cafeteria, the kitchen. Existing recessed fixtures will receive T8 lamps, electronic ballasts, and reflectors in halls, offices, baths, the library, classrooms and the auditorium.

Loring Elementary: Existing recessed fixtures will receive T8 lamps, electronic ballasts, and reflectors in halls, the cafeteria, offices, baths and classrooms. Existing fixtures will receive T8 lamps and electronic ballasts in baths, classrooms, offices, storage areas, halls, the kitchen, mechanical areas, and the auditorium.

Haynes Elementary: Existing fixtures will receive T8 lamps and electronic ballasts in classrooms, halls, offices, baths, the auditorium, labs, mechanical areas and storage areas. Existing recessed fixtures will receive T8 lamps, electronic ballasts, and reflectors in the kitchen, halls, labs and offices.

Nixon Elementary: Existing fixtures will receive T8 lamps and electronic ballasts in classrooms, halls, offices, baths, the library, the kitchen and storage areas. Existing recessed fixtures will receive T8 lamps, electronic ballasts, and reflectors in the stage area.

> Integration of Proposed Equipment with Existing Systems

The new lighting system, and all components thereof, will be fully integrated into the existing lighting systems. We assume the entire lighting and lighting controls systems comply with, but not limited to, the latest codes, the latest standards, local jurisdictions, and work was done in a quality workmanship manner, per NECA, and other applicable recommend best practices universally accepted throughout the electrical industry. Further we assume that all existing devices, which are defined in NEC, which includes but not limited to switches, outlets, wiring, etc. are in acceptable condition in order to implement our scope as outlined in the contract documents. All existing junction boxes, poles, mounting surfaces and structures are assumed to be in acceptable condition to allow the installation of the products indicated in the scope.

> Maintenance Savings

Implementation of this measure will result in annual maintenance savings, since installation of new equipment will extend service intervals. This is based on the calculated frequency of equipment replacement of the old system versus the new system. No current recycling, disposal, or labor costs were included in this calculation, so additional savings would be expected.

> Environmental Impact

There are no potential adverse environmental impacts associated with this lighting upgrade. During construction, Ameresco will remove, package, and recycle all existing lamps that contain mercury and ballasts that contain PCBs or DEHP according to applicable regulations.

> Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. The lighting system audit completed for each facility will be submitted as the basis for construction. The audit will include the existing descriptions, operating hours, and proposed retrofit description. These documents will be submitted for review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect "As-Built" conditions, and submitted in multiple for record.

> Impact on Facility Operations and Performance

All installations will be conducted during normal business hours or after normal operating hours if interruption of functions is anticipated. Installations will be coordinated with appointed personnel.

Despite our best efforts, cataloguing every single fixture in every location is extremely difficult and time consuming. Therefore, fixtures or areas not listed are excluded from our scope, which typically include areas under renovation, low use areas such as closets and crawlspaces, areas inaccessible during the audit, and specialty fixtures such as medical or stage lighting.

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Appendix for ECM 1:
Lighting System Improvements

I. Energy Savings Calculations

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MAPC - Sudbury

Energy and Demand Savings Summary

Measure ID: 1

Measure Name: **Lighting System Improvements**

Measure Location:

Engineers:

Site Name:		**DPW_Old**	**Flynn**	**Library**	**FDHQ**	**Curtis**	**Loring**	**Haynes**	**Nixon**	**Summary**
Item	Units	Savings	Savings	Savings	Savings	Savings	Savings	Savings	Savings	
Electricity										
Energy On-Peak	kWh	5,525	9,447	32,641	7,574	81,590	14,395	24,331	33,765	209,268
Energy Off-Peak	kWh	0	0	0	0	0	0	0	0	0
Energy Total	kWh	5,525	9,447	32,641	7,574	81,590	14,395	24,331	33,765	209,268
Demand On-Peak, Monthly	kW	2.0	4.1	5.7	2.4	30.3	5.6	10.5	14.2	74.7
Demand On-Peak, Annual	kW	21.7	43.8	61.2	26.4	258.8	48.1	89.5	121.3	670.7
Demand Off-Peak, Monthly	kW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Demand Off-Peak, Annual	kW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fossil Fuel										0
Natural Gas (NG)	Therms	-36	-74	-141	-49	-669	-123	-218	-287	-1,597
Liquid Propane Gas (LPG)	Gallons	0	0	0	0	0	0	0	0	0
Steam	Mlbs	0	0	0	0	0	0	0	0	0
Fuel Oil, #2	Gallons	0	0	0	0	0	0	0	0	0
Fuel Oil, #4	Gallons	0	0	0	0	0	0	0	0	0
Fuel Oil, #6	Gallons	0	0	0	0	0	0	0	0	0
Miscellaneous	Misc	0	0	0	0	0	0	0	0	0
Water										0
Water Savings	kGallons									0
Sewer										0
Sewer Savings	kGallons									0

MAPC - Sudbury

Interactive Lighting Savings Calculation

	Lighting Savings		Heating Penalty				Cooling Benefit			
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Facility	**Annual kW**	**Annual kWh**	**Heat Gain to Space**	**Heating Months**	**Heating System Efficiency**	**Heating Penalty MMBtu**	**Total Space Cooled**	**Cooling Months**	**Cooling System COP**	**Cooling Benefit MMBtu**
DPW Highway	2.0	4,403	50.0%	5.0	86.0%	(3.6)	25.0%	5.0	3.22	0.2
Flynn Building	4.1	8,885	50.0%	5.0	85.0%	(7.4)	80.0%	5.0	2.64	1.9
Public Library	5.7	15,858	50.0%	5.0	80.0%	(14.1)	90.0%	5.0	2.93	3.5
Fire Dept Headquarters	2.4	5,495	50.0%	5.0	80.0%	(4.9)	20.0%	5.0	2.93	0.3
Curtis Middle School	30.3	77,199	50.0%	5.0	82.0%	(66.9)	80.0%	5.0	2.93	15.0
Loring Elementary	5.6	14,314	50.0%	5.0	83.0%	(12.3)	8.0%	5.0	2.93	0.3
Haynes Elementary	10.5	23,906	50.0%	5.0	78.0%	(21.8)	25.0%	5.0	2.93	1.5
Nixon Elementary	14.2	33,479	50.0%	5.0	83.0%	(28.7)	12.0%	5.0	2.93	1.0
Totals	**74.7**	**183,538**				**(159.7)**				**23.6**

Notes:	
A	Applicable building included in comprehensive energy audit
B	Lighting demand savings {kW} associated with lighting retrofit measures
C	Lighting energy savings {kWh} associated with lighting retrofit measures
D	Estimated percentage of lighting energy transmitted to conditioned space
E	Estimated length of heating season
F	Estimated heating system efficiency, interacted with other measures
G	Resulting heating penalty due to lighting upgrades = [col C] x [col D] x 3,413 x ([col E] / 12) / [col F] / 1,000,000
H	Estimated percentage of space cooled
I	Estimated Length of cooling season
J	Estimated cooling system efficiency, interacted with other measures
K	Resulting cooling benefit due to lighting upgrades = [col C] x [col D] x 3,413 x ([col I] / 12) / [col J] / 1,000,000

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
1	Flynn Building	Conference Top Of Stairs	2	4L4' T8/EL-8'	wrap	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	75	2,600
2	Flynn Building	Conference Top Of Stairs	2	2L4' T8/EL	wrap	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	187	2,600
3	Flynn Building	Office Open Board Of Selectman	2	2L4' T8/EL	wrap	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	47	2,600
4	Flynn Building	Office Open Board Of Selectman	2	2L4' T8/EL	trof acr	12	60	2L4' T8 28w/ELEE LO	rlrb	12	42	0.22	562	2,600
5	Flynn Building	Office Drafting	2	4L4' T8/EL-8'	wrap	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	302	2,600
6	Flynn Building	Office Drafting	2	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
7	Flynn Building	Storage Files	2	2L4' T8/EL	wrap	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	9	500
8	Flynn Building	Office Valente	2	2L4' T8/EL	wrap	6	60	2L4' T8 28w/ELEE LO	rlrb	6	42	0.11	281	2,600
9	Flynn Building	Kitchen Board Of Selctman	2	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	37	1,040
10	Flynn Building	Conference	2	4L4' T8/EL-8'	wrap	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	452	2,600
11	Flynn Building	Conference	2	65W INCANDESCENT	can rec	4	65	15W COMPACT SI	screw in	4	15	0.20	520	2,600
12	Flynn Building	Office Open Hr	2	3L4' T8/EL	wrap	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	130	2,600
13	Flynn Building	Office Open Hr	2	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
14	Flynn Building	Office Hr	2	2L4' T8/EL	wrap	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	47	2,600
15	Flynn Building	Office Next To Hr	2	2L4' T8/EL	wrap	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	187	2,600
16	Flynn Building	Storage Copy	2	4L4' T8/EL-8'	wrap	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	60	1,040
17	Flynn Building	Office Peter Andersen	2	4L4' T8/EL-8'	wrap	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	151	2,600
18	Flynn Building	Office Social Worker	2	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
19	Flynn Building	Bath By Social Worker	2	1L4' T12 EE/EEMAG	valance	1	40	1L4' T8 28w/ELEE LO	rlrb	1	22	0.02	47	2,600
20	Flynn Building	Office Rust	2	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
21	Flynn Building	Office Ka Black	2	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
22	Flynn Building	Office Ka Black	2	4L4' T8/EL-8'	wrap	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	75	2,600
23	Flynn Building	Office Ka Black	2	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
24	Flynn Building	Hall 2Nd Floor	2	2L4' T8/EL	wrap	5	60	2L4' T8 28w/ELEE LO	rlrb	5	42	0.09	234	2,600
25	Flynn Building	Office Open Assessor	1	2L4' T8/EL	trof acr	9	60	2L4' T8 28w/ELEE LO	rlrb	9	42	0.16	421	2,600
26	Flynn Building	Storage Files	1	4L4' T8/EL	wrap wide	2	112	4L4' T8 28w/ELEE LO	rlrb	2	83	0.06	29	500
27	Flynn Building	Office Files	1	4L4' T8/EL-8'	wrap wide	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	75	2,600
28	Flynn Building	Bath Girl'S	1	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
29	Flynn Building	Lounge Staff	1	2L4' T8/EL	wrap	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	140	2,600
30	Flynn Building	Office Director Assessing	1	4L4' T8/EL-8'	old wrap	3	112	2L4' T8 28w/ELEE HI/NEW-8'	new wrap	3	64	0.14	374	2,600
31	Flynn Building	Storage Copy	1	4L4' T8/EL-8'	wrap	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	60	1,040
32	Flynn Building	Office Mail Room	1	4L4' T8/EL-8'	wrap	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	151	2,600
33	Flynn Building	Office Open Tech	1	4L4' T8/EL-8'	wrap	12	112	4L4' T8 28w/ELEE LO-8'	rlrb	12	83	0.35	905	2,600
34	Flynn Building	Bath Men'S	1	4L4' T8/EL-8'	wrap	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	75	2,600
35	Flynn Building	Storage Server	1	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	37	1,040
36	Flynn Building	Office Open Tresury	1	2L4' T8/EL	wrap	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
37	Flynn Building	Office Open Tresury	1	4L4' T8/EL-8'	wrap wide	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	452	2,600
38	Flynn Building	Office Tresury	1	4L4' T8/EL-8'	wrap wide	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	75	2,600
39	Flynn Building	Office Tresury	1	4L4' T8/EL-8'	wrap	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	151	2,600
40	Flynn Building	Storage Safe	1	2L4' T8/EL	old wrap	1	60	1L4' T8 28w/ELEE/NEW	new wrap	1	24	0.04	18	500
41	Flynn Building	Storage Files	1	2L4' T8/EL	old wrap wide	1	60	1L4' T8 28w/ELEE/NEW	new wrap	1	24	0.04	37	1,040
42	Flynn Building	Office Open Accounting	1	2L4' T8/EL	wrap wide	5	60	2L4' T8 28w/ELEE LO	rlrb	5	42	0.09	234	2,600
43	Flynn Building	Office Accounting	1	4L4' T8/EL-8'	wrap wide	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	151	2,600
44	Flynn Building	Hall 1St Floor	1	2L4' T8/EL	wrap	6	60	2L4' T8 28w/ELEE LO	rlrb	6	42	0.11	281	2,600
45	Flynn Building	Storage Basement	b	60W INCANDESCENT	keyless	6	60	15W COMPACT SI	screw in	6	15	0.27	135	500
46	Flynn Building	Storage Bawsement	b	2L4' T8/EL	strip	7	60	2L4' T8 28w/ELEE LO	rlrb	7	42	0.13	63	500
47	Flynn Building	Storage Bawsement	b	2L4' T12 EE/EEMAG	strip	2	70	2L4' T8 28w/ELEE LO	rlrb	2	42	0.06	28	500
48	Flynn Building	Hall Basement	b	2L8' T8/EL	strip	4	109	4L4' T8 28w/ELEE LO/NEW-8'	new industrial	4	83	0.10	270	2,600
49	Flynn Building	Storage Basement	b	2L4' T8/EL	strip	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	27	500
50	Flynn Building	Office Open Basement	b	2L8' T8/EL	strip	8	109	4L4' T8 28w/ELEE LO/NEW-8'	new industrial	8	83	0.21	541	2,600
134	Public Library	Library Reading Rotunda	2	4L2' F40 BIAX/EL	decorative	1	144	NO RETRO	no change needed		144			2,962

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
135	Public Library	Library Reading Rotunda	2	2x 13W COMPACT HARDWIRED	can rec	8	30	NO RETRO	no change needed		30			2,962
136	Public Library	Library Stacks By Reading Rotunda	2	4L4' T8 32w/ELEE-8'	trof para 1' wide	36	107	4L4' T8 28w/ELEE LO-8'	rlrb	36	83	0.86	2,559	2,962
137	Public Library	Library Stacks By Reading Rotunda	2	2x 13W COMPACT HARDWIRED	can rec	23	30	NO RETRO	no change needed		30			2,962
138	Public Library	Library Stacks By Reading Rotunda	2	2L2' F40 BIAX/EL	decorative	4	72	NO RETRO	no change needed		72			2,962
139	Public Library	Library Stacks By Study Area	2	4L4' T8 32w/ELEE-8'	trof para 1' wide	24	107	4L4' T8 28w/ELEE LO-8'	rlrb	24	83	0.58	1,706	2,962
140	Public Library	Library Stacks By Study Area	2	2x 13W COMPACT HARDWIRED	can rec	14	30	NO RETRO	no change needed		30			2,962
141	Public Library	Library Stacks By Study Area	2	2L2' F40 BIAX/EL	decorative	6	72	NO RETRO	no change needed		72			2,962
142	Public Library	Lounge Young Adult Room	2	4L4' T8 32w/ELEE-8'	indirect/direct	6	107	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.14	427	2,962
143	Public Library	Lounge Young Adult Room	2	2x 13W COMPACT HARDWIRED	can rec	5	30	NO RETRO	no change needed		30			2,962
144	Public Library	Library Stacks By Video & Audio	2	2L2' F40 BIAX/EL	decorative	5	72	NO RETRO	no change needed		72			2,962
145	Public Library	Library Stacks By Video & Audio	2	2x 13W COMPACT HARDWIRED	can rec	20	30	NO RETRO	no change needed		30			2,962
146	Public Library	Library Stacks By Video & Audio	2	4L4' T8 32w/ELEE-8'	trof para 1' wide	4	107	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.10	284	2,962
147	Public Library	Library Stacks By Video & Audio	2	2L4' T8 32w/ELEE	trof para 1' wide	4	53	2L4' T8 28w/ELEE LO	rlrb	4	42	0.04	130	2,962
148	Public Library	Office Tech Services	2	3L4' T8 32w/ELEE	trof parabolic	6	82	3L4' T8 28w/ELEE LO	rlrb	6	63	0.11	338	2,962
149	Public Library	Hall Paintingsantiques	2	2x 13W COMPACT HARDWIRED	can rec	9	30	NO RETRO	no change needed		30			2,962
150	Public Library	Hall Paintingsantiques	2	100W INCANDESCENT	track can	16	100	20 WATT LED/NEW	new LED track head	16	20	1.28	3,791	2,962
151	Public Library	Library Local Trustees Room	2	2L2' F40 BIAX/EL	decorative	6	72	NO RETRO	no change needed		72			2,962
152	Public Library	Library Local Trustees Room	2	2x 13W COMPACT HARDWIRED	can rec	8	30	NO RETRO	no change needed		30			2,962
153	Public Library	Lounge Staff	2	3L4' T8 32w/ELEE	trof parabolic	8	82	3L4' T8 28w/ELEE LO	rlrb	8	63	0.15	450	2,962
154	Public Library	Office Business	2	3L4' T8 32w/ELEE	trof parabolic	2	82	3L4' T8 28w/ELEE LO	rlrb	2	63	0.04	113	2,962
155	Public Library	Closet Cust	2	2L4' T12 EE/EEMAG	strip	1	70	2L4' T8 28w/ELEE LO	rlrb	1	42	0.03	14	500
156	Public Library	Bath Men'S (X2)	2	4L4' T8 32w/ELEE-8'	soffit	2	107	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.05	108	2,255
157	Public Library	Office Director	2	2L4' T8 U/EL	trof parabolic	6	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	6	40	0.12	355	2,962
158	Public Library	Hall Back Office	2	2x 13W COMPACT HARDWIRED	can rec	5	30	NO RETRO	no change needed		30			2,962
159	Public Library	Office Open Reception	2	2L4' T8 U/EL	trof parabolic	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	237	2,962
160	Public Library	Office Open Reception	2	2x 13W COMPACT HARDWIRED	can rec	8	30	NO RETRO	no change needed		30			2,962
161	Public Library	Office Open Reference Office	2	3L4' T8 32w/ELEE	trof parabolic	2	82	3L4' T8 28w/ELEE LO	rlrb	2	63	0.04	113	2,962
162	Public Library	Office Open Reference Office	2	2L2' F40 BIAX/EL	decorative	1	72	NO RETRO	no change needed		72			2,962
163	Public Library	Classroom Computer Room	2	2L4' T8 U/EL	trof parabolic	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	237	2,962
164	Public Library	Bath Men'S (X2)	2	4L4' T8 32w/ELEE-8'	soffit	2	107	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.05	108	2,255
165	Public Library	Office Study Room 1	2	3L4' T8 32w/ELEE	trof parabolic	2	82	3L4' T8 28w/ELEE LO	rlrb	2	63	0.04	113	2,962
166	Public Library	Stair Main	2	2x 13W COMPACT HARDWIRED	can rec	11	30	NO RETRO	no change needed		30			2,962
167	Public Library	Stair Main	2	50W METAL HALIDE	track can	9	65	NO RETRO	no change needed		65			2,962
168	Public Library	Library Stacks By Childrens Section	1	4L4' T8 32w/ELEE-8'	trof para 1' wide	22	107	4L4' T8 28w/ELEE LO-8'	rlrb	22	83	0.53	1,564	2,962
169	Public Library	Library Stacks By Childrens Section	1	2x 13W COMPACT HARDWIRED	can rec	12	30	NO RETRO	no change needed		30			2,962
170	Public Library	Library Stacks By Childrens Section	1	2L2' F40 BIAX/EL	decorative	10	72	NO RETRO	no change needed		72			2,962
171	Public Library	Library Childrens Rotu Nda	1	4L2' F40 BIAX/EL	decorative	1	144	NO RETRO	no change needed		144			2,962
172	Public Library	Library Childrens Rotu Nda	1	2x 13W COMPACT HARDWIRED	can rec	8	30	NO RETRO	no change needed		30			2,962
173	Public Library	Library Stacks By Kids Lounge	1	2x 13W COMPACT HARDWIRED	can rec	12	30	NO RETRO	no change needed		30			2,962
174	Public Library	Library Stacks By Kids Lounge	1	2L4' T8 32w/ELEE	trof para 1' wide	5	53	2L4' T8 28w/ELEE LO	rlrb	5	42	0.06	163	2,962
175	Public Library	Library Stacks By Kids Lounge	1	4L4' T8 32w/ELEE-8'	trof para 1' wide	8	107	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.19	569	2,962
176	Public Library	Lounge Kids	1	4L4' T8 32w/ELEE-8'	trof para 1' wide	6	107	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.14	427	2,962
177	Public Library	Office Kids Section	1	4L4' T8 32w/ELEE-8'	trof para 1' wide	2	107	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.05	142	2,962
178	Public Library	Office Kids Section	1	2L4' T8 32w/ELEE	trof para 1' wide	3	53	2L4' T8 28w/ELEE LO	rlrb	3	42	0.03	98	2,962
179	Public Library	Library Stacks Fiction	1	2L2' F40 BIAX/EL	decorative	10	72	NO RETRO	no change needed		72			2,962
180	Public Library	Library Stacks Fiction	1	2x 13W COMPACT HARDWIRED	can rec	36	30	NO RETRO	no change needed		30			2,962
181	Public Library	Library Stacks Fiction	1	75W INCANDESCENT	track can	8	75	NO RETRO	no change needed		75			2,962
182	Public Library	Library Stacks Fiction	1	4L4' T8 32w/ELEE-8'	trof para 1' wide	16	107	4L4' T8 28w/ELEE LO-8'	rlrb	16	83	0.38	1,137	2,962
183	Public Library	Library Stacks Fiction	1	2L4' T8 32w/ELEE	trof para 1' wide	4	53	2L4' T8 28w/ELEE LO	rlrb	4	42	0.04	130	2,962
184	Public Library	Classroom Community Meeting Room	1	2x 13W COMPACT HARDWIRED	can rec	27	30	NO RETRO	no change needed		30			2,962
185	Public Library	Classroom Community Meeting Room	1	75W INCANDESCENT	track can	11	75	NO RETRO	no change needed		75			2,962

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
186	Public Library	Office Open Reception	1	2L4' T8 U/EL	trof parabolic	3	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	3	40	0.06	178	2,962
187	Public Library	Office Open Reception	1	2x 13W COMPACT HARDWIRED	can rec	6	30	NO RETRO	no change needed		30			2,962
188	Public Library	Office Reception	1	4L4' T8 32w/ELEE-8'	trof para 1' wide	1	107	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.02	71	2,962
189	Public Library	Office Reception	1	2L4' T8 32w/ELEE	trof para 1' wide	1	53	2L4' T8 28w/ELEE LO	rlrb	1	42	0.01	33	2,962
190	Public Library	Bath Men'S (X2)	1	4L4' T8 32w/ELEE-8'	soffit	2	107	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.05	108	2,255
191	Public Library	Hall Front Of Bldg	1	2x 13W COMPACT HARDWIRED	can rec	4	30	NO RETRO	no change needed		30			2,962
192	Public Library	Storage Fire Control	1	2L4' T8 32w/ELEE	strip	3	53	2L4' T8 28w/ELEE LO	rlrb	3	42	0.03	17	500
193	Public Library	Storage Frie Nds Storage	1	2L4' T8 32w/ELEE	wrap	8	53	2L4' T8 28w/ELEE LO	rlrb	8	42	0.09	44	500
194	Public Library	Storage Electrical Closet	1	2L4' T8 32w/ELEE	wrap wide	2	53	2L4' T8 28w/ELEE LO	rlrb	2	42	0.02	11	500
195	Public Library	Storage Old Books	1	2L4' T12 EE/EEMAG	wrap	6	70	2L4' T8 28w/ELEE LO	rlrb	6	42	0.17	84	500
196	Public Library	Bldg Mt Main Vest	ext	100W INCANDESCENT	can rec	18	100	26W COMPACT SI	screw in	18	26	1.33	5,834	4,380
197	Public Library	Bldg Mt Main Vest	ext	13W COMPACT HARDWIRED	wallpack	5	15	NO RETRO	no change needed		15			4,380
198	Public Library	Parking Lot	ext	250W HI PRESSURE SODIUM	shoebox pole	8	295	133 WATT LED/NEW	new LED shoebox	8	133	1.30	5,676	4,380
199	Public Library	Parking Lot (X3)	ext	250W HI PRESSURE SODIUM	shoebox pole	6	295	133 WATT LED/NEW	new LED shoebox	6	133	0.97	4,257	4,380
238	DPW Highway	Repair Garage	1	4L4' T8 28w/ELEE-8'	strip reflector	16	95	4L4' T8 28w/ELEE LO-8'	rlrb	16	83	0.19	399	2,080
239	DPW Highway	Storage Parts	1	2L8' T8/EL	strip	5	109	4L4' T8 28w/ELEE LO/NEW-8'	new industrial	5	83	0.13	270	2,080
240	DPW Highway	Storage Parts	1	250W METAL HALIDE	dome	2	295	4L4' T8 28w/ELEE/NEW-8'	new industrial	2	94	0.40	836	2,080
241	DPW Highway	Repair Garage Lounge	1	250W METAL HALIDE	high bay	2	295	4L4' T8 28w/ELEE HI/NEW	new vaportight hibay	2	126	0.34	703	2,080
242	DPW Highway	Repair Garage Lounge	1	2L8' T8/EL	strip reflector	4	109	4L4' T8 28w/ELEE LO/NEW-8'	new industrial	4	83	0.10	216	2,080
243	DPW Highway	Parking Garage Saltshed	1	250W METAL HALIDE	high bay	5	295	4L4' T8 28w/ELEE HI/NEW	new vaportight hibay	5	126	0.85	1,977	2,340
244	DPW Highway	Bldg Mt Saltshed	ext	50W METAL HALIDE	wallpack	2	65	26 WATT LED/NEW	new LED wallpack	2	26	0.08	342	4,380
245	DPW Highway	Bldg Mt Saltshed	ext	250W HI PRESSURE SODIUM	flood	1	295	133 WATT LED/NEW	new LED flood	1	133	0.16	710	4,380
275	Fire Dept Headquarters	Lounge Tv	2	3L4' T8/EL	trof acr	8	88	3L4' T8 28w/ELEE LO	rlrb	8	63	0.20	520	2,600
276	Fire Dept Headquarters	Classroom Projector	2	3L4' T8/EL	trof acr	5	88	3L4' T8 28w/ELEE LO	rlrb	5	63	0.13	130	1,040
277	Fire Dept Headquarters	Hall 2Nd Floor	2	2L4' T8 U/EL	trof acr	5	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	5	40	0.10	260	2,600
278	Fire Dept Headquarters	Gym	2	3L4' T8/EL	trof acr	6	88	3L4' T8 28w/ELEE LO	rlrb	6	63	0.15	312	2,080
279	Fire Dept Headquarters	Bedroom 1	2	3L4' T8/EL	trof acrylic dbl switch	3	88	3L4' T8 28w/ELEE LO 2 BAL	rlrb dbl switched	3	64	0.07	187	2,600
280	Fire Dept Headquarters	Bedroom 2	2	3L4' T8/EL	trof acrylic dbl switch	2	88	3L4' T8 28w/ELEE LO 2 BAL	rlrb dbl switched	2	64	0.05	125	2,600
281	Fire Dept Headquarters	Bath Showers	2	2L4' T8 U/EL	trof acr	1	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	1	40	0.02	47	2,340
282	Fire Dept Headquarters	Bath Showers	2	13W COMPACT HARDWIRED	can rec	4	15	NO RETRO	no change needed		15			2,340
283	Fire Dept Headquarters	Bath Men'S	2	2L4' T12 EE/EEMAG	vanity	2	70	2L4' T8 28w/ELEE LO	rlrb	2	42	0.06	131	2,340
284	Fire Dept Headquarters	Stair Main	2	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	94	2,600
285	Fire Dept Headquarters	Stair Main	2	2L4' T8 U/EL	trof acr	3	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	3	40	0.06	156	2,600
286	Fire Dept Headquarters	Stair Main	2	2L4' T8/EL	wrap	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	47	2,600
287	Fire Dept Headquarters	Hall 1St Floor	1	2L4' T8 U/EL	trof acr	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	208	2,600
288	Fire Dept Headquarters	Office Open Dispatch	1	3L4' T8/EL	trof acrylic dbl switch	4	88	3L4' T8 28w/ELEE LO 2 BAL	rlrb dbl switched	4	64	0.10	250	2,600
289	Fire Dept Headquarters	Bedroom Dispatch	1	3L4' T8/EL	trof acr	1	88	3L4' T8 28w/ELEE LO	rlrb	1	63	0.03	65	2,600
290	Fire Dept Headquarters	Office Shift Commander	1	3L4' T8/EL	trof acrylic dbl switch	2	88	3L4' T8 28w/ELEE LO 2 BAL	rlrb dbl switched	2	64	0.05	125	2,600
291	Fire Dept Headquarters	Bath Men'S (X2)	1	2L4' T8/EL	old vanity	2	60	1L4' T8 28w/ELEE/NEW	new wrap	2	24	0.07	168	2,340
292	Fire Dept Headquarters	Office Open Men'S	1	3L4' T8/EL	trof acrylic dbl switch	2	88	3L4' T8 28w/ELEE LO 2 BAL	rlrb dbl switched	2	64	0.05	125	2,600
293	Fire Dept Headquarters	Office Open Men'S	1	2L4' T8 U/EL	trof acr	5	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	5	40	0.10	260	2,600
294	Fire Dept Headquarters	Office Chief	1	3L4' T8/EL	trof acrylic dbl switch	4	88	3L4' T8 28w/ELEE LO 2 BAL	rlrb dbl switched	4	64	0.10	250	2,600
295	Fire Dept Headquarters	Office Asst Fire Cief	1	3L4' T8/EL	trof acrylic dbl switch	3	88	3L4' T8 28w/ELEE LO 2 BAL	rlrb dbl switched	3	64	0.07	187	2,600
296	Fire Dept Headquarters	Storage Server	1	3L4' T8/EL	trof acr	1	88	3L4' T8 28w/ELEE LO	rlrb	1	63	0.03	13	500
297	Fire Dept Headquarters	Storage Filews	1	3L4' T8/EL	trof acrylic dbl switch	2	88	3L4' T8 28w/ELEE LO 2 BAL	rlrb dbl switched	2	64	0.05	24	500
298	Fire Dept Headquarters	Closet Clean (X3)	1	2L4' T8 U/EL	trof acr	3	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	3	40	0.06	30	500
299	Fire Dept Headquarters	Storage Jackets	1	2L4' T8/EL	strip reflector	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	18	500
300	Fire Dept Headquarters	Parking Garage Trucks	1	4L4' T8/EL-8'	strip reflector	26	112	4L4' T8 28w/ELEE LO-8'	rlrb	26	83	0.75	1,764	2,340
301	Fire Dept Headquarters	Bldg Mt Tru8Cks	ext	60W INCANDESCENT	decorative	7	60	15W COMPACT SI	screw in	7	15	0.32	1,380	4,380
302	Fire Dept Headquarters	Bldg Mt Tru8Cks	ext	100W METAL HALIDE	flood	2	120	49 WATT LED/NEW	new LED flood	2	49	0.14	622	4,380
303	Curtis Middle School	Classroom 306	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
304	Curtis Middle School	Classroom 306	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
305	Curtis Middle School	Classroom 306	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
306	Curtis Middle School	Classroom 306	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
307	Curtis Middle School	Classroom 303	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
308	Curtis Middle School	Classroom 303	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
309	Curtis Middle School	Classroom 303	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
310	Curtis Middle School	Classroom 303	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
311	Curtis Middle School	Classroom 309	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
312	Curtis Middle School	Classroom 309	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
313	Curtis Middle School	Classroom 309	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
314	Curtis Middle School	Classroom 309	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
315	Curtis Middle School	Classroom 312	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
316	Curtis Middle School	Classroom 312	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
317	Curtis Middle School	Classroom 312	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
318	Curtis Middle School	Classroom 312	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
319	Curtis Middle School	Classroom 315	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
320	Curtis Middle School	Classroom 315	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
321	Curtis Middle School	Classroom 315	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
322	Curtis Middle School	Classroom 315	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
323	Curtis Middle School	Classroom 318	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
324	Curtis Middle School	Classroom 318	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
325	Curtis Middle School	Classroom 318	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
326	Curtis Middle School	Classroom 318	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
327	Curtis Middle School	Lab 319	3	4L4' T8/EL-8'	indirect/direct dbl switch	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	603	2,080
328	Curtis Middle School	Lab 319	3	2L4' T8/EL-8'	indirect/direct dbl switch	10	60	2L4' T8 28w/ELEE LO-8'	rlrb	10	42	0.18	374	2,080
329	Curtis Middle School	Classroom 321	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
330	Curtis Middle School	Classroom 321	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
331	Curtis Middle School	Classroom 321	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
332	Curtis Middle School	Classroom 321	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
333	Curtis Middle School	Classroom 324	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
334	Curtis Middle School	Classroom 324	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
335	Curtis Middle School	Classroom 324	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
336	Curtis Middle School	Classroom 324	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
337	Curtis Middle School	Office 325	3	2L4' T8/EL	trof acr	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	174	2,414
338	Curtis Middle School	Classroom 351	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
339	Curtis Middle School	Classroom 351	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
340	Curtis Middle School	Classroom 351	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
341	Curtis Middle School	Classroom 351	3	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
342	Curtis Middle School	Office 326	3	2L4' T8/EL	trof acr	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	174	2,414
343	Curtis Middle School	Classroom 327	3	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
344	Curtis Middle School	Classroom 327	3	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
345	Curtis Middle School	Classroom 327	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
346	Curtis Middle School	Classroom 346	3	4L4' T8/EL-8'	indirect/direct dbl switch	5	112	4L4' T8 28w/ELEE LO-8'	rlrb	5	83	0.15	350	2,414
347	Curtis Middle School	Classroom 346	3	2L4' T8/EL-8'	indirect/direct dbl switch	5	60	2L4' T8 28w/ELEE LO-8'	rlrb	5	42	0.09	217	2,414
348	Curtis Middle School	Classroom 346	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
349	Curtis Middle School	Classroom 348	3	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
350	Curtis Middle School	Classroom 348	3	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
351	Curtis Middle School	Classroom 348	3	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
352	Curtis Middle School	Classroom 349	3	4L4' T8/EL-8'	indirect/direct dbl switch	3	112	4L4' T8 28w/ELEE LO-8'	rlrb	3	83	0.09	210	2,414
353	Curtis Middle School	Classroom 349	3	2L4' T8/EL-8'	indirect/direct dbl switch	3	60	2L4' T8 28w/ELEE LO-8'	rlrb	3	42	0.05	130	2,414
354	Curtis Middle School	Classroom 328	3	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
355	Curtis Middle School	Classroom 328	3	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
356	Curtis Middle School	Classroom 330	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
357	Curtis Middle School	Classroom 330	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
358	Curtis Middle School	Classroom 330	3	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
359	Curtis Middle School	Classroom 333	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
360	Curtis Middle School	Classroom 333	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
361	Curtis Middle School	Classroom 333	3	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
362	Curtis Middle School	Classroom 336	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
363	Curtis Middle School	Classroom 336	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
364	Curtis Middle School	Classroom 336	3	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
365	Curtis Middle School	Classroom 339	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
366	Curtis Middle School	Classroom 339	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
367	Curtis Middle School	Classroom 339	3	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
368	Curtis Middle School	Classroom 342	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
369	Curtis Middle School	Classroom 342	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
370	Curtis Middle School	Classroom 342	3	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
371	Curtis Middle School	Classroom 345	3	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
372	Curtis Middle School	Classroom 345	3	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
373	Curtis Middle School	Classroom 345	3	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
374	Curtis Middle School	Bath Staff (X4)	3	2L4' T8/EL	valance	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	223	3,094
375	Curtis Middle School	Closet Clean (X3)	3	2L4' T8/EL	trof acr	6	60	2L4' T8 28w/ELEE LO	rlrb	6	42	0.11	46	425
376	Curtis Middle School	Closet Data (X3)	3	4L4' T8/EL-8'	strip reflector	3	112	4L4' T8 28w/ELEE LO-8'	rlrb	3	83	0.09	37	425
377	Curtis Middle School	Closet Elect (X3)	3	4L4' T8/EL-8'	strip reflector	3	112	4L4' T8 28w/ELEE LO-8'	rlrb	3	83	0.09	37	425
378	Curtis Middle School	Classroom 301	3	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
379	Curtis Middle School	Classroom 301	3	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
380	Curtis Middle School	Lounge 353	3	3L4' T8/EL	trof parabolic	3	88	3L4' T8 28w/ELEE LO	rlrb	3	63	0.08	219	2,924
381	Curtis Middle School	Hall 3Rd Floor	3	2L4' T8 U/EL	trof acr	45	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	45	40	0.90	2,785	3,094
382	Curtis Middle School	Hall 3Rd Floor	3	2x 13W COMPACT HARDWIRED	can rec	20	30	NO RETRO	no change needed		30			3,094
383	Curtis Middle School	Hall 3Rd Floor	3	2L4' T8/EL	cove	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	223	3,094
384	Curtis Middle School	Stair 3 (X2)	3	2x 13W COMPACT HARDWIRED	can rec	12	30	NO RETRO	no change needed		30			3,094
385	Curtis Middle School	Stair 3 (X2)	3	2L4' T8/EL	valance	22	60	2L4' T8 28w/ELEE LO	rlrb	22	42	0.40	1,225	3,094
386	Curtis Middle School	Stair Main	3	2x 13W COMPACT HARDWIRED	can rec	11	30	NO RETRO	no change needed		30			3,094
387	Curtis Middle School	Stair Main	3	2L4' T8/EL	valance	10	60	2L4' T8 28w/ELEE LO	rlrb	10	42	0.18	557	3,094
388	Curtis Middle School	Classroom 219	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
389	Curtis Middle School	Classroom 219	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
390	Curtis Middle School	Classroom 218	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
391	Curtis Middle School	Classroom 218	2	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
392	Curtis Middle School	Classroom 218	2	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
393	Curtis Middle School	Classroom 215	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
394	Curtis Middle School	Classroom 215	2	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
395	Curtis Middle School	Classroom 215	2	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
396	Curtis Middle School	Classroom 212	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
397	Curtis Middle School	Classroom 212	2	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
398	Curtis Middle School	Classroom 212	2	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
399	Curtis Middle School	Classroom 209	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
400	Curtis Middle School	Classroom 209	2	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
401	Curtis Middle School	Classroom 209	2	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
402	Curtis Middle School	Classroom 206	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
403	Curtis Middle School	Classroom 206	2	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
404	Curtis Middle School	Classroom 206	2	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
405	Curtis Middle School	Classroom 203	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
406	Curtis Middle School	Classroom 203	2	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
407	Curtis Middle School	Classroom 203	2	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
408	Curtis Middle School	Classroom 220	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
409	Curtis Middle School	Classroom 220	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
410	Curtis Middle School	Bath Boy'S (X4)	2	2L4' T8 U/EL	trof acr	8	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	8	40	0.16	495	3,094
411	Curtis Middle School	Bath Boy'S (X4)	2	2L4' T8/EL	valance	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	223	3,094
412	Curtis Middle School	Bath Boy'S (X4)	2	2x 13W COMPACT HARDWIRED	can rec	4	30	NO RETRO	no change needed		30			3,094
413	Curtis Middle School	Classroom 221	2	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
414	Curtis Middle School	Classroom 221	2	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
415	Curtis Middle School	Classroom 221	2	2x 13W COMPACT HARDWIRED	can rec	2	30	NO RETRO	no change needed		30			2,414
416	Curtis Middle School	Office 221	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
417	Curtis Middle School	Office 221	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
418	Curtis Middle School	Classroom 224	2	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
419	Curtis Middle School	Classroom 224	2	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
420	Curtis Middle School	Classroom 224	2	2x 13W COMPACT HARDWIRED	can rec	2	30	NO RETRO	no change needed		30			2,414
421	Curtis Middle School	Office 224	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
422	Curtis Middle School	Office 224	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
423	Curtis Middle School	Bath Staff	2	2L4' T8/EL	valance	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	56	3,094
424	Curtis Middle School	Classroom 251	2	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
425	Curtis Middle School	Classroom 251	2	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
426	Curtis Middle School	Classroom 251	2	2x 13W COMPACT HARDWIRED	can rec	2	30	NO RETRO	no change needed		30			2,414
427	Curtis Middle School	Office 251	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
428	Curtis Middle School	Office 251	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
429	Curtis Middle School	Classroom 227	2	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
430	Curtis Middle School	Classroom 227	2	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
431	Curtis Middle School	Classroom 227	2	2x 13W COMPACT HARDWIRED	can rec	2	30	NO RETRO	no change needed		30			2,414
432	Curtis Middle School	Office 227	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
433	Curtis Middle School	Office 227	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
434	Curtis Middle School	Classroom 248	2	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
435	Curtis Middle School	Classroom 248	2	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
436	Curtis Middle School	Classroom 248	2	2x 13W COMPACT HARDWIRED	can rec	2	30	NO RETRO	no change needed		30			2,414
437	Curtis Middle School	Office 248	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
438	Curtis Middle School	Office 248	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
439	Curtis Middle School	Office 247	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
440	Curtis Middle School	Office 247	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
441	Curtis Middle School	Classroom 229	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
442	Curtis Middle School	Classroom 229	2	2L4' T8/EL	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
443	Curtis Middle School	Classroom 229	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
444	Curtis Middle School	Classroom 229	2	2L4' T8/EL	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	174	2,414
445	Curtis Middle School	Classroom 229	2	2L2' T8/EL	wallwash	3	37	2L2' T8 15w/ELEE LO	rlrb	3	27	0.03	72	2,414
446	Curtis Middle School	Classroom 233	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
447	Curtis Middle School	Classroom 233	2	2L4' T8/EL	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	174	2,414
448	Curtis Middle School	Classroom 233	2	2L2' T8/EL	wallwash	3	37	2L2' T8 15w/ELEE LO	rlrb	3	27	0.03	72	2,414
449	Curtis Middle School	Classroom 236	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
450	Curtis Middle School	Classroom 236	2	2L4' T8/EL	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	174	2,414
451	Curtis Middle School	Classroom 236	2	2L2' T8/EL	wallwash	3	37	2L2' T8 15w/ELEE LO	rlrb	3	27	0.03	72	2,414
452	Curtis Middle School	Classroom 239	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
453	Curtis Middle School	Classroom 239	2	2L4' T8/EL	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	174	2,414
454	Curtis Middle School	Classroom 239	2	2L2' T8/EL	wallwash	3	37	2L2' T8 15w/ELEE LO	rlrb	3	27	0.03	72	2,414
455	Curtis Middle School	Office 246	2	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
456	Curtis Middle School	Office 246	2	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
457	Curtis Middle School	Classroom 245	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
458	Curtis Middle School	Classroom 245	2	2L4' T8/EL	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	174	2,414
459	Curtis Middle School	Classroom 245	2	2L2' T8/EL	wallwash	3	37	2L2' T8 15w/ELEE LO	rlrb	3	27	0.03	72	2,414
460	Curtis Middle School	Classroom 242	2	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
461	Curtis Middle School	Classroom 242	2	2L4' T8/EL	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	174	2,414
462	Curtis Middle School	Classroom 242	2	2L2' T8/EL	wallwash	3	37	2L2' T8 15w/ELEE LO	rlrb	3	27	0.03	72	2,414
463	Curtis Middle School	Classroom 201	2	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
464	Curtis Middle School	Classroom 201	2	2L4' T8 U/EL	trof acr	2	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	2	40	0.04	97	2,414
465	Curtis Middle School	Office Open 253	2	3L4' T8/EL	trof parabolic	3	88	3L4' T8 28w/ELEE LO	rlrb	3	63	0.08	219	2,924
466	Curtis Middle School	Classroom 254	2	4L4' T8/EL-8'	indirect/direct dbl switch	9	112	4L4' T8 28w/ELEE LO-8'	rlrb	9	83	0.26	630	2,414
467	Curtis Middle School	Classroom 254	2	2L4' T8/EL-8'	indirect/direct dbl switch	9	60	2L4' T8 28w/ELEE LO-8'	rlrb	9	42	0.16	391	2,414
468	Curtis Middle School	Classroom 257	2	4L4' T8/EL-8'	indirect/direct dbl switch	9	112	4L4' T8 28w/ELEE LO-8'	rlrb	9	83	0.26	630	2,414
469	Curtis Middle School	Classroom 257	2	2L4' T8/EL-8'	indirect/direct dbl switch	9	60	2L4' T8 28w/ELEE LO-8'	rlrb	9	42	0.16	391	2,414
470	Curtis Middle School	Classroom 260	2	2L4' T8/EL	trof acr	9	60	2L4' T8 28w/ELEE LO	rlrb	9	42	0.16	391	2,414
471	Curtis Middle School	Classroom 260	2	2L2' T8/EL	wallwash	3	37	2L2' T8 15w/ELEE LO	rlrb	3	27	0.03	72	2,414
472	Curtis Middle School	Storage 260	2	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	75	2,074
473	Curtis Middle School	Office Open Guidance	2	3L4' T8/EL	trof parabolic	3	88	3L4' T8 28w/ELEE LO	rlrb	3	63	0.08	219	2,924
474	Curtis Middle School	Office Open Guidance	2	2L4' T8 U/EL	trof acr	5	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	5	40	0.10	292	2,924
475	Curtis Middle School	Office Mrs. Miller (X4)	2	3L4' T8/EL	trof parabolic	8	88	3L4' T8 28w/ELEE LO	rlrb	8	63	0.20	483	2,414
476	Curtis Middle School	Office House Administrator (X2)	2	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	121	2,414
477	Curtis Middle School	Bath Boy'S (X2)	2	2L4' T8 U/EL	trof acr	6	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	6	40	0.12	371	3,094
478	Curtis Middle School	Bath Boy'S (X2)	2	2L4' T8/EL	valance	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	111	3,094
479	Curtis Middle School	Classroom 263 (X2)	2	4L4' T8/EL-8'	indirect/direct dbl switch	18	112	4L4' T8 28w/ELEE LO-8'	rlrb	18	83	0.52	1,260	2,414
480	Curtis Middle School	Classroom 263	2	2L4' T8/EL-8'	indirect/direct dbl switch	9	60	2L4' T8 28w/ELEE LO-8'	rlrb	9	42	0.16	391	2,414
481	Curtis Middle School	Classroom 266	2	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
482	Curtis Middle School	Classroom 266	2	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
483	Curtis Middle School	Classroom 266	2	2x 13W COMPACT HARDWIRED	can rec	3	30	NO RETRO	no change needed		30			2,414
484	Curtis Middle School	Library	2	2x 13W COMPACT HARDWIRED	sconce	13	30	NO RETRO	no change needed		30			2,414
485	Curtis Middle School	Library	2	2L4' T8 U/EL	trof parabolic	20	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	20	40	0.40	966	2,414
486	Curtis Middle School	Library	2	100W METAL HALIDE	decorative	10	120	NO RETRO	no change needed		120			2,414
487	Curtis Middle School	Library	2	150W METAL HALIDE	indirect	4	190	NO RETRO	no change needed		190			2,414
488	Curtis Middle School	Office Open Lib	2	3L4' T8/EL	trof parabolic	8	88	3L4' T8 28w/ELEE LO	rlrb	8	63	0.20	585	2,924
489	Curtis Middle School	Hall 2Nd Floor	2	2x 13W COMPACT HARDWIRED	can rec	17	30	NO RETRO	no change needed		30			3,094
490	Curtis Middle School	Hall 2Nd Floor	2	2L4' T8 U/EL	trof acr	54	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	54	40	1.08	3,342	3,094
491	Curtis Middle School	Hall 2Nd Floor	2	2L4' T8/EL	cove	22	60	2L4' T8 28w/ELEE LO	rlrb	22	42	0.40	1,225	3,094
492	Curtis Middle School	Stair Front Officve	2	2x 13W COMPACT HARDWIRED	can rec	6	30	NO RETRO	no change needed		30			3,094
493	Curtis Middle School	Stair Front Officve	2	2L4' T8/EL	valance	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	223	3,094
494	Curtis Middle School	Classroom 110	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
495	Curtis Middle School	Classroom 110	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
496	Curtis Middle School	Classroom 110	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
497	Curtis Middle School	Classroom 115	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
498	Curtis Middle School	Classroom 115	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
499	Curtis Middle School	Classroom 115	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
500	Curtis Middle School	Classroom 112	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
501	Curtis Middle School	Classroom 112	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
502	Curtis Middle School	Classroom 112	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
503	Curtis Middle School	Classroom 109	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
504	Curtis Middle School	Classroom 109	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
505	Curtis Middle School	Classroom 109	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
506	Curtis Middle School	Classroom 106	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
507	Curtis Middle School	Classroom 106	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
508	Curtis Middle School	Classroom 106	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
509	Curtis Middle School	Classroom 103	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
510	Curtis Middle School	Classroom 103	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
511	Curtis Middle School	Classroom 103	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
512	Curtis Middle School	Classroom 119	1	3L4' T8/EL	trof parabolic	3	88	3L4' T8 28w/ELEE LO	rlrb	3	63	0.08	181	2,414
513	Curtis Middle School	Office 119B	1	3L4' T8/EL	trof parabolic	1	88	3L4' T8 28w/ELEE LO	rlrb	1	63	0.03	60	2,414
514	Curtis Middle School	Office 119A	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	121	2,414
515	Curtis Middle School	Bath Boy'S (X2)	1	2L4' T8 U/EL	trof acr	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	248	3,094
516	Curtis Middle School	Bath Boy'S (X2)	1	2L4' T8/EL	valance	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	111	3,094
517	Curtis Middle School	Bath Boy'S (X2)	1	2x 13W COMPACT HARDWIRED	can rec	2	30	NO RETRO	no change needed		30			3,094
518	Curtis Middle School	Classroom 121	1	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
519	Curtis Middle School	Classroom 121	1	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
520	Curtis Middle School	Classroom 121	1	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
521	Curtis Middle School	Storage 121	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	104	2,074
522	Curtis Middle School	Bath Staff (X2)	1	2L4' T8/EL	valance	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	111	3,094
523	Curtis Middle School	Classroom 151	1	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
524	Curtis Middle School	Classroom 151	1	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
525	Curtis Middle School	Classroom 151	1	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
526	Curtis Middle School	Storage 151	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	104	2,074
527	Curtis Middle School	Classroom 124	1	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
528	Curtis Middle School	Classroom 124	1	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
529	Curtis Middle School	Classroom 124	1	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
530	Curtis Middle School	Storage 124	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	104	2,074
531	Curtis Middle School	Office 150	1	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
532	Curtis Middle School	Storage 149	1	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	15	425
533	Curtis Middle School	Classroom 127	1	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
534	Curtis Middle School	Classroom 127	1	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
535	Curtis Middle School	Classroom 127	1	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
536	Curtis Middle School	Storage 127	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	104	2,074
537	Curtis Middle School	Classroom 148	1	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
538	Curtis Middle School	Classroom 148	1	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
539	Curtis Middle School	Classroom 148	1	2L4' T8/EL	wallwash	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	87	2,414
540	Curtis Middle School	Storage 148	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	104	2,074
541	Curtis Middle School	Classroom 147	1	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
542	Curtis Middle School	Classroom 147	1	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
543	Curtis Middle School	Classroom 129	1	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
544	Curtis Middle School	Classroom 129	1	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
545	Curtis Middle School	Classroom 130	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
546	Curtis Middle School	Classroom 130	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
547	Curtis Middle School	Classroom 130	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
548	Curtis Middle School	Classroom 133	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
549	Curtis Middle School	Classroom 133	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
550	Curtis Middle School	Classroom 133	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
551	Curtis Middle School	Classroom 136	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
552	Curtis Middle School	Classroom 136	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
553	Curtis Middle School	Classroom 136	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
554	Curtis Middle School	Classroom 139	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
555	Curtis Middle School	Classroom 139	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
556	Curtis Middle School	Classroom 139	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
557	Curtis Middle School	Classroom 142	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
558	Curtis Middle School	Classroom 142	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
559	Curtis Middle School	Classroom 142	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
560	Curtis Middle School	Classroom 145	1	4L4' T8/EL-8'	indirect/direct dbl switch	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	280	2,414
561	Curtis Middle School	Classroom 145	1	2L4' T8/EL-8'	indirect/direct dbl switch	4	60	2L4' T8 28w/ELEE LO-8'	rlrb	4	42	0.07	174	2,414
562	Curtis Middle School	Classroom 145	1	2L2' T8/EL	wallwash	4	37	2L2' T8 15w/ELEE LO	rlrb	4	27	0.04	97	2,414
563	Curtis Middle School	Classroom 146	1	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	140	2,414
564	Curtis Middle School	Classroom 146	1	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	87	2,414
565	Curtis Middle School	Classroom 146	1	2L2' T8/EL	wallwash	2	37	2L2' T8 15w/ELEE LO	rlrb	2	27	0.02	48	2,414
566	Curtis Middle School	Lounge 153	1	2L4' T8 U/EL	trof acr	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	234	2,924
567	Curtis Middle School	Lounge 101	1	4L4' T8/EL-8'	indirect/direct dbl switch	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	170	2,924
568	Curtis Middle School	Lounge 101	1	2L4' T8/EL-8'	indirect/direct dbl switch	2	60	2L4' T8 28w/ELEE LO-8'	rlrb	2	42	0.04	105	2,924
569	Curtis Middle School	Office 152	1	3L4' T8/EL	trof parabolic	1	88	3L4' T8 28w/ELEE LO	rlrb	1	63	0.03	60	2,414
570	Curtis Middle School	Hall Recieving	1	3L4' T8/EL	trof parabolic	5	88	3L4' T8 28w/ELEE LO	rlrb	5	63	0.13	387	3,094
571	Curtis Middle School	Closet Clean	1	2L4' T8/EL	trof acr	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	8	425
572	Curtis Middle School	Office Open Cust	1	3L4' T8/EL	trof parabolic	6	88	3L4' T8 28w/ELEE LO	rlrb	6	63	0.15	439	2,924
573	Curtis Middle School	Storage Parts	1	2L4' T8/EL	trof acr	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	23	425
574	Curtis Middle School	Lounge Staff Dining	1	4L4' T8/EL-8'	indirect/direct dbl switch	3	112	4L4' T8 28w/ELEE LO-8'	rlrb	3	83	0.09	254	2,924
575	Curtis Middle School	Lounge Staff Dining	1	2L4' T8/EL-8'	indirect/direct dbl switch	3	60	2L4' T8 28w/ELEE LO-8'	rlrb	3	42	0.05	158	2,924
576	Curtis Middle School	Classroom 154 (X2)	1	4L4' T8/EL-8'	indirect/direct dbl switch	12	112	4L4' T8 28w/ELEE LO-8'	rlrb	12	83	0.35	840	2,414
577	Curtis Middle School	Classroom 154 (X2)	1	2L4' T8/EL-8'	indirect/direct dbl switch	12	60	2L4' T8 28w/ELEE LO-8'	rlrb	12	42	0.22	521	2,414
578	Curtis Middle School	Classroom Art	1	4L4' T8/EL-8'	indirect/direct dbl switch	11	112	4L4' T8 28w/ELEE LO-8'	rlrb	11	83	0.32	770	2,414
579	Curtis Middle School	Classroom Art	1	2L4' T8/EL-8'	indirect/direct dbl switch	11	60	2L4' T8 28w/ELEE LO-8'	rlrb	11	42	0.20	478	2,414
580	Curtis Middle School	Storage Kiln	1	2L4' T8/EL	trof acr	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	37	2,074
581	Curtis Middle School	Storage Supplies	1	2L4' T8/EL	trof acr	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	31	425
582	Curtis Middle School	Cafeteria	1	2x 13W COMPACT HARDWIRED	can rec	42	30	NO RETRO	no change needed		30			2,924
583	Curtis Middle School	Cafeteria	1	2L4' T8/EL	trof para 1' wide	18	60	2L4' T8 28w/ELEE LO	rlrb	18	42	0.32	947	2,924
584	Curtis Middle School	Cafeteria	1	250W METAL HALIDE	sconce	14	295	NO RETRO	no change needed		295			2,924
585	Curtis Middle School	Kitchen	1	3L4' T8/EL	trof acr	9	88	3L4' T8 28w/ELEE LO	rlrb	9	63	0.23	543	2,414
586	Curtis Middle School	Kitchen Dishes	1	3L4' T8/EL	trof acr	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	121	2,414
587	Curtis Middle School	Storage Dry Goods	1	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	75	2,074
588	Curtis Middle School	Kitchen Hood	1	18W COMPACT HARDWIRED	jar	8	20	NO RETRO	no change needed		20			2,414
589	Curtis Middle School	Storage Pans	1	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	75	2,074
590	Curtis Middle School	Office Kitch	1	3L4' T8/EL	trof parabolic	1	88	3L4' T8 28w/ELEE LO	rlrb	1	63	0.03	60	2,414
591	Curtis Middle School	Bath Kitch	1	2L4' T8/EL	valance	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	56	3,094
592	Curtis Middle School	Office Open Health	1	2L4' T8 U/EL	trof parabolic	9	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	9	40	0.18	526	2,924
593	Curtis Middle School	Office Open Health	1	2x 13W COMPACT HARDWIRED	can rec	4	30	NO RETRO	no change needed		30			2,924
594	Curtis Middle School	Office Nurse	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	121	2,414
595	Curtis Middle School	Office Nurse	1	2L4' T8 U/EL	trof parabolic	1	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	1	40	0.02	48	2,414
596	Curtis Middle School	Bath Nurse (X2)	1	2L4' T8/EL	valance	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	111	3,094
597	Curtis Middle School	Office Treatment	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	121	2,414
598	Curtis Middle School	Storage Nurse	1	2L4' T8/EL	trof acr	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	8	425
599	Curtis Middle School	Office Open Main	1	2x 13W COMPACT HARDWIRED	can rec	6	30	NO RETRO	no change needed		30			2,924
600	Curtis Middle School	Office Open Main	1	2L4' T8 U/EL	trof parabolic	14	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	14	40	0.28	819	2,924
601	Curtis Middle School	Office Princ	1	2L4' T8 U/EL	trof parabolic	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	193	2,414
602	Curtis Middle School	Conference Princ	1	4L4' T8/EL-8'	indirect/direct dbl switch	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	70	2,414
603	Curtis Middle School	Conference Princ	1	2L4' T8/EL-8'	indirect/direct dbl switch	1	60	2L4' T8 28w/ELEE LO-8'	rlrb	1	42	0.02	43	2,414
604	Curtis Middle School	Conference Princ	1	2x 13W COMPACT HARDWIRED	can rec	8	30	NO RETRO	no change needed		30			2,414
605	Curtis Middle School	Storage Paper	1	2L4' T8/EL	trof acr	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	8	425
606	Curtis Middle School	Lounge Staff	1	2L4' T8 U/EL	trof parabolic	7	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	7	40	0.14	409	2,924
607	Curtis Middle School	Bath Staff (X2)	1	2L4' T8/EL	valance	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	111	3,094
608	Curtis Middle School	Bath Boy'S (X2)	1	2L4' T8 U/EL	trof acr	6	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	6	40	0.12	371	3,094
609	Curtis Middle School	Bath Boy'S (X2)	1	2L4' T8/EL	valance	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	111	3,094

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
610	Curtis Middle School	Bath Boy'S (X2)	1	2x 13W COMPACT HARDWIRED	can rec	4	30	NO RETRO	no change needed		30			3,094
611	Curtis Middle School	Locker Men & Women (X2)	1	2L4' T8 U/EL	trof acr	12	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	12	40	0.24	743	3,094
612	Curtis Middle School	Locker Men & Women (X2)	1	2L4' T8/EL	trof acr	12	60	2L4' T8 28w/ELEE LO	rlrb	12	42	0.22	668	3,094
613	Curtis Middle School	Locker Men & Women (X2)	1	2L4' T8/EL	soffit	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	111	3,094
614	Curtis Middle School	Locker Mens (X2)	1	2x 13W COMPACT HARDWIRED	can rec	2	30	NO RETRO	no change needed		30			3,094
615	Curtis Middle School	Office Coach (X2)	1	2L4' T8 U/EL	trof parabolic	8	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	8	40	0.16	386	2,414
616	Curtis Middle School	Auditorium	1	2x 13W COMPACT HARDWIRED	sconce	9	30	NO RETRO	no change needed		30			2,754
617	Curtis Middle School	Auditorium	1	26W COMPACT HARDWIRED	can rec	36	28	NO RETRO	no change needed		28			2,754
618	Curtis Middle School	Auditorium	1	2L4' T8 U/EL	trof acr	1	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	1	40	0.02	55	2,754
619	Curtis Middle School	Closet Data	1	4L4' T8/EL-8'	strip reflector	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	12	425
620	Curtis Middle School	Classroom 181	1	3L4' T8/EL	trof parabolic	3	88	3L4' T8 28w/ELEE LO	rlrb	3	63	0.08	181	2,414
621	Curtis Middle School	Storage 184	1	2L4' T8/EL	trof acr	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	149	2,074
622	Curtis Middle School	Storage 187	1	3L4' T8/EL	trof parabolic	3	88	3L4' T8 28w/ELEE LO	rlrb	3	63	0.08	156	2,074
623	Curtis Middle School	Classroom 190	1	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
624	Curtis Middle School	Classroom 190	1	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
625	Curtis Middle School	Classroom 175	1	4L4' T8/EL-8'	indirect/direct dbl switch	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	420	2,414
626	Curtis Middle School	Classroom 175	1	2L4' T8/EL-8'	indirect/direct dbl switch	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	261	2,414
627	Curtis Middle School	Gym	1	4L4' T5 HO/EL	high bay	20	234	NO RETRO	no change needed		234			2,924
628	Curtis Middle School	Hall 1St Floor	1	2L4' T8 U/EL	trof acr	64	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	64	40	1.28	3,960	3,094
629	Curtis Middle School	Hall 1St Floor	1	2x 13W COMPACT HARDWIRED	can rec	56	30	NO RETRO	no change needed		30			3,094
630	Curtis Middle School	Hall 1St Floor	1	2x 18W COMPACT HARDWIRED /EL	wallpack	12	40	NO RETRO	no change needed		40			3,094
631	Curtis Middle School	Hall 1St Floor	1	2L4' T8/EL	cove	44	60	2L4' T8 28w/ELEE LO	rlrb	44	42	0.79	2,450	3,094
632	Curtis Middle School	Bldg Mt 1St Floor	ext	50W METAL HALIDE	indirect	3	65	NO RETRO	no change needed		65			3,723
633	Curtis Middle School	Bldg Mt 1St Floor	ext	3 WATT LED	wallpack	8	3	NO RETRO	no change needed		3			3,723
634	Curtis Middle School	Bldg Mt Canopy	ext	50W METAL HALIDE	square surface mt.	2	65	NO RETRO	no change needed		65			3,723
635	Curtis Middle School	Bldg Mt Canopy	ext	50W METAL HALIDE	wallpack	6	65	NO RETRO	no change needed		65			3,723
636	Loring Elementary	Conference 239	2	2L4' T5 HO/EL	indirect/direct	6	117	NO RETRO	no change needed		117			2,088
637	Loring Elementary	Classroom 33	2	2L4' T5 HO/EL	indirect/direct	12	117	NO RETRO	no change needed		117			2,268
638	Loring Elementary	Classroom 32	2	2L4' T5 HO/EL	indirect/direct	12	117	NO RETRO	no change needed		117			2,268
639	Loring Elementary	Classroom 31	2	2L4' T5 HO/EL	indirect/direct	12	117	NO RETRO	no change needed		117			2,268
640	Loring Elementary	Classroom 29 (X15)	2	2L4' T5 HO/EL	indirect/direct	180	117	NO RETRO	no change needed		117			2,268
641	Loring Elementary	Classroom 230	2	3L4' T8/EL	trof parabolic	6	88	3L4' T8 28w/ELEE LO	rlrb	6	63	0.15	340	2,268
642	Loring Elementary	Storage 230	2	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	95	1,908
643	Loring Elementary	Storage 229	2	4L4' T8/EL-8'	strip	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	111	1,908
644	Loring Elementary	Bath Boy'S (X6)	2	4L4' T8/EL-8'	valance	12	112	4L4' T8 28w/ELEE LO-8'	rlrb	12	83	0.35	1,040	2,988
645	Loring Elementary	Bath Boy'S (X6)	2	2x 13W COMPACT HARDWIRED	can rec	12	30	NO RETRO	no change needed		30			2,988
646	Loring Elementary	Bath Boy'S (X6)	2	2L4' T8 U/EL	trof acr	6	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	6	40	0.12	359	2,988
647	Loring Elementary	Closet Clean	2	2x 13W COMPACT HARDWIRED	drum	1	30	NO RETRO	no change needed		30			450
648	Loring Elementary	Classroom 208	2	2L4' T8 U/EL	trof parabolic	3	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	3	40	0.06	136	2,268
649	Loring Elementary	Classroom 208	2	4L4' T8/EL-8'	tube light	8	112	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.23	526	2,268
650	Loring Elementary	Storage 208	2	3L4' T8/EL	trof acr	1	88	3L4' T8 28w/ELEE LO	rlrb	1	63	0.03	11	450
651	Loring Elementary	Classroom 244	2	3L4' T8/EL	trof parabolic	4	88	3L4' T8 28w/ELEE LO	rlrb	4	63	0.10	227	2,268
652	Loring Elementary	Storage 245	2	4L4' T8/EL-8'	strip	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	13	450
653	Loring Elementary	Hall 2Nd Floor	2	2x 13W COMPACT HARDWIRED	can rec	42	30	NO RETRO	no change needed		30			3,258
654	Loring Elementary	Hall 2Nd Floor	2	2L4' T8 U/EL	trof acr	24	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	24	40	0.48	1,564	3,258
655	Loring Elementary	Hall 2Nd Floor	2	4L4' T8/EL-8'	box acrylic	8	112	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.23	756	3,258
656	Loring Elementary	Hall 2Nd Floor	2	2L4' T8/EL	box acrylic	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	59	3,258
657	Loring Elementary	Classroom 164 (X2)	1	2L4' T5 HO/EL	indirect/direct	32	117	NO RETRO	no change needed		117			2,268
658	Loring Elementary	Office 165 (X2)	1	3L4' T8/EL	trof parabolic	4	88	3L4' T8 28w/ELEE LO	rlrb	4	63	0.10	209	2,088
659	Loring Elementary	Classroom 12 (X12)	1	2L4' T5 HO/EL	indirect/direct	144	117	NO RETRO	no change needed		117			2,268
660	Loring Elementary	Office 149 (X2)	1	3L4' T8/EL	trof parabolic	4	88	3L4' T8 28w/ELEE LO	rlrb	4	63	0.10	209	2,088

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
661	Loring Elementary	Bath Boy'S (X4)	1	2L4' T8 U/EL	trof acr	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	239	2,988
662	Loring Elementary	Bath Boy'S (X4)	1	4L4' T8/EL-8'	valance	8	112	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.23	693	2,988
663	Loring Elementary	Bath Boy'S (X4)	1	2x 13W COMPACT HARDWIRED	can rec	8	30	NO RETRO	no change needed		30			2,988
664	Loring Elementary	Gym	1	4L4' T5 HO/EL	high bay	16	234	NO RETRO	no change needed		234			2,628
665	Loring Elementary	Office Coach	1	4L4' T8/EL-8'	strip	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	121	2,088
666	Loring Elementary	Library	1	2L4' T5 HO/EL	indirect/direct	48	117	NO RETRO	no change needed		117			2,268
667	Loring Elementary	Library	1	2L4' T5 HO/EL	indirect/direct	4	117	NO RETRO	no change needed		117			2,268
668	Loring Elementary	Office 121	1	2L4' T5 HO/EL	indirect/direct	2	117	NO RETRO	no change needed		117			2,088
669	Loring Elementary	Storage 119	1	3L4' T8/EL	trof acr	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	23	450
670	Loring Elementary	Storage 117	1	4L4' T8/EL-8'	strip	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	13	450
671	Loring Elementary	Storage 116	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	95	1,908
672	Loring Elementary	Lab 115	1	2L4' T5 HO/EL	indirect/direct	24	117	NO RETRO	no change needed		117			2,080
673	Loring Elementary	Office Open 111	1	3L4' T8/EL	trof acr	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	122	2,448
674	Loring Elementary	Office Open 111	1	2L4' T8 U/EL	trof acr	1	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	1	40	0.02	49	2,448
675	Loring Elementary	Office 112	1	3L4' T8/EL	trof parabolic	1	88	3L4' T8 28w/ELEE LO	rlrb	1	63	0.03	52	2,088
676	Loring Elementary	Office Guidance	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	104	2,088
677	Loring Elementary	Office Open 107	1	2L4' T8 U/EL	trof parabolic	3	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	3	40	0.06	147	2,448
678	Loring Elementary	Office Open 107	1	2L4' T8/EL	trof parabolic	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	44	2,448
679	Loring Elementary	Office Exam	1	2L4' T8 U/EL	trof parabolic	2	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	2	40	0.04	84	2,088
680	Loring Elementary	Office Open Main	1	2L4' T8 U/EL	trof parabolic	8	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	8	40	0.16	392	2,448
681	Loring Elementary	Office 103	1	2L4' T8 U/EL	trof parabolic	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	167	2,088
682	Loring Elementary	Office 102	1	3L4' T8/EL	trof parabolic	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	104	2,088
683	Loring Elementary	Cafeteria	1	2x 13W COMPACT HARDWIRED	can rec	4	30	NO RETRO	no change needed		30			2,448
684	Loring Elementary	Cafeteria	1	2L4' T8 U/EL	trof parabolic	39	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	39	40	0.78	1,909	2,448
685	Loring Elementary	Cafeteria	1	4L4' T8/EL	high bay	8	112	NO RETRO	no change needed		112			2,448
686	Loring Elementary	Storage 190	1	4L4' T8/EL-8'	strip	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	13	450
687	Loring Elementary	Stage	1	4L4' T8/EL-8'	strip reflector	5	112	4L4' T8 28w/ELEE LO-8'	rlrb	5	83	0.15	303	2,088
688	Loring Elementary	Kitchen	1	3L4' T8/EL	trof acr	12	88	3L4' T8 28w/ELEE LO	rlrb	12	63	0.30	518	1,728
689	Loring Elementary	Storage 178	1	3L4' T8/EL	trof acr	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	95	1,908
690	Loring Elementary	Bath Kitch	1	4L4' T8/EL-8'	valance	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	87	2,988
691	Loring Elementary	Hall 183	1	3L4' T8/EL	trof acr	2	88	3L4' T8 28w/ELEE LO	rlrb	2	63	0.05	163	3,258
692	Loring Elementary	Hall 183	1	4L4' T8/EL-8'	strip	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	189	3,258
693	Loring Elementary	Mechanical 182	1	4L4' T8/EL-8'	strip	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	13	450
694	Loring Elementary	Hall 1St Floor	1	2x 13W COMPACT HARDWIRED	can rec	37	30	NO RETRO	no change needed		30			3,258
695	Loring Elementary	Hall 1St Floor	1	2L4' T8 U/EL	trof acr	44	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	44	40	0.88	2,867	3,258
696	Loring Elementary	Hall 1St Floor	1	50W METAL HALIDE	can rec	8	65	NO RETRO	no change needed		65			3,258
697	Loring Elementary	Mechanical Boiler	1	4L4' T8/EL-8'	strip	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	52	450
698	Loring Elementary	Bldg Mt Canopy	ext	2L4' T8/EL	vapor tight	4	60	NO RETRO	no change needed		60			3,942
699	Loring Elementary	Bldg Mt Canopy	ext	2x 13W COMPACT HARDWIRED	drum	1	30	NO RETRO	no change needed		30			3,942
700	Loring Elementary	Bldg Mt	ext	3 WATT LED	wallpack	8	3	NO RETRO	no change needed		3			3,942
701	Loring Elementary	Bldg Mt	ext	100W METAL HALIDE	wallpack	4	120	NO RETRO	no change needed		120			3,942
702	Loring Elementary	Bldg Mt	ext	2x 13W COMPACT HARDWIRED	wallpack	2	30	NO RETRO	no change needed		30			3,942
703	Loring Elementary	Parking Lot	ext	250W METAL HALIDE	shoebox pole	12	295	NO RETRO	no change needed		295			3,942
704	Haynes Elementary	Classroom 8	1	4L4' T8/EL-8'	indirect/direct	8	112	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.23	526	2,268
705	Haynes Elementary	Classroom 8	1	2L4' T8/EL	indirect/direct	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	41	2,268
706	Haynes Elementary	Classroom 9	1	4L4' T8/EL-8'	indirect/direct	9	112	4L4' T8 28w/ELEE LO-8'	rlrb	9	83	0.26	592	2,268
707	Haynes Elementary	Classroom 9	1	2L4' T8/EL	indirect/direct	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	41	2,268
708	Haynes Elementary	Bath Boy'S (X2)	1	2x 13W COMPACT HARDWIRED	can rec	2	30	NO RETRO	no change needed		30			2,988
709	Haynes Elementary	Bath Boy'S (X2)	1	4L4' T8/EL-8'	soffit	8	112	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.23	693	2,988
710	Haynes Elementary	Classroom Ot/Pt	1	4L4' T8/EL-8'	indirect/direct	3	112	4L4' T8 28w/ELEE LO-8'	rlrb	3	83	0.09	197	2,268
711	Haynes Elementary	Classroom Ot/Pt	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
712	Haynes Elementary	Classroom Art	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
713	Haynes Elementary	Classroom Art	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
714	Haynes Elementary	Storage Art (X2)	1	2L4' T8/EL	strip	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	16	450
715	Haynes Elementary	Classroom 10	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
716	Haynes Elementary	Classroom 10	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
717	Haynes Elementary	Gym	1	4L4' T5 HO/EL	high bay	16	234	NO RETRO	no change needed		234			2,628
718	Haynes Elementary	Classroom 7	1	4L4' T8/EL-8'	indirect/direct	7	112	4L4' T8 28w/ELEE LO-8'	rlrb	7	83	0.20	460	2,268
719	Haynes Elementary	Classroom 7	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
720	Haynes Elementary	Classroom 6	1	4L4' T8/EL-8'	indirect/direct	7	112	4L4' T8 28w/ELEE LO-8'	rlrb	7	83	0.20	460	2,268
721	Haynes Elementary	Classroom 6	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
722	Haynes Elementary	Classroom 12	1	4L4' T8/EL-8'	indirect/direct	7	112	4L4' T8 28w/ELEE LO-8'	rlrb	7	83	0.20	460	2,268
723	Haynes Elementary	Classroom 12	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
724	Haynes Elementary	Classroom 13 (X2)	1	4L4' T8/EL-8'	indirect/direct	12	112	4L4' T8 28w/ELEE LO-8'	rlrb	12	83	0.35	789	2,268
725	Haynes Elementary	Classroom 13 (X2)	1	2L4' T8/EL	indirect/direct	6	60	2L4' T8 28w/ELEE LO	rlrb	6	42	0.11	245	2,268
726	Haynes Elementary	Closet Cust (X4)	1	4L4' T8/EL-8'	strip	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	52	450
727	Haynes Elementary	Classroom 4	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
728	Haynes Elementary	Classroom 4	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
729	Haynes Elementary	Classroom 14	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
730	Haynes Elementary	Classroom 14	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
731	Haynes Elementary	Classroom 3	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
732	Haynes Elementary	Classroom 3	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
733	Haynes Elementary	Classroom 15	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
734	Haynes Elementary	Classroom 15	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
735	Haynes Elementary	Office Open Guidance	1	2L4' T8/EL	trof parabolic	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	132	2,448
736	Haynes Elementary	Office Guidanhce	1	2L4' T8/EL	trof parabolic	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	150	2,088
737	Haynes Elementary	Office Speech	1	2L4' T8/EL	trof parabolic	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	150	2,088
738	Haynes Elementary	Classroom 2	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
739	Haynes Elementary	Classroom 2	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
740	Haynes Elementary	Classroom 16	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
741	Haynes Elementary	Classroom 16	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
742	Haynes Elementary	Classroom 1	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
743	Haynes Elementary	Classroom 1	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
744	Haynes Elementary	Classroom By Kitch	1	2L4' T8/EL	strip	6	60	2L4' T8 28w/ELEE LO	rlrb	6	42	0.11	245	2,268
745	Haynes Elementary	Classroom 17	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
746	Haynes Elementary	Classroom 17	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
747	Haynes Elementary	Lounge Staff	1	4L4' T8/EL-8'	indirect/direct	7	112	4L4' T8 28w/ELEE LO-8'	rlrb	7	83	0.20	497	2,448
748	Haynes Elementary	Lounge Staff	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	132	2,448
749	Haynes Elementary	Bath Boy'S (X4)	1	4L4' T8/EL-8'	soffit	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	347	2,988
750	Haynes Elementary	Classroom 18	1	4L4' T8/EL-8'	indirect/direct	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
751	Haynes Elementary	Classroom 18	1	2L4' T8/EL	indirect/direct	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	122	2,268
752	Haynes Elementary	Classroom 27 (X9)	1	4L4' T8/EL-8'	indirect/direct	54	112	4L4' T8 28w/ELEE LO-8'	rlrb	54	83	1.57	3,552	2,268
753	Haynes Elementary	Classroom 27 (X9)	1	2L4' T8/EL	indirect/direct	27	60	2L4' T8 28w/ELEE LO	rlrb	27	42	0.49	1,102	2,268
754	Haynes Elementary	Conference	1	4L4' T8/EL-8'	trof parabolic	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	121	2,088
755	Haynes Elementary	Cafeteria (X18)	1	42W COMPACT HARDWIRED	decorative	108	44	NO RETRO	no change needed		44			2,448
756	Haynes Elementary	Stage	1	2L4' T8/EL	wrap wide	12	60	2L4' T8 28w/ELEE LO	rlrb	12	42	0.22	451	2,088
757	Haynes Elementary	Kitchen	1	4L4' T8/EL	trof acr	18	112	2L4' T8 28w/ELEE HI/RFL	rlrb rfl	18	64	0.86	1,493	1,728
758	Haynes Elementary	Bath Kitch	1	2L4' T8/EL	vapor tight	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	54	2,988
759	Haynes Elementary	Office Kitch	1	2L4' T8/EL	vapor tight	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	38	2,088
760	Haynes Elementary	Storage Dry7 Goods	1	2L4' T8/EL	trof acr	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	69	1,908
761	Haynes Elementary	Office Open Cust	1	2L4' T8/EL	strip	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	132	2,448
762	Haynes Elementary	Mechanical Elect	1	4L4' T8/EL-8'	strip	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	26	450

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
763	Haynes Elementary	Mechanical Boiler	1	2L4' T8/EL	strip	7	60	2L4' T8 28w/ELEE LO	rlrb	7	42	0.13	57	450
764	Haynes Elementary	Office Cust	1	2L4' T8/EL	strip	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	75	2,088
765	Haynes Elementary	Lab Computers	1	2L4' T8/EL	trof parabolic	11	60	2L4' T8 28w/ELEE LO	rlrb	11	42	0.20	412	2,080
766	Haynes Elementary	Lab Computers	1	2L4' T8 U/EL	trof parabolic	1	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	1	40	0.02	42	2,080
767	Haynes Elementary	Classroom A/V 1	1	2L4' T8/EL	wrap wide	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	82	2,268
768	Haynes Elementary	Office Psych	1	2L4' T8/EL	trof parabolic	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	75	2,088
769	Haynes Elementary	Hall 1St Floor	1	2L4' T8 U/EL	trof acr	10	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	10	40	0.20	652	3,258
770	Haynes Elementary	Hall 1St Floor	1	4L4' T8/EL-8'	valance	15	112	4L4' T8 28w/ELEE LO-8'	rlrb	15	83	0.44	1,417	3,258
771	Haynes Elementary	Hall 1St Floor	1	2L4' T8/EL	valance	6	60	2L4' T8 28w/ELEE LO	rlrb	6	42	0.11	352	3,258
772	Haynes Elementary	Hall 1St Floor	1	2x 13W COMPACT HARDWIRED	can rec	56	30	NO RETRO	no change needed		30			3,258
773	Haynes Elementary	Hall 1St Floor	1	2L4' T8/EL-8'	tube light	15	60	2L4' T8 28w/ELEE LO-8'	rlrb	15	42	0.27	880	3,258
774	Haynes Elementary	Hall 1St Floor	1	1L4' T8/EL	tube light	8	30	1L4' T8 28w/ELEE LO	rlrb	8	22	0.06	209	3,258
775	Haynes Elementary	Lobby Main	1	2x 42W COMPACT HARDWIRED /EL	sconce	16	88	NO RETRO	no change needed		88			3,258
776	Haynes Elementary	Office Open Main	1	2x 13W COMPACT HARDWIRED	can rec	4	30	NO RETRO	no change needed		30			2,448
777	Haynes Elementary	Office Open Nurse	1	2L4' T8 U/EL	trof parabolic	1	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	1	40	0.02	49	2,448
778	Haynes Elementary	Office Open Nurse	1	2L4' T8/EL	trof parabolic	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	44	2,448
779	Haynes Elementary	Office Open Nurse	1	2L4' T8/EL	soffit	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	44	2,448
780	Haynes Elementary	Office Princ	1	2L4' T8/EL	trof parabolic	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	75	2,088
781	Haynes Elementary	Bldg Mt	ext	3 WATT LED	wallpack	14	3	NO RETRO	no change needed		3			3,942
782	Haynes Elementary	Bldg Mt	ext	2x 13W COMPACT HARDWIRED	can rec	5	30	NO RETRO	no change needed		30			3,942
783	Haynes Elementary	Bldg Mt	ext	50W METAL HALIDE	wallpack	14	65	NO RETRO	no change needed		65			3,942
784	Haynes Elementary	Parking Lot	ext	250W METAL HALIDE	shoebox pole	8	295	NO RETRO	no change needed		295			3,942
785	Nixon Elementary	Classroom 34	1	4L4' T8/EL-8'	box acrylic	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
786	Nixon Elementary	Classroom 34	1	2L4' T8/EL	box acrylic	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
787	Nixon Elementary	Classroom 19	1	4L4' T8/EL-8'	box acrylic	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
788	Nixon Elementary	Classroom 19	1	2L4' T8/EL	box acrylic	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
789	Nixon Elementary	Classroom 32	1	4L4' T8/EL-8'	box acrylic	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
790	Nixon Elementary	Classroom 32	1	2L4' T8/EL	box acrylic	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
791	Nixon Elementary	Bath Boy'S (X2)	1	2L4' T8/EL-8'	vanity	6	60	2L4' T8 28w/ELEE LO-8'	rlrb	6	42	0.11	323	2,988
792	Nixon Elementary	Bath Boy'S (X2)	1	2L4' T8/EL	soffit	2	60	2L4' T8 28w/ELEE LO	rlrb	2	42	0.04	108	2,988
793	Nixon Elementary	Classroom 30	1	4L4' T8/EL-8'	box acr 1' wide	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
794	Nixon Elementary	Classroom 30	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
795	Nixon Elementary	Classroom 17 B	1	4L4' T8/EL-8'	box acr 1' wide	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
796	Nixon Elementary	Classroom 17 B	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
797	Nixon Elementary	Classroom 28	1	4L4' T8/EL-8'	box acr 1' wide	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
798	Nixon Elementary	Classroom 28	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
799	Nixon Elementary	Classroom 17A	1	4L4' T8/EL-8'	box acr 1' wide	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
800	Nixon Elementary	Classroom 17A	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
801	Nixon Elementary	Classroom 26	1	4L4' T8/EL-8'	box acr 1' wide	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
802	Nixon Elementary	Classroom 26	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
803	Nixon Elementary	Classroom 24	1	4L4' T8/EL-8'	box acr 1' wide	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
804	Nixon Elementary	Classroom 24	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
805	Nixon Elementary	Office Open Learning Center	1	4L4' T8/EL-8'	box acr 1' wide	7	112	4L4' T8 28w/ELEE LO-8'	rlrb	7	83	0.20	497	2,448
806	Nixon Elementary	Storage Av	1	4L4' T8/EL-8'	box acr 1' wide	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	55	1,908
807	Nixon Elementary	Library	1	4L4' T8/EL-8'	soffit	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	263	2,268
808	Nixon Elementary	Library	1	2x 13W COMPACT HARDWIRED	can rec	9	30	NO RETRO	no change needed		30			2,268
809	Nixon Elementary	Library	1	2L4' T8/EL	box acr 1' wide	14	60	2L4' T8 28w/ELEE LO	rlrb	14	42	0.25	572	2,268
810	Nixon Elementary	Library	1	4L4' T8/EL-8'	box acr 1' wide	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	395	2,268
811	Nixon Elementary	Closet Server	1	4L4' T8/EL-8'	box acr 1' wide	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	13	450
812	Nixon Elementary	Closet Server	1	2L4' T8/EL	box acr 1' wide	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	8	450
813	Nixon Elementary	Classroom 22	1	4L4' T8/EL-8'	box acr 1' wide	8	112	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.23	526	2,268

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
814	Nixon Elementary	Classroom 22	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
815	Nixon Elementary	Storage Art	1	4L4' T8/EL-8'	strip reflector	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	13	450
816	Nixon Elementary	Storage Kiln	1	2L4' T8/EL	strip	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	34	1,908
817	Nixon Elementary	Classroom 23	1	4L4' T8/EL-8'	box acr 1' wide	8	112	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.23	526	2,268
818	Nixon Elementary	Classroom 23	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
819	Nixon Elementary	Classroom 21	1	4L4' T8/EL-8'	box acr 1' wide	8	112	4L4' T8 28w/ELEE LO-8'	rlrb	8	83	0.23	526	2,268
820	Nixon Elementary	Classroom 21	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
821	Nixon Elementary	Conference (X2)	1	2x 13W COMPACT HARDWIRED	can rec	8	30	NO RETRO	no change needed		30			2,088
822	Nixon Elementary	Classroom 23 (X2)	1	4L4' T8/EL-8'	box acr 1' wide	24	112	4L4' T8 28w/ELEE LO-8'	rlrb	24	83	0.70	1,579	2,268
823	Nixon Elementary	Bath Boy'S (X2)	1	4L4' T8/EL-8'	soffit	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	173	2,988
824	Nixon Elementary	Bath Boy'S (X2)	1	2L4' T8/EL-8'	vanity	10	60	2L4' T8 28w/ELEE LO-8'	rlrb	10	42	0.18	538	2,988
825	Nixon Elementary	Gym	1	3L4' T5 HO/EL	high bay	8	177	NO RETRO	no change needed		177			2,628
826	Nixon Elementary	Office P.E	1	4L4' T8/EL-8'	box acr 1' wide	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	121	2,088
827	Nixon Elementary	Office P.E	1	2L4' T8/EL	box acr 1' wide	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	38	2,088
828	Nixon Elementary	Classroom 20	1	4L4' T8/EL-8'	box acr 1' wide	16	112	4L4' T8 28w/ELEE LO-8'	rlrb	16	83	0.46	1,052	2,268
829	Nixon Elementary	Classroom 20	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
830	Nixon Elementary	Storage Tech Services	1	4L4' T8/EL-8'	box acr 1' wide	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	55	1,908
831	Nixon Elementary	Storage Tech Services	1	2L4' T8/EL	box acr 1' wide	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	34	1,908
832	Nixon Elementary	Classroom 18	1	4L4' T8/EL-8'	box acr 1' wide	16	112	4L4' T8 28w/ELEE LO-8'	rlrb	16	83	0.46	1,052	2,268
833	Nixon Elementary	Classroom 18	1	2L4' T8/EL	box acr 1' wide	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	163	2,268
834	Nixon Elementary	Classroom 1	1	4L4' T8/EL-8'	box acr 1' wide	10	112	4L4' T8 28w/ELEE LO-8'	rlrb	10	83	0.29	658	2,268
835	Nixon Elementary	Classroom 2 (X14)	1	4L4' T8/EL-8'	box acr 1' wide	140	112	4L4' T8 28w/ELEE LO-8'	rlrb	140	83	4.06	9,208	2,268
836	Nixon Elementary	Office Open Speech	1	4L4' T8/EL-8'	box acr 1' wide	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	142	2,448
837	Nixon Elementary	Office Speech	1	2L4' T8/EL	wrap	3	60	2L4' T8 28w/ELEE LO	rlrb	3	42	0.05	113	2,088
838	Nixon Elementary	Bath Boy'S (X2)	1	4L4' T8/EL-8'	box acr 1' wide	4	112	4L4' T8 28w/ELEE LO-8'	rlrb	4	83	0.12	347	2,988
839	Nixon Elementary	Closet Cust	1	4L4' T8/EL-8'	strip reflector	1	112	4L4' T8 28w/ELEE LO-8'	rlrb	1	83	0.03	13	450
840	Nixon Elementary	Office Open Main	1	2L4' T8/EL	wrap	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	44	2,448
841	Nixon Elementary	Office Open Main	1	23W COMPACT HARDWIRED /EL	dome	4	25	NO RETRO	no change needed		25			2,448
842	Nixon Elementary	Office Priunc	1	4L4' T8/EL-8'	box acr 1' wide	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	121	2,088
843	Nixon Elementary	Cafeteria	1	3L4' T5 HO/EL	high bay	15	177	NO RETRO	no change needed		177			2,448
844	Nixon Elementary	Stage	1	2L4' T8 U/EL	trof minicube	4	60	2L2' T8 15w/ELEE HI/RFL	rlrb rfl	4	40	0.08	167	2,088
845	Nixon Elementary	Kitchen	1	3L4' T8/EL	trof acr	10	88	3L4' T8 28w/ELEE LO	rlrb	10	63	0.25	432	1,728
846	Nixon Elementary	Conference By Main Office	1	4L4' T8/EL-8'	box acr 1' wide	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	121	2,088
847	Nixon Elementary	Office Open Nurse	1	4L4' T8/EL-8'	box acr 1' wide	3	112	4L4' T8 28w/ELEE LO-8'	rlrb	3	83	0.09	213	2,448
848	Nixon Elementary	Storage Supplies	1	2L4' T8/EL	box acrylic	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	34	1,908
849	Nixon Elementary	Mechanical Boiler	1	42W COMPACT HARDWIRED	dome	4	44	NO RETRO	no change needed		44			450
850	Nixon Elementary	Bath Staff	1	2L4' T8/EL	box acr 1' wide	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	54	2,988
851	Nixon Elementary	Lounge Staff	1	4L4' T8/EL-8'	box acr 1' wide	2	112	4L4' T8 28w/ELEE LO-8'	rlrb	2	83	0.06	142	2,448
852	Nixon Elementary	Lounge Staff	1	2L4' T8/EL	box acr 1' wide	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	44	2,448
853	Nixon Elementary	Office By Teachers Lounge	1	2L4' T8/EL	box acrylic	1	60	2L4' T8 28w/ELEE LO	rlrb	1	42	0.02	38	2,088
854	Nixon Elementary	Conference By Teachers Lounge	1	3L4' T8/EL	trof acr	8	88	3L4' T8 28w/ELEE LO	rlrb	8	63	0.20	418	2,088
855	Nixon Elementary	Office Open Cust	1	2L4' T8/EL	wrap	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	176	2,448
856	Nixon Elementary	Hall 1St Floor	1	2L4' T8/EL	box acr 1' wide	47	60	2L4' T8 28w/ELEE LO	rlrb	47	42	0.85	2,756	3,258
857	Nixon Elementary	Hall 1St Floor	1	2x 13W COMPACT HARDWIRED	can rec	17	30	NO RETRO	no change needed		30			3,258
858	Nixon Elementary	Hall 1St Floor	1	4L4' T8/EL-8'	soffit	6	112	4L4' T8 28w/ELEE LO-8'	rlrb	6	83	0.17	567	3,258
859	Nixon Elementary	Hall 1St Floor	1	2L4' T8/EL	soffit	4	60	2L4' T8 28w/ELEE LO	rlrb	4	42	0.07	235	3,258
860	Nixon Elementary	Hall 1St Floor	1	13W COMPACT HARDWIRED	jar	28	15	NO RETRO	no change needed		15			3,258
861	Nixon Elementary	Hall 1St Floor	1	4L3' T8/EL-6'	box acr 1' wide	28	88	4L3' T8 21w/ELEE LO-6'	rlrb	28	80	0.22	730	3,258
862	Nixon Elementary	Bldg Mt	ext	2x 26W COMPACT HARDWIRED /EL	square surface mt.	10	54	NO RETRO	no change needed		54			3,942
863	Nixon Elementary	Bldg Mt	ext	2x 26W COMPACT HARDWIRED /EL	wallpack	2	54	NO RETRO	no change needed		54			3,942
864	Nixon Elementary	Bldg Mt	ext	3 WATT LED	wallpack	1	3	NO RETRO	no change needed		3			3,942

Line	Building Name	Location	Fl	Pre Fixture Description	Pre Fixture Style	Pre Qty	Pre Watts	Post Fixture Description	Post Fixture Style	Post Qty	Post Watts	kW Saved	kWh Saved	Annual Hours
865	Nixon Elementary	Bldg Mt	ext	26W COMPACT HARDWIRED	jar	60	28	NO RETRO	no change needed		28			3,942
866	Nixon Elementary	Bldg Mt	ext	50W METAL HALIDE	wrap	4	65	NO RETRO	no change needed		65			3,942
Totals												**79.01**	**202,359**	

Appendix for ECM 1: Lighting System Improvements

II. Manufacturer Specification Sheets

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OCTRON® 800 XP® SUPERSAVER® ECOLOGIC®3

EXtended Performance Fluorescent Lamps

The OCTRON 800 XP SUPERSAVER T8 fluorescent offering includes a full complement of lengths and wattages, ensuring there is an energy-saving lamp to satisfy nearly all applications. These lamps operate on standard T8 instant start systems and provide up to 22 percent energy savings over 32 Watt lamps. At 11¢/kWh and 4000 hours of operation per year, the 22 percent energy savings translate to a savings of $12.32 per fixture per year for a 4-lamp fixture. The initial lumen output, lumen maintenance and high color rendering of the OCTRON 800 XP SUPERSAVER/ECO3 lamps help ensure that lighting quality is maintained while energy is saved. These lamps pass the Federal TCLP test, classifying them as non-hazardous waste in most states and feature lead-free glass, bases and manufacturing process, reducing overall environmental impact.

For optimal performance and system warranty, pair with QUICKTRONIC® electronic ballast systems.

Key Features & Benefits

- Energy savings compared to standard 32W T8 lamp
  - 22% with the 25W XP®/SS
  - 12% with the 28W XP®/SS
  - 6% with the 30W XP®/SS
- 94% mean lumens
- Lead free
- Made in the USA
- Dimmable (see application note 5)
- TCLP and RoHS compliant
- Retrofit lamp for existing T8 instant start systems
  - 40,000 hours rated life @ 12 hours per start
- Increased life on SYLVANIA QUICKTRONIC® PROStart® PSX and PSN programmed rapid start ballasts
  - 42,000 hours rated life @ 12 hours per start
- QUICK60+® system warranty when lamps are paired with QUICKTRONIC electronic ballasts

SYLVANIA OCTRON ECOLOGIC3 T8 fluorescent lamps pass the Federal Toxic Characteristic Leaching Procedure (TCLP)[1] criteria for classification as non-hazardous waste in most states[2].

ECOLOGIC3 represents a more comprehensive approach to sustainability encompassing high efficiency, long life and RoHS/TCLP compliance.

1. TCLP test results are based on NEMA LL Series standards and are available on request.
2. Lamp disposal regulations may vary; check your local & state regulations.

MADE IN USA

LEAD-FREE

RoHS compliant
This light source meets restrictions on hazardous substances.

ecologic3

Product Offering

Lamp Type	Wattage	CCT
F017/15W/800XP/SS/ECO3	15	3000K, 3500K, 4100K, 5000K
F025/21W/800XP/SS/ECO3	21	3000K, 3500K, 4100K, 5000K
F032/25W/800XP/SS/ECO3	25	3000K, 3500K, 4100K, 5000K
F028/800XP/SS/ECO3	28	3000K, 3500K, 4100K, 5000K
F030/800XP/SS/ECO3	30	3000K, 3500K, 4100K, 5000K
F032/25W/800/XP/XL/SS/ECO3	25	3000K, 3500K, 4100K
F028/800/XP/XL/SS/ECO3	28	3000K, 3500K, 4100K, 5000K
F096/50W/800/XP/SS/ECO3	50	3500K, 4100K, 5000K
F096/54W/800/XP/SS/ECO3	54	3500K, 4100K, 5000K

Application Information

Applications

- Cove
- Direct/indirect luminaires
- Recessed troffers
- Schools
- Valance

Application Notes

1. F025, F028 and F030 SUPERSAVER lamps are recommended to be used on F32T8 instant start ballast with minimum open circuit voltage of 550V RMS at the lamp.
   a. Electronically ballasted fixture configurations which operate lamps remotely, such as Master/Satellite applications, can cause reduction of lamp open circuit voltage, in the remote fixture, below the minimum required for reliable lamp starting. For more information, please call 1-800-LIGHTBULB and ask for Ballast Technical Assistance or call your fixture manufacturer.
   b. Not recommended to be used: (1) in remotely ballasted fixtures with lamp open circuit voltages below 550V, (2) in air handling fixtures, (3) on low power factor ballasts or (4) inverter operated emergency lighting systems unless any of the above equipment is specifically listed for SUPERSAVER (SS) lamps. Any of the above situations could result in lamp starting and stabilization problems, or system compatibility issues.
2. F096 SUPERSAVER lamps are recommended to be used on F96T8 instant start ballast with minimum open circuit voltage of 725V.
3. If a 28W SUPERSAVER lamp is exposed to drafts or the ambient temperature falls below 60°F (70°F for 25W), striation (a rhythmic pulsing pattern of light running down the tube) and/or reduction in lamp brightness may occur. While visually disconcerting, neither behavior is damaging to the lamp and removing the cause (draft or temperature) will return the lamp to normal operation.
4. Fixture must conform to ANSI C78.81–2005 requirements for luminaire design.
5. F096 types are not dimmable. For all other types, contact OSRAM SYLVANIA for approved dimming ballasts.

SEE THE WORLD IN A NEW LIGHT SYLVANIA

Specification Data

Fixture Description:

Type

Project/Job:

SYLVANIA lamp:

SYLVANIA ballast:

Notes:

Ordering Information

							Average Rated Life					
							Instant Start		Prog. Rapid Start			
Item Number	Ordering Abbreviation	Watts	Nominal Length (in)	Initial Lumens	Mean Lumens[1]	Lumens per Watt	3 hrs/ start	12 hrs/ start	3 hrs/ start	12 hrs/ start	CCT	CRI
OCTRON® 800 XP® SUPERSAVER®												
22405	F017/15W/830/XP/SS/ECO3	15	24	1200	1130	80	24,000	40,000	40,000	42,000	3000K	85
22406	F017/15W/835/XP/SS/ECO3	15	24	1200	1130	80	24,000	40,000	40,000	42,000	3500K	85
22407	F017/15W/841/XP/SS/ECO3	15	24	1200	1130	80	24,000	40,000	40,000	42,000	4100K	85
22408	F017/15W/850/XP/SS/ECO3	15	24	1200	1130	80	24,000	40,000	40,000	42,000	5000K	81
22394	F025/21W/830/XP/SS/ECO3	21	36	1925	1810	92	24,000	40,000	40,000	42,000	3000K	85
22395	F025/21W/835/XP/SS/ECO3	21	36	1925	1810	92	24,000	40,000	40,000	42,000	3500K	85
22396	F025/21W/841/XP/SS/ECO3	21	36	1925	1810	92	24,000	40,000	40,000	42,000	4100K	85
22397	F025/21W/850/XP/SS/ECO3	21	36	1925	1810	92	24,000	40,000	40,000	42,000	5000K	81
22232	F032/25W/830/XP/SS/ECO3	25	48	2500	2350	100	24,000	40,000	40,000	42,000	3000K	85
22233	F032/25W/835/XP/SS/ECO3	25	48	2500	2350	100	24,000	40,000	40,000	42,000	3500K	85
22234	F032/25W/841/XP/SS/ECO3	25	48	2500	2350	100	24,000	40,000	40,000	42,000	4100K	85
22235	F032/25W/850/XP/SS/ECO3	25	48	2500	2350	100	24,000	40,000	40,000	42,000	5000K	81
22177	F028/830/XP/SS/ECO3	28	48	2725	2560	97	24,000	40,000	40,000	42,000	3000K	85
22178	F028/835/XP/SS/ECO3	28	48	2725	2560	97	24,000	40,000	40,000	42,000	3500K	85
22179	F028/841/XP/SS/ECO3	28	48	2725	2560	97	24,000	40,000	40,000	42,000	4100K	85
22184	F028/850/XP/SS/ECO3	28	48	2725	2560	97	24,000	40,000	40,000	42,000	5000K	81
22063	F030/830/XP/SS/ECO3	30	48	2850	2680	95	24,000	40,000	40,000	42,000	3000K	85
22060	F030/835/XP/SS/ECO3	30	48	2850	2680	95	24,000	40,000	40,000	42,000	3500K	85
22062	F030/841/XP/SS/ECO3	30	48	2850	2680	95	24,000	40,000	40,000	42,000	4100K	85
22202	F030/850/XP/SS/ECO3	30	48	2850	2680	95	24,000	40,000	40,000	42,000	5000K	81
OCTRON 800 XP XL SUPERSAVER												
22349	F032/25W/830/XP/XL/SS/ECO3	25	48	2400	2305	96	36,000	52,000	60,000	62,000	3000K	85
22222	F032/25W/835/XP/XL/SS/ECO3	25	48	2400	2305	96	36,000	52,000	60,000	62,000	3500K	85
22223	F032/25W/841/XP/XL/SS/ECO3	25	48	2400	2305	96	36,000	52,000	60,000	62,000	4100K	85
21528	F028/830/XP/XL/SS/ECO3	28	48	2600	2495	93	36,000	52,000	60,000	62,000	3000K	85
22166	F028/835/XP/XL/SS/ECO3	28	48	2600	2495	93	36,000	52,000	60,000	62,000	3500K	85
22167	F028/841/XP/XL/SS/ECO3	28	48	2600	2495	93	36,000	52,000	60,000	62,000	4100K	85
22326	F028/850/XP/XL/SS/ECO3	28	48	2600	2495	93	36,000	52,000	60,000	62,000	5000K	81
OCTRON F096 XP SUPERSAVER												
22420	F096/50W/835/XP/SS/ECO3	50	96	5400	5075	108	24,000	36,000			3500K	85
22421	F096/50W/841/XP/SS/ECO3	50	96	5400	5075	108	24,000	36,000			4100K	85
22422	F096/50W/850/XP/SS/ECO3	50	96	5400	5075	108	24,000	36,000			5000K	81
22100	F096/54W/835/XP/SS/ECO3	54	96	5700	5360	106	24,000	36,000			3500K	85
22101	F096/54W/841/XP/SS/ECO3	54	96	5700	5360	106	24,000	36,000			4100K	85
22347	F096/54W/850/XP/SS/ECO3	54	96	5700	5360	106	24,000	36,000			5000K	81

1. Measured at 40% of rated life.

Ordering Guide

FO	30	/	8	35	XP or XL	/	SS	/	ECO3
Fluorescent OCTRON	Actual Wattage 15, 21,25, 28, 30, 50 and 54		Actual CRI 80 or 85	Color Temperature 30 = 3000K CCT, 35 = 3500K CCT 41 = 4100K CCT, 50 = 5000K CCT	XP=E**X**tended **P**erformance XL=**EX**treme **L**ife		SUPERSAVER		ECOLOGIC3

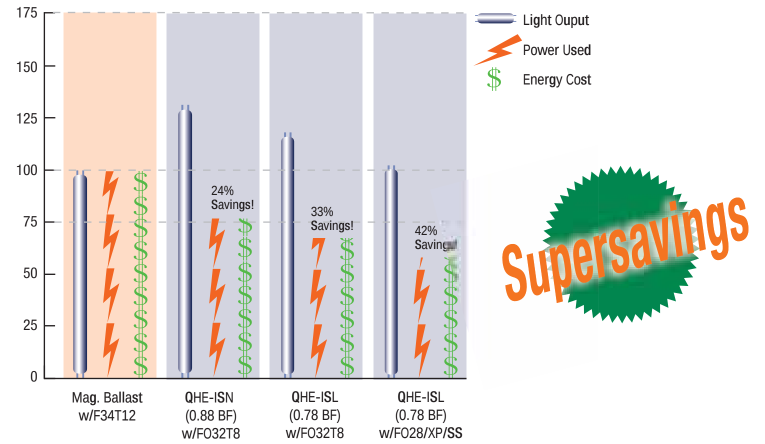
QHE High Efficiency Instant Start

NEMA Premium

QUICKTRONIC® High Efficiency QHE instant start ballasts operate OCTRON® T8 lamps with maximum efficacy and high lumen output, while providing **30-60% energy savings** when compared to F40T12 magnetic systems. The **QHE** energy saving electronic T8 ballasts save an additional 6% over standard electronic ballasts without compromising light output or lamp life, thus allowing for a quicker payback.

QHE-IS: High Efficiency Series utilizes high grade components and optimized ballast design, to ensure that >90% of the system power is provided to the lamps. Enhanced efficiency inductors and semiconductors play a critical role.

TYPICAL SAVINGS QHE-IS: Two Lamp



Based on 4000 operating hours per year with energy cost of $0.10/kWh

Magnetic T12 system: 'Energy Saving' T12 Magnetic ballast with F34T12CW lamps

Electronic T8 systems: 0.88 & 0.78 ballast factor – High Efficiency Instant Start ballast with FO32T8/800/XPS/ECO and FO28T8/800/XP/SS/ECO lamps

Key System Features:

- Highest ballast efficiency – over 90%
- NEMA Premium Ballast Program Compliant
- Highest system efficiency available
- Lowest power instant start systems
- Universal input voltage (120-277V)
- 30-60% energy savings
- SAME LIGHT, LESS POWER
- Available ballast factors:
  - – Low (0.78)
  - – Normal (0.88)
  - – High (1.15-1.20)

Applications:

- Meeting stringent energy codes
- Energy retrofits
- Commercial & retail
- Hospitality & institutional

QUICKTRONIC® High Efficiency T8 Systems

NEMA Premium

32 T8 Instant Start Universal Voltage (120-277V)

Item Number	OSRAM SYLVANIA Description	Input Current (AMPS) @120/277V	ecologic3 Lamp Type [1]	Rated Lamp Lumens (lm)	No. of Lamps	Ballast Factor (BF)	Initial System Lumens	Mean System Lumens	Input Power (W) @120/277V	System Efficacy (lm/W) @120/277V	BEF [2]
LOW BALLAST FACTOR											
	QHE 1x32T8/UNV ISL-SC	0.21/0.09	F032/XPS	3100	1	0.78	2420	2275	25	97	3.12
49837	*Banded Pack*	0.19/0.08	F028XP/SS	2725	1	0.78	2125	2000	22	97	3.55
49861	*10-Pack*	0.19/0.08	F028XP/XL/SS	2600	1	0.78	2030	1945	22	92	3.55
49862	*Pallet Pack*	0.17/0.08	F032/25W/XP/SS	2475	1	0.78	1930	1815	20	97	3.90
		0.17/0.08	F032/25W/XP/XL/SS	2400	1	0.78	1870	1795	20	94	3.90
	QHE 2x32T8/UNV ISL-SC	0.41/0.18	F032/XPS	3100	2	0.78	4835	4545	48	101	1.63
49838	*Banded Pack*	0.35/0.15	F028XP/SS	2725	2	0.78	4250	3995	42	101	1.86
49863	*10-Pack*	0.35/0.15	F028XP/XL/SS	2600	2	0.78	4055	3895	42	97	1.86
49864	*Pallet Pack*	0.32/0.14	F032/25W/XP/SS	2475	2	0.78	3860	3630	38	102	2.05
		0.32/0.14	F032/25W/XP/XL/SS	2400	2	0.78	3745	3595	38	99	2.05
	QHE 3x32T8/UNV ISL-SC	0.61/0.27	F032/XPS	3100	3	0.78	7255	6820	73/72	99/101	1.08
49839	*Banded Pack*	0.53/0.23	F028XP/SS	2725	3	0.78	6380	5995	63	101	1.24
49865	*10-Pack*	0.53/0.23	F028XP/XL/SS	2600	3	0.78	6085	5840	63	97	1.24
49866	*Pallet Pack*	0.48/0.21	F032/25W/XP/SS	2475	3	0.78	5790	5445	57	102	1.37
		0.48/0.21	F032/25W/XP/XL/SS	2400	3	0.78	5615	5390	57	99	1.37
	QHE 4x32T8/UNV ISL-SC	0.80/0.35	F032/XPS	3100	4	0.78	9670	9090	95	102	0.82
49840	*Banded Pack*	0.71/0.31	F028XP/SS	2725	4	0.78	8500	7990	84	101	0.93
49867	*10-Pack*	0.71/0.31	F028XP/XL/SS	2600	4	0.78	8110	7790	84	97	0.93
49868	*Pallet Pack*	0.62/0.27	F032/25W/XP/SS	2475	4	0.78	7720	7260	76/75	102/103	1.04
		0.62/0.27	F032/25W/XP/XL/SS	2400	4	0.78	7490	7190	76/75	99/100	1.04
NORMAL BALLAST FACTOR											
	QHE 1x32T8/UNV ISN-SC	0.25/0.11	F032/XPS	3100	1	0.88	2730	2565	28	98	3.14
49968	*Banded Pack*	0.21/0.09	F028XP/SS	2725	1	0.88	2400	2255	25	96	3.52
49851	*10-Pack*	0.21/0.09	F028XP/XL/SS	2600	1	0.88	2290	2195	25	92	3.52
49852	*Pallet Pack*	0.19/0.09	F032/25W/XP/SS	2475	1	0.88	2175	2045	22	99	4.00
		0.19/0.09	F032/25W/XP/XL/SS	2400	1	0.88	2110	2030	22	96	4.00
	QHE 2x32T8/UNV ISN-SC	0.47/0.20	F032/XPS	3100	2	0.88	5455	5130	55	99	1.60
49969	*Banded Pack*	0.40/0.18	F028XP/SS	2725	2	0.88	4800	4510	48	100	1.83
49853	*10-Pack*	0.40/0.18	F028XP/XL/SS	2600	2	0.88	4575	4395	48	95	1.83
49854	*Pallet Pack*	0.36/0.16	F032/25W/XP/SS	2475	2	0.88	4355	4095	43	101	2.05
		0.36/0.16	F032/25W/XP/XL/SS	2400	2	0.88	4225	4055	43	98	2.05
	QHE 3x32T8/UNV ISN-SC	0.69/0.30	F032/XPS	3100	3	0.88	8185	7695	83/82	99/100	1.07
49970	*Banded Pack*	0.61/0.26	F028XP/SS	2725	3	0.88	7195	6760	72	100	1.22
49855	*10-Pack*	0.61/0.26	F028XP/XL/SS	2600	3	0.88	6865	6590	72	95	1.22
49856	*Pallet Pack*	0.55/0.23	F032/25W/XP/SS	2475	3	0.88	6530	6140	65/64	101/102	1.38
		0.55/0.23	F032/25W/XP/XL/SS	2400	3	0.88	6335	6085	65/64	97/99	1.38
	QHE 4x32T8/UNV ISN-SC	0.91/0.39	F032/XPS	3100	4	0.88	10,910	10,255	108/107	101/102	0.82
49971	*Banded Pack*	0.80/0.35	F028XP/SS	2725	4	0.88	9590	9015	95	101	0.93
49857	*10-Pack*	0.80/0.35	F028XP/XL/SS	2600	4	0.88	9150	8785	95	96	0.93
49858	*Pallet Pack*	0.71/0.30	F032/25W/XP/SS	2475	4	0.88	8710	8190	85	102	1.04
		0.71/0.30	F032/25W/XP/XL/SS	2400	4	0.88	8450	8110	85	99	1.04
HIGH BALLAST FACTOR											
	QHE 1x32T8/UNV ISH-SC	0.32/0.14	F032/XPS	3100	1	1.20	3720	3495	38	98	3.16
49919	*Banded Pack*	0.27/0.12	F028XP/SS	2725	1	1.20	3270	3075	33	99	3.64
49871	*10-Pack*	0.27/0.12	F028XP/XL/SS	2600	1	1.20	3120	2995	33	95	3.64
49872	*Pallet Pack*	0.26/0.12	F032/25W/XP/SS	2475	1	1.20	2970	2790	30	99	4.00
		0.26/0.12	F032/25W/XP/XL/SS	2400	1	1.20	2880	2765	30	96	4.00
	QHE 2x32T8/UNV ISH-SC	0.65/0.28	F032/XPS	3100	2	1.20	7440	6995	74/73	101/102	1.64
49920	*Banded Pack*	0.55/0.23	F028XP/SS	2725	2	1.20	6540	6150	65/64	101/102	1.88
49873	*10-Pack*	0.55/0.23	F028XP/XL/SS	2600	2	1.20	6240	5990	65/64	96/98	1.88
49874	*Pallet Pack*	0.50/0.22	F032/25W/XP/SS	2475	2	1.20	5940	5585	58/57	102/104	2.11
		0.50/0.22	F032/25W/XP/XL/SS	2400	2	1.20	5760	5530	58/57	99/101	2.11
	QHE 3x32T8/UNV ISH-SC	0.93/0.40	F032/XPS	3100	3	1.18	10,975	10,315	111/109	99/101	1.08
49921	*Banded Pack*	0.82/0.35	F028XP/SS	2725	3	1.18	9650	9070	98/96	98/101	1.23
49875	*10-Pack*	0.82/0.35	F028XP/XL/SS	2600	3	1.18	9205	8835	98/96	94/96	1.23
49876	*Pallet Pack*	0.72/0.31	F032/25W/XP/SS	2475	3	1.18	8760	8235	87/86	101/102	1.37
		0.72/0.31	F032/25W/XP/XL/SS	2400	3	1.18	8495	8155	87/86	98/99	1.37
	QHE 4x32T8/UNV ISH	1.21/0.52	F032/XPS	3100	4	1.15	14,260	13,405	144/141	99/101	0.82
49922	*Banded Pack*	1.06/0.46	F028XP/SS	2725	4	1.15	12,535	11,785	127/124	99/101	0.93
49877	*10-Pack*	1.06/0.46	F028XP/XL/SS	2600	4	1.15	11,960	11,480	127/124	94/96	0.93
49878	*Pallet Pack*	0.94/0.41	F032/25W/XP/SS	2475	4	1.15	11,385	10,700	112/111	102/103	1.04
		0.94/0.41	F032/25W/XP/XL/SS	2400	4	1.15	11,040	10,600	112/111	99/100	1.04

1: CEE compliant lamps 2: Ballast Efficiency Factor (BEF) shown = (Ballast Factor x 100) divided by Input Power (Note: calculation based on lowest wattage value).

Instant Start QHE ballasts operate additional T8 lamp types. Complete performance data is in the Ballast Technology Applications & Specification Guide and at www.sylvania.com

ecologic3

SYLVANIA OCTRON® ECOLOGIC3 fluorescent lamps are designed to satisfy the Federal Toxicity Characteristic Leaching Procedure (TCLP) criteria for classification as non-hazardous waste in most states.* ECOLOGIC3 represents a more comprehensive approach to sustainability encompassing high efficiency, long life and RoHS/TCLP compliance. *Regulations may vary. Check your local and state regulations.

NEMA Premium

NEMA Premium Ballast (NPB) program compliant. The NPB program promotes the use of high efficiency T8 electronic ballasts by meeting or exceeding the Ballast Efficiency Factors, (BEF) established by the CEE, (Consortium for Energy Efficiency). For additional information on this program go to: www.cee1.org or www.nema.org

The QUICK60+® System Warranty

It's the simple way to make sure you're completely covered Just call 1-800-LIGHTBULB

Simply better coverage

QUICK60+® is the industry's original and most comprehensive system warranty, providing coverage for QUICKTRONIC® ballasts and the SYLVANIA lamps they power. As the originator of the System Solution,® we have unparalleled lamp and ballast technology — within one company — that enables us to produce systems that perform better and are more reliable. Of course we design our ballasts and lamps to be compatible with other manufacturers' products and back their operation accordingly, but our systems approach allows us to back our systems with a warranty that simply gives you better coverage.

