



Prepared for
Town of Salisbury, Massachusetts

May 15, 2014

Final Investment Grade Audit

Presented by

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Executive Summary

The Merrimack Valley Planning Commission (MVPC) issued a Request for Qualifications (RFQ) to Energy Service Companies (ESCOs) to provide for Comprehensive Energy Management Services for 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 assessment (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. The IGA will form the basis for the subsequent Energy Services Agreement (ESA) which will enable the design and construction phase.



Table ES.1

Financing Term (after construction)	20 years
Capital Cost	\$1,047,325
Estimated Rebates	\$44,395
Net Assumed Capital Cost	\$1,002,930
Guaranteed Cost Savings / Year 1	\$90,214
Net Excess Cumulative Cash Flow	\$702,200

The IGA quantifies how the Town will be able to reduce utility costs by over \$90,000 dollars annually, through the acquisition of \$1,047,325 in capital improvements. When subtracting utility company rebates, the net cost to the Town is \$1,002,930. This

investment however, will not require any up-front capital by the Town. The Town will achieve these improvements via a Performance Contract 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. The initial capital investment does not exceed the available energy cost savings over a 20-year period as stipulated by MGL Chapter 25A governing procurement via a Performance Contract.

Ameresco performed an Investment Grade Audit (IGA) for the Town of Salisbury, Massachusetts. Salisbury is a coastal community located in Northeastern Massachusetts. The IGA's scope included the fire and police stations, beach services, department of public works, town hall, wastewater plant facility, senior center and the Memorial Boys and Girls Club. The library and historical society buildings were audited during the

Preliminary Energy Audit (PEA); however these buildings were removed from the scope of the IGA. After completing the draft IGA the Town decided to pull out the police station as it is anticipated to be replaced.

Ameresco audited eight Town buildings for the IGA and developed a baseline energy model for each facility. The model accounts for each building's energy consumption in terms of its various end-uses, e.g., space heating, cooling and lighting. The baseline energy model is utilized to estimate the energy savings for each energy conservation measure (ECM) that was evaluated in the IGA.

The gross area included in this project is approximately 91,000 square feet amongst all buildings. The baseline developed for each building is based on fiscal year 2011 (FY2011) utility consumption data (except for the Council on Aging, FY2010's natural gas). No weather adjustments were necessary since fiscal year 2011 closely correlates to the thirty-year typical meteorological year (TMY2) weather data for the Salisbury, MA area. The total electrical energy consumption of the buildings for FY2011 was 1,454,947 kWh, the total natural gas usage was 16,800 Therms, the total fuel oil (#2) consumed was 13,209 gallons and the total propane consumed was 226 gallons. The total utility spend for this time period was \$265,926. The Library, Police and Historical Society buildings were included in the Preliminary Audit, but were excluded from the IGA and are not included in these totals.

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 the ECMs across all facilities and are delineated in the tables following and presented in detail herein in Section 3.

Table ES.2: ECM Matrix

MVPC - Town of Salisbury														
Energy Conservation Measures (ECMs)														
Facility	1	2	3	4	5	8	10	11	12	13	14	15		
Lighting System Improvements														
Lighting Controls		X	X											
New Energy Management Systems			X	X										
Attic Insulation				X	X									
Boiler Replacements														
Install High Efficiency Furnaces														
Oil to Gas Conversion														
Pipe Insulation														
Steam Trap Replacement														
Variable Frequency Drives														
Vending Machine Controls														
Weatherization Improvements														

Table ES.3: Cost and Savings by Measure

ECM #	ECM Name	Annual kW	Total kWh	Natural Gas (Therms)	#2 Fuel Oil (Gallons)	Energy Savings	O&M Savings	Total Project Savings	Total Project Costs	SPB
1	Lighting System Improvements	525	101,155	(332)	(370)	\$ 12,524	\$ 1,389	\$ 13,913	\$ 199,611	14.35
2	Lighting Controls	-	11,941	(68)	(11)	\$ 1,495	-	\$ 1,495	\$ 19,139	12.80
3	New Energy Management Systems	-	18,970	6,088	2,362	\$ 17,908	-	\$ 17,908	\$ 185,940	10.38
4	Attic Insulation	-	-	-	238	\$ 833	-	\$ 833	\$ 23,839	28.63
5	Boiler Replacements	-	-	(2,253)	2,859	\$ 7,557	\$ 21,500	\$ 29,057	\$ 299,236	10.30
8	Install High Efficiency Furnaces	-	-	388	-	\$ 485	-	\$ 485	\$ 50,171	103.39
10	Oil to Gas Conversion	-	-	(11,965)	8,514	\$ 16,784	\$ 1,500	\$ 18,284	\$ 219,572	12.01
11	Pipe Insulation	-	-	335	358	\$ 1,670	-	\$ 1,670	\$ 7,871	4.71
12	Steam Trap Replacement	-	-	-	467	\$ 1,634	-	\$ 1,634	\$ 16,463	10.07
13	Variable Frequency Drives	-	3,090	-	-	\$ 470	-	\$ 470	\$ 7,000	14.88
14	Vending Machine Controls	-	7,395	(106)	(36)	\$ 754	-	\$ 754	\$ 1,456	1.93
15	Weatherization Improvements	-	4,175	351	239	\$ 1,695	-	\$ 1,695	\$ 17,027	10.05
		525	146,726	(7,562)	14,619	\$ 63,809	\$ 24,389	\$ 88,198	\$ 1,047,325	11.87

Table ES.4: Project Pro-Forma

MVPC - Town of Salisbury - Pro-Forma

Initial Project Costs:	
Implementation costs	\$ 1,047,325
Total Initial Project Costs	\$ 1,047,325
Utility Rebates	
	\$ 44,395
Net Project Costs after rebates	\$ 1,002,930

Financial Assumptions	
Term of Project (yrs)	20.0 yrs
Term of Financing (yrs)	20.0 yrs
Estimated Financing Rate	3.50%
Payments per year (frequency)	4
Discount Rate	3.50%
Average Energy escalation rate (annual)	3.00%
Average Cost escalation rate (annual)	3.00%
Project Simple Payback	11.87

	Year									
Pro-forma	1	2	3	4	5	6	7	8	9	10
1 Annual energy costs without improvements	\$ 277,242	\$ 285,559	\$ 294,126	\$ 302,950	\$ 312,038	\$ 321,399	\$ 331,041	\$ 340,973	\$ 351,202	\$ 361,738
2 Annual energy costs with improvements	\$ 211,519	\$ 217,864	\$ 224,400	\$ 231,132	\$ 238,066	\$ 245,208	\$ 252,565	\$ 260,142	\$ 267,946	\$ 275,984
3 Annual energy cost savings (1-2)	\$ 65,723	\$ 67,695	\$ 69,726	\$ 71,817	\$ 73,972	\$ 76,191	\$ 78,477	\$ 80,831	\$ 83,256	\$ 85,754
4 O&M Savings	\$ 24,491	\$ 24,596	\$ 24,703	\$ 24,814	\$ 24,929	\$ 25,047	\$ 25,168	\$ 25,293	\$ 25,422	\$ 25,555
5 Total Project Savings	\$ 90,214	\$ 92,290	\$ 94,429	\$ 96,632	\$ 98,901	\$ 101,238	\$ 103,645	\$ 106,124	\$ 108,678	\$ 111,308
6 Payments for financing equipment	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185
7 Payments for Ongoing Services	\$ 5,561	\$ 5,728	\$ 5,899	\$ 6,076	\$ 6,259	\$ 6,446	\$ 6,639	\$ 6,839	\$ 7,044	\$ 7,255
8 Net annual benefits	\$ 13,301	\$ 15,206	\$ 17,168	\$ 19,188	\$ 21,269	\$ 23,413	\$ 25,621	\$ 27,896	\$ 30,238	\$ 32,650
9 Cumulative cash flow	\$ 13,301	\$ 28,507	\$ 45,675	\$ 64,863	\$ 86,132	\$ 109,545	\$ 135,166	\$ 163,061	\$ 193,299	\$ 225,949
10 Net Present Value of cash flow										
11 Interest Rate										
12 Discount Rate										

Line #	11	12	13	14	15	16	17	18	19	20	Totals
1	\$ 372,590	\$ 383,768	\$ 395,281	\$ 407,139	\$ 419,353	\$ 431,934	\$ 444,892	\$ 458,239	\$ 471,986	\$ 486,145	\$ 7,449,595
2	\$ 284,264	\$ 292,792	\$ 301,576	\$ 310,623	\$ 319,941	\$ 329,540	\$ 339,426	\$ 349,609	\$ 360,097	\$ 370,900	\$ 5,683,592
3	\$ 88,326	\$ 90,976	\$ 93,705	\$ 96,517	\$ 99,412	\$ 102,394	\$ 105,466	\$ 108,630	\$ 111,889	\$ 115,246	\$ 1,766,003
4	\$ 25,691	\$ 25,832	\$ 25,977	\$ 26,126	\$ 26,280	\$ 26,439	\$ 26,602	\$ 26,770	\$ 26,943	\$ 27,121	\$ 513,799
5	\$ 114,018	\$ 116,808	\$ 119,682	\$ 122,643	\$ 125,692	\$ 128,833	\$ 132,068	\$ 135,400	\$ 138,832	\$ 142,367	\$ 2,279,802
6	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 1,423,700
7	\$ 7,697	\$ 7,928	\$ 8,166	\$ 8,411	\$ 8,663	\$ 8,923	\$ 9,191	\$ 9,467	\$ 9,751	\$ 10,043	\$ 153,901
8	\$ 35,135	\$ 37,695	\$ 40,331	\$ 43,047	\$ 45,844	\$ 48,725	\$ 51,692	\$ 54,748	\$ 57,896	\$ 61,139	\$ 702,200
9	\$ 261,084	\$ 298,779	\$ 339,111	\$ 382,157	\$ 428,001	\$ 476,726	\$ 528,418	\$ 583,166	\$ 641,062	\$ 702,200	
10											
11											
12											

Notes:

- 1 This Proforma Cash Flow reflects an estimated financing rate of 3.5%. 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 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 GHG gasses and emissions.

ECM 1: Lighting System Improvements

Ameresco will install a state-of-the-art lighting system to benefit the building occupants of the Town of Salisbury. Our project replaces or upgrades approximately 729 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.

ECM 2: Lighting Controls

Ameresco proposes to install 105 new lighting controls in the Town of Salisbury buildings to ensure that lighting does not operate unnecessarily. Energy waste occurs when a fixture is energized but not used and when illuminance exceeds what is necessary for task performance. Ameresco noted some occupants are not careful about turning off lights when they leave the room, making automated controls advantageous.

Ameresco has proposed occupancy sensors to be installed in many classrooms, offices, and bathrooms, plus a number of facility-specific control strategies.



Figure 1.1: New light fixtures will improve aesthetics and provide substantial energy savings.

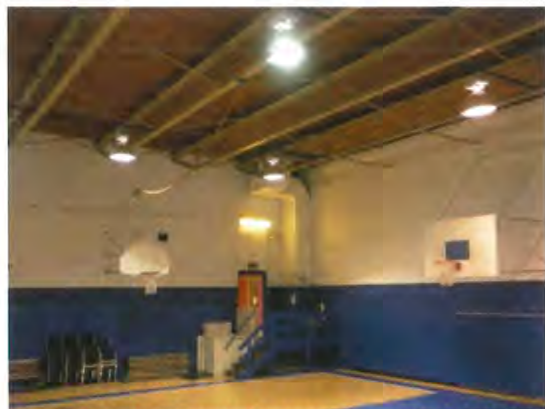


Figure 2.1: Fixture mounted occupancy controls combined with new linear fluorescent fixtures will provide energy savings in this gym.

ECM 3: New Energy Management Systems

Ameresco proposes to install programmable thermostats and boiler plant controllers at the Fire Station, Department of Public Works, Town Hall and the Memorial Boys and Girls Club. Ameresco proposes automatic control equipment at the Council on Aging - Hilton Senior Center to improve comfort while reducing energy consumption, and at the Wastewater Treatment Plant to improve its operations and save energy costs.

ECM 4: Attic Insulation

Ameresco proposes to install an air barrier and additional insulation for the ceiling in the Fire Department's Apparatus Bay. Rigid board insulation air-sealed with spray foam is proposed for each of the ceiling truss bays above the perforated metal ceiling and the existing fiberglass insulation reinstalled above rigid board. This measure will reduce air leakage through the ceiling and improve thermal resistance.



Figure 4.1: Air-sealing and enhanced insulation is proposed for the Fire Department Apparatus Bay's metal ceiling

ECM 5: Boiler Replacements

Ameresco proposes to replace the Fire Department boiler and switch its fuel source to natural gas from fuel oil. The boiler will be replaced, fuel oil systems will be removed and natural gas piping added. This ECM will provide an efficiency improvement as well as immediate cost savings since natural gas is currently half the cost of fuel oil. In addition, natural gas requires less maintenance. Work associated with this ECM will be coordinated with ECM 3, Controls and ECM 8, Pipe Insulation.



Figure 5.1: The oil-fired boiler and burner at the Fire Department will be replaced under the scope of this measure.

In addition, Ameresco proposes to replace the Clever Brooks hot water boiler serving the Memorial School. A new gas service will be installed under ECM 10.

ECM 8: Install High Efficiency Furnaces

Ameresco proposes to replace the furnaces which serve the Activity Room and its surrounding offices at the Council on Aging - Hilton Center. The replacement furnaces will be premium efficiency. This measure will reduce energy costs by improved efficiency.



Figure 8.1: The existing furnaces at the Senior Center are standard efficiency and will be replaced in this measure

ECM 10: Oil to Gas Conversion

Ameresco proposes to convert the Memorial Boys and Girls Club heating systems to natural gas from fuel oil. The Boys and Girls Club's two boilers will be switched to natural gas by replacement of the steam boiler's burner and replacement of the Clever Brook hot water boiler under ECM 5 Boiler Replacements. This conversion will provide immediate cost savings because natural gas is currently half the cost of fuel oil. In addition, natural gas requires less maintenance.

ECM 11: Pipe Insulation

The scope of work for this ECM is to insulate bare steam and hot water piping. Uninsulated steam or hot water piping is a major source of uncontrolled heat gain, which results in energy losses and can cause overheating. The original portions of the Memorial Boys and Girls Club

and the first floor of the Town Hall are heated by steam. This ECM will insulate the steam piping in the mechanical rooms of these two buildings. The Fire Department is heated with a hot water boiler plant and distribution system. This ECM will insulate bare hot water piping in the mechanical rooms of this building.

The hot water heating boiler plant at the Memorial Boys and Girls Club is insulated with asbestos containing material (ACM). This material will be removed and reinsulated as part of ECM 10's scope of work.

ECM 12: Steam Trap Replacement

Ameresco proposes to replace and/or repair steam traps at the Memorial Boys and Girls Club. The proposed replacement and/or repair of steam traps will improve the overall steam use and heating system efficiencies. Steam distribution is accomplished at low pressure with thermal energy waste due to failing traps. Properly functioning steam traps pass air and drain condensate formed in the steam distribution system and prevent live steam from exiting. This measure will address approximately 30 existing steam traps, and the improvement will result in energy and maintenance cost savings for the Town of Salisbury

ECM 13: Variable Frequency Drives

Ameresco proposes to install a variable speed drive and associated controls to control the airflow from the rooftop unit which serves the offices and conference room at the Hilton Senior Center. The results will be that airflow will be better



Figure 10.1: The existing oil-fired boiler burner at the Memorial will be replaced.



Fig 12.1 This end-of-main steam trap will be rebuilt or replaced as part of the scope of this measure.



Figure 13.1: The supply fan in this unit will be controlled by a variable frequency drive for improved comfort and energy savings.

distributed between the two zones in addition to saving fan electrical energy.

ECM14: Vending Machine Controls

Ameresco proposes to install vending machine controllers on drink vending machines at the Memorial Boys and Girls Club, Council on Aging - Hilton Center, and Town Hall. Each controller will save energy used by the 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.



Figure 14.1: Beverage machine at the Hilton Center

ECM 15: Weatherization Improvements

Ameresco proposes to reduce uncontrolled air infiltration at a number of buildings. Entry door weather-stripping is proposed for all buildings. Other air sealing measures to be applied in selected buildings include roof wall joint foam application, window air sealing, exhaust hatch air sealing, soffits air sealing, and overhead door weather-stripping. The proposed air sealing will reduce heat loss and increase occupant by reducing drafts. All of the buildings were surveyed and evaluated, but measures are excluded at some buildings due to long payback. This measure will be performed at the Fire Department, Council on Aging - Hilton Center, Town Hall, Waste Water Treatment Plant and Memorial Boys and Girls Club.



Figure 15.1: Window weather-stripping is proposed for Town Hall to reduce air infiltration.

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 the Merrimack Valley, 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.

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Section 1: Baseline

Overview

Ameresco performed an Investment Grade Audit (IGA) for the Town of Salisbury, Massachusetts. Salisbury is a coastal community located in Northeastern Massachusetts. The IGA's scope included the fire and police stations, beach services, department of public works, town hall, wastewater plant facility, senior center and the Memorial Boys and Girls Club. The library and historical society buildings were audited during the Preliminary Energy Audit (PEA), however these buildings were removed from the scope of the IGA. After completing the draft IGA the Town decided to pull out the police station as it is anticipated to be replaced.



Ameresco audited eight Town buildings for the IGA and developed a baseline energy model for each facility. The model accounts for each building's energy consumption in terms of its various end-uses, e.g., space heating, cooling and lighting. The baseline energy model is utilized to estimate the energy savings for each energy conservation measure (ECM) that was evaluated in the IGA.

The gross area included in this project is approximately 91,000 square feet amongst all buildings. The baseline developed for each building is based on fiscal year 2011 (FY2011) utility consumption data (except for the Council on Aging, FY2010's natural gas). No weather adjustments were necessary since fiscal year 2011 closely correlates to the thirty-year typical meteorological year (TMY2) weather data for the Salisbury, MA area. The total electrical energy consumption of the buildings for FY2011 was 1,454,947 kWh, the total natural gas usage was 16,800 Therms, the total fuel oil (#2) consumed was 13,209 gallons and the total propane consumed was 226 gallons. The total utility spend for this time period was \$265,926. The Library, Police and Historical Society buildings were included in the Preliminary Audit, but were excluded from the IGA and are not included in these totals.

Table 1 gives the square footage for the facility analyzed, along with the energy performance of the 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 the Water Treatment Plant was calculated from the utility information provided by Town personnel and directly from the utility companies.

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.
Fire Department	7,350	76.1	28.2	104.4
Department of Public Works	5,600	102.9	25.9	128.8
Beach Services - Comfort Station	1,250	2.0	84.3	86.3
Council on Aging- Hilton Senior Center	6,492	68.0	25.7	93.7
Town Hall	9,704	63.8	32.6	96.3
Sewage Treatment Plant	6,000	3.4	586.8	590.2
Memorial School-Boys and Girls Club	5,4357	24.2	9.3	33.4
Totals	90,753	38.7	54.7	93.4

The total mbtu/gsf represents the total energy usage for the entire facility on a square foot basis. The total energy usage for an entire facility on a square foot basis is the addition of both electrical and fossil fuel performance (mbtu/gsf) if applicable. At the Sewer Treatment Plant, the primary source for space heating is electricity. Electric cooling is present at most facilities, but is generally localized to office spaces. In evaluating performance, buildings with larger central cooling systems operate at a higher annual electrical mbtu/gsf. In the case of the Sewer Treatment Plant, the large annual electrical mbtu/gsf is a result of electric heat and process equipment.

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), with the exception of the Council on Aging – Hilton Center’s natural gas consumption, for which FY2010 data was utilized due to metering issues. This was the most recent, complete fiscal year information available and its annual heating degree days (HDD) closely matched the 30-year average weather conditions for Salisbury, 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.

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.

The summary of baseline annual energy usage at each facility is listed in Table 2:

Table 2: Annual Energy Use by Facility

Facility Name	Natural Gas Usage (Therms)	#2 Fuel Oil Usage (Gallons)	Propane Usage (Gallons)	Electric Energy Usage (kWh)	Annual Electric Demand (kW)
Fire Department	104	3,959	0	60,828	
Department of Public Works	5,761		0	42,560	
Salisbury Beach Comfort Station	25		0	30,879	
Council on Aging; Hilton Senior Center	4,416			48,928	
Town Hall	6,187		0	92,633	
Sewer Treatment Plant			226	1,031,600	1,866.0
Memorial School Boys and Girls Club	307	9,250	0	147,519	775.0
Totals	16,800	13,209	226	1,454,947	2,641.0

Buildings in the Town are delivered electric service by National Grid. The Town purchases its electric supply from Glacial Energy with the exception of the Boys and Girls Club, which obtains both services from National Grid.

The Town receives electric service under, National Grid G1 or G2 rates. National Grid's G1 rate does not charge for demand.

The baseline's average rates are shown in table 3 below.

Table 3: Average Electric Rates

Electric Code	Provider – Delivery	Provider – Supply	On-Peak Rate (\$/kWh)	Off-Peak Rate (\$/kWh)	Rate (\$/kW)
G-1	National Grid	Glacial Energy	\$0.1523	-	-
G-2	National Grid	Glacial Energy	\$0.1001	-	\$6.00
G-1	National Grid	National Grid	\$0.1546	-	-
G-2	National Grid	National Grid	\$0.1019	-	\$6.00

Natural gas is delivered to the Town buildings by National Grid at two rates. Natural gas is supplied by National Grid. The current average rate is shown in Table 4 below.

Table 4: Average Natural Gas Rates

Gas Code	Provider – Delivery	Provider – Supply	Rate (\$/Therm)
G-41T	Keyspan/National Grid	Keyspan/National Grid	\$1.2507
G-51T	Keyspan/National Grid	Keyspan/National Grid	\$1.0877

Number 2 fuel oil is purchased and delivered by Townsend Oil and Propane Company. For the baseline period, the Town paid on average of \$3.12/Gallon.

Propane is purchased and delivered by Townsend Oil and Propane Company. For the baseline period, the Town paid on average of \$4.23/Gallon.

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, some building(s) receive electricity, natural gas and water under 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

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, fuel oil 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 municipal 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.

IGA Baseline Information

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Town of Salisbury, Massachusetts

Utility Data Summary

Fiscal 2011, Fiscal 2010 for COA Gas

Facility Name	CSE Area (SF)	Cost			Annual Electric						Annual Fossil Fuel						Performance		
		Annual Cost (\$)	Unit Cost (\$/SF)	Demand (kW)	Energy Consump (kWh)	Energy Cost (\$)	Total Cost	W/Sqft	kWh/Sqft	Natural Gas (Therms)	Natural Gas Cost (\$)	Propane (Gallons)	Propane Cost (\$)	#2 Oil (Gallons)	#2 Oil Cost (\$)	Total MMBtu	kWh/Sqft	Fossil Fuel (MMBtu/Sqft)	Annual EUI (MMBtu/Sqft)
Fire Department	7,350	\$22,529	\$3.07		60,828	\$9,445	\$9,445	0.0	8.3	104	\$571			3,959	\$12,713	560	8.3	76.1	104.4
Department of Public Works	5,600	\$13,634	\$2.43		42,560	\$6,575	\$6,575	0.0	7.6	5,761	\$7,059					576	7.6	102.9	128.8
Beach Services - Comfort Station	1,250	\$5,448	\$4.36		30,879	\$4,755	\$4,755	0.0	24.7	25	\$693					3	24.7	2.0	86.3
Council on Aging- Hilton Senior Center	6,492	\$15,347	\$2.36		48,928	\$7,716	\$7,716	0.0	7.5	4,416	\$7,632					442	7.5	68.0	93.7
Town Hall	9,704	\$25,055	\$2.58		92,633	\$15,047	\$15,047	0.0	9.5	6,187	\$10,008					619	9.5	63.8	96.3
Sewage Treatment Plant	6,000	\$133,770	\$22.29	1,866.0	1,031,600	\$132,815	\$132,815	25.9	171.9			226	\$954			21	171.9	3.4	590.2
Spartan Memorial School-Boys and Girls Club	54,357	\$50,143	\$0.92	775.0	147,519	\$21,040	\$21,040	1.2	2.7	307	\$576			9,250	\$28,528	1,314	2.7	24.2	33.4
Totals	90,753	\$266,976	\$2.93	2,641.0	1,454,947	\$197,393	\$197,393	2.4	16.0	16,800	\$26,337	226	\$954	13,209	\$41,341	2,533	16.0	38.9	93.6

Fossil HDD	
2,000	6.375
2,010	5.793
2,011	6.172
Average	6.110
30-yr Ave.	6.575

Conversions	
Electricity	3,413 BTU/kWh
Natural gas	100,000 BTU/Therms
Propane	91,300 BTU/Gallons
Steam	1,000,000 BTU/Mbs
Fuel Oil #2	138,700 BTU/Gallons
Fuel Oil #4	145,000 BTU/Gallons
Fuel Oil #6	150,000 BTU/Gallons
Miscellaneous	1 BTU/Misc

Utility Baseline Backup Information

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**Town of Salisbury
Fire Department
Electric Utility Tracking**

Service: Main Meter
Safi: 0
Meter # 83259868
Account # 51621-39009
Supplier: Glacial Energy - 35481211
Tariff: National Grid
Deliverer: General Service - Small C/I G-1

Month	Last Read Date	Current Read Date	Read Days	HDD	CDD	Monthly Billed kW	Monthly On-Peak kW/h	Monthly Demand Cost \$	Monthly Peak Supply Cost \$	Monthly On-Peak Delivery Cost \$	Total Monthly Off-Peak Electric Cost \$	Monthly Peak Electric Cost \$	Monthly Demand Unit Cost \$/kW	Monthly On-Peak Unit Cost \$/kW	Monthly Off-Peak Unit Cost \$/kW	Total Monthly Unit Blended Cost \$/kWh	
Jul-08			0	0	0	4,721											
Aug-08	1/0/00		0	0	0	4,847											
Sep-08	1/0/00		0	0	0	3,488											
Oct-08	1/0/00		0	0	0	3,829											
Nov-08	1/0/00		0	0	0	6,145											
Dec-08	1/0/00		0	0	0	7,888											
Jan-09	1/0/00		0	0	0	9,309											
Feb-09	1/0/00	3/9/09	39,881	5,019	585				\$318.98		\$318.98	\$0.00	\$0.00	\$0.063	\$0.00	\$0.063	\$0.063
Mar-09	3/9/09	4/8/09	30	751	0		6,468		\$394.71		\$394.71	\$0.00	\$0.00	\$0.061	\$0.00	\$0.061	\$0.061
Apr-09	4/8/09	5/8/09	30	412	18		3,692		\$229.17		\$229.17	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
May-09	5/8/09	6/9/09	32	183	23		3,651		\$226.74		\$226.74	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
Jun-09	6/9/09	7/10/09	31	105	33		3,690		\$229.08		\$229.08	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
Jul-09	7/10/09	8/7/09	28	4	170		3,845		\$238.30		\$238.30	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
Aug-09	8/7/09	9/8/09	32	39	197		4,342		\$267.90		\$267.90	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
Sep-09	9/8/09	10/8/09	30	203	12		3,324		\$207.11		\$207.11	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
Oct-09	10/8/09	11/5/09	28	489	0		3,644		\$226.18		\$226.18	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
Nov-09	11/5/09	12/8/09	33	680	0		4,729		\$290.91		\$290.91	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
Dec-09	12/8/09	1/8/10	31	1,160	0		7,408		\$457.07		\$457.07	\$0.00	\$0.00	\$0.062	\$0.00	\$0.062	\$0.062
Jan-10	1/8/10	2/8/10	31	1,195	0		7,429		\$484.53		\$484.53	\$0.00	\$0.00	\$0.065	\$0.00	\$0.065	\$0.065
Feb-10	2/8/10	3/10/10	30	883	0		6,437		\$433.83		\$433.83	\$0.00	\$0.00	\$0.067	\$0.00	\$0.067	\$0.067
Mar-10	3/10/10	4/9/10	30	529	1		4,990		\$303.97		\$303.97	\$0.00	\$0.00	\$0.181	\$0.00	\$0.181	\$0.181
Apr-10	4/9/10	5/10/10	31	385	20		4,131		\$263.45		\$263.45	\$0.00	\$0.00	\$0.185	\$0.00	\$0.185	\$0.185
May-10	5/10/10	6/8/10	29	120	75		3,341		\$216.55		\$216.55	\$0.00	\$0.00	\$0.187	\$0.00	\$0.187	\$0.187
Jun-10	6/8/10	7/12/10	34	33	269		4,869		\$527.20		\$527.20	\$0.00	\$0.00	\$0.183	\$0.00	\$0.183	\$0.183
Jul-10	7/12/10	8/12/10	31	0	340		5,841		\$652.56		\$652.56	\$0.00	\$0.00	\$0.180	\$0.00	\$0.180	\$0.180
Aug-10	8/12/10	9/9/10	28	4	204		2,910		\$354.72		\$354.72	\$0.00	\$0.00	\$0.186	\$0.00	\$0.186	\$0.186
Sep-10	9/9/10	10/8/10	29	127	51		3,388		\$404.88		\$404.88	\$0.00	\$0.00	\$0.184	\$0.00	\$0.184	\$0.184
Oct-10	10/8/10	11/5/10	28	435	4		3,490		\$409.86		\$409.86	\$0.00	\$0.00	\$0.183	\$0.00	\$0.183	\$0.183
Nov-10	11/5/10	12/9/10	34	811	0		4,813		\$323.31		\$323.31	\$0.00	\$0.00	\$0.183	\$0.00	\$0.183	\$0.183
Dec-10	12/9/10	1/7/11	29	1,017	0		6,309		\$427.93		\$427.93	\$0.00	\$0.00	\$0.177	\$0.00	\$0.177	\$0.177
Jan-11	1/7/11	2/8/11	32	1,376	0		8,808		\$687.02		\$687.02	\$0.00	\$0.00	\$0.145	\$0.00	\$0.145	\$0.145
Feb-11	2/8/11	3/10/11	30	1,068	0		7,664		\$597.79		\$597.79	\$0.00	\$0.00	\$0.146	\$0.00	\$0.146	\$0.146
Mar-11	3/10/11	4/7/11	38	712	0		5,649		\$446.27		\$446.27	\$0.00	\$0.00	\$0.149	\$0.00	\$0.149	\$0.149
Apr-11	4/7/11	5/10/11	33	423	5		4,593		\$358.25		\$358.25	\$0.00	\$0.00	\$0.148	\$0.00	\$0.148	\$0.148
May-11	5/10/11	6/8/11	29	175	73		3,596		\$255.11		\$255.11	\$0.00	\$0.00	\$0.143	\$0.00	\$0.143	\$0.143
Jun-11	6/8/11	7/8/11	30	23	194		3,767		\$268.43		\$268.43	\$0.00	\$0.00	\$0.143	\$0.00	\$0.143	\$0.143

	HDD	CDD	kW	kWh	kWh \$
Fiscal 2009	6,470	659	N/A	62,831	\$1,399
Fiscal 2010	5,720	744	N/A	58,489	\$5,789
Fiscal 2011	6,171	871	N/A	60,828	\$9,446
Average	6,120	768	0	60,716	\$5,544

Town of Salisbury
Department of Public Works
Electric Utility Tracking

Service: Main Meter
 Sqt: 0
 Meter #: 71982902
 Account #: 39155-83008
 Supplier: Glacial Energy - 35481241
 Tariff: National Grid
 Deliverer: General Service - Small C/I G-1
 Tariff:

Month	Last Read Date	Current Read Date	Read Days	HDD	CDD	Monthly Billed kW	Monthly On-Peak kWh	Monthly Off-Peak kWh	Monthly Demand Cost \$	Monthly Supply Cost \$	Monthly Peak Delivery Cost \$	Monthly Off-Peak Delivery Cost \$	Total Monthly Peak Electric kWh	Total Monthly Electric Cost \$	Total Monthly Off-Peak Electric Cost \$	Monthly On-Peak Unit Cost \$/kWh	Monthly Off-Peak Unit Cost \$/kWh	Monthly Demand Unit Cost \$/kWh	Total Monthly Unit Cost \$/kWh	
Jan-08	1/00/00		0	0	0		2,800						2,800	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Feb-08	1/00/00		0	0	0		3,360						3,360	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Mar-08	1/00/00		0	0	0		2,720						2,720	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Apr-08	1/00/00		0	0	0		3,120						3,120	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
May-08	1/00/00		0	0	0		3,760						3,760	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jun-08	1/00/00		0	0	0		3,680						3,680	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jul-08	1/00/00		0	0	0		3,360						3,360	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Aug-08	1/00/00	3/3/09	39,875	4,530	585		3,200				\$203.38		3,200	\$203.38	\$0.00	\$203.38	\$0.00	\$0.00	\$0.00	\$0.00
Sep-08	3/3/09	4/8/09	36	940	0		2,800				\$175.98		2,800	\$175.98	\$0.00	\$175.98	\$0.00	\$0.00	\$0.00	\$0.00
Oct-08	4/8/09	5/6/09	30	412	18		3,120				\$195.06		3,120	\$195.06	\$0.00	\$195.06	\$0.00	\$0.00	\$0.00	\$0.00
Nov-08	5/6/09	6/9/09	32	183	23		3,440				\$214.16		3,440	\$214.16	\$0.00	\$214.16	\$0.00	\$0.00	\$0.00	\$0.00
Dec-08	6/9/09	7/10/09	31	105	33		2,960				\$185.55		2,960	\$185.55	\$0.00	\$185.55	\$0.00	\$0.00	\$0.00	\$0.00
Jan-09	7/10/09	8/7/09	28	4	170		2,400				\$152.13		2,400	\$152.13	\$0.00	\$152.13	\$0.00	\$0.00	\$0.00	\$0.00
Feb-09	8/7/09	9/8/09	32	39	197		2,800				\$175.95		2,800	\$175.95	\$0.00	\$175.95	\$0.00	\$0.00	\$0.00	\$0.00
Mar-09	9/8/09	10/8/09	30	203	12		2,640				\$166.35		2,640	\$166.35	\$0.00	\$166.35	\$0.00	\$0.00	\$0.00	\$0.00
Apr-09	10/8/09	11/5/09	28	489	0		2,720				\$171.13		2,720	\$171.13	\$0.00	\$171.13	\$0.00	\$0.00	\$0.00	\$0.00
May-09	11/5/09	12/8/09	33	680	0		3,360				\$209.31		3,360	\$209.31	\$0.00	\$209.31	\$0.00	\$0.00	\$0.00	\$0.00
Jun-09	12/8/09	1/8/10	31	1,160	0		3,360				\$207.24		3,360	\$207.24	\$0.00	\$207.24	\$0.00	\$0.00	\$0.00	\$0.00
Jul-09	1/8/10	2/8/10	30	883	0		3,440				\$210.17		3,440	\$210.17	\$0.00	\$210.17	\$0.00	\$0.00	\$0.00	\$0.00
Aug-09	2/8/10	3/10/10	30	529	1		2,960				\$196.66		2,960	\$196.66	\$0.00	\$196.66	\$0.00	\$0.00	\$0.00	\$0.00
Sep-09	3/10/10	4/9/10	31	385	20		3,440				\$219.99		3,440	\$219.99	\$0.00	\$219.99	\$0.00	\$0.00	\$0.00	\$0.00
Oct-09	4/9/10	5/10/10	31	120	75		2,960				\$188.95		2,960	\$188.95	\$0.00	\$188.95	\$0.00	\$0.00	\$0.00	\$0.00
Nov-09	5/10/10	6/8/10	29	34	269		4,000				\$264.28		4,000	\$264.28	\$0.00	\$264.28	\$0.00	\$0.00	\$0.00	\$0.00
Dec-09	6/8/10	7/12/10	34	33	269		3,440				\$237.72		3,440	\$237.72	\$0.00	\$237.72	\$0.00	\$0.00	\$0.00	\$0.00
Jan-10	7/12/10	8/12/10	31	4	340		2,800				\$183.16		2,800	\$183.16	\$0.00	\$183.16	\$0.00	\$0.00	\$0.00	\$0.00
Feb-10	8/12/10	9/9/10	28	4	204		2,640				\$165.77		2,640	\$165.77	\$0.00	\$165.77	\$0.00	\$0.00	\$0.00	\$0.00
Mar-10	9/9/10	10/8/10	29	127	51		3,040				\$343.95		3,040	\$343.95	\$0.00	\$343.95	\$0.00	\$0.00	\$0.00	\$0.00
Apr-10	10/8/10	11/5/10	28	435	4		4,000				\$450.94		4,000	\$450.94	\$0.00	\$450.94	\$0.00	\$0.00	\$0.00	\$0.00
May-10	11/5/10	12/9/10	34	811	0		3,440				\$374.02		3,440	\$374.02	\$0.00	\$374.02	\$0.00	\$0.00	\$0.00	\$0.00
Jun-10	12/9/10	1/7/11	29	1,017	0		4,080				\$310.46		4,080	\$310.46	\$0.00	\$310.46	\$0.00	\$0.00	\$0.00	\$0.00
Jul-10	1/7/11	2/8/11	32	1,376	0		4,080				\$318.24		4,080	\$318.24	\$0.00	\$318.24	\$0.00	\$0.00	\$0.00	\$0.00
Aug-10	2/8/11	3/10/11	30	1,068	0		4,560				\$365.44		4,560	\$365.44	\$0.00	\$365.44	\$0.00	\$0.00	\$0.00	\$0.00
Sep-10	3/10/11	4/7/11	28	712	0		2,800				\$192.99		2,800	\$192.99	\$0.00	\$192.99	\$0.00	\$0.00	\$0.00	\$0.00
Oct-10	4/7/11	5/10/11	33	423	5		3,520				\$251.68		3,520	\$251.68	\$0.00	\$251.68	\$0.00	\$0.00	\$0.00	\$0.00
Nov-10	5/10/11	6/8/11	29	175	73		3,520				\$249.16		3,520	\$249.16	\$0.00	\$249.16	\$0.00	\$0.00	\$0.00	\$0.00
Dec-10	6/8/11	7/8/11	30	23	194		3,520				\$249.16		3,520	\$249.16	\$0.00	\$249.16	\$0.00	\$0.00	\$0.00	\$0.00

	HDD	CDD	kW	kWh	kWh \$
Fiscal 2009	6,470	659	N/A	38,320	\$974
Fiscal 2010	5,720	744	N/A	37,200	\$3,913
Fiscal 2011	6,171	871	N/A	42,560	\$6,575
Average	6,120	758	\$0	39,360	\$3,620

Town of Salisbury
Beach Services - DPW
Electric Utility Tracking

Service: Main Meter
 Sftl 0
 Meter # 80059362
 Account # 26492-35005
 Supplier: Glacial Energy - 35481241
 Tariff:
 Deliverer: National Grid
 Tariff: General Service - Small C/I G-1

Month	Last Read Date	Current Read Date	Real Days	HDD	CDD	Monthly Billed kW	Monthly On-Peak kW	Monthly Off-Peak kW	Monthly Demand Cost \$	Monthly Peak Supply Cost \$	Monthly Off-Peak Delivery Cost \$	Monthly On-Peak Delivery Cost \$	Total Monthly Electric kWh	Total Monthly On-Peak Electric Cost \$	Total Monthly Off-Peak Electric Cost \$	Total Monthly Electric Cost \$	Monthly Demand Unit Cost \$/kWh	Monthly On-Peak Unit Cost \$/kWh	Monthly Off-Peak Unit Cost \$/kWh	Total Monthly Blended Unit Cost \$/kWh
Jul-08													1,915	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Aug-08	1/0/00			0	0		2,491						2,491	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sep-08	1/0/00			0	0		2,057						2,057	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Oct-08	1/0/00			0	0		2,907						2,907	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Nov-08	1/0/00			0	0		3,423						3,423	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Dec-08	1/0/00			0	0		3,268						3,268	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jan-09	1/0/00			0	0		2,947						2,947	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Feb-09	1/0/00	3/6/09	39,878	4,963	585		2,569			\$165.35			2,569	\$165.35	\$0.00	\$0.00	\$165.35	\$0.00	\$0.00	\$0.00
Mar-09	3/6/09	4/7/09	32	784	0		2,311			\$146.85			2,311	\$146.85	\$0.00	\$0.00	\$146.85	\$0.00	\$0.00	\$0.00
Apr-09	4/7/09	5/7/09	30	427	18		1,890			\$121.73			1,890	\$121.73	\$0.00	\$0.00	\$121.73	\$0.00	\$0.00	\$0.00
May-09	5/7/09	6/6/09	32	191	23		1,772			\$114.69			1,772	\$114.69	\$0.00	\$0.00	\$114.69	\$0.00	\$0.00	\$0.00
Jun-09	6/6/09	7/6/09	30	96	33		1,649			\$107.34			1,649	\$107.34	\$0.00	\$0.00	\$107.34	\$0.00	\$0.00	\$0.00
Jul-09	7/6/09	8/6/09	29	13	166		1,433			\$94.48			1,433	\$94.48	\$0.00	\$0.00	\$94.48	\$0.00	\$0.00	\$0.00
Aug-09	8/6/09	9/6/09	29	24	196		2,243			\$142.75			2,243	\$142.75	\$0.00	\$0.00	\$142.75	\$0.00	\$0.00	\$0.00
Sep-09	9/6/09	10/7/09	33	211	17		2,016			\$188.76			2,016	\$188.76	\$0.00	\$0.00	\$188.76	\$0.00	\$0.00	\$0.00
Oct-09	10/7/09	11/4/09	28	473	0		2,952			\$184.94			2,952	\$184.94	\$0.00	\$0.00	\$184.94	\$0.00	\$0.00	\$0.00
Nov-09	11/4/09	12/7/09	33	663	0		3,704			\$229.81			3,704	\$229.81	\$0.00	\$0.00	\$229.81	\$0.00	\$0.00	\$0.00
Dec-09	12/7/09	1/7/10	31	1,162	0		3,769			\$232.64			3,769	\$232.64	\$0.00	\$0.00	\$232.64	\$0.00	\$0.00	\$0.00
Jan-10	1/7/10	2/5/10	29	1,100	0		3,228			\$194.48			3,228	\$194.48	\$0.00	\$0.00	\$194.48	\$0.00	\$0.00	\$0.00
Feb-10	2/5/10	3/9/10	32	986	0		2,708			\$167.25			2,708	\$167.25	\$0.00	\$0.00	\$167.25	\$0.00	\$0.00	\$0.00
Mar-10	3/9/10	4/8/10	30	544	1		1,594			\$94.34			1,594	\$94.34	\$0.00	\$0.00	\$94.34	\$0.00	\$0.00	\$0.00
Apr-10	4/8/10	5/7/10	29	355	20		1,333			\$81.11			1,333	\$81.11	\$0.00	\$0.00	\$81.11	\$0.00	\$0.00	\$0.00
May-10	5/7/10	6/7/10	31	157	75		1,438			\$181.62			1,438	\$181.62	\$0.00	\$0.00	\$181.62	\$0.00	\$0.00	\$0.00
Jun-10	6/7/10	7/9/10	32	36	226		2,179			\$106.24			2,179	\$106.24	\$0.00	\$0.00	\$106.24	\$0.00	\$0.00	\$0.00
Jul-10	7/9/10	8/9/10	31	0	340		2,392			\$132.39			2,392	\$132.39	\$0.00	\$0.00	\$132.39	\$0.00	\$0.00	\$0.00
Aug-10	8/9/10	9/8/10	30	4	238		2,414			\$282.12			2,414	\$282.12	\$0.00	\$0.00	\$282.12	\$0.00	\$0.00	\$0.00
Sep-10	9/8/10	10/6/10	28	108	60		2,414			\$317.47			2,414	\$317.47	\$0.00	\$0.00	\$317.47	\$0.00	\$0.00	\$0.00
Oct-10	10/6/10	11/4/10	29	431	4		2,757			\$174.27			2,757	\$174.27	\$0.00	\$0.00	\$174.27	\$0.00	\$0.00	\$0.00
Nov-10	11/4/10	12/7/10	33	763	0		3,387			\$389.13			3,387	\$389.13	\$0.00	\$0.00	\$389.13	\$0.00	\$0.00	\$0.00
Dec-10	12/7/10	1/6/11	30	1,045	0		3,243			\$307.94			3,243	\$307.94	\$0.00	\$0.00	\$307.94	\$0.00	\$0.00	\$0.00
Jan-11	1/6/11	2/4/11	29	1,272	0		3,228			\$160.28			3,228	\$160.28	\$0.00	\$0.00	\$160.28	\$0.00	\$0.00	\$0.00
Feb-11	2/4/11	3/9/11	33	1,180	0		2,786			\$327.33			2,786	\$327.33	\$0.00	\$0.00	\$327.33	\$0.00	\$0.00	\$0.00
Mar-11	3/9/11	4/6/11	28	715	0		2,313			\$172.91			2,313	\$172.91	\$0.00	\$0.00	\$172.91	\$0.00	\$0.00	\$0.00
Apr-11	4/6/11	5/6/11	30	418	5		2,320			\$186.66			2,320	\$186.66	\$0.00	\$0.00	\$186.66	\$0.00	\$0.00	\$0.00
May-11	5/6/11	6/7/11	32	202	67		1,822			\$133.54			1,822	\$133.54	\$0.00	\$0.00	\$133.54	\$0.00	\$0.00	\$0.00
Jun-11	6/7/11	7/7/11	30	23	191		1,822			\$130.27			1,822	\$130.27	\$0.00	\$0.00	\$130.27	\$0.00	\$0.00	\$0.00

	HDD	CDD	kW	kWh	kW \$	kWh \$
Fiscal 2009	6,461	659	N/A	29,199	N/A	\$656
Fiscal 2010	5,729	701	N/A	29,177	N/A	\$2,374
Fiscal 2011	6,171	905	N/A	30,879	N/A	\$4,755
Average	6,120	755	0	29,752	\$0	\$2,595

**Town of Salisbury
Council on Aging
Electric Utility Tracking**

Service: Main Meter
Sgt 0
Meter # 76468417
Account # 51659-19009
Supplier: Glacial Energy - 35481241
Tariff: National Grid
Deliverer: General Service - Small C/I G-1
Tariff:

Month	Last Read Date	Current Read Date	Read Days	HDD	CDD	Monthly Billed kW	Monthly On-Peak kWh	Monthly On-Peak Delivery Cost \$	Monthly Off-Peak Delivery Cost \$	Total Monthly Peak Electric kWh	Total Monthly Peak Electric Cost \$	Total Monthly Off-Peak Electric Cost \$	Total Monthly Electric Cost \$	Monthly Demand Unit Cost \$/kWh	Monthly On-Peak Unit Cost \$/kWh	Monthly Off-Peak Unit Cost \$/kWh	Total Monthly Unit Blended Cost \$/kWh
Jul-08			0	0	0	3,837				3,837	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Aug-08	1/0/00		0	0	0	2,798				2,798	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sep-08	1/0/00		0	0	0	2,141				2,141	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Oct-08	1/0/00		0	0	0	2,427				2,427	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Nov-08	1/0/00		0	0	0	2,818				2,818	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Dec-08	1/0/00		0	0	0	3,876				3,876	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jan-09	1/0/00		0	0	0	4,666				4,666	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Feb-09	1/0/00	3/9/09	39	585	585	5,144		\$321.48		5,144	\$321.48	\$0.00	\$321.48	\$0.00	\$0.062	\$0.00	\$0.062
Mar-09	3/9/09	4/8/09	30	751	0	4,677		\$287.92		4,677	\$287.92	\$0.00	\$287.92	\$0.00	\$0.062	\$0.00	\$0.062
Apr-09	4/8/09	5/8/09	30	412	18	3,623		\$235.09		3,623	\$235.09	\$0.00	\$235.09	\$0.00	\$0.062	\$0.00	\$0.062
May-09	5/8/09	6/9/09	32	183	23	3,626		\$235.26		3,626	\$235.26	\$0.00	\$235.26	\$0.00	\$0.062	\$0.00	\$0.062
Jun-09	6/9/09	7/10/09	31	105	33	2,797		\$175.81		2,797	\$175.81	\$0.00	\$175.81	\$0.00	\$0.063	\$0.00	\$0.063
Jul-09	7/10/09	8/7/09	28	4	170	3,235		\$201.94		3,235	\$201.94	\$0.00	\$201.94	\$0.00	\$0.062	\$0.00	\$0.062
Aug-09	8/7/09	9/8/09	32	39	197	4,174		\$257.90		4,174	\$257.90	\$0.00	\$257.90	\$0.00	\$0.062	\$0.00	\$0.062
Sep-09	9/8/09	10/8/09	30	203	12	3,252		\$202.82		3,252	\$202.82	\$0.00	\$202.82	\$0.00	\$0.062	\$0.00	\$0.062
Oct-09	10/8/09	11/5/09	28	489	0	2,844		\$178.51		2,844	\$178.51	\$0.00	\$178.51	\$0.00	\$0.063	\$0.00	\$0.063
Nov-09	11/5/09	12/8/09	33	680	0	3,518		\$218.74		3,518	\$218.74	\$0.00	\$218.74	\$0.00	\$0.062	\$0.00	\$0.062
Dec-09	12/8/09	1/8/10	31	1,160	0	4,221		\$260.35		4,221	\$260.35	\$0.00	\$260.35	\$0.00	\$0.062	\$0.00	\$0.062
Jan-10	1/8/10	2/8/10	31	1,195	0	4,796		\$303.44		4,796	\$303.44	\$0.00	\$303.44	\$0.00	\$0.063	\$0.00	\$0.063
Feb-10	2/8/10	3/10/10	30	883	0	4,588		\$301.64		4,588	\$301.64	\$0.00	\$301.64	\$0.00	\$0.066	\$0.00	\$0.066
Mar-10	3/10/10	4/9/10	30	529	1	3,567		\$227.26		3,567	\$227.26	\$0.00	\$227.26	\$0.00	\$0.175	\$0.00	\$0.175
Apr-10	4/9/10	5/10/10	31	385	20	3,770		\$243.63		3,770	\$243.63	\$0.00	\$243.63	\$0.00	\$0.176	\$0.00	\$0.176
May-10	5/10/10	6/8/10	29	120	75	2,207		\$134.40		2,207	\$134.40	\$0.00	\$134.40	\$0.00	\$0.179	\$0.00	\$0.179
Jun-10	6/8/10	7/12/10	34	33	269	4,609		\$338.24		4,609	\$338.24	\$0.00	\$338.24	\$0.00	\$0.179	\$0.00	\$0.179
Jul-10	7/12/10	8/12/10	31	0	340	5,021		\$549.30		5,021	\$549.30	\$0.00	\$549.30	\$0.00	\$0.179	\$0.00	\$0.179
Aug-10	8/12/10	9/9/10	28	4	204	3,195		\$334.13		3,195	\$334.13	\$0.00	\$334.13	\$0.00	\$0.178	\$0.00	\$0.178
Sep-10	9/9/10	10/8/10	29	127	51	3,028		\$193.89		3,028	\$193.89	\$0.00	\$193.89	\$0.00	\$0.179	\$0.00	\$0.179
Oct-10	10/8/10	11/5/10	28	435	4	3,195		\$205.98		3,195	\$205.98	\$0.00	\$205.98	\$0.00	\$0.179	\$0.00	\$0.179
Nov-10	11/5/10	12/9/10	34	811	0	5,230		\$353.52		5,230	\$353.52	\$0.00	\$353.52	\$0.00	\$0.178	\$0.00	\$0.178
Dec-10	12/9/10	1/7/11	29	1,017	0	5,154		\$362.75		5,154	\$362.75	\$0.00	\$362.75	\$0.00	\$0.147	\$0.00	\$0.147
Jan-11	1/7/11	2/8/11	32	1,376	0	5,547		\$341.49		5,547	\$341.49	\$0.00	\$341.49	\$0.00	\$0.143	\$0.00	\$0.143
Feb-11	2/8/11	3/10/11	30	1,068	0	5,135		\$272.34		5,135	\$272.34	\$0.00	\$272.34	\$0.00	\$0.145	\$0.00	\$0.145
Mar-11	3/10/11	4/7/11	28	712	0	3,330		\$223.42		3,330	\$223.42	\$0.00	\$223.42	\$0.00	\$0.146	\$0.00	\$0.146
Apr-11	4/7/11	5/10/11	33	423	5	3,190		\$215.42		3,190	\$215.42	\$0.00	\$215.42	\$0.00	\$0.146	\$0.00	\$0.146
May-11	5/10/11	6/8/11	29	175	73	2,627		\$179.49		2,627	\$179.49	\$0.00	\$179.49	\$0.00	\$0.140	\$0.00	\$0.140
Jun-11	6/8/11	7/8/11	30	23	194	4,569		\$331.00		4,569	\$331.00	\$0.00	\$331.00	\$0.00	\$0.144	\$0.00	\$0.144

	HDD	CDD	kW	kWh	kWh \$
Fiscal 2009	6,470	659	N/A	42,430	\$1,236
Fiscal 2010	5,720	744	N/A	44,781	\$4,429
Fiscal 2011	6,171	871	N/A	48,928	\$7,716
Average	6,120	758	0	45,380	\$0

Town of Salisbury

Town Hall

Electric Utility Tracking

Service: Main Meter

Soft: 0

Meter #: 23583779

Account #: 26732-47000

Supplier: Glacial Energy - 35481241

Tariff: National Grid

Deliverer: General Service - Small C/I G-1

Tariff: General Service - Small C/I G-1

Month	Last Read Date	Current Read Date	Read Days	HDD	CDD	Monthly Billed kW	Monthly On-Peak kW/h	Monthly Off-Peak kW/h	Monthly Demand Cost \$	Monthly Peak Supply Cost \$	Monthly On-Peak Delivery Cost \$	Monthly Off-Peak Delivery Cost \$	Total Monthly Peak Electric Cost \$	Total Monthly Off-Peak Electric Cost \$	Total Monthly Electric Cost \$	Monthly Demand Unit Cost \$/kW	Monthly On-Peak Unit Cost \$/kWh	Monthly Off-Peak Unit Cost \$/kWh	Total Monthly Blended Unit Cost \$/kWh	
Jul-08			0	0	0		7,721						7,721	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Aug-08	1/0/00		0	0	0		7,442						7,442	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sep-08	1/0/00		0	0	0		5,652						5,652	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Oct-08	1/0/00		0	0	0		5,644						5,644	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Nov-08	1/0/00		0	0	0		6,539						6,539	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Dec-08	1/0/00		0	0	0		5,826						5,826	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jan-09	2/6/09	3/9/09	39,850	3,968	585		6,275				\$393.06		\$393.06	\$0.00	\$0.00	\$393.06	\$0.00	\$0.00	\$0.00	\$0.00
Feb-09	2/6/09	3/9/09	31	1,051	0		6,718				\$417.13		\$417.13	\$0.00	\$0.00	\$417.13	\$0.00	\$0.00	\$0.00	\$0.00
Mar-09	3/9/09	4/6/09	30	751	0		6,301				\$384.75		\$384.75	\$0.00	\$0.00	\$384.75	\$0.00	\$0.00	\$0.00	\$0.00
Apr-09	4/6/09	5/6/09	30	412	18		6,104				\$373.01		\$373.01	\$0.00	\$0.00	\$373.01	\$0.00	\$0.00	\$0.00	\$0.00
May-09	5/6/09	6/9/09	32	183	23		7,942				\$482.61		\$482.61	\$0.00	\$0.00	\$482.61	\$0.00	\$0.00	\$0.00	\$0.00
Jun-09	6/9/09	7/10/09	31	105	33		8,963				\$543.48		\$543.48	\$0.00	\$0.00	\$543.48	\$0.00	\$0.00	\$0.00	\$0.00
Jul-09	7/10/09	8/7/09	28	4	170		9,290				\$563.00		\$563.00	\$0.00	\$0.00	\$563.00	\$0.00	\$0.00	\$0.00	\$0.00
Aug-09	8/7/09	9/8/09	32	39	197		9,263				\$561.29		\$561.29	\$0.00	\$0.00	\$561.29	\$0.00	\$0.00	\$0.00	\$0.00
Sep-09	9/8/09	10/9/09	0	0	0		0				\$0.00		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Oct-09	10/9/09	11/5/09	58	692	12		4,313				\$275.06		\$275.06	\$0.00	\$0.00	\$275.06	\$0.00	\$0.00	\$0.00	\$0.00
Nov-09	11/5/09	12/8/09	33	680	0		3,877				\$387.37		\$387.37	\$0.00	\$0.00	\$387.37	\$0.00	\$0.00	\$0.00	\$0.00
Dec-09	12/8/09	1/8/10	31	1,160	0		16,425				\$1,013.56		\$1,013.56	\$0.00	\$0.00	\$1,013.56	\$0.00	\$0.00	\$0.00	\$0.00
Jan-10	1/8/10	2/8/10	31	1,195	0		7,277				\$474.07		\$474.07	\$0.00	\$0.00	\$474.07	\$0.00	\$0.00	\$0.00	\$0.00
Feb-10	2/8/10	3/10/10	30	883	0		7,722				\$490.02		\$490.02	\$0.00	\$0.00	\$490.02	\$0.00	\$0.00	\$0.00	\$0.00
Mar-10	3/10/10	4/9/10	30	529	1		7,710				\$1,393.56		\$1,393.56	\$0.00	\$0.00	\$1,393.56	\$0.00	\$0.00	\$0.00	\$0.00
Apr-10	4/9/10	5/10/10	31	385	20		7,189				\$1,309.41		\$1,309.41	\$0.00	\$0.00	\$1,309.41	\$0.00	\$0.00	\$0.00	\$0.00
May-10	5/10/10	6/8/10	29	120	75		7,329				\$1,376.25		\$1,376.25	\$0.00	\$0.00	\$1,376.25	\$0.00	\$0.00	\$0.00	\$0.00
Jun-10	6/8/10	7/12/10	34	33	269		11,217				\$2,059.40		\$2,059.40	\$0.00	\$0.00	\$2,059.40	\$0.00	\$0.00	\$0.00	\$0.00
Jul-10	7/12/10	8/11/10	30	0	330		11,206				\$2,034.69		\$2,034.69	\$0.00	\$0.00	\$2,034.69	\$0.00	\$0.00	\$0.00	\$0.00
Aug-10	8/11/10	9/9/10	29	4	214		9,254				\$1,695.96		\$1,695.96	\$0.00	\$0.00	\$1,695.96	\$0.00	\$0.00	\$0.00	\$0.00
Sep-10	9/9/10	10/8/10	29	127	51		7,638				\$1,368.81		\$1,368.81	\$0.00	\$0.00	\$1,368.81	\$0.00	\$0.00	\$0.00	\$0.00
Oct-10	10/8/10	11/8/10	31	493	4		7,326				\$1,379.93		\$1,379.93	\$0.00	\$0.00	\$1,379.93	\$0.00	\$0.00	\$0.00	\$0.00
Nov-10	11/8/10	12/9/10	31	753	0		7,354				\$836.90		\$836.90	\$0.00	\$0.00	\$836.90	\$0.00	\$0.00	\$0.00	\$0.00
Dec-10	12/9/10	1/7/11	29	1,017	0		7,110				\$1,174.08		\$1,174.08	\$0.00	\$0.00	\$1,174.08	\$0.00	\$0.00	\$0.00	\$0.00
Jan-11	1/7/11	2/9/11	33	1,415	0		8,106				\$1,060.21		\$1,060.21	\$0.00	\$0.00	\$1,060.21	\$0.00	\$0.00	\$0.00	\$0.00
Feb-11	2/9/11	3/11/11	30	1,056	0		7,028				\$834.88		\$834.88	\$0.00	\$0.00	\$834.88	\$0.00	\$0.00	\$0.00	\$0.00
Mar-11	3/11/11	4/7/11	27	685	0		6,584				\$985.21		\$985.21	\$0.00	\$0.00	\$985.21	\$0.00	\$0.00	\$0.00	\$0.00
Apr-11	4/7/11	5/10/11	33	423	5		6,584				\$1,058.83		\$1,058.83	\$0.00	\$0.00	\$1,058.83	\$0.00	\$0.00	\$0.00	\$0.00
May-11	5/10/11	6/8/11	29	175	73		7,228				\$1,199.21		\$1,199.21	\$0.00	\$0.00	\$1,199.21	\$0.00	\$0.00	\$0.00	\$0.00
Jun-11	6/8/11	7/8/11	30	23	194		8,191				\$1,146		\$1,146	\$0.00	\$0.00	\$1,146	\$0.00	\$0.00	\$0.00	\$0.00

	HDD	CDD	kWh	kW	kWh \$
Fiscal 2009	6,470	659	81,127	N/A	\$2,594
Fiscal 2010	5,720	744	93,802	N/A	\$9,903
Fiscal 2011	6,171	871	92,633	N/A	\$15,047
Average	6,120	758	89,187	\$0	\$9,181

**Town of Salisbury
Sewer Treatment Plant
Electric Utility Tracking**

Service: Plant
Sgt 0
Meter # 04996735
Account # 14041-99007
Supplier: Glacial Energy - 35481241
Tariff:
National Grid
Deliverer:
General Service - Demand G-2

Month	Last Read Date	Current Read Date	Read Days	HDD	CDD	Monthly Billed kW	Monthly On-Peak kW	Monthly Off-Peak Supply Cost \$	Monthly On-Peak Delivery Cost \$	Monthly Off-Peak Delivery Cost \$	Total Monthly Electric Cost \$	Total Monthly Demand Unit Cost \$/kW	Monthly On-Peak Unit Cost \$/kW	Monthly Off-Peak Unit Cost \$/kW	Total Monthly Blended Unit Cost \$/kWh
Jan-08			0	0	0		109,200				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Feb-08	1/6/08		0	0	0		114,200				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Mar-08	1/6/08		0	0	0		83,400				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Apr-08	1/6/08		0	0	0		96,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
May-08	1/6/08		0	0	0		69,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jun-08	1/6/08		0	0	0		83,400				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jul-08	1/6/08		0	0	0		77,400				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Aug-08	1/6/08		0	0	0		81,800				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sep-08	1/6/08		0	0	0		71,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Oct-08	1/6/08		0	0	0		76,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Nov-08	1/6/08		0	0	0		85,800				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Dec-08	1/6/08		0	0	0		106,600				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jan-09	1/6/09		0	0	0		89,200				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Feb-09	1/6/09		0	0	0		71,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Mar-09	1/6/09		0	0	0		82,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Apr-09	1/6/09		0	0	0		93,800				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
May-09	1/6/09		0	0	0		77,200				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jun-09	1/6/09		0	0	0		76,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jul-09	1/6/09		0	0	0		94,200				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Aug-09	1/6/09		0	0	0		92,600				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sep-09	1/6/09		0	0	0		97,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Oct-09	1/6/09		0	0	0		95,200				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Nov-09	1/6/09		0	0	0		84,600				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Dec-09	1/6/09		0	0	0		67,600				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jan-10	1/6/10		0	0	0		83,200				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Feb-10	1/6/10		0	0	0		80,800				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Mar-10	1/6/10		0	0	0		77,600				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Apr-10	1/6/10		0	0	0		73,000				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
May-10	1/6/10		0	0	0		92,600				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jun-10	1/6/10		0	0	0		98,800				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jul-10	1/6/10		0	0	0		92,200				\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Aug-10	1/6/10		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sep-10	1/6/10		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Oct-10	1/6/10		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Nov-10	1/6/10		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Dec-10	1/6/10		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jan-11	1/6/11		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Feb-11	1/6/11		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Mar-11	1/6/11		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Apr-11	1/6/11		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
May-11	1/6/11		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Jun-11	1/6/11		0	0	0						\$0.00	\$0.00	\$0.00	\$0.00	\$0.00

Fiscal 2009	HDD	CDD	kW	kWh	kWh \$
	6,466	659	746	1,022,800	N/A
Fiscal 2010					
Fiscal 2011	5,724	701	1,918	1,023,600	N/A
Average	6,120	765	1,510	1,026,000	\$0

**Town of Salisbury
Sparhawk School
Electric Utility Tracking**

Service: High School Meter
Soft: 0
Meter #: 05064672
Account #: 20241-05004
Supplier: Glacial Energy - 35481241
Tariff: National Grid
Deliverer: General Service - Small C/I G-1

Month	Last Read Date	Current Read Date	Read Days	HDD	CDD	Monthly Billed kW	Monthly On-Peak kW	Monthly Off-Peak kW	Monthly Demand Cost \$	Monthly Supply Cost \$	Monthly Peak Electric Cost \$	Monthly On-Peak Electric Cost \$	Total Monthly Off-Peak Electric Cost \$	Total Monthly Electric Cost \$	Monthly Demand Unit Cost \$/kW	Monthly On-Peak Unit Cost \$/kW	Monthly Off-Peak Unit Cost \$/kW	Total Monthly Blended Unit Cost \$/kW
Jul-08							45								\$0.00	\$0.00	\$0.00	\$0.00
Aug-08	1/000		0	0	0		38								\$0.00	\$0.00	\$0.00	\$0.00
Sep-08	1/000		0	0	0		80								\$0.00	\$0.00	\$0.00	\$0.00
Oct-08	1/000		0	0	0		41								\$0.00	\$0.00	\$0.00	\$0.00
Nov-08	1/000		0	0	0		23								\$0.00	\$0.00	\$0.00	\$0.00
Dec-08	1/000		0	0	0		1								\$0.00	\$0.00	\$0.00	\$0.00
Jan-09	1/000		0	0	0		0								\$0.00	\$0.00	\$0.00	\$0.00
Feb-09	1/000		0	0	0		0								\$0.00	\$0.00	\$0.00	\$0.00
Mar-09	1/000	3/27/09	39	899	585		1								\$0.00	\$0.00	\$0.00	\$0.00
Apr-09	3/27/09	4/28/09	32	573	311		7								\$0.00	\$0.00	\$0.00	\$0.00
May-09	4/28/09	5/27/09	29	199	28		16								\$0.00	\$0.00	\$0.00	\$0.00
Jun-09	5/27/09	6/29/11	763	12,064	1,567		20								\$0.00	\$0.00	\$0.00	\$0.00
Jul-09	6/29/11	7/28/09	-701	0	0		22								\$0.00	\$0.00	\$0.00	\$0.00
Aug-09	7/28/09	8/26/09	29	2	270		31								\$0.00	\$0.00	\$0.00	\$0.00
Sep-09	8/26/09	9/28/09	33	156	30		98								\$0.00	\$0.00	\$0.00	\$0.00
Oct-09	9/28/09	10/26/09	28	397	0		57								\$0.00	\$0.00	\$0.00	\$0.00
Nov-09	10/26/09	11/24/09	29	539	0		58								\$0.00	\$0.00	\$0.00	\$0.00
Dec-09	11/24/09	12/28/09	34	1,049	0		7								\$0.00	\$0.00	\$0.00	\$0.00
Jan-10	12/28/09	1/28/10	31	1,153	0		6								\$0.00	\$0.00	\$0.00	\$0.00
Feb-10	1/28/10	2/25/10	28	1,013	0		7								\$0.00	\$0.00	\$0.00	\$0.00
Mar-10	2/25/10	3/29/10	32	762	0		8								\$0.00	\$0.00	\$0.00	\$0.00
Apr-10	3/29/10	4/28/10	30	400	1		14								\$0.00	\$0.00	\$0.00	\$0.00
May-10	4/28/10	5/26/10	28	206	38		18								\$0.00	\$0.00	\$0.00	\$0.00
Jun-10	5/26/10	6/28/10	33	38	155		29								\$0.00	\$0.00	\$0.00	\$0.00
Jul-10	6/28/10	7/28/10	30	1	359		34								\$0.00	\$0.00	\$0.00	\$0.00
Aug-10	7/28/10	8/27/10	31	3	238		31								\$0.00	\$0.00	\$0.00	\$0.00
Sep-10	8/27/10	9/27/10	31	55	146		83								\$0.00	\$0.00	\$0.00	\$0.00
Oct-10	9/27/10	10/26/10	29	351	23		123								\$0.00	\$0.00	\$0.00	\$0.00
Nov-10	10/26/10	11/24/10	29	526	4		90								\$0.00	\$0.00	\$0.00	\$0.00
Dec-10	11/24/10	12/28/10	34	1,135	0		9								\$0.00	\$0.00	\$0.00	\$0.00
Jan-11	12/28/10	1/28/11	31	1,239	0		5								\$0.00	\$0.00	\$0.00	\$0.00
Feb-11	1/28/11	2/25/11	28	1,102	0		4								\$0.00	\$0.00	\$0.00	\$0.00
Mar-11	2/25/11	3/28/11	31	904	0		5								\$0.00	\$0.00	\$0.00	\$0.00
Apr-11	3/28/11	4/28/11	31	569	0		5								\$0.00	\$0.00	\$0.00	\$0.00
May-11	4/28/11	5/27/11	29	242	18		4								\$0.00	\$0.00	\$0.00	\$0.00
Jun-11	5/27/11	6/29/11	33	45	171		6								\$0.00	\$0.00	\$0.00	\$0.00

	HDD	CDD	kW	kWh	kWh \$
Fiscal 2009	18,351	2,191	N/A	273	\$43
Fiscal 2010	5,715	484	N/A	355	\$168
Fiscal 2011	6,172	959	N/A	399	\$174
Average	10,083	1,215	0	342	\$128

**Town of Salisbury
Sparhawk School
Electric Utility Tracking**

Service: Boys & girls Club
Sgt 0
Meter # 51038539
Account # 76555-83008
Supplier: National Grid
Tariff: National Grid
Deliverer: General Service - Demand G-2
Tariff:

Month	Last Read Date	Current Read Date	Read Days	HDD	CDD	Monthly kW	Monthly Peak kW	Monthly On-Peak kW	Monthly Off-Peak kW	Monthly Demand Cost \$	Monthly Supply Cost \$	Monthly Peak Supply Cost \$	Monthly Off-Peak Supply Cost \$	Monthly On-Peak Delivery Cost \$	Monthly Off-Peak Delivery Cost \$	Total On-Peak Electric Cost \$	Total Off-Peak Electric Cost \$	Total Monthly Electric Cost \$	Monthly Demand Unit Cost \$/kWh	Monthly On-Peak Unit Cost \$/kWh	Monthly Off-Peak Unit Cost \$/kWh	Total Monthly Blended Unit Cost \$/kWh
Jul-08																						
Aug-08	1/0000		0	0	0														\$0.00	\$0.00	\$0.00	\$0.00
Sep-08	1/0000		0	0	0														\$0.00	\$0.00	\$0.00	\$0.00
Oct-08	1/0000		0	0	0														\$0.00	\$0.00	\$0.00	\$0.00
Nov-08	1/0000		0	0	0														\$0.00	\$0.00	\$0.00	\$0.00
Dec-08	1/0000		0	0	0														\$0.00	\$0.00	\$0.00	\$0.00
Jan-09	1/0000		0	0	0														\$0.00	\$0.00	\$0.00	\$0.00
Feb-09	1/0000		0	0	0														\$0.00	\$0.00	\$0.00	\$0.00
Mar-09	1/0000		0	0	0														\$0.00	\$0.00	\$0.00	\$0.00
Apr-09	5/809	5/809	39/941	6,182	603														\$0.00	\$0.00	\$0.00	\$0.00
May-09	5/809	6/909	32	183	23	54.0	11,160					\$1,441.29		\$1,441.29		\$1,441.29		\$1,441.29	\$0.00	\$0.00	\$0.00	\$0.00
Jun-09	6/909	7/10/09	31	105	33	50.0	9,240	\$1,272.05				\$1,272.05		\$1,272.05		\$1,272.05		\$1,272.05	\$0.00	\$0.00	\$0.00	\$0.00
Jul-09	7/10/09	8/7/09	28	4	170	50.0	9,360	\$1,294.96				\$1,294.96		\$1,294.96		\$1,294.96		\$1,294.96	\$0.00	\$0.00	\$0.00	\$0.00
Aug-09	8/7/09	9/8/09	32	39	197	52.0	10,560	\$1,387.37				\$1,387.37		\$1,387.37		\$1,387.37		\$1,387.37	\$0.00	\$0.00	\$0.00	\$0.00
Sep-09	9/8/09	10/8/09	30	203	12	51.0	9,960	\$1,319.65				\$1,319.65		\$1,319.65		\$1,319.65		\$1,319.65	\$0.00	\$0.00	\$0.00	\$0.00
Oct-09	10/8/09	11/5/09	28	489	0	63.0	13,200	\$1,740.36				\$1,740.36		\$1,740.36		\$1,740.36		\$1,740.36	\$0.00	\$0.00	\$0.00	\$0.00
Nov-09	11/5/09	12/8/09	33	680	0	62.0	16,200	\$1,945.43				\$1,945.43		\$1,945.43		\$1,945.43		\$1,945.43	\$0.00	\$0.00	\$0.00	\$0.00
Dec-09	12/8/09	1/8/10	31	1,160	0	62.0	16,200	\$2,116.45				\$2,116.45		\$2,116.45		\$2,116.45		\$2,116.45	\$0.00	\$0.00	\$0.00	\$0.00
Jan-10	1/8/10	2/8/10	30	1,195	0	63.0	15,840	\$2,281.13				\$2,281.13		\$2,281.13		\$2,281.13		\$2,281.13	\$0.00	\$0.00	\$0.00	\$0.00
Feb-10	2/8/10	3/10/10	30	883	0	64.0	13,080	\$2,322.43				\$2,322.43		\$2,322.43		\$2,322.43		\$2,322.43	\$0.00	\$0.00	\$0.00	\$0.00
Mar-10	3/10/10	4/9/10	30	529	1	64.0	13,080	\$1,973.63				\$1,973.63		\$1,973.63		\$1,973.63		\$1,973.63	\$0.00	\$0.00	\$0.00	\$0.00
Apr-10	4/9/10	5/11/10	32	403	20	68.0	12,000	\$1,709.43				\$1,709.43		\$1,709.43		\$1,709.43		\$1,709.43	\$0.00	\$0.00	\$0.00	\$0.00
May-10	5/11/10	6/8/10	28	102	75	62.0	10,320	\$1,448.49				\$1,448.49		\$1,448.49		\$1,448.49		\$1,448.49	\$0.00	\$0.00	\$0.00	\$0.00
Jun-10	6/8/10	7/12/10	34	33	269	51.0	9,240	\$1,705.00				\$1,705.00		\$1,705.00		\$1,705.00		\$1,705.00	\$0.00	\$0.00	\$0.00	\$0.00
Jul-10	7/12/10	8/12/10	31	0	340	51.0	9,240	\$1,364.80				\$1,364.80		\$1,364.80		\$1,364.80		\$1,364.80	\$0.00	\$0.00	\$0.00	\$0.00
Aug-10	8/12/10	9/9/10	28	4	204	52.0	9,240	\$1,776.18				\$1,776.18		\$1,776.18		\$1,776.18		\$1,776.18	\$0.00	\$0.00	\$0.00	\$0.00
Sep-10	9/9/10	10/8/10	29	127	51	51.0	9,600	\$1,874.04				\$1,874.04		\$1,874.04		\$1,874.04		\$1,874.04	\$0.00	\$0.00	\$0.00	\$0.00
Oct-10	10/8/10	11/8/10	31	493	4	64.0	12,480	\$1,839.97				\$1,839.97		\$1,839.97		\$1,839.97		\$1,839.97	\$0.00	\$0.00	\$0.00	\$0.00
Nov-10	11/8/10	12/9/10	31	753	0	64.0	13,920	\$2,008.98				\$2,008.98		\$2,008.98		\$2,008.98		\$2,008.98	\$0.00	\$0.00	\$0.00	\$0.00
Dec-10	12/9/10	1/7/11	29	1,017	0	64.0	14,760	\$1,917.31				\$1,917.31		\$1,917.31		\$1,917.31		\$1,917.31	\$0.00	\$0.00	\$0.00	\$0.00
Jan-11	1/7/11	2/9/11	33	1,415	0	58.0	14,040	\$1,946.50				\$1,946.50		\$1,946.50		\$1,946.50		\$1,946.50	\$0.00	\$0.00	\$0.00	\$0.00
Feb-11	2/9/11	3/10/11	29	1,029	0	62.0	14,040	\$1,847.68				\$1,847.68		\$1,847.68		\$1,847.68		\$1,847.68	\$0.00	\$0.00	\$0.00	\$0.00
Mar-11	3/10/11	4/7/11	28	712	0	68.0	13,080	\$1,703.91				\$1,703.91		\$1,703.91		\$1,703.91		\$1,703.91	\$0.00	\$0.00	\$0.00	\$0.00
Apr-11	4/7/11	5/9/11	32	418	5	68.0	12,480	\$1,517.81				\$1,517.81		\$1,517.81		\$1,517.81		\$1,517.81	\$0.00	\$0.00	\$0.00	\$0.00
May-11	5/9/11	6/9/11	31	180	83	62.0	12,480												\$0.00	\$0.00	\$0.00	\$0.00
Jun-11	6/9/11	7/8/11	29	23	184	111.0	7,800												\$0.00	\$0.00	\$0.00	\$0.00

	HDD	CDD	kW	kWh \$
Fiscal 2009	6,470	659	104	\$2,713
Fiscal 2010	5,720	744	710	\$21,784
Fiscal 2011	6,171	871	775	\$20,866
Average	6,120	758	530	\$15,121

**Town of Salisbury
Fire Department
Natural Gas Utility Tracking**

Service: DHW
Sqt 0
Meter # 00Y308534
Account # 40716-17500
Supplier: Keyspan/National Grid
Tariff:
Deliverer: Keyspan/National Grid
Tariff: Rate G-51T Commercial Non-Heat