It starts with the ballast. When you purchase any QUICKTRONIC ballast, it's warranted for a period of up to 60 months. Then, when you add SYLVANIA lamps, you benefit from additional coverage for those lamps; that's the PLUS.

More combinations and wider applications provide the broadest range of coverage available in the industry. Another benefit comes each time you group relamp, as the lamp portion of the warranty will extend for an additional term. In short, if you have SYLVANIA ballasts and lamps, you're covered — it's that simple.

Simply peace of mind

When you specify SYLVANIA electronic ballasts and lamps, your installation will enjoy the highest available levels of performance, and you will enjoy the added benefit of peace of mind. If there is an issue, you'll never need to worry about whether it's the lamp or it's the ballast, and you won't get caught in the middle of solving the problem (we may argue with ourselves, but you won't have to!). All it takes is a phone call and you can get back to business. The bottom line is these are our products, and we stand behind them as no one else can.

For lamp replacements OSRAM SYLVANIA will send lamps to your facility (NO LABOR FOR LAMPS).

Simply better service

Only QUICK60+offers you a choice of three service options to resolve warranty claims for ballasts, including our unique "Fixtureside Assistance℠" program from our own nation-wide service organization, SYLVANIA Lighting Services. At our discretion, we will dispatch a trained technician to make a service call to resolve any issues with our products. Our people taking care of our products ensure that you get the level of expert service you deserve. Of course, OSRAM SYLVANIA can also coordinate ballast replacement with an independent service provider, or you can manage the replacement yourself and we will determine labor reimbursement costs. OSRAM SYLVANIA will determine which option best suits your needs to make sure you're covered.

The QUICK60+® warranty is simple to put to work. If you have SYLVANIA electronic ballasts and lamps — you're covered. Just call 1-800-LIGHTBULB (1-800-544-4828) and request warranty service. Any installation of QUICKTRONIC® ballasts and SYLVANIA brand lamps is covered by QUICK60+ for periods defined in the warranty and by the date codes incorporated on all of our products. As an added value, by simply registering the installation, all warranty periods will be defined by the actual date of installation providing complete assurance that you'll receive the coverage you deserve. If there's ever a problem, it's not a problem — you won't have to look up old records and worry about who's responsible. It's that simple.

QUICK60+® LIMITED WARRANTY

The Heart of a Comprehensive System Service Program

Compare lighting system warranties – you'll see that our QUICK60+ warranty offers better coverage, more service options and, more important, peace of mind.

Combination Lamp and Ballast System Limited Warranty

OSRAM SYLVANIA Products Inc. ("OSPI") warrants SYLVANIA lamps installed on QUICKTRONIC® ballasts to be free from defects in material and workmanship and to operate from the date of installation (or date of manufacture if installation date is not known or available) for the time periods and subject to the Terms and Conditions specified below. If lamps fail to operate for the warranty period, OSPI will provide a free replacement lamp *(but no labor allowance).* If a QUICKTRONIC ballast fails to operate within the warranty period, OSPI will provide a free replacement ballast and labor allowance in accordance with the "Labor Options" set forth below.

System[3,4]	**Lamp**	**Ballast Warranty Period**[8]	**Lamp Warranty Period***
QUICKTRONIC® T8[1]	OCTRON XPS®, XP & XP/SS[2, 3]	60 mos.	36 mos.
QUICKTRONIC T8[1]	OCTRON XP/XL & XP/XL/SS family	60 mos.	48 mos.
QUICKTRONIC T8[1]	OCTRON family	60 mos.	30 mos.
QUICKTRONIC T8 High Ambient[1, 9]	OCTRON XP, XP/SS[2, 3]	36/60mos.@<90°/70°C	36 mos.
QUICKTRONIC 59	OCTRON FO96/XP, FO96/XP/SS	60 mos.	30 mos.
QUICKTRONIC 59	OCTRON FO96	60 mos.	24 mos.
QUICKTRONIC 86/T8HO High Ambient[1]	OCTRON FO96HO	36/60mos.@<90°/70°C	30 mos.
QUICKTRONIC 96IS/96HO & 40T12	N/A	60 mos.	N/A
QUICKTRONIC T5[1], T5/HO[1]	PENTRON® Family	60 mos.	24 mos.
QUICKTRONIC 54T5HO[1] High Ambient	PENTRON® FP54/HO, FP54/C/HO	36/60 mos.@<90°/70°C	36 mos.
QUICKTRONIC 54T5/HO[1]	PENTRON® FP54/HO, FP54/C/HO	60 mos.	36 mos.
QUICKTRONIC 54PHO & DL40	DULUX® FT55DL, FT40DL & FT40/28SS	60 mos.	12 mos.
QUICKTRONIC CF[1]	DULUX® D/E, T/E, T/E/IN, T/E/C	60 mos.	12 mos.
QUICKTRONIC FM	FM	24 mos.	6 mos.
QUICKTRONIC ICE[1, 5]	ICETRON®	60 mos.	60 mos.
QUICKTRONIC MH[7]	METALARC® Family[6] (7K-12K hrs. avg. rated life)	36/60 mos.	6 mos.
QUICKTRONIC MH[7]	METALARC® Family[6] (15K-20K hrs. avg. rated life)	36/60 mos.	12 mos.

***NOTE:** Fluorescent lamp warranty periods are based on a 3 hour minimum cycle, unless otherwise noted, with a maximum of 4000 hours per year. Other operating cycles may affect warranty period. Lamp warranty can renew when installation is group relamped, contact OSRAM SYLVANIA for details.

[1] **Occupancy sensor application, 15 minute/start minimum, allowed with QUICKTRONIC PROStart® and with QUICKTRONIC ICE ballasts.**

[2] OCTRON SUPERSAVER® bipin lamps operate on Instant Start & PROStart (non-dimming) models only.

[3] **QUICKTRONIC, Professional Series and High Efficiency Series including all IS, PS & DIM models where applicable.**

[4] **Labor options must be pre-approved by OSPI. Any labor option or cost that is not pre-approved will not be eligible for reimbursement.**

[5] ICETRON Lamp Warranty Period allows up to 8760 hrs per year (continuous operation).

[6] Contact OSRAM SYLVANIA for detailed specifications of METALARC® lamps.

[7] QUICKTRONIC MH ballasts warranty is 36 or 60 months, depending on maximum case temperature. Refer to product specifications for details. Electronic HID system warranty period is based on a minimum cycle of 10hr/start up to a maximum operation of 6,000 hours/year.

[8] **Maximum Case Temperature <70°C, for normal environmental operating conditions (40°C max. ambient) unless noted. Refer to product specifications for details.**

[9] QUICKTRONIC T8 High Ambient (HT) Series

TERMS AND CONDITIONS

SYLVANIA lamps and QUICKTRONIC ballasts must be installed together as a system and be installed and operated under suitable environmental conditions and in accordance with the latest National Electrical Code, Underwriters Laboratory Bulletins, and ANSI Specifications. **This warranty will not apply in the event of conditions demonstrating abnormal use or stress, such as operating temperatures in excess of maximum rated temperatures, under/over voltage conditions, excessive switching cycles (see above Note #1) or operating hours, dirty or cracked sockets, or improper lamp or ballast installation.** Replacement of SYLVANIA lamps with lamps of other manufacturers will void the lamp portion of this warranty. Replacement of the QUICKTRONIC ballast with any other ballast will void the entire warranty.

WARRANTY ACTIVATION / SERVICE CLAIMS

The QUICK 60+ warranty is automatically activated after OSPI receives a completed QUICK 60+ warranty registration form within 30 days after installation. An acknowledgment will be sent for each registration along with a reference number for future correspondence. Service claims can be made by contacting 1-800-LIGHTBULB to initiate the process for problem resolution.

LABOR OPTIONS (Ballast and ICETRON lamps only)

No labor allowance is made for any lamp replacement except ICETRON, during the warranty period. OSPI provides for several labor options for service under the QUICK 60+ warranty program.

1. OSPI will provide full service coverage through SYLVANIA LIGHTING SERVICES at no cost to the user of the ballast, or
2. OSPI will contact a service provider and coordinate replacement at no cost to the user of the ballast, or
3. OSPI will reimburse the purchaser reasonable, customary and necessary labor charges required to install the ballast replacement.
4. **Labor options must be pre-approved by OSPI. Any labor option or cost that is not pre-approved will not be eligible for reimbursement.**

RETURN OF DEFECTIVE PRODUCT

After contacting OSRAM SYLVANIA and receiving a return AUTHORIZATION NUMBER, the user shall promptly return the product at the user's expense to OSRAM SYLVANIA after receiving instructions as to if, when and where to ship product. Failure to follow this procedure shall void this warranty.

REPLACEMENT OF PRODUCT, LIMITS OF LIABILITY

The foregoing shall constitute the sole and exclusive remedy of the purchaser and the sole and exclusive liability of OSPI. NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE OR IS TO BE IMPLIED. OSPI will not, under any circumstance, whether as a result of breach of contract or warranty, tort, or otherwise, be liable for any incidental, special or consequential damages, including lost profits or revenues or any other costs or damages.

OSPI reserves the right to examine all failed lamps and/or ballasts and reserves the right to be the sole judge as to whether any lamps and/or ballasts are defective and covered under this warranty.

Category: ECS
Energy Conservation Series

Prefix:
LPW

Fixture Series (Name):
Low Profile Wrap

RENOVA™
Innovative Lighting Ideas
Energy Efficient Solutions

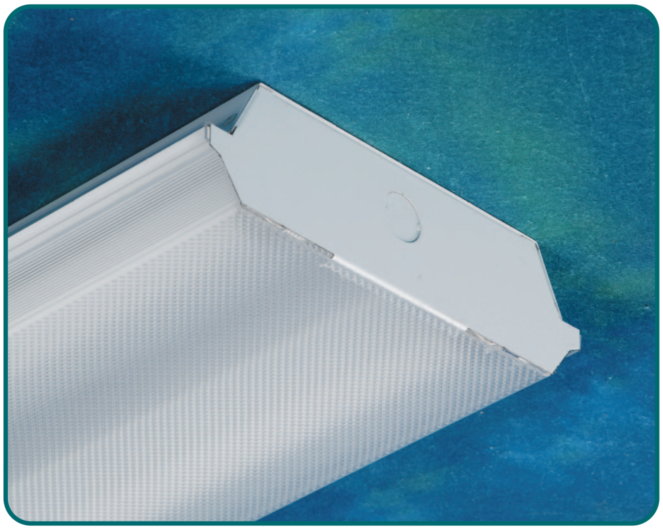
Low Profile Wrap Series
general purpose fluorescent luminaire

GENERAL DESCRIPTION

The Low Profile Wrap (LPW) Series has been developed for general illumination for surface or pendant mounted applications. This series utilizes computer designed reflector technology for optimal fixture efficiency, reduction of energy consumption and improved quality of light. It also provides instant-on operation and offers many other energy saving options.

Typical applications for this type of product are interior spaces where finished ceilings exist. Applications include:

- Corporate / Office Buildings
- Hospitals, Government Facilities and Military Bases
- Retail and Industrial Facilities
- Schools, Colleges and Universities



DESIGN FEATURES / SPECIFICATIONS

CONSTRUCTION

- Precision die formed from 22 ga. cold rolled steel.
- Mechanically fastened or resistance welded depending on model.
- Heavy gauge steel (CRS) may be custom ordered.
- Finish to be pre-painted gloss white polyester powder coat.
- Post-painted polyester powder coat finishes are available. Consult factory for all special colors and finishes.
- Heavy guage steel (NYC) and heavy guage aluminum are available as alternate materials.

REFLECTOR

- Precision die formed optics which has been designed for maximum efficiency and photometric properties using the latest CAD software.
- Choice of optics includes focused, normal and spread beam distribution. Consult factory for custom optics design and spacing criteria options.
- Choice of materials include:
  - Alanod Miro4® Enhanced Specular Aluminum, 95% total reflectance, 25 year warranty.
  - Enhanced Specular Aluminum, 92% total (min.) reflectance, 25 year warranty.
  - High Reflectance White Powder Coated Aluminum, 91% total reflectance, 10 year warranty.
  - Polished Aluminum, 87% total (min.) reflectance, 25 year warranty.
  - Consult factory for availability of all other material choices.

LAMPHOLDERS

- Vossloh-Schwabe® premium type featuring:
  - Anti-vibration internal lamp locking design
  - High temperature resistant ("T" marking).
  - Heat and UV blocking shield to prevent degradation of material.
  - Multi-point contact design for optimum lamp pin contact.
  - Produced in accordance with DIN ISO 9001 and IEC standards.

BALLASTS

- All standard ballasts are electronic, energy saving, thermally protected, Class-P, non-PCB, Sound Rated “A”, 0 degree (Type 1 Outdoor). Verify with factory for latest information regarding High Temperature (HT) or Extreme Low Temperature (XLT) rated ballast options.
- UL/CSA certified, where applicable. Compliant with Federal Ballast Law (Public Law 100-357, 1988).
- Choice of ballast factors. L=Low, N=Normal, H=High.
- Choice of dedicated, universal or special voltage - Consult factory for available options.
- Warranted by ballast manufacturer. Typical ballast warranty is for 5 years (120-277v) and 3-years (347-480v). Consult factory for latest warranty information.

LAMPS

- Supplied by others unless otherwise specified.
- Factory installed if required - Consult factory.
- Lamp type, CRI ratings, temperature colors, lamp life ratings are all viable options which can be supplied - Consult factory for information.

LENS (Diffuser)

- Extruded profile for precision fit.
  - 100% virgin clear acrylic resin (for max. optical clarity).
  - Linear prisms extruded into sides of lens.
  - Pattern 12 prisms embossed into bottom of lens
  - 30% “DR” additive (standard) to resist breakage (50% “DR” additive optional).
  - Consult factory for all available lens options.

MOUNTING

- The luminaire may be surface mounted or may be suspended by pendant, threaded rod, hook, chain or cable. (Mounting hardware supplied by others unless otherwise specified).

ELECTRICAL

- Luminaire is bi-national listed and labeled (UL 1598 and CSA C22.2 No. 250.0-00) and is suitable for damp locations.
- Product includes luminaire disconnect as specified in NEC 410.73(G), 2005 Edition, and CEC part I, rule 30-308(4), 2006 Edition.

QUALITY CONTROL

- All fixtures and retrofit kits are designed, fabricated, assembled and tested at RENOVA's manufacturing facility. All fixtures are 100% lamp tested, inspected and labeled prior to shipment.

GUARANTEE

- RENOVA warrants all fixtures to be free of defects in manufacturing and workmanship for a period of (1) year from date of purchase. This warranty excludes damage of any kind resulting from improper installation, misuse, abuse, accidents, mis-application, or natural disasters. Please refer to the "Terms and Conditions" section of the RENOVA website for additional information.

Note: RENOVA products are constantly being improved; therefore, the information shown is subject to change without notice. Always consult your lighting representative or RENOVA Lighting Systems, Inc. for the latest information.

Category: ECS
Energy Conservation Series

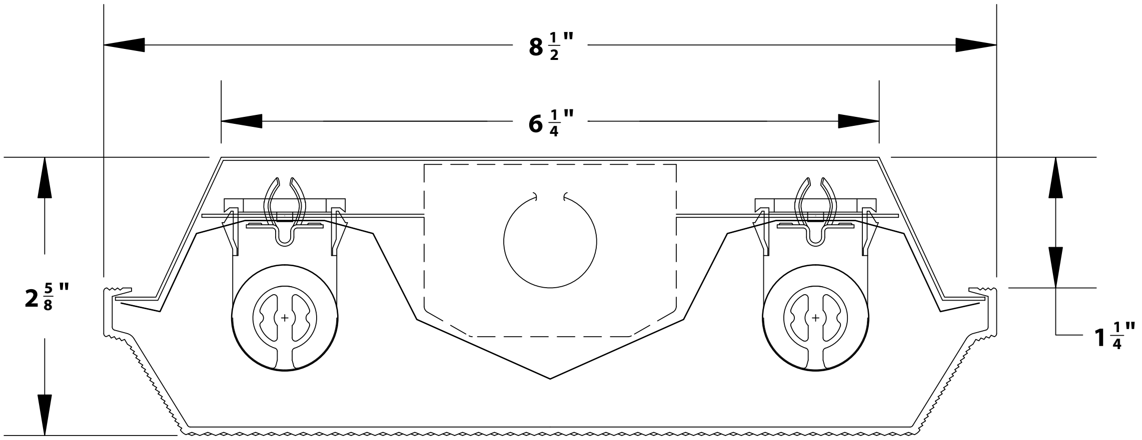
Prefix:
LPW

Fixture Series (Name):
Low Profile Wrap

Universal Lighting Technologies • GE Lighting North America • ADVANCE • PHILIPS sense and simplicity • SYLVANIA • alanod • VOSSLOH SCHWABE

RENOVA™
Innovative Lighting Ideas
Energy Efficient Solutions

2-Lamp T8 Low Profile Wrap Cross Section Shown



ORDERING GUIDE

CATEGORY	SERIES	SIZE	REFLECTOR MATERIAL	REFLECTOR PHOTOMETRY	NUMBER OF LAMPS	LAMP TYPE (WATTAGE)	BALLAST VOLTAGE	NUMBER OF BALLASTS	LAMPS PER BALLAST	BALLAST FACTOR	OPTIONS
ECS -	LPW	4 -	M	N -	2	32 -	UNV -	1	2	N -	
Energy Conservation Series	**LPW** - LOW PROFILE WRAP	**2** - 24" **3** - 36" **4** - 48" **6** - 72" **8** - 96"	**M** - MIRO4 (95% TR) **E** - ENHANCED ALUMINUM (92% TR min.) **W** - WHITE (91% TR) **A** - ALUMINUM (87% TR min.) **B** - BALLAST COVER (White) (83% TR min.) **R** - MIRO4 MICRO-MATT (95% TR)	**F** - FOCUSED **N** - NORMAL **S** - SPREAD **C** - CUSTOM OPTICS ***N** - NORMAL IS STANDARD *(BLANK)=N ***C** - CUSTOM OPTICS ARE DESCRIBED IN OPTIONS BOX	**2** - 2L 2' - 4' HSG **4** - 4L 6' & 8' HSG	**17** 17w T8 **25** 25w T8 **32** 32w T8 **14** 14w T5 **21** 21w T5 **28** 28w T5 **24** 24w T5HO **39** 39w T5HO **54** 54w T5HO	**120** - 120v, 60 Hz **277** - 277v, 60 Hz **347** - 347v, 60 Hz **UNV** - 120v - 277v, 60 Hz **480** - 480v, 60 Hz **xxx** - Less Ballast	**S** - SLAVE **(BLANK)** - 1 **2** - 2 **3** - 3 **4** - 4	**(BLANK)** - 0 **1** - 1 **2** - 2 **3** - 3 **4** - 4 *Use Suffix "M" for Master (Example: 4M)	**L** - Low **N** - Normal **H** - High	***ADDITIONAL OPTIONS** (See "Options" sheet for all available options)

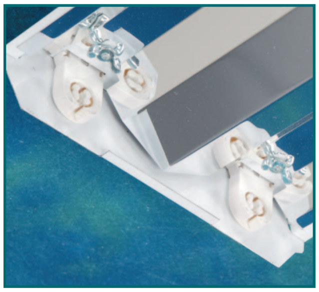
IES SUSTAINING MEMBER

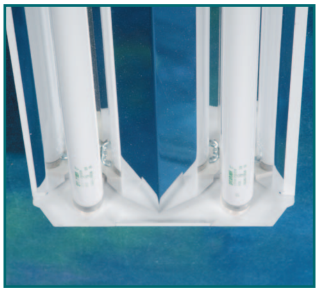
MADE IN THE USA

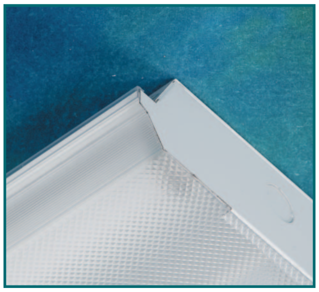
c UL us LISTED

Photometric data, IES files and all other information is available upon request.

Veteran OWNED AND OPERATED


Vossloh Locking Lampholders
(Standard)


Multi-Faceted Reflector
(Designed for Maximum Efficiency)


Standard Lens
(Bottom: Pattern 12 Prismatic Embossment)
(Side: Linear Prisms)


Mounting Details
(Included in all Housings)

Note: RENOVA products are constantly being improved; therefore, the information shown is subject to change without notice. Always consult your lighting representative or RENOVA Lighting Systems, Inc. for the latest information.

Category: ECS
Energy Conservation Series

Prefix:
SVT

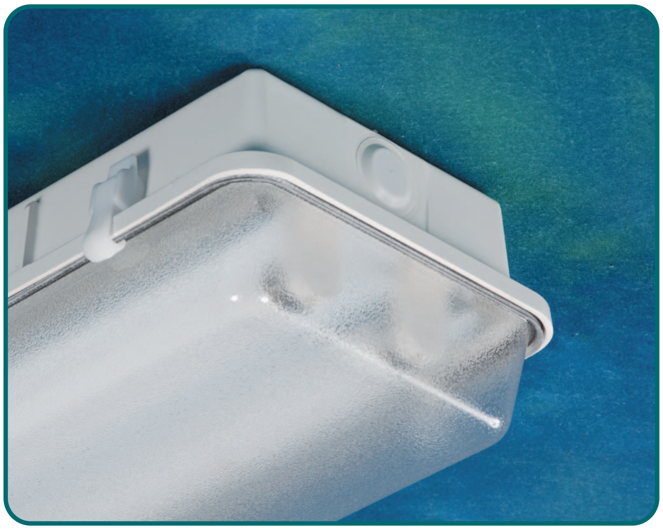
Fixture Series (Name):
Standard Vapor Tight

Universal Lighting Technologies | GE Lighting North America | ADVANCE | PHILIPS sense and simplicity | SYLVANIA | alanod | VS VOSSLOH SCHWABE

RENOVA™
Innovative Lighting Ideas
Energy Efficient Solutions

Standard Vapor Tight Series
general purpose fluorescent luminaire

GENERAL DESCRIPTION



The Standard Vapor Tight (SVT) Series has been developed for all dust, damp/wet, vapor proof, cold weather and outdoor applications. Fixture can be surface (wall or ceiling), pendent, chain or cable mounted. This series utilizes computer designed reflector technology for optimal fixture efficiency, reduction of energy consumption and improved quality of light. It also provides instant-on operation and offers many other energy saving options.

Typical applications for this type of product are interior and exterior spaces where dust, moisture and vapor infiltration must be avoided. Applications include:

- Parking Garages, Car Washes, Shipping Docks and Outdoor Locations
- Government / Industrial Facilities, Gas Stations and Subways
- Swimming Pool Facilities, Locker / Shower Rooms
- Food and Drug Handling Areas, Public Areas and Commercial Kitchens

DESIGN FEATURES / SPECIFICATIONS

CONSTRUCTION

- Housing is precision injection molded from fiberglass reinforced polyester resin. Approval and / or listings as follows:
- UL/CUL/NSF International
- U.S. Department of Agriculture
- Canadian Standards Association
- Achieves IP65 / IP67 Rating (Certain models only)
- Housing matl. is self-extinguishable (ASTM D635-74)
- Internal housing and brackets to be precision die formed from 22 ga. cold rolled steel. Finish to be pre-painted gloss white polyester powder coat.

GASKETING

- New technology molecular structure gasket material is poured into pre-treated housing channel to insure stronger adhesion and to provide maximum protection against moisture and dust.

REFLECTOR

- Precision die formed optics which has been designed for maximum efficiency and photometric properties using the latest CAD software.
- Choice of optics includes focused, normal and spread beam distribution. Consult factory for custom optics design and spacing criteria options.
- Choice of materials include:
  - Alanod Miro4® Enhanced Specular Aluminum, 95% total reflectance, 25 year warranty.
  - High Reflectance White Powder Coated Aluminum, 91% total reflectance, 10 year warranty.
  - Consult factory for all other material choices.

LAMPHOLDERS

- Vossloh-Schwabe® premium type featuring:
  - Anti-vibration internal lamp locking design
  - High temperature resistant ("T" marking).
  - Heat and UV blocking shield to prevent degradation of material.
  - L/H contact design for optimum lamp pin contact.
  - Manufactured to DIN ISO 9001 and IEC standards.

BALLASTS

- All standard ballasts are electronic, energy saving, thermally protected, Class-P, non-PCB, Sound Rated “A”, 0 degree (Type 1 Outdoor). Verify with factory for latest information regarding High Temperature (HT) or Extreme Low Temperature (XLT) rated ballast options.
- UL/CSA certified, where applicable. Compliant with Federal Ballast Law (Public Law 100-357, 1988).
- Choice of ballast factors. L=Low, N=Normal, H=High.
- Choice of dedicated, universal or special voltage - Consult factory for available options.
- Warranted by ballast manufacturer. Typical warranty is for 5 years (120-277v) and 3-years (347-480v). Consult factory for latest warranty information.

LATCHES

- Standard Latch - Acetal copolymer offers increased strength over conventional plastic latches.
- Stainless Steel Latch - Designed for maximum maintainability and corrosion resistance. Tamperproof screws & tool available as option.
- Additional latches to achieve IP65 and IP67 Rating. Consult factory for all available configurations.

LAMP SHIELDING (LENS)

- Clear Acrylic with an internal crepe pattern to provide general lamp obscurity. Lenses are thermoformed for precision fit.
- Smooth exterior surface for ease of cleaning.
- “HI” – High Impact “DR” Additive to resist breakage is optional.

LAMPS

- Supplied by others unless otherwise specified.
- Factory installed if required - Consult factory.
- Lamp type, CRI ratings, temperature colors, lamp life ratings are all viable options which can be supplied - Consult factory for information.

MOUNTING

- The luminaire may be surface mounted or may be suspended by pendant, threaded rod, chain or cable. (Mounting hardware supplied by others unless otherwise specified).
- Custom mounting options / accessories are available - Consult factory.

ELECTRICAL

- Luminaire is bi-national listed and labeled (UL 1598 and CSA C22.2 No. 250.0-00) and is suitable for damp locations.
- Product includes luminaire disconnect as specified in NEC 410.73(G), 2005 Edition, and CEC part I, rule 30-308(4), 2006 Edition.

QUALITY CONTROL

- All fixtures and retrofit kits are designed, fabricated, assembled and tested at RENOVA's manufacturing facility. All fixtures are 100% lamp tested, inspected and labeled prior to shipment.

GUARANTEE

- RENOVA warrants all fixtures to be free of defects in manufacturing and workmanship for a period of (1) year from date of purchase. This warranty excludes damage of any kind resulting from improper installation, misuse, abuse, accidents, mis-application, or natural disasters. Please refer to the "Terms and Conditions" section of the RENOVA website for additional information.

Note: RENOVA products are constantly being improved; therefore, the information shown is subject to change without notice. Always consult your lighting representative or RENOVA Lighting Systems, Inc. for the latest information.

Category: ECS
Energy Conservation Series

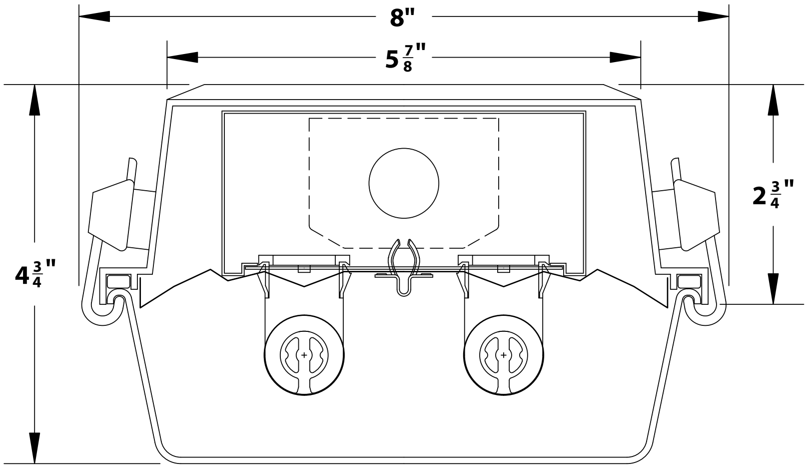
Prefix:
SVT

Fixture Series (Name):
Standard Vapor Tight

Universal Lighting Technologies | GE Lighting North America | ADVANCE | PHILIPS sense and simplicity | SYLVANIA | alanod | VOSSLOH SCHWABE

RENOVA™
Innovative Lighting Ideas
Energy Efficient Solutions

2-Lamp T8 Standard Vapor Tight Cross Section Shown



ORDERING GUIDE

CATEGORY		SERIES	SIZE		REFLECTOR MATERIAL	REFLECTOR PHOTOMETRY		NUMBER OF LAMPS	LAMP TYPE (WATTAGE)		BALLAST VOLTAGE		NUMBER OF BALLASTS	LAMPS PER BALLAST	BALLAST FACTOR		OPTIONS
ECS	-	**SVT**	**4**	-	**M**	**N**	-	**2**	**32**	-	**UNV**	-	**1**	**2**	**N**	-	
Energy Conservation Series		**SVT** - STD VAPOR TIGHT	**2** - 24" **4** - 48" **8** - 96"		**M** - MIRO4 (95% TR) **E** - ENHANCED ALUMINUM (92% TR min.) **W** - WHITE (91% TR) **A** - ALUMINUM (87% TR min.) **B** - BALLAST COVER (White) (83% TR min.) **R** - MIRO4 MICRO-MATT (95% TR)	**F** - FOCUSED **N** - NORMAL **S** - SPREAD **C** - CUSTOM OPTICS ***N** - NORMAL IS STANDARD *(BLANK)=N ***C** - CUSTOM OPTICS ARE DESCRIBED IN OPTIONS BOX		2' & 4' HSG: **1** - 1L **2** - 2L **3** - 3L 8' HSG: **2** - 2L **4** - 4L **6** - 6L	**17** 17w T8 **32** 32w T8 **14** 14w T5 **28** 28w T5 **24** 24w T5HO **54** 54w T5HO		**120** - 120v, 60 Hz **277** - 277v, 60 Hz **347** - 347v, 60 Hz **UNV** - 120v - 277v, 60 Hz **480** - 480v, 60 Hz **xxx** - Less Ballast		**(BLANK)** - 1 **2** - 2 **3** - 3	**1** - 1 **2** - 2 **3** - 3 **4** - 4	**L** - Low **N** - Normal **H** - High		***ADDITIONAL OPTIONS** (See "Options" sheet for all available options)

IES SUSTAINING MEMBER

MADE IN THE USA

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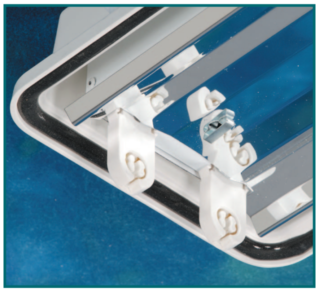
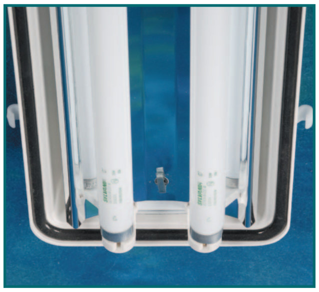
Photometric data, IES files
and all other information
is available upon request.

Veteran OWNED AND OPERATED

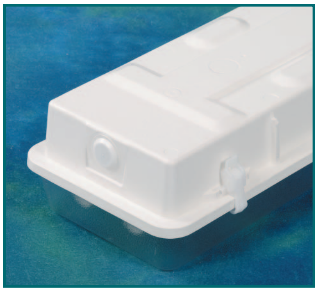


Vossloh Locking Lampholders
(Standard)



Multi-Faceted Reflector
(Designed for Maximum Efficiency)

Standard Lens
(Crepe pattern provides lamp obscurity)



Mounting Details
(Included in all Housings)

Note: RENOVA products are constantly being improved; therefore, the information shown is subject to change without notice. Always consult your lighting representative or RENOVA Lighting Systems, Inc. for the latest information.

RENOVA Lighting Systems, Inc. • 15 Wellstown Road • Ashaway, RI 02804 • (800) 635-6682 • www.renova.com

Category: ECS
Energy Conservation Series

Prefix:
SGI

Fixture Series (Name):
Std. Grade Industrial

RENOVA™
Innovative Lighting Ideas
Energy Efficient Solutions

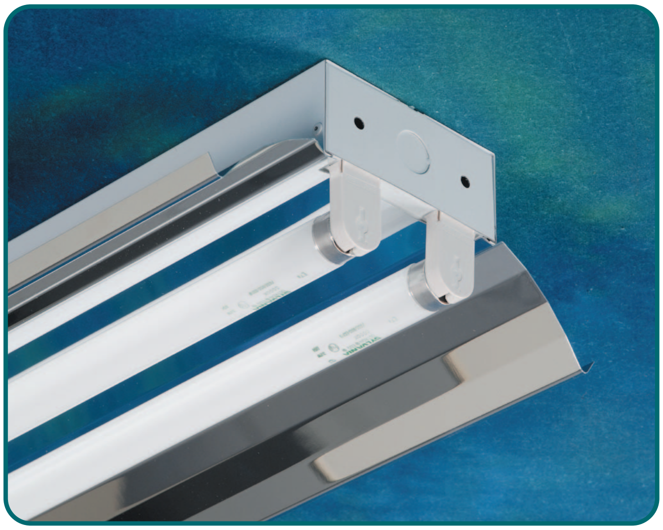
Standard Grade Industrial Series general purpose fluorescent luminaire

GENERAL DESCRIPTION

The Standard Grade Industrial (SGI) Series has been developed for general illumination for surface or pendant mounted applications. This series utilizes computer designed reflector technology for optimal fixture efficiency, reduction of energy consumption and improved quality of light. It also provides instant-on operation and offers many other energy saving options.

Typical applications for this type of product are interior spaces where appearance and performance are important. Applications include:

- Industrial, Commercial and Manufacturing Areas
- Warehouse Spaces – Isle and Open Areas
- Storage Facilities and Specialized Retail Applications
- Schools, Colleges and Universities



DESIGN FEATURES / SPECIFICATIONS

CONSTRUCTION

- Precision die formed from 22 ga. cold rolled steel.
- Mechanically fastened or resistance welded depending on model.
- Heavy gauge steel (CRS) or aluminum alloy may be custom ordered.
- Finish to be pre-painted gloss white polyester powder coat.
- Post-painted polyester powder coat finishes are available. Consult factory for all special colors and finishes.
- Heavy guage steel (NYC) and heavy guage aluminum are available as alternate materials.

REFLECTOR

- Precision die formed optics which has been designed for maximum efficiency and photometric properties using the latest CAD software.
- Choice of optics includes focused, normal and spread beam distribution. Consult factory for custom optics design and spacing criteria options.
- Choice of materials include:
  - Alanod Miro4® Enhanced Specular Aluminum, 95% total reflectance, 25 year warranty.
  - Enhanced Specular Aluminum, 92% total (min.) reflectance, 25 year warranty.
  - High Reflectance White Powder Coated Aluminum, 91% total reflectance, 10 year warranty.
  - Polished Aluminum, 87% total (min.) reflectance, 25 year warranty.
  - Consult factory for availability of all other material choices.

LAMPHOLDERS

- Vossloh-Schwabe® premium type featuring:
  - Anti-vibration internal lamp locking design
  - High temperature resistant ("T" marking).
  - Heat and UV blocking shield to prevent degradation of material.
  - Multi-point contact design for optimum lamp pin contact.
  - Produced in accordance with DIN ISO 9001 and IEC standards.

BALLASTS

- All standard ballasts are electronic, energy saving, thermally protected, Class-P, non-PCB, Sound Rated "A", 0 degree (Type 1 Outdoor). Verify with factory for latest information regarding High Temperature (HT) or Extreme Low Temperature (XLT) rated ballast options.
- UL/CSA certified, where applicable. Compliant with Federal Ballast Law (Public Law 100-357, 1988).
- Choice of ballast factors. L=Low, N=Normal, H=High.
- Choice of dedicated, universal or special voltage - Consult factory for available options.
- Warranted by ballast manufacturer. Typical ballast warranty is for 5 years (120-277v) and 3-years (347-480v). Consult factory for latest warranty information.

LAMPS

- Supplied by others unless otherwise specified.
- Factory installed if required - Consult factory.
- Lamp type, CRI ratings, temperature colors, lamp life ratings are all viable options which can be supplied - Consult factory for information.

MOUNTING

- The luminaire may be surface mounted or may be suspended by pendant, threaded rod, hook, chain or cable. (Mounting hardware supplied by others unless otherwise specified).
- Custom mounting options / accessories are available - Consult factory.

ELECTRICAL

- Luminaire is bi-national listed and labeled (UL 1598 and CSA C22.2 No. 250.0-00) and is suitable for damp locations.
- Product includes luminaire disconnect as specified in NEC 410.73(G), 2005 Edition, and CEC part I, rule 30-308(4), 2006 Edition.

QUALITY CONTROL

- All fixtures and retrofit kits are designed, fabricated, assembled and tested at RENOVA's manufacturing facility. All fixtures are 100% lamp tested, inspected and labeled prior to shipment.

GUARANTEE

- RENOVA warrants all fixtures to be free of defects in manufacturing and workmanship for a period of (1) year from date of purchase. This warranty excludes damage of any kind resulting from improper installation, misuse, abuse, accidents, mis-application, or natural disasters. Please refer to the "Terms and Conditions" section of the RENOVA website for additional information.

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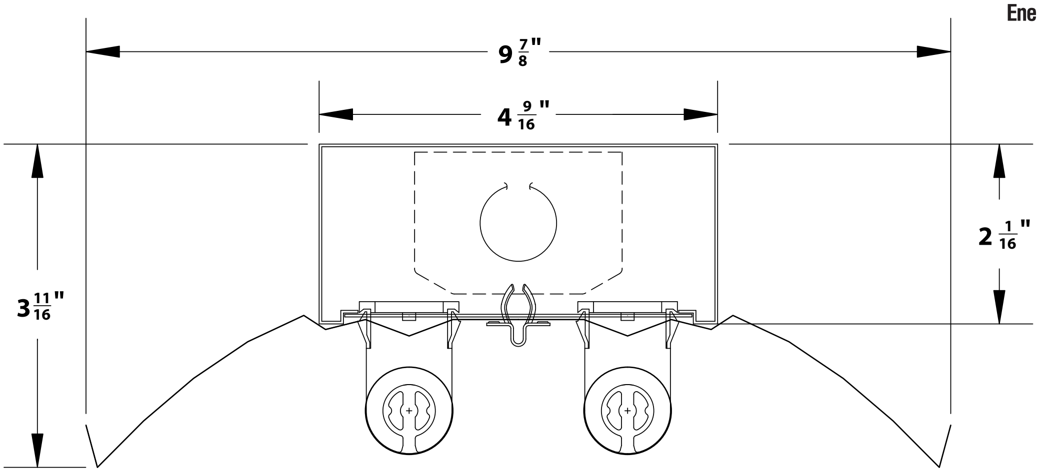
Category: ECS
Energy Conservation Series

Prefix:
SGI

Fixture Series (Name):
Std. Grade Industrial

RENOVA™
Innovative Lighting Ideas
Energy Efficient Solutions

2-Lamp T8 Std. Grade Industrial Cross Section Shown



ORDERING GUIDE

CATEGORY	SERIES	SIZE	REFLECTOR MATERIAL	REFLECTOR PHOTOMETRY	NUMBER OF LAMPS	LAMP TYPE (WATTAGE)	BALLAST VOLTAGE	NUMBER OF BALLASTS	LAMPS PER BALLAST	BALLAST FACTOR	OPTIONS
ECS -	SGI	4 -	M	N -	2	32 -	UNV -	1	2	N -	
Energy Conservation Series	**SGI** - STANDARD GRADE INDUSTRIAL	**2** - 24" **3** - 36" **4** - 48" **6** - 72" **8** - 96"	**M** - MIRO4 (95% TR) **E** - ENHANCED ALUMINUM (92% TR min.) **W** - WHITE (91% TR) **A** - ALUMINUM (87% TR min.) **R** - MIRO4 MICRO-MATT (95% TR)	**F** - FOCUSED **N** - NORMAL **S** - SPREAD **C** - CUSTOM OPTICS ***N** - NORMAL IS STANDARD *(BLANK)=N ***C** - CUSTOM OPTICS ARE DESCRIBED IN OPTIONS BOX	2' - 4' HSG: **1** - 1L **2** - 2L **3** - 3L **4 - 4L** 6' & 8' HSG: **2** - 2L **4** - 4L **6** - 6L **8 - 8L** * T5 LAMP ONLY	**17** 17w T8 **25** 25w T8 **32** 32w T8 **14** 14w T5 **21** 21w T5 **28** 28w T5 **24** 24w T5HO **39** 39w T5HO **54** 54w T5HO	**120** - 120v, 60 Hz **277** - 277v, 60 Hz **347** - 347v, 60 Hz **UNV** - 120v - 277v, 60 Hz **480** - 480v, 60 Hz **xxx** - Less Ballast	**S** - SLAVE **(BLANK)** - 1 **2** - 2 **3** - 3 **4** - 4	**(BLANK)** - 0 **1** - 1 **2** - 2 **3** - 3 **4** - 4 *Use Suffix "M" for Master (Example: 4M)	**L** - Low **N** - Normal **H** - High	***ADDITIONAL OPTIONS** (See "Options" sheet for all available options)

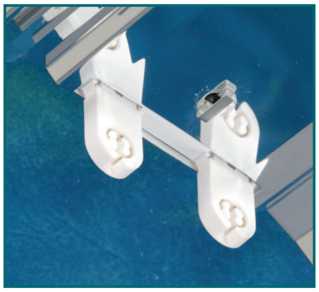
IES SUSTAINING MEMBER

MADE IN THE USA

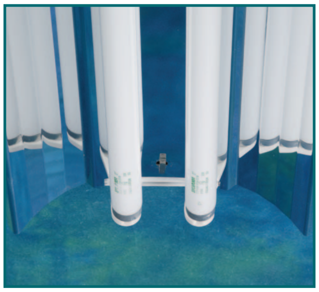
c UL us LISTED

Photometric data, IES files and all other information is available upon request.

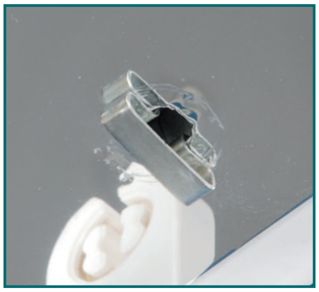
Veteran OWNED AND OPERATED



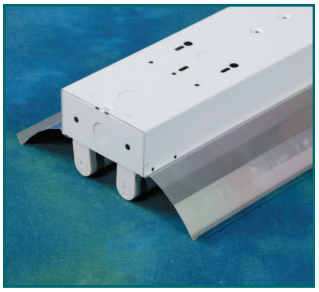
Vossloh Locking Lampholders
(Standard)



Multi-Faceted Reflector
(Designed for Maximum Efficiency)



Captive Quarter-Turn Fastener
(Allows Toolless Access to
Ballast Compartment)



Mounting Details
(Included in all Housings)

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DULUX® EL

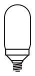
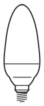
When considering your lighting options, Energy Savings, Long Life/Maintenance Cost Savings and Color Excellence are key factors. SYLVANIA products can help you make the right decision.

Compact Fluorescent Lamps

		Item Number	Ordering Abbreviation	Replaced Incandescent Wattage	Nominal Wattage	Initial Lumens	Color Temp.	CRI	Average Rated Life (hr.)	ENERGY STAR
General Purpose	**Micro Mini**	29160	CF5EL/MICRO/827/RP	25	5	200	2700K	82	12,000	
		21095	CF5EL/MICRO/827/LS/RP	25	5	300	2700K	82	12,000	
		29133	CF5EL/MICRO/827/C	25	5	200	2700K	82	12,000	
		21094	CF5EL/MICRO/827/LS/C	25	5	300	2700K	82	12,000	
		29401	CF10EL/MICRO/827	40	10	600	2700K	82	12,000	✔
		27718	CF10EL/MICRO/827/LS/RP2	40	10	600	2700K	82	12,000	✔
		29727	CF13EL/MICRO/827/RP2	60	13	825	2700K	82	12,000	✔
		29759	CF13EL/MICRO/827/C/RP2	60	13	825	2700K	82	12,000	✔
		27716	CF13EL/MICROC/827/LS/RP2	60	13	800	2700K	82	12,000	✔
		29972	CF13EL/MICRO/827/LS/RP2	60	13	800	2700K	82	12,000	✔
		29734	CF13EL/MICRO/C/827/RP2	60	13	800	2700K	82	12,000	✔
		29898	CF13EL/MICRO/830/ECO	60	13	825	3000K	82	12,000	
		29728	CF20EL/MICRO/827/RP2	75	20	1280	2700K	82	12,000	✔
		29973	CF20EL/MICRO/827/LS/RP2	75	20	1200	2700K	82	12,000	
		29899	CF20EL/MICRO/830/ECO	75	20	1280	3000K	82	12,000	
		29729	CF23EL/MICRO/827/RP2	100	23	1600	2700K	82	12,000	✔
		29895	CF23EL/MICROLED/827/RP***	100	23	1600	2700K	82	12,000	
		29941	CF23EL/MICROLED/827/HVP/RP	100	23	1600	2700K	82	12,000	
		29974	CF23EL/MICRO/827/LS/RP2	100	23	1400	2700K	82	12,000	
		29901	CF23EL/MICRO/830/ECO	100	23	1640	3000K	82	12,000	
		29026	CF26EL/MICRO/827/RP2	100	26	1750	2700K	82	12,000	
		29023	CF26EL/MICRO/827/LS	100	26	1550	2700K	82	12,000	
		28990	CF26EL/MICRO/830/ECO	100	26	1280	3000K	82	12,000	
	Super Mini Twist	29707	CF7EL/SUPER/827/RP	25	7	375	2700K	82	10,000	
		29708	CF11EL/SUPER/827/RP	40	11	600	2700K	82	10,000	✔
		29767	CF11EL/SUPER/827/RP3	40	11	600	2700K	82	10,000	✔
		29710	CF13EL/SUPER/827/RP	60	13	880	2700K	82	10,000	✔
		29588	CF13EL/SUPER/850/BL	60	13	800	5000K	82	10,000	
		29711	CF13EL/SUPER/865/RP	60	13	880	6500K	82	10,000	
		29693	CF19EL/SUPER/827/RP	75	19	1200	2700K	82	10,000	✔
		29683	CF19EL/SUPER/850/RP	75	19	1200	5000K	82	10,000	
		29712	CF23EL/SUPER/827/RP	100	23	1600	2700K	82	10,000	✔
		29699	CF23EL/SUPER/850/RP	100	23	1600	5000K	82	10,000	
		29674	CF23EL/SUPER/865/RP	100	23	1600	6500K	82	10,000	
	Mini Twist	29733	CF4EL/MINI/827/RP	25	4	250	2700K	82	8000	✔
		29451	CF7EL/MINI/827	25	7	375	2700K	82	8000	
		29379	CF7EL/MINI/830	25	7	375	3000K	82	8000	
		29378	CF11EL/MINI/830	40	11	600	3000K	82	8000	✔
		29409	CF13EL/MINI/827	60	13	800	2700K	82	10,000	
		29376	CF13EL/MINI/830	60	13	800	3000K	82	8000	✔
		29781	CF13EL/MINI/835/DAY/RP	60	13	800	3500K	82	8000	✔
		29567	CF13EL/MINI/841	60	13	800	4100K	82	10,000	
		29608	CF13EL/MINI/C/830/RP	60	13	800	3000K	82	8000	
		29700	CF13EL/MINI/O	60	13	—	Orange	—	8000	
		29701	CF13EL/MINI/R	60	13	—	Red	—	8000	
		29702	CF13EL/MINI/B	60	13	—	Blue	—	8000	
		29703	CF13EL/MINI/G	60	13	—	Green	—	8000	
		29704	CF13EL/MINI/Y	60	13	—	Yellow	—	8000	
		29705	CF13EL/MINI/BLB	60	13	—	Blacklight- blue	—	8000	
		29410	CF19EL/MINI/827	75	19	1200	2700K	82	10,000	✔
		29396	CF19EL/MINI/830	75	19	1200	3000K	82	8000	✔
		29411	CF23EL/MINI/827	100	23	1600	2700K	82	10,000	
		29397	CF23EL/MINI/830	100	23	1600	3000K	82	8000	✔
		29784	CF23EL/MINI/835/DAY/RP	100	23	1600	3500K	82	8000	✔
		29564	CF23EL/MINI/841	100	23	1600	4100K	82	10,000	
	Twist	29957	CF13EL/GU24/827/RP	60	13	800	2700K	82	8000	
		29172	CF23EL/GU24/827/RP	100	23	1600	2700K	82	8000	
		29162	CF13EL/GU24/TWIST/827/BL/10	60	13	800	2700K	82	8000	
		29969	CF14EL/TWIST/827/DIM/RP*	60	14	800	2700K	82	8000	✔
		29163	CF23EL/GU24/TWIST/830/BL/10	100	23	1600	3000K	82	8000	
		29968	CF24EL/TWIST/827/DIM/RP*	75	24	1500	2700K	82	8000	✔
		29415	CF30EL/TWIST/827	100	30	2000	2700K	82	10,000	✔
		29792	CF30EL/TWIST/827/RP	100	30	2000	2700K	82	10,000	✔
		29395	CF30EL/TWIST/830	100	30	2000	3000K	82	10,000	✔
		29793	CF30EL/TWIST/835/DAY/RP	100	30	2000	3500K	82	10,000	✔
		29147	CF40EL/TWIST/827	150	40	2600	2700K	82	10,000	✔
		29786	CF40EL/TWIST/827/RP	150	40	2720	2700K	82	10,000	✔
		29508	CF65EL/TWIST/841	200	65	4200	4100K	82	8000	
	3-Way Twist	29913	CF33EL/3WAY/830/RP	50	12	600	3000K	82	10,000	✔
				100	22	1200	3000K	82	10,000	✔
				150	33	2000	3000K	82	10,000	✔
		28974	CF33EL/3WAY/827/LS/RP	50	12	600	2700K	82	10,000	
				100	22	1200	2700K	82	10,000	
				150	33	2150	2700K	82	10,000	
		29134	CF40EL/3WAY/TWIST/827	60	20	1000	2700K	82	8000	
				120	30	2050	2700K	82	8000	
				150	40	2650	2700K	82	8000	

DULUX® EL

Compact Fluorescent Lamps

			Item Number	Ordering Abbreviation	Replaced Incandescent Wattage	Nominal Wattage	Initial Lumens	Color Temp.	CRI	Average Rated Life (hr.)	ENERGY STAR
General Purpose	Bullet		29196	CF14EL/B/830	60	14	700	3000K	82	6000	
	Classic A-line		29743**	CF5EL/A15/DIM/827/BL*	15	5	200	2700K	82	25,000	
			29665	CF9EL/FAN/827	40	9	450	2700K	82	8000	
			29526	CF9EL/FAN/830/BL2	40	9	450	3000K	82	8000	✔
			29575	CF14EL/A19/827	60	14	800	2700K	82	8000	✔
			29468	CF14EL/A19/830	60	14	800	3000K	82	6000	✔
			29485	CF14EL/A19/830/BL	60	14	800	3000K	82	8000	✔
Decorative	G25		29495	CF9EL/G25/827/BL	40	9	495	2700K	82	8000	✔
			29414	CF9EL/G25/827	40	9	495	2700K	82	8000	
			29528	CF9EL/G25/830/BL2	40	9	495	3000K	82	8000	✔
	G30		29195	CF14EL/G30/830	60	14	700	3000K	82	6000	
	Décor		29121	CF4EL/B10/C/830/BL	15	4	170	3000K	82	6000	
			29742**	CF5EL/B10/DIM/827/ADP/BL*	15	5	200	2700K	82	25,000	
			29750**	CF5EL/B10/DIM/827/C/ADP/RP*	15	5	200	2700K	80	25,000	
			29167	CF7EL/B10/830/BL	25	7	280	3000K	82	6000	
			25986	CF9EL/B10/827/C/ADP/BL2	40	9	450	2700K	82	8000	
			29600	CF9EL/B10/C/ADP/830	40	9	450	3000K	82	8000	
Specialty	Bug		29789	CF14EL/A19/YELLOW/RP	N/A	14	405	—	—	6000	
Directional	R20		29638	CF9EL/R20/827	40	9	300	2700K	82	8000	
			29624	CF14EL/R20/827	50	14	495	2700K	82	8000	✔
			29587	CF14EL/R20/830/BL	50	14	495	3000K	82	8000	✔
			28998	CF14EL/R20/DIM/827/RP*	50	14	500	2700K	82	8000	✔
	BR30		29465	CF15EL/BR30/DIM/827*	65	15	600	2700K	82	6000	
			29496	CF15EL/BR30/DIM/827/RP*	65	15	600	2700K	82	6000	
			29539	CF15EL/BR30/850/BL	65	15	560	5000K	82	6000	
			29565	CF16EL/BR30/827/BL	65	16	750	2700K	82	8000	✔
			26937	CF16EL/BR30/LS/827/BL	65	16	650	2700K	82	8000	
			29590	CF16EL/BR30/830	65	16	750	3000K	82	8000	✔
			29591	CF16EL/BR30/827	65	16	750	2700K	82	8000	✔
	PAR38		29359	CF23EL/PAR38/827	75	23	1200	2700K	82	8000	✔
			29625	CF23EL/PAR38/827/BL	75	23	1200	2700K	82	8000	✔
			29744	CF23EL/PAR38/GL/827/BL	75	23	1000	2700K	82	8000	
			29897	CF23EL/PAR38/GL/827	75	23	1000	2700K	82	8000	
			29140	CF23EL/PAR38/GL/830	75	23	1000	3000K	82	8000	
			29902	CF23EL/PAR38/R/RP	75	23	—	Red	—	8000	
			29903	CF23EL/PAR38/B/RP	75	23	—	Blue	—	8000	
			29904	CF23EL/PAR38/G/RP	75	23	—	Green	—	8000	
			29905	CF23EL/PAR38/Y/RP	75	23	—	Yellow	—	8000	
			29906	CF23EL/PAR38/O/RP	75	23	—	Orange	—	8000	
			29907	CF23EL/PAR38/BLB/RP	75	23	—	Blacklight Blue	—	8000	
	BR40		28997	CF19EL/BR40/DIM/827/RP*	75	19	900	2700K	82	8000	✔
			29452	CF23EL/BR40/827/RP	90	23	1250	2700K	82	8000	✔
			26926	CF23EL/BR40/LS/827/BL	90	23	1050	2700K	82	8000	
			29455	CF23EL/BR40/830	90	23	1250	3000K	82	8000	
			29442	CF23EL/BR40/827/BL	90	23	1250	2700K	82	8000	✔

*Compatible with standard electronic incandescent dimmers. **Cold cathode technology ***2W during LED operation

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CF034-INSERTR21

SEE THE WORLD IN A NEW LIGHT SYLVANIA


Made and Designed by ElectraLED

LTH

JOB NAME:

FIXTURE TYPE:

LED TRACK HEAD

FEATURES

- Available in 20 watt LED
- LED technology offers an unprecedented 80,000 hour lamp life. This fixture is virtually maintenance-free.
- Engineered for illumination of retail displays or any area where high efficiency and color rendering are desired.
- Designed to replace 35-150 watt fixtures which are commonly used for retail and display applications.
- Available with four different track adaptors to fit most existing line voltage systems.
- Also available with stand alone mono point mounting canopy.
- Controllable with optional occupancy sensors.

SPECIFICATIONS

- **HOUSING**
  Heavy aluminum alloy housing provides durability and maximum heat sinking for longer life of electronic components.
- **ELECTRICAL**
  Highest quality driver, emitters and power supply for long life.
- **LED COLOR**
  Available in a variety of Kelvin temperatures
  Cool White in 5000K, 65000K & 7000K
  Warm White in 2750K, 3000K, 3500K & 4200K.
- **OPTICS**
  Available in 3 beam patterns: Spot, Medium, or Flood.
- **FINISH**
  Exterior housing is finished in architectural bronze as standard. Available in gloss white.
- **CERTIFICATION**
  CSA & UL Listed.

TOSHIBA

Project:	**Toshiba Lamp:**
Type:	**Notes:**

Dimmable LED PAR38 1100 Series

Ordering Information

Ordering Code	Input Voltage *VAC*	Lamp Shape	Base Type	Wattage *W*	CCT ¹	Beam Angle	Initial Lumens *lm²*	Lamp Efficacy *lm/W*	Rated Life *hrs³*	CBCP *cd*	CRI	Power Factor	Equivalency⁴	Lamp Weight *lbs. (g)*
20P38/27LNF-UP	120	PAR38	E26	20.3	2700K	25°	1090	53.7	40,000	4240	84	> 0.77	90W	1.18 (535)
20P38/27LFL-UP	120	PAR38	E26	20.3	2700K	35°	1090	53.7	40,000	2750	84	> 0.77	100W	1.18 (535)
20P38/30LNF-UP	120	PAR38	E26	20.3	3000K	25°	1120	55.2	40,000	4400	84	> 0.77	90W	1.18 (535)
20P38/30LFL-UP	120	PAR38	E26	20.3	3000K	35°	1120	55.2	40,000	2860	84	> 0.77	110W	1.18 (535)
20P38/35LNF-UP	120	PAR38	E26	20.3	3500K	25°	1120	55.2	40,000	4400	84	> 0.77	90W	1.18 (535)
20P38/35LFL-UP	120	PAR38	E26	20.3	3500K	35°	1120	55.2	40,000	2860	84	> 0.77	110W	1.18 (535)
20P38/40LNF-UP	120	PAR38	E26	20.3	4000K	25°	1170	57.6	40,000	4600	85	> 0.77	90W	1.18 (535)
20P38/40LFL-UP	120	PAR38	E26	20.3	4000K	35°	1170	57.6	40,000	2990	85	> 0.77	110W	1.18 (535)

1. CCT range complies with ANSI C78.377-2008
2. Thermally stable typical lumens (±10%)
3. Rated life is based on 70% lumen maintenance and engineering testing and probability analysis
4. Equivalency based on the Energy Star® Integral LED Lamp Program

Note: All Information consistent with IESNA LM-80-08 results and IESNA LM-79-08 testing completed by a qualified third party facility
Note: All lamps meet Energy Star® Integral LED Lamp requirements and will be submitted for testing
Note: Five-year warranty based on 24 hr/day usage

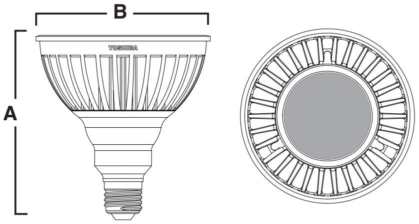
5 FIVE YEAR WARRANTY

c UL US LISTED

Dimensions

Model	MOL (A) *in. (mm)*	Diameter (B) *in. (mm)*
PAR38	5.01 (127)	4.76 (121)

Note: Lamp shape conforms to ANSI C78.21-2003
Note: Designed to comply with RoHS Directive 2002/95/EC

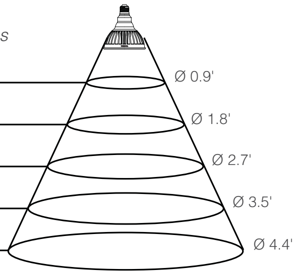


Illuminance Cone Diagrams

20P38/30LNF-UP

Wattage 20.3 CBCP (cd) 4400
Lumens 1120 Beam Angle 25°

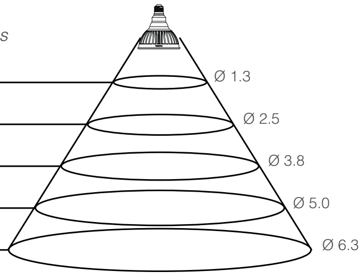
Distance ft.	*Footcandles*
2'	1100
4'	275
6'	122
8'	69
10'	44



20P38/30LFL-UP

Wattage 20.3 CBCP (cd) 2860
Lumens 1120 Beam Angle 35°

Distance ft.	*Footcandles*
2'	715
4'	179
6'	79
8'	45
10'	29



Energy Savings

	45W Halogen	60W Halogen	75W Halogen	80W Halogen	90W Halogen	110W Halogen
20P38/30LNF-UP	$67.95	$109.18	$150.43	$164.18	$191.68*	$246.68
20P38/30LFL-UP	$67.95	$109.18	$150.43	$164.18	$191.68	$246.68*

*Actual equivalent replacement based on the Energy Star® Integral LED Lamp Program
Note: Energy savings based on using one bulb for 25,000 hr rated life at 11¢/kWh; Does not include maintenance and replacement lamp savings

Ordering Guide

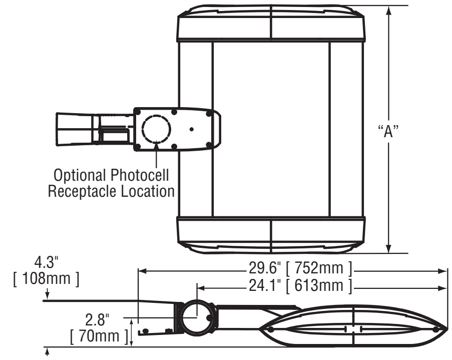
20	P38 /	27	L —	UP
Wattage 20.3 Watts = 20	**Lamp Type** PAR38 = P38	**CRI + CCT** 2700K = 27 3000K = 30 3500K = 35 4000K = 40	1100 Series = L	NF = Narrow Flood FL = Flood US Professional Package = UP

PAR381100S122011

FLD-EDG-25-AA THE EDGE® LED Floodlight – 25º Optic

Rev. Date: 1/5/11

BetaLED Catalog #: FLD - EDG - 25 - AA -   - C -   -   -   -



# of LEDs	Dim. "A"
20	12.06"
40	12.06"
60	14.06"
80	16.06"
100	18.06"
120	20.06"
140	22.06"
160	24.06"
180	26.06"
200	28.06"
220	30.06"
240	32.06"

Notes:

Product	Family	Optic in Degrees	Mounting	# of LEDs (x 10)	LED Series	Voltage	Color Options	Factory-Installed Options Please type additional options in manually on the lines provided above.
FLD	**EDG**	**25**[1]	**AA**[2]	☐ **02** ☐ **04** ☐ **06** ☐ **08** ☐ **10** ☐ **12** ☐ **14** ☐ **16** ☐ **18** ☐ **20** ☐ **22** ☐ **24**	**C**	☐ **UL** Universal 120–277V ☐ **UH** Universal 347–480V ☐ **12** 120V ☐ **24** 240V ☐ **27** 277V ☐ **34** 347V	☐ **SV** Silver ☐ **BK** Black ☐ **BZ** Bronze ☐ **PB** Platinum Bronze ☐ **WH** White	☐ **43K** 4300K Color Temperature[3] ☐ **525** 525mA Drive Current[4,5] ☐ **DIM5** 0–10V Dimming (525mA maximum)[6,7] ☐ **F** Fuse[8,9] ☐ **HL** Hi/Low (175/350/525, dual circuit input)[10] ☐ **P** Photocell[11,12] ☐ **R** NEMA Photocell Receptacle[8,12,13] ☐ **TL** Two-Level (175/525 w/ integrated sensor control)[10] ☐ **TL2** Two-Level (0/350 w/ integrated sensor control)[10] ☐ **TL3** Two-Level (0/525 w/ integrated sensor control)[10]

Footnotes

1. Distribution similar to narrow flood (25º)
2. Adjustable arm for mounting to 2" (2-3/8" [60mm] O.D.) tenon
3. Color temperature per fixture; minimum 70 CRI
4. Driver operates at 525mA instead of the standard 350mA providing a higher lumen output and a shorter life
5. Available on fixtures with 20–120 LEDs
6. Control by others
7. Refer to dimming spec sheet for availability and additional information
8. Not available when UH voltage is selected
9. When code dictates fusing use time delay fuse
10. Refer to multi-level spec sheet for availability and additional information
11. Must specify voltage other than UL or UH
12. This option not available with all multi-level options. Refer to multi-level spec sheet for more information
13. Intended for horizontal mounting

LED PERFORMANCE SPECS

# of LEDs	Initial Delivered Lumens – 25º Flood Optic @ 6000K	Initial Delivered Lumens – 25º Flood Optic @ 4300K	System Watts 120–277V	Total Current @ 120V	Total Current @ 230V	Total Current @ 277V	System Watts 347–480V*	Total Current @ 347V	Total Current @ 480V	L_{70} Hours** @ 25º C (77º F)
350mA (Standard) Fixture Operating at 25º C (77º F)										
20	1,937 (02)	1,699 (02)	25	0.23	0.11	0.10	30	0.09	0.08	105,000
40	3,875 (04)	3,398 (04)	49	0.41	0.23	0.20	51	0.15	0.12	105,000
60	5,812 (06)	5,098 (06)	71	0.60	0.32	0.28	74	0.22	0.17	105,000
80	7,749 (08)	6,797 (08)	93	0.78	0.41	0.35	96	0.28	0.21	105,000
100	9,686 (10)	8,496 (10)	116	0.98	0.52	0.43	119	0.35	0.26	105,000
120	11,624 (12)	10,195 (12)	139	1.17	0.61	0.52	141	0.41	0.30	105,000
140	13,561 (14)	11,895 (14)	164	1.39	0.74	0.63	170	0.49	0.35	105,000
160	15,498 (16)	13,594 (16)	186	1.58	0.83	0.71	192	0.55	0.40	105,000
180	17,436 (18)	15,293 (18)	211	1.77	0.93	0.79	215	0.62	0.45	105,000
200	19,373 (20)	16,992 (20)	233	1.97	1.03	0.87	237	0.68	0.49	105,000
220	21,310 (22)	18,692 (22)	256	2.16	1.13	0.95	259	0.75	0.54	105,000
240	23,247 (24)	20,391 (24)	279	2.35	1.23	1.03	282	0.81	0.59	105,000
525mA Fixture Operating at 25º C (77º F)										
20	2,518 (02)	2,209 (02)	37	0.31	0.18	0.17	43	0.13	0.15	61,000
40	5,037 (04)	4,418 (04)	69	0.58	0.31	0.27	75	0.22	0.19	61,000
60	7,555 (06)	6,627 (06)	110	0.92	0.49	0.41	116	0.33	0.27	61,000
80	10,074 (08)	8,836 (08)	138	1.16	0.62	0.54	145	0.42	0.32	61,000
100	12,592 (10)	11,045 (10)	177	1.49	0.79	0.68	186	0.53	0.40	61,000
120	15,111 (12)	13,254 (12)	217	1.82	0.96	0.81	226	0.65	0.48	61,000

* Utilizes magnetic step-down transformer when 525mA drive current or multi-level options are selected

** For recommended lumen depreciation data see TD-13

NOTE: All data subject to change without notice.

• 1200 92nd Street • Sturtevant, WI 53177 • 800-236-6800 • www.betaLED.com

Made in the U.S.A. of U.S. and imported parts.
Meets Buy American requirements within the ARRA.

FLD-EDG-25-AA THE EDGE® LED Floodlight – 25° Optic

Rev. Date: 1/5/11

General Description

Slim, low profile design minimizes wind load requirements. Fixture sides are rugged cast aluminum with integral, weather-tight LED driver compartments and high performance aluminum heatsinks. Adjustable mounting arm is rugged die cast aluminim and mounts to 2" tenon. Includes leaf/debris guard. Five year limited warranty on fixture.

Electrical

Modular design accommodates varied lighting output from high power, white, 6000K (+/- 500K per full fixture), minimum 70 CRI, long life LED sources. 120–277V 50/60 Hz, Class 1 LED drivers are standard. 347–480V 50/60 Hz option is available. LED drivers have power factor >90% and THD <20% at full load. Units provided with integral 9kV surge suppression protection standard. Integral weather-tight electrical box with terminal strip for easy power hook-up. Surge protection tested in accordance with IEEE C62.41.2 and ANSI standard 62.41.2.

Testing & Compliance

UL listed in the U.S. and Canada for wet locations and enclosure classified IP66 per IEC 529 when ordered without P or R options. Consult factory for CE Certified products. RoHS compliant. International Dark-Sky Association approved.

Finish

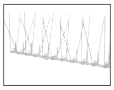
Exclusive Colorfast DeltaGuard® finish features an E-Coat epoxy primer with an ultra-durable silver powder topcoat, providing excellent resistance to corrosion, ultraviolet degradation and abrasion. Bronze, black, white and platinum bronze powder topcoats are also available. The finish is covered by our 10 year limited warranty.

Fixture and finish are endurance tested to withstand 5,000 hours of elevated ambient salt fog conditions as defined in ASTM Standard B 117.

Patents

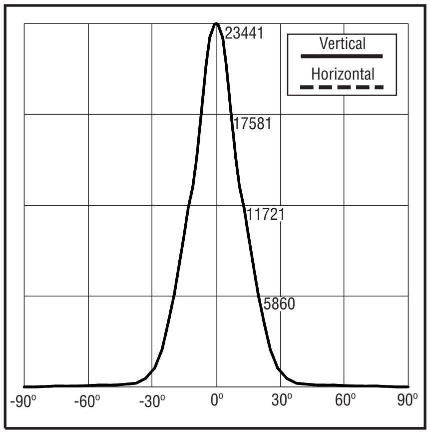
U.S. and international patents granted and pending. BetaLED is a division of Ruud Lighting, Inc. For a listing of Ruud Lighting, Inc. patents, visit www.uspto.gov.

Field-Installed Accessories

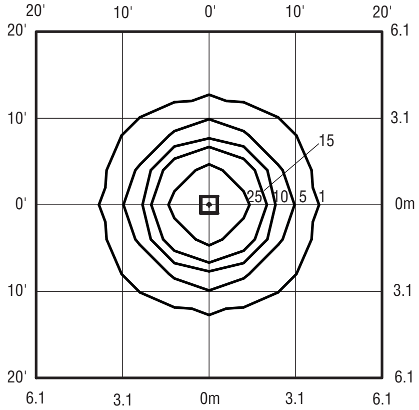


☐ **Bird Spikes**
XA-BRDSPK

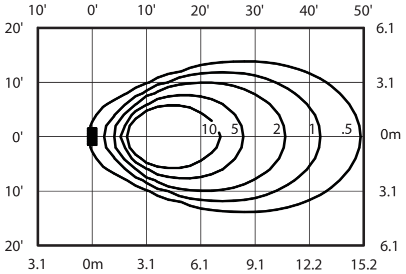
Photometrics



Independent Testing Laboratories certified test. Report No. ITL64084. Candlepower trace of 6000K, 60 LED 25° flood luminaire with 6,114 initial delivered lumens operating at 350mA. **All published luminaire photometric testing performed to IESNA LM-79-08 standards.**



Isofootcandle plot of 6000K, 60 LED 25° flood luminaire with 0° vertical tilt at 20' (6.1m) A.F.G. Luminaire with 5,812 initial delivered lumens operating at 350mA. Initial FC at grade.



Isofootcandle plot of 6000K, 60 LED 25° flood luminaire with 60° vertical tilt at 10' (3.1m) A.F.G. Luminaire with 5,812 initial delivered lumens operating at 350mA. Initial FC at grade.

THE EDGE® EPA & Weight Calculations

# of LEDs	Approximate Weight 120–277V[1]	Single	2@ 180°	2@ 90°	3@ 90°	4@ 90°
Adjustable Fitter Mount 0°						
20	21.0 lbs.	0.66	1.31	0.98	1.64	1.97
40	23.8 lbs.	0.66	1.31	0.98	1.64	1.97
60	27.1 lbs.	0.66	1.31	1.02	1.68	2.05
80	28.2 lbs.	0.66	1.31	1.07	1.72	2.13
100	35.4 lbs.	0.66	1.31	1.11	1.76	2.21
120	33.5 lbs.	0.66	1.31	1.15	1.80	2.29
140	36.9 lbs.	0.66	1.31	1.19	1.84	2.38
160	41.4 lbs.	0.66	1.31	1.23	1.89	2.46
180	42.2 lbs.	0.66	1.31	1.27	1.93	2.54
200	43.3 lbs.	0.66	1.31	1.31	1.97	2.62
220	47.0 lbs.	0.70	1.39	n/a	n/a	n/a
240	47.8 lbs.	0.74	1.48	n/a	n/a	n/a

1. Add 5 lbs. for transformer in 347–480V fixtures when 525mA drive current or multi-level options are selected

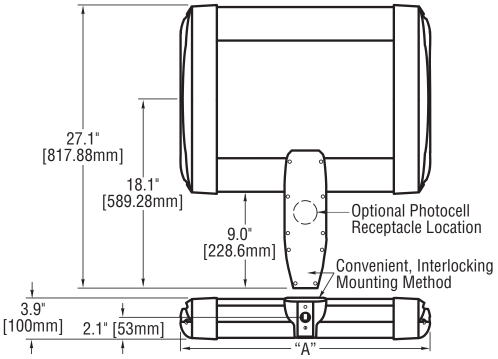
Made in the U.S.A. of U.S. and imported parts.
Meets Buy American requirements within the ARRA.

ARE-EDG-3M-DA THE EDGE® LED Area Light – Type III Medium

Rev. Date: 8/23/11

BetaLED Catalog #: ARE - EDG - - DA - - D - - - - -

Notes:



# of LEDs	Dim. "A"
20	12.06" [306mm]
40	12.06" [306mm]
60	14.06" [357mm]
80	16.06" [408mm]
100	18.06" [459mm]
120	20.06" [510mm]
140	22.06" [560mm]
160	24.06" [611mm]
200	28.06" [713mm]
240	32.06" [814mm]

Product	Family	Optic	Mounting	# of LEDs (x 10)	LED Series	Voltage	Color Options	Drive Current Not Field Adjustable	Factory-Installed Options Please type additional options in manually on the lines provided above.
ARE	EDG	☐ **3M**[1]	**DA**[3]	☐ **02**	**D**	☐ **UL**	☐ **SV**	☐ **350**	☐ **43K** 4300K Color Temperature[6]
		☐ **3MB**[2]		☐ **04**		Universal	Silver	350mA	☐ **DIM** 0–10V Dimming[7,8,9]
				☐ **06**		120–277V	☐ **BK**	☐ **525**[4]	☐ **F** Fuse[10,11,12]
				☐ **08**		☐ **UH**	Black	525mA	☐ **HL** Hi/Low (175/350/525, dual circuit input)[13]
				☐ **10**		Universal	☐ **BZ**	☐ **700**[5]	☐ **P** Photocell[12,14]
				☐ **12**		347–480V	Bronze	700mA	☐ **R** NEMA Photocell Receptacle[12,15,16]
				☐ **14**		☐ **34**	☐ **PB**		☐ **ML** Multi-Level (75/525)[13]
				☐ **16**		347V	Platinum		
				☐ **20**			Bronze		
				☐ **24**			☐ **WH**		
							White		

Footnotes

1. IESNA Type III Medium distribution
2. IESNA Type III Medium distribution w/ backlight control
3. Direct mounting arm for use with 3–6" (76–152mm) square or round pole
4. Available on fixtures with 20–160 LEDs
5. Available on fixtures with 20–60 LEDs
6. Color temperature per fixture; 6000K standard; minimum 70 CRI
7. Control by others
8. Refer to dimming spec sheet for availability and additional information
9. Not available when UH voltage is selected
10. When code dictates fusing use time delay fuse
11. Not available with all multi-level options. Refer to the multi-level spec sheet for availability and additional information
12. Refer to multi-level spec sheet for availability and additional information
13. Must specify voltage other than UH
14. Intended for horizontal mounting
15. Photocell by others

LED PERFORMANCE SPECS

# of LEDs	Initial Delivered Lumens – Type III Medium @ 6000K	B	U	G	Initial Delivered Lumens – Type III Medium w/ backlight control @ 6000K	B	U	G	Initial Delivered Lumens – Type III Medium @ 4300K	B	U	G	Initial Delivered Lumens – Type III Medium w/ backlight control @ 4300K	B	U	G	System Watts 120–480V	Total Current @ 120V	Total Current @ 240V	Total Current @ 277V	Total Current @ 347	Total Current @ 480V	L70 Hours* @ 25° C (77° F)	50K Hours Lumen Maintenance Factor* @ 15° C (59° F)
		Rating**				Rating**				Rating**				Rating**										
350mA Fixture Operating at 25° C (77° F)																								
20	1,814 (02)	1	1	1	1,342 (02)	0	1	1	1,672 (02)	1	1	1	1,237 (02)	0	1	1	26	0.20	0.11	0.10	0.09	0.07	>150,000	93%
40	3,628 (04)	1	1	1	2,683 (04)	1	1	1	3,343 (04)	1	1	1	2,473 (04)	0	1	1	47	0.40	0.21	0.19	0.15	0.12	>150,000	
60	5,371 (06)	2	2	2	3,973 (06)	1	2	1	4,950 (06)	2	2	2	3,662 (06)	1	2	1	68	0.58	0.30	0.26	0.20	0.16	>150,000	
80	7,161 (08)	2	2	2	5,298 (08)	1	2	2	6,600 (08)	2	2	2	4,882 (08)	1	2	1	90	0.77	0.38	0.34	0.26	0.20	>150,000	
100	8,929 (10)	3	3	3	6,605 (10)	1	3	2	8,230 (10)	2	2	2	6,088 (10)	1	2	2	111	0.95	0.47	0.42	0.32	0.24	>150,000	
120	10,715 (12)	3	3	3	7,926 (12)	1	3	2	9,876 (12)	3	3	3	7,305 (12)	1	3	2	132	1.15	0.56	0.50	0.38	0.28	>150,000	
140	12,444 (14)	3	3	3	9,205 (14)	1	3	2	11,469 (14)	3	3	3	8,484 (14)	1	3	2	157	1.34	0.67	0.61	0.47	0.35	149,000	
160	14,222 (16)	3	3	3	10,520 (16)	1	3	2	13,108 (16)	3	3	3	9,696 (16)	1	3	2	179	1.54	0.76	0.68	0.53	0.39	149,000	
200	17,778 (20)	3	3	3	13,151 (20)	2	3	3	16,385 (20)	3	3	3	12,120 (20)	1	3	2	221	1.92	0.95	0.84	0.65	0.48	149,000	
240	21,333 (24)	3	3	3	15,781 (22)	2	3	3	19,662 (24)	3	3	3	14,544 (24)	2	3	3	264	2.30	1.12	1.00	0.77	0.56	149,000	
525mA Fixture Operating at 25° C (77° F)																								
20	2,539 (02)	1	1	1	1,878 (02)	0	1	1	2,340 (02)	1	1	1	1,731 (02)	0	1	1	37	0.31	0.17	0.16	0.12	0.10	136,000	92%
40	5,079 (04)	2	2	2	3,757 (04)	1	2	1	4,681 (04)	2	2	2	3,462 (04)	1	2	1	70	0.57	0.29	0.26	0.21	0.16	136,000	
60	7,520 (06)	2	2	2	5,562 (06)	1	2	2	6,930 (06)	2	2	2	5,127 (06)	1	2	1	102	0.87	0.44	0.39	0.30	0.22	129,000	
80	10,026 (08)	3	3	3	7,417 (08)	1	3	2	9,240 (08)	3	3	3	6,835 (08)	1	3	2	133	1.14	0.56	0.49	0.39	0.29	129,000	
100	12,501 (10)	3	3	3	9,247 (10)	1	3	2	11,521 (10)	3	3	3	8,523 (10)	1	3	2	172	1.47	0.75	0.67	0.51	0.38	128,000	
120	15,001 (12)	3	3	3	11,097 (12)	1	3	2	13,826 (12)	3	3	3	10,227 (12)	1	3	2	204	1.76	0.88	0.78	0.60	0.44	128,000	
140	17,422 (14)	3	3	3	12,888 (14)	2	3	2	16,057 (14)	3	3	3	11,878 (14)	1	3	2	233	2.01	0.99	0.87	0.69	0.51	123,000	
160	19,911 (16)	3	3	3	14,729 (16)	2	3	2	18,351 (16)	3	3	3	13,575 (16)	2	3	3	265	2.29	1.11	0.98	0.78	0.57	123,000	
700mA Fixture Operating at 25° C (77° F)																								
20	3,102 (02)	1	1	1	2,281 (02)	0	1	1	2,858 (02)	1	1	1	2,102 (02)	0	1	1	50	0.42	0.22	0.20	0.15	0.12	111,000	90%
40	6,203 (04)	2	2	2	4,562 (04)	1	2	1	5,717 (04)	2	2	2	4,204 (04)	1	2	1	93	0.79	0.40	0.35	0.27	0.20	111,000	
60	9,185 (06)	3	3	3	6,754 (06)	1	3	2	8,465 (06)	2	3	2	6,225 (06)	1	2	2	137	1.18	0.59	0.51	0.39	0.29	111,000	

* For recommended lumen maintenance factor data see TD-13

** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit www.iesna.org/PDF/Erratas/TM-15-07BugRatingsAddendum.pdf

NOTE: All data subject to change without notice.

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Made in the U.S.A. of U.S. and imported parts.
Meets Buy American requirements within the ARRA.

ARE-EDG-3M-DA THE EDGE® LED Area Light – Type III Medium Rev. Date: 8/23/11

General Description

Slim, low profile design minimizes wind load requirements. Fixture sides are rugged cast aluminum with integral, weather-tight LED driver compartments and high performance aluminum heatsinks. Convenient, interlocking mounting method. Mounting housing is rugged die cast aluminum and mounts to 3–6" (76–152mm) square or round pole. Fixture is secured by two (2) 5/16-18 UNC bolts spaced on 2" (51mm) centers. Includes leaf/debris guard. Five year limited warranty on fixture.

Electrical

Modular design accommodates varied lighting output from high power, white, 6000K (+/- 500K per full fixture), minimum 70 CRI, long life LED sources. Optional 4300K (+/- 300K per full fixture) also available. 120–277V 50/60 Hz, Class 1 LED drivers are standard. 347–480V 50/60 Hz driver is optional. LED drivers have power factor >90% and THD <20% at full load. Units provided with integral 10kV surge suppression protection standard. Integral weather-tight electrical box with terminal strips (12Ga - 20Ga) for easy power hook-up. Surge protection tested in accordance with IEEE/ANSI C62.41.2.

Testing & Compliance

UL listed in the U.S. and Canada for wet locations and enclosure rated IP66 per IEC 60529 when ordered without P or R options. Consult factory for CE Certified products. Certified to ANSI C136.31-2001, 3G bridge and overpass vibration standards.
Dark Sky Friendly. IDA Approved. RoHS Compliant.

Product qualified on the Design Lights Consortium ("DLC") Qualified Products List ("QPL") when ordered without backlight control shield.

Finish

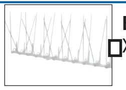
Exclusive Colorfast DeltaGuard® finish features an E-Coat epoxy primer with an ultra-durable silver powder topcoat, providing excellent resistance to corrosion, ultraviolet degradation and abrasion. Bronze, black, white and platinum bronze powder topcoats are also available. The finish is covered by our 10 year limited warranty.

Fixture and finish are endurance tested to withstand 5,000 hours of elevated ambient salt fog conditions as defined in ASTM Standard B 117.

Patents

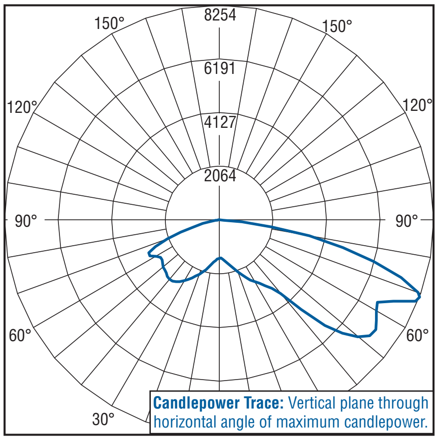
U.S. and international patents granted and pending. BetaLED is a division of Ruud Lighting, Inc. For a listing of Ruud Lighting, Inc. patents, visit www.uspto.gov.

Field-Installed Accessories



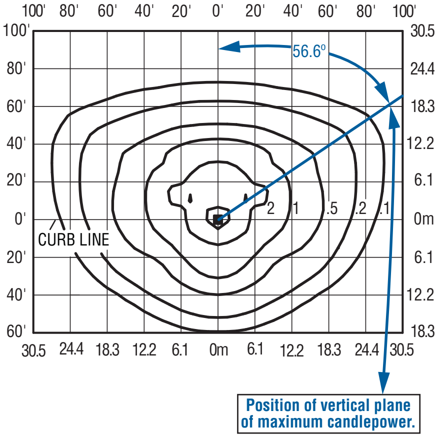
Bird Spikes
☐ XA-BRDSPK

Photometrics



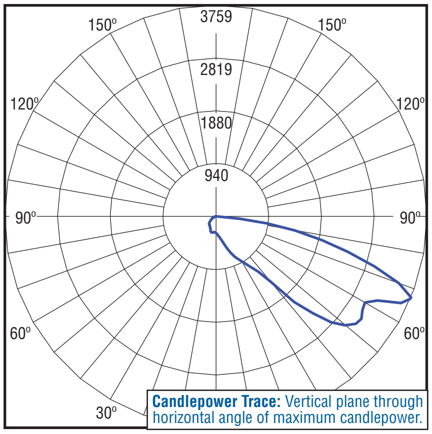
Candlepower Trace: Vertical plane through horizontal angle of maximum candlepower.

Independent Testing Laboratories certified test. Report No. ITL67871. Candlepower trace of 4300K, 160 LED Type III Medium area luminaire with 18,862 initial delivered lumens operating at 525mA. **All published luminaire photometric testing performed to IESNA LM-79-08 standards.**



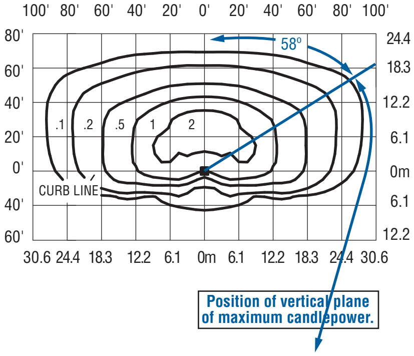
Position of vertical plane of maximum candlepower.

Isofootcandle plot of 4300K, 120 LED Type III Medium area luminaire at 25' (7.6m) A.F.G. Luminaire with 13,826 initial delivered lumens operating at 525mA. Initial FC at grade.



Candlepower Trace: Vertical plane through horizontal angle of maximum candlepower.

Independent Testing Laboratories certified test. Report No. ITL68539. Candlepower trace of 4300K, 40 LED Type III Medium w/ backlight control area luminaire with 5,084 initial delivered lumens operating at 525mA. **All published luminaire photometric testing performed to IESNA LM-79-08 standards.**



Position of vertical plane of maximum candlepower.

Isofootcandle plot of 4300K, 120 LED Type III Medium area luminaire at 25' (7.6m) A.F.G. Luminaire with 10,227 initial delivered lumens operating at 525mA. Initial FC at grade.

THE EDGE® EPA & Weight Calculations

# of LEDs	Approximate Weight 120–480V[1]	Single	2@ 180º	2@ 90º	3@ 90	4@ 90º
Fixed Arm Mount						
20	21.0 lbs. (9.5kg)	0.60	1.20	0.87	1.47	1.75
40	23.7 lbs. (10.8g)	0.60	1.20	0.87	1.47	1.75
60	27.0 lbs. (12.3kg)	0.60	1.20	0.92	1.51	1.83
80	28.1 lbs. (12.8kg)	0.60	1.20	0.96	1.55	1.91
100	32.3 lbs. (14.7kg)	0.60	1.20	1.00	1.60	2.00
120	33.5 lbs. (15.2kg)	0.60	1.20	1.04	1.64	2.08
140	36.9 lbs. (16.7kg)	0.60	1.20	1.08	1.68	2.16
160	41.4 lbs. (18.8kg)	0.60	1.20	1.12	1.72	2.24
200	43.3 lbs. (19.6kg)	0.61	1.21	n/a[2]	n/a[2]	n/a[2]
240	47.8 lbs. (21.7kg)	0.69	1.38	n/a[2]	n/a[2]	n/a[2]

1. Add 5 lbs. (2.3kg) for transformer in 347–480V fixtures when multi-level options are selected.
2. For applications requiring 200 or more LEDs at 90 degrees refer to the DL mount version of our spec sheet.

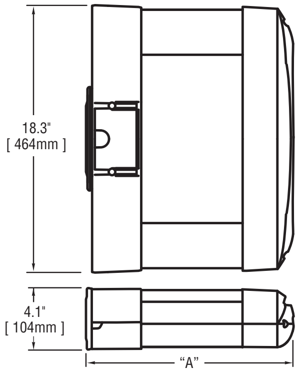
NOTE: All data subject to change without notice.

Made in the U.S.A. of U.S. and imported parts.
Meets Buy American requirements within the ARRA.

SEC-EDG-3M-WM THE EDGE® LED Wall Pack

Rev. Date: 2/21/12

BetaLED Catalog #: SEC - EDG - - WM - - D - - - - -



# of LEDs	Dim. "A"
20	11.91" [303mm]
40	11.91" [303mm]
60	13.91" [353mm]
80	15.91" [404mm]
100	17.91" [455mm]
120	19.91" [505mm]

Notes:

Product	Family	Optic	Mounting	# of LEDs (x 10)	LED Series	Voltage	Color Options	Drive Current Not Field Adjustable	Factory-Installed Options Please type additional options in manually on the lines provided above.
SEC	EDG	☐ 3M[1] ☐ 3MB[2]	WM[3]	☐ 02 ☐ 04 ☐ 06 ☐ 08 ☐ 10 ☐ 12	D	☐ UL Universal 120–277V ☐ UH Universal 347–480V ☐ 12 120V ☐ 24 240V ☐ 27 277V ☐ 34 347V	☐ SV Silver (Standard) ☐ BK Black ☐ BZ Bronze ☐ PB Platinum Bronze ☐ WH White	☐ 350 350mA ☐ 525[4] 525mA ☐ 700[5] 700mA	☐ 40K 4000K Color Temperature[6] ☐ DIM 0–10V Dimming[7,8,9] ☐ F Fuse[10,11,12] ☐ P Photocell[11,12] ☐ ML Multi-Level (75/525)[13]

Footnotes

1. IESNA Type III Medium distribution
2. IESNA Type III Medium distribution w/ backlight control
3. Wall mount
4. Available on fixtures with 20–80 LEDs
5. Available on fixtures with 20–60 LEDs
6. Color temperature per fixture; 5700K standard; minimum 70 CRI
7. Control by others
8. Refer to dimming spec sheet for availability and additional information
9. Not available when UH voltage is selected
10. When code dictates fusing use time delay fuse
11. Not available with all multi-level options. Refer to multi-level spec sheet for availability and additional information
12. Must specify voltage other than UL or UH
13. Refer to multi-level spec sheet for availability and additional information

LED PERFORMANCE SPECS

# of LEDs	Initial Delivered Lumens – Type III Medium @ 5700K	B	U	G	Initial Delivered Lumens – Type III Medium with Backlight Control @ 5700K	B	U	G	Initial Delivered Lumens – Type III Medium @ 4000K	B	U	G	Initial Delivered Lumens – Type III Medium with Backlight Control @ 4000K	B	U	G	System Watts 120–480V	Total Current @ 120V	Total Current @ 240V	Total Current @ 277V	Total Current @ 347V	Total Current @ 480V	L_{70} Hours* @ 25° C (77° F)	50K Hours Lumen Maintenance Factor* @ 15° C (59° F)
		Rating**				Rating**				Rating**				Rating**										
350mA Fixture Operating at 25° C (77° F)																								
20	1,814 (02)	1	1	1	1,342 (02)	0	1	1	1,672 (02)	1	1	1	1,237 (02)	0	1	1	26	0.20	0.11	0.10	0.09	0.07	>150,000	93%
40	3,628 (04)	1	1	1	2,683 (04)	1	1	1	3,343 (04)	1	1	1	2,473 (04)	0	1	1	47	0.40	0.21	0.19	0.15	0.12	>150,000	
60	5,371 (06)	2	2	2	3,973 (06)	1	2	1	4,950 (06)	2	2	2	3,662 (06)	1	2	1	68	0.58	0.30	0.26	0.20	0.16	>150,000	
80	7,161 (08)	2	2	2	5,298 (08)	1	2	2	6,600 (08)	2	2	2	4,882 (08)	1	2	1	90	0.77	0.38	0.34	0.26	0.20	>150,000	
100	8,929 (10)	3	3	3	6,605 (10)	1	3	2	8,230 (10)	2	2	2	6,088 (10)	1	2	2	111	0.95	0.47	0.42	0.32	0.24	>150,000	
120	10,715 (12)	3	3	3	7,926 (12)	1	3	2	9,876 (12)	3	3	3	7,305 (12)	1	3	2	132	1.15	0.56	0.50	0.38	0.28	>150,000	
525mA Fixture Operating at 25° C (77° F)																								
20	2,539 (02)	1	1	1	1,878 (02)	0	1	1	2,340 (02)	1	1	1	1,731 (02)	0	1	1	37	0.31	0.17	0.16	0.12	0.10	136,000	92%
40	5,079 (04)	2	2	2	3,757 (04)	1	2	1	4,681 (04)	2	2	2	3,462 (04)	1	2	1	70	0.57	0.29	0.26	0.21	0.16	136,000	
60	7,520 (06)	2	2	2	5,562 (06)	1	2	2	6,930 (06)	2	2	2	5,127 (06)	1	2	1	102	0.87	0.44	0.39	0.30	0.22	129,000	
80	10,026 (08)	3	3	3	7,417 (08)	1	3	2	9,240 (08)	3	3	3	6,835 (08)	1	3	2	133	1.14	0.56	0.49	0.39	0.29	129,000	
700mA Fixture Operating at 25° C (77° F)																								
20	3,102 (02)	1	1	1	2,281 (02)	0	1	1	2,858 (02)	1	1	1	2,102 (02)	0	1	1	50	0.42	0.22	0.20	0.15	0.12	111,000	90%
40	6,203 (04)	2	2	2	4,562 (04)	1	2	1	5,717 (04)	2	2	2	4,204 (04)	1	2	1	93	0.79	0.40	0.35	0.27	0.20	111,000	
60	9,185 (06)	3	3	3	6,754 (06)	1	3	2	8,465 (06)	2	3	2	6,225 (06)	1	2	2	137	1.18	0.59	0.51	0.39	0.29	111,000	

* For recommended lumen maintenance factor data see TD-13

** For more information on the IES BUG (Backlight-Uplight-Glare) Ratin visit www.iesna.org/PDF/Erratas/TM-15-07BugRatingsAddendum.pdf

9201 Washington Ave • Racine, WI 53406-3772 • 800-236-6800 • www.BetaLED.com

Made in the U.S.A. of U.S. and imported parts.
Meets Buy American requirements within the ARRA.

General Description

Slim, low profile design. Fixture sides are rugged cast aluminum with integral, weather-tight LED driver compartments and high performance aluminum heatsinks specifically designed for LED applications. Housing is rugged aluminum. Furnished with low copper, lightweight mounting box designed for installation over standard and mud ring single gang J boxes. Secures to wall with four (4) 3/16" (4.8mm) screws (by others). Conduit entry from top, bottom, sides and rear. Allows mounting for uplight or downlight. Designed and approved for easy through-wiring. Includes leaf/debris guard. Five year limited warranty on fixture.

Electrical

Modular design accommodates varied lighting output from high power, white, 5700K (+/- 500K per full fixture), minimum 70 CRI, long life LED sources. Optional 4000K (+/- 300K per full fixture) also available. 120–277V 50/60 Hz, Class 1 LED drivers are standard. 347–480V 50/60 Hz driver is optional. LED drivers have power factor >90% and THD <20% at full load. Integral weather-tight J-box with leads (wire nuts) for easy power hook-up. Units provided with integral 10kV surge suppression protection standard. Surge protection tested in accordance with IEEE/ANSI C62.41.2.

Testing & Compliance

UL listed in the U.S. and Canada for wet locations and enclosure rsted IP66 per IEC 60529. Consult factory for CE Certified products. Dark Sky Friendly. IDA Approved. RoHS compliant.

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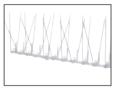
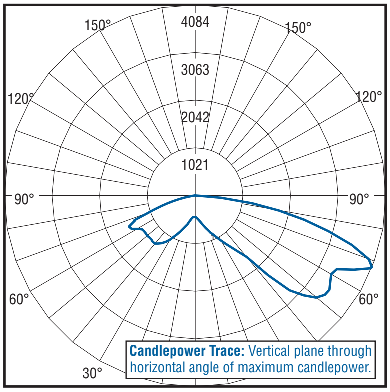


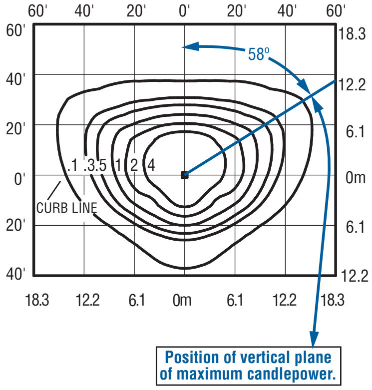
Bird Spikes
☐XA-BRDSPK

Photometrics



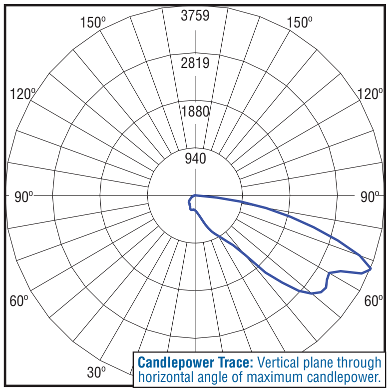
Candlepower Trace: Vertical plane through horizontal angle of maximum candlepower.

Independent Testing Laboratories certified test. Report No. ITL70203. Candlepower trace of 4000K, 60 LED Type III Medium security EDGE luminaire with 8,812 initial delivered lumens operating at 700mA. **All published luminaire photometric testing performed to IESNA LM-79-08 standards.**



Position of vertical plane of maximum candlepower.

Isofootcandle plot of 4000K, 60 LED Type III Medium security EDGE luminaire at 10' (3m) A.F.G. Luminaire with 8,465 initial delivered lumens operating at 700mA. Initial FC at grade.



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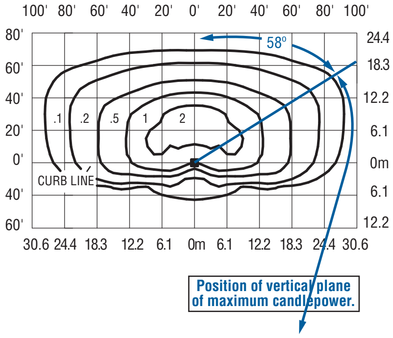


Position of vertical plane of maximum candlepower.

Isofootcandle plot of 4000K, 80 LED Type III Medium area luminaire at 25' (7.6m) A.F.G. Luminaire with 6,835 initial delivered lumens operating at 525mA. Initial FC at grade.

Made in the U.S.A. of U.S. and imported parts.
Meets Buy American requirements within the ARRA.

SYLVANIA
ProPoint™ Outdoor Luminaires
LED Shoebox Fixture

Catalog #

Type

Project

Notes

Date

EPA: 1.8 ft. Length: 20" Width: 15" Height: 6.75" Weight: 28 lbs

The SYLVANIA ProPoint LED Shoebox luminaires, available from 55 Watts to 150 Watts, are suitable for replacing up to 400W existing architectural luminaires for illuminating roadways, area lighting, driveways, site lighting, entrance ways, parking areas, and walkways.

The SYLVANIA ProPoint LED Shoebox luminaire is your best choice for energy-efficient, environmentally preferable lighting for parking, area and site lighting. The Shoebox luminaire uses up to 68% less energy than traditional high pressure sodium and metal halide fixtures and maintains virtually all its luminosity for the 10+-year life of the light, significantly reducing replacement and maintenance costs. Cutting-edge “heat sink” technology keeps the LEDs at their optimum performance temperature and extends product life. And the proprietary photometric design technique will minimize glare and improve nighttime visibility to deliver superior illumination. SYLVANIA ProPoint Shoebox luminaires meet all LEED requirements for light pollution reduction credits by minimizing light trespass, reducing sky-glow, and reducing the impact on nocturnal environments.

The Shoebox optical is available with an acrylic lens. SYLVANIA LED Shoeboxes possess full cut-off and are Dark Sky friendly.

Specifications

LED Systems/Electrical: The SYLVANIA ProPoint LED Shoebox luminaire features efficacy up to 87 lumens per watt and is offered in 55 Watts, 80 Watts, 100 Watts, 120 Watts and 150 Watts. The Shoebox luminaire has a 120, 220, 240 or 277 VAC voltage range and incorporates SYLVANIA lightning surge protection in each unit, which is effective at suppressing most surges on the AC line and meets IEEE C62.41-2002 Category C low. The LED driver is a constant current device with a high-power factor correction to maximize power utilization. The driver meets UL1310 and UL48 Class 2 with built-in over-temperature protection. Input voltage ranges from 120-277 VAC. The driver passes FCC Part 15, Class A for both conducted and radiated emissions.

Optic: Light Distribution is available in Type II or Type III with a profiled acrylic lens for maximum transmission of light. The LED modules utilize an aluminum metal clad board for maximum heat transfer, thus leading to longer life. Direction and intensity of light is tightly controlled. Control of the LEDs allows the Shoebox fixtures to maintain light control of the LEDs to levels equal to or greater than MH or HPS at much lower energy consumption levels.

Listings: Testing and Compliances include: LM79, CE Certified, Dark Sky compliant, IP 55 Certified Optical Assembly, UL1310, FCC and RoHS Certified and meets IEEE C62.41-2002 Category C low.

Color Characteristics: The CRI is 70 or above with a CCT of 4500 or 6000K.

Installation: Fixture mounts horizontally with rectangular arm to round and square poles.

Life: Life is >70,000 hours at L_{70}.

Construction: The luminaire is constructed of a one-piece cast, low copper (<0.4%CU) aluminum alloy. It has a TGIC thermoset polyester powder coat paint finish, 2.5-mil nominal thickness; standard colors are black and bronze.

Options: Twist lock photo cell is optional. Receptacle is included.

Warranty: SYLVANIA ProPoint LED Shoebox luminaires are covered by our standard five year outdoor LED Fixture Warranty.

Comparison

HID Source	LED Source	Energy Savings
100W HPS (120W)	55W	54%
100W MH (130W)	55W	58%
150W HPS (170W)	80W	53%
150W MH (185W)	80W	57%
175W MH (208 W)	80W	62%
200W MH (230W)	100W	57%
250W HPS (295W)	100W	66%
400W HPS (465W)	150W	68%
400W MH (452W)	150W	67%

SEE THE WORLD IN A NEW LIGHT

Ordering Guide

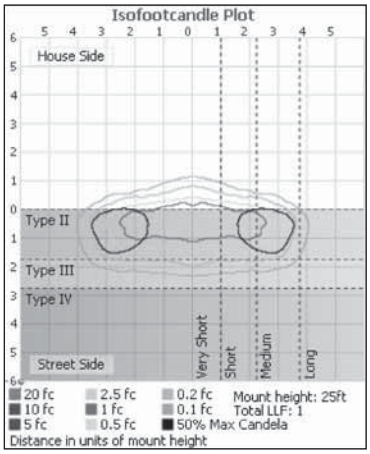
SB	L	XX	7	XX	XX	MV	XX
Product Name	Lamp Type	Wattage	CRI	Color Temp	Photometric Distribution	Voltage	Finish/Color
Shoebox	L = LED	55 = 55 Watts 80 = 80 Watts 100 = 100 Watts 120 = 120 Watts 150 = 150 Watts	CRI>70	45 = 4500K 60 = 6000K	M2 = Medium Type II Distribution S3 = Short Type III Distribution	120-277 V	BL = Black BZ = Bronze

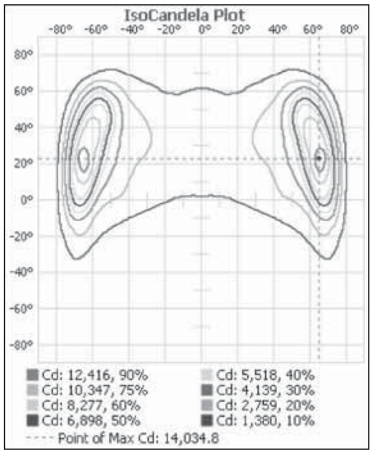
Ordering Information

Item Number	Ordering Abbreviation	Power (W)	CRI	Color Temp (CCT)	Distribution	Total Fixture Lumens	Lumens per Watt (LPW)	BUG Rating
70845	SB-L-55-760-M2-MV-BL	55	70+	6000K	Medium Type II	–	–	–
70846	SB-L-80-760-M2-MV-BL	80	70+	6000K	Medium Type II	–	–	–
70861	SB-L-100-760-M2-MV-BL	100	70+	6000K	Medium Type II	–	–	222
70847	SB-L-120-760-M2-MV-BL	120	70+	6000K	Medium Type II	–	–	–
70848	SB-L-150-760-M2-MV-BL	150	70+	6000K	Medium Type II	–	–	–
70849	SB-L-55-760-S3-MV-BL	55	70+	6000K	Short Type III	–	–	–
70850	SB-L-80-760-S3-MV-BL	80	70+	6000K	Short Type III	–	–	–
70862	SB-L-100-760-S3-MV-BL	100	70+	6000K	Short Type III	–	–	–
70851	SB-L-120-760-S3-MV-BL	120	70+	6000K	Short Type III	–	–	–
70852	SB-L-150-760-S3-MV-BL	150	70+	6000K	Short Type III	–	–	–
70853	SB-L-55-760-M2-MV-BZ	55	70+	6000K	Medium Type II	–	–	–
70854	SB-L-80-760-M2-MV-BZ	80	70+	6000K	Medium Type II	–	–	–
70863	SB-L-100-760-M2-MV-BZ	100	70+	6000K	Medium Type II	–	–	222
70855	SB-L-120-760-M2-MV-BZ	120	70+	6000K	Medium Type II	–	–	–
70856	SB-L-150-760-M2-MV-BZ	150	70+	6000K	Medium Type II	–	–	–
70857	SB-L-55-760-S3-MV-BZ	55	70+	6000K	Short Type III	–	–	–
70858	SB-L-80-760-S3-MV-BZ	80	70+	6000K	Short Type III	–	–	–
70864	SB-L-100-760-S3-MV-BZ	100	70+	6000K	Short Type III	–	–	–
70859	SB-L-120-760-S3-MV-BZ	120	70+	6000K	Short Type III	–	–	–
70860	SB-L-150-760-S3-MV-BZ	150	70+	6000K	Short Type III	–	–	–

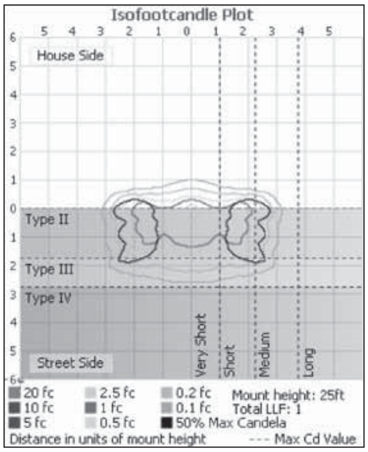
Photometric Information

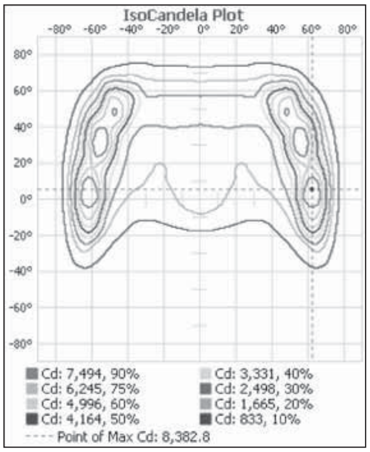
Shoebox – 120 watts
Short Cutoff Type III
BUG Rating – B2-U2-G2





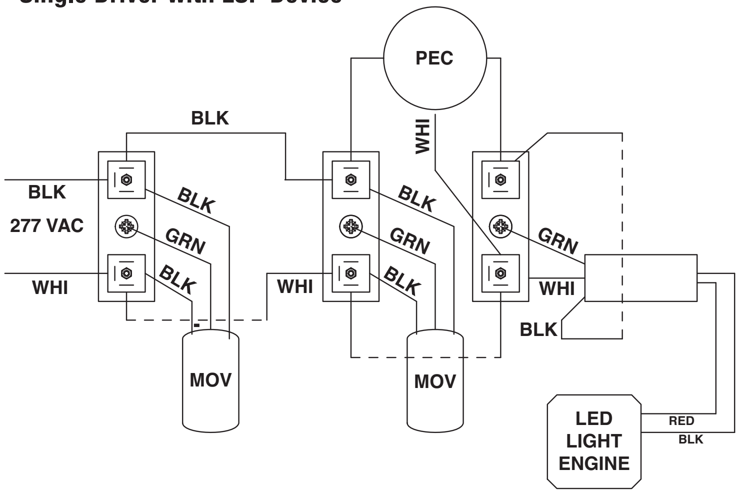
Shoebox – 120 watts
Medium Semi-cutoff Type II
BUG Rating – B2-U2-G2



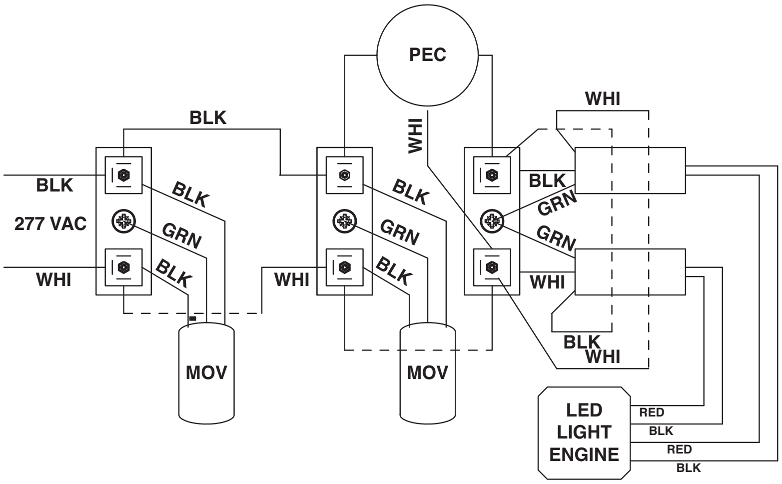


Wiring Diagram

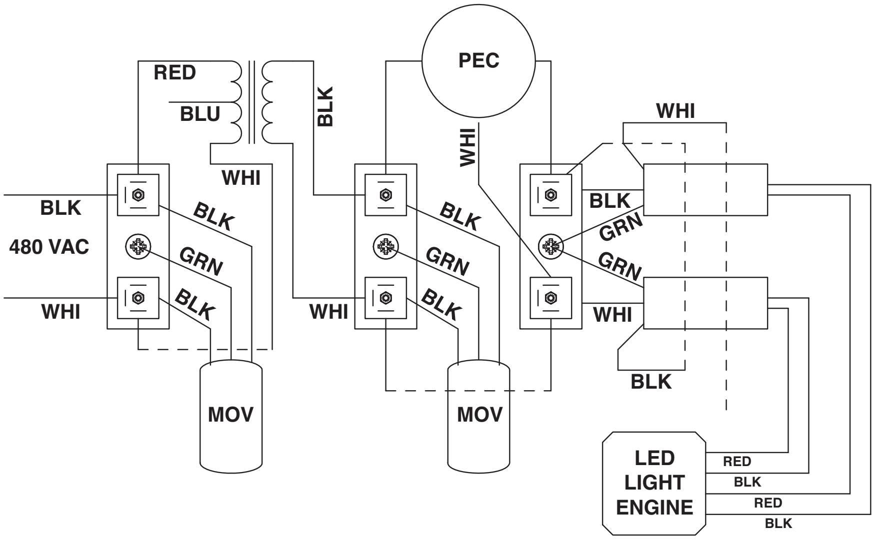
100-277 VAC – Single Driver with LSP Device



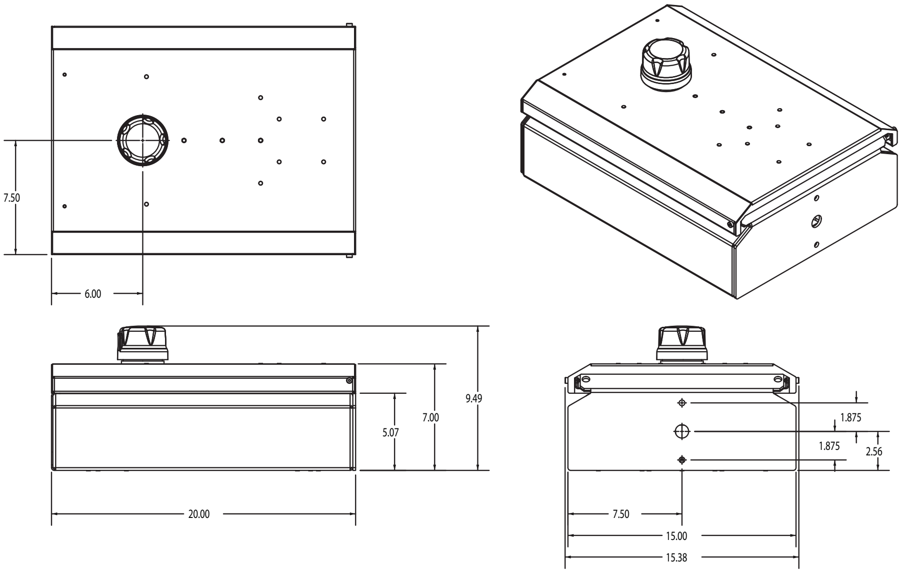
100-277 VAC – Dual Driver with LSP Device



347 or 480 VAC with Step Down Transformer – Dual Driver with LSP Device



Mechanical Drawing



Measurements are in inches.

Safety Information

WARNING: ONLY QUALIFIED PERSONNEL SHOULD PERFORM INSTALLATION.

TO AVOID ELECTRICAL SHOCK OR COMPONENT DAMAGE, DISCONNECT POWER BEFORE ATTEMPTING INSTALLATION OF THE FIXTURES.

Failure to install the fixtures in accordance with the National Electric Code (NEC), all applicable Federal, State and local electric codes as well as the specific Underwriters Laboratories (UL) safety standards for the installation, location and application may cause serious personal injury, death, property damage and/or product malfunction.

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ECM 3:
Integrated and New Energy Management Systems

ECM Overview

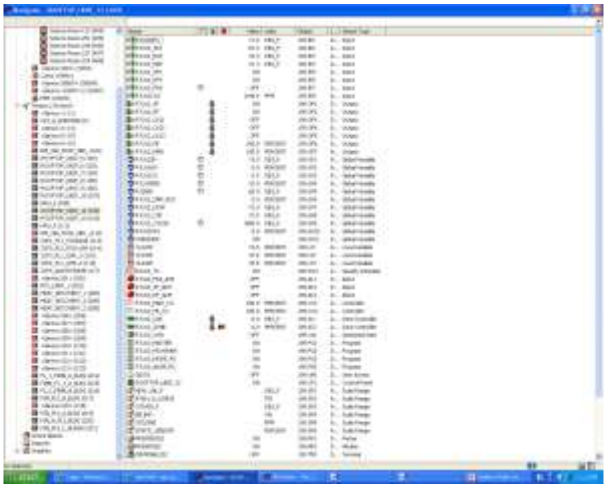


Figure 3.1: Ameresco proposes to expand and recommission the existing EMS.

Ameresco proposes to replace and/or integrate where possible the different existing EMS systems installed in Loring Elementary School, Noyes Elementary School, Haynes Elementary School and Nixon Elementary School.

The proposed EMS would be "open protocol" and "interoperable" with other manufacturer's products. This feature would allow products from any vendor to be installed as the system is maintained or expanded in the future. The recommended EMS would be accessible from any Internet-enabled personal computer with web browsing software and would provide reduced energy consumption, increase system reliability and improve occupant comfort for the Town. The proposed EMS will provide dynamic systems control and utility consumption reporting capabilities for the entire Town.

Under the proposed EMS, Ameresco would install a new open protocol Tridium^{AX} based EMS that would be installed on top of existing controls for the air handling units and other control valves, as well as exhaust fans and circulator pumps. All existing pneumatic logic controllers will be removed as well as existing pneumatic thermostats controlling unit ventilators and cabinet heaters.

ECM Detail

Existing System

Loring Elementary School:

The Loring Elementary School originally had a Johnson Controls Metasys EMS and Tekmar boiler controller installed to control all the HVAC equipment and boiler plant. The EMS was recently upgraded with a new Johnson Controls Facility Explorer EMS consisting of some new Facility Explorer field controllers and front end software. An FX60 Supervisory Controller was installed to manage all the existing Metasys and new Facility Explorer field controllers and provides web accessibility of the EMS front end software. All of the HVAC equipment is controlled and monitored by the Facility Explorer EMS which provides hot water loop temperature and occupancy schedule adjustments. Metasys temperature sensors in each occupied zone communicate with the FX system and provide control of the rooftop units, VAV boxes, and finned tube radiators.

Noyes Elementary School:

A Johnson Controls Facility Explorer EMS was installed to control the building HVAC equipment. An FX60 Supervisory Controller was installed to manage all the existing Honeywell and new Facility Explorer field controllers and provides web accessibility of the EMS front end software. Most of the equipment in renovated areas is equipped with Facility Explorer field controllers, sensors, valves, and actuators, including the boiler plant, some unit ventilators, and finned tube radiators. Much of the building HVAC equipment is being controlled by the previously existing Honeywell field controllers including the remaining unit ventilators, rooftop units, and fan boxes. All of the HVAC equipment is controlled and monitored by the Facility Explorer EMS which provides hot water loop temperature and occupancy schedule adjustments. Honeywell and Johnson Controls temperature sensors in each occupied zone communicate with the FX system and provide control of the terminal units. A small roof-mounted solar array was installed to offset the electric utility costs. The output can be monitored by a Solren View internet data monitoring system.

Haynes Elementary School:

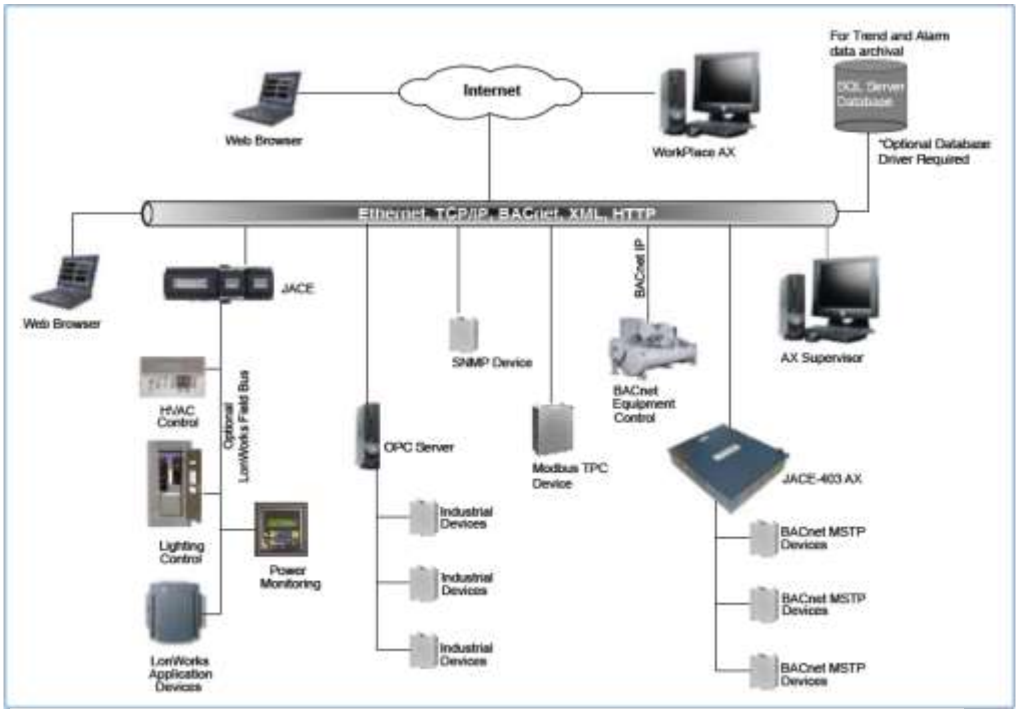
A Honeywell Excel 15B Building Management System (BMS) was installed to control the HVAC equipment at Haynes Elementary School. The Honeywell BMS allows facility staff to monitor HVAC equipment operation and modify temperature setpoint temperatures and operation schedules. A Honeywell Excel 15B Building Manager operator interface was installed to connect the system to the internet and allow for web accessibility. Honeywell field controllers are installed on equipment throughout the building including the boiler plant and rooftop units. The controllers communicate with the Honeywell wall sensors located within each occupied space to monitor temperature and operate the associate equipment to meet space heating or cooling loads. The Honeywell BMS has full control of the rooftop units and boiler plant but only limited control of the exhaust fans and the AAF unit ventilators. The exhaust fans and unit ventilators are controlled through the BMS by RIB relays that provide basic on/off operation of the equipment. The unit ventilators are controlled by MicroTech 325 controllers that operate the units based on integral thermostats.

Nixon Elementary School:

A Johnson Controls Facility Explorer EMS was installed to control the boiler plant and rooftop units with intentions of expanding the EMS to control the remaining HVAC equipment in the future. The HVAC equipment is being controlled by the previously existing Honeywell field controllers. An FX60 Supervisory Controller was installed to manage all the existing Honeywell field controllers and provides web accessibility of the EMS front end software. The HVAC equipment is controlled and monitored by the Facility Explorer EMS which provides hot water loop temperature and occupancy schedule adjustments. Honeywell and Johnson Controls temperature sensors in each occupied zone communicate with the FX system and provide control of the rooftop units. The unit ventilators, cabinet unit heaters, and finned tube radiators are still being controlled by an antiquated pneumatic control system. Air compressors in the boiler room provide the required amount of air for the system and distribute it throughout the building through a tubing network. Pneumatic thermostats in each of the zones provide a signal to the associated terminal unit's pneumatic valves and dampers to open/close when there is demand for heat or when the space setpoint temperature is satisfied. The EMS has minimal control of the exhaust fans and unit ventilators by the use of numerous RIB relays that provide basic on/off operation of the equipment.

Proposed System

Ameresco is proposing an "open protocol" energy management system with Tridium's Niagara^{AX} Framework. The open protocol specification will allow the Town to connect products from almost any LonWorks™ or BACnet vendor to the proposed system, in addition to other systems based on MODBUS or JCI's N2. Future upgrades and expansions can be competitively bid and will not be limited to the products of any one manufacturer. Ameresco has no commercial alliance with any EMS vendor and considers all applicable products. Ameresco believes the Town's interests would be best served with an open protocol EMS architecture.



Typical Tridium ™ configuration.

The existing Johnson Control Facility Explorer FX server located at the Fairbank Community Center will be reused in the DPW Offices server room to control and monitor the new EMS in the four schools. The new server will have all the software necessary to program and expand the EMS including all necessary licenses. This server will sit on the existing WAN, behind existing firewalls. Access to the server will be secured through password gateways and existing Town security systems. Communications between the field controllers will take place on a dedicated, non-Ethernet network. The new EMS will be networked using the Town's existing WAN. New control system interface equipment will be connected to the existing communications infrastructure. An Internet interface built into the new EMS will allow an authorized and authenticated operator to access EMS information through standard web browser software from any computer connected to the WAN.

All new animated graphics will be created for each building. The following specifications will be incorporated into the scope of work and required to be met by the installing contractor.

- The subcontractor shall have employees that are certified in Tridium Niagara AX working on this project, proof of certification shall be required before contract approval.
- Provide four (4) references of Niagara AX projects similar in scope and size to this project which will serve to illustrate the ability of firm to act as primary contractor to accomplish the work here in as specified.
- All work shall be performed in a neat and workmanship like manner.
- All wiring shall be run at 90 degree angles, no wiring to be run as "the crow flies".
- All electrical work in mechanical space to be run in EMT.
- All concealed wiring shall be plenum rated and be sized according to the controllers specification.
- Wiring associated with the reheats can be run as open cable but must be secured neatly above the duct work to conceal as much of the cable as possible. Secure the wiring using Tie Wrap adhesive base at no more than 4' intervals.
- All wiring located in drop ceiling shall be secured to the structure and shall be tie wrapped at no more than 10' intervals. Wiring shall not be attached to other wiring systems, light fixtures etc. Wiring shall not be placed on top of suspended ceilings.
- All junction boxes shall be clearly marked identifying what is located in each junction box.
- Create all new animated graphics, existing graphics that the Town's wishes to retain will need to be recreated.
    - A master Town graphic shall be created with access to each individual building.
    - A graphic for each individual building showing all mechanical systems that have graphics.
    - Create a new, user friendly, floor plan graphic for building navigation with available temperature sensors shown with clickable links to area specific HVAC equipment.
    - Each AHU shall have a dedicated animated graphic page.
    - Hot water, chilled water and DHW systems shall have dedicated animated graphics pages.
    - All graphics are to be submitted for the Town/Ameresco approval during construction.

Below is a list of clarifications to the scope of work described in detail further below.

1. All pricing is based on work performed during normal working hours, Monday through Friday 7:30 - 4:30
2. All existing controls systems assumed to be in good working condition except where called out specifically.
3. Excluded is the replacement of control dampers.
4. All air and water balancing is excluded.
5. Excluded is the replacement of air compressors.
6. Coordination of shutdown and cutovers of HVAC systems are assumed to be during normal working hours.
7. The Town shall provide a secure location on site to be utilized for equipment and job coordination.
8. Standard point to point commissioning and point check out is included. Excluded from this proposal is any cost associated with 3rd party commissioning agent.
9. Ameresco assumes that all existing systems to remain and be integrated are in good working condition. Excluded from this proposal is cost associated with repair of any existing controllers.
10. Excluded is any work associated with coring. Ameresco will utilize existing risers for network wiring.
11. Cutover and commissioning of air handling units, AC units, exhaust fans, pumps etc. shall be coordinated during normal working hours in cooperation with the Town.
12. Existing controllers that are to remain shall be connected to the new Tridium JACE controllers. All existing wiring for the controllers that are to remain is assumed to be in good working condition.
13. Ameresco's scope does not include fire alarm modifications or installation of fire alarm components.
14. All mechanical systems to remain are expected to be in good working condition. Any cost associated with repairs is not included in this proposal unless specified.
15. Any painting and patching to be performed by the Town.
16. Ameresco is responsible for installing the network Cat 5 wiring from the JACE controllers to the network closets as specified and will be coordinated with the Town's IT department.
17. Any control equipment to remain in operation is expected to be in good working condition, any cost associated with repairs is not included in this proposal unless specified. A deficiency list will be generated during the commissioning phase in which the Town will be expected to cover any failed controls components.

The specifications and clarifications listed above shall apply to all other ECMs which include scopes associated with the EMS. Please refer to the points list in the Appendix for details of each control point to be added in each building.

Detailed Scope of Work - Loring Elementary School:

Integrate Existing DDC EMS

- Integrate existing Johnson Controls Facility Explorer EMS into new Town-wide system.
- Reuse existing front end
  - Integrate existing JCI FX60 Controller (see points list for details)
  - Perform point by point inspection of existing control system and provide a report listing any deficiencies.
    - Existing damper actuators, control valves, and other control devises found to be deficient are not to be replaced unless specified in scope of work outlined below
  - Setup trends and alarms per Ameresco specifications
- Integrate existing systems per attached points list
  - ***Existing Points of Control to be integrated***: *JCI FX/Metasys Systems*
    - (2) Burnham V1117W Hot Water Boilers
    - (2) Hot Water Circulation Pumps
    - (8) Rooftop Units
    - (14) Exhaust Fans
    - (11) Fan Powered VAV Boxes
    - (59) Convector Units

Detailed Scope of Work - Noyes Elementary School:

Integrate Existing DDC EMS

- Integrate existing Johnson Controls Facility Explorer EMS into new Town-wide system.
- Reuse existing front end
  - Integrate existing JCI FX60 Controller (see points list for details)
  - Perform point by point inspection of existing control system and provide a report listing any deficiencies.
    - Existing damper actuators, control valves, and other control devises found to be deficient are not to be replaced unless specified in scope of work outlined below
  - Setup trends and alarms per Ameresco specifications
- Integrate existing systems per attached points list
  - ***Existing Points of Control to be integrated***: *JCI FX System/Honeywell Controls*
    - (3) Thermal Solutions Model EVCA Hot Water Boilers
    - (4) Hot Water Circulation Pumps
    - (3) Boiler Return Hot Water Pumps
    - (5) Air Handling Units
    - (2) Rooftop Units

        - (1) Make-up Air Unit
        - (16) Exhaust Fans
        - (37) Unit Ventilators
        - (6) Fan Powered VAV Boxes
        - (5) VAV Boxes
        - (4) Fan Coil Units
        - (9) Convector Units

Detailed Scope of Work - Haynes Elementary School:

Integrate Existing EMS

- Provide and install a new Johnson Controls FX (or equivalent) Network Level Supervisory Controller running on the latest version of FX Workbench (or equivalent) software at the time of construction with all updates provided until the date of acceptance.
- New Supervisory Controller to pick up existing Honeywell Excel 15 control points.
- Integrate EMS into new Town-wide system.
    - New Supervisory Controller to come with open license having no expiration (Ameresco OrgId must be added at time of licensing)
    - New system to be based on points list provided by Ameresco (see attachment for points list)
        - Reuse existing damper actuators and control valves unless specified in scope of work outlined below
        - Provide all category 5e communication wiring from new Supervisory Controller to customer network closet
    - Provide all communication wiring between existing LonWorks™ field controllers and new Supervisory Controller for a complete operable system. Reuse existing control wiring where feasible.
    - Perform point by point inspection of existing control system and provide a report listing any deficiencies.
        - Existing damper actuators, control valves, and other control devises found to be deficient are not to be replaced unless specified in scope of work outlined below.
    - Setup trends and alarms per Ameresco/ Town's specifications.
- Integrate existing systems per attached points list
    - ***Existing Points of Control to be integrated***: *Honeywell Excel 15 Controls*
        - (3) Hydrotherm Modular MR-1800B-PV Multi-Temp Boilers (6 modules per boiler)
        - (2) Heating Hot Water Pumps
        - (4) Heating and Ventilation Units
        - (2) Packaged Rooftop Units
        - (4) Exhaust Fan Zone Relays
        - (4) Unit Ventilator Zone Relays

Detailed Scope of Work - Nixon Elementary School:

Integrate Existing DDC EMS

- Integrate existing Johnson Controls Facility Explorer EMS into new Town-wide system.
- Reuse existing front end
    - Integrate existing JCI FX60 Controller (see points list for details)
    - Perform point by point inspection of existing control system and provide a report listing any deficiencies.
        - Existing damper actuators, control valves, and other control devises found to be deficient are not to be replaced unless specified in scope of work outlined below
    - Setup trends and alarms per Ameresco specifications
- Integrate existing Boiler plant and RTUs controls per attached points list
- Provide and install new control points and integrate existing mechanical systems per attached points list
    - ***Existing Points of Control to be integrated***: *JCI FX System/Honeywell Controls*
        - (3) Patterson Kelly Thermific N-1200 Boilers
        - (2) Heating Hot Water Pumps
        - (2) Rooftop units
        - (9) Exhaust Fan RIB Relays
        - (10) Unit Ventilator RIB Relays

Install New Unit Ventilator Controllers

- Replace existing Honeywell pneumatic controllers on (37) unit ventilators with new DDC BACnet controllers.
    - Replace existing unit ventilator pneumatic controls including existing EP switches, thermostats, face-and-bypass damper actuators, outside air damper actuators.
    - Provide and control new ¾", 2-way, modulating hot water control valves with DDC actuators on existing unit ventilators. Provide all necessary programming to integrate into the existing control system.
    - ***New Points of Control***:
        - (37) Unit Ventilators

Install New Finned Tube Radiation and Cabinet Unit Heater Control

- Provide and control new 2-way, modulating hot water control valves with DDC actuators on (18) finned tube radiators and (8) cabinet unit heaters.
- Provide all necessary programming to integrate into the control system.
    - ***New Points of Control***:
        - (18) Finned Tube Radiators (convectors)
        - (8) Cabinet Unit Heaters

General Zone and Special Area Event Scheduling

Ameresco proposes to provide operating schedule software for all controlled spaces. For example, during unoccupied periods, areas can be maintained in unoccupied status. This software will permit complicated event scheduling for specifics zones in any building. For example, an "auditorium event" will schedule auditorium air handling units on for the occupied periods only while the remainder of the building is in unoccupied mode.

Optimum Start/Stop of HVAC Equipment

Ameresco proposes to implement optimum start/stop of HVAC Equipment. System energy will be saved if occupied zone temperature is conditioned to its set point as close to the beginning of the occupancy period as is possible. For example, if the occupied zone set point is 70°F and one hour is required to "pull the temperature up" to set point from the unoccupied temperature, the start time of HVAC equipment shall be delayed until one hour before the occupied period. This optimum start time of HVAC equipment is a function of the building characteristics, set points and ambient conditions. The EMS will create a database of measurements for the facility from which an optimum start time will be automatically determined for each day. Similarly, the stop time of HVAC equipment will be determined from this database.

Boiler and Pump Control Sequences

Hot water boilers and pumps will be enabled based on both an operating schedule and an outdoor temperature setpoint. During normal operation the boilers and pumps will only be enabled whenever any of the heating related zones are occupied, i.e., classrooms, gymnasiums, etc., and the outside air temperature is less than or equal to 60° (adjustable). During unoccupied periods the boilers and pumps will be off unless the outside air temperature is less than or equal to 37.5°, at which time the boilers will maintain a lower hot water loop temperature and the pumps will be operated continuously to prevent frozen coils. If the pumps are driven by VFDs then they will be operated at the minimum design flow rate and all hot water coils will be commanded open.

Unoccupied Zone Temperature Reset

Ameresco proposes to fully implement unoccupied zone temperature reset. Zone temperature set points will be varied based on occupancy schedules. Unoccupied zone temperature reset is currently implemented by existing control systems, and will be implemented for existing pneumatic systems. The addition of numerous DDC temperature sensors in all buildings will permit more accurate temperature control. More accurate sensing and control will permit maximum unoccupied reset savings. The following table lists the proposed set points. These set points are proposed for all unoccupied periods.

	Cooling (ºF)	Heating (ºF)
Unoccupied	85.0	55.0

Occupied Scheduling

Ameresco will initially setup the occupancy schedules in the EMS to reflect the major occupancy schedule of the buildings. The HVAC systems will only be operated when the buildings are supposed to be occupied. Other areas of the buildings like offices, conference rooms, gymnasiums and auditoriums can have longer schedules to reflect occupancy outside of the normal schedules; however, classroom systems will be turned off based on the class schedule. A temporary override will need to be activated to provide after-hours conditioning of classroom spaces. The table below lists the proposed time schedules. The vacation schedule will also be initially setup in the system to turn off equipment on vacation days. The Town will be responsible for updating the vacation and special days schedule to ensure the systems are not operating when the buildings are not occupied. An optimum start sequence will be programmed to ensure the building is at setpoint for the desired start times. Refer to the optimum start discussion below for more details.

Building	Start time (Mon – Fri)	Stop time (Mon – Fri)	Weekends/ Holidays	Period
Loring Middle School	8:00am	3:00pm	Off	Sept - Jun
Noyes Elementary School	8:30am	3:30pm	Off	Sept - Jun
Haynes Elementary School	8:30am	3:30pm	Off	Sept - Jun
Nixon Elementary School	8:30am	3:30pm	Off	Sept - Jun

Fault and Exception Alarming

Ameresco proposes to provide fault or exception alarming for HVAC equipment. Equipment operation status will be proved by sensors operation; a commanded "ON" will result in a proved "ON" or an alarm will be generated. An alarm list will be maintained in a database to provide maintenance information to operators in real time. Operators will save significant time by addressing needs as indicated by the EMS. During non-working hours the EMS will have the capability of paging operators automatically to announce system faults.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect "As-Built" conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The installation of remotely-accessible energy management systems will improve comfort, reduce energy use and cost, and reduce on-site man-hours by specialized maintenance personnel.

Appendix for ECM 3:
Integrated and New Energy Management Systems

I. Energy Savings Calculations

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MAPC - Sudbury	
Energy and Demand Savings Summary	
Measure ID:	**3**
Measure Name:	**Integrated and New Energy Management System**
Measure Location:	
Engineers:	

Site Name:		**Loring**	**Noyes**	**Haynes**	**Nixon**	**Summary**
Item	Units	Savings	Savings	Savings	Savings	
Electricity						
Energy On-Peak	kWh	407	220	7,223	1,377	9,227
Energy Off-Peak	kWh					0
Energy Total	kWh	407	220	7,223	1,377	9,227
Demand On-Peak, Monthly	kW					0.0
Demand On-Peak, Annual	kW					0.0
Demand Off-Peak, Monthly	kW					0.0
Demand Off-Peak, Annual	kW					0.0
Fossil Fuel						0
Natural Gas (NG)	Therms	1,204	2,342	4,743	3,648	11,938
Liquid Propane Gas (LPG)	Gallons	0	0	0	0	0
Steam	Mlbs	0	0	0	0	0
Fuel Oil, #2	Gallons	0	0	0	0	0
Fuel Oil, #4	Gallons	0	0	0	0	0
Fuel Oil, #6	Gallons	0	0	0	0	0
Miscellaneous	Misc	0	0	0	0	0
Water						0
Water Savings	kGallons					0
Sewer						0
Sewer Savings	kGallons					0

MAPC - Sudbury
Loring Elementary
Integrated and New Energy Management System

TMY-2 Weather Data for Worcester, MA								**Existing Occupancy Schedule**				**Existing Heating/Cooling Schedule**				**Existing Motor Operating Schedule**				**Existing**				**Proposed**								**Savings**		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Cooling Energy Savings (MMBTU)	HVAC Electrical Savings (kWh)	Heating Energy Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**
Cooling																																		
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	222	169	0	0	0	0	0	0	222	169	0	0	0	0	
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	199	152	0	0	0	0	0	0	199	152	0	0	0	0	
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	177	136	0	0	0	0	0	1	177	136	0	0	0	0	
90 to 95	92.5	69.8	34.2	0	8	0	8	1	1	0	6	2	0	0	6	2	0	0	6	155	119	0	0	2	0	0	6	155	119	0	0	0	0	
85 to 90	87.5	70.3	34.6	1	37	6	44	8	4	0	31	10	2	0	31	10	2	0	31	133	102	0	1	10	2	0	31	133	102	0	1	0	2	
80 to 85	82.5	68.4	33.0	8	138	29	175	33	17	0	125	41	9	0	125	41	9	0	125	111	85	2	4	40	9	0	125	111	85	2	4	0	7	
75 to 80	77.5	66.2	31.2	27	202	83	312	58	31	0	223	72	17	0	223	72	17	0	223	89	68	2	6	72	17	0	223	89	68	2	6	0	14	
70 to 75	72.5	64.3	29.7	64	269	160	493	92	49	0	352	115	26	0	352	115	26	0	352	66	51	3	7	114	27	0	352	66	51	3	7	0	23	
65 to 70	67.5	61.2	27.5	185	208	243	636	118	63	0	454	148	34	0	454	148	34	0	454	44	34	2	6	147	34	0	454	44	34	2	6	0	29	
60 to 65	62.5	57.3	24.8	315	249	298	862	160	86	0	616	200	46	0	616	200	46	0	616	22	17	2	4	199	47	0	616	22	17	2	4	0	40	
Heating																																		
55 to 60	57.5	52.7	0.0	303	245	276	824	153	82	0	589	191	44	0	589	191	44	0	589	(511)	(22)	0	22	191	45	0	589	(511)	0	0	21		43	0
50 to 55	52.5	47.8	0.0	262	184	228	674	125	67	0	482	157	36	0	482	157	36	0	482	(715)	(97)	28	60	156	36	0	482	(715)	(75)	28	45		36	15
45 to 50	47.5	42.5	0.0	204	230	211	645	120	64	0	461	150	34	0	461	150	34	0	461	(920)	(172)	57	109	149	35	0	461	(920)	(150)	57	95		31	14
40 to 45	42.5	38.3	0.0	210	191	234	635	118	63	0	454	148	34	0	454	148	34	0	454	(1,124)	(247)	85	159	147	34	0	454	(1,124)	(225)	85	145		30	14
35 to 40	37.5	33.8	0.0	321	301	286	908	169	90	0	649	211	48	0	649	211	48	0	649	(1,328)	(322)	163	300	210	49	0	649	(1,328)	(300)	163	280		43	20
30 to 35	32.5	28.7	0.0	356	221	313	890	166	88	0	636	207	47	0	636	207	47	0	636	(1,533)	(397)	201	366	206	48	0	636	(1,533)	(375)	201	347		37	20
25 to 30	27.5	23.5	0.0	228	211	211	650	121	65	0	464	151	34	0	464	151	34	0	464	(1,737)	(472)	176	320	150	35	0	464	(1,737)	(450)	176	305		27	15
20 to 25	22.5	19.1	0.0	104	94	124	322	60	32	0	230	75	17	0	230	75	17	0	230	(1,941)	(547)	102	185	74	17	0	230	(1,941)	(525)	102	177		13	7
15 to 20	17.5	14.3	0.0	144	78	117	339	63	34	0	242	79	18	0	242	79	18	0	242	(2,146)	(622)	123	222	78	18	0	242	(2,146)	(600)	123	214		14	8
10 to 15	12.5	9.3	0.0	118	40	85	243	45	24	0	174	56	13	0	174	56	13	0	174	(2,350)	(697)	99	178	56	13	0	174	(2,350)	(675)	99	173		10	6
5 to 10	7.5	5.0	0.0	52	10	15	77	14	8	0	55	18	4	0	55	18	4	0	55	(2,554)	(772)	35	63	18	4	0	55	(2,554)	(750)	35	61		3	2
0 to 5	2.5	2.2	0.0	18	3	1	22	4	2	0	16	5	1	0	16	5	1	0	16	(2,759)	(847)	11	20	5	1	0	16	(2,759)	(825)	11	19		1	1
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(2,963)	(922)	0	0	0	0	0	0	(2,963)	(900)	0	0		0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(3,167)	(997)	0	0	0	0	0	0	(3,167)	(975)	0	0		0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(3,372)	(1,072)	0	0	0	0	0	0	(3,372)	(1,050)	0	0		0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(3,576)	(1,147)	0	0	0	0	0	0	(3,576)	(1,125)	0	0		0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(3,780)	(1,222)	0	0	0	0	0	0	(3,780)	(1,200)	0	0		0	0
				2,920	2,920	2,920	8,760	1,630	870	0	6,260	2,035	465	0	6,260	2,035	465	0	6,260			1,091	2,030	2,026	474	0	6,260			1,091	1,910	0	403	120

Cell Ref.	**Comment**
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Existing Occupancy hours
M - P	Existing Heating/Cooling hours
Q - T	Existing Motor Operating Hours
U	Occupied Cooling and Heating loads (MBH)
V	Unoccupied Cooling and Heating loads (MBH)
W	Cooling = [col U] x ([col M] + [col O]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col M] + [col O]) x MIN([col U] + internal gains , 0) + IF([col I] + [col K] > [col M]+[col O] , (([col I] + [col K]) - ([col M] + [col O])) x MIN([col V] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
X	Cooling = [col R] x ([col J] + [col L]) ÷ 1,000 ÷ AD45
	Heating = -([col N] + [col P]) x MIN([col V] + internal gains , 0) + IF([col I] + [col K] < [col M] + [col O] , (([col M] + [col O]) - ([col I] + [col K])) x MIN([col U] + internal gains , 0)) ÷ 1,000 ÷ AD44
Y - AB	Proposed Operating hours
AC	Proposed Occupied Cooling and Heating Loads:
	Cooling = ([col B] - AC60) ÷ ([col B] - AC55) x [col U]
	Heating = ([col B] - AE60) ÷ ([col B] - AE55) x [col U]
AD	Proposed Unoccupied Cooling and Heating Loads:
	Cooling = ([col B] - AC61) ÷ ([col B] - AC56) x [col V]
	Heating = ([col B] - AE61) ÷ ([col B] - AE56) x [col V] ([col V] is modified to account for reduced kitchen and building ventilation due to EMS)
AE	Cooling = [col AC] x ([col Y] + [col AA]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col Y] + [col AA]) x MIN([col AC] + internal gains , 0) + IF([col I] + [col K] > [col Y]+[col AA] , (([col I] + [col K]) - ([col Y] + [col AA])) x MIN([col AD] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
AF	Cooling = [col AD] x ([col Z] + [col AB]) ÷ 1,000 ÷ AD45
	Heating = -([col Z] + [col AB]) x MIN([col AD] + internal gains , 0) + IF([col I] + [col K] < [col Y] + [col AA] , (([col Y] + [col AA]) - ([col I] + [col K])) x MIN([col AC] + internal gains , 0)) ÷ 1,000 ÷ AD44
AG	= ([col W] + [col X]) - ([col AE] + [col AF])
	HVAC Fan and Pump Savings
AH	Cooling =([col Q] + [col S] + ([col R] + [col T]) x AD49) x (AD46 + AD48) - ([col Y] + [col AA] + ([col Z] + [col AB]) x AD49) x (AD46 + AD48)
	Heating =([col Q] + [col S]) x AD46 + IF(B20<35,([col R] + [col T]) x AD49 x AD46, IF(B20>50,0,([col R] + [col T]) x AD49 x AD46)) - (([col Y] + [col AA]) x AD46 + IF(B20<35,([col Z] + [col AB]) x AD49 x AD46, IF(B20>50,0,([col Z] + [col AB]) x AD49 x AD46)))
AI	= ([col W] + [col X]) - ([col AE] + [col AF])

Assumptions:	**Value**	**Unit**	**CELL**	**Description**
			REF	
Occupied Area	71,451	SF	**AD43**	
Existing Heating Plant Efficiency	83.0%		**AD44**	
Existing Chiller Efficiency	2.9	COP	**AD45**	
Fan Power	43.4	kW	**AD46**	
Heating Pump Power	6.3	kW	**AD47**	
Cooling Pump Power	0.0	kW	**AD48**	
UnOcc. Fan & Pump Cycling	10.0%		**AD49**	% Operating Hours During UnOcc.
UnOcc. Kitchen Vent. Reduction	0.0%		**AD50**	% CFM Saved
UnOcc. Ventilation Reduction	0.0%		**AD51**	% CFM Saved

Average Existing Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC55**	70.0	**AE55**	
UnOccupied	78.0	**AC56**	59.0	**AE56**	

Average Proposed Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC60**	70.0	**AE60**	
UnOccupied	78.0	**AC61**	57.5	**AE61**	

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TMY-2 Weather Data for Worcester, MA								**Existing Occupancy Schedule**				**Existing Heating/Cooling Schedule**				**Existing Motor Operating Schedule**				**Existing**				**Proposed**								**Savings**		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Cooling Energy Savings (MMBTU)	HVAC Electrical Savings (kWh)	Heating Energy Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**
Cooling																																		
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	309	237	0	0	0	0	0	0	309	237	0	0	0	0	
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	278	213	0	0	0	0	0	0	278	213	0	0	0	0	
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	248	189	0	0	0	0	0	1	248	189	0	0	0	0	
90 to 95	92.5	69.8	34.2	0	8	0	8	1	1	0	6	2	1	0	6	2	1	0	6	217	166	0	0	2	1	0	6	217	166	0	0	0	0	
85 to 90	87.5	70.3	34.6	1	37	6	44	8	4	0	31	9	3	0	31	9	3	0	31	186	142	1	2	9	3	0	31	186	142	1	2	0	1	
80 to 85	82.5	68.4	33.0	8	138	29	175	33	17	0	125	37	13	0	125	37	13	0	125	155	118	2	6	37	13	0	125	155	118	2	6	0	4	
75 to 80	77.5	66.2	31.2	27	202	83	312	58	31	0	223	66	23	0	223	66	23	0	223	124	95	3	8	66	23	0	223	124	95	3	8	0	7	
70 to 75	72.5	64.3	29.7	64	269	160	493	92	49	0	352	105	36	0	352	105	36	0	352	93	71	3	9	104	36	0	352	93	71	3	9	0	11	
65 to 70	67.5	61.2	27.5	185	208	243	636	118	63	0	454	135	46	0	454	135	46	0	454	62	47	3	8	135	47	0	454	62	47	3	8	0	15	
60 to 65	62.5	57.3	24.8	315	249	298	862	160	86	0	616	183	63	0	616	183	63	0	616	31	24	2	5	183	63	0	616	31	24	2	5	0	20	
Heating																																		
55 to 60	57.5	52.7	0.0	303	245	276	824	153	82	0	589	175	60	0	589	175	60	0	589	(598)	(53)	13	14	175	61	0	589	(598)	(8)	13	14		25	1
50 to 55	52.5	47.8	0.0	262	184	228	674	125	67	0	482	143	49	0	482	143	49	0	482	(837)	(128)	46	64	143	50	0	482	(837)	(83)	46	35		21	29
45 to 50	47.5	42.5	0.0	204	230	211	645	120	64	0	461	137	47	0	461	137	47	0	461	(1,076)	(203)	78	111	137	47	0	461	(1,076)	(158)	78	83		18	28
40 to 45	42.5	38.3	0.0	210	191	234	635	118	63	0	454	135	46	0	454	135	46	0	454	(1,316)	(278)	110	158	135	47	0	454	(1,316)	(233)	110	131		17	27
35 to 40	37.5	33.8	0.0	321	301	286	908	169	90	0	649	193	66	0	649	193	66	0	649	(1,555)	(354)	205	296	192	67	0	649	(1,555)	(308)	205	257		25	39
30 to 35	32.5	28.7	0.0	356	221	313	890	166	88	0	636	189	65	0	636	189	65	0	636	(1,794)	(429)	247	359	189	65	0	636	(1,794)	(384)	247	320		18	39
25 to 30	27.5	23.5	0.0	228	211	211	650	121	65	0	464	138	47	0	464	138	47	0	464	(2,033)	(504)	215	312	138	48	0	464	(2,033)	(459)	215	284		13	28
20 to 25	22.5	19.1	0.0	104	94	124	322	60	32	0	230	69	23	0	230	69	23	0	230	(2,272)	(579)	123	180	68	24	0	230	(2,272)	(534)	123	166		7	14
15 to 20	17.5	14.3	0.0	144	78	117	339	63	34	0	242	72	25	0	242	72	25	0	242	(2,511)	(654)	147	215	72	25	0	242	(2,511)	(609)	147	200		7	15
10 to 15	12.5	9.3	0.0	118	40	85	243	45	24	0	174	52	18	0	174	52	18	0	174	(2,751)	(730)	118	173	51	18	0	174	(2,751)	(684)	118	162		5	11
5 to 10	7.5	5.0	0.0	52	10	15	77	14	8	0	55	16	6	0	55	16	6	0	55	(2,990)	(805)	42	61	16	6	0	55	(2,990)	(760)	42	57		2	3
0 to 5	2.5	2.2	0.0	18	3	1	22	4	2	0	16	5	2	0	16	5	2	0	16	(3,229)	(880)	13	19	5	2	0	16	(3,229)	(835)	13	18		0	1
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(3,468)	(955)	0	0	0	0	0	0	(3,468)	(910)	0	0		0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(3,707)	(1,031)	0	0	0	0	0	0	(3,707)	(985)	0	0		0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(3,947)	(1,106)	0	0	0	0	0	0	(3,947)	(1,061)	0	0		0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(4,186)	(1,181)	0	0	0	0	0	0	(4,186)	(1,136)	0	0		0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(4,425)	(1,256)	0	0	0	0	0	0	(4,425)	(1,211)	0	0		0	0
				2,920	2,920	2,920	8,760	1,630	870	0	6,260	1,864	636	0	6,260	1,864	636	0	6,260			1,372	2,001	1,856	644	0	6,260			1,372	1,766	0	216	234

Cell Ref.	**Comment**
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Existing Occupancy hours
M - P	Existing Heating/Cooling hours
Q - T	Existing Motor Operating Hours
U	Occupied Cooling and Heating loads (MBH)
V	Unoccupied Cooling and Heating loads (MBH)
W	Cooling = [col U] x ([col M] + [col O]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col M] + [col O]) x MIN([col U] + internal gains , 0) + IF([col I] + [col K] > [col M]+[col O] , (([col I] + [col K]) - ([col M] + [col O])) x MIN([col V] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
X	Cooling = [col R] x ([col J] + [col L]) ÷ 1,000 ÷ AD45
	Heating = -([col N] + [col P]) x MIN([col V] + internal gains , 0) + IF([col I] + [col K] < [col M] + [col O] , (([col M] + [col O]) - ([col I] + [col K])) x MIN([col U] + internal gains , 0)) ÷ 1,000 ÷ AD44
Y - AB	Proposed Operating hours
AC	Proposed Occupied Cooling and Heating Loads:
	Cooling = ([col B] - AC60) ÷ ([col B] - AC55) x [col U]
	Heating = ([col B] - AE60) ÷ ([col B] - AE55) x [col U]
AD	Proposed Unoccupied Cooling and Heating Loads:
	Cooling = ([col B] - AC61) ÷ ([col B] - AC56) x [col V]
	Heating = ([col B] - AE61) ÷ ([col B] - AE56) x [col V] ([col V] is modified to account for reduced kitchen and building ventilation due to EMS)
AE	Cooling = [col AC] x ([col Y] + [col AA]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col Y] + [col AA]) x MIN([col AC] + internal gains , 0) + IF([col I] + [col K] > [col Y]+[col AA] , (([col I] + [col K]) - ([col Y] + [col AA])) x MIN([col AD] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
AF	Cooling = [col AD] x ([col Z] + [col AB]) ÷ 1,000 ÷ AD45
	Heating = -([col Z] + [col AB]) x MIN([col AD] + internal gains , 0) + IF([col I] + [col K] < [col Y] + [col AA] , (([col Y] + [col AA]) - ([col I] + [col K])) x MIN([col AC] + internal gains , 0)) ÷ 1,000 ÷ AD44
AG	= ([col W] + [col X]) - ([col AE] + [col AF])
	HVAC Fan and Pump Savings
AH	Cooling =([col Q] + [col S] + ([col R] + [col T]) x AD49) x (AD46 + AD48) - ([col Y] + [col AA] + ([col Z] + [col AB]) x AD49) x (AD46 + AD48)
	Heating =([col Q] + [col S]) x AD46 + IF(B20<35,([col R] + [col T]) x AD49 x AD46, IF(B20>50,0,([col R] + [col T]) x AD49 x AD46)) - (([col Y] + [col AA]) x AD46 + IF(B20<35,([col Z] + [col AB]) x AD49 x AD46, IF(B20>50,0,([col Z] + [col AB]) x AD49 x AD46)))
AI	= ([col W] + [col X]) - ([col AE] + [col AF])

Assumptions:	**Value**	**Unit**	**CELL REF**	**Description**
Occupied Area	65,000	SF	**AD43**	
Existing Heating Plant Efficiency	85.0%		**AD44**	
Existing Chiller Efficiency	2.9	COP	**AD45**	
Fan Power	25.2	kW	**AD46**	
Heating Pump Power	8.3	kW	**AD47**	
Cooling Pump Power	0.0	kW	**AD48**	
UnOcc. Fan & Pump Cycling	10.0%		**AD49**	% Operating Hours During UnOcc.
UnOcc. Kitchen Vent. Reduction	0.0%		**AD50**	% CFM Saved
UnOcc. Ventilation Reduction	0.0%		**AD51**	% CFM Saved

Average Existing Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC55**	70.0	**AE55**	
UnOccupied	78.0	**AC56**	61.0	**AE56**	

Average Proposed Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC60**	70.0	**AE60**	
UnOccupied	78.0	**AC61**	58.0	**AE61**	

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TMY-2 Weather Data for Worcester, MA								**Existing Occupancy Schedule**				**Existing Heating/Cooling Schedule**				**Existing Motor Operating Schedule**				**Existing**				**Proposed**								**Savings**		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Cooling Energy Savings (MMBTU)	HVAC Electrical Savings (kWh)	Heating Energy Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**
Cooling																																		
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	324	248	0	0	0	0	0	0	324	248	0	0	0	0	
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	291	223	0	0	0	0	0	0	291	223	0	0	0	0	
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	259	198	0	0	0	0	0	1	259	198	0	0	0	1	
90 to 95	92.5	69.8	34.2	0	8	0	8	1	1	0	6	2	0	0	6	2	0	0	6	227	173	0	0	2	1	0	6	227	173	0	0	0	6	
85 to 90	87.5	70.3	34.6	1	37	6	44	8	4	0	31	11	2	0	31	11	2	0	31	194	149	1	2	9	3	0	31	194	149	1	2	0	32	
80 to 85	82.5	68.4	33.0	8	138	29	175	33	17	0	125	43	6	0	125	43	7	0	125	162	124	2	6	37	13	0	125	162	124	2	6	0	127	
75 to 80	77.5	66.2	31.2	27	202	83	312	58	31	0	223	78	11	0	223	77	12	0	223	130	99	3	8	66	23	0	223	130	99	3	8	0	251	
70 to 75	72.5	64.3	29.7	64	269	160	493	92	49	0	352	123	18	0	352	122	19	0	352	97	74	4	9	104	36	0	352	97	74	3	10	0	397	
65 to 70	67.5	61.2	27.5	185	208	243	636	118	63	0	454	158	23	0	454	157	24	0	454	65	50	3	8	135	47	0	454	65	50	3	8	0	512	
60 to 65	62.5	57.3	24.8	315	249	298	862	160	86	0	616	214	32	0	616	213	33	0	616	32	25	2	5	183	63	0	616	32	25	2	6	0	694	
Heating																																		
55 to 60	57.5	52.7	0.0	303	245	276	824	153	82	0	589	205	30	0	589	204	31	0	589	(221)	(58)	3	43	175	61	0	589	(221)	(4)	3	5		758	37
50 to 55	52.5	47.8	0.0	262	184	228	674	125	67	0	482	168	25	0	482	167	26	0	482	(309)	(102)	17	69	143	50	0	482	(309)	(47)	17	24		620	45
45 to 50	47.5	42.5	0.0	204	230	211	645	120	64	0	461	160	24	0	461	160	24	0	461	(397)	(147)	30	98	137	47	0	461	(397)	(89)	30	53		534	45
40 to 45	42.5	38.3	0.0	210	191	234	635	118	63	0	454	158	23	0	454	157	24	0	454	(485)	(192)	42	128	135	47	0	454	(485)	(131)	42	81		526	47
35 to 40	37.5	33.8	0.0	321	301	286	908	169	90	0	649	226	33	0	649	225	34	0	649	(573)	(236)	80	229	192	67	0	649	(573)	(174)	80	157		752	72
30 to 35	32.5	28.7	0.0	356	221	313	890	166	88	0	636	221	33	0	636	220	34	0	636	(662)	(281)	97	269	189	65	0	636	(662)	(216)	97	195		645	74
25 to 30	27.5	23.5	0.0	228	211	211	650	121	65	0	464	162	24	0	464	161	25	0	464	(750)	(325)	85	229	138	48	0	464	(750)	(258)	85	172		471	57
20 to 25	22.5	19.1	0.0	104	94	124	322	60	32	0	230	80	12	0	230	80	12	0	230	(838)	(370)	49	129	68	24	0	230	(838)	(301)	49	100		233	30
15 to 20	17.5	14.3	0.0	144	78	117	339	63	34	0	242	84	12	0	242	84	13	0	242	(926)	(414)	58	153	72	25	0	242	(926)	(343)	58	121		246	33
10 to 15	12.5	9.3	0.0	118	40	85	243	45	24	0	174	60	9	0	174	60	9	0	174	(1,015)	(459)	47	122	51	18	0	174	(1,015)	(385)	47	98		176	24
5 to 10	7.5	5.0	0.0	52	10	15	77	14	8	0	55	19	3	0	55	19	3	0	55	(1,103)	(503)	16	42	16	6	0	55	(1,103)	(428)	16	34		56	8
0 to 5	2.5	2.2	0.0	18	3	1	22	4	2	0	16	5	1	0	16	5	1	0	16	(1,191)	(548)	5	13	5	2	0	16	(1,191)	(470)	5	11		16	2
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,279)	(592)	0	0	0	0	0	0	(1,279)	(512)	0	0		0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,367)	(637)	0	0	0	0	0	0	(1,367)	(555)	0	0		0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,456)	(681)	0	0	0	0	0	0	(1,456)	(597)	0	0		0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,544)	(726)	0	0	0	0	0	0	(1,544)	(639)	0	0		0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,632)	(771)	0	0	0	0	0	0	(1,632)	(682)	0	0		0	0
				2,920	2,920	2,920	8,760	1,630	870	0	6,260	2,177	323	0	6,260	2,168	332	0	6,260			546	1,563	1,856	644	0	6,260			543	1,091	1	7,054	474

Cell Ref.	**Comment**
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Existing Occupancy hours
M - P	Existing Heating/Cooling hours
Q - T	Existing Motor Operating Hours
U	Occupied Cooling and Heating loads (MBH)
V	Unoccupied Cooling and Heating loads (MBH)
W	Cooling = [col U] x ([col M] + [col O]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col M] + [col O]) x MIN([col U] + internal gains , 0) + IF([col I] + [col K] > [col M]+[col O] , (([col I] + [col K]) - ([col M] + [col O])) x MIN([col V] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
X	Cooling = [col R] x ([col J] + [col L]) ÷ 1,000 ÷ AD45
	Heating = -([col N] + [col P]) x MIN([col V] + internal gains , 0) + IF([col I] + [col K] < [col M] + [col O] , (([col M] + [col O]) - ([col I] + [col K])) x MIN([col U] + internal gains , 0)) ÷ 1,000 ÷ AD44
Y - AB	Proposed Operating hours
AC	Proposed Occupied Cooling and Heating Loads:
	Cooling = ([col B] - AC60) ÷ ([col B] - AC55) x [col U]
	Heating = ([col B] - AE60) ÷ ([col B] - AE55) x [col U]
AD	Proposed Unoccupied Cooling and Heating Loads:
	Cooling = ([col B] - AC61) ÷ ([col B] - AC56) x [col V]
	Heating = ([col B] - AE61) ÷ ([col B] - AE56) x [col V] ([col V] is modified to account for reduced kitchen and building ventilation due to EMS)
AE	Cooling = [col AC] x ([col Y] + [col AA]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col Y] + [col AA]) x MIN([col AC] + internal gains , 0) + IF([col I] + [col K] > [col Y]+[col AA] , (([col I] + [col K]) - ([col Y] + [col AA])) x MIN([col AD] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
AF	Cooling = [col AD] x ([col Z] + [col AB]) ÷ 1,000 ÷ AD45
	Heating = -([col Z] + [col AB]) x MIN([col AD] + internal gains , 0) + IF([col I] + [col K] < [col Y] + [col AA] , (([col Y] + [col AA]) - ([col I] + [col K])) x MIN([col AC] + internal gains , 0)) ÷ 1,000 ÷ AD44
AG	= ([col W] + [col X]) - ([col AE] + [col AF])
	HVAC Fan and Pump Savings
AH	Cooling =([col Q] + [col S] + ([col R] + [col T]) x AD49) x (AD46 + AD48) - ([col Y] + [col AA] + ([col Z] + [col AB]) x AD49) x (AD46 + AD48)
	Heating =([col Q] + [col S]) x AD46 + IF(B20<35,([col R] + [col T]) x AD49 x AD46, IF(B20>50,0,([col R] + [col T]) x AD49 x AD46)) - (([col Y] + [col AA]) x AD46 + IF(B20<35,([col Z] + [col AB]) x AD49 x AD46, IF(B20>50,0,([col Z] + [col AB]) x AD49 x AD46)))
AI	= ([col W] + [col X]) - ([col AE] + [col AF])

Assumptions:	**Value**	**Unit**	**CELL**	**Description**
			REF	
Occupied Area	62,811	SF	**AD43**	
Existing Heating Plant Efficiency	78.0%		**AD44**	
Existing Chiller Efficiency	2.9	COP	**AD45**	
Fan Power	22.6	kW	**AD46**	
Heating Pump Power	3.2	kW	**AD47**	
Cooling Pump Power	0.0	kW	**AD48**	
UnOcc. Fan & Pump Cycling	10.0%		**AD49**	% Operating Hours During UnOcc.
UnOcc. Kitchen Vent. Reduction	0.0%		**AD50**	% CFM Saved
UnOcc. Ventilation Reduction	30.0%		**AD51**	% CFM Saved

Average Existing Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC55**	70.0	**AE55**	
UnOccupied	78.0	**AC56**	64.0	**AE56**	

Average Proposed Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC60**	70.0	**AE60**	
UnOccupied	78.0	**AC61**	58.0	**AE61**	

MAPC - Sudbury
Nixon Elementary
Integrated and New Energy Management System

TMY-2 Weather Data for Worcester, MA								**Existing Occupancy Schedule**				**Existing Heating/Cooling Schedule**				**Existing Motor Operating Schedule**				**Existing**				**Proposed**								**Savings**		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Cooling Energy Savings (MMBTU)	HVAC Electrical Savings (kWh)	Heating Energy Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**
Cooling																																		
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	139	106	0	0	0	0	0	0	139	106	0	0	0	0	
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	96	0	0	0	0	0	0	125	96	0	0	0	0	
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	111	85	0	0	0	0	0	1	111	85	0	0	0	0	
90 to 95	92.5	69.8	34.2	0	8	0	8	1	1	0	6	2	0	0	6	2	0	0	6	97	74	0	0	2	1	0	6	97	74	0	0	0	1	
85 to 90	87.5	70.3	34.6	1	37	6	44	8	5	0	31	10	3	0	31	10	3	0	31	83	64	0	1	9	3	0	31	83	64	0	1	0	4	
80 to 85	82.5	68.4	33.0	8	138	29	175	32	18	0	125	39	11	0	125	39	11	0	125	70	53	1	2	37	13	0	125	70	53	1	2	0	17	
75 to 80	77.5	66.2	31.2	27	202	83	312	56	33	0	223	70	19	0	223	70	19	0	223	56	43	1	4	67	23	0	223	56	43	1	4	0	35	
70 to 75	72.5	64.3	29.7	64	269	160	493	89	52	0	352	110	30	0	352	110	30	0	352	42	32	2	4	105	36	0	352	42	32	1	4	0	55	
65 to 70	67.5	61.2	27.5	185	208	243	636	115	66	0	454	142	39	0	454	142	39	0	454	28	21	1	4	136	46	0	454	28	21	1	4	0	71	
60 to 65	62.5	57.3	24.8	315	249	298	862	156	90	0	616	193	53	0	616	193	53	0	616	14	11	1	2	184	62	0	616	14	11	1	2	0	96	
Heating																																		
55 to 60	57.5	52.7	0.0	303	245	276	824	149	86	0	589	184	51	0	589	184	51	0	589	(190)	(40)	0	22	176	59	0	589	(190)	(9)	0	5		128	16
50 to 55	52.5	47.8	0.0	262	184	228	674	122	70	0	482	151	42	0	482	151	42	0	482	(265)	(84)	8	48	144	49	0	482	(265)	(53)	8	27		105	21
45 to 50	47.5	42.5	0.0	204	230	211	645	117	67	0	461	144	40	0	461	144	40	0	461	(341)	(128)	18	75	138	47	0	461	(341)	(97)	18	55		90	21
40 to 45	42.5	38.3	0.0	210	191	234	635	115	66	0	454	142	39	0	454	142	39	0	454	(417)	(173)	29	103	135	46	0	454	(417)	(142)	29	82		89	21
35 to 40	37.5	33.8	0.0	321	301	286	908	164	95	0	649	203	56	0	649	203	56	0	649	(493)	(217)	56	189	194	66	0	649	(493)	(186)	56	159		127	30
30 to 35	32.5	28.7	0.0	356	221	313	890	161	93	0	636	199	55	0	636	199	55	0	636	(569)	(261)	70	225	190	64	0	636	(569)	(230)	70	196		89	30
25 to 30	27.5	23.5	0.0	228	211	211	650	118	68	0	464	145	40	0	464	145	40	0	464	(644)	(306)	62	194	139	47	0	464	(644)	(275)	62	172		65	22
20 to 25	22.5	19.1	0.0	104	94	124	322	58	34	0	230	72	20	0	230	72	20	0	230	(720)	(350)	36	111	69	23	0	230	(720)	(319)	36	100		32	11
15 to 20	17.5	14.3	0.0	144	78	117	339	61	35	0	242	76	21	0	242	76	21	0	242	(796)	(394)	43	132	72	24	0	242	(796)	(363)	43	120		34	12
10 to 15	12.5	9.3	0.0	118	40	85	243	44	25	0	174	54	15	0	174	54	15	0	174	(872)	(438)	35	106	52	18	0	174	(872)	(407)	35	97		24	8
5 to 10	7.5	5.0	0.0	52	10	15	77	14	8	0	55	17	5	0	55	17	5	0	55	(948)	(483)	12	37	16	6	0	55	(948)	(452)	12	34		8	3
0 to 5	2.5	2.2	0.0	18	3	1	22	4	2	0	16	5	1	0	16	5	1	0	16	(1,024)	(527)	4	12	5	2	0	16	(1,024)	(496)	4	11		2	1
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,099)	(571)	0	0	0	0	0	0	(1,099)	(540)	0	0		0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,175)	(616)	0	0	0	0	0	0	(1,175)	(585)	0	0		0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,251)	(660)	0	0	0	0	0	0	(1,251)	(629)	0	0		0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,327)	(704)	0	0	0	0	0	0	(1,327)	(673)	0	0		0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,403)	(748)	0	0	0	0	0	0	(1,403)	(717)	0	0		0	0
				2,920	2,920	2,920	8,760	1,585	915	0	6,260	1,959	541	0	6,260	1,959	541	0	6,260			379	1,270	1,868	632	0	6,260			379	1,075	0	1,072	195

Cell Ref.	**Comment**
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Existing Occupancy hours
M - P	Existing Heating/Cooling hours
Q - T	Existing Motor Operating Hours
U	Occupied Cooling and Heating loads (MBH)
V	Unoccupied Cooling and Heating loads (MBH)
W	Cooling = [col U] x ([col M] + [col O]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col M] + [col O]) x MIN([col U] + internal gains , 0) + IF([col I] + [col K] > [col M]+[col O] , (([col I] + [col K]) - ([col M] + [col O])) x MIN([col V] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
X	Cooling = [col R] x ([col J] + [col L]) ÷ 1,000 ÷ AD45
	Heating = -([col N] + [col P]) x MIN([col V] + internal gains , 0) + IF([col I] + [col K] < [col M] + [col O] , (([col M] + [col O]) - ([col I] + [col K])) x MIN([col U] + internal gains , 0)) ÷ 1,000 ÷ AD44
Y - AB	Proposed Operating hours
AC	Proposed Occupied Cooling and Heating Loads:
	Cooling = ([col B] - AC60) ÷ ([col B] - AC55) x [col U]
	Heating = ([col B] - AE60) ÷ ([col B] - AE55) x [col U]
AD	Proposed Unoccupied Cooling and Heating Loads:
	Cooling = ([col B] - AC61) ÷ ([col B] - AC56) x [col V]
	Heating = ([col B] - AE61) ÷ ([col B] - AE56) x [col V] ([col V] is modified to account for reduced kitchen and building ventilation due to EMS)
AE	Cooling = [col AC] x ([col Y] + [col AA]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col Y] + [col AA]) x MIN([col AC] + internal gains , 0) + IF([col I] + [col K] > [col Y]+[col AA] , (([col I] + [col K]) - ([col Y] + [col AA])) x MIN([col AD] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
AF	Cooling = [col AD] x ([col Z] + [col AB]) ÷ 1,000 ÷ AD45
	Heating = -([col Z] + [col AB]) x MIN([col AD] + internal gains , 0) + IF([col I] + [col K] < [col Y] + [col AA] , (([col Y] + [col AA]) - ([col I] + [col K])) x MIN([col AC] + internal gains , 0)) ÷ 1,000 ÷ AD44
AG	= ([col W] + [col X]) - ([col AE] + [col AF])
	HVAC Fan and Pump Savings
AH	Cooling =([col Q] + [col S] + ([col R] + [col T]) x AD49) x (AD46 + AD48) - ([col Y] + [col AA] + ([col Z] + [col AB]) x AD49) x (AD46 + AD48)
	Heating =([col Q] + [col S]) x AD46 + IF(B20<35,([col R] + [col T]) x AD49 x AD46, IF(B20>50,0,([col R] + [col T]) x AD49 x AD46)) - (([col Y] + [col AA]) x AD46 + IF(B20<35,([col Z] + [col AB]) x AD49 x AD46, IF(B20>50,0,([col Z] + [col AB]) x AD49 x AD46)))
AI	= ([col W] + [col X]) - ([col AE] + [col AF])

Assumptions:	**Value**	**Unit**	**CELL REF**	**Description**
Occupied Area	58,215	SF	**AD43**	
Existing Heating Plant Efficiency	83.0%		**AD44**	
Existing Chiller Efficiency	2.9	COP	**AD45**	
Fan Power	10.7	kW	**AD46**	
Heating Pump Power	4.3	kW	**AD47**	
Cooling Pump Power	0.0	kW	**AD48**	
UnOcc. Fan & Pump Cycling	10.0%		**AD49**	% Operating Hours During UnOcc.
UnOcc. Kitchen Vent. Reduction	0.0%		**AD50**	% CFM Saved
UnOcc. Ventilation Reduction	0.0%		**AD51**	% CFM Saved

Average Existing Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC55**	70.0	**AE55**	
UnOccupied	78.0	**AC56**	62.0	**AE56**	

Average Proposed Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC60**	70.0	**AE60**	
UnOccupied	78.0	**AC61**	58.5	**AE61**	

MAPC - Sudbury
Nixon Elementary
Control Unit Ventilators

TMY-2 Weather Data for Worcester, MA								Existing Occupancy Schedule				Existing Heating/Cooling Schedule				Existing Motor Operating Schedule				Existing				Proposed								Savings		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Cooling Energy Savings (MMBTU)	HVAC Electrical Savings (kWh)	Heating Energy Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**
Cooling																																		
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	121	93	0	0	0	0	0	0	121	93	0	0	0	0	
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	109	84	0	0	0	0	0	0	109	84	0	0	0	0	
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	97	74	0	0	0	0	0	1	97	74	0	0	0	0	
90 to 95	92.5	69.8	34.2	0	8	0	8	1	1	0	6	2	0	0	6	2	0	0	6	85	65	0	0	2	1	0	6	85	65	0	0	0	0	
85 to 90	87.5	70.3	34.6	1	37	6	44	8	5	0	31	10	3	0	31	10	3	0	31	73	56	0	1	9	3	0	31	73	56	0	1	0	1	
80 to 85	82.5	68.4	33.0	8	138	29	175	32	18	0	125	39	11	0	125	39	11	0	125	61	46	1	2	37	13	0	125	61	46	1	2	0	5	
75 to 80	77.5	66.2	31.2	27	202	83	312	56	33	0	223	70	19	0	223	70	19	0	223	49	37	1	3	67	23	0	223	49	37	1	3	0	10	
70 to 75	72.5	64.3	29.7	64	269	160	493	89	52	0	352	110	30	0	352	110	30	0	352	36	28	1	4	105	36	0	352	36	28	1	4	0	16	
65 to 70	67.5	61.2	27.5	185	208	243	636	115	66	0	454	142	39	0	454	142	39	0	454	24	19	1	3	136	46	0	454	24	19	1	3	0	20	
60 to 65	62.5	57.3	24.8	315	249	298	862	156	90	0	616	193	53	0	616	193	53	0	616	12	9	1	2	184	62	0	616	12	9	1	2	0	28	
Heating																																		
55 to 60	57.5	52.7	0.0	303	245	276	824	149	86	0	589	184	51	0	589	184	51	0	589	(166)	(35)	0	19	176	59	0	589	(166)	(8)	0	5		27	14
50 to 55	52.5	47.8	0.0	262	184	228	674	122	70	0	482	151	42	0	482	151	42	0	482	(232)	(73)	7	42	144	49	0	482	(232)	(46)	7	24		22	19
45 to 50	47.5	42.5	0.0	204	230	211	645	117	67	0	461	144	40	0	461	144	40	0	461	(298)	(112)	16	66	138	47	0	461	(298)	(85)	16	48		19	18
40 to 45	42.5	38.3	0.0	210	191	234	635	115	66	0	454	142	39	0	454	142	39	0	454	(364)	(151)	25	90	135	46	0	454	(364)	(124)	25	72		18	18
35 to 40	37.5	33.8	0.0	321	301	286	908	164	95	0	649	203	56	0	649	203	56	0	649	(430)	(190)	49	165	194	66	0	649	(430)	(162)	49	139		26	26
30 to 35	32.5	28.7	0.0	356	221	313	890	161	93	0	636	199	55	0	636	199	55	0	636	(497)	(228)	61	197	190	64	0	636	(497)	(201)	61	171		26	26
25 to 30	27.5	23.5	0.0	228	211	211	650	118	68	0	464	145	40	0	464	145	40	0	464	(563)	(267)	54	169	139	47	0	464	(563)	(240)	54	150		19	19
20 to 25	22.5	19.1	0.0	104	94	124	322	58	34	0	230	72	20	0	230	72	20	0	230	(629)	(306)	31	97	69	23	0	230	(629)	(278)	31	87		9	10
15 to 20	17.5	14.3	0.0	144	78	117	339	61	35	0	242	76	21	0	242	76	21	0	242	(695)	(344)	38	115	72	24	0	242	(695)	(317)	38	105		10	10
10 to 15	12.5	9.3	0.0	118	40	85	243	44	25	0	174	54	15	0	174	54	15	0	174	(761)	(383)	31	92	52	18	0	174	(761)	(356)	31	85		7	7
5 to 10	7.5	5.0	0.0	52	10	15	77	14	8	0	55	17	5	0	55	17	5	0	55	(828)	(422)	11	32	16	6	0	55	(828)	(394)	11	30		2	2
0 to 5	2.5	2.2	0.0	18	3	1	22	4	2	0	16	5	1	0	16	5	1	0	16	(894)	(460)	3	10	5	2	0	16	(894)	(433)	3	9		1	1
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(960)	(499)	0	0	0	0	0	0	(960)	(472)	0	0		0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,026)	(538)	0	0	0	0	0	0	(1,026)	(511)	0	0		0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,092)	(576)	0	0	0	0	0	0	(1,092)	(549)	0	0		0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,159)	(615)	0	0	0	0	0	0	(1,159)	(588)	0	0		0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,225)	(654)	0	0	0	0	0	0	(1,225)	(627)	0	0		0	0
				2,920	2,920	2,920	8,760	1,585	915	0	6,260	1,959	541	0	6,260	1,959	541	0	6,260			331	1,109	1,868	632	0	6,260			331	939	0	266	170

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Existing Occupancy hours
M - P	Existing Heating/Cooling hours
Q - T	Existing Motor Operating Hours
U	Occupied Cooling and Heating loads (MBH)
V	Unoccupied Cooling and Heating loads (MBH)
W	Cooling = [col U] x ([col M] + [col O]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col M] + [col O]) x MIN([col U] + internal gains , 0) + IF([col I] + [col K] > [col M]+[col O] , (([col I] + [col K]) - ([col M] + [col O])) x MIN([col V] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
X	Cooling = [col R] x ([col J] + [col L]) ÷ 1,000 ÷ AD45
	Heating = -([col N] + [col P]) x MIN([col V] + internal gains , 0) + IF([col I] + [col K] < [col M] + [col O] , (([col M] + [col O]) - ([col I] + [col K])) x MIN([col U] + internal gains , 0)) ÷ 1,000 ÷ AD44
Y - AB	Proposed Operating hours
AC	Proposed Occupied Cooling and Heating Loads:
	Cooling = ([col B] - AC60) ÷ ([col B] - AC55) x [col U]
	Heating = ([col B] - AE60) ÷ ([col B] - AE55) x [col U]
AD	Proposed Unoccupied Cooling and Heating Loads:
	Cooling = ([col B] - AC61) ÷ ([col B] - AC56) x [col V]
	Heating = ([col B] - AE61) ÷ ([col B] - AE56) x [col V] ([col V] is modified to account for reduced kitchen and building ventilation due to EMS)
AE	Cooling = [col AC] x ([col Y] + [col AA]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col Y] + [col AA]) x MIN([col AC] + internal gains , 0) + IF([col I] + [col K] > [col Y]+[col AA] , (([col I] + [col K]) - ([col Y] + [col AA])) x MIN([col AD] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
AF	Cooling = [col AD] x ([col Z] + [col AB]) ÷ 1,000 ÷ AD45
	Heating = -([col Z] + [col AB]) x MIN([col AD] + internal gains , 0) + IF([col I] + [col K] < [col Y] + [col AA] , (([col Y] + [col AA]) - ([col I] + [col K])) x MIN([col AC] + internal gains , 0)) ÷ 1,000 ÷ AD44
AG	= ([col W] + [col X]) - ([col AE] + [col AF])
	HVAC Fan and Pump Savings
AH	Cooling =([col Q] + [col S] + ([col R] + [col T]) x AD49) x (AD46 + AD48) - ([col Y] + [col AA] + ([col Z] + [col AB]) x AD49) x (AD46 + AD48)
	Heating =([col Q] + [col S]) x AD46 + IF(B20<35,([col R] + [col T]) x AD49 x AD46, IF(B20>50,0,([col R] + [col T]) x AD49 x AD46)) - (([col Y] + [col AA]) x AD46 + IF(B20<35,([col Z] + [col AB]) x AD49 x AD46, IF(B20>50,0,([col Z] + [col AB]) x AD49 x AD46)))
AI	= ([col W] + [col X]) - ([col AE] + [col AF])

Assumptions:	Value	Unit	CELL	Description
			REF	
Occupied Area	58,215	SF	**AD43**	
Existing Heating Plant Efficiency	83.0%		**AD44**	
Existing Chiller Efficiency	2.9	COP	**AD45**	
Fan Power	3.1	kW	**AD46**	
Heating Pump Power	0.0	kW	**AD47**	
Cooling Pump Power	0.0	kW	**AD48**	
UnOcc. Fan & Pump Cycling	10.0%		**AD49**	% Operating Hours During UnOcc.
UnOcc. Kitchen Vent. Reduction	0.0%		**AD50**	% CFM Saved
UnOcc. Ventilation Reduction	0.0%		**AD51**	% CFM Saved

Average Existing Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC55**	70.0	**AE55**	
UnOccupied	78.0	**AC56**	62.0	**AE56**	

Average Proposed Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC60**	70.0	**AE60**	
UnOccupied	78.0	**AC61**	58.5	**AE61**	

Appendix for ECM 3:
Integrated and New Energy Management Systems

II. Manufacturer Specification Sheets

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AX Supervisor®

Overview

Tridium's suite of Niagara-based products integrate diverse smart devices into unified, Internet-enabled, web-based systems. These solutions integrate LonWorks™, BACnet™, oBIX, Internet and web services protocols in a software platform that can be used in embedded controllers and server applications. The products include integrated network management tools to support the design, configuration, installation, and maintenance of interoperable networks.

The AX Supervisor is a flexible network server used in applications where multiple Niagara^{AX}-based JACE® controllers can be networked together. The AX Supervisor serves real-time graphical information to standard web-browser clients and also provides server-level functions such as: centralized data logging, archiving, alarming, trending, master scheduling, system-wide database management, and integration with enterprise software applications. In addition, the AX Supervisor provides a comprehensive, graphical engineering toolset for application development.

In addition to the 32 bit AX Supervisor, a 64 bit version for Windows based PCs is available for monitoring systems intended to monitor in excess of 150 and up to 500 JACEs. It supports the same feature set as the standard version.

With Niagara^{AX} release 3.4 or greater, Tridium offers a platform for the AX Supervisor which runs on Red Hat Linux. Niagara^{AX} 3.4 and later versions provide AX Supervisor software that is targeted for a specific Linux-based platform: an Intel-based PC platform running the operating system of Red Hat Enterprise Linux 5.

For smaller installations, the Small Building Supervisor offers the full functions of the Niagara Framework, but limits the number of Niagara-based connections. The Small Building Supervisor can run on a 32 and 64-bit Windows based PCs as well as Red Hat Enterprise Linux 5 based PCs. Also, the Small Building Supervisor can be upgraded to a full AX Supervisor if the job outgrows the limit of three Niagara-based connections.

oBIX is now included in all AX Supervisors as a means of integrating Niagara-based Release 2 (R2) JACEs. With release 2.3.522 or greater, the oBIX driver can be added to expose all data points, schedules, trends and alarms to an AX system. This oBIX driver is both a client and a server.

Features

- Java-enabled user interface (UI) as well as a non-Java UI for browsers
- Supports an unlimited number of users over the Internet / Intranet with a standard web browser, depending on the host PC resources
- Optional enterprise-level data archival using SQL, MySQL, CSV, Oracle or DB2 database, and HTTP/HTML/XML text formats
- "Audit Trail" of database changes, database storage and backup, global time functions, calendar, central scheduling, control, and energy management routines
- Sophisticated alarm processing and routing, including e-mail alarm acknowledging
- Access to alarms, logs, graphics, schedules, and configuration data with a standard web browser

- Password protection and security using standard Java (on Windows platforms only) authentication and encryption techniques with optional security supported via an external LDAP connection
- HTML-based help system that includes comprehensive on-line system documentation
- Supports multiple Niagara-based stations connected to a local Ethernet network, or the Internet
- Provides online/offline use of the Niagara Framework Workbench AX® graphical configuration tool and a comprehensive Java Object Library
- Optional direct Ethernet based driver support for BACnet I/P, OPC (Client), Modbus TCP, Lon IP and SNMP; additional point blocks for each driver may be purchased in blocks of 500 for each protocol
- A "Small Building System" version for both Windows and Linux platforms is available for support of a system with up to three JACEs
- A 64-bit compliant version of the AX Supervisor for Windows is available for large systems monitoring in excess of 200 Niagara based controllers. All features of the standard AX Supervisor are included with this platform.

Platform Requirements

Processor

- Intel Pentium® IV, 2 GHz or higher, Core 2 Duo also acceptable

Operating System

- 32-bit Windows AX Supervisors, Microsoft Windows XP Professional, Windows 2003 or 2008 Server (if Microsoft IIS is disabled), Vista Business, or Windows 7, with Mozilla Firefox™ or Internet Explorer™ 5.0 or later is the required OS
- 64-bit Windows AX Supervisor, Win64 version of Windows XP Professional or Win64 version of Windows 7 is the required OS
- Linux AX Supervisors (32-bit), Red Hat Enterprise Linux 5 is the required OS

Memory

- 1 GB minimum, 2GB or more recommended for large systems, 8 GB or more recommended for the Windows 64-bit version

Hard Drive

- 1 GB minimum, 5 GB for applications that need more archiving capacity

Display

- Video card and monitor capable of displaying 1024 x 768 pixel resolution or greater

Network Support

- Ethernet adapter (10/100 Mb with RJ-45 connector)

Connectivity

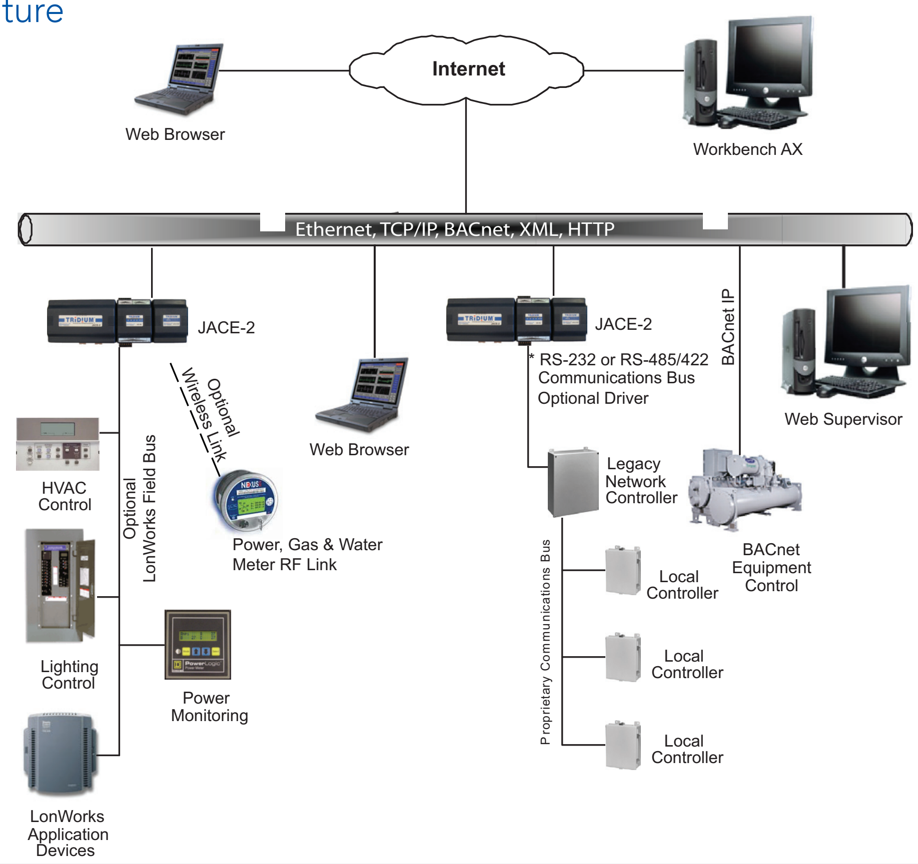
- Full time high speed ISP connection recommended for remote site access (i.e. T1, ADSL, cable modem)

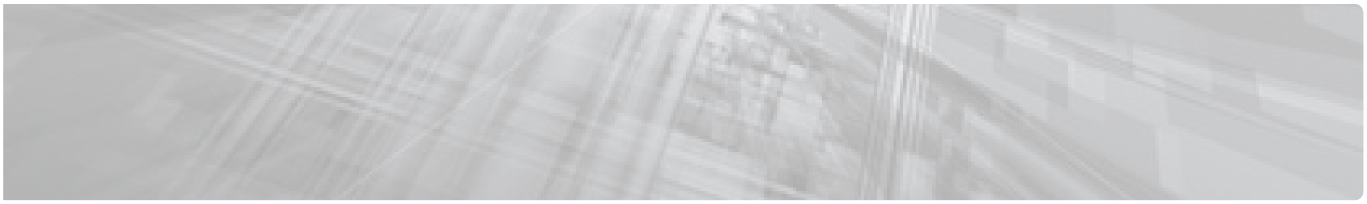
Ordering Information

Model Number	Description
T-S-AX	AX Supervisor for a 32-bit Windows Platform; Includes Niagara Historical Database and Workbench AX. Includes OBIX client/server driver for connecting to Niagara-based controllers only
T-S-AX-SBS	Small Building System version of the AX Supervisor for a 32-bit Windows Platform; Limited to 3 JACE controllers; Includes Niagara Historical Database and Workbench AX. Includes OBIX client/server driver for connecting to Niagara-based controllers only.
T-S-AX-64	AX Supervisor for a 64-bit Windows Platforms; Includes Niagara Historical Database and Workbench AX. Includes OBIX client/server driver for connecting to Niagara-based controllers only.
T-S-AX-64-SBS	Small Building System version of the AX Supervisor for a 64-bit Windows Platform; Limited to 3 JACE controllers; Includes Niagara Historical Database and Workbench AX. Includes OBIX client/server driver for connecting to Niagara-based controllers only
T-S-AX-LNX	AX Supervisor for a 32-bit Red Hat Enterprise Linux 5 Platform; Includes Niagara Historical Database and Workbench AX. Includes OBIX client/server driver for connecting to Niagara-based controllers only.
T-S-AX-LNX-SBS	Small Building System version of the AX Supervisor for a 32-bit Red Hat Linux 5 Platform; Limited to 3 JACE controllers; Includes Niagara Historical Database and Workbench AX. Includes oBIX client/server driver for connecting to Niagara-based controllers only
S-AX-SBS-EXUP	Small Building System Upgrade (remove Niagara device limit of 3 for any Platform) *Note: Upgrades a 32-bit SBS to a 32-bit Supervisor or a 64-bit SBS to a 64-bit Supervisor*
S-AX-64-UP	Upgrade from a 32-bit to a 64 bit Platform (for Windows only) *Note: Upgrades a 32-bit Supervisor to a 64-bit Supervisor or a 32-bit SBS to a 64-bit SBS*
Optional Database Drivers for External Database applications	
S-DB-SQL	Microsoft SQL Database Driver
S-DB-DB2	IBM DB2 Database Driver
S-DB-ORCL	Oracle Database Driver
S-DB-MYSQL	MySQL Database Driver
S-DB-CSV	Allows Excel and CSV file data to be imported into Niagara^{AX}
Open System Drivers for AX Supervisor (not available for Small Building Systems or Linux Supervisors))	
DR-S-BACNET	AX Supervisor BACnet IP Client and Server Driver; Includes license for 500 BACnet points (Available for Linux Supervisor)
DR-S-BAC-CL	AX Supervisor BACnet IP Client Driver; Includes License for 500 BACnet points (Available for Linux Supervisor)
DR-S-BAC-SRV	AX Supervisor BACnet IP Server Driver; allows for BACnet export function
DR-S-BAC-SRV-UP	Add BACnet export functions to a BACnet IP Client Driver for the AX Supervisor
DR-S-BAC-CL-UP	Add BACnet IP client functions to a BACnet IP Server for the AX Supervisor; Includes license for 500 BACnet points
DR-S-BAC-500	Additional 500 point block for BACnet IP Client Driver (Available for Linux Supervisor)
DR-S-BAC-OWS	Add BACnet Operator Workstation (OWS) to the AX Supervisor. Requires the BACnet IP Client Driver
DR-S-BAC-AWS	Add BACnet Advanced Workstation (AWS) to the AX Supervisor. Requires the BACnet IP Client Driver
DR-S-BAC-AWS-UP	Upgrade from an Operator Workstation (OWS) to an Advanced Workstation (AWS)
DR-S-MDB-500	Additional 500 point block for AX Supervisor Modbus TCP Driver
DR-S-MDB-SL-AX	AX Supervisor Modbus TCP Slave Driver; Includes 500 Modbus TCP Slave points
DR-S-MDB-SL-500	Additional 500 point block for AX Supervisor Modbus TCP Slave Driver
DR-S-SNMP-AX	AX Supervisor SNMP Driver; Includes license for 500 SNMP points
DR-S-SNMP-500	Additional 500 point block for AX Supervisor SNMP Driver

DR-S-OPC-AX	AX Supervisor OPC Client Driver; Includes license for 500 OPC points
DR-S-OPC-500	Additional 500 point block for AX Supervisor OPC Driver
DR-S-OBIX-AX	AX Supervisor OBIX Driver for connecting to devices not powered by Niagara; Includes license for 500 OBIX points (Available for Linux Supervisor)
DR-S-OBIX-500	Additional 500 point block for AX Supervisor OBIX Driver
DR-S-ILON-AX	AX Supervisor ILON Driver; includes license for 500 ILON points (Available for Linux Supervisor)
DR-S-ILON-500	Additional 500 point block for AX Supervisor ILON Driver
DR-S-SimpleADR-AX	AX Supervisor Simple OpenADR Driver; Allows for communication to the Akuacom DRAS or any other Tridium approved OpenADR compliant DRAS. Limits one DRAS client connection to the DRAS
DR-S-ADRClient-AX	License for one additional DRAS client server connection.
Video Drivers for AX Supervisor (not available for Small Building Systems or Linux Supervisors))	
DR-S-AXS-AX	AX Supervisor AXIS IP Camera Driver; Includes license for 16 cameras
DR-S-AXS-4	Additional 4 camera block for AX Supervisor AXIS IP Camera Driver
DR-S-DED-AX	AX Supervisor Dedicated Micros Video Driver; Includes license for 16 cameras (Dedicated Micros DVR must be purchased separately)
DR-S-DED-4	Additional 4 camera block for AX Supervisor Dedicated Micros Video Driver
DR-S-MLS-AX	AX Supervisor Milestone Systems Driver; Includes license for 16 cameras
DR-S-MLS-4	Additional 4 camera block for AX Supervisor Milestone Driver
DR-S-RPD-AX	AX Supervisor Honeywell Rapid Eye DVR Driver; Includes license for 16 cameras
DR-S-RPD-4	Additional 4 camera block for AX Supervisor Honeywell Rapid Eye DVR Driver

Architecture





BACnet Operator Workstation and BACnet Advanced Workstation

Overview

Tridium's BACnet Operator Workstation (OWS) and BACnet Advanced Workstation (AWS) enhance the ability to monitor and control a BACnet system through the Niagara AX Supervisor. The workstations provide additional control and presentation features on top of the BACnet Client IP Driver.

Operator Workstation (OWS)

The BACnet OWS device profile, standardized by BACnet International, is used for monitoring and basic control of a system. This device profile is designed for daily operators who need the ability to monitor basic system status and perform simple modification to the operation of the system.

Features of OWS:

Includes features of the BACnet IP Client along with:

- Presentation of data
- Ability to modify setpoints and parameters
- Adjustment of alarm/event parameters
- Operator notification and presentation of event information
- Alarm acknowledgements by operators
- Alarm summarization
- Adjustment of analog alarm limits

Advanced Workstation (AWS)

The BACnet AWS device profile is used to monitor the performance of a system and to modify parameters that affect the operation of a system. This profile is designed for the building operator or technician with a higher level of technical ability. The Advanced Workstation provides support for limited configuration actions and ongoing commissioning activities.

Features of AWS:

Includes features of the BACnet IP Client Driver and BACnet OWS along with:

- Ability to monitor the value of all BACnet object types
- Adjustment of alarm routing
- Creating of new Event Enrollment and Notification Classes
- Presentation of Event Logs

- Creation of new calendars and schedules
- Ability to silence a device on the network that is transmitting erroneous data
- Ability to cause a remote device to reinitialize
- Ability to backup and restore the configuration of other devices

System Requirements

Niagara^{AX} version 3.6 or later must be running on the Supervisor PC. Also the Supervisor must have the BACnet IP Client Driver license.

JACE-600

Overview

The JACE-600™ is a compact, embedded controller/server platform. It combines integrated control, supervision, data logging, alarming, scheduling and network management functions with Internet connectivity and web serving capabilities in a small, compact platform. The JACE-600 makes it possible to control and manage external devices over the Internet and present real-time information to users in web-based graphical views.

The JACE-600 is a member of Tridium's suite of controller/server products, software applications and tools, which are designed to integrate a variety of devices and protocols into unified, distributed systems. These products are powered by the revolutionary Niagara^{AX} Framework®, the industry's first software technology designed to integrate diverse systems and devices into a seamless system. Niagara supports a wide range of protocols including LonWorks™, BACnet™, Modbus, oBIX and Internet standards. The AX Framework also includes integrated network management tools to support the design, configuration, installation and maintenance of interoperable networks.

Applications

The JACE-600 is ideal for smaller facilities, remote sites, and for distributing control and monitoring throughout large facilities. Optional input/output modules can be plugged in for applications where local control is required. The JACE-600 also supports a wide range of field busses for connection to remote I/O and standalone controllers. In small facility applications, the JACE-600 is all you need for a complete system.

The JACE-600 serves data and rich graphical displays to a standard web browser via an Ethernet LAN or remotely over the Internet, or dial-up modem. In larger facilities, multi-building applications and large-scale control system integrations, AX Supervisor™ software can be used to aggregate information (real-time data, history, alarms, etc.) from large numbers of JACEs into a single unified application. The AX Supervisor can manage global control functions, support data passing over multiple networks, connect to enterprise level software applications, and host multiple, simultaneous client workstations connected over the local network, the Internet, or dial-up modem.

Features

- Embedded PowerPC Platform@ 524MHz
- Supports open and legacy protocols
- QNX Real-time Operating System
- Web User interface (standard) serves rich graphical browser presentations
- Run stand-alone control, energy management, and integration applications within the JACE-600 series controllers
- Supports two optional communications boards
- Optional 16 and 34 point I/O Modules

Powered by Niagara^{AX} FRAMEWORK®

Ordering Information

JACE and Memory Upgrade Option

Part Number	Description
T-600	Base Unit including two Ethernet ports, one RS-232 port, one RS-485 port, one USB port, Web User Interface and Niagara Connectivity included. oBIX Client/Server driver included.
NPB-256	Upgrade RAM memory to 256 MB DDR.

Optional Communications Cards

Part Number	Description
NPB-LON	Optional 78 Kbps FTT10 A Lon Adapter
NPB-232	NPB-232 - Optional RS-232 port adapter with 9 pin D- shell connector
NPB-2X-485	Optional dual port RS-485 adapter; electrically isolated

Power Supply & Optional Power Modules

Note: All modules are universal input 90 – 240 volts, 50/60 Hz.; the model numbers below represent the various plug configurations only (except NPB-PWR-UN)

Part Number	Description
NPB-PWR	Optional: 24 Volt AC/DC power supply module, Din Rail mounted
WPM-US	120 Vac, 50-60 Hz. US
WPM-EU	230 Vac. 50-60 Hz. Europe/Asia
WPM-UK	WPM-UK - 230 Vac 50-60 Hz. UK
WPM-JP	100 Vac 50-60 Hz. Japan
NPB-PWR-UN	Optional universal voltage input power supply module, Din Rail mounted. Input voltage is 90-263 Volts AC, 50/60 Hz auto adjusting

Optional IO Modules

Part Number	Description
IO-16	Optional 16 point IO module; directly connects to JACE IO connector.
IO-34	Optional 34 point IO Module; directly connects to JACE IO connector.
IO-16-485	Optional remote 16 point IO module, RS-485 bus connected to JACE-600; up to 16 units may be connected max., additional power supply required to power the remote IO.

Specifications

Platform

- PowerPC 440 524 MHz processor
- 128MB DDR RAM & 128 MB Serial Flash
- Optional 256 MB DDR RAM
- Battery Backup
- Real-time clock

Operating System

- QNX Real-time Operating System
- IBM J9 JVM Java Virtual Machine
- Niagara^{AX} 3.4 or later

Optional I/O Modules

IO-34 - 34 Point I/O Module

- Max of 1 per JACE-600; includes integral 24 volt AC/DC input power supply for JACE 2 and IO; no other power required
- 16 Universal Inputs (Type 3 (10k) Thermistors, 0-1000 ohm, 0-10 volts, 0-20 mA with external resistor)
- 10 relay outputs (Form A contacts, 24 VAC @.5 amp rated
- 8 analog outputs (0-10 volt DC)

IO-16 - 16 Point I/O Module

- Up to 4 per Jace-600, 2 per Jace-600 if combined with a 34 Point I/O module
- 8 Universal Inputs (Type 3 (10k) Thermistors, 0-1000 ohm, 0-10 volts, 0-20 mA with external resistor)
- 4 relay outputs (Form A contacts, 24 VAC @.5 amp rated
- 4 analog outputs (0-10 volt DC)

IO-16-485 Remote IO module

- 16 IO Points per device
- 8 Universal Inputs - Type 3 (10k) Thermistors, 0-100K ohm, 0-10 vdc, 0-20 mA with external resistor
- 4 relay outputs (Form A contacts, 24 VAC @ .5 amp rated)
- 4 analog outputs (0-10 vdc)
- Up to 16 remote IO-16-485 modules max per JACE-600

Power Options

- Direct connect (Pin compatible) with the NPB-PWR & NPB-PWR-UN power supplies.
- Modules can be powered directly from select JACE models with 15VDC outputs.
- External 15 VDC power supply
- DIN rail or surface mounting

Chassis

- Construction: Plastic, din rail or screw mount chassis, plastic cover
- Cooling: Internal air convection

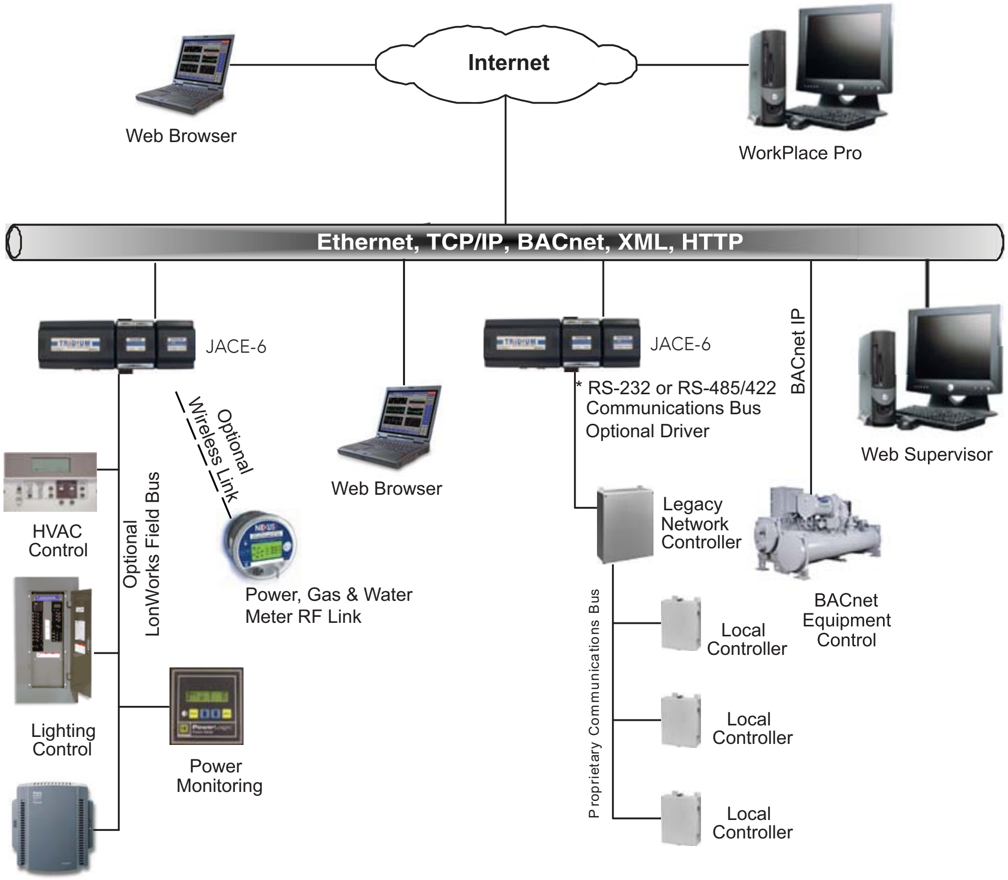
Environment

- Operating temperature range: 0° to 50°C (32°F to 122°F)
- Storage Temperature range: 0° to 70°C (32°F to 158°F)
- Relative humidity range: 5% to 95%, non-condensing

Agency Listings

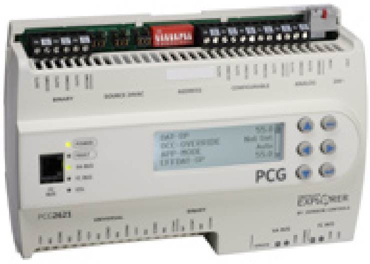
- RoHS Compliant
- BTL
- UL 916
- C-UL listed to Canadian Standards Association (CSA) C22.2 No. 205-M1983 “Signal Equipment”
- CE
- FCC part 15 Class A.

Architecture

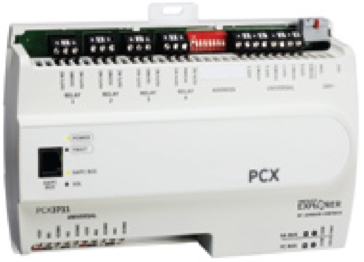


Programmable Controllers

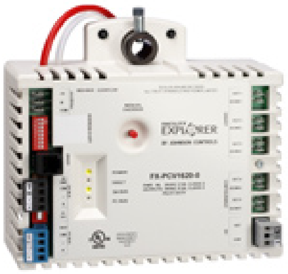
FX-PCG1611



FX-PCG2621



FX-PCX3711



FX-PCV1620

The Facility Explorer Programmable Controllers provide you with a comprehensive controls solution for a wide variety of HVAC applications. These controllers are designed to provide direct, closed loop control over mechanical HVAC equipment, either as standalone devices or as part of a larger, networked control system. With their automatic self tuning algorithm your facility will have optimal control with less wear and tear on the equipment. These controllers include a rich set of embedded and optional features, enabling you to quickly and simply build a control strategy based on improved access to information. The more visibility you have, the more you know how equipment systems are performing. And that leads to improved facility operations.

Applications:

- Packaged rooftop units
- Fan coil units
- Unit ventilators
- Heat pumps
- Variable air volume boxes
- Air handling units
- Chilled water & hot water systems

FACILITY EXPLORER

BY JOHNSON CONTROLS

Features

The Facility Explorer Programmable Controller family has a rich set of features that provide the appropriate functionality for your particular control needs.

- Configurable and fully programmable
- Standard BACnet® protocol
- BTL listed
- Zigbee® wireless field communications
- Zigbee wireless sensor communications
- Auto tuned control processes
- Flexible input/output configurations
- Point expansion
- Local display option

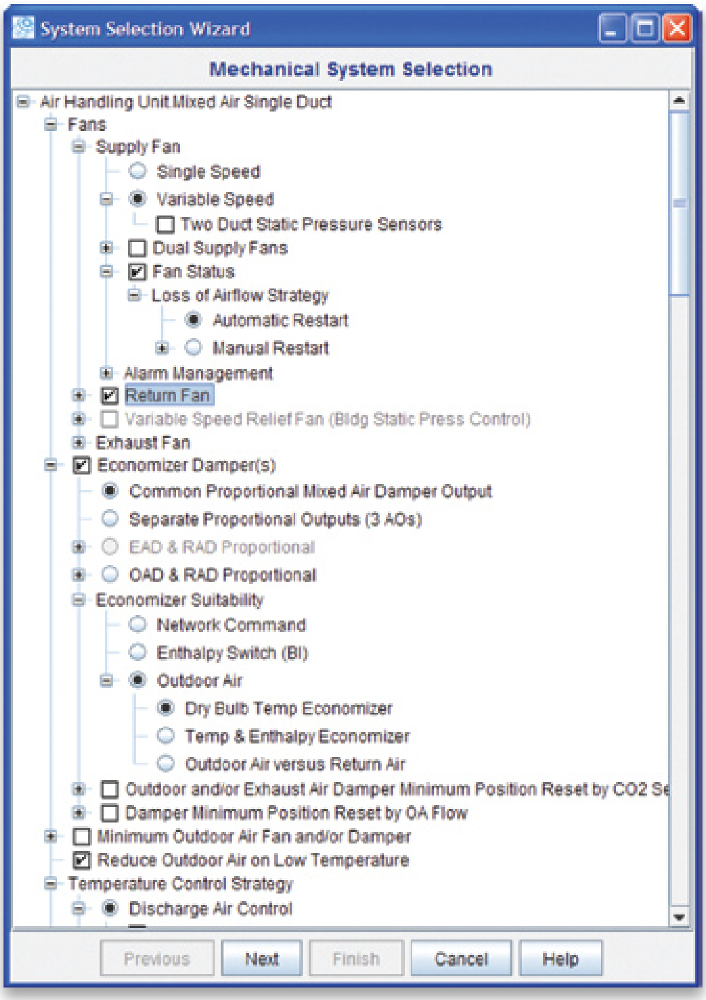
Simpler setup, better results

A core team of controls engineers have developed applications and application modules that have been laboratory tested and proven through years of field use. From VAV boxes, to rooftop units, to built-up air handlers, to chiller plants, we have the control algorithms to deliver optimum performance of your HVAC equipment.

These applications allow you to quickly and easily select the control sequence needed to properly control the HVAC equipment in your building. The simple, unique tree-like user interface allows you to choose the control modules required for the specific application. You can specify the details of control without writing complex programming code.

Network Zone Sensors
Discharge Air Sensor

ZFR1811 Router
ZFR1810 Coordinator
WRZ Series Sensors



- Air Handling Unit Mixed Air Single Duct
  - Fans
    - Supply Fan
      - ○ Single Speed
      - ● Variable Speed
        - ☐ Two Duct Static Pressure Sensors
      - ☐ Dual Supply Fans
      - ☑ Fan Status
        - Loss of Airflow Strategy
          - ● Automatic Restart
          - ○ Manual Restart
      - Alarm Management
    - ☑ Return Fan
    - ☐ Variable Speed Relief Fan (Bldg Static Press Control)
    - Exhaust Fan
  - ☑ Economizer Damper(s)
    - ● Common Proportional Mixed Air Damper Output
    - ○ Separate Proportional Outputs (3 AOs)
    - ○ EAD & RAD Proportional
    - ○ OAD & RAD Proportional
    - Economizer Suitability
      - ○ Network Command
      - ○ Enthalpy Switch (BI)
      - ● Outdoor Air
        - ● Dry Bulb Temp Economizer
        - ○ Temp & Enthalpy Economizer
        - ○ Outdoor Air versus Return Air
    - ☐ Outdoor and/or Exhaust Air Damper Minimum Position Reset by CO2 Se
    - ☐ Damper Minimum Position Reset by OA Flow
  - ☐ Minimum Outdoor Air Fan and/or Damper
  - ☑ Reduce Outdoor Air on Low Temperature
  - Temperature Control Strategy
    - ● Discharge Air Control

System Selection Wizard

Special control needs

Need to customize a standard application? Just switch to the block programming mode and you'll be able to view and to modify the particular control sequence. No need to start from scratch. Combine pre-built and tested control modules with your own custom modules. They all work together. You immediately see the control application you've created. Once done, you can test your changes with the included simulator before downloading it to the controller.

Wired and wireless working together

The Facility Explorer Programmable Controller family uses the HVAC industry standard BACnet over MS/TP (master, slave, token passing) protocol to communicate with supervisory controllers and other device controllers. For added flexibility, the same controllers can be fitted with a wireless router to provide wireless Zigbee communications on the field controller bus. These controllers are so flexible that they can even use Zigbee to communicate with their room sensors.

Less wear and tear, more comfort

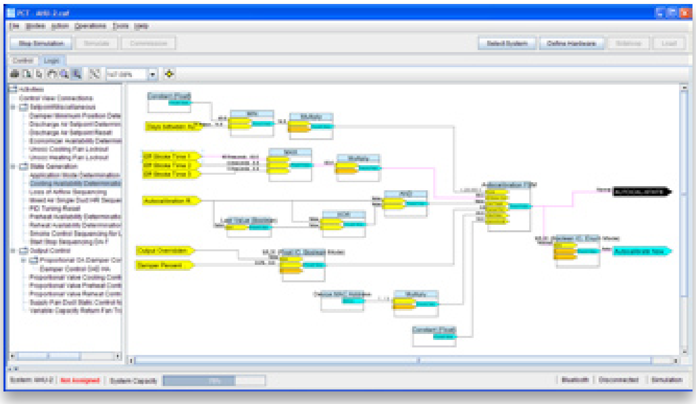
Patented proportional adaptive control (P-Adaptive) and Pattern Recognition Adaptive Control (PRAC) technologies provide continuous loop tuning. Not only does this reduce control loop tuning time, it can actually reduce the wear on mechanical systems and improve the comfort of the occupants while reducing cost.

Local user interface

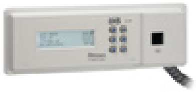
Need to have local access to the information of your HVAC equipment? The controller mounted or remote mounted local display provides graphic user interaction right at the equipment. It even has password protection to limit access to authorized users.

Point expansion

When large or complex control sequences require additional inputs and outputs, point expansion modules can be used. The expansion modules come in various point counts and point mixes so that it is easy to provide just the right amount needed.



Control Logic Simulation

Controller	Photo	Inputs	Outputs	Display
FX-PCG1611		2 Universal 1 Binary	3 Binary (Triac) 4 Configurable	
FX-PCG1621		2 Universal 1 Binary	3 Binary (Triac) 4 Configurable	✓
FX-PCG2611		6 Universal 2 Binary	3 Binary (Triac) 4 Configurable 2 Analog	
FX-PCG2621		6 Universal 2 Binary	3 Binary (Triac) 4 Configurable 2 Analog	✓
FX-PCX1711		4 Binary		
FX-PCX2711		2 Universal	2 Binary (Relay) 2 Universal	
FX-PCX3711		4 Universal	4 Binary (Relay) 4 Universal	
FX-PCX4711		6 Universal 2 Binary	3 Binary (Triac) 4 Configurable 2 Analog	
FX-PCV1610		1 Universal 1 Integrated Flow Sensor	1 Integrated Actuator	
FX-PCV1620		1 Universal 1 Integrated Flow Sensor	3 Binary (Triac) 2 Configurable 1 Integrated Actuator	
FX-DIS1710		Local Controller Display		

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NS Series Network Sensors

Description

The NS Series Network Sensor offering includes NS Series Network Zone Sensors and NS Series Network Discharge Air Sensors. The NS Series Network Sensors are designed to function directly with Metasys® system Field Equipment Controllers (FECs), Input/Output Modules (IOMs), Variable Air Volume (VAV) Modular Assembly (VMA16) Controllers, and Facility Explorer FX-PC Series Programmable Controllers (FX-PCGs, FX-PCVs, and FX-PCXs).

The majority of NS Series Network Zone Sensors monitor room temperature; however, options are available to also monitor zone humidity, carbon dioxide (CO_2), local temperature setpoint adjustments, and other variables. This data is transmitted to a controller on the Sensor Actuator (SA) Bus.

Some models of NS Series Network Zone Sensors include an onboard passive infrared (PIR) occupancy sensor that detects motion to determine if a space is occupied. This feature maximizes up to 30% energy savings in high-energy usage environments such as schools, dormitories, offices, hospitals, and hotels by adjusting the temperature of the space based on the occupancy status. In addition, the PIR occupancy sensor facilitates trending of floor space usage in these environments.

The NS Series Network Zone Sensors include models with a temperature setpoint dial and Liquid Crystal Display (LCD) that allows occupants to view the zone temperature, Relative Humidity (RH), and view and adjust the zone temperature setpoint. Some temperature and humidity models include a push button to toggle between temperature and RH on the display. These models also have the capability to set the desired default display to either temperature or RH.

A fan mode push button is included to set the desired fan speed (AUTO-OFF-low-medium-high). An occupancy override function allows the user to signal the controller that the zone is occupied to override the scheduled mode. Some models have DIP switches to set a unique address for applications that require multiple sensors.

For communication wiring flexibility, the wires connecting the network zone sensor to a controller can be terminated using a modular jack or screw terminals.

Each network sensor includes an SA Bus access port to allow accessories to access the SA Bus. This plug allows accessories to service or commission the connected controller or gain access to any other controller on the same Field Controller (FC) Bus.

The NS Series Network Zone Sensor offering includes models that can be surface mounted, vertical wallbox mounted, or flush mounted to meet the requirements of the specific application.

The NS Series Network Discharge Air Sensors monitor the duct temperature, typically at the discharge of the VAV box, and transmit this data to a local controller on the SA Bus using the 10 ft (305 cm) wiring lead included with the unit. The 10 ft (305 cm) wiring lead consists of four 22 AWG (0.6 mm) trade size color-coded wires encased in a plenum-rated jacket. Each of the wires is stripped and tinned for easy connection to the SA Bus screw terminal block.

The NS Series Network Discharge Air Sensors are available with either a 4 or 8 in. (102 or 203 mm) temperature probe. All models include DIP switches for applications requiring multiple discharge air sensors, each with a unique DIP switch address.

NS Series Network Sensors

Features

- BACnet® Master-Slave/Token-Passing (MS/TP) protocol communication — provides compatibility with Metasys system field controllers and Facility Explorer programmable controllers in a proven communication network
- backlit Liquid Crystal Display (LCD) available on some models — provides real-time status of the environment with backlighting activated during user interaction
- simple temperature setpoint adjustment available on some models — enables you to change the setpoint with the turn of a dial
- onboard PIR occupancy sensor available on some models — maximizes up to 30% energy savings in high-energy usage environments, and facilitates trending of floor space usage
- temporary occupancy available on some models — provides a timed override command, which temporarily initiates an alternate mode
- field selectable default display setting on some models — allows you to toggle between temperature and RH on the display, and set the desired default for continuous viewing
- Fahrenheit/Celsius (F/C) button available on some models — toggles the display temperature between degrees Celsius and degrees Fahrenheit

Repair Information

If the NS Series Network Zone Sensor or the NS Series Network Discharge Air Sensor fails to operate within its specifications, replace the unit. For a replacement sensor, contact the nearest Johnson Controls® representative.

NS Series Network Sensors (Continued)

Selection Charts

Network Zone Sensor Ordering Information — Temperature Only Models

Product Code Number	Size (mm), Height x Width	Vertical Wallbox-Mounted (WB) or Surface-Mounted (SM)	Johnson Controls Logo	LCD Display	Temperature Adjustment: Setpoint (Set) or Warmer/ Cooler Dial (W/C)	Occupancy Override Button, PIR Occupancy Sensor	F/C Scale Toggle	Fan Control	Screw Terminals (ST) or Modular Jack (MJ)	Address Switches	VAV Balancing Feature
NS-ATA7001-0	80 x 80	SM	Yes	Yes	Set	Yes, No	No	No	MJ	No	No
NS-ATA7002-0	80 x 80	SM	Yes	Yes	Set	Yes, No	No	No	ST	No	No
NS-ATA7003-0	80 x 80	SM	Yes	Yes	Set	Yes, No	No	No	ST	Yes	No
NS-ATB7001-0	80 x 80	SM	Yes	Yes	Set	Yes, No	Yes	No	MJ	No	No
NS-ATB7002-0	80 x 80	SM	Yes	Yes	Set	Yes, No	Yes	No	ST	No	No
NS-ATB7003-0	80 x 80	SM	Yes	Yes	Set	Yes, No	Yes	No	ST	Yes	No
NS-ATC7001-0	80 x 80	SM	Yes	Yes	Set	Yes, No	No	Yes	MJ	No	No
NS-ATC7002-0	80 x 80	SM	Yes	Yes	Set	Yes, No	No	Yes	ST	No	No
NS-ATD7001-0	80 x 80	SM	Yes	Yes	Set	Yes, No	Yes	Yes	MJ	No	No
NS-ATD7002-0	80 x 80	SM	Yes	Yes	Set	Yes, No	Yes	Yes	ST	No	No
NS-ATF7001-0	80 x 80	SM	Yes	Yes	W/C	Yes, No	Yes	No	MJ	No	No
NS-ATF7002-0	80 x 80	SM	Yes	Yes	W/C	Yes, No	Yes	No	ST	No	No
NS-ATN7001-0	80 x 80	SM	Yes	No	N/A	No, No	No	No	MJ	No	No
NS-ATN7001-2	80 x 80	SM	No	No	N/A	No, No	No	No	MJ	No	No
NS-ATN7003-0	80 x 80	SM	Yes	No	N/A	No, No	No	No	ST	Yes	No
NS-ATN7003-2	80 x 80	SM	No	No	N/A	No, No	No	No	ST	Yes	No
NS-ATP7001-0	80 x 80	SM	Yes	No	W/C	Yes, No	No	No	MJ	No	No
NS-ATP7001-2	80 x 80	SM	No	No	W/C	Yes, No	No	No	MJ	No	No
NS-ATP7002-0	80 x 80	SM	Yes	No	W/C	Yes, No	No	No	ST	No	No
NS-ATP7002-2	80 x 80	SM	No	No	W/C	Yes, No	No	No	ST	No	No
NS-ATP7003-0	80 x 80	SM	Yes	No	W/C	Yes, No	No	No	ST	Yes	No
NS-ATP7003-2	80 x 80	SM	No	No	W/C	Yes, No	No	No	ST	Yes	No
NS-ATV7001-0	80 x 80	SM	Yes	Yes	Set	Yes, No	Yes	No[1]	MJ	No	Yes
NS-ATV7002-0	80 x 80	SM	Yes	Yes	Set	Yes, No	Yes	No[1]	ST	No	Yes
NS-BTB7001-0	120 x 80	WB, SM	Yes	Yes	Set	Yes, No	Yes	No	MJ	No	No
NS-BTB7001-2	120 x 80	WB, SM	No	Yes	Set	Yes, No	Yes	No	MJ	No	No
NS-BTB7002-0	120 x 80	WB, SM	Yes	Yes	Set	Yes, No	Yes	No	ST	No	No
NS-BTB7003-0	120 x 80	WB, SM	Yes	Yes	Set	Yes, No	Yes	No	ST	Yes	No
NS-BTB7003-2	120 x 80	WB, SM	No	Yes	Set	Yes, No	Yes	No	ST	Yes	No
NS-BTF7001-0	120 x 80	WB, SM	Yes	Yes	W/C	Yes, No	Yes	No	MJ	No	No
NS-BTF7002-0	120 x 80	WB, SM	Yes	Yes	W/C	Yes, No	Yes	No	ST	No	No
NS-BTN7001-0	120 x 80	WB, SM	Yes	No	N/A	No, No	No	No	MJ	No	No
NS-BTN7001-2	120 x 80	WB, SM	No	No	N/A	No, No	No	No	MJ	No	No
NS-BTN7003-0	120 x 80	WB, SM	Yes	No	N/A	No, No	No	No	ST	Yes	No
NS-BTN7003-2	120 x 80	WB, SM	No	No	N/A	No, No	No	No	ST	Yes	No
NS-BTP7001-0	120 x 80	WB, SM	Yes	No	W/C	Yes, No	No	No	MJ	No	No
NS-BTP7001-2	120 x 80	WB, SM	No	No	W/C	Yes, No	No	No	MJ	No	No
NS-BTP7002-0	120 x 80	WB, SM	Yes	No	W/C	Yes, No	No	No	ST	No	No
NS-BTP7002-2	120 x 80	WB, SM	No	No	W/C	Yes, No	No	No	ST	No	No
NS-BTP7003-0	120 x 80	WB, SM	Yes	No	W/C	Yes, No	No	No	ST	Yes	No
NS-BTV7001-0	120 x 80	WB, SM	Yes	Yes	Set	Yes, No	Yes	No[1]	MJ	No	Yes
NS-BTV7002-0	120 x 80	WB, SM	Yes	Yes	Set	Yes, No	Yes	No[1]	ST	No	Yes
NS-MTB7001-0	120 x 80	WB, SM	Yes	Yes	Set	No, Yes	Yes	No	MJ	No	No
NS-MTB7002-0	120 x 80	WB, SM	Yes	Yes	Set	No, Yes	Yes	No	ST	No	No
NS-MTL7001-0	120 x 80	WB, SM	Yes	No	N/A	Yes, Yes	No	No	MJ	No	No
NS-MTL7002-0	120 x 80	WB, SM	Yes	No	N/A	Yes, Yes	No	No	ST	No	No

1. In the VAV balancing models, the fan control button is replaced by a light bulb button used in the VAV balancing process.