					Conversion in Use				
					Therms	100,000	Btu/Therms		
Date	Last Read Date	Current Read Date	Read Days	HDD	Monthly Therms	Monthly Supply Cost \$	Monthly Delivery Cost \$	Total Monthly Cost \$	Monthly Supply Unit Cost \$/Therms
Jul-08	6/16/08	7/16/08	30	6	10	\$0.00	\$25.77	\$25.77	\$0.000
Aug-08	7/16/08	8/15/08	30	2	15	\$0.00	\$36.77	\$36.77	\$0.000
Sep-08	8/15/08	9/16/08	32	27	9	\$0.00	\$23.11	\$23.11	\$0.000
Oct-08	9/16/08	10/15/08	29	256	8	\$0.00	\$18.23	\$18.23	\$0.000
Nov-08	10/15/08	11/13/08	29	519	7	\$0.00	\$17.86	\$17.86	\$0.000
Dec-08	11/13/08	12/16/08	33	972	10	\$12.43	\$13.09	\$25.52	\$1.243
Jan-09	12/16/08	1/15/09	30	1,167	10	\$12.44	\$12.28	\$24.72	\$1.244
Feb-09	1/15/09	2/13/09	29	1,221	7	\$8.70	\$10.80	\$19.50	\$1.243
Mar-09	2/13/09	3/16/09	31	1,017	10	\$12.44	\$12.57	\$25.01	\$1.244
Apr-09	3/16/09	4/14/09	29	689	7	\$8.70	\$10.80	\$19.50	\$1.243
May-09	4/14/09	5/14/09	30	316	9	\$11.19	\$11.33	\$22.52	\$1.243
Jun-09	5/14/09	6/16/09	33	183	8	\$9.94	\$11.25	\$21.19	\$1.243
Jul-09	6/16/09	7/17/09	31	66	10	\$12.44	\$11.24	\$23.68	\$1.244
Aug-09	7/17/09	8/17/09	31	4	8	\$9.94	\$10.70	\$20.64	\$1.243
Sep-09	8/17/09	9/16/09	30	69	9	\$11.19	\$10.69	\$21.88	\$1.243
Oct-09	9/16/09	10/15/09	29	284	8	\$9.94	\$10.14	\$20.08	\$1.243
Nov-09	10/15/09	11/13/09	29	533	8	\$9.94	\$10.70	\$20.64	\$1.243
Dec-09	11/13/09	12/14/09	31	732	8	\$9.95	\$11.95	\$21.90	\$1.244
Jan-10	12/14/09	1/14/10	31	1,223	10	\$12.43	\$12.87	\$25.30	\$1.243
Feb-10	1/14/10	2/12/10	29	1,064	8	\$9.95	\$11.53	\$21.48	\$1.244
Mar-10	2/12/10	3/15/10	31	878	9	\$11.19	\$12.55	\$23.74	\$1.243
Apr-10	3/15/10	4/14/10	30	475	35	\$26.64	\$23.66	\$50.30	\$0.761
May-10	4/14/10	5/12/10	28	340	8	\$9.95	\$10.87	\$20.82	\$1.244
Jun-10	5/12/10	6/29/10	48	115	13	\$16.87	\$17.38	\$34.25	\$1.298
Jul-10	6/29/10	7/28/10	29	1	10	\$12.43	\$11.15	\$23.58	\$1.243
Aug-10	7/28/10	8/30/10	33	3	7	\$9.47	\$11.37	\$20.84	\$1.353
Sep-10	8/30/10	9/27/10	28	55	8	\$9.94	\$10.27	\$20.21	\$1.243
Oct-10	9/27/10	10/27/10	30	351	10	\$12.43	\$11.43	\$23.86	\$1.243
Nov-10	10/27/10	11/29/10	33	669	7	\$9.48	\$23.58	\$33.06	\$1.354
Dec-10	11/29/10	12/30/10	31	1,064	11	\$13.67	\$25.64	\$39.31	\$1.243
Jan-11	12/30/10	1/28/11	29	1,167	8	\$9.94	\$23.29	\$33.23	\$1.243
Feb-11	1/28/11	2/25/11	28	1,102	7	\$9.30	\$22.25	\$31.55	\$1.329
Mar-11	2/25/11	3/28/11	31	904	8	\$9.94	\$24.71	\$34.65	\$1.243
Apr-11	3/28/11	4/28/11	31	569	11	\$13.67	\$25.71	\$39.38	\$1.243
May-11	4/28/11	5/27/11	29	242	8	\$9.94	\$23.30	\$33.24	\$1.243
Jun-11	5/27/11	6/29/11	33	45	9	\$11.18	\$26.48	\$37.66	\$1.242

	HDD	Therms	\$
Fiscal 2009	6,375	110	\$280
Fiscal 2010	5,783	134	\$305
Fiscal 2011	6,172	104	\$371
Average	6,110	116	\$318

Town of Salisbury
Department of Public Works
Natural Gas Utility Tracking

Service: Heat and DHW
 Sqft 0
 Meter # 705480
 Account # 40716-17530
 Supplier: Keyspan/National Grid
 Tariff:
 Deliverer: Keyspan/National Grid
 Tariff: Rate G-51 Comm'l Non-Heat

Tariff:	Rate G-51		Comm'n Non-Heat		Conversion in Use							
					Therms	100,000	Btu/Therms					
	Date	Last Read Date	Current Read Date	Read Days	HDD	Monthly Therms	Monthly Supply Cost \$	Monthly Delivery Cost \$	Total Monthly Cost \$	Monthly Supply Unit Cost \$/Therms	Monthly Delivery Unit Cost \$/Therms	Total Monthly Unit Cost \$/Therms
	Jul-08	6/16/08	7/16/08	30	6	18	\$0.00	\$39.78	\$39.78	\$0.000	\$2.210	\$2.210
	Aug-08	7/16/08	8/15/08	30	2	23	\$0.00	\$51.91	\$51.91	\$0.000	\$2.257	\$2.257
	Sep-08	8/15/08	9/16/08	32	27	21	\$0.00	\$42.19	\$42.19	\$0.000	\$2.009	\$2.009
	Oct-08	9/16/08	10/15/08	29	256	240	\$0.00	\$315.81	\$315.81	\$0.000	\$1.316	\$1.316
	Nov-08	10/15/08	11/13/08	29	519	570	\$0.00	\$808.57	\$808.57	\$0.000	\$1.419	\$1.419
	Dec-08	11/13/08	12/16/08	33	972	933	\$0.00	\$1,469.23	\$1,469.23	\$0.000	\$1.575	\$1.575
	Jan-09	12/16/08	1/15/09	30	1,167	1,298	\$0.00	\$2,031.58	\$2,031.58	\$0.000	\$1.565	\$1.565
	Feb-09	1/15/09	2/13/09	29	1,221	1,236	\$0.00	\$1,864.80	\$1,864.80	\$0.000	\$1.509	\$1.509
	Mar-09	2/13/09	3/16/09	31	1,017	1,051	\$0.00	\$1,517.40	\$1,517.40	\$0.000	\$1.444	\$1.444
	Apr-09	3/16/09	4/14/09	29	689	738	\$0.00	\$1,071.14	\$1,071.14	\$0.000	\$1.451	\$1.451
	May-09	4/14/09	5/14/09	30	316	464	\$0.00	\$519.28	\$519.28	\$0.000	\$1.119	\$1.119
	Jun-09	5/14/09	6/16/09	33	183	444	\$0.00	\$321.94	\$321.94	\$0.000	\$0.725	\$0.725
	Jul-09	6/16/09	7/17/09	31	66	29	\$0.00	\$29.20	\$29.20	\$0.000	\$1.007	\$1.007
	Aug-09	7/17/09	8/17/09	31	4	15	\$0.00	\$19.23	\$19.23	\$0.000	\$1.282	\$1.282
	Sep-09	8/17/09	9/16/09	30	69	14	\$0.00	\$18.23	\$18.23	\$0.000	\$1.302	\$1.302
	Oct-09	9/16/09	10/15/09	29	284	249	\$0.00	\$185.34	\$185.34	\$0.000	\$0.744	\$0.744
	Nov-09	10/15/09	11/13/09	29	533	555	\$0.00	\$551.12	\$551.12	\$0.000	\$0.993	\$0.993
	Dec-09	11/13/09	12/14/09	31	732	659	\$0.00	\$879.24	\$879.24	\$0.000	\$1.334	\$1.334
	Jan-10	12/14/09	1/14/10	31	1,223	1,195	\$0.00	\$1,574.71	\$1,574.71	\$0.000	\$1.318	\$1.318
	Feb-10	1/14/10	2/12/10	29	1,064	1,033	\$0.00	\$1,414.36	\$1,414.36	\$0.000	\$1.369	\$1.369
	Mar-10	2/12/10	3/15/10	31	878	855	\$0.00	\$1,239.61	\$1,239.61	\$0.000	\$1.450	\$1.450
	Apr-10	3/15/10	4/14/10	30	475	628	\$0.00	\$919.63	\$919.63	\$0.000	\$1.464	\$1.464
	May-10	4/14/10	5/12/10	28	340	273	\$0.00	\$332.50	\$332.50	\$0.000	\$1.218	\$1.218
	Jun-10	5/12/10	6/29/10	48	115	27	\$0.00	\$35.91	\$35.91	\$0.000	\$1.330	\$1.330
	Jul-10	6/29/10	7/28/10	29	1	5	\$0.00	\$12.27	\$12.27	\$0.000	\$2.454	\$2.454
	Aug-10	7/28/10	8/30/10	33	3	5	\$0.00	\$13.39	\$13.39	\$0.000	\$2.678	\$2.678
	Sep-10	8/30/10	9/27/10	28	55	4	\$0.00	\$11.16	\$11.16	\$0.000	\$2.790	\$2.790
	Oct-10	9/27/10	10/27/10	30	351	284	\$0.00	\$244.66	\$244.66	\$0.000	\$0.861	\$0.861
	Nov-10	10/27/10	11/29/10	33	669	718	\$0.00	\$863.16	\$863.16	\$0.000	\$1.202	\$1.202
	Dec-10	11/29/10	12/29/10	30	1,031	831	\$0.00	\$1,038.53	\$1,038.53	\$0.000	\$1.250	\$1.250
	Jan-11	12/29/10	1/28/11	30	1,200	994	\$0.00	\$1,240.37	\$1,240.37	\$0.000	\$1.248	\$1.248
	Feb-11	1/28/11	2/25/11	28	1,102	1,073	\$0.00	\$1,337.49	\$1,337.49	\$0.000	\$1.246	\$1.246
	Mar-11	2/25/11	3/28/11	31	904	919	\$0.00	\$1,147.86	\$1,147.86	\$0.000	\$1.249	\$1.249
	Apr-11	3/28/11	4/28/11	31	569	696	\$0.00	\$871.83	\$871.83	\$0.000	\$1.253	\$1.253
	May-11	4/28/11	5/27/11	29	242	214	\$0.00	\$237.62	\$237.62	\$0.000	\$1.110	\$1.110
	Jun-11	5/27/11	6/29/11	33	45	18	\$0.00	\$41.06	\$41.06	\$0.000	\$2.281	\$2.281

	HDD	Therms	\$
Fiscal 2009	6,375	7,036	\$10,054
Fiscal 2010	5,783	5,532	\$7,199
Fiscal 2011	6,172	5,761	\$7,059
Average	6,110	6,110	\$8,104

Town of Salisbury
Beach Services - DPW
Natural Gas Utility Tracking

Service: Heat
 Sqft 0
 Meter # 004723548
 Account # 40726-20770
 Supplier: Keyspan/National Grid
 Tariff: Keyspan/National Grid
 Deliverer: Keyspan/National Grid
 Tariff: Rate G-5 JT Comm'l Non-Heat

Tariff:	Rate G-51IT Comm'l Non-Heat				Conversion in Use							
					Therms	100,000	Btu/Therms					
	Last Read Date	Current Read Date	Read Days	HDD	Monthly Therms	Monthly Supply Cost \$	Monthly Delivery Cost \$	Total Monthly Cost \$	Monthly Supply Unit Cost \$/Therms	Monthly Delivery Unit Cost \$/Therms	Total Monthly Unit Cost \$/Therms	
Jul-08	6/16/08	7/16/08	30	6	24	\$0.00	\$50.16	\$50.16	\$0.000	\$2.090	\$2.090	
Aug-08	7/16/08	8/15/08	30	2	21	\$0.00	\$48.11	\$48.11	\$0.000	\$2.291	\$2.291	
Sep-08	8/15/08	9/16/08	32	27	24	\$0.00	\$46.76	\$46.76	\$0.000	\$1.948	\$1.948	
Oct-08	9/16/08	10/15/08	29	256	12	\$0.00	\$23.35	\$23.35	\$0.000	\$1.946	\$1.946	
Nov-08	10/15/08	11/13/08	29	519	66	\$0.00	\$101.56	\$101.56	\$0.000	\$1.539	\$1.539	
Dec-08	11/13/08	12/16/08	33	972	285	\$314.80	\$123.72	\$438.52	\$1.105	\$0.434	\$1.539	
Jan-09	12/16/08	1/15/09	30	1,167	135	\$231.68	\$62.56	\$294.24	\$1.716	\$0.463	\$2.180	
Feb-09	1/15/09	2/13/09	29	1,221	0	\$0.00	\$7.98	\$7.98	\$0.000	\$0.000	\$0.000	
Mar-09	2/13/09	3/16/09	31	1,017	0	\$100.75	\$8.54	\$109.29	\$0.000	\$0.000	\$0.000	
Apr-09	3/16/09	4/14/09	29	689	0	\$82.18	\$7.98	\$90.16	\$0.000	\$0.000	\$0.000	
May-09	4/14/09	5/14/09	30	316	0	\$34.75	\$8.26	\$43.01	\$0.000	\$0.000	\$0.000	
Jun-09	5/14/09	6/16/09	33	183	0	\$14.28	\$9.09	\$23.37	\$0.000	\$0.000	\$0.000	
Jul-09	6/16/09	7/17/09	31	66	0	\$13.54	\$8.54	\$22.08	\$0.000	\$0.000	\$0.000	
Aug-09	7/17/09	8/17/09	31	4	0	\$0.00	\$8.54	\$8.54	\$0.000	\$0.000	\$0.000	
Sep-09	8/17/09	8/17/09	0	0				\$0.00	\$0.000	\$0.000	\$0.000	
Oct-09	8/17/09	8/17/09	0	0				\$0.00	\$0.000	\$0.000	\$0.000	
Nov-09	8/17/09	11/13/09	88	886	88	\$99.39	\$51.92	\$151.31	\$1.129	\$0.590	\$1.719	
Dec-09	11/13/09	12/14/09	31	732	2	\$74.49	\$9.40	\$83.89	\$37.245	\$4.700	\$41.945	
Jan-10	12/14/09	1/14/10	31	1,223	3	\$80.03	\$9.88	\$89.91	\$26.677	\$3.293	\$29.970	
Feb-10	1/14/10	2/12/10	29	1,064	3	\$63.53	\$9.40	\$72.93	\$21.177	\$3.133	\$24.310	
Mar-10	2/12/10	3/15/10	31	878	2	\$99.49	\$9.54	\$109.03	\$49.745	\$4.770	\$54.515	
Apr-10	3/15/10	4/14/10	30	475	1	\$86.53	\$8.83	\$95.36	\$86.530	\$8.830	\$95.360	
May-10	4/14/10	5/12/10	28	340	1	\$32.45	\$8.24	\$40.69	\$32.450	\$8.240	\$40.690	
Jun-10	5/12/10	6/29/10	48	115	2	\$18.97	\$14.04	\$33.01	\$9.485	\$7.020	\$16.505	
Jul-10	6/29/10	7/29/10	30	1	2	\$12.06	\$9.00	\$21.06	\$6.030	\$4.500	\$10.530	
Aug-10	7/29/10	8/30/10	32	3	3	\$19.05	\$9.87	\$28.92	\$6.350	\$3.290	\$9.640	
Sep-10	8/30/10	9/27/10	28	55	3	\$12.77	\$8.75	\$21.52	\$4.257	\$2.915	\$7.172	
Oct-10	9/27/10	10/27/10	30	351	1	\$13.30	\$8.70	\$22.00	\$13.300	\$8.700	\$22.000	
Nov-10	10/27/10	11/29/10	33	669	2	\$13.60	\$21.92	\$35.52	\$6.800	\$10.960	\$17.760	
Dec-10	11/29/10	12/29/10	30	1,031	3	\$94.61	\$22.26	\$116.87	\$31.537	\$7.420	\$38.957	
Jan-11	12/29/10	1/28/11	30	1,200	3	\$57.25	\$22.33	\$79.58	\$19.083	\$7.443	\$26.527	
Feb-11	1/28/11	2/25/11	28	1,102	3	\$68.37	\$20.91	\$89.28	\$22.790	\$6.970	\$29.760	
Mar-11	2/25/11	3/28/11	31	904	2	\$104.78	\$22.71	\$127.49	\$52.390	\$11.355	\$63.745	
Apr-11	3/28/11	4/28/11	31	569	2	\$56.14	\$22.71	\$78.85	\$28.070	\$11.355	\$39.425	
May-11	4/28/11	5/27/11	29	242	1	\$15.10	\$20.95	\$36.05	\$15.100	\$20.950	\$36.050	
Jun-11	5/27/11	6/29/11	33	45	0	\$12.11	\$23.46	\$35.57	\$0.000	\$0.000	\$0.000	

	HDD	Therms	\$
Fiscal 2009	6,375	567	\$1,277
Fiscal 2010	5,783	102	\$707
Fiscal 2011	6,172	25	\$693
Average	6,110	231	\$892

Town of Salisbury
Council on Aging
Natural Gas Utility Tracking

Service: Heat, DHW and Kitchen
 Sqft 0
 Meter # 0E0003172
 Account # 40716-17560
 Supplier: Keyspan/National Grid
 Tariff: Keyspan/National Grid
 Deliverer: Rate G-41T Commercial Heat
 Tariff:

Conversion in Use									
				Therms	100,000	Btu/Therms			
Date	Last Read Date	Current Read Date	Read Days	HDD	Monthly Therms	Monthly Supply Cost \$	Monthly Delivery Cost \$	Total Monthly Cost \$	Monthly Supply Unit Cost \$/Therms
Jul-08	6/16/08	7/16/08	30	6	1	\$0.00	\$8.58	\$8.58	\$0.000
Aug-08	7/16/08	8/15/08	30	2	3	\$0.00	\$12.64	\$12.64	\$0.000
Sep-08	8/15/08	9/16/08	32	27	2	\$0.00	\$10.15	\$10.15	\$0.000
Oct-08	9/16/08	10/15/08	29	256	62	\$0.00	\$86.18	\$86.18	\$0.000
Nov-08	10/15/08	11/13/08	29	519	348	\$0.00	\$494.97	\$494.97	\$0.000
Dec-08	11/13/08	12/16/08	33	972	783	\$973.27	\$309.13	\$1,282.40	\$1.243
Jan-09	12/16/08	1/15/09	30	1,167	1,003	\$1,246.73	\$391.72	\$1,638.45	\$1.243
Feb-09	1/15/09	2/13/09	29	1,221	1,010	\$1,255.43	\$394.04	\$1,649.47	\$1.243
Mar-09	2/13/09	3/16/09	31	1,017	856	\$1,064.01	\$336.20	\$1,400.21	\$1.243
Apr-09	3/16/09	4/14/09	29	689	550	\$694.94	\$219.20	\$914.14	\$1.243
May-09	4/14/09	5/14/09	30	316	178	\$378.67	\$67.79	\$446.46	\$2.127
Jun-09	5/14/09	6/16/09	33	183	62	\$140.50	\$24.54	\$165.04	\$2.266
Jul-09	6/16/09	7/17/09	31	66	26	\$31.58	\$14.35	\$45.93	\$1.215
Aug-09	7/17/09	8/17/09	31	4	4	\$1.82	\$8.29	\$10.11	\$0.455
Sep-09	8/17/09	9/16/09	30	69	14	\$10.20	\$10.82	\$21.02	\$0.729
Oct-09	9/16/09	10/15/09	29	284	120	\$83.78	\$37.66	\$121.44	\$0.698
Nov-09	10/15/09	11/13/09	29	533	240	\$241.99	\$83.84	\$325.83	\$1.008
Dec-09	11/13/09	12/14/09	31	732	586	\$728.40	\$247.81	\$976.21	\$1.243
Jan-10	12/14/09	1/14/10	31	1,223	1,120	\$1,390.45	\$463.83	\$1,854.28	\$1.241
Feb-10	1/14/10	2/12/10	29	1,064	967	\$1,201.99	\$401.32	\$1,603.31	\$1.243
Mar-10	2/12/10	3/15/10	31	878	733	\$938.82	\$309.97	\$1,248.79	\$1.281
Apr-10	3/15/10	4/14/10	30	475	380	\$643.39	\$167.87	\$811.26	\$1.693
May-10	4/14/10	5/12/10	28	340	192	\$365.33	\$82.06	\$447.39	\$1.903
Jun-10	5/12/10	6/29/10	48	115	34	\$144.14	\$21.85	\$165.99	\$1.245
Jul-10	6/29/10	7/28/10	29	1	2	\$2.49	\$7.46	\$9.95	\$1.245
Aug-10	7/28/10	8/30/10	33	3	3	\$1.65	\$8.73	\$10.38	\$0.550
Sep-10	8/30/10	9/27/10	28	55	3	\$7.01	\$7.55	\$14.56	\$2.337
Oct-10	9/27/10	10/27/10	30	351	114	\$102.14	\$40.42	\$142.56	\$0.896
Nov-10	10/27/10	11/29/10	33	669	402	\$496.50	\$173.82	\$670.32	\$1.235
Dec-10	11/29/10	12/29/10	30	1,031	827	\$1,027.96	\$345.97	\$1,373.93	\$1.243
Jan-11	12/29/10	1/28/11	30	1,200	939	\$1,167.18	\$390.94	\$1,558.12	\$1.243
Feb-11	1/28/11	2/28/11	31	1,211	825	\$1,025.48	\$345.73	\$1,371.21	\$1.243
Mar-11	2/28/11	3/28/11	28	795	0	\$464.97	\$19.91	\$484.88	\$0.000
Apr-11	3/28/11	4/28/11	31	569	0	\$405.91	\$22.04	\$427.95	\$0.000
May-11	4/28/11	5/27/11	29	242	90	\$217.35	\$47.70	\$265.05	\$2.415
Jun-11	5/27/11	6/29/11	33	45	18	\$57.37	\$28.45	\$85.82	\$3.187

	HDD	Therms	\$
Fiscal 2009	6,375	4,858	\$8,109
Fiscal 2010	5,783	4,416	\$7,632
Fiscal 2011	6,172	3,223	\$6,415
Average	6,110	4,166	\$7,385

Town of Salisbury
Town Hall
Natural Gas Utility Tracking

Service: Heat and DHW
 Sqft: 0
 Meter # 004671560
 Account # 40716-21310
 Supplier: Keyspan/National Grid
 Tariff: Keyspan/National Grid
 Deliverer: Rate G-41T Commercial Heat
 Tariff:

Conversion in Use										
Therms				100,000		Btu/Therms				
				Monthly Therms	Monthly Supply Cost \$	Monthly Delivery Cost \$	Total Monthly Cost \$	Monthly Supply Unit Cost \$/Therms	Monthly Delivery Unit Cost \$/Therms	Total Monthly Unit Cost \$/Therms
Jul-08	6/16/08	7/16/08	30	112	\$0.00	\$199.90	\$199.90	\$0.000	\$1.785	\$1.785
Aug-08	7/16/08	8/15/08	30	99	\$0.00	\$194.04	\$194.04	\$0.000	\$1.960	\$1.960
Sep-08	8/15/08	9/16/08	32	83	\$0.00	\$137.11	\$137.11	\$0.000	\$1.652	\$1.652
Oct-08	9/16/08	10/15/08	29	256	\$0.00	\$198.19	\$198.19	\$0.000	\$1.313	\$1.313
Nov-08	10/15/08	11/13/08	29	519	\$0.00	\$570.13	\$570.13	\$0.000	\$1.418	\$1.418
Dec-08	11/13/08	12/16/08	33	972	\$1,040.39	\$329.65	\$1,370.04	\$1.243	\$0.394	\$1.637
Jan-09	12/16/08	1/15/09	30	1,167	\$1,438.15	\$450.26	\$1,888.41	\$1.243	\$0.389	\$1.632
Feb-09	1/15/09	2/13/09	29	1,221	\$1,424.47	\$445.73	\$1,870.20	\$1.243	\$0.389	\$1.632
Mar-09	2/13/09	3/16/09	31	942	\$1,170.91	\$368.89	\$1,539.80	\$1.243	\$0.392	\$1.635
Apr-09	3/16/09	4/14/09	29	588	\$803.49	\$233.64	\$1,037.13	\$1.366	\$0.397	\$1.764
May-09	4/14/09	5/14/09	30	242	\$479.38	\$88.78	\$568.16	\$1.981	\$0.367	\$2.348
Jun-09	5/14/09	6/16/09	33	159	\$253.74	\$48.38	\$302.12	\$1.596	\$0.304	\$1.900
Jul-09	6/16/09	7/17/09	31	113	\$140.46	\$36.51	\$176.97	\$1.243	\$0.323	\$1.566
Aug-09	7/17/09	8/17/09	31	34	\$54.36	\$16.56	\$70.92	\$1.599	\$0.487	\$2.086
Sep-09	8/17/09	9/16/09	30	69	\$14.27	\$6.95	\$21.22	\$0.000	\$0.000	\$0.000
Oct-09	9/16/09	10/15/09	29	284	\$77.43	\$33.73	\$111.16	\$0.745	\$0.324	\$1.069
Nov-09	10/15/09	11/13/09	29	533	\$390.33	\$144.37	\$534.70	\$0.906	\$0.335	\$1.241
Dec-09	11/13/09	12/14/09	31	732	\$766.93	\$260.35	\$1,027.28	\$1.243	\$0.422	\$1.665
Jan-10	12/14/09	1/14/10	31	1,223	\$1,376.00	\$458.57	\$1,834.57	\$1.243	\$0.414	\$1.657
Feb-10	1/14/10	2/12/10	29	1,064	\$1,218.14	\$406.58	\$1,624.72	\$1.243	\$0.415	\$1.658
Mar-10	2/12/10	3/15/10	31	878	\$1,034.36	\$314.53	\$1,348.89	\$1.390	\$0.423	\$1.813
Apr-10	3/15/10	4/14/10	30	475	\$735.14	\$164.56	\$899.70	\$1.976	\$0.442	\$2.419
May-10	4/14/10	5/12/10	28	340	\$415.19	\$63.51	\$478.70	\$2.824	\$0.432	\$3.256
Jun-10	5/12/10	6/29/10	48	115	\$335.40	\$75.16	\$410.56	\$1.525	\$0.342	\$1.866
Jul-10	6/29/10	7/29/10	30	1	\$118.09	\$35.12	\$153.21	\$1.243	\$0.370	\$1.613
Aug-10	7/29/10	8/30/10	32	3	\$93.25	\$43.51	\$136.76	\$0.758	\$0.354	\$1.112
Sep-10	8/30/10	9/28/10	29	62	\$75.51	\$41.52	\$117.03	\$0.635	\$0.349	\$0.983
Oct-10	9/28/10	10/27/10	29	344	\$174.08	\$91.78	\$265.86	\$0.582	\$0.307	\$0.889
Nov-10	10/27/10	11/29/10	33	669	\$702.29	\$249.55	\$951.84	\$1.180	\$0.419	\$1.600
Dec-10	11/29/10	12/28/10	29	992	\$1,206.95	\$403.21	\$1,610.16	\$1.243	\$0.415	\$1.658
Jan-11	12/28/10	1/28/11	31	1,239	\$1,484.14	\$493.63	\$1,977.77	\$1.243	\$0.413	\$1.656
Feb-11	1/28/11	2/25/11	28	1,102	\$1,274.08	\$424.44	\$1,698.52	\$1.243	\$0.414	\$1.657
Mar-11	2/25/11	3/28/11	31	904	\$1,066.49	\$358.95	\$1,425.44	\$1.243	\$0.418	\$1.661
Apr-11	3/28/11	4/28/11	31	554	\$749.47	\$237.11	\$986.58	\$1.353	\$0.428	\$1.781
May-11	4/28/11	5/27/11	29	275	\$367.16	\$106.32	\$473.48	\$1.335	\$0.387	\$1.722
Jun-11	5/27/11	6/29/11	33	45	\$164.19	\$46.90	\$211.09	\$2.078	\$0.594	\$2.672

	HDD	Therms	\$
Fiscal 2009	6,375	5,918	\$9,875
Fiscal 2010	5,783	4,869	\$8,539
Fiscal 2011	6,172	6,187	\$10,008
Average	6,110	5,658	\$9,474

Town of Salisbury
Sparhawk School
Natural Gas Utility Tracking

Service: DHW
 Sqft 0
 Meter # 006472679
 Account # 40716-19633
 Supplier: Keyspan/National Grid
 Tariff: Keyspan/National Grid
 Deliverer: Rate G-51T Comm'l Non-Heat

Conversion in Use

Date	Last Read Date	Current Read Date	Read Days	HDD	Therms			100,000 Btu/Therms			Monthly Delivery Unit Cost \$/Therms	Total Monthly Cost \$	Monthly Supply Unit Cost \$/Therms	Monthly Delivery Unit Cost \$/Therms	Total Monthly Cost \$
					Monthly Therms	Monthly Supply Cost \$	Monthly Delivery Cost \$	Monthly Supply Cost \$	Monthly Delivery Cost \$	Monthly Supply Cost \$	Monthly Delivery Cost \$	Monthly Supply Cost \$	Monthly Delivery Cost \$	Monthly Supply Cost \$	Monthly Delivery Cost \$
Jul-08			0	0								\$0.00	\$0.00	\$0.00	\$0.00
Aug-08	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Sep-08	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Oct-08	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Nov-08	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Dec-08	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Jan-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Feb-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Mar-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Apr-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
May-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Jun-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Jul-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Aug-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Sep-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Oct-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Nov-09	1/0/00		0	0								\$0.00	\$0.00	\$0.00	\$0.00
Dec-09	1/0/00	12/14/09	40,161	8,094	53		\$83.84	\$83.84	\$83.84	\$0.00	\$1,582	\$1,582	\$1,582	\$1,582	\$1,582
Jan-10	1/14/10	1/14/10	31	1,223	77		\$117.77	\$117.77	\$117.77	\$0.00	\$1,529	\$1,529	\$1,529	\$1,529	\$1,529
Feb-10	1/14/10	2/12/10	29	1,064	66		\$105.23	\$105.23	\$105.23	\$0.00	\$1,594	\$1,594	\$1,594	\$1,594	\$1,594
Mar-10	2/12/10	3/15/10	31	878	72		\$120.29	\$120.29	\$120.29	\$0.00	\$1,671	\$1,671	\$1,671	\$1,671	\$1,671
Apr-10	3/15/10	4/14/10	30	475	65		\$109.57	\$109.57	\$109.57	\$0.00	\$1,686	\$1,686	\$1,686	\$1,686	\$1,686
May-10	4/14/10	5/12/10	28	340	62		\$86.68	\$86.68	\$86.68	\$0.00	\$1,398	\$1,398	\$1,398	\$1,398	\$1,398
Jun-10	5/12/10	6/11/10	30	103	62		\$63.73	\$63.73	\$63.73	\$0.00	\$1,028	\$1,028	\$1,028	\$1,028	\$1,028
Jul-10	6/11/10	7/29/10	48	13	30		\$40.80	\$40.80	\$40.80	\$0.00	\$1,360	\$1,360	\$1,360	\$1,360	\$1,360
Aug-10	7/29/10	8/30/10	32	3	15		\$22.78	\$22.78	\$22.78	\$0.00	\$1,519	\$1,519	\$1,519	\$1,519	\$1,519
Sep-10	8/30/10	9/27/10	28	55	0		\$8.33	\$8.33	\$8.33	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Oct-10	9/27/10	10/27/10	30	351	18		\$24.83	\$24.83	\$24.83	\$0.00	\$1,379	\$1,379	\$1,379	\$1,379	\$1,379
Nov-10	10/27/10	11/29/10	33	669	41		\$72.29	\$72.29	\$72.29	\$0.00	\$1,763	\$1,763	\$1,763	\$1,763	\$1,763
Dec-10	11/29/10	12/28/10	29	992	32		\$61.99	\$61.99	\$61.99	\$0.00	\$1,937	\$1,937	\$1,937	\$1,937	\$1,937
Jan-11	12/28/10	1/28/11	31	1,239	38		\$71.11	\$71.11	\$71.11	\$0.00	\$1,871	\$1,871	\$1,871	\$1,871	\$1,871
Feb-11	1/28/11	2/25/11	28	1,102	29		\$57.55	\$57.55	\$57.55	\$0.00	\$1,984	\$1,984	\$1,984	\$1,984	\$1,984
Mar-11	2/25/11	3/28/11	31	904	36		\$68.58	\$68.58	\$68.58	\$0.00	\$1,905	\$1,905	\$1,905	\$1,905	\$1,905
Apr-11	3/28/11	4/28/11	31	569	28		\$58.55	\$58.55	\$58.55	\$0.00	\$2,091	\$2,091	\$2,091	\$2,091	\$2,091
May-11	4/28/11	5/27/11	29	242	20		\$42.99	\$42.99	\$42.99	\$0.00	\$2,150	\$2,150	\$2,150	\$2,150	\$2,150
Jun-11	5/27/11	6/29/11	33	45	20		\$45.71	\$45.71	\$45.71	\$0.00	\$2,286	\$2,286	\$2,286	\$2,286	\$2,286

	HDD	Therms	\$
Fiscal 2009	N/A	N/A	N/A
Fiscal 2010	12,177	457	\$687
Fiscal 2011	6,184	307	\$576
Average	9,181	382	\$631

**Town of Salisbury
Fire Department
Fuel Oil Utility Tracking**

Service: Heat
Sqft 0
Account # 03995
Supplier: Townsend Oil & Propane Co Inc
Tariff:

Conversion in Use									
Month	HDD	Monthly Delivered Barrels	Monthly Delivered Gallons	Total Monthly Delivered Cost \$	Total Monthly Unit Cost \$/Gallons	Annual Gallons	Annual MBtu/Sqft	Annual Cost \$	Annual Unit Cost \$/Gallons
Jul-08			0.0	\$0.00	\$0.000				
Aug-08			0.0	\$0.00	\$0.000				
Sep-08			0.0	\$0.00	\$0.000				
Oct-08			380.7	\$1,038.85	\$2.729				
Nov-08			421.3	\$972.53	\$2.308				
Dec-08			388.3	\$783.43	\$2.018				
Jan-09			801.6	\$1,591.72	\$1.986				
Feb-09			371.5	\$715.10	\$1.925				
Mar-09			417.1	\$767.92	\$1.841				
Apr-09			375.2	\$735.32	\$1.960				
May-09			0.0	\$0.00	\$0.000				
Jun-09			0.0	\$0.00	\$0.000	3,156	0.0	\$6,605	\$2.093
Jul-09			0.0	\$0.00	\$0.000	3,156	0.0	\$6,605	\$2.093
Aug-09			0.0	\$0.00	\$0.000	3,156	0.0	\$6,605	\$2.093
Sep-09			0.0	\$0.00	\$0.000	3,156	0.0	\$6,605	\$2.093
Oct-09			372.1	\$867.37	\$2.331	3,147	0.0	\$6,433	\$2.044
Nov-09			592.2	\$1,504.08	\$2.540	3,318	0.0	\$6,965	\$2.099
Dec-09			335.2	\$808.50	\$2.412	3,265	0.0	\$6,990	\$2.141
Jan-10			793.7	\$2,096.03	\$2.641	3,257	0.0	\$7,494	\$2.301
Feb-10			771.4	\$1,966.27	\$2.549	3,657	0.0	\$8,745	\$2.392
Mar-10			338.0	\$876.03	\$2.592	3,578	0.0	\$8,854	\$2.475
Apr-10			269.9	\$742.79	\$2.752	3,473	0.0	\$8,861	\$2.552
May-10			0.0	\$0.00	\$0.000	3,473	0.0	\$8,861	\$2.552
Jun-10			0.0	\$0.00	\$0.000	3,473	0.0	\$8,861	\$2.552
Jul-10			0.0	\$0.00	\$0.000	3,473	0.0	\$8,861	\$2.552
Aug-10			0.0	\$0.00	\$0.000	3,473	0.0	\$8,861	\$2.552
Sep-10			0.0	\$0.00	\$0.000	3,473	0.0	\$8,861	\$2.552
Oct-10			503.9	\$1,406.79	\$2.792	3,604	0.0	\$9,400	\$2.608
Nov-10			481.1	\$1,358.19	\$2.823	3,493	0.0	\$9,255	\$2.649
Dec-10			404.5	\$1,211.29	\$2.995	3,563	0.0	\$9,657	\$2.711
Jan-11			756.1	\$2,358.11	\$3.119	3,525	0.0	\$9,919	\$2.814
Feb-11			989.2	\$3,333.60	\$3.370	3,743	0.0	\$11,287	\$3.016
Mar-11			447.7	\$1,611.63	\$3.600	3,852	0.0	\$12,022	\$3.121
Apr-11			376.9	\$1,433.70	\$3.804	3,959	0.0	\$12,713	\$3.211
May-11			0.0	\$0.00	\$0.000	3,959	0.0	\$12,713	\$3.211
Jun-11			0.0	\$0.00	\$0.000	3,959	0.0	\$12,713	\$3.211

	#2 Oil	\$	HDD
Fiscal 2009	3,156	\$6,605	N/A
Fiscal 2010	3,473	\$8,861	N/A
Fiscal 2011	3,959	\$12,713	N/A
Average	3,529	\$9,393	0

Town of Salisbury
Sparhawk School
Fuel Oil Utility Tracking

Service: Heat
Sqft 0
Account # 164251
Supplier: Knight Oil Inc
Tariff:

Month	HDD	Monthly Delivered Barrels	Monthly Delivered Gallons	Total Monthly Delivered Cost \$	Conversion in Use			Annual Unit Cost \$/Gallons
					#2 Oil	138,700	Btu/Gal	
Jul-08			0.0	\$0.00				
Aug-08			0.0	\$0.00				
Sep-08			0.0	\$0.00				
Oct-08			3,930.2	\$8,712.02				
Nov-08			0.0	\$0.00				
Dec-08			2,125.7	\$3,614.89				
Jan-09			1,500.0	\$2,790.00				
Feb-09			2,999.9	\$5,399.83				
Mar-09			1,900.0	\$3,239.00				
Apr-09			975.0	\$1,818.00				
May-09			0.0	\$0.00				
Jun-09			0.0	\$0.00				
Jul-09			0.0	\$0.00		13,431	0.0	\$25,574 \$1,904
Aug-09			0.0	\$0.00		13,431	0.0	\$25,574 \$1,904
Sep-09			0.0	\$0.00		13,431	0.0	\$25,574 \$1,904
Oct-09			1,000.0	\$2,260.00		10,501	0.0	\$19,122 \$1,821
Nov-09			1,300.0	\$3,068.00		11,801	0.0	\$22,190 \$1,880
Dec-09			2,700.0	\$6,587.00		12,375	0.0	\$25,162 \$2,033
Jan-10			1,500.0	\$4,185.00		12,375	0.0	\$26,557 \$2,146
Feb-10			2,400.0	\$6,174.00		11,775	0.0	\$27,331 \$2,321
Mar-10			750.0	\$1,972.50		10,625	0.0	\$26,065 \$2,453
Apr-10			500.0	\$1,325.00		10,150	0.0	\$25,572 \$2,519
May-10			0.0	\$0.00		10,150	0.0	\$25,572 \$2,519
Jun-10			0.0	\$0.00		10,150	0.0	\$25,572 \$2,519
Jul-10			0.0	\$0.00		10,150	0.0	\$25,572 \$2,519
Aug-10			0.0	\$0.00		10,150	0.0	\$25,572 \$2,519
Sep-10			0.0	\$0.00		10,150	0.0	\$25,572 \$2,519
Oct-10			1,000.0	\$2,640.00		10,150	0.0	\$25,952 \$2,557
Nov-10			1,000.0	\$2,720.00		9,850	0.0	\$25,604 \$2,599
Dec-10			2,000.0	\$5,760.00		9,150	0.0	\$24,777 \$2,708
Jan-11			3,000.0	\$9,470.00		10,650	0.0	\$30,062 \$2,823
Feb-11			2,000.0	\$6,990.00		10,250	0.0	\$30,878 \$3,012
Mar-11			0.0	\$0.00		9,500	0.0	\$28,905 \$3,043
Apr-11			250.0	\$947.50		9,250	0.0	\$28,528 \$3,084
May-11			0.0	\$0.00		9,250	0.0	\$28,528 \$3,084
Jun-11			0.0	\$0.00		9,250	0.0	\$28,528 \$3,084

	#2 Oil	\$	HDD
Fiscal 2009	13,431	\$25,574	N/A
Fiscal 2010	10,150	\$25,572	N/A
Fiscal 2011	9,250	\$28,528	N/A
Average	10,944	\$26,558	0

Town of Salisbury
Sewer Treatment Plant
Fuel Propane Utility Tracking

Service: Garage Heat
 Sqft 0
 Account # 7-27414
 Supplier: Townsend Oil & Propane Co Inc
 Tariff:

Month	HDD	Monthly Delivered Gallons	Total Monthly Delivered Cost \$	Total Monthly Unit Cost \$/Gallons	Conversion in Use			Annual Cost \$/Gallons	Annual Cost \$/Sqft
					Propane	93,000	Btu/Gal		
Jul-08		0.0	\$0.00	\$0.000					
Aug-08		0.0	\$0.00	\$0.000					
Sep-08		0.0	\$0.00	\$0.000					
Oct-08		0.0	\$0.00	\$0.000					
Nov-08		0.0	\$0.00	\$0.000					
Dec-08		128.3	\$415.69	\$3.240					
Jan-09		211.8	\$686.23	\$3.240					
Feb-09		0.0	\$0.00	\$0.000					
Mar-09		147.9	\$526.52	\$3.560					
Apr-09		0.0	\$0.00	\$0.000					
May-09		0.0	\$0.00	\$0.000					
Jun-09		0.0	\$0.00	\$0.000	488	0.0	\$1,628	\$3.337	#DIV/0!
Jul-09		0.0	\$0.00	\$0.000	488	0.0	\$1,628	\$3.337	#DIV/0!
Aug-09		17.9	\$51.19	\$2.860	506	0.0	\$1,680	\$3.320	#DIV/0!
Sep-09		0.0	\$0.00	\$0.000	506	0.0	\$1,680	\$3.320	#DIV/0!
Oct-09		0.0	\$0.00	\$0.000	506	0.0	\$1,680	\$3.320	#DIV/0!
Nov-09		41.3	\$122.25	\$2.960	547	0.0	\$1,802	\$3.293	#DIV/0!
Dec-09		176.6	\$549.23	\$3.110	596	0.0	\$1,935	\$3.250	#DIV/0!
Jan-10		0.0	\$0.00	\$0.000	384	0.0	\$1,249	\$3.256	#DIV/0!
Feb-10		0.0	\$0.00	\$0.000	384	0.0	\$1,249	\$3.256	#DIV/0!
Mar-10		90.6	\$322.54	\$3.560	326	0.0	\$1,045	\$3.202	#DIV/0!
Apr-10		0.0	\$0.00	\$0.000	326	0.0	\$1,045	\$3.202	#DIV/0!
May-10		0.0	\$0.00	\$0.000	326	0.0	\$1,045	\$3.202	#DIV/0!
Jun-10		0.0	\$0.00	\$0.000	326	0.0	\$1,045	\$3.202	#DIV/0!
Jul-10		0.0	\$0.00	\$0.000	326	0.0	\$1,045	\$3.202	#DIV/0!
Aug-10		0.0	\$0.00	\$0.000	309	0.0	\$994	\$3.222	#DIV/0!
Sep-10		0.0	\$0.00	\$0.000	309	0.0	\$994	\$3.222	#DIV/0!
Oct-10		53.6	\$201.54	\$3.760	362	0.0	\$1,196	\$3.302	#DIV/0!
Nov-10		0.0	\$0.00	\$0.000	321	0.0	\$1,073	\$3.346	#DIV/0!
Dec-10		0.0	\$0.00	\$0.000	144	0.0	\$524	\$3.634	#DIV/0!
Jan-11		171.9	\$752.92	\$4.380	316	0.0	\$1,277	\$4.040	#DIV/0!
Feb-11		0.0	\$0.00	\$0.000	316	0.0	\$1,277	\$4.040	#DIV/0!
Mar-11		0.0	\$0.00	\$0.000	226	0.0	\$954	\$4.233	#DIV/0!
Apr-11		0.0	\$0.00	\$0.000	226	0.0	\$954	\$4.233	#DIV/0!
May-11		0.0	\$0.00	\$0.000	226	0.0	\$954	\$4.233	#DIV/0!
Jun-11		0.0	\$0.00	\$0.000	226	0.0	\$954	\$4.233	#DIV/0!

	Propane	\$	HDD
Fiscal 2009	488	\$1,628	N/A
Fiscal 2010	326	\$1,045	N/A
Fiscal 2011	226	\$954	N/A
Average	347	\$1,209	0

Section 2: Existing Conditions

Salisbury Beach Comfort Station

Building Characteristics

The Comfort Station is located behind the Police Station on Cable Avenue in Salisbury Beach. The facility's area is estimated to be 1000 ft. The facility consists of a public bathroom and is only open during the summer season.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

This facility can be heated by natural gas unit heaters, but is currently unheated.



Domestic Hot Water Systems

Domestic hot water is provided by storage hot water heater fired by natural gas fired storage (State, 40 gal).

Lighting Systems

T12 troffers are in use.

Fire Department

Building Characteristics

The Salisbury Fire Department is located at 37 Lafayette Rd. in Salisbury. The facility's area is estimated to be 6,190 ft²; the original building (4720 ft²) was built in 1977 and with an addition (1420 ft²) constructed in the 1990's. The single story masonry structure consists of an Apparatus Bay, living quarters, meeting space, maintenance and a hose drying tower. A wood frame addition created additional office and conference room space. The original section of the facility includes solid walls of uninsulated masonry with face brick for the Apparatus Bay, wood-faced exterior of concrete block in the living quarters and painted concrete block in the maintenance areas. The addition is standard insulated wood frame construction faced



with T-111 panels. The overall U-value for the facility's walls is estimated to be 0.19 BTUh/SF-deg F. Its window systems include double pane-glazed, operable windows with an estimated overall U-value of 0.60 BTUh/SF-deg F. Its roof is a sloped truss construction with asphalt shingles. Its ceilings are insulated with unfaced fiberglass batts with an estimated U-value of 0.08 BTUh/SF-deg F. The ceiling of the Apparatus Bay is a perforated metal panel insulated with 6" of unfaced fiberglass batts above in its attic.

The original design intended for air to flow through the ceiling system and currently there is no air barrier in this system. Consequently air can leak through the panels. This condition reduces the thermal performance of fiberglass.

Fiberglass batt insulation is suspended on framing above the drop ceiling of the office/ living spaces of the building. There is no air barrier in this assembly; as a result there is excessive heat loss from the office spaces through the roof. The renovated kitchen has a hard sheetrock ceiling.

The weather stripping at select entry doors is not performing effectively and allowing unwanted infiltration/exfiltration at the perimeter of the doors. The weather stripping at the overhead doors is damaged and is not preventing air leaks at the sides and top of the door systems. The existing weather stripping is not caulked to the brick wall – this condition is allowing air to leak "behind" the weather stripping and into the building.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The facility's original first floor area is heated by a hot water boiler plant of a single boiler whose gross output is 521 MBH. The boiler (Weil McLain 578) is fired by number 2 fuel oil; fuel oil is stored in two above ground tanks of 275 gallons each. The addition's space includes offices and a conference room whose heat are electric baseboard. The average thermal efficiency of the oil-fired heating plant is estimated to be 78%.

The heating hot water distribution system includes two pumped zones and a spare pump. The pumps are in-line circulators; the pumps were originally located on the hot water supply piping; one remains, while other replacements have been located in the hot water return piping. The boiler room piping includes original gate and balancing valves and is in poor condition. Most of the original type insulation is missing.

The Apparatus Bay is heated by vertical unit heaters. This equipment is original and appears to be in overall poor condition. The units' coils are fouled from engine exhaust which dates from the time that vehicles were up rated without dedicated exhaust systems. Four of the units' fans are operational and two no longer operate.

The original living quarters and support areas, including the hose tower, are heated by hot water finned tube radiation. Staff reports that the control valves for this radiation need replacement.

Electric baseboard is utilized in the addition office and conference room.

Window air conditioning units are utilized in occupied areas.

Automatic Temperature Controls

The boiler pumps are controlled by outside air temperature. A line voltage, outside air thermostat (Penn) set at 65 deg. F controls the pumps operation via a three pole relay. The circulating pumps operate continuously whenever outside air temperature is below the set point, regardless of indoor temperature.

The boiler's hot water set point is controlled by a boiler-mounted aquastat and set at 180 deg. F.

Conventional, wall-mounted, heating-only thermostats (e.g. Honeywell T87) control each room within of the finned tube radiation zone. These thermostats serve to limit the temperature within each room, but are not connected to the distribution system. There are seven room thermostats.

Line voltage thermostats control each of the unit heaters in the Apparatus Bay. There are six thermostats and each is located in a security enclosure.

Domestic Hot Water Systems

An electric storage domestic hot water (Vaughn, 50 gallons) serves the facility and is located in the boiler room.

Lighting Systems

The entire building was recently retrofitted with energy efficient 4' T8 28w lamps and high efficiency electronic ballasts. Incandescent lamps were also changed to compact fluorescent.

Department of Public Works

Building Characteristics

The Salisbury Department of Public Works is located at 41 Lafayette Road. The facility's conditioned area is estimated to be 5,130 ft²; the building was built in 1978. The single story masonry structure with exterior wood finish consists of a Garage, as well as maintenance and office spaces. The facility's solid walls of concrete masonry unit (CMU) with face plywood siding. The exterior CMU's design called for fill insulation in maintenance area walls. The office area walls are 2 x 4 frame with fiberglass batt insulation.. The overall U-value for the facility's walls is estimated to be 0.24 BTUh/SF-deg F. Its windows systems include double pane-glazed, operable windows with an estimated overall U-value of 0.51 BTUh/SF-deg F. Its roof is a sloped truss construction with asphalt shingles. It ceilings are insulated with 6" unfaced fiberglass batts with an estimated overall U-value of 0.08 BTUh/SF-deg F. The garage attic is ventilated with gable-end louvers.



Fiberglass batt insulation is suspended on framing above the suspended ceilings of the office and garage areas. There is no air barrier in this assembly; as a result there is excessive heat loss into the attic.

A former sliding window in the office on the left side of the building that was once used for communication between the garage and the offices is still allowing air transfer between the garage and the office. A prior attempt to seal this window reduced the infiltration.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The facility is heated by a hot water boiler plant of a pair of boilers with a combined gross output is 422 MBH. Each boiler (Utica BOP66) was originally fired by number 2 fuel oil and later converted to natural gas by replacing the oil burners with gas burners (Economite E2011 and removing the fuel oil system. The average thermal efficiency of the heating plant is estimated to be 76%.

The heating hot water distribution system includes two pumped zones and a spare pump. The pumps are in-line circulators located on the hot water supply piping. Most of the original pipe insulation is missing.

The offices are heated by hot water finned tube radiation.

Electric baseboard is utilized in the addition office and conference room.

Window air conditioning units are utilized in occupied areas.

Automatic Temperature Controls

There are two heating zones for the building, the garage and maintenance area in the office area. Each zone is served by a hot water circulator pump.

The boiler pumps are controlled by outside air temperature. A line voltage, outside air thermostat (Penn) set at 65 deg. F controls the pumps operation. The circulating pumps operate continuously whenever outside air temperature is below the set point, regardless of indoor temperature.

The boiler's hot water set point is controlled by a boiler-mounted aquastat and set at 180 deg. F.

Conventional, wall-mounted, heating-only thermostats (e.g. Honeywell T87) control rooms within of the office radiation zone. These thermostats serve to limit the temperature within each room, but are not connected to the distribution system. There are room thermostats.

Line voltage thermostats control each of the unit heaters in the garage and maintenance shops. Each has a thermostat without a security enclosure.

Domestic Hot Water Systems

Domestic hot water for the building is provided by and electric storage water heater (State, 40 gallons).

Lighting Systems

Workshops have standard T8 wraps. Offices and hallways utilize standard T8 troffers. Bathrooms employ T12 troffers. The parking lot has HPS parking fixtures.

Council of Aging Hilton Senior Center

Building Characteristics

The Hilton Senior Center and Council on Aging is located at 39 Lafayette Road. The facility's conditioned area is estimated to be 6,140 ft²; a major addition to the building was completed in 2006. The single story wood framed and truss structure consists of an Activity Room, offices, a kitchen and auxiliary spaces in the original portion of the building, and office conference room in the addition. Solid walls are 2 x 4 framed with fiberglass batt insulation. The overall U-value for the facility's walls is estimated to be 0.08 BTUh/SF-deg F. Its windows systems include double pane-glazed, operable windows with an estimated overall U-value of 0.6 BTUh/SF-deg F. Its roof is a sloped truss construction with asphalt shingles. The ceiling in the original portion of the building is insulated with 6" fiberglass batts with an estimated overall U-value of 0.07 BTUh/SF-deg F. This insulation is in poor condition and in areas near the duct distribution system. The attic to this area is accessible from a pull-down stairway in the Activity room. Insulation for the addition is closed cell spray foam in the truss rafter spaces. The garage attic is ventilated with gable-end louvers.



The attic and roof above the original section of the building is the most significant point of air and heat loss in the building. The existing attic assembly's fiberglass batt insulation is installed directly above the suspended ceiling without an air barrier. The mechanical equipment and ductwork is located on the unconditioned side of the insulation in this system.

The roof of the addition section of the building is insulated with closed cell spray polyurethane foam directly on the underside of the roof surface. The insulation is removed below four roof vents; however in this insulation system, attic fans are not required, and serve only to allow breach the air barrier and allow conditioned air to exfiltrate.

The entry door systems in the addition are architectural-style doors; the existing weather stripping is a pile-style that does not create a compression seal with the door and allows unwanted air leakage. The condition of the weather stripping at the original section of the building varies by door system. The storage closet should be considered "outside" of the conditioned space of the building because it is not heated. The double door that connects the storage closet and the building is a point of unwanted air and heat transfer.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The facility is heated by natural gas furnaces. The original portion of the building is heated by two furnaces located in the attic above the Activity Room. These are 1980s era units manufactured by Williamson with an input of 160 MBH. Their burners are single stage and atmospheric draft. One of the furnaces serve the Activity Room; the other furnace serves the office and function room areas surrounding the Activity Room. The overall thermal efficiency of the furnaces is estimated to be 72%.

The Council on Aging offices and conference rooms are heated and cooled by a “rooftop unit”, i.e., a single package, heating and air-conditioning unit (Rheem RKKB-A102CL22E) located behind the building at grade. This unit provides a constant flow rate of air whenever it's operating. If airflow is close to one of the two zones, then the entire airflow will be diverted to the other zone, which results in it being oversupplied. The over-supply results in excessively rapid heating or cooling and operates with considerable noise. The overall thermal efficiency of its furnace is estimated to be 78%.

Each furnace for the original area of the building has a separately installed cooling system, including evaporator coil downstream of the furnace, a condensing unit located at grade behind the building, and a condensate pump. The nominal capacity of the systems is five tons.

The air distribution ductwork for the original furnaces is deteriorated and return duct branches are detached in a couple of instances. The trunk ductwork is metal and all takeoffs are flexible ductwork lying on the attic floor. Both ductwork systems lack balancing dampers for the takeoff; consequently, rooms further from the unit failed to the expected or sufficient air flow.

The addition's HVAC unit includes a direct expansion coil section the capacity of nine tons.

Automatic Temperature Controls

The original area is divided into two zones of heating and cooling. Each zone is controlled by a programmable thermostat (Aprilaire 8362). The units cycle on and off based on thermostat call and do not operate continuously.

The Addition is a single zone of equipment in which an attempt is made to create two sub zones by a duct damper control system. These sub zones are the conference room in the offices. Each of these sub zones include a programmable thermostat (Aprilaire 8366). Each thermostat controls a zone damper whose intent is to vary the flow rate of air into the area. In turn, the zone damper controller starts and stops the unit; the unit does not operate continuously. Each damper is normally closed, and opens when its thermostat calls for heating or cooling. It's often the case that one thermostat calls for heating or cooling while the other is satisfied. Once the duct damper is open, the unit starts and delivers its full flow and capacity to the sub zone that initiated it. The result is that the sub zone is deluged with the full error flow of the unit, which causes excessive noise and unit cycling.

Domestic Hot Water Systems

Domestic hot water is provided by a storage electric domestic hot water heater (State). This unit provides 40 gallons of storage.

Lighting Systems

The cafeteria, kitchen, offices, and hallways all have standard T8 troffers. Bathrooms use standard T8 wraps.

Town Hall

Building Characteristics

Salisbury's Town Hall is located on 5 Beach Road. The two story building and full height basement was renovated in 1977. The facility's conditioned area is estimated to be 8,650 ft², which includes the first and second floors, but not the basement. The facility is a wood framed structure and consists of offices and town departments on the first floor, offices, conference rooms and an auditorium on the second floor and basement storage areas. Solid walls are 2 x 4 framed with fiberglass batt insulation. The overall U-value for the facility's walls is estimated to be 0.13 BTUh/SF-deg F.



Town Hall's attic is insulated on the flat surface of the plaster ceiling with fiberglass batt insulation. The plaster ceiling serves as an effective air barrier; however, the access hatch at the top of the front stairs is a bypass that allows unwanted air transfer between the unconditioned attic space and the conditioned space below. The landing area around the access hatch is a weak point in the insulation of the attic; insulation is installed on top of old attic flooring and the coverage is poor. The overall U-value is estimated to be of 0.07 BTUh/SF-deg F.

Weather stripping of the facilities entry doors is not properly stopping air infiltration/ exfiltration. Occupants reported that the area around the front door is excessively cold from drafts.

Windows

Double Hung (Compression Jamb) – the double hung windows on the 2nd story appear that they were retrofit with compression jamb balances during the renovation of the 2nd story. The window systems are leaking at the joint between the compression jamb and the interior casing and at the bottom of the lower sash. At some window systems daylight can be seen between the sill and the lower sash.

Double Hung (Original Balances) – the windows that still have the original balance systems are leaking air at the perimeter of the upper sash, the perimeter of the lower sash and at the pulley balance system. Its windows

systems include double hung single glazed, operable windows and storm windows with an estimated overall U-value of 0.8 BTUh/SF-deg F.

Window AC Unit – the cable and server room is continuously air conditioned by a window unit; the AC unit is installed in a propped open double hung window. This strategy of installing an AC unit that is needed all year creates excessive air leakage pathways around the unit and through the gap between the raised lower sash and the top sash.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

Town Hall's first floor department offices are heated by a steam boiler (Peerless G-1061) with the gross output of 288 MBH. This boiler is a conventional, atmospheric draft boiler. "One pipe" steam radiators with a single steam and condensate pipe are located in each of these spaces.

The inspectional services and planning departments is heated by a gas-fired furnace (Heil DC90). Warm air is ducted to the planning department and inspectional departments.

The second floor is heated by a hot water boiler (Weil McLain PFG-7-PN) plant with a gross capacity of 296 MBH. . The overall heating plant thermal efficiency is estimated to be 76%. This boiler's return temperature is protected by a blend pump. Heating hot water is distributed to the second floor's perimeter finned tube radiation and air handling unit coils by a base mounted circulation pump (1 HP).

Three air handling units provide ventilation and cooling to the second floor. AHU-1 serves the west side of second floor; AHU-2 serves the auditorium and AHU-3 serves the east side of second floor. Each air handling units has a hot water preheat coil and a direct expansion cooling coil.

Automatic Temperature Controls

Town Hall is heated by three independent systems: a steam system that serves original radiators on the First Floor, a warm air furnace which serves the inspectional services and planning departments on the First Floor and a hot water that serves the Second Floor. Town Hall has five zones of control as well as the second floor perimeter finned tube radiation which serves as "skin" heating and the inspectional services office which is a sub zone of the planning department.

Planning has a standard thermostat and switching sub base with a single stage of either heating or cooling for its warm air furnace which is equipped with a split system cooling coil. Inspectional Services is a subzone of this system with a thermostat which controls a zone damper to limit its amount of heating or cooling. An inspectional service has supplementary electric baseboard heat controlled by a wall-mounted thermostat; this system is operated only on very cold days.

The first floor offices' steam boiler is controlled by a programmable thermostat in the corridor of the first floor. This thermostat has a security enclosure.

The second floor is served by three air handling units; each is controlled by programmable thermostats with a remote temperature sensor. These thermostats in an enclosure in a mechanical area to the rear of the stage.

AHU-1 and AHU-3's sensors are in the conference rooms. AHU-2 sensor is near the return grill in the stage area. The second floor's perimeter is heated with hot water finned tube radiation; this system is continuously operating during heating system whenever the outside air temperature is greater than the pump controller set point.

The second floor finned tube radiation's pumps and hot water supply temperature is controlled by a dedicated controller in the basement mechanical room.

Domestic Hot Water Systems

Domestic hot water is provided by an electric storage hot water heater. (State 1650 W).

Lighting Systems

Offices use standard T8 indirect luminaires, wraps, T12 troffers, and incandescent cans. Halls employ standard T8 indirect luminaires and compact fluorescent cans. The auditorium has incandescent decorative and dimmable fixtures. Baths utilize standard T8 vanities.

Wastewater Treatment Plant

Building Characteristics

The Wastewater Treatment Plant is located on Elm Street in Salisbury. The single level building was constructed in 1988. The conditioned area of this facility is estimated to be 4,205 ft². The plant consists of office, training, chemical testing laboratory, maintenance and mechanical spaces. The building's solid wall is masonry with an estimated overall U-value of 0.29 BTUh/SF-deg F.



Its window systems includes fixed windows with an estimated overall U-value of 0.64 BTUh/SF-deg F

Roof-Wall Intersection – there is a 16" gap at the roof-wall intersection of the pitched roof on the left side of the building (view from parking lot). This large gap is leading to excessive infiltration/ exfiltration. The overhang at the front door is a direct pathway for air infiltration/exfiltration.

There are two types of roof: a ballasted flat roof and a sloped metal roof. The metal roof is above the office and laboratory areas; it has leaked chronically for years. The leaks stem from improperly flashed penetrations, including fans and skylights. The roof's seam joint covers have detached and fallen off for many sections. The roof is in poor condition and at the end of its operating life. By design, the roof system included 2 inches of poly-iso insulation. The overall estimated U-value for the roof is 0.07 BTUh/SF-deg F.

The entry door bottom sweeps are deteriorated at the front double door system.

Window sealant is missing at the header of the window systems on the left side of the building. The joint at the top of the window system is allowing unwanted air leakage. Its window systems have an estimated overall U-value of 0.64 BTUh/SF-deg F.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The laboratory and office areas are heated, cooled in ventilated by a rooftop unit, AC-1, (Trane). This unit has electric preheat and direct expansion. Its outside air damper motor is failed to the closed position. Electric finned tube radiation provides glass heating for the buildings occupied spaces facing south.

The garage is heated by a propane fired unit heater. The heating and ventilating unit, which is part of the original designs heating and ventilation of the space, is not in operation.

A chemical fume hood is operated as needed in the laboratory area.

Automatic Temperature Controls

Rooftop unit, AC-1, provides heating, cooling and air conditioning to the occupied areas of the facility. AC-1 is controlled by a programmable thermostat located in the plant office. AC-1's outside air damper is not operating, which results in a lack of ventilation and, during cooling season, economizer cooling.

The laboratory area's temperature is controlled by an electrical reheat coil located in a main branch of AC-1's ductwork. The laboratory fume hood sash is normally closed and its fan, off.

Electric baseboard heaters with unit-mounted thermostats are located along glazed walls in the office areas. Reportedly, this equipment is rarely operated.

The garage propane heater is controlled by a wall mounted thermostat and maintained at 55 deg. F. The heating and ventilating unit, HV-1, is not operated.

Domestic Hot Water Systems

Domestic hot water for the building is provided by an electric storage domestic water heater.

Lighting Systems

Offices, baths, and hallways employ T12 troffers. Workshops use standard T8 bay fixtures. The building exterior and surrounding driveways utilize HPS parking and roadway fixtures.

Memorial Boys and Girls Club

Building Characteristics

The Memorial Boys and Girls Club Facility is located on 18 Maple Avenue in Salisbury. This facility was constructed in two parts: the Maple Avenue Elementary School whose original construction is 1950 and the Memorial School, originally constructed in 1961. The Boys and Girls Club of the Lower Merrimack Valley

occupy the lower level of the Memorial facility and a portion of the original elementary school. The upper level of Memorial is occupied by a tenant. Most of the lower level and the upper level of the elementary school is unoccupied. The elementary school portion's conditioned area is estimated to be 20,870 ft² and the Memorial portion's conditioned area is estimated to be 21,410 ft². The facility's solid wall is masonry with face brick with an estimated overall U-value of 0.15 BTUh/SF-deg F. Its roof is a flat, insulated, rubber roof with stone ballast with an estimated U-value of 0.07 BTUh/SF-deg F.



The entry doors' weather-stripping is worn or missing and allowing excessive air infiltration at the door systems.

The window systems throughout the building are in poor condition. Many of the compression seal windows are operable, but there deteriorated glazing seals in frames and glazing broken in a number of locations. The best course of action for the windows in the building is replacement; there is no existing weather-stripping or sealant at the single pane compression seal windows throughout the building. The windows are allowing significant air infiltration. The window systems have an estimated overall U-value of 1.20 BTUh/SF-deg F.

Heating, Ventilating, and Air Conditioning Systems (HVAC)

The original Maple Street Elementary School portion of the facility is heated with low pressure steam. This portion of the facility is mostly unoccupied. The steam boiler is a cast iron sectional (H.B. Smith LO-28A-S-08) whose gross output is 1955 MBH. Its burner is fired with number 2 fuel oil. This boiler was a replacement for the original boiler and is located on the original boiler's elevated base. A boiler feed unit receives returning condensate and its duplex pumps return condensate to the boiler. The boiler feed unit is vented outdoors through the room's single combustion air louver; this arrangement is not in accordance with current best practice.

Steam is distributed to the elementary school building in three pipe "mains" to its east and west facades and to the Gym and Stage area. Steam is distributed to the first floor and condensate is returned through piping located in a trench around the perimeter of the building. Access panels in the floor near terminal units and at the end of the lines permit steam trap replacements.

The air handling unit which serves the Gymnasium is located in a mechanical space above the Stage; this unit has not operated in many years.

Steam terminal units include radiators, unit ventilator coils and an air handling unit coil. Unit ventilators are original and are mostly utilized as convectors: their fans not operate. The air handling unit which serves the Gym has not operated in many years.

Condensate is returned to the boiler plant by gravity flow. Recently, sections of condensate returns have been replaced to maintain the system's operation. Overall, the steam distribution system is in poor, but serviceable, condition. Steam traps have not been maintained and are leaking steam.

The original Memorial School and current Boys and Girls Club portion of the facility is heated by a hot water boiler plant. This plant is separate from the steam heating system. The hot water plant includes a fire-tube boiler (CB 548-200) whose gross output is 6,272 MBH and fired by number two fuel oil.

Fuel oil storage is provided by two underground 5000 gallon storage tanks. The condition of these tanks is unknown. Fuel oil supply and return piping is located underground from each tank to each of the boiler rooms. Fuel oil is pumped is pumped to each burner by a pair of duplex pumps.

Hot water is distributed to finned tube radiation, radiators and unit ventilators. A pair of lead lag, a base mounted hot water pumps circulate the water. A three-way mixing valve exists for the purpose of hot water supply temperature control. A control valve was originally installed to maintain a maximum pressure difference between the supply and return piping systems.

Portions of the breaching insulation of the hot water boiler are breaking away from the breaching and are friable. It is suspected that this is asbestos containing material (ACM). In addition, pipe and equipment insulation is likely to be ACM.

Automatic Temperature Controls

The facility's steam heating system is manually controlled. Once enabled, the boiler operates as required to maintain its pressure control set point. Fuel oil pumps operate continuously. Unit ventilator fans are manually switched off in the units function as convectors. There's heat loss from steam and condensate piping on the first floor which adds heat to the spaces. Their temperatures fluctuates based ambient conditions. The air handling unit which serves the gymnasium has not operated for many years. The motor starter for its single phase, 5 hp motor, is disassembled.

The facility's hot water heating system is manually controlled. Once enabled, the hot water boiler operates as required to maintain its aquastat set point. The hot water pumps operate continuously; the three way valve that would control hot water supply temperature is currently not operating. Occupants switch unit ventilator fans on and off as required.

Automatic control systems are in substantial disrepair and not operating. The steam section of the facility retains portions of its original pneumatic control system, including an operating air compressor. However, pneumatic thermostats are largely missing and there are substantial leaks. The outside air reset control of the main steam control valve does not operate.

The hot water portion of the facility is not currently distributing control air from the boiler room. Its compressor is relatively new and appears to be functioning well. However, the main distribution pipe filters are plugged and completely obstructing air flow. Most components of the original control systems remain, including a main panel with time-clocks, zone P/E switches, etc., but their condition is identified to be very

poor or failed. Room thermostats are in poor condition. Overall, terminal equipment controls, including unit ventilator control valves and ventilation dampers, appear to be mostly original and not operating.

Domestic Hot Water Systems

Domestic hot water is provided by storage, natural gas-fired, domestic water heater (State).

Lighting Systems

Classrooms and the library employ aged T12 louver fixtures. Halls have old T12 strips, incandescent cans, and exits. The auditorium, cafeteria, kitchen, and bathrooms utilize old T12 surface fixtures. Some offices employ the old T12 fixtures, while some use standard T8 wraps. The gym employs MH bay fixtures.

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Section 3: Energy Conservation Measures

Table 1: Recommended Measures Index

ECM No.	Title	Tab
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3	New Energy Management Systems	3
4	Attic Insulation	4
5	Boiler Replacements	5
8	Install High Efficiency Furnaces	8
10	Oil to Gas Conversion	10
11	Pipe Insulation	11
12	Steam Trap Replacement	12
13	Variable Frequency Drives	13
14	Vending Machine Controls	14
15	Weatherization Improvements	15

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 details 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 2: Lighting Controls	No maintenance required	✓	
ECM 3: New Energy Management Systems	Calibrate sensors periodically to maintain accuracy. Replace or repair failed components.	✓	
ECM 4: Attic Insulation	Perform preventative maintenance as detailed in manufactures O&M manual.	✓	
ECM 5: Boiler Replacements	Perform preventative maintenance as detailed in manufactures O&M manual including water treatment.	✓	
ECM 8: Install High Efficiency Furnaces	Perform preventative maintenance as detailed in manufactures O&M manual.	✓	
ECM 10: Oil to Gas Conversion	Perform preventative maintenance as detailed in manufactures O&M manual.	✓	
ECM 11: Pipe Insulation	Replace insulation if removed for maintenance of other systems.	✓	
ECM 12: Steam Trap Replacement	Perform preventative maintenance which includes testing and replacing traps on a regular basis	✓	
ECM 13: Variable Frequency Drives	Clean filters as required	✓	
ECM 14: Vending Machine Controls	Transfer controls to any replacement machines.	✓	
ECM 15: Weatherization Improvements	Replace or repair failed components.	✓	

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)	#2 Fuel Oil (Gallons)	Energy Savings	O&M Savings	Total Project Savings	Total Project Costs	SPB
1	Lighting System Improvements	525	101,155	(332)	(370)	\$ 12,524	\$ 1,389	\$ 13,913	\$ 199,611	14.35
2	Lighting Controls	-	11,941	(68)	(11)	\$ 1,495	\$ -	\$ 1,495	\$ 19,139	12.80
3	New Energy Management Systems	-	18,970	6,088	2,362	\$ 17,908	\$ -	\$ 17,908	\$ 185,940	10.38
4	Attic Insulation	-	-	-	238	\$ 833	\$ -	\$ 833	\$ 23,839	28.63
5	Boiler Replacements	-	-	(2,253)	2,859	\$ 7,557	\$ 21,500	\$ 29,057	\$ 299,236	10.30
8	Install High Efficiency Furnaces	-	-	388	-	\$ 485	\$ -	\$ 485	\$ 50,171	103.39
10	Oil to Gas Conversion	-	-	(11,965)	8,514	\$ 16,784	\$ 1,500	\$ 18,284	\$ 219,572	12.01
11	Pipe Insulation	-	-	335	358	\$ 1,670	\$ -	\$ 1,670	\$ 7,871	4.71
12	Steam Trap Replacement	-	-	-	467	\$ 1,634	\$ -	\$ 1,634	\$ 16,463	10.07
13	Variable Frequency Drives	-	3,090	-	-	\$ 470	\$ -	\$ 470	\$ 7,000	14.88
14	Vending Machine Controls	-	7,395	(106)	(36)	\$ 754	\$ -	\$ 754	\$ 1,456	1.93
15	Weatherization Improvements	-	4,175	351	239	\$ 1,695	\$ -	\$ 1,695	\$ 17,027	10.05
		525	146,726	(7,562)	14,619	\$ 63,809	\$ 24,389	\$ 88,198	\$ 1,047,325	11.87

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Existing and Proposed EUIs

MVPC - Town of Salisbury

Building EUI Summary

Building	Square Feet	Baseline mbtu/sqft	Proposed mbtu/sqft	Overall Reduction
Fire Department	7,350	104.4	77.7	26%
Department of Public Works	5,600	128.8	76.6	41%
Beach Services - Comfort Station	1,250	86.3	84.6	2%
Council on Aging- Hilton Senior Center	6,492	93.7	57.5	39%
Town Hall	9,704	96.3	63.3	34%
Sewage Treatment Plant	6,000	590.2	568.7	4%
Sparhawk/Memorial School-Boys and Girls Club	54,357	33.4	22.4	33%
	90,753	93.4	73.9	21%

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 Salisbury. Our project replaces or upgrades approximately **729** 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 light fixtures will improve aesthetics and provide substantial energy savings.

ECM Detail

Existing System

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

We identified over 80 different lamp/ballast/fixture combinations, the majority of which are linear fluorescent, which provide general lighting in key areas such as offices & halls.

The majority of linear fluorescent fixtures, 69%, use T12s on magnetic ballasts. Many of these fixtures are in disrepair and their ballasts produce an irritating humming noise.

Approximately 26% of linear fluorescent fixtures use standard-grade T8s on electronic ballasts of varying grades.

The final 5% of linear fluorescent fixtures use premium performance 28 watt T8s and high efficiency electronic ballasts. These are only found in the Fire Station, which was recently retrofitted.

High-intensity discharge (HID) lamps are used in the school gym and on most building exteriors. Color rendition from the lamps is good to poor depending on lamp quality and age, which unfortunately can be a characteristic of HID lamps.

Incandescent lamps are installed in almost every building in a small quantity of fixtures. Most of which are found at the Town Hall auditorium.

Although the lighting system is generally performing as designed, significant improvements are possible. Light levels are appropriate in the majority of areas. Most fixtures are in good condition. The most noted exceptions are the old fixtures in parts of the school.

- *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. Rooms not listed are excluded from the scope, such as areas under renovation, low occupancy such as crawlspaces, or inaccessible spaces.

Fire Department: The entire building was recently retrofitted with energy efficient 4' T8 28w lamps and high efficiency electronic ballasts. Incandescent lamps were also changed to compact fluorescent.

Department of Public Works: Workshops have standard T8 wraps. Offices and hallways utilize standard T8 troffers. Bathrooms employ T12 troffers. The parking lot has HPS parking fixtures.

Beach Services - Comfort Station: T12 troffers are used.

Council on Aging- Hilton Senior Center: The cafeteria, kitchen, offices, and hallways all have standard T8 troffers. Bathrooms use standard T8 wraps.

Town Hall: Offices use standard T8 indirects, wraps, T12 troffers, and incandescent cans. Halls employ standard T8 indirects and compact fluorescent cans. The auditorium has incandescent decorative and dimmable fixtures. Baths utilize standard T8 vanities.

Sewer Treatment Plant: Offices, baths, and hallways employ T12 troffers. Workshops use standard T8 bay fixtures. The building exterior and surrounding driveways utilize HPS parking and roadway fixtures.

Sparhawk/Memorial School-Boys and Girls Club: Classrooms and the library employ old T12 louver fixtures. Halls have old T12 strips, incandescent cans, and exits. The auditorium, cafeteria, kitchen, and bathrooms utilize old T12 surface fixtures. Some offices employ the old T12 fixtures, while some use standard T8 wraps. The gym employs MH bay fixtures.

Proposed System

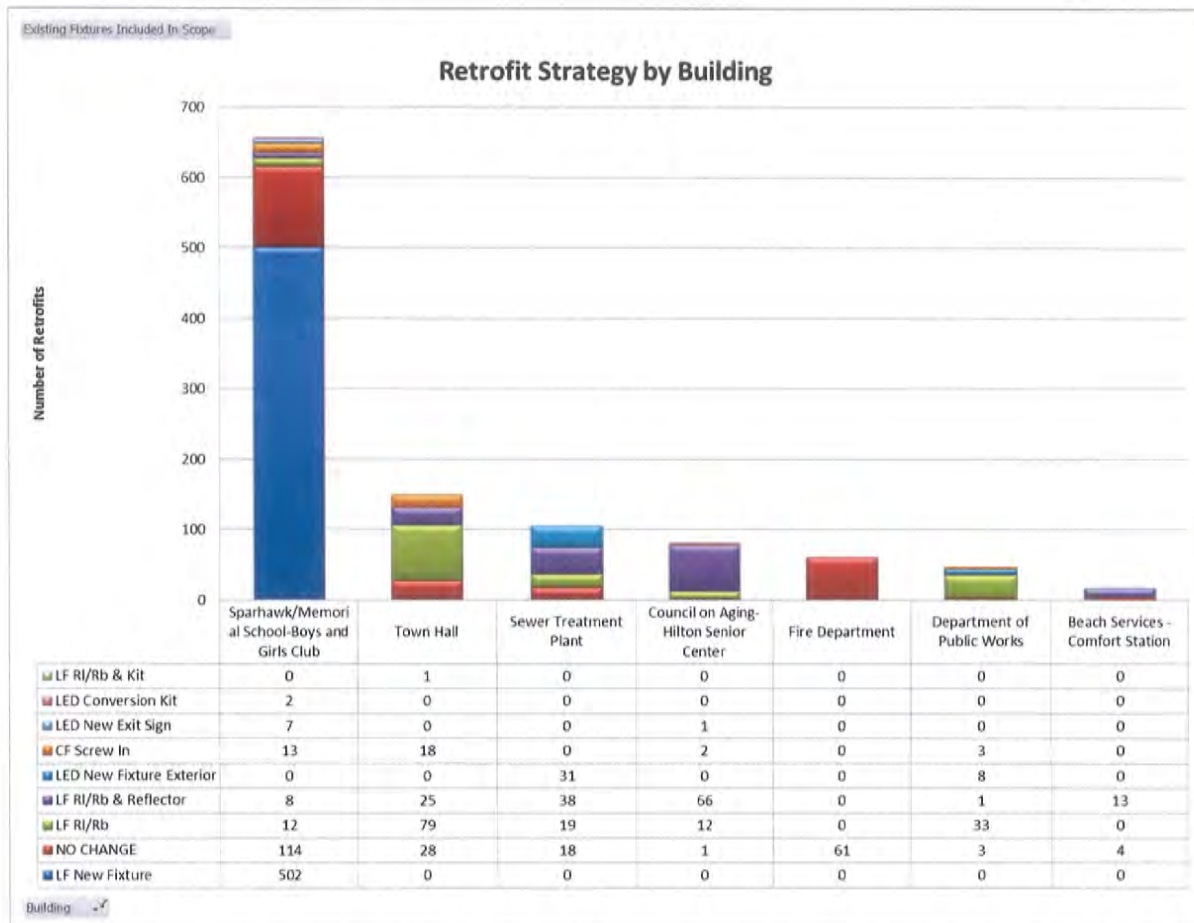
- *General Information about the Proposed System*

Ameresco standardized the lighting system where practical, reducing the number of different products Salisbury must purchase, stock and maintain. Most fixtures replaced or retrofitted with 4' T8 lamps will receive 28-watt "energy-efficient" lamps and 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. Then 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.

Most existing four foot “U” shaped lamps will be replaced by 15 watt linear lamps, and 8’ lamps will be eliminated because they are expensive and awkward to store.

Our project replaces or upgrades **729** 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*

New wraps will replace 329 old existing fixtures at Memorial School-Boys and Girls Club.

New T8 high-bays with cages will replace 10 metal halides in the school gym. These high-performance fixtures will improve light levels & distribution, reduce shadowing and “hot spots”, while savings substantial energy. Additional benefits of fluorescent over HID sources are improved color rendition, better lumen

maintenance, and reduced color shift over lamp life. Further, HID's need time to re-strike when hot, whereas T8 fixtures are instant on, allowing us to specify lighting controls in ECM 2 to reduce total operating hours.

Existing fixtures will receive T8 lamps, electronic ballasts, and reflectors in 151 existing fixtures

Existing fixtures will receive T8 lamps and electronic ballasts in 153 existing fixtures with 1 additional getting a retrofit kit

Compact fluorescent lamps will be installed in 36 existing fixtures. Compact fluorescent lamps are much more efficient than incandescent lamps, with a typical efficiency of 50 to 70 lumens per watt. With an average rated lamp life of 10,000 hours, maintenance costs are reduced.

New LED wall packs will replace 39 old exterior fixtures at the Sewer Plant and DPW. These features ensure long (30,000 hr. - 50,000 hr.) lamp lifetimes.

New LED exit signs will replace 7 old exit signs at Memorial School-Boys and Girls Club and 1 old exit sign at the Senior Center.

Existing exit signs will receive LED retrofits in 2 exit signs at Memorial School-Boys and Girls Club

Sizing Considerations

The new lighting system is designed to maintain lighting levels, while meeting IESNA standards in effected areas. All recommendations were made with the intent to optimize energy savings without compromising the quality and the level of light output.

Integration of Proposed Equipment with Existing Systems

The new lighting system, and all components thereof, will be fully integrated into the Town's existing lighting systems. This holds true for all of the existing electrical power and controls associated with the facilities' lighting system.

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 the work scope outlined in the contract documents. Existing junction boxes, existing poles, existing mounting surfaces and existing structures are assumed to be in acceptable condition to allow the installation of a new fixture, or retrofit of an existing fixture (replacement of lamps, ballast, and reflector etc.).

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. In addition, Ameresco will compile

product specification sheets for all specified equipment. 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

The new lighting system will enhance facility operations by providing fixtures and components that have new high-efficiency electronic ballasts. These ballasts will minimize costs incurred to replace existing ballasts as they reach their end of life. In addition, all new T8 lamps installed will be low mercury, with a color-rendering index of 85.

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.

Maintenance Savings

Implementation of this measure will result in annual maintenance savings, since installation of new lamps and ballasts will greatly reduce service intervals. This is based on the calculated frequency of equipment replacement of the old system versus the new system. No current recycling or disposal costs were included in this calculation, so additional savings would be expected. No incremental labor costs were included in these savings as it is assumed that Town personnel will replace lamps and ballasts as required.

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.



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Appendix for ECM 1: Lighting System Improvements

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	1	
Measure Name:	Lighting System Improvements	
Measure Location:		
Engineers:		

Site Name:			DPW	Beach	COA	TownHall	Sewer	Memorial	Summary
Item	Units		Savings	Savings	Savings	Savings	Savings	Savings	
Electricity									
Energy On-Peak	kWh		12,208	937	5,974	11,827	24,019	46,189	101,155
Energy Off-Peak	kWh		0	0	0	0	0	0	0
Energy Total	kWh		12,208	937	5,974	11,827	24,019	46,189	101,155
Demand On-Peak, Monthly	kW		3.2	0.4	3.1	4.0	10.5	22.7	43.7
Demand On-Peak, Annual	kW		37.8	4.4	37.5	47.4	125.5	272.4	525.0
Demand Off-Peak, Monthly	kW		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
Fossil Fuel									
Natural Gas (NG)	Therms		-134	-10	-69	-118	0	0	-332
Liquid Propane Gas (LPG)	Gallons		0	0	0	0	0	0	0
Steam	Mlbs		0	0	0	0	0	0	0
Fuel Oil, #2	Gallons		0	0	0	0	0	-370	-370
Fuel Oil, #4	Gallons		0	0	0	0	0	0	0
Fuel Oil, #6	Gallons		0	0	0	0	0	0	0
Miscellaneous	Misc		0	0	0	0	0	0	0
Water									
Water Savings	kGallons								0
Sewer									
Sewer Savings	kGallons								0

Town of Salisbury, Massachusetts
Interactive Lighting Savings Calculation



Facility	Lighting Savings		Heating Penalty			Cooling Benefit				
	B	C	D	E	F	G	H	I	J	K
	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
Department of Public Works	3.2	11,970	50.0%	6.0	76.0%	(13.4)	35.0%	4.0	2.93	0.8
Beach Services - Comfort Station	0.4	937	50.0%	6.0	80.0%	(1.0)	0.0%	4.0	2.93	0.0
Council on Aging- Hilton Senior Center	3.1	5,680	50.0%	6.0	70.0%	(6.9)	100.0%	4.0	3.22	1.0
Town Hall	4.0	11,388	50.0%	6.0	82.0%	(11.8)	95.0%	4.0	4.10	1.5
Sewage Treatment Plant	10.5	30,942	50.0%	6.0	100.0%	(26.4)	60.0%	4.0	3.81	2.8
Sparhawk/Memorial School-Boys and Girls Club	22.7	46,058	50.0%	6.0	76.5%	(51.4)	5.0%	4.0	2.93	0.4
Totals	43.7	106,975				(111.0)				6.5

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

Line	Building Name	Location	Floor	Pre Fixture Description	Pre Fixture Style	Pre Qty	Post Fixture Description	Post Fixture Style	Post Qty	Annual Hours	Pre Watt	kW Saved	Post Watt	kWh Saved
1	Town Hall	Mechanical Boiler	B	214' T12 EE/EMAG	strip	1	214' T8 28w/EE/EE LO	rftb	1	1,125	70	0.03	42	32
2	Town Hall	Mechanical Boiler	B	15W COMPACT SCREW IN	keyless	2	NO RETRO	no change needed		1,125	15		15	344
3	Town Hall	Storage Files	B	214' T8/EL	strip	7	214' T8 28w/EE/EE LO	rftb	7	2,730	60	0.13	83	108
4	Town Hall	Storage Files	B	214' T12 EE/EMAG	strip	1	414' T8 28w/EE/EE LO STRIP KIT-8'	rftb strip kit	1	2,730	123	0.04	24	70
5	Town Hall	Storage Files	B	22W CIRCLINE HARDWIRED	drum	1	NO RETRO	no change needed		2,730	24		24	
6	Town Hall	Storage Vault	B	90W INCANDESCENT	jar	1	20W COMPACT SI	screw in	1	1,000	90	0.07	20	
7	Town Hall	Storage Old Records	B	15W COMPACT SCREW IN	keyless	1	NO RETRO	no change needed		1,000	15		15	
8	Town Hall	Stair	S	22W CIRCLINE HARDWIRED	drum	1	NO RETRO	no change needed		3,640	24	0.04	24	131
9	Town Hall	Stair	S	214' T8/EL	strip	2	214' T8 28w/EE/EE LO	rftb	2	3,640	60	0.07	60	262
10	Town Hall	Hall 1st	1	13W COMPACT HARDWIRED	wrap wide	6	NO RETRO	no change needed		3,640	15		15	
11	Town Hall	Hall 1st	1	15W COMPACT SCREW IN	square surface mt.	1	NO RETRO	no change needed		3,640	15		15	
12	Town Hall	Hall 1st	1	214' T8/EL	strip	1	214' T8 28w/EE/EE LO	rftb labor	1	3,640	60	0.02	60	66
13	Town Hall	Stair To 2nd Fl	S	414' T8/EL	wrap wide	2	414' T8 28w/EE/EE LO	rftb	2	3,458	112	0.06	83	201
14	Town Hall	Office Open Clerk	1	414' T8/EL	wrap wide	1	414' T8 28w/EE/EE LO	rftb	1	3,458	112	0.03	83	100
15	Town Hall	Office Open Clerk	1	414' T8/EL	wrap wide	1	414' T8 28w/EE/EE LO	rftb	1	3,458	112	0.03	83	100
16	Town Hall	Lounge Staff	1	414' T8/EL	wrap wide	2	414' T8 28w/EE/EE LO	rftb	2	3,458	112	0.03	83	201
17	Town Hall	Office Open Tax Collector	1	414' T8/EL	wrap wide	2	414' T8 28w/EE/EE LO	rftb	2	3,458	112	0.06	83	201
18	Town Hall	Office Open Tax Collector	1	414' T8/EL	wrap wide	2	414' T8 28w/EE/EE LO	rftb	2	3,458	112	0.06	83	201
19	Town Hall	Office Open Assessor	1	414' T8/EL	wrap wide	2	414' T8 28w/EE/EE LO	rftb	2	3,458	112	0.06	83	201
20	Town Hall	Office Open Assessor	1	414' T8/EL	wrap wide	2	414' T8 28w/EE/EE LO	rftb	2	3,458	112	0.06	83	201
21	Town Hall	Office Open Assessor	1	214' T8 U/EL	trof acr	2	214' T8 15w/EE/EE HI/RFL	rftb rfl	2	3,458	60	0.04	40	138
22	Town Hall	Office Open Assessor	1	414' T8/EL	wrap wide	1	414' T8 28w/EE/EE LO	rftb	1	3,458	112	0.03	83	100
23	Town Hall	Office Open Health	1	414' T8/EL	wrap wide	2	414' T8 28w/EE/EE LO	rftb	2	3,458	112	0.03	83	201
24	Town Hall	Office Open Health	1	414' T8/EL	wrap wide	1	414' T8 28w/EE/EE LO	rftb	1	3,458	112	0.03	83	100
25	Town Hall	Hall By Bath	1	214' T8 U/EL	trof acr	1	214' T8 15w/EE/EE HI/RFL	rftb rfl	1	3,640	60	0.02	73	
26	Town Hall	Bath Men	1	214' T8/EL	vanity	1	214' T8 15w/EE/EE LO	rftb	1	3,458	37	0.01	35	
27	Town Hall	Bath Men	1	214' T8 U/EL	trof acr	1	214' T8 15w/EE/EE HI/RFL	rftb rfl	1	3,458	60	0.02	69	
28	Town Hall	Bath Women	1	214' T8/EL	vanity	1	214' T8 15w/EE/EE LO	rftb	1	3,458	37	0.01	35	
29	Town Hall	Bath Women	1	214' T8 U/EL	trof acr	1	214' T8 15w/EE/EE HI/RFL	rftb rfl	1	3,458	60	0.02	69	
30	Town Hall	Office Open Buildings	1	414' T8/EL	trof acr	4	214' T8 28w/EE/EE HI/RFL	rftb rfl	4	3,458	112	0.19	664	
31	Town Hall	Office Open Planning	1	214' T12 U EE/EMAG	trof minicube	14	214' T8 15w/EE/EE HI/RFL	rftb rfl	14	3,458	70	0.40	42	1,452
32	Town Hall	Storage Copier5	1	414' T12 EE/EMAG	trof acr	2	214' T8 28w/EE/EE HI/RFL	rftb rfl	2	2,730	140	0.15	415	
33	Town Hall	Closet Elevator	1	214' T8/EL	strip	2	214' T8 28w/EE/EE LO	rftb	2	1,000	60	0.04	36	
34	Town Hall	Hall 2nd	2	214' T8/EL	indirect/direct	11	214' T8 28w/EE/EE LO	rftb	11	3,640	60	0.20	721	
35	Town Hall	Hall 2nd	2	2x 13W COMPACT HARDWIRED	can rec	1	NO RETRO	no change needed		3,640	30		30	
36	Town Hall	Stair By Auditorium	S	22W CIRCLINE HARDWIRED	drum	1	NO RETRO	no change needed		3,640	24		24	
37	Town Hall	Stair By Auditorium	S	150W INC HALOGEN	indirect	2	NO RETRO	no change needed		3,640	150		150	
38	Town Hall	Auditorium 201	2	200W INCANDESCENT	decorative dim	6	NO RETRO	no change - specialized		2,730	200		200	
39	Town Hall	Auditorium 201	2	150W INC HALOGEN	indirect	6	NO RETRO	no change needed		2,730	150		150	
40	Town Hall	Stage 201	2	90W INCANDESCENT	can rec	5	20W COMPACT SI	screw in	5	2,730	90	0.35	956	
41	Town Hall	Storage Behind Stage	2	214' T8/EL	strip cage	12	214' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	12	1,000	60	0.22	216	
42	Town Hall	Office 209	2	314' T8/EL	indirect/direct dbl switch	2	314' T8 28w/EE/EE LO	rftb dbl switched	2	2,730	88	0.05	131	
43	Town Hall	Bath Men	2	214' T8/EL	vanity	1	214' T8 28w/EE/EE LO	rftb	1	3,458	60	0.02	62	
44	Town Hall	Bath Women	2	214' T8/EL	vanity	1	214' T8 28w/EE/EE LO	rftb	1	3,458	60	0.02	62	
45	Town Hall	Office 202	2	314' T8/EL	indirect/direct dbl switch	3	314' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	3	2,730	88	0.07	197	
46	Town Hall	Conference 208	2	314' T8/EL	indirect/direct dbl switch	2	314' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	2	2,730	88	0.05	131	
47	Town Hall	Conference 208	2	100W INCANDESCENT	can dim rec	6	23W COMPACT SI DIM RFL	screw in dim r40	6	2,730	100	0.46	1,261	
48	Town Hall	Conference 203	2	314' T8/EL	indirect/direct dbl switch	2	314' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	2	2,730	88	0.05	131	
49	Town Hall	Conference 203	2	100W INCANDESCENT	can dim rec	6	23W COMPACT SI DIM RFL	screw in dim r40	6	2,730	100	0.46	1,261	
50	Town Hall	Office 207	2	314' T8/EL	indirect/direct dbl switch	2	314' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	2	2,730	88	0.05	131	
51	Town Hall	Office 204	2	314' T8/EL	indirect/direct dbl switch	2	314' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	2	2,730	88	0.05	131	
52	Town Hall	Office 204	2	314' T8/EL	indirect/direct dbl switch	2	314' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	2	2,730	88	0.05	131	
53	Town Hall	Office 205	2	314' T8/EL	indirect/direct dbl switch	2	314' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	2	2,730	88	0.05	131	
54	Town Hall	Office 205	2	314' T8/EL	indirect/direct dbl switch	2	314' T8 28w/EE/EE LO 2 BAL	rftb dbl switched	2	2,730	88	0.05	131	
78	Spaulhawk Memorial School-Boys and Girls Club	Hall 2nd	2	114' T12 EE/EMAG	old strip	16	214' T8 28w/EE/EE LO/NEV-8'	rftb dbl switched	8	2,400	40	0.30	730	
79	Spaulhawk Memorial School-Boys and Girls Club	Hall 2nd	2	114' T12 EE/EMAG	old wrap	20	214' T8 28w/EE/EE LO/NEV-8'	new wrap	10	2,400	40	0.38	912	
80	Spaulhawk Memorial School-Boys and Girls Club	Hall 2nd	2	114' T12 EE/EMAG	old wrap	3	114' T8 28w/EE/EE HI/NEV	new wrap	3	2,400	40	0.02	50	

Line	Building Name	Location	Floor	Pre Fixture Description	Pre Fixture Style	Pre Qty	Post Fixture Description	Post Fixture Style	Post Qty	Annual Hours	Pre Wait	Post Wait	kW Saved	kWh
81	Sparhawk/Memorial School-Boys and Girls Club	Hall 2nd	2	2x 15W INCANDESCENTS	exit sign	4	3 WATT LEDNEW EXIT BATTERY	new exit bat	4	8,760	30	3	0.11	946
82	Sparhawk/Memorial School-Boys and Girls Club	Star South	2	2L4' T12 EE/EEMAG	eggcrate	2	1L4' T8 28W/EELE HINEW-8'	new wrap	2	2,400	70	33	0.07	176
83	Sparhawk/Memorial School-Boys and Girls Club	Classroom E5	2	2L4' T12 EE/EEMAG	eggcrate	8	4L4' T8 28W/EELE LOINEW-8'	new wrap	9	1,800	123	83	0.24	427
84	Sparhawk/Memorial School-Boys and Girls Club	Classroom W7	2	2L4' T12 EE/EEMAG	eggcrate	8	4L4' T8 28W/EELE LOINEW-8'	new wrap	9	1,800	123	83	0.24	427
85	Sparhawk/Memorial School-Boys and Girls Club	Bath Girls	2	2L4' T12 EE/EEMAG	eggcrate	2	1L4' T8 28W/EELE HINEW-8'	new wrap	1	2,280	70	33	0.04	84
86	Sparhawk/Memorial School-Boys and Girls Club	Bath Boys	2	2L4' T12 EE/EEMAG	eggcrate	2	1L4' T8 28W/EELE HINEW-8'	new wrap	1	2,280	70	33	0.04	84
87	Sparhawk/Memorial School-Boys and Girls Club	Bath Boys	2	2L4' T12 EE/EEMAG	eggcrate	2	1L4' T8 28W/EELE HINEW-8'	new wrap	1	2,280	70	33	0.04	84
88	Sparhawk/Memorial School-Boys and Girls Club	Bath Boys	2	2L4' T12 EE/EEMAG	eggcrate	2	1L4' T8 28W/EELE HINEW-8'	new wrap	1	2,280	70	33	0.04	84
89	Sparhawk/Memorial School-Boys and Girls Club	Closet Maintenance	2	60W INCANDESCENT	eggcrate	2	20W COMPACT SI	screw in	2	500	60	20	0.08	40
90	Sparhawk/Memorial School-Boys and Girls Club	Classroom W6	2	2L4' T12 EE/EEMAG	eggcrate	8	4L4' T8 28W/EELE LOINEW-8'	new wrap	9	1,800	123	83	0.24	427
91	Sparhawk/Memorial School-Boys and Girls Club	Classroom W5	2	2L4' T12 EE/EEMAG	eggcrate	6	2L4' T8 28W/EELE HINEW-8'	new wrap	3	1,800	70	64	0.23	410
92	Sparhawk/Memorial School-Boys and Girls Club	Classroom W8	2	2L4' T12 EE/EEMAG	eggcrate	8	4L4' T8 28W/EELE LOINEW-8'	new wrap	9	1,800	123	83	0.24	427
93	Sparhawk/Memorial School-Boys and Girls Club	Classroom E4	2	2L4' T12 EE/EEMAG	eggcrate	8	4L4' T8 28W/EELE HINEW-8'	new wrap	4	1,800	70	64	0.30	547
94	Sparhawk/Memorial School-Boys and Girls Club	Classroom E4	2	2L4' T12 EE/EEMAG	eggcrate	1	1L4' T8 28W/EELE HINEW	new wrap	1	1,800	70	33	0.04	67
95	Sparhawk/Memorial School-Boys and Girls Club	Bath E4	2	60W INCANDESCENT	eggcrate	1	20W COMPACT SI	screw in	1	2,280	60	20	0.04	91
96	Sparhawk/Memorial School-Boys and Girls Club	Closet E4	2	15W COMPACT SCREW IN	keyless	1	NO RETRO	no change needed	1	500	15	15		
97	Sparhawk/Memorial School-Boys and Girls Club	Star Center	2	2L4' T12 EE/EEMAG	eggcrate	3	1L4' T8 28W/EELE HINEW	new wrap	3	2,400	70	33	0.11	266
98	Sparhawk/Memorial School-Boys and Girls Club	Classroom W4	2	2L4' T12 EE/EEMAG	old wrap	4	2L4' T8 28W/EELE HINEW-8'	new wrap	2	1,800	70	64	0.15	274
99	Sparhawk/Memorial School-Boys and Girls Club	Classroom W4	2	2L4' T12 EE/EEMAG	old wrap	3	1L4' T8 28W/EELE HINEW	new wrap	3	1,800	70	33	0.11	200
100	Sparhawk/Memorial School-Boys and Girls Club	Storage W4	2	2L4' T12 EE/EEMAG	old wrap	1	1L4' T8 28W/EELE HINEW	new wrap	1	500	70	33	0.04	19
101	Sparhawk/Memorial School-Boys and Girls Club	Bath W4	2	60W INCANDESCENT	keyless	1	20W COMPACT SI	screw in	1	2,280	60	20	0.04	91
102	Sparhawk/Memorial School-Boys and Girls Club	Classroom W3	2	2L4' T12 EE/EEMAG	eggcrate	18	2L4' T8 28W/EELE HINEW-8'	new wrap	9	1,800	70	64	0.68	1,231
103	Sparhawk/Memorial School-Boys and Girls Club	Classroom W3	2	2L4' T12 EE/EEMAG	eggcrate	3	1L4' T8 28W/EELE HINEW	new wrap	3	1,800	70	33	0.11	200
104	Sparhawk/Memorial School-Boys and Girls Club	Classroom E3	2	2L4' T12 EE/EEMAG	eggcrate	18	2L4' T8 28W/EELE HINEW-8'	new wrap	9	1,800	70	64	0.68	1,231
105	Sparhawk/Memorial School-Boys and Girls Club	Classroom E3	2	2L4' T12 EE/EEMAG	eggcrate	3	1L4' T8 28W/EELE HINEW	new wrap	3	1,800	70	33	0.11	200
106	Sparhawk/Memorial School-Boys and Girls Club	Classroom W2	2	2L4' T12 EE/EEMAG	eggcrate	18	2L4' T8 28W/EELE HINEW-8'	new wrap	9	1,800	70	64	0.68	1,231
107	Sparhawk/Memorial School-Boys and Girls Club	Classroom W2	2	2L4' T12 EE/EEMAG	eggcrate	3	1L4' T8 28W/EELE HINEW	new wrap	3	1,800	70	33	0.11	200
108	Sparhawk/Memorial School-Boys and Girls Club	Classroom E2	2	2L4' T12 EE/EEMAG	eggcrate	3	1L4' T8 28W/EELE HINEW	new wrap	3	1,800	70	33	0.11	200
109	Sparhawk/Memorial School-Boys and Girls Club	Classroom E2	2	2L4' T12 EE/EEMAG	eggcrate	18	2L4' T8 28W/EELE HINEW-8'	new wrap	9	1,800	70	64	0.68	1,231
110	Sparhawk/Memorial School-Boys and Girls Club	Classroom W1	2	2L4' T12 EE/EEMAG	eggcrate	3	1L4' T8 28W/EELE HINEW	new wrap	3	1,800	70	33	0.11	200
111	Sparhawk/Memorial School-Boys and Girls Club	Classroom W1	2	2L4' T12 EE/EEMAG	eggcrate	18	2L4' T8 28W/EELE HINEW-8'	new wrap	9	1,800	70	64	0.68	1,231
112	Sparhawk/Memorial School-Boys and Girls Club	Classroom E1	2	2L4' T12 EE/EEMAG	eggcrate	3	1L4' T8 28W/EELE HINEW	new wrap	3	1,800	70	33	0.11	200
113	Sparhawk/Memorial School-Boys and Girls Club	Classroom E1	2	2L4' T12 EE/EEMAG	old wrap	2	2L4' T8 28W/EELE HINEW-8'	new wrap	1	2,280	70	64	0.08	173
114	Sparhawk/Memorial School-Boys and Girls Club	Bath Boys	2	2L4' T12 EE/EEMAG	old wrap	2	1L4' T8 28W/EELE HINEW	new wrap	2	2,280	70	33	0.07	169
115	Sparhawk/Memorial School-Boys and Girls Club	Bath Boys	2	2L4' T12 EE/EEMAG	old wrap	2	1L4' T8 28W/EELE HINEW-8'	new wrap	1	2,280	70	64	0.08	173
116	Sparhawk/Memorial School-Boys and Girls Club	Bath Girls	2	2L4' T12 EE/EEMAG	old wrap	2	1L4' T8 28W/EELE HINEW	new wrap	2	2,280	70	33	0.07	169
117	Sparhawk/Memorial School-Boys and Girls Club	Bath Girls	2	2L4' T12 EE/EEMAG	old wrap	2	1L4' T8 28W/EELE HINEW	new wrap	2	2,280	70	33	0.07	169
118	Sparhawk/Memorial School-Boys and Girls Club	Closet Maintenance	2	60W INCANDESCENT	keyless	1	20W COMPACT SI	screw in	1	500	60	20	0.04	20
119	Sparhawk/Memorial School-Boys and Girls Club	Star North	5	2L4' T12 EE/EEMAG	old wrap	10	1L4' T8 28W/EELE HINEW-8'	new wrap	5	2,400	70	64	0.38	912
120	Sparhawk/Memorial School-Boys and Girls Club	Star North	5	2L4' T12 EE/EEMAG	old wrap	1	1L4' T8 28W/EELE HINEW	new wrap	1	2,400	70	33	0.04	89
121	Sparhawk/Memorial School-Boys and Girls Club	Bath Staff	2	2L4' T12 EE/EEMAG	old wrap	1	1L4' T8 28W/EELE HINEW	new wrap	1	2,280	70	33	0.04	84
122	Sparhawk/Memorial School-Boys and Girls Club	Star Spaulding	5	2L4' T12 EE/EEMAG	strip	6	NO RETRO	no change needed		2,400	70	70		
123	Sparhawk/Memorial School-Boys and Girls Club	Hall 2nd	2	2x 15W INCANDESCENTS	exit sign	1	NO RETRO	no change needed		2,400	140	140		
124	Sparhawk/Memorial School-Boys and Girls Club	Classroom 2A	2	2L4' T12 EE/EEMAG	eggcrate	6	NO RETRO	no change needed		500	123	123		
125	Sparhawk/Memorial School-Boys and Girls Club	Classroom 2B	2	2L4' T12 EE/EEMAG	eggcrate	6	NO RETRO	no change needed		500	123	123		
126	Sparhawk/Memorial School-Boys and Girls Club	Classroom 2C	2	2L4' T12 EE/EEMAG	eggcrate	6	NO RETRO	no change needed		500	123	123		
127	Sparhawk/Memorial School-Boys and Girls Club	Classroom 2D	2	2L4' T12 EE/EEMAG	eggcrate	6	NO RETRO	no change needed		500	123	123		
128	Sparhawk/Memorial School-Boys and Girls Club	Office Open Admin	2	4L4' T12 EE/EEMAG	old wrap	1	NO RETRO	no change needed		500	140	140		
129	Sparhawk/Memorial School-Boys and Girls Club	Office Open Admin	2	4L4' T12 EE/EEMAG	eggcrate	1	NO RETRO	no change needed		500	70	70		
130	Sparhawk/Memorial School-Boys and Girls Club	Office Open Admin	2	4L4' T12 EE/EEMAG	old wrap	1	NO RETRO	no change needed		500	140	140		
131	Sparhawk/Memorial School-Boys and Girls Club	Office Open Admin	2	4L4' T12 EE/EEMAG	eggcrate	1	NO RETRO	no change needed		500	70	70		
132	Sparhawk/Memorial School-Boys and Girls Club	Office Open Admin	2	4L4' T12 EE/EEMAG	old wrap	3	NO RETRO	no change needed		2,400	140	140		
133	Sparhawk/Memorial School-Boys and Girls Club	Hall 1st	1	2x 15W INCANDESCENTS	exit sign	1	NO RETRO	no change needed		8,760	30	30		
134	Sparhawk/Memorial School-Boys and Girls Club	Classroom 1	1	2L4' T12 EE/EEMAG	eggcrate	6	NO RETRO	no change needed		500	123	123		
135	Sparhawk/Memorial School-Boys and Girls Club	Classroom 2	1	2L4' T12 EE/EEMAG	eggcrate	6	NO RETRO	no change needed		500	123	123		

Line	Building Name	Location	Floor	Pre Fixture Description	Pre Fixture Style	Pre Qty	Post Fixture Description	Post Fixture Style	Post Qty	Annual Hours	Pre Watt	Post Watt	kW Saved	kWh Saved
137	Spaulhawk/Memorial School-Boys and Girls Club	Classroom 4	1	2L8" T12 EE/EEMAG	eggcrate	6	NO RETRO	no change needed		500	123	123		
138	Spaulhawk/Memorial School-Boys and Girls Club	Classroom 5	1	2L8" T12 EE/EEMAG	eggcrate	6	NO RETRO	no change needed		500	123	123		
139	Spaulhawk/Memorial School-Boys and Girls Club	Office Open 3	1	4L4" T12 EE/EEMAG	old wrap	2	NO RETRO	no change needed		500	140	140		
140	Spaulhawk/Memorial School-Boys and Girls Club	Office Open 3	1	2L4" T12 EE/EEMAG	eggcrate	1	NO RETRO	no change needed		500	70	70		
141	Spaulhawk/Memorial School-Boys and Girls Club	Storage By Stair	1	60W INCANDESCENT	keyless	2	NO RETRO	no change needed		500	60	60		
142	Spaulhawk/Memorial School-Boys and Girls Club	Stair Exit	1	2L4" T12 EE/EEMAG	strip	1	NO RETRO	no change needed		2,400	70	70		
143	Spaulhawk/Memorial School-Boys and Girls Club	Hall Basement	1	2L4" T12 EE/EEMAG	wrap	2	NO RETRO	no change needed		2,400	70	70		
144	Spaulhawk/Memorial School-Boys and Girls Club	Hall Basement	1	2L4" T12 EE/EEMAG	exit sign	1	NO RETRO	no change needed		8,760	30	30		
145	Spaulhawk/Memorial School-Boys and Girls Club	Classroom 1b	1	2L4" T12 EE/EEMAG	wrap wide	8	NO RETRO	no change needed		500	70	70		
146	Spaulhawk/Memorial School-Boys and Girls Club	Storage Boys & Girls	1	2L4" T8/EL	old wrap	2	NO RETRO	no change needed		500	60	60		
147	Spaulhawk/Memorial School-Boys and Girls Club	Storage B&G	1	2L4" T8/EL	strip	1	NO RETRO	no change needed		500	60	60		
148	Spaulhawk/Memorial School-Boys and Girls Club	Storage Lc	1	2L4" T12 EE/EEMAG	old wrap	2	NO RETRO	no change needed		500	70	70		
149	Spaulhawk/Memorial School-Boys and Girls Club	Storage Custodian	1	2L4" T12 EE/EEMAG	old wrap	3	NO RETRO	no change needed		500	70	70		
150	Spaulhawk/Memorial School-Boys and Girls Club	Storage Custodian	1	90W INCANDESCENT	keyless	1	NO RETRO	no change needed		500	90	90		
151	Spaulhawk/Memorial School-Boys and Girls Club	Classroom 1b	1	2L8" T12 EE/EEMAG	eggcrate	4	NO RETRO	no change needed		500	123	123		
152	Spaulhawk/Memorial School-Boys and Girls Club	Hall 1st Boys & Girls	1	1L4" T12 EE/EEMAG	old wrap	4	2L4" T8 28W/EL LONENW-8"	new wrap	2	2,400	40	42	0.08	182
153	Spaulhawk/Memorial School-Boys and Girls Club	Hall 1st B&G	1	1L4" T12 EE/EEMAG	old wrap	1	1L4" T8 28W/EL LONENW-8"	new wrap	1	2,400	40	33	0.07	17
154	Spaulhawk/Memorial School-Boys and Girls Club	Hall 1st B&G	1	2x 15W INCANDESCENTS	exit sign	3	3 WATT LED NEW EXIT BATTERY	new exit bat	3	8,760	30	3	0.08	710
155	Spaulhawk/Memorial School-Boys and Girls Club	Hall 1st B&G	1	4L4" T8/EL	trif ac	8	2L4" T8 28W/EL LONENW-8"	trif rft	8	2,400	112	64	0.38	922
156	Spaulhawk/Memorial School-Boys and Girls Club	Hall 1st B&G	1	65W INCANDESCENT	track head dim	15	NO RETRO	no change needed		2,400	65	65		
157	Spaulhawk/Memorial School-Boys and Girls Club	Hall 1st B&G	1	2L4" T12 EE/EEMAG	eggcrate	5	1L4" T8 28W/EL LONENW-8"	new wrap	5	2,400	70	33	0.19	444
158	Spaulhawk/Memorial School-Boys and Girls Club	Hall 1st B&G	1	2L8" T12 EE/EEMAG	eggcrate	6	2L4" T8 28W/EL LONENW-8"	new wrap	6	2,400	123	64	0.35	850
159	Spaulhawk/Memorial School-Boys and Girls Club	Bath Girls	1	2L4" T12 EE/EEMAG	old wrap	2	2L4" T8 28W/EL LONENW-8"	new wrap	2	2,280	70	64	0.08	173
160	Spaulhawk/Memorial School-Boys and Girls Club	Bath Girls	1	2L4" T12 EE/EEMAG	old wrap	2	1L4" T8 28W/EL LONENW-8"	new wrap	2	2,280	70	33	0.07	169
161	Spaulhawk/Memorial School-Boys and Girls Club	Bath Boys	1	2L4" T12 EE/EEMAG	old wrap	2	2L4" T8 28W/EL LONENW-8"	new wrap	1	2,280	70	64	0.08	173
162	Spaulhawk/Memorial School-Boys and Girls Club	Bath Boys	1	2L4" T12 EE/EEMAG	old wrap	2	1L4" T8 28W/EL LONENW-8"	new wrap	2	2,280	70	33	0.07	169
163	Spaulhawk/Memorial School-Boys and Girls Club	Closet Clean	1	60W INCANDESCENT	keyless	1	20W COMPACT SI	screw in	1	500	60	20	0.04	20
164	Spaulhawk/Memorial School-Boys and Girls Club	Classroom Teen Center	1	2L4" T12 EE/EEMAG	strip reflector	10	2L4" T8 28W/EL LONENW-8"	new wrap	5	1,800	70	64	0.38	564
165	Spaulhawk/Memorial School-Boys and Girls Club	Classroom Teen Center	1	2L4" T12 EE/EEMAG	strip reflector	2	1L4" T8 28W/EL LONENW-8"	new wrap	2	1,800	70	33	0.07	133
166	Spaulhawk/Memorial School-Boys and Girls Club	Classroom Arts	1	2L4" T12 EE/EEMAG	eggcrate	18	2L4" T8 28W/EL LONENW-8"	new wrap	9	1,800	70	64	0.68	1,231
167	Spaulhawk/Memorial School-Boys and Girls Club	Classroom Arts	1	2L4" T12 EE/EEMAG	eggcrate	3	1L4" T8 28W/EL LONENW-8"	new wrap	3	1,800	70	33	0.11	200
168	Spaulhawk/Memorial School-Boys and Girls Club	Office Open Staff	1	2L4" T12 EE/EEMAG	wrap wide	2	2L4" T8 28W/EL LONENW-8"	rftb	2	2,280	70	42	0.06	128
169	Spaulhawk/Memorial School-Boys and Girls Club	Office Open Staff	1	2L4" T12 EE/EEMAG	wrap wide	2	2L4" T8 28W/EL LONENW-8"	rftb	2	2,280	70	42	0.06	128
170	Spaulhawk/Memorial School-Boys and Girls Club	Classroom Tech	1	2L4" T12 EE/EEMAG	eggcrate	18	2L4" T8 28W/EL LONENW-8"	new wrap	9	1,800	70	64	0.68	1,231
171	Spaulhawk/Memorial School-Boys and Girls Club	Classroom Tech	1	2L4" T12 EE/EEMAG	eggcrate	3	1L4" T8 28W/EL LONENW-8"	new wrap	3	1,800	70	33	0.11	200
172	Spaulhawk/Memorial School-Boys and Girls Club	Cafeteria	1	2L4" T12 EE/EEMAG	eggcrate	50	2L4" T8 28W/EL LONENW-8"	new wrap	25	2,280	70	64	1.90	4,332
173	Spaulhawk/Memorial School-Boys and Girls Club	Cafeteria	1	2L4" T12 EE/EEMAG	eggcrate	5	1L4" T8 28W/EL LONENW-8"	new wrap	5	2,280	70	33	0.19	422
174	Spaulhawk/Memorial School-Boys and Girls Club	Stage	1	2L4" T12 EE/EEMAG	eggcrate	8	2L4" T8 28W/EL LONENW-8"	new wrap	4	1,800	70	64	0.30	547
175	Spaulhawk/Memorial School-Boys and Girls Club	Storage Videogame	1	2L4" T12 EE/EEMAG	eggcrate	1	1L4" T8 28W/EL LONENW-8"	new wrap	1	500	70	33	0.04	19
176	Spaulhawk/Memorial School-Boys and Girls Club	Kitchen	1	2L4" T12 EE/EEMAG	eggcrate	18	2L4" T8 28W/EL LONENW-8"	new wrap	9	2,280	70	64	0.68	1,560
177	Spaulhawk/Memorial School-Boys and Girls Club	Kitchen	1	2L4" T12 EE/EEMAG	eggcrate	3	1L4" T8 28W/EL LONENW-8"	new wrap	3	2,280	70	33	0.11	253
178	Spaulhawk/Memorial School-Boys and Girls Club	Mechanical Boiler	1	150W INCANDESCENT	old keyless	6	new industrial	new industrial	6	500	150	64	0.52	298
179	Spaulhawk/Memorial School-Boys and Girls Club	Gym	1	400W METAL HALIDE	high bay	10	6L4" T8 28W/EL LONENW-8"	new T8 hi bay cage	10	2,400	455	192	2.63	6,312
180	Spaulhawk/Memorial School-Boys and Girls Club	Gym	1	2L4" T12 EE/EEMAG	old vapor light	4	1L4" T8 28W/EL LONENW-8"	new vaporlight	4	2,400	70	33	0.15	355
181	Spaulhawk/Memorial School-Boys and Girls Club	Gym	1	2x 15W INCANDESCENTS	exit rec	2	3 WATT LED KIT	exit sign retro kit	2	8,760	30	3	0.05	473
182	Spaulhawk/Memorial School-Boys and Girls Club	Storage Equipment	1	60W INCANDESCENT	keyless	3	20W COMPACT SI	screw in	3	500	60	20	0.12	59
183	Spaulhawk/Memorial School-Boys and Girls Club	Storage Over Gym	1	2L8" T12 EE/EEMAG	strip	2	2L4" T8 28W/EL LONENW-8"	new wrap	2	500	123	64	0.12	59
184	Spaulhawk/Memorial School-Boys and Girls Club	Storage Over Gym	1	90W INCANDESCENT	jar	2	20W COMPACT SI	screw in	2	500	90	20	0.14	70
185	Spaulhawk/Memorial School-Boys and Girls Club	Office Open Main	1	2L4" T12 EE/EEMAG	eggcrate	4	2L4" T8 28W/EL LONENW-8"	new wrap	2	2,280	70	64	0.15	347
186	Spaulhawk/Memorial School-Boys and Girls Club	Office Open Main	1	2L4" T12 EE/EEMAG	eggcrate	2	1L4" T8 28W/EL LONENW-8"	new wrap	2	2,280	70	33	0.07	169
187	Spaulhawk/Memorial School-Boys and Girls Club	Office Main	1	2L4" T12 EE/EEMAG	eggcrate	4	2L4" T8 28W/EL LONENW-8"	new wrap	2	1,800	70	64	0.15	274
188	Spaulhawk/Memorial School-Boys and Girls Club	Office Main	1	2L4" T12 EE/EEMAG	eggcrate	2	1L4" T8 28W/EL LONENW-8"	new wrap	2	1,800	70	33	0.07	133
189	Spaulhawk/Memorial School-Boys and Girls Club	Office Main	1	4L4" T8/EL	wrap wide	8	4L4" T8 28W/EL LONENW-8"	rftb	8	1,800	112	83	0.23	418
190	Spaulhawk/Memorial School-Boys and Girls Club	Library	1	2L4" T12 EE/EEMAG	eggcrate	8	1L4" T8 28W/EL LONENW-8"	new wrap	8	2,280	70	33	0.30	675
191	Spaulhawk/Memorial School-Boys and Girls Club	Classroom Stage	1	2L4" T12 EE/EEMAG	eggcrate	12	2L4" T8 28W/EL LONENW-8"	new wrap	6	1,800	70	64	0.46	821
192	Spaulhawk/Memorial School-Boys and Girls Club	Classroom Stage	1	2L4" T12 EE/EEMAG	eggcrate	2	1L4" T8 28W/EL LONENW-8"	new wrap	2	1,800	70	33	0.07	133

5/15/2014

Line	Building Name	Location	Floor	Pre Fixture Description	Pre Fixture Style	Pre Qty	Post Fixture Description	Post Fixture Style	Post Qty	Annual Hours	Pre Wait	Post Wait	kW Saved	kWh Saved
296	Council on Aging- Hilton Senior Center	Bath Men's	1	2L4" T8/EEL	wrap	1	2L4" T8 28w/ELEE LO	rftb	1	1,729	60	42	0.02	31
297	Council on Aging- Hilton Senior Center	Bath Men's	1	4L4" T8/EEL-8"	wrap	2	4L4" T8 28w/ELEE LO-8"	rftb	2	1,729	112	83	0.05	100
298	Council on Aging- Hilton Senior Center	Bath Men's	1	2L4" T8/EEL	wrap	2	2L4" T8 28w/ELEE LO	rftb	2	1,729	60	42	0.04	62
299	Council on Aging- Hilton Senior Center	Kitchen	1	4L4" T8/EEL	trof scr	5	2L4" T8 28w/ELEE HIRFL	rftb rft	5	1,729	112	64	0.24	415
300	Council on Aging- Hilton Senior Center	Storage Pantry	1	4L4" T8/EEL	trof scr	1	2L4" T8 28w/ELEE HIRFL	rftb rft	1	1,365	112	64	0.05	66
301	Council on Aging- Hilton Senior Center	Storage 5	1	2L4" T12 EEE/EEMAG	strip	2	2L4" T8 28w/ELEE LO	rftb	2	1,000	70	42	0.06	56
302	Council on Aging- Hilton Senior Center	Hall To Offices	1	2L4" T8 U/EEL	trof parabolic	5	2L2" T8 15w/ELEE HIRFL	rftb rft	5	1,820	60	40	0.10	182
303	Council on Aging- Hilton Senior Center	Conference	1	2L4" T8 U/EEL	trof parabolic	6	2L2" T8 15w/ELEE HIRFL	rftb rft	6	1,365	60	40	0.12	164
304	Council on Aging- Hilton Senior Center	Closet	1	1L4" T8/EEL	wrap narrow	2	1L4" T8 28w/ELEE LO	rftb	2	1,000	30	22	0.02	16
305	Council on Aging- Hilton Senior Center	Office 2	1	3L4" T8/EEL	trof parabolic	1	3L4" T8 28w/ELEE LO	rftb	1	1,365	88	63	0.03	34
306	Council on Aging- Hilton Senior Center	Office Open 3	1	2L4" T8 U/EEL	trof parabolic	4	2L2" T8 15w/ELEE HIRFL	rftb rft	4	1,729	60	40	0.08	138
307	Council on Aging- Hilton Senior Center	Office 3	1	2L4" T8 U/EEL	trof parabolic	2	2L2" T8 15w/ELEE HIRFL	rftb rft	2	1,365	60	40	0.04	55
308	Council on Aging- Hilton Senior Center	Hall Side Entry	1	3/13W COMPACT HARDWIRED	decorative	1	NO RETRO	no change needed	1,820	45	45			
309	Council on Aging- Hilton Senior Center	Bldg Mt Front Entry	Ext	90W INCANDESCENT	can rec	2	20W COMPACT SI	screw in	2	4,380	90	20	0.14	613
Totals													43.75	106,975

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) criteria for classification as non-hazardous waste in most states².

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.



This light source meets restrictions on hazardous substances.



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/800XP/XL/SS/ECO3	25	3000K, 3500K, 4100K
F028/800XP/XL/SS/ECO3	28	3000K, 3500K, 4100K, 5000K
F096/50W/800XP/SS/ECO3	50	3500K, 4100K, 5000K
F096/54W/800XP/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.



Specification Data

Fixture Description:

Type

Project/Job:

SYLVANIA lamp:

SYLVANIA ballast:

Notes:

Ordering Information

Item Number	Ordering Abbreviation	Watts	Nominal Length (in)	Initial Lumens	Mean Lumens¹	Lumens per Watt	Average Rated Life				CCT	CRI
							Instant Start	12 hrs/ start	Prog. Rapid Start	12 hrs/ start		
OCTRON® 800 XP® SUPERSAVER®												
22405	F017/15W/830/XP/SS/EC03	15	24	1200	1130	80	24,000	40,000	40,000	42,000	3000K	85
22406	F017/15W/835/XP/SS/EC03	15	24	1200	1130	80	24,000	40,000	40,000	42,000	3500K	85
22407	F017/15W/841/XP/SS/EC03	15	24	1200	1130	80	24,000	40,000	40,000	42,000	4100K	85
22408	F017/15W/850/XP/SS/EC03	15	24	1200	1130	80	24,000	40,000	40,000	42,000	5000K	81
22394	F025/21W/830/XP/SS/EC03	21	36	1925	1810	92	24,000	40,000	40,000	42,000	3000K	85
22395	F025/21W/835/XP/SS/EC03	21	36	1925	1810	92	24,000	40,000	40,000	42,000	3500K	85
22396	F025/21W/841/XP/SS/EC03	21	36	1925	1810	92	24,000	40,000	40,000	42,000	4100K	85
22397	F025/21W/850/XP/SS/EC03	21	36	1925	1810	92	24,000	40,000	40,000	42,000	5000K	81
22232	F032/25W/830/XP/SS/EC03	25	48	2500	2350	100	24,000	40,000	40,000	42,000	3000K	85
22233	F032/25W/835/XP/SS/EC03	25	48	2500	2350	100	24,000	40,000	40,000	42,000	3500K	85
22234	F032/25W/841/XP/SS/EC03	25	48	2500	2350	100	24,000	40,000	40,000	42,000	4100K	85
22235	F032/25W/850/XP/SS/EC03	25	48	2500	2350	100	24,000	40,000	40,000	42,000	5000K	81
22177	F028/830/XP/SS/EC03	28	48	2725	2560	97	24,000	40,000	40,000	42,000	3000K	85
22178	F028/835/XP/SS/EC03	28	48	2725	2560	97	24,000	40,000	40,000	42,000	3500K	85
22179	F028/841/XP/SS/EC03	28	48	2725	2560	97	24,000	40,000	40,000	42,000	4100K	85
22184	F028/850/XP/SS/EC03	28	48	2725	2560	97	24,000	40,000	40,000	42,000	5000K	81
22063	F030/830/XP/SS/EC03	30	48	2850	2680	95	24,000	40,000	40,000	42,000	3000K	85
22060	F030/835/XP/SS/EC03	30	48	2850	2680	95	24,000	40,000	40,000	42,000	3500K	85
22062	F030/841/XP/SS/EC03	30	48	2850	2680	95	24,000	40,000	40,000	42,000	4100K	85
22202	F030/850/XP/SS/EC03	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/EC03	25	48	2400	2305	96	36,000	52,000	60,000	62,000	3000K	85
22222	F032/25W/835/XP/XL/SS/EC03	25	48	2400	2305	96	36,000	52,000	60,000	62,000	3500K	85
22223	F032/25W/841/XP/XL/SS/EC03	25	48	2400	2305	96	36,000	52,000	60,000	62,000	4100K	85
21528	F028/830/XP/XL/SS/EC03	28	48	2600	2495	93	36,000	52,000	60,000	62,000	3000K	85
22166	F028/835/XP/XL/SS/EC03	28	48	2600	2495	93	36,000	52,000	60,000	62,000	3500K	85
22167	F028/841/XP/XL/SS/EC03	28	48	2600	2495	93	36,000	52,000	60,000	62,000	4100K	85
22326	F028/850/XP/XL/SS/EC03	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/EC03	50	96	5400	5075	108	24,000	36,000			3500K	85
22421	F096/50W/841/XP/SS/EC03	50	96	5400	5075	108	24,000	36,000			4100K	85
22422	F096/50W/850/XP/SS/EC03	50	96	5400	5075	108	24,000	36,000			5000K	81
22100	F096/54W/835/XP/SS/EC03	54	96	5700	5360	106	24,000	36,000			3500K	85
22101	F096/54W/841/XP/SS/EC03	54	96	5700	5360	106	24,000	36,000			4100K	85
22347	F096/54W/850/XP/SS/EC03	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	/	EC03
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=EXtended Performance XL=EXtreme Life		SUPERSAVER		ECOLOGIC3

QHE High Efficiency Instant Start



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.



Key System Features:

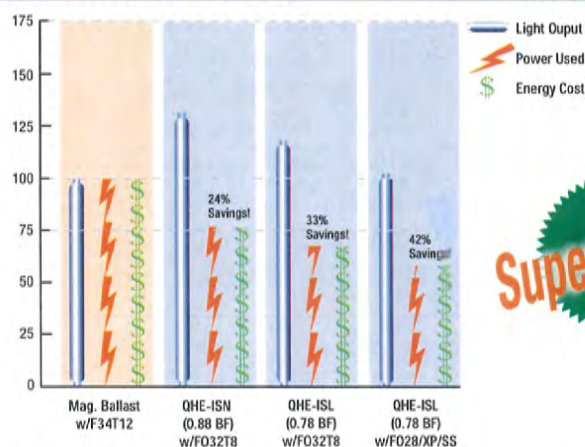
- Highest ballast efficiency – over 90%
- NEMA Premium Ballast Program Compliant
- Highest system efficiency available
- Lowest power instant start systems
- Universal input voltage (120-277V)
- 30-60% energy savings
- SAME LIGHT, LESS POWER
- Available ballast factors:
 - Low (0.78)
 - Normal (0.88)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

Applications:

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

TYPICAL SAVINGS

QHE-IS: Two Lamp



Supersavings

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 F032T8/800/XPS/ECO and F028T8/800/XP/SS/ECO lamps

SEE THE WORLD IN A NEW LIGHT

SYLVANIA



QUICKTRONIC® High Efficiency T8 Systems



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

Item Number	OSRAM SYLVANIA Description	Input Current (AMPS) @120/277V	Lamp Type¹	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	BEF²
LOW BALLAST FACTOR											
49837	QHE 1x32T8/UNV ISL-SC	0.21/0.09	F032/XPS	3100	1	0.78	2420	2275	25	97	3.12
49861	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
49838	QHE 2x32T8/UNV ISL-SC	0.41/0.18	F032/XPS	3100	2	0.78	4835	4545	48	101	1.63
49863	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
49839	QHE 3x32T8/UNV ISL-SC	0.61/0.27	F032/XPS	3100	3	0.78	7255	6820	73/72	99/101	1.08
49865	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
49840	QHE 4x32T8/UNV ISL-SC	0.80/0.35	F032/XPS	3100	4	0.78	9670	9090	95	102	0.82
49867	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											
49968	QHE 1x32T8/UNV ISN-SC	0.25/0.11	F032/XPS	3100	1	0.88	2730	2565	28	98	3.14
49851	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
49969	QHE 2x32T8/UNV ISN-SC	0.47/0.20	F032/XPS	3100	2	0.88	5455	5130	55	99	1.60
49853	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
49970	QHE 3x32T8/UNV ISN-SC	0.69/0.30	F032/XPS	3100	3	0.88	8185	7695	83/82	99/100	1.07
49855	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
49971	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
49857	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											
49919	QHE 1x32T8/UNV ISH-SC	0.32/0.14	F032/XPS	3100	1	1.20	3720	3495	38	98	3.16
49871	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
49920	QHE 2x32T8/UNV ISH-SC	0.65/0.28	F032/XPS	3100	2	1.20	7440	6995	74/73	101/102	1.64
49873	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
49921	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
49875	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
49922	QHE 4x32T8/UNV ISH	1.21/0.52	F032/XPS	3100	4	1.15	14,260	13,405	144/141	99/101	0.82
49877	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

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 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

Specifications subject to change without notice.

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.

Simply better service

Only QUICK60+ offers you a choice of three service options to resolve warranty claims for ballasts, including our unique "Fixtureside AssistanceSM" 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 ⁴	Lamp Warranty Period ⁴
QUICKTRONIC® T8'	OCTRON XPS®, XP & XP/SS ^{2,3}	60 mos.	36 mos.
QUICKTRONIC T8'	OCTRON XP/XL & XP/XL/SS family	60 mos.	48 mos.
QUICKTRONIC T8'	OCTRON family	60 mos.	30 mos.
QUICKTRONIC T8 High Ambient ^{1, 5}	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 86/78HO High Ambient ¹	OCTRON FO96HO	36/60mos. @ <90°/70°C	30 mos.
QUICKTRONIC 96IS/96HO & 40T12	N/A	60 mos.	N/A
QUICKTRONIC T5', T5/HO'	PENTRON® Family	60 mos.	24 mos.
QUICKTRONIC 54T5HO' High Ambient	PENTRON® FP54/HO, FP54/C/HO	36/60 mos. @ <90°/70°C	36 mos.
QUICKTRONIC 54T5/HO'	PENTRON® FP54/HO, FP54/C/HO	60 mos.	36 mos.
QUICKTRONIC 54PHO & DL40	DULUX® FT55DL, FT40DL & FT40/28SS	60 mos.	12 mos.
QUICKTRONIC CF'	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'	METALARC® Family ⁶ (7K-12K hrs. avg. rated life)	36/60 mos.	6 mos.
QUICKTRONIC MH'	METALARC® Family ⁶ (15K-20K hrs. avg. rated life)	36/60 mos.	12 mos.

¹NOTE: 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.

² Occupancy sensor application, 15 minute/start minimum, allowed with QUICKTRONIC PROStart® and with QUICKTRONIC ICE ballasts.

³ OCTRON SUPERSAVER® bipin lamps operate on Instant Start & PROStart (non-dimming) models only.

⁴ QUICKTRONIC, Professional Series and High Efficiency Series including all IS, PS & DIM models where applicable.

⁵ Labor options must be pre-approved by OSPI. Any labor option or cost that is not pre-approved will not be eligible for reimbursement.

⁶ ICETRON Lamp Warranty Period allows up to 8760 hrs per year (continuous operation).

⁷ Contact OSRAM SYLVANIA for detailed specifications of METALARC® lamps.

⁸ 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.

⁹ Maximum Case Temperature <70°C, for normal environmental operating conditions (40°C max. ambient) unless noted.

Refer to product specifications for details.

¹⁰ 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.

- OSPI will provide full service coverage through SYLVANIA LIGHTING SERVICES at no cost to the user of the ballast, or
- OSPI will contact a service provider and coordinate replacement at no cost to the user of the ballast, or
- OSPI will reimburse the purchaser reasonable, customary and necessary labor charges required to install the ballast replacement.
- 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



GE Lighting North America



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 gauge steel (NYC) and heavy gauge 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.

LAMP HOLDERS

- 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.

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RLS-5840A-3

Category: ECS
Energy
Conservation
Series

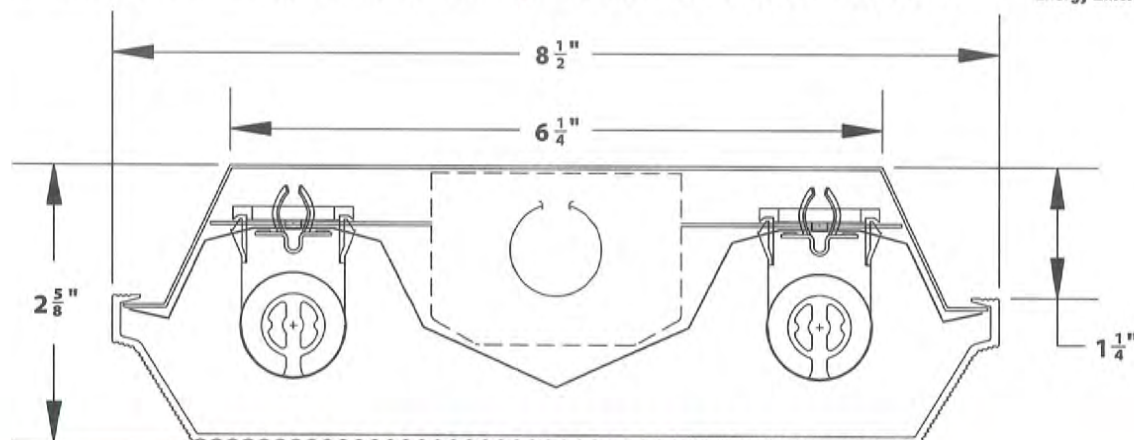
Prefix:
LPW

Fixture Series (Name):
Low Profile Wrap



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 4 - 4L	17 17w T8 25 25w T8 32 32w T8 14 14w T5 21 21w T5 28 28w T5 24 24w TSHO 39 39w TSHO 54 54w TSHO	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	L - Low N - Normal H - High	



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



***ADDITIONAL OPTIONS**
(See "Options" sheet for all available options)



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)

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RLS-5840A-3

Category: ECS
Energy
Conservation
Series

Prefix:
MVT

Fixture Series (Name):
Mini Vapor Tight



GE Lighting North America



Innovative Lighting Ideas
Energy Efficient Solutions

Mini Vapor Tight Series general purpose fluorescent luminaire

GENERAL DESCRIPTION

The Mini Vapor Tight (MVT) 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 fiber-glass 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 mat. 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.

LAMP HOLDERS

- 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 a "stepped" design to provide general lamp obscuring. Lenses are injection-molded 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.
- 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).
- Spring-Mount Brackets Option (Stainless Steel) provides for easy installation. This option can be factory or field installed. - 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.

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RLS-5465A-3

Category: ECS
Energy
Conservation
Series

Prefix:
MVT

Fixture Series (Name):
Mini Vapor Tight

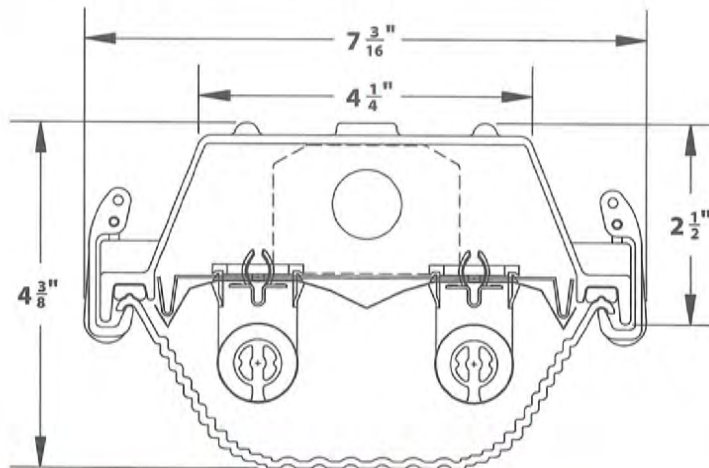


GE Lighting North America



Innovative Lighting Ideas
Energy Efficient Solutions

2-Lamp T8 Mini 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	MVT	4	M	N	2	32	UNV	1	2	N	
Energy Conservation Series	MVT - MINI 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.)	F - FOCUSED N - NORMAL S - SPREAD C - CUSTOM OPTICS *N - NORMAL IS STANDARD (BLANK)=N *C - CUSTOM OPTICS ARE DESCRIBED IN OPTIONS BOX	1 - 1L HSG 2 - 2L 3 - 3L 2 - 2L HSG 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	S - SLAVE (BLANK) - 1 2 - 2 3 - 3	(BLANK) - 0 1 - 1 2 - 2 3 - 3 4 - 4	L - Low N - Normal H - High	

IES
SUSTAINING MEMBER



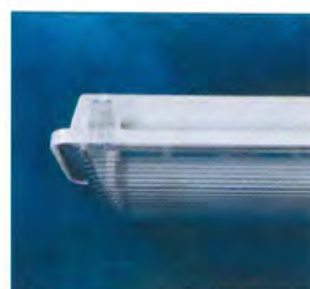
***ADDITIONAL OPTIONS**
(See "Options" sheet for all available options)



Vossloh Locking Lampholders
(Standard)



Multi-Faceted Reflector
(Designed for Maximum Efficiency)



Standard Lens
(High-Impact Clear "Ribbed" Acrylic)



Mounting Details
(Included in all Housings)

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RLS-5465A-3

Category: ECS
**Energy
Conservation
Series**

Prefix:
SGI

Fixture Series (Name):
Std. Grade Industrial



GE Lighting North America



ADVANCE



PHILIPS
sense and simplicity



SYLVANIA



alanod



VOSLOH-SCHWABE



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 gauge steel (NYC) and heavy gauge 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.

LAMP HOLDERS

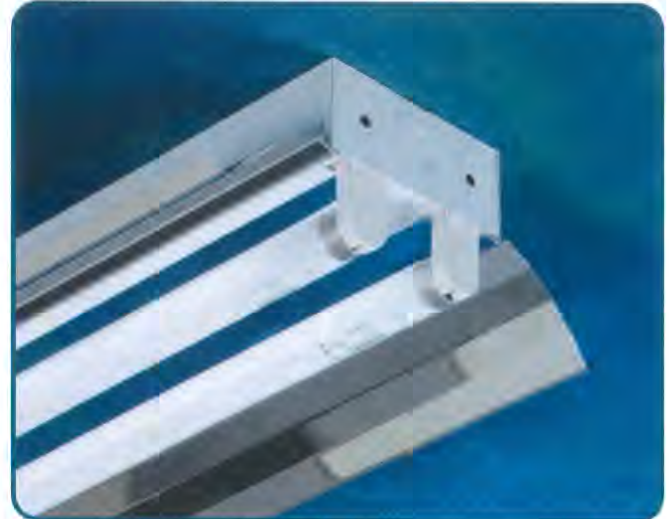
- Vossloh-Schwabe® premium type featuring:
 - Anti-vibration internal lamp locking design
 - High temperature resistant ("T" marking).
 - Heat and UV blocking shield to prevent degradation of material.
 - Multi-point contact design for optimum lamp pin contact.
- Produced in accordance with DIN ISO 9001 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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RLS-5315A-3

Category: ECS
Energy
Conservation
Series

Prefix:
SGI

Fixture Series (Name):
Std. Grade Industrial

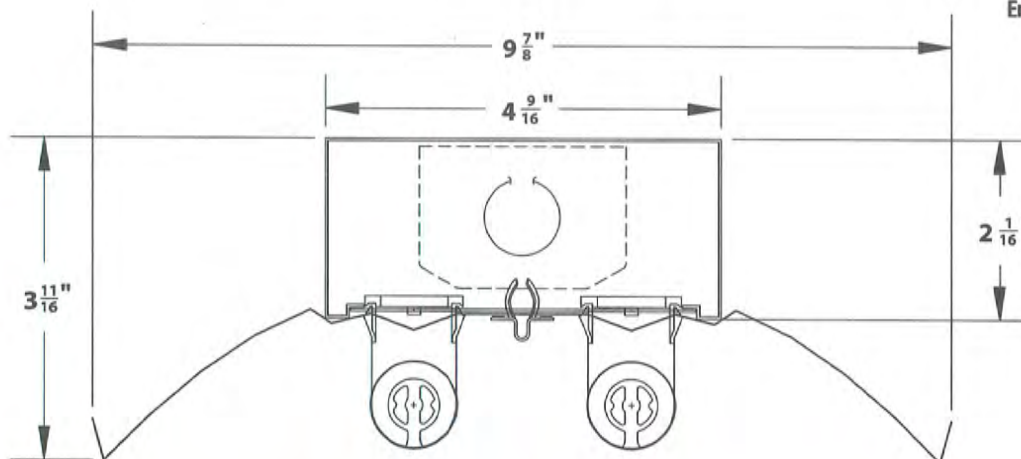


GE Lighting North America



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	1 - 1L 2 - 2L 3 - 3L 4 - 4L 2 - 2L 4 - 4L 6 - 6L 8 - 8L *TS 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	L - Low N - Normal H - High *Use Suffix "M" for Master (Example: 4M)	



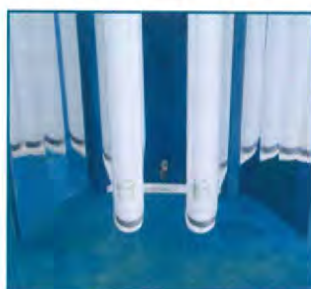
Photometric data, IES files and all other information is available upon request.



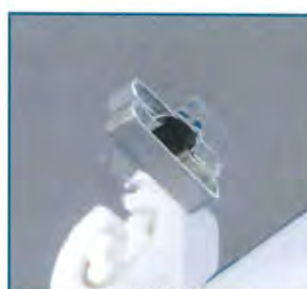
***ADDITIONAL OPTIONS**
(See "Options" sheet for all available options)



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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RLS-5315A-3

Category: ECS
Energy
Conservation
Series

Prefix:
MGM

Fixture Series (Name):
Magnum



GE Lighting North America



Innovative Lighting Ideas
Energy Efficient Solutions

Magnum Series high performance fluorescent high/low bay luminaire

GENERAL DESCRIPTION

The Magnum (MGM) Series has been developed as an energy efficient alternative to HID lighting systems. This series utilizes "High Intensity Fluorescent" technology to dramatically reduce energy consumption, improve quality of light and provide instant-on operation. It also offers many switching and sensor options.

Typical applications for this type of product are interior spaces with high mounting heights where high lumen output is required and an aesthetic look is desired. Applications include:

- Retail – "Big Box" – Distribution Centers and Warehouses
- Industrial, Commercial and Manufacturing Areas
- School Gymnasiums, Auditoriums and Convention Centers
- Ice Rinks, Indoor Courts and Sports Arenas

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 gauge steel (NYC) and heavy gauge 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.

LAMP HOLDERS

- 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.

LAMP SHIELDING

- Lamp shielding options include:
 - Heavy duty powder coated or zinc-plated wire guards.
 - Flat or drop dish lenses, clear acrylic, clear polycarbonate, high light transmission white, prismatic and linear prism lenses. Consult factory for all available options.
 - Louvers and cross-blade baffles - Consult factory.

MOUNTING

- The luminaire may be surface mounted or may be suspended by pendant, threaded rod, hook, chain or cable.

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.

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

RLS-6290A-3

Category: ECS
Energy
Conservation
Series

Prefix:
MGM

Fixture Series (Name):
Magnum

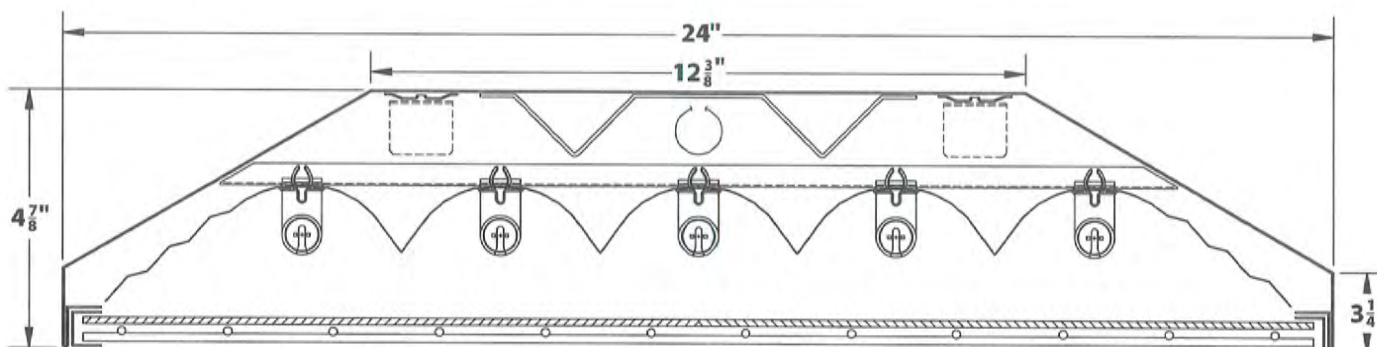


GE Lighting North America



Innovative Lighting Ideas
Energy Efficient Solutions

5-Lamp T5 HO Magnum 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	MGM	4	M	N	5	54	UNV	3	2	H	AWW

Energy
Conservation
Series

MGM - MAGNUM

4 - 48"

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

4 - 4L
5 - 5L
6 - 6L
7 - 7L
8 - 8L

32 32w T8
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
4 - 4

1 - 1
2 - 2
3 - 3
4 - 4

L - Low
N - Normal
H - High



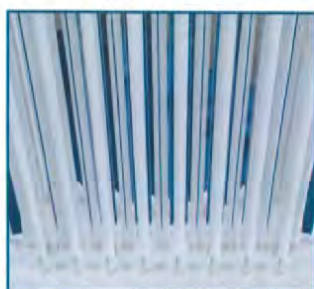
Photometric data, IES files and all other
information is available upon request.



OOW - Open Style
OWW - White Wire-Guard
AOW - Clear Acrylic Lens
AWW - White Wire-Guard & Clear Acrylic Lens
***ADDITIONAL OPTIONS**
(See "Options" sheet for all available options)



Vossloh Locking Lampholders
(Standard)



Multi-Faceted Reflector
(Designed for Maximum Efficiency)



Flush Mount J-Box (Standard)
(Consult Factory for All Available
Mounting Options)



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.

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RLS-6290A-3

LED EXIT SIGN

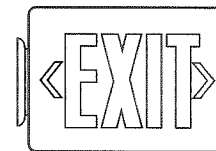
EXIT

SUBMITTAL:

JOB:

TYPE:

VOLTAGE:



EXAMPLE:

EXIT - R - EM - WHT - OPTIONS

SERIES

LETTER
COLOR

POWER
OPTIONS

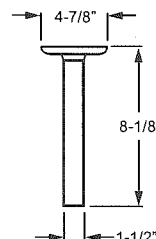
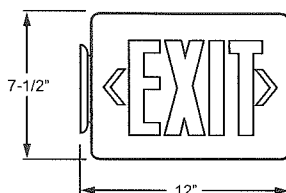
HOUSING
COLOR

OPTIONS/
ACCESSORIES

SERIES

FEATURES

- Available as full-time AC powered unit or emergency unit with battery backup.
- LED lamp life of 25 years.
- Provided as universal single face/double face unit.
- Ni-Cad battery on emergency (EM) units provides 90 minutes of emergency operation.
- Automatic, low voltage disconnect (LVD) activates EM unit in event of partial power failure or brownout.
- Universal mounting canopy for top or side installation.
- Energy consumption of 3.2 watts for red letters and 3.8 watts for green letters.
- Charge rate/power on LED indicator light.
- Removable directional indicators.
- Available with industry-standard white or black housing.



EXIT SERIES

HOUSING — Injection-molded, V0 flame retardant, high-impact thermoplastic housing.

ELECTRICAL — Universal transformer for 120 or 277 VAC operation.

MOUNTING — Universal mounting canopy included for top or side installation.

LETTER COLOR (Must specify)

R

Red

G

Green

POWER OPTIONS (Must specify)

AC

AC operation

EM

AC operation with Emergency Battery Backup

HOUSING COLOR (Must specify)

BLK

Black

WHT

Industry-standard White

OPTIONS

DC

Dual Circuit

SDT

Self-Diagnostic Test

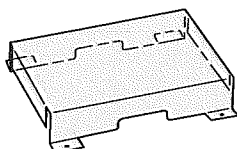
SALIDA

Salida Faceplate (Industry-standard White only)

COPY

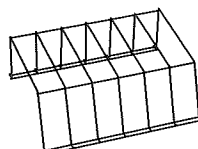
Consult factory for custom message

ACCESSORIES



PC1

Polycarbonate Shield



WG

Wireguard

LABELS

Listed to UL 924 standard as an exit light suitable for dry or damp location.

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

General Purpose

	Item Number	Ordering Abbreviation	Replaced Incandescent Wattage	Nominal Wattage	Initial Lumens	Color Temp.	CRI	Average Rated Life (hr.)	
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/MICRO/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	
Mini Twist 	29674	CF23EL/SUPER/865/RP	100	23	1600	6500K	82	10,000	
	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	✓
Twist 	29784	CF23EL/MINI/835/DAY/RP	100	23	1600	3500K	82	8000	✓
	29564	CF23EL/MINI/841	100	23	1600	4100K	82	10,000	
	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	✓
3-Way Twist 	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	
	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.)	
General Purpose	Bullet		29196	CF14EL/B/830	60	14	700	3000K	82	6000	
			29743**	CF5EL/A15/DIM/827/BL*	15	5	200	2700K	82	25,000	
	Classic A-line		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	✓
			29359	CF23EL/PAR38/827	75	23	1200	2700K	82	8000	✓
	PAR38		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

CF034-INSERTR21

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SEE THE WORLD IN A NEW LIGHT

SYLVANIA



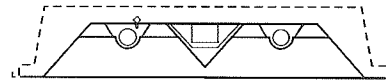
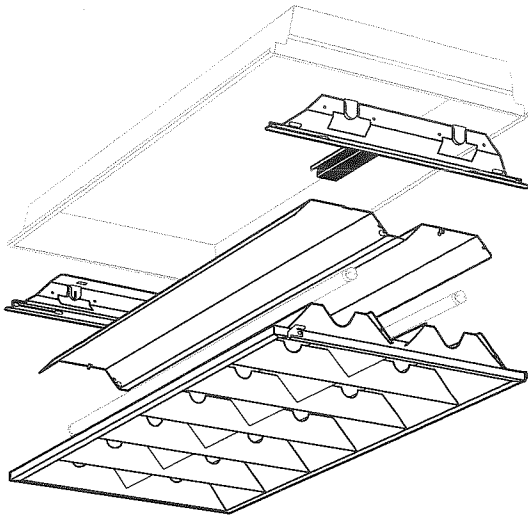
2' x 4' EFFICIENT TROFFER RETROFIT KIT

SERIES **EFTR**
2' x 4' T8

JOB _____

TYPE _____

VOLTAGE _____



Housing provided by others.
See back for dimensional requirements.
Lamps not included.

SPECIFICATIONS

- **HOUSING** – Provided by others, must fit within approved minimum dimensions (see back for details).
- **REFLECTORS/WIREWAY COVERS** – 25-gauge C.R.S.
- **DOOR FRAME & LOUVER** – Door Frame: 22-gauge C.R.S., flat with mitered corners. T-slot steel hinge allows reversible hinging and latching. Louver: 25-gauge C.R.S.
- **FINISH** – Reflectors/Wireway Covers: 92% minimum average reflective white powder coat with multi-stage iron/phosphate prepared metal. Door Frame & Louver: Highly-reflective texture matte white powder coat.
- **ELECTRICAL** – Electronic ballast standard, instant start T8, rated Class P.
- **LABELS** – UL/CUL listed as recessed fluorescent luminaire suitable for dry or damp locations. UL/CUL classified as luminaire conversion, retrofit kit.
- **MOUNTING** – Designed to retrofit existing troffers and parabolics in grid ceiling applications.

FEATURES

- Attractive and environmentally sensitive—provides the fresh appearance of a new architecturally designed fixture while recycling the existing fixture housing.
- Can improve optical efficiency as much as 20% when replacing dated troffers and parabolics, realizing substantial energy savings.
- Allows fixture upgrades without disturbing the ceiling.
- 2-5/8" cross baffles provide lamp cutoff and assist in glare reduction.
- Designed to fit into most 2' x 4' fixture housings with a minimum fixture depth of 4".
- T-slot steel hinge allows reversible hinging and latching and ensures positive retention when door is opened.
- Cam latches close securely and allow hassle-free maintenance.
- Tool-less access to the electrical from room-side of fixture.
- Quick and easy installation.
- All parts painted after fabrication to facilitate installation, increase efficiency, and inhibit corrosion.
- This fixture is proudly made in the USA.

H.E. Williams, Inc.
strongly recommends
installing a trial fixture
prior to ordering full
project quantities.

ORDERING INFORMATION

Submital

EXAMPLE: SERIES **EFTR** - NOM. WIDTH **2** - NOM. LENGTH **4** - TOTAL WATTAGE/LAMP TYPE **32** - OPTIONS **OPTIONS** - BALLAST **EB2** - VOLTAGE **120**

SERIES	
EFTR	Efficient Troffer Retrofit Kit
NOMINAL WIDTH	
2	2'
NOMINAL LENGTH	
4	4'

TOTAL LAMPS	
2	
LAMP WATTAGE/TYPE	
32	4', 32-watt T8
OPTIONS	
For emergency ballasts and other options, consult factory.	