NS Series Network Sensors (Continued)

Network Zone Sensor Ordering Information — Temperature and Humidity Models without RH Display

Product Code Number	Size (mm), Height x Width	Vertical Wallbox-Mounted (WB) or Surface-Mounted (SM)	Johnson Controls Logo	LCD Display, RH Display	Humidity Element Accuracy	Temperature Adjustment: Setpoint (Set) or Warmer/ Cooler Dial (W/C)	Occupancy Override Button, PIR Occupancy Sensor	F/C Scale Toggle	Screw Terminals (ST) or Modular Jack (MJ)	Address Switches
NS-AHA7001-0	80 x 80	SM	Yes	Yes, No	3%	Set	Yes, No	No	MJ	No
NS-AHA7002-0	80 x 80	SM	Yes	Yes, No	3%	Set	Yes, No	No	ST	No
NS-AHB7001-0	80 x 80	SM	Yes	Yes, No	3%	Set	Yes, No	Yes	MJ	No
NS-AHB7002-0	80 x 80	SM	Yes	Yes, No	3%	Set	Yes, No	Yes	ST	No
NS-AHB7003-0	80 x 80	SM	Yes	Yes, No	3%	Set	Yes, No	Yes	ST	Yes
NS-AHN7001-0	80 x 80	SM	Yes	None	3%	N/A	No, No	No	MJ	No
NS-AHP7001-0	80 x 80	SM	Yes	None	3%	W/C	Yes, No	No	MJ	No
NS-AHN7001-2	80 x 80	SM	No	None	3%	N/A	No, No	No	MJ	No
NS-APA7001-0	80 x 80	SM	Yes	Yes, No	2%	Set	Yes, No	No	MJ	No
NS-APA7002-0	80 x 80	SM	Yes	Yes, No	2%	Set	Yes, No	No	ST	No
NS-APB7001-0	80 x 80	SM	Yes	Yes, No	2%	Set	Yes, No	Yes	MJ	No
NS-APB7002-0	80 x 80	SM	Yes	Yes, No	2%	Set	Yes, No	Yes	ST	No
NS-APB7003-0	80 x 80	SM	Yes	Yes, No	2%	Set	Yes, No	Yes	ST	Yes
NS-BHB7001-0	120 x 80	WB, SM	Yes	Yes, No	3%	Set	Yes, No	Yes	MJ	No
NS-BHB7002-0	120 x 80	WB, SM	Yes	Yes, No	3%	Set	Yes, No	Yes	ST	No
NS-BHB7003-0	120 x 80	WB, SM	Yes	Yes, No	3%	Set	Yes, No	Yes	ST	Yes
NS-BHN7001-0	120 x 80	WB, SM	Yes	None	3%	N/A	No, No	No	MJ	No
NS-BHN7001-2	120 x 80	WB, SM	No	None	3%	N/A	No, No	No	MJ	No
NS-BHP7001-0	120 x 80	WB, SM	Yes	None	3%	W/C	Yes, No	No	MJ	No
NS-BPB7001-0	120 x 80	WB, SM	Yes	Yes, No	2%	Set	Yes, No	Yes	MJ	No
NS-BPB7002-0	120 x 80	WB, SM	Yes	Yes, No	2%	Set	Yes, No	Yes	ST	No
NS-BPB7003-0	120 x 80	WB, SM	Yes	Yes, No	2%	Set	Yes, No	Yes	ST	Yes
NS-MHL7001-0	120 x 80	WB, SM	Yes	No, No	3%	N/A	Yes, Yes	No	MJ	No
NS-MHL7002-0	120 x 80	WB, SM	Yes	No, No	3%	N/A	Yes, Yes	No	ST	No

Network Zone Sensor Ordering Information — Temperature and Humidity Models with Temperature or RH Display (Field Selectable Default Display)

Product Code Number	Size (mm), Height x Width	Vertical Wallbox-Mounted (WB) or Surface-Mounted (SM)	LCD Display, RH Display	Humidity Element Accuracy	Temperature Adjustment: Setpoint (Set) or Warmer/ Cooler Dial (W/C)	Occupancy Override Button	F/C Scale Toggle	Screw Terminals (ST) or Modular Jack (MJ)	Address Switches
NS-AHR7101-0	80 x 80	SM	Yes, Yes	3%	Set	Yes	Yes	MJ	No
NS-AHR7102-0	80 x 80	SM	Yes, Yes	3%	Set	Yes	Yes	ST	No
NS-AHR7103-0	80 x 80	SM	Yes, Yes	3%	Set	Yes	Yes	ST	Yes
NS-APR7101-0	80 x 80	SM	Yes, Yes	2%	Set	Yes	Yes	MJ	No
NS-APR7102-0	80 x 80	SM	Yes, Yes	2%	Set	Yes	Yes	ST	No
NS-BHR7101-0	120 x 80	WB, SM	Yes, Yes	3%	Set	Yes	Yes	MJ	No
NS-BHR7103-0	120 x 80	WB, SM	Yes, Yes	3%	Set	Yes	Yes	ST	Yes

Network Zone Sensor Ordering Information — Motion Detection Only Models (No Temperature or Humidity Sensing)

Product Code Number	Size (mm), Height x Width	Vertical Wallbox-Mounted (WB), or Surface-Mounted (SM)	LCD Display	PIR Occupancy Sensor	Screw Terminals (ST), or Modular Jack (MJ)	Address Switches
NS-MNN7001-0	120 x 80	WB, SM	No	Yes	MJ	No
NS-MNN7003-0	120 x 80	WB, SM	No	Yes	ST	Yes

NS Series Network Sensors (Continued)

Network Zone Sensor Ordering Information — CO_2 Models

Product Code Number	Size (mm), Height x Width	Vertical Wallbox-Mounted (WB), or Surface-Mounted (SM)	LCD Display	CO_2 Measurement Range	Johnson Controls Logo	Screw Terminals (ST), or Modular Jack (MJ)	Sensor Addressing
NS-BCN7004-0	120 x 80	WB, SM	No	0 to 2,000 ppm	Yes	ST, MJ	DIP Switch (212 to 219)
NS-BCN7004-2	120 x 80	WB, SM	No	0 to 2,000 ppm	No	ST, MJ	DIP Switch (212 to 219)

Network Zone Sensor Ordering Information — Flush-Mount Temperature Only Models

Product Code Number	Faceplate Dimensions, Height x Width	Mounting	LCD Display	Temperature Measurement Range	Johnson Controls Logo	Terminations	Sensor Addressing
NS-FTN7003-0	4-1/2 in. x 2-3/4 in. (114 mm x 70 mm)	Flush-Mount	No	32.0°F/0.0°C to 104.0°F/40.0°C	Yes	Screw Terminal Block	DIP Switch (200 to 203)
NS-FTN7003-2	4-1/2 in. x 2-3/4 in. (114 mm x 70 mm)	Flush-Mount	No	32.0°F/0.0°C to 104.0°F/40.0°C	No	Screw Terminal Block	DIP Switch (200 to 203)

Network Discharge Air Sensor Ordering Information

Product Code Number	Dimensions, Height x Width x Depth	Temperature Probe Length	10 ft (305 cm) Wiring Lead Included	Terminations	Sensor Addressing
NS-DTN7043-0	3 in. x 3 in. x 2 in. (76 mm x 76 mm x 51 mm)	4 in. (102 mm)	Yes	Screw Terminal Block	DIP Switch (204 to 211)
NS-DTN7083-0	3 in. x 3 in. x 2 in. (76 mm x 76 mm x 51 mm)	8 in. (203 mm)	Yes	Screw Terminal Block	DIP Switch (204 to 211)

Technical Specifications

NS Series Network Zone Sensors — Temperature Only Models and Temperature and Humidity Models (Part 1 of 2)	
Supply Voltage	9.8 to 16.5 VDC; 15 VDC Nominal (From SA Bus)
Current Consumption	**Temperature Only Models with LCD Display:** 21 mA Maximum (Non-transmitting)
	Temperature Only Models without LCD Display: 13 mA Maximum (Non-transmitting)
	Temperature and Humidity Models with LCD Display: 25 mA Maximum (Non-transmitting)
	Temperature and Humidity Models without LCD Display: 17 mA Maximum (Non-transmitting)
Terminations	Modular Jack or Screw Terminal Block
Sensor Addressing	**NS-AHx7003-0, NS-APB7003-0, NS-ATx7003-0, NS-BHx7003-0, NS-BPB7003-0, NS-BTB7003-0, NS-BTN7003-0, and NS-BTP7003-0 Models:** DIP Switch Set from 200 to 203; Factory Set at 203
	All Other Models: Fixed Address of 199
Wire Size	**Modular Jack Models:** 24 or 26 AWG (0.5 or 0.4 mm Diameter) Recommended; Three Twisted Pair (Six Conductors)
	Screw Terminal Block Models: 18 to 22 AWG (1.0 to 0.6 mm Diameter); 22 AWG (0.6 mm Diameter) Recommended
Communication Rate	**Auto-Detect:** 9.6k, 19.2k, 38.4k, or 76.8k bps
Mounting	**Surface-Mounted:** 80 x 80 mm
	Surface-Mounted or Vertical Wallbox-Mounted: 120 x 80 mm
Temperature Measurement Range	32.0°F/0.0°C to 104.0°F/40.0°C
Humidity Measurement Range	**Full Range:** 0 to 100% RH
	Calibrated Range: 10 to 90% RH
Temperature Sensor Type	Local Platinum Resistance Temperature Detector (RTD)
Humidity Sensor Type	Thin Film Capacitive Sensor
Temperature Resolution (Models with LCD)	±0.5F°/±0.5C°
Temperature Sensor Accuracy	±1.0F°/±0.6C°
Humidity Element Accuracy	**NS-APx700x-0 and NS-BPB700x-0 Models:** ±2% RH for 20 to 80% RH; ±4% RH for 10 to 20% and 80 to 90% RH
	NS-AHx700x-0, NS-BHx700x-0, and NS-MHL700x-0 Models: ±3% RH for 20 to 80% RH; ±6% RH for 10 to 20% and 80 to 90% RH
Time Constant	10 Minutes Nominal at 10 fpm Airflow
Default Temperature Setpoint Adjustment Range	**With LCD Display:** 50.0°F/10.0°C to 86.0°F/30.0°C in 0.5° Increments
	Without LCD Display: ±5.0F°/±3.0C°
PIR Occupancy Sensor Motion Detection (Models with PIR Occupancy Sensor)	Minimum 94 Angular Degrees up to a Distance of 15 ft (4.6 m); Based on a Clear Line of Sight
Ambient Conditions	**Operating:** 32 to 104°F (0 to 40°C); 10 to 90% RH, Noncondensing; 85°F (29°C) Maximum Dew Point
	Storage with LCD Display: -4 to 140°F (-20 to 60°C); 5 to 95% RH, Noncondensing
	Storage without LCD Display: -40 to 158°F (-40 to 70°C); 5 to 95% RH, Noncondensing

NS Series Network Sensors (Continued)

NS Series Network Zone Sensors — Temperature Only Models and Temperature and Humidity Models (Part 2 of 2)		
Compliance CE	**BACnet International**	BACnet Testing Laboratories™ (BTL) 135-2004 Listed BACnet Smart Sensor (B-SS) Note: Excludes the NS-ATV700x-0 and NS-BTV700x-0 models.
	United States	UL Listed, File E107041, CCN PAZX, Under UL 916, Energy Management Equipment; FCC Compliant to CFR 47, Part 15, Subpart B, Class A
	Canada	UL Listed, File E107041, CCN PAZX7, Under CAN/CSA C22.2 No. 205, Signal Equipment; Industry Canada, ICES-003
	Europe	CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC.
	Australia and New Zealand	C-Tick Mark, Australia/NZ Emissions Compliant
Accessory (Order Separately)		**NS-WALLPLATE-0:** Adapts an 80 x 80 mm NS Series Network Zone Sensor to a Standard 80 x 120 mm Wallbox
Shipping Weight		**NS-Axx7xxx-0 Models:** 0.20 lb (0.09 kg)
		NS-Bxx7xxx-0 and NS-Mxx700x-0 Models: 0.25 lb (0.11 kg)

NS Series Network Zone Sensors — Motion Detection Only Models (No Temperature or Humidity Sensing)		
Supply Voltage		9.8 to 16.5 VDC; 15 VDC Nominal (From SA Bus)
Current Consumption		13 mA Maximum (Non-transmitting)
Terminations		Modular Jack or Screw Terminal Block
Sensor Addressing (NS-MNN7003-0 Model)		DIP Switch Set from 200 to 203; Factory Set at 203
Wire Size		**Modular Jack Model:** 24 AWG or 26 AWG (0.5 or 0.4 mm Diameter) Recommended; Three Twisted Pair (Six Conductors)
		Screw Terminal Block Model: 18 to 22 AWG (1.0 to 0.6 mm Diameter); 22 AWG (0.6 mm Diameter) Recommended
Communication Rate		**Auto-Detect:** 9.6k, 19.2k, 38.4k, or 76.8k bps
Mounting		**Surface-Mounted or Vertical Wallbox-Mounted:** 120 x 80 mm
PIR Occupancy Sensor Motion Detection		Minimum 94 Angular Degrees up to a Distance of 15 ft (4.6 m); Based on a Clear Line of Sight
Ambient Conditions		**Operating:** 32 to 104°F (0 to 40°C); 10 to 90% RH, Noncondensing; 85°F (29°C) Maximum Dew Point
		Storage: -40 to 158°F (-40 to 70°C); 5 to 95% RH, Noncondensing
Compliance CE	**BACnet International**	BACnet Testing Laboratories™ (BTL) 135-2004 Listed BACnet Smart Sensor (B-SS)
	United States	UL Listed, File E107041, CCN PAZX, Under UL 916, Energy Management Equipment; FCC Compliant to CFR 47, Part 15, Subpart B, Class A
	Canada	UL Listed, File E107041, CCN PAZX7, Under CAN/CSA C22.2 No. 205, Signal Equipment; Industry Canada, ICES-003
	Europe	CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC.
	Australia and New Zealand	C-Tick Mark, Australia/NZ Emissions Compliant
Shipping Weight		0.25 lb (0.11 kg)

NS Series Network Zone Sensor — CO_2 Models (Part 1 of 2)	
Supply Voltage	**Non-isolated:** 20 to 30 VAC (18 to 30 VDC), Class 2 or Safety Extra-Low Voltage (SELV)
	Isolated: 9.8 to 16.5 VDC; 15 VDC Nominal (From SA Bus)
Current Consumption	**Non-isolated:** 22 mA Average at 24 VAC; 28 mA Average at 24 VDC
	Isolated: 5 mA Maximum, Non-transmitting (From SA Bus)
Power Consumption	**Non-isolated:** Less Than 0.7 W Average
Terminations	**Non-isolated Supply:** Screw Terminal Block
	SA Bus: Modular Jack or Screw Terminal Block
Sensor Addressing	DIP Switch Set from 212 to 219; Factory Set at 212
Wire Size	**Modular Jack:** 24 or 26 AWG (0.5 or 0.4 mm Diameter) Recommended; Three Twisted Pair (Six Conductors)
	Screw Terminal Block: 18 to 22 AWG (1.0 to 0.6 mm Diameter); 22 AWG (0.6 mm Diameter) Recommended
Communication Rate	**Auto-Detect:** 9.6k, 19.2k, 38.4k, or 76.8k bps
CO_2 Measurement Range	0 to 2,000 ppm
CO_2 Sensing Accuracy	Plus or Minus the Sum of 50 ppm and 3.0% of the CO_2 Reading at 77°F (25°C) and 978 hPa or an Altitude of 1,000 ft/300 m Note: All accuracy specifications reflect the testing of the device using high-grade certified gases. This device is intended for an altitude range of 0 ft/0 m to 2,000 ft/600 m above sea level without compensation.
	Temperature Dependence of Output: -0.35% of the CO_2 Reading per 1.8F°/1C° Typical
	Pressure Dependence of Output: +0.15% of the CO_2 Reading per 1 hPa Typical
CO_2 Sensing Resolution	1 ppm

NS Series Network Sensors (Continued)

NS Series Network Zone Sensor — CO_2 Models (Part 2 of 2)		
CO_2 Sensing Response Time		1 Minute (0 to 90%)
CO_2 Sensing Warm-Up Time		Less Than 1 Minute; Less Than 10 Minutes for Full Accuracy
CO_2 Sensing Long-Term Stability		Less Than ±100 ppm Over 5 Years
Mounting		**Surface-Mounted or Vertical Wallbox-Mounted:** 120 x 80 mm
Ambient Conditions		**Operating:** 32 to 104°F (0 to 40°C); 10 to 90% RH, Noncondensing; 85°F (29°C) Maximum Dew Point; 700 to 1,200 hPa
		Storage: -40 to 158°F (-40 to 70°C); 0 to 95% RH, Noncondensing
Compliance CE	**BACnet International**	BACnet Testing Laboratories™ (BTL) 135-2004 Listed BACnet Smart Sensor (B-SS)
	United States	UL Listed, File E107041 CCN PAZX, Under UL 916, Energy Management Equipment; FCC Compliant to CFR 47, Part 15, Subpart B, Class A
	Canada	UL Listed, File E107041, CCN PAZX7, Under CAN/CSA C22.2 No. 205, Signal Equipment; Industry Canada, ICES-003
	Europe	CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC.
	Australia and New Zealand	C-Tick Mark, Australia/NZ Emissions Compliant
Supply Voltage		0.35 lb (0.16 kg)

NS Series Network Zone Sensor — Flush-Mount Temperature Only Models		
Supply Voltage		9.8 to 16.5 VDC; 15 VDC Nominal (From SA Bus)
Current Consumption		12 mA Maximum (Non-transmitting) per Flush-Mount Network Sensor
Terminations		Screw Terminal Block Note: Wire leads are field supplied and are not tinned.
Sensor Addressing		DIP Switch Set from 200 to 203; Factory Set at 203
Wire Size		18 to 22 AWG (1.0 to 0.6 mm Diameter); 22 AWG (0.6 mm Diameter) Recommended; 10 ft (304.8 cm) Wiring Lead Included with the Unit
Communication Rate		**Auto-Detect:** 9.6k, 19.2k, 38.4k, or 76.8k bps
Temperature Measurement Range		32.0°F/0.0°C to 104.0°F/40.0°C
Temperature Sensor Type		Local Platinum Resistance Temperature Detector (RTD)
Temperature Sensor Accuracy		±1.0F°/±0.6C°
Ambient Conditions		**Operating:** 32 to 104°F (0 to 40°C); 10 to 90% RH, Noncondensing; 85°F (29°C) Maximum Dew Point
		Storage: -40 to 158°F (-40 to 70°C); 5 to 95% RH, Noncondensing
Compliance CE	**BACnet International**	BACnet Testing Laboratories™ (BTL) 135-2004 Listed BACnet Smart Sensor (B-SS)
	United States	UL Listed, File E107041, CCN PAZX, Under UL 916, Energy Management Equipment; FCC Compliant to CFR 47, Part 15, Subpart B, Class A
	Canada	UL Listed, File E107041, CCN PAZX7, Under CAN/CSA C22.2 No. 205, Signal Equipment; Industry Canada, ICES-003
	Europe	CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC.
	Australia and New Zealand	C-Tick Mark, Australia/NZ Emissions Compliant
Shipping Weight		0.25 lb (0.11 kg)

NS Series Network Discharge Air Sensors (Part 1 of 2)	
Supply Voltage	9.8 to 16.5 VDC; 15 VDC Nominal
Current Consumption	12 mA Maximum (Non-transmitting) per Discharge Air Sensor
Terminations	Four Color-Coded Wiring Leads, Stripped and Tinned; Factory-Installed at the Discharge Air Sensor Screw Terminal Block
Sensor Addressing	DIP Switch Set from 204 to 211; Factory Set at 204
Wire Size	18 to 22 AWG (1.0 to 0.6 mm Diameter); 22 AWG (0.6 mm Diameter) Recommended; 10 ft (305 cm) Wiring Lead Included with the Unit
Communication Rate	**Auto-Detect:** 9.6k, 19.2k, 38.4k, or 76.8k bps
Mounting	**Duct-Mounted:** 4 or 8 in. (102 or 203 mm) Temperature Probe Length
Temperature Measurement Range	14°F/-10°C to 140°F/60°C
Temperature Sensor Type	Local Platinum Resistance Temperature Detector (RTD)
Temperature Sensor Accuracy	±1.0F°/±0.6C°
Ambient Conditions	**Operating:** 14 to 140°F (-10 to 60°C); 10 to 90% RH, Noncondensing; 85°F (29°C) Maximum Dew Point
	Storage: -40 to 158°F (-40 to 70°C); 5 to 95% RH, Noncondensing

NS Series Network Sensors (Continued)

NS Series Network Discharge Air Sensors (Part 2 of 2)		
Compliance CE	**BACnet International**	BACnet Testing Laboratories™ (BTL) 135-2004 Listed BACnet Smart Sensor (B-SS)
	United States	UL Listed, File E107041, CCN PAZX, Under UL 916, Energy Management Equipment; FCC Compliant to CFR 47, Part 15, Subpart B, Class A
	Canada	UL Listed, File E107041, CCN PAZX7, Under CAN/CSA C22.2 No. 205, Signal Equipment; Industry Canada, ICES-003
	Europe	CE Mark – Johnson Controls, Inc., declares that this product is in compliance with the essential requirements and other relevant provisions of the EMC Directive 2004/108/EC.
	Australia and New Zealand	C-Tick Mark, Australia/NZ Emissions Compliant
Shipping Weight		**NS-DTN7043-0:** 1.15 lb (0.52 kg)
		NS-DTN7083-0: 1.17 lb (0.53 kg)

Code No. LIT-1900191
Issued January 15, 2008

J Series

Electric Zone Valves – Two-Way Spring Open (Normally Open), Modulating Control

Description

This electric zone valve with forged brass body offers two--way spring open (normally open), modulating control for hot or chilled water applications. For complete details, refer to *J Series Electric Zone Valves Product Bulletin (LIT-977282)*.

Features

- economical control of hot or chilled water (up to 50% glycol) for fan coil, baseboard radiator and VAV reheat applications.
- 0 to 10 VDC proportional and three wire floating control.
- 32 to 200°F (0 to 93°C) fluid temperature rating
- 32 to 125°F (0 to 52°C) ambient temperature rating
- 300 psig Static Pressure Rating
- 20 to 30 VAC 50/60 Hz
- forged brass body

JM Series Two-Way Spring Return Modulating Zone Valve

Selection Chart

Valve	Size	Cv	Close-off	Actuator	
				Three Wire Floating	**0 to 10 VDC Proportional**
				JT13A000	**JP13A000**
Two-Way – Sweat Connections					
JM2211	1/2”	1	50	**JM2211T23A000**	**JM2211P23A000**
JM2212	1/2”	2	50	**JM2212T23A000**	**JM2212P23A000**
JM2213	1/2”	4	35	**JM2213T23A000**	**JM2213P23A000**
JM2312	3/4”	2	50	**JM2312T23A000**	**JM2312P23A000**
JM2313	3/4”	4	35	**JM2313T23A000**	**JM2313P23A000**
JM2317	3/4”	7.5	35	**JM2317T23A000**	**JM2317P23A000**
JM2413	1”	4	35	**JM2413T23A000**	**JM2413P23A000**
JM2417	1”	8	35	**JM2417T23A000**	**JM2417P23A000**
JM2517	1-1/4”	8	35	**JM2517T23A000**	**JM2517P23A000**
Two-Way – NPT Connections					
JM2221	1/2”	1	50	**JM2221T23A000**	**JM2221P23A000**
JM2222	1/2”	2	50	**JM2222T23A000**	**JM2222P23A000**
JM2223	1/2”	4	35	**JM2223T23A000**	**JM2223P23A000**
JM2322	3/4”	2	50	**JM2322T23A000**	**JM2322P23A000**
JM2323	3/4”	4	35	**JM2323T23A000**	**JM2323P23A000**
JM2327	3/4”	7.5	35	**JM2327T23A000**	**JM2327P23A000**
JM2427	1”	8	35	**JM2427T23A000**	**JM2427P23A000**

Repair Information

If the J Series Electric Zone Valve – Two-Way Spring Open, Modulating Control fails to operate within its specifications, replace the unit. For a replacement valve, contact the nearest Johnson Controls® representative.

Note: Actuators and valve bodies can be ordered separately using the actuator and valve code numbers shown. JM Series Modulating Three-Way Electric Zone Valves must be piped in a mixing configuration only.

Technical Specifications

J Series Electric Zone Valves – Two-Way Spring Open, Modulating Control		
Service[1]		Hot Water Chill Water, and 50/50 Glycol Solutions for HVAC Systems
Fluid Temperature Limits	**Water**	32 to 200°F (0 to 93°C)
	Steam	Not rated for steam service
Valve Body Pressure Rating		300 psig (2,067 kPa)
Leakage		0.01% of Maximum Flow per ANSI/FCI 70-2 Class IV
Ambient Operating Temperature Limits		32 to 125°F (0 to 52°C)
Cycle Time		Full Close to Full Open 150 seconds
Control Signal	**“T” Type Actuator**	24 VAC, 60 Hz, Three-Wire Floating Control
	“P” Type Actuator	0 to 10 VDC (1 to 9 VDC Actual) Factory Setting, 0 to 5 VDC, 5 to 10 VDC jumper selectable
Control Action	**“P” Type Actuator**	Factory Setting: Direct Acting Valve opens Port “B” as signal increases. Jumper selectable
Power Requirements		1.6 VA
Electrical Connection		Terminal Block
Materials	**Body**	Brass
	Stem	Brass (Hard Chrome Plated)
	Base Plate and Bearing Plate	Stainless Steel
	Actuator Housing	High Temperature Plastic
	Valve Plug	High Temperature Thermoplastic Rubber
	Stem Seals	Viton™ O-rings

1. Refer to VDI 2035 Standard for recommended proper water treatment.

www.johnsoncontrols.com

Code No. LIT-1900094
Issued July 13, 2011

J Series

Electric Zone Valves – Two-Way Spring Open (Normally Open), On/Off Control

Description

This electric zone valve with forged brass body offers two-way spring open (normally open), on/off control for hot or chilled water applications. For complete details, refer to J *Series Electric Zone Valves Product Bulletin (LIT-977282)*.

Features

- forged brass body and hard chrome-plated brass stem
- provides economical control of hot or chilled water for fan coil, baseboard radiator, and VAV reheat applications
- On/Off control from a two-wire thermostat
- 300 psig system operating pressure
- 400 psig static pressure rating
- buna-N (standard temperature) or nitrile disk (high temperature) provides tight closeoff
- 1/2, 3/4, and 1 in. line sizes
- sweat, NPT, or inverted flare end connections
- actuator can be factory or field installed
- actuator snaps in place for easy removal and assembly during installation

Standard Closeoff

Selection Charts

J Series Electric Zone Valve – Two-Way Spring Open (Normally Open), On/Off Control (Part 1 of 2)

Valve Model Number					Actuator Model Number G Style Actuators have Standard Pressure Closeoff H Style Actuators have High Pressure Closeoff			
					Standard Temperature Rating: 200°F (93°C) Fluid, 104°F (40°C) Ambient		High Temperature Rating: 250°F (121°C) Fluid, 15 psig Steam, 169°F (76°C) Ambient	
Standard Temp	High Temp	Size, in.	Cv	Closeoff	24 VAC, 60 Hz	120 VAC, 60 Hz	24 VAC, 60 Hz	120 VAC, 60 Hz
					JG23A020 JH23A020	JG23B020 JH23B020	JG24A020 JH24A020	JG24B020 JH24B020
Sweat Connections – Standard Pressure Closeoff								
JT2211	JS2211	1/2	1.0	60	**JT2211G23A020**	**JT2211G23B020**	**JS2211G24A020**	**JS2211G24B020**
JT2212	JS2212	1/2	2.5	40	**JT2212G23A020**	**JT2212G23B020**	**JS2212G24A020**	**JS2212G24B020**
JT2213	JS2213	1/2	3.5	25	**JT2213G23A020**	**JT2213G23B020**	**JS2213G24A020**	**JS2213G24B020**
JT2312	JS2312	3/4	2.5	40	**JT2312G23A020**	**JT2312G23B020**	**JS2312G24A020**	**JS2312G24B020**
JT2313	JS2313	3/4	3.5	25	**JT2313G23A020**	**JT2313G23B020**	**JS2313G24A020**	**JS2313G24B020**
JT2417	JS2417	1	8.0	17	**JT2417G23A020**	**JT2417G23B020**	**JS2417G24A020**	**JS2417G24B020**
JT2517	JS2517	1-1/4	8.0	17	**JT2517G23A020**	**JT2517G23B020**	**JS2517G24A020**	**JS2517G24B020**
NPT Connections – Standard Pressure Closeoff								
JT2221	JS2221	1/2	1.0	60	**JT2221G23A020**	**JT2221G23B020**	**JS2221G24A020**	**JS2221G24B020**
JT2222	JS2222	1/2	2.5	40	**JT2222G23A020**	**JT2222G23B020**	**JS2222G24A020**	**JS2222G24B020**
JT2223	JS2223	1/2	3.5	25	**JT2223G23A020**	**JT2223G23B020**	**JS2223G24A020**	**JS2223G24B020**
JT2322	JS2322	3/4	2.5	40	**JT2322G23A020**	**JT2322G23B020**	**JS2322G24A020**	**JS2322G24B020**
JT2323	JS2323	3/4	3.5	25	**JT2323G23A020**	**JT2323G23B020**	**JS2323G24A020**	**JS2323G24B020**
JT2427	JS2427	1	8.0	17	**JT2427G23A020**	**JT2427G23B020**	**JS2427G24A020**	**JS2427G24B020**
Inverted Flare Connections – Standard Pressure Closeoff								
JT2343	JS2343	3/4	3.5	25	**JT2343G23A020**	**JT2343G23B020**	**JS2343G24A020**	**JS2343G24B020**
Sweat Connections – High Pressure Closeoff								
JT2211	JS2211	1/2	1.0	75	**JT2211H23A020**	**JT2211H23B020**	**JS2211H24A020**	**JS2211H24B020**
JT2212	JS2212	1/2	2.5	50	**JT2212H23A020**	**JT2212H23B020**	**JS2212H24A020**	**JS2212H24B020**
JT2213	JS2213	1/2	3.5	30	**JT2213H23A020**	**JT2213H23B020**	**JS2213H24A020**	**JS2213H24B020**
JT2312	JS2312	3/4	2.5	50	**JT2312H23A020**	**JT2312H23B020**	**JS2312H24A020**	**JS2312H24B020**
JT2313	JS2313	3/4	3.5	30	**JT2313H23A020**	**JT2313H23B020**	**JS2313H24A020**	**JS2313H24B020**
JT2417	JS2417	1	8.0	20	**JT2417H23A020**	**JT2417H23B020**	**JS2417H24A020**	**JS2417H24B020**
JT2517	JS2517	1-1/4	8.0	20	**JT2517H23A020**	**JT2517H23B020**	**JS2517H24A020**	**JS2517H24B020**

Electric Zone Valves – Two-Way Spring Open (Normally Open), On/Off Control (Continued)

J Series Electric Zone Valve – Two-Way Spring Open (Normally Open), On/Off Control (Part 2 of 2)

Valve Model Number					Actuator Model Number G Style Actuators have Standard Pressure Closeoff H Style Actuators have High Pressure Closeoff			
					Standard Temperature Rating: 200°F (93°C) Fluid, 104°F (40°C) Ambient		High Temperature Rating: 250°F (121°C) Fluid, 15 psig Steam, 169°F (76°C) Ambient	
Standard Temp	High Temp	Size, in.	Cv	Closeoff	24 VAC, 60 Hz	120 VAC, 60 Hz	24 VAC, 60 Hz	120 VAC, 60 Hz
					JG23A020 JH23A020	JG23B020 JH23B020	JG24A020 JH24A020	JG24B020 JH24B020
NPT Connections – High Pressure Closeoff								
JT2221	JT2221	1/2	1.0	75	**JT2221H23A020**	**JT2221H23B020**	**JS2221H24A020**	**JS2221H24B020**
JT2222	JT2222	1/2	2.5	50	**JT2222H23A020**	**JT2222H23B020**	**JS2222H24A020**	**JS2222H24B020**
JT2223	JT2223	1/2	3.5	30	**JT2223H23A020**	**JT2223H23B020**	**JS2223H24A020**	**JS2223H24B020**
JT2322	JT2322	3/4	2.5	50	**JT2322H23A020**	**JT2322H23B020**	**JS2322H24A020**	**JS2322H24B020**
JT2323	JT2323	3/4	3.5	30	**JT2323H23A020**	**JT2323H23B020**	**JS2323H24A020**	**JS2323H24B020**
JT2427	JT2427	1	8.0	20	**JT2427H23A020**	**JT2427H23B020**	**JS2427H24A020**	**JS2427H24B020**
Inverted Flare Connections – High Pressure Closeoff								
JT2343	JS2343	3/4	3.5	30	**JT2343H23A020**	**JT2343H23B020**	**JS2343H24A020**	**JS2343H24B020**

Inverted Flare Fittings (Order Separately)

Code Number	Description	Length, in. (mm)
J647-601	For 1/2 in. (5/8 in. O.D.) Copper Tubing	15/16 (24)
J647-602	For 1/2 in. (5/8 in. O.D.) Copper Tubing	1-11/16 (43)
J647-603	For 1/2 in. (5/8 in. O.D.) Copper Tubing	3 (76)
J647-604	For 3/4 in. (7/8 in. O.D.) Copper Tubing	1-27/32 (47)
J647-605	For 1/2 in. (5/8 in. O.D.) Copper Tubing	1-15/16 (49)
J647-606	For 1 in. (1-1/8 in. O.D.) Copper Tubing	2-3/8 (60)

Inverted Flare Fittings

Repair Information

If the J Series Electric Zone Valve – Two-Way Spring Closed (Normally Closed), On/Off Control fails to operate within its specifications, refer to the *J Series Electric Zone Valves Product Bulletin (LIT-977282)* for a list of repair parts available. Available repair parts for J Series Electric Zone Valves include replacement valve bodies, replacement actuators, and the end connections listed in the Inverted Flare Fittings. No other field repairs should be attempted.

Technical Specifications

J Series Electric Zone Valves – Two-Way Spring Closed (Normally Closed), On/Off Controls			
Service[1]			Hot Water Chill Water, and 50/50 Glycol Solutions for HVAC Systems
Fluid Temperature Limits	**Water**	**JT Series**	32 to 200°F (0 to 93°C)
		JS Series	32 to 250°F (0 to 121°C)
	Steam	**JT Series**	Not rated for steam service
		JS Series	15 psig (103 kPa) Saturated Steam
Valve Body Pressure Rating			300 psig (2,067 kPa)
Leakage			Bubble tight shut off
Ambient Operating Temperature Limits		**JT Series**	32 to 104°F (0 to 40°C)
		JS Series	32 to 169°F (0 to 76°C)
Cycle Time			Power stroke 9 to 11 seconds, spring return 4 to 5 seconds
Control Signal			24 VAC or 120 VAC, 60 Hz, Two-wire On/Off
Power Requirements			7 VA
Electrical Connection			18 in. (457 mm) wire leads
Materials	**Body**		Brass
	Stem		Brass (Hard Chrome Plated)
	Base Plate and Bearing Plate		Stainless Steel
	Actuator Housing		Stainless Steel
	Actuator Cover		Aluminum
	Valve Paddle	**JT Series**	Buna-N Rubber
		JS Series	Saturated Nitrile
	Stem Seals		Viton® O-rings

1. Refer to VDI 2035 Standard for recommended proper water treatment.

HVAC CONTROL PRODUCTS – NORTH AMERICA

Direct mount actuators selection guide summary

Johnson Controls

Non-Spring Return Actuator Product Range

		Rotation Time 90°	Power Requirements			Power Consumption		Input Signal					Position Feedback				Auxiliary Switches	Electrical Connection				
		Power On - Running (seconds)	24 VAC +25%/-20%, Class 2, SELV	24 VAC +25%/-15%, Class 2, SELV	24 VAC +25%/-15%, VDC +/- 10%	VA Rating, Transformer Sizing	VA: Running (Holding)	Floating Point without Timeout	On/Off and Floating Point	Resistive 100 to 10,000 Ω	0(2) to 10 VDC 0(4) to 20 mA (w/500Ω Resistor)	Adjustable Start and Span: Start: 0 to 10 VDC, Span 2 to 10 VDC	Resistive 135 Ω Potentiometer	Resistive 1,000 Ω Potentiometer	Resistive 10,000 Ω Potentiometer	0(2) to 10 VDC	2 SPDT, 3.0 A (1.5 A Inductive) @ 24 VAC	48 in. (1.2 m) 19 AWG Plenum Cable	Screw Terminals	¼" Spade Terminals	¼" Spade Terminals w/Pluggable Terminal. Block	½" conduit connectors
 **M9102 Series** 18 in-lb (2) Nm and **M9104 Series** 35 in-lb (4) Nm	M9102-AGA-2S	30	■			2.1	2.1 (0)	■										■				
	M9102-AGA-3S	30	■			2.1	2.1 (0)	■											■			
	M9102-IGA-2S	30	■			2.6	2.6 (0.4)		■									■				
	M9102-IGA-3S	30	■			2.6	2.6 (0.4)		■										■			
	M9104-AGA-2S	60	■			2.1	2.1 (0)	■										■				
	M9104-AGA-3S	60	■			2.1	2.1 (0)	■											■			
	M9104-IGA-2S	60	■			3.0	3.0 (0.4)		■									■				
	M9104-IGA-3S	60	■			3.0	3.0 (0.4)		■										■			
	M9104-GGA-2S	60	■			3.6	3.6 (1.0)				■					■		■				
	M9104-GGA-3S	60	■			3.6	3.6 (1.0)				■								■			
 **M9104-AGx-2N0x Series** 35 in-lb (6 Nm) and **M9106-AGx-2N0x Series** **VAV Systems** 53 in-lb (6 Nm)	M9104-AGA-2N	90		■		2.1	2.1 (0)	■											■			
	M9104-AGS-2N*	90		■		2.1	2.1 (0)	■											■			
	M9106-AGA-2N01	60		■		2.5	2.5 (0)	■											■			
	M9106-AGA-2N02	120		■		2.1	2.1 (0)	■											■			
	M9106-AGS-2N02* * Includes DPT-2015 Differential Pressure Transmitter and CBL-2000-1 Wire Harness	120		■		2.1	2.1 (0)	■											■			
 **M9106 Series** 53 in-lb (6 Nm)	M9106-AGA-2	60		■		2.5	2.5 (0)	■												■		■
	M9106-AGC-2	60		■		2.5	2.5 (0)	■									■			■		■
	M9106-AGF-2	60		■		2.5	2.5 (0)	■							■					■		■
	M9106-IGA-2	60▲		■		2.8	2.8 (0.5)		■											■		■
	M9106-IGC-2	60▲		■		2.8	2.8 (0.5)		■								■			■		■
	M9106-GGA-2	60		■		3.2	3.2 (0.5)				■					■				■		■
	M9106-GGC-2	60		■		3.2	3.2 (0.5)				■					■	■			■		■
 **M9109 Series** 80 in-lb (9 Nm)	M9109-AGA-2	60		■		2.5	2.5 (0)	■												■		■
	M9109-AGC-2	60		■		2.5	2.5 (0)	■									■			■		■
	M9109-GGA-2	60		■		3.2	3.2 (0.5)				■					■				■		■
	M9109-GGC-2	60		■		3.2	3.2 (0.5)				■					■	■			■		■

▲ Factory Set for 60 seconds, User selectable for 90, 120, 330, and 660 seconds.

Non-Spring Return Actuator Product Range

(continued)

		Rotation Time 90°	Power Requirements			Power Consumption		Input Signal					Position Feedback				Auxiliary Switches	Electrical Connection				
		Power On – Running (seconds)	24 VAC +25%/-20%, Class 2, SELV	24 VAC +25%/-15%, Class 2, SELV	24 VAC +25%/-15%, VDC +/- 10%	VA Rating, Transformer Sizing	VA: Running (Holding)	Floating Point without Timeout	On/Off and Floating Point	Resistive 100 to 10,000 Ω	0(2) to 10 VDC 0(4) to 20 mA (w/500Ω Resistor)	Adjustable Start and Span: Start: 0 to 10 VDC, Span 2 to 10 VDC	Resistive 135 Ω Potentiometer	Resistive 1,000 Ω Potentiometer	Resistive 10,000 Ω Potentiometer	0(2) to 10 VDC	2 SPDT, 3.0 A (1.5 A Inductive) @ 24 VAC	48 in. (1.2 m) 19 AWG Plenum Cable	Screw Terminals	¼″ Spade Terminals	¼″ Spade Terminals w/Pluggable Terminal. Block	½″ conduit connectors
 **M9108 Series** 70 in-lb (8 Nm)	M9108-AGA-2	25 to 50			■	6.5	6.5 (0.9)		■										■			■
	M9108-AGC-2	25 to 50			■	6.5	6.5 (0.9)		■								■		■			■
	M9108-AGD-2	25 to 50			■	6.5	6.5 (0.9)		■				■						■			■
	M9108-AGE-2	25 to 50			■	6.5	6.5 (0.9)		■					■					■			■
	M9108-GGA-2	25 to 50			■	7.1	7.1 (1.5)				■					■			■			■
	M9108-GGC-2	25 to 50			■	7.1	7.1 (1.5)				■					■	■		■			■
	M9108-HGA-2	25 to 50			■	7.4	7.4 (1.8)					■				■			■			■
	M9108-HGC-2	25 to 50			■	7.4	7.4 (1.8)					■				■	■		■			■
	M9108-JGA-2	25 to 50			■	7.1	7.1 (1.5)			■						■			■			■
	M9108-JGC-2	25 to 50			■	7.1	7.1 (1.5)			■						■	■		■			■
 **M9116 Series** 140 in-lb (16 Nm)	M9116-AGA-2	70 to 115			■	5.8	5.8 (0.9)		■										■			■
	M9116-AGC-2	70 to 115			■	5.8	5.8 (0.9)		■								■		■			■
	M9116-AGD-2	70 to 115			■	5.8	5.8 (0.9)		■				■						■			■
	M9116-AGE-2	70 to 115			■	5.8	5.8 (0.9)		■					■					■			■
	M9116-GGA-2	70 to 115			■	6.4	6.4 (1.5)				■					■			■			■
	M9116-GGC-2	70 to 115			■	6.4	6.4 (1.5)				■					■	■		■			■
	M9116-HGA-2	70 to 115			■	6.7	6.7 (1.8)					■				■			■			■
	M9116-HGC-2	70 to 115			■	6.7	6.7 (1.8)					■				■	■		■			■
	M9116-JGA-2	70 to 115			■	6.4	6.4 (1.5)			■						■			■			■
	M9116-JGC-2	70 to 115			■	6.4	6.4 (1.5)			■						■	■		■			■
 **M9124 Series** 210 in-lb (24 Nm)	M9124-AGA-2	115 to 175			■	5.9	5.9 (1.5)		■											■		■
	M9124-AGC-2	115 to 175			■	5.9	5.9 (1.5)		■								■			■		■
	M9124-AGD-2	115 to 175			■	5.9	5.9 (1.5)		■				■							■		■
	M9124-AGE-2	115 to 175			■	5.9	5.9 (1.5)		■					■						■		■
	M9124-GGA-2	115 to 175			■	5.9	5.9 (1.5)				■					■			■			■
	M9124-GGC-2	115 to 175			■	5.9	5.9 (1.5)				■					■	■		■			■
	M9124-HGA-2	115 to 175			■	6.2	6.2 (1.8)					■				■			■			■
	M9124-HGC-2	115 to 175			■	6.2	6.2 (1.8)					■				■	■		■			■
	M9124-JGA-2	115 to 175			■	5.9	5.9 (1.5)			■						■			■			■
	M9124-JGC-2	115 to 175			■	5.9	5.9 (1.5)			■						■	■		■			■
 **M9132 Series** 280 in-lb (32 Nm)	M9132-AGA-2	115 to 205			■	6.5	6.5 (1.5)		■											■		■
	M9132-AGC-2	115 to 205			■	6.5	6.5 (1.5)		■								■			■		■
	M9132-AGE-2	115 to 205			■	6.5	6.5 (1.5)		■					■						■		■
	M9132-GGA-2	115 to 205			■	6.5	6.5 (1.5)				■					■			■			■
	M9132-GGC-2	115 to 205			■	6.5	6.5 (1.5)				■					■	■		■			■

Spring Return Actuator Product Range

		Rotation Time for 90°		Power Requirements					Power Consumption			Input Signal				Position Feedback	Auxiliary Switches		Electrical Connection			
		Power On – Running (seconds)	Power Off – Spring Return (seconds)	24 VAC +/- 25%, VDC +/- 10%	24 VAC +/- 20%, VDC +/- 10%	120 VAC +10%/-15% at 60 Hz	198 to 264 VAC at 50/60 Hz	85 to 264 VAC at 50/60 Hz	VA Rating, Transformer Sizing	VA: Running (Holding)	Amperage: Running (Holding)	On/Off	On/Off and Floating Point	0(2) to 10 VDC 0(4) to 20 mA (w/500Ω Resistor)	Adjustable Start and Span: Start: 0 to 10 VDC, Span 2 to 10 VDC	0(2) to 10 VDC	1 SPDT, 5.0 A (2.9 A Inductive) @ 240V	2 SPDT, 5.0 A (2.9 A Inductive) @ 240V	48 in. (1.2 m) 18 AWG Appliance Cable	120 in. (3.05 m) 19 AWG Plenum Cable	½" conduit connectors	Integral 3/8" FMC Connectors
 **M9203 Series** 27 in-lb (3 Nm)	M9203-AGA-2	150	<25		■				6	4.7 (2.7)			■							■	■	
	M9203-AGB-2	150	<25		■				6	4.7 (2.7)			■				■		■		■	
	M9203-AGA-2Z	90	<25		■				6	5.1 (2.8)			■							■	■	
	M9203-AGB-2Z	90	<25		■				6	5.1 (2.8)			■				■		■		■	
	M9203-BGA-2	<75	<25		■				6	5.0 (2.5)		■							■		■	
	M9203-BGB-2	<75	<25		■				6	5.0 (2.5)		■					■		■		■	
	M9203-BUA-2	<75	<25					■			.06 (.02)	■							■		■	
	M9203-BUB-2	<75	<25					■			.06 (.02)	■					■		■		■	
	M9203-BUA-2Z	<30	<25					■			.08 (.02)	■							■		■	
	M9203-BUB-2Z	<30	<25					■			.08 (.02)	■					■		■		■	
	M9203-GGA-2	150	<25		■				6	4.7 (2.7)				■		■				■	■	
	M9203-GGB-2	150	<25		■				6	4.7 (2.7)				■		■	■		■		■	
	M9203-GGA-2Z	90	<25		■				6	5.1 (2.8)				■		■				■	■	
	M9203-GGB-2Z	90	<25		■				6	5.1 (2.8)				■		■	■		■		■	
 **M9208 Series** 70 in-lb (8 Nm)	M9208-AGA-2	150	18 to 24▲		■				8	7.9 (5.5)			■							■		■
	M9208-AGA-3	150	18 to 24▲		■				8	7.9 (5.5)			■						■			■
	M9208-AGC-3	150	18 to 24▲		■				8	7.9 (5.5)			■					■	■			■
	M9208-BGA-3	<75	13 to 26†	■					7	6.1 (1.2)		■							■			■
	M9208-BGC-3	<75	13 to 26†	■					7	6.1 (1.2)		■						■	■			■
	M9208-BAA-3	<75	13 to 26†			■					.05 (.03)	■							■			■
	M9208-BAC-3	<75	13 to 26†			■					.05 (.03)	■						■	■			■
	M9208-BDA-3	<75	13 to 26†				■				.04 (.03)	■							■			■
	M9208-BDC-3	<75	13 to 26†				■				.04 (.03)	■						■	■			■
	M9208-GGA-2	150	18 to 24▲		■				8	7.9 (5.5)				■		■				■		■
	M9208-GGA-3	150	18 to 24▲		■				8	7.9 (5.5)				■		■			■			■
	M9208-GGC-3	150	18 to 24▲		■				8	7.9 (5.5)				■		■		■	■			■
 **M9210 Series** 89 in-lb (10 Nm)	M9210-AGA-3	150	26		■				15	9.6 (6.0)			■						■			■
	M9210-AGC-3	150	26		■				15	9.6 (6.0)			■					■	■			■
	M9210-BGA-3	24 to 57	11 to 15 ‡		■				25	17.7 (5.1)		■							■			■
	M9210-BGC-3	24 to 57	11 to 15 ‡		■				25	17.7 (5.1)		■						■	■			■
	M9210-BAA-3	24 to 57	11 to 15 ‡			■			25		.25 (.13)	■							■			■
	M9210-BAC-3	24 to 57	11 to 15 ‡			■			25		.25 (.13)	■						■	■			■
	M9210-BDA-3	24 to 57	11 to 15 ‡				■		25		.15 (.09)	■							■			■
	M9210-BDC-3	24 to 57	11 to 15 ‡				■		25		.15 (.09)	■						■	■			■
	M9210-GGA-3	150	26		■				15	9.6 (6.0)				■		■			■			■
	M9210-GGC-3	150	26		■				15	9.6 (6.0)				■		■		■	■			■
	M9210-HGA-3	150	26		■				15	9.6 (6.0)					■	■			■			■
	M9210-HGC-3	150	26		■				15	9.6 (6.0)					■	■		■	■			■
 **M9220 Series** 177 in-lb (20 Nm)	M9220-AGA-3	150	20		■				20	15.5 (7.7)			■						■			■
	M9220-AGC-3	150	20		■				20	15.5 (7.7)			■					■	■			■
	M9220-BGA-3	24 to 57	11 to 15 ‡		■				25	24.6 (7.7)		■							■			■
	M9220-BGC-3	24 to 57	11 to 15 ‡		■				25	24.6 (7.7)		■						■	■			■
	M9220-BAA-3	24 to 57	11 to 15 ‡			■			25		.25 (.13)	■							■			■
	M9220-BAC-3	24 to 57	11 to 15 ‡			■			25		.25 (.13)	■						■	■			■
	M9220-BDA-3	24 to 57	11 to 15 ‡				■		25		.15 (.09)	■							■			■
	M9220-BDC-3	24 to 57	11 to 15 ‡				■		25		.15 (.09)	■						■	■			■
	M9220-GGA-3	150	20		■				20	15.5 (7.7)				■		■			■			■
	M9220-GGC-3	150	20		■				20	15.5 (7.7)				■		■		■	■			■
	M9220-HGA-3	150	20		■				20	15.5 (7.7)					■	■			■			■
	M9220-HGC-3	150	20		■				20	15.5 (7.7)					■	■		■	■			■

▲ 22 seconds nominal @ room temp. and rated load, 94 seconds max. @ rated load and -40°F (-40°C)

† 21 seconds nominal @ room temp. and rated load, 39 seconds max. @ rated load and -4°F (-20°C), 108 seconds max. @ 53 lb·in. (6 Nm) and -40°F (-40°C).

‡ 13 seconds nominal @ room temp. and rated load, 35 seconds max. @ rated load and -22°F (-30°C), 130 seconds max. @ rated load and -40°F (-40°C).

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Appendix for ECM 3: Integrated and New Energy Management Systems

III. Points List

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MAPC - Sudbury
Loring Elementary

			Hardware																	
			Outputs								Inputs									
			Digital				Analog				Digital						Analog			
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Integrate Existing DDC EMS																					
Facility Explorer FX60 Integration																					
Outside Air Conditions	1	1															1				
Hot Water Boiler		2																			
Stage-1 Enable/Disable	2	2	2																		
Stage-2 Enable/Disable	2	2	2																		
Status	2	2									2										
Combustion Air	1	1								1											
Differential Pressure	1	1																	1		
Hot Water Supply Temp.	1	1															1				
Heating Hot Water Circulation Pump		2																			
Enable/Disable	2	2	2																		
Status	2	2									2										
VFD	1	1							1												
RTU-1		1																			
Supply Start/Stop	1	1	1																		
Supply Fan Status	1	1									1										
Return Fan Start/Stop	1	1	1																		
Return Fan Status	1	1									1										
Space Temperature	1	1															1				
Outside Air Temperature	1	1															1				
Supply Air Temperature	1	1															1				
Mixed Air Temperature	1	1															1				

			Hardware																		
			Outputs								Inputs										
			Digital				Analog				Digital						Analog				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Return Air Temperature	1	1															1				
Static Pressure	1	1																	1		
Heating Control Valve	1	1								1											
4-Stage Cooling	4	4	4																		
Smoke Detector	1	1	1																		
O.A.Damper	1	1								1											
RTU-2 & 3 Gym, RTU-6 Café		3																			
Start/Stop	3	3	3																		
Status	3	3									3										
Space Temperature	3	3															3				
Supply Air Temperature	3	3															3				
Mixed Air Temperature	3	3															3				
Return Air Temperature	3	3															3				
Air Quality	3	3																			3
Heating Control Valve	3	3								3											
Smoke Detector	3	3	3																		
Dampers	3	3								3											
RTU-5 Kitchen, RTU-4, 7 & 8 Classrms		4																			
Start/Stop	4	4	4																		
Status	4	4									4										
Space Temperature	4	4															4				
Supply Air Temperature	4	4															4				
Mixed Air Temperature	4	4															4				
Outside Air Temperature	4	4															4				
Heating Control Valve	4	4								4											
Damper	4	4								4											

			Hardware																	
			Outputs								**Inputs**									
			Digital				**Analog**				**Digital**						**Analog**			
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Exhaust Fan		14																			
Start/Stop	14	14	14																		
Status	14	14									14										
VAV Boxes		11																			
Fan Start/Stop	11	11	11																		
Status	11	11									11										
Space Temperature	11	11															11				
Damper	11	11								11											
Heating Control Valve	11	11								11											
Differential Pressure	11	11																	11		
Classroom Convectors		59																			
Space Temperature	59	59															59				
Heating Control Valve	59	59								59											
Totals	**306**	**402**	**48**	**0**	**0**	**0**	**0**	**0**	**1**	**98**	**38**	**0**	**0**	**0**	**0**	**0**	**105**	**0**	**13**	**0**	**3**

			Hardware																		
			Outputs								**Inputs**										
			Digital				**Analog**				**Digital**						**Analog**				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Integrate Existing DDC EMS																					
Facility Explorer FX60 Integration																					
Outside Air Conditions	1	1															1				
Hot Water Boiler		3																			
Enable/Disable	3	3	3																		
Status	3	3									3										
Hot Water System Differential Pressure	1	1																	1		
Hot Water Supply Temp.	1	1															1				
Hot Water Return Temp.	1	1															1				
Boiler Return Hot Water Pump		3																			
Enable/Disable	3	3	3																		
Status	3	3									3										
Heating Hot Water Circulation Pump		4																			
Enable/Disable	4	4	4																		
Status	4	4									4										
MAU-1		1																			
Start/Stop	1	1	1																		
Status	1	1									1										
Space Temperature	1	1															1				
Outside Air Temperature	1	1															1				
Supply Air Temperature	1	1															1				
Supply Air Temperature	1	1															1				

			Hardware																		
			Outputs								**Inputs**										
			Digital				**Analog**				**Digital**						**Analog**				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Heating Control Valve	1	1								1											
Freezestat	1	1	1																		
O.A.Damper	1	1								1											
AHU-1 Admin, AHU-2 Library		2																			
Start/Stop	2	2	2																		
Status	2	2									2										
Outside Air Temperature	2	2															2				
Static Pressure	2	2																	2		
Supply Air Temperature	2	2															2				
Cooling (2-Stage DX)	4	4	4																		
Freezestat	2	2	2																		
Economizer Damper	2	2								2											
Bypass Damper	2	2								2											
AHU-3, AHU-4, AHU-5		3																			
Start/Stop	3	3	3																		
Status	3	3									3										
Space Temperature	3	3															3				
Outside Air Temperature	3	3															3				
Supply Air Temperature	3	3															3				
Space CO2	3	3														3					
Supply Air Temperature	3	3															3				
Heating Control Valve	3	3								3											
Freezestat	3	3	3																		
Economizer Damper	3	3								3											
Bypass Damper	3	3								3											

			Hardware																			
			Outputs								**Inputs**											
			Digital				**Analog**				**Digital**						**Analog**					
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
RTU-1, RTU-2		2																			
Start/Stop	2	2	2																		
Status	2	2									2										
Space Temperature	2	2															2				
Static Pressure	2	2																	2		
Supply Air Temperature	2	2															2				
Cooling (1-Stage DX)	2	2	2																		
Freezestat	2	2	2																		
Bypass Damper	2	2								2											
Exhaust Fan		16																			
Start/Stop	16	16	16																		
Status	16	16									16										
Domestic Hot Water Heater		1																			
Enable/Disable	1	1	1																		
Status	1	1									1										
Unit Ventilators (2000 Renovation)		37																			
Start/Stop	37	37		37																	
Status	37	37									37										
Space Temperature	37	37															37				
Discharge Air Temperature	37	37															37				
Space CO2	37	37														37					
Face-and-bypass Damper	37	37								37											
Outside Air Damper	37	37								37											
Heating Control Valve	37	37								37											

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			Hardware																		
			Outputs								Inputs										
			Digital				Analog				Digital						Analog				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Fan Powered VAV Boxes		6																			
Start/Stop	6	6		6																	
Status	6	6									6										
Space Temperature	6	6															6				
Air Volume	6	6																		6	
Damper	6	6								6											
Re-heat Control Valve	6	6								6											
VAV Boxes		5																			
Space Temperature	5	5															5				
Air Volume	5	5																		5	
Damper	5	5								5											
Re-heat Control Valve	5	5								5											
FCUs (SPED, Admin Corr, Main Lobby)		4																			
Start/Stop	4	4		4																	
Status	4	4									4										
Space Temperature	4	4															4				
Radiators (Convectors)		9																			
Space Temperature	9	9															9				
Heating Control Valve	9	9								9											
Totals	**518**	**614**	**49**	**47**	**0**	**0**	**0**	**0**	**0**	**159**	**82**	**0**	**0**	**0**	**0**	**40**	**125**	**0**	**5**	**11**	**0**

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			Hardware																		
			Outputs								**Inputs**										
			Digital				**Analog**				**Digital**						**Analog**				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Integrate Existing DDC EMS																					
Honeywell Controls XL15 Integration																					
Outside Air Conditions	1	1															1				
Hydrotherm Modular Boilers (3-stage)		3																			
Enable/Disable	3	3	3																		
Status	3	3									3										
Hot Water Supply Temp.	1	1															1				
System Differential Pressure	1	1																	1		
Heating Hot Water Circulation Pump		2																			
Enable/Disable	2	2	2																		
Status	2	2									2										
Variable Frequency Drive	1	1								1											
Honeywell Excel 10 W7750C Controller (LonWorks)																					
Air Handling Unit (HV-1 Library)		1																			
Start/Stop	1	1	1																		
Status	1	1									1										
Space Temperature	1	1															1				
Supply Air Temperature	1	1															1				
Heating Control Valve	1	1								1											
Cooling (DX)	1	1	1																		
Smoke Monitor	1	1									1										
Economizer Damper	1	1								1											
Economizer Enable (OA)	1	1															1				
Humidity (OA)	1	1																1			

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Base Bid

			Hardware																		
			Outputs								Inputs										
			Digital				Analog				Digital						Analog				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Honeywell XL15C Controller (LonWorks)																					
Air Handling Unit (HV-2,3 Cafe)		2																			
Start/Stop	2	2	2																		
Status	2	2									2										
Space Temperature	2	2															2				
Supply Air Temperature	2	2															2				
Heating Control Valve	2	2								2											
Smoke Monitor	2	2									2										
Economizer Damper	2	2								2											
Economizer Enable (OA)	2	2															2				
Humidity (OA)	2	2																2			
Honeywell Excel 10 W7750C Controller (LonWorks)																					
Air Handling Unit (HV-4 Gym)		1																			
Start/Stop	1	1	1																		
Status	1	1									1										
Space Temperature	1	1															1				
Supply Air Temperature	1	1															1				
Heating Control Valve	1	1								1											
Economizer Damper	1	1								1											
Economizer Enable (OA)	1	1															1				
Honeywell W7750B Controller																					
Air Handling Unit (AC-2 Computer Rm)		1																			
Start/Stop	1	1	1																		
Status	1	1									1										
Space Temperature	1	1															1				

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Base Bid

			Hardware																		
			Outputs								Inputs										
			Digital				Analog				Digital						Analog				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Supply Air Temperature	1	1															1				
Heating Control Valve	1	1								1											
Cooling (DX)	1	1	1																		
Smoke Monitor	1	1									1										
Honeywell Excel 10 W7750C Controller (LonWorks)																					
Air Conditioning Unit (AC-3 Admin)		1																			
Start/Stop	1	1	1																		
Status	1	1									1										
Space Temperature	1	1															1				
Supply Air Temperature	1	1															1				
Cooling (DX)	1	1	1																		
Smoke Monitor	1	1									1										
Economizer Damper	1	1								1											
Economizer Enable (OA)	1	1															1				
Exhaust Fan Zone Control		4																			
On/Off	4	4	4																		
Unit Ventilator Zone Control		4																			
On/Off	4	4	4																		
Install New UV Controllers																					
Replace Micro Tech 325 Controller																					
Unit Ventilators (A,B,C Wings)		34																			
Start/Stop	34	34		34																	
Status	34	34									34										
Space Temperature	34	34															34				

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Base Bid

			Hardware																		
			Outputs								**Inputs**										
			Digital				**Analog**				**Digital**						**Analog**				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Supply Temperature	34	34															34				
Outside Air Damper	34	34								34											
Face and Bypass Damper	34	34								34											
Control New Hot Water Valves																					
Unit Ventilators (A,B,C Wings)		34																			
Heating Control Valve	34	34								34											
Integrate Existing DDC EMS	**72**	**91**	**22**	**0**	**0**	**0**	**0**	**0**	**0**	**11**	**16**	**0**	**0**	**0**	**0**	**0**	**19**	**3**	**1**	**0**	**0**
Install New UV Controllers	**204**	**238**	**0**	**34**	**0**	**0**	**0**	**0**	**0**	**68**	**34**	**0**	**0**	**0**	**0**	**0**	**68**	**0**	**0**	**0**	**0**
Control New Hot Water Valves	**34**	**68**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**34**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

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Base Bid

			Hardware																		
			Outputs								Inputs										
			Digital				Analog				Digital						Analog				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Integrate Existing DDC EMS																					
Facility Explorer FX60 Integration																					
Outside Air Conditions	1	1															1				
Pneumatic Day/Night Zone	2	2															2				
Hot Water Boiler		3																			
Enable/Disable	3	3	3																		
Status	3	3									3										
System Differential Pressure	1	1																	1		
Hot Water Supply Temp.	1	1															1				
Heating Hot Water Circulation Pump		2																			
Enable/Disable	2	2	2																		
Status	2	2									2										
VFD	2	2							2												
RTU-1 (Gym)		1																			
Start/Stop	1	1	1																		
Status	1	1									1										
Space Temperature	1	1															1				
Supply Air Temperature	1	1															1				
Heating Control Valve	1	1								1											
Freezestat	1	1	1																		
O.A.Damper	1	1								1											

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Base Bid

			Hardware																		
			Outputs								Inputs										
			Digital				Analog				Digital						Analog				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
RTU-2 (Library)		1																			
Start/Stop	1	1	1																		
Status	1	1									1										
Space Temperature (Library, Rotunda N+S)	3	3															3				
Supply Air Temperature	1	1															1				
Mixed Air Temperature	1	1															1				
Outside Air Temperature	1	1															1				
Static Pressure	1	1																	1		
Supply Fan VFD	1	1							1												
Heating Control Valve	3	3								3											
2-Stage Cooling	2	2	2																		
Freezestat	1	1	1																		
O.A. Damper	1	1								1											
Mixed Air Damper	1	1								1											
Exhaust Fan Control (RIB Relays)		9																			
On/Off	9	9	9																		
Unit Ventilator Control (RIB Relays)		10																			
On/Off	10	10	10																		
Install New UV Controllers																					
Replace pneumatic controls w/ new DDC																					
Unit Ventilator		37																			
Fan Start/Stop	37	37		37																	
Fan Status	37	37									37										
Space Temperature	37	37															37				
3/4" Heating Control Valve	37	37								37											

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Base Bid

			Hardware																		
			Outputs								Inputs										
			Digital				Analog				Digital						Analog				
Point Description	Total Points	Unit Multiplier	Relay	Contactor	Solenoid	0	P/E	E/P	Speed Reference	0-10V or 4-20 mA	Current Switch	Pressure	Dry Contact	Flame Fail	Flow switch	CO2 Sensor	Temperature	Humidity	Pressure	Flow Rate	CO2
Damper	37	37								37											
Install New FTR+CUH Control																					
Finned Tube Radiation		18																			
Space Temperature	18	18															18				
Heating Control Valve	18	18								18											
Cabinet Unit Heaters		8																			
Space Temperature	8	8															8				
Heating Control Valve	8	8								8											
Integrate Existing DDC EMS	**61**	**87**	**30**	**0**	**0**	**0**	**0**	**0**	**3**	**7**	**7**	**0**	**0**	**0**	**0**	**0**	**12**	**0**	**2**	**0**	**0**
Install New UV Controllers	**185**	**222**	**0**	**37**	**0**	**0**	**0**	**0**	**0**	**74**	**37**	**0**	**0**	**0**	**0**	**0**	**37**	**0**	**0**	**0**	**0**
Install New FTR+CUH Control	**52**	**78**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**26**	**0**	**0**	**0**	**0**	**0**	**0**	**26**	**0**	**0**	**0**	**0**

ECM 4:
Programmable Thermostats

ECM Overview

Ameresco proposes to install new local programmable thermostats at the DPW Highway Building to control the existing infrared heaters serving the garage bays. The new programmable thermostats will be installed in each of the three existing zones to monitor space temperature and provide control of the existing infrared heaters according to occupancy schedules and setpoint temperatures.

Figure 4.1: Ameresco proposes to replace the existing T87 thermostats at the DPW Highway Building with new programmable thermostats.

ECM Detail

Existing System

The DPW Highway Building consists of three large garages that are currently heated by eight gas-fired Vantage II infrared heaters that are mounted from the ceiling. The infrared heaters are each controlled by their own individual T87 style Honeywell thermostat. These thermostats provide basic occupied setpoint temperature control with no schedule or unoccupied setpoint temperature control.

Proposed System

Ameresco proposes to install (8) new local programmable thermostats to control the (8) existing infrared heaters serving the three garage bays. The new programmable thermostats will be installed on the walls near the locations of the existing thermostats. Existing control wiring will be reused where feasible.

Unoccupied Zone Temperature Reset

Ameresco proposes to fully implement unoccupied zone temperature reset. Zone temperature set points will be varied based on occupancy schedules. The following table lists the proposed set points. These set points are proposed for all unoccupied periods.

	Heating (ºF)
Unoccupied	50.0

Occupied Scheduling

Ameresco will initially setup the occupancy schedules in the programmable thermostats to reflect the major occupancy schedule of the building. The HVAC systems will only be operated when the building is supposed to be occupied. The table below lists the proposed time schedule. The vacation schedule will also be initially setup in the system to turn off equipment on vacation days. The Town will be responsible for updating the vacation and special days schedule to ensure the systems are not operating when the buildings are not occupied.

Building	Start time (Mon – Fri)	Stop time (Mon – Fri)	Weekends/ Holidays	Period
DPW Highway	6:30am	3:30pm	Off	Year-round

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect "As-Built" conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The installation of programmable thermostats will reduce energy use by automatically lowering the setpoint temperature during unoccupied periods and thus reducing the amount of time the infrared heaters are operating during those periods.

Appendix for ECM 4: Programmable Thermostats

I. Energy Savings Calculations

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Energy and Demand Savings Summary

Measure ID: **4**

Measure Name: **Programmable Thermostats**

Measure Location:

Engineers:

Site Name:		**DPW_Old**	**Summary**
Item	Units	Savings	
Electricity			
Energy On-Peak	kWh		0
Energy Off-Peak	kWh	637	637
Energy Total	kWh	637	637
Demand On-Peak, Monthly	kW		0.0
Demand On-Peak, Annual	kW		0.0
Demand Off-Peak, Monthly	kW		0.0
Demand Off-Peak, Annual	kW		0.0
Fossil Fuel			0
Natural Gas (NG)	Therms	1,400	1,400
Liquid Propane Gas (LPG)	Gallons	0	0
Steam	Mlbs	0	0
Fuel Oil, #2	Gallons	0	0
Fuel Oil, #4	Gallons	0	0
Fuel Oil, #6	Gallons	0	0
Miscellaneous	Misc	0	0
Water			0
Water Savings	kGallons		0
Sewer			0
Sewer Savings	kGallons		0

MAPC - Sudbury
DPW Highway
Programmable Thermostats

TMY-2 Weather Data for Worcester, MA								Existing Occupancy Schedule				Existing Heating/Cooling Schedule				Existing Motor Operating Schedule				Existing				Proposed								Savings		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Cooling Energy Savings (MMBTU)	HVAC Electrical Savings (kWh)	Heating Energy Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**
Cooling																																		
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	67	0	0	0	0	0	0	67	51	0	0	0	0	
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	60	0	0	0	0	0	0	60	46	0	0	0	0	
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	54	54	0	0	0	0	0	1	54	41	0	0	0	0	
90 to 95	92.5	69.8	34.2	0	8	0	8	2	0	0	6	2	0	0	6	2	0	0	6	47	47	0	0	2	0	0	6	47	36	0	0	0	0	
85 to 90	87.5	70.3	34.6	1	37	6	44	12	1	0	31	12	0	0	31	12	0	0	31	40	40	0	0	12	1	0	31	40	31	0	0	0	0	
80 to 85	82.5	68.4	33.0	8	138	29	175	47	3	0	125	49	0	0	125	49	0	0	125	34	34	1	1	47	3	0	125	34	26	0	1	0	0	
75 to 80	77.5	66.2	31.2	27	202	83	312	84	5	0	223	88	1	0	223	88	1	0	223	27	27	1	2	84	5	0	223	27	21	1	1	0	0	
70 to 75	72.5	64.3	29.7	64	269	160	493	132	9	0	352	139	1	0	352	139	1	0	352	20	20	1	2	132	9	0	352	20	15	1	2	1	0	
65 to 70	67.5	61.2	27.5	185	208	243	636	170	11	0	454	180	2	0	454	180	2	0	454	13	13	1	2	170	11	0	454	13	10	1	1	0	0	
60 to 65	62.5	57.3	24.8	315	249	298	862	231	15	0	616	244	2	0	616	244	2	0	616	7	7	1	1	231	15	0	616	7	5	0	1	0	0	
Heating																																		
55 to 60	57.5	52.7	0.0	303	245	276	824	221	14	0	589	233	2	0	589	233	2	0	589	(58)	(50)	6	33	221	14	0	589	(58)	(24)	6	14		0	18
50 to 55	52.5	47.8	0.0	262	184	228	674	181	12	0	482	191	2	0	482	191	2	0	482	(89)	(76)	11	42	181	12	0	482	(89)	(50)	11	27		0	15
45 to 50	47.5	42.5	0.0	204	230	211	645	173	11	0	461	182	2	0	461	182	2	0	461	(119)	(102)	17	55	173	11	0	461	(119)	(76)	17	40		0	14
40 to 45	42.5	38.3	0.0	210	191	234	635	170	11	0	454	180	2	0	454	180	2	0	454	(150)	(129)	23	68	170	11	0	454	(150)	(103)	23	54		0	14
35 to 40	37.5	33.8	0.0	321	301	286	908	243	16	0	649	257	2	0	649	257	2	0	649	(180)	(155)	41	117	243	16	0	649	(180)	(129)	41	97		0	20
30 to 35	32.5	28.7	0.0	356	221	313	890	238	16	0	636	252	2	0	636	252	2	0	636	(211)	(181)	49	135	238	16	0	636	(211)	(155)	49	115		0	20
25 to 30	27.5	23.5	0.0	228	211	211	650	174	11	0	464	184	2	0	464	184	2	0	464	(241)	(207)	42	113	174	11	0	464	(241)	(181)	42	98		0	15
20 to 25	22.5	19.1	0.0	104	94	124	322	86	6	0	230	91	1	0	230	91	1	0	230	(272)	(233)	24	63	86	6	0	230	(272)	(208)	24	56		0	7
15 to 20	17.5	14.3	0.0	144	78	117	339	91	6	0	242	96	1	0	242	96	1	0	242	(302)	(260)	28	74	91	6	0	242	(302)	(234)	28	66		0	8
10 to 15	12.5	9.3	0.0	118	40	85	243	65	4	0	174	69	1	0	174	69	1	0	174	(333)	(286)	23	59	65	4	0	174	(333)	(260)	23	53		0	6
5 to 10	7.5	5.0	0.0	52	10	15	77	21	1	0	55	22	0	0	55	22	0	0	55	(363)	(312)	8	20	21	1	0	55	(363)	(286)	8	19		0	2
0 to 5	2.5	2.2	0.0	18	3	1	22	6	0	0	16	6	0	0	16	6	0	0	16	(394)	(338)	2	6	6	0	0	16	(394)	(312)	2	6		0	1
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(424)	(364)	0	0	0	0	0	0	(424)	(339)	0	0		0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(455)	(391)	0	0	0	0	0	0	(455)	(365)	0	0		0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(485)	(417)	0	0	0	0	0	0	(485)	(391)	0	0		0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(516)	(443)	0	0	0	0	0	0	(516)	(417)	0	0		0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(546)	(469)	0	0	0	0	0	0	(546)	(443)	0	0		0	0
				2,920	2,920	2,920	8,760	2,346	154	0	6,260	2,477	23	0	6,260	2,477	23	0	6,260			278	794	2,346	154	0	6,260			278	652	2	0	140

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Existing Occupancy hours
M - P	Existing Heating/Cooling hours
Q - T	Existing Motor Operating Hours
U	Occupied Cooling and Heating loads (MBH)
V	Unoccupied Cooling and Heating loads (MBH)
W	Cooling = [col U] x ([col M] + [col O]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col M] + [col O]) x MIN([col U] + internal gains , 0) + IF([col I] + [col K] > [col M]+[col O] , (([col I] + [col K]) - ([col M] + [col O])) x MIN([col V] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
X	Cooling = [col R] x ([col J] + [col L]) ÷ 1,000 ÷ AD45
	Heating = -([col N] + [col P]) x MIN([col V] + internal gains , 0) + IF([col I] + [col K] < [col M] + [col O] , (([col M] + [col O]) - ([col I] + [col K])) x MIN([col U] + internal gains , 0)) ÷ 1,000 ÷ AD44
Y - AB	Proposed Operating hours
AC	Proposed Occupied Cooling and Heating Loads:
	Cooling = ([col B] - AC60) ÷ ([col B] - AC55) x [col U]
	Heating = ([col B] - AE60) ÷ ([col B] - AE55) x [col U]
AD	Proposed Unoccupied Cooling and Heating Loads:
	Cooling = ([col B] - AC61) ÷ ([col B] - AC56) x [col V]
	Heating = ([col B] - AE61) ÷ ([col B] - AE56) x [col V] ([col V] is modified to account for reduced kitchen and building ventilation due to EMS)
AE	Cooling = [col AC] x ([col Y] + [col AA]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col Y] + [col AA]) x MIN([col AC] + internal gains , 0) + IF([col I] + [col K] > [col Y]+[col AA] , (([col I] + [col K]) - ([col Y] + [col AA])) x MIN([col AD] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
AF	Cooling = [col AD] x ([col Z] + [col AB]) ÷ 1,000 ÷ AD45
	Heating = -([col Z] + [col AB]) x MIN([col AD] + internal gains , 0) + IF([col I] + [col K] < [col Y] + [col AA] , (([col Y] + [col AA]) - ([col I] + [col K])) x MIN([col AC] + internal gains , 0)) ÷ 1,000 ÷ AD44
AG	= ([col W] + [col X]) - ([col AE] + [col AF])
	HVAC Fan and Pump Savings
AH	Cooling =([col Q] + [col S] + ([col R] + [col T]) x AD49) x (AD46 + AD48) - ([col Y] + [col AA] + ([col Z] + [col AB]) x AD49) x (AD46 + AD48)
	Heating =([col Q] + [col S]) x AD46 + IF(B20<35,([col R] + [col T]) x AD49 x AD46, IF(B20>50,0,([col R] + [col T]) x AD49 x AD46)) - (([col Y] + [col AA]) x AD46 + IF(B20<35,([col Z] + [col AB]) x AD49 x AD46, IF(B20>50,0,([col Z] + [col AB]) x AD49 x AD46)))
AI	= ([col W] + [col X]) - ([col AE] + [col AF])

Assumptions:	Value	Unit	CELL REF	Description
Occupied Area	4,000	SF	**AD43**	
Existing Heating Plant Efficiency	86.0%		**AD44**	
Existing Chiller Efficiency	3.2	COP	**AD45**	
Fan Power	0.0	kW	**AD46**	
Heating Pump Power	0.0	kW	**AD47**	
Cooling Pump Power	0.0	kW	**AD48**	
UnOcc. Fan & Pump Cycling	10.0%		**AD49**	% Operating Hours During UnOcc.
UnOcc. Kitchen Vent. Reduction	0.0%		**AD50**	% CFM Saved
UnOcc. Ventilation Reduction	0.0%		**AD51**	% CFM Saved

Average Existing Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC55**	67.0	**AE55**	
UnOccupied	72.0	**AC56**	67.0	**AE56**	

Average Proposed Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC60**	67.0	**AE60**	
UnOccupied	78.0	**AC61**	62.1	**AE61**	

Appendix for ECM 4: Programmable Thermostats

II. Manufacturer Specification Sheets

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Robertshaw®

9725i2 DELUXE UNIVERSAL PROGRAMMABLE THERMOSTAT

G GAS E ELECTRIC O OIL H HEAT PUMP

Menu Driven Display
Universal Staging
up to 3 Heat / 2 Cool

Even More Homeowner Friendly™

Programming Made Even Easier

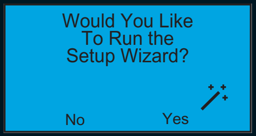
Do you want to spend less time installing and setting up thermostats?

The new 9725i2 makes installation even easier with our new Setup Wizard. The Setup Wizard allows you to spend 50% less time setting up the thermostat over competitive models. Plus everything is in plain language so there are no complicated codes or button combinations to memorize.

We've also made programming even easier for your customers. Menus are easier to navigate. We've even added additional convenience features such as Automated Time adjustment for Daylight Saving Time, along with new indoor air quality reminders.

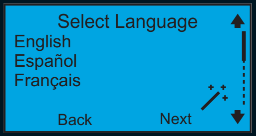
The new 9725i2 is so user friendly, it sets a higher standard in efficiency and simplicity for programmable thermostats. It is truly programming made even easier.

Features and Benefits



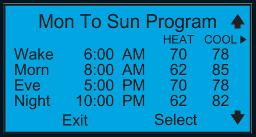
Would You Like
To Run the
Setup Wizard?
No Yes

Set-up Wizard **NEW**
Helps speed through the installation process with step-by-step setup and programming instructions.



Select Language
English
Español
Français
Back Next

Trilingual Display Option
Set to your customers' language of choice – English, Spanish or French

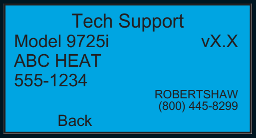


Mon To Sun Program

		HEAT	COOL
Wake	6:00 AM	70	78
Morn	8:00 AM	62	85
Eve	5:00 PM	70	78
Night	10:00 PM	62	82

Exit Select

Convenient Displays
View a full day of programming at once for quick review or easy adjustment.



Tech Support
Model 9725i vX.X
ABC HEAT
555-1234
ROBERTSHAW
(800) 445-8299
Back

Contractor ID Feature
Set it yourself or custom order with your information preloaded. Your name and phone number remind your customers when service is needed.

Daylight Saving Time Adjustment
Automatically adjusts to correct time regardless of seasonal changes.

Adjustable Backlighting **NEW**
Choose to have backlighting on at all times or only when programming. You can also adjust the brightness and contrast for improved readability.

Time of Day Zoning **NEW**
When coupled with a remote sensor (part #9020i), you can control the temperature in remote locations given different scheduled events.

Three Levels of Security **NEW**
Secure protection against unwanted changes to the programming menus, temperature or set-up functions with your own 4-digit PIN.

Auto Changeover
Automatically adjusts between heating and cooling cycles to maintain optimal comfort.

Worry-Free Memory Storage
Even during power outages, the thermostat maintains set point and programmed parameters.

Adjustable Temperature Offset
Change the displayed temperature from the actual sensed temperature.

Adjustable Temperature Differential
Maintains optimal customer comfort.

Intermittent Fan
Maintains optimal air filtration and circulation with minimal energy use.

24 VAC POWERED

ENERGY STAR

Five Year Warranty

Robertshaw®

9725i2 DELUXE UNIVERSAL PROGRAMMABLE THERMOSTAT

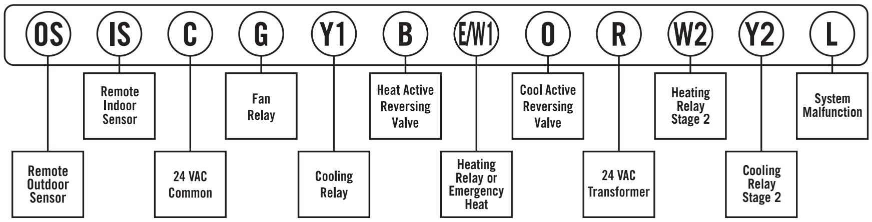
G GAS · **E** ELECTRIC · **O** OIL · **H** HEAT PUMP

THE ROBERTSHAW 9725i2 REPLACES:

White-Rodgers Co.*	1F92-71, 1F93-380, 1F94-71, 1F95-377
Honeywell, Inc.*	TH8320U1006
Carrier Corp.*	P274-1300, P274-2100, P374-1000, P374-1100, P474-1050

* Verify specific application requirements before substitution.

Terminal Designations



Optional Sensors:
9020i REMOTE INDOOR
9025i REMOTE OUTDOOR

Specifications

Electrical rating: 24 Volt AC (18-30 VAC)
1 amp maximum load per terminal (relay outputs)
3 amp total maximum load (all terminals combined)
Temperature control range: 45°- 90°F (7°- 32°C)
Accuracy: +/-1.0°F (+/-0.5°C)
Power Source: 24 VAC
Auto Changeover deadband: Selectable 2° to 8°F
Temporary temperature override: 3 hour maximum or next setpoint
Remote sensor capable: 1 indoor and 1 outdoor sensor
System configurations: Multi-stage gas, oil or electric heating/cooling systems
Terminations: R, E/W1, W2, Y1, Y2, B, O, G, C, IS, OS, L

Shipping Information

Indiv. Ctn. Dim.: 6.625" x 4.25" x 1.625"
Master Ctn. Qty.: 6
Master Ctn. Dim.: 9.25" x 5.625 x 7.5"
Master Ctn. Cu. Ft.: .23
Master Ctn. Wt.: 3.5 lbs.
Max. Pallet Qty.: 1260
Max. Pallet Wt.: 785 lbs.

Item 9020i and 9025i Remote Sensors

Indiv. Ctn. Dim.: 2.625" x 1.5625" x 4.4375"
Master Ctn. Qty.: 6
Master Ctn. Dim.: 5.625" x 5.125" x 5.125"
Master Ctn. Cu. Ft.: .09
Master Ctn. Wt.: .78 lbs.

Other Multi-Stage Heat / Cool Thermostats

9615: Programmable, 7 Day
9415: Non-Programmable

Patent Information

This product is covered by one or more of the following U.S. patents. Foreign patent rights may be pending. 4967382, 5803357, 6502758, 7000849, D301207, D462940

	Invensys i2-Series	Honeywell Vision Pro	Carrier Infinity	White-Rodgers 1F97-371
Menu Driven (Ease of Programming)	X			
Installation Wizard	X			
Displays Complete Program	X			
Adjustable Backlighting	X			
Cooling System Monitor	X			
Heating System Monitor	X			
Multi-Language	X			
1/2 Degree Resolution	X			
Time of Day Zoning	X			
Adjustable Timed Upstaging	X			
5/2 Program	X			X
24 Hour Programming	X			X
7-Day Programming	X	X	X	
Large Display	X	X	X	
Adjustable Timed Override/Hold	X	X		
Automatic Daylight Saving Time Adjustment	X	X		
Adjustable Temperature Limits	X	X		
High/Low Balance Points	X	X		
LED Status Indicators	X	X		
Adjustable Differential	X	X		
Adjustable Compressor Short Cycle Protection	X	X		
Adjustable Residual Cooling	X	X		
Fossil Fuel Kit required on HP units	No	No	Yes	Yes
Battery Free Memory Retention	X		X	
Manual Override	X	X	X	X
Resume	X	X	X	X
Auto Changeover	X	X	X	X
Gas/Electric	X	X	X	X
Single Stage Heat Pump Compatible	X	X	X	X
Line Powered	X	X	X	X
Programmable Fan	X	X	X	X
Intermittent Fan	X		X	
°F and °C	X	X	X	X
12 or 24 Hour	X	X		X
Air Filter Monitor	X	X	X	X
Humidifier Pad Monitor	X	X	X	
UV Light Monitor	X	X	X	
Vacation Setting	X	X	X	X
O & B Terminals	X	X	Partial	X
Events per day	2, 4, 6	4	4	2, 4
Remote Outdoor Sensor	X	Combo	X	X
Remote Indoor Sensor	X		X	X
Energy Efficient Recovery	X	X	X	X
Pre-set Program	X	X	X	X
Hidden Service Level	X	X	X	
Security Key Pad	X			X
Temperature Recalibration	X	X	X	
Customizable Contractor ID	X			Factory Only

invensys® **Controls Americas**
515 South Promenade Avenue
Corona California 92879-1736 USA
Telephone +1 800 951 5526 Facsimile +1 630 260 7299
Technical Service +1 800 445 8299
M-F 7:00 a.m. - 5:30 p.m. CST
www.about-i-series.com

ECM 5:
PC Load Management

ECM Overview

Ameresco proposes to install a client/server software application that will manage the power consumption of computers located throughout the Town of Sudbury buildings. Ameresco identified 149 personal computers (PCs) of various models located at a number of Town buildings. This software will save energy and money by reducing the time the computers spend in high power modes while not in use. These packages are easy-to-deploy software utilities that address network energy waste and reduce operating costs without impacting computer users. The applications manage and minimize the energy consumed by the network's clients through one centralized interface.

Figure 5.1: These are typical computers found at the DPW Offices and throughout the other Town buildings as well.

ECM Detail

Existing System

Most Town employees use personal computers for their daily work. Some of these computers are left on even when the user is not present. Ameresco used computer counts based on details provided by the Town's Technology Administrator as well as onsite walk through visits. All Town computers are windows based and the majority use LCD monitors.

Buildings	**No. of Computers**
DPW Highway	7
DPW Offices	19
Flynn Building	49
Town Hall	7
Fairbank Community Center	16
Public Library	42
Fire Dept HQ	7
Fire Dept South	1
Fire Dept North	1
Total	149

Proposed System

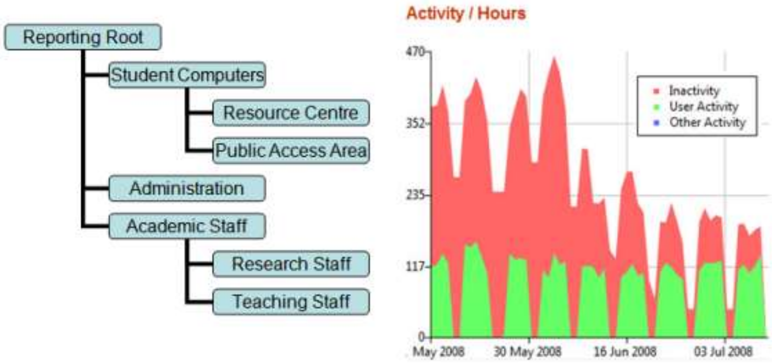


Figure 5.2: Example of Computer Usage Reporting available through PowerMAN software

Ameresco proposes to install a software utility that will allow measurement, management, and reduction of power usage of the Town's personal computers. This software will save energy consumed by computers during unoccupied periods. The software is fully configurable by Information Technology (IT) personnel and provides a means to schedule software updates as well as to reduce energy and power consumption. The software detects user presence by tracking inputs such as mouse movement or use of the keyboard. During unoccupied periods the software resets parameters to reduce lower power consumption after a period of time specified by the IT department.

Ameresco proposes to install Data Synergy's PowerMAN Power Management or equivalent software for this purpose. This software will save energy when the computer is not in use without affecting performance while the computer is in use. Computer energy management is a financial and environmental priority for organizations today. Unfortunately, most IT personnel find the basic power saving options that are included with their workstation operating system to be disruptive to user and IT productivity.

PowerMAN Power Management changes all this by providing system administrators with minimally disruptive computer power management. By delivering enterprise level control over computer power configurations, workstations can now be configured to shutdown, standby and hibernate based upon CPU, disk, and application activity. The application activity feature is particularly useful if you would like a system to remain powered on whenever a certain application is running. PowerMAN even has the ability to generate detailed reports outlining enterprise-wide energy consumption levels and associated cost savings.

Using PowerMAN, system administrators have the ability to assign their workstations into groups, employ flexible scheduling and configuration options, and generate savings reports that prove this measure's return-on-investment.

Intelligent Configuration Settings

- Definitions can be based on CPU, disk, keyboard, mouse and application activity
- Shutdown without the loss of user productivity

Flexible Scheduling

- Options to turn off the monitor, and standby, hibernate or shutdown the computer

- Schedule Wake-on-LAN, shutdown, or restart events
- Promotes user needs in tandem with energy conservation

Compatibility Options

- Customize the deployment as well as update and control the client workstations
- Localized in five languages: English, French, German, Spanish and Japanese

Customized Inactivity Definitions

- Employ energy saving actions when CPU or disk activity falls below a defined level
- Prevent the workstation from employing power saving actions when a particular application is running

Enterprise Control

- Provides unified workstation management capabilities
- Workstation grouping makes managing large deployments easy

Detailed workstation utilization reporting allows you to see how much power you are saving based upon your regional electricity cost.

In order to facilitate the installation of the software, the wake-on-LAN feature will need to be enabled on all of the computers. Ameresco has not included the labor to physically enable this feature on any disabled computers. The software will be installed on one of the existing servers and pushed out to all of the computers. Assistance by the IT staff during the installation is required for the pushing of the software into each computer. Ameresco will provide instructions and details to the IT staff for the installation of the software.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect “As-Built” conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The computer load management software will enhance facility operations by reducing electricity usage associated with computers during unoccupied periods.

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Appendix for ECM 5:
PC Load Management

I. Energy Savings Calculations

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MAPC - Sudbury

Energy and Demand Savings Summary

Measure ID: **5**
Measure Name: **PC Load Management**
Measure Location:
Engineers:

Site Name:		**DPW_Old**	**DPW_New**	**Flynn**	**Townhall**	**Fairbank**	**Library**	**FDHQ**	**Fire_S**	**Fire_N**	**Summary**
Item	Units	Savings	Savings	Savings	Savings	Savings	Savings	Savings	Savings	Savings	
Electricity											
Energy On-Peak	kWh	812	2,105	4,978	627	1,638	4,388	644	89	89	15,369
Energy Off-Peak	kWh										0
Energy Total	kWh	812	2,105	4,978	627	1,638	4,388	644	89	89	15,369
Demand On-Peak, Monthly	kW										0.0
Demand On-Peak, Annual	kW										0.0
Demand Off-Peak, Monthly	kW										0.0
Demand Off-Peak, Annual	kW										0.0
Fossil Fuel											0
Natural Gas (NG)	Therms	-13	-36	-74	-12	-26	-69	-11	-2	-2	-244
Liquid Propane Gas (LPG)	Gallons	0	0	0	0	0	0	0	0	0	0
Steam	Mlbs	0	0	0	0	0	0	0	0	0	0
Fuel Oil, #2	Gallons	0	0	0	0	0	0	0	0	0	0
Fuel Oil, #4	Gallons	0	0	0	0	0	0	0	0	0	0
Fuel Oil, #6	Gallons	0	0	0	0	0	0	0	0	0	0
Miscellaneous	Misc	0	0	0	0	0	0	0	0	0	0
Water											0
Water Savings	kGallons										0
Sewer											0
Sewer Savings	kGallons										0

MAPC - Sudbury

PC Load Management

						Existing					Proposed					Savings
Total Qty of PCs	**Building**	**PC type1**	**PC type2**	**CRT Monitor**	**LCD monitor**	**Existing Operating Hours**	**Overnight Standby Factor**	**Overnight Shutdown Factor**	**Overnight Operating Factor**	**Existing Power Consumption (kWh)**	**Proposed Operating Hours**	**Overnight Standby Factor**	**Overnight Shutdown Factor**	**Overnight Operating Factor**	**Proposed Power Consumption (kWh)**	**Savings (kWh)**
[A]	**[B]**	**[C]**	**[D]**	**[E]**	**[F]**	**[G]**	**[H]**	**[I]**	**[J]**	**[K]**	**[L]**	**[M]**	**[N]**	**[O]**	**[P]**	**[Q]**
7	DPW Highway	0	7	2	5	2,477	30%	50%	20%	1,760	2,229	5%	95%	0%	974	787
19	DPW Offices	0	19	0	19	2,500	30%	50%	20%	4,606	2,250	5%	95%	0%	2,558	2,047
49	Flynn Building	0	49	10	39	2,500	35%	50%	15%	11,218	2,250	5%	95%	0%	6,799	4,419
7	Town Hall	0	7	0	7	2,500	35%	50%	15%	1,557	2,250	5%	95%	0%	943	614
16	Fairbank Community Center (Including Pool)	0	16	4	12	2,500	35%	50%	15%	3,687	2,250	5%	95%	0%	2,235	1,452
42	Public Library	0	42	17	25	2,500	35%	50%	15%	9,887	2,250	5%	95%	0%	5,997	3,890
7	Fire Dept Headquarters	0	7	1	6	2,500	35%	50%	15%	1,589	2,250	5%	95%	0%	963	626
1	Fire Dept South	0	1	0	1	2,500	35%	50%	15%	222	2,250	5%	95%	0%	135	88
1	Fire Dept North	0	1	0	1	2,500	35%	50%	15%	222	2,250	5%	95%	0%	135	88
149		0	149	34	115					34,747					20,737	14,010

Item	**Value**	**Units**	**cell ref**	**Remarks**
Watts used by PC type1	165	W	**[D62]**	Mac
Watts used by PC type2	195	W	**[D63]**	Tower PC
Watts used by CRT Monitor	70	W	**[D64]**	
Watts used by LCD Monitor	35	W	**[D65]**	
Watts Used during sleep mode	5	W	**[D66]**	
Computer Load Factor	30.0%	%	**[D67]**	Estimated computer power loading
Software usage percentage	10.0%	%	**[D68]**	Assumes new software puts PCs to sleep for 10% of occupied hours
Occupied period usage factor	85.0%	%	**[D69]**	Assumes 15% of computers are off during existing conditions
Hours in a year	8,760	hr	**[D70]**	

Cell Ref.	**Comment**
A	Estimated quantity of machines appropriate for retrofit, per IT Personnel
B	Location of Computers
C	Estimated quantity of 165W machines appropriate for retrofit, per IT Personnel
D	Estimated quantity of 195W machines appropriate for retrofit, per IT Personnel
E	Estimated quantity of CRT monitors appropriate for retrofit, per IT Personnel
F	Estimated quantity of LCD monitors appropriate for retrofit, per IT Personnel
G	Annual occupied hours of operation
H	Percentage of computers currently put into standby mode overnight
I	Percentage of computers currently shutdown overnight
J	Percentage of computers currently left on overnight
K	= ((PC Power) x [D67] x [col G] ÷ 1,000) x [D69] + (([col C] + [col D]) x [D66] x ([D70] - [col G]) ÷ 1,000) x [col H] + ((PC Power) x [D67] x ([D70] - [col G]) ÷ 1,000) x (1 - [col H] - [col I])
L	= [col G] x (1 - [D68])
M	Percentage of computers proposed to be in standby mode overnight
N	Percentage of computers proposed to be shutdown overnight
O	Percentage of computers proposed to be left on overnight
P	= ((PC Power) x [D67] x [col L] ÷ 1,000) x [D69] + ([col C] + [col D]) x [D66] x ([col G] - [col L]) ÷ 1,000 x [D69] + (([col C] + [col D]) x [D66] x ([D70] - [col L]) ÷ 1,000) x [col M] + ((PC Power) x [D67] x ([D70] - [col L]) ÷ 1,000) x (1 - [col M] - [col N])
Q	= [col K] - [col P]

MAPC - Sudbury

PC Load Management

Interactive Savings Calculation

	Savings		Heating Penalty				Cooling Benefit			
A	B	C	D	E	F	G	H	I	J	K
Facility	Annual kW	Annual kWh	Heat Gain to Space	Heating Months	Heating System Efficiency	Heating Penalty MMBtu	Total Space Cooled	Cooling Months	Cooling System COP	Cooling Benefit MMBtu
DPW Highway		787	100.0%	5.0	86.0%	(1.3)	25.0%	5.0	3.22	0.1
DPW Offices		2,047	100.0%	5.0	82.0%	(3.6)	20.0%	5.0	2.93	0.2
Flynn Building		4,419	100.0%	5.0	85.0%	(7.4)	80.0%	5.0	2.64	1.9
Town Hall		614	100.0%	5.0	74.0%	(1.2)	15.0%	5.0	2.93	0.0
Fairbank Community Center (Including Pool)		1,452	100.0%	5.0	80.0%	(2.6)	90.0%	5.0	2.93	0.6
Public Library		3,890	100.0%	5.0	80.0%	(6.9)	90.0%	5.0	2.93	1.7
Fire Dept Headquarters		626	100.0%	5.0	80.0%	(1.1)	20.0%	5.0	2.93	0.1
Fire Dept South		88	100.0%	5.0	78.0%	(0.2)	10.0%	5.0	2.93	0.0
Fire Dept North		88	100.0%	5.0	78.0%	(0.2)	10.0%	5.0	2.93	0.0
Totals	**0.0**	**14,010**				**(24.4)**				**4.6**

Notes:	
A	Applicable building included in comprehensive energy audit
B	Measure demand savings {kW} associated with Measure retrofit measures
C	Measure energy savings {kWh} associated with Measure retrofit measures
D	Estimated percentage of Measure energy transmitted to conditioned space
E	Estimated length of heating season
F	Estimated heating system efficiency, interacted with other measures
G	Resulting heating penalty due to Measure upgrades = [col C] x [col D] x 3,413 x ([col E] / 12) / [col F] / 1,000,000
H	Estimated percentage of space cooled
I	Estimated Length of cooling season
J	Estimated cooling system efficiency, interacted with other measures
K	Resulting cooling benefit due to Measure upgrades = [col C] x [col D] x 3,413 x ([col I] / 12) / [col J] / 1,000,000

Appendix for ECM 5: PC Load Management

II. Manufacturer Specification Sheets

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PowerMAN Power Manager Overview

Release 5.2.4 July 2011

*"We estimate this straightforward project, will save the Trust more than 350 tonnes of CO_2 and £70,000 per year…Direct financial savings are achieved by reducing the energy being used by computers being left idle by users." - **Phil Brennan, Estates Director, Sheffield NHS Teaching Hospitals***

Data Synergy PowerMAN Power Manager is an advanced software product giving organisations of all sizes a simple, effective and uniform solution to manage PC running costs. PowerMAN complements the built-in power management features of Microsoft Windows® by providing:

- **Comprehensive, centralised, configuration of PC power management**
- **Web-based, enterprise-wide reporting of PC usage and costs**

PowerMAN builds upon the features available in the Windows operating system to deliver power management that maximizes savings whilst avoiding any loss of productivity. The software's innovative approach allows PC power features to be simply managed using familiar Windows tools. This dramatically reduces implementation time and delivers rapid results. PowerMAN's unique web-based graphical system allows both IT and non-IT staff to monitor progress and identify areas for improvement.

*"I only know one power management product that truly addresses our problems…PowerMAN" **- Lisa Nelson, University of Liverpool***

PowerMAN is a best of breed solution. The unique combination of effective power management **control** and **measurement reporting** greatly enhances the available savings:

PowerMAN Benefits

*"This is a great opportunity to save a whole lot of money, but at a low cost" - **Merry Rankin, Director of the Office of Sustainability, Iowa State University***

PowerMAN is very cost effective and will deliver effective power management whilst maintaining user productivity. The solution will deliver the following business benefits:

- Save up to 70% of PC energy costs
- Save up to £60 per annum per PC
- Flexible solution that overcomes common barriers to energy saving
- Pay for itself in weeks NOT months

The product is available with a **free 30 day, no-obligation, evaluation**. This will allow you to fully understand the powerful range of features available and measure the potential savings in your organisation. The evaluation is unlimited and we encourage you to use it on as many workstations as possible. The savings achievable can be estimated using our free, on-line, savings calculator.

The management software is highly flexible and offers numerous power management policy options:

- Rapid deployment using almost any industry standard technique
- Flexible policies per-user, per-workstation or per-group
- Mix/match techniques to work alongside user requirements and maximize productivity
- Built-in wake-up support for patch management, anti-virus scans, and updates
- Minimally intrusive to users and includes an optional user override tool
- Uniform solution for all supported operating systems

The optional reporting suite provides:

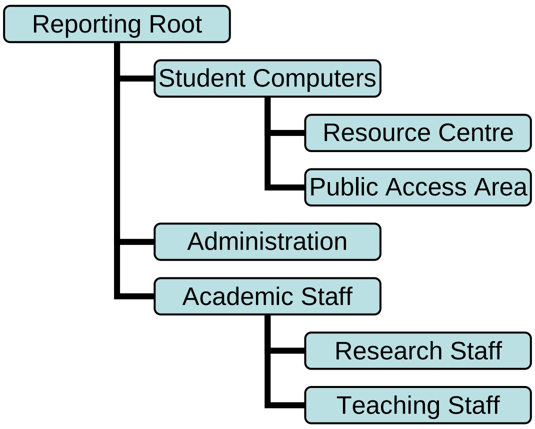
- Management insight of workstation activity, waste and areas of best practice
- Reporting per area, department or physical location
- Measurement by time, estimated cost or CO_2 equivalence
- Informed decision making based upon reality and **NOT** guess work
- Optional hosted solution for ultra-rapid setup and low implementation cost

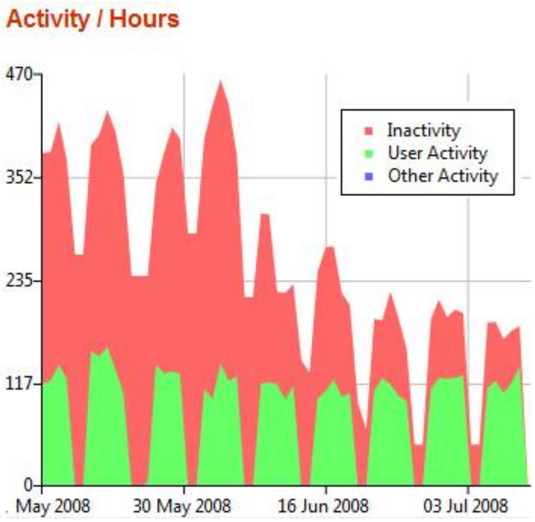
Enterprise PC Power Reporting

The optional PowerMAN web-based reporting solution is available as either **standalone, on-premise, software** or as **a hosted reporting service**. The system reports workstation power usage related information in a variety of easily accessible graphical and tabular formats. Both reporting solutions offer exactly the same reporting features:

- The **hosted (cloud) reporting service** can be setup in minutes and will securely report power statistics directly to Data Synergy's servers. This removes the need for a local server and associated backups. Hosted reporting is **included free for the first year** with all direct PowerMAN purchases.

- The **on-premise PowerMAN Enterprise Server** reporting software is particularly suitable for larger organisations and keeps all information in-house. The system offers an open database model that is ideal for further integration or development of custom queries.





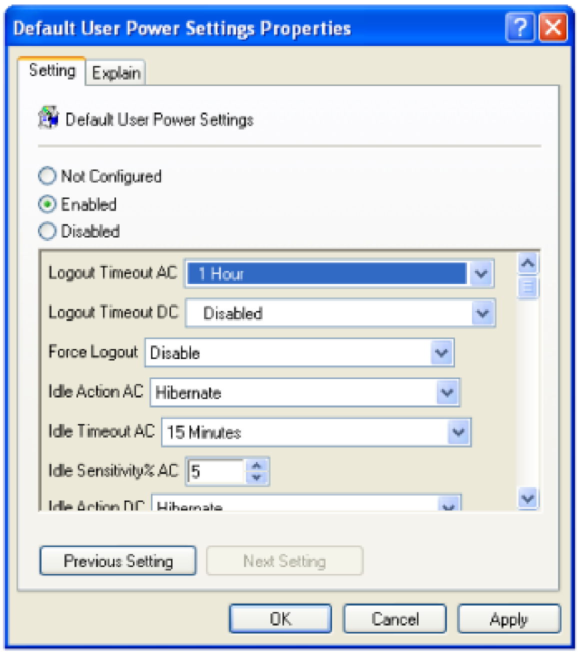
A live demonstration of the reporting solution features is available on the [Data Synergy website.]

The reporting solution provides:

- On-going measurement of efficiency and waste over weeks, months or even years
- Reports true hours/minutes of activity and estimated cost and CO_2 equivalents
- Groups computers by area, use or location, display summary information and drill-down to individual PCs
- Ranks computers by inactivity level and highlights the most and least wasteful computers
- Displays data graphically and allows data download in Excel compatible format
- Provides multiple access security levels and only collects anonymous data. Does not create any privacy or data confidentiality issues and provides
- Minimal network overhead and storage requirements. There is no practical limit to historic data retention.

Technical Features and Requirements

PowerMAN is supported on Windows 2000 and later. The software uses a small agent which may be quickly deployed to each workstation:

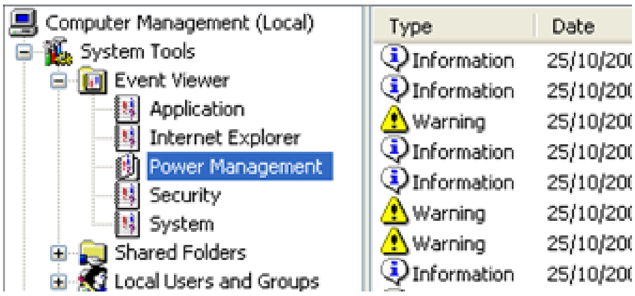


Default User Power Settings Properties

Default User Power Settings

○ Not Configured
● Enabled
○ Disabled

Logout Timeout AC: 1 Hour
Logout Timeout DC: Disabled
Force Logout: Disable
Idle Action AC: Hibernate
Idle Timeout AC: 15 Minutes
Idle Sensitivity% AC: 5



Computer Management (Local)
System Tools
Event Viewer
Application
Internet Explorer
Power Management
Security
System
Shared Folders
Local Users and Groups

Type	Date
Information	25/10/20
Information	25/10/20
Warning	25/10/20
Information	25/10/20
Information	25/10/20
Warning	25/10/20
Warning	25/10/20
Information	25/10/20

- Simple deployment via either standard MSI or single-EXE file. Less than 1MB on-disk required
- Deploy via GPO/AD, ZEN, SCCM, SMS, XCOPY or similar
- ADM/ADMX supplied - Configure via Group Policy, ZEN, SCCM or even direct Registry settings
- Define separate policies per-user, per-computer, group or time of day
- Configure timeouts for logout, sleep, hibernate, and power-off
- Schedule wake-up, sleep, hibernate or power-off
- Distinct policies for when nobody is logged on

Enforce policies, prevent unauthorised changes and override problem applications preventing PC ‘insomnia’

Protect critical applications or files

Optional opt-out by user and computer. Permit authorised users to self opt-in/out to power management

The PowerMAN reporting solution requires less than 0.5KB of network bandwidth per workstation per day. The optional on-premise, PowerMAN Enterprise Server, reporting software is highly scalable and supports a minimum of 100,000 client computers. The software does not normally require a dedicated server and will work in a virtualised environment. The server software requires the following:

- Windows Server 2003 or later (x86 or x86-64) with at least 2GB of RAM. Larger installations may require more RAM.
- Approximately 1MB of data storage per client computer per year. e.g. 20,000 PCs will require approximately 20GB of storage.
- Microsoft® SQL Server Standard Edition 2005 or later. Smaller deployments may also use the free SQL Express Edition

We also offer a range of services to help deploy, integrate, and customise PowerMAN in your organisation.

Better than Windows alone

PowerMAN leads the market because it significantly enhances the features available from Windows alone. This is because:

- Windows XP and earlier do not provide any built-in, centrally configured, power management.
- Windows® Vista / Windows® 7 **only provide a single timeout-based power policy to be defined for all users on a particular computer**. This policy applies at all times and can be changed by any user and remains in effect even when the user logs off. The policy may be easily circumvented by rouge applications causing 'PC Insomnia'

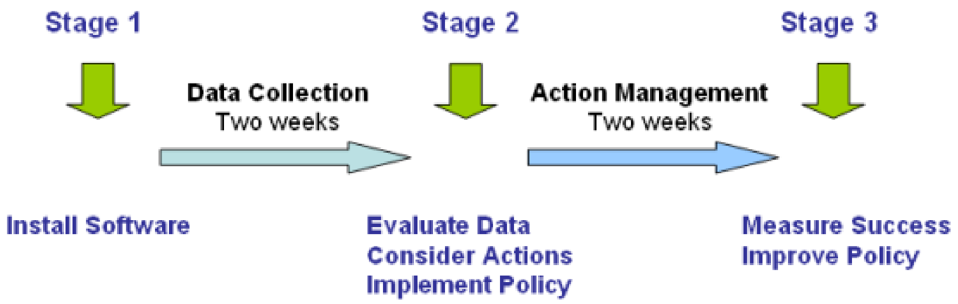
PowerMAN offers many more comprehensive features beyond those present in Windows alone. The following table highlights the key features of PowerMAN compared to Windows XP, Windows Vista/Windows 7 and the Energy Star EZ GPO tool:

Feature	**Win XP**	**Win Vista/7**	**EZ GPO**	**PowerMAN**
Configure power features via Group Policy	No	Basic	Basic	**Advanced**
Report power usage per PC/Site	No	No	No	**Yes**
Configure policy per user	Yes	No	Yes	**Yes**
Configure policy per PC	No	Yes	Yes	**Yes**
Distinct policy for no logged-on user	No	No	Yes	**Yes**
Enforce policy (prevent 'PC Insomnia')	No	No	No	**Yes**
Power Management Event Log	No	No	No	**Yes**
Prevent unauthorised policy changes	Yes	Yes	No	**Yes**
Optional user override tool	No	No	No	**Yes**
Supports logout/power-off	No	No	No	**Yes**
Supports scheduled sleep/shutdown	No	No	No	**Yes**
Supports scheduled wake-up	No	No	No	**Yes**
Remote ad-hoc wake-up	No	No	No	**Yes**
Full support for Windows® Vista/7	NA	NA	No	**Yes**
Regular updates available	NA	NA	No	**Yes**
Fully supported via email and telephone	NA	NA	No	**Yes**

Evaluate Free Today

We are confident PowerMAN will save you money but we know you will want to see this for yourself. The product is available with a **free 30 day, no-obligation, evaluation**.

The evaluation will allow you to fully understand the powerful range of features available and measure the potential savings in your organisation. The evaluation is **unlimited** and we encourage you to use it on as many representative workstations as possible. The typical evaluation cycle is:



Please talk to your Sales Representative to arrange your PowerMAN evaluation today.

Complementary Tools

Data Synergy provides a range of related software. The following tools complement PowerMAN:

- **WakeMyPC** provides a web-based, user-driven, remote desktop access gateway. This allows users to wake their own workstations when required for remote access. WakeMyPC is the ideal companion for PowerMAN and used together will maximize the savings achieved.

- Free **WOLMAN command-line** tool for investigating and debugging WoL network issues. This is included with the WakeMyPC Server and is also available directly from the Data Synergy website

- **DMCMOS32 utility** for configuring BIOS features, such as WoL, on large numbers of similar computers

Further Information

To find out more about **Data Synergy PowerMAN** please talk to your Sales Representative or authorised reseller. Alternatively please read the following documents available on the Data Synergy website:

- **PowerMAN Administrator Guide** – provides full technical details and several installation walk-throughs

- **PowerMAN Reporting Guide** - explains how to use the WakeMyPC Server software.

- **PowerMAN Enterprise Server Guide** – explains how to deploy the on-premise reporting suite

- **PowerMAN FAQ** – Answers frequently asked product questions

Our Customers

Data Synergy PowerMAN is already used successfully by a large number of both public and private sector customers. Some examples include:

STATE REVENUE OFFICE VICTORIA
www.sro.vic.gov.au

NORTH WALES POLICE
A safer North Wales

MYCOLOGIA
PERTH · MELBOURNE · SYDNEY

Manchester Metropolitan University

IOWA STATE UNIVERSITY

UEA University of East Anglia

ascent media

NHS Sheffield

MANCHESTER 1824

University of Dundee

HARLOW COLLEGE

Lincolnshire Police

The University of Nottingham

UNIVERSITY OF LIVERPOOL

DEVON & SOMERSET FIRE & RESCUE SERVICE
ACTING TO PROTECT & SAVE

CHESHIRE FIRE & RESCUE SERVICE

UNIVERSITY OF OXFORD

Rushcliffe Borough Council

Sheffield Teaching Hospitals NHS
NHS Foundation Trust

London School of Hygiene & Tropical Medicine

St Richard Gwyn Catholic High School

Leeds Trinity University College

UEL University of East London

About Data Synergy

Data Synergy is a British company based in Sheffield. We have over ten years' experience developing and supporting software solutions for enterprise PC deployment and management. We do not resell other vendors’ products and do all of our development, sales and support from our UK base.

Our products have evolved through listening to customer ideas and applying our unrivalled knowledge of PC internals. If you have a suggestion for a new product or feature we would love to talk to you.

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VAT Registration GB 939 7559 56

ECM 6:
Demand Control Ventilation

ECM Overview

Ameresco identified energy saving opportunities at the Curtis Middle School and Haynes Elementary School through the installation of demand control ventilation (DCV) controls. DCV controls modulate the amount of outdoor air supplied to a space to maintain a required ventilation rate (CFM/person) based on the actual occupancy at that time. This strategy saves energy by reducing the amount of outdoor air that is conditioned during low occupancy periods.

Figure 6.1: Existing constant air volume system serving the gymnasium at the Haynes Elementary School.

ECM Detail

Existing System

Ameresco identified one (1) air-handling unit (AHU) at the Haynes Elementary School and three (3) AHUs at the Curtis Middle School that can be upgraded with DCV controls. All spaces have a high occupant density that varies throughout the day and all spaces are supplied with a large volume of air. These units currently use constant air volume strategies.

The gymnasium at the Haynes Elementary School is provided with heating and ventilation by a McQuay Model RDS rooftop unit, HV-4, equipped with a hot water coil and outside air damper. The 7.5 HP supply fan provides 9,000 CFM of conditioned air and 4,000 CFM of outside air. The air is distributed to the space through an exposed overhead ductwork system. Air is returned to HV-4 through a sidewall register located low within the space.

The cafeteria, gym, and auditorium at the Curtis Middle School are provided with heating and ventilation by AHU-8, AHU-10, and AHU-12 respectively. These units are Trane Model RAUCC rooftop units of various sizes equipped with hot water coils and economizers. AHU-8 has a 7.5 HP supply fan that provides 6,400 CFM of conditioned air and 4,500 CFM of outside air. AHU-10 has a 7.5 HP supply fan that provides 7,000 CFM of conditioned air and 5,100 CFM of outside air. AHU-12 has a 15 HP supply fan that provides 12,000 CFM of conditioned air and 7,500 CFM of outside air. These units distribute the conditioned air to the spaces through an overhead ductwork system and the air is returned to the units through sidewall registers.

Proposed System

Ameresco proposes to install demand control ventilation (DCV) on the four (4) AHU's listed in the following table. The single zone HV-4 serving the Haynes gymnasium will have a new CO_2 sensor installed in the return air ductwork. AHU-8, 10, and 12 have existing CO_2 sensors already installed that will be reused for this measure. All outdoor air damper actuators will be tested for proper operation (modulating). New and existing CO_2 sensors will monitor CO_2 levels in the spaces and control ventilation rates for each occupied space according to ASHRAE Standard 62 requirements. The sensors will be wired back to existing AHU controllers. The existing controls will be modified and programmed to control the outdoor air dampers via CO_2 levels. The new sensors will have the capability to override the outdoor air dampers based on CO_2 control algorithm. Work for this measure excludes repair of existing air handling equipment and dampers, actuators, etc.

Please refer to the following table for a list of AHU's to be retrofit in this measure.

Building	Unit	Serves
Curtis Middle School	AHU-8	Cafeteria
Curtis Middle School	AHU-10	Gymnasium
Curtis Middle School	AHU-12	Auditorium
Haynes Elementary School	HV-4	Gymnasium

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect "As-Built" conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The new DCV controls will reduce the over-ventilation of high volume spaces by providing the required amount of air based on actual occupancy. This strategy will save energy by reducing the amount of outdoor air that is conditioned during low occupancy periods.