BALLAST TYPE	
EB2	2-lamp electronic ballast
For additional ballast combinations, consult factory.	
VOLTAGE	
120	120V
277	277V
UNV	120 - 277V
347	347V



FLUORESCENT LIGHTING

H.E. Williams, Inc. • Carthage, Missouri • www.hewilliams.com • 417-358-4065 • Fax: 417-358-6015

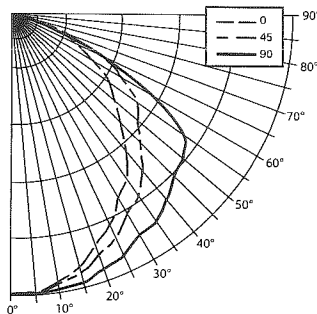
Retrofit Kits page 3

Williams Catalog #EFTR-24-232-EB2-120
Test Report #14758.0, Dated 06/22/09

Lamp Type: F32WT8/835/RS
Lamp Quantity: 2

CANDLEPOWER DISTRIBUTION

VERTICAL ANGLE	HORIZONTAL ANGLE			ZONAL LUMENS
	0	45	90	
0	1884.	1884.	1884.	
5	1878.	1883.	1892.	179.8
15	1761.	1802.	1866.	512.4
25	1560.	1651.	1782.	768.4
35	1339.	1481.	1687.	937.9
45	1023.	1210.	1535.	959.9
55	788.	1021.	1399.	946.2
65	489.	666.	679.	613.2
75	207.	204.	154.	200.9
85	54.	49.	32.	51.0
90	0.	0.	0.	



LUMEN SUMMARY

ZONE	LUMENS	%LAMP	% FIXTURE
0 - 30	1461.	24.8	28.3
0 - 40	2398.	40.7	46.4
0 - 60	4305.	73.0	83.3
0 - 90	5170.	87.6	100.0
0 - 180	5170.	87.6	100.0

ZONAL CAVITY COEFFICIENTS

EFFECTIVE FLOOR CAVITY REFL. = .20

CEILING	.80			.70			.50		
	WALL	ROR		.70	.50	.30	.50	.30	.10
0	1.04	1.04	1.04	1.02	1.02	1.02	.97	.97	.97
1	.97	.93	.90	.94	.91	.88	.87	.85	.83
2	.89	.82	.77	.87	.81	.76	.78	.74	.70
3	.82	.73	.67	.80	.72	.66	.70	.64	.60
4	.75	.65	.58	.73	.64	.57	.62	.56	.52
5	.68	.58	.50	.67	.57	.50	.55	.49	.44
6	.63	.52	.44	.61	.51	.44	.49	.43	.38
7	.58	.46	.39	.56	.45	.38	.44	.38	.33
8	.53	.41	.34	.52	.41	.34	.40	.33	.29
9	.49	.37	.30	.48	.36	.30	.35	.29	.25
10	.45	.34	.27	.44	.33	.26	.32	.26	.22

TOTAL LUMINAIRE

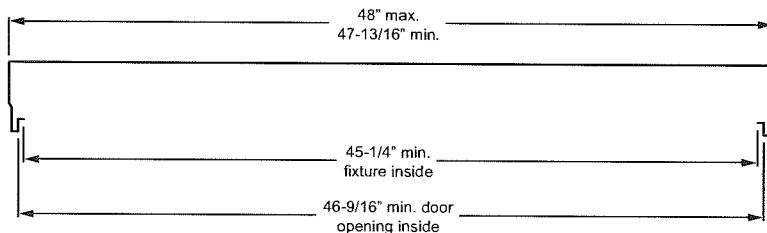
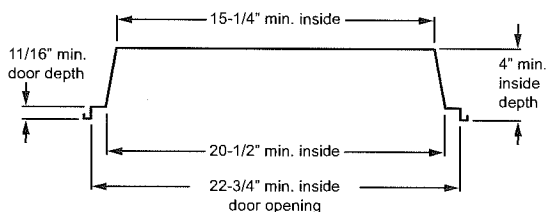
OPTICAL EFFICIENCY = 87.6%

SPACING CRITERIA: END=1.1 DIAG=1.2 ACROSS=1.4

ADDITIONAL INFORMATION

MINIMUM FIXTURE HOUSING DIMENSIONS

H.E. Williams, Inc. strongly recommends installing a trial fixture prior to ordering full project quantities.



H.E. WILLIAMS, INC.

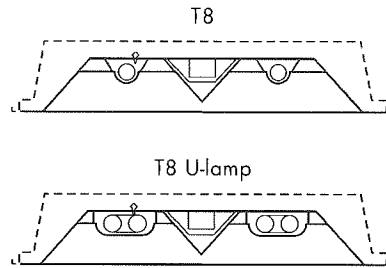
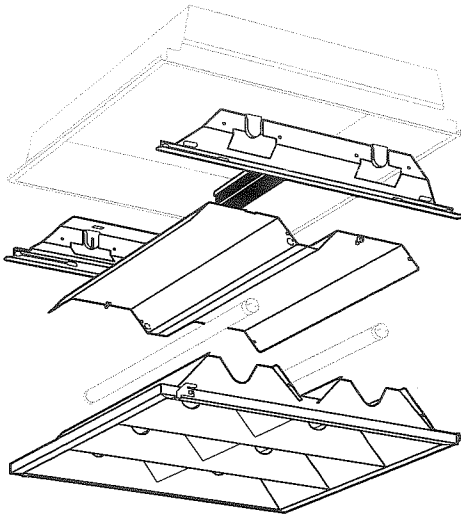
2' x 2' EFFICIENT TROFFER RETROFIT KIT

SERIES **EFTR**
2' x 2' T8

JOB _____

TYPE _____

VOLTAGE _____



Housing provided by others.
See back for dimensional requirements.
Lamps not included.

SPECIFICATIONS

- **HOUSING** – Provided by others, must fit within approved minimum dimensions (see back for details).
- **REFLECTORS/WIREWAY COVERS** – 25-gauge C.R.S.
- **DOOR FRAME & LOUVER** – Door Frame: 22-gauge C.R.S., flat with mitered corners. T-slot steel hinge allows reversible hinging and latching. Louver: 25-gauge C.R.S.
- **FINISH** – Reflectors/Wireway Covers: 92% minimum average reflective white powder coat with multi-stage iron/phosphate prepared metal. Door Frame & Louver: Highly-reflective textured matte white powder coat.
- **ELECTRICAL** – Electronic ballast standard, instant start T8, rated Class P.
- **LABELS** – UL/CUL listed as recessed fluorescent luminaire suitable for dry or damp locations. UL/CUL classified as luminaire conversion, retrofit kit.
- **MOUNTING** – Designed to retrofit existing troffers and parabolics in grid ceiling applications.

FEATURES

- Attractive and environmentally sensitive—provides the fresh appearance of a new architecturally designed fixture while recycling the existing fixture housing.
- Can improve optical efficiency as much as 20% when replacing dated troffers and parabolics, realizing substantial energy savings.
- Allows fixture upgrades without disturbing the ceiling.
- 2-5/8" cross baffles provide lamp cutoff and assist in glare reduction.
- Designed to fit into most 2' x 2' fixture housings with a minimum fixture depth of 4".
- T-slot steel hinge allows reversible hinging and latching and ensures positive retention when door is opened.
- Cam latches close securely and allow hassle-free maintenance.
- Tool-less access to the electrical from room-side of fixture.
- Quick and easy installation.
- All parts painted after fabrication to facilitate installation, increase efficiency, and inhibit corrosion.
- This fixture is proudly made in the USA.

H.E. Williams, Inc.
strongly recommends
installing a trial fixture
prior to ordering full
project quantities.

ORDERING INFORMATION

Submital

EXAMPLE: SERIES **EFTR** - NOM. WIDTH **2** - NOM. LENGTH **2** - TOTAL WATTAGE/LAMPS **17** - TYPE **OPTIONS** - BALLAST **EB2** - VOLTAGE **120**

SERIES

EFTR Efficient Troffer Retrofit Kit

NOMINAL WIDTH

2 2'

NOMINAL LENGTH

2 2'

TOTAL LAMPS

2

LAMP WATTAGE/TYPE

17 2', 17-watt T8

31UN 2', U-bent, 31-watt T8,
1-5/8" leg spacing

OPTIONS

For emergency ballasts and other options,
consult factory.

BALLAST TYPE

EB2 2-lamp electronic ballast
For additional ballast combinations, consult factory.

VOLTAGE

120 120V

277 277V

UNV 120 - 277V

347 347V



FLUORESCENT LIGHTING

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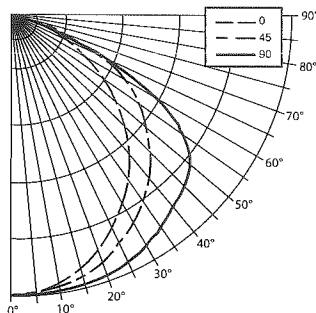
Retrofit Kits page 1

Williams Catalog #EFTR-22-217-EB2-120
Test Report #14756.0, Dated 06/19/09

Lamp Type: F17WT8/835/RS
Lamp Quantity: 2

CANDLEPOWER DISTRIBUTION

VERTICAL ANGLE	HORIZONTAL ANGLE			ZONAL LUMENS
	0	45	90	
0	839.	839.	839.	
5	834.	835.	838.	79.8
15	786.	809.	833.	229.4
25	706.	756.	815.	350.8
35	600.	681.	777.	429.3
45	475.	584.	729.	457.1
55	331.	464.	628.	422.9
65	193.	292.	310.	267.4
75	75.	79.	61.	77.5
85	13.	13.	8.	13.0
90	0.	0.	0.	



LUMEN SUMMARY

ZONE	LUMENS	%LAMP	% FIXTURE
0 - 30	660.	23.6	28.4
0 - 40	1089.	38.9	46.8
0 - 60	1969.	70.3	84.6
0 - 90	2327.	83.1	100.0
0 - 180	2327.	83.1	100.0

ZONAL CAVITY COEFFICIENTS

EFFECTIVE FLOOR CAVITY REFL. = .20

CEILING	.80			.70			.50		
WALL RCR	.70	.50	.30	.70	.50	.30	.50	.30	.10
0	.99	.99	.99	.97	.97	.97	.92	.92	.92
1	.92	.89	.85	.90	.87	.84	.83	.81	.79
2	.85	.79	.74	.83	.77	.73	.74	.71	.67
3	.78	.70	.64	.76	.69	.63	.66	.62	.58
4	.72	.62	.56	.70	.61	.55	.59	.54	.50
5	.65	.55	.48	.64	.54	.48	.52	.47	.42
6	.60	.49	.42	.58	.48	.42	.47	.41	.37
7	.55	.44	.37	.54	.43	.37	.42	.36	.32
8	.51	.39	.32	.49	.39	.32	.38	.32	.27
9	.46	.35	.28	.45	.35	.28	.34	.28	.24
10	.43	.32	.25	.42	.32	.25	.31	.25	.21

TOTAL LUMINAIRE

OPTICAL **EFFICIENCY = 83.1%**

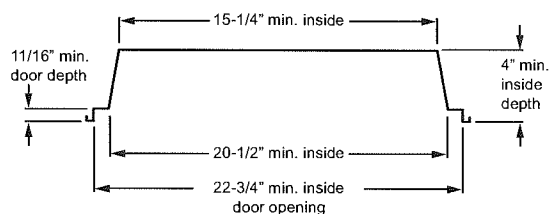
SPACING CRITERIA: END=1.2 DIAG=1.3 ACROSS=1.4

ADDITIONAL INFORMATION

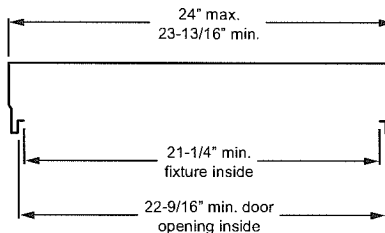
MINIMUM FIXTURE HOUSING DIMENSIONS

H.E. Williams, Inc. strongly recommends installing a trial fixture prior to ordering full project quantities.

WIDTH



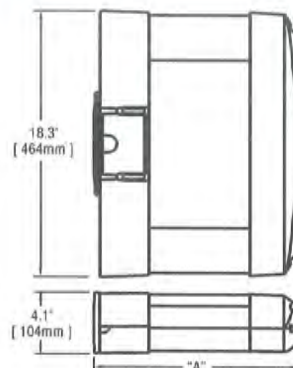
LENGTH



H.E. WILLIAMS, INC.



Notes:



# of LEDs	Dim. "A"
20	11.91"
40	11.91"
60	13.91"
80	15.91"
100	17.91"
120	19.91"

Product	Family	Optic	Mounting	# of LEDs (x 10)	LED Series	Voltage	Color Options	Factory-Installed Options
SEC	EDG	☐ 2M ¹ ☐ 2MB ²	WM ³	☐ 02 ☐ 04 ☐ 06 ☐ 08 ☐ 10 ☐ 12	C	☐ UL Universal 120-277V ☐ UH Universal 347-480V ☐ 12 120V ☐ 24 240V ☐ 27 277V ☐ 34 347V	☐ SV Silver ☐ BZ Bronze ☐ BK Black ☐ WH White ☐ PB Platinum Bronze	Please type additional options in manually on the lines provided above. ☐ 43K 4300K Color Temperature ⁴ ☐ 525 525mA Drive Current ^{5,6} ☐ F Fuse ^{7,8} ☐ P Photocell ^{9,10} ☐ TL2 Two-level (0/350 w/integrated sensor control) ¹¹

Footnotes

- IESNA Type II Medium distribution
- IESNA Type II Medium distribution with backlight control
- Wall mount
- Color temperature per fixture; minimum 70 CRI
- Driver operates at 525mA instead of the standard 350mA providing a higher lumen output and a shorter life
- Available on fixtures with 20-40 LEDs
- Not available when UH voltage is selected
- When code dictates fusing use time delay fuse
- Must specify voltage other than UL or UH
- Not available with multi-level options
- Refer to multi-level spec sheet for availability and additional information

LED PERFORMANCE SPECS

# of LEDs	Initial Delivered Lumens – Type II Medium @ 6000K	B	U	G	Initial Delivered Lumens – Type II Medium w/ Backlight Control @ 6000K	B	U	G	Initial Delivered Lumens – Type II Medium @ 4300K	B	U	G	Initial Delivered Lumens – Type II Medium w/ Backlight Control @ 4300K	B	U	G	System Watts 120–277V	Total Current @ 120V	Total Current @ 230V	Total Current @ 277V	System Watts 347–480V	Total Current @ 347V	Total Current @ 480V	L ₉₀ Hours* @ 25° C (77° F)
		Rating***				Rating***				Rating***				Rating***										
350mA (Standard) Fixture Operating at 25° C (77° F)																								
20	1,711 (02)	1	1	1	1,278 (02)	0	1	1	1,500 (02)	1	1	1	1,121 (02)	0	1	1	25	0.23	0.11	0.10	30	0.09	0.08	105,000
40	3,421 (04)	1	1	1	2,556 (04)	0	1	1	3,001 (04)	1	1	1	2,242 (04)	0	1	1	49	0.41	0.23	0.20	51	0.15	0.12	105,000
60	5,132 (06)	2	2	1	3,833 (06)	1	1	1	4,501 (06)	1	1	1	3,362 (06)	1	1	1	71	0.60	0.32	0.28	74	0.22	0.17	105,000
80	6,842 (08)	2	2	2	5,111 (08)	1	2	1	6,002 (08)	2	2	2	4,483 (08)	1	2	1	93	0.78	0.41	0.35	96	0.28	0.21	105,000
100	8,553 (10)	2	2	2	6,389 (10)	1	2	2	7,502 (10)	2	2	2	5,604 (10)	1	2	1	116	0.98	0.52	0.43	119	0.35	0.26	105,000
120	10,263 (12)	2	3	2	7,667 (12)	1	2	2	9,002 (12)	2	2	2	6,725 (12)	1	2	2	139	1.17	0.61	0.52	141	0.41	0.30	105,000
525mA Fixture Operating at 25° C (77° F)																								
20	2,224 (02)	1	1	1	1,661 (02)	0	1	1	1,950 (02)	1	1	1	1,457 (02)	0	1	1	37	0.31	0.18	0.17	43	0.13	0.15	61,000
40	4,448 (04)	1	1	1	3,322 (04)	1	1	1	3,901 (04)	1	1	1	2,914 (04)	0	1	1	69	0.58	0.31	0.27	75	0.22	0.19	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

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

NOTE: All data subject to change without notice.

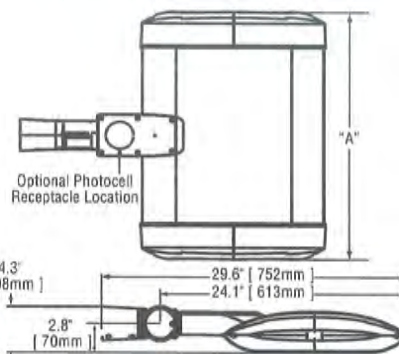
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Made in the U.S.A. of U.S. and imported parts.
Meets Buy American requirements within the ABRA.



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



# of LEDs	Dim. "A"
20	11.75"
40	11.75"
60	13.75"
80	15.75"
100	17.75"
120	19.75"
140	21.75"
160	23.75"
180	25.75"
200	27.75"
220	29.75"
240	31.75"

Notes:

Product	Family	Optic in Degrees	Mounting	# of LEDs (x 10)	LED Series	Voltage	Color Options	Factory-Installed Options
FLD	EDG	15°	AA²	☐ 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	Please type additional options in manually on the lines provided above. ☐ 43K 4300K Color Temperature³ ☐ 525 525mA Drive Current⁴,⁵ ☐ DIM 0–10V Dimming⁶,⁷ ☐ F Fuse⁸ ☐ HL Hi/Low (175/350/525, dual circuit input)⁹,¹¹ ☐ P Photocell¹²-¹⁵ ☐ R NEMA Photocell Receptacle¹⁴-¹⁸ ☐ TL Two-Level (175/525 w/ integrated sensor control)⁹,¹¹ ☐ TL2 Two-Level (0/350 w/ integrated sensor control)¹¹ ☐ TL3 Two-Level (0/525 w/ integrated sensor control)⁹,¹¹

Footnotes

- Distribution similar to spot (15°)
- Adjustable arm for mounting to 2" tenon
- Color temperature per fixture; minimum 70 CRI
- Driver operates at 525mA instead of the standard 350mA providing a higher lumen output and a shorter life
- Available on fixtures with 20–120 LEDs
- Control by others
- Please consult factory for availability
- Not available with TL, TL2, or TL3 options when UH voltage is selected
- Available on 120–277V fixtures with 20–120 LEDs and 347–480V fixtures with 40–120 LEDs
- Sensor not included
- Refer to [multi-level spec sheet](#) for more information
- Not available with HL option when UH voltage is selected
- Must specify voltage other than UL or UH
- Not available with TL2, or TL3 options
- Not available with TL option when UH voltage is selected
- 100 LED maximum when used with TL option
- Not available with HL option
- Intended for horizontal mounting

LED PERFORMANCE SPECS

# of LEDs	Initial Delivered Lumens – 15° Flood Optic @ 6000K	Initial Delivered Lumens – 15° Flood Optic @ 4300K	System Watts 120–277V	Total Current @ 120V	Total Current @ 230V	Total Current @ 277V	System Watts 347–480V¹	Total Current @ 347V	Total Current @ 480V	L ₇₀ Hours² @ 25° C (77° F)
350mA (Standard) Fixture Operating at 25° C (77° F)										
20	1,958 (02)	1,717 (02)	25	0.23	0.11	0.10	30	0.10	0.15	105,000
40	3,916 (04)	3,435 (04)	49	0.41	0.23	0.20	55	0.16	0.16	105,000
60	5,874 (06)	5,152 (06)	71	0.60	0.32	0.28	77	0.22	0.20	105,000
80	7,832 (08)	6,869 (08)	93	0.78	0.41	0.35	99	0.29	0.23	105,000
100	9,789 (10)	8,587 (10)	116	0.98	0.52	0.43	123	0.35	0.28	105,000
120	11,747 (12)	10,304 (12)	139	1.17	0.61	0.52	146	0.42	0.33	105,000
140	13,705 (14)	12,021 (14)	164	1.39	0.74	0.63	172	0.50	0.37	105,000
160	15,663 (16)	13,738 (16)	186	1.58	0.83	0.71	195	0.56	0.41	105,000
180	17,621 (18)	15,456 (18)	211	1.77	0.93	0.79	220	0.63	0.47	105,000
200	19,579 (20)	17,173 (20)	233	1.97	1.03	0.87	243	0.70	0.51	105,000
220	21,537 (22)	18,890 (22)	256	2.16	1.13	0.95	267	0.77	0.56	105,000
240	23,495 (24)	20,608 (24)	279	2.35	1.23	1.03	291	0.84	0.61	105,000
525mA Fixture Operating at 25° C (77° F)										
20	2,545 (02)	2,232 (02)	37	0.31	0.18	0.17	43	0.13	0.15	61,000
40	5,091 (04)	4,465 (04)	69	0.58	0.31	0.27	75	0.22	0.19	61,000
60	7,636 (06)	6,697 (06)	110	0.92	0.49	0.41	116	0.33	0.27	61,000
80	10,181 (08)	8,930 (08)	138	1.16	0.62	0.54	145	0.42	0.32	61,000
100	12,726 (10)	11,162 (10)	177	1.49	0.79	0.68	186	0.53	0.40	61,000
120	15,272 (12)	13,395 (12)	217	1.82	0.96	0.81	226	0.65	0.48	61,000

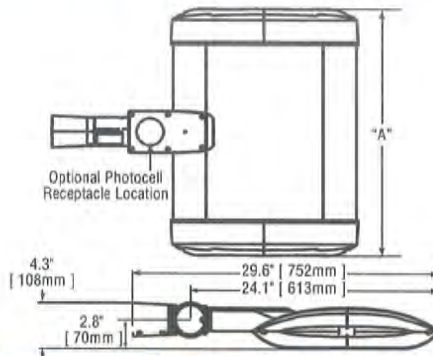
1. Utilizes magnetic step-down transformer

2. For recommended lumen depreciation data see [TD-13](#)3. For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit www.iesna.org/PDF/Erratas/TM-15-07BugRatingsAddendum.pdf

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



Notes:



# 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"

Product	Family	Optic	Mounting	# of LEDs (x 10)	LED Series	Voltage	Color Options	Factory-Installed Options
ARE	EDG	3M ¹ 3MB ²	AA ³	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	Please type additional options in manually on the lines provided above. 43K 4300K Color Temperature ⁴ 525 525mA Drive Current ^{5,6} DIM5 0-10V Dimming (525mA maximum) ^{7,8} F Fuse ^{9,10} HL Hi/Low (175/525/525, dual circuit input) ¹¹ P Photocell ^{12,13} R NEMA Photocell Receptacle ^{13,14} TL Two-Level (175/525 w/ integrated sensor control) ¹¹ TL2 Two-Level (0/350 w/ integrated sensor control) ¹¹ TL3 Two-Level (0/525 w/ integrated sensor control) ¹¹

Footnotes

- IESNA Type III Medium distribution
- IESNA Type III Medium distribution with backlight control
- Adjustable arm for mounting to 2" (2-3/8" [60mm] O.D.) tenon
- Color temperature per fixture; minimum 70 CRI
- Driver operates at 525mA instead of the standard 350mA providing a higher lumen output and a shorter life
- Available on fixtures with 20-120 LEDs
- Control by others
- Refer to [dimming spec sheet](#) for availability and additional information
- Not available when UH voltage is selected
- When code dictates fusing use time delay fuse
- Refer to [multi-level spec sheet](#) for availability and additional information
- Must specify voltage other than UL or UH
- This option not available with all multi-level options. Refer to [multi-level spec sheet](#) for more information
- Intended for horizontal mounting

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 120-277V	Total Current @ 120V	Total Current @ 230V	Total Current @ 277V	System Watts 347-480V	Total Current @ 347V	Total Current @ 480V	L ₇₀ Hours** @ 25° C (77° F)	
		Rating***				Rating***				Rating***				Rating***											
350mA (Standard) Fixture Operating at 25° C (77° F)																									
20	1,649 (02)	1	1	1	1,237 (02)	0	1	1	1,446 (02)	1	1	1	1,085 (02)	0	1	1	25	0.23	0.11	0.10	30	0.09	0.08	105,000	
40	3,298 (04)	1	1	1	2,473 (04)	0	1	1	2,892 (04)	1	1	1	2,169 (04)	0	1	1	49	0.41	0.23	0.20	51	0.15	0.12	105,000	
60	4,946 (06)	2	2	2	3,710 (06)	0	1	1	4,338 (06)	2	2	2	3,254 (06)	0	1	1	71	0.60	0.32	0.28	74	0.22	0.17	105,000	
80	6,595 (08)	2	2	2	4,946 (08)	1	2	2	5,785 (08)	2	2	2	4,338 (08)	1	2	1	93	0.78	0.41	0.35	96	0.28	0.21	105,000	
100	8,244 (10)	3	3	3	6,183 (10)	1	3	2	7,231 (10)	2	2	2	5,423 (10)	1	2	2	116	0.98	0.52	0.43	119	0.35	0.26	105,000	
120	9,893 (12)	3	3	3	7,419 (12)	1	3	2	8,677 (12)	3	3	3	6,508 (12)	1	3	2	139	1.17	0.61	0.52	141	0.41	0.30	105,000	
140	11,541 (14)	3	3	3	8,656 (14)	1	3	2	10,123 (14)	3	3	3	7,592 (14)	1	3	2	164	1.39	0.74	0.63	170	0.49	0.35	105,000	
160	13,190 (16)	3	3	3	9,893 (16)	1	3	2	11,569 (16)	3	3	3	8,677 (16)	1	3	2	186	1.58	0.83	0.71	192	0.55	0.40	105,000	
180	14,839 (18)	3	3	3	11,129 (18)	1	3	2	13,015 (18)	3	3	3	9,762 (18)	1	3	2	211	1.77	0.93	0.79	215	0.62	0.45	105,000	
200	16,488 (20)	3	3	3	12,366 (20)	2	3	2	14,462 (20)	3	3	3	10,846 (20)	1	3	2	233	1.97	1.03	0.87	237	0.68	0.49	105,000	
220	18,136 (22)	3	3	3	13,602 (22)	2	3	2	15,908 (22)	3	3	3	11,931 (22)	1	3	2	256	2.16	1.13	0.95	259	0.75	0.54	105,000	
240	19,785 (24)	3	3	3	14,839 (24)	2	3	3	17,354 (24)	3	3	3	13,015 (24)	2	3	2	279	2.35	1.23	1.03	282	0.81	0.59	105,000	
525mA Fixture Operating at 25° C (77° F)																									
20	2,143 (02)	1	1	1	1,608 (02)	0	1	1	1,880 (02)	1	1	1	1,410 (02)	0	1	1	37	0.31	0.18	0.17	43	0.13	0.15	61,000	
40	4,287 (04)	2	2	2	3,215 (04)	0	1	1	3,760 (04)	1	1	1	2,820 (04)	0	1	1	69	0.58	0.31	0.27	75	0.22	0.19	61,000	
60	6,430 (06)	2	2	2	4,823 (06)	1	2	2	5,640 (06)	2	2	2	4,230 (06)	1	2	1	110	0.92	0.49	0.41	116	0.33	0.27	61,000	
80	8,574 (08)	3	3	3	6,430 (08)	1	3	2	7,520 (08)	2	2	2	5,640 (08)	1	2	2	138	1.16	0.62	0.54	145	0.42	0.32	61,000	
100	10,717 (10)	3	3	3	8,038 (10)	1	3	2	9,400 (10)	3	3	3	7,050 (10)	1	3	2	177	1.49	0.79	0.68	186	0.53	0.40	61,000	
120	12,860 (12)	3	3	3	9,645 (12)	1	3	2	11,280 (12)	3	3	3	8,460 (12)	1	3	2	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

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

NOTE: All data subject to change without notice.

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ECM 2: Lighting Controls

ECM Overview

Ameresco proposes to install new lighting controls in the Town of Salisbury buildings to ensure that lighting does not operate unnecessarily. Energy waste occurs when a fixture is energized but not used and when illuminance exceeds what is necessary for task performance. Ameresco noted some occupants are not careful about turning off lights when they leave the room, making automated controls advantageous.

Ameresco has proposed occupancy sensors to be installed in many classrooms, offices, and bathrooms, plus a number of facility-specific control strategies.



Figure 2.1: Fixture mounted occupancy controls combined with new linear fluorescent fixtures will provide energy savings in this gym.

ECM Detail

Existing System

The majority of existing lighting controls are standard toggle style switches and can benefit from automated lighting controls. The exterior lighting is controlled by photocells or time clocks.

Proposed System

- *General Information about the Proposed System*

Project wide, Ameresco will install almost **105** local lighting controls employing a variety of strategies, each of which was customized to the unique space. We selected appropriate areas that contain several controllable fixtures, which have intermittent occupancy, and where a safety hazard will not be created if the sensor inadvertently turns the lights off. Applicable areas include classrooms, offices, conference rooms, and shops.

Bathrooms or other areas without direct line-of-sight to the sensor, will receive dual-technology sensors that “listen” for activity in addition to “looking” for motion.

The fluorescent high-bays in gyms will have motion sensors, allowing each one to operate independently for maximum savings and flexibility.

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

Below is a brief description of some of the work to be accomplished. Please refer to the "Lighting System Analysis" in Appendix I, as this is a complete list of work to be performed.

Fire Department: Ceiling mounted occupancy controls will be installed in 6 locations. Wall mounted occupancy controls will be installed in 3 locations. Ceiling mounted dual technology occupancy controls will be installed in 1 bathroom.

Department of Public Works: Wall mounted occupancy controls will be installed in 5 locations. Ceiling mounted occupancy controls will be installed in 4 locations. Ceiling mounted dual technology occupancy controls will be installed in 1 bathroom. Eight new exterior fixtures will have photocells to turn the lights off during the day.

Town Hall: Wall mounted occupancy controls will be installed in 19 locations. Ceiling mounted occupancy controls will be installed in 6 locations. Wireless occupancy controls will be installed in 1 location.

Sewer Treatment Plant: Controls that dim lights in relation to how much natural light is available and occupancy sensors will be installed in 14 locations. Occupancy controls will be incorporated in to each fixture in the 3 locations. Wall mounted occupancy controls will be installed in 2 locations. Ceiling mounted dual technology occupancy controls will be installed in 1 bathroom. Thirty-one new exterior fixtures will have photocells to turn the lights off during the day.

Integration of Proposed Equipment with Existing Systems

New equipment will be connected to the existing wiring and switchgear, in accordance with safety guidelines, regulations, and codes governing the facility and in accordance with all local, state, and federal agencies having jurisdiction. The lighting controls, and all components, will be fully integrated into the existing electrical system. Automatic controls may be unacceptable to some occupants, so special consideration will be given to commissioning these systems to meet both, energy saving goals and occupant satisfaction. Ameresco will provide written information for each building enabling staff to understand and operate the lighting system in the most visually effective and energy conserving manner.

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 the work scope outlined in the contract documents. Existing junction boxes, existing poles, existing mounting surfaces and existing structures are assumed to be in acceptable condition to allow the installation of a new fixture, or retrofit of an existing fixture (replacement of lamps, ballast, and reflector etc.).

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. In addition, Ameresco will compile product specification sheets for all specified equipment. 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

There will be no change in the facility structure. The low profile lighting controls will be mounted on the existing wall switches, walls or ceilings. The proposed lighting controls will have no adverse impact on occupants, working environment, or critical equipment such as computer systems and associated environmental controls.

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.

Environmental Impact

There are no potential adverse environmental impacts associated with these lighting controls.

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Appendix for ECM 2: Lighting Controls

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	2	
Measure Name:	Lighting Controls	
Measure Location:		
Engineers:		

Site Name:							
Item	Units	Fire Savings	DPW Savings	TownHall Savings	Sewer Savings	Summary	
Electricity							
Energy On-Peak	kWh	1,469	2,552	4,009	3,912	11,941	
Energy Off-Peak	kWh	0	0	0	0	0	
Energy Total	kWh	1,469	2,552	4,009	3,912	11,941	
Demand On-Peak, Monthly	kW	0.0	0.0	0.0	0.0	0.0	
Demand On-Peak, Annual	kW	0.0	0.0	0.0	0.0	0.0	
Demand Off-Peak, Monthly	kW	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	
Fossil Fuel							
Natural Gas (NG)	Therms	0	-28	-40	0	-68	
Liquid Propane Gas (LPG)	Gallons	0	0	0	0	0	
Steam	Mlbs	0	0	0	0	0	
Fuel Oil, #2	Gallons	-11	0	0	0	-11	
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							
Water Savings	kGallons					0	
Sewer							
Sewer Savings	kGallons					0	

Town of Salisbury, Massachusetts
Interactive Lighting Savings Calculation



A	Lighting Savings		Heating Penalty				Cooling Benefit			
	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
Fire Department	0.0	1,447	50.0%	6.0	81.0%	(1.5)	26.7%	4.0	2.93	0.1
Department of Public Works	0.0	2,502	50.0%	6.0	76.0%	(2.8)	35.0%	4.0	2.93	0.2
Town Hall	0.0	3,860	50.0%	6.0	82.0%	(4.0)	95.0%	4.0	4.10	0.5
Sewage Treatment Plant	0.0	5,040	50.0%	6.0	100.0%	(4.3)	60.0%	4.0	3.81	0.5
Totals	0.0	12,848				(12.6)				1.2

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	Floor	Pre Fixture Description	Pre Qty	Post Fixture Description	Post Qty	Annual Hours	Post Watt	Control Style	Control Qty	Control kWh Saved
14	Town Hall	Office Open Clerk	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	3,458	83	corner mt 1 circuit	1	172
15	Town Hall	Office Open Clerk	1	4L4' T8/EL	1	4L4' T8 28W/EL L O	1	3,458	83	switch 1 circuit	1	86
16	Town Hall	Lounge Staff	1	4L4' T8/EL	1	4L4' T8 28W/EL L O	1	3,458	83	switch 1 circuit	1	86
17	Town Hall	Office Open Tax Collector	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	3,458	83	switch 1 circuit	1	172
18	Town Hall	Office Open Tax Collector	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	3,458	83	corner mt 1 circuit	1	172
19	Town Hall	Office Open Assessor	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	3,458	83	wireless 1 cell & 2 wall	1	172
20	Town Hall	Office Open Assessor	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	3,458	83	refer to line above	1	172
21	Town Hall	Office Open Assessor	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	3,458	40	dropile 1 circuit	1	83
22	Town Hall	Office Open Assessor	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	3,458	83	refer to line above	1	86
23	Town Hall	Office Open Health	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	3,458	83	switch 1 circuit	1	172
24	Town Hall	Office Open Health	1	4L4' T8/EL	1	4L4' T8 28W/EL L O	1	3,458	83	switch 1 circuit	1	86
26	Town Hall	Bath Men	1	2L2' T8/EL	1	2L2' T8 15W/EL L O	1	3,458	27	switch 2 circuit	1	28
27	Town Hall	Bath Men	1	2L2' T8/EL	1	2L2' T8 15W/EL L O	1	3,458	40	refer to line above	1	41
28	Town Hall	Bath Women	1	2L2' T8/EL	1	2L2' T8 15W/EL L O	1	3,458	27	switch 2 circuit	1	28
29	Town Hall	Bath Women	1	2L2' T8/EL	1	2L2' T8 15W/EL L O	1	3,458	40	refer to line above	1	41
30	Town Hall	Office Open Buildings	1	4L4' T8/EL	4	2L4' T8 28W/EL L O	4	3,458	64	dropile 2 circuit	1	266
31	Town Hall	Office Open Planning	1	2L4' T12 U EE/EE/MAG	14	2L4' T8 28W/EL L O	14	3,458	40	dropile 2 circuit	2	561
32	Town Hall	Storage Copiers	1	4L4' T12 EE/EE/MAG	2	2L4' T8 28W/EL L O	2	2,730	64	switch 1 circuit	1	105
42	Town Hall	Office 209	2	3L4' T8/EL	2	3L4' T8 28W/EL L O	2	2,730	64	switch 2 circuit	1	105
43	Town Hall	Bath Men	2	2L4' T8/EL	1	2L4' T8 28W/EL L O	1	3,458	42	switch 1 circuit	1	44
44	Town Hall	Bath Women	2	2L4' T8/EL	1	2L4' T8 28W/EL L O	1	3,458	42	switch 1 circuit	1	44
45	Town Hall	Office 202	2	3L4' T8/EL	3	3L4' T8 28W/EL L O	3	2,730	64	switch 2 circuit	1	157
46	Town Hall	Conference 208	2	3L4' T8/EL	2	3L4' T8 28W/EL L O	2	2,730	64	switch 2 circuit	1	105
47	Town Hall	Conference 208	2	100W INCANDESCENT	6	23W COMPACT SI DIM RFL	6	2,730	23	refer to line above	1	113
48	Town Hall	Conference 203	2	3L4' T8/EL	2	3L4' T8 28W/EL L O	2	2,730	64	switch 2 circuit	1	105
49	Town Hall	Conference 203	2	100W INCANDESCENT	6	23W COMPACT SI DIM RFL	6	2,730	23	refer to line above	1	113
50	Town Hall	Office 207	2	3L4' T8/EL	2	3L4' T8 28W/EL L O	2	2,730	64	switch 2 circuit	1	105
51	Town Hall	Office 204	2	3L4' T8/EL	2	3L4' T8 28W/EL L O	2	2,730	64	switch 2 circuit	1	105
52	Town Hall	Office 204	2	3L4' T8/EL	2	3L4' T8 28W/EL L O	2	2,730	64	switch 2 circuit	1	105
53	Town Hall	Office 206	2	3L4' T8/EL	2	3L4' T8 28W/EL L O	2	2,730	64	switch 2 circuit	1	105
54	Town Hall	Office 205	2	3L4' T8/EL	2	3L4' T8 28W/EL L O	2	2,730	64	switch 2 circuit	1	105
238	Fire Department	Office Dispatch	1	2L4' T8 28W/EL L O	4	NO RETRO	4	1,755	42	dropile 1 circuit	1	88
239	Fire Department	Office Officers	1	2L4' T8 28W/EL L O	1	NO RETRO	1	1,755	42	switch 1 circuit	1	22
242	Fire Department	Bath Men	1	2L4' T8 28W/EL L O	1	NO RETRO	1	2,223	42	dropile dualtech 1 circuit	1	28
243	Fire Department	Bedroom	1	2x 13W COMPACT HARDWIRED	2	NO RETRO	2	2,340	30	switch 1 circuit	1	42
244	Fire Department	Kitchen	1	2L4' T8 28W/EL L O	2	NO RETRO	2	8,760	42	switch 1 circuit	1	221
245	Fire Department	Lounge Dayroom	1	2L4' T8 28W/EL L O	2	NO RETRO	2	8,760	42	dropile 1 circuit	1	221
246	Fire Department	Mechanical Parts	1	2L4' T8 28W/EL L O	2	NO RETRO	2	1,125	42	corner mt 1 circuit	1	28
249	Fire Department	Conference Eoc	1	3L4' T8 28W/EL L O	12	NO RETRO	12	1,755	63	dropile 2 circuit	1	398
250	Fire Department	Office Eoc	1	3L4' T8 28W/EL L O	6	NO RETRO	6	1,755	63	dropile 1 circuit	1	199
251	Fire Department	Office Eoc	1	3L4' T8 28W/EL L O	6	NO RETRO	6	1,755	63	dropile 1 circuit	1	199
254	Department of Public Works	Storage Parts	1	2L4' T8/EL-8"	1	2L4' T8 28W/EL L O-8"	1	1,950	42	switch 1 circuit	1	25
255	Department of Public Works	Storage Signs	1	26W COMPACT SCREW IN	2	NO RETRO	2	1,950	26	switch 1 circuit	1	30
256	Department of Public Works	Storage Oil	1	26W COMPACT SCREW IN	1	NO RETRO	1	1,950	26	switch 1 circuit	1	15
257	Department of Public Works	Storage Electric	1	1L4' T8/EL	2	1L4' T8 28W/EL L O	2	1,950	22	switch 1 circuit	1	26
259	Department of Public Works	Bath Men	1	2L4' T8/EL	1	2L4' T8 28W/EL L O	1	2,964	42	dropile dualtech 1 circuit	1	37
260	Department of Public Works	Bath Men	1	2L4' T12 U EE/EE/MAG	1	2L2' T8 15W/EL L O	1	2,964	40	refer to line above	1	36
262	Department of Public Works	Hall To Offices	1	2L4' T8/EL	1	2L4' T8 28W/EL L O	1	3,120	42	switch 1 circuit	1	39
264	Department of Public Works	Office Foreman's	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	1,950	83	dropile 2 circuit	1	97
266	Department of Public Works	Office Director	1	4L4' T8/EL	4	4L4' T8 28W/EL L O	4	1,950	83	dropile 2 circuit	1	194
267	Department of Public Works	Office Dispatch	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	1,950	83	dropile 2 circuit	1	97
268	Department of Public Works	Office Reception	1	4L4' T8/EL	2	4L4' T8 28W/EL L O	2	1,950	83	dropile 2 circuit	1	97
269	Department of Public Works	Parking Lot	Ext	400W HI PRESSURE SODIUM	8	172 WATT LED/NEW	8	4,380	172	on/off "button" photocell in each fixture	8	1,808

Line	Building Name	Location	Floor	Pre Fixture Description	Pre Qty	Post Fixture Description	Post Qty	Annual Hours	Post Watt	Control Style	Control Qty	Control kWh Saved
272	Sewer Treatment Plant	Lounge Staff	1	4L4' T12 EE/EEMAG	4	2L4' T8 28w/ELEE HIRFL	4	2,223	64	ballasts dimming & cell sensor 2 circuit	4	171
273	Sewer Treatment Plant	Office Staff	1	4L4' T12 EE/EEMAG	2	2L4' T8 28w/ELEE HIRFL	2	1,755	64	switch 1 circuit	1	67
274	Sewer Treatment Plant	Office Open Staff	1	4L4' T12 EE/EEMAG	10	2L4' T8 28w/ELEE HIRFL	10	2,223	64	ballasts dimming & cell sensor 2 circuit	10	427
276	Sewer Treatment Plant	Bath Men	1	4L4' T12 EE/EEMAG	4	2L4' T8 28w/ELEE HIRFL	4	2,223	64	dropile dualtech 1 circuit	1	171
277	Sewer Treatment Plant	Bath Women	1	4L4' T12 EE/EEMAG	1	2L4' T8 28w/ELEE HIRFL	1	2,223	64	switch 1 circuit	1	43
279	Sewer Treatment Plant	Shop Tools	1	4L4' T8/EL-8'	3	4L4' T8 28w/ELEE LO-8'	3	2,223	83	occ. sensor on hillyard fixture	3	166
285	Sewer Treatment Plant	Bldg Mt Office	Ext	250W HI PRESSURE SODIUM	17	102 WATT LED/NEW	17	4,380	102	on/off "button" photocell in each fixture	17	2,278
286	Sewer Treatment Plant	Walkway Office	Ext	250W HI PRESSURE SODIUM	2	102 WATT LED/NEW	2	4,380	102	on/off "button" photocell in each fixture	2	268
288	Sewer Treatment Plant	Driveway Lagoons	Ext	400W HI PRESSURE SODIUM	12	172 WATT LED/NEW	12	2,340	172	on/off "button" photocell in each fixture	12	1,449
Totals											105	12,848

Appendix for ECM 2: Lighting Controls

II. Manufacturer Specification Sheets

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WALL SWITCH DECORATOR SENSOR LINE VOLTAGE • PASSIVE INFRARED (PIR)

SPECIFICATIONS

FEATURES

- PIR Occupancy Detection
- Self-Contained Relay - No Power Pack Needed
- Interchangeable Hot & Load Wires - Impossible to Wire Backwards
- No Neutral Connection Required
- Small Motion Detection to 20 ft (6.10 m)
- Self-Grounding Mounting Strap
- No Minimum Load
- Push-Button Programmable w/o Removing the Switch Plate
- Adjustable Time Delay
- 3-way & 4-way Switching
- Green LED Indicator

PHYSICAL SPECS

- SIZE 4.2"H x 1.8"W x 1.5"D (10.67cm x 4.57cm x 3.81cm)
- WEIGHT 5 oz
- MOUNTING Single Gang Switch Box
- MOUNTING HEIGHT 30-48 in (76.2-121.9 cm)
- COLORS White, Ivory, Gray, Almond, Black

ELECTRICAL SPECS

- MAXIMUM LOAD 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC
- MINIMUM LOAD None
- WATTAGE LOAD 1/4 HP
- FREQUENCY 50/60 Hz (timers are 1.2x for 50 Hz)

ENVIRONMENTAL SPECS

- OPERATING TEMP 14° to 160° F (-10° to 71° C)
- STORAGE TEMP -14° to 160° F (-26° to 71° C)
- RELATIVE HUMIDITY 20 to 90% non-condensing

OTHER

- UL and CUL Listed
- Title 24 Compliant
- 5 Year Warranty
- Made in the U.S.A.

The WSD is a stylish, easy to install, and simple to use Wall Switch Decorator style Passive Infrared (PIR) sensor. It is ideal for private offices, copy rooms, closets, or any small enclosed space without obstructions. A user programmable time delay ensures that once the room is vacated the sensor will time out and turn off the lights. Additionally, the WSD sensor has several On Modes and Switch Modes that can be programmed using the front push-button. For rooms with obstructions, the Dual Technology WSD PDT Series sensor is recommended.

SENSOR OPERATION & MODES

The sensor detects changes in the infrared energy given off by occupants as they move within the field-of-view. When occupancy is detected, a self-contained relay switches the connected lighting load on. The sensor is line powered and switches line voltage (see specifications). A timer, factory set at 10 minutes, keeps the lights on during brief periods of inactivity. This timer is push-button programmable from 30 seconds to 20 minutes, and resets every time occupancy is re-detected. This state-of-the-art design requires no field calibration or sensitivity adjustments.

ON MODES

- AUTOMATIC ON (default)** - Lights come on when occupancy is detected.
- MANUAL ON** - Requires the occupant manually turn on lights via the push-button.
- REDUCED TURN ON** - Sensor is initially set to only detect large motions, effectively ignoring PIR signals reflected off of surfaces, while still sensing occupants when they enter the room. Once lights are on, the sensor returns to maximum sensitivity.

SWITCH MODES

- PREDICTIVE OFF MODE (default)** - This mode allows occupants to turn lights off via the switch without losing the convenience of having the lights automatically turn on when they re-enter the room. Pressing the switch turns the lights off and temporarily disables the occupancy detection in the sensor. After a short exit time delay, the occupancy detection reactivates and monitors for an additional grace period. If no occupancy is detected, the zone will remain in Automatic On operation. If occupancy is detected, the zone will go to a Permanent Off mode, requiring the switch to be pressed again in order to turn the lights on and restore the sensor to Automatic On operation.
- PERMANENT OFF** - Pressing the switch turns the lights and the sensor off. Lights will not come on until switch is pressed again.
- SWITCH DISABLE** - Prevents user from manually turning off the lights via the push-button. Button can still be utilized for programming.

OPTIONS

VANDAL-RESISTANT LENS (V)

- Ideal for high abuse or public areas, where occupants simply come and go
- Decreases detection range by 50%

INHIBIT PHOTOCELL (P)

- Auto set-point calibration
- Photocell prevents lights from turning on if adequate daylight is available, but does not turn lights off

347 VAC (347)

- Allows sensor to be powered from and switch 347 VAC
- Wall Plate Provided

COLOR

- White, Ivory, Gray, Almond, Black
- Wall Plate Provided

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant
- Operates down to -40° F/C

ORDERING INFO

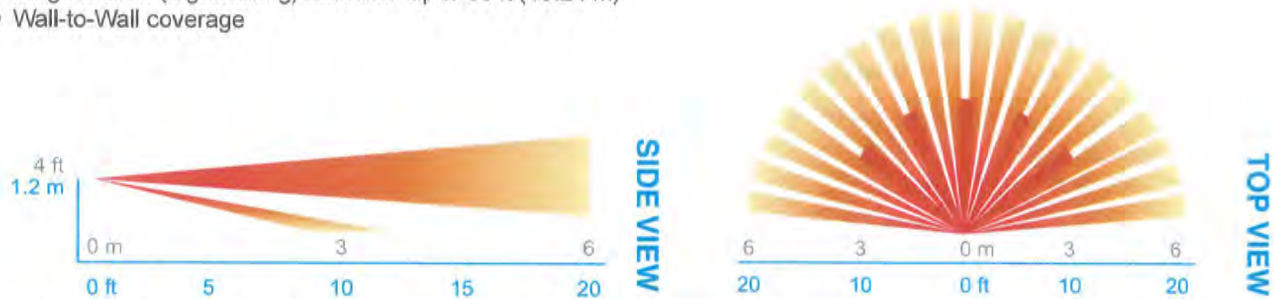
WSD [LENS] [PHOTOCELL] [VOLTAGE] [COLOR] [TEMP/HUMIDITY]

LENS	PHOTOCELL	VOLTAGE	COLOR	TEMP/HUMIDITY
Blank = None	Blank = None	Blank = 120/277 VAC	WH = White	Blank = Standard
V = Vandal Resistant	P = Photocell	347 = 347 VAC	IV = Ivory	LT = Low Temp
			GY = Gray	
			AL = Almond	
			BK = Black	

COVERAGE PATTERN

WSD WALL SWITCH DECORATOR LENS

- Small motion (e.g. hand movements) detection up to 20 ft (6.10 m)
- Large motion (e.g. walking) detection up to 50 ft (15.24 m)
- Wall-to-Wall coverage



WIRING (DO NOT WIRE HOT)

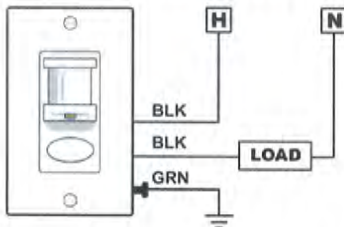
STANDARD WIRING

- BLACK* - Line Input
 BLACK* - Load Output
 GREEN SCREW - Ground (required connection)
- *BLACK wires can be reversed

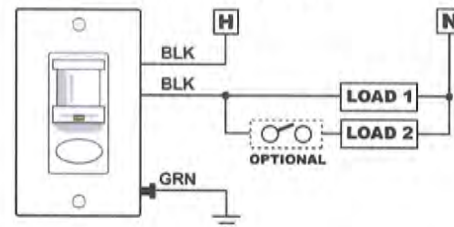
347 VAC OPTION (347)

Black wires are replaced w/ Red wires

STANDARD CONFIGURATION



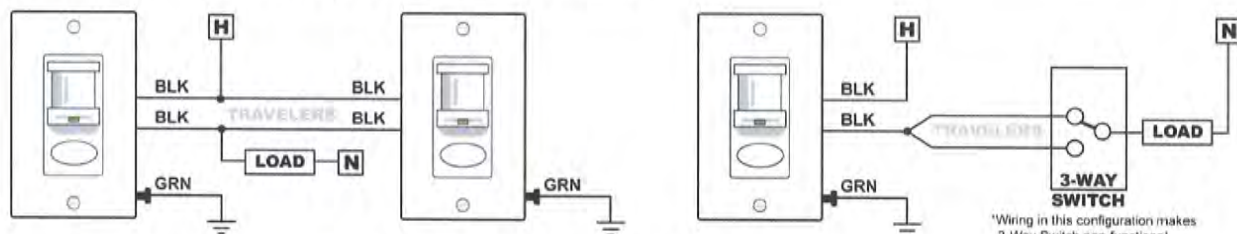
BI-LEVEL CONFIGURATION



Note: Connection to Ground required for sensor to function

3-WAY CONFIGURATIONS

Travelers are used to wire sensors (or sensor and 3-way switch) i



Note: Connection to Ground required for sensor to function

WARNING

Fire Hazard Caution: Maximum Lamps 1500 Watts, Type 347 VAC.

Attention: Risque d'incendie : Puissance Maximales Des Lampes 1500 Watts, Type 347 VAC.

Warning: The units are intended to be installed by a qualified person with properly rated branch circuit protectors as per applicable local and national regulations (CEC, NEC).

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WARRANTY: Sensor Switch, Inc. warrants these products to be free of defects in manufacture and workmanship for a period of 60 months. Sensor Switch, Inc., upon prompt notice of such defect, will, at its option, provide a Returned Material Authorization number and repair or replace returned product.

LIMITATIONS AND EXCLUSIONS: This Warranty is in full lieu of all other representation and expressed and implied warranties (including the implied warranties of merchantability and fitness for use) and under no circumstances shall Sensor Switch, Inc. be liable for any incidental or consequential property damages or losses.

T059-004-P

WALL SWITCH DECORATOR SENSOR LINE VOLTAGE • 2-POLE • PASSIVE INFRARED (PIR)

SPECIFICATIONS

FEATURES

- PIR Occupancy Detection
- Two Self-Contained Relays -
- No Power Packs Needed
- 1st Pole Auto-On, 2nd Pole Manual-On
- Interchangeable Hot & Load Wires -
- Impossible to Wire Backwards
- No Neutral Connection Required
- Small Motion Detection to 20 ft (6.10 m)
- Self-Grounding Mounting Strap
- No Minimum Load
- Adjustable Time Delay / Pole
- Replaces Two Switches at Once
- Push-Button Programmable w/o
- Removing the Switch Plate
- Green LED Indicator

PHYSICAL SPECS

- 2E (not including mounting strap)
- 2.74"H x 1.68"W x 1.63"D
- (6.96cm x 4.27cm x 4.14cm)
- WEIGHT 5 oz
- MOUNTING Single Gang Switch Box
- MOUNTING HEIGHT 30-48 in
- (76.2-121.9 cm)
- COLORS White, Ivory, Gray,
- Almond, Black

ELECTRICAL SPECS

- MAXIMUM LOAD / POLE
- 800 W @ 120 VAC
- 1200 W @ 277 VAC
- 1500 W @ 347 VAC
- MINIMUM LOAD None
- MOTOR LOAD 1/4 HP
- FREQUENCY 50/60 Hz
- (timers are 1.2x for 50 Hz)

ENVIRONMENTAL SPECS

- OPERATING TEMP
- 14° to 160° F (-10° to 71° C)
- STORAGE TEMP
- 14° to 160° F (-26° to 71° C)
- RELATIVE HUMIDITY
- 20 to 90% non-condensing

OTHER

- UL and CUL Listed
- Title 24 Compliant
- 5 Year Warranty
- Made in the U.S.A.

The WSD 2P Series is a Wall Switch Decorator style Passive Infrared (PIR) sensor designed to control two independent loads. Utilizing two isolated power relays, the WSD 2P is factory set to automatically turn load 1 on when initial occupancy is detected while holding load 2 off until the push-button is pressed. Although perfect for rooms wired for bi-level lighting, the WSD 2P is also convenient for controlling multiple load types and/or voltages (for example a restroom light and fan). For rooms with obstructions, the Dual Technology WSD PDT 2P should be used. Additionally, the settings of the WSD 2P Series sensors can be programmed, without removing the switch plate, by entering simple command sequences via the push-button.

SENSOR OPERATION

The sensor detects changes in the infrared energy given off by occupants as they move within the field-of-view. When occupancy is detected, the 1st Pole's relay will switch on the connected load. The 2nd Pole's relay can be switched on by pressing the units push-button. The sensor is line powered and switches line voltage (see specifications). Two timers, each factory set at 10 minutes, keep the lights on during brief periods of inactivity. These timers are each push-button programmable from 30 seconds to 20 minutes, and are reset every time occupancy is re-detected. This state-of-the-art design requires no field calibration or sensitivity adjustments.

OPTIONS

VANDAL-RESISTANT LENS (V)

- Ideal for high abuse or public areas, where occupants simply come and go
- Decreases detection range by 50%

PHOTOCELL (P)

- Auto set-point calibration
- Maintains two set-points, enabling separate control of both poles
- Photocell prevents lights from turning on if adequate daylight is available, but does not turn lights off

347 VAC (347)

- Allows sensor to be powered from and switch 347 VAC
- Wall plate provided

COLOR

- White, Ivory, Gray, Almond, Black
- Wall plate provided
- Must be specified

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant
- Operates down to -40° F/C



ORDERING INFO WSD 2P [LENS] [PHOTOCELL] [VOLTAGE] [COLOR] [TEMP/HUMIDITY]

LENS	PHOTOCELL	VOLTAGE	COLOR	TEMP/HUMIDITY
Blank = None	Blank = None	Blank = 120/277 VAC	WH = White	Blank = Standard
V = Vandal Resistant	P = Photocell	347 = 347 VAC	IV = Ivory	LT = Low Temp
			GY = Gray	
			AL = Almond	
			BK = Black	

COVERAGE PATTERN

WSD WALL SWITCH DECORATOR LENS

- Small motion (e.g. hand movements) detection up to 20 ft (6.10 m)
- Large motion (e.g. walking) detection up to 50 ft (15.24 m)
- Wall-to-Wall coverage



CONTROL MODES

ON MODES (programmable per pole)

AUTOMATIC ON (default Pole 1) - Lights come on when occupancy is detected.

MANUAL ON (default Pole 2) - Requires the occupant to manually turn on the lights via the push-button.

REDUCED TURN ON - Sensor is initially set to only detect large motions, effectively ignoring any PIR signals reflected off of surfaces, while still sensing occupants when they enter the room. Once lights are on, the sensor returns to maximum sensitivity.

SWITCH MODES (programmable per pole)

PREDICTIVE OFF MODE (default Pole 1) - This mode allows occupants to turn lights off via the switch without losing the convenience of having the lights automatically turn on when they re-enter the room. Pressing the switch turns the lights off and temporarily disables the occupancy detection in the sensor. After a short exit time delay, the occupancy detection reactivates and monitors for an additional grace period. If no occupancy is detected, the zone will remain in Automatic On operation. If occupancy is detected, the zone will go to a Permanent Off mode, requiring the switch to be pressed again in order to turn the lights on and restore the sensor to Automatic On operation.

PERMANENT OFF (default Pole 2) - Pressing the switch turns the lights and the sensor off. Lights will not come on until switch is pressed again.

SWITCH DISABLE - Prevents user from manually turning off the lights via the push-button. Button can still be utilized for programming.

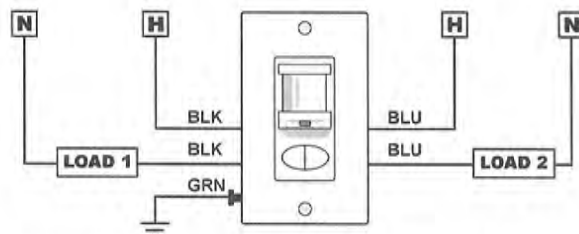
WIRING (DO NOT WIRE HOT)

STANDARD WIRING

- | | |
|--|--------------------------------|
| BLACK* - Line Input 1 | } *BLACK wires can be reversed |
| BLACK* - Load Output 1 | |
| BLUE** - Line Input 2 | } **BLUE wires can be reversed |
| BLUE** - Load Output 2 | |
| GREEN SCREW - Ground (required connection) | |

347 VAC OPTION (347)

Black wires are replaced w/ Red wires



Note: Connection to Ground required for sensor to function.
Unit powers off BLK Hot (Line) Input

WARNING

Fire Hazard Caution: Maximum Lamps 1500 Watts, Type 347 VAC.

Attention: Risque d'incendie : Puissance Maximales Des Lampes 1500 Watts, Type 347 VAC.

Warning: The units are intended to be installed by a qualified person with properly rated branch circuit protectors as per applicable local and national regulations (CEC, NEC).

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T064-004-P

WALL SWITCH DECORATOR SENSOR LINE VOLTAGE • PASSIVE DUAL TECHNOLOGY (PDT)

SPECIFICATIONS

FEATURES

- Patented Dual Technology with PIR / Microphonics™ Detection
- Self-Contained Relay - No Power Pack Needed
- Interchangeable Hot & Load Wires - Impossible to Wire Backwards
- No Neutral Connection Required
- Small Motion Detection to 20 ft (6.10 m)
- Self-Grounding Mounting Strap
- No Minimum Load
- Push-Button Programmable w/o Removing the Switch Plate
- Adjustable Time Delay
- 3-way & 4-way Switching
- Green LED Indicator

PHYSICAL SPECS

- SIZE 4.2"H x 1.8"W x 1.5"D (10.67cm x 4.57cm x 3.81cm)
- WEIGHT 5 oz
- MOUNTING Single Gang Switch Box
- MOUNTING HEIGHT 30-48 in (76.2-121.9 cm)
- COLORS White, Ivory, Gray, Almond, Black

ELECTRICAL SPECS

- MAXIMUM LOAD
 - 800 W @ 120 VAC
 - 1200 W @ 277 VAC
 - 1500 W @ 347 VAC
- MINIMUM LOAD None
- MOTOR LOAD 1/4 HP
- FREQUENCY 50/60 Hz (timers are 1.2x for 50 Hz)

ENVIRONMENTAL SPECS

- OPERATING TEMP 14° to 160° F (-10° to 71° C)
- STORAGE TEMP -14° to 160° F (-26° to 71° C)
- RELATIVE HUMIDITY 20 to 90% non-condensing

OTHER

- UL and CUL Listed
- Title 24 Compliant
- 5 Year Warranty
- Made in the U.S.A.

The WSD PDT Series is a Wall Switch Decorator style Passive Dual Technology (PDT) occupancy sensor. The combination of Passive Infrared and patented Microphonics™ detection allows this sensor to literally see & hear occupants. It is ideal for restrooms with stalls, private offices where occupant turns their back to the sensor, or rooms with obstructions.

SENSOR OPERATION & MODES

Passive Dual Technology (PDT) sensors first see motion using Passive Infrared (PIR) and then engage Microphonics™ to hear sounds that indicate continued occupancy. This patented technology uses Automatic Gain Control (AGC) to dynamically self-adapt a sensor to its environment by filtering out constant background noise and detecting only noises typical of human activity. When occupancy is detected, a self-contained relay switches the connected lighting load on. The sensor is line powered and can switch line voltage (see specifications). A timer, factory set at 10 minutes, keeps the lights on during brief periods of inactivity. This timer is push-button programmable from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected. If needed, a 10 second grace period also allows the lights to be voice reactivated after shutting off. This state-of-the-art design requires no field calibration or sensitivity adjustments.

ON MODES

- AUTOMATIC ON (default)** - Lights come on when occupancy is detected.
- MANUAL ON** - Requires the occupant manually turn on lights via the push-button.
- REDUCED TURN ON** - Sensor is initially set to only detect large motions, effectively ignoring PIR signals reflected off of surfaces, while still sensing occupants when they enter the room. Once lights are on, the sensor returns to maximum sensitivity.

SWITCH MODES

- PREDICTIVE OFF MODE (default)** - This mode allows occupants to turn lights off via the switch without losing the convenience of having the lights automatically turn on when they re-enter the room. Pressing the switch turns the lights off and temporarily disables the occupancy detection in the sensor. After a short exit time delay, the occupancy detection reactivates and monitors for an additional grace period. If no occupancy is detected, the zone will remain in Automatic On operation. If occupancy is detected, the zone will go to a Permanent Off mode, requiring the switch to be pressed again in order to turn the lights on and restore the sensor to Automatic On operation.
- PERMANENT OFF** - Pressing the switch turns the lights and the sensor off. Lights will not come on until switch is pressed again.
- SWITCH DISABLE** - Prevents user from manually turning off the lights via the push-button. Button can still be utilized for programming.

OPTIONS

VANDAL-RESISTANT LENS (V)

- Ideal for high abuse or public areas, where occupants simply come and go
- Decreases detection range by 50%

INHIBIT PHOTOCELL (P)

- Auto set-point calibration
- Photocell prevents lights from turning on if adequate daylight is available, but does not turn lights off

347 VAC (347)

- Allows sensor to be powered from and switch 347 VAC
- Wall Plate Included

COLOR

- White, Ivory, Gray, Almond, Black
- Wall Plate Included

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant
- Operates down to -4° F (-20°C)



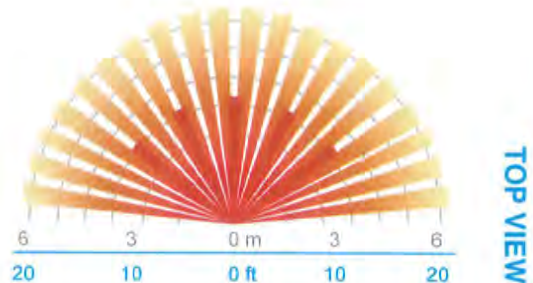
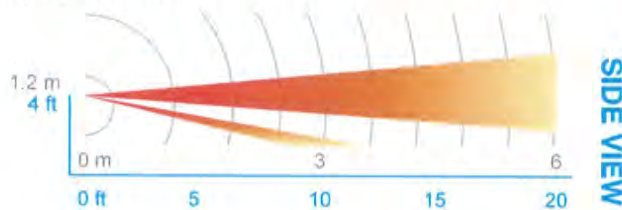
ORDERING INFO WSD PDT [LENS] [PHOTOCELL] [VOLTAGE] [COLOR] [TEMP/HUMIDITY]

LENS	PHOTOCELL	VOLTAGE	COLOR	TEMP/HUMIDITY
Blank = None	Blank = None	Blank = 120/277 VAC	WH = White	Blank = Standard
V = Vandal Resistant	P = Photocell	347 = 347 VAC	IV = Ivory	LT = Low Temp
			GY = Gray	
			AL = Almond	
			BK = Black	

COVERAGE PATTERN

WSD WALL SWITCH DECORATOR LENS W/ MICROPHONICS™

- Small motion (e.g. hand movements) detection up to 20 ft (6.10 m)
- Large motion (e.g. walking) detection up to 50 ft (15.24 m)
- Wall-to-Wall coverage
- Microphonics™ provides overlapping detection of human activity over the complete PIR coverage area
- Advanced filtering is utilized to prevent non-occupant noises from keeping the lights on



WIRING (DO NOT WIRE HOT)

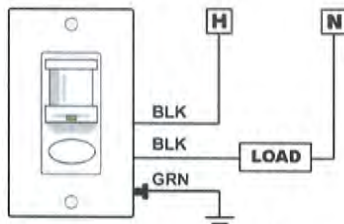
STANDARD WIRING

- BLACK* - Line Input
 BLACK* - Load Output } *BLACK wires can be reversed
 GREEN SCREW - Ground (required connection)

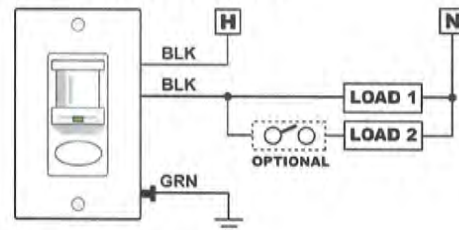
347 VAC OPTION (347)

Black wires are replaced w/ Red wires

STANDARD CONFIGURATION



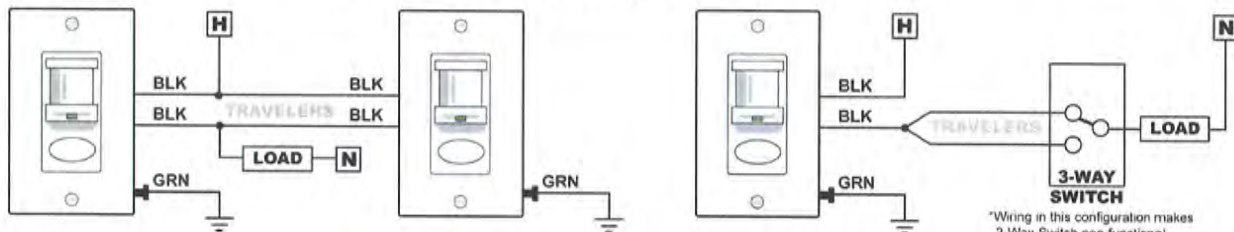
BI-LEVEL CONFIGURATION



Note: Connection to Ground required for sensor to function

3-WAY WIRING CONFIGURATIONS

Travelers are used to wire sensors (or sensor and 3-way switch) in parallel.



Note: Connection to Ground required for sensor to function

WARNING

Fire Hazard Caution: Maximum Lamps 1500 Watts, Type 347 VAC.

Attention: Risque d'incendie : Puissance Maximales Des Lampes 1500 Watts, Type 347 VAC.

Warning: The units are intended to be installed by a qualified person with properly rated branch circuit protectors as per applicable local and national regulations (CEC, NEC).

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T065-004-P

EXTENDED RANGE 360° SENSOR CEILING MOUNT • LOW VOLTAGE • PASSIVE INFRARED (PIR)

SPECIFICATIONS

FEATURES

- PIR Occupancy Detection
- 360° Coverage
- Push-Button Programmable
- Adjustable Time Delay
- 100 Hr Lamp Burn-in Timer
- Green LED Indicator

PHYSICAL SPECS

- SIZE 4.55" Dia. (11.56 cm)
- 1.55" Deep (3.94 cm)
- WEIGHT 6 oz
- MOUNTING
 - Ceiling Tile Surface
 - 3.5" Octagon Box
 - Single Gang Handy Box
- COLOR White

ELECTRICAL SPECS

- OPERATING VOLTAGE
 - 12-24 VAC/VDC
- CURRENT DRAIN
 - Standard, 4 mA
 - w/ -R option, 16 mA
- DIMMING LOAD
 - Sinks / Sources < 20mA;
 - ~40 Ballasts @ .5mA each
- RECOMMENDED POWER PACK
 - PP20

ENVIRONMENTAL SPECS

- OPERATING TEMP
 - 14° to 160° F (-10° to 71° C)
- STORAGE TEMP
 - 14° to 160° F (-26° to 71° C)
- RELATIVE HUMIDITY
 - 20 to 90% non-condensing

OTHER

- UL and CUL Listed
- Title 24 Compliant
- 5 Year Warranty
- Made in the U.S.A.

The CM 10 Series Extended Range 360° occupancy sensor incorporates Passive Infrared (PIR) technology into an attractive and economical sensor to provide maximum viewing from the ceiling. When mounted at 9 ft (2.74 m), this sensor views up to 28 ft (8.53 m) in all directions. Its circular coverage pattern is designed for walking motions; making it ideal for T-shaped intersections in corridors, or other areas where wall mounting a sensor is not practical. A long hallway, for example, may require a HW13 Series Hallway sensor at each end, with CM 10's mounted in the center to fill in the distance. Low ceiling heights are also best covered by the CM 10. For example, when mounted at only 7 ft (2.13 m), the height of pick aisles in many distribution centers, the CM 10 provides a 32 ft (9.75 m) diameter pattern of coverage. In applications where detection of minor motion is also required, use the CM PDT 10 Series Dual Technology sensor.

SENSOR OPERATION

The sensor detects changes in the infrared energy given off by occupants as they move within the field-of-view. When occupancy is detected, a DC output goes high and can drive up to 200 mA of connected load. The sensor is powered with 12-24 VAC/VDC and typically operates with a PP20 or MP20 power pack, enabling complete 20 Amp circuits to be controlled. An internal timer, factory set at 10 minutes, keeps the lights on during brief periods of inactivity. This timer is push-button programmable from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected. This state-of-the-art design requires no field calibration or sensitivity adjustments.

OPTIONS

LOW VOLTAGE RELAY (R)

- Enables sensors to interface with other systems (e.g., BMS, lighting panels)
- Provides dry contact closure via a SPDT, 1 Amp, 40 Volt relay
- Only one relay needed per zone
- Changes state when all connected sensors register unoccupied
- Relay requires sensor power to function

OCCUPANCY CONTROLLED DIMMING (D)

- Provides dimming output to control 0-10 VDC dimmable ballasts
- Provides a second occupancy time-out period that enables the lights to go to a dim setting before turning off
- Adjustable max/min dim setting

PHOTOCELL (P)

- Auto set-point calibration
- Two selectable modes of operation
- On/Off mode: Photocell has full control during periods of occupancy
- Inhibit mode: Photocell can prevent lights from turning on if adequate daylight is available, but cannot turn lights off

PHOTOCELL W/ DIMMING (ADC)

- Photocell within sensor maintains total room light level by controlling levels of 0-10 VDC dimmable ballasts
- Photocell also has full on/off control during periods of occupancy
- Provides a second occupancy time-out period that enables the lights to go to a dim setting before turning off

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant to moisture
- Operates down to -40° F/C

ORDERING INFO CM 10 [RELAY] [DIMMING/PHOTOCELL] [TEMP/HUMIDITY]

RELAY

- Blank = None
- R = Low Voltage Relay

DIMMING / PHOTOCELL CHOOSE ONE ONLY

- Blank = None
- D = Occupancy Controlled Dimming
- P = Photocell
- ADC = Photocell w/ Dimming

TEMP/HUMIDITY

- Blank = Standard
- LT = Low Temp

COVERAGE PATTERN

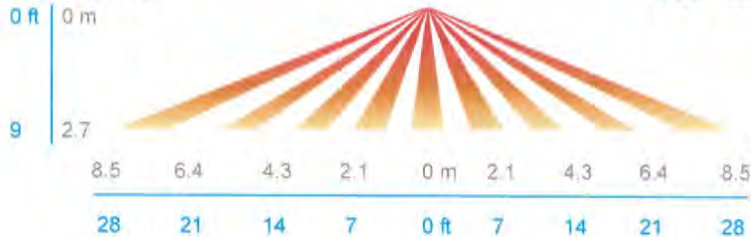
10 EXTENDED RANGE LENS

- Best choice for large motion (e.g. walking) detection
- Viewing angle of 67° in a 360° conical shaped pattern
- Provides 28 ft (8.53 m) radial coverage when mounted to standard 9 ft (2.74 m) ceiling
- 7 to 15 ft (2.13 to 4.57 m) mounting heights provide 16 to 36 ft (4.88 to 10.97 m) radial coverage

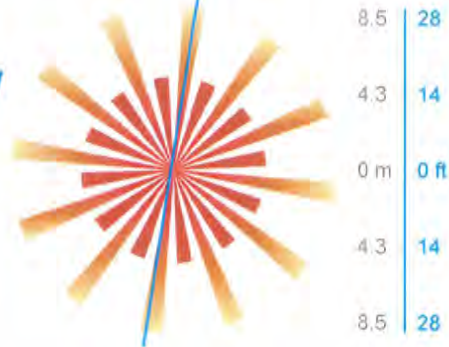


Note: Sensor's screw axis is offset 7.5° from a long detection segment

SIDE VIEW



TOP VIEW



WIRING (DO NOT WIRE HOT)

STANDARD WIRING

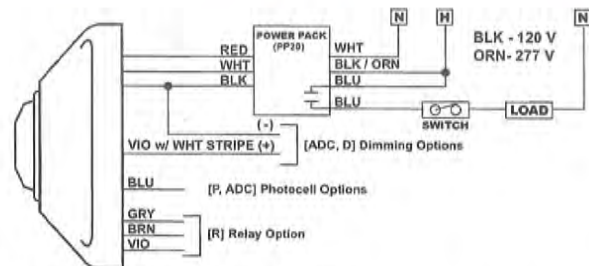
- RED** - Power Input (12-24 VAC/VDC)
- BLACK** - Common
- WHITE** - Output (high VDC for occupancy)

RELAY OPTION (R)

- GRAY / BROWN** - Connected during occupied state
- VIOLET / BROWN** - Connected during unoccupied state
- Note: Relay is energized during unoccupied state

DIMMING OPTIONS (D, ADC)

- VIOLET w/ WHITE STRIPE** - Connect to Violet control wire from 0-10 VDC dimmable ballast
- GRAY from Ballast** - Connect to sensor Black wire

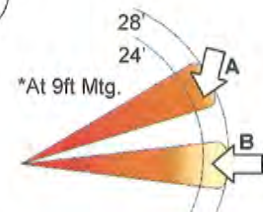
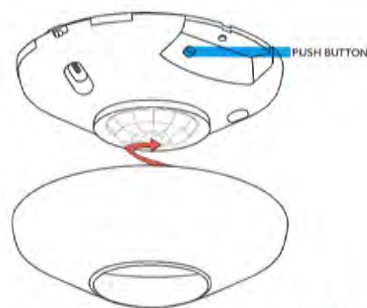


PHOTOCELL OPTIONS (P, ADC)

BLUE - Use in place of White output wire. Photocell output is high VDC with occupancy & low light. For multi-level control, use two power packs and connect White to primary load and Blue to daylight load.

INSTALLATION

- Mount sensor directly to a ceiling tile or a metallic grid (two self-tapping screws provided).
- Sensor's mounting holes also align with 3.5" octagon or single gang handy box (screws not provided).
- Sensor will detect motions crossing segments more effectively than motions parallel to beams.
- For optimal detection, position sensor such that segments are crossed upon entrance and unable to view outside the space.



A: When walking across beam, detection will occur at approximately 28 feet. (8.53 m)
B: When walking into beam, detection will occur at approximately 24 feet. (7.32 m)

PROGRAMMING

Refer to included instruction card for default settings and directions on programming the sensor via the push-button.

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T003-004-P

900 Northrop Road, Wallingford, CT 06492 • 1.800.PASSIVE • FX 203.269.9621 • www.sensorswitch.com



EXTENDED RANGE 360° SENSOR CEILING MOUNT • LOW VOLTAGE • DUAL TECHNOLOGY (PDT)

SPECIFICATIONS

FEATURES

- Patented Dual Technology with PIR / Microphonics Detection
- 360° Coverage
- Push-Button Programmable Adjustable Time Delay
- 100 Hr Lamp Burn-in Timer
- Green LED Indicator

PHYSICAL SPECS

- SIZE 4.55" Dia. (11.56 cm)
- 1.55" Deep (3.94 cm)
- WEIGHT 6 oz
- MOUNTING Ceiling Tile Surface
- 3.5" Octagon Box
- Single Gang Handy Box
- COLOR White

ELECTRICAL SPECS

- OPERATING VOLTAGE 12-24 VAC/VDC
- CURRENT DRAW Standard, 4 mA
- w/ -R option, 16 mA
- DIMMING LOAD Sinks / Sources < 20mA;
- ~40 Ballasts @ .5mA each
- RECOMMENDED POWER SUPPLY PP20

ENVIRONMENTAL SPECS

- OPERATING TEMP 14° to 160° F (-10° to 71° C)
- STORAGE TEMP -14° to 160° F (-26° to 71° C)
- RELATIVE HUMIDITY 20 to 90% non-condensing

OTHER

- UL and CUL Listed
- Title 24 Compliant
- 5 Year Warranty
- Made in the U.S.A.