Appendix for ECM 6:
Demand Control Ventilation

I. Energy Savings Calculations

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MAPC - Sudbury	
Energy and Demand Savings Summary	
Measure ID:	**6**
Measure Name:	**Demand Control Ventilation**
Measure Location:	
Engineers:	

Site Name:		**Curtis**	**Haynes**	**Summary**
Item	Units	Savings	Savings	
Electricity				
Energy On-Peak	kWh	33,206	621	33,827
Energy Off-Peak	kWh			0
Energy Total	kWh			0
Demand On-Peak, Monthly	kW			0.0
Demand On-Peak, Annual	kW			0.0
Demand Off-Peak, Monthly	kW			0.0
Demand Off-Peak, Annual	kW			0.0
Fossil Fuel				0
Natural Gas (NG)	Therms	129	285	414
Liquid Propane Gas (LPG)	Gallons			0
Steam	Mlbs			0
Fuel Oil, #2	Gallons			0
Fuel Oil, #4	Gallons			0
Fuel Oil, #6	Gallons			0
Miscellaneous	Misc			0
Water				0
Water Savings	kGallons			0
Sewer				0
Sewer Savings	kGallons			0

MAPC - Sudbury
Curtis Middle School
Demand Control Ventilation

TMY-2 Weather Data for Worcester, MA								Existing Occupancy Schedule				Existing Heating/Cooling Schedule				Existing Motor Operating Schedule				Existing				Proposed								Savings		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Cooling Energy Savings (MMBTU)	HVAC Electrical Savings (kWh)	Heating Energy Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**
Cooling																																		
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	584	447	0	0	0	0	0	0	584	447	0	0	0	0	
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	526	402	0	0	0	0	0	0	526	402	0	0	0	0	
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	467	357	0	0	0	0	0	1	467	357	0	0	0	4	
90 to 95	92.5	69.8	34.2	0	8	0	8	2	1	0	6	2	0	0	6	2	0	0	6	409	313	0	1	2	0	0	6	409	313	0	1	0	30	
85 to 90	87.5	70.3	34.6	1	37	6	44	9	4	0	31	10	2	0	31	10	2	0	31	351	268	1	3	10	2	0	31	351	268	1	3	0	167	
80 to 85	82.5	68.4	33.0	8	138	29	175	34	15	0	125	41	9	0	125	41	9	0	125	292	223	4	10	41	9	0	125	292	223	4	10	0	663	
75 to 80	77.5	66.2	31.2	27	202	83	312	61	28	0	223	74	16	0	223	74	16	0	223	234	179	6	15	74	16	0	223	234	179	6	15	0	1,183	
70 to 75	72.5	64.3	29.7	64	269	160	493	97	44	0	352	116	25	0	352	116	25	0	352	175	134	7	17	116	25	0	352	175	134	7	17	0	1,869	
65 to 70	67.5	61.2	27.5	185	208	243	636	125	56	0	454	150	32	0	454	150	32	0	454	117	89	6	15	150	32	0	454	117	89	6	15	0	2,411	
60 to 65	62.5	57.3	24.8	315	249	298	862	170	76	0	616	203	43	0	616	203	43	0	616	58	45	4	10	203	43	0	616	58	45	4	10	0	3,267	
Heating																																		
55 to 60	57.5	52.7	0.0	303	245	276	824	162	73	0	589	194	41	0	589	194	41	0	589	(62)	(1)	0	0	194	41	0	589	(41)	(1)	0	0		3,123	0
50 to 55	52.5	47.8	0.0	262	184	228	674	133	60	0	482	159	33	0	482	159	33	0	482	(87)	(12)	0	0	159	33	0	482	(57)	(12)	0	0		2,555	0
45 to 50	47.5	42.5	0.0	204	230	211	645	127	57	0	461	152	32	0	461	152	32	0	461	(111)	(22)	0	0	152	32	0	461	(74)	(22)	0	0		2,445	0
40 to 45	42.5	38.3	0.0	210	191	234	635	125	56	0	454	150	32	0	454	150	32	0	454	(136)	(33)	0	1	150	32	0	454	(90)	(33)	0	0		2,407	1
35 to 40	37.5	33.8	0.0	321	301	286	908	179	80	0	649	214	45	0	649	214	45	0	649	(161)	(44)	0	3	214	45	0	649	(106)	(44)	0	0		3,442	2
30 to 35	32.5	28.7	0.0	356	221	313	890	175	79	0	636	210	44	0	636	210	44	0	636	(186)	(55)	0	4	210	44	0	636	(122)	(55)	0	1		3,374	3
25 to 30	27.5	23.5	0.0	228	211	211	650	128	58	0	464	153	32	0	464	153	32	0	464	(210)	(65)	0	3	153	32	0	464	(138)	(65)	0	1		2,464	2
20 to 25	22.5	19.1	0.0	104	94	124	322	63	28	0	230	76	16	0	230	76	16	0	230	(235)	(76)	0	2	76	16	0	230	(154)	(76)	0	1		1,221	1
15 to 20	17.5	14.3	0.0	144	78	117	339	67	30	0	242	80	17	0	242	80	17	0	242	(260)	(87)	0	3	80	17	0	242	(171)	(87)	0	1		1,285	1
10 to 15	12.5	9.3	0.0	118	40	85	243	48	21	0	174	57	12	0	174	57	12	0	174	(285)	(97)	0	2	57	12	0	174	(187)	(97)	0	1		921	1
5 to 10	7.5	5.0	0.0	52	10	15	77	15	7	0	55	18	4	0	55	18	4	0	55	(309)	(108)	0	1	18	4	0	55	(203)	(108)	0	1		292	0
0 to 5	2.5	2.2	0.0	18	3	1	22	4	2	0	16	5	1	0	16	5	1	0	16	(334)	(119)	0	1	5	1	0	16	(219)	(119)	0	0		83	0
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(359)	(129)	0	0	0	0	0	0	(235)	(129)	0	0		0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(384)	(140)	0	0	0	0	0	0	(251)	(140)	0	0		0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(500)	(151)	0	0	0	0	0	0	(293)	(151)	0	0		0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(513)	(162)	0	0	0	0	0	0	(306)	(162)	0	0		0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(526)	(172)	0	0	0	0	0	0	(319)	(172)	0	0		0	0
				2,920	2,920	2,920	8,760	1,725	775	0	6,260	2,065	435	0	6,260	2,065	435	0	6,260			28	90	2,065	435	0	6,260			28	77	0	33,206	13

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Existing Occupancy hours
M - P	Existing Heating/Cooling hours
Q - T	Existing Motor Operating Hours
U	Occupied Cooling and Heating loads (MBH)
V	Unoccupied Cooling and Heating loads (MBH)
W	Cooling = [col U] x ([col M] + [col O]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col M] + [col O]) x MIN([col U] + internal gains , 0) + IF([col I] + [col K] > [col M]+[col O] , (([col I] + [col K]) - ([col M] + [col O])) x MIN([col V] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
X	Cooling = [col R] x ([col J] + [col L]) ÷ 1,000 ÷ AD45
	Heating = -([col N] + [col P]) x MIN([col V] + internal gains , 0) + IF([col I] + [col K] < [col M] + [col O] , (([col M] + [col O]) - ([col I] + [col K])) x MIN([col U] + internal gains , 0)) ÷ 1,000 ÷ AD44
Y - AB	Proposed Operating hours
AC	Proposed Occupied Cooling and Heating Loads:
	Cooling = ([col B] - AC61) ÷ ([col B] - AC56) x [col U]
	Heating = ([col B] - AE61) ÷ ([col B] - AE56) x [col U]
AD	Proposed Unoccupied Cooling and Heating Loads:
	Cooling = ([col B] - AC62) ÷ ([col B] - AC57) x [col V]
	Heating = ([col B] - AE62) ÷ ([col B] - AE57) x [col V] ([col V] is modified to account for reduced kitchen and building ventilation due to EMS)
AE	Cooling = [col AC] x ([col Y] + [col AA]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col Y] + [col AA]) x MIN([col AC] + internal gains , 0) + IF([col I] + [col K] > [col Y]+[col AA] , (([col I] + [col K]) - ([col Y] + [col AA])) x MIN([col AD] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
AF	Cooling = [col AD] x ([col Z] + [col AB]) ÷ 1,000 ÷ AD45
	Heating = -([col Z] + [col AB]) x MIN([col AD] + internal gains , 0) + IF([col I] + [col K] < [col Y] + [col AA] , (([col Y] + [col AA]) - ([col I] + [col K])) x MIN([col AC] + internal gains , 0)) ÷ 1,000 ÷ AD44
AG	= ([col W] + [col X]) - ([col AE] + [col AF])
	HVAC Fan and Pump Savings
AH	Cooling =([col Q] + [col S] + ([col R] + [col T]) x AD49) x (AD46 + AD48) - ([col Y] + [col AA] + ([col Z] + [col AB]) x AD49) x (AD46 + AD48)
	Heating =([col Q] + [col S]) x AD46 + IF(B20<35,([col R] + [col T]) x AD49 x AD46, IF(B20>50,0,([col R] + [col T]) x AD49 x AD46)) - (([col Y] + [col AA]) x AD46 + IF(B20<35,([col Z] + [col AB]) x AD49 x AD46, IF(B20>50,0,([col Z] + [col AB]) x AD49 x AD46)))
AI	= ([col W] + [col X]) - ([col AE] + [col AF])

Assumptions:	**Value**	**Unit**	**CELL REF**	**Description**
Occupied Area	155,000	SF	**AD43**	
Existing Heating Plant Efficiency	82.0%		**AD44**	Electric HW
Existing Chiller Efficiency	2.9	COP	**AD45**	
Fan Power	26.5	kW	**AD46**	RTU-8,10,12
Heating Pump Power	0.0	kW	**AD47**	
Cooling Pump Power	0.0	kW	**AD48**	
UnOcc. Fan & Pump Cycling	10.0%		**AD49**	% Operating Hours During UnOcc.
UnOcc. Kitchen Vent. Reduction	0.0%		**AD50**	% CFM Saved
UnOcc. Ventilation Reduction	0.0%		**AD51**	% CFM Saved
Occ. Ventilation Reduction	5.2%		**AD52**	% CFM Saved due to DCV

Average Existing Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC56**	70.5	**AE56**	
UnOccupied	78.0	**AC57**	58.0	**AE57**	

Average Proposed Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC61**	70.5	**AE61**	
UnOccupied	78.0	**AC62**	58.0	**AE62**	

MAPC - Sudbury
Haynes Elementary
Demand Control Ventilation

TMY-2 Weather Data for Worcester, MA								Existing Occupancy Schedule				Existing Heating/Cooling Schedule				Existing Motor Operating Schedule				Existing				Proposed								Savings		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Cooling Energy Savings (MMBTU)	HVAC Electrical Savings (kWh)	Heating Energy Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**
Cooling																																		
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	324	248	0	0	0	0	0	0	324	248	0	0	0	0	
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	291	223	0	0	0	0	0	0	291	223	0	0	0	0	
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	259	198	0	0	0	0	0	1	239	198	0	0	0	0	
90 to 95	92.5	69.8	34.2	0	8	0	8	1	1	0	6	2	1	0	6	2	1	0	6	227	173	0	0	2	1	0	6	207	173	0	0	0	1	
85 to 90	87.5	70.3	34.6	1	37	6	44	8	4	0	31	9	3	0	31	9	3	0	31	194	149	1	2	9	3	0	31	173	149	1	2	0	4	
80 to 85	82.5	68.4	33.0	8	138	29	175	33	17	0	125	37	13	0	125	37	13	0	125	162	124	2	6	37	13	0	125	146	124	2	6	0	14	
75 to 80	77.5	66.2	31.2	27	202	83	312	58	31	0	223	66	23	0	223	66	23	0	223	130	99	3	8	66	23	0	223	119	99	3	8	0	18	
70 to 75	72.5	64.3	29.7	64	269	160	493	92	49	0	352	104	36	0	352	104	36	0	352	97	74	3	10	104	36	0	352	91	74	3	10	0	29	
65 to 70	67.5	61.2	27.5	185	208	243	636	118	63	0	454	135	47	0	454	135	47	0	454	65	50	3	8	135	47	0	454	65	50	3	8	0	37	
60 to 65	62.5	57.3	24.8	315	249	298	862	160	86	0	616	183	63	0	616	183	63	0	616	32	25	2	6	183	63	0	616	32	25	2	6	0	50	
Heating																																		
55 to 60	57.5	52.7	0.0	303	245	276	824	153	82	0	589	175	61	0	589	175	61	0	589	(221)	(4)	0	5	175	61	0	589	(213)	(4)	0	5		48	0
50 to 55	52.5	47.8	0.0	262	184	228	674	125	67	0	482	143	50	0	482	143	50	0	482	(309)	(47)	0	13	143	50	0	482	(298)	(47)	0	12		39	0
45 to 50	47.5	42.5	0.0	204	230	211	645	120	64	0	461	137	47	0	461	137	47	0	461	(397)	(89)	4	41	137	47	0	461	(384)	(89)	2	41		52	2
40 to 45	42.5	38.3	0.0	210	191	234	635	118	63	0	454	135	47	0	454	135	47	0	454	(485)	(131)	17	70	135	47	0	454	(469)	(131)	15	70		51	3
35 to 40	37.5	33.8	0.0	321	301	286	908	169	90	0	649	192	67	0	649	192	67	0	649	(573)	(174)	44	141	192	67	0	649	(554)	(174)	40	141		73	5
30 to 35	32.5	28.7	0.0	356	221	313	890	166	88	0	636	189	65	0	636	189	65	0	636	(662)	(216)	62	179	189	65	0	636	(640)	(216)	57	179		72	5
25 to 30	27.5	23.5	0.0	228	211	211	650	121	65	0	464	138	48	0	464	138	48	0	464	(750)	(258)	59	161	138	48	0	464	(725)	(258)	55	160		52	4
20 to 25	22.5	19.1	0.0	104	94	124	322	60	32	0	230	68	24	0	230	68	24	0	230	(838)	(301)	36	94	68	24	0	230	(810)	(301)	34	94		26	2
15 to 20	17.5	14.3	0.0	144	78	117	339	63	34	0	242	72	25	0	242	72	25	0	242	(926)	(343)	45	115	72	25	0	242	(895)	(343)	42	114		27	3
10 to 15	12.5	9.3	0.0	118	40	85	243	45	24	0	174	51	18	0	174	51	18	0	174	(1,015)	(385)	37	93	51	18	0	174	(981)	(385)	35	93		20	2
5 to 10	7.5	5.0	0.0	52	10	15	77	14	8	0	55	16	6	0	55	16	6	0	55	(1,103)	(428)	13	33	16	6	0	55	(1,066)	(428)	13	33		6	1
0 to 5	2.5	2.2	0.0	18	3	1	22	4	2	0	16	5	2	0	16	5	2	0	16	(1,191)	(470)	4	10	5	2	0	16	(1,151)	(470)	4	10		2	0
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,279)	(512)	0	0	0	0	0	0	(1,237)	(512)	0	0		0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,367)	(555)	0	0	0	0	0	0	(1,322)	(555)	0	0		0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,456)	(597)	0	0	0	0	0	0	(1,407)	(597)	0	0		0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,544)	(639)	0	0	0	0	0	0	(1,492)	(639)	0	0		0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1,632)	(682)	0	0	0	0	0	0	(1,578)	(682)	0	0		0	0
				2,920	2,920	2,920	8,760	1,630	870	0	6,260	1,856	644	0	6,260	1,856	644	0	6,260			336	997	1,856	644	0	6,260			311	993	1	621	29

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Existing Occupancy hours
M - P	Existing Heating/Cooling hours
Q - T	Existing Motor Operating Hours
U	Occupied Cooling and Heating loads (MBH)
V	Unoccupied Cooling and Heating loads (MBH)
W	Cooling = [col U] x ([col M] + [col O]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col M] + [col O]) x MIN([col U] + internal gains , 0) + IF([col I] + [col K] > [col M]+[col O] , (([col I] + [col K]) - ([col M] + [col O])) x MIN([col V] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
X	Cooling = [col R] x ([col J] + [col L]) ÷ 1,000 ÷ AD45
	Heating = -([col N] + [col P]) x MIN([col V] + internal gains , 0) + IF([col I] + [col K] < [col M] + [col O] , (([col M] + [col O]) - ([col I] + [col K])) x MIN([col U] + internal gains , 0)) ÷ 1,000 ÷ AD44
Y - AB	Proposed Operating hours
AC	Proposed Occupied Cooling and Heating Loads:
	Cooling = ([col B] - AC61) ÷ ([col B] - AC56) x [col U]
	Heating = ([col B] - AE61) ÷ ([col B] - AE56) x [col U]
AD	Proposed Unoccupied Cooling and Heating Loads:
	Cooling = ([col B] - AC62) ÷ ([col B] - AC57) x [col V]
	Heating = ([col B] - AE62) ÷ ([col B] - AE57) x [col V] ([col V] is modified to account for reduced kitchen and building ventilation due to EMS)
AE	Cooling = [col AC] x ([col Y] + [col AA]) ÷ 1,000 ÷ AD45
	Heating = -MIN([col I] + [col K] , [col Y] + [col AA]) x MIN([col AC] + internal gains , 0) + IF([col I] + [col K] > [col Y]+[col AA] , (([col I] + [col K]) - ([col Y] + [col AA])) x MIN([col AD] + internal gains , 0) , 0) ÷ 1,000 ÷ AD44
AF	Cooling = [col AD] x ([col Z] + [col AB]) ÷ 1,000 ÷ AD45
	Heating = -([col Z] + [col AB]) x MIN([col AD] + internal gains , 0) + IF([col I] + [col K] < [col Y] + [col AA] , (([col Y] + [col AA]) - ([col I] + [col K])) x MIN([col AC] + internal gains , 0)) ÷ 1,000 ÷ AD44
AG	= ([col W] + [col X]) - ([col AE] + [col AF])
	HVAC Fan and Pump Savings
AH	Cooling =([col Q] + [col S] + ([col R] + [col T]) x AD49) x (AD46 + AD48) - ([col Y] + [col AA] + ([col Z] + [col AB]) x AD49) x (AD46 + AD48)
	Heating =([col Q] + [col S]) x AD46 + IF(B20<35,([col R] + [col T]) x AD49 x AD46, IF(B20>50,0,([col R] + [col T]) x AD49 x AD46)) - (([col Y] + [col AA]) x AD46 + IF(B20<35,([col Z] + [col AB]) x AD49 x AD46, IF(B20>50,0,([col Z] + [col AB]) x AD49 x AD46)))
AI	= ([col W] + [col X]) - ([col AE] + [col AF])

Assumptions:	**Value**	**Unit**	**CELL**	**Description**
			REF	
Occupied Area	62,811	SF	**AD43**	
Existing Heating Plant Efficiency	78.0%		**AD44**	HW
Existing Chiller Efficiency	2.9	COP	**AD45**	
Fan Power	4.3	kW	**AD46**	HV-4
Heating Pump Power	0.0	kW	**AD47**	
Cooling Pump Power	0.0	kW	**AD48**	
UnOcc. Fan & Pump Cycling	10.0%		**AD49**	% Operating Hours During UnOcc.
UnOcc. Kitchen Vent. Reduction	0.0%		**AD50**	% CFM Saved
UnOcc. Ventilation Reduction	30.0%		**AD51**	% CFM Saved
Occ. Ventilation Reduction	3.9%		**AD52**	% CFM Saved due to DCV

Average Existing Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC56**	70.0	**AE56**	
UnOccupied	78.0	**AC57**	58.0	**AE57**	

Average Proposed Space Temperatures					
	Cooling		Heating		**Description**
Occupied	72.0	**AC61**	70.0	**AE61**	
UnOccupied	78.0	**AC62**	58.0	**AE62**	

Assumptions:	**Value**	**Unit**	**CELL**	**Description**
			REF	
Proposed Occ Cooling Enthaply Setpoin	27.5		**AD66**	74° @ 50% RH

Appendix for ECM 6: Demand Control Ventilation

II. Manufacturer Specification Sheets

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GREYSTONE

ACCURACY BY DESIGN

CARBON DIOXIDE (CO2) DETECTORS

Corporate Space Enclosure

Air quality starts with sensing the problem

Greystone's Carbon Dioxide (CO2) detectors provide unsurpassed accuracy, reliability and selection.

Peace of mind through reliable gas sensors

GREYSTONE IS AN ISO 9002 REGISTERED COMPANY

CO_2 DETECTOR

Environmental, industrial and commercial indoor Carbon Dioxide (CO_2) gas detector. Available in both a space and duct mount version.

Duct Mount ABS Enclosure with Sampling Tube

APPLICATION:

To sense and transmit to any compatible electronic analog control, DDC/PLC controller or automation system for the control of ventilation equipment. Designed to meet ventilation requirements specified in ASHRAE Standard 62-1989.

FEATURES:

- Setup/calibration fully menu driven (requires LCD option)
- Monitors CO2 over range 0-2000 PPM (factory default)
- Field adjustable range from 0-1500 PPM up to 10,000 PPM without re-calibration!
- NDIR single beam with patented ACLP self-calibration algorithm
- Guaranteed 5 year calibration interval
- Optional on board relay with field adjustable trip point
- Optional LCD for displaying PPM level and menu options
- Powered by either AC or DC source with no change to circuit required
- Choice of two field adjustable analog output signals, linearized over full range
- Easy to calibrate in the field

SPECIFICATIONS	CO_2 DETECTOR – Product # CDD
Gas Detected	Carbon Dioxide (CO_2)
Range	0 – 2000 ppm standard, programmable from 1500 up to 10,000 ppm in 500 ppm increments
Standard Accuracy	±75 PPM or3% of reading (whichever is greater) 15-32 C (59-90 F) for 0-2000 ppm range ±5% of reading for 2000-10,000 ppm
Extended Accuracy	±150 ppm or 5% of reading (whichever is greater) 0-50 C (32-122 F) for 0-2000 ppm range ±7% of reading for 2000-10,000 ppm
Sensing Element	Non-Dispersive Infrared (NDIR)
Operation Conditions	0-50C(32-122F), 0-95% RH non-condensing
Repeatability	±20 PPM
Stability	±20 PPM typical, 5 year calibration interval
Manufacturing Process	ISO 9002 certified
Output Signal	4-20 mA active (sourcing), 0-5Vdc and 0-10Vdc, jumper selectable (Note correct part number)
Output Drive Capability	550 ohm max for current output, 10 Kohm min for voltage output
Output Resolution	10 bit PWM
LCD Display (optional)	LCD for displaying PPM level (required for field programming) 1 ppm resolution, 1.1” w x 0.5” h (28 x 13 mm) alpha-numeric 2 line x 8 characters
Field Calibration	Calibration, applying calibration gas standards (Contact Greystone for Calibration kit)
External Dimensions	Corporate Space – 91mm W x 127mm H x 43 mm D (3.6” x 5” x 1.7”) Duct ABS – 124 mm W x 183 mm H x 43 mm D (4.9” x 7.22” x 1.69”)

SPECIFICATIONS (Con't)	CO$_2$ DETECTOR – Product # CDD
Pressure Dependence	0.13% of reading per mm Hg
Altitude Correction	Programmable from 0-5000 ft in 500 ft increments
Response Time	< 60 seconds for 90% step change
Warm-up Time	< two (2) minutes
Power Supply	20-30 Vac/dc (non-isolated half-wave rectified)
Consumption	80 mA max @ 24 Vdc, 36 mA avg @24 Vdc
Input Voltage Effect	Negligible over specified operating range
Protection Circuitry	Reverse voltage protected and output limited
Optional Relay Output	One Form C contact (N.O. and N.C.), status LED, 5 amps @ 250 Vac, 5 amps @ 30Vdc, p.f. = 1 Relay Trip Point – Programmable 500-1500 ppm in 50 ppm increments Relay Hysteresis – Programmable 25-200 ppm in 25 ppm increments
Programming and Selection	Via internal push-buttons and jumper
Wiring Connections	Screw terminal block (14 to 22 AWG)

CARBON DIOXIDE (CO2): PRODUCT ORDERING INFORMATION

MODEL	Description
CDD	Carbon Dioxide Detector (CO$_2$)

CODE	Sensing Element
1	Non-Dispersive Infrared (NDIR)

CODE	Gas Type	Range	
A	CO$_2$ – Carbon Dioxide Detector (CDD)	0-2000 PPM Standard	User programmable up to 10,000 PPM

CODE	Enclosure and Outputs
1	Corporate Space c/w 4-20 mA and 0-5 Vdc outputs
2	Corporate Space c/w 4-20 mA and 0-10 Vdc outputs
6	Duct ABS c/w Sampling Tube, 4-20 mA, 0-5 Vdc and 0-10 Vdc outputs

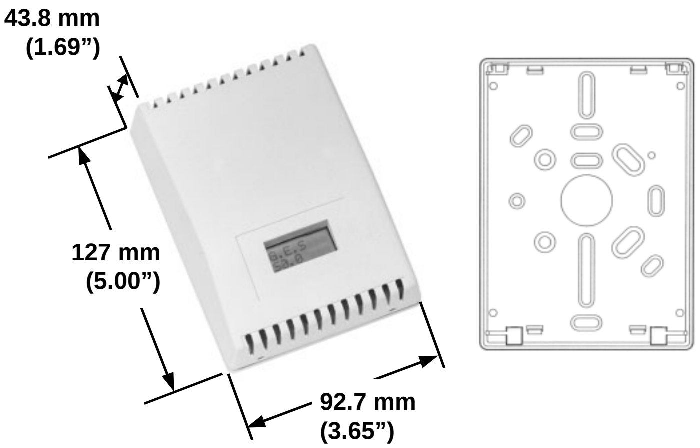
CODE	Circuit Board Relay
00	No Relay
10	One Relay (DPDT, N.O. or N.C., 5A @ 24 VDC)

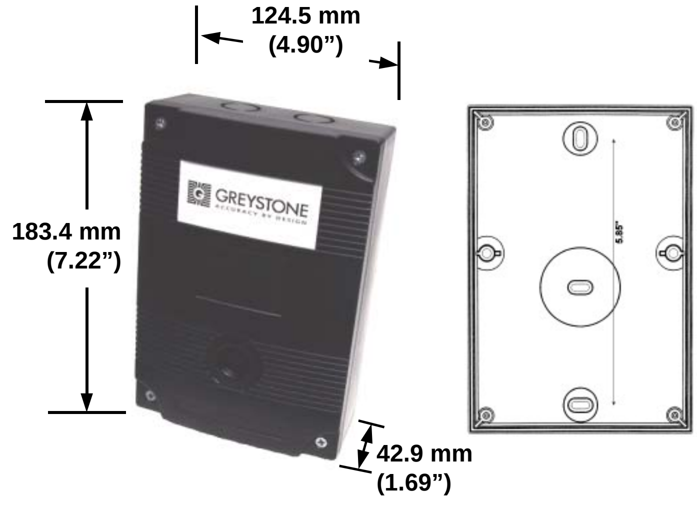
CODE	Options
0	No options
1	LCD
2	RS-485 Communication (Please contact Greystone)

CDD 1 A 1 00 0 ← **Typical Model Number**

Example: NDIR CO2 Corporate No Relay No Options

DIMENSIONS nts





ACLP SOFTWARE AND 5 YEAR CALIBRATION GUARANTEE

ACLP SOFTWARE

ACLP (Automatic Calibration Logic Program) software utilizes the computing power in the sensor's on-board microprocessor to remember the lowest CO2 concentration that takes place every 24 hours. The sensor assumes this low point is at outside levels. The sensor is also smart enough to discount periodic elevated readings that might occur if for example a space was used 24 hours per day over a few days. Once the sensor has collected 14 days worth of low concentration points it performs a statistical analysis to see if there has been any small changes in the sensor reading over background levels that could be attributable to sensor drift. If the analysis concludes there is drift, a small correction factor is made to the sensor calibration to adjust for this change.

5 YEAR CALIBRATION GUARANTEE

Based on the results of years of testing of **ACLP** software, Greystone now offers a 5 year calibration guarantee on all its CDD series wall and duct mount sensors used for CO2 based ventilation control when operated in an environment that can utilize **ACLP** software. If the sensor is found to be out of calibration more than 150 ppm as compared to a calibration gas or recently calibrated reference, Greystone will provide a free factory calibration of the sensor if returned to Greystone. This guarantee only applies if the sensor is operated in an environment where inside levels periodically drop to outside concentrations (i.e. during evenings or weekends when there is no occupancy) as is required by **ACLP** software. If a space does not experience a periodic drop to outside levels (e.g. where occupancy is 24 hours, 7 days/week), **ACLP** software should be deactivated off. With **ACLP** deactivated (via menu buttons) calibration may be required every 2 to 3 years.

GREYSTONE
ACCURACY BY DESIGN

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Greystone Energy Systems Inc., established in 1983, is Canada's largest manufacturer of HVAC sensors and transducers for Building Automation Management Systems. We have conscientiously established a worldwide reputation as an industry leader by maintaining leading-edge design technology, prompt technical support, and a commitment to on-time deliveries. We take pride in our Quality Management System which is ISO 9002 certified, assuring our customers of consistent product reliability.

GREYSTONE IS AN ISO 9002 REGISTERED COMPANY

Eaton H-Max™ HVAC Drives

The H-Max Series adjustable frequency drive is specifically designed to meet the needs of the HVAC industry by offering leading HVAC software and hardware features. With an industry leading energy efficiency algorithm, high short circuit current rating and robust design, it offers customers increased efficiency, safety and reliability.

Product Range

- 0.75 – 125HP 230V AC
- 1.5 – 250HP 480V AC
- NEMA 1/IP21 or NEMA 12/IP54 Packaging

Benefits

- Industry leading energy efficient solution
- Easy menu navigation
- Multi-monitoring capability
- Corrosion resistant circuit boards
- Extended shelf life
- Meets EMC Class C2 requirements
- Ideal feature set for HVAC

Features

- Active Energy control algorithm
- Graphic display and keypad
- On board communications (RS485: ModBus, BacNet, N2 Ethernet: ModBus TCP, BacNet IP)
- OnBoard I/O (6DI, 3RO, 2AI, 1AO)
- Conformal coated circuit boards
- Real-time clock with battery backup
- 5% DC link choke
- Thin metal film bus capacitors

Product	FS4		FS5		FS6		FS7		FS8		FS9	
Voltage	230 Vac	480 Vac	230 Vac	480 Vac	230 Vac	480 Vac	230 Vac	480 Vac	230 Vac	480 Vac	230 Vac	480 Vac
hp	0.75 - 4	1.5 - 7.5	5 - 10	10 - 20	15 - 20	25 - 40	25 - 30	50 - 75	50 - 75	100 -150	100 - 120	200 - 250
kW	0.55 - 3.0	1.1 - 5.5	4 - 7.5	7.5 - 15	11 - 15	18.5 - 30	18.5 - 30	37 - 55	37 - 55	75 - 110	75 - 90	132 - 160
Amps	3.7 - 12.5	3.4 - 12	18 - 31	16 - 31	48 - 62	38 - 61	75 - 105	72 - 105	140 - 205	140 - 205	261 - 310	261 - 310

Powering Business Worldwide

Output Ratings

Output voltage	0 to Vin/Uin line voltage in
Continuous output current	Ambient temperature max. 104°F (40°C)
IL overload	1.1 x IL (1 min./10 min.)
Overload current	110% (1 min./10 min.)
Initial output current	150% for two seconds
Output frequency	0 to 320 Hz
Frequency resolution	0.01 Hz

Ambient Conditions

Operating Temperature	14 degree's F (-10° C), no frost to 104 degree's F (40° C). (Drive can operate at 122° F (50° C), See Catalog for derating)
Storage Temperature	-40 degree's F (-40° C) to 158° F (70° C)
Relative Humidity	0 to 95%, noncondensing, non-corrosive, no dripping water
Altitude	100% load capacity up to 3280ft (1000m) 1% derating for each 328ft (100m) above 3280ft (1000m); max. 9842ft (3000m); 380 - 480V

Input Ratings

Input voltage (V_{in})	200–240 Vac, 380–480 Vac, –10%/+10%
Input frequency (f_{in})	50/60 Hz (variation up to 47–66 Hz)
Connection to power	Once per minute or less (typical operation)
Short circuit withstand rating	100 kAIC

Protections

Overcurrent protection	Yes
Overvoltage protection	Yes
DC bus regulation anti-trip	Yes (accelerates or decelerates the load)
Undervoltage protection	Yes
Earth fault protection	Yes (in case of earth fault in motor or motor cable, only the frequency converter is protected)
Input phase supervision	Yes (trips if any of the input phases are missing)
Motor phase supervision	Yes (trips if any of the output phases are missing)
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Motor underload protection	Yes
Short circuit protection	Yes
Surge protection	Yes (varistor input)
Conformed coated(varnished) boards	Yes (prevents corrosion)

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ECM 7:
Variable Frequency Drives

ECM Overview

Ameresco proposes to install (2) variable frequency drives for the two rooftop units (RTU-1 and RTU-2) located at the Goodnow Library. The VFDs will be integrated to the new EMS system. The installation of VFDs and controls on these RTUs will allow them to modulate with varying load more efficiently than the existing inlet guide vane method of control, which will reduce electrical energy and to improve system efficiency.

Figure 7.1: Existing belt driven fan with inlet guide vanes inside RTU-1.

ECM Detail

Existing System

The Goodnow Library is provided with heating hot water by a Smith gas-fired boiler that distributes hot water supply to RTU-1 and RTU-2, in addition to VAV boxes and baseboard radiators. The two Trane Model YCD rooftop units provide heating, cooling, and ventilation to the entire library through an overhead variable air volume (VAV) distribution system. RTU-1 is equipped with a 15 HP supply fan that supplies 10,600 CFM of conditioned air, and RTU-2 is equipped with a 15 HP supply fan that supplies 14,150 CFM of conditioned air. Air is distributed to each zone through 31 VAV boxes equipped with air dampers that modulate the amount of conditioned air supplied to each space based on the demand for heating or cooling. As the VAV boxes close and increase the system pressure, the inlet guide vanes in the rooftop units close as well to maintain the pressure setpoint. This modulates the amount of air flow into the system while maintaining the fan at a constant speed.

Building	Unit	Service	Motor Horse Power
Public Library	RTU-1	1st Level	15
Public Library	RTU-2	2nd Level	15

Proposed System

Ameresco proposes to install (2) variable frequency drives on the supply fans in RTU-1 and RTU-2. The new VFD's will be integrated in the proposed EMS as described in ECM 3. The existing inlet guide vanes will be disconnected from the existing control system and will be locked in the wide open position. The existing system pressure sensor signals will be connected to the new VFDs. The EMS system will capture the distribution system pressure of the rooftop units. The RTU controllers will output to the VFDs for min/max control based on the system pressure setpoint. The existing 15 HP standard motors will be replaced with new inverter duty rated motors to protect against voltage spikes.

In addition, VFD's will also provide the motors with soft-start capability, which will help to decrease spikes in power draw and decrease mechanical stress to equipment. All VFD's specified will come with bypass to enable operators to keep the fans operational if any maintenance on the VFD is required.

Electric energy savings will be realized because of the reduced power consumption of the motors controlled by the VFDs. The savings analyses are based on a calculated speed reduction estimated for each motor.

Work for this measure excludes any repair work to the identified air handling equipment.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect "As-Built" conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The new VFD's will provide improved fan control and significantly reduce electrical energy. VFD's will also enable soft start capability, which will reduce power draw spikes and decrease mechanical damage to equipment.

Appendix for ECM 7: Variable Frequency Drives

I. Energy Savings Calculations

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MAPC - Sudbury	
Energy and Demand Savings Summary	
Measure ID:	**7**
Measure Name:	**Variable Frequency Drives**
Measure Location:	
Engineers:	

Site Name:		**Library**	**Summary**
Item	Units	Savings	
Electricity			
Energy On-Peak	kWh	7,595	7,595
Energy Off-Peak	kWh	7,969	7,969
Energy Total	kWh	15,564	15,564
Demand On-Peak, Monthly	kW		0.0
Demand On-Peak, Annual	kW		0.0
Demand Off-Peak, Monthly	kW		0.0
Demand Off-Peak, Annual	kW		0.0
Fossil Fuel			
Natural Gas (NG)	Therms		0
Liquid Propane Gas (LPG)	Gallons		0
Steam	Mlbs		0
Fuel Oil, #2	Gallons		0
Fuel Oil, #4	Gallons		0
Fuel Oil, #6	Gallons		0
Miscellaneous	Misc		0
Water			
Water Savings	kGallons		0
Sewer			
Sewer Savings	kGallons		0

MAPC - Sudbury
Public Library
Variable Frequency Drives

TMY-2 Weather Data for Worcester, MA								Proposed EMS Schedule and Loads								Existing Fan Usage		Proposed Fan Usage			Savings	
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ. Cool/ Heat Load (MBH)	UnOcc. Cool/ Heat Load (MBH)	Occ Cooling/Heating Energy Consump. (MMBTU)	UnOcc Cooling/Heating Energy Consump. (MMBTU)	Peak Cool/Heat Fan Usage (kWh)	Off-Peak Cool/Heat Fan Usage (kWh)	Proposed VFD Load Percentage (%)	Occ Cool/Heat Fan Usage (kWh)	UnOcc Cool/Heat Fan Usage (kWh)	HVAC Fan Savings (Peak kWh)	HVAC Fan Savings (Off-Peak kWh)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**
Cooling																						
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	1,160	705	0	0	0	0	100%	0	0	0	0
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	1,044	634	0	0	0	0	100%	0	0	0	0
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	0	928	564	0	0	4	4	100%	4	4	(0)	(0)
90 to 95	92.5	69.8	34.2	0	8	0	8	2	0	2	4	812	493	1	1	31	32	100%	31	33	(1)	(1)
85 to 90	87.5	70.3	34.6	1	37	6	44	13	0	11	20	696	423	6	3	152	159	90%	136	143	15	16
80 to 85	82.5	68.4	33.0	8	138	29	175	50	0	44	81	580	352	19	10	537	563	80%	419	439	118	123
75 to 80	77.5	66.2	31.2	27	202	83	312	89	0	79	144	464	282	27	14	837	878	70%	557	584	280	294
70 to 75	72.5	64.3	29.7	64	269	160	493	141	0	125	227	348	211	32	16	1,134	1,189	60%	627	657	507	532
65 to 70	67.5	61.2	27.5	185	208	243	636	182	0	161	293	232	141	27	14	1,219	1,279	50%	541	568	677	711
60 to 65	62.5	57.3	24.8	315	249	298	862	246	0	218	398	116	70	18	10	1,321	1,386	40%	449	471	872	915
Heating																						
55 to 60	57.5	52.7	0.0	303	245	276	824	235	0	209	380	(134)	(3)	0	12	1,263	1,325	40%	429	450	834	875
50 to 55	52.5	47.8	0.0	262	184	228	674	192	0	171	311	(187)	(36)	12	20	1,205	1,265	47%	493	517	713	748
45 to 50	47.5	42.5	0.0	204	230	211	645	184	0	163	298	(240)	(69)	31	36	1,318	1,383	53%	633	664	686	719
40 to 45	42.5	38.3	0.0	210	191	234	635	181	0	161	293	(294)	(102)	49	51	1,460	1,532	60%	807	847	653	685
35 to 40	37.5	33.8	0.0	321	301	286	908	259	0	230	419	(347)	(135)	96	97	2,320	2,434	67%	1,455	1,527	865	907
30 to 35	32.5	28.7	0.0	356	221	313	890	254	0	225	411	(401)	(168)	120	118	2,501	2,624	73%	1,759	1,846	742	779
25 to 30	27.5	23.5	0.0	228	211	211	650	186	0	165	300	(454)	(202)	106	103	1,993	2,091	80%	1,556	1,632	437	459
20 to 25	22.5	19.1	0.0	104	94	124	322	92	0	82	149	(508)	(235)	62	60	1,069	1,122	87%	919	964	150	158
15 to 20	17.5	14.3	0.0	144	78	117	339	97	0	86	156	(561)	(268)	75	72	1,213	1,272	93%	1,139	1,195	74	77
10 to 15	12.5	9.3	0.0	118	40	85	243	69	0	62	112	(614)	(301)	61	58	931	977	100%	950	997	(19)	(20)
5 to 10	7.5	5.0	0.0	52	10	15	77	22	0	20	36	(668)	(334)	22	20	295	310	100%	301	316	(6)	(6)
0 to 5	2.5	2.2	0.0	18	3	1	22	6	0	6	10	(721)	(367)	7	6	84	88	100%	86	90	(2)	(2)
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	(775)	(400)	0	0	0	0	100%	0	0	0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	(828)	(433)	0	0	0	0	100%	0	0	0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	(882)	(466)	0	0	0	0	100%	0	0	0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	(935)	(499)	0	0	0	0	100%	0	0	0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	(988)	(532)	0	0	0	0	100%	0	0	0	0
				2,920	2,920	2,920	8,760	2,500	0	2,219	4,041			769	720	20,886	21,914		13,291	13,945	7,595	7,969
																					2469.17882	2,591
																					5125.8712	5,378

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Proposed Operating hours
M	Proposed Occupied Cooling and Heating Loads from EMS
N	Proposed Unoccupied Cooling and Heating Loads from EMS
O	Proposed Occupied Cooling and Heating Usage from EMS
P	Proposed Unoccupied Cooling and Heating Usage from EMS
Q	= ([col I] + [col J] x P47) x P44 x [col S] ^ P45
R	= ([col K] + [col L] x P47) x P44 x [col S] ^ P45
S	Estimated VFD Loading based on 100% at design day load and 40% at minimum
T	= ([col I] + [col J] x P47) x P44 x [col S] ^ P46 ÷ 0.98
U	= ([col K] + [col L] x P47) x P44 x [col S] ^ P46 ÷ 0.98
V	= ([col Q] - [col T])
W	= ([col R] - [col U])

Assumptions:	Value	Unit	CELL		Description
			REF		
Occupied Area	32,800	SF	**P43**		
Fan Power	13.4	kW	**P44**		2 RTUs with 15 HP Fan Motors
Exisiting VAV Factor	1.0		**P45**		IGV
Proposed VAV Factor	2.2		**P46**		VFD with static pressure control
UnOcc. Fan Cycling	10.0%		**P47**		% Operating Hours During UnOcc.

Appendix for ECM 7: Variable Frequency Drives

II. Manufacturer Specification Sheets

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Eaton H-Max^{TM} HVAC Drives

The H-Max Series adjustable frequency drive is specifically designed to meet the needs of the HVAC industry by offering leading HVAC software and hardware features. With an industry leading energy efficiency algorithm, high short circuit current rating and robust design, it offers customers increased efficiency, safety and reliability.

Product Range

- 0.75 – 125HP 230V AC
- 1.5 – 250HP 480V AC
- NEMA 1/IP21 or NEMA 12/IP54 Packaging

Benefits

- Industry leading energy efficient solution
- Easy menu navigation
- Multi-monitoring capability
- Corrosion resistant circuit boards
- Extended shelf life
- Meets EMC Class C2 requirements
- Ideal feature set for HVAC

Features

- Active Energy control algorithm
- Graphic display and keypad
- On board communications (RS485: ModBus, BacNet, N2 Ethernet: ModBus TCP, BacNet IP)
- OnBoard I/O (6DI, 3RO, 2AI, 1AO)
- Conformal coated circuit boards
- Real-time clock with battery backup
- 5% DC link choke
- Thin metal film bus capacitors

Product	FS4		FS5		FS6		FS7		FS8		FS9	
Voltage	230 Vac	480 Vac	230 Vac	480 Vac	230 Vac	480 Vac	230 Vac	480 Vac	230 Vac	480 Vac	230 Vac	480 Vac
hp	0.75 - 4	1.5 - 7.5	5 - 10	10 - 20	15 - 20	25 - 40	25 - 30	50 - 75	50 - 75	100 -150	100 - 120	200 - 250
kW	0.55 - 3.0	1.1 - 5.5	4 - 7.5	7.5 - 15	11 - 15	18.5 - 30	18.5 - 30	37 - 55	37 - 55	75 - 110	75 - 90	132 - 160
Amps	3.7 - 12.5	3.4 - 12	18 - 31	16 - 31	48 - 62	38 - 61	75 - 105	72 - 105	140 - 205	140 - 205	261 - 310	261 - 310

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Output Ratings

Output voltage	0 to Vin/Uin line voltage in
Continuous output current	Ambient temperature max. 104°F (40°C)
IL overload	1.1 x IL (1 min./10 min.)
Overload current	110% (1 min./10 min.)
Initial output current	150% for two seconds
Output frequency	0 to 320 Hz
Frequency resolution	0.01 Hz

Ambient Conditions

Operating Temperature	14 degree's F (-10° C), no frost to 104 degree's F (40° C). (Drive can operate at 122° F (50° C), See Catalog for derating)
Storage Temperature	-40 degree's F (-40° C) to 158° F (70° C)
Relative Humidity	0 to 95%, noncondensing, non-corrosive, no dripping water
Altitude	100% load capacity up to 3280ft (1000m) 1% derating for each 328ft (100m) above 3280ft (1000m); max. 9842ft (3000m); 380 - 480V

Input Ratings

Input voltage (V_{in})	200–240 Vac, 380–480 Vac, –10%/+10%
Input frequency (f_{in})	50/60 Hz (variation up to 47–66 Hz)
Connection to power	Once per minute or less (typical operation)
Short circuit withstand rating	100 kAIC

Protections

Overcurrent protection	Yes
Overvoltage protection	Yes
DC bus regulation anti-trip	Yes (accelerates or decelerates the load)
Undervoltage protection	Yes
Earth fault protection	Yes (in case of earth fault in motor or motor cable, only the frequency converter is protected)
Input phase supervision	Yes (trips if any of the input phases are missing)
Motor phase supervision	Yes (trips if any of the output phases are missing)
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Motor underload protection	Yes
Short circuit protection	Yes
Surge protection	Yes (varistor input)
Conformed coated(varnished) boards	Yes (prevents corrosion)

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EATON
Powering Business Worldwide

H-Max Series Drives

Contents

Product Overview

H-Max Family Introduction

Eaton's H-Max™ Series VFD is the next generation of drives specifically engineered for HVAC pump and fluid control applications. The H-Max family of products boasts industry leading energy efficiency algorithms for your applications. Not only are the drives ultra-efficient—they contain software that minimizes motor winding energy loses in your applications. Designed for easy installation, simple startup, and long life; the H-Max Series drive family provides exceptional value to our customers,

Product Range

Open Style Drives:

- 0.75–125 hp at 230 Vac
- 1.5–250 hp at 480 Vac

Note: Available in NEMA 1 or NEMA 12 designs.

IntelliPass/IntelliDisconnect Drives:

- 1–30 hp at 208 Vac
- 1–30 hp at 230 Vac
- 1–75 hp at 480 Vac

Note: Available in NEMA 1, NEMA 12, or NEMA 3R enclosures.

Application Description

The H-Max Series drive was designed specifically for HVAC pump and fluid control applications. It is intended to be used on variable torque loads with the intent of moving air or liquids. With this in mind, the H-Max drive has onboard I/O pre-programmed to meet the common needs for these applications. The H-Max drive supports items such as standard speed control, PID functionality, as well as multi-motor applications. The drive easily supports interlock, second motor parameter set, as well as fire mode functionality.

Key Feature

Active Energy Control Algorithm

Eaton's H-Max Series drives have been designed to provide industry leading energy saving solutions. Not only is the drive ultra-efficient, the drive seeks the most efficient operating point of the motor, minimizing energy loss in the windings per the given load requirements. This is an Eaton protected control algorithm exclusive to H-Max drives.

H-Max Drives

Contents

H-Max Drives

Product Description

Eaton's H-Max Series VFD has software and hardware designed specifically for the HVAC, pump industry. The ultra-efficient DC capacitor and power structure allows the drive to consume less energy, lowering greenhouse gases.

The I/O configuration is designed with wiring ergonomics in mind by including removable terminal blocks. The main, easily removable, control board used for all drive frames with six digital IN, two analog IN, one analog OUT, three relay OUT accepts two additional I/O or communication board. In addition, the control board has built-in RS-485 and Ethernet communication.

These drives continue the tradition of robust performance, and raise the bar on features and functionality, ensuring the best solution at the right price.

In addition to the Active Energy Control Algorithm to maximize motor efficiency, the drive boasts an ultra-efficient DC capacitor and power structure to allow less energy consumption, lowering greenhouse gases.

Features and Benefits

Hardware

- Thin metal capacitor design—ultra-efficient drive operation and extended self life (up to five years without reforming)
- Integrated 5% DC link choke with Input surge protection—protects against voltage spikes and provides a clean wave form to the motor
- EMI/RFI filters standard on all drives—meets EMC Category 2 for commercial applications
- Real-time clock—supports calendaring and PLC functionality
- Graphic LCD display and keypad—supports simple menu navigation as well as on-screen diagnostics and troubleshooting
- HAND-OFF-AUTO and drive-bypass selector on keypad—simplifies control
- Standard I/O: 6DI, 2AI, 1AO, 2 Form C RO (NO/NC), 1 Form A RO (NO)—supports requirements for most installations
- Onboard RS 485: Modbus, N2, BACnet—meets needs of most communication requirements
- Onboard Ethernet: BACnet/IP, Modbus/TCP—meets needs of most communication requirements
- Two expansion slots—intended to support additional I/O or communication protocols as necessary
- Quick disconnect terminals for I/O connections—supports fast easy installation

Software

- Active energy control—minimizes energy losses in your motor resulting in industry leading energy efficiency for your application
- Quick Start Wizard upon initial power up—supports fast easy installation
- Copy/paste functionality on drive keypad—allows for fast setup of multiple drives
- Pre-programmed I/O—supports fast easy installation for most applications

Standards and Certifications

Product

- IEC 61800-5-1
- CE
- cUL

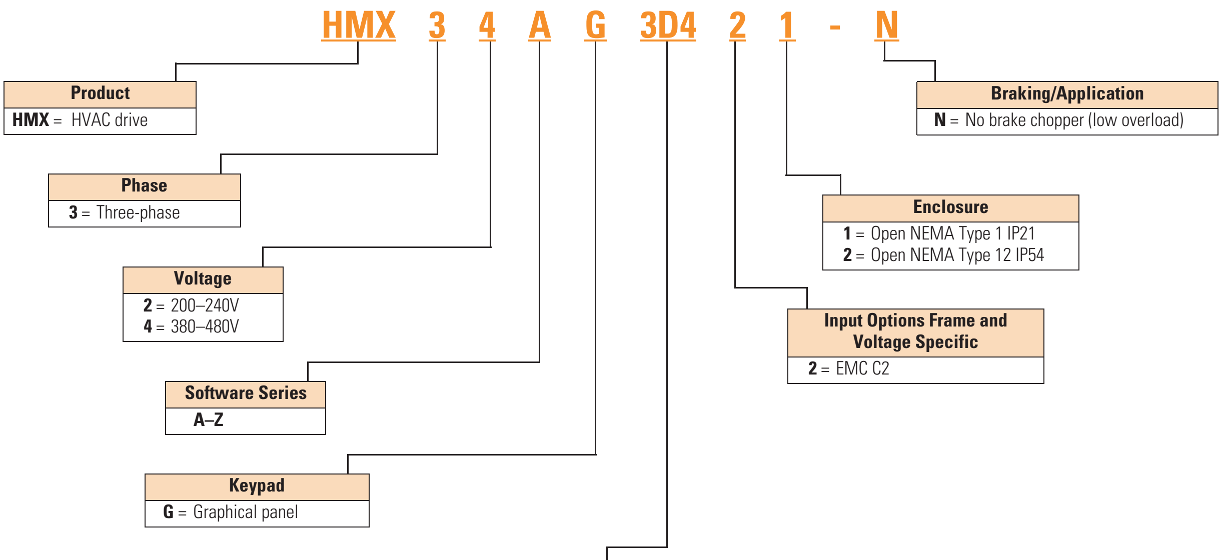
Safety

- UL 508C
- EN 61800-5-1
- CE
- cUL

- C-Tick Mark

Catalog Number Selection

H-Max Series Drives



Product
HMX = HVAC drive

Phase
3 = Three-phase

Voltage
2 = 200–240V
4 = 380–480V

Software Series
A–Z

Keypad
G = Graphical panel

Braking/Application
N = No brake chopper (low overload)

Enclosure
1 = Open NEMA Type 1 IP21
2 = Open NEMA Type 12 IP54

Input Options Frame and Voltage Specific
2 = EMC C2

Amperes			
200–240 Volts		**380–480 Volts**	
3D7 = 3.7A–0.75 hp, 0.55 kW	**062** = 62A–20 hp, 15 kW	**3D4** = 3.4A–1.5 hp, 1.1 kW	**046** = 46A–30 hp, 22 kW
4D8 = 4.8A–1 hp, 0.75 kW	**075** = 75A–25 hp, 18.5 kW	**4D8** = 4.8–2 hp, 1.5 kW	**061** = 61A–40 hp, 30 kW
6D6 = 6.6A–1.5 hp, 1.1 kW	**088** = 88A–30 hp, 22 kW	**5D6** = 5.6A–3 hp, 2.2 kW	**072** = 72A–50 hp, 37 kW
8D0 = 8A–2 hp, 1.5 kW	**105** = 105A–40 hp, 30 kW	**8D0** = 8A–4 hp, 3 kW	**087** = 87A–60 hp, 45 kW
011 = 11A–3 hp, 2.2 kW	**140** = 140A–50 hp, 37 kW	**9D6** = 9.6A–5 hp, 4 kW	**105** = 105A–75 hp, 55 kW
012 = 12A–4 hp, 3 kW	**170** = 170A–60 hp, 45 kW	**012** = 12A–7.5 hp, 5.5 kW	**140** = 140A–100 hp, 75 kW
018 = 18A–5 hp, 4 kW	**205** = 205A–75 hp, 55 kW	**016** = 16A–10 hp, 7.5 kW	**170** = 170A–125 hp, 90 kW
024 = 24A–7.5 hp, 5.5 kW	**261** = 261A–100 hp, 75 kW	**023** = 23A–15 hp, 11 kW	**205** = 205A–150 hp, 110 kW
031 = 31A–10 hp, 7.5 kW	**310** = 310A–125 hp, 90 kW	**031** = 31A–20 hp, 15 kW	**261** = 261A–200 hp, 132 kW
048 = 48A–15 hp, 11 kW		**038** = 38A–25 hp, 18.5 kW	**310** = 310A–250 hp, 160 kW

Notes

All boards are varnished (conformed coated). Corrosion resistant.

Battery included in all drives for real-time clock.

Keypad kit includes HOA bypass.

Keypad kit includes HOA, back reset for Europe application.

EMI/RFI filters included.

DC link choke included.

Product Selection

H-Max Series Drives—230 Vac

NEMA Type 1

NEMA Type 1/IP21

FS Frame Size	Drive Output Current Low Overload Full Load Amps at 40°C	Horsepower	Assigned Motor Ratings Drive kW 230 Vac/50 Hz	230 Vac NEC Amps ①	Low Overload Full Load Amps at 50°C	Catalog Number
4	3.7	0.75	0.55	3.2	2.6	**HMX32AG3D721-N**
	4.8	1	0.75	4.2	3.7	**HMX32AG4D821-N**
	6.6	1.5	1.1	6.6	4.8	**HMX32AG6D621-N**
	8	2	1.5	6.8	6.6	**HMX32AG8D021-N**
	11	3	2.2	9.6	8	**HMX32AG01121-N**
	12.5	4	3	N/A	11	**HMX32AG01221-N**
5	18	5	4	15.2	12.5	**HMX32AG01821-N**
	24	7.5	5.5	22	18	**HMX32AG02421-N**
	31	10	7.5	28	24	**HMX32AG03121-N**
6	48	15	11	42	31	**HMX32AG04821-N**
	62	20	15	54	48	**HMX32AG06221-N**
7	75	25	18.5	68	62	**HMX32AG07521-N**
	88	30	22	80	75	**HMX32AG08821-N**
	105	40	30	104	88	**HMX32AG10521-N**
8	140	50	37	130	105	**HMX32AG14021-N**
	170	60	45	154	140	**HMX32AG17021-N**
	205	75	55	192	170	**HMX32AG20521-N**
9	261	100	75	248	205	**HMX32AG26121-N**
	310	125	90	N/A	261	**HMX32AG31021-N**

NEMA Type 12

NEMA Type 12/IP54

FS Frame Size	Drive Output Current Low Overload Full Load Amps at 40°C	Horsepower	Assigned Motor Ratings Drive kW 230 Vac/50 Hz	230 Vac NEC Amps ①	Low Overload Full Load Amps at 50°C	Catalog Number
4	3.7	0.75	0.55	3.2	2.6	**HMX32AG3D722-N**
	4.8	1	0.75	4.2	3.7	**HMX32AG4D822-N**
	6.6	1.5	1.1	6.6	4.8	**HMX32AG6D622-N**
	8	2	1.5	6.8	6.6	**HMX32AG8D022-N**
	11	3	2.2	9.6	8	**HMX32AG01122-N**
	12.5	4	3	N/A	11	**HMX32AG01222-N**
5	18	5	4	15.2	12	**HMX32AG01822-N**
	24	7.5	5.5	22	18	**HMX32AG02422-N**
	31	10	7.5	28	24	**HMX32AG03122-N**
6	48	15	11	42	31	**HMX32AG04822-N**
	62	20	15	54	48	**HMX32AG06222-N**
7	75	25	18.5	68	62	**HMX32AG07522-N**
	88	30	22	80	75	**HMX32AG08822-N**
	105	40	30	104	88	**HMX32AG10522-N**
8	140	50	37	130	105	**HMX32AG14022-N**
	170	60	45	154	140	**HMX32AG17022-N**
	205	75	55	192	170	**HMX32AG20522-N**
9	261	100	75	248	205	**HMX32AG26122-N**
	310	125	90	N/A	261	**HMX32AG31022-N**

Note

① For sizing reference.

H-Max Series Drives—480 Vac

NEMA Type 1

NEMA Type 1/IP21

FS Frame Size	Drive Output Current Low Overload Full Load Amps at 40°C	Horsepower	Assigned Motor Ratings Drive kW 400 Vac/50 Hz	480 Vac NEC Amps ①	Low Overload Full Load Amps at 50°C	Catalog Number
4	3.4	1.5	1.1	2.1	2.6	**HMX34AG3D421-N**
	4.8	2	1.5	3.4	3.4	**HMX34AG4D821-N**
	5.6	3	2.2	5.6	4.8	**HMX34AG5D621-N**
	8.0	4	3.0	N/A	5.6	**HMX34AG8D021-N**
	9.6	5	4	7.6	8	**HMX34AG9D621-N**
	12	7.5	5.5	11	9.6	**HMX34AG01221-N**
5	16	10	7.5	14	12	**HMX34AG01621-N**
	23	15	11	21	16	**HMX34AG02321-N**
	31	20	15	27	23	**HMX34AG03121-N**
6	38	25	18.5	34	31	**HMX34AG03821-N**
	46	30	22	40	38	**HMX34AG04621-N**
	61	40	30	52	46	**HMX34AG06121-N**
7	72	50	37	65	61	**HMX34AG07221-N**
	87	60	45	77	72	**HMX34AG08721-N**
	105	75	55	96	87	**HMX34AG10521-N**
8	140	100	75	124	105	**HMX34AG14021-N**
	170	125	90	156	140	**HMX34AG17021-N**
	205	150	110	180	170	**HMX34AG20521-N**
9	261	200	132	240	205	**HMX34AG26121-N**
	310	250	160	302	261	**HMX34AG31021-N**

NEMA Type 12

NEMA Type 12/IP54

FS Frame Size	Drive Output Current Low Overload Full Load Amps at 40°C	Horsepower	Assigned Motor Ratings Drive kW 400 Vac/50 Hz	480 Vac NEC Amps ①	Low Overload Full Load Amps at 50°C	Catalog Number
4	3.4	1.5	1.1	2.1	2.6	**HMX34AG3D422-N**
	4.8	2	1.5	3.4	3.4	**HMX34AG4D822-N**
	5.6	3	2.2	5.6	4.8	**HMX34AG5D622-N**
	8.0	4	3.0	N/A	5.6	**HMX34AG8D022-N**
	9.6	5	4	7.6	8	**HMX34AG9D622-N**
	12	7.5	5.5	11	9.6	**HMX34AG01222-N**
5	16	10	7.5	14	12	**HMX34AG01622-N**
	23	15	11	21	16	**HMX34AG02322-N**
	31	20	15	27	23	**HMX34AG03122-N**
6	38	25	18.5	34	31	**HMX34AG03822-N**
	46	30	22	40	38	**HMX34AG04622-N**
	61	40	30	52	46	**HMX34AG06122-N**
7	72	50	37	65	61	**HMX34AG07222-N**
	87	60	45	77	72	**HMX34AG08722-N**
	105	75	55	96	87	**HMX34AG10522-N**
8	140	100	75	124	105	**HMX34AG14022-N**
	170	125	90	156	140	**HMX34AG17022-N**
	205	150	110	180	170	**HMX34AG20522-N**
9	261	200	132	240	205	**HMX34AG26122-N**
	310	250	160	302	261	**HMX34AG31022-N**

Note

① For sizing reference.

Onboard Network Communications

Johnson Controls Metasys N2

H-Max Series provides communication between the drive and a Johnson Controls Metasys™ N2 network. With this connection, the drive can be controlled, monitored and programmed from the Metasys system. N2 can be selected and programmed by the drive keypad.

BACnet

H-Max Series provides communication to BACnet networks. Data transfer is master-slave/token passing (MS/TP) RS-485.

BACnet IP

100 base T interface.

Modbus TCP

Ethernet based protocol.

Modbus RTU

H-Max Series provides communication to Modbus RTU RS-485 as a slave on a Modbus network. Other communication parameters include an address range from 1–247; a parity of None, Odd or Even; and the stop bit is 1.

H-Max Series Option Board Kits Available for Slot B

The factory issued relay option board can be replaced with the following option boards to customize the drive for your application needs.

The standard board provides 2 Form C RO (NO/NC) and 1 Form A RO (NO).

Option Boards Mounted in Slot B

Option Kit Description	Option Kit Catalog Number
I/O expander card, 2 RO and thermistor input	**Relay Board 2**

H-Max Series Option Board Kits Available for Slots D and E

The H-Max Series drives can accommodate a wide selection of expander and adapter option boards to customize the drive for your application needs. The drive's control unit is designed to accept a total of two option boards.

The H-Max Series factory-installed standard board configuration includes an I/O board and a relay output board.

Option Boards Mounted in Slots D and E

Option Kit Description	Option Kit Catalog Number
6 x DI /DO, each digital input can be individually programmed as digital output	**XMX-IO-B1-A**
1RO Form C (NO/NC), 1RO Form A (NO), 1 thermistor	**XMX-IO-B2-A**
1 x AI, 2 x AO (isolated)	**XMX-IO-B4-A**
3 x RO Form A (NO)	**XMX-IO-B5-A**
1RO Form A (NO), 5DI 42–240 Vac input	**XMX-IO-B9-A**
1 x AO, 1 x DO, 1 x RO	**XMX-IO-BF-A**
LonWorks®	**XMX-COM-C4-A**

NEMA Type 1 to NEMA Type 12/IP54 Conversion Kit

The NEMA Type 12/IP54 option kit is used to convert a NEMA Type 1 to a NEMA Type 12 drive.

Kit consists of a drive cover, fan kit and plugs.

NEMA Type 12/IP54 Cover

Option Kit Description	Option Kit Catalog Number
FS4-branded N12/IP54 cover with gasket, plastic plug, fans, Eaton logos	**FS4-N12KIT**
FS5-branded N12/IP54 cover with gasket, plastic plug, fans, Eaton logos	**FS5-N12KIT**
FS6-branded N12/IP54 cover with gasket, plastic plug, fans, Eaton logos	**FS6-N12KIT**

Accessories

Flange Kits

The flange kit is used when the power section heat sink is mounted through the back panel of an enclosure.

Flange Kit NEMA Type 1/IP21

Includes flange, mounting brackets, and screws.

Flange Kit NEMA Type 12/IP54

Includes flange, mounting brackets, NEMA Type 12 fan components, air shroud screws and plugs.

Frames FS4–FS9 ①②

Description	Catalog Number
NEMA Type 12/IP54	
FS4 N12/IP54 flange kit (mounting N1 drive into N12 enclosure)	**FS4-Flange-N12KIT**
FS5 N12/IP54 flange kit (mounting N1 drive into N12 enclosure)	**FS5-Flange-N12KIT**
FS6 N12/IP54 flange kit (mounting N1 drive into N12 enclosure)	**FS6-Flange-N12KIT**
FS7 N12/IP54 flange kit (mounting N1 drive into N12 enclosure)	**FS7-Flange-N12KIT**

Keypad Accessories

Remote Mounting Keypad Kit

Frames FS4–FS9

Description	Catalog Number
Remote mounting keypad kit—bezel and cable	**OPTRMT-BP-HMAX**

Drive Demo

H-Max Series Drive Demo

Demos and Power Supply

Description	Catalog Number
H-Max Series drive demo	**H-MAX-DEMO**
H-Max Series bypass demo	**H-MAX-BYPASS-DEMO**
Hand-held 24V auxiliary power supply—used to supply power to the control module in order to perform keypad programming before the drive is connected to line voltage	**9000XAUX24V**

Notes

① For installation of a NEMA Type 1 drive into a NEMA Type 12 oversized enclosure.

② Frame size 8 and 9 must be ordered from the factory as a flange mount unit.

Replacement Parts

Control Board/Keypad

Description	Current Catalog Number
H-Max Series graphic bypass, HOA	**KeypadbypassHOA**
H-Max Series graphic back, HOA	**KeypadbackHOA**

PC Cable

Description	Catalog Number
Remote download USB to RJ-45 cable with software driver disk	**REM-USB-Down**

Replacement Relay Board in Slot B

Description	Catalog Number
Replacement relay board qty 2 Form C relay, qty 1 Form A relay	**Relay board 1**

Main Fan

Description	Catalog Number
FS4 main fan	**FS4-Main Fan**
FS5 main fan	**FS5-Main Fan**
FS6 main fan	**FS6-Main Fan**
FS7 main fan	**FS7-Main Fan**

Internal Fan

Description	Catalog Number
FS4 internal fan (IP54/NEMA 12)	**FS4-Internal Fan**
FS5 internal fan (IP54/NEMA 12)	**FS5-Internal Fan**
FS6 internal fan (IP54/NEMA 12)	**FS6-Internal Fan**
FS7 internal fan (IP54/NEMA 12)	**FS7-Internal Fan**

Technical Data and Specifications

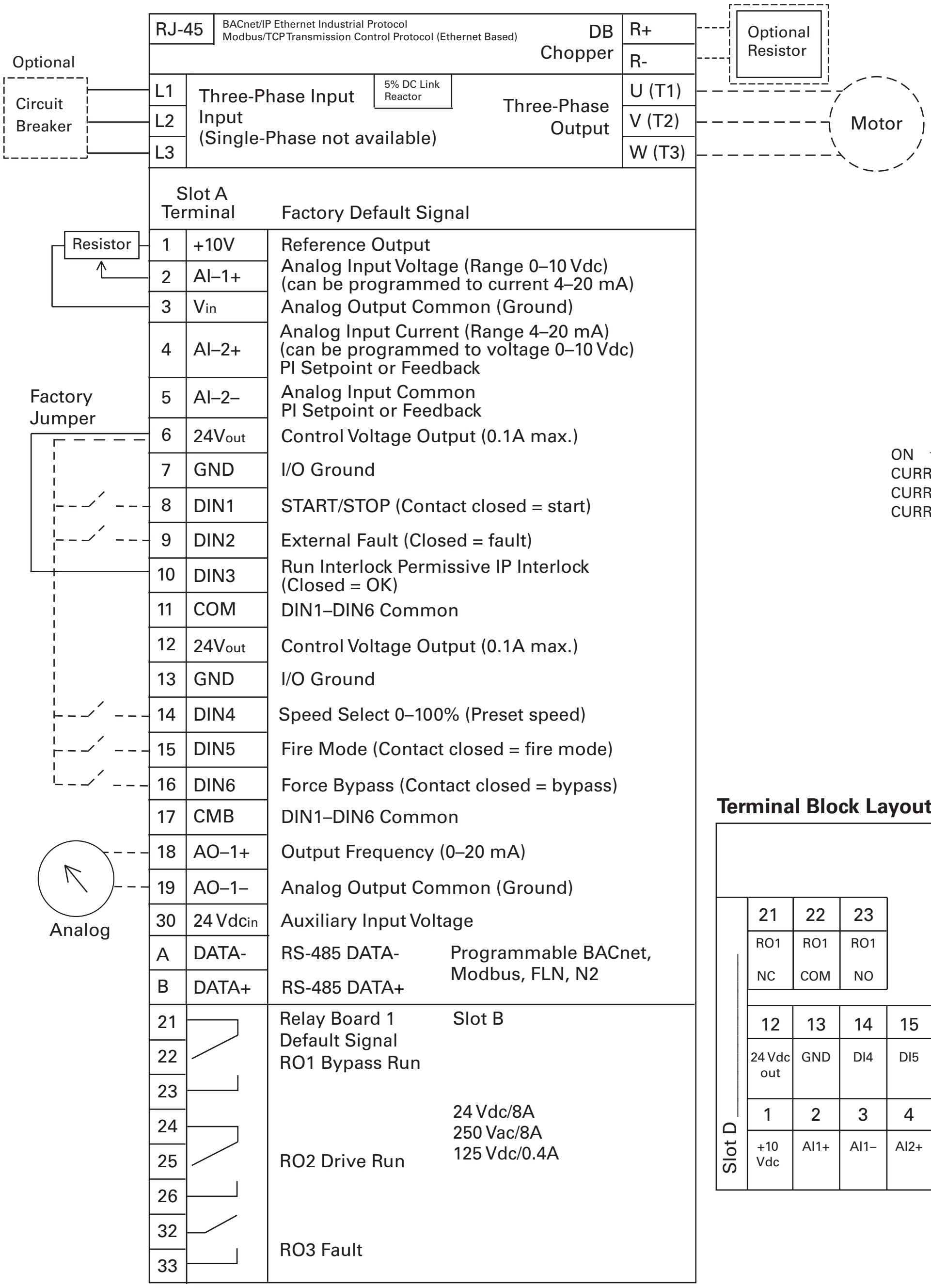
H-Max Series Drives

Description	Specification
Input Ratings	
Input voltage (V_{in})	200–240 Vac, 380–480 Vac, –10%/+10%
Input frequency (f_{in})	50/60 Hz (variation up to 47–66 Hz)
Connection to power	Once per minute or less (typical operation)
Short circuit withstand rating	100 kAIC
Output Ratings	
Output voltage	0 to V_{in}/U_{in} line voltage in
Continuous output current	Ambient temperature max. 104°F (40°C)
I_L overload	1.1 x I_L (1 min./10 min.)
Overload current	110% (1 min./10 min.)
Initial output current	150% for two seconds
Output frequency	0 to 320 Hz
Frequency resolution	0.01 Hz
Control Characteristics	
Control method	Frequency control (V/f) open loop sensorless vector control
Switching frequency	1–310 amps FS4–9: default 6 kHz
Frequency reference	Analog input: Resolution 0.1% (10-bit), accuracy ±1% Panel reference: Resolution 0.01 Hz
Field weakening point	8 to 320 Hz
Acceleration time	0.1 to 3000 seconds
Deceleration time	0.1 to 3000 seconds
Braking torque	DC brake: 30% x T_n
Ambient Conditions	
Ambient operating temperature	FS4–FS9: 14°F (–10°C), no frost to 104°F (40°C) (Drive can operate at 122°F (50°C), see **Pages V6-T2-141** and **V6-T2-142**)
Storage temperature	–40° to 158°F (–40° to 70°C)
Relative humidity	0 to 95% RH, noncondensing, non-corrosive, no dripping water
Air quality	Chemical vapors: IEC 60721-3-3, unit in operation, Class 3C2; Mechanical particles: IEC 60721-3-3, unit in operation, Class 3S2
Altitude	100% load capacity (no derating) up to 3280 ft (1000m); 1% derating for each 328 ft (100m) above 3280 ft (1000m); max. 9842 ft (3000m); 380–480V
Vibration	FS4–FS9: EN 61800-5-1, EN 60068-2-6; 5 to 150 Hz, displacement amplitude 1 mm (peak) at 5 to 15.8 Hz, max. acceleration amplitude 1G at 15.8 to 150 Hz
Shock	EN 61800-5-1, EN 60068-2-27 UPS Drop test (for applicable UPS weights) Storage and shipping: max. 15G, 11 ms (in package)
Enclosure class	NEMA Type 1/IP21 or NEMA Type 12/IP54 (keypad required for IP54/Type 12)
Standards	
EMC	Immunity: Fulfills all EMC immunity requirements; Emissions: EN 61800-3, LEVEL H (EMC C2)
Emissions	EMC level dependent— +EMC 2: EN61800-3 (2004) Category C2 Delivered with Class C2 EMC filtering as default.

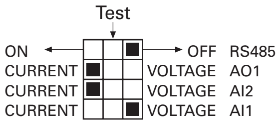
Description	Specification
Control Connections	
Analog input voltage	0 to 10V, R = 200 kohms differential Resolution 0.1%; Accuracy ±1% Dip switch selection (voltage/current)
Analog input current	0(4) to 20 mA; R_i –250 ohms differential
Digital inputs (6)	Positive or negative logic; 18 to 30 Vdc
Auxiliary voltage	+24V ±10%, max. 250 mA
Output reference voltage	+10V +3%, max. load 10 mA
Analog output	0–10V, 0(4) to 20 mA; R_L max. 500 ohms; Resolution 10 bit; Accuracy ±2% Dip switch selection (voltage/current)
Relay outputs	3 programmable, 2 Form C, 1 Form A relay outputs Switching capacity: 24 Vdc/8A, 250 Vac/8A, 125 Vdc/0.4A
Hard wire jumper	Between terminal 6 and 10 factory default
Dip switch setting default	RS485 = off A01 = current A12 = current A11 = voltage
Protections	
Overcurrent protection	Yes
Overvoltage protection	Yes
DC bus regulation anti-trip	Yes (accelerates or decelerates the load)
Undervoltage protection	Yes
Earth fault protection	Yes (in case of earth fault in motor or motor cable, only the frequency converter is protected)
Input phase supervision	Yes (trips if any of the input phases are missing)
Motor phase supervision	Yes (trips if any of the output phases are missing)
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Motor underload protection	Yes
Short circuit protection	Yes
Surge protection	Yes (varistor input)
Conformed coated (varnished) boards	Yes (prevents corrosion)

Wiring Diagram

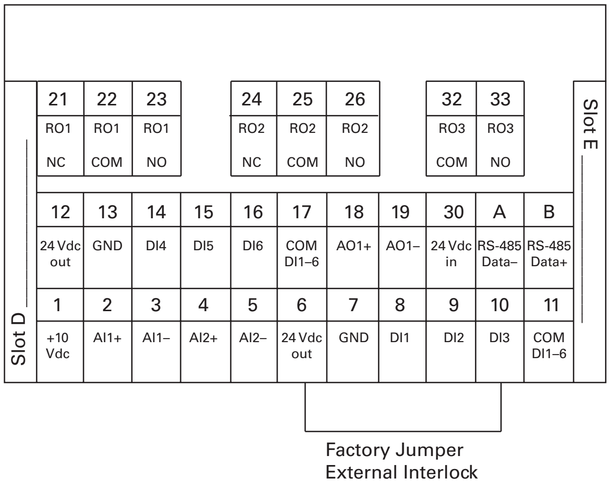
Control Input/Output, PID Application



Slot A Terminal		Factory Default Signal	
1	+10V	Reference Output	
2	AI–1+	Analog Input Voltage (Range 0–10 Vdc) (can be programmed to current 4–20 mA)	
3	Vin	Analog Output Common (Ground)	
4	AI–2+	Analog Input Current (Range 4–20 mA) (can be programmed to voltage 0–10 Vdc) PI Setpoint or Feedback	
5	AI–2–	Analog Input Common PI Setpoint or Feedback	
6	24Vout	Control Voltage Output (0.1A max.)	
7	GND	I/O Ground	
8	DIN1	START/STOP (Contact closed = start)	
9	DIN2	External Fault (Closed = fault)	
10	DIN3	Run Interlock Permissive IP Interlock (Closed = OK)	
11	COM	DIN1–DIN6 Common	
12	24Vout	Control Voltage Output (0.1A max.)	
13	GND	I/O Ground	
14	DIN4	Speed Select 0–100% (Preset speed)	
15	DIN5	Fire Mode (Contact closed = fire mode)	
16	DIN6	Force Bypass (Contact closed = bypass)	
17	CMB	DIN1–DIN6 Common	
18	AO–1+	Output Frequency (0–20 mA)	
19	AO–1–	Analog Output Common (Ground)	
30	24 Vdcin	Auxiliary Input Voltage	
A	DATA-	RS-485 DATA-	Programmable BACnet, Modbus, FLN, N2
B	DATA+	RS-485 DATA+	
21		Relay Board 1 Default Signal RO1 Bypass Run	Slot B
22			
23			
24			24 Vdc/8A 250 Vac/8A 125 Vdc/0.4A
25		RO2 Drive Run	
26			
32			
33		RO3 Fault	



Terminal Block Layout



21	22	23	24	25	26	32	33
RO1 NC	RO1 COM	RO1 NO	RO2 NC	RO2 COM	RO2 NO	RO3 COM	RO3 NO

12	13	14	15	16	17	18	19	30	A	B
24 Vdc out	GND	DI4	DI5	DI6	COM DI1–6	AO1+	AO1–	24 Vdc in	RS-485 Data–	RS-485 Data+

1	2	3	4	5	6	7	8	9	10	11
+10 Vdc	AI1+	AI1–	AI2+	AI2–	24 Vdc out	GND	DI1	DI2	DI3	COM DI1–6

Standards

- Digital inputs D1–D6, relay out, analog in/out are freely programmed
- The user can assign a single input to multiple functions

Includes

- Six digital input
- Two analog input
- One analog output
- Three relay output
- RS-485
- Ethernet (BACnet and Modbus)

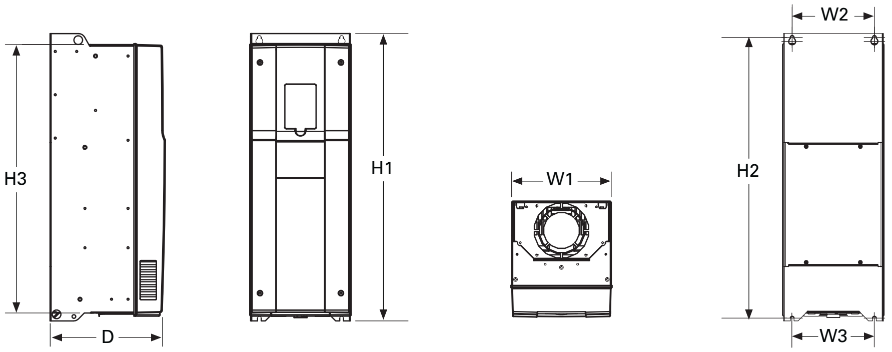
Reliability

- Pretested components
- Conformal coated (varnished) boards
- 40°C rated
- 110% overload for one minute
- Eaton Electrical Services & Systems national network of AF drive specialists

Dimensions

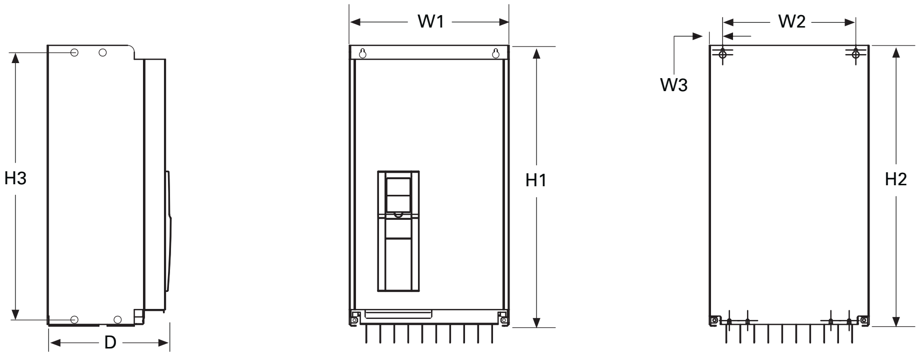
Approximate Dimensions in Inches (mm)

H-Max Series Frames FS4–FS7



Voltage	hp	kW	Amps	D	H1	Hole Center-to-Center H2	H3	W1	W2	W3	Weight in Lbs (kg)
FS4											
230 Vac	0.75–4	0.55–3.0	3.7–12.5	7.77 (197.3)	12.89 (327.5)	12.32 (313.0)	11.22 (285.0)	5.04 (128.0)	3.94 (100.0)	3.94 (100.0)	13.2 (6)
480 Vac	1.5–7.5	1.1–5.5	3.4–12								
FS5											
230 Vac	5–10	4–7.5	18–31	8.73 (221.6)	16.50 (419.0)	15.98 (406.0)	15.04 (382.0)	5.67 (144.0)	4.53 (115.0)	3.94 (100.0)	22.0 (10)
480 Vac	10–20	7.5–15	16–31								
FS6											
230 Vac	15–20	11–15	48–62	9.29 (236.0)	21.93 (557.0)	21.28 (540.5)	20.24 (514.0)	7.68 (195.0)	5.83 (148.0)	5.83 (148.0)	44.1 (20)
480 Vac	25–40	18.5–30	38–61								
FS7											
230 Vac	25–30	18.5–30	75–105	10.49 (266.5)	25.98 (660.0)	25.39 (645.0)	24.29 (617.0)	9.06 (230.0)	7.48 (190.0)	7.48 (190.0)	82.6 (37.5)
480 Vac	50–75	37–55	72–105								

H-Max Series Frames FS8 and FS9



Voltage	hp	kW	Amps	D	H1	Hole Center-to-Center H2	H3	W1	W2	W3	Weight in Lbs (kg)
FS8											
230 Vac	50–75	37–55	140–205	13.76 (349.6)	38.02 (965.7)	37.26 (946.4)	37.26 (946.4)	11.42 (290.1)	9.29 (236.0)	1.42 (36.0)	154.3 (70)
480 Vac	100–150	75–110									
FS9											
230 Vac	100–120	75–90	261–310	14.63 (371.6)	33.09 (890.4)	31.89 (810.0)	31.89 (810.0)	18.90 (480.0)	15.75 (400.0)	1.57 (40.0)	238.1 (108)
480 Vac	200–250	132–160									

Note: For flange dimension, please reference User Manual.

H-Max IntelliPass and IntelliDisconnect Drives

Contents

H-Max IntelliPass and IntelliDisconnect Drives

Product Description

The IntelliPass electronic bypass is a two or optional three contactor design using a 24 Vdc ***XT*** Series contactor with an optional manual override switch that allows the unit to run in bypass without the H-Max Series drive.

The IntelliPass software parameters utilize engineering units common to the HVAC industry. Onboard startup wizard guarantees flawless commissioning with plug-and-play screen entry. Available in NEMA/UL Type 1 and 12 with optional pre-engineered operator devices to meet all customized specification requirements.

The IntelliPass construction features allow for easy installation, reliable operation and serviceability with additional onboard wire space and removable conduit plates with knockouts.

Features and Benefits

Industry leading energy saving solution—uses the Eaton H-Max drive with Active Energy Control algorithm.

Built to be as tough as the application—Eaton's robust design boasts an industrial grade enclosure and industry proven components.

- PSG Industrial Power Supply
- ***XT*** Contactors
- 22 mm Pilot Devices

Designed with Our Customers in Mind

- Removable top and bottom entry panels
- Door mounted graphic display and keypad
- Easily accessible connection terminals with removable I/O terminal connections

Engineered Product Solution

- The Eaton H-Max IntelliPass and IntelliDisconnect products are available with a variety of factory tested and certified options meeting or exceeding UL508C requirements

Standards and Certifications

Product

- IEC 61800-5-1
- CE
- cUL

Safety

- UL 508C
- EN 61800-5-1
- CE
- cUL

- Plenum Rated

Catalog Number Selection

H-Max Series IntelliPass and IntelliDisconnect Drives

HMX 011 3 4 N A _ _ _ _ _ _ _ _ _ _

Build options alphabetically and numerically.

Product

HMX = HVAC drive (VT) (low overload)

NEC Ampere Ratings

208 Volts	480 Volts
4D5 = 4.5A—1 hp	**2D1** = 2.1A—1 hp
7D5 = 7.5A—2 hp	**3D4** = 3.4A—2 hp
011 = 11A—3 hp	**5D6** = 5.6A—3 hp
017 = 17A—5 hp	**9D6** = 9.6A—5 hp
025 = 25A—7.5 hp	**011** = 11A—7.5 hp
031 = 31A—10 hp	**014** = 14A—10 hp
047 = 47A—15 hp	**021** = 21A—15 hp
060 = 60A—20 hp	**027** = 27A—20 hp
075 = 75A—25 hp	**034** = 34A—25 hp
088 = 88A—30 hp	**040** = 40A—30 hp
230 Volts	**052** = 52A—40 hp
4D2 = 4.2A—1 hp	**065** = 65A—50 hp
7D5 = 7.5A—2 hp	**077** = 77A—60 hp
9D6 = 9.6A—3 hp	**096** = 96A—75 hp
016 = 16A—5 hp	
022 = 22A—7.5 hp	
028 = 28A—10 hp	
042 = 42A—15 hp	
054 = 54A—20 hp	
068 = 68A—25 hp	
080 = 80A—30 hp	

Enclosure Style

3 = IntelliPass NEMA Type 1
4 = IntelliPass NEMA Type 12
5 = IntelliPass NEMA Type 3R
A = IntelliDisconnect NEMA Type 1
B = IntelliDisconnect NEMA Type 12
C = IntelliDisconnect NEMA Type 3R

Voltage

1 = 208V
2 = 230V
4 = 480V

Braking/Application

N = No brake chopper (low overload)

Software Series

A–Z

Extended I/O Options in Slot D and E

B1 = 6 x DI /DO, Each digital input can be individually programmed as digital output
B2 = 1RO (NC/NO), 1RO (NO), 1 Thermistor
B4 = 1 x AI, 2 x AO (isolated)
B5 = 3 x RO
B9 = 1RO (NO), 5 DI 42–240 Vac input
BF = Expander IO, 1 AO, 1 DO, 1 RO

Optional Communications in Slot D and E

C4 = LonWorks®

EMC Upgrade Option

EMC C2 Standard

Keypad Options

None available

IntelliDisconnect Options

L3 = Pilot lights (Power ON, RUN, Fault)
P3 = Fused drive isolation
PE = Output contactor
SA = Space heater w/transformer (Type 3R only)

IntelliPass Bypass Options

L4 = Pilot lights (Power ON, RUN, Fault, Bypass)
P3 = Fused drive isolation (can not be used with P6 or MI)
P6 = Third contactor drive isolation (cannot be used with P3, IS or MI)
M1 = Manual bypass, includes isolation contactor and pilot lights (not available with P3, L4, P6 or IS)
SA = Space heater w/transformer (Type 3R only)
K9 = Auxiliary contacts
IS = Isolation switch (cannot be used with P6 or MI)

Standard Onboard Communications

RS-485 Communications

BACnet MS/TP = Master slave/token protocol (Universal BACnet) RS-485
Modbus RTU RS-485, ASCII or RTU, remote terminal unit 32 nodes
N2 = Johnson Controls Metasys N2 network

Onboard Ethernet-Based Communications (port left side of keypad)

BACnet/IP Ethernet industrial protocol
Modbus/TCP Transmission control protocol (Ethernet-based)

Notes

IntelliPass—two contactor electronic bypass standard.

All boards are varnished. Corrosion resistant.

Battery included in all drives for real-time clock. Three year lifetime.

Keypad kit includes HOA bypass.

EMI/RFI filters included.

DC link choke included.

Product Selection

H-Max Series IntelliPass NEMA Type 1—Two Contactor Bypass Standard

HMX_

208 Vac

FS Frame Size	Horsepower	Drive Rated NEC Amps	Catalog Number
4	1	4.5	**HMX4D531NA**
	2	7.5	**HMX7D531NA**
	3	10.6	**HMX01131NA**
5	5	16.7	**HMX01731NA**
	7.5	24.2	**HMX02531NA**
	10	30.8	**HMX03131NA**
6	15	46.2	**HMX04731NA**
	20	59.4	**HMX06031NA**
7	25	74.9	**HMX07531NA**
	30	88	**HMX08831NA**

230 Vac

FS Frame Size	Horsepower	Drive Rated NEC Amps	Catalog Number
4	1	4.2	**HMX4D232NA**
	2	7.5	**HMX7D532NA**
	3	9.6	**HMX9D632NA**
5	5	15.2	**HMX01632NA**
	7.5	22	**HMX02232NA**
	10	28	**HMX02832NA**
6	15	42	**HMX04232NA**
	20	54	**HMX05432NA**
7	25	68	**HMX06832NA**
	30	80	**HMX08032NA**

480 Vac

FS Frame Size	Horsepower	Drive Rated NEC Amps	Catalog Number
4	1	2.1	**HMX2D134NA**
	2	3.4	**HMX3D434NA**
	3	5.6	**HMX5D634NA**
	5	9.6	**HMX9D634NA**
	7.5	11	**HMX01134NA**
5	10	14	**HMX01434NA**
	15	21	**HMX02134NA**
	20	27	**HMX02734NA**
6	25	34	**HMX03434NA**
	30	40	**HMX04034NA**
	40	52	**HMX05234NA**
7	50	65	**HMX06534NA**
	60	77	**HMX07734NA**
	75	96	**HMX09634NA**

Notes

For Wiring Diagrams, see **Page V6-T2-157**.
For NEMA 12 or 3R enclosures, see Catalog Number Selection on Page **V6-T2-150**.
Call Technical Support for NEMA 3R specifics. Enclosure size and weight differ from NEMA 1 and 12 products.

H-Max Series IntelliDisconnect NEMA Type 1—Main Disconnect Standard

HMX_

208 Vac

FS Frame Size	Horsepower	Drive Rated NEC Amps	Catalog Number
4	1	4.5	**HMX4D5A1NA**
	2	7.5	**HMX7D5A1NA**
	3	11	**HMX011A1NA**
5	5	17	**HMX017A1NA**
	7.5	25	**HMX025A1NA**
	10	31	**HMX031A1NA**
6	15	47	**HMX047A1NA**
	20	60	**HMX060A1NA**
7	25	75	**HMX075A1NA**
	30	88	**HMX088A1NA**

230 Vac

FS Frame Size	Horsepower	Drive Rated NEC Amps	Catalog Number
4	1	4.2	**HMX4D2A2NA**
	2	7.5	**HMX7D5A2NA**
	3	9.6	**HMX9D6A2NA**
5	5	15.2	**HMX016A2NA**
	7.5	22	**HMX022A2NA**
	10	28	**HMX028A2NA**
6	15	42	**HMX042A2NA**
	20	54	**HMX054A2NA**
7	25	68	**HMX068A2NA**
	30	80	**HMX080A2NA**

480 Vac

FS Frame Size	Horsepower	Drive Rated NEC Amps	Catalog Number
4	1	2.1	**HMX2D1A4NA**
	2	3.4	**HMX3D4A4NA**
	3	5.6	**HMX5D6A4NA**
	5	9.6	**HMX9D6A4NA**
	7.5	11	**HMX011A4NA**
5	10	14	**HMX014A4NA**
	15	21	**HMX021A4NA**
	20	27	**HMX027A4NA**
6	25	34	**HMX034A4NA**
	30	40	**HMX040A4NA**
	40	52	**HMX052A4NA**
7	50	65	**HMX065A4NA**
	60	77	**HMX077A4NA**
	75	96	**HMX096A4NA**

Notes

For Wiring Diagrams, see **Page V6-T2-157**.

For NEMA 12 or 3R enclosures, see Catalog Number Selection on **Page V6-T2-150**.

Call Technical Support for NEMA 3R specifics. Enclosure size and weight differ from NEMA 1 and 12 products.

Onboard Network Communications

Johnson Controls Metasys N2

H-Max Series provides communication between the drive and a Johnson Controls Metasys™ N2 network. With this connection, the drive can be controlled, monitored and programmed from the Metasys system. N2 can be selected and programmed by the drive keypad.

BACnet

H-Max Series provides communication to BACnet networks. Data transfer is master-slave/token passing (MS/TP) RS-485.

BACnet IP

100 base T interface.

Modbus TCP

Ethernet based protocol.

Modbus RTU

H-Max Series provides communication to Modbus RTU RS-485 as a slave on a Modbus network. Other communication parameters include an address range from 1–247; a parity of None, Odd or Even; and the stop bit is 1.

H-Max Series Option Board Kits Available for Slots D and E

The H-Max Series drives can accommodate a wide selection of expander and adapter option boards to customize the drive for your application needs. The drive's control unit is designed to accept a total of two option boards.

The H-Max Series factory-installed standard board configuration includes an I/O board and a relay output board.

Option Boards Mounted in Slots D and E

Option Kit Description	Option Kit Catalog Number
6 x DI /DO, each digital input can be individually programmed as digital output	**XMX-IO-B1-A**
1RO Form C (NO/NC), 1RO Form A (NO), 1 thermistor	**XMX-IO-B2-A**
1 x AI, 2 x AO (isolated)	**XMX-IO-B4-A**
3 x RO Form A (NO)	**XMX-IO-B5-A**
1RO Form A (NO), 5DI 42–240 Vac input	**XMX-IO-B9-A**
LonWorks®	**XMX-COM-C4-A**
1 x AO, 1 x DO, 1 x RO	**XMX-IO-BF-A**

Extended I/O Options in Slot D and E

Description	Suffix Number
6 x DI /DO, Each digital input can be individually programmed as digital output	**B1**
1RO (NC/NO), 1RO (NO), 1 Thermistor	**B2**
1 x AI, 2 x AO (isolated)	**B4**
3 x RO	**B5**
1RO (NO), 5 DI 42–240 Vac input	**B9**
Expander IO, 1 AO, 1 DO, 1 RO	**BF**

Optional Communications in Slot D and E

Description	Suffix Number
LonWorks®	**C4**

EMC Upgrade Option

Description	Suffix Number
Standard	**EMC C2**

Keypad Options

Description	Suffix Number
None available	—

IntelliDisconnect Options

Description	Suffix Number
Pilot lights (Power ON, RUN, Fault)	**L3**
Fused drive isolation (cannot be used with PE)	**P3**
Output contactor (cannot be used with P3)	**PE**
Space heater w/transformer (Type 3R only)	**SA**

IntelliPass Bypass Options

Description	Suffix Number
Pilot lights (Power ON, RUN, Fault)	**L4**
Fused drive isolation (can not be used with P6)	**P3**
Third contactor drive isolation (cannot be used with P3 or IS)	**P6**
Manual bypass switch located on front door	**M1**
Space heater w/transformer (Type 3R only)	**SA**
Auxiliary contacts	**K9**
Isolation switch	**IS**

Standard Onboard Communications

Description	Suffix Number
RS-485 Communications	
BACnet MS/TP = Master slave/token protocol (Universal BACnet) RS-485	**BACnet**
Modbus RTU RS-485, ASCII or RTU, remote terminal unit 32 nodes	**Modbus**
Johnson Controls Metasys N2 network	**N2**
Onboard Ethernet-Based Communications (port left side of keypad)	
BACnet/IP Ethernet industrial protocol	**BACnet**
Modbus/TCP Transmission control protocol (Ethernet-based)	**Modbus**

Technical Data and Specifications

Primary Design Features

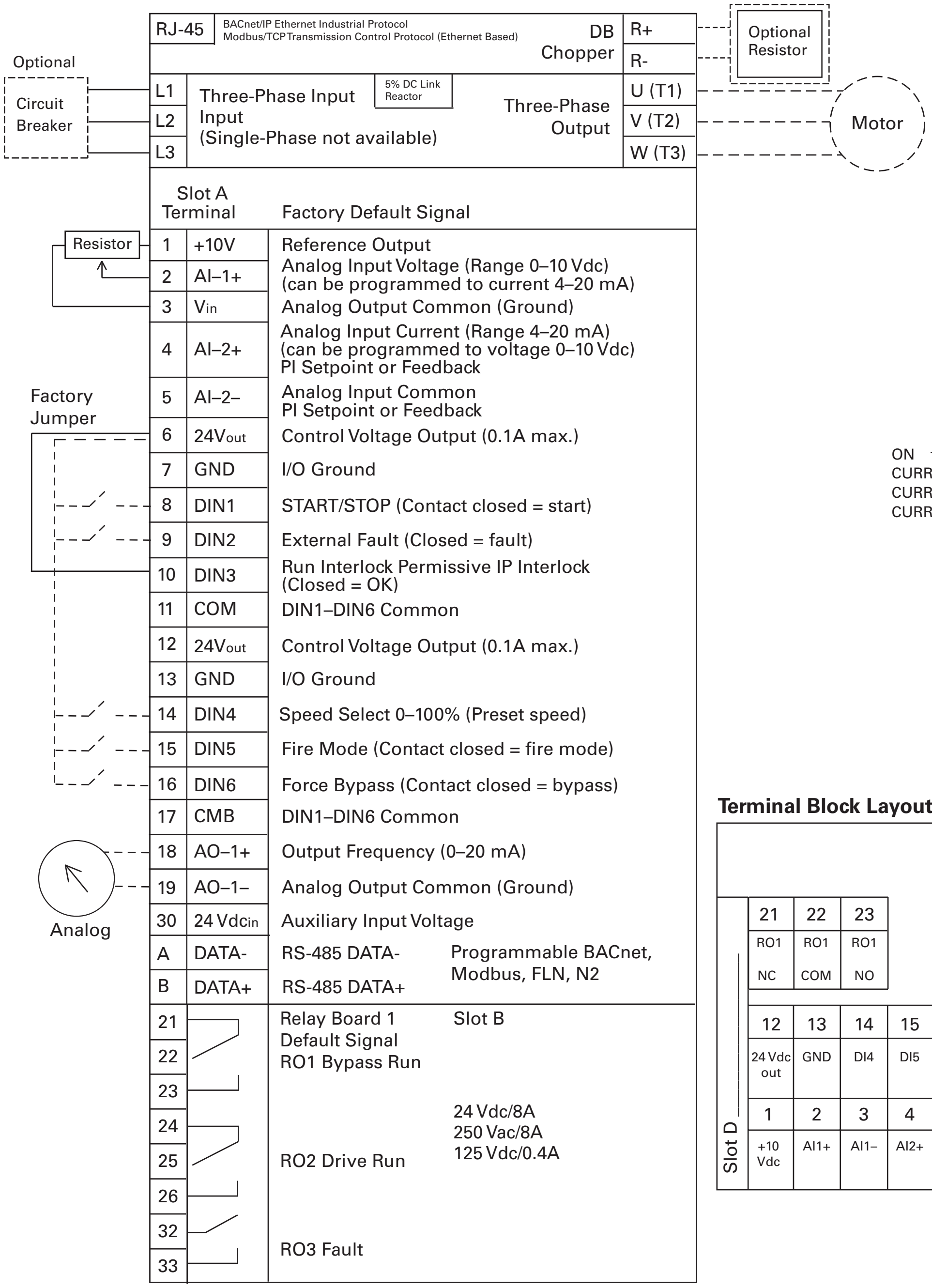
Description	IntelliPass	IntelliDisconnect
CB MMP	Standard	Standard
2 contactor bypass	Standard	N/A
Mechanical interlock	Standard	N/A
Electrical interlock	Standard	N/A
Third contactor (isolation)	Optional	N/A
Isolation switch	Optional	N/A
Top entry (power)	Standard	Standard
Bottom entry (power)	Standard	Standard
Output contactor	Standard	Optional

H-Max Series Drives

Description	Specification
Input Ratings	
Input voltage (V_{in})	208, 230, 480 Vac, –10%/+10%
Input frequency (f_{in})	50/60 Hz (variation up to 47–66 Hz)
Connection to power	Once per minute or less (typical operation)
Short circuit withstand rating	65 kAIC combination
Output Ratings	
Output voltage	0 to V_{in}/U_{in} line voltage in
Continuous output current	Ambient temperature max. 104°F (40°C)
I_L overload	1.1 x I_L (1 min./10 min.)
Overload current	110% (1 min./10 min.)
Initial output current	150% for two seconds
Output frequency	0 to 320 Hz
Frequency resolution	0.01 Hz
Control Characteristics	
Control method	Frequency control (V/f) open loop sensorless vector control
Switching frequency	1–310 amps; adjustable with parameter 2.6.9 FS4–FS7: default 6 kHz
Frequency reference	Analog input: Resolution 0.1% (10-bit), accuracy ±1% Panel reference: Resolution 0.01 Hz
Field weakening point	8 to 320 Hz
Acceleration time	0.1 to 3000 seconds
Deceleration time	0.1 to 3000 seconds
Braking torque	DC brake: 30% x T_n
Ambient Conditions	
Ambient operating temperature	FS4–FS7: 14°F (–10°C), no frost to 104°F (40°C) (Drive can operate at 122°F (50°C)
Storage temperature	–40° to 158°F (–40° to 70°C)
Relative humidity	0 to 95% RH, noncondensing, non-corrosive, no dripping water
Air quality	Chemical vapors: IEC 60721-3-3, unit in operation, Class 3C2; Mechanical particles: IEC 60721-3-3, unit in operation, Class 3S2
Altitude	100% load capacity (no derating) up to 3280 ft (1000m); 1% derating for each 328 ft (100m) above 3280 ft (1000m); max. 9842 ft (3000m); 380–480V
Vibration	FS4–FS7: IEC 60068-2-6, 10–150 Hz Displacement amplitude = 1 mm peak-to-peak from 10–15.8 Hz Max. acceleration amplitude = 1G peak from 15.8–150 Hz
Shock	FS4–FS7: IEC 60068-2-27, 15G peak acceleration at 11 ms duration, 1/2-sine. ISTA 1A Certified
Enclosure class	NEMA Type 1/IP21 or NEMA Type 12/IP54 (keypad required for IP54/Type 12)
Standards	
EMC	Immunity: Fulfills all EMC immunity requirements; Emissions: EN 61800-3, LEVEL H (EMC C2)
Emissions	EMC level dependent— +EMC 2: EN61800-3 (2004) Category C2 Delivered with Class C2 EMC filtering as default.
Control Connections	
Analog input voltage	0 to 10V, R = 200 kohms differential Resolution 0.1%; Accuracy ±1% Dip switch selection (voltage/current)
Analog input current	0(4) to 20 mA; R_i –250 ohms differential
Digital inputs (6)	Positive or negative logic; 18 to 30 Vdc
Auxiliary voltage	+24V ±10%, max. 250 mA
Output reference voltage	+10V +3%, max. load 10 mA
Analog output	0–10V, 0(4) to 20 mA; R_L max. 500 ohms; Resolution 10 bit; Accuracy ±2%; Dip switch selection (voltage/current)
Relay outputs	3 programmable, 2 Form C, 1 Form A relay outputs Switching capacity: 24 Vdc/8A, 250 Vac/8A, 125 Vdc/0.4A
Hard wire jumper	Between terminal 6 and 10 factory default
Dip switch setting default	RS485 = off A01 = current A12 = current A11 = voltage
Protections	
Overcurrent protection	Yes
Overvoltage protection	Yes
DC bus regulation anti-trip	Yes (accelerates or decelerates the load)
Undervoltage protection	Yes
Earth fault protection	Yes (in case of earth fault in motor or motor cable, only the frequency converter is protected)
Input phase supervision	Yes (trips if any of the input phases are missing)
Motor phase supervision	Yes (trips if any of the output phases are missing)
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Motor underload protection	Yes
Short circuit protection	Yes
Surge protection	Yes (varistor input)
Conformed coated (varnished) board	Yes (prevents corrosion)

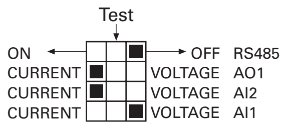
Wiring Diagrams

Control Input/Output, PID Application

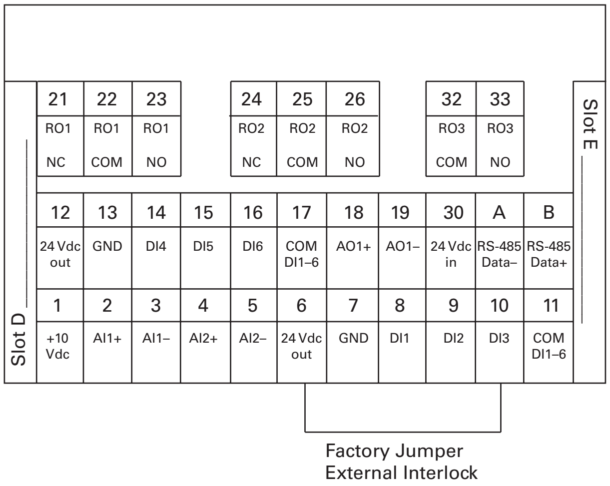


Slot A Terminal		Factory Default Signal
1	+10V	Reference Output
2	AI–1+	Analog Input Voltage (Range 0–10 Vdc) (can be programmed to current 4–20 mA)
3	Vin	Analog Output Common (Ground)
4	AI–2+	Analog Input Current (Range 4–20 mA) (can be programmed to voltage 0–10 Vdc) PI Setpoint or Feedback
5	AI–2–	Analog Input Common PI Setpoint or Feedback
6	24Vout	Control Voltage Output (0.1A max.)
7	GND	I/O Ground
8	DIN1	START/STOP (Contact closed = start)
9	DIN2	External Fault (Closed = fault)
10	DIN3	Run Interlock Permissive IP Interlock (Closed = OK)
11	COM	DIN1–DIN6 Common
12	24Vout	Control Voltage Output (0.1A max.)
13	GND	I/O Ground
14	DIN4	Speed Select 0–100% (Preset speed)
15	DIN5	Fire Mode (Contact closed = fire mode)
16	DIN6	Force Bypass (Contact closed = bypass)
17	CMB	DIN1–DIN6 Common
18	AO–1+	Output Frequency (0–20 mA)
19	AO–1–	Analog Output Common (Ground)
30	24 Vdcin	Auxiliary Input Voltage
A	DATA-	RS-485 DATA- Programmable BACnet, Modbus, FLN, N2
B	DATA+	RS-485 DATA+

	Relay Board 1 Default Signal	Slot B
21	RO1 Bypass Run	
22		
23		
24		24 Vdc/8A 250 Vac/8A 125 Vdc/0.4A
25	RO2 Drive Run	
26		
32		
33	RO3 Fault	



Terminal Block Layout



21	22	23	24	25	26	32	33
RO1 NC	RO1 COM	RO1 NO	RO2 NC	RO2 COM	RO2 NO	RO3 COM	RO3 NO

12	13	14	15	16	17	18	19	30	A	B
24 Vdc out	GND	DI4	DI5	DI6	COM DI1–6	AO1+	AO1–	24 Vdc in	RS-485 Data–	RS-485 Data+
1	2	3	4	5	6	7	8	9	10	11
+10 Vdc	AI1+	AI1–	AI2+	AI2–	24 Vdc out	GND	DI1	DI2	DI3	COM DI1–6

Standards

- Digital inputs D1–D6, relay out, analog in/out are freely programmed
- The user can assign a single input to multiple functions

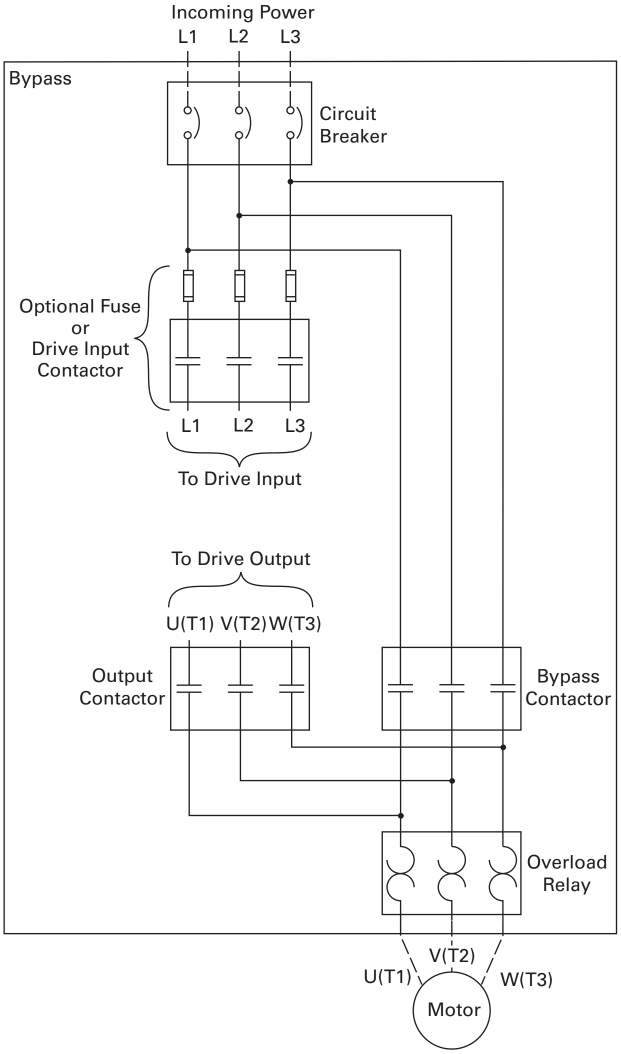
Includes

- Six digital input
- Two analog input
- One analog output
- Three relay output
- RS-485
- Ethernet

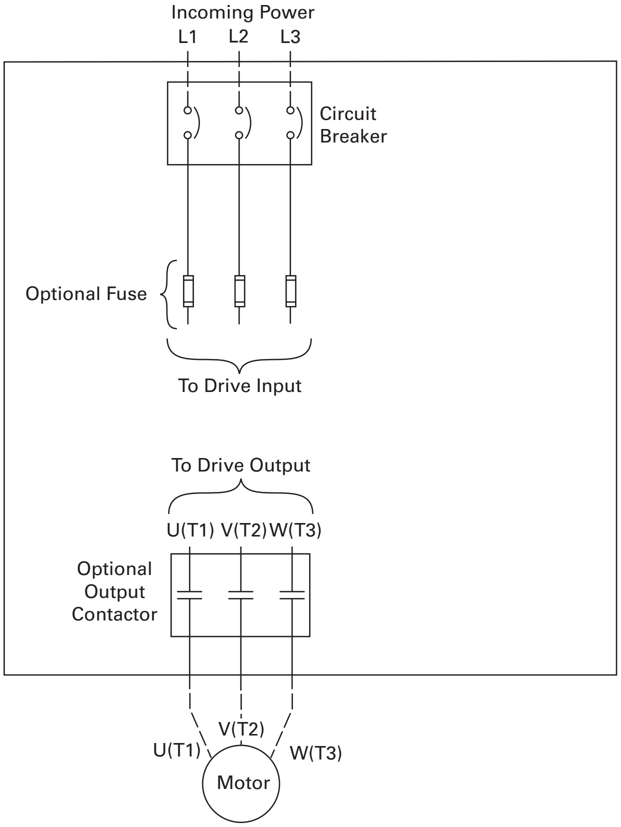
Reliability

- Pretested components
- Conformal coated (varnished) boards
- 40°C rated
- 110% overload for one minute
- Eaton Electrical Services & Systems national network of AF drive specialists

H-Max Series IntelliPass



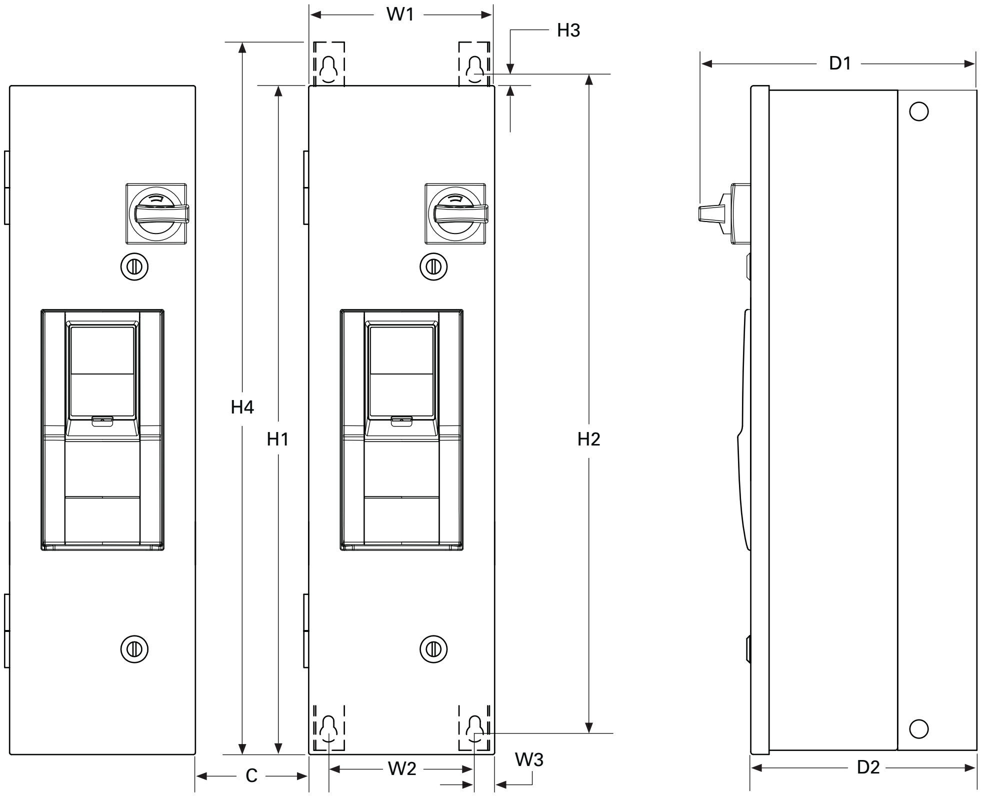
H-Max Series IntelliDisconnect Power Wiring



Dimensions

Approximate Dimensions in Inches (mm)

H-Max Series IntelliPass and IntelliDisconnect Drives



Consult factory or use manual for final dimensions.

Frame Size	Voltage	Horsepower (I_L)	H1	H2	H3	H4	C	W1	W2	W3	D1	D2	Weight in Lbs (kg)
FS4	208	1–3	29.69 (754.1)	37.12 (942.9)	0.25 (6.35)	31.00 (914.4)	3.00 (76.2)	7.88 (200.2)	6.33 (160.8)	0.75 (19.1)	11.40 (289.6)	9.27 (235.5)	45 (20.41)
	230	1–3											
	480	1–7.5											
FS5	208	5–10	37.00 (939.8)	34.47 (875.5)	0.25 (6.35)	38.31 (973.0)	3.00 (76.2)	9.40 (238.8)	7.75 (196.9)	0.75 (19.1)	15.30 (388.6)	13.17 (334.6)	57.5 (26.10)
	230	5–10											
	480	10–20											
FS6	208	15–20	45.08 (1145.0)	40.28 (1023.1)	0.25 (6.35)	46.4 (1178.6)	4.00 (101.6)	10.90 (276.9)	9.35 (327.5)	0.75 (19.1)	15.75 (400.0)	13.62 (346.0)	98.0 (44.45)
	230	15–20											
	480	25–40											
FS7	208	25–30	58.32 (1481.3)	56.30 (1430.0)	0.25 (6.35)	59.46 (1510.3)	5.00 (127.0)	13.98 (355.1)	12.35 (313.7)	0.75 (19.1)	15.50 (393.7)	13.55 (244.2)	165.0 (74.84)
	230	25–30											
	480	50–75											

Note: C distance is spacing required to mount multiple drives.

WATTSAVER® PREMIUM EFFICIENCY MOTORS

GENERAL PURPOSE • THREE PHASE

THREE PHASE • DRIP-PROOF • RIGID BASE 208-230/460V

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Meets NEMA Premium	F.L. Amps 230V	3/4 Load Eff.	% F.L. Eff.	"C" Dim. (Inches)
1/3	1725	S56	**103017**	A	23	N/A	1.3	73.5	77.0	10.24
1/2	1725	S56	**103018**	A	26	N/A	1.8	73.8	77.0	10.74
3/4	1725	56	**116738**	A	30	N/A	2.4	80.4	81.5	10.86
1	3450	56	**116128**	A	29	✓	2.8	78.5	80.0	10.18
	1725	56	**116752**	A	36	✓	3.2	84.7	85.5	11.68
	1725	143T	**121003**	B	36	✓	3.2	84.7	85.5	12.12
	1160	145T	**121517**	B	41	✓	3.8	81.5	82.5	12.62
1½	3450	56	**116753**	A	36	✓	4.0	83.5	84.0	11.84
	3450	143T	**121514**	B	36	✓	4.0	83.5	84.0	12.28
	1725	56	**116754**	A	35	✓	4.8	86.1	86.5	12.22
	1725	145T	**121004**	B	35	✓	4.8	86.1	86.5	12.62
	1170	182T	**131971**	B	70	✓	5.6	86.0	86.5	14.69
2	3450	56	**116755**	A	43	✓	4.8	86.8	85.5	12.18
	3450	145T	**121515**	B	43	✓	4.8	86.8	85.5	12.62
	1725	56H	**116756**	A	37	✓	5.8	86.7	86.5	13.22
	1725	145T	**121005**	B	37	✓	5.8	86.7	86.5	13.62
	1170	184T	**131972**	B	81	✓	7.2	87.5	87.5	15.19
3	3450	145T	**121516**	B	45	✓	7.2	85.5	86.5	12.62
	1760	182T	**131519**	B	75	✓	7.8	90.2	89.5	13.69
	1190	213T	**171574**	C	154	✓	10.0	87.5	88.5	16.38
5	3450	184T	**131986**	B	92	✓	12.0	86.8	86.5	15.19
	1760	184T	**131520**	B	86	✓	12.8	89.4	89.5	14.69
	1190	215T	**171575**	C	291	✓	15.0	89.5	90.2	16.38
7½	3450	184T	**131988**	B	106	✓	17.6	88.0	88.5	16.19
	1760	213T	**140470**	B	133	✓	20.6	91.7	91.0	16.25
	1760	213T	**170142**	C	160	✓	19.8	91.7	91.0	16.38
	1170	254T	**170145**	C	281	✓	22.4	91.0	91.7	20.94
10	3515	213T	**140753**	B	160	✓	23.4	89.5	89.5	17.30
	3510	213T	**170143**	C	150	✓	23.6	91.0	91.0	16.38
	1760	215T	**140472**	B	144	✓	26.8	91.0	91.7	17.25
	1760	215T	**170144**	C	200	✓	25.6	91.7	91.7	17.87
	1190	256T	**170146**	C	305	✓	29.6	91.7	91.7	22.60
15	3510	215T	**140754**	B	170	✓	35.0	91.0	91.0	18.55
	3510	215T	**170064**	C	175	✓	34.6	91.0	91.0	17.87
	1770	254T	**170065**	C	279	✓	37.0	93.0	93.0	20.94
	1170	284T	**170067**	C	414	✓	39.4	92.4	92.4	23.54
20	3525	254T	**170032**	C	275	✓	46.0	93.0	93.0	20.94
	1770	256T	**170006**	C	324	✓	51.0	93.0	93.0	22.60
	1190	286T	**170000**	C	467	✓	55.0	92.4	92.4	25.00
25	3525	256T	**170034**	C	327	✓	57.4	93.0	93.0	22.60
	1770	284T	**170009**	C	404	✓	59.6	93.6	93.6	23.54
	1190	324T	**170002**	C	705	✓	67.0	93.0	93.0	26.02
30	3550	284TS	**170036**	C	396	✓	67.0	94.1	94.1	22.17
	1770	286T	**170013**	C	471	✓	71.0	94.5	94.1	25.00
	1190	326T	**170004**	C	760	✓	78.0	93.6	93.6	27.52
40	3550	286TS	**170038**	C	441	✓	91.2	94.1	93.6	23.62
	1780	324T	**170017**	C	560	✓	96.0	94.1	94.1	26.02
	1190	364T	**170147**	C	892	✓	103.0	94.1	94.1	28.01

All WATTSAVER® motors have normally closed thermostats for over-temperature alert.