Classrooms are ideal applications for the **CM PDT 10** Series Extended Range 360° occupancy sensor. When mounted at 9 ft (2.74 m), this sensor provides line of sight Passive Infrared (PIR) detection of walking type motions up to 28 ft (8.53 m) in all directions. Additionally, the **CM PDT 10** provides overlapping Microphonics™ technology to detect smaller motions and occupant movements that occur behind obstructions. This is important for classrooms filled with obstructions like shelving, hanging projects, or lab benches. When comparing small motion detection, the **CM PDT 10** far out performs dual technology sensors on the market that are specified with 2,000 ft² of coverage. Spaces with low ceiling heights are also best covered by the **CM PDT 10**. For example, when mounted at the 7 ft (2.13 m) ceiling height of many distribution center pick aisles, the **CM PDT 10** provides a 32 ft (9.75 m) diameter pattern of coverage. Additionally, the **CM PDT 10** may be used in combination with other sensors to customize coverage for very large or irregularly shaped spaces.

SENSOR OPERATION

The sensor has Passive Dual Technology (PDT), which first sees motion using Passive Infrared (PIR), and then engages Microphonics™ to hear sounds that indicate continued occupancy. This patented technology uses Automatic Gain Control (AGC) to dynamically self-adapt the sensor to its environment by filtering out constant background noise and detecting only noises typical of human activity. When occupancy is detected, a DC output goes high and can drive up to 200 mA of connected load. The sensor is powered with 12-24 VAC/VDC and typically operates with a **PP20** or **MP20** power pack, enabling complete 20 Amp circuits to be controlled. An internal timer, factory set at 10 minutes, keeps the lights on during brief periods of inactivity. This timer is push-button programmable from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected. This state-of-the-art sensor requires no field calibration or adjustment.

OPTIONS

LOW VOLTAGE RELAY (R)

- Enables sensors to interface with other systems (e.g., BMS, lighting panels)
- Provides dry contact closure via a SPDT, 1 Amp, 40 Volt relay
- Only one relay needed per zone
- Changes state when all connected sensors register unoccupied
- Relay requires sensor power to function

OCCUPANCY CONTROLLED DIMMING (D)

- Provides dimming output to control 0-10 VDC dimmable ballasts
- Provides a second occupancy time-out period that enables the lights to go to a dim setting before turning off
- Adjustable max/min dim setting

PHOTOCELL (P)

- Auto set-point calibration
- Two selectable modes of operation
- On/Off mode: Photocell has full control during periods of occupancy
- Inhibit mode: Photocell can prevent lights from turning on if adequate daylight is available, but cannot turn lights off

PHOTOCELL W/ DIMMING (ADC)

- Photocell within sensor maintains total room light level by controlling levels of 0-10 VDC dimmable ballasts
- Photocell also has full on/off control during periods of occupancy
- Provides a second occupancy time-out period that enables the lights to go to a dim setting before turning off

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant to moisture
- Operates down to -4° F/ 20° C

ORDERING INFO CM PDT 10 [RELAY] [DIMMING/PHOTOCELL] [TEMP/HUMIDITY]

RELAY

- Blank = None
- R = Low Voltage Relay

DIMMING / PHOTOCELL CHOOSE ONE ONLY

- Blank = None
- D = Occupancy Controlled Dimming
- P = Photocell
- ADC = Photocell w/ Dimming

TEMP/HUMIDITY

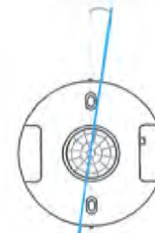
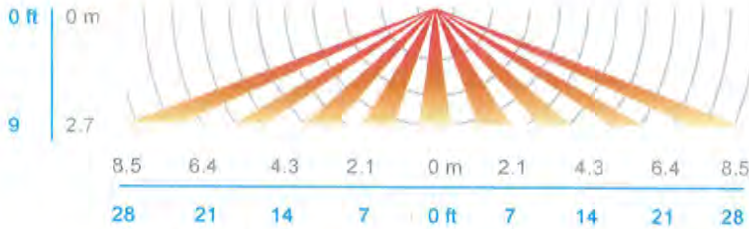
- Blank = Standard
- LT = Low Temp

COVERAGE PATTERN

10 EXTENDED RANGE 360° LENS WITH MICROPHONICS™

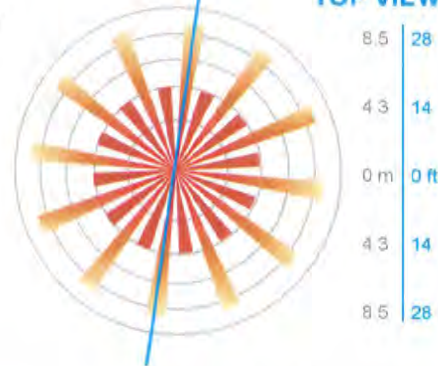
- Best choice for large motion (e.g. walking) detection
- Viewing angle of 67° in a 360° conical shaped pattern
- Provides 28 ft (8.53 m) radial coverage when mounted to standard 9 ft (2.74 m) ceiling
- 7 to 15 ft (2.13 to 4.57 m) mounting heights provide 16 to 36 ft (4.88 to 10.97 m) radial coverage
- Microphonics™ provides overlapping detection of human activity over the complete PIR coverage area. Advanced filtering is also utilized to prevent non-occupant noises from keeping the lights on.

SIDE VIEW



Note: Sensor's screw axis is offset 7.5° from a long detection segment

TOP VIEW



WIRING (DO NOT WIRE HOT)

STANDARD WIRING

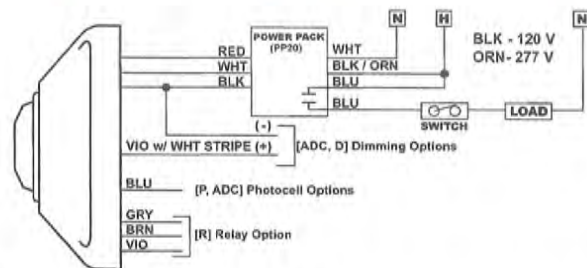
- RED** - Power Input (12-24 VAC/VDC)
- BLACK** - Common
- WHITE** - Output (high VDC for occupancy)

RELAY OPTION (R)

- GRAY / BROWN** - Connected during occupied state
- VIOLET / BROWN** - Connected during unoccupied state
- Note:** Relay is energized during unoccupied state

DIMMING OPTIONS (D, ADC)

- VIOLET w/ WHITE STRIPE** - Connect to Violet control wire from 0-10 VDC dimmable ballast
- GRAY from Ballast** - Connect to sensor Black wire

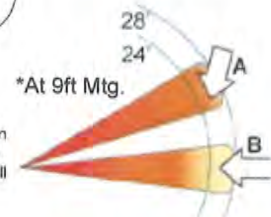
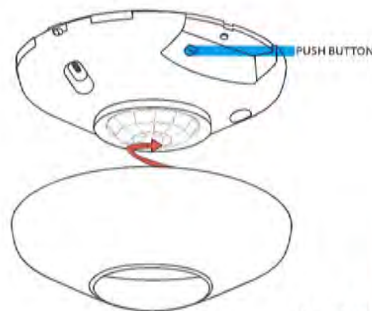


PHOTOCELL OPTIONS (P, ADC)

BLUE - Use in place of White output wire. Photocell output is high VDC with occupancy & low light. For multi-level control, use two power packs and connect White to primary load and Blue to daylight load.

INSTALLATION

- Mount sensor directly to a ceiling tile or a metallic grid (two self-tapping screws provided).
- Sensor's mounting holes also align with 3.5" octagon or single gang handy box (screws not provided).
- Sensor will detect motions crossing segments more effectively than motions parallel to beams.
- For optimal detection, position sensor such that segments are crossed upon entrance and unable to view outside the space.
- For maximum Microphonics™ sensitivity, avoid locating sensor near HVAC air diffusers.



A: When walking across beam, detection will occur at approximately 28 ft (8.53 m)
B: When walking into beam, detection will occur at approximately 24 ft (7.32 m)

PROGRAMMING

Refer to included instruction card for default settings and directions on programming the sensor via the push-button.

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T011-004-P

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CMR 10 2P

EXTENDED RANGE 360° SENSOR

CEILING MOUNT • LINE VOLTAGE • PASSIVE INFRARED (PIR) • 2 POLE

SPECIFICATIONS

FEATURES

- 100% Digital PIR Detection, Excellent RF Immunity
- 360° Coverage Pattern
- Two Self-Contained Relays, No Power Pack(s) Needed
- No Minimum Load Requirements
- Interchangeable Hot & Load Wires, Impossible to Wire Backwards
- Push-Button Programmable Adjustable Time Delays
- No Field Calibration or Sensitivity Adjustments Required
- Convenient Test Mode
- 100 hr Lamp Burn-in Timer
- Green LED Indicator

LAMP MAXIMIZER TECHNOLOGY

- Protects Lamp Life while Maximizing Energy Savings
- Minimum On Timer (15 min default)
- Occ. Time Delay (10 min default)

PHYSICAL SPECS

SIZE 4.55" Dia. (11.56 cm)

1.55" Deep (3.94 cm)

WEIGHT 6 oz

MOUNTING

3.5" Octagon Box

Single Gang Handy Box

COLOR White

ELECTRICAL SPECS

MAXIMUM LOAD 2 POLE

(1 Phase Only)

800 W @ 120 VAC

1200 W @ 277 VAC

1500 W @ 347 VAC

MINIMUM LOAD None

MOTOR LOAD 1/4 HP

FREQUENCY 50/60 Hz

ENVIRONMENTAL SPECS

OPERATING TEMP

14° to 160° F (-10° to 71° C)

STORAGE TEMP

-14° to 160° F (-26° to 71° C)

RELATIVE HUMIDITY

20 to 90% non-condensing

SILICONE FREE

ROHS COMPLIANT

OVERVIEW

Corridors with A/B switching are ideal for the CMR 10 2P Passive Infrared 2-Pole occupancy sensor. At a 9 ft (2.74 m) height, this sensor views up to 28 ft (8.53 m) in all directions. Ideal for applications where each fixture is controlled with inboard/outboard switch legs and low voltage wiring is not practical; these sensors connect directly to line voltage without the need of a power pack. Universal mounting allows for 3.5" octagon boxes, wiremold, or standard mud rings. In cold damp environments, the CMR 10 2P LT version should be used.

SENSOR OPERATION

The sensor detects changes in the infrared energy given off by occupants as they move within the field-of-view. When occupancy is detected, two self-contained relays switch the connected lighting loads on. The sensor is line powered, switches line voltage, and requires no field calibration or sensitivity adjustments.

LAMP MAXIMIZER®

This sensor also contains patent pending LampMaximizer technology that allows users to aggressively target energy savings while still protecting lamp life. A minimum on timer, factory set at 15 minutes, helps preserve lamp life by eliminating all lamp cycles shorter than lamp warranties specify.

A standard occupancy time delay is also present that ensures lights turn off (assuming minimum on timer has elapsed) if no occupancy is detected. This timer is factory set at 10 minutes to promote energy savings, but is adjustable between 30 seconds and 20 minutes. These adjustments are done manually through the unit's push-button; no tools required.

OPTIONS

INHIBIT PHOTOCELL (P)

- Photocell can prevent lights from turning on if adequate daylight is available, but cannot turn lights off
- Maintains two set-points, enabling separate control of both poles

DUAL ZONE PHOTOCELL (DZ)

- Provides more advanced control than P option
- DUO Operation: Determines necessary on/off combination of poles in inboard/outboard applications
- Percentage Offset Operation: Uses relative set-point for second pole in dual zone applications

347 VAC (347)

- Allows sensor to be powered from and switch 347 VAC

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant to moisture
- Operates down to -40° F/C



TITLE 24
MADE in U.S.A.
5 YEAR WARRANTY

ORDERING INFO CMR 10 2P [PHOTOCELL] [VOLTAGE] [TEMP/HUMIDITY]

PHOTOCELL CHOOSE ONE ONLY

Blank = None
P = Inhibit Photocell
DZ = Dual Zone Photocell

VOLTAGE

Blank = 120/277 VAC
347 = 347 VAC

TEMP/HUMIDITY

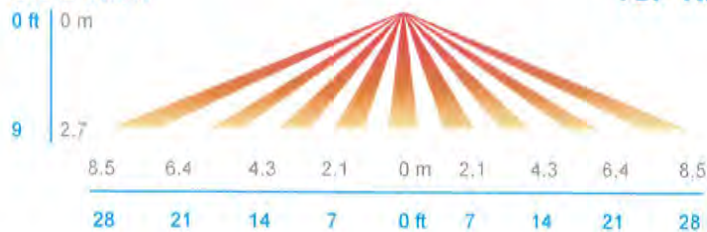
Blank = Standard
LT = Low Temp

COVERAGE PATTERN

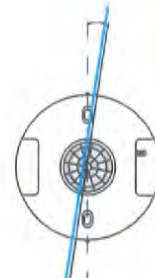
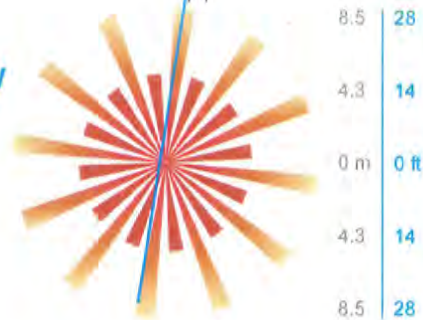
10 EXTENDED RANGE 360° LENS

- Best choice for large motion detection (e.g. walking)
- Viewing angle of 67° in a 360° conical shaped pattern
- Provides 28 ft (8.53 m) radial coverage when mounted to standard 9 ft (2.74 m) ceiling
- 7 to 15 ft (2.13 to 4.57 m) mounting heights provide 16 to 36 ft (4.88 to 10.97 m) radial coverage

SIDE VIEW



TOP VIEW

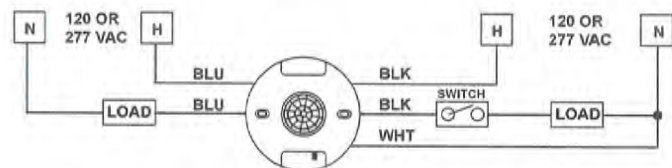


Note: Sensor's screw axis is offset 7.5° from a long detection segment

WIRING (DO NOT WIRE HOT)

STANDARD WIRING

- BLACK* - Line Input 1
 - BLACK* - Load Output 1
 - BLUE** - Line Input 2
 - BLUE** - Load Output 2
 - WHITE - Neutral
- *BLACK wires can be reversed
- **BLUE wires can be reversed



347 VAC OPTION (347)

Black wires are replaced w/ Red wires

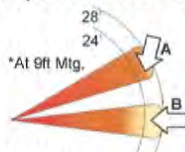
INITIAL POWER UP

The sensor's relays are shipped in a latched closed position so the lights will come on upon initial power-up. If the lights do not immediately turn on (initial installation only) the latching relays opened during shipment and will close within 30 secs.

Note: If the sensor loses power, the internal relays will latch to on.

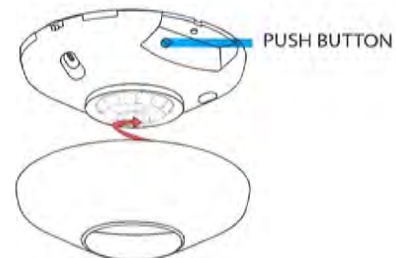
INSTALLATION

- Sensor's mounting holes align with 3.5" octagon or single gang handy box (screws not provided)
- Sensor will detect motions crossing segments more effectively than motions parallel to beams
- For optimal detection, position sensor such that segments are crossed upon entrance and unable to view outside the space



*At 9ft Mtg.

- A:** When walking across beam, detection will occur at approximately 28 ft.
- B:** When walking into beam, detection will occur at approximately 24 ft.



PUSH BUTTON

PROGRAMMING

Refer to instruction card IC8.001 for default settings and directions on programming the sensor via the push-button.

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TS-CMR-002A

WIDE VIEW SENSOR CORNER MOUNT • LOW VOLTAGE • PASSIVE INFARED (PIR)

SPECIFICATIONS

FEATURES

- PIR Occupancy Detection
- 120° by 40 ft (12.19 m) Coverage for Small Motion
- Adjustable Time Delay
- 100 Hr. Lamp Burn-In Timer Mode
- Green LED Indicator

PHYSICAL SPECS

- SIZE 3.0" H x 3.6" W x 1.75" D
(7.62 cm x 9.14 cm x 4.45 cm)
- WEIGHT 5 oz
- MOUNTING Directly to corner or to ceiling using WV BR bracket.
- COLOR White

ELECTRICAL SPECS

- OPERATING VOLTAGE 12-24 VAC/VDC
- CURRENT DRAW Standard, 4 mA
w/ R option, 16 mA
- RECOMMENDED POWER PACK PP20

ENVIRONMENTAL SPECS

- OPERATING TEMP 14° to 160° F (-10° to 71° C)
- STORAGE TEMP -14° to 160° F (-26° to 71° C)
- RELATIVE HUMIDITY 20 to 90% non-condensing

OTHER

- UL and CUL Listed
- Title 24 Compliant
- 5 Year Warranty
- Made in the U.S.A.

The WV 16 Series Wide View occupancy sensor is designed to mount in a corner and detect small motions up to 40 ft (12.19 m) away, and larger motions up to 70 ft (21.34 m) away. This makes it ideal for 30 ft x 30 ft (9.14 m x 9.14 m) classrooms or corridors up to 70 ft (21.34 m) long (for specific long narrow hallway applications, see HW13 product data sheet). The enclosure's convenient tilting feature enables the sensor to be mounted at any height from 8 to 10 ft (2.44 to 3.05 m). When corner or wall mounting is not possible, the WV BR bracket accessory can be used to mount the WV 16 to the ceiling. Additionally, the WV 16 may be used in combination with other sensors to customize coverage for very large or irregularly shaped spaces. For rooms with obstructions, use the WV PDT 16 Series sensor which adds Microphonics™ detection.

SENSOR OPERATION

The sensor detects changes in the infrared energy given off by occupants as they move within the field-of-view. When occupancy is detected, a DC output goes high and can drive up to 200 mA of connected load. The sensor is powered with 12-24 VAC/VDC and typically operates with a PP20 or MP20 power pack, enabling complete 20 Amp circuits to be controlled. An internal timer, factory set at 10 minutes, keeps the lights on during brief periods of inactivity. This timer is push-button programmable from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected. This state-of-the-art design requires no field calibration or sensitivity adjustments.



OPTIONS

LOW VOLTAGE RELAY (R)

- Enables low voltage sensors to interface with other systems
- Provides dry contact closure via a SPDT, 1 Amp, 40 Volt relay.
- Only one relay needed per zone
- Changes state when all connected sensors register unoccupied
- Relay requires sensor power to function

PHOTOCELL (P)

- Auto set-point calibration
- Two selectable modes of operation
- On/Off mode: Photocell has full control during periods of occupancy
- Inhibit mode: Photocell can prevent lights from turning on if adequate daylight is available, but cannot turn lights off

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant to moisture
- Operates down to -40° F/C

ORDERING INFO WV 16 [RELAY] [PHOTOCELL] [TEMP/HUMIDITY]

RELAY

- Blank = None
- R = Low Voltage Relay

PHOTOCELL

- Blank = None
- P = Photocell

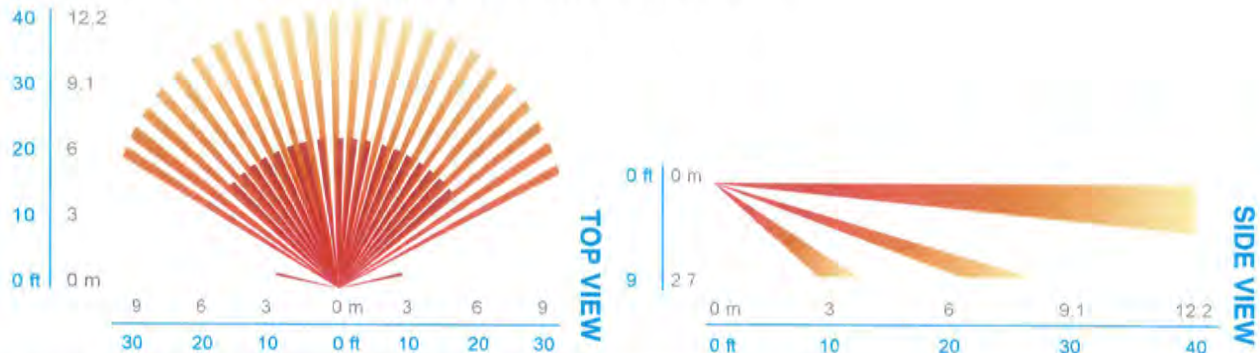
TEMP/HUMIDITY

- Blank = Standard
- LT = Low Temp

COVERAGE PATTERN

16 WIDE VIEW LENS

- Small motion (e.g. **hand movements**) detection up to 40 ft (12.19 m).
- Large motion (e.g. **walking**) detection up to 70 ft (21.34 m).
- Designed for 8 to 10 ft (2.44 to 3.05 m) high mounting in room corner.



WIRING (DO NOT WIRE HOT)

STANDARD WIRING

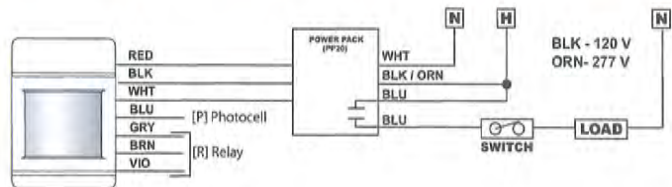
- RED - Power Input (12-24 VAC/VDC)
- BLACK - Common
- WHITE - Output (high VDC for occupancy)

RELAY OPTION (R)

- GRAY/BROWN - Connected during occupied state
- VIOLET/BROWN - Connected during unoccupied state
- Note: Relay is energized during unoccupied state

PHOTOCELL OPTION (P)

- BLUE - Use in place of White output wire. Photocell output is high VDC with occupancy & low light.
- For multi-level control, use two power packs and connect White to primary load and Blue to daylight load.



INSTALLATION

- Sensor has rear enclosure, which is beveled so as to be corner mounted at 8-10 ft (2.44-3.05 m); see tilt settings below.
- Mount in corner above entrance door or in a corner along the same wall as the entrance.
- For mounting heights above 10 ft (3.05 m), use the WV BR and mount sensor to angled side to provide an initial 30° look down.

TILT ADJUSTMENT Mounting Height Position

- | | |
|-----------|-----------|
| 7' - 8' | Vertical |
| 8' - 9' | Center |
| 9' - 10' | Forward |
| Above 10' | Use WV BR |



CEILING MOUNT BRACKET (WV BR)

The WV BR Ceiling Mount Bracket allows the WV 16 to be mounted in the corner of the area from the ceiling for conditions where mounting to the wall is not possible.



PROGRAMMING

Refer to included instruction card for default settings and directions on programming the sensor via the push-button.

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T070-004P

WIDE VIEW SENSOR

CORNER MOUNT • LOW VOLTAGE • DUAL TECHNOLOGY (PDT)

SPECIFICATIONS

FEATURES

- PIR Occupancy Detection
- 120° by 40 ft (12.19 m) Coverage for Small Motion
- Adjustable Time Delay
- 100 Hr. Lamp Burn-In Timer Mode
- Green LED Indicator

PHYSICAL SPECS

- SIZE 3.0" H x 3.6" W x 1.75" D (7.62 cm x 9.14 cm x 4.45 cm)
- WEIGHT 5 oz
- MOUNTING Directly to corner or to ceiling using WV BR bracket
- COLOR White

ELECTRICAL SPECS

- OPERATING VOLTAGE 12-24 VAC/VDC
- CURRENT DRAW Standard, 4 mA w/ R option, 16 mA
- RECOMMENDED POWER PACK PP20

ENVIRONMENTAL SPECS

- OPERATING TEMP 14° to 160° F (-10° to 71° C)
- STORAGE TEMP -14° to 160° F (-26° to 71° C)
- RELATIVE HUMIDITY 20 to 90% non-condensing

OTHER

- UL and CUL Listed
- Title 24 Compliant
- 5 Year Warranty
- Made in the U.S.A.

Classrooms are the ideal application for the WV PDT 16 Dual Technology Wide View Sensor. Installed in the corner of the room along the entrance wall, this inconspicuous sensor provides line of sight PIR detection of small movements up to 40 ft (12.19 m) away, and combines overlapping Microphonics™ for detection around obstructions. Many classrooms are filled with shelving, projects, or lab benches. Total coverage of the room is always maintained no matter how cluttered the space becomes. The WV PDT 16 is also used in corridors due to its ability to view up to 70 ft (21.34 m) for walking motions, or large open storage areas where obstructions may block the PIR's ability to view. For large lecture halls, multiple WV PDT 16s may be wired together, or along with any other low voltage sensors.

SENSOR OPERATION

The sensor has Passive Dual Technology (PDT), which first sees motion using Passive Infrared (PIR), and then engages Microphonics™ to hear sounds that indicate continued occupancy. This patented technology uses Automatic Gain Control (AGC) to dynamically self-adapt the sensor to its environment by filtering out constant background noise and detecting only noises typical of human activity. When occupancy is detected, a DC output goes high and can drive up to 200 mA of connected load. The sensor is powered with 12-24 VAC/VDC and typically operates with a PP20 or MP20 power pack, enabling complete 20 Amp circuits to be controlled. An internal timer, factory set at 10 minutes, keeps the lights on during brief periods of inactivity. This timer is push-button programmable from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected. This state-of-the-art sensor requires no field calibration or adjustment.



OPTIONS

LOW VOLTAGE RELAY (R)

- Enables sensors to interface with other systems (e.g., BMS, lighting panels)
- Provides dry contact closure via a SPDT, 1 Amp, 40 Volt relay
- Only one relay needed per zone
- Changes state when all connected sensors register unoccupied
- Relay requires sensor power to function

PHOTOCELL (P)

- Auto set-point calibration
- Two selectable modes of operation
- On/Off mode: Photocell has full control during periods of occupancy
- Inhibit mode: Photocell can prevent lights from turning on if adequate daylight is available, but cannot turn lights off

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant to moisture
- Operates down to -4° F/ 20° C

ORDERING INFO WV PDT 16 [RELAY] [PHOTOCELL] [TEMP/HUMIDITY]

RELAY

- Blank = None
- R = Low Voltage Relay

PHOTOCELL

- Blank = None
- P = Photocell

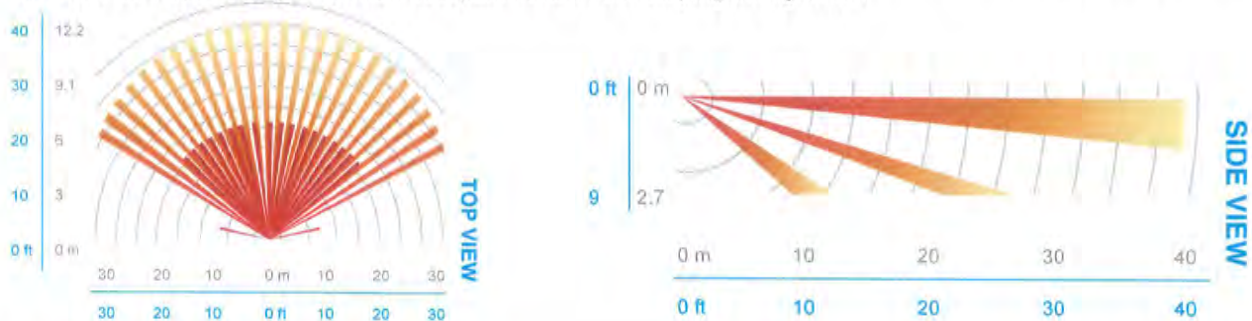
TEMP/HUMIDITY

- Blank = Standard
- LT = Low Temp

COVERAGE PATTERN

16 WIDE VIEW LENS WITH MICROPHONICS™

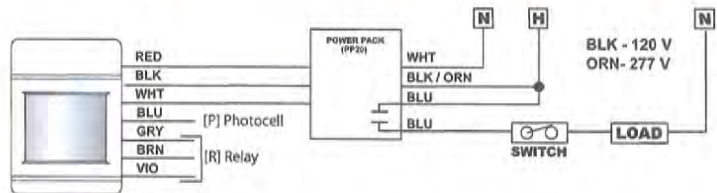
- Small motion (e.g. **hand movements**) detection up to 40 ft (12.19 m).
- Large motion (e.g. **walking**) detection up to 70 ft (21.34 m).
- Designed for 8 to 10 ft (2.44 to 3.05 m) high mounting in room corner.
- Microphonics™ provides overlapping detection of human activity over the complete PIR coverage area. Advanced filtering is also utilized to prevent non-occupant noises from keeping the lights on.



WIRING (DO NOT WIRE HOT)

STANDARD WIRING

RED - Power Input (12-24 VAC/VDC)
BLACK - Common
WHITE - Output (high VDC for occupancy)



RELAY OPTION (R)

GRAY/BROWN - Connected during occupied state
VIOLET/BROWN - Connected during unoccupied state
Note: Relay is energized during unoccupied state.

PHOTOCELL OPTION (P)

BLUE - Use in place of White output wire. Photocell output is high VDC with occupancy & low light. For multi-level control, use two power packs and connect White to primary load and Blue to daylight load.

INSTALLATION

- Sensor has rear enclosure, which is beveled so as to be corner mounted at 8-10 ft (2.44-3.05 m); see tilt settings below.
- Mount in corner above entrance door or in a corner along the same wall as the entrance.
- For mounting heights above 10 ft (3.05 m), use the **WV BR** and mount sensor to angled side to provide an initial 30° look down.

TILT ADJUSTMENT

Mounting Height Position

7' - 8'	Vertical
8' - 9'	Center
9' - 10'	Forward
Above 10'	Use WV BR

**CEILING MOUNT BRACKET (WV BR)**

The **WV BR** Ceiling Mount Bracket allows the **WV PDT 16** to be mounted in the corner of the area from the ceiling for conditions where mounting to the wall is not possible.



PROGRAMMING

Refer to included instruction card for default settings and directions on programming the sensor via the push-button.



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T069-004P



HIGH BAY 360° SENSOR

FIXTURE MOUNT BOX • LINE VOLTAGE • PASSIVE INFRARED (PIR)

SPECIFICATIONS

FEATURES

- PIR Occupancy Detection
- Up to 45 ft (13.72 m) Mounting
- 360° Coverage
- Self-Contained Relay Switches
- Line Voltage Load
- No Minimum Load Requirements
- Push-Button Programmable
- Adjustable Time Delay
- 100 Hr Lamp Burn-in Timer
- Green LED Indicator

PHYSICAL SPECS

- SIZE 3.63" H x 3.63" W x 1.50" D
(9.22 cm x 9.22 cm x 3.81 cm)
- WEIGHT 6 oz
- MOUNTING 1/2" knockout
- COLOR White

ELECTRICAL SPECS

- MAXIMUM LOAD
 - 800 W @ 120 VAC
 - 1200 W @ 277 VAC
 - 1500 W @ 347 VAC
- MINIMUM LOAD None
- MOTOR LOAD 1/4 HP
- FREQUENCY 50/60 Hz
- DIMMING LOAD
 - Sinks / Sources < 20mA;
 - ~40 Ballasts @ .5mA each

ENVIRONMENTAL SPECS

- OPERATING TEMP
 - 14° to 160° F (-10° to 71° C)
- STORAGE TEMP
 - 14° to 160° F (-26° to 71° C)
- RELATIVE HUMIDITY
 - 20 to 90% non-condensing

OTHER

- UL and CUL Listed
- Title 24 Compliant
- 5 Year Warranty
- Made in the U.S.A.

Designed for mounting heights of up to 45 ft (13.72 m), the **CMRB 6** High Bay 360° sensor provides Passive Infrared (PIR) occupancy detection over a 15-20 ft (4.57-6.10 m) radial coverage pattern that overlaps the areas lit by a typical high bay fixture. This line voltage sensor switches loads directly without the need for a power pack. The **CMRB 6** sensor mounts directly to the end of a lighting fixture through an extended 1/2 inch chase nipple, and is ideal for individual on/off control of T5/T8 fluorescent lighting. HID bi-level fixtures can also be controlled when the Start-to-High (SH) option is added to the **CMRB 6**. For multiple fixture control, multiple low voltage **CMB 6**, **CMB 50**, and/or **HMB 10** Series High Bay sensors with power packs are recommended. For lower mounting height applications, **CMRB 9** or **CMRB 10** Series sensors are recommended.

SENSOR OPERATION

The sensor detects changes in the infrared energy given off by occupants as they move within the field-of-view. When occupancy is detected, a self-contained relay switches the connected lighting load on. The sensor is line powered and can switch line voltage (see specifications). An internal timer, factory set at 15 minutes, keeps the lights on during brief periods of inactivity. This timer is push-button programmable from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected. This state-of-the-art sensor requires no field calibration or sensitivity adjustments.

OPTIONS

START-TO-HIGH TIMER (SH)

- Upon power up sensor holds lights on and high for 20 min

OCCUPANCY CONTROLLED DIMMING (D)

- Provides dimming outputs to control 0-10 VDC dimmable ballasts
- Provides a second occupancy time-out period that enables the lights to go to a dim setting before turning off
- Adjustable max/min dim setting

PHOTOCELL (P)

- Ideal for high bay applications with skylights
- Photocell looks out through rear of sensor enclosure
- Auto set-point calibration
- Two selectable modes of operation
- On/Off mode: Photocell has full control during periods of occupancy
- Inhibit mode: Photocell can prevent lights from turning on if adequate daylight is available, but cannot turn lights off

DOWN LOOKING PHOTOCELL (PD)

- Ideal for high bay applications with daylight entering space from side windows or bay doors
- Photocell views down through sensor lens
- Auto set-point calibration
- Two selectable modes of operation
- On/Off mode: Photocell has full control during periods of occupancy
- Inhibit mode: Photocell can prevent lights from turning on if adequate daylight is available, but cannot turn lights off

347 VAC (347)

- Allows sensor to be powered from and switch 347 VAC

LOW TEMP/HIGH HUMIDITY (LT)

- Sensor is corrosion resistant to moisture
- Operates down to -40° F/C

ORDERING INFO

CMRB 6 [START-TO-HIGH] [DIMMING] [PHOTOCELL] [VOLTAGE] [TEMP/HUMIDITY]

START-TO-HIGH

Blank = No STH
SH = w/STH

DIMMING

Blank= None
D = Occupancy
Controlled
Dimming

PHOTOCELL

Blank= None
P= Up Looking Photocell
PD= Down Looking
Photocell

VOLTAGE

Blank = 120/277 VAC
347 = 347 VAC

TEMP/HUMIDITY

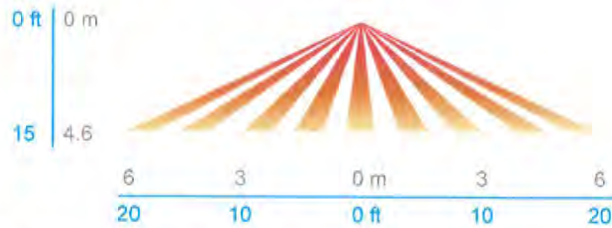
Blank = Standard
LT = Low Temp

COVERAGE PATTERN

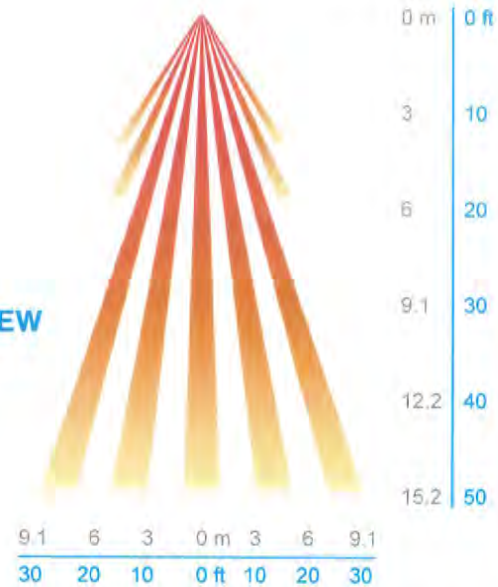
6 HIGH BAY 360° LENS

- Best choice for 15 to 45 ft (4.57 to 13.72 m) mounting heights
- 15 to 20 ft (4.57 to 6.10 m) radial coverage overlaps area lit by a typical high bay fixture
- Excellent detection of large motion (e.g. **walking**) up to a 35 ft (10.76 m) mounting height
- Excellent detection of extra large motion (e.g. **forklifts**) up to a 45 ft (13.72 m) mounting height

LOW VIEW



HIGH VIEW



WIRING (DO NOT WIRE HOT)

STANDARD WIRING

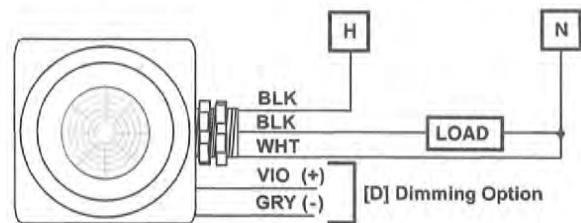
- BLACK*** - Line Input } *BLACK wires can be reversed
BLACK* - Load Output
WHITE - Neutral

347 VAC OPTION (347)

Black wires are replaced w/ Red wires

INITIAL POWER UP (3 MINUTE WARM-UP)

The sensor's relay is shipped in a latched closed position so the lights will come on upon initial power-up. After a 1-3 minute warm-up period, the sensor will begin to time out. If the lights do not immediately turn on (initial installation only) the latching relay opened during shipment and will close after warm-up period is over.



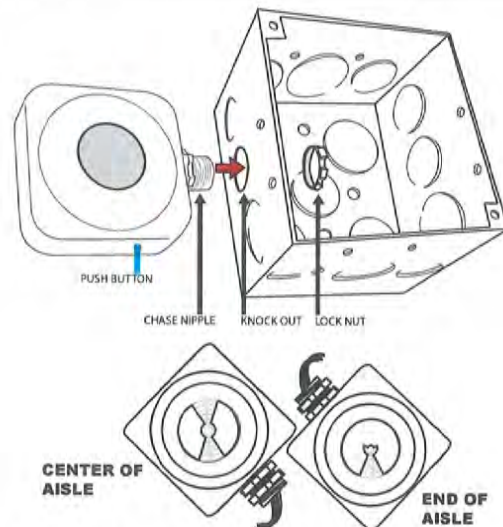
DIMMING OPTION (D)

VIOLET - Connect to Violet control wire from 0-10 VDC dimmable ballast

GRAY - Connect to Gray common wire from ballast

INSTALLATION

- Sensor mounts through a 1/2" knockout hole to a fixture or junction box.
- A label kit is included to mask off half of the sensor's coverage pattern for end of aisle, or trim the side viewing to create a rectangular pattern for center of aisle.
- If the sensor's field-of-view is partially blocked by the fixture housing, the FB-1 Fixture Bracket (not included) can be used to lower the sensor down to a level where its view is not impaired.



PROGRAMMING

Refer to included instruction card for default settings and directions on programming the sensor via the push-button.

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T018-005-P

TYPICAL APPLICATIONS

- Daylight Harvesting
- On/Off Lighting Control

FEATURES

- Full On/Off Switching of Lighting
- Works as Stand Alone Unit or with Occupancy Sensor System
- Capable of finding optimum set-point
- Digital Set-Point Control
- Programmable via simple push-button commands
- Outputs to Power Pack or Lighting Control System via SPDT Relay
- Green LED Activity Indicator
- 100 Hour Lamp Burn-in Timer Mode

AVAILABLE OPTIONS

- Dual Zone Control (-DZ)
- Low Temp/Hi Humidity (-LT)

SPECIFICATIONS

- Size: Circular, 4.55" Dia., 1.55" Deep (11.56 cm Dia., 3.94 cm Deep)
- Sensor Weight: 5 Ounces
- Sensor Color: White
- Mounting: Ceiling Tile Surface, Round Fixture or Junction Box
- Relative Humidity: 20 to 90% non-condensing
- Operating Temp: 14° to 160° F (-10° to 71° C)
- Storage Temp: -14° to 160° F (-26° to 71° C)
- Operating Voltage: 12-24 VAC/VDC
- UL, CUL, and Title 24 Compliant
- 5 Year Warranty
- Made in U.S.A.

LOW TEMP/HI HUMIDITY(-LT)

- Conformally coated Circuit Board is corrosion resistant from moisture
- Operates down to -40° F (-40° C)

CM-PC

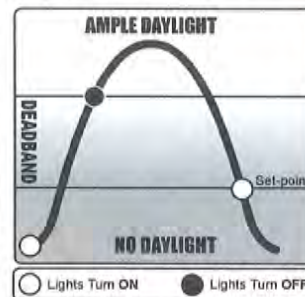
w/ Dual Zone Option!



The CM-PC series of On/Off Photocell sensors provide the industry's most intelligent control of lighting for daylight harvesting applications. Ideal for public spaces with windows like vestibules, corridors, or bathrooms; the sensors work by monitoring daylight conditions in a room, then controlling the lighting so as to insure that adequate lighting levels are maintained. The CM-PC is used for On/Off lighting control; turning off the lights when sufficient natural light is present and turning them on when additional lighting is necessary. Additionally with the Dual Zone (-DZ) option, a second set of customized control outputs is provided. All CM-PC sensors can be used alone or as part of an occupancy sensor system. The sensors are powered with 12 to 24 VAC/VDC and typically operate with a PP-20 or MP-20 Power Pack; enabling complete 20 Amp circuits to be controlled. To add dimming control to the On/Off switching provided by the CM-PC, see the Technical Data Sheet on the CM-PC-ADC sensor.

ON/OFF SWITCHING OPERATION

The lights turn "On" when the space's overall light level drops below a programmable threshold called a "set-point". The lights turn "Off" when light is above the set-point plus a 10 to 20% safety factor and deadband. The safety factor will prevent the system from cycling when the light level is very near the set-point. The deadband is the level of light contributed by the artificial lights being controlled. This level is tracked so if the lighting conditions change (for example a lamp burns out) the point at which the lights turn off is adapted accordingly. If the photocell is looking up at skylights and can not view the lights being controlled, there is no deadband and the sensor is said to be working "open loop". There is also an adaptive 5-25 minute delay before the photocell turns the lights off to prevent the system from cycling on a cloudy day; and a 45 second delay before switching from "Off" to "On".



DUAL ZONE (-DZ) OPTION

With the -DZ option, a second low voltage output is provided to control an additional zone of lighting according to one of two operational modes. The default mode, referred to as "Duo" operation, is ideal for A/B switching applications (also called inboard/outboard) as it determines the necessary On/Off combination of the zones in order to maintain adequate lighting. The alternate mode uses a relative set-point for the second zone that is a selected percentage higher than the primary zone's set-point. This mode accounts for the fact that daylight contribution diminishes as the distance from the source (windows) increases. Called "Percentage" operation, this second mode is ideal for classrooms with individually controlled parallel rows of lights. A single shared set-point is used by both modes and can be user programmed or automatically determined by the sensor itself.

Model Numbering System: CM-PC-[DUAL ZONE]-[TEMP/HUMIDITY]

SERIES #	DESCRIPTION	DUAL ZONE	TEMP/HUMIDITY
CM-PC	On/Off Photocell Sensor - Ceiling Mount, Low Voltage	Blank = Single Zone -DZ = Dual Zone	Blank = 14° to 160° F -LT = -40° to 160° F

LIGHT LEVEL SET-POINT

The sensor functions by comparing the amount of daylight available with a defined acceptable lighting level. This threshold, called the set-point, is utilized in all daylight harvesting lighting control decisions. The sensor can find its optimum set-point via the **Automatic Set-Point Programming** mode. In this mode, the sensor sets the minimum light level to be the amount contributed by the artificial lights being controlled. It is assumed that the space is properly lit by design, however, if this is not the case the set-point may be easily adjusted to the occupant's preference. All modes and settings are entered digitally via a push button sequence. Once programmed, the exact value of the set-point (in foot candles) can be read out from the sensor via a series of LED flashes.

DIGITAL SET-POINT CONTROL

Each sensor contains a microcontroller that enables the user to engage the Automatic Set-Point Programming mode or to manually set / adjust the set-point. The manual process involves calculating and inputting the exact foot-candle value of the desired set-point into the sensor. It is important to note that the set-point is the light level required at the face of the sensor and that this value will be much different than the level required at a work surface. Typically, light levels at the ceiling are 3 to 5 times less than the work surface. For example, if 50 fc is desired at the work surface, the sensor should be set at 10 fc. For best results, measure the levels at both locations using a foot-candle meter before programming the set-point.

WIRING INSTRUCTIONS

Wire lead connections are Class II, 18 to 22 AWG.

STANDARD CM-PC

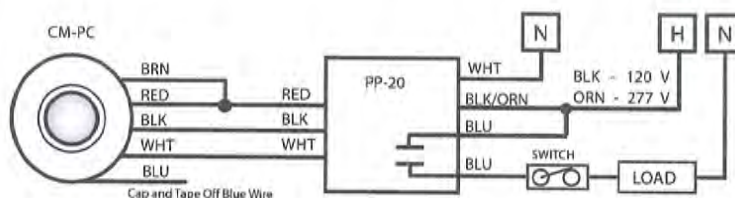
WHITE - Outputs high VAC/VDC (from Brown wire) when sensor calls for Lights "On" (eg. the room is Dark)

BLUE - Outputs high VAC/VDC (from Brown wire) when sensor calls for Lights "Off" (eg. adequate daylight light is present)

RED - 12 to 24 VAC/VDC

BLACK - Common

BRN - Connect to Low Voltage Control input (Red wire on a Power Pack, White wire on an occupancy sensor)



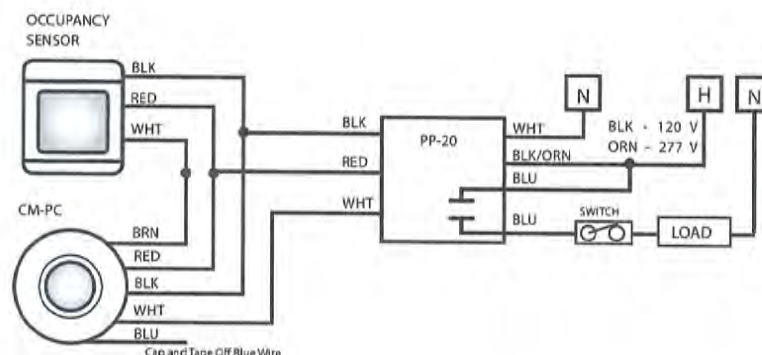
DUAL ZONE OPTION (CM-PC-DZ)

BLUE wire will output high DC when sensor calls for Lights "On" for Zone 2.

(Note: With the -DZ option the SPDT Relay is no longer present and the White wire will output only DC)

WIRING TOGETHER WITH OCCUPANCY SENSORS

Wire upstream occupancy sensor White wire to sensor Brown wire. When the space is unoccupied, the lights stay off regardless of daylight levels. However when occupied, the photocell sensor will control the lights according to daylight level and set-point.



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www.sensorswitch.com

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TYPICAL APPLICATIONS

- Used with Low Voltage Sensors
- Multiple Sensors
- Multiple Loads
- AC Switching Only

HIGHLIGHTS

- Dual Voltage Transformer
- Self-Contained Relay
- Patented Relay Circuit Protection (Tested to over 400,000 cycles)
- Powers up to 14 sensors

SPECIFICATIONS

- Size: (1/2" inch chase nipple not inc.)
PP-20-2P: 4 1/8 x 3" x 1 7/8"
PP-20 & SP-20: 3" x 2 1/4" x 1 7/8"
- Mounting: 1/2" inch chase nipple
- Operating Voltage: 120, 240, or 277 VAC (Single Phase only)
- Each Relay: 20 Amps
- 1 HP Motor Load
- Output Voltage: 15 VDC, 150 mA at 120 or 277 VAC
- Class II: 18 AWG, up to 2,000 ft.
- Plenum Rated
- Relative Humidity: 20 to 90% non-condensing
- Operating Temp: 14° to 160° F
- Storage Temp: -14° to 160° F
- UL and CUL Listed
- 5 Year Warranty
- Made in U.S.A.

LOW TEMP/HI HUMIDITY(-LT)

- Conformally Coated PCB
- Operates down to -40° F
- Corrosion resistant from moisture

PLENUM CONSIDERATIONS

Most local codes allow for small plastic controls in Return Air Plenums; *Some Do Not!* To meet local code, the Power Pack can be mounted inside an adjacent (Deep) junction box as shown below.



PP-20 PP-20-2P SP-20

Plenum Rated



Power Packs are the heart of the Low Voltage Sensor System. The *PP-20* transforms 120, 240 or 277 Volts (single phase) to class II 15 VDC to power the remote sensors. Utilizing Patented Relay Circuit Protection the *PP-20* also switches the lighting load "On" and "Off": Tested to over 400,000 cycles at rated load! Although Plenum Rated, the elongated mounting nipple allows for the *PP-20* to be mounted either directly thru a 1/2" inch knockout in a junction box, or to be located inside an adjacent box for specific local code requirements. Up to 14 sensors may be connected to one *PP-20*. Multi-circuit control can be handled by multiple *PP-20*'s, or 2-Pole Power Packs (*PP-20-2P*) and Slave Packs (*SP-20*) may be configured. *PP-20*'s can be wired continuously hot (line side), or on the switch leg (load side) without nuisance delays upon turn "On".

LOW VOLTAGE OPERATION AND TEST

The Low Voltage Wires or Terminal is color coded Red (15 VDC), Black (Common), and White (Occupancy Signal). With no sensors connected, using a small wire, connect the Red terminal to the White. The lights should turn "On". Remove the connection and the lights should turn "Off". With the sensors connected, the Red and Black wires provide DC power to the remote sensors, and when there is occupancy detected, the White wire produces a 15 VDC signal from the sensor to the power pack initiating the lights to "On". Upon initial power up, the Sensors automatically send an "On" signal until the sensors have stabilized and "Timed Out".

SIZING OF THE SYSTEM - VARIOUS COMBINATIONS

Combining Power Packs provides for additional power to drive remote devices. Maximum numbers of remote sensors are shown below based on the Power Pack/Slave Pack being used. *Maximum number of "Relays" is 30.*

	Sensors	Sensors with Relay
1 PP-20	14	8
1 PP-20-2P	7	6
1 PP-20 w/SP-20	7	6
1 PP-20-2P w/SP-20	5	5
2 PP-20	28	16
2 PP-20-2P	14	12

Note 1: Only three relays may be controlled with one Power Pack. If more than three circuits are required, multiple Power Packs must be used.

Note 2: Only one "Sensor with Relay" is required in most cases. See Technical Datasheet on Low Voltage Sensors with -R Interface Option.

SYSTEMS CONSIDERATIONS

The local override switch may be upstream or downstream of a *PP-20*. However, if an *SP-20* Auxiliary Relay or a *PP-20-2P* controller is being used, the switch(es) should be downstream on the load side of the relay. If power is disconnected to the Power Pack all subsequent relays will open, turning off all of the loads. If wiring the local switches before the Power Pack and Slave Pack, use multiple *PP-20*'s, one for each circuit. This will allow for one circuit to remain powered, keeping the system operational when the other is turned off. When controlling a dimming circuit, *PP-20* must be wired before dimmer, or *SP-20* may be wired after dimmer.

INTERFACING WITH ELECTRONIC CONTROL SYSTEMS

The Relay Switching System is designed to switch Alternating Currents Only. The relay will not switch DC signal inputs to EMS or Lighting Control Systems. Use model #MP-20, or "-R" for signal relay located in Low Voltage Sensor Heads.

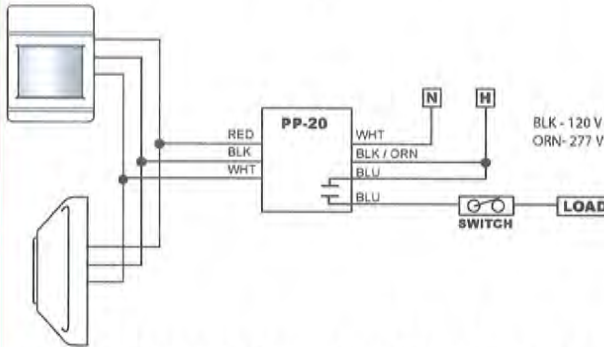
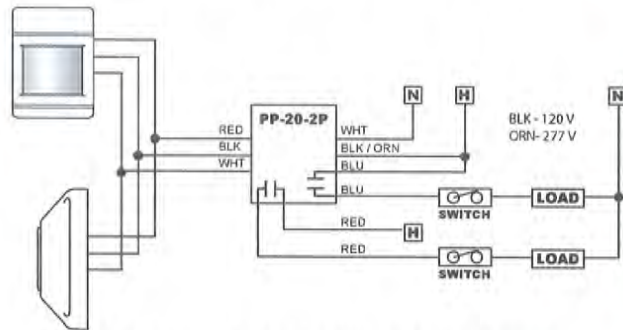
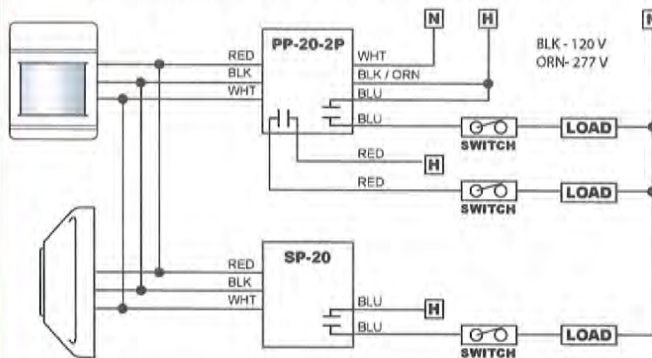
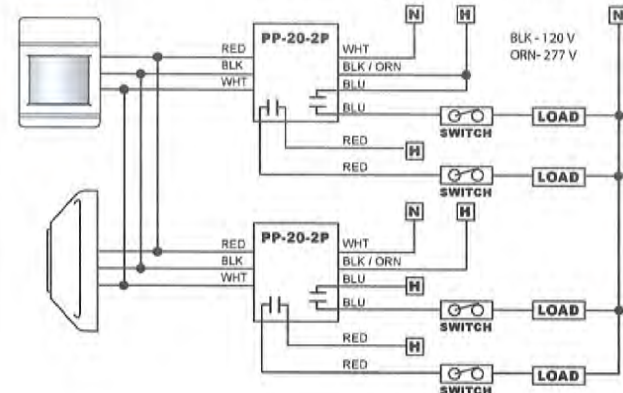
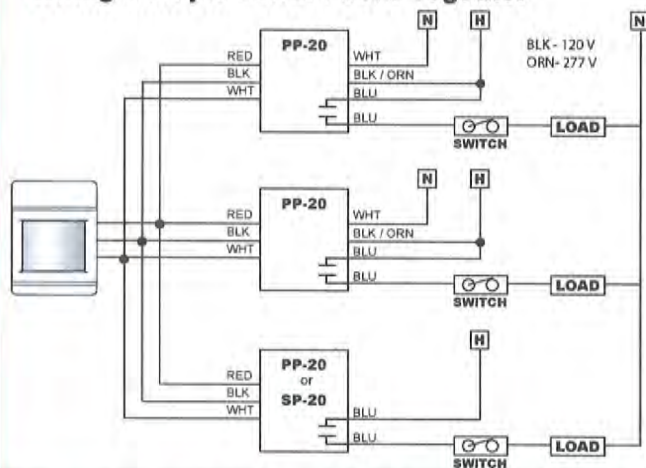
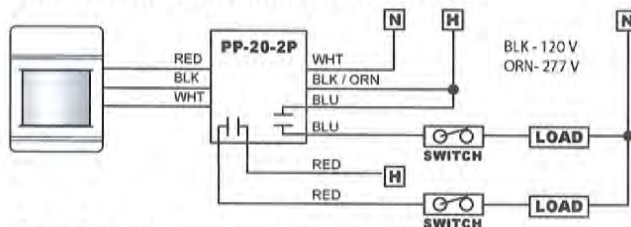
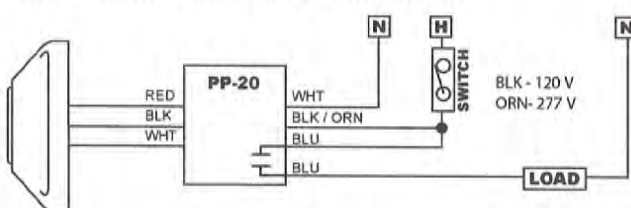
CATALOG INFORMATION

MODEL#	DESCRIPTION	OUTPUT VOLTAGE	OUTPUT CURRENT
PP-20	Power Pack with 20 Amp Relay	15 to 24 VDC	70 to 110 mA
PP-20-2P	Power Pack with two 20 Amp Relays	15 to 24 VDC	35 to 70 mA
SP-20	Slave Pack with 20 Amp Relay	N/A	40 mA (consumption)

**Add suffix -LT for Low Temp/Hi Humidity

TYPICAL WIRING DIAGRAMS - DO NOT WIRE HOT

NOTE: The Power Pack must be connected to a single phase Hot and Neutral System. For 120 VAC, connect the Black wire to Hot, White wire to Neutral, and Cap off the Orange wire. For 240-277 VAC, connect the Orange to Hot, White to Neutral, and Cap off the Black wire. *Never connect both the Black and Orange wires!* Low Voltage wire can be 18 to 22 AWG; shielding is not necessary. Class II terminal Block on PP-20-2P only accepts one conductor per terminal of 18 AWG stranded or smaller.

Multiple Sensors Controlling One Circuit**Multiple Sensors Controlling Two Circuits****Multiple Sensors Controlling Three Circuits****Multiple Sensors Controlling Four Circuits****Wiring Multiple Power Packs Together****One Sensor Controlling Two Circuits****One Sensor Controlling One Circuit**

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Fixed Position Mounting	K4021C	K4023C	K4024	K4022	K4033	K4035*	K4321C
Watts Tungsten	1800	3100-4150	3100	3600	4150	1000	1800
VA Ballast	1000	1700-2300	1700	2000	2300	4000	1000
AMPS Tungsten	15	15	15	15	15	15	15
AMPS Ballast	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Volts	120	208-277	208	240	277	480	120

*Not UL or CSA Certified



Stem Mounting	K4121C	K4121M	K4124	K4122	K4123C	K4123M	K4133	K4135	K4136M	K4141C*
Watts Tungsten	1800	2000	3100	3600	3100-4150	2000-2660	4150	1000	2000-4625	3000
VA Ballast	1000	1800	1700	2000	1700-2300	1800	2300	4000	1800	3000
AMPS Tungsten	15	16.7	15	15	15	9.6	15	15	16.7	25
AMPS Ballast	8.3	15	8.3	8.3	8.3	8.6	8.3	8.3	8.6	25
Volts	120	120	208	240	208-277	208-277	277	480	120-277	120

*Not UL or CSA Certified



Stem and Swivel Mounting	K4221C	K4224	K4222	K4223C	K4233	K4235	K4236C	K4251	K4253
Watts Tungsten	1800	3100	3600	3100-4150	4100	1000	1800-4150	1800	2000
VA Ballast	1000	1700	2000	1700-2300	2300	4000	1000-2300	1000	1800
AMPS Tungsten	15	15	15	15	15	15	15	15	16.7
AMPS Ballast	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	15
Volts	120	208	240	208-277	277	480	120/208-277	120	208-277



Twist Lock Mounting	K4521	K4524*	K4522	K4533*	K4533*
Watts Tungsten	1800	3100	3600	4100	1000
VA Ballast	1000	1700	2000	2300	4000
AMPS Tungsten	15	15	15	15	15
AMPS Ballast	8.3	8.3	8.3	8.3	8.3
Volts	120	208	240	277	480

*Not CSA Certified



Relay Type	K1121	K1122	K1221	K1222
Watts Tungsten	1800	1800	1800	1800
VA Ballast	1800	1800	1800	1800
Volts	105-130	210-240	105-130	210-240



Low Cost Twist Lock	LC4521C	LC4523	LC4535	LC4536C	LC4521LA	LC4523LA	LC4535LA	LC4536LAC
Watts Tungsten	1000	1700-2300	7200	1000-2300	1000	1700-2300	1000	1000-2300
VA Ballast	1000	1700-2300	4000	1000-2300	1000	1700-2300	4000	1000-2300
AMPS Tungsten	15	15	15	15	15	15	15	15
Volts	120	208-277	480	120-277	120	208-277	480	120-277



Solid State Fixed Position	K4536SS	K4536SST
Watts Tungsten	1000	1000
VA Ballast	1800	1800
AMPS Tungsten	9.6	9.6
Volts	105-305	105-305

Intermatic Incorporated
 Spring Grove, Illinois 60081-9698

www.intermatic.com
www.energycontrols.com

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ELOGIC™ Lighting Controls Sensor & Control for Daylight Harvesting



RetroFriendly™ Series

Compatible Ballast Guide

T8 QUICKTRONIC® POWERSENSE®
(100-5% Dimming)

QTP1x32T8/UNV DIM

QTP2x32T8/UNV DIM

QTP3x32T8/UNV DIM

QTP4x32T8/UNV DIM

T5 QUICKTRONIC POWERSENSE
(100-1% Dimming)

QTP2x28T5/UNV DIM

T5HO QUICKTRONIC HELIOS™
(100-1% Dimming)

QT1x54/120PHO-DIM

QT1x54/277PHO-DIM

QT2x54/120PHO-DIM

QT2x54/277PHO-DIM

Note: Other vendors' 0-10V dimming ballasts should also work. Contact SYLVANIA for compatibility.

ELOGIC LIGHTING CONTROLS FOR DAYLIGHT HARVESTING provide closed-loop daylight harvesting control using the 0-10V port on a dimming ballast.

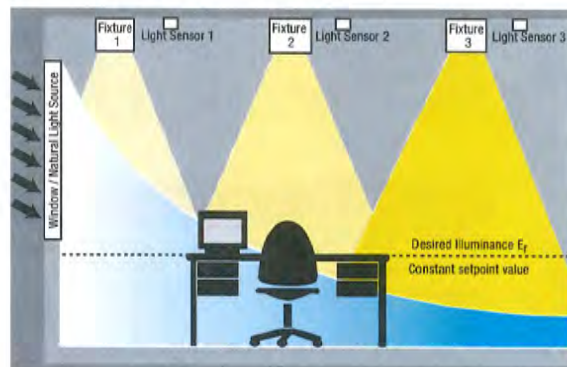
Fast Way To Save Energy: Simply clip the sensor onto a lamp in the fixture and wire directly to the QUICKTRONIC POWERSENSE or HELIOS ballast using low-voltage wiring. Complete the installation with a single adjustment.

Flexible Wiring: Use one sensor per fixture or share the low voltage dimming signal from one sensor with up to ten ballasts in the same row near the windows.

Save Money on Labor and Materials: The *RetroFriendly* Daylight Sensor requires no power pack when connected to POWERSENSE ballasts.

Ready to Mount: Many fixture configurations allow mounting of the sensor directly to the lamp with either the T8 or T5 clip. If desired, the sensor can mount directly on the fixture surface or ceiling rail or industrial two-sided tape.

Improve Occupant Satisfaction: Governmental studies have shown that occupants are more productive when given personal control over their workspace lighting. Satisfy occupant needs by adding wall controls with AC line dimming.



Key System Features

Save Energy Two Ways at Once: Take advantage of the QUICKTRONIC POWERSENSE ballast's ability to be controlled by both the 0-10V daylight sensor and AC line dimming.

Application Information

ELOGIC Lighting Controls for Daylight Harvesting Controls are ideally suited to achieving energy savings when:

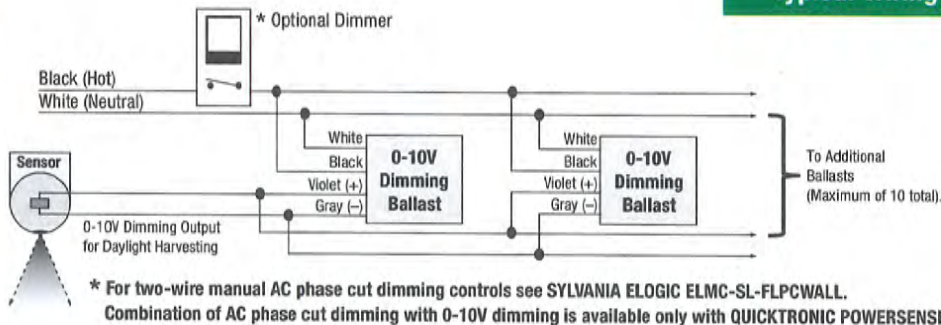
Retrofitting existing fixtures

- mount to lamps

Mixing daylight harvesting energy savings with occupant control:

- add power-line dimmer in wallbox

Typical Wiring Diagram



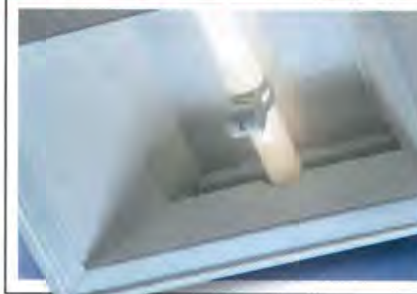
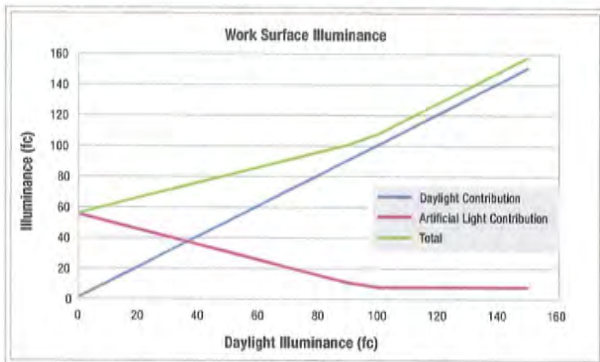
SPECIFICATION DATA

Catalog #	Date	Type
Project	Prepared by	
Comments		

Daylight Sensor Ordering Information

Item Number	OSRAM SYLVANIA Description	Type	Ballast Control Method	Output Voltage (VDC)	Max. Input Current (mA)	Lamp Type
45030	ELSC-DLH-TV LAMP/BUS	Sensor & Control for Daylight Harvesting	Analog	0-10V	6	T8 or T5

Operation Example with ELOGIC Lighting Control for Daylight Harvesting (100-1% Dimming)



This sensor has a light control function that reduces the amount of artificial light by approximately 50% measured against the increase in daylight. The diagram shows how a typical workplace installation works for a level of 50 fc.

Dimensions:

Overall: 1.2"L x 0.85"W x 0.85"D

Mounting: Use included lamp clips for T8 or T5.

Use customer-supplied two-sided tape for surface mount.

Packaging:

Quantity: 1 per box with T8 and T5 mounting clips

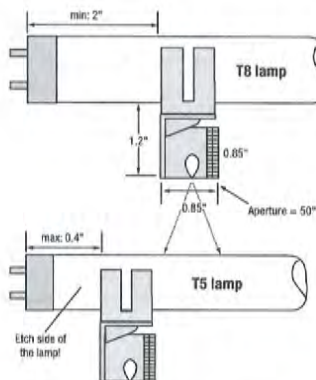
Weight: 0.5 lbs each (approx)

Wiring:

Leads only: 25"

Wires run into fixture and connect directly to ballast.

Violet and Gray leads connect directly to 0-10V control port on ballasts



Surface Mount with user-supplied two-sided tape.

Item Number	45030	EL	SC	-	DLH	-	TV	LAMP / BUS	Ballast Powered
ELOGIC Lighting Control									Lamp Mounted T8-T5 Clips
Sensor & Control									0-10V Analog Output
Daylight Harvesting									

Sensor and Control for Daylight Harvesting

Field of View



Specifications

Technical data for ELOGIC Lighting Controls for Daylight Harvesting

- Closed-loop daylight harvesting control using 0-10V input to/from QUICKTRONIC® POWERSENSE® dimming ballast.
- Up to 10 POWERSENSE ballasts per sensor (max. 6 mA)
- Max. voltage on 0-10V leads: 12V
- Up to 50% energy savings
- Adjust daylight aperture by turning the case
- Daylight measurement angle: 50°
- Max. case temperature: 55°C
- Lead insulation Temperature: 105°C
- Lead insulation Voltage: 600VAC
- Lead length: 25"
- Mount: clips for T8 & T5

UL recognized (FNFT) as Electric Discharge Lamp Control Equipment/ Specialty.
Flame retardant to UL standard 94HB.

System Life / Warranty

OSRAM SYLVANIA ELOGIC Lighting Controls for Daylight Harvesting are covered by a full two year warranty.

OSRAM SYLVANIA
National Customer
Service and Sales Center
1-800-LIGHTBULB
(1-800-544-4828)
www.sylvania.com

Specifications subject to change without notice.

Ordering information

Model number	Control type
LRF2-OCRB-P-XX	ceiling-mounted occupancy/vacancy sensor, auto-on/auto-off or manual on/auto-off settings
LRF2-VCRB-P-XX ¹	ceiling-mounted vacancy sensor, manual on/auto-off setting only
LRF2-DCRB-WH	ceiling-mounted daylight sensor
LRF2-OWLB-P-WH ²	180° wall-mounted occupancy/vacancy sensor, auto-on/auto-off or manual on/auto-off settings
LRF2-VWLB-P-WH ^{1,2}	180° wall-mounted vacancy sensor, manual on/auto-off setting only
LRF2-OKLB-P-WH ²	90° wall-mounted occupancy/vacancy sensor, auto-on/auto-off or manual on/auto-off settings
LRF2-VKLB-P-WH ^{1,2}	90° wall-mounted vacancy sensor, manual on/auto-off setting only
LRF2-OHLB-P-WH ²	hallway occupancy/vacancy sensor, auto-on/auto-off or manual on/auto-off settings
LRF2-VHLB-P-WH ^{1,2}	hallway vacancy sensor, manual on/auto-off setting only

¹ Vacancy models meet California Title 24 section 119(j) requirements

² Available Q2 2010

- Ceiling mount occupancy/vacancy sensor available in the following colors:
white (WH)  black (BL)  light almond (LA)

Detection range for fine motion (ceiling-mount occupancy/vacancy sensors)

Ceiling height	Maximum room dimensions for complete floor coverage	Square feet
8 ft (2.4 m)	18 × 18 ft (5.5 × 5.5 m)	324 ft ² (30.2 m ²)
9 ft (2.7 m)	20 × 20 ft (6.1 × 6.1 m)	400 ft ² (37.2 m ²)
10 ft (3.0 m)	22 × 22 ft (6.7 × 6.7 m)	484 ft ² (44.9 m ²)
12 ft (3.7 m)	26 × 26 ft (7.9 × 7.9 m)	676 ft ² (62.4 m ²)

www.lutron.com

World Headquarters 1.610.282.3800

Technical Support Center 1.800.523.9466 (Available 24/7)

Customer Service 1.888.LUTRON1



What is Radio Powr Savr™?

Radio Powr Savr is a family of wireless occupancy/vacancy sensors and daylight sensors that provide convenient light control and are engineered for optimum energy savings and easy installation. Radio Powr Savr wireless sensors save energy by directing compatible Lutron RF dimmers and switches to reduce lighting levels or turn lights off based on room occupancy/vacancy and available daylight.

Saves energy

- Occupancy/vacancy sensors turn lights off when room is unoccupied—choose a 1-, 5-, 15- or 30-minute time-out based on needs in the space
- Daylight sensors reduce electric lighting or turn lights off when there is enough available daylight to light the space
- Use sensors with dimmers for additional energy savings

Delivers reliable lighting performance

- Exclusive Lutron XCT™ technology in occupancy/vacancy sensors detects fine motions of room occupants
- Clear Connect™ Radio Frequency (RF) technology ensures reliable, consistent RF performance between devices
- Proportional daylight control in daylight sensor provides accurate daylight harvesting
- 10-year battery life

Installs in minutes

- Sensors require no wiring
- Front-accessible buttons make setup easy
- Sensors have simple test modes to verify ideal locations during installation



ECM 3: New Energy Management Systems

ECM Overview

Ameresco proposes to install programmable thermostats and boiler plant controllers at the Fire Station, Department of Public Works, Town Hall and the Memorial Boys and Girls Club. Ameresco proposes automatic control equipment at the Council on Aging - Hilton Senior Center to improve comfort while reducing energy consumption, and at the Wastewater Treatment Plant to improve its operations and save energy costs.

ECM Detail

Existing System

The following descriptions are an overview of the existing systems of heating, ventilation and air-condition automatic controls.

- **Fire Department**

The boiler pumps are controlled by outside air temperature. A line voltage, outside air thermostat (Penn) set at 65 deg. F controls the pump's operation via a three pole relay. The circulating pumps operate continuously whenever outside air temperature is below the setpoint, regardless of indoor temperature. The boiler's hot water setpoint is controlled by a boiler-mounted aquastat and set at 180 deg. F.

Conventional, wall-mounted, heating only thermostats (e.g. Honeywell T87) control each room within the finned tube radiation zone. These thermostats serve to limit the temperature within each room, but are not connected to the distribution system. There are seven room thermostats.

Line voltage thermostats control each of the unit heaters in the Apparatus Bay. There are six thermostats and each is located in a security enclosure.

- **Department of Public Works**

There are two heating zones for the building, the garage and maintenance area in the office area. Each zone is served by a hot water circulator pump. The boiler pumps are controlled by outside air temperature. A line voltage, outside air thermostat (Penn) set at 65 deg. F controls the pump's operation. The circulating pumps



Figure 3.1: The Town Hall AHU thermostats have been difficult to maintain and are replaced as part of the scope of this measure.

operate continuously whenever outside air temperature is below the setpoint, regardless of indoor temperature. The boiler's hot water setpoint is controlled by a boiler-mounted aquastat and set at 180 deg. F. Conventional, wall-mounted, heating-only thermostats (e.g. Honeywell T87) control rooms within the office radiation zone. These thermostats serve to limit the temperature within each room, but are not connected to the distribution system. There are eight room thermostats.

Line voltage thermostats control each of the unit heaters in the garage and maintenance shops. Each has a thermostat without a security enclosure.

- **Council on Aging – Hilton Senior Center**

The original area, which includes the current Senior Center Activity Rooms, is divided into two zones of heating and cooling. Each zone is controlled by a programmable thermostat (Aprilaire 8362). The units cycle on and off based on thermostat call and do not operate continuously.

The Council on Aging office area is served by a single zone of equipment in which an attempt is made to create two sub zones by a duct damper control system. These sub zones are the conference room and the offices. Each of these sub zones includes a programmable thermostat (Aprilaire 8366). Each thermostat controls a zone damper whose intent is to vary the flow rate of air into the area. In turn, the zone damper controller starts and stops the unit; the unit does not operate continuously. Each damper is normally closed, and opens when its thermostat calls for heating or cooling. It's often the case that one thermostat calls for heating or cooling while the other is satisfied. Once the duct damper is open, the unit starts and delivers its full flow and capacity to the sub zone that initiated it. The result is that the sub zone is deluged with the full airflow of the unit, which causes excessive noise and unit cycling.

- **Town Hall**

Town Hall is heated by three independent systems: a steam system that serves original radiators on the First Floor, a warm air furnace which serves the inspectional services and planning departments on the First Floor and a hot water system that serves the Second Floor. Town Hall has five zones of control as well as the second floor perimeter finned tube radiation which serves as "skin" heating and the inspectional services office which is a sub zone of the planning department.

Planning has a standard thermostat and switching subbase with a single stage of either heating or cooling for its warm air furnace which is equipped with a split system cooling coil. Inspectional Services is a subzone of this system with a thermostat which controls a zone damper to limit its amount of heating or cooling. Inspectional Services has supplementary electric baseboard heat controlled by a dedicated, wall-mounted thermostat; this system is operated only on very cold days.

The first floor offices' steam boiler is controlled by a programmable thermostat in the corridor of the first floor. This thermostat has a security enclosure.

The second floor is served by three air handling units; each is controlled by programmable thermostats with a remote temperature sensor. These thermostats are in an enclosure in a mechanical area to the rear of the

stage. AHU-1 and AHU-3's sensors are in the conference rooms. AHU-2's sensor is near the return grill in the stage area. The second floor's perimeter is heated with hot water finned tube radiation; this system is continuously operating during the heating season whenever the outside air temperature is greater than the pump controller setpoint. The second floor finned tube radiation's pumps and hot water supply temperature is controlled by a dedicated controller in the basement mechanical room.

- **Memorial Boys and Girls Club**

The facility's steam heating system is manually controlled. Once enabled, the boiler operates as required to maintain its pressure control setpoint. Fuel oil pumps operate continuously. Unit ventilator fans are manually switched off and the units function as convectors. There's heat loss from steam and condensate piping on the first floor which adds heat to the spaces. Their temperatures fluctuate based upon ambient conditions. The air handling unit which serves the gymnasium has not operated for many years. The motor starter for its single phase, 5 hp motor, is disassembled.

The facility's hot water heating system is manually controlled. Once enabled, the hot water boiler operates as required to maintain its aquastat setpoint. The hot water pumps operate continuously; the three way valve that would control hot water supply temperature is currently not operating. Occupants switch unit ventilator fans on and off as required.

Automatic control systems are in substantial disrepair and not operating. The steam section of the facility retains portions of its original pneumatic control system, including an operating air compressor. However, pneumatic thermostats are largely missing and there are substantial leaks. The outside air reset control of the main steam control valve does not operate.

The hot water portion of the facility is not currently distributing control air from the boiler room. Its compressor is relatively new and appears to be functioning well. However, the main distribution pipe filters are plugged and completely obstructing air flow. Most components of the original control systems remain, including a main panel with time-clocks, zone P/E switches, etc., but their condition is identified to be very poor or failed. Room thermostats are in poor condition. Overall, terminal equipment controls, including unit ventilator control valves and ventilation dampers, appear to be mostly original and not operating.

- **Waste Water Treatment Plant**

Rooftop unit, AC-1, provides heating, cooling and air conditioning to the occupied areas of the facility. AC-1 is controlled by a programmable thermostat located in the plant office. AC-1's outside air damper is not operating, which results in a lack of ventilation and, during cooling season, economizer cooling.

The laboratory area's temperature is controlled by an electrical reheat coil located in a main branch of AC-1's ductwork. The laboratory fume hood sash is normally closed and its fan off.

Electric baseboard heaters with unit-mounted thermostats are located along glazed walls in the office areas. Reportedly, this equipment is rarely operated.

The garage propane heater is controlled by a wall mounted thermostat and maintained at 55 deg. F. The heating and ventilating unit, HV-1, is not operated.

Proposed System

Ameresco proposes to install programmable thermostats and boiler plant controllers at the Fire Station, Department of Public Works, Town Hall and the Memorial Boys and Girls Club. Ameresco proposes automatic control equipment at the Council on Aging - Hilton Senior Center to improve comfort while reducing energy consumption, and at the Wastewater Treatment Plant to improve its operations and save energy costs.

> General Scope of Work:

- Perform all work in a neat and workmanlike manner.
- Locate wiring parallel to building surfaces and make transitions with 90-degree angles. No wiring may be run as "the crow flies".
- Locate mechanical spaces wiring in in existing EMT raceways or add new EMT, as required
- Concealed wiring shall be plenum-rated and shall be sized according to the controller manufacturer's specification.
- Wiring in ceiling plenums for reheat controls may be open cable but must be secured neatly above the ductwork to conceal as much of the cable as possible. Secure the wiring using tie-wrap adhesive base at intervals not greater than four feet.
- Wiring located in suspended ceilings shall be secured to the structure and shall be tie-wrapped at intervals not greater than ten feet. Wiring shall not be attached to other wiring systems, light fixtures etc. Wiring shall not be placed on top of suspended ceilings.
- Clearly label all cabinet doors, junction boxes, actuators, sensors, controller outputs, transducers, etc. prior to commissioning.
- Communications wiring shall meet applicable wiring guidelines.
- New control panels shall meet the UL508A listed equipment standard as well as NFPA79 guidelines and NEC requirements.
- Dispose of existing mercury thermostats as per the MA Mercury Management Act of 2006; see <http://www.thermostat-recycle.org/>

The following clarifications apply to the work scopes described for individual buildings 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 are assumed to be in good working condition except as specifically noted. Repairs to existing equipment are excluded except as specifically noted herein.
3. Excluded is the replacement of control dampers, air and water balancing, and the replacement of air compressors except as specifically noted.
4. Coordination of shutdown and cutovers of HVAC systems are assumed to be during normal working hours.
5. The Town shall provide a secure location on site to be utilized for equipment and job coordination.
6. Standard point-to-point commissioning and point check out is included as described below; excluded from this proposal is any cost associated with a 3rd party commissioning agent.
7. Excluded is any work associated with coring. Ameresco will utilize existing risers for network wiring.
8. 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.
9. Ameresco's scope does not include fire alarm modifications or installation of fire alarm components.
10. All mechanical systems to remain are expected to be in good working condition, any cost associated with repairs is not included in this proposal except as specifically noted.
11. Painting and patching is excluded except as specifically noted.
12. 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 except as specifically noted.

The specifications and clarifications listed above shall apply to any other ECMs that include scopes associated with the EMS.

> Detailed Scope of Work

• Fire Department

• *Install Programmable Thermostats*

- Install a programmable thermostat in the Day Room
 - Install wiring (min 4 conductor, 18 gage) from the thermostat to the boiler room; this thermostat shall serve as the zone thermostat
 - Replace the existing finned tube radiation control valve in the Day Room
 - Verify proper operation of the new thermostat and control valve
 - Install a secure thermostat guard over the new thermostat
- Install a programmable thermostat in the Apparatus Room
 - Locate this thermostat adjacent to the existing thermostat for UH #4 (see drawing H-1)
 - Install wiring (min 4 conductor, 18 gage) from the thermostat to the boiler room; this thermostat shall serve as the zone thermostat

- Install a secure guard over the new thermostat
- The line voltage unit heater (UH) thermostats shall remain in place
- Thermostats: Honeywell CommercialPro 7000 series, or equal
 - Connect the Common wire to the low voltage transformer “common” and utilize it to power the thermostat
- Furnish Programming for the thermostats
 - Set thermostats for “occupied” (Occ) and “unoccupied (UnOcc) as per the following (schedule and set points are adjustable)

Zone	Occ. T ° F	UnOcc T ° F.	Occ Time	UnOcc Time	Remarks
Day Room	70	60	8:00	17:00	Mon- Sun, Occ.
Apparatus Room	60	60	8:00	17:00	Mon- Sun, Occ.

• *Install a boiler plant controller*

- Remove the existing line voltage pump relay (3p) and the line voltage outside air temperature sensor
- Install a zone relays for two (2) zones (note: one zone pump serves as a stand-by and should be normally off)
- Boiler plant controller: Tekmar 260, or equal
 - Install a hot water supply or boiler water temperature sensor
 - Install an outdoor air temperature sensor
 - The controller software shall vary hot water supply temperature linearly with outside air temperature. The minimum boiler water supply temperature shall be 140°
 - The boiler shall be enabled whenever any zone thermostat switch closes

• *Install thermostatic radiator valve*

- Install one new TRV on baseboard radiator in the hose drying room.
- Set the internal thermostat for 50°

• **Department of Public Works**

• *Install Programmable Thermostats*

- Install seven (7) programmable, low voltage thermostats in place of the existing thermostats in seven rooms included in the Office zone
 - Install new wiring to the Boiler Room from the proposed thermostats
 - Install a secure thermostat guard over each thermostat
- Install a programmable thermostat in the Garage near the Electric Room; (reference: existing drawing HV-1)
 - Locate this thermostat adjacent to the existing thermostat for UH #4 (see existing conditions drawing H-1)
 - Install wiring (min 4 conductor, 18 gage) from the thermostat to the boiler room; this thermostat shall serve as the zone thermostat
 - Install a secure guard over the new thermostat
 - The line voltage unit heater (UH) thermostats shall remain in place

- Thermostats: Honeywell CommercialPro 7000 series, or equal
 - Connect the Common wire to the low voltage transformer “common” and utilize it to power the thermostat
- Furnish Programming for the thermostats
 - Set thermostats for “occupied” (Occ) and “unoccupied (UnOcc) as per the following (schedule and set points are adjustable)

Zone	Occ. T ° F	UnOcc T ° F.	Occ Time	UnOcc Time	Remarks
Office Zone Rooms	70	55	7:00	15:30	Mon- Fri, Occ.
Garage Zone	70	55	7:00	15:30	Mon- Fri, Occ.

• *Install a boiler plant controller*

- Remove the existing zone relays and line voltage OAT thermostat
- Install a switching relay panels for the eight (8) new thermostats
- Install a two stage boiler plant controller (Tekmar 261, or equal)
 - The boilers shall be lead-lagged and staged
 - Install a hot water supply or boiler water temperature sensor
 - Install an outdoor air temperature sensor
 - The controller software shall vary hot water supply temperature linearly with outside air temperature.
 - The minimum boiler water supply temperature shall be 140°
- The boiler shall be enabled whenever any programmable thermostat switch closes

• **Hilton Senior Center**

• *Single Package Unit (RTU-1) Zone Damper Improvements*

- Verify that the two zone dampers are 2-position and open and close as designed
- Install a variable frequency drive (VFD) for RTU-1 supply fan (2 HP, 208/3)
- The maximum speed of the VFD shall be determined when both dampers are fully opened, but set at 90% of full speed (adj)
- The VFD speed shall be reduced to 45% (adj) when one damper is open and the other is closed
- When both dampers are closed the RTU shall be off, as per the current control
- Note: the scope of work does not include damper or actuator replacements, but new controls for this equipment.

• *Furnish Programming for the existing thermostats*

- Furnish Programming for the thermostats
- Set thermostats for “occupied” (Occ) and “unoccupied (UnOcc) as per the following (schedule and set points are adjustable)

• *Furnish Balancing Dampers*

- Furnish and install balancing dampers at each branch supply connection for the attic furnaces
- Rebalance units

Zone	Occ. T ° F	UnOcc T ° F.	Occ Time	UnOcc Time	Remarks
Activity Room	70	55	8:00	17:00	Mon- Fri, Occ.
Activity Room Offices	70	55	8:00	17:00	Mon- Fri, Occ.
COA Offices	70	55	8:00	17:00	Mon- Fri, Occ.
COA Conference Room	70	55	8:00	17:00	Mon- Fri, Occ.

• Town Hall

• Install Programmable Thermostats

- Install a programmable thermostat in place of the existing thermostat in the Planning Office (reference drawing A2.0)
 - Utilize the existing thermostat wiring to the unit above (Heil furnace with DX coil)
 - Install secure thermostat guard over the thermostat
- Balance the Planning and Inspection rooms furnace air flows including 6 diffusers and two motorized dampers whose actuators would be disconnected and serve as fixed balancing dampers.
- Thermostat: Honeywell CommercialPro 7000 series, or equal
 - Connect the Common wire to the low voltage transformer “common” and utilize it to power the thermostat

• Replace Thermostat with Temperature Sensor

- Replace the first floor thermostat with a temperature sensor (see below for Steam Boiler)

• Furnish Programming for the existing thermostats

- Second Floor thermostats, three (3)
- Set thermostats for “occupied” (Occ) and “unoccupied (UnOcc) as per the following (schedule and set points are adjustable)

Zone	Occ. T ° F	UnOcc T ° F.	Occ Time	UnOcc Time	Remarks
Planning Office	70	55	8:00	16:00	Mon- Fri, Occ.
First Floor Offices	70	55	8:00	16:00	Mon- Fri, Occ.
Second Floor West Offices	70	55	8:00	16:00	Mon- Fri, Occ.
Second Floor East Offices	70	55	8:00	16:00	Mon- Fri, Occ.
Auditorium	70	55	8:00	16:00	Mon- Fri, Occ.

• Install a boiler plant controller for the steam boiler

- Install an indoor air temperature sensor in place of the existing programmable thermostat
- Install an outdoor air temperature sensor
- Install a condensate temperature sensor
- Boiler Plant controller: Tekmar 279, or equal
- Install schedule programming for the controller as listed above

- **Install a boiler plant controller for the hot water boiler**

- Remove the existing hot water supply temperature reset controller
- Install a boiler plant controller (Tekmar 360, or equal)
 - Vary hot water supply temperature utilizing the existing 3-way valve
 - Install a hot water supply or boiler water temperature sensor
 - Install an outdoor air temperature sensor
 - Install the optional time-clock to schedule the operation of the controller
 - Install an indoor temperature sensor, located on the Second Floor
 - Programming:
 - The controller software shall vary hot water supply temperature linearly with outside air temperature by modulating the 3-way mixing valve
 - The minimum hot water supply temperature shall be 140° F.
 - The maximum hot water supply temperature shall be 180° F.
 - The distribution pump shall be switched off during the unoccupied period when the second floor temperature as sensed by the indoor sensor is exceeds 55 ° F and the outside air temperature is greater than 38° F.

- **Waste Water Treatment Plant**

- **Install Programmable Thermostats**

- Install a programmable thermostat in place of the existing thermostat (Chronotherm III) the office area
- Install a programmable thermostat in place of the existing thermostat in the Laboratory area
- Thermostat: Honeywell CommercialPro 7000 series, or equal
 - Connect the Common wire to the low voltage transformer “common” and utilize it to power the thermostat
- Furnish Programming for the thermostats
 - Set thermostats for “occupied” (Occ) and “unoccupied (UnOcc) as per the following (schedule and set points are adjustable)

Zone	Occ. T ° F	UnOcc T ° F.	Occ Time	UnOcc Time	Remarks
Offices	65	55	7:00	15:00	Mon- Fri, Occ.
Laboratory	65	55	7:00	15:00	Mon- Fri, Occ.

- **Replace Outside Air Damper Actuator for RTU-1**

- Replace the OAD actuator and control module for the rooftop unit, AC-1
- Verify proper operation
- Set minimum position at 10% open (adj)

- **Replace Zone Damper Actuator in Laboratory Area**

- Replace the zone damper actuator
- Verify proper operation

• **Memorial Boys and Girls Club**

• **Install Zone Sensors in the Steam Area**

- Install a room sensors in the steam heated areas;
 - reference attached drawing ECM 3, 1 of 2
 - Room E5
 - Room W7
 - Dance
- Install secure guards over the sensors
- The sensors shall display the current temperature and permit occupant adjustment to plus or minus 2° F.

• **Install Modulating Steam Control Valves**

- Reference: attached drawing ECM 3, 1 of 2
- Z-1, 5", associated with zone sensor Ts1
- Z-2, 4", associated with zone sensor Ts2
- Z-3, 5", associated with zone sensor Ts3

• **Install a Direct Digital Control (DDC) for the Steam Boiler Plant**

- Install a direct digital controller:
 - The controller shall be capable of Web access
 - The controller shall permit weekly occupied and unoccupied set point schedules for the each of the three steam zones
 - Install an OAT sensor
 - Furnish programming and scheduling
 - The controller shall modulate each (normally open) valve to maintain its zone temperature set point
 - The controller shall provide outputs to enable/disable the boiler when the OAT is above a set point or if the interior zones are at their set points
 - Furnish programming for the controller
 - "occupied" (Occ) and "unoccupied (UnOcc) as per the following (schedule and set points are adjustable)

Zone	Occ. T° F	UnOcc T ° F.	Occ Time	UnOcc Time	Remarks
Steam Zone 1	45	45	0:00	0:00	Normally UnOcc.
Steam Zone 2	45	45	0:00	0:00	Normally UnOcc..
Steam Zone 3	70	55	10:00	17:00	Dance area

• **Install DDC for the Hot Water Boiler Plant**

• **Install room sensors in the hot water heated areas**

- Reference: attached drawing ECM 3, 1 of 2
- Office
- Room W1
- Room E1
- Install secure guards over the sensors

- The sensors shall display the current temperature and permit occupant adjustment to plus or minus 2° F.
- **Install a direct digital controller (DDC) for the boiler plant**
 - The controller shall be capable of Web access for authorized users
 - Install a hot water supply temperature sensor
 - Install an outside air temperature (OAT) sensor
 - The pumps shall be enabled when the OAT is less than 60° F (adj)
 - The boiler shall be enabled when the pumps are operating
- **Provide HWS temperature reset utilizing the 3-way mixing valve**
 - Replace the mixing valve actuator
 - The minimum hot water supply temperature shall be 150° F
 - The maximum hot water supply temperature shall be 180° F
 - Vary the hot water supply temperature linearly with OAT
- **Furnish programming and scheduling**
 - Alternate the in-service pump weekly
 - The in-service pump is normally on during occupied period and when the OAT is less than 60 ° F
 - The in-service pump shall be switched off when all the room temperature sensors exceed their set points and the outside air temperature is greater than 38° F.
 - Furnish schedule programming for the controller
 - “Occupied” (Occ) and “Unoccupied (UnOcc) as per the following (schedule and set points are adjustable)

Zone	Occ. T° F	UnOcc T ° F.	Occ Time	UnOcc Time	Remarks
Hot Water Zone 1	70	55	8:30	18:00	

Exclusions

- Proposal is based on all existing DDC controllers, wiring, and end devices that are to be reused properly functioning.
- Proposal is based on all pneumatic end devices that are to be reused properly functioning (damper actuators, heating valves and bypass valves).
- Proposal is based on any devices that are found in need of repair or replacement during system checkout will be identified. A separate proposal will be created for these corrections.
- Proposal is based on reusing existing temperature wells and if not available/compatible strap-on temperature sensors shall be provided.
- Proposal excludes painting and patching.
- Network connections and static IP addresses shall be provided by the Town for the DDC network managers.
- Proposal is based on Ameresco having remote access to these DDC systems during the warranty period.

The proposed systems will implement the following energy management strategies as appropriate:

> **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 specific 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 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.

> **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.

> **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 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.

> 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.

For steam boilers the occupied period operation will be similar to the hot water sequence above. When the unoccupied outside air temperature is less than or equal to 37.5° the boilers will maintain the steam header setpoint.

> 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 Town 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

The installation of a district wide energy management system will be to improve comfort, energy and cost and reduce on-site man-hours by qualified maintenance personnel.

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Appendix for ECM 3: New Energy Management Systems

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts
Council on Aging- Hilton Senior Center
New Energy Management Systems

[illegible]

Cell Ref.	Comments	Value	Unit	Cell1	Description
A:H	INV-2 Weather Data for Lawrence Municipal Airport, MA				
T-1	Existing Occupancy Hours	8,493	h/yr	A9:A3	
M-1	Existing Heating Cooling Hours	70,096	h/yr	A9:A4	
Q-1	Existing Motor Operating Hours	3.2	Cy/yr	A9:A5	
U	Unoccupied Cooling and Heating Loads (MWH)	1.6	MWh	A9:A6	
V	Unoccupied Cooling and Heating Loads (SEER)	0.0	kWh	A9:A7	
W	Cooling - (cool T-1 x (cool M-1 - cool Q-1)) / (800 + A9:A4)				
X	Cooling - (cool T-1 x (cool M-1 - cool Q-1)) / (1070 + A9:A5)				
Y	Heating - (heat T-1 x (heat M-1 - heat Q-1)) / (1,000 - A9:A6)				
Z	Heating - (heat T-1 x (heat M-1 - heat Q-1)) / (1,000 - A9:A5)				
AA	Heating - (heat T-1 x (heat M-1 - heat Q-1)) / (1,000 - A9:A6)				
AB	Heating - (heat T-1 x (heat M-1 - heat Q-1)) / (1,000 - A9:A5)				
AC	Proposed Occupant Cooling and Heating Loads				
AD	Proposed Occupant Cooling and Heating Loads				
AE	Proposed Occupant Cooling and Heating Loads				
AF	Proposed Occupant Cooling and Heating Loads				
AG	Proposed Occupant Cooling and Heating Loads				
AH	Proposed Occupant Cooling and Heating Loads				
AI	Proposed Occupant Cooling and Heating Loads				
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BZ	Proposed Occupant Cooling and Heating Loads				
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ENR-2 Weather Data for Lawrence Municipal Airport, MA										Existing Occupancy Schedule				Existing Heating & Cooling Schedule				Existing Mass Operating Schedule				Building				Proposed				Savings																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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Appendix for ECM 3: New Energy Management Systems

II. Manufacturer Specification Sheets

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CommercialPRO™ 7000

Honeywell



**AN ATTRACTIVE, LARGE-SCREEN
CHOICE THAT LOOKS GREAT
AND SAVES ENERGY.**

**Good Looks.
Great Features.**

Meet all your commercial application needs with one brand — Honeywell.



For your commercial customers who don't need the sophistication of the T7350 or the touchscreen programming of the Commercial VisionPRO™ 8000, the Honeywell CommercialPRO™ 7000 is a great choice. Perfect for smaller commercial settings such as restaurants, banks, small businesses and more, the CommercialPRO 7000 features a display that's twice the size of competitive thermostats while still maintaining a sleek, slim body. So along with the energy savings your customers will enjoy from the CommercialPRO 7000's menu-driven programming, they'll also appreciate its stylish look on their walls.

Value-Priced. Feature-Rich.

The CommercialPRO 7000 offers you and your customers great value. The combination of easy installation, reliability and accuracy saves you time and reduces callbacks. And the features ranging from energy savings to Title 24 compliance to holiday setback options will definitely please your commercial customers.



The combination of **easy** installation, reliability and accuracy **saves** you time and reduces callbacks.



- **Large, Easy-To-Read Display**

Screen size is more than double competitive thermostats in this class, allowing for more information to be displayed on the easy-to-view backlit display.

- **Saves Energy**

Easy-to-use, menu-driven programming helps your customers save up to 33% off energy bills.¹

- **Title 24 Energy/Air Quality Compliance**

Preoccupancy Purge and Override Limits meet all fresh air and override limitation requirements. Qualifies for utility rebates.²

- **Multiple Lockout Levels**

Save energy and money by preventing unauthorized setting changes.

- **Holiday Setback**

Lets users select the temperature to maintain while they're away from the building without re-programming. Menu-driven programming makes it even easier.

- **Commercial Comfort**

Commercial algorithm, configurable recovery ramps, and temporary override button allow users to control at setpoint and guarantee a comfortable environment.

¹ If used as directed. Savings may vary depending on geographic region and usage.

² Where applicable.

For more information, contact your
Honeywell distributor. Or call Honeywell
directly at 1-800-345-6770, ext. 560 or visit
customer.honeywell.com/buildings.

Automation and Control Solutions

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Golden Valley, MN 55422-3992

In Canada:

Honeywell Limited

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Toronto, Ontario M1V 4Z9

In Latin America:

Honeywell

9315 NW 112th Avenue
Miami, FL 33178
www.honeywell.com



63-9401
June 2011
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Honeywell

VisionPRO® 8000 Touchscreen 7-Day Programmable Thermostat

Honeywell



Honeywell's VisionPRO® 8000 is effortless to use. Its intuitive logic and menu-driven programming respond to your choices and schedule for optimal comfort and energy savings. VisionPRO offers you top-of-the-line features like touchscreen interaction, a real-time clock, and large, easy-to-read backlit display. If you want your home to feel as comfortable as it looks, then VisionPRO is the thermostat for you. You'll enjoy the convenience, energy savings and consistent comfort for years to come.

VisionPRO® 8000

MAXIMUM COMFORT AND ENERGY SAVINGS MADE EFFORTLESS.

Energy Savings — Program to save up to 33% on annual heating and cooling costs.*

#1 Choice of Homeowners — Honeywell is the leading brand in temperature control.

Effortless, Menu-Driven Programming — Simplifies programming by responding to your choices.

Precise Comfort Control (+/-1°F) — Maintains consistent comfort to the highest level of accuracy.

Programmable Fan — Offers increased indoor air quality when combined with a Honeywell Whole-house Air Cleaner.

Large, Clear Backlit Digital Display — Easy to read in various lighting conditions.

Touchscreen Interaction

Selectable IAQ Control — Select models allow for control of humidification, dehumidification or ventilation systems.

Multiple HOLD Options — Allows you to override the program schedule as desired, with temporary and vacation hold settings.

5-Year Warranty

Change/Check Reminders — Let you know when to service or replace filters, batteries, etc.

Real-Time Clock — Keeps time during power failure and automatically updated for daylight savings.

Dual Fuel Capable — Select models allow for control of dual fuel systems.

VisionPRO 8000 Touchscreen 7-Day Programmable Thermostat

Part Numbers	Stages	Dehumidification Control	Selectable IAQ Control (Humidification, Dehumidification or Ventilation)
TH8321U1097	Up to 3H/2C	•	•
TH8321U1006	Up to 3H/2C	•	
TH8320U1008	Up to 3H/2C		
TH8110U1003	1H/1C		

*If used as directed, programmable thermostats can save up to 33% on annual heating and cooling costs. Savings may vary depending on geographic region and usage.

Learn More

Call toll-free 1-800-328-5111
or visit <http://yourhome.honeywell.com>
e-mail info@honeywell.com

Automation and Control Solutions

Honeywell
1985 Douglas Drive North
Golden Valley, MN 55422-3992
www.honeywell.com



50-9104 RL 6/11
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Honeywell



Expanding your business has just been made easier. Offer your customers the VisionPRO® Wi-Fi thermostat from Honeywell, a trusted name and leader of thermostats. Millions of homes today are equipped with Wi-Fi enabled devices, and while a consumer might not understand the technology, they certainly understand what it allows them to do on a daily basis. This could translate into an easy selling opportunity for you. Conscientious homeowners who want a simple way to remotely monitor and help manage their energy costs will have the peace of mind with this latest Wi-Fi offering from Honeywell. And, they will have you to thank.

Wi-Fi VisionPRO® Thermostat

COMFORT, CONNECTIVITY AND ENERGY SAVINGS

Energy Savings — Program to save up to 33% on annual heating and cooling costs.*

Remote Access — Easily manage your energy usage by remotely adjusting your thermostat while you're away.

Remote Control — Convenience, comfort and control from anywhere through web, tablet or smartphone access.

Precise Comfort Control (+/-1°F) — Maintains consistent comfort to the highest level of accuracy.

Get Connected — Connect to the home's existing wireless system.

Large, Clear Backlit Digital Display — Easy to read in various lighting conditions.

Touchscreen Interaction

Change/Check Reminders — Let you know when to service or replace filters, batteries, etc.

Real-Time Clock — Keeps time during power failure and automatically updated for daylight savings.

Dual Fuel Capable — Select models allow for control of dual fuel systems.

Multiple HOLD Options — Allows you to override the program schedule as desired, with temporary and vacation hold settings.

5-Year Warranty

Wi-Fi VisionPRO® Thermostat

Part Numbers	Stages
TH8320WF1029	Up to 3H/2C



*If used as directed, programmable thermostats can save up to 33% on annual heating and cooling costs. Savings may vary depending on geographic region and usage.

Learn More

Call toll-free 1-800-328-5111
or visit <http://yourhome.honeywell.com>
e-mail info@honeywell.com

Automation and Control Solutions

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1985 Douglas Drive North
Golden Valley, MN 55422-3992
www.honeywell.com



50-1864 RL
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Honeywell

tekmar® Submittal

Boiler Control 261

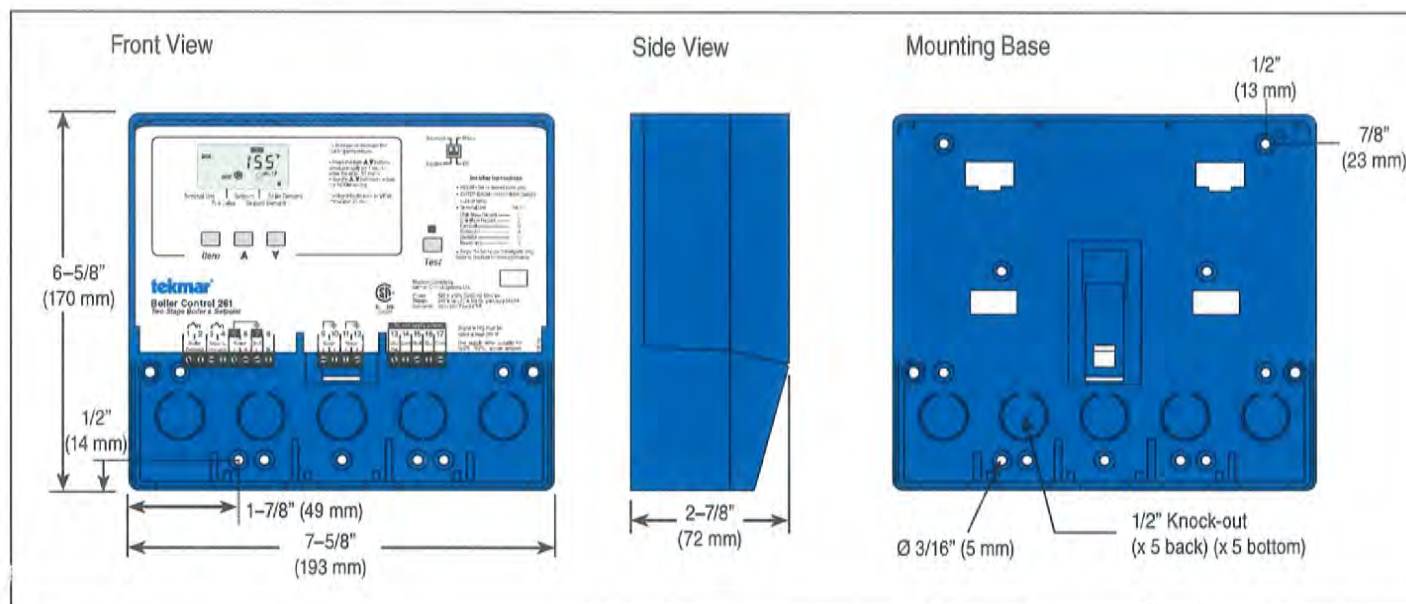


C 261
01/11

HVAC Systems Replaces: New

Job _____ Designer _____ Contact _____

The Boiler Control 261 is designed to stage multiple boilers using outdoor reset. It can be used in applications ranging from a single zone of baseboard, multiple baseboard and fan coil zones, to dedicated setpoint heating in commercial buildings. This control regulates a single heating water temperature through outdoor reset and/or setpoint target control. It is capable of controlling (stage and rotate) up to 2 on/off boilers, or a single 2 stage boiler, as well as the system pump.



Specifications

Boiler Control 261 Two Stage Boiler & Setpoint	
Literature	D261, A261, D001, D070
Control	Microprocessor control. This is not a safety (limit) control
Packaged weight	3.0 lb. (1340 g)
Dimensions	6-5/8" H x 7-9/16" W x 2-13/16" D (170 x 193 x 72 mm)
Enclosure	Blue PVC plastic, NEMA type 1
Approvals	CSA C US, meets class B: ICES & FCC Part 15
Ambient conditions	Indoor use only, 32 to 113°F (0 to 45°C), RH ≤90% Non-condensing
Power supply	120 V (ac) ±10%, 50/60 Hz, 1300 VA
Relays	240 V (ac) 10 A, 1/3 hp
Demands	20 to 260 V (ac) 2 VA
Sensors	NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) β=3892
-Included	Outdoor Sensor 070 and Universal Sensor 082
-Optional	tekmar type #: 033
Warranty	Limited 3 Year (See D261 for full warranty)

Energy Saving Features

- Outdoor Reset
- Setback input for energy savings
- Warm Weather Shut Down
- Automatic Boiler Differential

Additional Features

- 2 Stage boiler control
- Quick setup for easy installation and programming of control
- User comfort adjustment to increase or decrease building space temperature
- Advanced settings to fine-tune building requirements
- Pump exercising
- Powered boiler pump output
- Test sequence to ensure proper component operation
- 120 V (ac) power supply

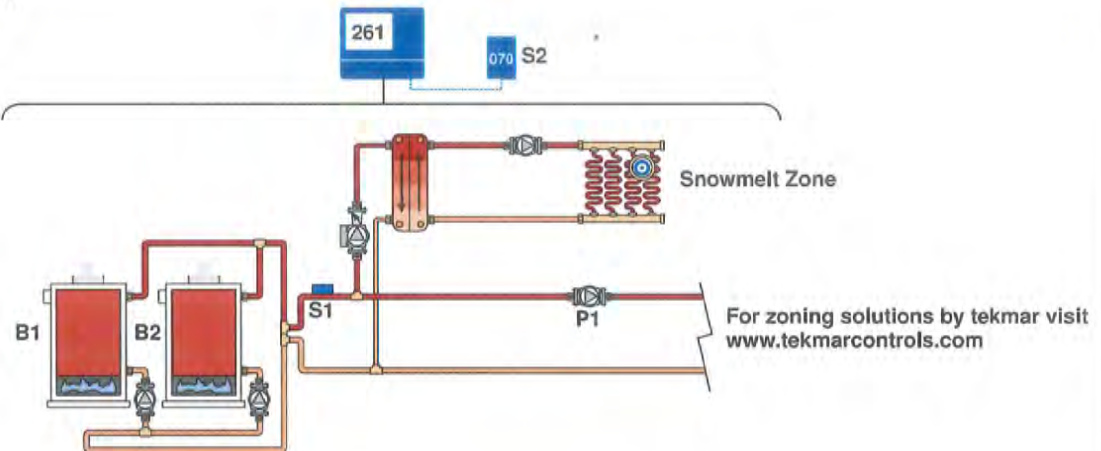
SPECIAL REQUIREMENTS

N / A

Sample Application Drawing

Below is a sample application drawing for this product. This application may include other tekmar products that are required for installation. More sample applications can be found at www.tekmarcontrols.com.

Sample Mechanical diagram

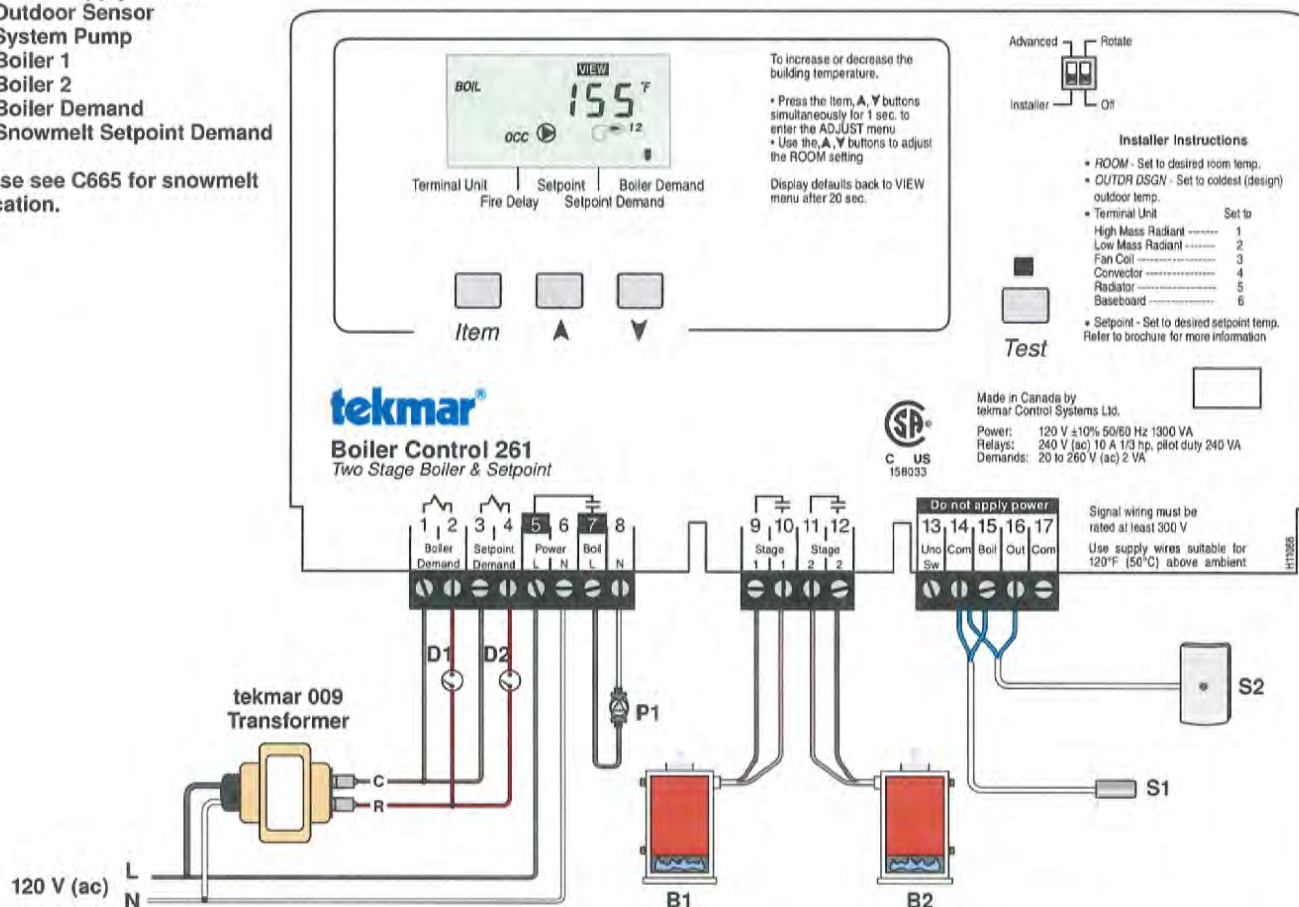


Sample Electrical diagram

Legend:

- S1 = Boiler Supply Sensor
- S2 = Outdoor Sensor
- P1 = System Pump
- B1 = Boiler 1
- B2 = Boiler 2
- D1 = Boiler Demand
- D2 = Snowmelt Setpoint Demand

* Please see C665 for snowmelt application.



tekmar® Submittal

Steam Control 279



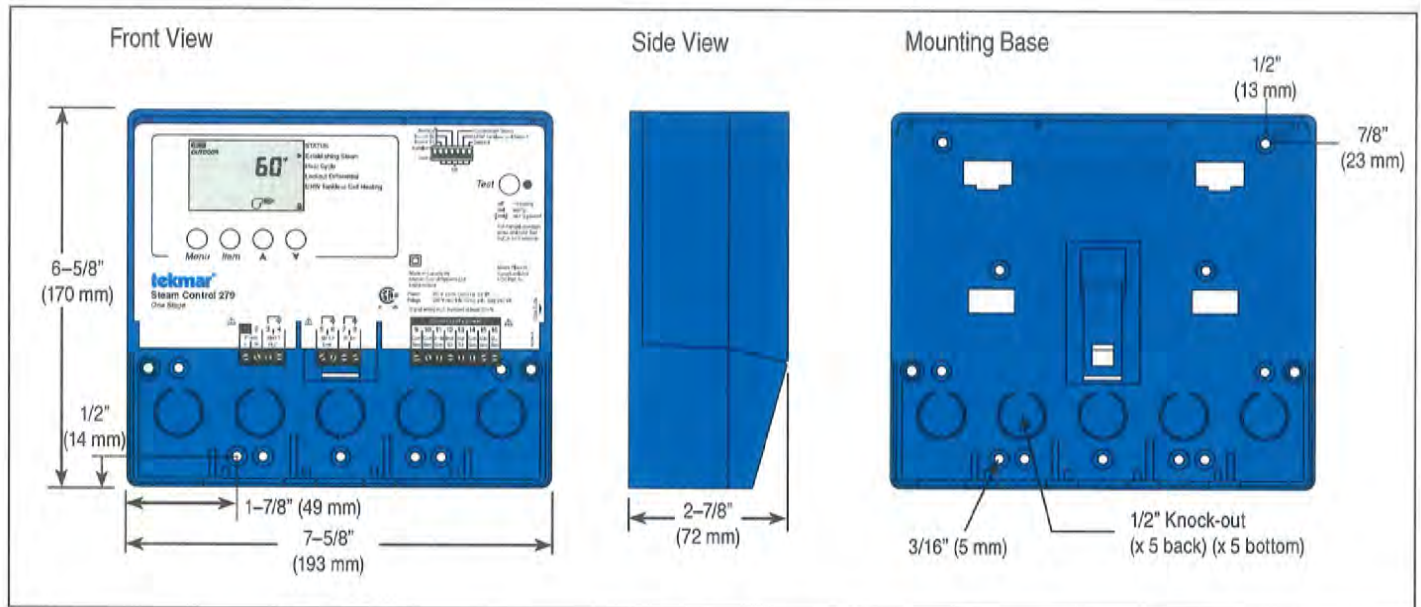
C279

01/11

HVAC Systems Replaces: New

Job _____ Designer _____ Contact _____

The Steam Control 279 is designed to operate a single steam boiler using outdoor reset. It can be used in single pipe steam applications as well as applications using a tankless DHW coil. This control regulates the on time of a steam boiler through outdoor reset control. It is capable of controlling a single on/off steam boiler.



Specifications

Steam Control 279 One Stage	
Literature	D279, A279, D001, D070
Control	Microprocessor control. This is not a safety (limit) control
Packaged weight	3.3 lb. (1500 g)
Dimensions	6-5/8" H x 7-9/16" W x 2-13/16" D (170 x 193 x 72 mm)
Enclosure	Blue PVC plastic, NEMA type 1
Approvals	CSA C US, meets Class B: ICES & FCC Part 15
Ambient conditions	Indoor use only, 32 to 122°F (0 to 50°C), RH ≤90% Non-condensing, Altitude <6560 ft. (2000 m), Installation Category II, Pollution Degree 2
Power supply	115 V (ac) ± 10%, 50/60 Hz, 3.5 VA
Relays	230 V (ac) 5 A, 1/3 hp, pilot duty 240 VA
Sensors	NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) β=3892
-Included	Outdoor Sensor 070 and Universal Sensor 071
-Optional	tekmar type #: 071, 076, 077, 078, 082, 084
Warranty	Limited 3 Year (See D279 for full warranty)

Energy Saving Features

- Outdoor Temperature Reset
- Warm Weather Shut Down
- Built-in programmable timer
- Indoor Temperature Feedback (with optional indoor sensor)

Additional Features

- Manual Override
- Includes outdoor sensor
- Includes condensate sensor
- Large LCD display
- DHW tankless coil operation
- 24 hour, 5-1-1, 7 day schedule
- Two or four schedule events per day
- Two alert level relays
- CSA approved for use in USA and Canada

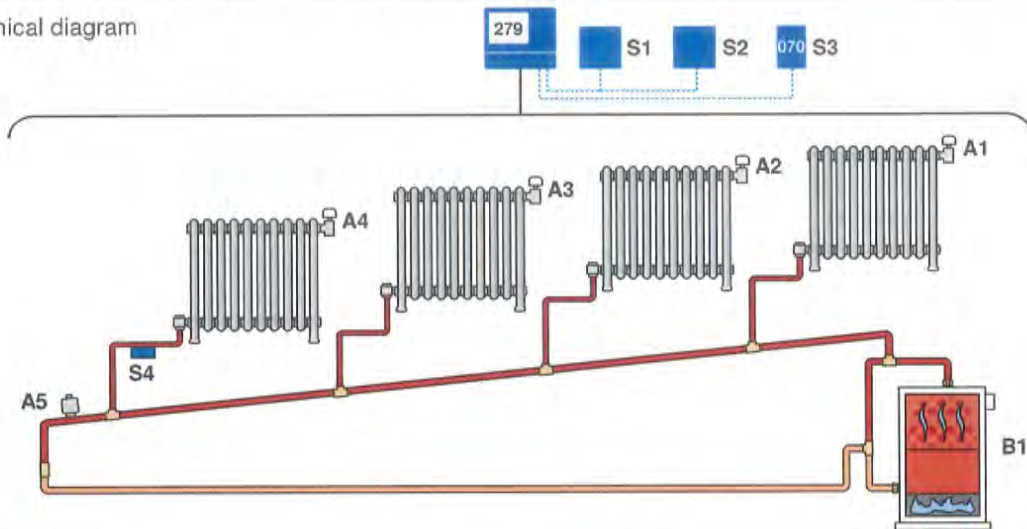
SPECIAL REQUIREMENTS

N / A

Sample Application Drawing

Below is a sample application drawing for this product. This application may include other tekmar products that are required for installation. More sample applications can be found at www.tekmarcontrols.com.

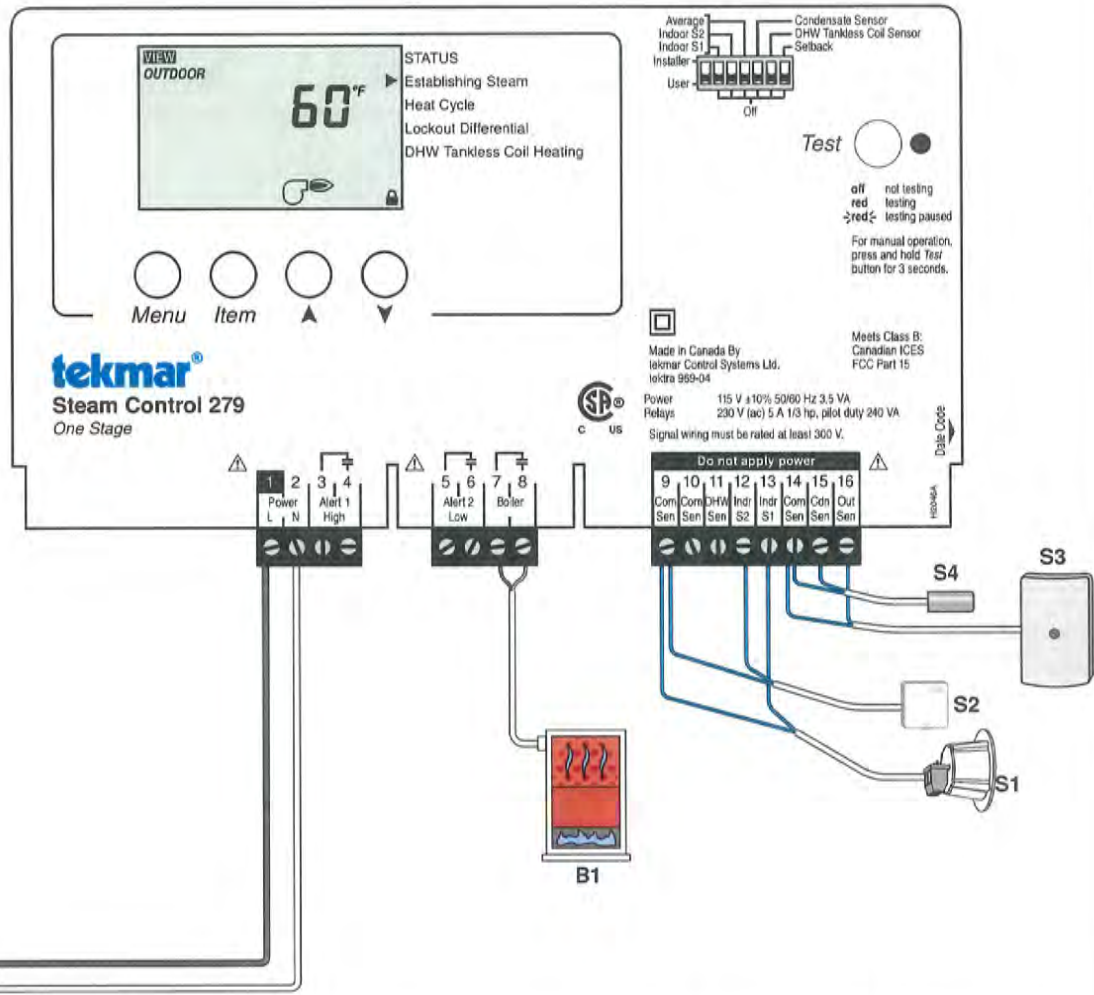
Sample Mechanical diagram



Sample Electrical diagram

Legend:

- B1 = Boiler 1
- S1 = Indoor Sensor
- S2 = Indoor Sensor
- S3 = Outdoor Sensor
- S4 = Condensate Return Sensor
- A1 = Air Vent 1
- A2 = Air Vent 2
- A3 = Air Vent 3
- A4 = Air Vent 4
- A5 = Main Air Vent



tekmar Control Systems Ltd., Canada, tekmar Control Systems, Inc., U.S.A. Head Office: 5100 Silver Star Road, Vernon, B.C. Canada V1B 3K4, 250-545-7749, Fax. 250-545-0650 Web Site: www.tekmarcontrols.com



tekmar® Submittal

Mixing Control 360



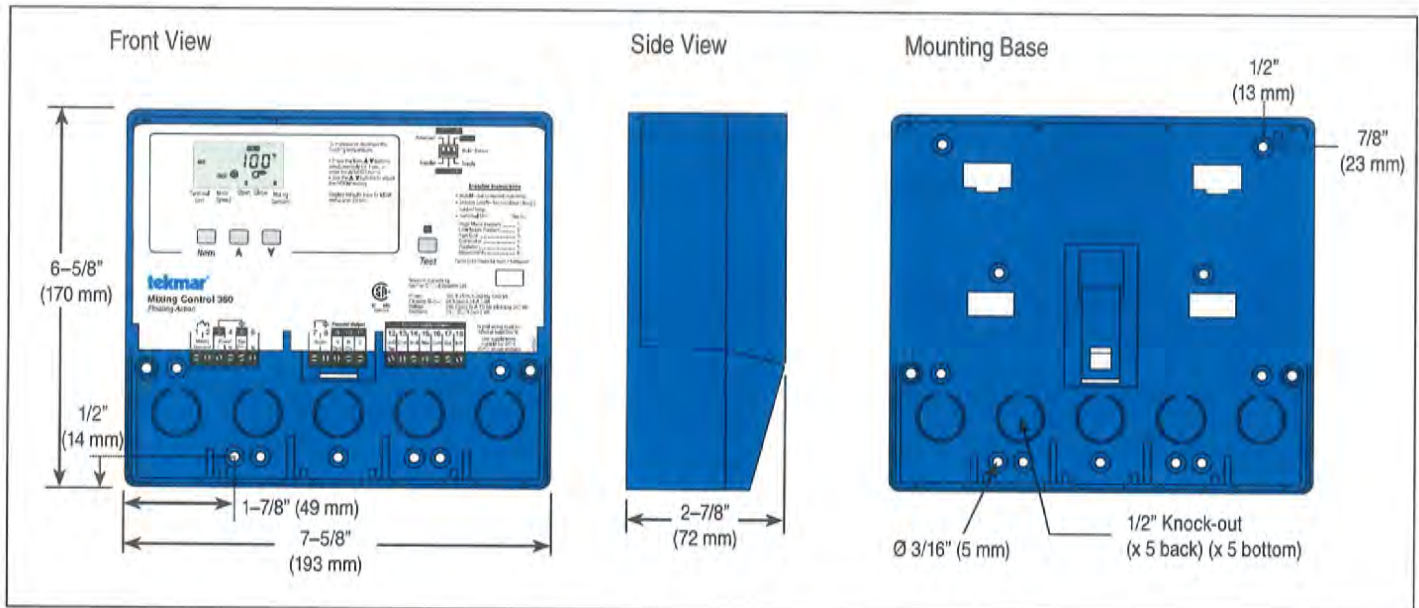
C 360

01/11

HVAC Systems Replaces: New

Job _____ Designer _____ Contact _____

The Mixing Control 360 is designed to operate a mixing valve using Outdoor Temperature Reset. It can be used in applications ranging from in-floor radiant to commercial baseboard systems for boiler protection with full reset. This control regulates a single heating water temperature through Outdoor Temperature Reset. It controls the mixing by opening or closing a floating action type mixing valve actuator (3 or 4 way valves), and also provides control of the mix system pump.



Specifications

Mixing Control 360 Floating Action	
Literature	D360, A360, D001, D070
Control	Microprocessor control. This is not a safety (limit) control
Packaged weight	3.1 lb. (1420 g)
Dimensions	6-5/8" H x 7-9/16" W x 2-13/16" D (170 x 193 x 72 mm)
Enclosure	Blue PVC plastic, NEMA type 1
Approvals	CSA C US, meets class B: ICES & FCC Part 15
Ambient conditions	Indoor use only, 32 to 104°F (0 to 40°C), RH ≤90% Non-condensing
Power supply	120 V (ac) ±10%, 50/60 Hz, 1300 VA
Floating output	24 V (ac) 0.34 A 8 VA
Relays	240 V (ac) 10 A 1/3 hp
Demand	20 to 260 V (ac) 2 VA
Sensors	NTC thermistor, 10 kΩ @ 77°F (25°C ±0.2°C) β=3892
-Included	Outdoor Sensor 070 and 2 of Universal Sensor 082
-Optional	tekmar type #: 033, 076, 077, 084
Warranty	Limited 3 Year (See D360 for full warranty)

Energy Saving Features

- Outdoor Temperature Reset
- Indoor Temperature Feedback (with optional indoor sensor)
- Warm Weather Shut Down
- Automatic Boiler Differential

Additional Features

- Floating Action Mixing Control
- Quick setup for easy installation and programming of control
- User comfort adjustment to increase or decrease building space temperature
- Advanced settings to fine-tune building requirements
- Powered mixing system pump output
- Optional indoor sensor for room air temperature control
- Test sequence to ensure proper component operation
- Setback input for energy savings
- 120 V (ac) power supply
- CSA C US certified (approved to applicable UL standards)

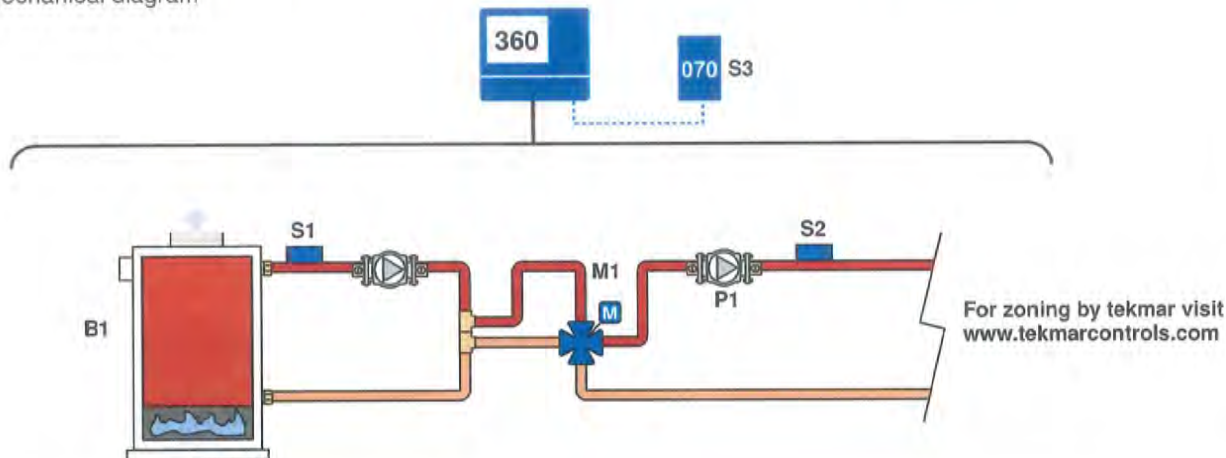
SPECIAL REQUIREMENTS

N / A

Sample Application Drawing

Below is a sample application drawing for this product. This application may include other tekmar products that are required for installation. More sample applications can be found at www.tekmarcontrols.com.

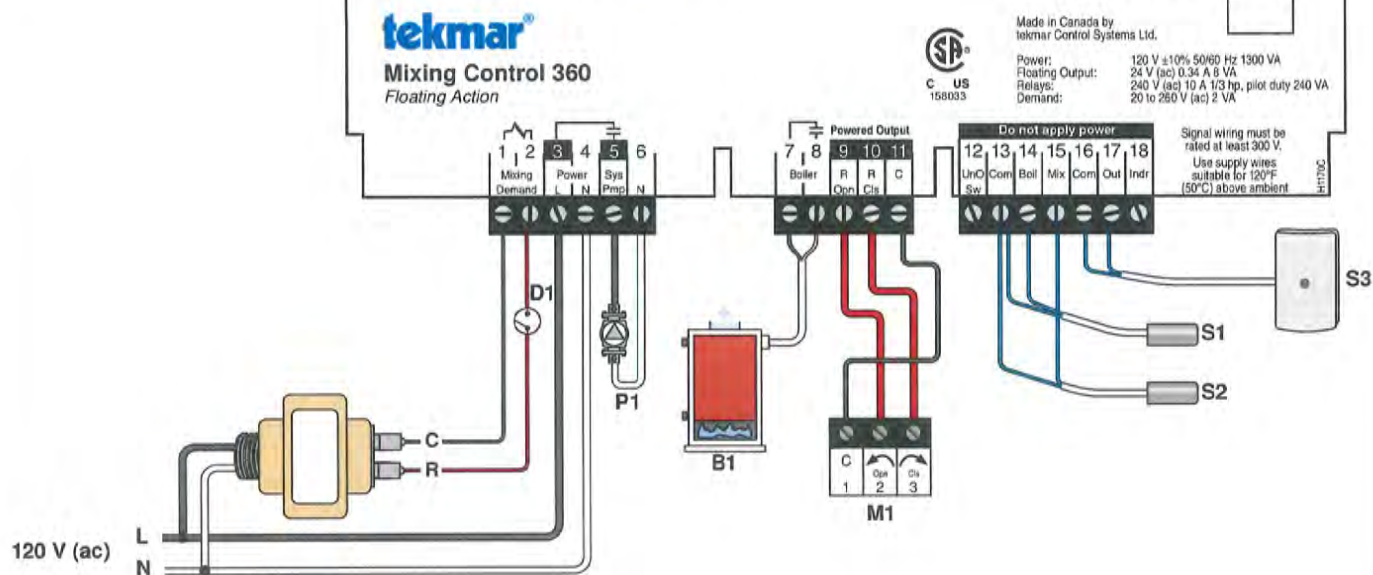
Sample Mechanical diagram



Sample Electrical diagram

Legend

B1 = Boiler 1
D1 = Mix Demand
(From thermostat or end switch)
S1 = Boiler Supply Sensor
S2 = Mix Supply Sensor
S3 = Outdoor Sensor
P1 = Mix System pump
M1 = Floating Action Actuator



Features and Highlights

- BACnet-enabled and adjustable BACnet priorities
- Embedded Web server and MS/TP router
- Secure monitoring and control from a Web browser
- Read/write ability to 250 third-party BACnet objects
- 6 universal inputs and 6 analog outputs
- EIA-232 local supervisor port
- SDU-xcite and IQView4 capable
- Small footprint with DIN-rail mounting
- Support for XML Web services



The Trend IQ3xact is a Web-enabled building automation system (BAS) controller that uses Ethernet, TCP/IP and BACnet/IP networking technologies. In addition to the standard IQ protocol, the IQ3xact incorporates a Web server, which can deliver user-specific Web pages to a personal computer or mobile device with Internet browser software. This allows you to monitor or adjust the controller from any Internet access point in the world.

As a BACnet-enabled controller, the IQ3xact integrates seamlessly with a BACnet system, communicating on a BACnet IP LAN. The IQ3xact provides master controller functionality for up to 64 Trend terminal unit devices and 64 third-party BACnet devices.

The XML Web services feature enables you to program many standard software packages to communicate directly with the IQ3xact, improving operations and communications, and reducing engineering time.

The IQ3xact controller is DIN-rail mounted and has 6 inputs and 6 outputs. Use the EIA-232 port on the IQ3xact to connect to a personal computer or display (SDU-xcite, IQView4).

Technical Data

- **Power** 24 to 36 VDC +/- 10%, 24 VAC +/- 15% 50/60 Hz, 40 VA max.
- **Universal Inputs** 6 universal inputs on channels 1–6. Linkable for analog voltage (V), analog current (I), thermistor (T), or digital (D).

V = 12 bit resolution. Minimum 60 dB series mode rejection at supply frequency.
0–10 V, input resistance 200k Ohm, accuracy 50 mV equivalent to +/- 0.5% of span.

I = 12 bit resolution (4096 steps—effective). Minimum 60 dB series mode rejection at supply frequency.
0–20 mA, input resistance 240 Ohm, accuracy 0.5% of span. Loop powered input supply is 20–36 VDC.

T = 12 bit resolution. Minimum 60 dB series mode rejection at supply frequency. Thermistor bridge resistor
10 k Ohm 0.1%, accuracy 0.5% of span. Bridge supply 5V.

D = Dry contact. Count rate 30 Hz (minimum pulse width of 20 ms). Wetting current = 3 mA nominal.
5V supply. Status LED per channel (ON = closed contact).

- **Analog Voltage Outputs** 6 voltage outputs on channels 11–16. 11 bit resolution. 0–10 V with 20 mA current limit, accuracy +/- 0.5% of span.
- **Memory** 16 Mbyte SDRAM and 8 Mbyte Flash.
- **Controller Dimensions** 10.35" (263mm) x 5.91" (150mm) x 1.81" (46mm).
- **Environmental** 32–113°F (0–45°C). 0–90% RH, non-condensing. Controller should be mounted inside enclosure.
- **Communications** BACnet IP LAN up to 10 Mbps.
- **Ratings** Listed Underwriters Laboratory for Energy Management Equipment under the UL Standard for Safety 916. U.S. and Canadian certification.

Ordering Information

Product number	Description
IQ31 -4012K4012	IQ3XACT/012/LAN/US/UL/BAC/24 - 12 point IQ3xact LAN controller with BACnet Comms (24 VAC)
IQ31 -4002K4012	IQ3XACT/012/US/UL/BAC/24 - 12 point IQ3xact controller with BACnet Comms (24 VAC)
IQ31 -4032K4012	IQ3XACT/012/XNC/LAN/US/UL/BAC/24 - 12 point IQ3xact LAN controller with BACnet Comms (24 VAC)
IQ31 -4062K4012	IQ3XACT/012/XNC/SER/US/UL/BAC/24 - IQ3XACT XNC for Serial (non-isolated RS232, RS422 or RS485) integration with BACnet Comms (24 VAC)
IQ31 -4022K4012	IQ3XACT/012/XNC/US/UL/BAC/24 - IQ3XACT XNC for Ethernet integration with BACnet Comms (24 VAC)
IUGR-320200	IQ3XACT/XML/UP - Upgrade to add XML services to IQ3xact v2.2 or greater
IQ31 -4043K4000	IQ3XACT/00/MSTP/BINC/USA/UL/24 - Web-enabled controller with no inputs or outputs, non-expandable by the I/O bus; 24 VAC or 24 to 36 VDC input power supply; MSTP/BINC option; UL rated
IQ31 -4043K4012	IQ3XACT/12/MSTP/BINC/USA/UL/24 - Web-enabled controller with 12 input or output points, non-expandable by the I/O bus; 24 VAC or 24 to 36 VDC input power supply; MSTP/BINC option; UL rated

Trend Control Systems

THE IQ3XCITE SYSTEM



INTRODUCTION TO THE IQ3XCITE SYSTEM

The management and control of modern buildings grows ever more sophisticated. A Building Energy Management System (BEMS) must be tailored to suit each customer's specific control requirements. It must provide efficient HVAC control, coupled with the flexibility to accommodate changes in occupancy status and staff relocation at short notice; whilst simultaneously delivering improved comfort conditions. A BEMS must also provide real time management information and control, enabling customers to achieve significant energy savings.

THE IQ3XCITE SYSTEM

Trend's IQ3xcite system delivers extensive flexibility and capability, and is designed to match your needs, both today and tomorrow. Ease of use is paramount, and enabled by means of market leading technology.

At the heart of the system, IQ3xcite controllers utilise Ethernet technology meaning they can integrate seamlessly with a client's IT network; the embedded web server enables access from anywhere in the world without the need for proprietary software. The native BACnet versions offer even greater network communications.

For a complete system offering, IQ3xcite controllers work hand in hand with a wide range of complementary products. Supervisors and displays, such as the innovative range of IQView touch screen displays, provide monitoring and control, with the ability to locally adjust environmental conditions.

Terminal unit control is provided by IQL controllers, which incorporate LonWorks® open systems technology and a competitively priced range of peripherals including Variable Speed Drives, Sensors, Valves and Actuators complete the portfolio.

BUT, YOU NEED MORE...

In choosing Trend, you can be assured of complete peace of mind. Whether you are looking for the best performing equipment, where Trend product quality is second to none, or value for money where competitive pricing and whole life costs come into their own, Trend's market leading offering speaks for itself.

One of the best indicators of future success is past performance, and Trend continue to prove this time and time again. We are committed to providing the right solution for each and every customer, with market leading products and unrivalled service and support.

THE BENEFITS DELIVERED

REDUCED INSTALLATION TIME ON NEW AND RETROFIT PROJECTS

Using open systems network architecture and flexible hardware minimises system complexity and site disturbance, thus reducing costs.

REDUCED ON-SITE COMMISSIONING TIME

Advanced tools automate many tasks, while self-learning supervisors and displays minimise data input, reducing commissioning time and the potential for human error.

POWERFUL NETWORK COMMUNICATIONS

TCP/IP over Ethernet enables vast connectivity capability, coupled with LON networking for 'QL terminal unit controllers. The BACnet versions of IQ3xcite now provide even greater network flexibility.

FLEXIBLE ALARM HANDLING

Advanced alarm strategies can easily be implemented, notifying whoever, wherever and whenever required direct to a users mobile phone, email system or indeed a Trend Supervisor by means of standard industry protocols such as Short Message Service (SMS), Simple Network Management Protocol (SNMP), and Internet Protocol (IP).

EASE OF USE

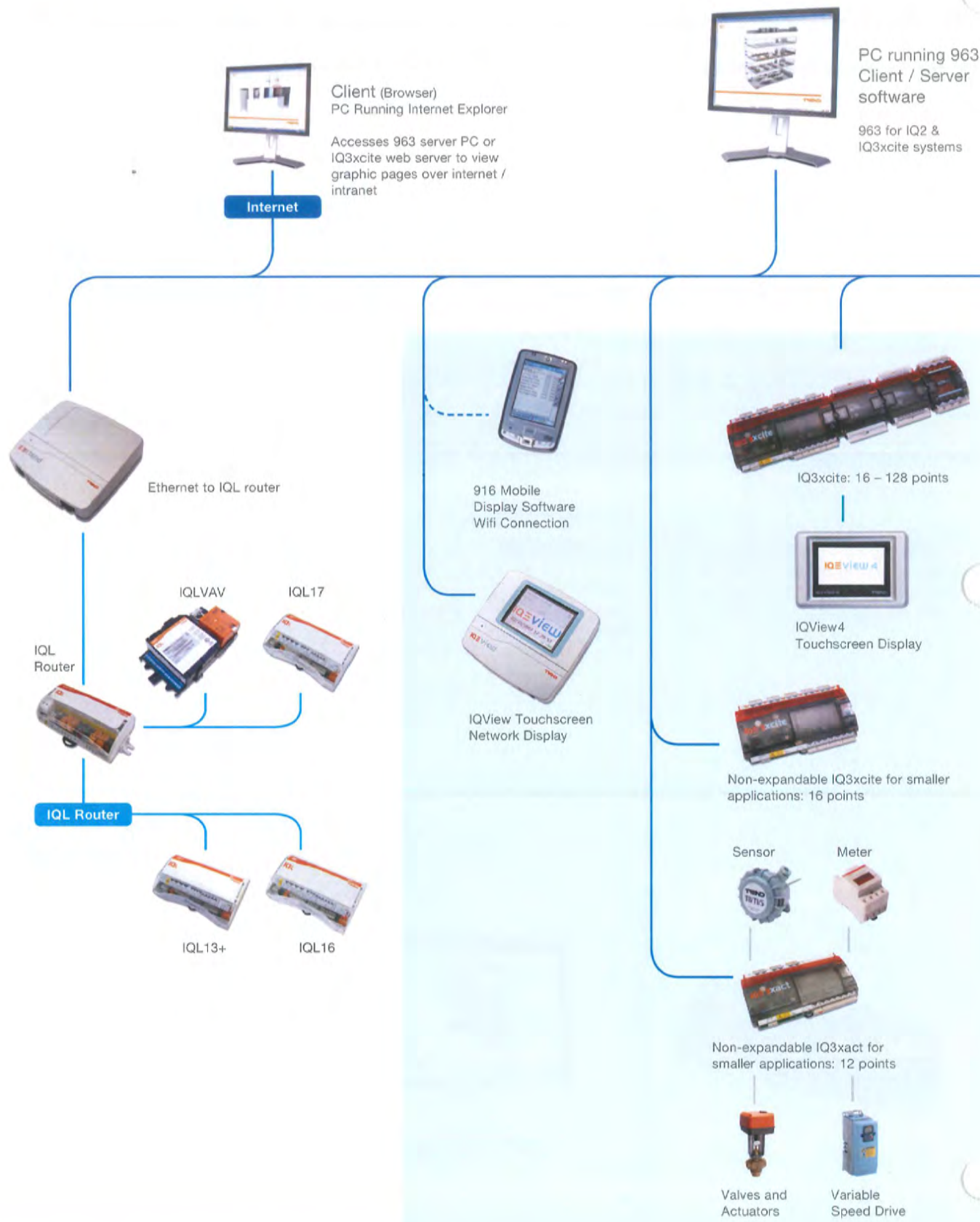
The voice of the customer is all important at Trend, resulting in products that are easy to use and that also ensure you get the most from your BEMS. Using your Trend BEMS correctly will deliver substantial savings on utility costs.

PROTECT YOUR INVESTMENT

Trend's philosophy of continuous improvement is maintained through progressive platform development, ensuring that the investments of today remain investments for the future.



SYSTEM DIAGRAM



TOTAL IQ3XCITE SYSTEM FEATURES

The Trend IQ3xcite solution is designed to simplify interaction with the Heating, Ventilation and Air Conditioning (HVAC) system, and to ease integration into your existing business systems and processes. It provides all users with unparalleled levels of access, control and ease of use, and in turn improves occupant comfort within the working environment. Trend's product portfolio includes programmable and fixed function controllers, supervisory software and a range of peripheral products including valves & actuators, sensors and motor controllers.



IQ3XCITE CONTROLLERS –

IQ3xcite controllers use TCP/IP over Ethernet, incorporating an on-board web server which can deliver user-specific web pages to a PC or mobile device running internet browser software. Native BACnet options are available in addition to variants that can connect directly to the Trend LAN. These DIN rail mounting controllers have 16 input/output points which can be expanded by up to 128 points by adding I/O modules. A 16 point non-expandable unit, as well as the 12 point IQ3xact controller are also available. Any of the IQview range of displays can be connected via the RS232 port.



IQL TERMINAL UNIT CONTROLLERS –

Designed primarily for commercial buildings, the IQLs provide intelligent solutions for either individual or open plan offices. They are also ideal for hotel applications where separate room control is required. The entire IQL range has passed the LONMARK® Interoperability Association's Conformance Review and as such are LONMARK certified.



963 SUPERVISOR –

Supervisors are used to graphically display monitored inputs and outputs, change control parameters and perform a wide range of energy analysis and maintenance functions simplifying the users interaction with the BEMS. Trend's 963 Supervisor is a client/server based software package where the 'client' requires nothing more than the browser Internet Explorer. 963 is available in both server and lite versions (client), and has a number of variants which include 963 Secure, for compliance with 21 CFR Part 11; 963 SNMP for transmitting alarms to IT monitoring systems and 963 SMS which enables retransmission of alarms to a GSM mobile phone. The TOPS (Trend Open Protocol Server) enables 963 to control and monitor both Trend and 3rd party BACnet products.



IQVIEW –

Trend's range of IQView displays provide user interaction with the Trend system. They are self configuring, touch screen displays designed to simplify usage and minimise engineering.



916 MOBILE DISPLAY SOFTWARE –

Running on a Windows Mobile Device, the 916 provides an interface to the IQ system enabling monitoring and adjustment of parameters within IQ and IQL controllers. The 916 can be connected to the IQ network via Bluetooth, Ethernet, modem or a standard network connection (local supervisor port or CNC2 if the mobile device supports a serial connection). A separate GSM phone should be used instead of a modem.

FIELD DEVICES

The efficient control and monitoring of a system depends heavily upon the field devices connected, and upon the quality of the information these provide:



SENSORS –

A range of devices for measuring temperature, humidity, air quality and pressure.



WIRELESS SENSORS –

Wireless technology delivers significant benefits in terms of ease of installation and cost, and equally importantly provides flexibility and convenience in areas that are regularly reconfigured.



METERS –

The ability to measure energy and utility usage is essential to run a building effectively – you cannot control what you cannot measure. Changes to the Building Regulations (Part L2) have made metering a mandatory requirement in the majority of commercial building applications. Trend's range of utility meters suit a broad range of applications.



MOTOR CONTROLLERS –

The NX and NXL range of frequency converters provide variable speed and torque control on AC motors. This ensures smoother, more efficient operation of HVAC plant and delivers considerable energy savings. The NXNI and NXIP interface cards enables the NX range to connect directly onto the Trend or Ethernet networks.



VALVES + ACTUATORS –

Trend's range of Valves and Actuators cover all HVAC applications.



NETWORK PRODUCTS –

Trend provide a range of devices which enable interaction between different communication systems or legacy installations. The 3xtend provides the means by which the Trend system network can be extended over a clients Ethernet network, seamlessly connecting all Trend IQ controllers thereby reducing initial installation and ongoing lifetime costs.

IQ3 Web Enabled Controller



The BTL listing applies to /BAC option controllers.

BACnet is a registered trademark of ASHREA. ASHREA does not endorse, approve, or test products for compliance with ASHREA standards. Compliance of listed products to the requirements of the ASHREA Standard 135 is the responsibility of BACnet International (BI). BTL is the registered trademark of BI.

Description

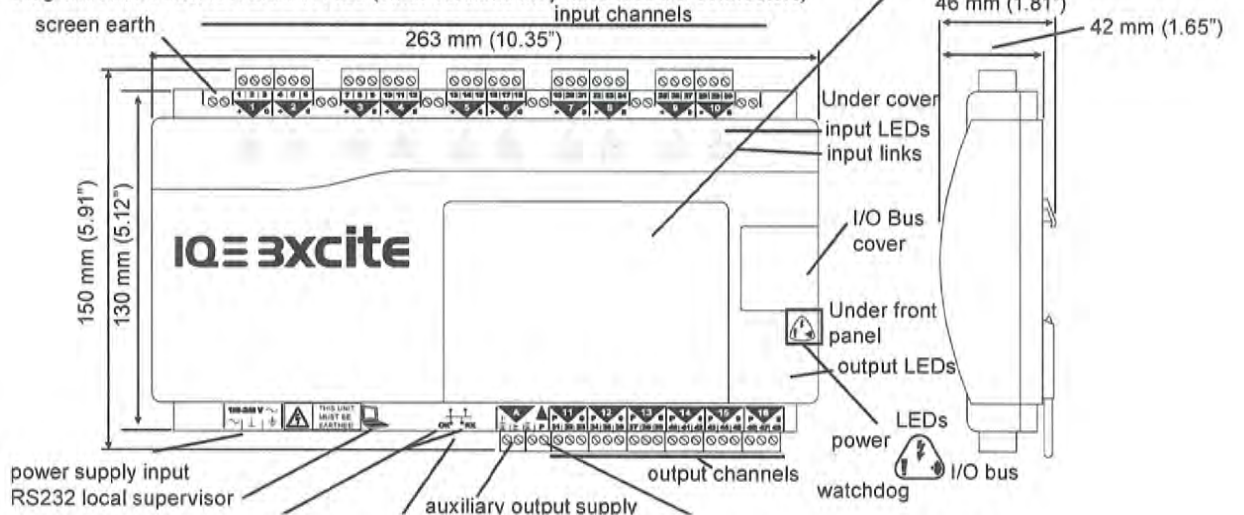
The IQ3 controllers are Building Management System controllers that use Ethernet and TCP/IP networking technologies; they are optionally able to use BACnet protocol over IP. Each controller incorporates a web server which can deliver user-specific web pages to a PC or mobile device running internet browser software. If a system is set up with the correct connections, a user with the appropriate security codes can monitor or adjust the controller from any Internet access point in the world. It is also compatible with the traditional IQ system protocol. The IQ3 range consists of DIN rail mounting controllers with from zero to 16 input/output points (expandable up to 128 points by adding DIN rail mounting I/O modules). This flexibility makes them suitable for a broad range of applications. A local PC or display (SDU-xcite) can be connected to the RS232 port.

Features

- Ethernet 10 Mbps main network with TCP/IP protocol
- Embedded web server with security protected monitor/control
- Embedded XML Web Services option
- BACnet over IP option (BTL Listed)
- Compatible with existing IQ system protocol
- IQ3xact with 12 I/O points and IQ3xcite with 0 or 16 I/O points
- IQ3xcite with 80 or 112 additional points by DIN rail I/O modules
- I/O bus allows separate placement of I/O modules
- Flexible number of software strategy modules
- RS232 local supervisor port
- 100 to 240 Vac, or 24 Vac and 24 to 60 Vdc input power supply versions
- Small footprint with DIN rail mounting
- Battery backup, current loop Lan, or serial auxiliary board options
- DHCP enabled.

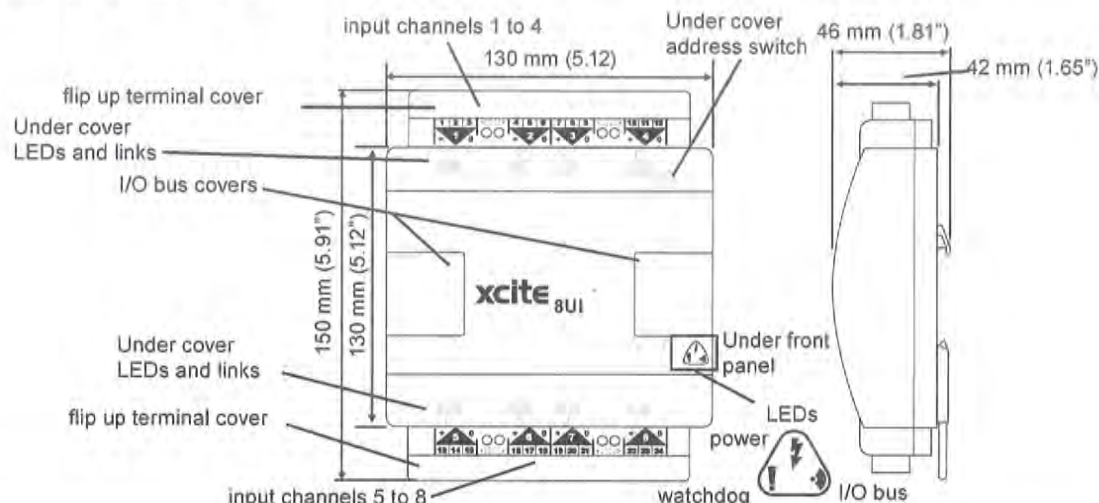
Physical

Diagram shows IQ3XCITE/96 or /128 (other versions may have less I/O connectors)



Physical (continued)

I/O Module (e.g. 8 universal input)

**FUNCTIONALITY**

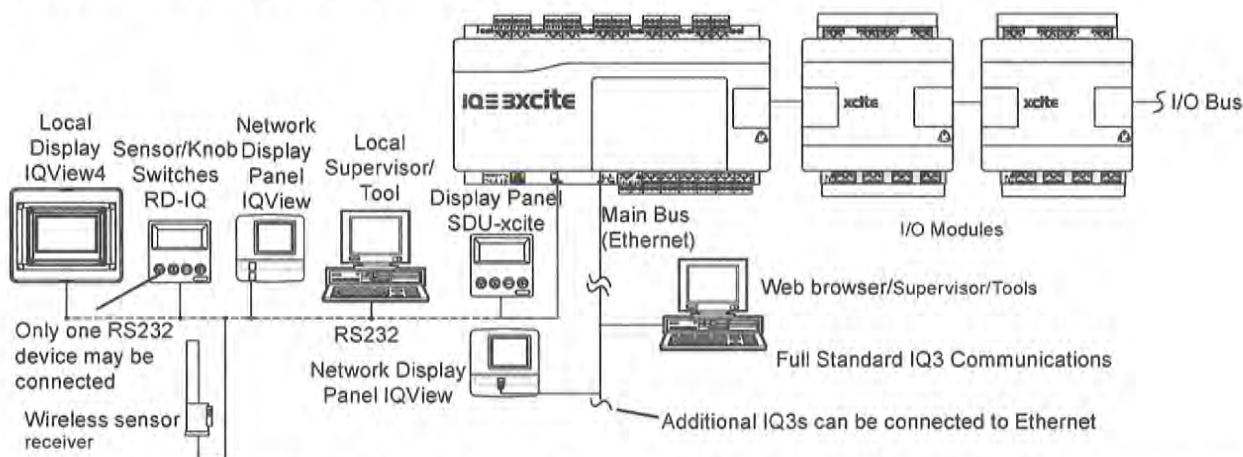
This data sheet gives a general description of IQ3, it does not provide information on the /BINC or /XNC options. For details of the /BINC option see the IQ3../MSTP/BINC../ Data Sheet (TA201095). For details of the /XNC option see the IQ3../.../XNC/... Controller/Interface Data Sheet (TA200912). Detailed information is given in the following manuals:

- IQ3/4 Configuration Reference Manual (TE20076) covers IQ3's communications, hardware, configuration and modules.
- SET Manual (TE200147) covers IQ3's configuration using SET
- IQ System Ethernet Products Engineering Manual (TE200369) covers the use of Trend products with Ethernet
- IQ3 Web User Guide covers the use of IQ3 Web Pages
- IP Tool Manual (TE200638) describes the use of the IP Tool.
- IQ3 Graphical Display Page Editor Manual (TE200629).
- IQ3 Reset Applet Manual (TE200767)

The IQ3 functionality can be divided into four sections: system, hardware, firmware, and strategy.