All 180 and 210 frame Rolled Steel motors have Class F Insulation.

SHADED FRAME INDICATES CAST IRON CONSTRUCTION

All three phase motors, 1 HP and above, are inverter rated. Refer to page 5 for speed ranges.

THREE PHASE • TEFC • RIGID BASE 208-230/460V

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Meets NEMA Premium	F.L. Amps 230V	3/4 Load Eff.	% F.L. Eff.	"C" Dim. (Inches)
1/3	1725	S56	**103019**	A	24	N/A	1.3	73.5	77.0	10.19
1/2	1725	S56	**103020**	A	27	N/A	1.8	73.8	77.0	10.69
3/4	1725	56	**116739**	A	31	N/A	2.4	80.2	81.5	11.31
1	3450	56	**116129**	A	29	✓	2.8	80.0	80.0	11.31
	1725	56	**116757**	A	32	✓	3.2	84.7	85.5	12.81
	1725	143T	**120921**	B	32	✓	3.2	84.7	85.5	13.25
	1725	143T	**171640**	B	50	✓	3.2	84.7	85.5	13.46
	1160	145T	**121520**	B	47	✓	3.8	81.5	82.5	13.75
	1140	145T	**171643**	B	58	✓	3.8	81.5	82.5	13.46
1½	3450	56	**116758**	A	33	✓	4.0	83.0	84.0	12.81
	3450	143T	**121518**	B	33	✓	4.0	83.0	84.0	13.25
	3450	143T	**171642**	B	49	✓	4.0	83.0	84.0	13.46
	1725	56	**116759**	A	34	✓	4.8	86.1	86.5	13.31
	1725	145T	**120922**	B	34	✓	4.8	86.1	86.5	13.75
	1725	145T	**171646**	B	54	✓	4.8	86.1	86.5	13.46
	1170	182T	**131980**	B	89	✓	5.6	87.4	87.5	15.96
2	3450	56	**116760**	A	44	✓	4.8	84.8	85.5	13.31
	3450	145T	**121519**	B	44	✓	4.8	84.8	85.5	13.75
	3450	145T	**171648**	B	56	✓	4.8	84.8	85.5	13.46
	1725	56H	**116761**	A	45	✓	5.8	86.7	86.5	14.32
	1725	145T	**120923**	B	45	✓	5.8	86.7	86.5	14.76
	1725	145T	**171647**	B	58	✓	5.8	86.5	86.5	13.46
	1170	184T	**131981**	B	92	✓	7.2	88.4	88.5	15.96
3	3450	182T	**131985**	B	66	✓	7.6	86.1	86.5	13.96
	1760	182T	**131463**	B	80	✓	7.8	89.0	89.5	14.96
	1760	182T	**171320**	C	104	✓	7.8	89.5	90.2	16.14
	1180	213T	**171378**	C	170	✓	9.4	88.5	89.5	18.19
5	3450	184T	**131987**	B	88	✓	12.0	89.0	88.5	16.46
	1760	184T	**131464**	B	94	✓	12.8	90.1	89.5	15.96
	1760	184T	**171322**	C	109	✓	12.8	89.9	89.5	16.80
	1180	215T	**171379**	C	176	✓	14.4	89.5	89.5	19.61
7½	3510	213T	**140756**	C	156	✓	17.8	89.5	90.2	19.84
	3510	213T	**170158**	C	147	✓	18.0	91.0	91.0	18.19
	1760	213T	**140450**	C	144	✓	21.4	90.6	91.7	18.70
	1760	213T	**170157**	C	155	✓	18.6	91.7	91.7	18.19
	1170	254T	**170122**	C	249	✓	22.2	91.0	91.7	23.19
10	3510	215T	**140755**	B	170	✓	23.6	92.4	91.7	21.09
	3510	215T	**170159**	C	181	✓	23.0	91.7	91.7	19.61
	1760	215T	**140451**	B	161	✓	26.6	91.6	91.7	19.70
	1760	215T	**170140**	C	177	✓	25.0	91.7	91.7	19.61
	1170	256T	**170123**	C	300	✓	29.0	91.7	91.7	24.92
15	3525	254T	**170062**	C	282	✓	34.6	92.4	92.4	23.19
	1770	254T	**170066**	C	280	✓	36.0	92.4	92.4	23.19
	1170	284T	**170068**	C	333	✓	40.6	92.0	92.4	26.26
20	3525	256T	**170033**	C	316	✓	46.0	92.4	92.4	24.92
	1770	256T	**170007**	C	322	✓	49.0	93.0	93.0	24.92
	1170	286T	**170001**	C	392	✓	54.0	92.4	92.4	27.83
25	3550	284TS	**170035**	C	383	✓	56.8	93.0	93.0	24.88
	1770	284T	**170011**	C	385	✓	59.0	93.6	93.6	26.26
	1190	324T	**170003**	C	545	✓	66.0	92.4	93.0	29.53
30	3550	286TS	**170037**	C	385	✓	67.6	93.6	93.0	26.46
	1770	286T	**170015**	C	432	✓	70.0	94.1	94.1	27.83
	1190	326T	**170005**	C	615	✓	77.2	93.6	93.6	31.02

All WATTSAVER® motors have normally closed thermostats for over-temperature alert.

Catalog numbers in blue are available in 3rd quarter 2008.

THREE PHASE • DRIP-PROOF • RIGID BASE 208-230/460V • CONTINUED

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Meets NEMA Premium	F.L. Amps 230V	3/4 Load Eff.	% F.L. Eff.	"C" Dim. (Inches)
50	3550	324TS	**170040**	C	548	✓	112.0	95.0	94.1	24.53
	1780	326T	**170021**	C	614	✓	118.0	94.5	94.5	27.52
	1190	365T	**170148**	C	918	✓	128.0	94.7	94.5	31.18
60	3550	326TS	**170042**	C	590	✓	136.0	95.0	94.1	26.02
	1780	364T	**170025**	C	716	✓	139.0	95.0	95.4	28.01
	1190	404T	**170149**	C	1031	✓	159.0	94.0	94.5	32.76
75	3570	364TS	**170044**	C	720	✓	176.0	94.5	93.6	26.89
	1780	365T	**170029**	C	766	✓	172.0	95.4	95.4	31.18
	1190	405T	**170150**	C	1095	✓	196.0	94.0	94.5	34.25
100	3570	365TS	**170151**	C	775	✓	234.0	94.5	94.5	29.06
	1780	404T	**170152**	C	1141	✓	225.0	95.4	95.4	32.76
	1190	444T	**170255❋**	C	1975	✓	118.0◆	95.4	95.4	40.00
125	3570	404TS	**170154**	C	1015	✓	284.0	94.5	94.5	29.76
	1780	405T	**170155**	C	1236	✓	280.0	95.4	95.4	34.25
	1190	445T	**170259❋**	C	2022	✓	148.0◆	95.8	95.8	40.00
150	3570	405TS	**171449❋**	C	1085	✓	169.0◆	94.5	94.5	31.26
	1780	444T	**171522❋**	C	2000	✓	164.0◆	95.8	95.8	40.00
	1190	445T	**171576❋**	C	2040	✓	206.0◆	95.8	95.8	40.00
200	3570	444TS	**171573❋**	C	1765	✓	216.0◆	95.4	95.4	36.25
	1780	445T	**171523❋**	C	2037	✓	220.0◆	95.8	95.8	40.00
	1190	447T	**171577❋**	C	2820	✓	239.0◆	95.8	96.2	43.12

All WATTSAVER® motors have normally closed thermostats for over-temperature alert.

THREE PHASE • TEFC • RIGID BASE 208-230/460V • CONTINUED

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Meets NEMA Premium	F.L. Amps 230V	3/4 Load Eff.	% F.L. Eff.	"C" Dim. (Inches)
40	3550	324TS	**170039**	C	504	✓	90.0	93.6	93.6	28.03
	1780	324T	**170019**	C	528	✓	92.0	93.6	94.1	29.53
	1180	364T	**170096**	C	636	✓	102.0	94.1	94.1	32.64
50	3550	326TS	**170041**	C	554	✓	111.0	95.0	94.5	29.53
	1780	326T	**170023**	C	587	✓	117.0	94.5	94.5	31.02
	1180	365T	**170097**	C	672	✓	124.0	94.1	94.1	33.62
60	3570	364TS	**170043**	C	735	✓	136.0	93.6	94.1	30.51
	1780	364T	**170027**	C	666	✓	137.0	95.0	95.4	32.64
	1190	404T	**170098**	C	870	✓	142.0	94.5	94.5	36.42
75	3570	365TS	**170045**	C	780	✓	169.0	94.5	94.5	31.50
	1780	365T	**170031**	C	733	✓	171.0	95.8	95.8	33.62
	1190	405T	**170099**	C	975	✓	176.0	95.0	95.0	37.91
100	3570	405TS	**170160**	C	955	✓	218.0	94.5	95.0	34.92
	1780	405T	**170087**	C	1070	✓	225.0	95.4	95.4	37.91
	1190	444T	**170256❋**	C	1457	✓	121.0◆	95.0	95.0	42.87
125	1790	444T	**170369❋**	C	1950	✓	137.5◆	95.4	95.4	42.87
	1190	445T	**170260❋**	C	1596	✓	155.0◆	95.4	95.4	44.88
	3570	444TS	**171580❋**	C	1316	✓	132.0	94.5	95.0	39.10
150	1790	445T	**170371❋**	C	1627	✓	163.0◆	95.8	95.8	44.88
	1190	447T	**171315❋**	C	2230	✓	185.5◆	95.8	95.8	48.00
	3570	445TS	**171578❋**	C	1445	✓	161.0	94.5	95.0	44.88
200	1790	447T	**170352❋**	C	2227	✓	216.0◆	96.2	96.2	48.00
	1190	449T	**171316❋**	C	2542	✓	241.5◆	95.8	95.8	52.80
	3570	447TS	**171579❋**	C	1977	✓	216.5	95.0	95.4	48.00

All WATTSAVER® motors have normally closed thermostats for over-temperature alert.

❋ 460V only
◆ Full Load Amps 460V

SHADED FRAME INDICATES CAST IRON CONSTRUCTION

All three phase motors, 1 HP and above, are inverter rated. Refer to page 5 for speed ranges.

WATTSAVER® PREMIUM EFFICIENCY MOTORS

GENERAL PURPOSE • THREE PHASE

THREE PHASE • DRIP-PROOF • C FACE LESS BASE 208-230/460V

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Meets NEMA Premium	F.L. Amps 230V	3/4 Load Eff.	% F.L. Eff.	"C" Dim. (Inches)
1/3	1725	S56C	**102695**	A	22	N/A	1.3	73.5	77.0	10.24
1/2	1725	S56C	**102200**	A	25	N/A	1.8	73.8	77.0	10.74
3/4	1725	56C	**114934**	A	29	N/A	2.4	80.4	81.5	10.86
1	1725	56C	**116740**	A	32	✓	3.4	84.7	85.5	11.68
	1725	143TC	**121064**	B	32	✓	3.4	84.7	85.5	12.12
1½	1725	56C	**116741**	A	36	✓	5.6	86.1	86.5	12.68
	1725	145TC	**121063**	B	36	✓	5.6	86.1	86.5	13.12
2	1725	56C	**116742**	A	41	✓	5.8	86.7	86.5	13.18
	1725	145TC	**121071**	B	41	✓	5.8	86.7	86.5	13.62
3	1760	182TC	**131518**	B	75	✓	7.8	90.2	89.5	14.20
5	1760	184TC	**131517**	B	96	✓	12.8	90.1	89.5	15.20
7½	1760	213TC	**140483**	B	132	✓	20.6	91.7	91.0	16.25
10	1760	215TC	**140485**	B	144	✓	26.8	92.2	91.7	17.25

All WATTSAVER® motors have normally closed thermostats for over-temperature alert.

THREE PHASE • DRIP-PROOF • C FACE WITH BASE 208-230/460V

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Meets NEMA Premium	F.L. Amps 230V	3/4 Load Eff.	% F.L. Eff.	"C" Dim. (Inches)
1/3	1725	S56C	**103021**	A	23	N/A	1.3	73.5	77.0	10.24
1/2	1725	S56C	**103022**	A	26	N/A	1.8	73.8	77.0	10.74
3/4	1725	56C	**116762**	A	30	N/A	2.4	80.4	81.5	10.86
1	1725	56C	**116763**	A	33	✓	3.4	84.7	85.5	11.68
	1725	143TC	**121674**	B	34	✓	3.4	84.7	85.5	12.12
1½	1725	56C	**116764**	A	37	✓	5.6	86.1	86.5	12.68
	1725	145TC	**121675**	B	37	✓	5.6	86.1	86.5	13.12
2	1725	56HC	**116765**	A	42	✓	5.8	86.7	86.5	13.18
	1725	145TC	**121676**	B	42	✓	5.8	86.7	86.5	13.62
3	1760	182TC	**132081**	B	76	✓	7.8	90.2	89.5	14.20
5	1760	184TC	**132082**	B	97	✓	12.8	90.1	89.5	15.20
7½	1760	213TC	**140767**	B	132	✓	20.6	91.7	91.0	16.25
10	1760	215TC	**140768**	B	144	✓	26.8	91.7	91.7	17.25

All WATTSAVER® motors have normally closed thermostats for over-temperature alert.

THREE PHASE • TEFC • C FACE LESS BASE 208-230/460V

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Meets NEMA Premium	F.L. Amps 230V	3/4 Load Eff.	% F.L. Eff.	"C" Dim. (Inches)
1/3	1725	S56C	**102696**	A	22	N/A	1.3	73.5	77.0	10.19
1/2	1725	S56C	**101780**	A	25	N/A	1.8	73.8	77.0	10.69
3/4	1725	56C	**114213**	A	27	N/A	2.7	80.2	81.5	11.31
1	3450	56C	**116748**	A	29	✓	2.8	80.0	80.0	11.31
	1725	56C	**114638**	A	34	N/A	3.4	84.7	85.5	12.81
	1725	143TC	**121067**	B	36	✓	3.4	84.7	85.5	13.25
	1160	56C	**116749**	A	47	✓	3.8	81.5	82.5	13.75
1½	3450	56C	**116750**	A	33	✓	4.0	83.0	84.0	13.25
	1725	56C	**116743**	A	41	✓	4.8	86.1	86.5	13.31
	1725	145TC	**121066**	B	41	✓	5.6	86.1	86.5	13.75
2	3450	56C	**116751**	A	44	✓	4.8	84.8	85.5	14.25
	1725	56C	**116744**	A	45	✓	5.8	86.7	86.5	13.82
	1725	145TC	**121065**	B	45	✓	5.8	86.7	86.5	14.26
3	1760	182TC	**131503**	B	72	✓	7.8	89.0	89.5	14.96
5	1760	184TC	**131501**	B	90	✓	12.8	90.1	89.5	15.97
7½	1760	213TC	**140486**	B	144	✓	21.4	90.6	91.7	18.70
10	1760	215TC	**140484**	B	160	✓	26.6	91.6	91.7	19.70

All WATTSAVER® motors have normally closed thermostats for over-temperature alert.

All 180 and 210 frame Rolled Steel motors have Class F Insulation.

SHADED FRAME INDICATES CAST IRON CONSTRUCTION

All three phase motors, 1 HP and above, are inverter rated. Refer to page 5 for speed ranges.

THREE PHASE • TEFC • C FACE WITH BASE 208-230/460V

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Meets NEMA Premium	F.L. Amps 230V	3/4 Load Eff.	% F.L. Eff.	"C" Dim. (Inches)
1/3	1725	S56C	**102697**	A	22	N/A	1.3	73.5	77.0	10.19
1/2	1725	S56C	**102024**	A	23	N/A	1.8	73.8	77.0	10.69
3/4	1725	56C	**114624**	A	25	N/A	2.7	80.2	81.5	11.31
1	1725	56C	**116745**	A	34	✓	3.4	84.7	85.5	12.81
	1725	143TC	**121179**	B	34	✓	3.4	84.7	85.5	13.25
1½	3450	143TC	**121672**	B	33	✓	3.6	83.0	84.0	13.25
	1725	56C	**116746**	A	37	✓	5.6	86.1	86.5	13.31
	1725	145TC	**121180**	B	37	✓	5.6	86.1	86.5	13.75
2	3450	145TC	**121673**	B	44	✓	4.8	84.8	85.5	13.75
	1725	56HC	**116747**	A	43	✓	5.8	86.7	86.5	13.82
	1725	145TC	**121181**	B	43	✓	5.8	86.7	86.5	14.26
3	3450	182TC	**132079**	B	70	✓	7.6	86.1	86.5	13.96
	1760	182TC	**131504**	B	75	✓	7.8	89.0	89.5	14.96
5	3450	184TC	**132080**	B	100	✓	12.8	88.0	88.5	16.46
	1760	184TC	**131502**	B	99	✓	12.8	90.1	89.5	15.97
7½	3450	213TC	**140770**	B	160	✓	17.8	89.5	90.2	19.64
	1760	213TC	**140521**	B	144	✓	21.4	90.6	91.7	18.70
10	3510	215TC	**140769**	B	175	✓	23.6	92.4	91.7	21.09
	1760	215TC	**140522**	B	160	✓	26.6	91.6	91.7	19.70
15	3525	254TC	**171586**	C	292	✓	34.6	92.0	92.4	23.19
	1770	254TC	**171587**	C	290	✓	36.0	92.4	92.4	23.19
20	3525	256TC	**171588**	C	326	✓	46.0	93.0	92.4	24.92
	1770	256TC	**171589**	C	332	✓	49.0	93.0	93.0	24.92
25	3550	284TSC	**171590**	C	393	✓	56.8	93.3	93.0	24.88
	1770	284TC	**171591**	C	395	✓	59.0	94.0	93.6	26.26
30	1770	286TC	**171592**	C	442	✓	70.0	94.1	94.1	27.83
40	1780	324TC	**171593**	C	538	✓	92.0	94.0	94.1	29.53
50	1780	326TC	**171594**	C	597	✓	117.0	94.6	94.5	31.02
60	1780	364TC	**171595**	C	676	✓	137.0	95.0	95.4	32.64
75	1780	365TC	**171596**	C	743	✓	170.0	95.8	95.8	33.62
100	1780	405TC	**171597**	C	1002	✓	225.0	95.4	95.4	37.91

All WATTSAVER® motors have normally closed thermostats for over-temperature alert.

WATTSAVER® PREMIUM EFFICIENCY HIGH TORQUE

WATTSAVER® Premium Efficiency Motors provide enhanced operating efficiencies, cooler operating temperatures, and reduced running amperage. See page 13 for complete list of features.

SINGLE PHASE • TEFC • RIGID BASE

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Voltage	Over-load Prot.	F.L. Amps 230V	% F.L. Eff.	"C" Dim. (Inches)
1/3	1725	56	**113765**☆	A	27	115/208-230	Man.	1.7	76.0	10.81
1/2	1725	56	**113766**☆	A	30	115/208-230	Man.	2.5	78.0	11.31
3/4	1725	56	**113767**☆	A	35	115/208-230	Man.	3.2	82.0	11.81
1	1725	56	**113768**☆	A	37	115/208-230	Man.	4.2	83.0	12.31
1½	1725	56H	**113769**☆□	A	43	115/208-230	Man.	6.5	84.0	13.31
2	1725	56HZ	**113770**☆■	A	49	230	Man.	8.2	85.0	14.25

WATTSAVER® PREMIUM EFFICIENCY FAN MOTORS

Premium efficiency motors for agricultural and industrial belted-fan applications.

Features include quiet bearings, resilient cradle base, and quiet flow-through ventilation. Class "F" insulated, with spade connectors on terminal board for quick and easy installation.

SINGLE PHASE • DRIP-PROOF • RESILIENT BASE

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Voltage	Over-load Prot.	F.L. Amps 115V	% F.L. Eff.	"C" Dim. (Inches)
1/4	1725	48	**101602**	A	19	115	Auto.	2.5	71.0	10.39
1/3	1725	48	**101405**	A	19	115	Auto.	3.2	75.0	10.39
	1725/ 1140	56HZ	**113771**②D	A	30	115	Auto.	3.0	73.0	11.44
	1725/ 1140	56HZ	**113970**②D	A	30	115	Auto.	3.2	73.0	11.94
	1725/ 850	56HZ	**113674**②D	A	30	115	Auto.	3.1	70.0	11.44
	1725/ 850	56HZ	**113969**②D	A	30	115	Auto.	3.2	73.0	11.94
1/2	1725	48	**101585**	A	25	115	Auto.	4.6	76.0	11.39

② These combination 56H base motors have mounting holes for 56 and 143-5T, and a 1/2" diameter shaft with flat 1½" long.

☆ Capacitor start/capacitor run design for reduced amperage, others are capacitor start/induction run.

□ Combination 56 H base motors have mounting holes for NEMA 56 and NEMA 143-5T and a standard NEMA 56 shaft.

■ Combination 56 HZ base has mounting holes for NEMA 56 and 143-5T and a standard NEMA 145T frame shaft of 7/8" diameter.

D Motors are to be discontinued once the inventory is depleted.

FHP MOTORS FOR AC DRIVES

- Compact 48-frame design with keyed shaft
- Class F insulation
- 20:1 Constant torque rated
- Inverter IRIS™ insulation system
- 1/2" diameter keyed shaft with 48-C Face
- 115/230V 3-phase design optimized for FHP drives

THREE PHASE • TEFC • C FACE WITH BASE

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	F.L. Amps 230V	% F.L. Eff.	"C" Dim. (Inches)
1/6	1725	48CZ	**102792**	A	25	1.25	56.0	8.94
1/4	1725	48CZ	**102793**	A	26	1.4	58.0	8.94
1/3	1725	48CZ	**102794**	A	28	1.6	64.3	9.19
1/2	1725	48CZ	**102795**	A	30	1.8	77.0	10.19

All three phase motors, 1 HP and above, are inverter rated. Refer to page 5 for speed ranges.

General Specifications:

Designed specifically to meet severe duty environments that you may find in applications such as chemical plants, foundries, pulp and paper mills, waste management facilities, refineries, above ground mines or other applications that demand corrosion protection for long motor life and dependability.

Mechanical Protection Features:

- Full cast iron construction
- Two-part Epoxy paint
- Inpro Shaft Seal on output shaft and Forsheda seal on non-drive end
- Internal corrosion protection
- Regreasable bearings 250 Frame and above
- Three Year warranty
- Stainless Steel nameplate
- Corrosion Resistant hardware

Electrical Performance and Protection Features:

- 1.15 Service Factor
- Meets IP 55 enclosure protection
- Dual voltage design
- Normally Closed Thermostats

Standards and Approvals:

- UL and CSA recognized
- Construction is CSA Certified for safety report number LR62104
- UL recognized construction, file number E57948

SEVERE DUTY • WATTSAVER PLUS

HP	RPM 60 Hz	NEMA Frame	Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Voltage	Over-load Prot.	F.L. Amps 230V	"C" Dim. (Inches)
3	1760	182T	**171623**	C	112	208-230/460	7.8	90.2	16.64
	1180	213T	**171634**	C	180	208-230/460	9.4	89.5	18.69
5	1760	184T	**171630**	C	120	208-230/460	12.8	89.5	17.30
	1180	215T	**171635**	C	186	208-230/460	14.4	89.5	20.11
7½	3510	213T	**171616**	C	155	208-230/460	18	91.0	18.69
	1760	213T	**171622**	C	165	208-230/460	18.6	91.7	18.69
	1170	254T	**171636**	C	263	208-230/460	22.2	91.7	23.69
10	3510	215T	**171617**	C	190	208-230/460	23	91.7	20.11
	1760	215T	**171631**	C	187	208-230/460	25	91.7	20.11
	1170	256T	**171637**	C	312	208-230/460	29	91.7	25.42
15	3525	254T	**171620**	C	294	208-230/460	34.6	92.4	23.69
	1770	254T	**171632**	C	294	208-230/460	36	92.4	23.69
	1170	284T	**171638**	C	346	208-230/460	40.6	92.4	26.76
20	3525	256T	**171621**	C	330	208-230/460	46	92.4	25.42
	1770	256T	**171633**	C	335	208-230/460	49	93.0	25.42
	1170	286T	**171639**	C	405	208-230/460	54	92.4	28.33

General Specifications:

Designed for harsh environments that you may find in refineries, above-ground mines, foundries, paper and pulp mills, cement plants or other severe duty applications requiring a premium efficient motor.

Mechanical Protection Features:

- Inpro Shaft Seals installed
- Re-greasable bearings by using extended grease tubes.
- Five-year warranty
- Two part epoxy painted
- Brass breather and drain plug

Electrical Performance and Protection Features:

- Tested to IEEE-841 Standards
- Actual test and vibration Data supplied with each motor
- Meets NEMA MG1 – 1.26.6 Waterproof Specification
- Nameplate stamped to Division 2 CSA certification for hazardous locations, Class 1 Groups A, B, C, D, Temperature code T2B
- Meets NEMA Premium Efficient standards
- 1.15 Service Factor
- Class F Insulation System

Standards and Approvals:

- UL Recognized and CSA Certified
- Tested to IEEE45 USCG Marine Duty, API RP14F for offshore platforms
- Meets IP56

IEEE 841 PREMIUM EFFICIENT MOTORS

HP	RPM	NEMA Frame	IEEE 841 Catalog Number	Disc. Sym.	App. Wgt. (lbs.)	Voltage	F.L. Amps 230V	% F.L. Eff.	"C" Dim. (Inches)
1	1725	143T	**811541**	C	55	460	1.5	85.5	10.43
1½	3460	143T	**811542**	C	58	460	2.0	86.5	10.43
	1730	145T	**811543**	C	65	460	2.2	84.0	11.43
2	3500	145T	**811544**	C	68	460	2.5	85.5	11.43
	1735	145T	**811545**	C	68	460	3.0	85.5	11.43
3	3525	182T	**811546**	C	105	460	3.8	87.5	12.71
	1760	182T	**811547**	C	100	460	4.0	90.2	12.71
5	3505	184T	**811548**	C	142	460	5.9	89.5	16.19
	1755	184T	**811549**	C	130	460	6.2	90.2	16.19
7½	3540	213T	**811550**	C	200	460	8.9	91.7	17.18
	1770	213T	**811551**	C	200	460	9.6	91.7	19.73
10	3535	215T	**811552**	C	218	460	11.2	91.7	20.97
	1765	215T	**811553**	C	225	460	12.5	91.7	19.73
15	3550	254T	**811554**	C	345	460	17.5	91.7	23.52
	1775	254T	**811555**	C	350	460	18.8	92.4	23.52
20	3537	256T	**811556**	C	375	460	23.4	92.4	25.27
	1775	256T	**811557**	C	425	460	24.1	93.0	25.27
25	3560	284TS	**811558**	C	481	460	28.1	93.6	24.97
	1775	284T	**811559**	C	478	460	31.0	93.6	26.34

All three phase motors, 1 HP and above, are inverter rated. Refer to page 5 for speed ranges.

SHADED FRAME INDICATES CAST IRON CONSTRUCTION

ECM 9:
Vending Machine Controls

ECM Overview

Ameresco proposes to install occupancy sensing, plug load controllers to reduce the unnecessary operation of the Town's vending machines during unoccupied periods. Each vending machine controller will save energy used by the refrigerated vending machine during unoccupied hours without compromising product quality. The controller will use a sensor to detect when the space is unoccupied and turn off the vending machine. Existing non-refrigerated snack machines will also be controlled.

Figure 9.1: Soda and drink vending machines will be controlled and set back by the VendingMiser®, or equal, resulting in electrical savings.

ECM Detail

Existing System

Vending machines were found throughout the Town's buildings. The vending machines are typically stocked with soda, juice and sports drinks and are cooled and illuminated year-round regardless of occupancy. Snack vending machines were also found in the same areas.

Ameresco identified the following vending machines for VendingMiser® controller installation:

Building	Snack Qty.	Drink Qty.
DPW Highway	0	1
Fairbank Community Center	1	3
Fire Department HQ	1	1
Fire Department South	0	1
Fire Department North	0	1
Loring Elementary School	0	1
Noyes Elementary School	0	1
Haynes Elementary School	0	1
Nixon Elementary School	0	1
Totals	**2**	**11**

Proposed System

Ameresco proposes to install a VendingMiser™ controller, or equal, on the soft drink and snack vending machine to save energy during unoccupied periods. This device controls the vending machine operation without compromising its product quality. The controller is external to the vending machine, therefore not requiring vendor maintenance. Major soft drink producers have approved the controller for use on vending machines offering their products.

The controller employs infrared sensing technology to interrupt power to a vending machine when the surrounding area is unoccupied. Regardless of occupancy, the controller automatically enables the vending machine to ensure that its product remains cold. The controller is designed so that it will not de-energize the vending machine during a cooling compressor cycle.

As reported by the American Council for an Energy Efficient Economy (ACEEE), the 2.5 million vending machines operating in the U.S. consume nearly $600 million in energy and demand costs. Since Town buildings are not constantly occupied, the Town's refrigerated vending machines consume more energy than needed.

Figure 9.2: Soda and drink vending machines at Fairbank Community Center.

According to the manufacturer's representative, if switched off, this product's resumes normal operation once its power is restored.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect "As-Built" conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The new vending machine controls will enhance facility operations by reducing electricity usage during unoccupied periods. Students, teachers and administrators will notice no reduction in drink quality as a result of this measure.

Appendix for ECM 9: Vending Machine Controls

I. Energy Savings Calculations

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MAPC - Sudbury
Energy and Demand Savings Summary
Measure ID: **9**
Measure Name: **Vending Machine Controls**
Measure Location:
Engineers:

Site Name:		**DPW_Old**	**Fairbank**	**FDHQ**	**Fire_S**	**Fire_N**	**Loring**	**Noyes**	**Haynes**	**Nixon**	**Summary**
Item	Units	Savings	Savings	Savings	Savings	Savings	Savings	Savings	Savings	Savings	
Electricity											
Energy On-Peak	kWh										0
Energy Off-Peak	kWh	2,356	3,451	1,713	1,423	1,423	1,227	2,573	1,325	1,310	16,801
Energy Total	kWh	2,356	3,451	1,713	1,423	1,423	1,227	2,573	1,325	1,310	16,801
Demand On-Peak, Monthly	kW										0.0
Demand On-Peak, Annual	kW										0.0
Demand Off-Peak, Monthly	kW										0.0
Demand Off-Peak, Annual	kW										0.0
Fossil Fuel											0
Natural Gas (NG)	Therms	-38	-54	-30	-26	-26	-21	-42	-23	-22	-282
Liquid Propane Gas (LPG)	Gallons	0	0	0	0	0	0	0	0	0	0
Steam	Mlbs	0	0	0	0	0	0	0	0	0	0
Fuel Oil, #2	Gallons	0	0	0	0	0	0	0	0	0	0
Fuel Oil, #4	Gallons	0	0	0	0	0	0	0	0	0	0
Fuel Oil, #6	Gallons	0	0	0	0	0	0	0	0	0	0
Miscellaneous	Misc	0	0	0	0	0	0	0	0	0	0
Water											0
Water Savings	kGallons										0
Sewer											0
Sewer Savings	kGallons										0

MAPC - Sudbury

Vending Machine Controls

Building	Quantity of Snack Machines	Quantity of Refrigerated Drink Machines	Total Connected Demand	Existing Hours of Operation	Existing Electric Consumption	Proposed Hours of Operation	Proposed Electric Consumption	Operating Months per Year
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]
DPW Highway	0	1	0.43	8,760	3,741	3,415	1,458	12
Fairbank Community Center (Including Pool)	1	3	0.73	8,760	6,417	4,583	3,357	12
Fire Dept Headquarters	1	1	0.51	8,760	4,441	5,475	2,776	12
Fire Dept South	0	1	0.43	8,760	3,741	5,475	2,338	12
Fire Dept North	0	1	0.43	8,760	3,741	5,475	2,338	12
Loring Elementary	0	1	0.20	8,760	1,789	2,818	575	12
Noyes Elementary	0	1	0.43	8,760	3,741	2,818	1,203	12
Haynes Elementary	0	1	0.22	8,760	1,887	2,818	607	12
Nixon Elementary	0	1	0.22	8,760	1,887	2,781	599	12
	2	11	3.58		31,383		15,252	

Item	Value	Units	cell ref	Remarks
Existing Annual Hours of Operation per Machine	8,760	Hrs.	**[C62]**	Vending Machines are constantly plugged in.
Time Between Auto Repower	2.00	Hrs.	**[C63]**	based on Bayview Tech data
Duration of Auto Repower	0.40	Hrs.	**[C64]**	based on Bayview Tech data
Non-perishable Snack Machine Average Power Dr	80	watts	**[C65]**	Average power draw
Refrigerated Drink Machine Average Power Draw	427	watts	**[C66]**	Average power draw
Refrigerated Drink Machine Average Power Draw	233	watts	**[C67]**	Energy Star model RVRVV 500-64 average power draw
Refrigerated Drink Machine Average Power Draw	215	watts	**[C68]**	Energy Star model RVCC660 average power draw
Refrigerated Drink Machine Average Power Draw	204	watts	**[C69]**	Energy Star model DN501E average power draw

Cell Ref.	Comment
A	Facility
B	Number of Snack Machines
C	Number of Drink Machines
D	Total connected electric demand per building
E	= [C62]
F	= [col D] x [col E]
G	Building Occ. hours + ([C62] - Building Occ. hours) ÷ ([C63] + [C64]) x [C64]
H	= [col D] x [col G]
I	Months per year the machine is powered on
J	= [col F] x [col H]

MAPC - Sudbury

Vending Machine Controls

Interactive Savings Calculation

	Savings		Heating Penalty				Cooling Benefit			
A	B	C	D	E	F	G	H	I	J	K
Facility	Annual kW	Annual kWh	Heat Gain to Space	Heating Months	Heating System Efficiency	Heating Penalty MMBtu	Total Space Cooled	Cooling Months	Cooling System COP	Cooling Benefit MMBtu
DPW Highway		2,282	100.0%	5.0	86.0%	(3.8)	25.0%	5.0	3.22	0.3
Fairbank Community Center (Including Pool)		3,060	100.0%	5.0	80.0%	(5.4)	90.0%	5.0	2.93	1.3
Fire Dept Headquarters		1,665	100.0%	5.0	80.0%	(3.0)	20.0%	5.0	2.93	0.2
Fire Dept South		1,403	100.0%	5.0	78.0%	(2.6)	10.0%	5.0	2.93	0.1
Fire Dept North		1,403	100.0%	5.0	78.0%	(2.6)	10.0%	5.0	2.93	0.1
Loring Elementary		1,213	100.0%	5.0	83.0%	(2.1)	8.0%	5.0	2.93	0.0
Noyes Elementary		2,537	100.0%	5.0	85.0%	(4.2)	10.0%	5.0	2.93	0.1
Haynes Elementary		1,280	100.0%	5.0	78.0%	(2.3)	25.0%	5.0	2.93	0.2
Nixon Elementary		1,288	100.0%	5.0	83.0%	(2.2)	12.0%	5.0	2.93	0.1
Totals	**0.0**	**16,131**				**(28.2)**				**2.3**

Notes:	
A	Applicable building included in comprehensive energy audit
B	Measure demand savings {kW} associated with Measure retrofit measures
C	Measure energy savings {kWh} associated with Measure retrofit measures
D	Estimated percentage of Measure energy transmitted to conditioned space
E	Estimated length of heating season
F	Estimated heating system efficiency, interacted with other measures
G	Resulting heating penalty due to Measure upgrades = [col C] x [col D] x 3,413 x ([col E] / 12) / [col F] / 1,000,000
H	Estimated percentage of space cooled
I	Estimated Length of cooling season
J	Estimated cooling system efficiency, interacted with other measures
K	Resulting cooling benefit due to Measure upgrades = [col C] x [col D] x 3,413 x ([col I] / 12) / [col J] / 1,000,000

Appendix for ECM 9: Vending Machine Controls

II. Manufacturer Specification Sheets

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SnackMiser™

ENERGY MANAGEMENT SYSTEM
For Snack Vending Machines

The power behind the profits…

SnackMiser™ puts the power of savings into your environment.

With SnackMiser, your current snack venders can achieve maximum energy savings resulting in a reduction in both operating costs and greenhouse gas emissions. Compatible with non-refrigerated snack vending machines, SnackMiser incorporates innovative, energy-saving technology into a small, plug-and-play unit that installs in minutes.

A Practical approach to power

SnackMiser uses a Passive Infrared Sensor (PIR) to determine if there is anyone within 25 feet of the machine. It waits for 15 minutes of vacancy, then powers down the machine. If a customer approaches the machine while powered down, SnackMiser will sense the presence and power up immediately. In addition to reducing energy costs, this practical power play lengthens the expected lifetime of your machine and reduces its exposure to power line spikes.

On average, SnackMiser reduces energy consumption annually per machine by $50 and CO2 emissions by 470 lbs. and 770 grams of NOx, based on occupancy and the Energy Information Administration's national average of greenhouse gas emissions and electricity generation.

This Miser runs the bank

For a bank of machines, SnackMiser can use its embedded Sensor Repeater, which allows it to be controlled from the PIR sensor of any other Miser in the bank. SnackMiser can stand alone or be an ideal partner for VendingMiser®.

SnackMiser offers…

- A quick, inexpensive solution to energy savings and conservation
- Longer machine lifespan
- Environmental benefits
- Early return on investment

SnackMiser Technical Specifications

Electrical Specifications
Input Voltage: 115 Volts
Input Frequency: 50/60 Hz
Maximum Load: 1050 Watts (Steady-State)
Power Consumption: Less than 1 Watt (Standby)

Environmental Specifications
Operating Temp: 0°C to 50°C
Storage Temp: -20°C to 60°C
Relative Humidity: 95% Maximum (Non-Condensing)

Compatibility
Snack Vending Machines: Any type, as long as SnackMiser's maximum power rating is not exceeded

Inactivity Timeouts
Occupancy Timeout: 15 minutes

Dimensions
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 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 VendingMiser®, VM2IQ™, CoolerMiser™ and PlugMiser™.

GSA Schedule
Contract GS-35F-0031R

energy ENERGY STAR PARTNER

USA TECHNOLOGIES

Optimum Energy Products Ltd. Toll Free 877-766-5412 Main 403-256-3636 Fax 403-256-3431

Frequently Asked Questions

How Does SnackMiser™ Work?

SnackMiser™ uses a PIR sensor to determine if there is anyone within 25 feet of the machine. SnackMiser™ waits for 15 minutes of vacancy and then powers off the snack machine. If a customer approaches the snack machine while powered down, SnackMiser™ will sense the person's presence and power up immediately.

Will SnackMiser™ affect the lifetime of the lights in my machine?

The replacement frequency of the fluorescent lamps will be reduced. While it is true that power cycling fluorescent lamps will shorten their life, the hours that the machine is powered down greatly exceeds this reduction in burn hours. The net effect is that the lamps will need replacement less often.

Are there any locations not appropriate for SnackMiser™?

A machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings.

Is the SnackMiser™ easy to install?

Yes. The SnackMiser™ can be installed on the wall with the supplied bracket holder or it can be attached to the snack machine using the new Easy-Install system. Because many SnackMisers™ are installed with a VendingMiser®, sensor installation might not even be needed.

Technical Specifications

ELECTRICAL SPECIFICATIONS

Input Voltage:	115 Volts (230 Volts available)
Input Frequency:	50/60 Hz
Maximum Load:	1050 Watts (Steady-State)
Power Consumption:	Less than 1 Watt (Standby)

ENVIRONMENTAL SPECIFICATIONS

Operating Temp:	0°C to 50°C
Storage Temp:	-20°C to 60°C
Relative Humidity:	80% Maximum (Non-Condensing)

COMPATIBILITY

Snack Machines:	Any type, as long as SnackMiser's maximum power rating is not exceeded

INACTIVITY TIMEOUTS

Timeout Period:	15 minutes

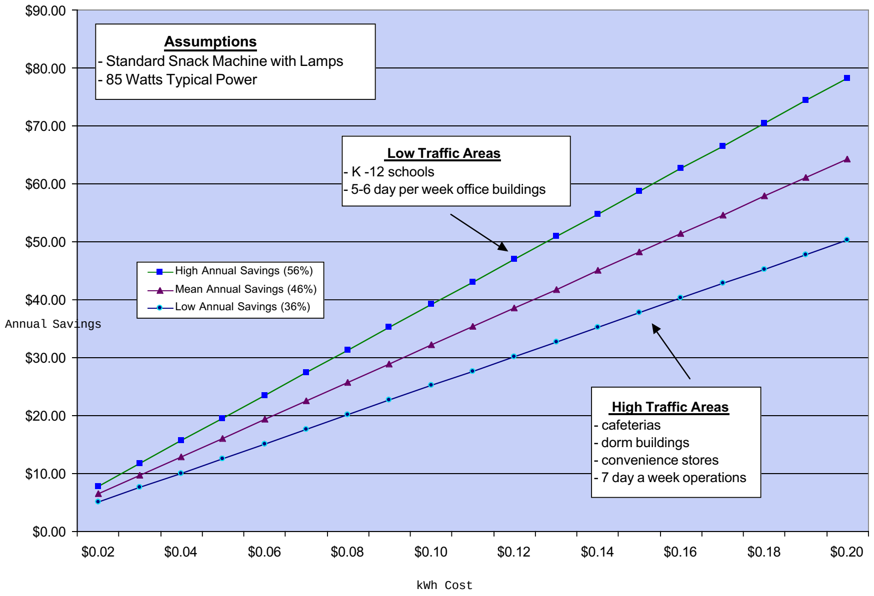
DIMENSIONS

Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

Typical Saving Generated with SnackMiser™



SnackMiser™ Products

SM150	SnackMiser with PIR Sensor
SM151	SnackMiser only
SM170	Easy-Install SnackMiser with PIR Sensor
SM171	Easy-Install SnackMiser only

For more information about the SnackMiser™
Contact Optimum Energy Products Ltd.
333, 11979 - 40th Street S.E.
Calgary, Alberta T2Z 4M3

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

Fore more information about VendingMiser contact Optimum Energy Products Ltd. Toll free 1.877.766.5412 or online www.VendingMiserStore.com

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.

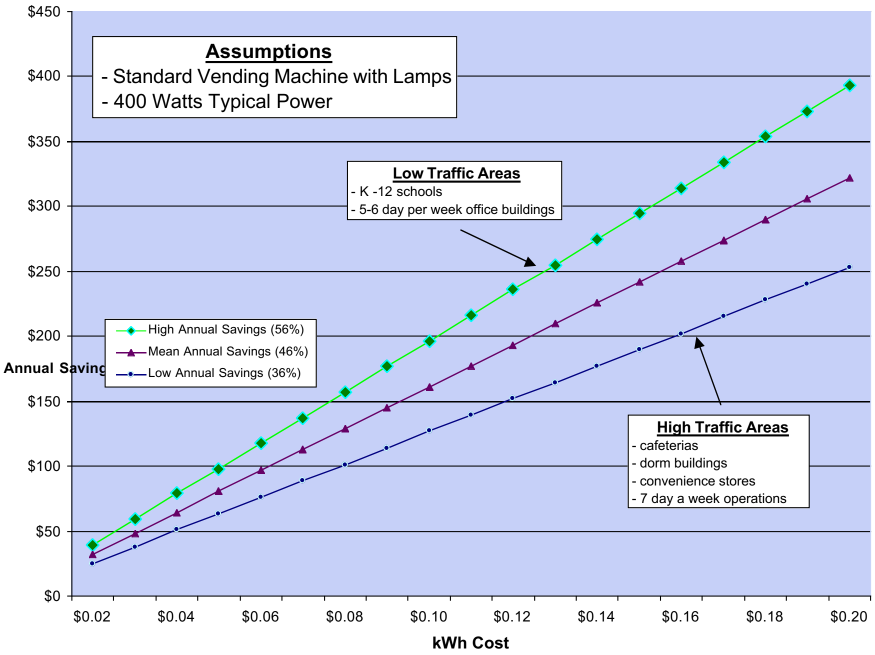
Are there any locations not appropriate for VendingMiser®?
VendingMiser's® savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings. Our VM2IQ is more appropriate for this type of location and 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

UL LISTED c UL LISTED

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

Fore more information about VendingMiser contact

Optimum Energy Products Ltd. Toll free 1.877.766.5412 or online www.VendingMiserStore.com

ECM 11:
Weatherization

ECM Overview

Ameresco proposes to perform a number of infiltration reduction measures at a number of buildings throughout the Town of Sudbury. Exterior doors, windows, roof-wall intersections, soffit overhangs, and wall penetrations at the identified buildings have many gaps that allow outside air to infiltrate the building. The new weather-stripping and sealants will greatly reduce heat loss as well as increase occupant comfort due to fewer drafts. All of the buildings were surveyed and evaluated, but not all infiltration reduction opportunities were included in the project due to poor payback.

Figure 11.1: By reducing building infiltration through leaky windows, energy savings will be achieved through reduced heating and cooling loads. Shown above is a single pane window at the Fairbank Community Center.

ECM Detail

Existing System

The infiltration of outdoor air can be a significant load on a building's central heating and cooling systems. There are many sources of infiltration in a building's exterior envelope that can be considerably reduced with proper weather-stripping and air sealing methods. The major sources of infiltration are exterior doors, windows, walls and roof-wall intersections.

Ameresco evaluated the exterior of each building and found many areas that were in need of proper weather-stripping. The majority of the doors recommended for weather-stripping replacement had worn weather-stripping and door sweeps causing large gaps between the door jam and door.

The various opportunities evaluated for each building are as follows:

Doors - These are generally the main source of air leakage. Weather-stripping is typically worn and/or missing. Also, older doors do not close tight or latch correctly as when first installed. A number of exterior doors at Fairbank Community Center, Fire Station Headquarters, Curtis Middle School, Haynes Elementary School and Nixon Elementary School have weather stripping that is in poor condition and in need of replacement.

Roof-Wall Interface - This is the most often missed area in a building during construction. This occurs above the ceiling tiles where the wall assembly meets the roof deck. Most wall assemblies are not fully completed above the ceiling line. The Fairbank Community Center, Goodnow Library, Curtis Middle School, Loring Elementary School and Noyes Elementary School have large gaps between the metal fluted roof and the steel framing. There is no continuous air barrier installed and there is excessive infiltration as a result.

Exterior Shell – The Senior Center area of the Fairbank Community Center and areas of the Goodnow Library have fiberglass batt insulation installed in the wall cavities above the dropped ceiling. There is however no continuous air barrier installed to prevent infiltration, greatly reducing the thermal performance of the insulation. The Pool Building area of the Fairbank Community Center, second level of the Goodnow Library, and various areas of the Curtis Middle School, Loring Elementary School and Noyes Elementary School have soffit overhangs that do not have continuous air barriers.

Windows – Windows throughout the Fire Department Headquarters, Curtis Middle School, Loring Elementary School and Haynes Elementary School are double hung styles of various sizes. The upper sash on most of the windows at the Fire Department Headquarters does not close properly, creating a gap at the upper sash and the meeting joint of the upper and lower sash. Most of the windows throughout these buildings are also missing sealant between the window stops and window frames, allowing infiltration.

Compartmentalization – At the Fire Department Headquarters and Fire Department North the doors between the garage and office areas are not weather stripped. At the Fairbank Community Center and the Nixon Elementary School the doors between mechanical rooms and occupied spaces are not weather stripped. These doors allow air to transfer from the garage and mechanical rooms to the remaining occupied spaces. Because the garage and mechanical rooms are maintained at low setpoint temperatures and have high air change rates, this door can be a source of unwanted infiltration.

Proposed System

Ameresco proposes to reduce the infiltration of outside air and the leaking of conditioned air by implementing proper weather-stripping and air-sealing of doors, windows, exterior shell and roof/wall junctions. Ameresco performed a survey at each building to determine the location and severity of air leakage. Based on the findings, there are many areas in each building where infiltration can be reduced. Table 11.1 shows the buildings that will receive new door weather-stripping and Table 11.2 shows buildings that will receive other air sealing strategies.

Doors & Compartmentalization - New weather-stripping and door sweeps will be installed to exterior doors and those doors identified in the compartmentalization measure. The new weather-stripping will conform to existing aesthetics as best as possible. Q-lon weather-stripping or equal with like colors will be used on main doors.

Windows – Ameresco proposes to seal air gaps in the window systems at Fire Department Headquarters, and Haynes Elementary School. This includes applying a siliconized acrylic latex caulk to all non-operational window joints such as window casing, jamb and trim. The upper sash of the double hung windows at the Fire Department Headquarters will be fastened shut and caulked to provide an air-tight seal.

Proposed work excludes repair to any existing damage of the building infrastructure (i.e. mortar, brick, painting, patching and wood), adjustments to existing doors and windows, and hazardous waste removal or remediation. Ameresco does not believe any of these cases will occur, though it won't be known fully until construction begins.

Table 11.1 & 11.2 below contains the crack area for each location of infiltration at each building.

Table 11.1: Proposed square feet of door air sealing

Building	Quantity of Doors	Crack Area (ft²)
Fire Station Headquarters	2 Single	0.21
Haynes Elementary School	7 Single, 3 Double	0.55
Total		**0.76**

Table 11.2: Proposed square feet of air sealing in addition to door air sealing

Building	Roof/Wall Junction Crack Area (ft²)	Exterior Shell Crack Area (ft²)	Window Crack Area (ft²)	Compartmentalization (Garage/Mech from Interior Doors)
Fire Station Headquarters	0	0	1.29	0.05
Fire Station North	0	0	0	0.37
Haynes Elementary School	0	0	5.21	0
Total	**0**	**0**	**6.5**	**0.42**

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect "As-Built" conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The new weather-stripping and air sealing will enhance facility operations by reducing infiltration that causes drafts during the winter. Students, teachers, administrators and Town employees will notice a more comfortable environment in which to work and learn.

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Appendix for ECM 11: Weatherization

I. Energy Savings Calculations

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MAPC - Sudbury	
Energy and Demand Savings Summary	
Measure ID:	**11**
Measure Name:	**Weatherization**
Measure Location:	
Engineers:	

Site Name:		**FDHQ**	**Fire_N**	**Haynes**	**Summary**
Item	Units	Savings	Savings	Savings	
Electricity					
Energy On-Peak	kWh	11	1	21	33
Energy Off-Peak	kWh				0
Energy Total	kWh	11	1	21	33
Demand On-Peak, Monthly	kW				0.0
Demand On-Peak, Annual	kW				0.0
Demand Off-Peak, Monthly	kW				0.0
Demand Off-Peak, Annual	kW				0.0
Fossil Fuel					0
Natural Gas (NG)	Therms	338	71	903	1,312
Liquid Propane Gas (LPG)	Gallons				0
Steam	Mlbs				0
Fuel Oil, #2	Gallons				0
Fuel Oil, #4	Gallons				0
Fuel Oil, #6	Gallons				0
Miscellaneous	Misc				0
Water					0
Water Savings	kGallons				0
Sewer					0
Sewer Savings	kGallons				0

MAPC - Sudbury
Fire Dept Headquarters
Weatherization

TMY-2 Weather Data for Worcester, MA								**Operating Hours**				**Savings**								
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Total Crack Area (ft^2)	Average Wind Speed (MPH)	Infiltration Flow Rate (CFM)	Occ. Heating / Cooling Savings (MBH)	UnOcc. Heating / Cooling Savings (MBH)	Occ. Cooling Savings (MMBTU)	UnOcc. Cooling Savings (MMBTU)	Occ. Heating Savings (MMBTU)	UnOcc. Heating Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**
Cooling																				
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	1.6	10.5	104	4	4	0	0		
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	1.6	10.5	104	3	3	0	0		
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	1	0	1.6	10.5	104	3	3	0	0		
90 to 95	92.5	69.8	34.2	0	8	0	8	2	0	6	0	1.6	10.5	104	2	2	0	0		
85 to 90	87.5	70.3	34.6	1	37	6	44	13	0	31	0	1.6	10.5	104	2	2	0	0		
80 to 85	82.5	68.4	33.0	8	138	29	175	50	0	125	0	1.6	10.5	104	1	1	0	0		
75 to 80	77.5	66.2	31.2	27	202	83	312	89	0	223	0	1.6	10.5	104	1	1	0	0		
70 to 75	72.5	64.3	29.7	64	269	160	493	141	0	352	0	1.6	10.5	104	0	0	0	0		
65 to 70	67.5	61.2	27.5	185	208	243	636	182	0	454	0	1.6	10.5	104	0	0	0	0		
60 to 65	62.5	57.3	24.8	315	249	298	862	246	0	616	0	1.6	10.5	104	0	0	0	0		
Heating																				
55 to 60	57.5	52.7	0.0	303	245	276	824	235	0	589	0	1.6	12.8	127	2	0			2	0
50 to 55	52.5	47.8	0.0	262	184	228	674	192	0	482	0	1.6	12.8	127	2	1			2	0
45 to 50	47.5	42.5	0.0	204	230	211	645	184	0	461	0	1.6	12.8	127	3	2			2	0
40 to 45	42.5	38.3	0.0	210	191	234	635	181	0	454	0	1.6	12.8	127	4	2			3	0
35 to 40	37.5	33.8	0.0	321	301	286	908	259	0	649	0	1.6	12.8	127	4	3			5	0
30 to 35	32.5	28.7	0.0	356	221	313	890	254	0	636	0	1.6	12.8	127	5	4			6	0
25 to 30	27.5	23.5	0.0	228	211	211	650	186	0	464	0	1.6	12.8	127	6	4			5	0
20 to 25	22.5	19.1	0.0	104	94	124	322	92	0	230	0	1.6	12.8	127	6	5			3	0
15 to 20	17.5	14.3	0.0	144	78	117	339	97	0	242	0	1.6	12.8	127	7	6			3	0
10 to 15	12.5	9.3	0.0	118	40	85	243	69	0	174	0	1.6	12.8	127	8	6			2	0
5 to 10	7.5	5.0	0.0	52	10	15	77	22	0	55	0	1.6	12.8	127	9	7			1	0
0 to 5	2.5	2.2	0.0	18	3	1	22	6	0	16	0	1.6	12.8	127	9	8			0	0
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	1.6	12.8	127	10	9			0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	1.6	12.8	127	11	9			0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	1.6	12.8	127	11	10			0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	1.6	12.8	127	12	11			0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	1.6	12.8	127	13	11			0	0
				2,920	2,920	2,920	8,760	2,500	0	6,260	0						0	0	34	0

Cell Ref.	**Comment**
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Occupied hours as per the RFP data
M	Total Crack area of windows and doors
N	Average wind speed during the cooling and heating seasons
O	= [col M] x [col N] x 5286 ÷ 60 x P51
P	= 1.08 x [col O] x (Q55 - [col B]) ÷ 1000 ÷ P46
Q	= 1.08 x [col O] x (Q56 - [col B]) ÷ 1000 ÷ P46
R	[col P] x ([col I] + [col K]) ÷ 1,000 ÷ P47 x P48
S	[col Q] x ([col J] + [col L]) ÷ 1,000 ÷ P47 x P48
T	[col P] x ([col I] + [col K]) ÷ 1,000 ÷ P46
U	[col Q] x ([col J] + [col L]) ÷ 1,000 ÷ P46

Assumptions:	**Value**	**Unit**	**CELL REF**	**Description**
Total Crack Area	1.55	SF	**P43**	
		SF	**P44**	
		SF	**P45**	
Existing Boiler Plant Efficiency	80.0%		**P46**	
Existing Cooling Plant Efficiency	2.93	COP	**P47**	
Percent Building Cooled	20.0%		**P48**	
Average Winter Wind Speed	12.8	MPH	**P49**	
Average Summer Wind Speed	10.5	MPH	**P50**	
Crack Area Windward Diversity	7.3%		**P51**	

Average Space Temperatures - After implementation of EMS					
	Cooling		Heating		**Description**
Occupied	72.0	**O55**	70.0	**Q55**	average temperature for all areas
UnOccupied	72.0	**O56**	60.0	**Q56**	

MAPC - Sudbury
Fire Dept North
Weatherization

TMY-2 Weather Data for Worcester, MA								**Operating Hours**				**Savings**								
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Total Crack Area (ft^2)	Average Wind Speed (MPH)	Infiltration Flow Rate (CFM)	Occ. Heating / Cooling Savings (MBH)	UnOcc. Heating / Cooling Savings (MBH)	Occ. Cooling Savings (MMBTU)	UnOcc. Cooling Savings (MMBTU)	Occ. Heating Savings (MMBTU)	UnOcc. Heating Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**
Cooling																				
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0.4	10.5	25	1	1	0	0		
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0.4	10.5	25	1	1	0	0		
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	1	0	0.4	10.5	25	1	1	0	0		
90 to 95	92.5	69.8	34.2	0	8	0	8	2	0	6	0	0.4	10.5	25	1	1	0	0		
85 to 90	87.5	70.3	34.6	1	37	6	44	13	0	31	0	0.4	10.5	25	0	0	0	0		
80 to 85	82.5	68.4	33.0	8	138	29	175	50	0	125	0	0.4	10.5	25	0	0	0	0		
75 to 80	77.5	66.2	31.2	27	202	83	312	89	0	223	0	0.4	10.5	25	0	0	0	0		
70 to 75	72.5	64.3	29.7	64	269	160	493	141	0	352	0	0.4	10.5	25	0	0	0	0		
65 to 70	67.5	61.2	27.5	185	208	243	636	182	0	454	0	0.4	10.5	25	0	0	0	0		
60 to 65	62.5	57.3	24.8	315	249	298	862	246	0	616	0	0.4	10.5	25	0	0	0	0		
Heating																				
55 to 60	57.5	52.7	0.0	303	245	276	824	235	0	589	0	0.4	12.8	30	0	0			0	0
50 to 55	52.5	47.8	0.0	262	184	228	674	192	0	482	0	0.4	12.8	30	0	0			0	0
45 to 50	47.5	42.5	0.0	204	230	211	645	184	0	461	0	0.4	12.8	30	1	0			0	0
40 to 45	42.5	38.3	0.0	210	191	234	635	181	0	454	0	0.4	12.8	30	1	1			1	0
35 to 40	37.5	33.8	0.0	321	301	286	908	259	0	649	0	0.4	12.8	30	1	1			1	0
30 to 35	32.5	28.7	0.0	356	221	313	890	254	0	636	0	0.4	12.8	30	1	1			1	0
25 to 30	27.5	23.5	0.0	228	211	211	650	186	0	464	0	0.4	12.8	30	1	1			1	0
20 to 25	22.5	19.1	0.0	104	94	124	322	92	0	230	0	0.4	12.8	30	1	1			1	0
15 to 20	17.5	14.3	0.0	144	78	117	339	97	0	242	0	0.4	12.8	30	2	1			1	0
10 to 15	12.5	9.3	0.0	118	40	85	243	69	0	174	0	0.4	12.8	30	2	2			1	0
5 to 10	7.5	5.0	0.0	52	10	15	77	22	0	55	0	0.4	12.8	30	2	2			0	0
0 to 5	2.5	2.2	0.0	18	3	1	22	6	0	16	0	0.4	12.8	30	2	2			0	0
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	0.4	12.8	30	2	2			0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	0.4	12.8	30	2	2			0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0.4	12.8	30	3	2			0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0.4	12.8	30	3	2			0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0.4	12.8	30	3	3			0	0
				2,920	2,920	2,920	8,760	2,500	0	6,260	0						0	0	7	0

Cell Ref.	**Comment**
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Occupied hours as per the RFP data
M	Total Crack area of windows and doors
N	Average wind speed during the cooling and heating seasons
O	= [col M] x [col N] x 5286 ÷ 60 x P51
P	= 1.08 x [col O] x (Q55 - [col B]) ÷ 1000 ÷ P46
Q	= 1.08 x [col O] x (Q56 - [col B]) ÷ 1000 ÷ P46
R	[col P] x ([col I] + [col K]) ÷ 1,000 ÷ P47 x P48
S	[col Q] x ([col J] + [col L]) ÷ 1,000 ÷ P47 x P48
T	[col P] x ([col I] + [col K]) ÷ 1,000 ÷ P46
U	[col Q] x ([col J] + [col L]) ÷ 1,000 ÷ P46

Assumptions:	**Value**	**Unit**	**CELL**	**Description**
			REF	
Total Crack Area	0.37	SF	**P43**	
		SF	**P44**	
		SF	**P45**	
Existing Boiler Plant Efficiency	78.0%		**P46**	
Existing Cooling Plant Efficiency	2.93	COP	**P47**	
Percent Building Cooled	10.0%		**P48**	
Average Winter Wind Speed	12.8	MPH	**P49**	
Average Summer Wind Speed	10.5	MPH	**P50**	
Crack Area Windward Diversity	7.3%		**P51**	

Average Space Temperatures - After implementation of EMS					
	Cooling		Heating		**Description**
Occupied	72.0	**O55**	66.0	**Q55**	average temperature for all areas
UnOccupied	72.0	**O56**	60.0	**Q56**	

MAPC - Sudbury
Haynes Elementary
Weatherization

TMY-2 Weather Data for Worcester, MA								**Operating Hours**				**Savings**								
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Total Crack Area (ft^2)	Average Wind Speed (MPH)	Infiltration Flow Rate (CFM)	Occ. Heating / Cooling Savings (MBH)	UnOcc. Heating / Cooling Savings (MBH)	Occ. Cooling Savings (MMBTU)	UnOcc. Cooling Savings (MMBTU)	Occ. Heating Savings (MMBTU)	UnOcc. Heating Savings (MMBTU)
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**
Cooling																				
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	5.8	10.5	386	15	12	0	0		
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	5.8	10.5	386	13	10	0	0		
95 to 100	97.5	0.0	34.2	0	1	0	1	0	0	0	1	5.8	10.5	386	11	8	0	0		
90 to 95	92.5	69.8	34.2	0	8	0	8	2	1	0	6	5.8	10.5	386	9	6	0	0		
85 to 90	87.5	70.3	34.6	1	37	6	44	9	3	0	31	5.8	10.5	386	6	4	0	0		
80 to 85	82.5	68.4	33.0	8	138	29	175	37	13	0	125	5.8	10.5	386	4	2	0	0		
75 to 80	77.5	66.2	31.2	27	202	83	312	66	23	0	223	5.8	10.5	386	2	0	0	0		
70 to 75	72.5	64.3	29.7	64	269	160	493	104	36	0	352	5.8	10.5	386	0	0	0	0		
65 to 70	67.5	61.2	27.5	185	208	243	636	135	47	0	454	5.8	10.5	386	0	0	0	0		
60 to 65	62.5	57.3	24.8	315	249	298	862	183	63	0	616	5.8	10.5	386	0	0	0	0		
Heating																				
55 to 60	57.5	52.7	0.0	303	245	276	824	175	61	0	589	5.8	12.8	469	6	0			1	0
50 to 55	52.5	47.8	0.0	262	184	228	674	143	50	0	482	5.8	12.8	469	9	3			2	2
45 to 50	47.5	42.5	0.0	204	230	211	645	137	47	0	461	5.8	12.8	469	11	5			2	3
40 to 45	42.5	38.3	0.0	210	191	234	635	135	47	0	454	5.8	12.8	469	14	8			2	5
35 to 40	37.5	33.8	0.0	321	301	286	908	192	67	0	649	5.8	12.8	469	16	10			4	10
30 to 35	32.5	28.7	0.0	356	221	313	890	189	65	0	636	5.8	12.8	469	19	13			5	12
25 to 30	27.5	23.5	0.0	228	211	211	650	138	48	0	464	5.8	12.8	469	22	15			4	10
20 to 25	22.5	19.1	0.0	104	94	124	322	68	24	0	230	5.8	12.8	469	24	18			2	6
15 to 20	17.5	14.3	0.0	144	78	117	339	72	25	0	242	5.8	12.8	469	27	21			2	7
10 to 15	12.5	9.3	0.0	118	40	85	243	51	18	0	174	5.8	12.8	469	29	23			2	6
5 to 10	7.5	5.0	0.0	52	10	15	77	16	6	0	55	5.8	12.8	469	32	26			1	2
0 to 5	2.5	2.2	0.0	18	3	1	22	5	2	0	16	5.8	12.8	469	34	28			0	1
-5 to 0	(2.5)	0.0	0.0	0	0	0	0	0	0	0	0	5.8	12.8	469	37	31			0	0
-10 to -5	(7.5)	0.0	0.0	0	0	0	0	0	0	0	0	5.8	12.8	469	39	33			0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	5.8	12.8	469	42	36			0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	5.8	12.8	469	44	38			0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	5.8	12.8	469	47	41			0	0
				2,920	2,920	2,920	8,760	1,856	644	0	6,260						0	0	27	63

Cell Ref.	**Comment**
A-H	TMY-2 Weather Data for Worcester, MA
I - L	Occupied hours as per the RFP data
M	Total Crack area of windows and doors
N	Average wind speed during the cooling and heating seasons
O	= [col M] x [col N] x 5286 ÷ 60 x P51
P	= 1.08 x [col O] x (Q55 - [col B]) ÷ 1000 ÷ P46
Q	= 1.08 x [col O] x (Q56 - [col B]) ÷ 1000 ÷ P46
R	[col P] x ([col I] + [col K]) ÷ 1,000 ÷ P47 x P48
S	[col Q] x ([col J] + [col L]) ÷ 1,000 ÷ P47 x P48
T	[col P] x ([col I] + [col K]) ÷ 1,000 ÷ P46
U	[col Q] x ([col J] + [col L]) ÷ 1,000 ÷ P46

Assumptions:	**Value**	**Unit**	**CELL REF**	**Description**
BE Retrofit Total Crack Area	5.76	SF	**P43**	
		SF	**P44**	
		SF	**P45**	
Existing Boiler Plant Efficiency	78.0%		**P46**	
Existing Cooling Plant Efficiency	2.93	COP	**P47**	
Percent Building Cooled	25.0%		**P48**	
Average Winter Wind Speed	12.8	MPH	**P49**	
Average Summer Wind Speed	10.5	MPH	**P50**	
Crack Area Windward Diversity	7.3%		**P51**	

Average Space Temperatures - After implementation of EMS

	Cooling		Heating		**Description**
Occupied	72.0	**O55**	70.0	**Q55**	average temperature for all areas
UnOccupied	78.0	**O56**	58.0	**Q56**	

Appendix for ECM 11: Weatherization

II. Manufacturer Specification Sheets

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CONTENTS

The Weatherization Materials Information package includes the following data sheets:

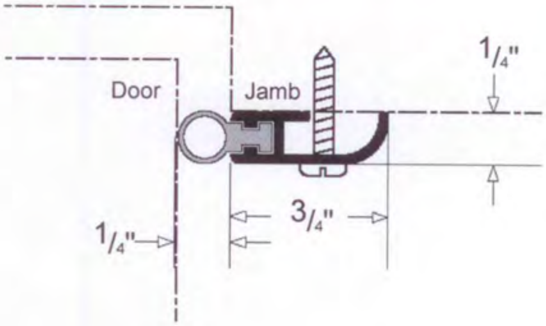
DS080 - Light Duty (Rounded) Door Weatherstripping

Construction: PVC rigid vinyl. Mitered corners ensure a secure fit with slotted mounting holes for easy adjustment.

Insert: 1/4" flexible, bubble type neoprene or vinyl insert.

Finish: Brown or white finish.

Set: 1-3' piece and 2-7' pieces. Custom lengths also available.



DS080-AL-V

MODEL	DESCRIPTION	FINISH		INSERT	
DS075	Door Weatherstripping	BR	Brown	V	Vinyl
		WH	White		

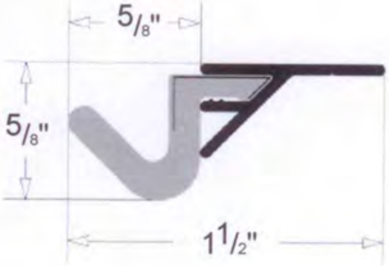
DS050 - Door Weatherstripping

Construction Q-Lon: Extruded aluminum. Mitered corners ensure a secure fit with slotted mounting holes for easy adjustment.

Insert: Soft cell foam insert. Foam has thermoplastic cover and will not deteriorate.

Finish: Aluminum, brown or white finish.

Set: 1-3' piece and 2-7' pieces. Custom lengths also available.



DS050-AL

MODEL	DESCRIPTION	FINISH	
DS100	Door Weatherstripping	AL	Aluminum
		BR	Brown
		WH	White

**Q-Lon is replaceable without removing holder from the door.*
**Approved for Sound Abatement Program.*

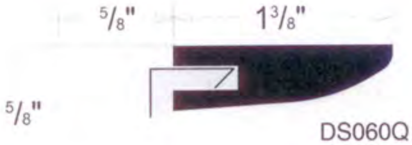
DS060 - Door Weatherstripping

Construction: Primed pine wood strip or PVC, available as 1³/₈" or ³/₄" Quarter Round, or Bullnose or narrow.

Insert: Q-Lon soft cell foam insert. Foam has thermoplastic cover and will not deteriorate.

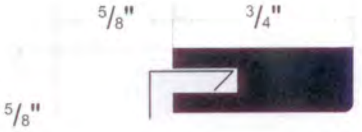
Finish: Brown or White foam. Wood is primed, PVC is white.

Lengths: 1-3' piece and 2-7' pieces. Specify wood or PVC.



DS060Q
(Quarter Round)

DS060B
(Bullnose)



DS060N
(Narrow)

DS060-AL-B

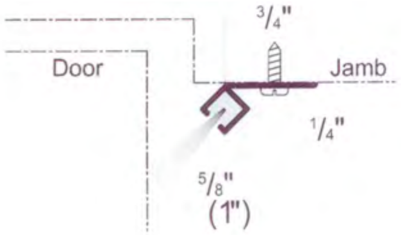
MODEL	DESCRIPTION	Q-Lon		INSERT	
DS060	Door Weatherstripping	WH	White	B	Bullnose
		BR	Brown	Q	Quarter Round 1³/₈
				N	Narrow ³/₄

OBS-296 - Offset Head Nylon Brush Door Gasket

Construction: Extruded aluminum.

Insert: ⁵/₈" or 1" nylon brush strip.

Finish: Aluminum or Brown anodized finish.



OBS-296-58-AL

MODEL	DESCRIPTION	BRUSH SIZE		FINISH	
OBS-296	Brush Weatherstripping	58	5/8 inch	AL	Aluminum
		1	1 inch	BR	Brown

BS88 - Pressure Sensitive Door Gasketing*

Finishes: Dark Bronze, White.

Lengths: 17', 21', 25', and 500' coils.

Self-adhesive: For application between 50°F and 100°F with end use temperature range from -30°F to 150°F

- Begins compressing at ¹/₄" and can be compressed to seal ¹/₁₆" toleranced openings; will not lose its form.
- Self-extinguishing and non-toxic.
- Impervious to dust and mildew, will not deteriorate under normal exposure. Unaffected by sunlight, ozone, and ultraviolet rays.

BS88

MODEL	DESCRIPTION	FINISH		LENGTH	
BS88	Self-Adhesive	BR	Brown	17	17ft. coil
	Door Weatherstripping	WH	White	21	21ft. coil
				25	25ft. coil
				500	500ft. coil

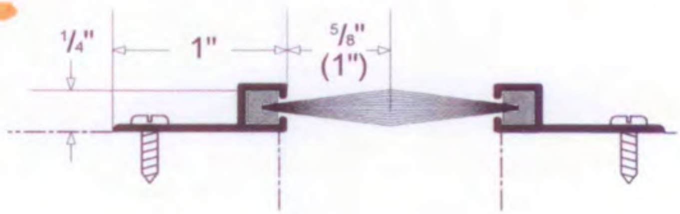
*Approved for Sound Abatement Program.

VISCO
WEATHER SEAL PRODUCTS

door ASTRAGALS

FS325 - Wool Pile Brush Astragal With Fin

Construction: Extruded Aluminum
Insert: .500" or .880" Wool Pile Brush.
Finish: Aluminum, Bronze or White
Standard Lengths: 7ft. or 8ft. pieces, 2 piece set.
Custom lengths also available.



FS-325-AL-58-7

MODEL	DESCRIPTION	FINISH		BRUSH SIZE		LENGTH	
FS325	Wood Pile Brush	AL	Aluminum	58	.500 inch	7	2-7ft. pieces
		BR	Bronze	1	.880 inch	8	2-8ft. pieces
		WH	White				

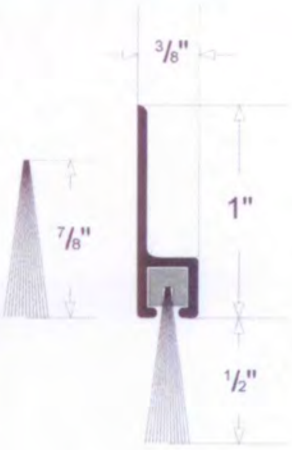
door BOTTOMS & SWEEPS

FS300 - Wool Pile Brush Sweep With Fin

Construction: Extruded Aluminum
Insert: .500" or .880" Wool Pile Brush.
Finish: Aluminum, Bronze or White
Standard Lengths: 36, 42, 48 inches.
Custom lengths also available.

FS-300-AL-58-36

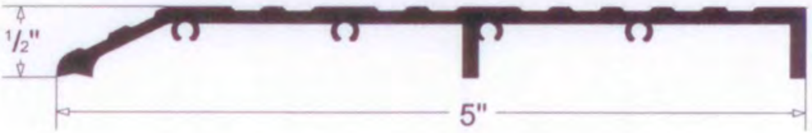
MODEL	DESCRIPTION	FINISH		BRUSH SIZE		LENGTH	
FS300	Wood Pile Sweep	AL	Aluminum	58	.500 inch	36	36 inches
		BR	Bronze	1	.880 inch	42	42 inches
		WH	White			48	48 inches
						LF	Specify Length



door THRESHOLDS

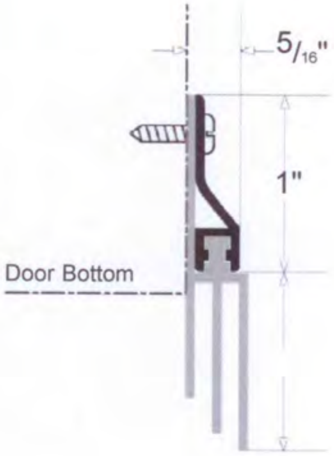
TB-550

- 5" Flat Threshold (Tile Back)
- ½" Rise
- Available in lengths up to 12ft.



TS100 Door Triple Sweep

Construction: Extruded Aluminum
Insert: 3/4" Vinyl Insert
Finish: Aluminum or Brown Finish
Lengths: 36", 42", or 48", or by the linear foot

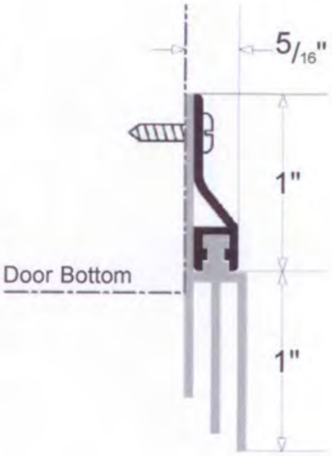


TS100-AL-36

MODEL	DESCRIPTION	FINISH		LENGTH	
TS100	Door Sweep	AL	Aluminum	36	36 Inches
		BR	Brown	42	42 Inches
				48	48 Inches
				72	72 Inches
				LF	Specify Length

TS150 Door Triple Sweep

Construction: Extruded Aluminum
Insert: 1" Vinyl Insert
Finish: Aluminum or Brown Finish
Lengths: 36", 42", or 48", or by the linear foot

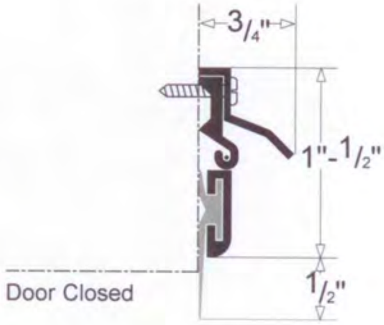


TS150-AL-36

MODEL	DESCRIPTION	FINISH		LENGTH	
TS150	Door Sweep	AL	Aluminum	36	36 Inches
		BR	Brown	42	42 Inches
				48	48 Inches
				72	72 Inches
				LF	Specify Length

DB215 - Automatic Door Bottom

Construction: Aluminum Construction, Piano Type Hinge and Stainless Steel Spring
Insert: Vinyl
Action: Cam Activated
Finish: Satin Aluminum
Lengths: 36" or 48"



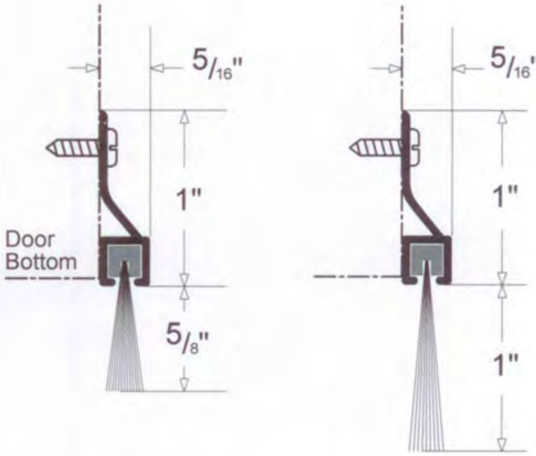
DB215-36

MODEL	DESCRIPTION	LENGTH	
DB215	Automatic Door Bottom	36	36 Inches
		48	48 Inches

**Approved for Sound Abatement Program.*

BS-196 - Brush Door Sweep

Construction: Extruded Aluminum
Insert: 5/8" or 1" Nylon Brush Strip
Finish: Aluminum or Brown Anodized Finish
Lengths: Sold by the linear foot

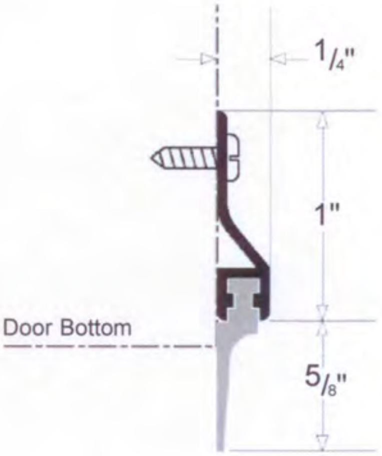


BS196-58-AL

MODEL	DESCRIPTION	BRUSH SIZE		FINISH	
BS-196	Brush Door Sweep	58	5/8 inch	AL	Aluminum
		1	1 inch	BR	Brown

SS045 - Standard Door Sweep

Construction: Extruded Aluminum
Insert: 5/8" Vinyl Insert
Finish: Aluminum, Brown or White Finish
Lengths: 36", 42", or 48", or by the linear foot

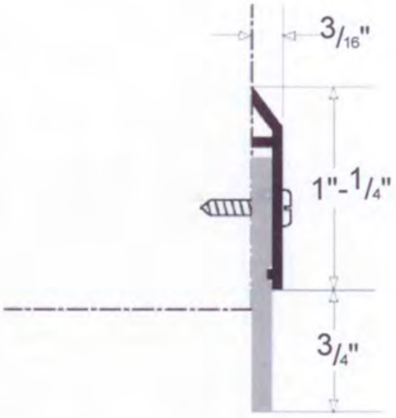


SS045-AL-36

MODEL	DESCRIPTION	FINISH		LENGTH	
SS045	Door Sweep	AL	Aluminum	36	36 inches
		BR	Brown	42	42 inches
		WH	White	48	48 inches
				LF	Specify Length

HS051 - Heavy Duty Door Sweep

Construction: Extruded Aluminum
Insert: 3/4" Neoprene Insert
Finish: Aluminum or Brown Finish
Lengths: 36", 42", or 48", or by the linear foot



HS051-AL-36

MODEL	DESCRIPTION	FINISH		LENGTH	
HS051	Door Sweep	AL	Aluminum	36	36 inches
		BR	Brown	42	42 inches
				48	48 inches
				LF	Specify Length

**Approved for Sound Abatement Program.*

Project Submittals: ALC, 10

T-SLOT: APTUS® TPE Weatherseals continued

AP 405

Backer Width: .187" (4.8mm)
Reach: .405" (10.3mm)

AP 519

Backer Width: .187" (4.8mm)
Reach: .625" (15.9mm)

AP 375

Backer Width: .270" (6.9mm)
Reach: .375" (9.5mm)

AP 527

Backer Width: 270" (6.9mm)
Reach: .625" (15.9mm)

AP 260

Backer Width: 270" (6.9mm)
Reach: .260" (6.6mm)

POCKET: Q-LON® Pocket Weatherseals

QWS-525
U91
available with card

Pocket Opening: .140" (3.5mm)
Reach: .225" (5.7mm)

QWS-530
U93

Pocket Opening: .125" (3.2mm)
Reach: .250" (6.4mm)

QWS-440
U37

Pocket Opening: .125" (3.2mm)
Reach: .280" (7.1mm)

QSW-PLS
UC9

Pocket Opening: .150" (3.8mm)
Reach: .375" (9.5mm)

QWS-580
U92

Pocket Opening: .125" (3.2mm)
Reach: .345" (8.8mm)

QWS-591
U97

Pocket Opening: .215" (5.5mm)
Reach: .402" (10.2mm)

~~**QEB-591**~~
~~UA2~~

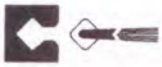
~~**Pocket Opening:** .150" (3.8mm)~~
Reach: .400" (10.2mm)

POCKET: Textile Skirting Weatherseals

SK-510

Pocket Opening: .090" (2.3mm)

SK-519



Pocket Opening: .090" (2.3mm)

SK-527

Pocket Opening: .090" (2.3mm)

SK-560

Pocket Opening: .090" (2.3mm)

Pocket APTUS®

AP-5210

Pocket Opening: .150" (3.8mm)
Reach: .150" (3.8mm)

AP-5211

Pocket Opening: .150" (3.8mm)
Reach: .340" (8.6mm)

Pocket Pile

KP-45

Pocket Opening: .125" (3.2mm)

SURFACE: Q-LON® Surface Mount Weatherseals

QWS-D
U90

Width: .240" (6.1mm)
Reach: .140" (3.6mm)

QWS 6x6
U79

Width: .235" (6.0mm)
Reach: .235" (6.0mm)

QWS 3/8x1/4
U66

Width: .375" (9.5mm)
Reach: .250" (6.4mm)

QWS 3/8x3/8
U63

Width: .375" (9.5mm)
Reach: .375" (9.5mm)

QWS 1/2x3/8
U68

Width: .500" (12.7mm)
Reach: .375" (9.5mm)

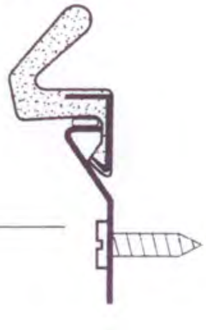
QDS-375
QFS-375
U98

Width: 420" (10.7mm)
Reach: .385" (9.8mm)

QDST-675
U32

Width: .580" (14.7mm)
Reach: .675" (17.1mm)

Replacement Door Seal



Q-LON Corner Seals

U16

Width: 1.313" (33.4mm)
Reach: .218" (5.5mm)

U61

Width: 1.688" (42.9mm)
Reach: .218" (5.5mm)

U76

Width: 1.75" (44.5mm)
Reach: .375" (9.5mm)

SURFACE: Surface Mount Textile Weatherseals

FIN-SEAL® Door Sweep

Adhesive Back Pile Weatherstripping

Metal Back Pile Weatherstripping

Corner seal profiles not shown to size.

FIN-SEAL® Corner Seal

POLY-BOND® Corner Seal

SURFACE: POLYFLEX® Surface Mount Weatherseals

PF-102

PF-114

PF-512

APTUS® Panel Seal

AP-PANEL

Footprint: .430" (10.9mm)
Reach: .250" (6.0mm)

Schlegel Systems, Inc.
1555 Jefferson Road
Rochester, New York
14692-3197

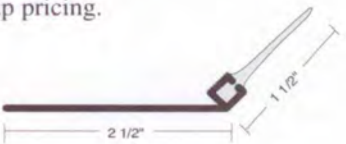
800.586.0354 Toll free
585.427.9993 Fax

Schlegel® AMESBURY GROUP®

www.schlegelusa.com

Style 25 - "JUMBO SEAL" - 1 1/2" Vinyl or Brush

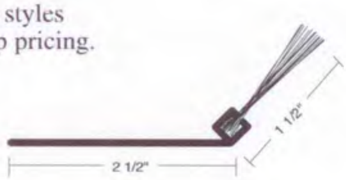
- Heavy aluminum extrusion with VINYL
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



10 Pieces per Carton, combine Jumbo Seal sizes and styles for best pricing.

STOCK #	MODEL	DESCRIPTION	PACK
143880	Style 25	10ft "JUMBO SEAL" w/1 1/2in Vinyl	1
143881	Style 25	12ft "JUMBO SEAL" w/1 1/2in Vinyl	1
143882	Style 25	14ft "JUMBO SEAL" w/1 1/2in Vinyl	1
143883	Style 25	16ft "JUMBO SEAL" w/1 1/2in Vinyl	1

- Heavy aluminum extrusion with BRUSH
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



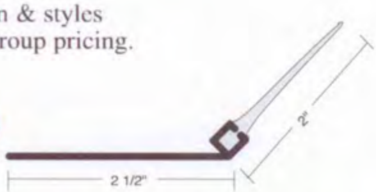
10 Pieces per Carton, combine Jumbo Seal sizes and styles for best pricing.

STOCK #	MODEL	DESCRIPTION	PACK
143910	Style 25	10ft "JUMBO SEAL" w/1 1/2in Brush	1
143911	Style 25	12ft "JUMBO SEAL" w/1 1/2in Brush	1
143912	Style 25	14ft "JUMBO SEAL" w/1 1/2in Brush	1
143913	Style 25	16ft "JUMBO SEAL" w/1 1/2in Brush	1

Style 25 - "JUMBO SEAL" - 2" Vinyl or Brush

Sides + Top

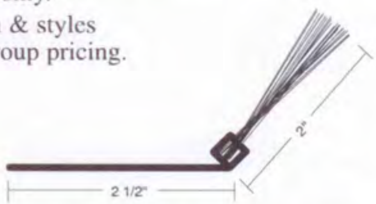
- Heavy aluminum extrusion with VINYL
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



10 Pieces per Carton, combine Jumbo Seal sizes and styles for best pricing.

STOCK #	MODEL	DESCRIPTION	PACK
143890	Style 25	10ft "JUMBO SEAL" w/2in Vinyl	1
143891	Style 25	12ft "JUMBO SEAL" w/2in Vinyl	1
143892	Style 25	14ft "JUMBO SEAL" w/2in Vinyl	1
143893	Style 25	16ft "JUMBO SEAL" w/2in Vinyl	1

- Heavy aluminum extrusion with BRUSH
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.

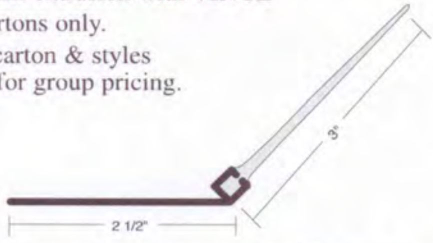


10 Pieces per Carton, combine Jumbo Seal sizes and styles for best pricing.

STOCK #	MODEL	DESCRIPTION	PACK
143920	Style 25	10ft "JUMBO SEAL" w/2in Brush	1
143921	Style 25	12ft "JUMBO SEAL" w/2in Brush	1
143922	Style 25	14ft "JUMBO SEAL" w/2in Brush	1
143923	Style 25	16ft "JUMBO SEAL" w/2in Brush	1

Style 25 - "JUMBO SEAL" - 3" Vinyl or Brush

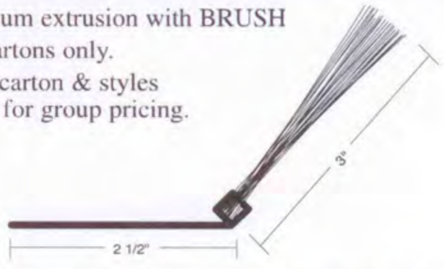
- Heavy aluminum extrusion with VINYL
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



10 Pieces per Carton, combine Jumbo Seal sizes and styles for best pricing.

STOCK #	MODEL	DESCRIPTION	PACK
143900	Style 25	10ft "JUMBO SEAL" w/3in Vinyl	1
143901	Style 25	12ft "JUMBO SEAL" w/3in Vinyl	1
143902	Style 25	14ft "JUMBO SEAL" w/3in Vinyl	1
143903	Style 25	16ft "JUMBO SEAL" w/3in Vinyl	1

- Heavy aluminum extrusion with BRUSH
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



10 Pieces per Carton, combine Jumbo Seal sizes and styles for best pricing.

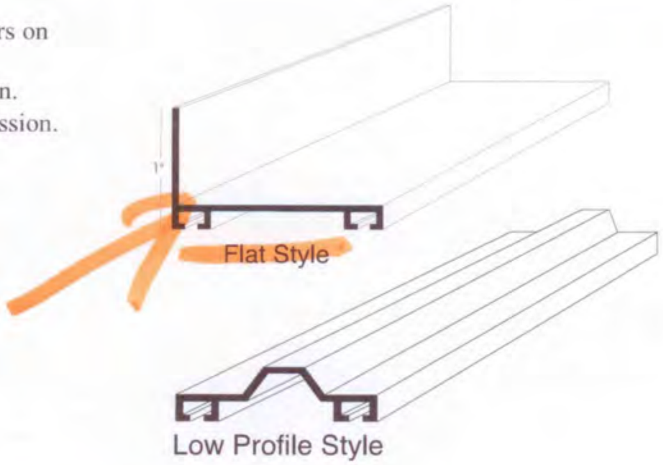
STOCK #	MODEL	DESCRIPTION	PACK
143930	Style 25	10ft "JUMBO SEAL" w/3in Brush	1
143931	Style 25	12ft "JUMBO SEAL" w/3in Brush	1
143932	Style 25	14ft "JUMBO SEAL" w/3in Brush	1
143933	Style 25	16ft "JUMBO SEAL" w/3in Brush	1

* Ask customer service for kit sizes *

Aluminum Weatherseal Retainer

WSR Rails (weatherseal retainer)
- Aluminum Weatherseal Retainer used as bottom retainers on ship lap or tongue & groove doors.
- Use with our 3 1/2" Single T vinyl for 1" of compression.
- Use with our 5 1/2" Single T vinyl for 2 1/4" of compression.
- Use with our 7" Single T vinyl for 3" of compression.
- Install with self drilling Tek Screws, nails or rivets.
- 1 3/8" width for Residential Doors.
- 2" width for Commercial Doors.
- Packed 4 pieces per bundle

Economy WSR Rail Low Profile
- Economy rail is a lighter weight rail for 2" tongue & groove doors.
- Packed 10 pieces per bundle



Flat Style

Low Profile Style

Bottom Carrier

1 3/8 inch - Flat Retainer

STOCK #	DESCRIPTION	PACK
148003	AWSR-138-080F 8ft x 1 3/8in Flat - 4pc	1ctn
148005	AWSR-138-090F 9ft x 1 3/8in Flat - 4pc	1ctn
148013	AWSR-138-016F 16ft x 1 3/8in Flat - 4pc	1ctn
148015	AWSR-138-018F 18ft x 1 3/8in Flat - 4pc	1ctn

2 inch - Flat Retainer

STOCK #	DESCRIPTION	PACK
148104	AWSR-200-082F 8ft 2in x 2in Flat - 4pc	1ctn
148108	AWSR-200-102F 10ft 2in x 2in Flat - 4pc	1ctn
148110	AWSR-200-122F 12ft 2in x 2in Flat - 4pc	1ctn
148112	AWSR-200-142F 14ft 2in x 2in Flat - 4pc	1ctn
148114	AWSR-200-162F 16ft 2in x 2in Flat - 4pc	1ctn
148116	AWSR-200-182F 18ft 2in x 2in Flat - 4pc	1ctn

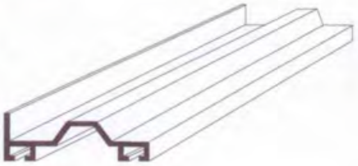
2 inch - Low Profile Retainer

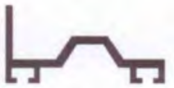
STOCK #	DESCRIPTION	PACK
148204	AWSR-200-082L 8ft 2in x 2inLow - 10pc	1ctn
148208	AWSR-200-102L 10ft 2in x 2inLow - 10pc	1ctn
148210	AWSR-200-122L 12ft 2in x 2inLow - 10pc	1ctn
148212	AWSR-200-142L 14ft 2in x 2inLow - 10pc	1ctn
148214	AWSR-200-162L 16ft 2in x 2inLow - 10pc	1ctn
148216	AWSR-200-182L 18ft 2in x 2inLow - 10pc	1ctn

Plastic Weatherseal Retainer

PWSR Rails (plastic weatherseal retainer)
- Plastic Weatherstrip Retainer used as bottom rail on 2" doors.
- Style F has a flat bottom for wood or steel doors, packed 25 pieces per carton.
- Style T is for Tongue & Grooved doors, packed 10 pieces per carton.
- Use with our 3 1/2" Singe T vinyl for 1" of compression.
- Use with our 5 1/2" Wide provides 2 1/4" compression.
- Use with our 7" Single T vinyl for 3" of compression.
- Install with self drilling Tek Screws, or rivets.
- Available from stock in White.
- Black and Grey are available by special order.

STYLE "F"





STYLE "T"

Style F - Flat Retainer

STOCK #	MODEL	DESCRIPTION	PACK
149004	PWSR-082F	8ft 2in Flat Style Retainer - 25 pcs	1
149006	PWSR-092F	9ft 2in Flat Style Retainer - 25 pcs	1
149008	PWSR-102F	10ft 2in Flat Style Retainer - 25 pcs	1
149010	PWSR-122F	12ft 2in Flat Style Retainer - 25 pcs	1
149012	PWSR-142F	14ft 2in Flat Style Retainer - 25 pcs	1
149014	PWSR-162F	16ft 2in Flat Style Retainer - 25 pcs	1
149016	PWSR-182F	18ft 2in Flat Style Retainer - 25 pcs	1

Style T - Tongue & Groove Retainer

STOCK #	MODEL	DESCRIPTION	PACK
149044	PWSR-082T	8ft 2in Tongue & Groove Style - 10 pcs	1
149046	PWSR-092T	9ft 2in Tongue & Groove Style - 10 pcs	1
149048	PWSR-102T	10ft 2in Tongue & Groove Style - 10 pcs	1
149050	PWSR-122T	12ft 2in Tongue & Groove Style - 10 pcs	1
149052	PWSR-142T	14ft 2in Tongue & Groove Style - 10 pcs	1
149054	PWSR-162T	16ft 2in Tongue & Groove Style - 10 pcs	1
149056	PWSR-182T	18ft 2in Tongue & Groove Style - 10 pcs	1

Vinyl Bottom Seal Inserts

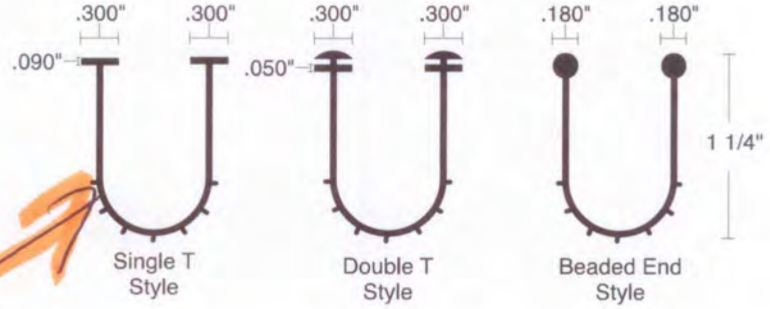
NATIONAL

Vinyl Bottomseal Inserts

- Provides better conformity to irregular floor situations.
- Stays flexible below Zeroº
- Seals against snow, water, dirt and wind.
- Made from 100% virgin vinyl, **first quality materials only**.
- Mount to door using our WSR Rails or our Adjustable Bottom Rails. (see pages W16-W17)
- Available in White, Brown, Grey, Black, Tan and safety YELLOW!
- Available in 300 ft rolls, or in cut to length pieces

Bottom Insert

OUR PREMIUM QUALITY MATERIAL GIVES A BETTER SEAL



STOCK #	MODEL	DESCRIPTION	PACK
141004	3in	Single "T" Vinyl Insert - 300ft/roll - Grey	1
141100	3 1/2in	Single "T" Vinyl Insert - 300ft/roll - Black	1
141102	3 1/2in	Single "T" Vinyl Insert - 300ft/roll - Brown	1
141104	3 1/2in	Single "T" Vinyl Insert - 300ft/roll - Grey	1
141106	3 1/2in	Single "T" Vinyl Insert - 300ft/roll - Tan	1
141108	3 1/2in	Single "T" Vinyl Insert - 300ft/roll - White	1
141110	3 1/2in	Single "T" Vinyl Insert - 300ft/roll - Safety Yellow	1
141124	3 1/2in	Double "T" Vinyl Insert - 300ft/roll - Grey	1
141144	3 1/2in	Beaded End Vinyl Insert - 300ft/roll - Grey	1

Twenty foot (20) Minimum order on cut to length pieces, and twenty foot increments

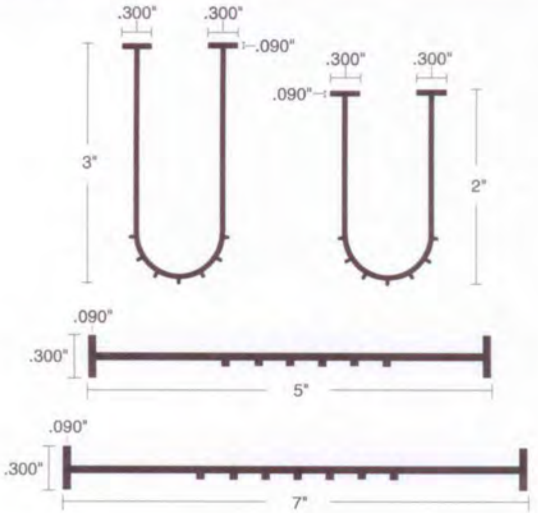
"We Do Not Use Cheap Materials 1st Quality Only"

STOCK #	MODEL	DESCRIPTION	PACK
141460	3 1/2in	Single "T" Vinyl - GREY - Cut to Length	20ft
141464	3 1/2in	Double "T" Vinyl - GREY - Cut to Length	20ft
141466	3 1/2in	Beaded End Vinyl - GREY - Cut to Length	20ft
141462	3 1/2in	Single "T" Vinyl - Safety YELLOW - Cut to Length	20ft

Twenty foot (20) Minimum order on cut to length pieces, and twenty foot increments

Vinyl Double-Wide Bottom Inserts

NATIONAL



Vinyl Double-Wide Bottom Vinyl Inserts

- National's weatherseal provides double the compression of conventional bottom seal weatherstripping.
- 5 1/2" Wide provides 2 1/4" compression.
- 7" Wide provides 3" compression.
- Provides better conformity to irregular floor situations.
- Seals against snow, water, dirt and wind.
- Made from 100% virgin vinyl, **first quality materials only**.
- Mount to door using our WSR Rails or our Adjustable Bottom Rails. (see page W16-W17)
- Available in rolls, or in cut to length pieces
- Other Colors & Styles not shown available by special order. (Safety Yellow, Brown, White, Tan, and Black in Single T, Double T or Beaded End)

STOCK #	MODEL DESCRIPTION	PACK
141200	5 1/2in Wide x 200ft roll Single T Vinyl Bottom Seal - Black	1
141202	5 1/2in Wide x 200ft roll Single T Vinyl Bottom Seal - Brown	1
141204	5 1/2in Wide x 200ft roll Single T Vinyl Bottom Seal - Grey	1
141210	5 1/2in Wide x 200ft roll Single T Vinyl Bottom Seal - Yellow	1
141470	5 1/2in Wide Single T Vinyl Cut to Length - Grey Only	20 ft

Twenty foot (20) Minimum order on cut to length pieces, and twenty foot increments

STOCK #	MODEL DESCRIPTION	PACK
141300	7in Wide x 200 ft roll Single T Vinyl Bottom Seal - Black	1
141302	7in Wide x 200 ft roll Single T Vinyl Bottom Seal - Brown	1
141304	7in Wide x 200 ft roll Single T Vinyl Bottom Seal - Grey	1
141310	7in Wide x 200 ft roll Single T Vinyl Bottom Seal - Yellow	1
141480	7in Wide Single T Vinyl Cut to Length - Grey Only	20 ft

Twenty foot (20) Minimum order on cut to length pieces, and twenty foot increments

PRODUCT INFORMATION . COMMERCIAL/RESIDENTIAL . UNITED STATES

FROTH-PAK™ FOAM INSULATION

1. PRODUCT NAME

FROTH-PAK™ Foam Insulation

2. MANUFACTURER

The Dow Chemical Company
Dow Building Solutions
200 Larkin
Midland, MI 48674
1-866-583-BLUE (2583)
Fax 1-989-832-1465

www.dowbuildingsolutions.com

3. PRODUCT DESCRIPTION

BASIC USE

FROTH-PAK™ Foam Insulation is a two-component, quick-cure polyurethane foam that fills cavities, penetrations, cracks and expansion joints. Unlike one-component foam, FROTH-PAK™ Foam Insulation is a chemically cured foam, significantly reducing curing time.

FROTH-PAK™ Foam Insulation dispenses, expands and becomes tack-free in seconds. The product will skin over in 30-40 seconds and will be completely cured in minutes.*

The Class-A rating (flame spread of 25 or less) of FROTH-PAK™ Foam Insulation allows its use in a wide range of interior and exterior industrial, commercial, institutional and residential settings. Check with local codes prior to use. If used in an exterior setting, a coating must be applied for ultraviolet (UV) protection.

SIZES

FROTH-PAK™ Foam Insulation is typically sold as a complete 42 lb (FROTH-PAK™ 200) portable kit that includes pressurized "A" and "B" cylinders, plus dispensing gun/hose assembly and accessories. FROTH-PAK™ Foam Insulation is also available in refillable, returnable cylinders for commercial applications requiring a large amount of foam. See Table 1 for yield and size information.

4. TECHNICAL DATA

APPLICABLE STANDARDS

ASTM International

- C203 – Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
- C273 – Standard Test Method for Shear Properties of Sandwich Core Materials
- C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics
- D1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics
- D1623 – Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
- D2842 – Standard Test Method for Water Absorption of Rigid Cellular Plastics
- E96 – Standard Test Methods for Water Vapor Transmission of Materials
- E283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
- E2178 – Standard Test Method for Air Permeance of Building Materials

PHYSICAL PROPERTIES

FROTH-PAK™ Foam Insulation exhibits the typical properties and characteristics indicated in Table 2 when tested as represented.

FIRE PROTECTION

Cured FROTH-PAK™ foam is combustible and will burn if exposed to open flame or sparks from high-energy sources. Do not expose to temperatures above 240°F.

CODE COMPLIANCES

FROTH-PAK™ Foam Insulation complies with the following codes:

- Underwriters Laboratories, Inc. (UL) Classified, see Classification Certificate R7813
- National Fire Protection Association – per NFPA 286 testing, can be left exposed in non-fire-resistant rated roof/wall junctures, maximum 6" high and 2" deep (unlimited width)

Contact your Dow sales representative or local authorities for state and local building code requirements and related acceptances.

5. INSTALLATION

Complete operating instructions are provided with each FROTH-PAK™ Foam Insulation purchase. Read all information and cautions before application. **Note: Avoid overfilling restricted spaces. Chemicals exert force during reaction, and expansion of foam may result in substrate deformation.**

TABLE 1: SIZES AND THEORETICAL YIELDS FOR FROTH-PAK™ FOAM INSULATION

PRODUCT	THEORETICAL YIELD[1], BOARD FT
Kits	
FROTH-PAK™ 200	200
FROTH-PAK™ 620	620
Refillable Cylinders (commercial use)	
FROTH-PAK™ 17 (gal)	2,060
FROTH-PAK™ 60 (gal)	6,860
FROTH-PAK™ 120 (gal)	15,430
FROTH-PAK™ 350 (gal)	43,890

(1) The theoretical yield has become an industry standard for identifying certain sizes of two-component kits. Theoretical yield calculations are performed in perfect laboratory conditions, without taking into account the loss of blowing agent or the variations in application methods and types.

---

*Actual cure time will depend on temperature, foam thickness, the specific nozzle [illegible]

SAFETY AND CONDITIONS OF USE

- Read the instructions and Material Safety Data Sheets carefully before use.
- FROTH-PAK™ spray polyurethane foam contains isocyanate, hydrofluorocarbon blowing agent and polyol. Do not breathe vapor or mist. Use only in well-ventilated areas or with proper respiratory protection. Supplied air or an approved air-purifying respirator equipped with an organic vapor sorbent and a P100 particulate filter may be required to maintain exposure levels below ACGIH, OSHA, WEEL or other applicable limits. For situations where the atmospheric levels may exceed the level for which an air-purifying respirator is effective, use a positive-pressure, air-supplying respirator (air line or self-contained breathing apparatus).
- Isocyanate is irritating to the eyes, skin and respiratory system, and may cause sensitization by inhalation or skin contact.
- FROTH-PAK™ foam will adhere to most surfaces and skin. Do not get foam on skin. Wear protective clothing (including long sleeves), gloves, and goggles or safety glasses. Cured foam must be mechanically removed or allowed to wear off in time.
- The contents are under pressure.
- FROTH-PAK™ foam should not be used around heaters, furnaces, fireplaces, recessed lighting fixtures or other applications where the foam may come in contact with heat-conducting surfaces. Cured FROTH-PAK™ foam is combustible and will burn if exposed to open flame or sparks from high-energy sources. Do not expose to temperatures above 240°F.

Visit www.dowbuildingsolutions.com or contact a local Dow representative for more specific instructions.

TABLE 2: TYPICAL PHYSICAL PROPERTIES OF FROTH-PAK™ FOAM INSULATION

PROPERTY AND TEST METHOD	VALUE
Flame Spread/Smoke Developed(1)(2), ASTM E84/UL 723	25/350
Nominal Density, ASTM D1622, lb/ft^3	1.75
Thermal Resistance(3) per inch, ASTM C518, ft^2•h•°F/Btu, R-value, min.	
Initial	6.6
Aged 90 days at 140°F	5.6
Air Leakage,	
ASTM E283, cfm/ft^2 @ 1.57 psf	0
ASTM E2178, L/s/m^2 @ 75 Pa	0
Water Vapor Permeance, ASTM E96	
perm @ 1" thick	3.9
perm @ 2" thick	2.0
Water Absorption, ASTM D2842, % by volume	2.17
Dimensional Stability, ASTM D2126, % volume change	
100°F/100% RH @ 1wk	4.6
100°F/100% RH @ 2wks	5.0
158°F/100% RH @ 1wk	6.5
158°F/100% RH @ 2wks	5.1
-40°F/amb RH @ 1wk	0.9
-40°F/amb RH @ 2wks	0.9
158°F/amb RH @ 1wk	3.1
158°F/amb RH @ 2wks	2.3
Compressive Strength, ASTM D1621, lb/in^2, parallel	21.1
Flexural Strength, ASTM C203, lb/in^2, parallel	22.7
Tensile Strength, ASTM D1623, lb/in^2, parallel	26.7
Shear Strength, ASTM C273, lb/in^2, parallel	16.7
Maximum Service Temperature, °F	240

(1) Tested at 2" thickness, full coverage.

(2) This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

(3) R means resistance to heat flow. The higher the R-value, the greater the insulating power.

6. AVAILABILITY

FROTH-PAK™ Foam Insulation is distributed through an extensive network. For more information, call 1-800-232-2436.

7. WARRANTY

Not applicable.

8. MAINTENANCE

Not applicable.

9. TECHNICAL SERVICES

Dow can provide technical information to help address questions when using FROTH-PAK™ Foam Insulation. Technical personnel are available to assist with any insulation project. For technical assistance, call 1-866-583-BLUE (2583).

10. FILING SYSTEMS

- www.dowbuildingsolutions.com
- www.sweets.com

www.dowbuildingsolutions.com

Technical Information
1-866-583-BLUE (2583)
Sales Information
1-800-232-2436

THE DOW CHEMICAL COMPANY
200 Larkin
Midland, MI 48674

Dow Polyurethane Foam Insulation and Sealants
CAUTION: When cured, these products are combustible and will burn if exposed to open flame or sparks from high-energy sources. Do not expose to temperatures above 240°F. For more information, consult MSDS, call Dow at 1-866-583-BLUE (2583) or contact your local building inspector. In an emergency, call 1-989-636-4400.

FROTH-PAK™ spray polyurethane foam contains isocyanate, hydrofluorocarbon blowing agent and polyol. Read the instructions and Material Safety Data Sheets carefully before use. Wear protective clothing (including long sleeves), gloves, goggles or safety glasses, and proper respiratory protection. Supplied air or an approved air-purifying respirator equipped with an organic vapor sorbent and a P100 particulate filter may be required to maintain exposure levels below ACGIH, OSHA, WEEL or other applicable limits. Provide adequate ventilation. Contents under pressure.

Building and/or construction practices unrelated to building materials could greatly affect moisture and the potential for mold formation. No material supplier including Dow can give assurance that mold will not develop in any specific system.

Printed in U.S.A.

ez flo gun foam

Product Benefits

- High Volume
- R-Factor of 5 per inch
- Closed Cell Foam
- 1/2" Bead runs 900 lin. ft
- Low Expansion

Gun Benefits

- Complete Control
- No Mess
- Labor Saving
- Quality Engineered
- Limited Warranty

Uses

- Around doors & windows
- Stops air flow
- Around pipe chases
- Seals out insects
- Keeps water out

Todol Products, Inc.

http://www.todol.com email: info@todol.com

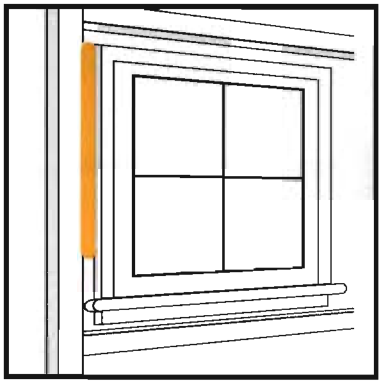
Pageris Gun

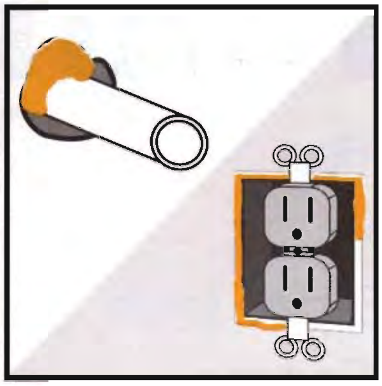
Pur Pistol

Pur Shooter

EZ Flo is a closed cell self curing foam which expands, bonds and seals. Stopping the passage of air, gases, water and dust. This helps to increase energy efficiency by stopping air exchange around windows, doors, wall intrusions and at sill plates. Its lightweight, closed cell structure makes it useful for deadening sound, flotation and thermal insulation. Ez Flo can expand to fill holes around pipes and ducts to reduce noise, seal out insects, and fill rodent holes. It is also useful for sealing work areas prior to asbestos stripping to prevent the transport of fibers.

Increases energy efficiency ●Fills holes around pipes and ducts ●Reduces noise ●Controls radon ●Stops foundation leaks ●Seals out insects ●Confines asbestos fibers ●Strengthens tub bases ●Seals stresskin panels ●Upgrades weatherization ●Seals electrical conduits ●Repairs boat flotation ●Seals refrigeration panels ●Waterproofs ●Caulks HVAC intrusions.





How to Use:

1. Shake the can of foam.
2. Thread the can into the adapter on the top of the gun - DO NOT OVER TIGHTEN.
3. Pull the trigger for about 5 seconds to purge all air and moisture out of the gun.
4. Wipe or mist water into the joint which is to be foamed.
5. Select the bead size by interacting between the trigger and the flow adjustment screw.
6. The can should be in a vertical position over the gun when foaming.
7. Remove uncured foam from the end of the dispensing tube after each use. Tighten the flow adjustment screw for storage.
8. To replace an empty can, unscrew the empty can and promptly screw a replacement can into the adapter. If no replacement is available, leave the empty can in place until a replacement is at hand.

ALWAYS KEEP A CAN OF FOAM ON THE GUN; FAILURE TO DO THIS WILL ALLOW FOAM TO CURE AND RESULT IN PERMANENT DAMAGE TO THE GUN.

Best Results:

Use in hot weather
1. Shake the can for 30 seconds.
2. Lay out practice beads.
3. Mist the area with water.

Use in cold weather
1. Warm the can to room temperature-60°F to 80°F
2. Lay out practice beads.
3. Mist the area with water.

Changing Cans of EZ Flo:

1. With the canister on its base and the gun nozzle pointing into a suitable container, squeeze the trigger until mainly gas is discharged.
2. Unscrew the can from the gun and wash away any foam residue from around the ball valve housing with a small amount of suitable solvent.
3. Fit a new canister as described in "How to Use". Purge out air.
4. Do not remove an empty can from the gun until you have a new can to put on the gun.

Safety Recommendations:

Due to possible production of highly flammable vapor/air mixtures, provide sufficient ventilation. Do not smoke around vapors. In case of eye contact; rinse with plenty of water and seek medical advice. In case of skin contact, wash off with plenty of water and soap. Wear suitable protective gloves and goggles during work. In case of accident, or if you feel unwell, seek immediate medical advice (if possible, show this label).

Caution

Container is pressurized. Protect from sunlight and temperatures above 500°C, Do not pierce or burn even after use. Do not spray against flames or onto incandescent objects.