SYSTEM**Standard Communications**

The full standard IQ3 has Ethernet, I/O bus, and RS232 ports.



Ethernet: This is the main network for the IQ3 controller. It enables PCs to connect directly to Ethernet and communicate with the IQ3 using IP addressing. It also enables Inter-Controller Communications (IC Comms - peer to peer Ethernet communications) between controllers. Remote PCs can communicate through standard IT networks (e.g. the Internet) using IP, enabling communication from anywhere in the world. The IP connection will support a web browser (thin client) running in a PC, but communication with an IQ System

use of the virtual CNC embedded in the IQ3 controller. The strategy and all other configuration files may be downloaded to the IQ3 from SET (System Engineering Tool) across Ethernet.

I/O bus: The controller has the option of a highly reliable I/O bus. This enables expansion I/O modules to be connected to add up to 112 additional I/O points (128 points in total with the 16 points in the IQ3). The bus can be up to 10 m (11 yds) or 30 m (33 yds) in length, and have a maximum of 15 I/O modules.

Standard Communications (continued)

RS232 port: A sensor/display (RD-IQ), 4 line display panel (SDU-xcite), network display (IQView or IQView4), a wireless sensor receiver (XWR/IQ) or a local PC running a supervisor or a software tool may be connected to the RS232 port. Only one device may be connected.

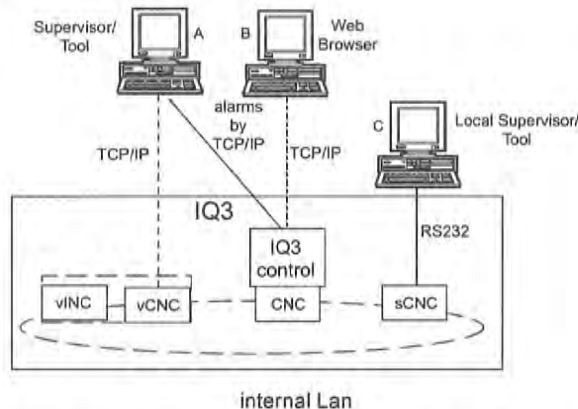
This port can communicate directly with the IQ3 (address 0) or to the IQ system network using the local supervisor CNC (see below).

The RD-IQ or SDU-xcite communicates only with the local IQ3, so for the RS232 port to operate with RD-IQ or SDU-xcite, its address module local supervisor port address must be set to zero.

Stand Alone Mode: Stand alone mode can be enabled in the Ethernet IP network module. Enabling stand alone mode will stop the IQ3 from attempting to build networks with other IQ3s or EINC's, but it will still communicate as a single IQ3 (with supervisor, web browser, and local supervisor). A controller is set to stand alone mode to reduce Ethernet network traffic (i.e. to disable polling messages trying to find other Trend devices).

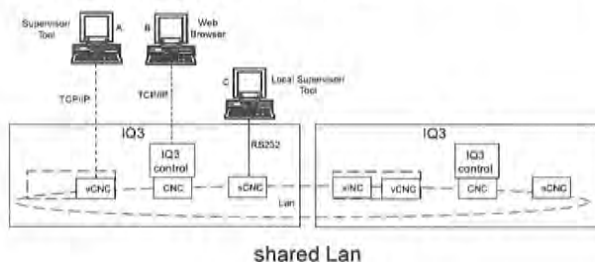
An IQ3 prior to firmware version 1.2 could be set to 'Stand Alone' by the IP Tool. If a controller's firmware prior to v1.2 is upgraded it will be taken out of stand alone mode. It is recommended that no IQ3 controller prior to version 2.2 should be operated in stand alone mode.

Networks: The IQ3 will create its own internal Lan which includes a node for its own controller, a CNC for its local supervisor port (sCNC - if supervisor port address is set non-zero), a virtual CNC (vCNC), and a virtual INC (vINC - address 126).



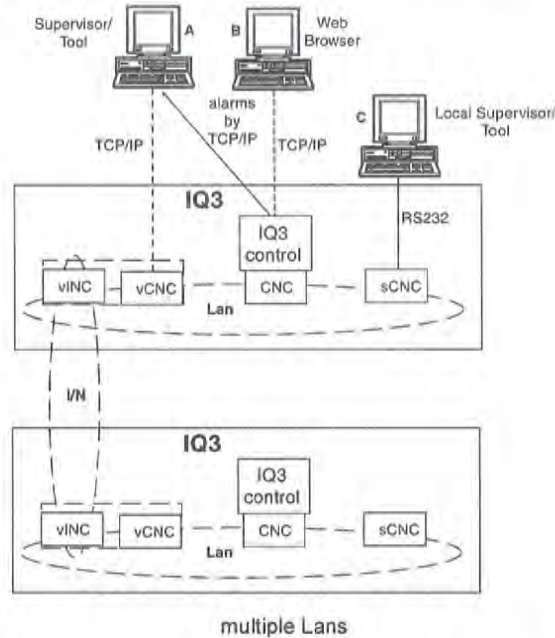
If multiple IQ3s with the same Lan number are connected to Ethernet, then an Ethernet Lan will form to include these IQ3s and their internal nodes. They must be on the same Ethernet segment, in the same subnet, and use same UDP port.

The IQ3 with the lowest IP address on the Lan also assumes the INC functionality (the other vINC's disappear) and is responsible for maintaining the Lan across the IQ3s.



If multiple IQ3s with different Lan numbers are connected to Ethernet then their INCs will form an internetwork (along with any EINC's/3xtends on the network).

Note that Trend Ethernet devices (e.g. IQ3, EINC, 3xtend/EINC L) on the same Ethernet segment must all be on the same subnet.



IC Comms: The IQ3s may communicate with each other IQ4, IQeco and earlier IQ (and IQL) controllers using Inter Controller Communications (peer to peer communications). This will use IQ System Lan/node addressing (not direct IP addressing).

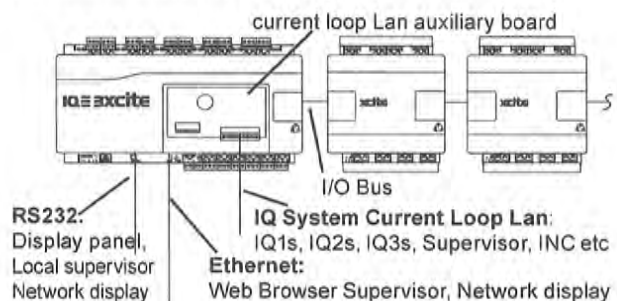
Alarm Delivery: Alarms can be delivered to the local supervisor port or to a supervisor making a permanent connection to the virtual CNC by normal IQ system comms. Alarms can be delivered to supervisors making temporary connections to the virtual CNC using TCP/IP by setting the supervisor's IP address and port number in the alarm destination module (i.e. IP alarms). Alarms may also be sent by email.

Note that network alarms are sent to any connected port (e.g. supervisor connected to local supervisor port, or supervisor connected to virtual CNC).

Optional Communications

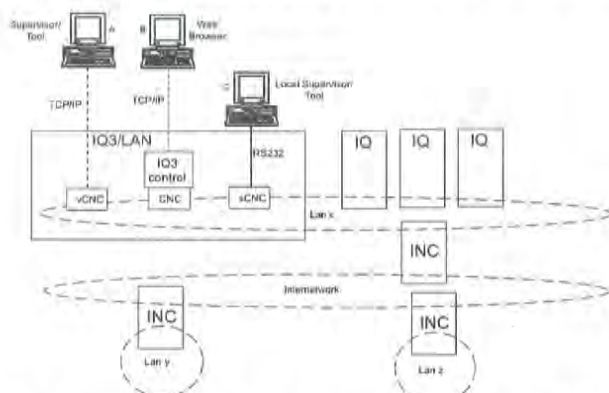
IQ System Current Loop Lan Auxiliary Board

The optional IQ system current loop Lan auxiliary board enables the IQ3 to become a device on an IQ system current loop Lan. It can no longer be part of an Ethernet Lan (or internetwork). However, it will still support access using a web browser or a supervisor or tool by way of a virtual CNC, and it can still send IP or email alarms across Ethernet. The current loop Lan auxiliary board is fitted in IQ3.../LAN versions of IQ3 (henceforth referred to as IQ3/LAN).



Optional Communications (continued)

Once another IQ (IQ1, IQ2, IQ3, or IQ4) is connected to the current loop, the two IQs form a Lan. This can then be extended onto an internetwork in the normal way using an INC type node (e.g. INC2, LINC, 3xtend/EINC L).



If a 3xtend/EINC L is used instead of an INC, then the internetwork (or a segment of it) can exist on Ethernet. This would enable Ethernet LANS of IQ3s to be part of the same system network as an IQ3/LAN.

Serial Auxiliary Board

The serial auxiliary board provides an additional RS232 or RS485/422 serial port for communicating with other devices. This board is used in some versions of the IQ3.../.../XNC/... (referred to as IQ3/XNC/SER, see IQ3.../.../XNC/... Data Sheet for more details).

BACnet Protocol Option

IQ3/BAC versions of IQ3 support BACnet protocol; BACnet is an open protocol that enables the products of a number of different manufacturers of building automation and control equipment to communicate with each other.

Each BACnet device has a number of objects (roughly corresponding to Trend modules) and each module has a number of properties (roughly corresponding to Trend module parameters). The mapping of the BACnet properties to the Trend parameters is covered in the IQ3/4 Configuration Reference Manual (TE20076).

BACnet communications can only occur if the BACnet Network module (Network module 3, type 5) is enabled and set up as this defines the controller's communication parameters on the BACnet network.

The network module's default settings normally allow BACnet communications to operate correctly, but under certain circumstances they may need to be changed - see IQ3/4 Configuration Reference Manual (TE20076).

SET is able to browse the BACnet system, and this can be used to confirm that the IQ3's BACnet communications are operating.

A specification of the objects, properties, and BIBBS (BACnet Interoperability Building Blocks) supported by the IQ3 are given in the IQ3 Product Implementation Conformance Statement (TP201002). This describes the IQ3 functionality which is submitted to the BACnet Testing Laboratory for conformance testing.

The IQ3 controller is BTL listed as a BACnet Application Specific Controller (B-ASC) because it complies with all the BIBBS required, but it supports more than this, and on a practical system can be treated as a BACnet Advanced Application Controller (B-AAC).

BACnet Alarms: IQ3/BAC is able to send alarms using BACnet protocol by way of the BACnet Device type of Alarm Destination Module. This will only accept Sensor, Digital Input, Driver (digital readback), and Plot (buffer ready) alarms (other alarms will be ignored).

BACnet IC Comms: IQ3/BAC controllers support BACnet IC comms. This enables it to send IC Comms to a BACnet device using BACnet protocol.

The Protocol parameter in the IC Comms module can be set to either Trend, or BACnet.

BACnet IC Comms supports Data From, Data To, and Global To Direction Classes, but not Minimum, Maximum, Sum, or Average.

The Data From, Data To, and Global To BACnet IC Comms supports Analogue and Digital Bit Variable Types, but not Digital Byte.

In order to send a BACnet IC Comms a Non-Trend Device module (NTD) must be set up for the BACnet device being communicated with.

The NTD module is allocated a Lan number (for the Lan of BACnet NTDs), a node address on that Lan, and address attributes so that the controller selection process operates similarly for both Trend and BACnet protocol IC Comms. BACnet IC Comms Global To IC Comms are restricted to a specific Lan, so the Remote Lan cannot be set to 128 (signifying a global message to every Lan, i.e. a global global).

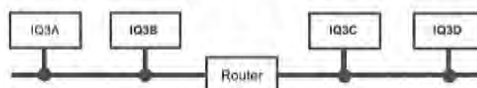
BACnet item selection is similar to that for the Trend protocol, except that BACnet variables must be specified absolutely (i.e. item selection by item label matching may not be used).

BACnet with Automatic IP Addressing: Certain issues exist when using automatic IP addressing and BACnet protocol. These are described in the IQ3/4 Configuration Reference Manual (TE20076).

System Configurations

Routers: IQ3s are able to construct an internetwork (but NOT a Lan) across a router. However, it is possible for PCs to connect to IQ3s across routers, and to treat IQ3s separated by routers as separate sites.

Using a Supervisor with Multiple Sites: In the diagram below there are two IQ3s either side of a router.



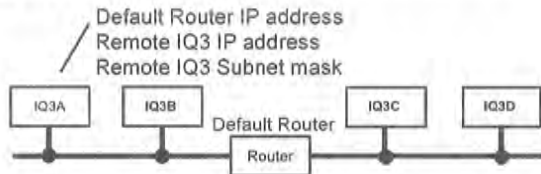
If the IQ3s are not configured to cross the router as described below, they will construct two separate networks, one each side of the router.

Only one internetwork is allowed on a site, but the Supervisor can treat the networks as separate sites and so each site may have an internetwork. The supervisor will change the IP address of the IQ3 virtual CNC it is using as it switches sites. *Note that there cannot be any IC comms between the sites.*

Alarms can be sent to the supervisor directly using TCP/IP.

System Configurations (continued)

Configuring IQ3s to Cross Routers: This is done by setting up the IQ3's network module with the 'Router 1' (default router) IP address (for a router on its own subnet) and with a Remote Device's IP address, and subnet mask (for an IQ3 on the other side of the router).



If several IQ3s are connected one side of a router, the unit with the lowest IP address (cross-router master) will attempt to construct the network across the router. In the above diagram, IQ3A is the cross-router master and is configured with the default router IP address and a remote IQ3's (e.g. IQ3C's) IP address and subnet mask. It will now send a message to IQ3C's subnet through the default router. IQ3C will then reply and the IQ3A will construct the internetwork between the two IQ3s.

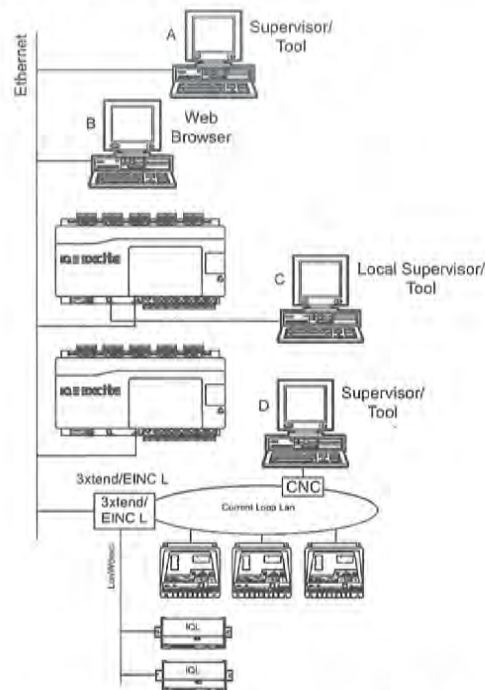
Because IP addresses may not be fixed (see Automatic IP Addressing Mode - below) it may not be possible to specify which controllers have the lowest IP addresses, so the details should be set up in every device on the subnet, so that any device may be able to become the cross-router master. If Automatic IP Addressing mode is being used, the remote devices will be identified by host names rather than IP addresses.

It is recommended that the details of two devices (either IQViews, 3xtend/EINC Ls, or IQ3s) in the network from each subnet the other side of a router should be set up in every device in the network (either IQViews, 3xtend/EINC Ls or IQ3s) on the local subnet. For increased reliability, details of additional devices should also be set up. *Note that up to 20 device's details may be entered in the network module.*

Internet Access: Because the Internet uses TCP/IP addressing, the 963/IQ3 communication can operate over the Internet. Company Internet access is normally protected by a firewall which is usually the responsibility of the company's IT department. The firewall will need to be set up to allow messages through the port addresses being used for sending and receiving IQ System messages. Additionally the firewall may be set up either to pass messages through or to redirect them. If redirection is being used, then the messages are sent to the firewall IP address and the firewall must be set up with the relevant IQ System IP address (e.g. IQ3 vCNC, 3xtend/EINC L vCNC, or IQ3's own IP address for web pages) so it can pass them on. If using an impermanent ISP connection (e.g. using a dial up modem) at either 963 or IQ3 end, the ISP (Internet Service Provider) must support reverse dial up.

Note that IQ3 to IQ3 networking communications will not operate across a firewall (i.e. virtual networks cannot be built across firewalls).

IQ3 with 3xtend/EINC L: The diagram below shows the addition of an 3xtend/EINC L to Ethernet. The 3xtend/EINC L supports an IQ System current loop Lan which may contain IQ1 IQ2 or IQ4 series controllers.

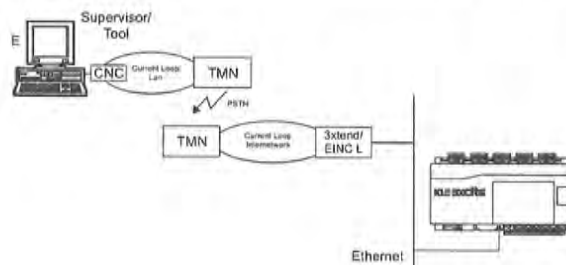


The 3xtend/EINC L differs from the EINC in that it can operate in an automatic IP addressing environment (e.g. with DHCP) and has a LONWORKS® bus connection enabling the extension of the internetwork over the LONWORKS network, and communication with IQLs.

Note that the LONWORKS network is not to be used where a high level of network traffic is expected e.g. joining internetworks or where there are many IQ system devices on many IQ system Lans being accessed across an internetwork routed through the LONWORKS network. An alternative topology should be used such as an Ethernet network.

Note that the IQ3 and the 3xtend/EINC L cannot have the same Lan number since the EINC's Lan number (set up on its address switches) is reserved for its current loop Lan.

IQ3 and TMN: The IQ3 can use a TMN connected to an 3xtend/EINC L's current loop network. The 3xtend/EINC L should operate in internetwork extension mode (i.e. device address =>100) which provides a current loop internetwork with an extension on Ethernet. However, this will only give normal IQ System Communications (i.e. text communications), it cannot provide web pages.



System Configurations (continued)

Automatic IP Addressing Mode: The IQ3 is able to operate in a system where the IP addresses are automatically allocated by a DHCP (Dynamic Host Configuration Protocol) server (i.e. the IP addresses are not fixed).

The IP Addressing Mode parameter (in network module) is set to 'Enter Manually' for traditional manual entry with a fixed IP address, and is set to 'Obtain Automatically' (default setting) for the IP address to be set automatically by the DHCP server.

DHCP Operation: If set to 'Obtain Automatically', when the controller powers up it will inform the DHCP server which can then provide it with:

IP Address
Subnet Mask
Router 1 (default router)
WINS Servers (1 to 5)
DNS Servers (1 to 5)

(These parameters cannot now be changed by SET unless IP Addressing mode parameter is set to 'Enter Manually'.)

Link/Local Operation: If the controller is in automatic IP addressing mode and the DHCP server fails to respond, the IQ3 will enter link/local mode where it will negotiate its IP address with the other devices on its Ethernet segment.

A PC (running supervisor or tool software) should be set up for auto-addressing. On DHCP failure it may take a very long time to enter link/local and be able to communicate with the IQ3s. This can be avoided by power cycling the PC which will cause it to enter link/local on power up. To communicate with an IQ3 it must be on the same segment.

IP Addressing Mode	IP addressing set up by	
Obtain Automatically	DHCP	IP address may vary
	Link/Local	
Enter Manually	Manual	IP address fixed

Summary of IP Addressing Modes

Note that it is recommended that link/local only be used as the default method of operation on a single segment system, (not across a router).

Host name: Because the IP address is no longer fixed in automatic IP addressing mode, the IQ3 uses a Host name, which is fixed. When the IQ3 powers up it sends its host name to a WINS (Windows Internet Naming Service) server. If a device wishes to communicate with the IQ3 it will send the IQ3's host name to the WINS server which will return the associated IP address.

If a WINS server does not exist, the host name can be used over the local segment only (i.e. not across routers).

The host name can also be used to communicate with the IQ3 if the IP Addressing Mode parameter (in network module) is set to 'Enter Manually'. This provides a user-friendly way of identifying the controller rather than remembering its IP address.

Default Host Name: If the host name has not been set up, the IQ3 will power up with a default host name which is a function of its MAC address ('Trend' plus the last six digits of the MAC address e.g. TREND_00_14_D0). The default host name will always be operational (as well as its Host name if it has been set up), unless the Default Host name parameter in the network module has been set to 'Disabled'.

Communication across the Internet: If a device (e.g. supervisor) wishes to communicate across the Internet with an IQ3 on a system with automatic IP addressing, then the firewall server either has to be able to use the host name, or the IQ3's IP address must be fixed.

Fixing the Controller's Address on a DHCP controlled System: It is possible for the IQ3 to operate in a DHCP regime with a fixed IP address by setting up the DHCP server so that it always gives that particular IQ3 the same IP address. An alternative is to set the IQ3 IP Addressing Mode parameter to 'Enter Manually', and set its IP address outside the range of the DHCP server.

Email Server Address: Because the Email Server Address is no longer fixed on a DHCP system, it must be set up (in the network module) to a host name or an Internet domain name. Thus when an email alarm is to be sent the Email Server IP Address is resolved by either a WINS server or a DNS (Domain Name System) server.

Crossing Routers if DHCP is operating: In the DHCP regime, if the internetwork is to cross a router(s), the Remote Devices (1 to 20) IP addresses should be set up as host names. This will enable the IP addresses to be obtained from the WINS servers.

Note that if any communication using a host name crosses a router(s), then a WINS server address must be set up.

Servers: If the IQ3's IP address settings are to be supplied by a DHCP server, the server must be installed on the same segment as the IQ3. On a multi-segment system a single DHCP server may be used providing it has a connection to each segment, i.e. multiple connections.

The server must be capable of downloading either or both (as appropriate, see below) the WINS server address, and the DNS server address.

If host names are being used for IP addressing across a router, then a WINS server must be installed somewhere on the system.

If email alarms are being sent, and the email server address is identified by Internet domain name, then a DNS server must be installed somewhere on the system.

HARDWARE

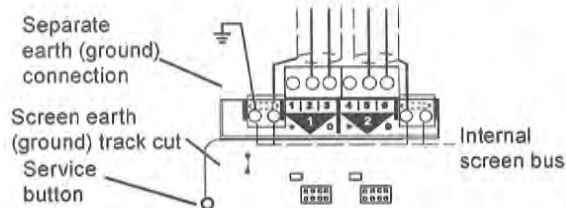
IQ3

Box: The controller box is DIN rail mounting and must be fitted inside a cabinet. The input channel links are accessible by means of a clear polycarbonate cover which can be unclipped using a screwdriver. The I/O bus connector has a hinged plastic cover. The auxiliary board cover can be levered off by inserting a screwdriver between the back of the cover and the main unit. It has a rear DIN rail clip.

I/O Bus: This feature is only available on the expandable IQ3s (IQ3XCITE/96, /128). The IQ3xcite is connected to an adjacent I/O module by a rigid connector. It can be connected to a remote I/O module by a flexible cable. The connection is made by opening the flap, plugging in the connector, and then closing the flap over the cable. The last module on the I/O bus must be correctly terminated (see I/O Modules section). The IQ3xcite is provided with a terminator, and each I/O module is provided with a rigid interconnector.

IQ3 (continued)

Connectors: Other than the screen terminals, which are single part, two part connectors are used throughout to facilitate installation. The screw terminals are of a rising cage clamp type to facilitate good connections. Each input channel has a terminal for cable screen connection. The internal cable screen earthing (grounding) terminal bus is connected to the controller earth (ground) by a soldered link on the board. If required to segregate the screen earth (ground) from the controller input power supply earth (ground), it may be connected to a separate external earth (ground) by lifting the cover and cutting the screen earth (ground) track and making a connection between the internal screen bus terminal and an external earth (ground).



Service Button: The IQ3 can be restored to defaults by holding down the service button for greater than 2 s (but less than 15 s) as the IQ3 is powered up. For earlier hardware versions without the service button it can be restored to defaults by using the Reset Applet (part of SET). *Note that this will clear the strategy; the data cleared down is defined in the Firmware/Strategy section below.*

Power Supply: The IQ3 can be supplied in two input power supply versions.

/100-240 :100 to 240 Vac at 50 or 60 Hz. Power requirement is 56 VA maximum.

The 230V supply must include a dedicated 5A fuse complying with BS1362 and a suitably rated switch in close proximity and be clearly marked as the disconnecting device for the unit. A 5A circuit breaker with high breaking capacity may be used as an alternative.

/24 :24 Vac at 50 or 60 Hz, 24 to 60 Vdc (36 Vdc maximum for /UL versions). Power requirement is 40 VA maximum.

The 24V supply must include a suitably rated switch in close proximity and be clearly marked as the disconnecting device for the unit.

A summary of the minimum and maximum power requirements is given below:

	Supply					
	240 Vac (nominal)		24 Vac		24 Vdc (nominal)	
	min	max	min	max	min	max
IQ3xcite/000	6 VA	15 VA	5 VA	11 VA	4 VA	8 VA
IQ3xact/012	6 VA	28 VA	5 VA	25 VA	4 VA	16 VA
IQ3xcite/016	6 VA	39 VA	5 VA	28 VA	4 VA	18 VA
IQ3xcite/096, /128	6 VA	56 VA	5 VA	40 VA	4 VA	27 VA

The minimum power is for the core electronics without any I/O auxiliary power or additional I/O modules. The maximum power for the IQ3xcite/000 includes core electronics and maximum auxiliary supply consumption, for the IQ3xact/012 and IQ3xcite/016 it also includes maximum I/O consumption; the maximum for the IQ3xcite/96 and /128 includes core electronics, maximum I/O consumption, and maximum auxiliary supply of 700 mA (which includes power to the I/O bus).

Fusing: The 24 Vdc combined supply to the IQ3's own I/O channels, the I/O bus, the RS232 connector (e.g. to power SDU-xcite), and the auxiliary supply output is protected by a self-resetting electronic circuit breaker. The part of the 24 Vdc combined supply which supplies the RS232, and the 24 V auxiliary supply output is limited to 150 mA. The 0V return of this supply (in A terminals set) of this supply is limited at 500 mA by a self resetting fuse, so that if this 0V terminal is mistakenly used for high currents, the fuse will blow and protect the 0V line; when the fault is removed the IQ3 will return to normal operation.

The analogue output P bus is protected by a 1.6 A self resetting multifuse.

The power supply is protected against catastrophic failure by a non-replaceable fuse. The analogue output circuitry is protected against the wrong connection of a non-isolated external supply by a non-replaceable fuse. If either non-replaceable fuse blows, the controller should be sent back for repair.

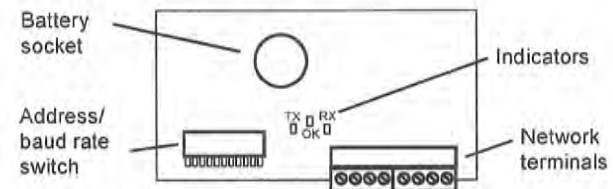
The I/O modules have protection as described in the I/O module section.

Battery Backup: The strategy configuration and data (logs, alarms) are stored in the unit in nonvolatile memory (Flash). A 'supercap' is used to maintain the real time clock (time and date). In the event of power failure this will support the clock for 6 days (typically). *Note that the supercap needs about 2 minutes to reach full charge after power is applied.*

Optionally a battery board (XCITE/BBC) can be fitted into the unit; this will support the clock for several years in the event of power failure (e.g. for Timemaster, see Firmware/Timemaster).

If the battery hasn't been discharged, it should be replaced routinely every 5 years. The battery (type CR2032) can be replaced after turning the power off and removing the auxiliary board cover (while the battery is not in circuit the supercap will maintain the real time clock).

IQ system Current Loop Lan Optional Auxiliary Board: The IQ3/LAN (IQ3.../LAN) is supplied complete with a Lan auxiliary board fitted in the auxiliary board slot, and with a special auxiliary board cover which enables access to the auxiliary board switches and connectors.



The auxiliary board also contains the circuit for a backup battery so it can also fulfil the function of XCITE/BBC as described above. However, the CR2032 battery is not supplied so must be purchased separately if a battery backup option is required.

The board contains the normal hardware for an IQ system current loop Lan node:

Address/Baud rate switch: The address on the Lan is set by poles 1 to 7 in range 1, 4 to 9, 11 to 119 and must be unique on the Lan. The strategy address module Local Address parameter monitors the address switch settings and is read only for IQ3/LAN. The baud rate is set by poles 8 to 10 in the range 9k6, 19k2 and must match the other nodes on the Lan (it can also be read in Network Module 2).

Note that zero address reset is not implemented on IQ3.

Network terminals: The network terminals facilitate connection of 4 wire cables (enabling a 'weaving' connection method).

IQ3 (continued)

Indicators: The standard LEDs are fitted (TX, RX, and network OK).

Bypass relays: The board contains 2 changeover relays which bypass the receive and transmit circuitry and maintain network integrity during power fail.

Serial Auxiliary Board: This board is fitted to IQ3/XNC/SER (IQ3.../XNC/SER) versions of IQ3, see IQ3.../XNC/... Data Sheet for details. This board also supports the battery backup facility in the same way as the IQ system current loop Lan auxiliary board (see previously).

Indicators: I/O Channels

Input LEDs: (yellow) Each input channel has an LED to monitor the input state when the input channel is set to a digital input. The LED will illuminate when the associated input contact is closed.

Output LEDs: (yellow) Each output channel has an LED whose light intensity increases with output voltage.

Core function

Watchdog (🐶): (red) On if controller has a software fault (i.e. strategy or firmware).

I/O bus error (⚡): (red, not fitted on IQ3xact) On if there is an I/O bus fault, (e.g. check for short circuit between Data Hi or Data Lo and either of the power lines).

Power (💡): (green) On when input power supply is connected. Flashes briefly at 1 second intervals if input power supply fault; return unit to supplier.

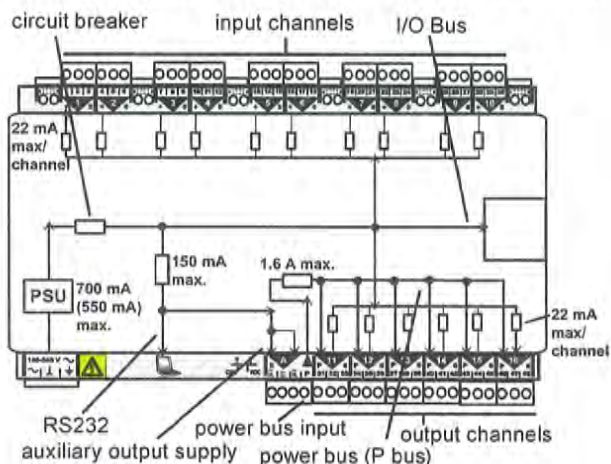
Ethernet

OK: (green) Normally called LINK on Ethernet systems. ON indicates a good Ethernet connection. If OFF indicates faulty Ethernet connection.

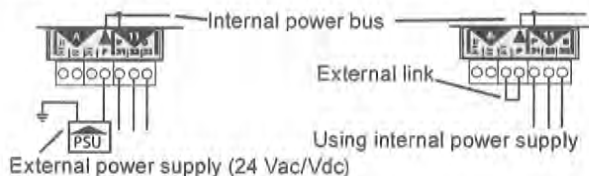
RX: (yellow) Flashes when packet of data is being received across the Ethernet.

24 Vdc Combined Supply: The 24 Vdc combined supply supplies the IQ3's own input/output channels, the I/O bus, the RS232 connector (e.g. to power SDU-xcite), and the 24 Vdc auxiliary output supply terminals. The total available current is 700 mA (reducing to 550 mA for /100-240 version if the 230 Vac input power supply is less than 200 Vac). The PSU has thermal overload protection and the combined supply is protected by a self resetting electronic circuit breaker.

The input and output channels are current limited at 22 mA each. The part of the combined supply used by the RS232 connector and the auxiliary output supply is current limited to 150 mA (typical). The auxiliary output supply can be linked into the P connector to supply auxiliary power for use by output devices.



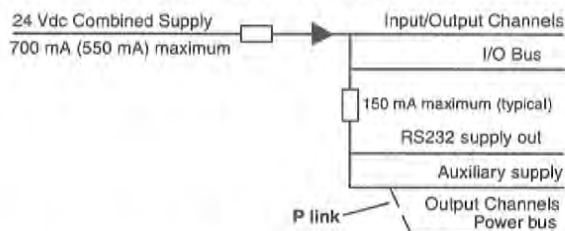
The P output terminals are used to supply the power to output devices. The internal power bus (P bus) is protected by a 1.6 A self-resetting multifuse. The power bus input terminal is normally supplied from the IQ3 24 Vdc auxiliary output supply by using an external link but it can be supplied from an external, dedicated, isolated, 24 Vac/Vdc power supply. The controller is protected against the wrong connection of a non-isolated external supply by a non-replaceable fuse.



Note that if an external 24 Vac/dc power supply is used, it must be dedicated to I/O channel use, and it must comply with the relevant EMC and safety standards.

The external supply can be either 24 Vac or 24 Vdc, but if the output devices require a mix of 24 Vac and 24 Vdc a decision will have to be made over which supply to connect to the P bus; the other supply will need to be provided by external wiring.

Note that the installer should note whether the P bus is 24 Vac, or 24 Vdc and only connect the appropriate loads.



The following checks should be made:

- The maximum current 700 mA (550 mA) available from 24 Vdc combined supply is not exceeded.
- The 150 mA supply to the RS232 and Auxiliary output supply is not exceeded.

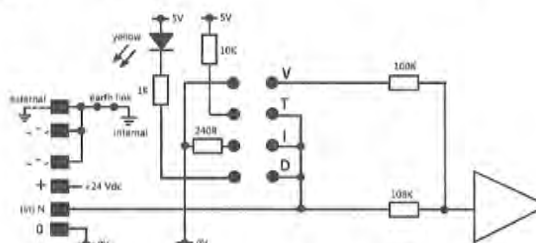
The calculation to perform these checks is described in the IQ3/4 Configuration Reference Manual (TE20076).

I/O Channels: The various models of IQ3 have differing numbers of I/O channels as shown below:

IQ3XCITE/00	Zero input/output channels
IQ3XACT/12	6 universal inputs and 6 analogue outputs
IQ3XCITE/16	0 universal inputs, and 6 analogue outputs
IQ3XCITE/96 IQ3XCITE/128	10 universal inputs, and 6 analogue outputs plus additional I/O channels can be provided by connecting I/O modules to the I/O bus to provide up to a maximum of 96 or 128 channels.

Universal Inputs: (Channels 1 to 10)

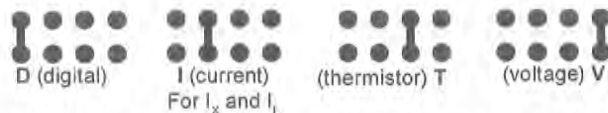
Linkable for digital (D), current (I), thermistor (T), or voltage (V) inputs.



For D, Ix, V, and T connect between (in)N and 0 V. For IL,

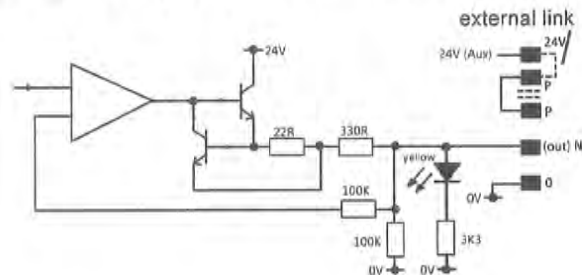
IQ3 (continued)

Links:



Digital inputs may be volt free contact, logic, or open collector (or drain) connected as shown in the I/O module channels section.

Analogue Voltage Outputs (Channels 11 to 16.)



The P output terminals are used to supply power to the output devices. The internal power bus (P bus) is protected by a 1.6 A solid state self-resetting multifuse. The P bus is normally supplied from the IQ3 24 Vdc auxiliary output supply through the external link shown above (supplied fitted by default) but if required it can be supplied from an external isolated 24 Vac/Vdc power supply. The controller is protected against the wrong connection of a non-isolated external supply by a non-replaceable fuse.

Ethernet: The controller should be connected to an Ethernet hub or switch using Cat 5e unshielded or shielded (UTP or FTP) cable and RJ45 plugs (shielded or unshielded appropriate to the cable).

A local PC (Ethernet) can either be connected to an adjacent port on the hub, or can be connected directly to the IQ3 Ethernet port using a standard Ethernet cable in conjunction with a crossover adaptor (XCITE/XA).

Displays

The IQ3 controller can be used with IQView, IQView4, SDU-xcite, and RD-IQ displays.

Note that the NDP is not compatible with IQ3; it will not recognise an IQ3 connected to its network.

IQView: The IQView is a touch screen network display (colour or mono) which can be either surface mounted or rear panel mounted. In addition to showing all the normal strategy items, it can access directories, timezones, and alarms, and users can be set up with configurable access rights. It can be connected to the IQ3 either by Ethernet or by RS232. The Ethernet connection can either be by the IQView's own virtual CNC or by an external vCNC (e.g. the IQ3's). The RS232 connection enables the IQView to communicate either only with that IQ3 (if local supervisor port address is zero), or with the network (if local supervisor port address is non-zero).

IQView4: The IQView is a touch screen colour display panel for rear panel mounting with a front cover. It can access inputs, outputs, alarms, and plots, and allows knobs, switches, timezones and time to be adjusted. Users can be set up with configurable access rights. It connects to the IQ3 by its RS232 port, and it can communicate only with that IQ3, so the local supervisor port address must be set to zero.

SDU-xcite: The SDU-xcite is a wall mounting 4 line display. In addition to showing all the normal strategy items, it can access directories and the IQ3's alarm log. It connects to the IQ3 by its RS232 port, and it can communicate only with that IQ3, so the local supervisor port address must be set to zero.

RD-IQ: The RD-IQ is a wall mounting temperature sensor and 3 digit display. It has the following variants:

RD-IQ/K: Room display with local temperature sensor and setpoint control

RD-IQ/KOS: As RD/K plus occupation override and occupation status display.

RD-IQ/KOSF: As RD-IQ/KOS plus fan speed control.

It connects to the IQ3 by its RS232 port, and it can communicate only with that IQ3, so the local supervisor port address must be set to zero. By default it accesses fixed strategy items (although these can be changed using the front panel buttons or SDU configuration software, SDU Tool):

Local temperature	S9
Setpoint	K1
Occupation status	K6
Fan speed status	K7

I/O Modules

The expandable versions of the IQ3 (IQ3XCITE/96/..., /128/...) have the option of connecting additional I/O modules to the I/O bus.

- A maximum of 15 I/O modules can be connected.
- A maximum of 96 or 128 points (16 points in the IQ3xcite and 80 or 112 expansion points) can be used.
- The controller and its I/O modules are to be fitted inside enclosures.
- No spurs are allowed on the I/O bus.
- If a single fully earth (ground) screened and bonded contiguous metal enclosure is used, then the total I/O bus cable length can be up to 30 m, 33 yds (this covers the use of a multiple section electrical control cabinet e.g. Form 4 enclosures).

However, if any other type of enclosure is used, or the I/O bus runs between enclosures, then the total I/O bus cable length can be up to 10 m, 11 yds.

For the calculation of cable length, rigid interconnectors can be ignored.)

- Multiple enclosures must be earthed (grounded) to a common earth (ground) point according to latest IEE regulations.

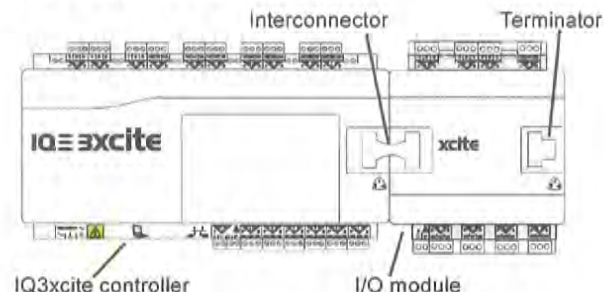
The current range of modules consists of:

- 8 Universal Inputs (/8UI)
- 4 Universal Inputs (/4UI)
- 4 Universal Inputs and 4 Analogue Voltage Outputs (/4UI/4AO)
- 2 Universal Inputs and 2 Analogue Voltage Outputs (/2UI/2AO)
- 8 Relay Outputs (/8DO)
- 4 Relay Outputs (/4DO)
- 8 Analogue Outputs (/8AO)
- 4 Analogue Outputs (/4AO)
- 16 Digital Inputs (/16DI)
- 8 Digital Inputs (/8DI)
- 8 Digital Inputs and 8 Thermistor Inputs (/8DI/8TI)
- 8 Relay outputs with Hand/Off/Auto (/8DO/HOA)
- 4 Relay outputs with Hand/Off/Auto (/4DO/HOA)

Layouts of the I/O modules are shown in the IQ3/4 Configuration Reference Manual (TE20076).

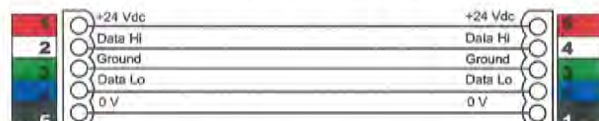
I/O Modules (continued)

I/O Bus: The I/O module has a hinged plastic cover each side for connection of the I/O bus, enabling the bus to be daisy chained by the I/O modules. A short rigid interconnector (XCITE/IC) is available for adjacent modules. An interconnector is supplied with each I/O module; spare interconnectors are available (XCITE/IC/5 pack of 5).

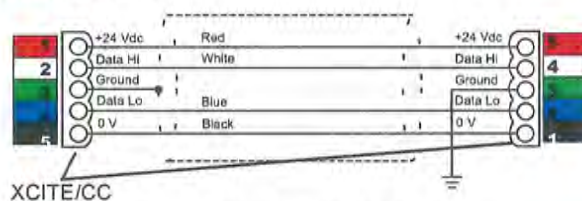


The bus should be terminated at the furthest end from the controller between Data Hi and Data Lo terminals with a 122 Ω resistor. A terminator is supplied with the IQ3xcite controller, and spare terminators (XCITE/TERM/5 - pack of 5) are available.

The rigid bus interconnector includes a ground connection.



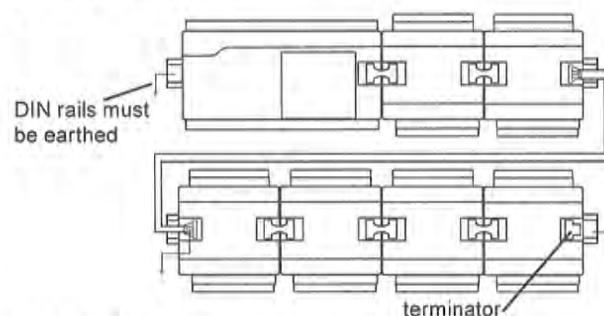
For modules further apart within a metal enclosure, plug in screw terminals (XCITE/CC/10 - pack of 10) are available, enabling the modules to be wired together. Belden 3084A cable should be used, the ground connector should be earthed (grounded) locally, and the cable screen should be grounded at the controller end.



Interconnecting cable

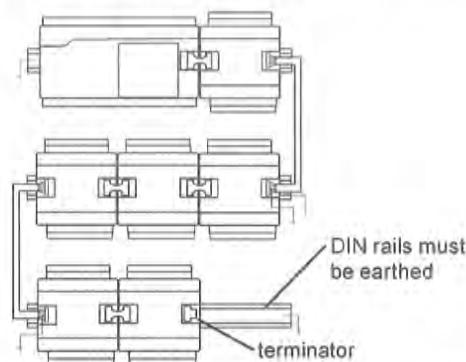
Note that the cable core colours shown are for the recommended cable, Belden 3084A.

This type of cable connects the right side of one module to the left side of another. It can be used for two sections of DIN rail in a panel as shown below:

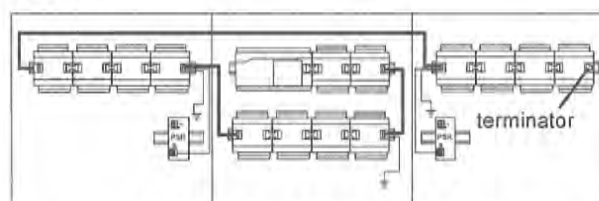


Use of cable to interconnect 2 sections of DIN rail

A different cable must be used if the connection is between the same side of each controller as one connector is rotated due to polarisation of the connectors.



No spurs are allowed. For example, in the multisection panel below the DIN rail sections are connected in series to form one single length of bus with termination at the farthest end from the controller.



Multisection panel with single length bus

The IQ3xcite can supply 24 Vdc to the I/O modules through the I/O bus 24 Vdc terminal. The available current from the controller's combined 24 Vdc supply can be calculated as described in the IQ3/4 Configuration Reference Manual (TE20076).

Alternatively an external 24 Vdc supply must be used if:

- There are more than 6 I/O modules*
- The main controller combined supply would be overloaded.

**Note that this rule does not apply to /8AO, /4AO, /16DI, /8DI, /8DI/8TI, /8DO (serial number M3D4 C0 508 012 or greater) /4DO (serial number M3D8 C0 508 0136 or greater), /8DO/HOA, /4DO/HOA modules which do not need to be included in this module count.*

The maximum I/O module currents are listed in the table below: these can be used to estimate the total current required by the I/O modules. A more accurate current consumption can be calculated as described in the I/O module 24 Vdc supply section below.

Module	Current Consumption
8DO	100 mA
4DO	6 mA
8UI	180 mA
4UI	100 mA
4UI/4AO	180 mA + aux supply max 150 mA
2UI/2AO	100 mA + aux supply max 150 mA
8AO	180 mA + aux supply max 3000 mA
4AO	100 mA + aux supply max 150 mA
16DI	36 mA
8DI	28 mA
8DI/8TI	30 mA
8DO/HOA	100 mA
4DO/HOA	60 mA

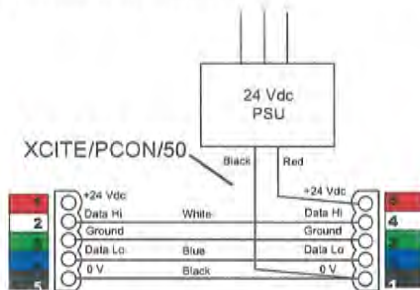
If an external supply is required, the normal bus connection

I/O Modules (continued)

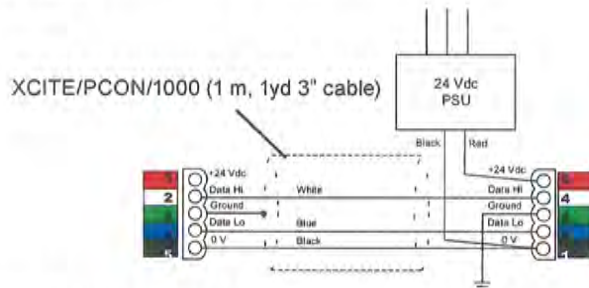
The maximum current that can be passed through an I/O module through the 24 Vdc and 0 V terminals, from one module to the next, is 1.6 A.

Note that if an external 24 Vdc power supply is used, its output must be isolated from earth (ground), and it must comply with the relevant EMC and safety standards.

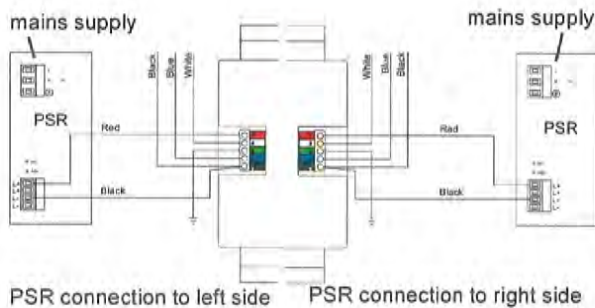
For adjacent modules the XCITE/PCON/50 cable facilitates the connection of the external power supply; it leaves a 10 mm (0.39") gap between the modules.



For non adjacent modules the following connections should be used. This is facilitated by XCITE/PCON/1000, a 1 metre (1 yd 3") cable.



The PSR range of DIN rail mounted auxiliary power supplies (e.g. 1.3 A, 2.5 A, or 5 A) are available. They have isolated outputs.

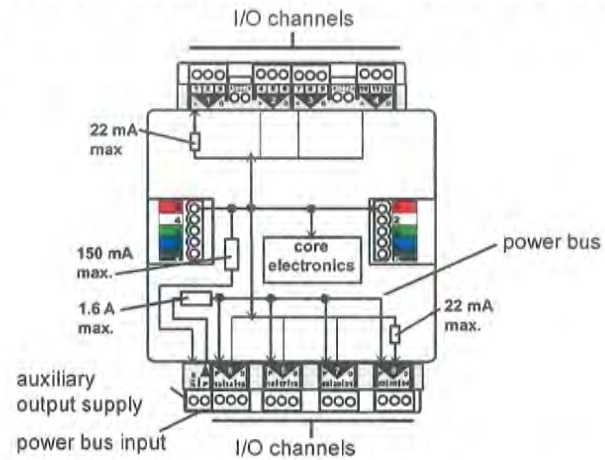


Consideration should be given to the maximum current flowing through from one I/O module to the next as this must not exceed 1.6 A. An example of the calculation of maximum current is given in the IQ3/4 Configuration Reference Manual (TE20076).

I/O Module 24 Vdc Supply: An I/O module can either take its supply from the main controller or from an external supply as described above.

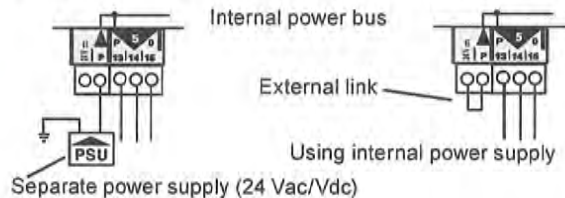
Maximum current consumptions were given in the table above, but a more accurate current consumption may be required to decide whether an additional power supply is required to supply the I/O module or to supply the P bus.

The I/O bus connector 24 Vdc terminal supplies the I/O module's core electronics, its input/output channels, and the 24 Vdc auxiliary supply terminal (present only in I/O module with analogue output channels) which is limited to 150 mA (typical). The auxiliary supply is provided so that it can be linked into the P connector to supply auxiliary power for use by output devices.



Just as for the main controller, on I/O modules with analogue outputs the P output terminals can be used to supply the power to output devices. The internal power bus (P bus) is protected by a 1.6 A self-resetting multifuse.

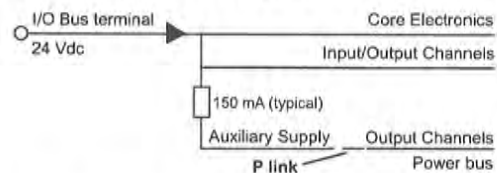
The P bus can be externally supplied by a dedicated, isolated, 24 Vac/Vdc power supply, or can be supplied from the I/O module's 24 Vdc auxiliary output supply by using an external link. The I/O module is protected against the wrong connection of a non-isolated external supply by a non-replaceable fuse.



Note that if an external 24 Vac/dc power supply is used, it must be dedicated to I/O channel use, and it must comply with the relevant EMC and safety standards.

The external supply can be either 24 Vac or 24 Vdc, but if the output devices require a mix of 24 Vac and 24 Vdc a decision will have to be made over which supply to connect to the P bus; the other supply will need to be provided by external wiring.

Note that the installer should note whether the P bus is 24 Vac, or 24 Vdc and only connect the appropriate loads.



The following checks should be made:

- Calculate the maximum current consumed from the I/O bus 24 Vdc terminal for use in the main controller's auxiliary calculation.
- Check that the 150 mA supply to the Auxiliary Supply is not exceeded.

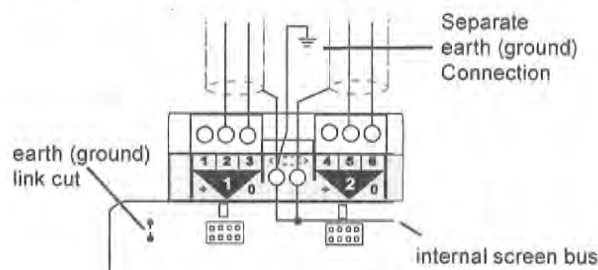
The calculation to perform these checks is described in the IQ3 Configuration Reference Manual (TE200768).

I/O Modules (continued)

I/O Module Enclosure: The I/O module enclosure is DIN rail mounting and must be installed in a cabinet. It has clear polycarbonate covers over both the upper and lower terminal sets to enable access to the channel links and the address switch. The strips can be unclipped using a screwdriver and clipped back in position after use. The I/O terminals are protected by clear polycarbonate flip up safety covers. It has a rear DIN rail clip.

The digital input LEDs, output LEDs, and the three controller status LEDs can be viewed through the clear polycarbonate.

Screen Earthing (Grounding): On I/O modules with universal inputs, the screens for universal input channels are normally connected to the module ground, but they may be separately earthed-grounded (if required to segregate the screen earth-ground from the I/O module ground).



This is similar to the controller screen earthing (grounding), see IQ3 connectors section. There is a separate link for each group of four channels (i.e. the 8 universal input module has two links).

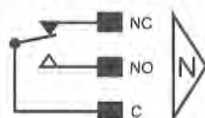
I/O Module Address Switch: The address switch consists of a hexadecimal switch, 0 to 9, A, B, C, D, E, F. Selecting address zero disables the module. If there is an address clash on the I/O bus, the I/O bus fault LEDs on all the modules with the same address will flash; a module's address can be corrected by setting its address switch to other addresses until its LED stops flashing.

When setting up the input and output channels in sensor, digital input, and driver software strategy modules, the I/O module address and the channel number have to be entered; the main controller is referred to as module zero.

I/O Module Channels: The universal inputs have similar connections to those in the main IQ3xcite.

Analogue Outputs: The analogue outputs have a similar arrangement to the main controller with the 24 Vdc auxiliary output supply and the P bus. The /8AO auxiliary output supply terminals can supply a maximum of 300 mA (shared between both sets of terminals); if this is exceeded the current limits and the two Excess Aux. Current LEDs (red) will illuminate. The /4AO can supply a maximum of 150 mA and it has one Excess Aux. Current LED (red) which will illuminate if this limit is exceeded.

Relay Outputs: The relay outputs are single pole changeover, and have a relay output status LED (yellow) which is ON when the relay is energised.



Relay Outputs with Hand/Off/Auto: The relay outputs with Hand/Off/Auto (HOA) facility are based on the standard relay outputs but also have a 3 position HOA switch per channel.

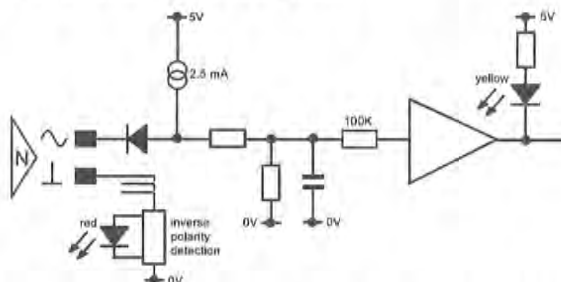
This switch can be set to Hand (H, manually overridden ON), Auto (A, under automatic control from the strategy), or Off (O, manually overridden OFF). In addition to the yellow output status LED there is a red LED which is ON when the output is manually overridden (i.e. Hand or Off). The output status LEDs are nearest to the terminals and the overridden LEDs are towards the centre of the unit.

The output can thus be in one of four states which are shown in the table below along with the switch and LED states.

State	Switch Position	Relay State	Overridden LED (red)	Output LED (yellow)
Manually overridden ON	Hand	ON	ON	ON
Manually overridden OFF	Off	OFF	ON	OFF
Automatic ON	Auto	ON	OFF	ON
Automatic OFF	Auto	OFF	OFF	OFF

The HOA switch position is fed back to the IQ3 strategy driver module from where it can be viewed using web pages, SET, or supervisors.

Digital Inputs: The digital input circuit used in the /16DI and /8DI modules enables the use of a volt free contact input (like the universal input, digital input), but also of an open collector, 24 Vac, or logic input.

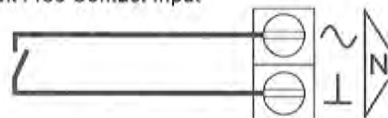


The input will be on when the input LED (yellow) is ON, and this is when the contact closes or AC voltage is applied. This corresponds to an open collector transistor or an open drain FET being ON, or a logic input sinking current from the $\sim$ terminal (low state).

There is an Input Polarity Error LED for each bank of 8 inputs. This LED (red) is ON if one (or more) of the digital inputs are supplied by an ac voltage, which has been grounded on the wrong side with respect to the IQ3's ground.

The various digital input connections are shown below:

Volt Free Contact Input



The volt free contact input has a nominal wetting current of 2.5 mA. The input is ON when the contact is closed.

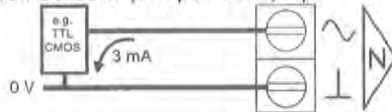
Logic Input



The logic high level can be between 5 and 50 V (e.g. TTL, CMOS). The logic low level must be able to sink 3 mA. Note that the digital input will be ON when the logic

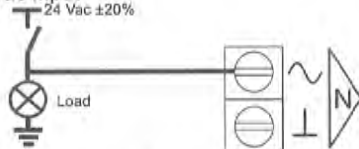
I/O Modules (continued)

Open Collector (or Open Drain) Input



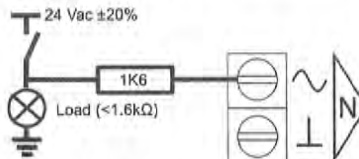
This can be an open collector or an open drain (FET) input. The collector or drain must be able to sink 3 mA. When the transistor or FET conducts, the digital input will be ON.

24 Vac Input



This type of digital input can monitor the state of a 24 Vac signal. In this example it will be ON when the load (e.g. a fan) is powered. For the above configuration the load impedance must exceed 1.6 kohms (e.g. an LED); if it does not (e.g. filament lamp or relay coil) then a 1.6 kohm resistor should be fitted in series with the input.

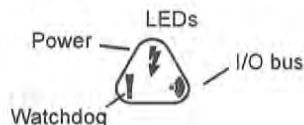
Thermistor Inputs: The I/O module thermistor input is similar to a Universal Input linked for thermistor (T). However, there are only 4 screen terminals located 2 at each end of the terminal row.



Indicators: The I/O modules have similar indicators to the controller: Universal input (digital), Analogue output, Power, and Watchdog. The Relay output, Analogue output (/8AO, /4AO) Excess Aux. Current, Digital input (/16DI, /8DI), and Input Polarity Error indicators are described above.

The I/O Bus LED will illuminate continuously for an I/O bus fault (e.g. check for short circuit between Data HI or Data LO and either of the power lines). If the LED flashes at 1 second intervals, the I/O module has not been in receipt of any valid comms for 30 s, and the module will switch off any outputs.

If the LED flashes faster it indicates an address clash as described above (I/O Module Address Switch); this duplicate address check is done after power up or after changing the address switch.



Firmware

Upgrade

The firmware in the IQ3 CPU board, baseboard, and XCITE I/O modules can be upgraded over Ethernet.

XML Web Services

'XML Web Services' is a field-upgradeable option. It can be added to any IQ3 variant by purchasing the XML Web Services Upgrade (IQ3XACT/XML/UP for IQ3xact, and IQ3XCITE/XML/UP for IQ3xcite). This will entitle the purchaser to obtain an unlock code for Trend Technical Support. In order to operate, the XML Web Services should be enabled in the

XML is a general purpose specification for creating custom markup languages. It helps developers create web pages and also provides a basic syntax that enables information to be shared by different computers and applications. The IQ3 XML syntax is described in the IQ3/4 Configuration Reference Manual (TE20076).

Strategy

The IQ3 strategy modules are based on the traditional IQ paradigm with minor changes to increase capability and efficiency.

The .IQ3 strategy file is created and downloaded using SET.

SET facilitates strategy creation by providing an indexed library of pre-configured strategy blocks or custom solutions (entire controller strategies); these may be viewed, printed, or edited to suit the user.

Once the strategy is complete it can be tested prior to download by using the SET controller simulator mode.

The strategy file and the other configuration files (language, backdrop, and XNC (IQ3/XNC only)) can be downloaded or uploaded across Ethernet (FTP) but only the strategy file can be downloaded or uploaded across the current loop Lan (IQ3/LAN only) or the RS232 port.

An Ethernet download requires the PC running SET to be connected to Ethernet, and to communicate with the IQ3 using the IQ3's IP address (SET will actually obtain the IP address from the IQ3 using the IQ System Lan number and device addresses).

Attempts to download a BACnet strategy file to a non-BACnet IQ3, or an XNC strategy file to a non-XNC IQ3 will fail and will result in a Feature Error Program State being declared in the Program module.

As explained in the hardware section above, the IQ3 can be restored to defaults by pressing the Service Button or by using the SET Reset Applet (e.g. to recover from a lost PIN when the user hasn't recourse to Trend Technical Support).

This will clear down strategy files and the XNC application file. It will restore the following strategy data to defaults (Lan number, outstation address, IP addressing mode, IP address, subnet mask, UDP port, identifier, Router 1, remote Trend devices, vCNC). It will clear all user modules (passwords, PINs etc), alarm logs, and plots. It will leave untouched the backdrop and language files, and leave Time and Date at their current settings. After the reset the IQ3 should be reconfigured from scratch and the strategy downloaded.

The IQ3 web server provides pages (HTML) which enable limited configuration from a web browser; most module parameters may be viewed and adjusted, but the strategy structure (module interconnections, adding or deleting a module) cannot be modified from a web browser.

Addressing

Each IQ3 has a unique MAC (Media Access Control) address allocated to its Ethernet node. The IP Tool (SET auxiliary application) enables the IQ3 IP address (and other Ethernet parameters), and the IQ System Lan number and device address to be set up.

The IP Tool can automatically fetch the details of all the IQ System IP devices (3xtend/EINC Ls and IQ3s) on its own segment of Ethernet; it can also fetch details from devices the other side of a router by reading the remote Trend Device modules from an IQ3 or 3xtend/EINC L (alternatively the user can enter the remote device's IP address by hand).

The IP Tool also enables the virtual CNCs to be configured,

Firmware (continued)

Strategy Modules

Modules: In the IQ3 the number of each type of module may be adjusted to match the requirements of the application as long as the memory capacity of the controller is not exceeded. As a general guideline the IQ3/96 has a capacity at least equal to a fully utilised IQ251.

The available capacity is measured in brIQs. The total available capacity in an IQ3 varies with the type and is given in the table below (along with maximum plot memory capacity).

		IQ3xcite	IQ3xact	IQ3xcite		
	I/O max	0	12	16	96	128
IQ3	brIQs max.	1	10,000	30,000	30,000	37,000
	plot memory max. (bytes)		100,000	500,000	500,000	500,000
IQ3/ XNC	brIQs max.	45,000	20,000	1	45,000	1
	plot memory max. (bytes)	500,000	100,000		500,000	

¹version not available

For synchronised plots each plot record requires 5 bytes, so IQ3xcite/128 can have up to 100,000 synchronised plot records. For triggered or periodic plots, each record requires 10 bytes, so IQ3xcite/128 can have up to 50,000 triggered or periodic plot records.

Prior to IQ3 v2.1, plots for sensors above sensor 99 could not be viewed by the 963, and that plots for sensors above 256 could only be viewed on web pages; these problems have been fixed with IQ3 v2.1 (and appropriate supervisor upgrade, e.g. 963 v3.1).

Each type of module has memory requirement in brIQs as listed below; SET also limits the number of modules as shown in the adjacent table.

Notes:

The actual size in (numbers of brIQs) varies with module type. The largest size is shown here.

* The time zone brIQ count allows for an average of 20 exceptions.

†The sequence table takes 106 brIQs, the table includes 600 steps.

††The maximum number of records for a plot is 1000, but maximum total records varies with the type of plots used and the option build of the IQ3 as explained above (see maximum plot memory in table). The maximum number of plots which can occur in 1 s is 100 so there could be 100 off 1 s plots (but no others). This is calculated on the average plots service in 1 s, so a 1 minute plot would contribute a 1/60. For example 90 off 1s, +360 off 1 min would give 90+6= plots/s on average. The periodic and triggered plots must also be counted and it's up to the engineer to make his best estimate.

†††The TCL application consumes brIQs as defined in the IQ3/.XNC data sheet.

††††The number of NTDs in the IQ3 is only limited by the available brIQs

§The alarm log can record up to 300 alarms after which the next alarm will overwrite the first alarm (FIFO). They can be viewed on the IQ3 web pages (up to 6 pages of 50 alarms)

§§The number of Network modules (1 - Ethernet, 2 - IQ Lan, 3 - BACnet), and Option modules (XNC Interface, Battery option card, IQ system Lan Card, Serial card RS232/RS485, XNC Interface, BACnet, XML Web Services) depends on the IQ3 option build.

Category	Module	Size (brIQs)	SET max
Alarm modules	Group	9	500
	Route	9	500
	Destination	14	(8
	Log§	0	1
Control Modules	Function#	19	500
	IC Comms#	19	250
	Logic#	19	500
	Loop	55	500
	Analogue node#	16	510
	Digital Byte#		1012
	OSS	34	500
	Sensor type	12	99
	Driver#	57	500
	Digital input#	28	1000
	Knob	13	1000
	Schedule	21	500
	Sequence†	106	1(600 steps)
	Sensor#	76	1000
	Switch	10	1000
	Time Module	38	1
	Time Zone*	566	100
General Modules	Virtual CNC	9	1
	Address	24	1
	I/O module	14	15
	Page	4	500
	XNC Interface†††	130	1
	Non-Trend Device	30	††††
	Network	0	§§
	Option	0	§§
	Program	0	1
†Display Modules	Plots††	12	500
	Directory	13	500
	Display	19	500
	User	12	500

IQ3 has an absolute limit of 4000 modules; the limits imposed by SET prevent this from being exceeded. The IQ3 also limits the number of destination modules to 8 as shown in the table. Network, Program, and Option modules have zero brIQs.

In SET, as the modules are created, a tally is kept of the brIQs used and the amount available to be used; an indication of this can be viewed. If the limit is exceeded, then SET will prohibit the creation of further modules.

It is possible to create modules which are not numerically sequential so module lists can be non-continuous (e.g. L1, L2, L5, L7...).

Firmware (continued)

IC Communications: The IQ3s may communicate with each other and IQ2 (and IQL) controllers using Inter Controller Communications (peer to peer communications) using IQ System Lan/node addressing.

IQ3/BAC is also able to communicate with BACnet devices using IC Comms; the 'Protocol' parameter specifies either Trend or BACnet protocol. The remote controller in the BACnet IC Comms module specifies an NTD (Non-Trend Device) module which is set with BACnet device's BACnet address information.

The table below specifies the types of IC Comms with which the IQ3 will operate.

IC Comms Type		Configured in IQ2 to IQ3	Configured in IQ3 to IQ2	Configured in IQ3 to IQ3 or IQ4	Configured in IQ3 to BACnet
Data From	Analogue	*Yes	†Yes	†Yes	†Yes
	Digital Byte	*#Yes	†Yes	†#Yes	No
	Digital Bit	*#Yes	†Yes	†#Yes	†Yes
Data To	Analogue	Yes	Yes	Yes	†Yes
	Digital Byte	Yes	*Yes	*Yes	No
	Digital Bit	Yes	Yes	Yes	†Yes
Global To	Analogue	Yes	Yes	Yes	†Yes
	Digital Byte	Yes	*Yes	*Yes	No
	Digital Bit	Yes	Yes	Yes	†Yes
Visitor Comms (max, min, sum, average)		*Yes	Yes	*Yes	No

*Only available on IQ3 v1.2 or greater firmware.

†Only available on IQ3 v2.0 or greater firmware.

#Although the IQ3 will respond to these requests, the digital byte module in the IQ3 cannot be set up by the strategy. However, Digital Bit Data From IC Comms using switch or digital input status as the parameter value being transferred works fine.

Note that IC Comms with IQ1 v3 controllers are similar to those with IQ2 controllers except the IQ3 can only receive messages (i.e. Data To from IQ1), not send them. However, IC Comms with IQ1 v4.1 or greater controllers can be considered to be the same as those with IQ2 controllers.

The receipt of IC Comms by an analog node or digital bit/byte is implemented by creating analogue node or digital byte modules during the strategy creation process on SET.

Alarms: The IQ3 will generate Network, General, and Item alarms. Network alarms are generated by the Trend Network nodes, General alarms are generated when the IQ3 detects a problem within its own hardware or program, and Item alarms are generated by the strategy, normally due to a faulty plant condition.

Network alarms are sent to supervisors or tools connected to the local supervisor port or to the controller's vCNC.

General and Item alarms can either be sent in text, coded, or attribute format, and can be sent either to a designated Trend Lan address, to an IP address, as an email, or to a BACnet device (IQ3 BAC only). They are stored locally in the Alarm Log.

Only sensor, digital input, digital driver readback, and plot alarms can be sent to a BACnet device.

For coded alarms the protocol limits the item number to 255. For text alarms the maximum item label length is 20 characters (although the 963 can be setup to use labels previously learnt).

Sending an Email alarm requires the Email Server Address to be set up in the address module. The Email Server Address can be set up as an IP address, an internet domain name, or a host name; the internet domain name or host name require a DNS server address or a WINS server address respectively to be set up in the network module so that the name can be resolved.

Timemaster: The IQ3 can act as a Timemaster for the Trend system (IQ1s - post 1989, IQ2s, IQ3s, IQ4s, IQecos, and IQLs). It will maintain time and date synchronisation for all IQ controllers and effect daylight savings from a single source. However, each section of a system separated by auto-dialled links requires its own Timemaster.

The IQ3 does not provide the Timekeeper functionality; this was only required for IQ90's which did not have a battery backed real time clock, and they should be supported by a pre-IQ3 Timekeeper controller on their own Lan.

Note that on a combined system (IQ3s with other IQs) an IQ3 or IQ4 must be the Timemaster.

The Timemaster IQ3 should be fitted with the battery option board which will support it in the case of power failure.

An IQ3 can be set by UTC time (Co-ordinated Universal Time, approximately the same as GMT), and has a UTC Offset parameter to define its time zone difference from UTC time.

The UTC offset and daylight savings details should be set up in the Timemaster so that all other IQs can be synchronised accordingly.

Language: The user can specify which language the IQ3 uses for the display of web pages and for transmitted alarms. All the required text is separately stored as a text file in SET and can be translated to form a language file. The required files can be selected for each SET project. English is always available in the controller, but SET enables a default language as well as additional languages to be selected. The appropriate language files will be downloaded to the controller when the strategy is downloaded. In the controller the Address module has a language parameter which will be set by default to the default language, but can be changed to any one of the other available language files or English (e.g. change to English by setting the language parameter to 'english' on the address module web page). The IQ3 can use languages which require 8 bit code (i.e. special or accented characters) and can also operate with right to left languages (e.g. Chinese, Arabic).

Plots: The IQ3 plot modules can plot any connectable module output (analogue or digital). There are three types of plot module: synchronised, triggered, and periodic. Although all three types are BACnet interoperable, only periodic plots can be BACnet compliant. All plot modules can generate a buffer ready alarm when the number of records equals the notification threshold.

Web Pages

Information from an IQ3 controller can easily be accessed using a Web browser (e.g. Internet Explorer) on a PC, smart phone, or PDA over any TCP/IP network (e.g. the company intranets, or the Internet). See the 'Compatibility' on page 17 for details of compatible web browsers and devices.

All that is required is the IP address or host name of the controller, and a valid user name and password (if users are set up in the controller). Once connection to the controller has been made, it is possible to view and adjust occupation times, view the alarm history, and view/adjust/graph individual module parameters.

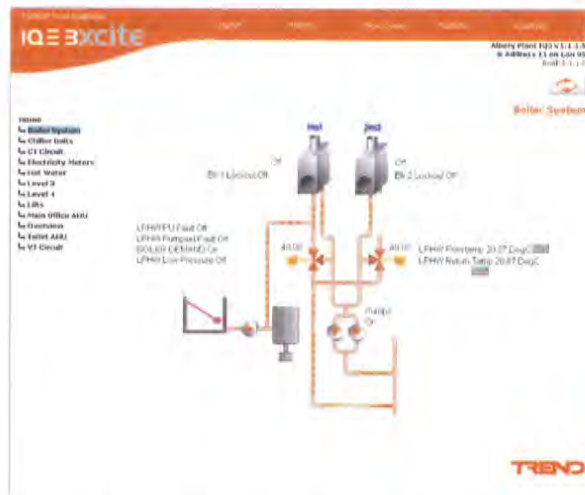
Note module creation, deletion, and linking can only be done using SET.

Web Pages (continued)

The IQ3 is provided with a standard set of web pages which covers all accessible modules (see the example below of the list of knobs, and their current settings).



Graphical display pages (GraphIQs) which are configured using IQ3 display and directory modules, can also be accessed (see the example below of a GraphIQ page).



For further details of web pages see the IQ3/4 Configuration Reference Manual (TE20076), the IQ3 Web User Guide, (TC200631), and the IQ3 Graphical Display Pages Editor Manual (TE200629).

FIELD MAINTENANCE

The IQ3 Controller requires virtually no routine maintenance, however it is recommended that if the battery option board is fitted, the battery should be replaced every 5 years, as explained in the IQ3xact or IQ3xcite Installation Instructions. **Other than accessing the auxiliary option board compartment, the unit should not be opened.**

The unit should be cleaned with a cloth moistened with water in order to avoid buildup of dust or other contaminants. **Disconnect power before carrying out any cleaning.**



Warning: Contains no serviceable parts.
Opening the unit exposes hazardous voltages

DISPOSAL

COSHH (Control of Substances Hazardous to Health - UK Government Regulations 2002) ASSESSMENT FOR DISPOSAL OF IQ CONTROLLER. The only part affected is the lithium battery (on the battery option board) which must be disposed of in a controlled way.

RECYCLING

All plastic and metal parts are recyclable. The printed circuit board may be sent to any PCB recovery contractor to recover some of the components for any metals such as gold and silver.



WEEE Directive:

At the end of their useful life the packaging, product, and battery (if fitted) should be disposed of by a suitable recycling centre.

Do not dispose of with normal household waste.
Do not burn.

COMPATIBILITY

Browsers: Internet Explorer v6, v7, v8, or v9, with the JAVA runtime environment, smart phones (Windows Mobile 2003 Second Edition), and PDAs (Windows CE4); *note that Mobile smart phones and PDAs cannot display graphs and right to left languages.*

Note that IQ3 has not been tested with all devices and Trend cannot guarantee a particular device's compatibility.

Supervisors: 963 v3.50 (for full compatibility), 915MDS >v3, 916, IQView, IQView4

Utility software: SET v6.7 for full compatibility (includes IP Tool auxiliary software)

Displays: IQView touch screen network display, IQView4 touch screen display, RD-IQ, SDU-xcite 4 line display (the IQ3 label lengths should be limited to 20 characters for SDU-xcite (< v1.01 firmware), SDU-xcite v1.01 will truncate the label to the first 20 characters.)

Note that the NDP is not compatible with IQ3; it will not recognise an IQ3 connected to its network.

I/O Modules: XCITE/IO/8UI, 4UI, 4UI/4AO, 2UI/2AO, 8DO, 4DO, 8AO, 4AO, 16DI, 8DI, 8DI/8TI, 8DO/HOA, 4DO/HOA can connect to IQ3XCITE/96 or /128 only

Controllers:
Over Ethernet IQ3 and IQ4 controllers, IQ1, IQ2 by way of 3xtend/EINC L, and IQeco by way of IQ3/BINC.

Over Current loop IQ3/LAN communicates with IQ4/LAN, IQ2, IQ1 directly and IQ3 and IQ4 by way of 3xtend/EINC L.

IC Comms: IQ4, IQ3, IQeco, IQ2 (including IQL, IQ1 (v3 onwards)).

Strategies: IQ1, and IQ2 strategies can be imported into SET, converted into IQ3 strategies, and then downloaded into an IQ3.

Ethernet Nodes: Compatible with 3xtend/EINC L. NXIP or EINC must not be used in an automatic IP addressing environment. NXIP cannot be used as cross router master.