Harmful when inhaled. Irritates eyes, respiratory organs and skin. Can result in sensitization when inhaled. Can produce highly flammable vapor/air mixtures during use.

Contains: Polyol prepolymer CAS 59675-67-1,4,4' Monomeric diphenylmethane disocyanate (MDI) CAS 101-68-8. Chlorodiflouroethane 75-68-3. MDI can irritate eyes respiratory organs and skin. Can cause sensitization when inhaled.

Helpful Hints:

1. Always keep a can on the gun. Never leave gun without a can on it, this will clog the gun.
2. Mist the area with water before foaming.
3. Can temperature must be over 60°F - 80°F
4. Shake can well.
5. Never use solvent cleaner on the gun.
6. For larger voids, foam a 2" layer, mist with water, keep alternating layer with mist.
7. Always foam with can vertical.
8. Tighten set screw when finished foaming.

Limited Warranty:

The manufacturer will replace at no charge to purchaser any product proven to be defective. The warranty is limited to replacement of material only, and no liability is assumed for use of this product by the purchaser, or for any consequential damages arising from its use in any form whatsoever.

TYPICAL PROPERTIES OF CURED FOAM

Color Yellowish
Expanded volume; free rise @ 68° relative humidity9
gals./can or 1800 cu. inches
Density1.2 Lbs /cu ft
Cell structure excessively closed, approx. 80%
Compression load deflection (10% compression)8.5 Lbs./in^2
Minimum can temperature40°F (5°C)
Minimum surface temperature32°F (0°C)
Temperature stability of cured foam
-40°F to +176°F (-40°C to +80°C)
Tack-free @ 68°F (20°C)15 minutes
Cuttable @ 68°F (20°C)30 minutes
Flammability test ASTM E 84Flame spread index:
25Smoke density. 210
Class 1: fire rating construction
Thermal resistance: R factor ASTM C 518 5.0/in.

Todol Products, Inc.

20 Charles Street
P.O. Box 398
Natick, MA 01760
Phone: 508-651-3818
Fax: 508-651-0729

Visit our web site:
http://www.todol.com
Contact us via email:
email: info@todol.com

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The miracles of science™

DuPont™ Caulk

- DuPont™ Caulk Home
- Pick Your Sealing Project
- Kitchen & Bath
- Windows, Doors & Siding Sealant
  - DuPont™ Paintable Premier Silicone
  - DuPont™ Window & Door Premier Silicone
  - DuPont™ Window & Door Choice Silicone
  - DuPont™ Window, Doors, & Siding Silicone w/ Kevlar®
  - DuPont™ Painters Caulk w/ Speed Dry™ Technology
  - DuPont™ AIRTITE® Siliconized Acrylic Caulk
- Aluminum & Metal
- Driveway & Roofing
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- Paintable Caulk
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- Using Our Products
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DuPont™ AIRTITE® Siliconized Acrylic Caulk with Weather-Tight Seal technology

DuPont™ AIRTITE® Siliconized Acrylic Caulk with Weather-Tight Seal technology is ideal for sealing gaps around windows, doors, trim, and a variety of other interior and exterior surfaces. With this new technology, DuPont™ AIRTITE® Siliconized Acrylic Caulk forms a weather-tight seal that has been tested by accepted standards for adhesion, low temperature flexibility, extension/recovery, and weathering. Reduce air leaks in your home and increase energy efficiency by caulking or sealing with an acrylic sealant.

DuPont™ AIRTITE® Siliconized Acrylic Caulk can help eliminate air infiltration into a home when used around doors and windows. The Department of Energy - ENERGY STAR® Home Sealing guidelines and the NAHB Green Home Building Guidelines recommend the use of caulk to increase the energy efficiency of a home. Using DuPont™ Caulk may also help contribute towards U.S. Green Building Council's LEED® (Leadership in Energy and Environmental Design) points.

DuPont™ AIRTITE® Siliconized Acrylic Caulk with Weather-Tight Seal technology comes in both a convenient squeeze tube and cartridge, which requires a caulk gun for application.

For interior and exterior acrylic sealant, choose the name that has brought you quality products for more than 200 years - DuPont.

Product Features:
- Exceeds ASTM C-834, Grade -18° C
- 40-year guarantee
- Interior / Exterior
- Paintable
- Water-resistant seal
- Airtight seal
- VOC less than 1.5%
- Cured bead is mildew resistant

Available colors and packaging:
- 10.1 oz. cartridges & 5.5 oz. squeeze tubes available in: White and Clear

Is Your Home Energy Efficient?

Air-seal your home with DuPont™ AIRTITE® Siliconized Acrylic Caulk to increase energy efficiency and comfort. Download the ENERGY STAR® Do-It-Yourself Guide to get started.

» Download Now

DuPont™ AIRTITE® Siliconized Acrylic Caulk

DuPont™ AIRTITE® Siliconized Acrylic Caulk with Weather-Tight Seal technology is now available at Lowe's Home Improvement Stores nationwide and online.

LOWE'S
Let's Build Something Together

» Buy Now!

DuPont™ Residential Sealant

Testing Standards:
- ASTM C-834, Type OP, Grade -18'C, White
- ASTM C-834, Type C, Grade 0˚C, Clear

Adheres to:
- Concrete
- Wood
- Metal
- Marble
- Glass
- Porcelain
- Ceramic tile
- Masonry

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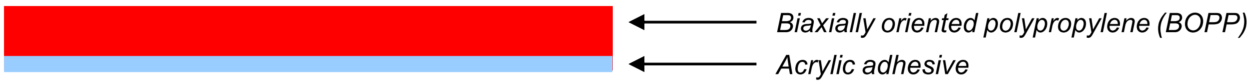
1585CW-2

SHEATHING TAPE

VentureTape® 1585CW-2 is a is a polypropylene sheathing tape coated with an aggressive acrylic pressure sensitive adhesive (PSA) designed for use as a closure system and vapor seal on all interior and exterior sheathing materials. VentureTape 1585CW-2 exceeds most building code requirements and can be used for new construction as well as repair on all vapor barrier materials. Available in red, white, and clear; VentureTape® 1585CW-2 is the highest performing, highest value product on the market today.

Product Construction



Features & Benefits

- *High performance sheathing tape installs and performs well over a wide temperature range*
- *Excellent vapor barrier tape on polyethylene film*
- *Performs well as a seam tape on extruded foam products such as **Styrofoam® and Foamular®***
- *Applies to all major housewraps including **Tyvek® and Typar®***
- *Great for use as a sealing tape on **DensGlass Gold®** and other sheathing brands*

Test	Typical Value	Typical Value (Metric)	Test Method
Product Thickness	3.0 mils	0.08 mm	PSTC-133
Peel Adhesion[Δ]			
to stainless steel	45 oz/in	12.5 N/25 mm	PSTC-101
to polyethylene	16 oz/in	4.5 N/25 mm	PSTC-101
to Tyvek®	25 oz/in	6.9 N/25 mm	PSTC-101
Shear Adhesion	>24 hrs @ 2.2 psi	>24 hrs @ 15.2 kPa	PSTC-107
Tensile Strength	20 lb/in	90.4 N/25 mm	PSTC-131
Elongation	130 %	130 %	PSTC-131
WVTR	0.061 perms		ASTM E96
Service Temperature	-40 to 185 °F	-40 to 85 °C	

[Δ] - 20 minute dwell

Typical values are not intended to be used for specification development. Technical data is believed to be true and accurate; Venture Tape recommends that the purchaser test for fitness of use in all applications.

Product Configurations

- *1 7/8" x 72 yards & 2 1/2" x 72 yards standard*
- *Custom rolls available on request*

Contact Venture Tape today for a complete list of products or a free sample

Toll Free North America 800-343-1076
From United Kingdom 0-800-962-957
From Australia 1-800-122-797
www.venturetape.com

VentureTape®

GTA - NHT, Inc.
Venture Tape
30 Commerce Rd., Rockland, MA 02370
Tel 781-331-5900; Fax 781-871-0065
800-343-1076 (U.S.A.), 800-544-1024 (Canada)
Toll Free Fax 877-264-5490
www.venturetape.com

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TAPES & ADHESIVES
a 3M Company

FIREBARRIER SPRAYACRYLIC

Table 1 – PHYSICAL PROPERTIES*

Color	Red
pH	7.0 - 9.0
VOC (grams/liter): EPA Method 310	65
Flame Spread (ASTM E84)	15
Smoke Development (ASTM E84)	0
STC Rating ASTM E90	Restored to 59 in a U411 wall
Antifungal	Contains antifungal additive
Cure Time	3 - 5 days
Skin over Time	Overnight
Movement Capability: (UL 2079; class I, II, III)	± 25 %, maximum
Shore "A" Hardness (ASTM C-661)	15 - 20
Application Temperature	40 - 110°F (5 - 43°C)
Freeze Sensitive	Yes
Paintable	Yes

*Values given above are not intended for specification preparation.

1. PRODUCT NAME

A/D FIREBARRIER SprayAcrylic

2. PRODUCT DESCRIPTION

A/D FIREBARRIER SprayAcrylic is a single component, water-based elastomeric that cures to a durable, flexible, fire resistant seal.

Basic Use: A/D FIREBARRIER SprayAcrylic is designed for use as a firestop sealant in joint firestop configurations including head-of-wall, curtain wall, perimeter and floor to wall construction joints.

Composition and Materials:
A/D FIREBARRIER SprayAcrylic is water-based. It is designed for spray and trowel application to vertical and horizontal surfaces. It forms durable, flexible, watertight bonds with most materials. Physical properties will remain stable over time. Product contains mold growth inhibiters.

A/D FIREBARRIER SprayAcrylic contains water and is best if protected from freezing. If frozen, thaw completely before use. Store, transport and install at temperatures above 40°F (5°C).

Packaging: A/D FIREBARRIER SprayAcrylic is available in 5 US gallon (18.9 L) pails. Coverage per pail is approximately 67 ft^2 (6.3 m^2) at 1/8-in. (3 mm) wet thickness.

Color: Red

Application Limitations:

- Do not install when ambient temperature or temperature of substrate is below 40°F (5°C).
- Protect from freezing and water until sealant is fully cured.
- Do not apply to surfaces with special protective or cosmetic coatings without first testing adhesion and prior consultation with manufacturer.
- Not intended for immersion or continuous exposure to water.
- Do not install on hot surfaces above 200°F (90°C).
- A/D FIREBARRIER SprayAcrylic has been tested in numerous firestop joint firestop systems. For optimum economy and performance, the product should be applied to a thickness equal to or slightly greater than the required minimum test design thickness. Excessive depth to width ratios may cause sealant failure – **do not apply excessive thickness.** As a guideline, we recommend that the minimum test system thicknesses not be exceeded by more than 25%.

3. TECHNICAL DATA

Standards: A/D FIREBARRIER SprayAcrylic has been tested and in accordance with the following: ANSI/UL1479, ANSI/UL2079, ASTM E814 and CAN4/ULC-S115M.

For details of rated firestop systems see UL' s Fire Resistance Directory, Volume 2. Systems certified for use in Canada are available under the cUL mark.

Surface Burning Characteristics:
(ASTM E84)
Flame Spread: 15
Smoke Developed: 0

4. INSTALLATION

No dilution or mixing is required for use. Clean all openings to be firestopped by removal of foreign matter and contaminants such as oil, dust, grease, frost, water, surface dirt, old sealants, glazing compounds, protective coatings, etc.

Priming: Generally, a primer will not be required. It is recommended that a test sample of sealant be applied on the surface to test adhesion.

Masking: Surfaces adjacent to openings to be firestopped can be masked to assure a neat appearance. The masking tape should not be allowed to touch the clean surface to which the sealant is to adhere. Remove masking tape immediately.

Forming/Backing: Install forming / backing material as specified by the tested firestop system. Unless otherwise specified, A/D FIREBARRIER Mineral Wool is the recommended backup material.

Application: A/D FIREBARRIER SprayAcrylic may be applied by spray or trowel to vertical and horizontal surfaces.

Refer to tested firestop system for minimum wet film thickness that is required - usually 1/8 (3.2 mm). Use a wet film gauge to measure wet film thickness. Apply A/D FIREBARRIER SprayAcrylic so as to seal the mineral wool backer with the required thickness and overlap adjacent surfaces a minimum of ½ in. (13 mm) or as otherwise specified in tested firestop system.

Excess sealant should be wiped from glass, metal and plastic surfaces while uncured. Clean up with water. Follow equipment manufacturers' instructions for clean up and use. Protect adjacent surfaces from overspray and unintended contact - **Cured Sealant**

Table 2 – Quick Reference Guide –
Spray Application of SprayAcrylic

Hoses	50 ft of 1/4 in. (I.D.) Blue Max
Whip line	6 ft - ¼" (I.D.) whip line with swivel
Tips	419 - 423 heavy-duty self cleaning reversible type 621 - 625 heavy-duty self cleaning reversible type
Spray machine	Airless sprayer capable of 3300psi pressure and min. delivery of 0.95 gpm without surging
Filters	60-80 mesh in gun & 60-80 in manifold
Mixing	Heavy-duty drill with paddle for 30 seconds
Application Rate	1/8 in. (3 mm) wet
Finish	Follows profile of backer material
Trowel	May be toweled
Clean-up	Water

May Be Very Difficult To Remove Without Altering Or Damaging The Surface To Which The Sealant Has Been Applied.

Precautions: May cause irritation. May be harmful if swallowed. Avoid contact with eyes. Wash hands thoroughly after handling. Use only as directed. **Keep out of reach of children.** To safely use this product, read and abide by Material Safety Data Sheet (MSDS).

Shelf Life: A/D FIREBARRIER SprayAcrylic has a shelf life of 1 year from the date of manufacture when stored in original and unopened container below 110°F (43°C) and above 40°F (5°C).

5. MAINTENANCE

No maintenance should be required. If product becomes damaged, replace with new A/D FIREBARRIER SprayAcrylic. All surfaces should be clean and free of any material that would prevent adhesion.

6. AVAILABILITY AND COST

Availability: A/D sales offices and technical representatives are located throughout North America. (See below).

7. TECHNICAL SERVICES

Contact nearest A/D office or representative

FIREBARRIER ACRYLIC SEALANT

1. PRODUCT NAME

A/D FIREBARRIER Acrylic Sealant

2. PRODUCT DESCRIPTION

A/D FIREBARRIER Acrylic Sealant is a single component, water-based acrylic sealant intended for use as a firestop system component.

Basic Use: A/D FIREBARRIER Acrylic Sealant is designed for economical use in joint and service penetration firestop configurations. It forms a durable, flexible, watertight bond with most construction materials. In most cases, no primer is required. May be applied by caulking gun or trowel. Physical properties will remain stable over time.

Composition and Materials:
A/D FIREBARRIER Acrylic Sealant is designed to tool easily. It is water based and must be protected from freezing and from water until fully cured. Store and install at temperatures above 40°F (5°C).

Color: Red

Packaging: See table 2**.** Refer to the A/D FIREBARRIER estimating guide for complete volume and coverage information.

Application Limitations:

- Do not install when ambient temperature or temperature of substrate is below 40°F (5°C).
- Protect from freezing and water until sealant is fully cured.
- Do not install to surfaces with special protective or cosmetic coatings without prior consultation with manufacturer and first testing adhesion.
- Do not install where abrasion or physical abuse is anticipated.
- For best economy and performance the product should be applied to a thickness equal to or slightly greater than the minimum test design thickness.
- Excessive depth to width ratios may cause sealant failure – **do not apply excessive thickness.** As a guideline, we recommend that the minimum test system thicknesses not be exceeded by more than 25%.

Table 1 – PHYSICAL PROPERTIES*

Color	Red
pH	7.0 - 9.0
VOC (grams/liter): EPA Method 310	35
Flame Spread (ASTM E84)	15
Smoke Developed (ASTM E84)	0
STC Rating ASTM E90	Restored to 56 in a U411 wall
Antifungal	Contains antifungal additive
Cure Time	3 - 5 days
Skin over Time	Overnight
Movement Capability: (UL 2079; class I, II, III)	± 33 %, maximum
Shore "A" Hardness (ASTM C-661)	15 - 20
Application Temperature	40 - 110°F (5 - 43°C)
Freeze Sensitive	Yes
Paintable	Yes

*Values given above are not intended for specification preparation.

Standards: A/D FIREBARRIER Acrylic Sealant has been tested in accordance with the following: ANSI/UL1479, ANSI/UL 2079, ASTM E814 and CAN/ULC-S115M.

3. TECHNICAL DATA

A/D FIREBARRIER Acrylic Sealant is listed by ULI. For details of rated firestop systems see ULI’ s Fire Resistance Directory, Volume 2. Systems certified for use in Canada are available under the cUL mark.

4. INSTALLATION

Clean all openings to be firestopped by removal of foreign matter and contaminants such as oil, dust, grease, frost, water, surface dirt, old sealants, glazing compounds, protective coatings etc. Cleaning of all surfaces should be done on the same day in which the sealant is applied.

Priming: A/D FIREBARRIER Acrylic Sealant does not require priming. In view of the unpredictability of surface characteristics, it is recommended that a test sample of sealant be applied on the surface to test adhesion.

Masking: Areas adjacent to openings to be firestopped can be masked to assure a neat appearance. The masking tape should not be allowed to touch the clean surface to which the sealant is to adhere. Remove masking tape immediately.

Install backup materials as specified. Excess sealant should be wiped from glass, metal and plastic surfaces while uncured. Clean up is with water.

CURED SEALANT IS USUALLY VERY DIFFICULT TO REMOVE WITHOUT ALTERING OR DAMAGING THE SURFACE TO WHICH THE SEALANT HAS BEEN APPLIED.

Precaution: May cause irritation. May be harmful if swallowed. Avoid getting in eyes. Wash hands thoroughly after handling. Use only as directed.

Keep out of reach of children.
To safely use this product, read and abide by Material Safety Data Sheet (MSDS).

Shelf Life: When stored at or below 110°F (43°C) and above 40°F (5°C), A/D FIREBARRIER Acrylic Sealant has a shelf life of one year from date of manufacture.

Note: Protect from freezing.

Table 2			
Type of Packaging	**Size**	**Volume**	**Coverage at ¼" deep x 1" wide**
Cartridges	10.1 fl. oz. (300 mL)	$18.2\ in^3$ ($300\ cm^3$)	6.1 lineal ft. (1.86 lineal m)
	28.7 fl. oz. (850 mL)	$51.8\ in^3$ ($850\ cm^3$)	17.3 lineal ft. (5.27 lineal m)
Foil packs	20 fl. oz. (600 mL)	$36\ in^3$ ($600\ cm^3$)	12.2 lineal ft. (3.72 lineal m)
Pails	5 gal (18.9 L)	$1155\ in^3$ ($18900\ cm^3$)	384.4 lineal ft. (117.18 lineal m)

5. AVAILABILITY AND COST

Availability: A/D sales offices and technical representatives are located throughout North America. (See below)

6. MAINTENANCE

No maintenance should be required. If sealant becomes damaged, replace damaged portion. Clean surfaces in damaged area and repair with fresh A/D FIREBARRIER Acrylic Sealant. Damage by other trades should be patched at the expense of trade causing damage.

7. TECHNICAL SERVICES

Contact nearest A/D office.

FIREBARRIER MINERAL WOOL

Table 1 - Physical Properties	
Property	**Result**
Density	Nominal 4 lb./ft^3 (64 kg/m^3)
Moisture Adsorption	< 1%; inorganic, will not mildew
Service Temperatures	Continuous to 1200F (649C)
Linear Shrinkage	0% @1050ºF (551ºC); <1% @1200ºF(649ºC)
Recovery after 10% compression	100%
Asbestos	None
Surface Burning, CAN4-S102, ASTM E84 & UL723	Flame Spread – 5; Smoke Developed – 0
Non-combustibility, CAN4-S114	Listed as noncombustible by ULC
Non-Corrosive, NRC 1.36, ASTM C692, C795 & C871	Will not cause or contribute to corrosion

1. PRODUCT NAME

A/D FIREBARRIER Mineral Wool

2. PRODUCT DESCRIPTION

Pre-formed, semi-rigid, non-combustible mineral wool insulation. The mineral wool is precut into 48 in. (1220 mm) lengths and is available in various depths and widths for immediate installation.

Basic Use: A/D FIREBARRIER Mineral Wool is intended for use as a firestop system component and forming material in tested firestop systems and designs. It is friction fitted into openings, joints, gaps, spaces and voids in fire rated assemblies. It is usually used in conjunction with firestop sealant products such as A/D FIREBARRIER Silicone, Silicone SL, Seal, Seal NS Acrylic Sealant and Intumescent Sealant.

Composition and Materials:
A/D FIREBARRIER Mineral Wool is a noncombustible semi-rigid combination of basaltic mineral wool and proprietary binders.

Packaging: A/D FIREBARRIER Mineral Wool is available in 25-lb (11 kg) nominal weight polyethylene bags. Precut to required width and depth, the 48 in. (1220 mm) strips allow for ease of handling and installation. Refer to Estimating Guide for size availability.

Color: Brown

Standards: A/D FIREBARRIER Mineral Wool has been tested in accordance with:

- CAN4-S114, “Standard Method of Test For Determination of Non-combustibility In Building Materials”
- ULC-S115-95, Standard Method of Fire Tests of Firestop Systems”
- ANSI / UL 1479 and ASTM E814, "Standard Method of Fire Tests of Through-Penetration Fire Stops”
- UL 2079, “Standard Method of Tests For Fire Resistance of Building Joint Systems.”

3. TECHNICAL DATA

Refer to Table 1 - Physical properties.
For details of rated firestop systems, see ULI' s Fire Resistance Directory, Volume 2, ULC’ s List of Equipment and Materials, Firestop Systems and Components, ITS’ s Directory of Listed Products and Factory Mutual’ s Approval Guide.
A/D FIREBARRIER Mineral Wool is nominal 4 lb/ft^3 (64 kg/m^3) and complies with the requirements of our UL tested firestop systems where generic mineral wool is referenced.

4. INSTALLATION

Install A/D FIREBARRIER Mineral Wool to the minimum 25% or 33% compression required by the tested firestop system - see Table 2. Compression must always be perpendicular to the grain. Butt adjacent sections of A/D FIREBARRIER Mineral Wool tightly against each other. Leave no voids. A/D FIREBARRIER Mineral Wool is the recommended backup material for A/D FIREBARRIER Silicone, Silicone SL, Seal, Seal NS, Acrylic Sealant and Intumescent Sealant. Determine the depth of firestop sealant required, and recess the A/D FIREBARRIER Mineral Wool the appropriate depth.
Precautions: To safely use this product, read and abide by the Material Safety Data Sheet (MSDS). Avoid inhalation of dust during use. Avoid skin and eye contact. Mineral Wool fibre, like other nuisance particulates, may cause itching and possible irritation of eyes and/or upper respiratory tract.

5. AVAILABILITY AND COST

Availability: A/D sales offices and technical representatives are located throughout North America.

6. MAINTENANCE

No maintenance should be needed. If the mineral wool becomes damaged, replace damaged section.

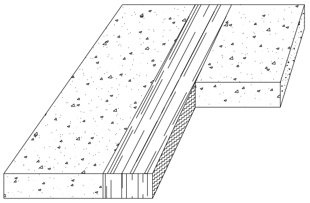
7. TECHNICAL SERVICES

Contact nearest A/D office.

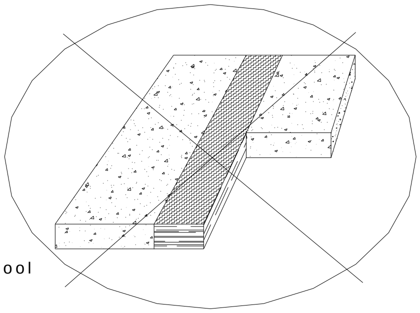
Table 2 - Thickness and Compression Data

Nominal Batt Thickness,		Maximum Width of Opening for 25% compression, in. (mm)		Maximum Width of Opening for 33% compression, in. (mm)	
in.	mm	in.	mm	in.	mm
1	25	3/4	19	5/8	17
1.5	38	1-1/8	29	1	25
2	50	1-1/2	38	1-5/16	34
3	75	2-1/4	57	2	51
4	100	3	75	2-5/8	68
5 (4 + 1)	125 (100 + 25)	3-3/4	95	3-5/16	85
5.5 (4 +1.5)	140 (100 + 38)	4-1/8	105	3-5/8	94
6 (4 + 2)	150 (100 + 50)	4-1/2	114	4	100
7 (4 + 3)	175 (100 + 75)	5-1/4	133	4-5/8	119
8 (4 + 4)	200 (100 + 100)	6	150	5-5/16	136

CORRECT



INCORRECT



Always install A/D FIREBARRIER Mineral Wool so that it is compressed perpendicular to the grain.

PRODUCT INFORMATION . COMMERCIAL . UNITED STATES

THERMAX™ SHEATHING

1. PRODUCT NAME

THERMAX™ Sheathing

2. MANUFACTURER

The Dow Chemical Company
Dow Building Solutions
200 Larkin
Midland, MI 48674
1-866-583-BLUE (2583)
Fax 1-989-832-1465

www.dowbuildingsolutions.com

3. PRODUCT DESCRIPTION

THERMAX™ Sheathing is a non-structural, rigid board insulation consisting of a glass-fiber-infused polyisocyanurate foam core laminated between 1.0 mil smooth, reflective aluminum facers on both sides. The glass-fiber reinforcement contributes to improved fire performance and dimensional stability. THERMAX™ Sheathing can be installed exposed to the interior without a thermal barrier.

THERMAX™ Sheathing offers high, long-term R-value. Used in conjunction with the appropriate joint closure system for the application, THERMAX™ Sheathing with its low perm rating helps to reduce moisture condensation within and behind the insulation.

BASIC USE

THERMAX™ Sheathing is specially designed to have a Class A fire rating and can be used in a range of concealed and exposed applications, above and below grade, and can be used in exterior walls. Because of its improved fire performance, THERMAX™ Sheathing is especially appropriate for hourly rated assemblies. THERMAX™ Sheathing is approved for use, per Section 2603.5 of the International Building Code, in Exterior Walls of Types I,II,III and IV construction. THERMAX™ Sheathing is designed for use as continuous insulation in both interior and exterior applications to assist in meeting and exceeding both the most current IECC and the ASHRAE 90.1 energy standards. Maximum length is 30 ft. (9.1 m) and maximum thickness is 4.25" (108 mm) with R-value of 27.0.

4. TECHNICAL DATA

APPLICABLE STANDARDS

THERMAX™ Sheathing meets ASTM C1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board, Type I, Class 2. Applicable standards include:

- C203 – Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
- C209 – Standard Test Methods for Cellulosic Fiber Insulating Board
- C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics
- D2126 – Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
- E96 – Standard Test Method for Water Vapor Transmission of Materials
- D1623 – Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics

TYPICAL PHYSICAL PROPERTIES

THERMAX™ Sheathing exhibits the typical physical properties and characteristics indicated in Table 2 when tested as represented.

ENVIRONMENTAL DATA

THERMAX™ Sheathing is manufactured with a zero ozone depleting potential. The use of THERMAX™ Sheathing helps reduce the carbon footprint of commercial buildings.

FIRE PROTECTION

THERMAX™ Sheathing products should be used only in strict accordance with product application instructions. THERMAX products are combustible and when used in a building containing combustible materials, may contribute to the spread of fire. For more information, consult MSDS and/or call Dow at 1-866-583-BLUE (2583). In an emergency, call 1-989-636-4400.

CODE COMPLIANCES

THERMAX™ Sheathing complies with the following codes:

- International Residential Code (IRC) Section 314
- International Building Code (IBC) Section 2603
- ICC-ES NER-681
- FM 4880 – Wall-Ceiling Construction Metal-Faced – Class 1 Fire Rated to Max. 30' Exposure High, 4.25" Thick, 4' Wide, When Installed as Described in the Current Edition of FMRC Approval Guide
- THERMAX™ products are classified by Underwriters Laboratories Inc. (UL)
- UL 1256 – Fire Test of Roof Deck Constructions, Roof Deck Construction No. 120 and No. 123
- UL 723 (ASTM E84) Surface Burning Characteristics of Building Materials
- The following designs are 1, 2, 3 or 4 hour wall rated assemblies as listed in the UL Fire Resistance Directory: U026, U326, U330, U354, U355, U424, U460, U902, U904, U905, U906, U907, V454, V482
- Fire Performance Evaluation of an Exterior Masonry Wall System Incorporating THERMAX™ Insulation Tested in Accordance With NFPA 285, 2006 Edition (UBC 26.9, intermediate scale – multistory testing)
- FMVSS No. 302 – Flammability of Interior Materials – Passenger Cars, Multipurpose Passenger Vehicles, Trucks and Buses (Docket No. 3-3; Notice 4)
- Miami-Dade NOA 08-0320.01 Interior Insulation on CMU Block

Contact your Dow sales representative or local authorities for state and local building code requirements and related acceptances.

5. INSTALLATION

Boards of THERMAX™ Sheathing are lightweight and can be sawed or cut with a knife. They install quickly to walls (girts, steel stud, tilt-up, block, wood) and ceilings – inside and outside of purlins, trusses or bar joints. Butt joints must be installed over structural members. "Best practice" recommendations for high-humidity environments include continuously sealing the surface of the insulation at all joints with a Dow joint closure system. Contact a local Dow representative or access the literature library at www.dowbuildingsolutions.com for more specific instructions.

6. AVAILABILITY

THERMAX™ Sheathing is manufactured in several locations and is distributed through an extensive network. For more information, call 1-800-232-2436.

TABLE 1: SIZES, R-VALUES AND EDGE TREATMENTS FOR THERMAX™ SHEATHING

NOMINAL BOARD THICKNESS(1), IN.	R-VALUE(2)(3)	BOARD SIZE, FT	EDGE TREATMENT
.50	3.3	4 x 8, 4 x 9, 4 x 10	Square Edge
.75	5.0	4 x 8, 4 x 9, 4 x 10	Square Edge
1.0	6.5	4 x 8, 4 x 9, 4 x 10	Square Edge
1.25	8.1	4 x 8, 4 x 9, 4 x 10	Square Edge
1.5	9.8	4 x 8, 4 x 9, 4 x 10	Square Edge, Shiplap
1.55	10.1	4 x 8, 4 x 9, 4 x 10	Square Edge, Shiplap
1.75	11.4	4 x 8, 4 x 9, 4 x 10	Square Edge, Shiplap
2.0	13.0	4 x 8, 4 x 9, 4 x 10	Square Edge, Shiplap
2.5	15.8	4 x 8, 4 x 9, 4 x 10	Square Edge, Shiplap
3.0	19.0	4 x 8, 4 x 9, 4 x 10	Square Edge, Shiplap
3.5	22.1	4 x 8, 4 x 9, 4 x 10	Square Edge
4.0	25.2	4 x 8, 4 x 9, 4 x 10	Square Edge

(1) Not all product sizes are available in all regions.
(2) R means resistance to heat flow. The higher the R-value, the greater the insulating power. Stabilized R-values @ 75°F mean temperature determined in accordance with ASTM C518. R-values expressed in ft2•h•°F/Btu.
(3) An additional 2.77 R-value can be achieved with a 3/4" dead airspace when properly installed.

TABLE 2: TYPICAL PHYSICAL PROPERTIES OF THERMAX™ SHEATHING

PROPERTY AND TEST METHOD	VALUE
Compressive Strength(1), ASTM D1621, psi, min.	25
Flexural Strength, ASTM C203, psi, min.	55
Dimensional Stability, ASTM D2126, % linear change, max.	0.1
Water Absorption, ASTM C209, % by volume, max.	0.05
Water Vapor Permeance, ASTM E96, perm, max.	<0.03
Maximum Use Temperature, °F	250

(1) Vertical compressive strength is measured at 10 percent deformation or at yield, whichever occurs first.

7. WARRANTY

Fifteen-year limited thermal warranty is available. Contact your Dow representative for details.

8. MAINTENANCE

Not applicable.

9. TECHNICAL SERVICES

Dow can provide technical information to help address questions when using THERMAX™ Sheathing. Technical personnel are available to assist with any insulation project. For technical assistance, call 1-866-586-BLUE (2583).

10. FILING SYSTEMS

- www.dowbuildingsolutions.com
- www.sweets.com
- www.thermaxbydow.com

www.dowbuildingsolutions.com

Technical Information
1-866-583-BLUE (2583)
Sales Information
1-800-232-2436

IN THE U.S.
THE DOW CHEMICAL COMPANY
200 Larkin
Midland, MI 48674

CAUTION: This product is combustible and shall only be used as specified by the local building code with respect to flame spread classification and to the use of a suitable thermal barrier. For more information, consult MSDS, call Dow at 1-866-583-BLUE (2583) or contact your local building inspector. In an emergency, call 1-989-636-4400.

WARNING: Rigid foam insulation does not constitute a working walkable surface or qualify as a fall protection product.

Building and/or construction practices unrelated to building materials could greatly affect moisture and the potential for mold formation. No material supplier including Dow can give assurance that mold will not develop in any specific system.

ENERGY STAR PARTNER

Printed in U.S.A.

Form No. 179-04015X-0810MCK
MCKAY205481

NF

NATIONAL FIBER

CEL-PAK INSULATION

Professional Cellulose for Cellulose Professionals

Cel-Pak Class 1 Cellulose Insulation

- SPECIFICATIONS -

National Fiber's Cel-Pak is a high quality, cellulose insulation for dense pack wall and ceiling applications. It is also installed as loose fill in flat attic areas in new construction and retrofit.

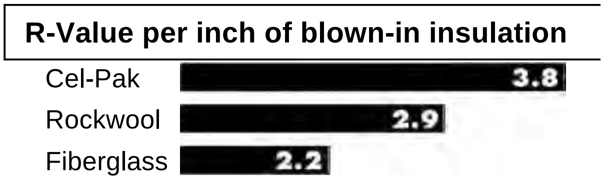
Cel-Pak is a premium, all-borate cellulose insulation. It is made almost primarily from over-issue news, which is the highest quality newsprint available. Our paper provides the best quality and fiber length for superior insulation. The quality of this newsprint and the purity and effectiveness of our special, all-borate chemical formulation, carefully blended in our state-of-the-art equipment, provide the optimum density for unsurpassed coverage and performance.

Cel-Pak's long, flexible fibers ensure void-free filling of the space to be insulated by sealing around wiring, plumbing, and other obstacles. This reduces air infiltration and results in a less drafty, more comfortable home.

ADVANTAGES OF CEL-PAK

- Low settled density provides superior coverage,
- Highly efficient thermal barrier (measured in R-value per inch),

  **R-value means resistance to heat flow. The higher the R-value, the greater the insulating capacity*



R-Value per inch of blown-in insulation

- Proven energy savings (conserves energy by reducing fuel consumption)
- Permanent fire resistance, with superior flame retardant qualities
- Significant sound barrier and moisture control (enhanced by dense fiber structure and naturally hygroscopic properties of the cellulose fiber)
- Contains no formaldehyde, asbestos or glass fibers
- Very clean (minimal dust)
- Highest recycled content of all common insulating materials, helping to preserve the environment

There are other factors to consider. The amount of insulation you need depends mainly on the climate you live in. In the Northeast, for example, R-38 is recommended for attics. Your energy savings also depend on the type and size of your home, your family size, and your comfort preferences.

To obtain the level of thermal insulation (R-Value) indicated, this insulation must be installed at the coverage rates shown in the chart below. Initial installed thicknesses were determined using a Krendl

2000 machine with shredder. Settings are not adjustable.

Average net weight 25 lbs

Net Coverage - Attics - 25 lbs. - Settled Density 1.40 lbs/cu.ft.					
R-Value @75°F	Initial Installed Thickness (in.)	Minimum Settled Thickness (in.)	Bags Per 1000 sq.ft. No joists	Net Coverage sq.ft./Bag No joists	Minimum Weight lb/sq.ft.
13	4.3	3.8	11.7	85.8	0.29
19	5.9	5.3	19.8	50.5	0.50
22	6.8	6.1	24.0	41.6	0.60
30	9.1	8.1	35.4	28.3	0.88
38	11.4	10.2	46.8	21.4	1.17
49	14.5	13.1	62.6	16.0	1.56
60	17.7	16.0	78.4	12.8	1.96
Net Coverage - Sidewalls - 25 lbs. - Settled Density 3.1 lbs/cu.ft.					
13	2 x 4	3.5	36.2	27.6	0.90
20	2 x 6	5.5	56.9	17.6	1.42

READ THIS BEFORE YOU BUY

What you should know about R-Values. The above chart shows the R-Value of this insulation. R means the resistance to heat flow. The higher the R-Value, the greater the insulating power. Compare insulation R-Values of cellulose with other insulating materials before you buy.

To get the indicated R-Value, it is essential that this insulation be installed properly. If you do it yourself, get instructions and follow them carefully. Instructions do not come with this package.

R & D Services Inc.
Classified
Cel-Pak Cellulose Insulation
Reference File: RDS-LF9256

This product meets the amended CPSC standard for flame resistance and corrosiveness of cellulose insulation.

Cel-Pak is periodically retested by R & D Services to assure compliance with Federal Specifications. In addition, we maintain a fully equipped on-site laboratory for monitoring product quality on a daily basis.

CPSP Standard HH-I-515E; 16CFR 1209

Meets ASTM C739 Class 1/A Building Material

Classified in accordance with the following ASTM C 739 characteristics

Flammability Characteristics

Critical Radiant Flux	Greater than or Equal to 0.12 W/cm^2
Smoldering Combustion	Less Than or Equal to 15.0%

Environmental Characteristics

Corrosiveness	Acceptable
Fungi resistance	Acceptable

Physical Characteristics

Density (Settled)	1.4 lb/ft^3
Thermal Resistance	3.8 R/in. (at 4 in.)
Moisture Vapor Sorption	Acceptable
Odor Emission	Acceptable

Appendix for ECM 11: Weatherization

III. Building Envelope Report

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2. FIRE HEADQUARTERS

ASSESSMENT FINDINGS

B|E Retrofit recommends a strategy in Fire Stations that isolates the office / living spaces from the garage as best and as consistent with the use of the building as possible, improves weaknesses in the envelope of the office / living spaces (as with any other style of building) and does not spend dollars on the envelope of the garage. We believe that this strategy aligns best with the realities of the use of a fire station.

➢ See pictures on the following pages for visual support of the text below.

- Doors
  - Entry Doors – the weather stripping on select entry doors does not create an effective seal around the perimeter of the doors. This is allowing infiltration / exfiltration at the door systems.

- Windows
  - Double Hung – the upper sash of the double hung windows is operable and is “sagging” when the windows are not closed properly which creates a gap at the top of the upper sash as well as a gap at the meeting rail (when the upper sash “sags” the meeting rail and closure system of the upper and lower sash does not align properly). The existing weather stripping at the bottom of the lower sash is not effectively stopping infiltration/ exfiltration. Sealant was never installed at the joint between the window stop and the compression jamb, so air can leak through the window rough opening, through this joint and into the building.

WEATHERIZATION RECOMMENDATIONS

➢ Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale behind a recommended measure, the installation process and the materials used to complete each measure recommended for the building.
➢ For specifications that vary from the Installation Factsheets or where measures do not have Installation Factsheets notes are included at the square bullets.
➢ Highlighted floor plans provide the locations for installation.

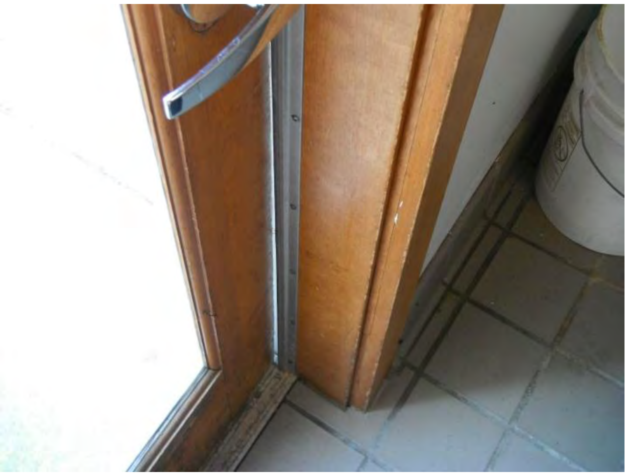
2. FIRE HEADQUARTERS

Air Leakage Control Measures

- Door Weather Stripping

- Double Hung Window Weatherization (Compression Jamb)
    - Select components of the specifications outlined in the Double Hung Window Weatherization (Compression Jamb) Installation Factsheet are recommended. Fixing shut the upper sash, caulking the upper sash for an air-tight seal, installing weather stripping at the bottom of the lower sash only and caulking the inoperable casing joints are the components from the Installation Factsheet that are recommended for the building.

2. FIRE HEADQUARTERS



Doors – daylight shining through the separation between the existing weather stripping and the door identifies an air leakage pathway.

Windows – air leakage shown by smoke tracer testing at the perimeter of the upper sash of the compression jamb double hung window.

Windows – air leakage shown by smoke tracer testing at the bottom of the lower sash of the double hung window.

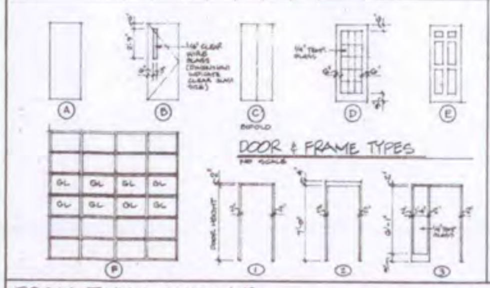
Windows – cob webs and dust accumulation at the bottom of the lower sash is an indicator of unwanted air leakage.

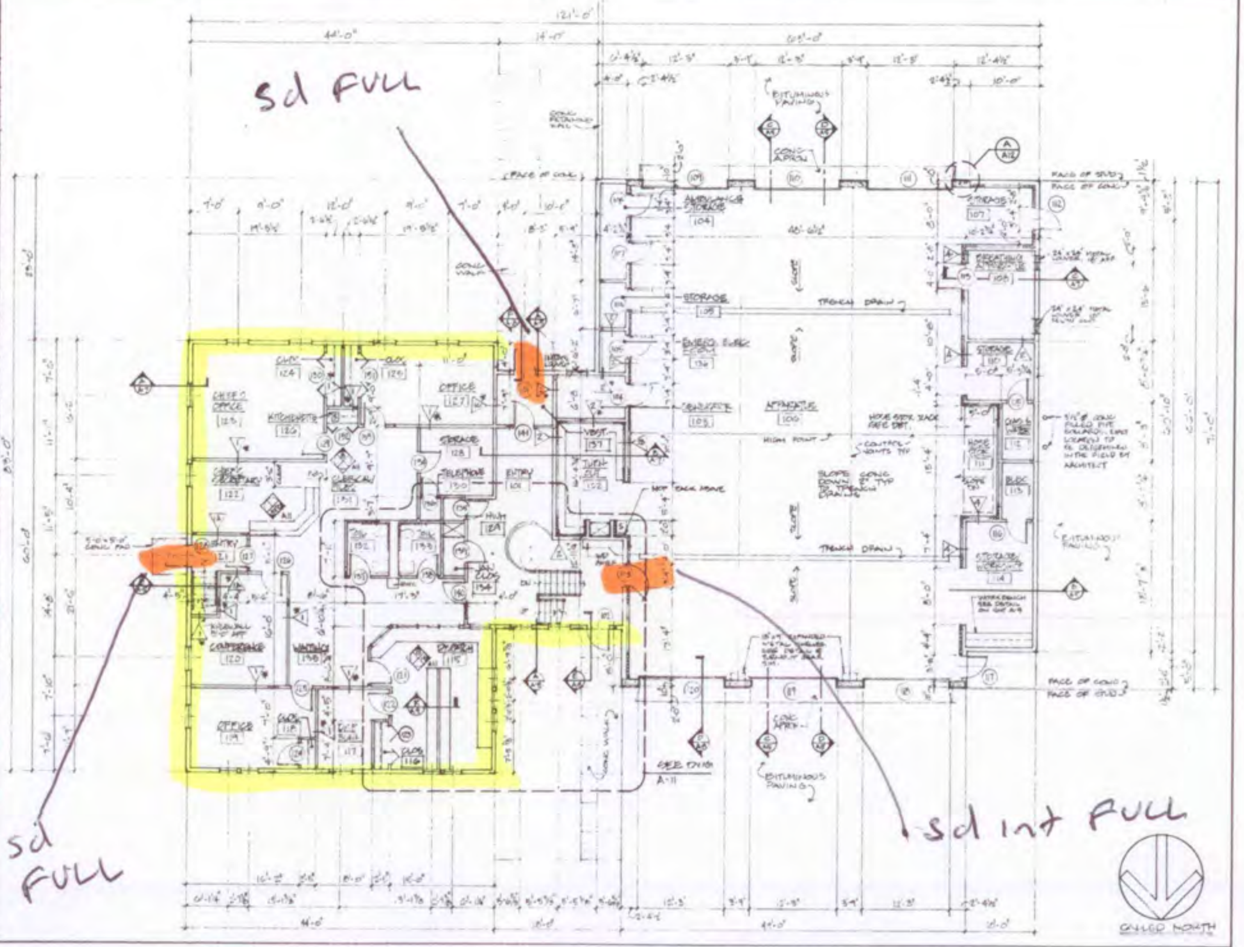
Windows – arrow points to the vertical joint between the compression jamb and the window stop where sealant was never installed.

🟧 Door Weather Stripping
sd - single door
FULL - full weather strip

DOOR SCHEDULE

DOOR					FRAME			HARDWARE	REMARKS
NO.	SIZE	TYPE	MAT'L	LBL	TYPE	MAT'L	LBL		
101	3^0×7^0×1¾"	D	WD	—		WD	—	5	WEATHER STRIP'G
102	↓	D	WD	—		WD	-	6	ELEC DOOR STRIKE & WEATHER STRIP'G
103		B	H.M.	B	2	PM	B	12	135° CLOSER, KICKPLATE
104		A	↓	—	↓	↓	-	4	
105				B			B	4	
106				B			B	4	
107				—			-	4	
108	↓	↓	↓	—	↓	↓	-	4	
109	12'×14'	F		—	-		-	-	OH DOORS W/ ELEC OPENERS & WEATHER STRIPPING
110	↓	F		-	-		-	-	↓
111		F		—	—		-	-	
112	3^0×7^0×1¾"	E	WD	-		WD	-	5	
113	3^0×7^0×1¾"	A	HM	-	2	PM	-	4	
114	-OMIT-								
115	3^0×7^0×1¾"	A	HM	-	1	PM	-	4	
116	↓	↓	↓	-	1	↓	-	4	
117		E	WD	-		WD	-	5	
118	12'×14'	F		-	-		-	-	OH DOORS W/ ELEC OPENERS & WEATHER STRIPPING
119	↓	F		-	-		-	-	
120	↓	F		-	-		-	-	↓
121	3^0×7^0×1¾"	A	WD	-	1	PM	-	8	
122	↓	↓		-	1	PM	-	11	
123	5^0×7^0×1⅜" PR	C		-	-	-	-	PULLS	BI-FOLD
124	2^8×7^0×1¾"	A		-	1	PM	-	10	
125	3^0×7^0×1¾"			-			-	6	
126				-			-	11	
127		↓		C		↓	C	2	HEAVY THRESH./ UNDERCUT DOOR [illegible]
128		E		-		WD	-	5	WEATHER STRIP'G
129	↓	A		-	↓	PM	-	6	
130	6^0×7^0×1⅜" PR	C		-	-	-	-	PULLS	BI-FOLD
131	"	C		-	-	-	-	PULLS	BI-FOLD
132	4^0×7^0×1⅜" PR	C		-	-	-	-	PULLS	BI-FOLD
133	3^0×7^0×1¾"	A		-	1	PM	-	6	
134	"			-			-	6	
135	2^6×7^0×1¾"			-			-	1	UNDERCUT DOOR
136	"			-			-	10	
137	3^0×7^0×1¾"			-			-	3	UNDERCUT DOOR
138	"			-			-	3	UNDERCUT DOOR
139	2^6×7^0×1¾"			-			-	9	UNDERCUT DOOR
140	3^0×7^0×1¾"	↓	↓	C	↓	↓	C	2	KICKPLATE
141	3^0×7^0×1¾"	D	WD	-	1	PM	-	13	ELEC DOOR STRIKE





ROOM FINISH SCHEDULE

NO.	NAME	FLOOR		WALLS				CEILING		REMARKS
		MAT'L	BASE	NORTH	EAST	SOUTH	WEST	MAT'L	HEIGHT	
101	ENTRY	QT	QT	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	SUSPENDED ACOUST TILE	9'-0"	RUBBER STAIR TREADS & RISERS
102	TURN-OUT	SEALED CONC	VINYL	PTD GYP BD/ GLAZED BLK	PTD GYP BD/ GLAZED BLK	PTD GYP BD/ GLAZED BLK	PTD GYP BD/ GLAZED BLK	SUSP VINYL FACED TILE	8'-0"	
103	GENERATOR	↓	↓	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD 2 LAYERS	16'-3"±	SOUND ATTENUATION BLANKETS ALL WALLS & CEILING SEE [illegible]
104	AMBULANCE STORAGE			↓	↓	↓	↓	—	—	
105	STORAGE		↓					—	—	
106	APPARATUS		—	PTD CONC/ PTD GYP BD	GLAZED BLK/ PTD GYP BD	PTD CONC/ PTD GYP BD	GLAZED BLK/ PTD GYP BD	SUSPENDED VINYL FACED TILE	16'-0"	SEE INTERIOR ELEVATIONS FOR HEIGHT OF GLAZED BLK
107	STORAGE		—	GLAZED BLK	—	GLAZED BLK	GLAZED BLK	↓	8'-0"	
108	BREATHING APPARATUS	↓	VINYL	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	—	—	
109	-OMIT-									
110	STORAGE	SEALED CONC	VINYL	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	SUSP VINYL FACED TILE	8'-0"	
111	HOSE STORAGE		—	GLAZED BLK	—	GLAZED BLK	GLAZED BLK	↓	8'-0"	
112	CMS & WATER		VINYL	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	—	—	
113	ELECTRICAL							—	—	
114	STORAGE/WORKSHOP	↓						SUSP VINYL FACED TILE	8'-0"	
115	DISPATCH	SHEET VINYL						SUSPENDED ACOUST TILE	9'-0"	
116	CLOSET	"								
117	DISPATCH BUNK	CARPET								
118	CLOSET									
119	OFFICE									
120	CONFERENCE	↓	↓	↓	↓	↓	↓	↓	↓	
121	ENTRY	SHEET VINYL	VINYL	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	SUSPENDED ACOUST TILE	9'-0"	RUBBER TREADS FINISH
122	CHIEF'S SECRETARY	CARPET					—			
123	CHIEF'S OFFICE						PTD GYP BD			
124	CLOSET									
125	CLOSET			↓					↓	
126	KITCHENETTE			—					8'-0"	
127	OFFICE	↓		PTD GYP BD					9'-0"	
128	STORAGE	SHEET VINYL								
129	HOT WATER HEATER	SEALED CONC								
130	TELEPHONE	SHEET VINYL								
131	CLERICAL/FILER	CARPET	↓	↓	↓	↓	↓		↓	
132	TOILET	CT	CT	CT WAINSCOT/ PTD GYP BD	CT WAINSCOT/ PTD GYP BD	CT WAINSCOT/ PTD GYP BD	CT WAINSCOT/ PTD GYP BD		8'-0"	4'-0" HIGH WAINSCOT/ MOIST. RESIST GYP WALL BD
133	TOILET			"	"	"	"			
134	JANITOR'S CLOSET	↓	↓	CT WAINSCOT/ PTD GYP BD	CT WAINSCOT/ PTD GYP BD	CT WAINSCOT/ PTD GYP BD	CT WAINSCOT/ PTD GYP BD		↓	↓
135	WAITING	CARPET	VINYL	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	↓	9'-0"	
136	EMERG. ELEC. ROOM	SEALED CONC	"	↓	↓	↓	↓	PTD GYP BD	18'-2¾"	
137	VESTIBULE	QT	QT	↓	↓	↓	↓	SUSPENDED ACOUST TILE	9'-0"	

🟨 Window Weatherization

the carell group
202 washington street
brookline, massachusetts

GENERAL NOTES
1) SEE SHT A-9 FOR PARTITION TYPE SCHEDULE
2) SEE SHT A-11 FOR INTERIOR ELEVATIONS
3) SEE SHEET A-1 FOR ENLARGED TOILET ROOM & STAIR PLANS
4) ALL PARTITIONS TYPE /1\ UNLESS OTHERWISE NOTED

Sudbury Fire Headquarters

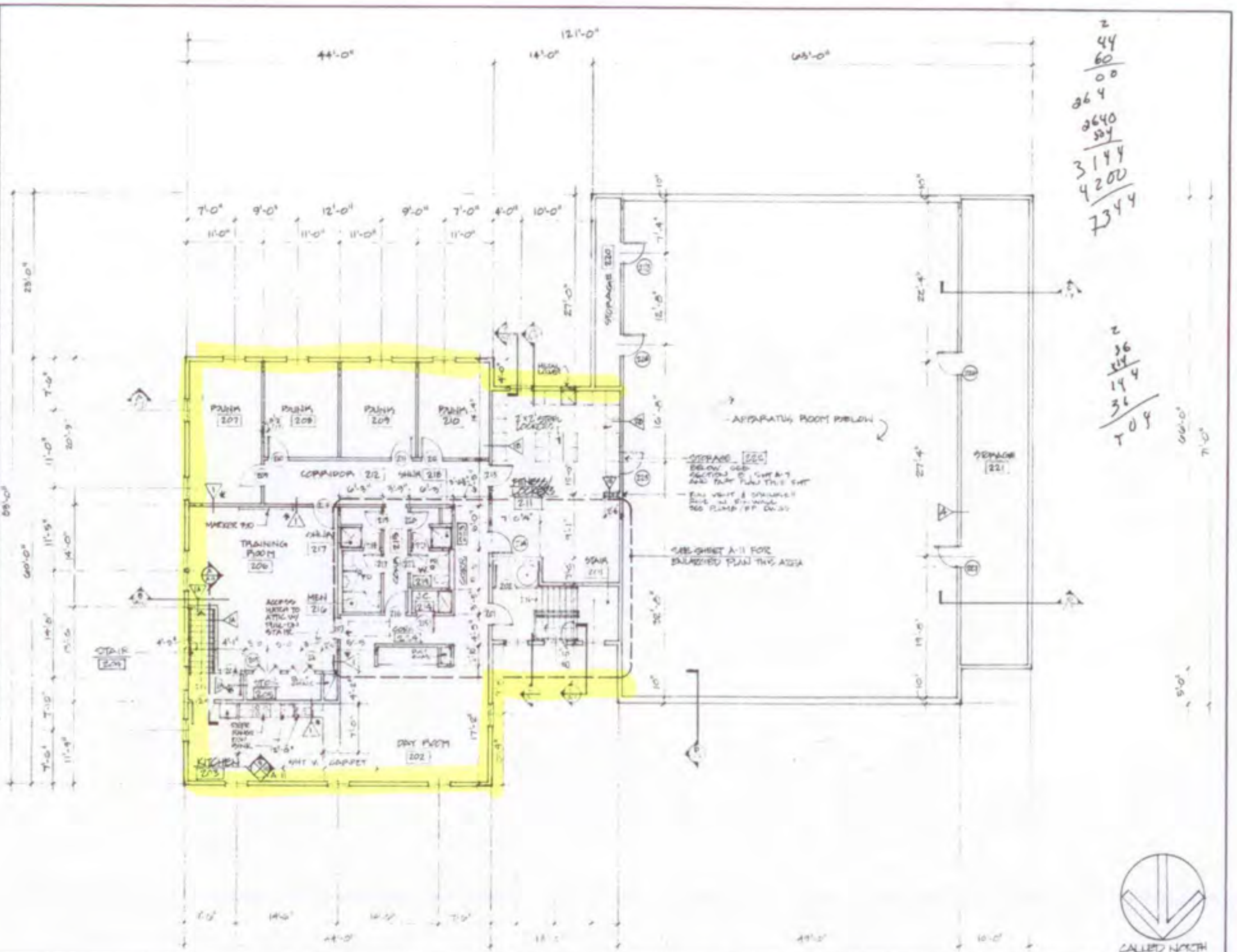
Sudbury, MA

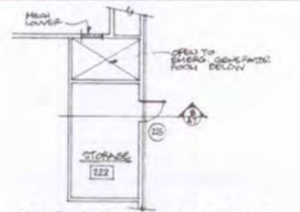
FIRST FLOOR PLAN, DOOR SCHEDULE & ROOM FINISH SCHEDULE

scale 1/8" = 1'-0"
date 2/11/91
drawn by KC
job no
sheet A-2

DOOR SCHEDULE

DOOR					FRAME			HARDWARE	REMARKS
NO.	SIZE	TYPE	MAT'L	LBL	TYPE	MAT'L	LBL		
201	3'X7'X1 3/4"	B	WD	C	1	HM	C	14	KICKPLATE
202	9'x5'	—	—	—	—	—	—	LATCH	TYPICAL GATE / SEE TYP. SHEET A-11
203	3'X7'X1 3/4"	B	WD	C	1	HM	C	2	
204	"	B		C			C	2	
205	4'X7'X1 3/8" PR	C						PULLS	BI-FOLD
206	"	C						PULLS	"
207	3'X7'X1 3/4"	B						10	
208	↓	B						10	
209		A						10	
210								10	
211								10	
212								10	
213								4	
214								4	
215	2'6"X7'X1 3/4"							10	UNDERCUT DOOR, MARBLE THRESHOLD
216	2'6"X7'X1 3/4"							15	
217	2'6"X7'X1 3/4"							15	MARBLE THRESHOLD UNDERCUT DOOR
218	2'X7'X1 3/4"							3	UNDER-CUT DOOR
219	2'6"X7'X1 3/4"							3	MARBLE THRESHOLD, UNDERCUT DOOR
220	"							3	" " "
221	2'6"X7'X1 3/4"							3	UNDER CUT DOOR
222	2'6"X7'X1 3/4"							3	MARBLE THRESHOLD, UNDERCUT DOOR
223	3'X5'X1 3/4"							10	
224	↓							10	
225								10	
226								10	
227	↓	↓	↓		↓	↓		10	





PART PLAN - STORAGE ABOVE TURNOUT

ROOM FINISH SCHEDULE

NO.	NAME	FLOOR		WALLS				CEILING		REMARKS
		MAT'L	BASE	NORTH	EAST	SOUTH	WEST	MAT'L	HEIGHT	
201	STAIR	SHEET VINYL	VINYL	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	SUSPENDED ACOUST TILE	8'-0"	RUBBER TREADS & RISERS
202	DAY ROOM	CARPET	↓	↓	↓	↓	↓	↓	8'-6"	
203	KITCHEN	SHEET VINYL							↓	MOIST RESIST PLASTIC FACE ACT CLG
204	STAIR	"								RUBBER TREADS & RISERS
205	STORAGE	CARPET							8'-0"	
206	TRAINING	↓							8'-6"	
207	BUNK									
208	BUNK									
209	BUNK									
210	BUNK								↓	
211	FITNESS/LOCKERS								8'-0"	PROVIDE & INSTALL (21) STEEL LOCKERS
212	CORRIDOR	↓	↓	↓	↓	↓	↓	↓	8'-6"	
213	— OMIT —									
214	JAN. CLOSET	CT	CT	PTD GYP BD CT	PTD GYP BD CT	PTD GYP BD CT	PTD GYP BD CT	SUSPENDED ACOUST TILE	8'-0"	CT WAINSCOT 4'-0" AFF ON MOIST RESIST GYP BD
215	CORRIDOR	CT	CT	PTD GYP BD	PTD GYP BD	PTD GYP BD	PTD GYP BD	"	8'-0"	
216	MEN	CT	CT	PTD GYP BD CT	PTD GYP BD CT	PTD GYP BD CT	PTD GYP BD CT	[illegible]	8'-0"	CT WAINSCOT 4'-0" AFF ON MOIST RESIST GYP BD
217	SHOWER	↓	↓	↓	↓	↓	↓	↓		" " 6'-0" " " " " "
218	SHOWER									" " 6'-0" " " " " "
219	WOMEN	↓	↓	↓	↓	↓	↓	↓	↓	" " 4'-0" " " " " "
220	STORAGE	EXP. WD	—	GYP BD	GYP BD	GYP BD	GYP BD	—	—	
221	STORAGE	EXP WD	—	GYP BD	GYP BD	GYP BD	GYP BD	—	—	
222	STORAGE	"	"	"	"	"	"	GWB		SEE SECTION 13 SHT A-7
223	CORRIDOR	CPT	VINYL	PTD GWB	PTD GWB	PTD GWB	PTD GWB	SUSP ACT	8'-6"	
224	CORRIDOR	"	"	"	"	"	"	"	"	

the carell group

202 washington street
brookline, massachusetts

GENERAL NOTES:

1. SEE ENLARGED PLANS OF TOILET AREA & STAIRS ON DWG A-11
2. SEE SHEET A-11 FOR INTERIOR ELEVATIONS
3. SEE SHEET A-5 FOR PARTN TYPES
4. ALL PARTNS ARE TYPE 1 UNLESS OTHERWISE NOTED
5. PITCH FLOORS TO FLOOR DRAIN TYPICAL

Sudbury Fire Headquarters

Sudbury, MA

SECOND FLOOR PLAN
DOOR SCHEDULE &
ROOM FINISH SCHEDULE

scale 1/8"=1'-0"
date 2/11/91
drawn by KC LP
job no
sheet A·3

2. FIRE STATION 3

ASSESSMENT FINDINGS

B|E Retrofit recommends a strategy in Fire Stations that isolates the office / living spaces from the garage as best and as consistent with the use of the building as possible, improves weaknesses in the envelope of the office / living spaces (as with any other style of building) and does not spend dollars on the envelope of the garage. We believe that this strategy aligns best with the realities of the use of a fire station.

- Compartmentalization
  - Entry Doors – the doors that isolate the garage from the office space and the break room are not weather stripped effectively. The office space has different interior environmental needs than the garage and the spaces should be separated. The existing weather stripping is not properly isolating these spaces.

WEATHERIZATION RECOMMENDATIONS

- ➢ Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale behind a recommended measure, the installation process and the materials used to complete each measure recommended for the building.
- ➢ For specifications that vary from the Installation Factsheets or where measures do not have Installation Factsheets notes are included at the square bullets.
- ➢ Highlighted floor plans are not provided for this building.

Air Leakage Control Measures

- Door Weather Stripping

2. HAYNES ELEMENTARY SCHOOL

ASSESSMENT FINDINGS

- See pictures on the following pages for visual support of the text below.

  - Attics/Roofs
    - Roof-Wall Intersection – the roof-wall intersection is hidden by a drywall “boxed-in” soffit at the perimeter of the majority of the building. This “box” hides services and the sprinkler system. There are vent plugs in each of these drywall boxes to allow air to flow into these cavities from the heated spaces of the building. If this system was developed to avoid frozen pipes at the perimeter of the building, there are likely substantial weaknesses at the roof-wall intersection. A measure related to this potential weakness is not included in the report at this point; the potential measure would include disruption of the drywall surface and repair.

  - Doors
    - Entry Doors – the weather stripping on the entry doors is performing effectively at the majority of the door systems. There is one double door with no existing weather stripping and air leakage is clear at the bottom of a number of door systems throughout the building. The single door systems in the classrooms are allowing infiltration at the perimeter of the door system due to missing sealant at the casing joints.

  - Windows
    - All Window Systems – sealant is missing at the casing joints of the window systems throughout the building. There is a gap between the window stop and the window frame that allows air to leak around the window system and the rough opening in the wall, through the stop-frame gap and into the building. There is a second gap between the window stop and the wall structure at the classroom window systems that is allowing infiltration/exfiltration.

WEATHERIZATION RECOMMENDATIONS

- Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale behind a recommended measure, the installation process and the materials used to complete each measure recommended for the building.

2. HAYNES ELEMENTARY SCHOOL

- For specifications that vary from the Installation Factsheets or where measures do not have Installation Factsheets notes are included at the square bullets.
- Highlighted floor plans provide the locations for installation.

Air Leakage Control Measures

- Door Weather Stripping
  - Full door weather stripping is not recommended at most door systems in the building. Weather stripping components to be installed at each door system are specified in the highlighted floor plans.

- Door and Window Caulking

2. HAYNES ELEMENTARY SCHOOL

Doors – air leakage shown by smoke tracer testing at double door system.

Doors – air leakage shown at single door system at the base of the door.

Doors – air leakage shown by smoke tracer testing at the perimeter casing of the door system.

Doors – gaps at the perimeter casing where sealant was not installed. Accumulation of cob webs is an indicator of excessive air leakage.

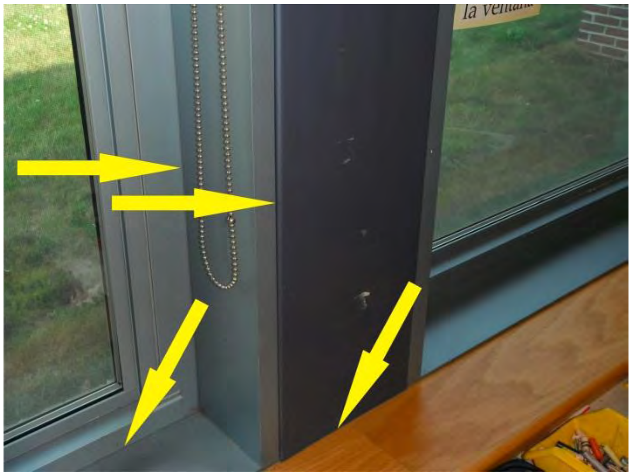
Doors – arrows point to locations of missing sealant and air leakage pathways at the perimeter casing of the door system.

2. HAYNES ELEMENTARY SCHOOL

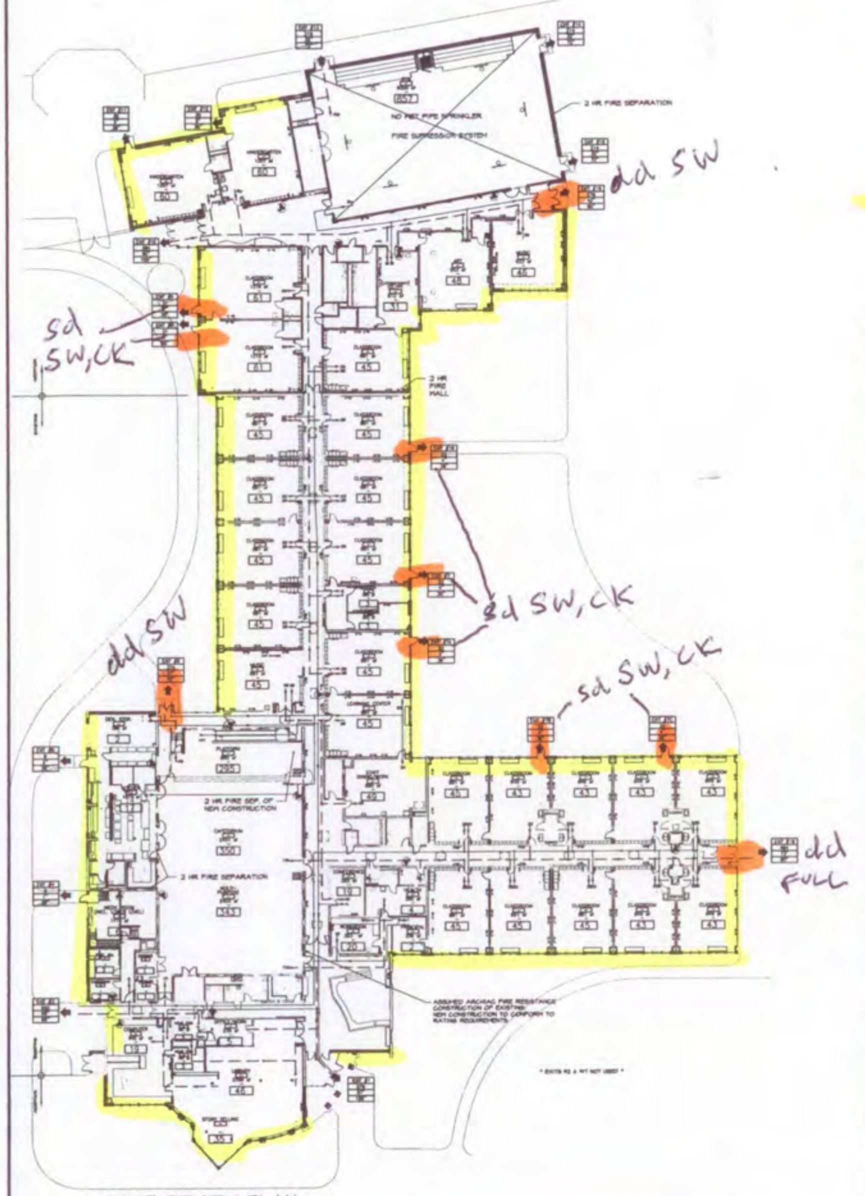
Windows – air leakage shown by smoke tracer testing at window stop-frame joint.

Windows – air leakage shown by smoke tracer testing at window casing-wall joint.

Windows – sealant missing at gap between the window frame and the stop.



Doors – arrows point to locations of missing sealant and air leakage pathways at the perimeter casing of the window system.



CODE REVIEW PLAN

Door Weather Stripping
sd - single door, dd - double door
Full - full weather strip, SW - sweep
CK - caulk

Window Caulking

SUMMARY		ACTUAL AREA	ALLOW. INCREASE TABLE 505	ALLOW. AREA TABLE 505
EXISTING BUILDING-		41,366 SF		
"E" - EDUCATIONAL USE GROUP "ASSEMBLY USE" AREAS CAFETORIUM & MULTI-PURPOSE 2 HR FIRE SEPARATION				
CONSTRUCTION TYPE - TYPE 5B				
ACCESSIBLE PERIMETER - 41%			81 %	
FIRE SUPPRESSION SYSTEM - WET PIPE SPRINKLER THROUGHOUT			200 %	
EXTERIOR WALLS-				
NON-BEARING WALL RATING	0 HR. REQ'D			
LOADBEARING WALL RATING	2 HR. REQ'D			
FIRE WALLS-	2 HR. REQ'D			
FIRE SEPARATION ASSEMBLIES-				
ENCLOSURE OF EXITS	-			
SHAFTS/ELEVATORS	-			
MIXED USE/FIRE AREAS	2 HR. REQ'D			
OTHER SEPARATION ASSEMBLIES	-			
SMOKE PARTITIONS				
EXIT ACCESS CORRIDORS(TABLE 1011.4)	0 HR. REQ'D			
LIBRARY ADDITION		2,000 SF		
TOTAL		43,366 SF	331 %	47,844 SF
MAIN ADDITION-		18,300 SF		
"A3" - ASSEMBLY (2HR FIRE WALL AT EXISTING)				
CONSTRUCTION TYPE - TYPE 2C				
ACCESSIBLE PERIMETER - 88%			126 %	
FIRE SUPPRESSION SYSTEM - WET PIPE SPRINKLER THROUGHOUT **			200 %	
EXTERIOR WALLS-				
NON-BEARING WALL RATING	0 HR. REQ'D			
LOADBEARING WALL RATING	0 HR. REQ'D			
FIRE WALLS-	2 HR. REQ'D			
FIRE SEPARATION ASSEMBLIES-				
ENCLOSURE OF EXISTS	-			
SHAFTS/ELEVATORS	-			
MIXED USE/FIRE AREAS	2 HR. REQ'D			
OTHER SEPARATION ASSEMBLIES	-			
SMOKE PARTITIONS				
EXIT ACCESS CORRIDORS(TABLE 1011.4)	0 HR. REQ'D			
TOTAL		18,300 SF	326 %	21,864 SF

** WET PIPE SPRINKLER SYSTEM OMITTED FROM GYM - ALTERNATE MEANS PROVIDED - SEE TDPC 5 JAN'98 LETTER

HAYNES ELEMENTARY SCHOOL, SUDBURY, MA
Required Plumbing Fixtures (Based On Actual Occupancy)

		* No. of Students	Girls WC	Boys WC	UNISEX WC	Urinals	Girls Lavs	Boys Lavs	UNISEX Lavs	Drnkg Ftns***
Students	ELEMENTARY (1-5 Grade)	441	7	4	0	4	4	4	0	8
	TOTAL		7	4	0	4	4	4	0	8
		No. of Users	Women's WC	Men's WC/UR	UNISEX WC	Urinals	Women's Lav	Men's Lav	UNISEX Lavs	Drnkg Ftns***
Staff	Staff Teachers	33	1	1	0	0	1	1	0	0
	Staff Kitchen	4	0	0	1	0	0	0	1	0
	TOTAL		1	1	1	0	1	1	1	0
Cafetorium/ Multi-purpose Use	Gymnasium	**								
	Multi-purpose (Cafetorium)	**								

* BASED ON MAXIMUM PROJECTED ENROLLMENT OF 441 GRADE 1-5
KINDERGARTENS HAVE THEIR OWN TOILET ROOMS & BUBBLERS
** INCLUDED IN STUDENT AND STAFF FIGURES
*** INCLUDES STAFF FIGURES
**** PROVIDE MINIMUM OF 1 UNISEX TOILET

REQUIREMENTS		
GRADES 1-5	Girls	1WC / 50, 1LAV / 60
	Boys	1WC / 60, UR / 60, 1LAV / 60
STAFF	Women	1 WC / 20, 1 LAV / 40
	Men	1 WC / 25, 50% UR, 1 LAV / 40
GYM	Women	1 WC / 300 SEATS, 1 LAV / 300
	Men	1 WC / 600 SEATS, 1 UR/200 SEATS, 1 LAV / 300
KITCHEN EMPLOYEES	Women	1 WC / 20, 1 LAV / 40
	Men	1 WC / 25, 50% UR, 1 LAV / 40
DRINKING FOUNTAINS		1 DF / 75

LEGEND OF SYMBOLS

EXIT NUMBER
NUMBER OF OCCUPANTS EXITING
EGRESS WIDTH REQ'D (inches per person .15")
EGRESS WIDTH PROVIDED IN INCHES

ROOM NAME
NET SQUARE FOOTAGE OF ROOM
OCCUPANTS PER ROOM

PROPOSED FIRE EXTINGUISHERS LOCATIONS

EXISTING HANDICAP RAMP

EGRESS PATH EXIT

EGRESS PATH DIRECTIONS

NO. OF OCC. ENTERING THIS EGRESS PATH

2 HR FIRE SEPARATION WALL
INCLUDES EXISTING CONSTRUCTION

2 HR FIRE WALL

TABLE 1008.1.2 MAX. FLR. AREA ALLOW. PER OCC.

USE	FL. AREA/OCC.
CLASSROOMS, ART, LEARN CENTER, MUSIC	20 s.f.
LIBRARY, COMPUTER, HEAD END	50 s.f.
TEACH, DINING, CONF.	30 s.f.
GYM, CAFETERIUM, MULTI-PURPOSE	7 s.f.
ADMIN. AREAS, HEALTH, KITCHEN, GUID.	100 s.f.
STORAGE	300 s.f.
PLATFORM	5 s.f.

TABLE 1006.5 LENGTH OF EXIT ACCESS TRAVEL

USE GROUP "E" & "A-3"
WITH FIRE SUPPRESSION SYSTEM
250'-0" MAX. PROVIDED

BOCA MECHANICAL CODE 1993
TABLE M-1604.3 REQUIRED MECHANICAL VENTILATION AIR

SPACE	RATE	RATE
CLASSROOMS	40 OCCUP. @ 15 CFM EA. =	600 CFM
MUSIC ROOM	47 OCCUP. @ 15 CFM EA. =	700 CFM
KINDERGARTEN	40 OCCUP. @ 15 CFM EA. =	600 CFM
GYM	200 OCCUP @ 20 CFM EA =	4000 CFM
CAFETORIUM	267 OCCUP. @ 15 CFM EA. =	4000 CFM
ADMIN	20 OCCUP. @ 20 CFM EA. =	400 CFM
MEDIA ROOM	40 OCCUP. @ 20 CFM EA. =	800 CFM

The Design
Partnership
of
Cambridge
Inc
TDPC
Architecture
Programming
Master Planning
Interior Design
[illegible] Street Cambridge, MA 02140 Tel.617/492-2500

HAYNES ELEMENTARY SCHOOL
SUDBURY, MA

Drawn By: KSL/JPWB
Checked By: MH
Scale: AS NOTED
Date: 20 JANUARY, 1998
Professional Seal

CODE STUDY

A0.1

ECM 22:
Pipe Insulation

ECM Overview

Ameresco proposes to insulate hot water piping at the Fire Station North and Fire Station South where insulation is absent or insufficient. The areas that lack insulation include the boiler header and hot water supply piping. Replacing insufficient insulation and insulating bare pipes will improve the overall efficiency of each system and alleviate over heating due to heat loss from exposed piping. Cost savings from the reduction of natural gas usage will result from the implementation of this measure.

Figure 22.1: Existing bare pipe at Fire Station North and Fire Station South will be insulated. Pictured above is the boiler at Fire Station North.

ECM Detail

Existing System

The hot water distribution systems at Fire Station North and Fire Station South have insufficient insulation. Much of the main hot water piping lacks proper insulation on the boilers as well as the supply piping branches. The lack of piping insulation allows unnecessary heat loss in the unoccupied boiler rooms.

Proposed System

Ameresco proposes to install a total of 140 linear feet of insulation throughout the Town. The proposed insulation will be a fibrous glass type with a factory applied fire retardant vapor barrier jacket. The insulation will have a K-factor of at least 0.23 at 75°F mean temperature. Typical manufacturers include Owens-Corning, Certain-Teed, Manville or Knauf.

Please refer to the following table for approximate pipe lengths to receive new pipe insulation.

Building	Item (OD, in.)	Insulation Thickness (in.)	Length (ft.)
Fire Dept South	¾”-1”	1	65
Fire Dept North	¾”-1”	1	75
Total			**140**

Ameresco has not included a cost for any asbestos abatement under this measure. Based on site visits, asbestos is not expected in the areas where insulation will be added. Scope of work excludes repair of piping, valves, etc.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect “As-Built” conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The new insulation will significantly reduce distribution heat losses and improve heating system efficiency.

Appendix for ECM 22: Pipe Insulation

I. Energy Savings Calculations

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MAPC - Sudbury	
Energy and Demand Savings Summary	
Measure ID:	**22**
Measure Name:	**Pipe Insulation**
Measure Location:	
Engineers:	

Site Name:		**Fire_S**	**Fire_N**	**Summary**
Item	Units	Savings	Savings	
Electricity				
Energy On-Peak	kWh			0
Energy Off-Peak	kWh			0
Energy Total	kWh	0	0	0
Demand On-Peak, Monthly	kW			0.0
Demand On-Peak, Annual	kW			0.0
Demand Off-Peak, Monthly	kW			0.0
Demand Off-Peak, Annual	kW			0.0
Fossil Fuel				0
Natural Gas (NG)	Therms	181	207	389
Liquid Propane Gas (LPG)	Gallons			0
Steam	Mlbs			0
Fuel Oil, #2	Gallons			0
Fuel Oil, #4	Gallons			0
Fuel Oil, #6	Gallons			0
Miscellaneous	Misc			0
Water				0
Water Savings	kGallons			0
Sewer				0
Sewer Savings	kGallons			0

MAPC - Sudbury

Fire Dept South
Pipe Insulation

	Existing Piping Details												Existing Insulation Details			Proposed Insulation Details					
Location	**Pipe Size (inches)**	**Fluid Type (Water or Steam)**	**Fluid Temperature (°F)**	**Heating Hours**	**Fluid Velocity (ft/s)**	**Length (ft)**	**Inside Pipe Diameter (inches)**	**Outside Pipe Diameter (inches)**	**Piping Emissivity**	**Pipe Conductivity (Btu/hr-ft-°F)**	**Cold Fluid Temperature - Air (°F)**	**Cold Fluid Conductivity - Air (Btu/hr-ft2-°F)**	**Insulation Thickness (inches)**	**Insulation Emissivity**	**Insulation Conductivity (Btu/hr-ft-°F)**	**Insulation Thickness (inches)**	**Insulation Emissivity**	**Insulation Conductivity (Btu/hr-ft-°F)**	**Existing Heat Loss (MBtu)**	**Proposed Heat Loss (MBtu)**	**Savings (MBtu)**
[A]	**[B]**	**[C]**	**[D]**	**[E]**	**[F]**	**[G]**	**[H]**	**[I]**	**[J]**	**[K]**	**[L]**	**[M]**	**[N]**	**[O]**	**[P]**	**[Q]**	**[R]**	**[S]**	**[T]**	**[U]**	**[V]**
Boiler Main Distribution	0.75	Water	180.0	6,229	5.0	50.0	0.82	1.05	0.65	227.0	70.0	1.00	0.0	0.93	0.0225	1.0	0.93	0.0225	22,887	9,930	12,957
Boiler Room	1	Water	180.0	6,229	5.0	15.0	1.05	1.32	0.65	227.0	70.0	1.00	0.0	0.93	0.0225	1.0	0.93	0.0225	8,599	3,410	5,189
Totals						**65.0**													**31,485**	**13,340**	**18,145**

Cell Ref.	**Comment**
A	Location of Pipe
B - K	Piping properties
L - M	Cold fluid properties, typically air
N - P	Existing insulation details
Q - S	Proposed insulation details
T	= (Existing Transmission + Radiation Heat Loss) x [col E] ÷ [P65] ÷ 1,000
U	= (Proposed Transmission + Radiation Heat Loss) x [col E] ÷ [P65] ÷ 1,000
V	= [col T] - [col U]

Item	**Value**	**Units**	**Cell Ref**	**Remarks**
Heating System Efficiency	78.0%		**[P65]**	From Baseline

MAPC - Sudbury
Fire Dept North
Pipe Insulation

AMERESCO

	Existing Piping Details												Existing Insulation Details			Proposed Insulation Details					
Location	**Pipe Size (inches)**	**Fluid Type (Water or Steam)**	**Fluid Temperature (°F)**	**Heating Hours**	**Fluid Velocity (ft/s)**	**Length (ft)**	**Inside Pipe Diameter (inches)**	**Outside Pipe Diameter (inches)**	**Piping Emissivity**	**Pipe Conductivity (Btu/hr-ft-°F)**	**Cold Fluid Temperature - Air (°F)**	**Cold Fluid Conductivity - Air (Btu/hr-ft2-°F)**	**Insulation Thickness (inches)**	**Insulation Emissivity**	**Insulation Conductivity (Btu/hr-ft-°F)**	**Insulation Thickness (inches)**	**Insulation Emissivity**	**Insulation Conductivity (Btu/hr-ft-°F)**	**Existing Heat Loss (MBtu)**	**Proposed Heat Loss (MBtu)**	**Savings (MBtu)**
[A]	**[B]**	**[C]**	**[D]**	**[E]**	**[F]**	**[G]**	**[H]**	**[I]**	**[J]**	**[K]**	**[L]**	**[M]**	**[N]**	**[O]**	**[P]**	**[Q]**	**[R]**	**[S]**	**[T]**	**[U]**	**[V]**
Boiler Main Distribution	0.75	Water	180.0	6,229	5.0	60.0	0.82	1.05	0.65	227.0	70.0	1.00	0.0	0.93	0.0225	1.0	0.93	0.0225	27,464	11,916	15,548
Boiler Room	1	Water	180.0	6,229	5.0	15.0	1.05	1.32	0.65	227.0	70.0	1.00	0.0	0.93	0.0225	1.0	0.93	0.0225	8,599	3,410	5,189
Totals						**75.0**													**36,063**	**15,326**	**20,737**

Cell Ref.	**Comment**
A	Location of Pipe
B - K	Piping properties
L - M	Cold fluid properties, typically air
N - P	Existing insulation details
Q - S	Proposed insulation details
T	= (Existing Transmission + Radiation Heat Loss) x [col E] ÷ [P65] ÷ 1,000
U	= (Proposed Transmission + Radiation Heat Loss) x [col E] ÷ [P65] ÷ 1,000
V	= [col T] - [col U]

Item	**Value**	**Units**	**Cell Ref**	**Remarks**
Heating System Efficiency	78.0%		**[P65]**	From Baseline

Appendix for ECM 22: Pipe Insulation

II. Manufacturer Specification Sheets

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Submittal Sheet

Fiberglas® Pipe Insulation

- ☐ **SSL II® All-Service Jacket (ASJ), Self-Sealing Lap**
- ☐ **SSL® I ASJ**
- ☐ **No-Wrap**

Description

Owens Corning Fiberglas® pipe insulations are molded of heavy density resin bonded inorganic glass fibers. These one-piece, 36" (914mm) long, hinged sections are opened, placed over the pipe, closed and secured by means specific to the type as described below.

Fiberglas SSL II® Pipe Insulation is jacketed with a smooth, reinforced, wrinkle-resistant all-service (ASJ) vapor retarder jacket. Factory applied DOUBLESURE† double pressure sensitive adhesive closure provides positive mechanical and vapor sealing of the longitudinal jacket seam. Pressure sensitive butt strip seals complete the positive closure. Available in the most popular sizes.

In larger sizes *Fiberglas* Pipe Insulation is furnished with SSL® I, a single adhesive lap seal.

Fiberglas "No-Wrap" Pipe Insulation is also available without a jacket. It is intended for field installation of jacketing appropriate to the vapor control, damage or corrosion resistance requirements of the application.

Uses

Insulation of hot, cold, concealed and exposed piping operating at temperatures from 0°F (-18°C) to 850°F (454°C) in commercial buildings, industrial facilities and process or power plants.

Features/Benefits

SSL II Positive Closure System

Effective long-term vapor sealing of both longitudinal and butt joints. With double-adhesive lap seal, plus two-part butt strip seal, positive closure is fast, neat and foolproof. No need for staples and mastic, promoting unexcelled jobsite productivity.

Jacket and Lap Shipped Adhered

Short pieces of insulation can be cut without jacket loss; it won't come apart in handling. No "dog-ears" in or out of the carton. Dust and moisture can't reach the seal. Butt strips come in sealed bags inside the carton, staying clean until the moment of use.

Excellent Thermal Performance

Fiberglas Pipe Insulation's low thermal conductivity contributes to lower operating costs of heating and cooling equipment.

Meets Model Code Fire Ratings

Flame spread rating of 25 or less, and smoke developed rating of 50 or less, usually means that *Fiberglas* Pipe Insulation will be granted immediate building code approval.

Availability

Fiberglas Pipe Insulations are available in thicknesses and for pipe sizes as follows:

Insulation Thickness,		Nominal Pipe Sizes, NPS, in. (DN, mm)					
in.	(mm)	SSL II Pipe Insulation		SSL I* Pipe Insulation*		No-Wrap** Pipe Insulation**	
½	(13)	½-6	(15-150)			½-6	(15-150)
1	(25)	½-15	(15-375)	16-33	(400-825)	½-33	(15-825)
1½	(38)	½-14	(15-350)	15-33	(375-825)	½-33	(15-825)
2	(51)	½-12	(15-300)	14-33	(350-825)	½-33	(15-825)
2½	(64)	2-11	(50-275)	12-26	(300-650)	½-32	(15-800)
3	(76)	3-10	(75-250)	11-26, 30	(275-650, 750)	½-31	(15-900)
3½	(89)	4½-9	(115-225)	10-18, 20-22, 24	(250-450, 500-550, 600)	½-30	(15-750)
4	(102)	4½-8	(115-200)	9-21, 24, 25	(225-525, 600, 625)	½-29	(15-725)
4½	(114)	6-7	(150-175)	8-10, 12, 14, 16, 18, 20, 24	(200-250, 300, 350, 400, 450, 500, 600)	½-28	(15-700)
5	(127)	6	(150)	7-14, 16-24	(175-350, 400-600)	½-27	(15-675)
5½	(140)					6-26	(150-650)
6	(152)					6-25	(150-625)

* SSL I all made-to-order except 14" x 2" (350mm x 51mm) and 16" x 1", 11/2" and 2" (400mm x 25mm, 38mm and 51mm).

** Consult Packaging Data Supplement (PP1.P5) available upon request for standard and made-to-order sizes.

Specification Compliance

- ASTM C 547, Mineral Fiber Pre-Formed Pipe Insulation, Type I to 850°F (454°C)
- ASTM C 1136, Flexible Low Permeance Vapor Retarders for Thermal Insulation: All Types
- ASTM C 795, Thermal Insulation for Use Over Austenitic Stainless Steel*
- Mil. Spec. MIL-I-22344D, Insulation, Pipe, Thermal, Fibrous Glass
- Nuclear Regulatory Commission Guide 1.36, Non-Metallic Thermal Insulation*
- U.S. Coast Guard Approval No. 164.009, Noncombustible Materials (no-wrap)
- New York City MEA No. 344-83
- CAN/CGSB-51.9 – Type 1, Class 2
- NFPA 90A

* Preproduction qualification testing complete and on file. Chemical analysis of each production lot required for total conformance.

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†DOUBLESURE is a registered trademark of Morgan Adhesives Company.

Fiberglas® Pipe Insulation

Physical Property Data

Property	Test Method	Value	
Operating temperature range	ASTM C 411	0 to 850°F* (-18°C to 454°C)*	
Jacket temperature limitation	ASTM C 1136	-20°F to 150°F (-29°C to 66°C)	
Jacket permeance	ASTM E 96, Proc.A	0.02 perm	
Puncture resistance	ASTM D 781	50 units	
Composite surface burning characteristics	UL 723,** ASTM E 84** or CAN/ULC-S102-M**	Flame spread Smoke developed	25** 50

*Limited to single layer applications above 650°F (343°C), but not greater than 6" (152mm) thickness.

** The surface burning characteristics of these products have been determined in accordance with UL 723, ASTM E 84 or CAN/ULC-S102-M. These standards should be used to measure and describe the properties of materials, products or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use. Values are reported to the nearest 5 rating.

Thermal Performance, ASTM C 680

Insulation NPS x Thk. in.	(DN x Thk. mm)	Pipe Operating Temperature, °F (°C) 300 (149) HL	ST	500 (280) HL	ST	700 (371) HL	ST
2 x ½	(50 x 13)	77 (74)	128 (53)				
4 x 1	(100 x 25)	78 (75)	109 (43)				
8 x 1	(200 x 25)	140 (135)	112 (44)				
12 x 1	(300 x 25)	199 (191)	113 (45)				
2 x 1½	(50 x 38)			88 (85)	116 (47)		
4 x 1½	(100 x 38)			142 (137)	123 (51)		
8 x 1½	(200 x 38)			242 (233)	128 (53)		
12 x 1½	(300 x 38)			330 (317)	129 (54)		
2 x 2	(50 x 51)					139 (134)	127 (53)
4 x 2½	(100 x 64)					188 (181)	125 (52)
8 x 2½	(200 x 64)					295 (284)	129 (54)
12 x 3	(300 x 76)					359 (345)	125 (52)

Heat Loss (HL), Btu/hr•ft (W/m); Surface Temperature (ST), °F (°C).
Design Conditions: Horizontal piping, 80°F (27°C) average ambient temperature, 0 mph wind speed, ASJ jacket.

Thickness to Prevent Surface Condensation

Owens Corning ASJ Jacket for up to 16" NPS (400mm DN)(1), in. (mm)

Ambient Temperature, °F	(°C)	Relative Humidity(2)	System Operating Temperatures 35°F	(2°C)	45°F	(7°C)	55°F	(13°C)
110	(43)	50%-70%	1	(25)	1	(25)	1	(25)
		80%	1½	(38)	1½	(38)	1	(25)
		90%	3½	(89)	3	(76)	2½	(64)
100	(38)	50%-70%	1	(25)	1	(25)	1	(25)
		80%	1½	(38)	1½	(38)	1	(25)
		90%	3	(76)	3	(76)	2½	(64)
90	(32)	50%-70%	1	(25)	1	(25)	1	(25)
		80%	1½	(38)	1	(25)	1	(25)
		90%	3	(76)	2½	(64)	2	(51)
80	(27)	50%-80%	1	(25)	1	(25)	1	(25)
		90%	2½	(64)	2	(51)	1½	(38)
70	(21)	50%-80%	1	(25)	1	(25)	1	(25)
		90%	1½	(38)	1½	(38)	1	(25)

(1) For NPS (DN) greater than 16" (400mm), please contact your local Owens Corning Representative.

(2) If humidity exceeds 90%, some condensation is to be expected; therefore, a coating of a mastic or PVC jacket overwrap is recommended as repeated or continual wetting of the ASJ jacket will degrade its vapor retarder performance.

OWENS CORNING WORLD HEADQUARTERS
ONE OWENS CORNING PARKWAY
TOLEDO, OHIO, USA 43659

1-800-GET-PINK
www.owenscorning.com

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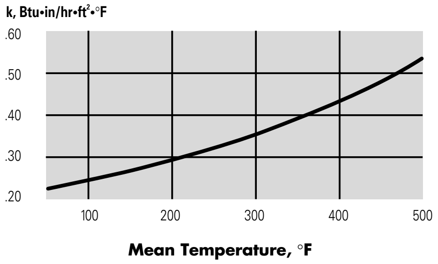
Thermal Conductivity



Apparent thermal conductivity curve determined in accordance with ASTM Practice C 1045 with data obtained by ASTM Test Method C 335. Values are nominal, subject to normal testing and manufacturing tolerances.

Mean Temp. °F	k Btu•in/hr•ft²•°F	Mean Temp. °C	λ W/m•°C
50	0.22	10	0.032
75	0.23	25	0.034
100	0.24	50	0.037
150	0.27	100	0.043
200	0.29	125	0.047
250	0.32	150	0.051
300	0.35	175	0.056
350	0.39	200	0.062
400	0.43	225	0.068
450	0.48	250	0.075
500	0.54	275	0.082

Application Recommendations

The hinged sections of *Fiberglas* Pipe Insulation are opened, placed over the pipe, carefully aligned, and sealed or jacketed as required by the form of the insulation and the application.

Fiberglas SSL II Pipe Insulation is shipped with the jacket and longitudinal lap closed, the two adhesives separated by a release strip. The insulation is opened by pulling the release strip from between the two adhesive strips. The insulation is placed on the pipe, carefully aligned, and the two adhesives rubbed firmly together to close and seal. The two part butt strip seal completes the positive closure. Application may be at ambient temperatures from 25°F (-4°C) to 110°F (43°C).

Fiberglas "No-Wrap" Pipe Insulation is designed for field-jacketing with pipe covering secured by wires or bands, vapor sealed where required.

Outdoor applications must be protected from weather. If painting is required, use only water base latex paint.

ECM 25:
Efficient Shower Heads

ECM Overview

Ameresco proposes to reduce domestic water consumption at the Fairbank Community Center and Fire Department Headquarters by replacing standard flow showerhead fixtures with low flow showerhead fixtures. The low-flow water fixtures will enhance facility operations by reducing water usage.

Figure 25.1: Standard flow showerhead fixtures like the one shown above at the Fire Department Headquarters will be replaced with low consumption models in this measure.

ECM Detail

Existing System

Ameresco identified a number of standard efficiency shower heads at the Fire Department Headquarters and the Fairbank Community Center. There are two (2) standard efficiency shower heads with flow rates of 2.5 GPM located in the second level restrooms at the Fire Department Headquarters. The building is occupied 24/7 and these showers are used by fire department staff at various times of the day. There are twelve (12) standard efficiency shower heads with flow rates of 2.5 GPM located in the girls and boys locker room at the Fairbank Community Center in the pool building wing. These showers are used primarily by visitors using the pool.

Table 25.1 illustrates the quantities of fixtures found throughout the audited facilities.

Building	**Shower heads**
Fire Department Headquarters	2
Fairbank Community Center	12
Totals	**14**

Table 25.1

Proposed System

Ameresco proposes to replace the existing high flow rate shower heads with new low flow rate shower heads at the Fairbank Community Center and Fire Department Headquarters. The existing 2.5 GPM shower heads will be replaced with high efficiency shower heads with a flow rate of 1.5 GPM.

The scope of work for the plumbing installation will include the removal and disposal of the existing fixtures and adding the new fixtures. Scope of work excludes repair, painting, and patching of piping, floors and walls.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect "As-Built" conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The low-flow water fixtures will enhance facility operations by reducing water usage.

Appendix for ECM 25: Efficient Shower Heads

I. Energy Savings Calculations

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MAPC - Sudbury	
Energy and Demand Savings Summary	
Measure ID:	**25**
Measure Name:	**Efficient Showerheads**
Measure Location:	
Engineers:	

Site Name:		**Fairbank**	**FDHQ**	**Summary**
Item	Units	Savings	Savings	
Electricity				
Energy On-Peak	kWh			0
Energy Off-Peak	kWh			0
Energy Total	kWh	0	0	0
Demand On-Peak, Monthly	kW			0.0
Demand On-Peak, Annual	kW			0.0
Demand Off-Peak, Monthly	kW			0.0
Demand Off-Peak, Annual	kW			0.0
Fossil Fuel				0
Natural Gas (NG)	Therms	661	59	720
Liquid Propane Gas (LPG)	Gallons			0
Steam	Mlbs			0
Fuel Oil, #2	Gallons			0
Fuel Oil, #4	Gallons			0
Fuel Oil, #6	Gallons			0
Miscellaneous	Misc			0
Water				0
Water Savings	kGallons	186	14	200
Sewer				0
Sewer Savings	kGallons	186	14	200

MAPC - Sudbury

Efficient Showerheads

Item	Value	Units	Cell Ref	Description	Fairbank	FDHQ
Daily Occupants	110	persons	B5		100	10
Area of occupied facilities	50,396	square feet	B6		40,341	10,055
Occupancy factor	90.0%		B7	estimate	90.0%	90.0%
Occupied days annually	205	days/yr	B8	estimate	345	365
Occupant days	34,335	occupant-days/yr	B9	= B5 x B7 x B8	31,050	3,285
Water Closet Consumption						
Toilet usage rate	1.00	flushes/day/occ.	B12	estimate	1.00	1.00
Existing toilet flow rate	1.64	gal/flush	B13	per site visit & manufacturer's specification	1.60	1.60
Existing annual toilet flow	55	kgallon	B14	= B9 x B12 x B13 / 1000	50	5
Proposed toilet flow rate	1.60	gal/flush	B15	per manufacturer's specification	1.60	1.60
Proposed annual toilet flow	55	kgallon	B16	= B9 x B12 x B15 / 1000	50	5
Urinal Consumption						
Does the Building Contain Urinals?			B19	per site visit	Yes	Yes
Urinal usage rate	1.00	flushes/occ-days	B20	estimate	1.00	2.00
Urinal usage factor	45.0%	estimate	B21	estimate	45.0%	45.0%
Existing urinal flow rate	1.09	gal/flush	B22	per site visit & manufacturer's specification	1.60	1.60
Existing annual urinal flow	27	kgallon	B23	= B9 x B20 x B21 x B22 / 1000	22	5
Proposed urinal flow rate	1.00	gal/flush	B24	per manufacturer's specification	1.60	1.60
Proposed annual urinal flow	27	kgallon	B25	= B9 x B20 x B21 x B24 / 1000	22	5
Lavatory/Sink Consumption						
Lavatory sink usage factor	0.30	min/occ-days	B28	estimate	0.30	0.30
Existing Sink flow rate	2.31	gal/min	B29	per site visit & manufacturer's specification	2.50	2.50
Existing annual Sink flow	26	kgallon	B30	= B9 x B28 x B29 / 1000	23	2
Proposed Sink flow rate	1.00	gal/min	B31	per manufacturer's specification	1.00	1.00
Proposed annual Sink flow	10	kgallon	B32	= B9 x B28 x B31 / 1000	9	1
Shower Consumption						
Shower Usage Factor	6.00	min/occ - day	B35	estimate	6.00	4.29
Existing shower head flow rate	2.50	gal/min	B36	per site visit & manufacturer's specification	2.50	2.50
Existing Shower Usage	501	kgallon	B37	= B35 x B36 x B9 / 1000	466	35
Proposed Shower flow rate	1.50	gal/min	B38	per manufacturer's specification	1.50	1.50
Proposed Shower flow rate	301	kgallon	B39	= B35 x B38 x B9 / 1000	279	21
Kitchen Consumption						
Does the Building Contain Kitchen?			B42	per site visit	Yes	Yes
% Persons eat breakfast	25.0%	persons/resident-day	B43	estimate	25.0%	25.0%
% Persons eat lunch	80.0%	persons/occupant-day	B44	estimate	80.0%	80.0%
% Persons eat dinner	0.0%	persons/resident-day	B45	estimate	0.0%	0.0%
Breakfast Consumption	0.65	gal/breakfast	B46	estimate	0.65	0.20
Lunch Consumption	0.95	gal/lunch	B47	estimate	0.95	0.60
Dinner Consumption	1.00	gal/dinner	B48	estimate	1.00	1.00
Total Meal Consumption	30	kgallon	B49	= ((B46 x B43) + (B48 x B45) + (B47 x B44) x B9) / 1000	29	2
Miscellanous						
Drinking Water	0.06	gal/occupant day	B52	estimate	0.06	0.06
Cleaning	0.01	gal/occupied sq. ft./day	B53	estimate	0.01	0.01
Campus area	0	acres	B54		0.0	0.0
Garden Care	0.15	gal/acre/day	B55	estimate	0.15	0.15
Total Irrigation	0	kgallon	B56	= (B54 x B55 x B8) / 1000	0	0
Vehicle Washing	0	gallon	B57	estimate	0	0
Laboratory Safety Equipment Testing	0	gallon	B58	estimate	0	0
Annual Cooling Load to Tower	0	MMBtu	B59	from EMS calculation	0	0
Cooling Tower Makeup	0	kgallon	B60	= B59 x 1,000,000 x 97% / 970.3 / 8.33 / 1000	0	0
Boiler Makeup	1,580	kgallon	B61	estimate	1,580	0
Total Miscellanoues uses	1,758	kgallon	B62	= ((B52 x B9) + (B53 x B6 x B8) + B57 + B58) / 1000 +B56 + B60 + B61	1,721	37
Laundry						
Load/person	0.00	loads/resident-day	B65	estimate	0.00	0.25
% Occupant's laundry done on site	0.0%	Usage Factor	B66	estimate	0.0%	10.0%
Gal/Load	0.00	gal/load	B67	estimate	0.00	1.00
Annual Use	27	kgallon	B68	= B9 x B7 x B8 x B65 x B66 x B67 / 1000	0	27
Leaks						
% Total Water Use	0.3%		B71	estimate	0.3%	0.3%
Total Loss	7	kgallon	B72	= B71 x	7	0
% of Loss Repaired during retrofits	10.0%		B73	estimate	10.0%	10.0%
Retrofit Water Consumption	7	kgallon	B74	= B72 x (1 - B73)	6	0

Facility Totals

Item	Value	Units	Cell Ref	Description		
Existing Water Usage						
Water Closet Consumption	55	kgallon	B80	= B14	50	5
Urinal Consumption	27	kgallon	B81	= B23	22	5
Lavatory/Sink Consumption	26	kgallon	B82	= B30	23	2
Shower Consumption	501	kgallon	B83	= B37	466	35

MAPC - Sudbury

Efficient Showerheads

Item	Value	Units	Cell Ref	Description	Fairbank	FDHQ
Kitchen Consumption	30	kgallon	B84	= B49	29	2
Miscellanous	1,758	kgallon	B85	= B62	1,721	37
Laundry	27	kgallon	B86	= B68	0	27
Leaks	7	kgallon	B87	= B72	7	0
Total	2,431	kgallon	B88	= B80 + B81 + B82 + B83 + B84 + B85 + B86 + B87	2,318	114
Proposed Water Usage						
Water Closet Consumption	55	kgallon	B91	= B16	50	5
Urinal Consumption	27	kgallon	B92	= B25	22	5
Lavatory/Sink Consumption	10	kgallon	B93	= B32	9	1
Shower Consumption	301	kgallon	B94	= B39	279	21
Kitchen Consumption	30	kgallon	B95	= B49	29	2
Miscellanous	1,758	kgallon	B96	= B62	1,721	37
Laundry	27	kgallon	B97	= B68	0	27
Leaks	7	kgallon	B98	= B74	6	0
Total	2,215	kgallon	B99	= B91 + B92 + B93 + B94 + B95 + B96 + B97 + B98	2,117	98
Water Savings						
Water Closet Consumption	0	kgallon	B102	= B80 - B91	0	0
Urinal Consumption	0	kgallon	B103	= B81 - B92	0	0
Lavatory/Sink Consumption	15	kgallon	B104	= B82 - B93	14	1
Shower Consumption	200	kgallon	B105	= B83 - B94	186	14
Kitchen Consumption	0	kgallon	B106	= B84 - B95	0	0
Miscellanous	0	kgallon	B107	= B85 - B96	0	0
Laundry	0	kgallon	B108	= B86 - B97	0	0
Leaks	1	kgallon	B109	= B87 - B98	1	0
Total	217	kgallon	B110	= B102 + B103 + B104 + B105 + B106 + B107 + B108 + B109	201	16
Thermal Savings						
Thermal Savings (MBTU)	83,458	MBTU	B113	= (B104 x 1 x 8.33 x (B126 - B125)) + (B105 x 1 x 8.33 x (B127 - B125))	77,594	5,864
Heater Efficiency			B114	estimate	95.0%	82.0%
Actual Savings (MBTU)	88,829	MBTU	B115	= B113 / B114	81,678	7,151

Appendix for ECM 25: Efficient Shower Heads

II. Manufacturer Specification Sheets

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Earth® Showerhead

1.5 GPM (5.7 LPM)

- Three spray settings: 9-jet spray, shower and combo
- Pressure compensated water flow

WaterSense℠
Meets EPA Criteria

Certified by
CSA International

WATER

NIAGARA
CONSERVATION®

3 spray settings:
9-jet needle, shower
and combination

Easy turn dial

N2915CH*
Earth® Showerhead

1.5 GPM (5.7 LPM)

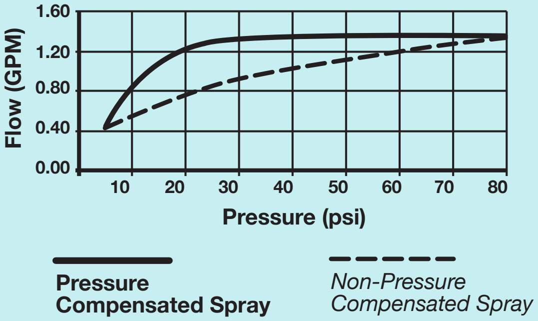
Niagara's Earth® showerheads are a step beyond "low- flow." These high-efficiency showerheads ensure 40% less water use than other low-flow showerheads currently on the market. The patented pressure compensating technology guarantees a feeling of great force while using less water!

- 1.5 gallon per minute flow rate (5.7 litre per minute)
- Niagara's patented non-removable pressure compensator provides a constant output of water regardless of pressure
- Three spray settings: 9-jet power spray, shower and combination
- Non-aerated spray means less temperature loss with maximum energy savings
- Easy installation without tools
- Corrosion-resistant, high-impact ABS thermoplastic body is maintenance-free
- 10-year warranty

Certifications: Meets or exceeds: ASME A112.18.1 / CSA B125.1
WaterSense certified - Max. Flow Rate: 1.5 GPM (5.7 LPM)
Min. Flow Rate at 45PSI: 1.13 GPM (4.3 LPM)

Case Qty: 50

1.5 GPM Flow Rate



Savings

Savings	Water (gallons)	Electric (kWh)	Gas (therms)	Dollars
Electric Water Heater	7,300	949	n/a	$143
Gas Water Heat	7,300	n/a	52	$91

*Savings based on FEMP/DOE data and assuming a water rate of $4/1,000 gallons.

*Also Available in:

White
Item# N2915

NIAGARA
CONSERVATION®

Corporate HQ
4200 Diplomacy Road
Fort Worth, TX 76155 USA
Toll Free: 800.831.8383
Phone: 973.829.0800 Fax: 817.390.0801

For more information please visit:
www.NiagaraConservation.com

REV.06/11

ECM 29:
Replace Transformers

ECM Overview

Ameresco proposes to replace a total of twenty four (24) existing step-down transformers with new energy-efficient transformers at Curtis Middle School and Loring Elementary School. All of the transformers are dry-type indoor transformers that step-down 480 volt power to 208Y/120 volt power. Ameresco proposes to replace these transformers with new premium efficiency units that will reduce the electric losses and lower the cooling load of some of the equipment rooms.

Figure 29.1: Existing standard efficiency transformers like the one pictured above at the Curtis Middle School will be replaced in this measure.

ECM Detail

Existing System

Most transformers in use today in the Town are estimated to be loaded at about 5% - 15% of their total capacity which is typical of other buildings. These loadings are based on spot measurements taken during the audit. These transformers are designed to be able to transform the electricity up to design ratings and are most efficient at or around the design rating. Operating at low levels for normal transformers is inefficient. The standard low voltage step-down transformer is widely considered a commodity and as such the only perceived differentiator is price – lowest purchase cost typically wins. Commercial transformer specifications rarely require a minimum efficiency. As one would expect, building a less efficient transformer is cheaper than building a more efficient one, so a typical low-first-cost transformer will have a low up-front cost but high operating cost, with the lifetime cost of the operating losses exceeding the purchase cost many times over.

The standard transformer is built to deliver its nameplate kVA rating under linear load only and is UL listed on this basis. As it has the lower purchase price on the market, it represents the majority of transformer purchases across the country. Along with the high operating cost goes substantial lost capacity and distortion of the voltage to connected equipment.

Proposed System

The Powersmiths E-SAVER model C3 transformers proposed for this measure are designed to increase efficiency of the electricity transformation. Understanding that efficiency and power quality are complimentary goals, Powersmiths designed its transformers with both in mind. Furthermore, they have been independently validated at Oak Ridge National Lab, a US DOE test facility, to run at 98% efficiency under single-phase nonlinear load profile, a dramatic improvement over traditional transformers. The chart below shows the efficiency and percent loaded an example transformer would have pre- and post-retrofit.

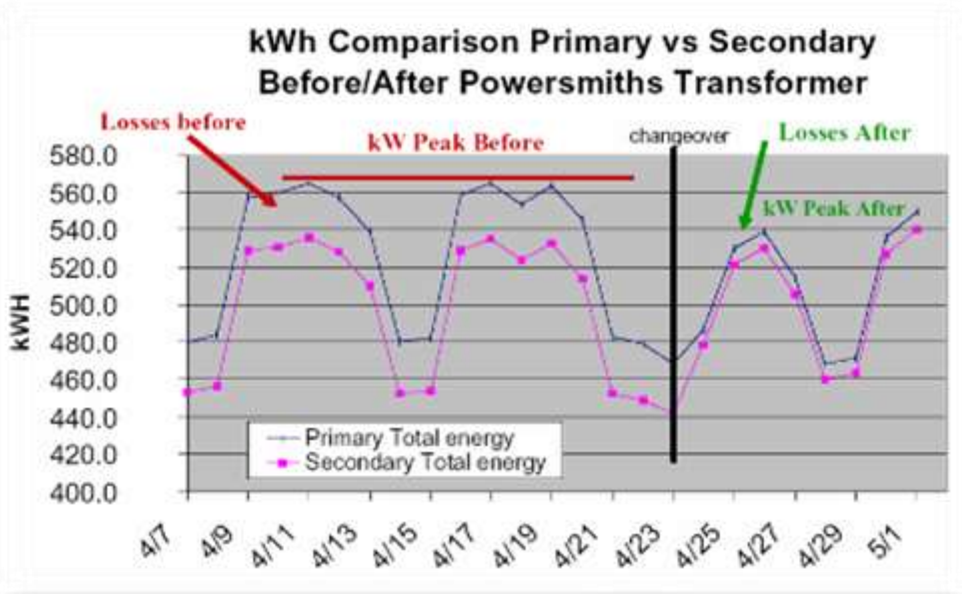


Figure 29.2: Transformer Efficiency Comparison

Twenty-four (24) existing step-down transformers were found throughout the Town of Sudbury that qualify for replacement. All of the transformers identified are dry-type indoor transformers that step-down 480-volt power to 208/120-volt power. Tie-ins to the existing primary and secondary power feeds will be required. Some may require work to meet code which has been included in the cost just in case. Ameresco recommends installing Powersmiths' E-SAVER Model C3 transformers under this ECM. Implementation of this ECM will result in electrical energy and demand savings. The following table lists all transformers recommended for replacement. These transformers measured very low loading.

Building	kVA	Quantity	Occupied % Load	Unoccupied % Load
Curtis Middle School	30	3	10.0	5.0
Curtis Middle School	45	5	10.0	5.0
Curtis Middle School	75	6	10.0	5.0
Curtis Middle School	112.5	1	10.0	5.0
Curtis Middle School	150	2	10.0	5.0
Loring Middle School	30	1	10.0	5.0
Loring Middle School	45	2	10.0	5.0
Loring Middle School	75	4	10.0	5.0
Total		**24**		

Ameresco assumes the installation of this ECM will occur during normal business hours. Ameresco will coordinate with the Town to schedule shutdowns of the affected areas. Transformers that would require after hours installation if done during the normal school year will be scheduled during a school break period.

Installation of the measure will require isolation of each of the affected transformers and the associated distribution panels that are fed by the transformer while the transformer is removed and the new transformer installed. The existing wiring is expected to be reused. Repair of any damaged wiring discovered after removal of the transformers is not included. During the replacement power will be cut to the loads served by the transformers. Some electrical equipment may require a manual reset or testing after power is resumed. Ameresco has not included any allowance for any such resets or testing. Ameresco assumes existing breakers and/or switches will re-energize after the shutdown. No allowance is included for replacements.

Figure 29.3: New energy efficient transformers will be installed in place of existing standard efficiency transformers

Typical installation sequence of the transformers would be as follows:

- Lockout/tagout panel feeding step-down transformer
- Disconnect primary and secondary feeds into transformer
- Remove and dispose of existing transformer, recycling where possible
- Install new transformer on same pad or floor footprint
- Reconnect primary and secondary feeds into transformer

Work excludes repair to existing wiring, breakers, disconnects, fuses, etc., corrections of any existing code violations, and resetting of fire alarm systems, computer systems, and clock systems after shutdown. If existing electrical components are found not to meet code, Ameresco will provide additional pricing for bringing these components up to code standards.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the facilities department for their review and comment. Upon approval, these will constitute the construction documents. Upon completion of the construction phase, the documents will be revised as needed to reflect “As-Built” conditions and submitted in multiple for record.

Impact on Facility Operations and Performance

The new transformers will operate in the same manner as the units they replace. There will be no difference in the power supplied from the transformers. The only difference will be the amount of power lost through the transformation process.

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Appendix for ECM 29: Replace Transformers

I. Energy Savings Calculations

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MAPC - Sudbury	
Energy and Demand Savings Summary	
Measure ID:	**29**
Measure Name:	**Replace Transformers**
Measure Location:	
Engineers:	

Site Name:		**Curtis**	**Loring**	**Summary**
Item	Units	Savings	Savings	
Electricity				
Energy On-Peak	kWh	32,220	11,429	43,650
Energy Off-Peak	kWh	61,351	24,217	85,569
Energy Total	kWh	93,572	35,647	129,218
Demand On-Peak, Monthly	kW	13.5	4.7	18.3
Demand On-Peak, Annual	kW	162.5	56.8	219.3
Demand Off-Peak, Monthly	kW			0.0
Demand Off-Peak, Annual	kW			0.0
Fossil Fuel				0
Natural Gas (NG)	Therms			0
Liquid Propane Gas (LPG)	Gallons			0
Steam	Mlbs			0
Fuel Oil, #2	Gallons			0
Fuel Oil, #4	Gallons			0
Fuel Oil, #6	Gallons			0
Miscellaneous	Misc			0
Water				0
Water Savings	kGallons			0
Sewer				0
Sewer Savings	kGallons			0

MAPC - Sudbury

Curtis Middle School

Replace Transformers

	Existing Transformer Details														Proposed Transformer Details						Savings		
Location	Unit Size (kVA)	Occ. Hours % Load	UnOcc. Hours % Load	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.	Load Power Factor	Existing Occ. Efficiency	Existing UnOcc. Efficiency	Existing Occ. kW Losses	Existing UnOcc. kW Losses	Existing Annual Peak Losses (kWh)	Existing Annual Off-Peak Losses (kWh)	Proposed Occ. Efficiency	Proposed UnOcc. Efficiency	Proposed Occ. kW Losses	Proposed UnOcc. kW Losses	Proposed Annual Peak Losses (kWh)	Proposed Annual Off-Peak Losses (kWh)	Monthly Demand Savings (kW)	Annual Peak Electric Energy Savings (kWh)	Annual Off-Peak Electric Energy Savings (kWh)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Boiler Room	30.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	84.4%	77.7%	0.47	0.37	1,134	2,297	96.7%	94.2%	0.09	0.08	214	495	0.38	920	1,802
Boiler Room	45.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	84.8%	78.4%	0.68	0.53	1,641	3,307	97.2%	95.0%	0.11	0.10	273	636	0.57	1,368	2,670
Main Electric Room	150.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	87.3%	82.4%	1.85	1.36	4,405	8,498	97.9%	96.1%	0.28	0.26	690	1,627	1.57	3,715	6,871
Main Electric Room	75.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	86.3%	80.7%	1.01	0.76	2,427	4,783	97.7%	95.9%	0.15	0.14	371	863	0.86	2,055	3,920
Main Electric Room	75.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	86.3%	80.7%	1.01	0.76	2,427	4,783	97.7%	95.9%	0.15	0.14	371	863	0.86	2,055	3,920
Main Electric Room	45.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	84.8%	78.4%	0.68	0.53	1,641	3,307	97.2%	95.0%	0.11	0.10	273	636	0.57	1,368	2,670
Auditorium Closet	75.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	86.3%	80.7%	1.01	0.76	2,427	4,783	97.7%	95.9%	0.15	0.14	371	863	0.86	2,055	3,920
3rd Floor across from 301	75.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	86.3%	80.7%	1.01	0.76	2,427	4,783	97.7%	95.9%	0.15	0.14	371	863	0.86	2,055	3,920
3rd Floor across from 301	45.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	84.8%	78.4%	0.68	0.53	1,641	3,307	97.2%	95.0%	0.11	0.10	273	636	0.57	1,368	2,670
2nd Floor across from 201	150.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	87.3%	82.4%	1.85	1.36	4,405	8,498	97.9%	96.1%	0.28	0.26	690	1,627	1.57	3,715	6,871
2nd Floor across from 201	75.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	86.3%	80.7%	1.01	0.76	2,427	4,783	97.7%	95.9%	0.15	0.14	371	863	0.86	2,055	3,920
2nd Floor across from 201	30.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	84.4%	77.7%	0.47	0.37	1,134	2,297	96.7%	94.2%	0.09	0.08	214	495	0.38	920	1,802
2nd Floor across from 201	30.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	84.4%	77.7%	0.47	0.37	1,134	2,297	96.7%	94.2%	0.09	0.08	214	495	0.38	920	1,802
Custodian Closet across from 201	112.5	10.0%	5.0%	2,065	435	0	6,260	85.0%	87.2%	82.1%	1.41	1.04	3,363	6,517	97.9%	96.2%	0.20	0.19	504	1,186	1.21	2,859	5,331
Locker Room Hall	45.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	84.8%	78.4%	0.68	0.53	1,641	3,307	97.2%	95.0%	0.11	0.10	273	636	0.57	1,368	2,670
Locker Room Hall	45.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	84.8%	78.4%	0.68	0.53	1,641	3,307	97.2%	95.0%	0.11	0.10	273	636	0.57	1,368	2,670
17. Closet by Main Elec Room	75.0	10.0%	5.0%	2,065	435	0	6,260	85.0%	86.3%	80.7%	1.01	0.76	2,427	4,783	97.7%	95.9%	0.15	0.14	371	863	0.86	2,055	3,920
Totals	**1,177.5**	**10.0%**	**5.0%**								**16.02**	**12.08**	**38,341**	**75,633**			**2.48**	**2.28**	**6,120**	**14,282**	**13.54**	**32,220**	**61,351**

Cell Ref.	Comment
A	Location of Transformer
B	Transformer Nameplate Rating - kVA
C - D	Estimated existing transformer loading as a percent of nameplate rating
E - H	Facility operating hours from EMS calculation
I	Estimated load powerfactor seen at the transformer - output
J	= [col B] x [col D] x 1,000 ÷ ([col B] x [col D] x 1,000 + (standard no load losses) + [col D]^2 x (standard full load losses minus standard no load losses))
K	= [col B] x [col E] x 1,000 ÷ ([col B] x [col E] x 1,000 + (standard no load losses) + [col E]^2 x (standard full load losses minus standard no load losses))
L	= ([col B] x [col D] x [col J] ÷ [col K] - [col B] x [col D] x [col J])
M	= ([col B] x [col E] x [col J] ÷ [col L] - [col B] x [col E] x [col J])
N	= [col M] x [col F] + [col N] x [col G]
O	= [col M] x [col H] + [col N] x [col I]
P	= [col B] x [col D] x 1,000 ÷ ([col B] x [col D] x 1,000 + (esaver no load losses) + [col D]^2 x (esaver full load losses minus esaver no load losses))
Q	= [col B] x [col E] x 1,000 ÷ ([col B] x [col E] x 1,000 + (esaver no load losses) + [col E]^2 x (esaver full load losses minus esaver no load losses))
R	= ([col B] x [col D] x [col J] ÷ [col Q] - [col B] x [col D] x [col J])
S	= ([col B] x [col E] x [col J] ÷ [col R] - [col B] x [col E] x [col J])
T	= [col S] x [col F] + [col T] x [col G]
U	= [col S] x [col H] + [col T] x [col I]
V	= [col M] - [col S]
W	= [col N] - [col T]
X	= [col O] -[col U]

ESAVER-C3L loss table		
kVA	No Load (W)	Full load (W)
15	55	851
30	90	1313
45	116	1552
75	157	2204
112.5	217	2546
150	298	3388
225	423	4881
300	526	6066
500	795	8527
750	1132	11423

Standard AL 115C loss table		
kVA	No Load (W)	Full load (W)
15	325	985
30	490	1218
45	680	1835
75	856	2789
112.5	1046	3559
150	1327	4620
225	2250	6740
300	2860	7160
500	3830	9830
750	3980	16800

MAPC - Sudbury

Loring Elementary
Replace Transformers

	Existing Transformer Details														Proposed Transformer Details						Savings		
Location	**Unit Size (kVA)**	**Occ. Hours % Load**	**UnOcc. Hours % Load**	**Occ On-Peak Hrs.**	**UnOcc On-Peak Hrs.**	**Occ Off-Peak Hrs.**	**UnOcc Off-Peak Hrs.**	**Load Power Factor**	**Existing Occ. Efficiency**	**Existing UnOcc. Efficiency**	**Existing Occ. kW Losses**	**Existing UnOcc. kW Losses**	**Existing Annual Peak Losses (kWh)**	**Existing Annual Off-Peak Losses (kWh)**	**Proposed Occ. Efficiency**	**Proposed UnOcc. Efficiency**	**Proposed Occ. kW Losses**	**Proposed UnOcc. kW Losses**	**Proposed Annual Peak Losses (kWh)**	**Proposed Annual Off-Peak Losses (kWh)**	**Monthly Demand Savings (kW)**	**Annual Peak Electric Energy Savings (kWh)**	**Annual Off-Peak Electric Energy Savings (kWh)**
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**
Electric Room 215 Closet	75.0	10.0%	5.0%	2,026	474	0	6,260	85.0%	86.8%	79.8%	0.97	0.81	2,355	5,050	97.7%	95.9%	0.15	0.14	371	863	0.82	1,984	4,187
Electric Room 215 Closet	75.0	10.0%	5.0%	2,026	474	0	6,260	85.0%	86.8%	79.8%	0.97	0.81	2,355	5,050	97.7%	95.9%	0.15	0.14	371	863	0.82	1,984	4,187
Main Electric Room 150	45.0	10.0%	5.0%	2,026	474	0	6,260	85.0%	85.3%	77.5%	0.66	0.56	1,603	3,483	97.2%	95.0%	0.11	0.10	273	636	0.55	1,330	2,846
Main Electric Room 150	30.0	10.0%	5.0%	2,026	474	0	6,260	85.0%	85.5%	77.8%	0.43	0.36	1,047	2,272	96.7%	94.2%	0.09	0.08	214	495	0.35	834	1,777
Kitchen Back Hall	75.0	10.0%	5.0%	2,026	474	0	6,260	85.0%	86.8%	79.8%	0.97	0.81	2,355	5,050	97.7%	95.9%	0.15	0.14	371	863	0.82	1,984	4,187
Room 175 Behind Stage	75.0	10.0%	5.0%	2,026	474	0	6,260	85.0%	86.8%	79.8%	0.97	0.81	2,355	5,050	97.7%	95.9%	0.15	0.14	371	863	0.82	1,984	4,187
Room 124	45.0	10.0%	5.0%	2,026	474	0	6,260	85.0%	85.3%	77.5%	0.66	0.56	1,603	3,483	97.2%	95.0%	0.11	0.10	273	636	0.55	1,330	2,846
Totals	**420.0**	**10.0%**	**5.0%**								**5.65**	**4.70**	**13,672**	**29,436**			**0.91**	**0.83**	**2,243**	**5,218**	**4.74**	**11,429**	**24,217**

Cell Ref.	**Comment**
A	Location of Transformer
B	Transformer Nameplate Rating - kVA
C - D	Estimated existing transformer loading as a percent of nameplate rating
E - H	Facility operating hours from EMS calculation
I	Estimated load powerfactor seen at the transformer - output
J	= [col B] x [col D] x 1,000 ÷ ([col B] x [col D] x 1,000 + (standard no load losses) + [col D]^2 x (standard full load losses minus standard no load losses))
K	= [col B] x [col E] x 1,000 ÷ ([col B] x [col E] x 1,000 + (standard no load losses) + [col E]^2 x (standard full load losses minus standard no load losses))
L	= ([col B] x [col D] x [col J] ÷ [col K] - [col B] x [col D] x [col J])
M	= ([col B] x [col E] x [col J] ÷ [col L] - [col B] x [col E] x [col J])
N	= [col M] x [col F] + [col N] x [col G]
O	= [col M] x [col H] + [col N] x [col I]
P	= [col B] x [col D] x 1,000 ÷ ([col B] x [col D] x 1,000 + (esaver no load losses) + [col D]^2 x (esaver full load losses minus esaver no load losses))
Q	= [col B] x [col E] x 1,000 ÷ ([col B] x [col E] x 1,000 + (esaver no load losses) + [col E]^2 x (esaver full load losses minus esaver no load losses))
R	= ([col B] x [col D] x [col J] ÷ [col Q] - [col B] x [col D] x [col J])
S	= ([col B] x [col E] x [col J] ÷ [col R] - [col B] x [col E] x [col J])
T	= [col S] x [col F] + [col T] x [col G]
U	= [col S] x [col H] + [col T] x [col I]
V	= [col M] - [col S]
W	= [col N] - [col T]
X	= [col O] -[col U]

ESAVER-C3L loss table

kVA	**No Load (W)**	**Full load (W)**
15	55	851
30	90	1313
45	116	1552
75	157	2204
112.5	217	2546
150	298	3388
225	423	4881
300	526	6066
500	795	8527
750	1132	11423

Standard AL 115C loss table

kVA	**No Load (W)**	**Full load (W)**
15	325	985
30	480	1218
45	750	1835
75	956	2789
112.5	1448	3559
150	1727	4620
225	1950	6740
300	2760	7160
500	3830	9830
750	3980	16800

Appendix for ECM 29: Replace Transformers

II. Manufacturer Specification Sheets

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POWERSMITHS

E-Saver™ Transformer

APPLICATIONS

The E-Saver transformer is available with multiple efficiency ratings to deliver the lowest lifecycle cost to a wide variety of applications. E-Saver's reduce transformer losses by as much as 74%, providing consistent predictable electricity savings for decades in commercial and institutional environments.

DESCRIPTION

Since their introduction in 2002, E-Saver transformers have set the benchmark for environmental protection, energy efficiency and reliability. Unlike standard and K-rated off-the-shelf transformers, E-Savers provide very high efficiency over broad load profiles including electronic loads. To ensure longer life and reduced environmental impact, E-Saver incorporates a Class 220 Nomex based insulation system with an organic epoxy impregnant.

QUIET OPERATION

Powersmiths transformers have embedded structural and acoustic treatments that combine to ensure quiet operation. Each transformer is noise tested as part of Powersmiths ISO 9001 production procedures.

INTEGRATED METERING OPTIONS

E-Saver transformers can be ordered with integrated SMART™ meters to acquire energy, power and efficiency measurements. Integrating meters helps lower the cost of commissioning and performance validation, by eliminating the need to open transformer enclosures to acquire measurements. A variety of meters are available including web-accessible meters that can be connected to Powersmiths WOW sustainability management system or third party building management systems to support ongoing accountability of energy use over time.

INTEGRATED BREAKER OPTION

To conserve wall-space and reduce installation costs, E-Saver can be ordered with integrated input and/or output breakers.

ROTATABLE INFRARED VIEWING PORT OPTION

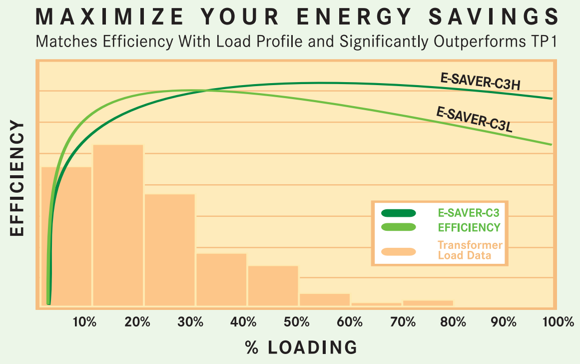
Powersmiths Rotatable IR (Infrared) Viewing Port enables safe, noninvasive thermographic imaging of live equipment, without exposing personnel to electrical hazards like Arc-Flash. It is available as a factory installed option on all Powersmiths transformers.

ENVIRONMENT AND QUALITY

A continuous improvement "lean green" strategy guides Powersmiths' product design and manufacturing. Initiatives such as increasing transformer efficiency, the Easy Skid, use of biodegradable product packaging and the reduction of harmful volatile organic compounds inproduction processes, are just a few examples of the extent to which Powersmiths takes its values seriously. Through these efforts Powersmiths has earned both ISO 14001 certification for its environmental management system and ISO 9001 for its quality management system.

TESTING AND WARRANTY

E-Saver is subjected to extensive performance validation including efficiency under real world operating conditions. E-Saver's long life and dependable performance is backed by Powersmiths' industry leading 25-year pro-rated warranty.


MAXIMIZE YOUR ENERGY SAVINGS

Matches Efficiency With Load Profile and Significantly Outperforms TP1

KEY FEATURES

- **Provides best available efficiency on the market**
- **k-rated for real world electronic loads**
- **Minimizes electricity waste**
- **Optimized for cool and quiet operation**
- **Significantly exceeds NEMA TP-1 (C-802) efficiency**
- **Provides the lowest life cycle cost for your energy rate**

STANDARD CONFIGURATION

Powersmiths E-Saver is a high efficiency k-rated 60Hz dry-type distribution transformer available in 3-phase and single phase models with either aluminum or copper windings.

The E-Saver-C3L is optimized for light loading with copper (k7) or aluminum (k4).
The E-Saver-C3H is optimized for heavy loading with copper (k13).

Standard temperature rise for the C3L model is 130C, for the C3H, C4, C5 it is 115C or lower. Under the static NEMA TP2 test, the C3L and C3H have up to 35% less losses than a TP1* (C802), but deliver over 50% less losses in real world conditions, as validated by extensive field testing.

The C4 and C5 models deliver additional incremental savings – up to 40% and 50% respectively compared to TP1 (C802), to satisfy the need for higher efficiencies and improved ROI (*) where higher energy rates prevail, including solar applications.

CERTIFICATIONS

E-Saver is certified to UL1561 and CSA-C22.2-47-M90 for distribution class transformers and meets applicable ANSI and IEEE standards; primary and secondary terminals and voltage taps are readily accessible by removing the front cover plate; 10kV BIL, 220C class insulation.

SELECT

Efficiency class: C3L, C3H, C4, C5
kVA: Rating of unit 15 -750 (special orders up to 5000 kVA)
PV: Primary voltage 600, 480, 415, 400, 380, 208 (special order up to 15 kV)
SV: Secondary voltage 208/120V, 480/277V, 600/347V (others available)
Options as listed

SAMPLE PART NUMBER

ESAVER-C3L-75-480-208

ESAVER-C5-225-208-600-K9

Winding Configurations: Delta-wye, Y-Y, split-phase, other

* FEDERAL REGISTER – US DOE, Office of Energy Efficiency and Renewable Energy. 10 CFR Part 430, July 29, 2004. Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Distribution Transformers; Proposed Rule

TECHNICAL DATA

kVA	Impedance (%Z)	Weight (lbs)	Case Size (Inches)
15	3.0 - 6.0%	200 - 260	A (18W x 17D x 27H)
30	3.0 - 6.0%	320 - 430	B (26W x 18D x 30H)
45	3.0 - 6.0%	400 - 520	B (26W x 18D x 30H)
75	3.0 - 6.0%	570 - 710	C (32W x 22D x 40H)
112.5	3.0 - 6.0%	850 - 1000	C (32W x 22D x 40H)
150	3.0 - 6.0%	1100 - 1350	D (38W x 27D x 48H)
225	3.0 - 6.0%	1550 - 1900	D+ (38W x 32D x 52H)
300	3.0 - 6.0%	1850 - 2150	D+ (38W x 32D x 52H)
400	3.0 - 6.0%	2400 - 2600	E (52W x 32D x 61H)
500	3.0 - 6.0%	2500 - 3100	E+ (52W x 38D x 61H)
750	3.0 - 6.0%	3700 - 4400	F (64W x 45D x 67H)

The above data applies to configurations up to 600V, with NEMA 1enclosure and standard temperature rise. Selection of some options may change enclosure size and weight. Consult factory for detailed product data sheet for these and other configurations. *Specific case used determined by factory unless specified. Special designs available to meet custom requirements.

AVAILABLE OPTIONS

SMART1: Integrated metering port

SMART2: Integrated Power & Energy Meter

SMART3: Integrated Meter with Web access

CYBERHAWK-TX: Efficiency & Power Meter

ROTATABLE IR PORT: 2”, 3”, 4”

INTEGRATED BREAKERS

TEMPERATURE RISE: 115 or 80 deg. C

FREQUENCY: 50Hz

K-RATING: K4, K9, K13, K20

ELECTROSTATIC SHIELDING: Single, dual, triple

SPD: 7 mode 80kA, 120kA, 160kA

LUG KIT: Screw-type compression

THERMAL SENSORS: 170C, 200C

SENSITIVE ENVIRONMENT: Extra low noise

WINDINGS: Copper, Aluminum

ENCLOSURE TYPES: N3R sprinkler proof, outdoor padmount, hinged doors, totally enclosed (75kVA Max), stainless steel

SEISMIC CERTIFICATIONS: OSHPD, IBC 2006/2009

ISO 9001
ISO 14001

Technical specification subject to change without notice.

POWERSMITHS

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www.powersmiths.com

Section 4:
Financial Results/ Recommendations

Project Specifics

Ameresco initially completed a preliminary energy audit and provided the Town of Sudbury with an interactive cost and savings spreadsheet to assist in selecting a final project scope of work. Based on the Town's requested selection, Ameresco has further developed a subset of the ECMs as described in Section 3 of this Investment Grade Audit. These selected ECMs self-fund from project savings within legislative limits as summarized below:

Table 4.1

Financing Term (after construction)	15 years
Estimated Tax-exempt Interest Rate	3.00%
Capital Cost	$1,093,073
Estimated Rebates	$118,928
Net Assumed Capital Cost	$974,145
Guaranteed Cost Savings / Year 1	$82,598
Assumed Utility Escalation Rate	3.00%
Net Excess Cumulative Cash Flow	$97,350

The following table summarizes the ECMs referenced in Section 3 and included in the recommended project scope.

Table 4.2: Measures to be Installed by Building

Town of Sudbury Energy Conservation Measures (ECMs)	Lighting System Improvements	Integrated and New Energy Management System	Programmable Thermostats	PC Load Management	Demand Control Ventilation	Variable Frequency Drives	Vending Machine Controls	Weatherization	Pipe Insulation	Efficient Showerheads	Replace Transformers	
Facility	**1**	**3**	**4**	**5**	**6**	**7**	**9**	**11**	**22**	**25**	**29**	
DPW Highway	X		X	X			X					
DPW Offices				X								
Flynn Building	X			X								
Town Hall				X								
Police Department												
Fairbank Community Center (Including Pool)				X			X			X		
Public Library	X			X		X						
Fire Dept Headquarters	X			X			X	X		X		
Fire Dept South				X			X		X			
Fire Dept North				X			X	X	X			
Curtis Middle School	X				X						X	
Loring Elementary	X	X					X				X	
Noyes Elementary		X					X					
Haynes Elementary	X	X			X		X	X				
Nixon Elementary	X	X					X					

Contract Cost

Ameresco has budgeted specific costs (and savings) for all measures which can be found at the end of this section. The Town desires an Open Book Pricing method, whereby the Town can review in detail the cost for the specified scope, including actual contractor and material quotes (Direct Pricing). The Contract Cost is comprised of the sum of the Direct Pricing, the Audit Fee plus the Indirect Pricing (Ameresco Services).

Direct Pricing

Prior to the implementation of the work, Ameresco will solicit pricing from subcontractors and/or equipment providers for each ECM and to the extent possible shall use the most competitive and qualified subcontractor or equipment provider to implement the work relating to such ECM. The determination of subcontractor qualification shall be in Ameresco's discretion and subject to Town's approval. All subcontracted services shall be considered part of the Direct Pricing. For the selected subset of ECMs, Ameresco has identified the following Direct Pricing budgets for the project:

Table 4.3: Direct Pricing Budgets

Ecm #	ECM Name	Direct Cost Budget
1	Lighting System Improvements	$ 244,630
3	Integrated and New Energy Management System	$ 264,275
4	Programmable Thermostats	$ 6,214
5	PC Load Management	$ 2,344
6	Demand Control Ventilation	$ 35,243
7	Variable Frequency Drives	$ 21,005
9	Vending Machine Controls	$ 4,109
11	Weatherization	$ 12,262
22	Pipe Insulation	$ 4,057
25	Efficient Showerheads	$ 286
29	Replace Transformers	$ 145,794
		$ 740,219

As stated above, Ameresco will solicit competitive pricing for each ECM and to the extent the total Direct Pricing comes in below anticipated levels, the benefit will be retained by the Town and can be used for additional work in the facilities. The Town will be presented the competitive bids for each ECM and will have ultimate approval over the selected contractor (and associated price) for the work.

Indirect Pricing

Design Oversight: Ameresco oversight of ECM design as well as Ameresco staff overseeing subcontracted design professionals*.

Project Management: Ameresco's management of the project, including management reviews of progress and attending project construction meetings periodically throughout the construction period.

Construction Management: Ameresco staff providing management of the project and subcontractors throughout the construction term.

Commissioning: Ameresco staff performing and overseeing commissioning activities required to ensure system is functional and meets the design intent.

Training: Ameresco's training of Town personnel at the time of commissioning, prior to turn over of the project to Town personnel.

Measurement and Verification (M&V): Measurement and verification activities performed at the commissioning phase, as described in the Section 7 Measurement and Verification Plan.

Performance and Payment Bonds: Performance and Payment Bonds on the gross project value of the project.

Construction Period Interest: Ameresco's carrying costs based upon progress payments during construction with a 10% project retainage paid upon completion of each ECM.

Travel: Ameresco travel costs associated with managing implementation of the project.

Warranty: Ameresco providing warranty related services as per the final energy services agreement.

Overhead and Profit: Ameresco's recovery of corporate overhead and recognition of profit

Indirect Pricing shall be calculated based upon the estimated Direct Pricing. Indirect Pricing shall equal the product of the Direct Pricing and a multiplier specific to individual ECMs as per the Table 4.4:

Table 4.4: Indirect Pricing

Ecm #	**ECM Name**	**Ameresco Fee Percentage from MAPC Solicitation**	**Ameresco Fee**
1	Lighting System Improvements	40.28%	$ 98,537
3	Integrated and New Energy Management System	45.38%	$ 119,928
4	Programmable Thermostats	45.38%	$ 2,820
5	PC Load Management	40.58%	$ 951
6	Demand Control Ventilation	45.38%	$ 15,993
7	Variable Frequency Drives	40.58%	$ 8,524
9	Vending Machine Controls	40.58%	$ 1,667
11	Weatherization	42.08%	$ 5,160
22	Pipe Insulation	48.38%	$ 1,963
25	Efficient Showerheads	40.58%	$ 116
29	Replace Transformers	48.38%	$ 70,535
			$ 326,195

Any cost not specifically included in the Indirect Pricing shall be included in the Direct Pricing, inclusive of all materials, labor, and other services or fees required to successfully implement the Scope of Services.

In the event the Contract Cost is anticipated to exceed the “not to exceed” total stated above, the Town and Ameresco will modify the Scope of Services in order to remain within the stated maximum.

*Ameresco currently intends to subcontract all design work to local professionals, with our staff overseeing their efforts to ensure the result is consistent with the audit scope.

Audit Fee:

The fee for performing the Investment Grade Audit of the requested facilities is per the Investment Grade Audit Agreement. As contracted, this cost will not be paid under that agreement as it is incorporated into the cost of the Performance Contract. The total cost of the audit to be included in the Contract Cost is $26,659.

Savings Coverage

It is important to note that revisions to the project scope during the design phase may have an effect on the savings levels and overall project economics. The Town and Ameresco need to remain cognizant of the ability to meet the guaranteed savings levels specified in the Contract and aware that changes in project scope may necessitate a modification to Ameresco’s guarantee. In the event the proposed design adversely affects the ability to meet these obligations, Ameresco and the Town will need to mutually agree upon revisions to the project scope or contract. Ameresco shall provide reasonable efforts to rerun project economics based upon actual costs and savings levels during the design phase, including for the addition of other opportunities, to show the effect of scope/pricing changes on the overall economics.

Rebates / Incentives

Ameresco has estimated rebates available for this project into the net financed cost of the project. These estimates are based on our expectations for incentives available through regular utility programs, but we are unable to guarantee the exact final level of rebates the Town will recognize as a result of implementing this project. Any additional rebates will be for the benefit of the Town, and the Town shall be responsible for addressing any financial shortfalls as a result of fewer than expected rebates. Ameresco’s pricing is based on payment of the gross project cost, not the cost net of rebates, based upon a percentage of completion.

Table 4.5: Rebates by Measure

Ecm #	ECM Name	Estimated Rebates
1	Lighting System Improvements	$ 54,540
3	Integrated and New Energy Management System	$ 21,900
6	Demand Control Ventilation	$ 14,850
7	Variable Frequency Drives	$ 6,900
9	Vending Machine Controls	$ 1,355
29	Replace Transformers	$ 19,383
		$ 118,928

Structure of Financing Arrangement

We assume the Town will be issuing financing based on parameters referenced in the attached pro forma cash flow, but Ameresco can work with the Town to identify other financing arrangements.

Ameresco included an allowance for construction period interest in the repayment cost as our construction period payments are based upon a percentage of the gross project size completed each month. This allowance, approximately $32,723, is based upon a capitalized interest calculation and may be more or less than that actually structured by the Town as part of its financing.

Interest Rate and Financing Term

For the assumed financing, Ameresco estimated the interest rates based upon an estimated bond financing rate. The ultimate rate may vary based on the Town's bond issuance or the ultimate financing structure, but Ameresco does not guarantee it will be less than or equal to the assumed 3.25% interest rate used in the pro forma cash flow.

The financing term is based on 15-years of repayment, which is after an assumed 12 months of construction.

Equipment Ownership and Security Interest Required

Title to the equipment installed by Ameresco will be transferred to the Town of Sudbury upon the Town's acceptance of the installation and payment in full.

Energy Savings Guarantee

As an integral part of its contract with the Town of Sudbury, Ameresco will guarantee energy savings over the full term of the contract. Ameresco's guarantee provides assurance to the Town that the cash inflows from the project, which include both energy and operational cost savings and any additional utility rebates, will exceed the Town's cash requirements for the project, the loan payments and any on-going payments for the provision of operations and maintenance services as delineated below. The Town of Sudbury will retain actual annual energy cost savings that exceed Ameresco's guarantee.

At any time during the contract term should there be a shortfall in energy cost savings Ameresco will make a payment to the Town of Sudbury in the full amount of the shortfall. Payments can be in the form of a check or a credit against future billings from Ameresco, at the Town's option.

Construction Financing

Ameresco assumes the financing proceeds will be funded into an escrow or similar account at the inception of the project. Monthly drawings are made against the escrow as the project is implemented, based upon a percentage of work completed for the preceding period.

Project Labor

Ameresco has based its labor costs on current prevailing wage rates for all expected construction disciplines. Ameresco can solicit competitive pricing on various labor components and work with the Town to select the ultimate contractor used for installation. Ameresco was not given explicit direction to use union labor and therefore has at a minimum ensured all labor is comparable to current prevailing wage rates. Should the Town require union labor or other specific labor agreements other than prevailing wage, the cost to perform the work included in this project may go up at the Town's expense.

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Table 4.6: Cost and Savings by Measure

Ecm #	ECM Name	Annual kW	Total kWh	Natural Gas (Therms)	Water (kGallons)	Sewer (kGallons)	Energy Savings	O&M Savings	Total Project Savings	Total Project Costs	SPB
1	Lighting System Improvements	671	209,268	(1,597)	-	-	$ 33,272	$ 3,174	$ 36,446	$ 350,467	9.62
3	Integrated and New Energy Management System	-	9,227	11,938	-	-	$ 14,769	$ -	$ 14,769	$ 392,039	26.54
4	Programmable Thermostats	-	637	1,400	-	-	$ 1,782	$ -	$ 1,782	$ 9,174	5.15
5	PC Load Management	-	15,369	(244)	-	-	$ 1,260	$ -	$ 1,260	$ 5,526	4.38
6	Demand Control Ventilation	-	33,827	414	-	-	$ 3,455	$ -	$ 3,455	$ 52,327	15.15
7	Variable Frequency Drives	-	15,564	-	-	-	$ 1,551	$ -	$ 1,551	$ 30,123	19.42
9	Vending Machine Controls	-	16,801	(282)	-	-	$ 1,529	$ -	$ 1,529	$ 7,272	4.76
11	Weatherization	-	33	1,312	-	-	$ 1,549	$ -	$ 1,549	$ 17,941	11.58
22	Pipe Insulation	-	-	389	-	-	$ 526	$ -	$ 526	$ 6,251	11.88
25	Efficient Showerheads	-	-	708	200	200	$ 1,543	$ -	$ 1,543	$ 582	0.38
29	Replace Transformers	219	129,218	-	-	-	$ 15,782	$ -	$ 15,782	$ 221,372	14.03
		890	**429,944**	**14,039**	**200**	**200**	**$ 77,018**	**$ 3,174**	**$ 80,192**	**$ 1,093,073**	**13.63**

Table 4.7: Project Pro-Forma

Town of Sudbury - Pro-Forma

Initial Project Costs:		
Implementation costs	$	1,093,073
Total Initial Project Costs	**$**	**1,093,073**
Utility Rebates	$	118,928
Total Rebates	**$**	**118,928**
Net Project Costs after rebates	**$**	**974,146**

Financial Assumptions	
Term of Project {yrs}	15.0 yrs
Term of Financing {yrs}	15.0 yrs
Estimated Financing Rate	3.25%
Payments per year (frequency)	12
Discount Rate	3.25%
Average Energy escalation rate {annual}	3.00%
Project Simple Payback	13.63

Pro-forma			*Year*									
		Initial Values	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	Annual energy costs without improvements	$ 1,093,162	$ 1,125,957	$ 1,159,736	$ 1,194,528	$ 1,230,364	$ 1,267,275	$ 1,305,293	$ 1,344,452	$ 1,384,785	$ 1,426,329	$ 1,469,119
2	Annual energy costs with improvements	$ 1,016,144	$ 1,046,629	$ 1,078,027	$ 1,110,368	$ 1,143,679	$ 1,177,990	$ 1,213,329	$ 1,249,729	$ 1,287,221	$ 1,325,838	$ 1,365,613
3	Annual energy cost savings (1-2)	$ 77,018	$ 79,329	$ 81,709	$ 84,160	$ 86,685	$ 89,285	$ 91,964	$ 94,723	$ 97,564	$ 100,491	$ 103,506
4	O&M Savings	$ 3,174	$ 3,269	$ 3,367	$ 3,468	$ 3,572	$ 3,679	$ 3,790	$ 3,903	$ 4,020	$ 4,141	$ 4,265
5	Total Project Savings	$ 80,192	$ 82,598	$ 85,076	$ 87,628	$ 90,257	$ 92,964	$ 95,753	$ 98,626	$ 101,585	$ 104,632	$ 107,771
6	Payments for financing equipment		$ 68,546	$ 70,797	$ 73,115	$ 75,503	$ 77,963	$ 80,496	$ 83,106	$ 85,793	$ 88,562	$ 91,413
7	Payments for Ongoing Services	$ -	$ 7,568	$ 7,795	$ 8,029	$ 8,270	$ 8,518	$ 8,773	$ 9,036	$ 9,307	$ 9,587	$ 9,874
8	Net annual benefits		$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484
9	Cumulative cash flow	**$ 97,260**	$ 6,484	$ 12,968	$ 19,452	$ 25,936	$ 32,420	$ 38,904	$ 45,388	$ 51,872	$ 58,356	$ 64,840
10	**Net Present Value of cash flow**	**$ 76,024**										
11	Interest Rate	3.25%										
12	Discount Rate	3.25%										

Line #	**11**	**12**	**13**	**14**	**15**	**Totals**
1	$ 1,513,192	$ 1,558,588	$ 1,605,346	$ 1,653,506	$ 1,703,111	$ 20,941,583
2	$ 1,406,581	$ 1,448,779	$ 1,492,242	$ 1,537,009	$ 1,583,120	$ 19,466,155
3	$ 106,611	$ 109,810	$ 113,104	$ 116,497	$ 119,992	$ 1,475,429
4	$ 4,393	$ 4,525	$ 4,661	$ 4,801	$ 4,945	$ 60,800
5	$ 111,004	$ 114,335	$ 117,765	$ 121,298	$ 124,936	$ 1,536,228
6	$ 94,350	$ 97,375	$ 100,491	$ 103,700	$ 107,005	$ 1,298,215
7	$ 10,171	$ 10,476	$ 10,790	$ 11,114	$ 11,447	$ 140,753
8	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 6,484	$ 97,260
9	$ 71,324	$ 77,808	$ 84,292	$ 90,776	$ 97,260	
10						
11						
12						

Notes:

1 This Proforma Cash Flow reflects an estimated financing rate of 3.25%. The actual rate will increase or decrease based on market conditions and customer credit rating at the time of funding.

2 Savings are based on current utility rate structures and usage information provided for purposes of this project.

Section 5:
Preliminary Implementation Schedule

The following schedule represents the estimated project schedule from IGA submission to final construction completion. This preliminary schedule is subject to revision based on actual contract execution date and changes in project timing. Naturally, all scheduling will be coordinated with Town personnel to ensure that no work will interfere with normal Town operations.

This preliminary schedule represents a roll-up of major project activities from execution of the Agreement, through completion of improvements and the Town's acceptance, to commencement of performance period services. As construction of this project requires significant involvement of Town personnel for review and approval of project specifications, design work, and selection of subcontractors, the schedule is intended to be representative of the expected construction period but in no way is a guarantee that any specific activities or the aggregate project will be completed in accordance with the specified periods.

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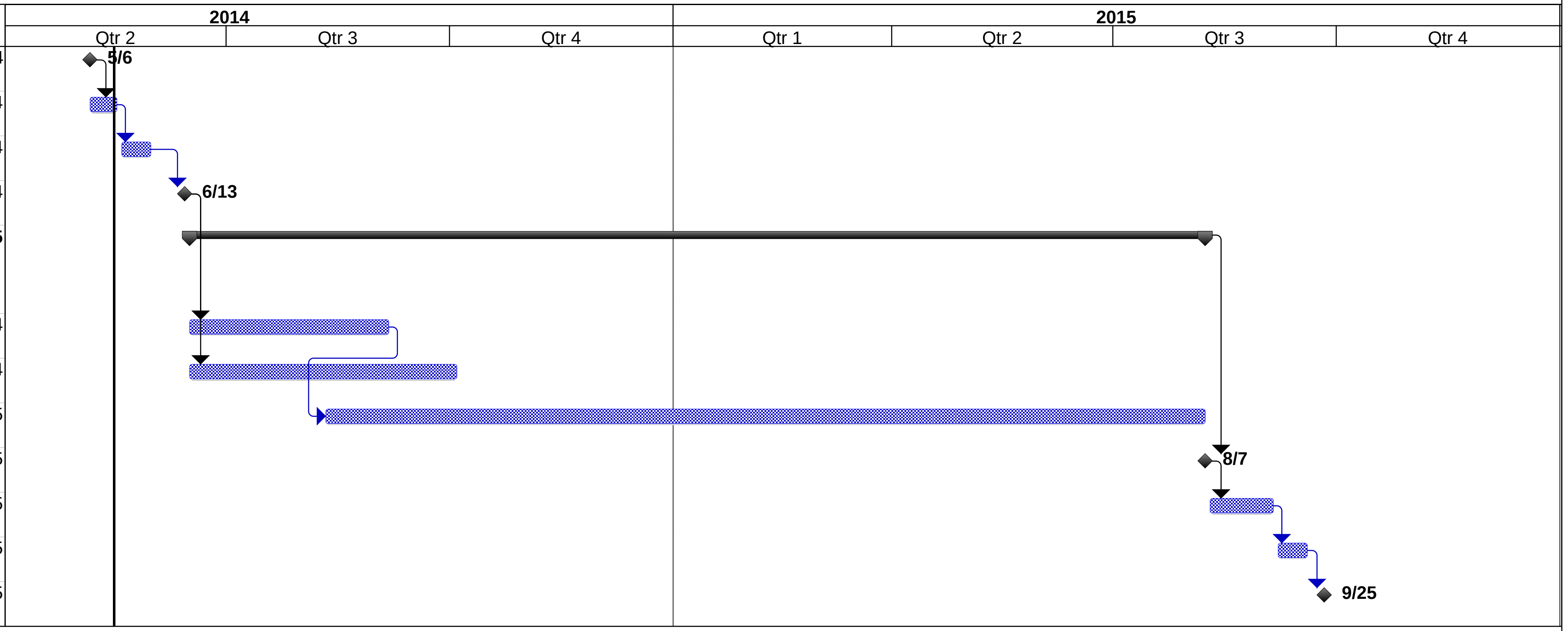
IGA for Town of Sudbury, MA

PRELIMINARY PROJECT SCHEDULE
Energy Savings Project

Draft Schedule for Construction & Completion

ID	Task Name	Duration	Start	Finish
1	Town Acceptance of Audit and Contract	0 days	Tue 5/6/14	Tue 5/6/14
2	Execute Energy Performance Contract	9 days	Tue 5/6/14	Fri 5/16/14
3	Secure Project Financing	2 wks	Mon 5/19/14	Fri 5/30/14
4	Project Kick-off Meeting	0 days	Fri 6/13/14	Fri 6/13/14
5	**Construction Phase (required permits and gov. approvals, install, test, start-up)**	**300 days**	**Mon 6/16/14**	**Fri 8/7/15**
6	Project design	3 mons	Mon 6/16/14	Fri 9/5/14
7	Equipment Procurement	4 mons	Mon 6/16/14	Fri 10/3/14
8	ECM Implementation	52 wks	Mon 8/11/14	Fri 8/7/15
9	Completion of Construction Phase	0 days	Fri 8/7/15	Fri 8/7/15
10	Post M&V and Commissioning	4 wks	Mon 8/10/15	Fri 9/4/15
11	Training of Personnel	2 wks	Mon 9/7/15	Fri 9/18/15
12	Project Completion and Commencement of Normal Operations	0 days	Fri 9/25/15	Fri 9/25/15



Project: Town of Sudbury, MA
Date: May 6, 2014

Task	▨	Rolled Up Progress	▬	External Milestone	◆	Manual Task	▬	Finish-only	]
Milestone	◆	External Tasks	▨	Inactive Task	◆	Duration-only	▬	Progress	▬
Summary	▬	Project Summary	▬	Inactive Task	☐	Manual Summary Rollup	▬	Deadline	⇩
Rolled Up Task	▨	Split	....	Inactive Milestone	◇	Manual Summary	▬		
Rolled Up Milestone	◇	Rolled Up Split	....	Inactive Summary	▭	Start-only	[		

AMERESCO

Section 6:
Preliminary Commissioning Plan

The commissioning of this project will utilize industry accepted standards to insure all ECMs' are completed and operating as designed and intended. Ameresco will utilize previously developed documents and strategies to insure the ECMs are installed according to the project specifications, that the installing contractor has provided all the necessary deliverables noted in the specifications, the equipment performs as expected, the facility staff have been properly trained, Operations & Maintenance documents have been provided, and the Measurement &Verification portion of the contract can successfully oversee the operation and maintenance of the equipment thus insuring the project meets the energy and operational expectations of Ameresco and the Town.

Commissioning is the systematic process of ensuring all mechanical equipment related to the project performs interactively according to the owner's requirements and the design narrative. Commissioning includes Design Review, Submittal Review, Pre-functional Testing, and Functional Testing. Commissioning additionally ensures that the owner has received all of the deliverables as specified and that the building staff, through supervised training, is prepared to take over the operations and maintenance of the systems and equipment.

The purpose of the commissioning plan is to provide direction for the commissioning process during construction. The plan will identify what equipment and systems will be commissioned. It will also identify parties involved in the commissioning process, their roles, and required deliverables. The commissioning plan will also identify the goals of commissioning and/or the project, if they have not been clearly defined elsewhere.

This preliminary plan will detail the following:

- A breakdown of each ECM and the level of pre-functional and functional testing including areas of responsibility and deliverables. This breakdown will be provided in an easy to read table.
- Acceptance and turn over procedures including the integration of commissioning activities.
- A brief description of commissioning documents.
- A training agenda and sample training goals for each ECM

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ECM Performance Testing Matrix

Pre-functional and functional reports shall be modified during the design and construction phases based on actual system design and installation. Results of Pre-functional Testing, as necessary, and Functional Testing will be included in the O & M Manuals.

ECM	Equipment/systems to be performance tested	Observations, Tests and Inspections during Construction (Pre-Functional)	Pre-functional Responsibility	Observations, Tests and Inspections Prior to Acceptance (Functional)	Functional Responsibility	Testing Documentation
ECM 1: Lighting System Improvements	Lighting fixtures	Verify operation of all fixtures as completed Inspect equipment and compare to approved submittals	Electrical Contractor Ameresco	Verify operation of all newly installed fixtures and/or lamps.	Electrical Contractor Ameresco	Commissioning Data Sheets will be completed for a statistically significant sample.
ECM 3: Integrated and New Energy Management Systems	Schedules, setpoints, sequences, lockouts, alarms, interlocks, control strategies, trending	Provide start up sheets for all controllers and programmable thermostats. Inspect construction progress for conformance to project specifications.	Controls Contractor Ameresco	Ameresco will Functionally test (Ft) the new controls by utilizing the approved sequence of operations to create project specific test sheets. The Ft's will document each step of the sequence and the outcome in order to show conformance to the design intent. Controls testing will be combined with individual equipment testing as it relates to operation and control. Sample sheets to show the depth and detail of testing have been included in appendix A.	Controls Contractor and Ameresco	FPT Reports will be completed for each system.
ECM 4: Programmable Thermostats	Schedules, setpoints	Provide start up sheets for all thermostats. Inspect construction progress for conformance to project specifications	Controls Contractor Ameresco	Ameresco will Functionally test (Ft) the thermostats by utilizing the approved sequence of operations to create project specific test sheets. The Ft's will document each step of the sequence and the outcome in order to show conformance to the design intent. Thermostat testing will be combined with individual equipment testing as it relates to operation and control. Sample sheets to show the depth and detail of testing have been included in appendix A.	Controls Contractor and Ameresco	FPT Reports will be completed for each system.
ECM 5: PC Load Management	Software Test	Start up and implementation report from Contractor	Contractor	A Software Performance Test will be coordinated with the Town's IT department to show program capabilities as well as response to scheduled tasks.	Software contractor Ameresco Town IT dept.	Results of software testing will be provided documenting the software setpoints, performance, number of computers affected, pre-installation energy use and post-installation energy use.
ECM 6: Demand Control Ventilation	Outside Air Dampers and related sensors	Verify operation of all dampers as completed.	Controls Contractors	Functional testing will be conducted and include the operation of the equipment as well as tie ins to the controls. See sample FPT's in the Appendix.	Controls Contractor Ameresco	FPT Reports will be provided for each system component.
ECM 7: Variable Frequency Drives	New VFDs	VFD start-up sheets will be provided by the manufacturer. Inspect construction progress for conformance to project specifications.	Controls Contractor Ameresco	Perform FPT in accordance with sample FPT Reports in the Appendix.	Controls Contractor Ameresco	FPT Reports will be completed for each system.
ECM 9: Vending Machine Controls	Control units	Inspect construction progress for conformance to project specifications.	Ameresco	Visual inspection of controls to ensure that they are installed and functioning properly	Installation Contractor Ameresco	FPT Reports will be completed for each system.
ECM 11: Weatherization	New weather-stripping, foam sealant and insulation	Inspect construction progress for conformance to project specifications.	Ameresco	Visual inspection to ensure that all weather stripping and air sealing material is installed and functioning properly.	Installation Contractor Ameresco	FPT Reports will be completed for each system.
ECM 22: Pipe Insulation	Insulation	Inspect construction progress for conformance to project specifications.	Ameresco	Visual inspection of insulation type and thickness for conformance with design documents and work scope.	Installation Contractor Ameresco	FPT Reports will be completed for each system.
ECM 25: Efficient Showerheads	New showerheads	Verify flow and proper operation of device for all fixtures.	Plumbing Contractor	Fixture consumption rates will be verified on a statistically significant sample size of measurable installed units/fixtures. Details to be further refined during design phase of project.	Ameresco	FPT Reports will be completed for each system.
ECM 29: Replace Transformers	Transformers	Verify operation and loading of equipment as installation is completed	Electrical Contractor	Visual inspection of all newly installed transformers to verify they are in place and properly installed.	Electrical Contractor AMERESCO	FPT Reports will be completed for each system.

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Acceptance Procedures and Documentation

Upon completion of the pre-functional testing, completion of the functional performance testing, and completion of the training as described below, Ameresco shall issue Certificates of Substantial Completion for each ECM that is providing a performance and financial benefit to the Town. The Certificates will have accompanying punch lists; all punch list items that could directly affect the potential to generate energy cost savings must be completed prior to functional performance testing. It is important to note that the warranty periods for equipment/systems that are in operation will begin upon execution of the Certificates of Substantial Completion, which is after completion of functional performance testing.

Upon successful completion of all functional performance tests and all construction period M&V testing, as prescribed in Section 7, the ECMs are deemed to have the potential to achieve the estimated energy cost and maintenance savings. Ameresco will also provide applicable training required to allow the Town to assume operational control and maintenance responsibilities for the ECMs, such training to be as described in the section on training, below. Ameresco will then formally request from the Town an inspection of the work completed. A Certificate of Substantial Completion will accompany the formal inspection request. The Certificate of Substantial Completion formally acknowledges that the work has been completed, or a portion thereof, and is being accepted. Some ECMs may not be able to be completed at that time due to circumstances beyond the control of Ameresco. In these instances, a percentage complete will be assigned to the ECM and a punch list of outstanding items will be included. These items typically will not have an impact on the savings or the potential to achieve savings since the functional performance test will have been completed prior to requesting the final inspection. All outstanding punch list items will be completed as soon as possible.

Commissioning will include two levels of testing for equipment and systems, Pre-functional Testing and Functional Performance Testing; Pre-functional testing checks the readiness of equipment to work within the system and includes contractor or manufacturer start up sheets. Functional testing tests the operation of the system, specifically the sequence of operations.

Pre-Functional Testing

The PFT is a validation of individual equipment for readiness to work in conjunction with the associated system. The contractors must successfully complete the pre-functional test for each component of a given system prior to formal functional performance testing of equipment and subsystems of the given system. Pre-functional Tests will augment and are combined with the manufacturer's start-up checklist. Completion of the Pre-functional Tests will allow the contractor to ensure that the overall installation reflects the requirements of the plans, specifications and manufacturer's installation manuals.

Functional Performance Testing

The FPT is the equipment or system performance evaluation under operating conditions for compliance with the project documents (installation drawings, one line diagrams, Sequences of Operation, and specifications including changes during construction). It verifies equipment or system component performances, e.g., temperature, humidity, pressure, flow, start/stop etc.

Functional testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes, such as during high/low heating loads, high/low steam loads, component failures, etc. The systems are run through all of the control system's sequences of operation and components are verified to be responding as the sequences state. Ameresco develops the FPT procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is performed with assistance, typically from the controls contractor.

The Energy Management or Control system will be used to verify and document the functional performance of the commissioned systems. Since the EMS is critical to the FPT process, the EMS PFT (performed by the contractor point-to-point checkout and controller start up reports) must be complete and accepted before any FPT can begin. Much of the BMS FPT is accomplished during the testing process for the equipment and systems. For example, while testing the hot water heating pumps, the BMS is tested at the same time for many of its individual features such as set point control and scheduling.

Inspection reports

Inspection reports are brief reports completed by an inspecting Ameresco employee that document the extent of construction, verify conformance to approved submittals and construction documents, and identifies any deficiencies. The intent of the reports are to insure equipment is properly supplied to the construction site and installed properly, this will aid in a quick and successful Functional test and final sign off of ECM's.

Operations and Maintenance Manuals

O & M Manuals will be provided upon completion of all functional performance tests and upon completion of the as-built documentation. O&M's will be provided for each ECM and be related to that specific ECM. The manuals will be provided as hard copy binders as well as electronic copies on a CD. A sample O&M outline follows:

Section I – System Description

- A brief description of the system, its major components and function.
- Control strategies and sequences describing start-up, modes of operation, and shutdown.
- Energy conservation strategies important to the selection of the equipment.

Section II – Equipment Data Sheets

- Corrected shop drawings, including performance curves, efficiency ratings, features and options
- Approved submittal
- Copies of approved certifications and factory test reports (where applicable)
- Wiring and control schematics detailing the operation and control of each component for troubleshooting

Section III – Maintenance

- Manufacturer's Operation and Maintenance instructions

- Manufacturer's Spare Parts Lists
- Manufacturer recommended spare parts inventory list
- Manufacturer's recommended maintenance frequency
- Name, address, and telephone number of the manufacturer's local representative for each type of equipment for replacement parts and service.

Section IV– Test Reports

- Pre-functional Reports (Equipment start-up reports and commissioning data sheets)
- Functional Reports (System start-up reports and functional performance tests)
- Copies of welder certifications (where applicable)
- Non-destructive testing reports (where applicable)
- Hydrostatic/pneumatic pipe testing reports (where applicable)
- Water treatment analysis and report (where applicable)
- Testing and Balancing reports (where applicable)
- Other reports as applicable

Section V – Warranties/Guarantees

- A typewritten warranty, on company letterhead, for each system installed. The warranty shall state the system and components covered, the duration of the warranty period, and emergency contact phone numbers for service and repair.
- Warranties/guarantees from subcontractors or equipment suppliers.

Training Plan

Training and orientation on the systems installed will vary depending on the complexity of the specific equipment installed for each ECM. At a minimum each ECM O&M manual will be reviewed with the staff to review the installed measure, scope of work, effect on energy consumption, and warrantee information. Additionally a site inspection to review a typical installation will be conducted. Ameresco will be present at all training sessions to insure training is provided as required and is thorough; a brief training report will be issued for each session that will include a sign in sheet and instructor contact information. Training is anticipated to be provided at the following levels depending on ECM complexity:

1. For systems and/or equipment that are essentially direct replacements of existing equipment, and where no additional specific skills will be required to perform operations and maintenance functions, training will be limited to a general overview of the equipment installed and a review of the O&M manuals. Training will be directed to operating personnel. Training should be provided at the completion of construction of each of the ECMs and will generally last less than a day.

2. For systems/equipment that are new to the site and require more in-depth understanding as to their function and operation, training will include classroom time that will provide an overview of the implemented technology and design intent as well as O&M review. Training will be geared towards operations staff as well as direct supervisors. Following the classroom training, a site tour will be conducted to view the installation and operation of the equipment, a "hands on" session of training will be provided at this time. Training will be scheduled to coincide with the completion of construction and should be anticipated to last as long as a full day for each ECM.

3. For systems and/or equipment that are new to the site and more complex in nature, training will be directed to the operations staff, immediate supervisors, and site supervisors as necessary. In general, training will consist of classroom training followed by hands-on instruction in the field. Training will be provided through a complement of Ameresco personnel, design engineers, installation contractors, and manufacturer's representatives. Specifics on the training program, including schedule and training materials, will be further refined during the design process, but the training, in general, will consist of the following:
    a. Explanation of the design concept
        i. Design intent
        ii. Energy efficiency considerations
        iii. Seasonal modes of operation
        iv. Emergency conditions and operation
        v. Comfort conditions and indoor air quality
    b. Systems operation
        i. Operation of individual components, instruction from authorized factory technicians, if required
        ii. Physical location of critical shut-off valves, fire, smoke, and balancing dampers, relief valves, safeties, and control panels
        iii. System operational procedures for all modes in manual and automatic modes
    c. Operation of the control systems
        i. Sequences of Operation
        ii. Use of Graphical User Interfaces
        iii. Alarms and problem indicators
        iv. Diagnostics and corrective actions
    d. Service and Maintenance
        i. Use of the O&M manuals
        ii. Instruction and logging procedures for maintenance
        iii. Instruction from authorized factory technicians, where applicable
        iv. Troubleshooting and investigation of malfunctions
        v. Recommended procedures for collecting, interpreting, and storing specific performance data

Training will be provided during construction, commissioning, and acceptance phases as dictated by the complexity of the ECM. It is also anticipated that additional training will be provided after 6 and 12 months from acceptance of the ECMs to ensure that the equipment is being operated and maintained in accordance with manufacturer's recommendations and within contract requirements so that the potential to generate cost savings is not jeopardized. All training activities will be coordinated carefully with Town facilities personnel.

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Training Goal Matrix

This is a general outline of training for each ECM. Specific times and topics will be adjusted as final equipment selections are made.

ECM	Equipment/ Systems	Classroom Training	Hands on Instruction	Personnel Groups Trained
ECM 1: Lighting System Improvements	Lighting Fixtures	1 hour to go over lighting, lighting controls and operation of controls	Site review to identify typical locations for lighting retrofits and controls.	Facility Engineers Facility Technicians O&M Personnel
ECM 3: Integrated and New Energy Management System	New and Existing Energy Management Systems	16 hours of classroom training to review the steps to change schedules, set-points, generate trend logs, reset alarms, interpret alarms, and review the control sequences. Classroom training will be broken up into several training sessions	Site review to identify controlled equipment, sensor types and locations.	Facility Engineers Facility Technicians Supervisors O&M Personnel
ECM 4: Programmable Thermostats	New thermostats	Review of O&M	Site review to identify controlled equipment, thermostat types and locations.	Facility Engineers
ECM 5: PC Load Management	Computer Servers and software	No classroom training is included. Three years of maintenance through the manufacture is included which includes technical support.	Remote training during installation through software vendor.	IT personnel Facility Manager
ECM 6: Demand Controlled Ventilation	New and Existing Energy Management Systems	To be combined with EMS training	Site review to identify implementation locations and discuss energy savings potentials.	Facility Engineers Facility Technicians O&M Personnel
ECM 7: Variable Frequency Drives	VFDs	2 hours of training to evaluate the new VFD equipment and review of the control sequences.	Onsite overview of equipment, how to adjust controls and settings.	Facility Technicians O&M Personnel
ECM 9: Vending Machine Controls	Control Units	None	Site review to identify implementation locations, training to discuss unit operation and sensor operation and discuss energy savings potentials.	Facility Technicians O&M Personnel

ECM	Equipment/ Systems	Classroom Training	Hands on Instruction	Personnel Groups Trained
ECM 11: Weatherization	Weather-stripping	None	Site review to identify implementation locations, training to discuss reinstalling weather-stripping during maintenance operations and discuss energy savings potentials.	Facility Technicians O&M Personnel8
ECM 22: Pipe Insulation	Pipe Insulation	None	Site review to identify implementation locations, training to discuss reinstalling insulation during maintenance operations and discuss energy savings potentials.	Facility Technicians O&M Personnel
ECM 25: Efficient Showerheads	Water Fixtures	None	Site review to identify implementation locations and discuss energy savings potentials and maintenance requirements for the new fixtures.	Facility Engineers Facility Technicians O&M Personnel
ECM 29: Replace Transformers	Transformers	Review of O&M	None	Facility Technicians O&M Personnel

Appendix:
Sample Testing Documentation Forms

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ECM1: Lighting Measurement & Verification Worksheet

Project Name: **Project #:**

Use this worksheet to document the measured post-retrofit light fixture watts, for each circuit of light fixtures, to the nearest whole watt.

Use a separate worksheet for each type of light fixtures. Calculate the overall average watt/fixture at the bottom of each sheet..

Complete Signatures and Metering Device Information at bottom of worksheet.

New/Retrofitted Light Fixtures (Post-Measurement)

Item	Building	Location	Qty	Lamp/Ballast Type	Amps	Voltage	PF	Total Watts	Watt Per Fixture
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
								Average Watts/Fixture	

Owner Representative (Print Name): **Signature:** **Date:**

Ameresco Project Manager (Print Name): **Signature:** **Date:**

Contractor Performing M&V (Print Name): **Signature:** **Date:**

Model & Serial Number of Watt Meter: **Date of Calibration:** **NIST Standard:**

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Functional Performance Test (FPT) Report

Energy Management System

Project:________________________________ Date: _____________________________________

System:_______________________________ Location:__________________________________

Functional Performance Test: Performance Partner shall verify the operation of the automatic controls to comply with the contract documents. As a minimum, the following functions shall be tested:

Compliance Checklist:

1. Verify that the wiring is correct to each point. **Compliance?** ____________

   (Attach a comprehensive list of points with this completed form)

2. Verify that the software address is correct. **Compliance?** ____________

   (Attach a list of all software addresses and a brief description of the address (i.e., OADB = Outside Air Dry Bulb temperature in degrees Fahrenheit) with this completed form)

3. If the device is/has an actuator, verify free movement through its full range. **Compliance?** ____________

4. Verify stroke/range calibration for all controlled valves, dampers, actuators, fans, pumps, etc.

   Simulate maximum and minimum transmitter signal values and verify minimum and maximum controller output values and verify the stroke and capacity range for each control device. *(Provide completed calibration forms for all sensors and controllers.)* **Compliance?** ____________

5. Verify that the software with the correct setpoints has been downloaded for each control loop. **Compliance?** ____________

6. ECM Specific:

- Verify the three EMCS front-end computers are installed and operationally identical. **Compliance?** ____________

- Verify all inoperable control devices, which were existing, have been replaced with new functional units as per scope. **Compliance?** ____________

- Verify existing Honeywell, Trane, and Automated Logic points have been migrated to the new Johnson EMCS. **Compliance?**______
- EMCS logic:

  Scheduled start / stop. **Compliance?** ____________

  Optimum start. **Compliance?** ____________ *(Attach control algorithm used to determine optimum start time based on historical weather data and space response time)*

  Enthalpy controlled economizer. **Compliance?** ____________

  Supply air temperature reset. **Compliance?** ____________

  Outside air lockout. **Compliance?** ____________

  Nighttime space temperature setup / setback. **Compliance?** ____________ *(space heating setback to 55°F, cooling set up to 85°F)*

  Attach a log, generated for one month at one-hour intervals by the EMCS, with recorded values for date, time, outside air temperature (dry bulb and wet bulb), AHU fan status (supply and return), discharge air temperature, return air temperature (dry bulb and wet bulb), mixed air temperature (dry bulb and wet bulb), supply temperature (dry bulb and wet bulb), supply temperature setpoint and outside air damper position for all AHUs.

7. Certification and Witness

Performance Partner ____

Client ____

Ameresco ____

Sensor Calibration Sheet

Date:

Sensor ID:

Manufacturer:

Model Number:

Serial Number:

Input Low: Output Low:

Input High: Output High:

Input Units: Output Units:

Input Mode:

AS FOUND

Input %	Actual Input in Deg. F	M/A Output	Computer Read	Controller Voltage Read

AS LEFT

Input %	Actual Input in Deg. F	M/A Output	Computer Read	Controller Voltage Read

Test Equipment Used

Manufacturer	Model Number	Serial Number	Cert Date	NIST Number

COMMENTS:

Functional Performance Test (FPT) Report

VFD – Fan Application

Project:_______________________________ Date:____________________________________

Air Handling Unit No.:___________________

System:______________________________ Location:_________________________________

Functional Performance Test: Performance Partner shall verify the operation of the variable frequency drive for control of a variable air volume system for compliance with the contract documents. As a minimum, the following items shall be tested and /or recorded:

1. **General Information**

VFD manufacturer and model no. ____

Supply Fan (SF) HP:_________ CFM: ___________ RPM: __________ SP: __________

Return Fan (RF) HP:_________ CFM: ___________ RPM: __________ SP: __________

2. **Static Pressure Sensor/Transmitter**

Verify location of the static pressure sensor in % of the distance from fan to terminal unit. (Normally, the sensor should be located 2/3 to 3/4 downstream of the fan to the terminal unit of the most restrictive branch)

Distance _________________%

3. **Pressure Reading Reliability**

Duct diameter or equivalent diameter ____________________

Nearest duct fitting upstream _____________________

Nearest duct fitting downstream ______________________

(Ideally, the most reliable readings occur when the sensor is at least 10 duct diameters downstream and 5 duct diameters upstream from takeoffs or fittings)

Does the location comply? ______________

4. Functional Performance Test

a. Terminal Units Full Cooling (Boxes at Max)

Adjust all space temperature setpoints at least 10ºF below design setpoints. All zones should be in full cooling and terminal units should be open to the maximum position.

- Measure or read the duct static pressure and record in column A of Table 1.
- Read the frequency output of the VFDs and record in Table 1.

b. Terminal Units Intermediate Position (Boxes Partially Opened)

Readjust thermostats to a few degrees below normal setpoints, to simulate an approaching thermostat satisfaction and take readings.

- Measure or read the duct static pressure and record in column B of Table 1.
- Read the frequency output of the VFDs and record in Table 1.

c. Terminal Units Satisfied (Boxes at Min)

Readjust thermostats to actual room temperatures to simulate a satisfied condition. Boxes should close to the minimum position.

- Measure or read the duct static pressure and record in column C of Table 1.
- Read the frequency output of the VFDs and record in Table 1.

d. Verify Static Pressure Sensor/Transmitter

Using a magnehelic gauge, record actual static pressure at the location of the sensor and record static pressure indicated by the BMS

Actual Static Pressure _______________

BMS Static Pressure _______________

Is the variance less than 5%? _____________ If no, investigate problem.

5. Test Data

Design Static Pressure (in.)_______________

Design Frequency (Hz): SF ___________ RF ___________

Design RPM: SF ___________ RF ___________

SP Setpoint during test (in.) _______________

Table 1.

Test Data	A Boxes at Max position		B Boxes Partially Open		C Boxes at Min position	
	SF	RF	SF	RF	SF	RF

VFD Frequency or RPM						
Static Pressure during Test						

6. Analysis

a. Compare the full open frequency or RPM to the design values for the supply fan. Divide the design value by the reading in Column A. If the percentage is less than 95%, all boxes may not have driven to the full open position. Investigate possible problems.

Is the variance less than 5%? _______________

b. Is the static pressure recorded in Columns B & C within 10% of the setpoint?
Is the variance less than 5%? ________________

c. The SP during the full open condition should be significantly less than the partially loaded conditions and close to the value calculated in Attachment A (within 0.15 inches). If not, investigate possible problems.

Compliance? ______________

7. General Issues

a. Verify that power quality requirements from the specifications have been completed.

b. Record results and include in the Operation and Maintenance Manuals.

c. Certification and Witness

Performance Partner ____

Client ____

Ameresco ____

Functional Performance Test (FPT) Report

VFD – Pump Application

Project:________________________________ Date:_____________________________________

Pump No.:_____________________________

System:________________________________ Location:__________________________________

Functional Performance Test: Performance Partner shall verify the operation of the variable frequency drive for control of a variable pumping system for compliance with the contract documents. As a minimum, the following items shall be tested and/or recorded:

1. **General Information**

   VFD manufacturer and model no. ____

   Pump HP:_________ GPM: ___________ Head (ft): __________

2. **Differential Sensor/Transmitter**

   Verify location of the differential pressure sensor.

   (Ideally, the sensor should be located at or near the last branch takeoff)

   Location __________________

3. **Functional Performance Test**

   a. Intermediate Flow – Valves Partially Opened
   It is expected to find the system in this condition.

      – Read the speed, DP at the sensor, and gpm in the loop, if available, and record in condition 3, in Table 1.

   b. Design Flow – Valves Full Open

   (maximum cooling or heating)

- Set the space temperature setpoints 10ºF below the current space temperature for cooling valves and 10ºF above the space temperature for heating so that all valves modulate to the full open position.
- Read the speed, DP at the sensor, and gpm in the loop, if available, and record in condition 2, in Table 1.

c. Minimum Flow – Valves Shut
(minimum cooling or heating)

- Set the space temperature setpoints equal to the current space temperature so that all conditions are satisfied, driving all valves to the minimum or closed position.
- Read the speed, DP at the sensor, and gpm in the loop, if available, and record in condition 4, in Table 1.

4. Test Data

Design Differential Pressure (psig)_______________

Design Frequency (Hz): ___________

Design RPM: ___________

DP Setpoint during test (psig) _______________

(The operating setpoint shall be determined using the procedure listed in attachment A)

Table 1.

Condition	Pump No.	Speed (Hz or RPM)		DP at Sensor (psig)		Total Flow (GPM)
		Unit	Avg	Unit	Avg	
1. At design flow by TAB report	Pump - 1					
	Pump - 2					
	Pump - 3					
2. At design flow (during commissioning)	Pump - 1					
	Pump - 2					
	Pump - 3					
3. At intermediate	Pump - 1					

flow (during commissioning)	Pump - 2					
	Pump - 3					
4. At minimum flow (during commissioning)	Pump - 1					
	Pump - 2					
	Pump - 3					

5. Analysis

a. During operation of each pump combination, the average DP readings for all conditions should remain within 10% of each other. If not, investigate problems.

Is the variance less than 5%? _______________

b. At no flow, Condition 4, is the flow and DP zero or equal to the minimum by-pass flows?

Compliance? ____________

c. Is the system balanced to the lowest DP? **Compliance?** ____________

6. General Issues

a. Verify that power quality requirements from the specifications have been completed.
Compliance? ___________

b. Verify that there are no 3-way valves in the piping system that may negate the savings from the VFD by allowing flow to bypass the coils.
Complete? ___________

c. Verify that the VFD control has been integrated into the BMS as specified.
Complete? ___________

7. Record results and include in the Operation and Maintenance Manuals.

8. Certification and Witness

Performance Partner ____

Client ____

Ameresco ____

COMMISSIONING DATA SHEET

AIR HANDLING UNIT

PROJECT NAME:_____________________________________ DATE: ___________________

LOCATION:____

UNIT NO.:____ COMPLETED BY: ___________________

Service/Location: ____________________

Manufacturer: ____________________

Model Number: ____________________

Serial Number: ____________________

*** Complete/Attach Data Sheet for the Supply Fan**

*** Complete/Attach Data Sheet for the Return Fan**

DATA	**DESIGN**	**ACTUAL**
Total Airflow Rate (cfm)		
Total System Static Pressure (in. of water)		
Discharge Static Pressure		
Filter Differential Static Pressure		
Coil(s) Differential Static Pressure		
Outside Air DB/WB		
Return Air DB/WB		
Mixed Air DB/WB		
Supply Air DB/WB		
Coil(s) Face Velocity (fpm)		
Ent/Lvg Chilled Water Temperature, if applicable		
Ent/Lvg Hot Water Temperature, if applicable		
Inlet Steam Pressure, if applicable		

CHECK	**COMPLETE**
Condensate Removal (Cond. piping is not obstructed)	
Lubrication	
Damper Operation	
Filters Installed	

Functional Performance Test (FPT) Report

VFD – VAV Fan Application

Project:______________________________ Date: ___________________________________

Air Handling Unit No.:___________________

System:______________________________ Location:________________________________

Functional Performance Test: Performance Partner shall verify the operation of the variable frequency drive for control of a variable air volume system for compliance with the contract documents. As a minimum, the following items shall be tested and /or recorded:

1. **General Information**

   VFD manufacturer and model no. ____

   Supply Fan (SF) HP:_________ CFM: ___________ RPM: __________ SP: __________

   Return Fan (RF) HP:_________ CFM: ___________ RPM: __________ SP: __________

2. **Static Pressure Sensor/Transmitter**

   a. Verify location of the static pressure sensor in % of the distance from fan to terminal unit. (Normally, the sensor should be located 2/3 to 3/4 downstream of the fan to the terminal unit of the most restrictive branch)

      Distance _________________%

   b. Pressure Reading Reliability

      - Duct diameter or equivalent diameter _____________________
      - Nearest duct fitting upstream ______________________
      - Nearest duct fitting downstream _______________________
      - (Ideally, the most reliable readings occur when the sensor is at least 10 duct diameters downstream and 5 duct diameters upstream from takeoffs or fittings)
      - **Does the location comply?** ______________

3. Functional Performance Test

a. Terminal Units Full Cooling (Boxes at Max)

Adjust all space temperature setpoints at least 10ºF below design setpoints. All zones should be in full cooling and terminal units should be open to the maximum position.

- Measure or read the duct static pressure and record in column A of Table 1.
- Read the frequency output of the VFDs and record in Table 1.

b. Terminal Units Intermediate Position (Boxes Partially Opened)

Readjust thermostats to a few degrees below normal setpoints, to simulate an approaching thermostat satisfaction and take readings.

- Measure or read the duct static pressure and record in column B of Table 1.
- Read the frequency output of the VFDs and record in Table 1.

c. Terminal Units Satisfied (Boxes at Min)

Readjust thermostats to actual room temperatures to simulate a satisfied condition. Boxes should close to the minimum position.

- Measure or read the duct static pressure and record in column C of Table 1.
- Read the frequency output of the VFDs and record in Table 1.

d. Verify Static Pressure Sensor/Transmitter

Using a magnehelic gauge, record actual static pressure at the location of the sensor and record static pressure indicated by the BMS

Actual Static Pressure ______________

BMS Static Pressure ______________

Is the variance less than 5%? ____________ If no, investigate problem.

4. Test Data

Design Static Pressure (in.)______________

Design Frequency (Hz): SF __________ RF __________

Design RPM: SF __________ RF __________

SP Setpoint during test (in.) ______________

Table 1.

Test Data	**A** Boxes at Max position		**B** Boxes Partially Open		**C** Boxes at Min position	
	SF	RF	SF	RF	SF	RF
VFD Frequency or RPM						
Static Pressure during Test						

5. **Analysis**

   a. Compare the full open frequency or RPM to the design values for the supply fan. Divide the design value by the reading in Column A. If the percentage is less than 95%, all boxes may not have driven to the full open position. Investigate possible problems.

   Is the variance less than 5%? _______________

   b. Is the static pressure recorded in Columns B & C within 10% of the setpoint?
   Is the variance less than 5%? ________________

   c. The SP during the full open condition should be significantly less than the partially loaded conditions and close to the value calculated in Attachment A (within 0.15 inches). If not, investigate possible problems.

   Compliance? ______________

6. **General Issues**

   Verify that power quality requirements from the specifications have been completed.

7. **Record results and include in the Operation and Maintenance Manuals.**

8. **Certification and Witness**

   Performance Partner ____

   Client ____

   Ameresco ____

Attachment A

To ensure that the energy savings are maximized, the system must be operated at the lowest static pressure (SP) possible. The objective is to find the lowest SP at the sensor that will allow full design flow at the terminal unit most difficult to satisfy (the duct run with the greatest pressure losses). The system minimum SP determined should be the setpoint for the VFD.

The procedure for finding the system minimum static pressure is as follows:

1. Manually or automatically set the temperature setpoints for all zones to 55 F, which should cause all units to open to the maximum position.
2. The airflow at each terminal unit should be measured and compared to the design flow.
3. The terminal unit receiving the lowest fraction of the design flow should be identified.
   (It should be the unit with the longest duct run, most fittings, etc.)
4. The SP at the controlling sensor should be noted.
5. A calculation should be made to determine the static pressure at the sensor that will allow the critical terminal unit to achieve its design flow.
   SP (setpoint) = SP (at the sensor from Step 4) X (1 / (fraction of flow from Step 3)^2)

It should be noted that if all terminal units were calling for full cooling simultaneously, the fan may not be able to achieve the SP setpoint calculated in Step 5 due to diversity allowances made by the design engineer.

Section 7:
Measurement & Verification Plan

Site Specific Plan

Ameresco has based its verification pricing on a short-term plan with certain instantaneous measurements performed at commissioning to ensure audit savings projections are met, and on-going monitoring over the project term to assist the Town in operating at peak efficiency throughout the project term. This approach allows Ameresco to be a long-term partner of the Town while minimizing the on-going cost of verification and thereby allowing significantly more capital improvements to be funded.

The above approach to verification minimizes the effect of inevitable changes at the facility, while still ensuring the Town savings will be realized. Other verification approaches require adjustments for changes outside of the ESCO's control and can result in conflicts about the true magnitude of the adjustment. Our recommended approach preserves the ability to recognize savings while minimizing the long-term potential for conflicts.

In addition to the services described herein, Ameresco will also provide the Town with a utility comparison highlighting usage for the current period versus baseline usage after any applicable adjustments. The utility comparison will encompass electric and gas utilities affected by the ECMs in the following locations:

Curtis Middle School
Haynes Elementary
Loring Elementary
Nixon Elementary
Noyes Elementary
Public Library

Such utility comparison shall not impact the reconciliation of Guaranteed Savings. However, Ameresco will provide reasonable assistance to the Town to identify reasons for variations between the actual utility use and post retrofit utility use anticipated to result from the implemented ECMs.

The following table outlines the measurement and verification plan included for this project.

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Measurement & Verification Summary Matrix

The matrix below represents a summary of specific details included in the attached Site-Specific M&V Plan.

ECM	Minimum Baseline M&V Requirements	Minimum Post Installation M&V Requirement	Metered or Measured Variables	Stipulated Variables	Minimum Performance Period M&V Requirements
ECM-1: Lighting System Improvements	Fixture wattages will be from an industry standard wattage table. Operating hours to be based on information provided by the Town.	Input power and foot-candles for a statistically significant sample of retrofitted fixtures will be measured at time of commissioning. Power measurements will be compared to values in the energy audit and foot candle readings will be compared to "IES" tables.	One time instantaneous power using a true RMS power meter and foot candle readings.	Baseline and post-installation (subject to one-time post-retrofit measurements) fixture power draw. Operating hours from energy audit. Interactive effects.	Adjust savings to measured results if beyond +/- 10% from energy audit values. Post-retrofit foot-candle readings will be provided for reference only. Ameresco will visually inspect a sample of lamps to verify the lamp types are as efficient as those proposed in the energy audit.
ECM-3: Integrated and New Energy Management System	Pre-retrofit parameters are based on industry information and energy audit data collection. Space temperatures and motor run hours sampled during energy audit.	Monitoring of equipment operating hours and space temperatures.	Trend readings of temperature and set points as well as set points for operating parameters over 4 weather bins at time of commissioning, up to a maximum of 4 weeks. Quarterly monitoring of post installation operating hours, set-points, and space temperatures will be performed. (for trendable systems only)	Load profile in weather bins. Pre- and post-retrofit variables. Operating hours	Annual inspection of installed systems to identify ability to maintain persistence of savings. Quarterly monitoring and reporting of operating hours, set-points, and space temperatures. (for trendable systems only) Annual inspection of schedules and set-points. (for non-trendable systems)
ECM-4: Programmable Thermostats	Pre-retrofit parameters are based on industry information and energy audit data collection. Space temperatures and motor run hours sampled during energy audit.	Commissioning of system to ensure installed to perform as designed.	N/A	Load profile in weather bins. Pre- and post-retrofit variables. Operating hours	Annual inspection of installed systems to identify ability to maintain persistence of savings including schedules and set-points.
ECM-5: PC Load Management	Survey the computers to determine counts.	Verify CPU and monitor operating policies are in place and being followed	N/A	Operating Run Hours and computer energy use.	Annual inspection of installed systems to identify ability to maintain persistence of savings
ECM-6: Demand Control Ventilation	Baseline parameters are based on industry information and the energy audit	Commissioning of system to ensure installed to perform as designed.	No variables will be specifically metered or measured. Quarterly monitoring of post installation operating hours and CO_2 setpoints in conjunction with ECM-3. (for trendable systems only)	Load profile in weather bins. Pre- and post-retrofit variables. Operating hours	Annual inspection of installed systems to identify ability to maintain persistence of savings. Quarterly monitoring and reporting of operating hours and CO_2 setpoints. (for trendable systems only)
ECM-7: Variable Frequency Drives	Baseline parameters are based on industry information and the energy audit	Monitoring of motor speed.	Post-retrofit measurements based on performance over at least a 24 hour period, incorporating at least three temperature bins at time of commissioning.	Load profile in weather bins. Operating hours.	Adjust savings to measured results if beyond +/- 10% from energy audit values. Annual inspection of installed systems to identify ability to maintain persistence of savings.
ECM-9: Vending Machine Controls	Survey the machines to verify counts.	Verify controllers are in place and being used	NA	Operating Run Hours and machine energy use.	Annual inspection of installed systems to identify ability to maintain persistence of savings.
ECM-11: Weatherization	Baseline parameters are based on industry information and the energy audit	Commissioning of system to ensure installed to perform as designed.	N/A	Heat transfer rates, infiltration amounts, space temperatures and operating hours of system.	Annual inspection of installed systems to identify ability to maintain persistence of savings.
ECM-22: Pipe Insulation	Baseline parameters are based on industry information and the energy audit	Commissioning of system to ensure installed to perform as designed.	N/A	Heat transfer rates and operating hours of system.	Annual inspection of installed systems to identify ability to maintain persistence of savings.
ECM 25: Efficient Showerheads	Usage and flow rates are based on industry information and energy audit.	Water Usage for a statistically significant sample size of measureable retrofitted fixtures will be measured at time of commissioning.	Flow rates for a statistically significant sample size of measureable fixtures	Baseline and post-installation (subject to one-time post-retrofit measurements) fixture water usage. Occurrences.	Adjust savings to measured results if beyond +/- 10% from energy audit values. Ameresco will visually inspect a sample of fixtures to verify the fixture types are as efficient as those proposed in the energy audit.

ECM	Minimum Baseline M&V Requirements	Minimum Post Installation M&V Requirement	Metered or Measured Variables	Stipulated Variables	Minimum Performance Period M&V Requirements
ECM 29: Replace Transformers	Baseline power draws are based on nameplate data collected during the energy audit.	Measurement of transformer input and output power consumption and efficiency of a statistically significant sample size of transformers at commissioning.	Measurement of power consumption and no load losses at post retrofit conditions.	Operating hours of the transformers and loading from baseline measurements.	Adjust savings to measured results if beyond +/- 15% from energy audit values. Annual inspection of installed systems to identify ability to maintain persistence of savings

ECM 1: Lighting System Improvements

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = LightingSavings - Heat + Cool$$

$$LightingSavings = DemandSavings + EnergySavings$$

$$DemandSavings = BaselineDemand - PostDemand$$

$$EnergySavings = BaselineEnergy - PostEnergy$$

$$BaselineDemand = \sum_{buildings}\sum_{fixtures}\left(kW_{Base} \times Months \times \$/_{kW}\right)$$

$$PostDemand = \sum_{buildings}\sum_{fixtures}\left(kW_{retro} \times Months \times \$/_{kW}\right)$$

$$BaselineEnergy = \sum_{buildings}\sum_{fixtures}\left(kW_{Base} \times Hrs_{Base(peak/offpeak)} \times \$/_{kWh_{(peak/offpeak)}}\right)$$

$$PostEnergy = \sum_{buildings}\sum_{fixtures}\left(kW_{Retro} \times Hrs_{Base(peak/offpeak)} \times \$/_{kWh_{(peak/offpeak)}}\right)$$

$$Heat =$$

$$\sum_{buildings}\sum_{fixtures}\left(\frac{(kW_{Base} - kW_{Retro}) \times Hrs_{Base} \times \frac{Mths_{heat}}{12months} \times 3{,}413\, {}^{btu}/_{kWh} \times Util}{Boiler_{Eff} \times 1{,}000{,}000\, {}^{btu}/_{mmbtu}} \times \$/_{mmbtu}\right)$$

$$Cool =$$

$$\sum_{buildings}\sum_{fixtures}\left(\frac{(kW_{Base} - kW_{Retro}) \times Hrs_{Base(peak/offpeak)} \times \frac{Mths_{cool}}{12months} \times Util \times Cool\%}{Cool_{Eff}} \times \$/_{kWh_{(peak/offpeak)}}\right)$$

Where:

kW_{Base} - Base fixture kW, as per lighting audit calculation included in the energy audit

kW_{Retro} - Retrofit fixture kW, as per lighting audit calculation included in the energy audit, subject to metering described below

Months - Number of months demand savings will occur factored for coincidence, as per lighting audit calculation included in the energy audit

Hrs_{Base} - Baseline fixture operating hours broken out into peak and offpeak, as per lighting audit calculation included in the energy audit

$Boiler_{Eff}$ - Average heating system efficiency, as per lighting audit calculation included in the energy audit

$Cool_{Eff}$ - Average cooling system performance (COP), as per lighting audit calculation included in the energy audit

Util - Factor representing the amount of energy transmitted to the space, as per lighting audit calculation included in the energy audit

Cool% - Factor representing the amount space with cooling, as per calculation in the energy audit

$Mths_{heat}$ - Number of months the heating penalty will occur, as per lighting audit calculation included in the energy audit

$Mths_{cool}$ - Number of months the cooling benefit will occur, as per lighting audit calculation included in the energy audit

$/kW - Unit cost of electric demand, as per Unit Prices section

$\$/kWh_{peak}$ - Unit cost of peak electric energy, as per Unit Prices section

$\$/kWh_{offpeak}$ - Unit cost of offpeak electric energy, as per Unit Prices section

$/mmbtu - Unit cost of fossil fuel, as per Unit Prices section

Metering Plan

Ameresco will measure the post-installation fixture input power for a statistically significant sample size of the retrofit fixtures, and if the total sample values are within 10% of the energy audit values no change will be made. If the total sample values are not within 10%, Ameresco will either take corrective action for them to be within this limit, or will utilize the measured values. Post-retrofit light level measurements for a sample of areas will be provided to the Town for reference. A "true-up" will be provided in spreadsheet format which will detail the measurement results and any savings guarantee adjustments.

Ameresco will use a calibrated hand held RMS meter (Fluke or equivalent) to measure power readings (kW, V, Amps, PF) from the lighting systems. These measurements can include individual fixtures or single lighting circuits with multiple fixtures of the same type and will continue until the sample size for each lighting group has been achieved. Fixtures to be metered must have at least 100 hours of operation following retrofit. Measurements shall be made only after the fixtures have reached steady state operating temperature and space temperatures are within normal occupied ranges.

The wattage measurements for each sample group will be averaged together. These averages will then be summed for all sample groups in order to determine the total measured wattage for the entire lighting sample. The difference between the total measured sample wattage and the total proposed wattage for the same sample will be subject to the 10% hurdle. If the difference is not within the 10% hurdle, the proposed wattage in the energy audit for the entire lighting project will be multiplied by the measured percentage difference and substituted into the energy audit calculation. The resulting savings will become the actual savings for this ECM. Interactive savings are stipulated and will not be part of the comparison.

Preliminary Lighting Metering Sample

Sudbury - Lighting Sample Counts*

Post Description	Flynn Building	Public Library	DPW Highway	Fire Dept Headquarters	Curtis Middle School	Loring Elementary	Haynes Elementary	Nixon Elementary	Total Sample Count	Total Fixture Count
2L2' T8 15w/ELEE HI/RFL		1		1	10	5			17	466
2L2' T8 15w/ELEE LO					16				16	137
2L4' T8 28w/ELEE LO	2	1			7		4	3	17	699
2L4' T8 28w/ELEE LO-8'					15		1	1	17	359
3L4' T8 28w/ELEE LO		2		2	7	4		1	16	186
4L4' T8 28w/ELEE LO-8'	1	2			5	1	3	5	17	1226
Grand Total	3	6	0	3	60	10	8	10	100	3073

* Sample based on FEMP Guidelines with 90% Confidence, 20% Precision, & Coefficient Variation = 0.5.

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ECM 3: Integrated and New Energy Management Systems

ECM 4: Programmable Thermostats

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = Motors + Heating + Cooling$$

$$Motors = ElecBase - ElecPost$$

$$ElecBase = \sum_{buildings}\left(kW_{Base} \times Hrs_{Base(peak/offpeak)} \times \$ / kWh_{(peak/offpeak)} \right)$$

$$ElecPost = \sum_{buildings}\left(kW_{Base} \times Hrs_{Retro(peak/offpeak)} \times \$ / kWh_{(peak/offpeak)} \right)$$

$$Heating = HeatBase - HeatPost$$

$$HeatBase =$$

$$\sum_{buildings}\left[\sum_{Bin}^{Heating}\left(\frac{Load_{OccBase} \times Hrs_{OccBase} + Load_{UnoccBase} \times Hrs_{UnoccBase}}{Eff \times 1{,}000\, mbtu / mmbtu} \right) \times \$ / mmbtu \right]$$

$$HeatPost =$$

$$\sum_{buildings}\left[\sum_{Bin}^{Heating}\left(\frac{Load_{OccRetro} \times Hrs_{OccRetro} + Load_{UnoccRetro} \times Hrs_{UnoccRetro}}{Eff \times 1{,}000\, mbtu / mmbtu} \right) \times \$ / mmbtu \right]$$

$$Cooling = CoolBase - CoolPost$$

$$CoolBase =$$

$$\sum_{buildings}\left[\sum_{Bin}^{Cooling}\left(\frac{Load_{OccBase} \times Hrs_{OccBase(peak/offpeak)} + Load_{UnoccBase} \times Hrs_{UnoccBase(peak/offpeak)}}{COP \times 3.413\, mbtu / kWh} \right) \times \$ / kWh_{(peak/offpeak)} \right]$$

$$CoolPost =$$

$$\sum_{buildings}\left[\sum_{Bin}^{Cooling}\left(\frac{Load_{OccRetro} \times Hrs_{OccRetro(peak/offpeak)} + Load_{UnoccRetro} \times Hrs_{UnoccRetro(peak/offpeak)}}{COP \times 3.413\, mbtu / kWh} \right) \times \$ / kWh_{(peak/offpeak)} \right]$$

Where:

kW_{Base} - Total fan and pump motor kW under EMS control, as per calculation in the energy audit

Hrs_{Base} - Base motor operating hours broken out into peak and offpeak, as per calculation in the energy audit

Hrs_{Retro} - Retrofit motor operating hours broken out into peak and offpeak, as per calculation in the energy audit

$Load_{OccBase}$ - Building load per bin, including infiltration load, (mbtu/hr) under current conditions during occupied hours, as per calculation in the energy audit

$Load_{UnoccBase}$ - Building load per bin, including infiltration load, (mbtu/hr) under current conditions during unoccupied hours, as per calculation in the energy audit

$Load_{OccRetro}$ - Building load per bin, including infiltration load, (mbtu/hr) with reduced setpoint temperature and improved control, as per calculation in the energy audit

$Load_{UnoccRetro}$ - Building load per bin, including infiltration load, (mbtu/hr) with night setback and improved control, as per calculation in the energy audit

$Hrs_{OccBase}$ - Baseline heating and cooling bin hours during occupied period broken out into peak and offpeak, as per calculation in the energy audit

$Hrs_{UnoccBase}$ - Baseline heating and cooling bin hours during unoccupied period broken out into peak and offpeak, as per calculation in the energy audit

$Hrs_{OccRetro}$ - Retrofit heating and cooling bin hours during occupied period broken out into peak and offpeak, as per calculation in the energy audit

$Hrs_{UnoccRetro}$ - Retrofit heating and cooling bin hours during unoccupied period broken out into peak and offpeak, as per calculation in the energy audit

Eff - Heating system efficiency, as per calculation in the energy audit

COP - Cooling system coefficient of performance, as per calculation included in the energy audit

$\$/kWh_{peak}$ - Unit cost of peak electric energy, as per Unit Prices section

$\$/kWh_{offpeak}$ - Unit cost of offpeak electric energy, as per Unit Prices section

$/mmbtu - Unit cost of fossil fuel, as per Unit Prices section

Metering Plan – (Direct Digital Controls)

Upon completion of the installation, Ameresco will commission the energy management system and test its functionality to ensure the ability of savings as specified in the energy audit to occur, as per the Commissioning Plan in Section 6. Monitoring of equipment operating hours and space temperatures will be completed in detail to verify the performance of the new EMS over at least 4 weather bins at time of commissioning, up to a maximum of 4 weeks. Performance of the new EMS shall be considered verified once all time schedules are shown to turn on and off controlled equipment per the programmed times and temperature setpoints, both occupied and unoccupied are substantially achieved. Additionally, the commissioning report for the EMS, completed during construction, will be attached to the first Annual Measurement and Verification report to confirm the EMS is commissioned per the designed intent. Trends will be setup to track operating hours and temperatures per the final commissioning plan developed during the design and construction phase.

Metering Plan – Programmable Thermostats

Upon completion of the installation, Ameresco will commission the programmable thermostats and boiler controls and test their functionality to ensure the ability of savings as specified in the energy audit to occur, as per the Commissioning Plan in Section 6. No measurements will be taken.

Occupied Scheduling – Direct Digital Controls

Ameresco will initially setup the occupancy schedules in the EMS to reflect the current occupancy of the buildings. The HVAC systems will only be operated when the buildings are supposed to be occupied. Other areas of the buildings like offices and gymnasiums can have slightly longer schedules to reflect occupancy outside of the normal occupancy; however, classroom systems will be turned off based on the bell schedule. The vacation schedule will also be initially setup in the system to turn off equipment on vacation days. The Town will be responsible for updating the vacation and special days schedule to ensure the systems are not operating when the buildings are not occupied.

Schedule	**M&V Operating Schedule**						
	Monday - Friday		Weekends				
Programmable Thermostats	On	Off	On	Off	Annual Occupied Hours	Additional Hrs. for Areas with Longer Occ.	Weighted Average Annual Occupied Hours used in EMS Calculation
Loring Elementary	8:00 AM	3:00 PM	Off	Off	1,585	441	2,026
Noyes Elementary	8:30 AM	3:30 PM	Off	Off	1,585	272	1,856
Haynes Elementary	8:30 AM	3:30 PM	Off	Off	1,585	272	1,856
Nixon Elementary	8:30 AM	3:30 PM	Off	Off	1,585	283	1,868

Occupied Scheduling – Programmable Thermostats

Ameresco will initially setup the occupancy schedules in the programmable thermostats to reflect the current occupancy of the buildings. The HVAC systems will only be operated when the buildings are supposed to be occupied.

Schedule	**M&V Operating Schedule**						
	Monday - Friday		Weekends				
EMS	On	Off	On	Off	Annual Occupied Hours	Additional Hrs. for Areas with Longer Occ.	Weighted Average Annual Occupied Hours used in EMS Calculation
DPW Highway	6:00 AM	3:30 PM	Off	Off	2,346	130	2,477

ECM 5: PC Load Management

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = EnergySavings - Heat + Cool$$

$$EnergySavings =$$

$$\sum_{machine}\left(kW \times \left(Hrs_{Base(peak/offpeak)} - Hrs_{Retro(peak/offpeak)}\right) \times \$/_{kWh_{(peak/offpeak)}}\right)$$

$$Heat =$$

$$\sum_{machine}\left(\frac{kW \times \left(Hrs_{Base} - Hrs_{Retro}\right) \times \frac{Mths_{heat}}{12months} \times 3{,}413\, btu/_{kWh} \times Util}{Boiler_{Eff} \times 1{,}000{,}000\, btu/_{mmbtu}} \times \$/_{mmbtu}\right)$$

$$Cool =$$

$$\sum_{machine}\left(\frac{kW \times \left(Hrs_{Base(peak/offpeak)} - Hrs_{Retro(peak/offpeak)}\right) \times \frac{Mths_{cool}}{12months} \times Util \times \mathrm{Cool\%}}{Cool_{Eff}} \times \$/_{kWh_{(peak/offpeak)}}\right)$$

Where:

kW - Computer kW, as per calculation in the energy audit

Hrs_{Base} - Total base operating hours broken out into peak and offpeak, as per calculation in the energy audit

Hrs_{Retro} - Total retro operating hours broken out into peak and offpeak, as per calculation in the energy audit

$Mths_{heat}$ - Number of months the heating penalty will occur, as per calculation in the energy audit

$Mths_{cool}$ - Number of months the cooling benefit will occur, as per calculation in the energy audit

$Boiler_{Eff}$ - Average heating system efficiency, as per calculation in the energy audit

$Cool_{Eff}$ - Average cooling system performance (COP), as per calculation in the energy audit

Util - Factor representing the amount of energy transmitted to the space, as per calculation in the energy audit

Cool% - Factor representing the amount space with cooling, as per calculation in the energy audit

$/mmbtu - Unit cost of fossil fuel, as per Unit Prices section below

$\$/kWh_{peak}$ - Unit cost of peak electric energy, as per Unit Prices section

$\$/kWh_{offpeak}$ - Unit cost of offpeak electric energy, as per Unit Prices section

Metering Plan

No measurements will be taken for this ECM.

ECM 6: Demand Control Ventilation

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = FuelBase - Fuel\,Retro$$

$$FuelBase = \sum_{Building}\sum_{Bin}\left(\frac{Load_{Base}\times Hrs_{BaseHeat}}{Eff \times 1{,}000\,{}^{mbtu}\!/_{mmbtu}}\right)\times {}^{\$}\!/_{mmbtu}$$

$$Fuel\,Retro = \sum_{Building}\sum_{Bin}\left(\frac{Load_{Retro}\times Hrs_{RetroHeat}}{Eff \times 1{,}000\,{}^{mbtu}\!/_{mmbtu}}\right)\times {}^{\$}\!/_{mmbtu}$$

Where:

$Load_{Base}$ - Building load {mbtu/hr} after EMS savings are accounted for, as per calculation in the energy audit

$Load_{Retro}$ - Building load {mbtu/hr} CO_2 control, as per calculation in the energy audit

$Hrs_{BaseHeat}$ - Base bin hours for each heating period, occ/unocc, as per calculation in the energy audit

$Hrs_{RetroHeat}$ - Retrofit bin hours for each heating period, occ/unocc, as per calculation in the energy audit

Eff - Average heating system efficiency, as per calculation in the energy audit

\$/mmbtu - Unit cost of fossil fuel, as per Unit Prices section below

Metering Plan

Upon completion of the installation, Ameresco will commission the CO_2 sensors and test their functionality to ensure the ability of savings as specified in the energy audit to occur. Monitoring of equipment operating hours and CO_2 will be completed to verify the performance of the new CO_2 sensors in conjunction with the EMS measurement and verification plan. Trends will be setup to track operating hours and CO_2 levels per the final commissioning plan developed during the design and construction phase.

No measurements will be taken for this ECM.

ECM 7: Variable Frequency Drives

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = Baseline - PostInstallation$$

$$Baseline = \sum_{Building} \left(kW \times Hours_{(peak/offpeak)} \times \$ / kWh_{(peak/offpeak)} \right)$$

$$Postinstallation = \sum_{Building} \left(Usage_{(peak/offpeak)} \times \$ / kWh_{(peak/offpeak)} \right)$$

Where:

kW	-	Base motor kW, as per calculation in the energy audit
Hours	-	Run hours of each applicable motor broken out into peak and off peak, as per calculation in the energy audit
Usage	-	Energy usage of each motor with VFD control, broken out into peak and offpeak, as per calculation in the energy audit
$\$/kWh_{peak}$	-	Unit cost of peak electric energy, as per Unit Prices section
$\$/kWh_{offpeak}$	-	Unit cost of offpeak electric energy, as per Unit Prices section

Metering Plan

Ameresco will confirm performance of the variable frequency drives by trending fan or pump speed over the course of at least one representative 24-hour period (operation across at least three 5 degree F temperature BINs). Trending will be extended to longer than 24 contiguous hours if necessary to capture a three bin operating range. If the fan or pump speed modulates based upon system loading and is able to turn down below the speed referenced in the energy audit, no change will be made. The mildest temperature BIN measured, plus 10%, will be compared to the same temperature bin in the savings calculation. If the fan or pump does not modulate as predicted, Ameresco will either take corrective action and remeasure, or will recalculate the savings using measured performance data as inputs into the energy audit savings analysis.

ECM 9: Vending Machine Controls

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = EnergySavings - Heat + Cool$$

$$EnergySavings =$$

$$\sum_{machine}\left(kW \times \left(Hrs_{Base(peak/offpeak)} - Hrs_{Retro(peak/offpeak)}\right) \times {}^{\$}\!/_{kWh_{(peak/offpeak)}}\right)$$

$$Heat =$$

$$\sum_{machine}\left(\frac{kW \times \left(Hrs_{Base} - Hrs_{Retro}\right) \times \frac{Mths_{heat}}{12months} \times 3{,}413\,{}^{btu}\!/_{kWh} \times Util}{Boiler_{Eff} \times 1{,}000{,}000\,{}^{btu}\!/_{mmbtu}} \times {}^{\$}\!/_{mmbtu}\right)$$

$$Cool =$$

$$\sum_{machine}\left(\frac{kW \times \left(Hrs_{Base(peak/offpeak)} - Hrs_{Retro(peak/offpeak)}\right) \times \frac{Mths_{cool}}{12months} \times Util \times Cool\%}{Cool_{Eff}} \times {}^{\$}\!/_{kWh_{(peak/offpeak)}}\right)$$

Where:

kW - Vending machine kW, as per calculation in the energy audit

Hrs_{Base} - Total base operating hours broken out into peak and offpeak, as per calculation in the energy audit

Hrs_{Retro} - Total retro operating hours broken out into peak and offpeak, as per calculation in the energy audit

$Mths_{heat}$ - Number of months the heating penalty will occur, as per calculation in the energy audit

$Mths_{cool}$ - Number of months the cooling benefit will occur, as per calculation in the energy audit

$Boiler_{Eff}$ - Average heating system efficiency, as per calculation in the energy audit

$Cool_{Eff}$ - Average cooling system performance (COP), as per calculation in the energy audit

Util - Factor representing the amount of energy transmitted to the space, as per calculation in the energy audit

Cool% - Factor representing the amount space with cooling, as per calculation in the energy audit

\$/mmbtu - Unit cost of fossil fuel, as per Unit Prices section below

$\$/kWh_{peak}$ - Unit cost of peak electric energy, as per Unit Prices section

$\$/kWh_{offpeak}$ - Unit cost of offpeak electric energy, as per Unit Prices section

Metering Plan

No measurements will be taken for this ECM.

ECM 11: Weatherization

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = Baseline - PostInstallation$$

$$Baseline =$$

$$\sum_{Building}\left(\sum_{Bin}^{Heating}\left(\frac{Load_{BaseOcc}\times Hrs_{Occ(peak/offpeak)}+Load_{BaseUnocc}\times Hrs_{Unocc(peak/offpeak)}}{Eff\times 1{,}000\,{}^{mbtu}\!/\!_{mmbtu}}\right)\times {}^{\$}\!/\!_{mmbtu} + \sum_{Bin}^{Cooling}\left(\frac{Load_{BaseOcc}\times Hrs_{Occ(peak/offpeak)}+Load_{BaseUnocc}\times Hrs_{Unocc(peak/offpeak)}}{COP\times 3.413\,{}^{mbtu}\!/\!_{kWh}}\right)\times {}^{\$}\!/\!_{kWh_{(peak/offpeak)}}\right)$$

$$PostInstallation =$$

$$\sum_{Building}\left(\sum_{Bin}^{Heating}\left(\frac{Load_{RetroOcc}\times Hrs_{Occ(peak/offpeak)}+Load_{RetroUnocc}\times Hrs_{Unocc(peak/offpeak)}}{Eff\times 1{,}000\,{}^{mbtu}\!/\!_{mmbtu}}\right)\times {}^{\$}\!/\!_{mmbtu} + \sum_{Bin}^{Cooling}\left(\frac{Load_{RetroOcc}\times Hrs_{Occ(peak/offpeak)}+Load_{RetroUnocc}\times Hrs_{Unocc(peak/offpeak)}}{COP\times 3.413\,{}^{mbtu}\!/\!_{kWh}}\right)\times {}^{\$}\!/\!_{kWh_{(peak/offpeak)}}\right)$$

$$Load_{Base/RetroOcc/Unocc} = \left(Infil_{Base/RetroOcc/Unocc}\right)$$

Where:

Infil	-	The infiltration load per bin (mbtu/hr) for either the base case or the retrofit case during either the occupied or unoccupied period, as per the calculation in the energy audit
Hrs_{Occ}	-	Bin hours for occupied period broken out into peak and off peak, as per calculation in the energy audit
Hrs_{Unocc}	-	Bin hours for unoccupied period broken out into peak and off peak, as per calculation in the energy audit
Eff	-	Heating system efficiency, as per calculation in the energy audit
COP	-	Cooling system coefficient of performance, as per calculation included in the energy audit
$/mmbtu	-	Unit cost of fossil fuel, as per Unit Prices section below
$\$/kWh_{peak}$	-	Unit cost of peak electric energy, as per Unit Prices section
$\$/kWh_{offpeak}$	-	Unit cost of offpeak electric energy, as per Unit Prices section

Metering Plan

No measurements will be taken for this ECM.

ECM 22: Pipe Insulation

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = \sum_{Heat}\left(Baseline_{Heat} - PostInstallation_{Heat}\right) + \sum_{Cool}\left(Baseline_{Cool} - PostInstallation_{Cool}\right)$$

$$Baseline_{Heat} = \sum_{Pipes}\left(\frac{LossRate_{Base} \times Hrs}{Eff \times 1000\,{}^{mbtu}\!/_{mmbtu}}\right) \times {}^{\$}\!/_{mmbtu}$$

$$PostInstallation_{Heat} = \sum_{Pipes}\left(\frac{LossRate_{Retro} \times Hrs}{Eff \times 1000\,{}^{mbtu}\!/_{mmbtu}}\right) \times {}^{\$}\!/_{mmbtu}$$

$$Baseline_{Cool} = \sum_{Pipes}\left(\frac{LossRate_{Base} \times Hrs}{COP} \times \frac{1{,}000\,{}^{btu}\!/_{mbtu}}{3{,}413\,{}^{btu}\!/_{kWh}}\right) \times {}^{\$}\!/_{kWh_{Peak}}$$

$$PostInstallation_{Heat} = \sum_{Pipes}\left(\frac{LossRate_{Retro} \times Hrs}{COP} \times \frac{1{,}000\,{}^{btu}\!/_{mbtu}}{3{,}413\,{}^{btu}\!/_{kWh}}\right) \times {}^{\$}\!/_{kWh_{Peak}}$$

Where:

$LossRate_{Base}$ - Existing pipe heat loss rate (mbtu/hr), as per calculation in energy audit
$LossRate_{Retro}$ - Proposed pipe heat loss rate (mbtu/hr), as per calculation in energy audit
Hrs - Total pipe run hours, as per calculation in energy audit
Eff - Base heating plant efficiency, as per calculation in energy audit
COP - Cooling system coefficient of performance, as per calculation included in energy audit
\$/mmbtu - Unit cost of fossil fuel, as per Unit Prices section below
$\$/kWh_{peak}$ - Unit cost of peak electric energy, as per Unit Prices section

Metering Plan

No measurements will be taken for this ECM.

ECM 25: Efficient Showerheads

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = Baseline_{Water} - Post_{Water}$$

$$OccDays = Occupants \times OccDays \times OccFact$$

$$Baseline_{Water} = \sum_{Fixture} \left[OccDays \times \left(Shower_{Base} \right) \times \$/kgal \right]$$

$$Shower_{Base} = UsageFactor_{Shower} \times FlowRate_{Shower_{Base}}$$

$$Post_{Water} = \sum_{Fixture} \left[OccDays \times \left(Shower_{Retro} \right) \times \$/kgal \right]$$

$$Shower_{Retro} = UsageFactor_{Shower} \times FlowRate_{Shower_{Retro}}$$

Where:

Occupants - Number of Occupants, as per calculation in energy audit
OccDays - Number of days occupants in facility, per year, as per calculation in energy audit
OccFact - Percentage of OccDays occupants actually in facility, as per calculation in energy audit
UsageFactor - Frequency of fixture usage (occurrences or time length), as per calculation in energy audit
$FlowRate_{Base}$ - Base fixture flow rate, as per calculation in energy audit
$FlowRate_{Retro}$ - Retrofit fixture flow rate, as per calculation in energy audit, subject to metering described below
UUF - Percentage of times urinal used with respect to toilet usage, as per calculation in energy audit
$/kgal - Unit cost of water and sewer, as per Unit Prices section below

Metering Plan

Ameresco will measure the post-installation consumption rate for a statistically significant sample size of measureable fixtures, and if the total sample values are within 10% of the energy audit values no change will be made. If the total sample values are not within 10%, Ameresco will either take corrective action for them to be within this limit, or will utilize the measured values. A "true-up" will be provided in spreadsheet format which will detail the measurement results and any savings guarantee adjustments.

A graduated container will be used to measure shower flow rates. At least three measurements will be taken for each metered fixture.

The flow rate measurements for each fixture type (showers) will be averaged together to determine the measured flow rate for each fixture type. The difference between the total measured sample flow rate and the total proposed flow rate for each fixture type will be subject to the 10% hurdle. If the differences are not within the 10% hurdle, the proposed flow rates in the energy audit for the particular fixture type will be multiplied by the measured percentage difference and substituted into the energy audit calculation. The sum of the resulting savings for each fixture type will become the actual savings for this ECM.

ECM 29: Replace Transformers

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = Baseline - PostInstallation$$

$$Baseline =$$

$$\sum_{transformer}\left(Usage_{Base_{(Peak/offPeak)}} \times \$/kWh_{(Peak/offPeak)} + kW_{Base} \times \$/kW\right)$$

$$PostInstallation =$$

$$\sum_{transformer}\left(Usage_{\mathrm{Retro}_{(Peak/offPeak)}} \times \$/kWh_{(Peak/offPeak)} + kW_{\mathrm{Retro}} \times \$/kW\right)$$

Where:

kW_{Base} - Baseline transformer kW, as per calculation in the energy audit

kW_{Retro} - Retrofit transformer kW, as per calculation in the energy audit, subject to metering described below

$Usage_{Base}$ - Baseline energy usage for transformers, as per calculation in the energy audit, subject to metering described below

$Usage_{Post}$ - Retrofit energy usage for transformers, as per calculation in the energy audit, subject to metering described below

\$/kW - Unit cost of electrical demand, as per Unit Prices section

$\$/kWh_{peak}$ - Unit cost of peak electric energy, as per Unit Prices section

$\$/kWh_{offpeak}$ - Unit cost of offpeak electric energy, as per Unit Prices section

Metering Plan

Ameresco will measure the input and output power for a statistically significant sample size of transformers after replacement, and if the total sample values are within 15% of the energy audit values no change will be made. If the total sample values are not within 15%, Ameresco will either take corrective action for them to be within this limit, or will utilize the measured values.

Measurement and Verification Report Services

ECM 1: Lighting System Improvements

Ameresco will perform a yearly site inspection of a sampling of the lighting systems to ensure that the lamp and ballast technologies that were installed are in operation and that future replacement lamps and ballasts are at least as efficient as the Ameresco installed technologies. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 3: Integrated and New Energy Management Systems

Ameresco will inspect the energy management system both quarterly and annually, as part of its site inspection. A review of available trend data will be performed, and a visual inspection of major control areas will be completed. Observations identified during the site inspection shall be incorporated into the annual reconciliation report.

Annual Inspection Procedures (General)

- Confirm that the system/equipment is functional and operating as intended.
- Verify that the system is being properly maintained. Review current O&M practices to ensure compliance with the contract requirements.
- Review current or past problems with the system, especially those that may affect energy savings.
- Identify any building renovations or changes in the facility operation during the past year that would affect the project performance and/or savings.

Quarterly Inspection Procedures (EMS)

- Review trend logs and compare with the standards established in the ESA.
- Review the notification history for set-points and occupancy schedules that have been modified since the last inspection.
- Recommend set-point and schedule adjustments – particularly those that do not comply with the contract standards.
- Review the basic system operation with new personnel and recommend training, if necessary.
- Review alarm history and discuss possible reasons and corrections.

ECM 4: Programmable Thermostats

Ameresco will inspect the programmable thermostats and boiler controls annually, as part of its site inspection. This inspection will include checking setpoints and schedules. Observations identified during the site inspection shall be incorporated into the annual reconciliation report.

Annual Inspection Procedures

- Confirm that the system/equipment is functional and operating as intended.

- Review set-point and schedule programming and compare with the standards established in the Agreement.
- Recommend set-point and schedule adjustments – particularly those that do not comply with the contract standards.

ECM 5: PC Load Management

Ameresco will perform a yearly site inspection of the computer load management server to ensure it is functional. Audit reports will be generated from the software to indicate whether power savings policies are in place. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 6: Demand Control Ventilation

The ongoing monitoring for the new CO_2 sensors will be completed with ECM-3, only for sensor connected to a direct digital control system with trending capability.

ECM 7: Variable Frequency Drives

Ameresco will perform a yearly site inspection of the variable frequency drives. This inspection will include a visual inspection of the drives to ensure they are operational and not in bypass. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 9: Vending Machine Controls

Ameresco will perform a yearly site inspection of the installed controllers to ensure they are operational. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 11: Weatherization

Ameresco will perform a yearly site inspection of a sampling of the installed infiltration reduction materials to ensure they are installed. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 22: Pipe Insulation

Ameresco will perform a yearly site inspection of a sampling of the installed insulation to ensure it is installed. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 25: Efficient Showerheads

Ameresco will perform a yearly site inspection of a sampling of the water fixtures to ensure that the showerhead technologies that were installed are in operation and that future replacement units are at least as efficient as the Ameresco installed technologies. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 29: Replace Transformers

Ameresco will perform a yearly site inspection of a sampling of the installed transformers to ensure they are installed. The observations during this inspection will be made part of the Annual Reconciliation Report.

Maintenance Savings

$$AnnualSavings = \$MAINT \Big/ year \times (1 + Esc)^{(CurrentYear - 2013)}$$

The maintenance savings breakdown per measure is as follows:

ECM	O&M Savings
ECM 1: Lighting System Improvements	$3,174
Totals	$3,174

ECM 1 O&M savings are based on reduced material replacements costs due to replacing old lamps and ballasts with new.

The variable “Esc” equals 3.0% for the term of the project and is described in the Unit Prices section.

Unit Prices Section

The following base unit prices are based on unit prices for the Town, as provided for purposes of this project. These unit prices were utilized in calculating the financial savings associated with modified energy use.

Electricity Costs:

$$\$/kW = Base\_kW \times (1+Esc)^{(CurrentYear-2013)}$$

$$\$/kWh_{peak} = Base\_kWh_{peak} \times (1+Esc)^{(CurrentYear-2013)}$$

$$\$/kWh_{offpeak} = Base\_kWh_{offpeak} \times (1+Esc)^{(CurrentYear-2013)}$$

The base for each location is listed in the following table.

Fossil Fuel Costs:

$$\$/mmbtu_{gas} = \frac{Base\_gas}{100\, mbtu/Therm} \times (1+Esc)^{(CurrentYear-2013)}$$

The base for each location is listed in the following table.

Water Costs:

$$\$/kgal = (Base\_water + Base\_sewer) \times (1+Esc)^{(CurrentYear-2013)}$$

The base for each location is listed in the following table.

Utility Escalation:

$$Esc = 3.0\%/yr$$

For the purposes of the calculations set forth in this verification plan, the Parties stipulate that all Base Year utility rates and avoided maintenance cost savings shall be cumulatively escalated at three percent (3.0%) for each successive twelve (12) month period commencing with the first twelve (12) month period following the date of the energy audit. This escalation rate will be fixed for the full term of the project and applied annually to all energy unit prices.

Utility Rate Tables:

Electricity Charges	Winter On-Peak (kWh)	Winter Off-Peak (kWh)	Winter Electric (kW)	Summer On-Peak (kWh)	Summer Off-Peak (kWh)	Summer Electric (kW)	Average On-Peak (kWh)	Average Off-Peak (kWh)	Average Electric (kW)
General Service – G-1	$0.1663	$0.1663	$0.00	$0.1943	$0.1943	$0.00	$0.1757	$0.1757	$0.00
General Service – G-2	$0.0997	$0.0997	$16.47	$0.1001	$0.1001	$38.88	$0.0998	$0.0998	$23.94
Time of Use – T-2	$0.0879	$0.0879	$20.20	$0.0879	$0.0879	$28.65	$0.0879	$0.0879	$23.02

The electric rate to be used for the calculation of dollar savings will be the winter rate unless depicted otherwise in the following table.

Facility	G-1	G-2	T-2	ECM-1	ECM-9	ECM-29
DPW Highway		X		Average	Average	
DPW Offices		X				
Flynn Building		X		Average		
Town Hall		X				
Fairbank Community Center		X			Average	
Public Library		X		Average		
Fire Department Headquarters		X		Average	Average	
Fire Department South	X				Average	
Fire Department North	X				Average	
Curtis Middle School			X	Average		Average
Loring Elementary School			X	Average	Average	Average
Noyes Elementary School		X			Average	
Haynes Elementary School			X	Average	Average	
Nixon Elementary School		X		Average	Average	

The fuel and water rates to be used for the calculation of dollar savings are depicted in the following table.

Facility	$/Therm Natural Gas	$/kGal Water	$/kGal Sewer
DPW Highway	$1.227	$4.000	$-
DPW Offices	$1.168	$4.000	$-
Flynn Building	$1.168	$4.000	$-
Town Hall	$1.227	$4.000	$-
Fairbank Community Center	$1.036	$4.000	$-
Public Library	$1.168	$4.000	$-
Fire Dept Headquarters	$1.168	$4.000	$-
Fire Dept South	$1.354	$4.000	$-
Fire Dept North	$1.354	$4.000	$-
Curtis Middle School	$1.168	$4.000	$-
Loring Elementary	$1.168	$4.000	$-
Noyes Elementary	$1.168	$4.000	$-
Haynes Elementary	$1.168	$4.000	$-
Nixon Elementary	$1.168	$4.000	$-

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