BACnet Devices: IQ3/BAC only. Rated as a BACnet Application Specific Controller (B-ASC). Compatibility defined in the IQ3 Product Implementation Conformance Statement (TP201002).

The supervisors and tools use different types of communications protocols as shown in the following table:

Function	Comms Level	Software	RJ45 Ethernet	RS232
Set up IP address	Ethernet, MAC	IP Tool	Yes	No
Create networks, IC Comms	Ethernet, UDP, TCP, Trend	IQ4, IQ3, 3xtend/EINC L, NXIP, EINC, IQView	Yes	No
Trend Text Comms	Ethernet, IP, TCP, Trend	963, 915MDS, 916, SET*, IQView, IQView4	Yes	Yes
Strategy Upload/Download	Ethernet, IP, TCP, FTP, Trend	SET	Yes	Yes*
Internet (web pages)	Ethernet, IP, TCP, HTTP, HTML	Browser, 963 (via browser)	Yes	No

*SET can upload or download the strategy file using the RS232 port, but not the other configuration files (language, backdrops, XNC (for IQ3/XNC only)).

INSTALLATION

The IQ3 controller is installed on a DIN rail by using the DIN rail clip, inside a cabinet or panel. The procedure involves:

mount the controller in position
connect power, do not power up
connect Ethernet if required
connect RS232 if required (Supervisor/Tool PC, IQView, IQView4, RD-IQ, or SDU-xcite)
connect IQ system Lan (IQ3/LAN only)
terminate the I/O channels, leave unconnected
connect the I/O bus, if used (IQ3XCITE/96 or /128 only)
mount and connect I/O modules (IQ3XCITE/96 or /128 only)
set I/O module address switches (IQ3XCITE/96 or /128 only)
perform input channel linking
insert battery in auxiliary board if appropriate
power up

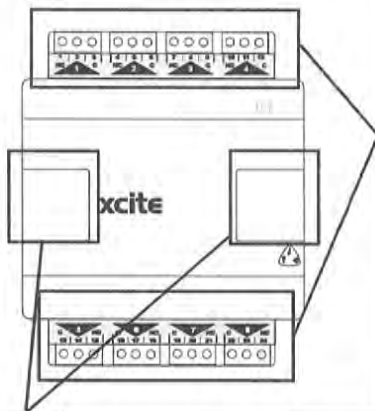
set up IP address parameters (Ethernet only) using IPTool
setup Lan number using IPTool,
setup Device address using address switch (IQ3/LAN) or by IPTool (IQ3s without current loop Lan auxiliary board)
check Ethernet network, current loop Lan network (IQ3/LAN only)
configure the strategy and I/O modules used (using SET)
test strategy by using Controller Simulation Mode in SET
download strategy file and other configuration files
check BACnet communications using SET (IQ3/BAC only)
connect inputs and check operation
connect outputs and check operation
check web pages using a browser

These installation procedures are covered as follows: IQ3xact Installation Instructions - Mounting (TG200766); IQ3xcite Installation Instructions - Mounting (TG200626); IQ3 Controller Installation Instructions - Configuration (TG201160); XCITE Standard I/O Modules Installation Instructions (TG200627); XCITE/IC I/O Bus Interconnector Installation Instructions (TG200644); XCITE/TERM I/O Bus Terminator Installation Instructions (TG200645); XCITE/BBC IQ3 Battery Option Board Installation Instructions (TG200627); IQ3.../XNC/... Installation Instructions (TG200911) (see IQ3.../XNC/... Data Sheet (TA200912)), IQ3.../LAN/... Installation Instructions (TG200916), IQ3 Web Services Upgrade Information Sheet (TP201077).

WARNING If the unit is used in a manner other than that specified in the installation instructions, the protection provided by the unit may be impaired.

CONNECTIONS

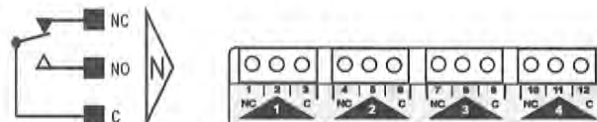
I/O MODULES (IQ3XCITE/96/.../128/...only)



Inputs and Outputs

The Universal input and Analogue output channel wiring is the same as shown for the main controller overleaf.

The Relay output connections are as follows:



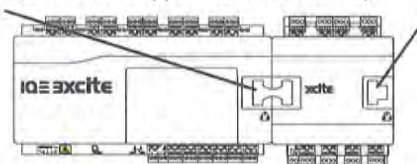
The Digital input (/16DI, /8DI) connections are as follows (details are on page 12):



Cable size 0.14 to 2.5 mm², 24 to 14 AWG (for USA/UL use 22 to 14 AWG) - Cu only

I/O Bus (Must use rules shown on page 9)

Connect IQ3xcite to I/O module. Use rigid interconnector for adjacent module (XCITE/IC, supplied with I/O module).



Terminate at far end using XCITE/TERM (supplied with controller)

Non-adjacent modules can be connected via connectors, and earthed locally. No spurs.

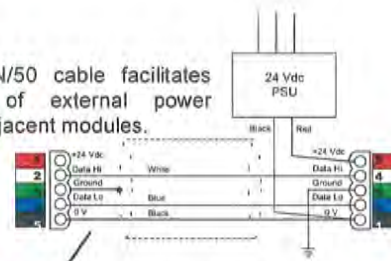
Use Belden 3084A cable



Connect additional 24 Vdc PSU (with isolated output) if needed.

Note that an external PSU must comply with relevant EMC and

XCITE/PCON/50 cable facilitates connection of external power supply for adjacent modules.

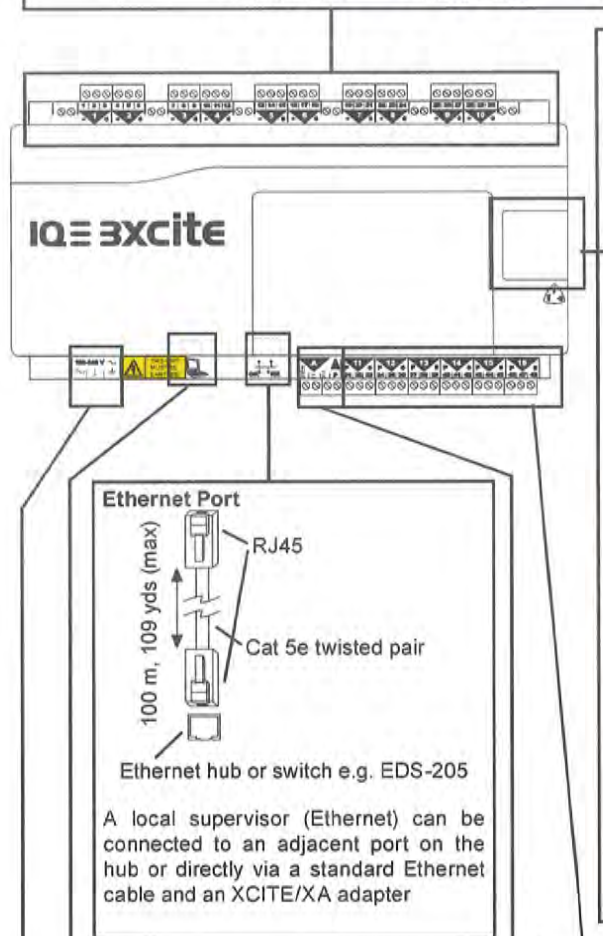


XCITE/PCON/1000 (1 m, 1 yd 3" cable) can be used for non adjacent modules

CONNECTIONS (continued)

MAIN CONTROLLER

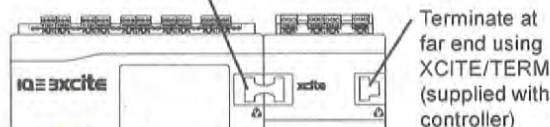
Universal Inputs Cable size 0.14 to 2.5 mm² cross section area, 24 to 14 AWG for USA/UL use 22 to 14 AWG) - Cu only



I/O Bus (IQ3XCITE/96/.., /128/.. only)

Must use rules shown on page 9

Connect IQ3xcite to I/O module. Use rigid interconnector for adjacent module (XCITE/IC, supplied with I/O module).

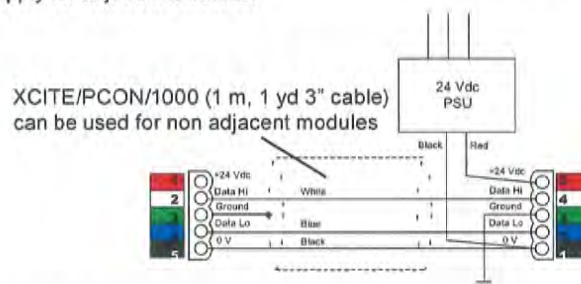


Non-adjacent modules can be connected via connectors, and earthed locally. No spurs.



Connect additional 24 Vdc PSU (with isolated output) if needed. *Note that external power supply must comply with relevant EMC and safety standards*

XCITE/PCON/50 cable facilitates connection of external power supply for adjacent modules.

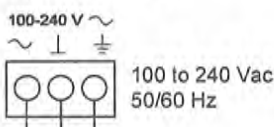


Analogue Outputs Cable size 0.14 to 2.5 mm² cross section area, 24 to 14 AWG (for USA/UL use 22 to 14 AWG) - Cu only

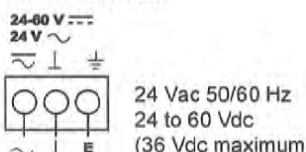


Supply (option)

/100-240 46 VA max



/24 40 VA max.



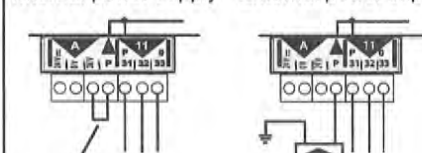
Power Bus

Either

Or

Internal power supply

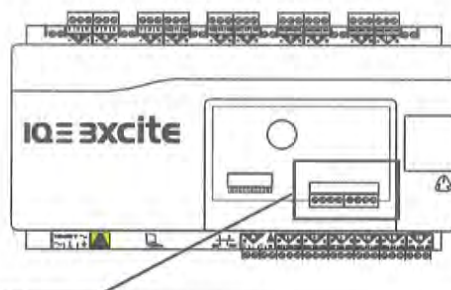
External power supply



Separate 24 Vac/Vdc power supply. Supply be dedicated to I/O channel use and must comply with relevant EMC and safety standards

CONNECTIONS (continued)

IQ3../.../LAN only

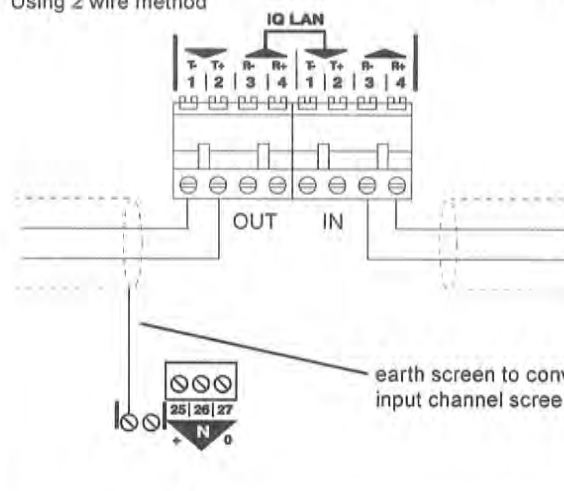


Network

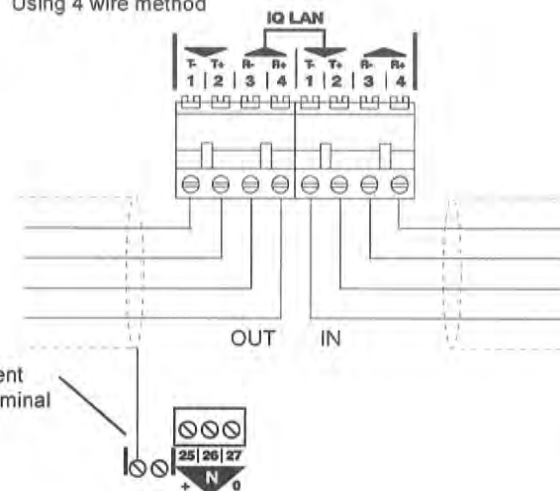
2 off 2 part connectors with 4 screw terminals for 0.14 to 2.5 mm² cross section area, 24 to 14 AWG (for USA/UL use 22 to 14 AWG) cable

polarity independent

Using 2 wire method



Using 4 wire method



ORDER CODES

This section does not provide order codes for the /BINC or /XNC options. this information is provided in the IQ3../MSTP/BINC/... Data Sheet (TA201095), and the IQ3../.../XNC/... Controller/Interface Data Sheet (TA200912).

CONTROLLERS

IQ3[TYPE]/[AUX BD]/[COUNTRY]/[BAC]/[POWER]

[TYPE]	XCITE/00	Zero I/O points, non expandable via I/O bus. Supplied with bus terminator.
	XACT/12	12 I/O points, 6 universal inputs, 6 analogue voltage outputs, non expandable via I/O bus.
	XCITE/16	16 I/O points, 10 universal inputs, 6 analogue voltage outputs, non expandable via I/O bus. Supplied with bus terminator.
	XCITE/96	16 I/O points, 10 universal inputs, 6 analogue outputs expandable up to 96 points (i.e. 80 additional I/O channels) by addition of I/O modules to I/O bus. Supplied with I/O bus terminator.
	XCITE/128	16 I/O points, 10 universal inputs, 6 analogue outputs expandable up to 128 points (i.e. 112 additional I/O channels) by addition of I/O modules to I/O bus. Supplied with I/O bus terminator.
[AUX BD]	Blank	No auxiliary board fitted
	LAN	IQ system current loop Lan interface fitted
	SER	Second serial port interface fitted (RS232 or RS422/485). See IQ3/XNC Data Sheet
[COUNTRY]	Blank	Worldwide except US
	USA/UL	For sale in US, UL rated
[BAC]	Blank	No BACnet protocol capability
	BAC	BACnet protocol capability included
[POWER]	100-240	100 to 240 Vac supply
	24	24 Vac or 24 to 60 Vdc supply (36 Vdc maximum for UL versions)

CONTROLLERS (continued)**Available codes**

IQ3XACT/12/100-240
 IQ3XACT/12/LAN/100-240
 IQ3XACT/12/XNC/LAN/100-240
 IQ3XACT/12/XNC/SER/100-240
 IQ3XACT/12/XNC/100-240
 IQ3XACT/12/24
 IQ3XACT/12/LAN/24
 IQ3XACT/12/XNC/LAN/24
 IQ3XACT/12/XNC/SER/24
 IQ3XACT/12/XNC/24
 IQ3XCITE/16/100-240

IQ3XCITE/16/LAN/100-240
 IQ3XCITE/16/24
 IQ3XCITE/16/LAN/24
 IQ3XCITE/96/100-240
 IQ3XCITE/96/LAN/100-240
 IQ3XCITE/96/24
 IQ3XCITE/96/LAN/24
 IQ3XCITE/128/100-240
 IQ3XCITE/128/LAN/100-240
 IQ3XCITE/128/24
 IQ3XCITE/128/LAN/24

BACnet versions

IQ3XACT/12/BAC/100-240
 IQ3XACT/12/LAN/BAC/100-240
 IQ3XACT/12/BAC/24
 IQ3XACT/12/LAN/BAC/24
 IQ3XCITE/16/BAC/100-240
 IQ3XCITE/16/LAN/BAC/100-240
 IQ3XCITE/16/BAC/24
 IQ3XCITE/16/LAN/BAC/24

IQ3XCITE/96/BAC/100-240
 IQ3XCITE/96/LAN/BAC/100-240
 IQ3XCITE/96/BAC/24
 IQ3XCITE/96/LAN/BAC/24
 IQ3XCITE/128/BAC/100-240
 IQ3XCITE/128/LAN/BAC/100-240
 IQ3XCITE/128/BAC/24
 IQ3XCITE/128/LAN/BAC/24

The versions available in the USA are restricted to /BAC/24 versions (BACnet, 24 V power) and are identified by adding /USA/UL/ before BAC/24 e.g.:

IQ3XACT/12/USA/UL/BAC/24: Web enabled controller with 6 Universal Inputs, and 6 Analogue Voltage Outputs, non expandable by the I/O bus. 24 Vac or 24 to 36 Vdc input power supply. BACnet option. For USA, UL rated.

Upgrades

IQ3XACT/XML/UP	:XML Web Services upgrade for IQ3xact
IQ3XCITE/XML/UP	:XML Web Services upgrade for IQ3xcite
IQ3XACT/BAC/UP	:BACnet upgrade for IQ3xact
IQ3XCITE/BAC/UP	:BACnet upgrade for IQ3xcite

I/O Modules

XCITE/IO/8UI	:8 channel universal input I/O module. Supplied with rigid interconnector.
XCITE/IO/4UI	:4 channel universal input I/O module. Supplied with rigid interconnector.
XCITE/IO/4UI/4AO	:4 channel universal input and 4 channel analogue voltage output I/O module. Supplied with rigid interconnector.
XCITE/IO/2UI/2AO	:2 channel universal input and 2 channel analogue voltage output I/O module. Supplied with rigid interconnector.
XCITE/IO/8DO	:8 channel relay output I/O module. Supplied with rigid interconnector.
XCITE/IO/4DO	:4 channel relay output I/O module. Supplied with rigid interconnector.
XCITE/IO/8AO	:8 channel analogue voltage output I/O module. Supplied with rigid interconnector.
XCITE/IO/4AO	:4 channel analogue voltage output I/O module. Supplied with rigid interconnector.
XCITE/IO/16DI	:16 channel digital input I/O module. Supplied with rigid interconnector.
XCITE/IO/8DI	:8 channel digital input output I/O module. Supplied with rigid interconnector.
XCITE/IO/8DI/8TI	:8 channel digital input and 8 channel thermistor input I/O module. Supplied with rigid interconnector.
XCITE/IO/8DO/HOA	:8 channel relay output with Hand/Off/Auto switch I/O module. Supplied with rigid interconnector.
XCITE/IO/4DO/HOA	:4 channel relay output with Hand/Off/Auto switch I/O module. Supplied with rigid interconnector.

The USA versions of I/O modules are identified by placing /USA/UL/ before the I/O module type code in the order codes e.g.:

XCITE/IO/USA/UL/8UI: 8 channel universal input I/O module. Supplied with rigid interconnector. UL rated.

Controller Accessories

XCITE/BBC	:Battery option board increases protection time of clock (in case of input power supply failure) to several years (e.g. for Timemaster).
XCITE/IC/5	:Pack of 5 rigid I/O bus interconnectors for adjacent I/O modules (spare)
XCITE/TERM/5	:Pack of 5 I/O bus terminators (spare)
XCITE/CC/10	:Pack of 10 I/O bus connectors with screw terminals to facilitate wired connection (one required each end).
XCITE/PCON/50	:I/O bus interconnector (4 wide) for adjacent I/O modules to facilitate connection of external bus power supply
XCITE/PCON/1000	:1 m, 1 yd 3" I/O bus connection cable (4 wide) between I/O modules to facilitate connection of external bus power supply
CABLE/EJ101442	:Adaptor cable to connect PC to local supervisor port

SPECIFICATIONS

MAIN CONTROLLER

Electrical

CPU	:MCF5272
CPU speed	:66 MHz
Cycle time	:sequence table 1s
Memory	:16 Mbyte SDRAM, and 8 Mbyte Flash.
IQ3xcite/128	:37000 brIQs (module capacity p14)
IQ3xact	:6000 brIQs (module capacity p14)
Input power supply voltage	
/100-240	:100 to 240 Vac $\pm 10\%$ 50/60 Hz
/24	:24 to 60 Vdc $\pm 10\%$ (36 Vdc maximum for /UL versions), 24 Vac $\pm 15\%$ 50/60 Hz
Input power supply consumption	
/100-240	:6 VA minimum
IQ3XCITE/000	:15 VA maximum
IQ3XACT/012	:28 VA maximum
IQ3XCITE/016	:39 VA maximum
IQ3XCITE/096, /128	:56 VA maximum
/24	:5 VA minimum
IQ3XCITE/000	:11 VA maximum
IQ3XACT/012	:25 VA maximum
IQ3XCITE/016	:28 VA maximum
IQ3XCITE/096	:40 VA maximum
IQ3XCITE/128	:40 VA maximum
Input Supply Leakage	:Leakage current at 230 Vac, 50 Hz is less than 0.3 mA.
24 Vdc combined supply	:24 Vdc $\pm 10\%$, 700 mA maximum (typical) to supply 24 Vdc auxiliary supply terminals, I/O bus, RS232, the I/O channels (see page 7). Output derated to 550 mA for input power supply <200 Vac.
24 Vdc auxiliary supply:	Part of combined supply, 20 to 24 Vdc limited to 150 mA supplied to RS232, 24 V auxiliary output supply, and may be linked to output power bus.
Fusing	:No replaceable fuses required.
24 Vdc combined supply	:protected by a self resetting solid state circuit breaker.
RS232, 24 V	:part of the combined supply to RS232, 24 V auxiliary output supply (and output power bus, if linked) is protected by 150 mA current limit.
Power bus	:protected by a 1.6 A multifuse.
Power supply	:protected against catastrophic failure by a non-replaceable fuse.
Analogue output	:circuitry is protected against the wrong connection of a non-isolated external supply by a non-replaceable fuse.
Power failure protection	:All strategy and data in nonvolatile memory. Supercap maintains real time clock for up to 6 days (typical). Option to fit a battery board to maintain clock for up to several years in the case of input supply failure.
Battery option	:XCITE/BBC, battery option board includes CR2032 3 V lithium button cell. Feature also included on IQ3.../LAN or IQ3.../SER versions but battery not provided.
Clock accuracy	:30 s per month (typical).
4-line display panel	:SDU-xcite to local supervisor port
Ethernet	:main bus, 10 BASE-T (IEEE 802.3). Supports TCP/IP, FTP
Supervisor Port	
Transmission	:RS232, EIA/TIA/232E, V28 supports IQ System comms
Distance	:15 m, 16 yds
Baud rate	:9k6.
Address	:Selectable by software, 116 nodes addressable (1, 4 to 119 excluding 2,3,10) set to be unique on Lan.

IQ Current Loop Lan	: (IQ3.../LAN only)
Transmission	:20 mA two wire current loop, opto-isolated, polarity independent receiver, balanced transmitter.
Distance	:Dependent on cable type, see table below:

Cable	9k6 baud	19k2 baud	No. of Wires
Belden 9182	1000 m (1090 yds)	700 m (765 yds)	2
Belden 9207	1000 m (1090 yds)	500 m (545 yds)	2
Trend TP/1/1/22/HF/200 (Belden 8761)	700 m (765 yds)	350 m (380 yds)	2
Trend TP/2/2/22/HF/200 (Belden 8723)	500 m (545 yds)	250 m (270 yds)	4

Baud rate	:Selectable by board switches 9k6, 19k2 - set to be same as other nodes on Lan.
Address	:The IQ3 address on Lan is set by board switches. Set to be unique on network; 116 nodes addressable (1 to 119 excluding addresses 2,3, and 10) <i>Virtual CNC address, supervisor port address to be configured in strategy.</i>
Serial Port 2	: (IQ3.../SER only) RS232 or RS422/485 selectable by software. See IQ3.../XNC Data Sheet for details
I/O bus	: (not fitted on IQ3xact or IQ3XCITE/00) maximum length 30 m, 33 yds, 15 additional nodes maximum, 96 points maximum. Signalling rate 125 kbits/s. Cable Belden 3084A.
Inputs/Outputs	
IQ3XCITE/00	:zero I/O
IQ3XACT	:6 universal inputs, 6 voltage outputs
IQ3XCITE/16	:10 universal inputs, 6 voltage outputs
IQ3XCITE/96	:10 universal inputs, 6 voltage outputs expandable by adding I/O modules to 96 points maximum
IQ3XCITE/128	:10 universal inputs, 6 voltage outputs expandable by adding I/O modules to 128 points maximum
Signal Cable	:Universal inputs, and analogue voltage outputs; TP/1/1/22/HF/200 recommended (Belden 8761)
Measurement Category	:Universal inputs and analogue voltage outputs are Measurement CAT I (EN61010:2001). They must be separated from 230 Vac input power supply by double or reinforced insulation.
Universal inputs	:Channels 1 to 10, linkable for analogue voltage (V), analogue current (I), thermistor (T) or digital (D).
Analogue voltage (V)	:12 bit resolution. Minimum 60 dB series mode rejection at input power supply frequency. 0 to 10 V, input resistance 200 k Ω , accuracy 50 mV equivalent to $\pm 0.5\%$ of span.
Analogue current (I)	:12 bit resolution (4096 steps - effective). Minimum 60 dB series mode rejection at input power supply frequency. 0 to 20 mA, input resistance 240 Ω , accuracy 0.5% of span (i.e. 100 μ A). Loop powered input supply is 20 to 36 Vdc.
Thermistor (T)	:12 bit resolution. Minimum 60 dB series mode rejection at input power supply frequency. Thermistor bridge resistor 10 k Ω 0.1%, accuracy 0.5% of span. Bridge supply 5 V.

Electrical (continued)

Digital (D)	:volt free contact, open collector (or drain), or logic input. Count rate 30 Hz (minimum pulse width of 16.6 ms). 5 V supply. Status LED per channel. Volt free contact input: Wetting current = 3 mA nominal. (ON = closed contact.) Open collector (or drain) input: Must be able to sink 3 mA. Must be earthed (grounded) to same earth (ground) as IQ3. Polarity dependent. (ON = transistor/FET conducts.) Logic input: Logic high level 5 to 50 V. Logic low level must be able to sink 3 mA (ON = logic low.)
Analogue voltage outputs	:Channels 11 to 16. 11 bit resolution. 0 to 10 V with 20 mA current limit, accuracy $\pm 0.5\%$ of span.
Indicators	
Inputs	:(yellow) Indicates status, only for digital inputs (ON= contact closed) Analogue Outputs :(yellow) Light intensity increases with output voltage
⚡ (power)	:(green) ON when input power supply is connected. Flashing at 1 second intervals indicates power supply fault.
🐶 (watchdog)	:(red) ON if controller has a software fault
🔊 (I/O bus)	:(red, not fitted on IQ3xact) On if there is an I/O bus fault.
OK	:(green) Normally called LINK on Ethernet systems. ON indicates a good Ethernet connection.
RX	:(yellow) Flashes when packet of data is being received across the Ethernet.
IQ Current Loop Lan Indicators IQ3.../LAN only	
TX	:(yellow) ON if current is flowing from the current loop network transmitter
RX	:(yellow) ON if current is entering the current loop network receiver
OK	:(green) ON if IQ3 successfully communicating over current loop network.

Mechanical

Dimensions	
IQ	:263 mm (10.35") x 150 mm (5.91") max. x 46 mm (1.81")
IQ3.../LAN	:263 mm (10.35") x 150 mm (5.91") max. x 56 mm (2.2")
IQ3.../SER	:263 mm (10.35") x 150 mm (5.91") max. x 56 mm (2.2")
Material	:Polycarbonate
Weight	:702 gm (1.5 lb)
Connectors	
Input power supply	:2 part connector with 3 rising cage clamp screw terminals for 0.5 to 2.5 mm ² cross section area (14 to 20 AWG) cable.
I/O	:2 part connectors with rising cage clamp screw terminals for 0.14 to 2.5 mm ² cross section area, 24 to 14 AWG (for USA/UL use 22 to 14 AWG) cable. Use copper cable only.
Screens	:Single part connectors with rising cage clamp screw terminals for 0.14 to 2.5 mm ² cross section area, 24 to 14 AWG (for USA/UL use 22 to 14 AWG) cable. Use copper cable only.
Supervisor port	:RJ11 (FCC68), for IQ System utility software, supervisor, RD-IQ, SDU-xcite, or IQView. Connected by adaptor cable. Can supply signal and power.

Ethernet	:RJ45 connector, unshielded or shielded twisted pair (UTP or FTP) cable 10 Mbps, 100 m (109 yds), 10 BASE-T. Cable and connectors are available. Connect local supervisor (Ethernet) by way of adjacent hub or directly using standard Ethernet cable and XCITE/XA adaptor
I/O bus	:(not fitted on IQ3xact or IQ3XCITE/00) 5 wide connector. For expandable controller only, connect with special rigid interconnector (XCITE/IC, supplied with I/O Module) to adjacent module, or use connector with screw terminals (XCITE/CC/10 - pack of 10) and wire in Belden 3084A or equivalent. Last connection requires termination (XCITE/TERM supplied with IQ3xcite controller only). Special 4 wide cables available to facilitate connection of additional I/O bus power supply; XCITE/PCON/50 for adjacent I/O module, XCITE/PCON/1000 for cable connection to I/O module up to 1 m, 1 yd 3". The maximum current that can be passed through the I/O module using the 24 Vdc and 0 V terminals from one module to the next is 2.5 A.

Environmental

EMC	:EN61326 -1: 2006
Immunity	:Table 2 For equipment used in industrial locations
Emissions	:Class B
Safety	
EU	:EN61010-1:2001 (Measurement Category III - fixed installations)
USA/Canada	:/24 only. UL rated as 'UL916 listed open energy management equipment'
Canada	:CSA22.2 No. 205-M1983 - Signal Equipment
Protection	:IP20, NEMA1
Ambient limits	
Storage	: -10 °C (14 °F) to +50 °C (122 °F)
Operating	: 0 °C (32 °F) to 45 °C (113 °F)
Humidity	: 0 to 90 %RH non-condensing
Altitude	: <2000 m (6562')

I/O MODULES (for use with IQ3XCITE/96 only)

Electrical

CPU	:microprocessor PIC 18F458
Input power supply voltage	:24 Vdc $\pm 15\%$
Input power supply consumption	:Maximum: 8DO=100 mA, 4DO=60 mA, 8UI=180 mA, 4UI=100 mA, 16DI=36 mA, 8DI=28 mA, 8DI/8TI=30 mA, 4UI/4AO=180 mA (+Aux supply 150 mA), 2UI/2AO=100 mA (+Aux supply 150 mA), 8AO=180 mA (+Aux supply 300 mA), 4AO=100 mA (+Aux supply 150 mA), 8DO/HOA=100 mA, 4DO/HOA=60 mA.
Auxiliary output supply	:(AO only) 18 to 24 Vdc, limited to 150 mA per bank of four AO.
Fusing	:no replaceable fuses required.
Auxiliary output supply	:protected by a 150 mA current limit.
Analogue output bus	:protected by a 1.6 A multifuse.
Analogue output circuitry	:protected against the wrong connection of a non-isolated external supply by a non-replaceable fuse.
I/O bus	:maximum length 30 m (33 yds), 15 additional nodes maximum, 96 points maximum. Signalling rate 125 kbits/s. Cable Belden 3084A.

Electrical (continued)

Inputs/outputs :selectable from range of 8UI, 4UI, 4UI/4VO, 2UI/2VO, 8DO, 4DO, 16DI, 8DI, 8DI/8TI, 8AO, 4AO, 8DO/HOA, or 4DO/HOA.

Key: UI Universal input, DI Digital input, TI Thermistor input, VO Analogue voltage output, RO Relay output

Signal Cable :Universal inputs, and analogue voltage outputs; TP/1/1/22/HF/200 recommended (Belden 8761)

Universal input :as for main controller

Analogue voltage output :as for main controller except 10 bit resolution

Relay output :Relay outputs with LED (yellow) status indication (on = energised) per channel. Single pole changeover relays. Outputs rated at 5 A maximum for 240 Vac single phase only (use same phase throughout) inductive, ($\cos\phi \geq 0.4$), or resistive load, 30 Vdc (resistive load). Reduce to 2 A for 24 Vdc (inductive load, $T \leq 30$ ms). For /USA only, UL rating applies up to 240 Vac (120 VA) maximum. Arc suppression recommended, (see Relay Output Arc Suppression Installation Instructions (TG200208)).

Relay output with Hand/Off/Auto :As for relay output above plus single 3 way switch per channel to select either manual override ON (Hand), manual override off (Off) or automatic control (Auto) and additional LED (red) per channel to indicate manual override condition.

Thermistor input :12 bit resolution. Minimum 60 dB series mode rejection at input power supply frequency. Thermistor bridge resistor 10 k Ω 0.1%, accuracy 0.5% of span. Bridge supply 5 V.

Digital input :voltage free contact, 24 Vac, open collector (or drain) or logic input. Count rate 30 Hz (minimum pulse width of 16.6 ms). 5 V supply. Status LED per channel. Voltage free contact input: Wetting current = 3 mA nominal. (ON = closed contact.) 24 Vac input: 24 Vac $\pm 20\%$. Must be floating or earthed (grounded) to same earth (ground) as IQ3, polarity dependent. (ON = load powered.) Open collector (or Drain) input: Must be able to sink 3 mA. Must be earthed (grounded) to same earth (ground) as IQ3, Polarity dependent. (ON = transistor/FET conducts.) Logic input: Logic high level 5 to 50 V. Logic low level must be able to sink 3 mA. (ON = logic low.)

Indicators

Inputs :(yellow) Indicates status, only for digital inputs (ON= contact closed or equivalent)

Analogue Outputs :(yellow) Light intensity increases with output voltage.

Relay Outputs :(yellow). Indicates relay status (ON = relay energised)

Manual override :(red). Indicates the relay output channel is manually overridden. /8DO/HOA, /4DO/HOA only.

Excess Aux. Current :(red) Indicates maximum auxiliary current exceeded. /8AO, /4AO only
Input Polarity Error : (r e d)
Indicates 24 Vac input grounding error (ON=error). /16DI, /8DI only.

⚡(power) :(green) ON when supply is connected

🐶(watchdog) :(red) ON if module has a software fault

🚌(I/O bus) :(red) On if there is an I/O bus fault. Flashes at 1 second intervals if the I/O module has not been in receipt of any valid comms for 30 s (outputs will be switched off). Flashes faster if an address clash on I/O bus, or the address has been set to zero (I/O module disabled).

Mechanical

Dimensions :130 mm (5.12") x 150 mm (5.91") max. x 46 mm (1.8")

Material :Polycarbonate

Protection :IP20, NEMA1

Weight :332 gm, 0.73 lb (approx.)

Connectors

Power in :2 part connector with 3 rising cage clamp screw terminals for 0.5 to 2.5 mm² cross section area (14 to 20 AWG) cable.

I/O :2 part connectors with rising cage clamp screw terminals for 0.14 to 2.5 mm² cross section area, 24 to 14 AWG (for USA/UL use 22 to 14 AWG) cable. Use copper cable only.

Screens :Single part connectors with rising cage clamp screw terminals for 0.14 to 2.5 mm² cross section area, 24 to 14 AWG (for USA/UL use 22 to 14 AWG) cable.

I/O bus :5 wide connector. Connect with special rigid interconnector (XCITE/IC supplied with I/O Module) to adjacent module or controller, or use connector with screw terminals (XCITE/CC/10 - pack of 10) and wire in Belden 3084A or equivalent. Last connection requires termination (XCITE/TERM supplied with controller). The maximum current that can be passed through the I/O module through the 24 Vdc and 0 V terminals from one module to the next is 2.5 A. Also see main controller for details of special cables.

Environmental

As for main controller except:

Safety USA/Canada :UL rated as 'UL 916 listed accessory to open energy management equipment'.

Please send any comments about this or any other Trend technical publication to techpubs@trendcontrols.com

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Trend Control Systems Limited

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Trend Control Systems USA

Appendix for ECM 3: New Energy Management Systems

III.

- **List of Existing Thermostats**
- **Memorial Boys and Girls Club Proposed Temperature Sensor Locations and Steam Valves**

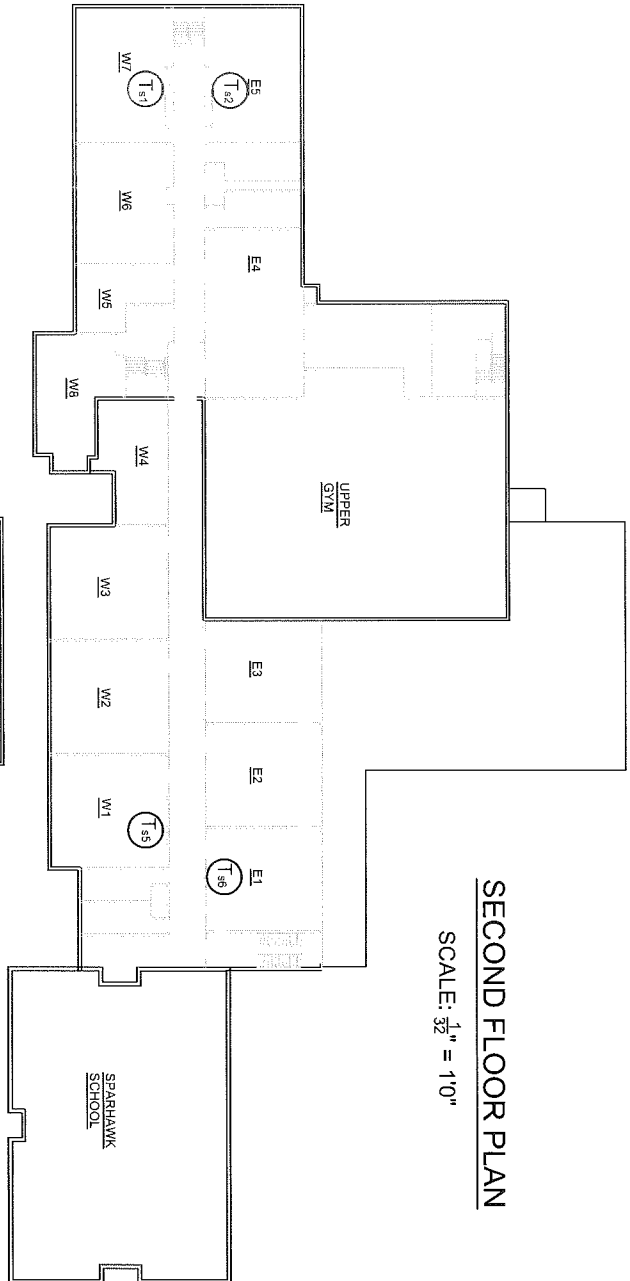
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Town of Salisbury
List of Thermostats

Building	Zone ID	Zone Control Equipment Type	Zone Actuated Device	Room Description Description	Room Terminal Units Type	Heating Service	Cooling Service
Police Department	FF-1	Zone Relay	SR501	First Floor Dispatch, Squad Room	FCU	1-stage	none
	FF-2			First Floor Cell Block	FTR		none
	FF-3			R485A	First Floor Interior		Furnace
	FF-5		none	Training Room	none		
	2F-4		R485A	Second Floor Offices	FTR		none
Fire Department	FF-1	OAT Tstat Penn LineV	Furnas 42BF35AF	Apparatus Room	UH-1		none
					UH-2		none
					UH-3		none
					UH-4		none
					UH-5		none
					UH-6		none
	FF-2			Break	FTR		none
				Chief			none
				Communications			none
				Entry			none
				Kitchen			none
				Quarters			none
				Storage			none
Department of Public Works	FF-1	OAT Tstat LineV	Pump Relay	Equipment Room	UH-1		none
	FF-2				UH-2		none
					UH-3		none
					UH-4		none
				UH-6	none		
				Electric	FTR		none
				Entry			none
	Maint Shop			none			
	Men's Room			none			
	Office			none			
Office #1	none						
Council on Aging-Hilton Senior Center	FF-1	none	none	Activity Room	Furnace		1-stage
	FF-2			Offices in Activity Area			1-stage
	FF-3		Honeywell TrolATemp	Offices, Addition	Zone Damper		1-stage
	FF-4			Conference Room,			1-stage
Town Hall	2F-3	Honeywell T775J (OAT Reset)	3-Way MX Valve	Second Floor west offices	FTR		none
		Honeywell Tstat-Prog	none	none	1-stage		
	2F-5	Honeywell T775J (OAT Reset)	3-Way MX Valve	Second Floor Auditorium	AHU Coils		none
		Honeywell Tstat-Prog	none	First Floor Planning/Inspection	none		1-stage
	FF-1	none					1-stage
	FF-2	First Floor Offices					Radiators 1-pipe
	Sewage Treatment Plant	2F-4	Honeywell T775J (OAT Reset)	3-Way MX Valve	Second Floor east offices		FTR
Honeywell Tstat-Prog			none				1-stage
FF-1			none	none	Occupied Areas	AC-1 RTU	1-stage
none	none	none			none	none	

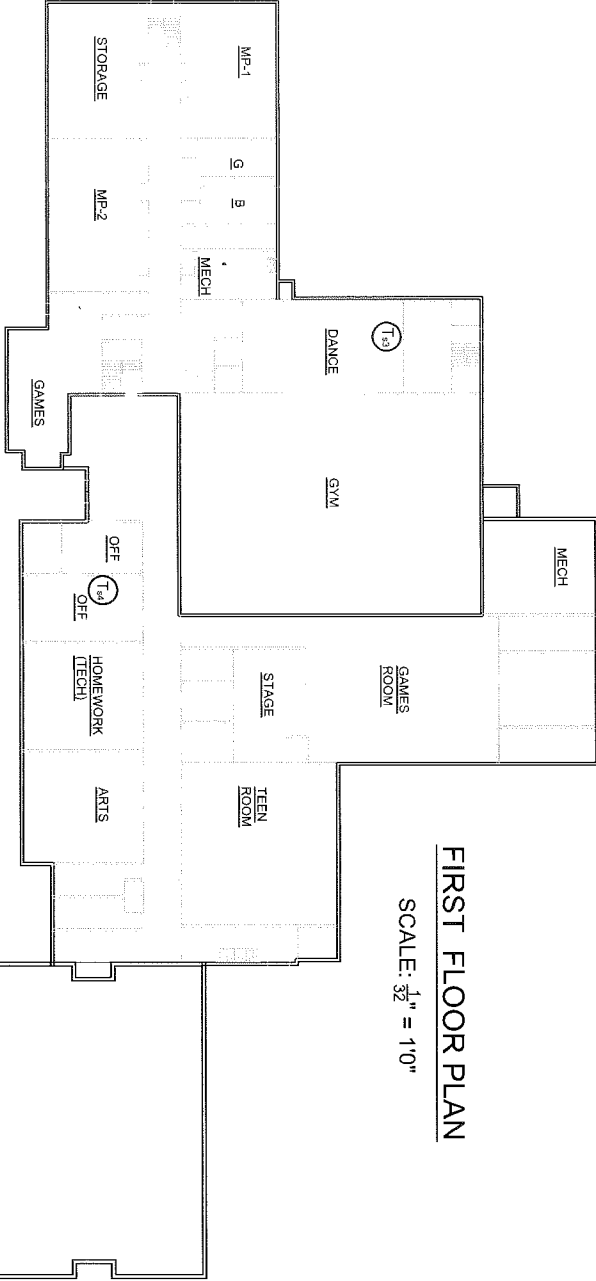
SECOND FLOOR PLAN

SCALE: $\frac{1}{32}'' = 1'0''$



FIRST FLOOR PLAN

SCALE: $\frac{1}{32}'' = 1'0''$



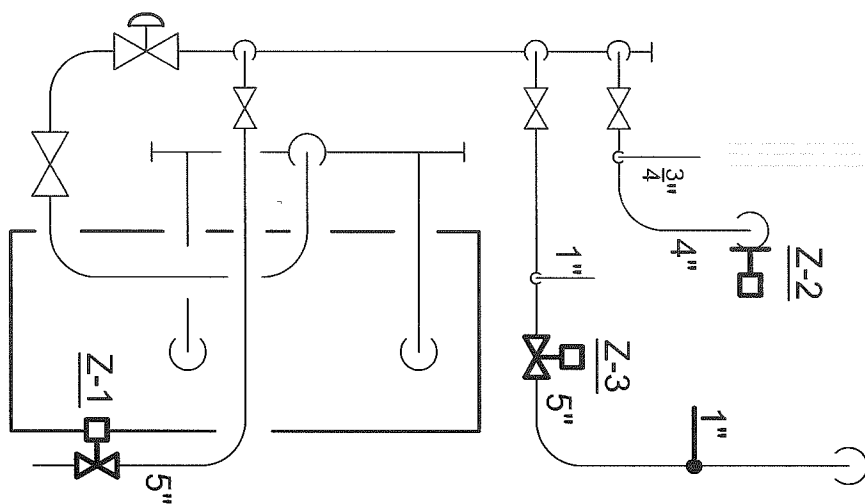
PROGRESS 12-16-12

ECM 3
1 OF 2



111 Spear Street, Suite 410
Birmingham, Massachusetts 02904
(617) 621-6200

MEMORIAL BOYS and GIRLS CLUB
SALISBURY, MA



LPS PIPING SCHEMATIC
NTS



111 Sporn Street, Suite 410
Framingham, Massachusetts 01701
(508) 681-8200

MEMORIAL BOYS and GIRLS CLUB
MAPLE STREET
SALISBURY, MA

ECM 4: Attic Insulation

ECM Overview

Ameresco proposes to install an air barrier and additional insulation for the ceiling in the Fire Department's Apparatus Bay. Rigid board insulation air-sealed with spray foam is proposed for each of the ceiling truss bays above the perforated metal ceiling and the existing fiberglass insulation reinstalled above rigid board. This measure will reduce air leakage through the ceiling and improve thermal resistance.

ECM Detail

Existing System

The ceiling of the Apparatus Bay is a perforated metal panel. It is insulated with 6" of unfaced fiberglass batts directly above in the attic floor joist (truss chord) spaces. This design was originally intended for air to flow through the ceiling system when the exhaust fan operated to remove fumes from the trucks. The exhaust fan is no longer used for this purpose: a dedicated tail-pipe exhausted system is currently in use. The lack of an air barrier in this system results in constant leakage of conditioned air leaks through the panels into the attic. This condition reduces the thermal performance of fiberglass.

See Appendix III to *ECM 15: Weatherization*, for additional description of this area.

Proposed System

Ameresco proposes to install an air barrier and additional insulation for the ceiling in the Fire Department's Apparatus Bay. Rigid board insulation air-sealed with spray foam is proposed for each of the ceiling truss bays above the perforated metal ceiling and the existing fiberglass insulation reinstalled above rigid board. This measure will reduce air leakage through the ceiling and improve thermal resistance.

> Detailed Scope of Work

- Install Dow Thermax™, or equal, rigid insulation on the attic side of the existing perforated ceiling between the trusses bottom chords;



Figure 4.1: Air-sealing and enhanced insulation is proposed for the Fire Department Apparatus Bay's metal ceiling

- Air-seal the perimeter of the rigid insulation to the framing of the truss system with spray foam (the air barrier becomes a combination of the wood truss system and the rigid insulation);
- Re-install the existing fiberglass in the attic atop of the rigid insulation;
- Note: Building Code interpretation and input will be required from the local authorities related to this application of the rigid board insulation.
- The scope of work for this ECM does not include structural evaluations or modifications of the roof.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. 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

The weatherization measures detailed above will reduce drafts as well as heating and cooling load and will result in more even and stable temperatures in the occupied spaces, reducing user complaints and dissatisfaction.

Appendix for ECM 4: Attic Insulation

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	4	
Measure Name:	Attic Insulation	
Measure Location:		
Engineers:		

Site Name:			Fire	Summary
Item	Units		Savings	
Electricity				
Energy On-Peak	kWh		0	0
Energy Off-Peak	kWh			0
Energy Total	kWh		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				
Natural Gas (NG)	Therms			0
Liquid Propane Gas (LPG)	Gallons			0
Steam	Mlbs			0
Fuel Oil, #2	Gallons		238	238
Fuel Oil, #4	Gallons			0
Fuel Oil, #6	Gallons			0
Miscellaneous	Misc			0
Water				
Water Savings	kGallons			0
Sewer				0
Sewer Savings	kGallons			0

	Comment	Call Ref.
A-H	DMF-2 Weather Data for Lawrence Municipal Airport, MA	
I-L	Occurred hours as per the RFP data	
M-P		
Q	Existing unoccupied design transmission heating loads [MBH]	
R	Existing unoccupied design transmission heating loads [MBH]. Interacted with EMS	
S	Y44 × Y45	
T	Cooling = $\lceil \text{col Q} \rceil \times \lceil \text{col I} \rceil - \lceil \text{col K} \rceil \times \lceil \text{Y} \rceil \times \text{Y46}$	
U	Heating = $\lceil \text{col H} \rceil - \lceil \text{col K} \rceil \times \lceil \text{col M} \rceil \times \lceil \text{col Q} \rceil \times \text{MIN}(\text{col Q} + \text{internal gains}, 0) - \text{Bt}(\text{col H}) - \lceil \text{col K} \rceil > \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil - \lceil \text{col I} \rceil - \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil \times \text{MIN}(\text{col M} + \text{internal gains}, 0) - \text{L}000 \times \text{Y49}$	
V	Heating = $\lceil \text{col H} \rceil - \lceil \text{col K} \rceil \times \lceil \text{col M} \rceil \times \text{MIN}(\text{col K} + \text{internal gains}, 0) - \text{Bt}(\text{col H}) - \lceil \text{col K} \rceil < \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil - \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil \times \text{MIN}(\text{col Q} + \text{internal gains}, 0) - \text{L}000 \times \text{Y49}$	
W	$\lceil \text{col Q} \rceil \times \lceil \text{col S} \rceil \times \lceil \text{col X} \rceil - \text{MIN}(\text{col K} + \text{internal gains}, 0) - \text{Bt}(\text{col H}) - \lceil \text{col K} \rceil < \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil - \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil \times \text{MIN}(\text{col Q} + \text{internal gains}, 0) - \text{L}000 \times \text{Y49}$	
X	$\lceil \text{col K} \rceil - \lceil \text{col S} \rceil \times \lceil \text{col X} \rceil$	
Y	Cooling = $\text{col V} \times \lceil \text{col I} \rceil - \lceil \text{col K} \rceil \times \lceil \text{Y} \rceil \times \text{Y46}$	
Z	Heating = $\text{MIN}(\text{col H}) - \lceil \text{col K} \rceil \times \lceil \text{col M} \rceil \times \lceil \text{col Q} \rceil \times \text{MIN}(\text{col V} + \text{internal gains}, 0) - \text{Bt}(\text{col H}) - \lceil \text{col K} \rceil > \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil - \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil \times \text{MIN}(\text{col M} + \text{internal gains}, 0) - \text{L}000 \times \text{Y49}$	
AA	Cooling = $\lceil \text{col W} \rceil \times \lceil \text{col I} \rceil - \lceil \text{col K} \rceil \times \lceil \text{Y} \rceil \times \text{Y46}$	
AB	Heating = $\lceil \text{col N} \rceil - \lceil \text{col P} \rceil \times \lceil \text{col V} \rceil \times \text{MIN}(\text{col W} + \text{internal gains}, 0) - \text{Bt}(\text{col H}) - \lceil \text{col K} \rceil < \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil - \lceil \text{col M} \rceil - \lceil \text{col Q} \rceil \times \text{MIN}(\text{col V} + \text{internal gains}, 0) - \text{L}000 \times \text{Y49}$	
AC	$\lceil \text{col U} \rceil - \lceil \text{col Z} \rceil$	
AD	$\lceil \text{col U} \rceil - \lceil \text{col Z} \rceil$	

Average Space Temperatures				
	Cooling	Heating	Description	
Occupied	75.0	71.0	Y53	
Unoccupied	80.0	60.0	Y54	

Appendix for ECM 4: Attic Insulation

II. Manufacturer Specification Sheets

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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).

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 INFORMATION

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:

- ASTM E2178 Standard Test Method for Air Permeance of Building Materials - leakage rates less than 0.001 L/s/m² at a test pressure of 75 Pa.
- ASTM E283 Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under specified Pressure differences across the specimen. Results were <0.02 L/s/m²
- ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies - no leakage
- ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference - no leakage
- 2009 International Residential Code (IRC) Section 316
- 2009 International Building Code (IBC) Section 2603
- ICC-ES ESR-1659
- 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
- FM 4450 Approval Standard for Class 1 Insulated - Steel Deck Roofs
- THERMAX™ products are covered under Underwriters Laboratories Inc. (UL) File R5622
- 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, U425, U460, U902, U904, U905, U906, U907, V454, V482, V499

- 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.

7. WARRANTY

Fifteen-year limited 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 1-866-583-BLUE (2583).

10. FILING SYSTEMS

- www.dowbuildingsolutions.com
- www.DowMetalBuilding.com

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
1.5	9.8	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

(1) Contact your Dow seller for information at different R-values and other sizes and lead time requirements. 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 may be added to the system R-value, when a minimum 3/4" ideal air space and horizontal heat flow are present in accordance with the ASHRAE Fundamentals Handbook on FTC, 16 CFR Part 460.

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.	40
Water Absorption, ASTM C209, % by volume, max.	0.1
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.

www.dowbuildingsolutions.com
www.thermaxbydow.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

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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 1-888-636-4400.

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.



ECM 5: Boiler Replacements

ECM Overview

Ameresco proposes to replace the Fire Department boiler and switch its fuel source to natural gas from fuel oil. The boiler will be replaced, fuel oil systems will be removed and natural gas piping added. This ECM will provide an efficiency improvement as well as immediate cost savings since natural gas is currently half the cost of fuel oil. In addition, natural gas requires less maintenance. Work associated with this ECM will be coordinated with ECM 3 Controls and ECM 8 Pipe Insulation.

In addition, Ameresco proposes to replace the Clever Brooks hot water boiler serving the Memorial School. A new gas service will be installed under ECM 10.



Figure 5.1: The oil-fired boiler and burner at the Fire Department will be replaced under the scope of this measure

ECM Detail

Existing System

> Fire Department

The Fire Department's (original) first floor area is heated by a hot water boiler plant of a single boiler whose gross output is 521 MBH. The boiler's fuel is number 2 fuel oil which is stored in two above ground tanks of 275 gallons each outside of the boiler plant.

Table 5.1: Existing Boiler Specifications

Location	Service	Boiler Manuf.	Burner Manuf.	Oil Input Max GPH
Fire Department	Hot water heating	Weil McLain 578	Carlin 301CRD	7

> Memorial School

The original Memorial School and current Boys and Girls Club portion of the facility is heated by a hot water boiler plant. This plant is separate from the steam heating system. The hot water plant includes a fire-tube boiler (CB 548-200) whose gross output is 6,272 MBH and fired by number two fuel oil. Fuel oil storage is provided by two underground 5000 gallon storage tanks. The condition of these tanks is unknown. Fuel oil

supply and return piping is located underground from each tank to each of the boiler rooms. Fuel oil is pumped to each burner by a pair of duplex pumps.

Portions of the breaching insulation of the hot water boiler are breaking away from the breaching and are friable. It is suspected that this is asbestos containing material (ACM). In addition, pipe and equipment insulation is likely to be ACM. Abatement of this ACM is included in ECM 10.

Proposed System

Ameresco proposes to replace the Fire Department boiler and switch its fuel source to natural gas from fuel oil as well as replace the hot water boiler at the Memorial School. The boilers will be replaced, fuel oil systems will be removed and natural gas piping added. This ECM will provide an efficiency improvement as well as immediate cost savings since natural gas is currently half the cost of fuel oil. In addition, natural gas requires less maintenance.

> Fire Department

Summary: Remove the fuel oil service and replace the oil-fired boiler with a high efficiency natural gas boiler

- Remove Existing Hot Water Boiler (Weil 578, Carlin 301CRD (3 to 7 GPH, 1/4 HP, 115V))
 - Remove existing fuel oil service and burner
 - Remove all fuel oil from the tanks (twined, 275 gal ea.) and existing piping
 - Oil tanks (twined 275 gallons): remove, dispose of tanks per MA Regulations listed in 527 CMR 09
 - Remove all oil piping; remove old gage and cut tubing flush with the floor
 - Note: The scope of work for this ECM does not include the removal of hazardous waste such as contaminated soil
 - Disconnect power to burner and remove feeder wires back to the overhead junction box; disconnect LWCO
 - Remove burner from boiler
 - Remove existing vent connector to the vent connector and stack
 - Remove existing line voltage outside air thermostat and pump contactor
 - Disconnect hot water supply and return piping at the existing unions
 - shut off make up water
 - close HWS and HWR isolation valves
 - drain boiler and remove
 - drain expansion tank and remove
- Furnish and install a high efficiency natural gas boiler (Thermal Solutions EVCA 750, or equal, input 750 MBH, net output 608 MBH)
 - Furnish and install gas piping (1 1/4" Sch 40 steel) from the load side of the meter to the mechanical room, approximately 15 linear feet
 - set the boiler and connect to existing hot water supply and return piping
 - connect to existing make-up water piping
 - Furnish and install and new expansion tank

- insulate all piping
- Furnish and install Cat IV vent (4") piping over and up through roof at stack location; pitched as per manufacturer's direction; seal roof water tight
- Furnish and install combustion air ducting (4" PVC) and up through roof at stack; seal roof water tight location; pitched as per manufacturer's installation instructions
- Furnish condensate drain to floor drain
- Furnish and install new electric feed to the burner and new circuit breaker and the existing panel
- Test fire the unit, verifying proper operation and measuring combustion efficiency
 - Furnish startup service.
 - Verify the unit performance by measuring combustion efficiency at 25, 50, 75 and 100% load
- Coordinate this work with the controls replacement work in ECM 3
- Exclusions: repairs to the chimney are excluded

> Memorial School

Summary: Replace the Cleaver Brooks boiler with one premium efficiency, natural-gas fired, modulating-condensing boiler

• Notes and Assumptions

- Natural gas service is available at both boiler rooms as part of the Base Case work, described above
- Asbestos abatement shall be completed by others: Asbestos containing material (ACM) will be identified and abated prior to demolition
- Fuel oil tank is removed remove existing fuel oil service and burner
 - remove all fuel oil from the tank and existing piping

• Demolition

- Electrical
 - Lock out and tag the electric feed to the boiler, remove the breakers, disconnects, starters and electric feeds
- Fuel Oil
 - flush and clean existing underground fuel oil supply and return piping and abandon in place
 - remove all fuel oil piping and pumps in the boiler room
- Cleaver Brooks Boiler
 - Disconnect and remove hot water supply and return
 - Remove the existing vent connector
 - Remove the existing breeching
 - remove the boiler and burner as a single unit and furnish to the owner for potential salvage value
 - Remove the existing hot water expansion tank and make-up water fill system

- Remove the domestic hot water heat exchangers; cap piping at HWS and HWR headers
- Remove the 3-way valve mixing valve and pipe connection from the HWR

• **New Work**

- Furnish and install one (1) premium efficiency, condensing, natural gas hot water heating boiler
 - Model: Lochinvar Crest FBN1500, or equal, with an input of 1,500 MBH; turndown of 25:1
 - Max NG input: 1,500 CFH,
 - Furnish and install IBR gas train
 - Furnish and install gas train vents piping to outdoors
 - Note: leave sufficient space for future boiler(s)
- Venting: Parallel sidewall direct vent:
 - Furnish and install a new 8" diameter PVC air intake for connection to the boiler intake pipe (7"). Seal all joints
 - Furnish and install a new sidewall 7" diameter vent pipe of AL29-4C stainless steel, Heatfab, or equal, in accordance with NFPA 54 and manufacturer's I&O manuals.
 - Air/Vent terminations: vent outlet and air inlet shall be separated by a minimum of 3 feet and comply with all Massachusetts codes
- Boiler Piping Configuration
 - Install the boiler in a primary/secondary configuration
 - Furnish and install a boiler pump, Taco 2470, 0.5 HP, or equal
 - Provide a connecting pipe for the existing HWS and HWR headers to create a primary distribution loop
 - Interface the boiler piping (secondary) to the primary loop
- Utilize the existing concrete housekeeping pad
- Furnish and install a hot water expansion tank and make-up water fill system
- Furnish and install a new dedicated electric circuit (208 volt, 3p, (TBD) and circuit breaker for the unit
- Furnish and install a boiler drain to an existing floor drain
- furnish and install condensate neutralization tank and discharge to drain
- Furnish startup service.
- Verify the unit performance by measuring combustion efficiency at 25, 50, 75 and 100% load

No changes to the existing fire suppression systems are included. The existing boiler rooms are assumed to meet all current building codes.

No changes to the existing boiler room piping are included. All existing pumps will be reused.

> Sizing Considerations

New boilers will be sized according to meet the current design load using ASHRAE guidelines and input from the Town.

> Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided to the Town for approval prior to procurement. Documents will be submitted to the engineering maintenance 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 to the Town for record.

> Impact on Facility Operations and Performance

Maintenance cost reductions will occur due to natural gas equipment. The scope of work for this ECM does not include the removal of unexpected hazardous waste such as contaminated soil.

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Appendix for ECM 5: Boiler Replacements

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	5	
Measure Name:	Boiler Replacements	
Measure Location:		
Engineers:		

Site Name:			Fire	Memorial	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	-3,650		1,398	-2,253
Liquid Propane Gas (LPG)	Gallons				0
Steam	Mlbs				0
Fuel Oil, #2	Gallons	2,859			2,859
Fuel Oil, #4	Gallons				0
Fuel Oil, #6	Gallons				0
Miscellaneous	Misc				0
Water					0
Water savings school	kGallons				0
Sewer					0
Sewer savings school	kGallons				0

Cell Ref.	Comment	Assumptions:	Value	Unit	CELL	Description
A-H	TMV-2 Weather Data for Lawrence Municipal Airport, MA				REF	
I-L	Occupied hours as per the RFP data					
M - P	Equipment operating hours after EMS is installed	Existing Heating Plant Efficiency	81.0%		R43	Baseline Boiler Efficiency
Q	Interacted Occupied Heating loads (MBH)	Proposed Heating Plant Efficiency	88.0%		R44	Proposed Boiler Efficiency
R	Interacted Unoccupied Heating loads (MBH)	Percent Heating Load	83.4%		R45	% Served by Oil
S	Heating = $-MIN[(col I) + (col K) \leq (col M) + (col O)] + MIN[(col Q) + (col R) + (col U)] + (col V)$	Percent Heating Load	100.0%		R46	% Served by Boilers
T	Heating = $-(col N) + (col P) + MIN[(col R) + (col S) + (col U)] + (col V)$					
U	Heating = $-MIN[(col I) + (col K) + (col M) + (col O)] + MIN[(col Q) + (col R) + (col U)] + (col V)$					
V	Heating = $-(col N) + (col P) + MIN[(col R) + (col S) + (col U)] + (col V)$					
W	Heating = $-(col N) + (col P) + MIN[(col R) + (col S) + (col U)] + (col V)$					

**Town of Salisbury, Massachusetts
Sparhawk/Memorial School-Boys and Girls Club
ADD Alternate Boiler Replacements**

TMY-2 Weather Data for Lawrence Municipal Airport, MA													Existing Occupancy Schedule						Proposed EMS Operating Hours						Proposed		Savings			
Amb. Bin	Temp 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																						
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	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															
95 to 100	97.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0															
90 to 95	92.5	72.6	36.2	0	8	0	8	2	6	0	0	2	6	0	0															
85 to 90	87.5	69.7	33.7	0	70	16	86	24	62	0	0	24	62	0	0															
80 to 85	82.5	68.9	33.1	2	202	67	271	77	194	0	0	77	194	0	0															
75 to 80	77.5	66.8	31.4	30	272	146	448	143	321	0	0	127	321	0	0															
70 to 75	72.5	64.1	29.4	89	245	171	505	143	362	0	0	143	362	0	0															
65 to 70	67.5	61.8	27.7	235	275	283	793	224	569	0	0	224	569	0	0															
60 to 65	62.5	58.3	25.3	372	248	341	961	272	689	0	0	272	689	0	0															
Heating																														
55 to 60	57.5	52.8	21.9	244	210	228	682	193	489	0	0	193	489	0	0	(123)	(3)	6	2	5	2	1								
50 to 55	52.5	48.5	19.5	299	202	240	741	210	531	0	0	210	531	0	0	(82)	(3)	22	2	19	2	3								
45 to 50	47.5	43.8	17.0	247	176	206	629	178	451	0	0	178	451	0	0	(142)	(21)	32	12	28	10	5								
40 to 45	42.5	38.9	14.7	261	276	246	783	221	562	0	0	221	562	0	0	(202)	(79)	57	56	50	49	14								
35 to 40	37.5	33.8	12.5	339	311	357	1,007	285	722	0	0	285	722	0	0	(261)	(137)	94	125	83	110	27								
30 to 35	32.5	29.3	10.6	300	189	268	757	214	543	0	0	214	543	0	0	(321)	(195)	87	134	76	118	27								
25 to 30	27.5	24.8	8.9	179	85	136	400	113	287	0	0	113	287	0	0	(381)	(253)	54	92	48	81	18								
20 to 25	22.5	20.0	7.1	115	60	83	258	73	185	0	0	73	185	0	0	(440)	(312)	41	73	36	64	14								
15 to 20	17.5	14.9	5.4	106	39	73	218	62	156	0	0	62	156	0	0	(500)	(370)	39	73	34	64	14								
10 to 15	12.5	10.7	4.0	34	20	26	80	23	57	0	0	23	57	0	0	(559)	(428)	16	31	14	27	6								
5 to 10	7.5	5.2	2.4	19	24	18	61	17	44	0	0	17	44	0	0	(619)	(486)	14	27	12	24	5								
0 to 5	2.5	0.8	1.1	34	7	13	54	15	39	0	0	15	39	0	0	(679)	(544)	13	27	12	23	5								
-5 to 0	(2.5)	(3.7)	(0.2)	12	1	2	15	4	11	0	0	4	11	0	0	(738)	(602)	4	8	3	7	1								
-10 to -5	(7.5)	(8.4)	(1.5)	3	0	0	3	1	2	0	0	1	2	0	0	(798)	(661)	1	2	1	2	0								
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	(854)	(715)	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	(914)	(774)	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	(973)	(832)	0	0	0	0	-								
				7,920	7,920	7,920	8,760	7,477	6,283	0	0	7,477	6,283	0	0			479	665	470	583	140								

Cell Ref.	Comment
A-H	TMV-2 Weather Data for Lawrence Municipal Airport, MA
I - L	Occupied hours as per the RFP data
M - P	Equipment operating hours after EMS is installed
Q	Estimated Occupied Heating Inside (MBtu/h)

R	Interacted Unoccupied Heating loads (MBH)
S	$\text{Heating} = -(\text{MIN}[\text{col N}] + [\text{col M}] \times \text{MIN}[\text{col Q}]) + \text{internal gains}, (0) + \text{IF}[(\text{col I}) + [\text{col J}] + [\text{col K}]] - ((\text{col M}) + [\text{col O}]) \times \text{MIN}[\text{col R}] + \text{internal gains}, (0, 0)] + \text{MIN}[(\text{col R}) + \text{internal gains}, (0, 0)] + 1,000 + \text{R43}$
T	$\text{Heating} = -((\text{col N}) + [\text{col P}] \times \text{MIN}[\text{col Q}]) - \text{IF}[(\text{col I}) + [\text{col J}] + [\text{col K}]] - ((\text{col M}) + [\text{col O}]) \times \text{MIN}[(\text{col Q}) + \text{internal gains}, (0, 0)] + 1,000 + \text{R43}$
U	$\text{Heating} = -(\text{MIN}[\text{col I}] + [\text{col M}] + [\text{col O}]) \times \text{MIN}[\text{col Q}] - \text{IF}[(\text{col I}) + [\text{col J}] + [\text{col K}]] - ((\text{col M}) + [\text{col O}]) \times \text{MIN}[(\text{col R}) + \text{internal gains}, (0, 0)] + 1,000 + \text{R44}$
V	$\text{Heating} = -((\text{col N}) + [\text{col P}] \times \text{MIN}[\text{col Q}]) - \text{IF}[(\text{col I}) + [\text{col J}] + [\text{col K}]] - ((\text{col M}) + [\text{col O}]) \times \text{MIN}[(\text{col Q}) + \text{internal gains}, (0, 0)] + 1,000 + \text{R44}$
W	$\text{Heating} = -(\text{col S}) + [\text{col U}] - [\text{col V}]$

Appendix for ECM 5: Boiler Replacements

II. Manufacturer Specification Sheets

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CONDENSING

EVOLUTION[®]

Higher Efficiency Heating Equipment

Making the Best Even Better

- UNMATCHED OPERATING CONTROLS
- UP TO 97% EFFICIENT
- ULTRA LOW NOX
- CERTIFIED TO BTS-2000 TEST STANDARD



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SOLUTIONS
Innovative Equipment for Hot Water Systems

MAKING THE BEST EVEN BETTER

The NEW Condensing Evolution® (EVCA)

Thermal Solutions has designed the high-efficiency copper-finned condensing Evolution® to meet the needs of today's commercial heating requirements. The Evolution EVCA design takes the very best of existing technology to the next level by incorporating a secondary heat exchanger. The result is higher efficiency and greater reliability in your application.



Heat Exchanger



Ceramic Radiant
Burner



Honeywell® RM 7800



TSBC Module

The Evolution is now being featured as a fully condensing boiler. Ranges are 750,000 through 3,000,000 BTU/hr. We offer the following features:

Infinite Modulation — Load Matching

The EVCA uses fuel/air ratio controls to modulate the firing rate, providing optimum performance and temperature control. There are no linkages or mechanical devices that can loosen during operation. It's the safest means of combustion control on the market.

Variable Water Flow Rates

Because of its condensing design, the EVCA has the flexibility to accommodate the variable flow rates and temperature requirements of today's diverse hydronic system designs.

Innovative Heat Exchanger Design

Central to the Evolution boiler's highly efficient operation is the design of its copper-tube heat exchanger. Not only does it efficiently maintain heat transfer, but the innovative gasketless header provides for easy inspection, cleaning and individual tube replacement. The specially designed condensing section is 100% stainless steel for maximum corrosion resistance and performance.

Clean and Efficient Advanced Combustion

Third-party certified to BTS-2000 at efficiencies up to 97% thermal and NOx ratings less than 9.9 ppm, the Evolution's noiseless ceramic radiant burner runs at minimal excess air levels, creating highly efficient, trouble-free operation. The rugged industrial cast-aluminum blower and fan wheel are equipped with a replaceable combustion air filter (99% efficient to one micron) to create excellent combustion characteristics and even air distribution. There's no need for tricky pressurized compartments...the Evolution boiler can even be operated with its jacket panels removed for easy inspection or maintenance.

Unique Timesaving Controls

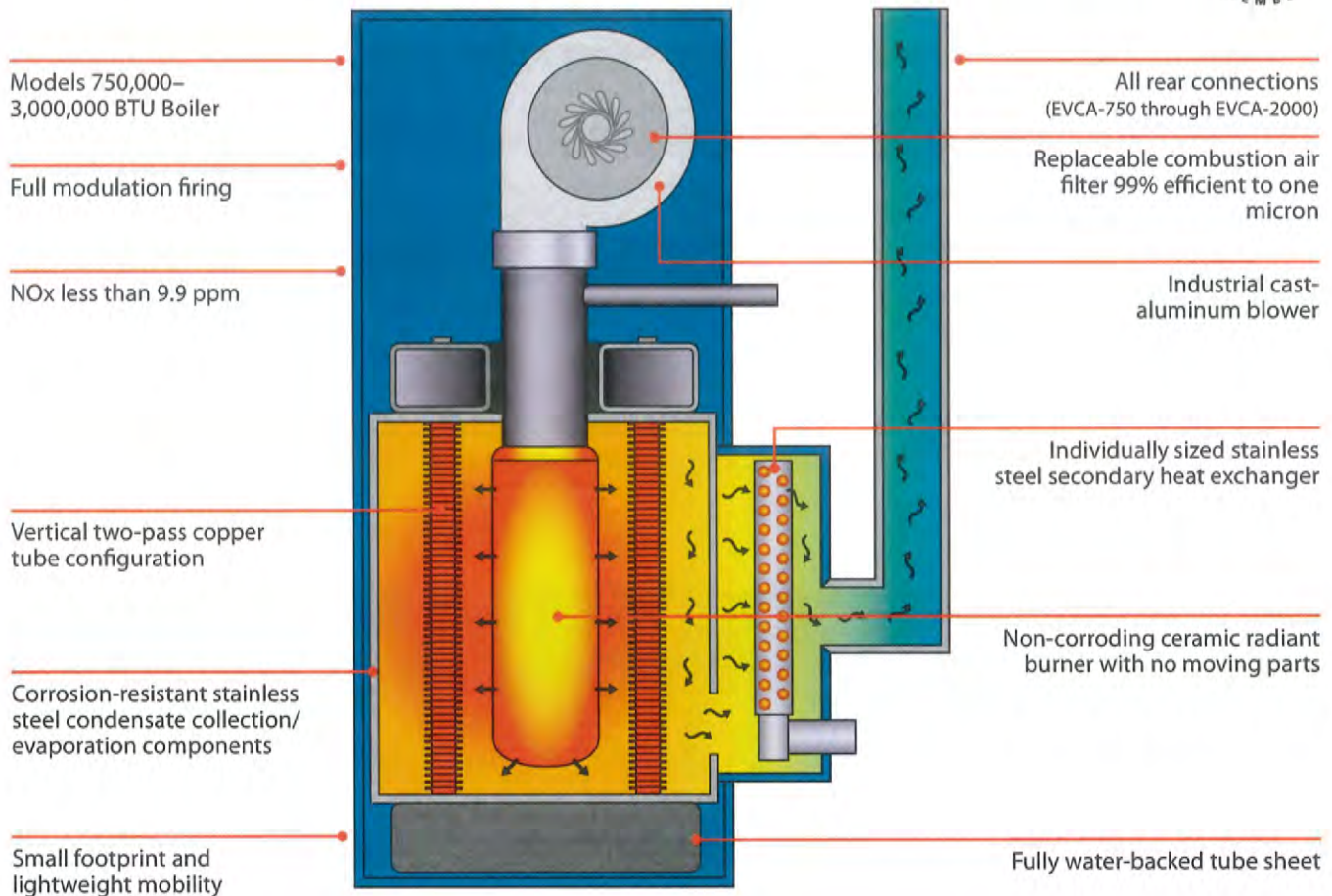
Instead of using a series of relays, the Evolution design uses state-of-the-art microprocessor flame safeguard controls to provide extensive diagnostic information including first-out fault annunciation using an LED diagnostic display. The proven spark-to-pilot ignition system ensures that the pilot is lit before allowing the main gas valve to open. The optional display unit, shown at the left, can be easily incorporated to provide additional operational information and history.

Unmatched Operating Controls

The Thermal Solutions Boiler Control™ Module (TSBC™) is truly the heart of the Evolution condensing boilers. Operation is through simple menu selections and doesn't require special training or certification. The TSBC offers boiler pump control, outdoor reset, lead/lag operation, inlet and outlet temperature sensors, boiler operating history and many other functions to stand alone or facilitate integration with your existing heating controls or building management system. The TSBC provides warm weather shutdown and domestic hot water priority.



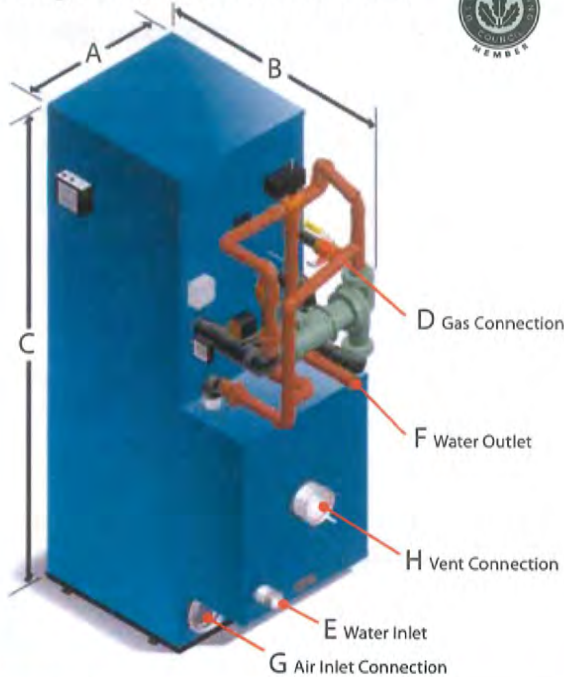
EVOLUTION® CONDENSING UNIT FEATURES



- Proven technology in higher efficiencies
- The most robust design on the market today
- Up to 97% thermal efficiency (BTS-2000 certified)
- Infinitely proportional firing
- VFD air control; no dampers or linkages
- Non-proprietary controls
- Ultra-low 9.9 NO_x; is below all current standards
- Non-proprietary parts
- Factory fire-test on every unit
- Standard sealed combustion

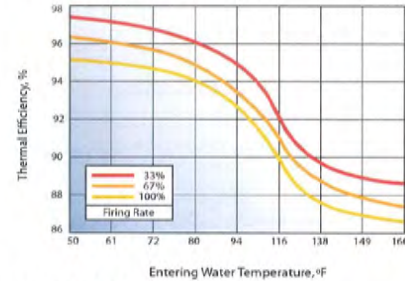
- Single-point electrical hook-up for all voltage options
- Standard UL/FM/CSD-1 controls and gas train (optional IRI or IRI with proof of closure)
- Quiet operation (<60 dB)
- Electric spark-to-pilot-ignition system
- Aluminum non-sparking fan assembly
- Filtered combustion air
- Jacket design provides complete access to all components for easy serviceability
- Quick-connect compact package
- Reduced stack sizes — multiple venting options

Ratings and Dimensional Data

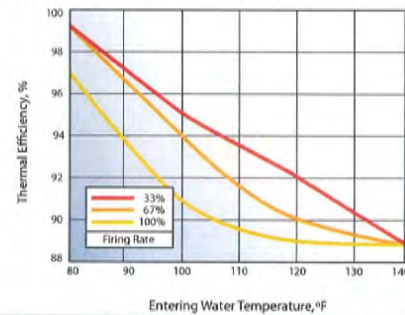


Thermal Efficiency

EVCA-750 through 2000



EVCA-3000



Evolution Condensing Models	EVCA-750	EVCA-1000	EVCA-1500	EVCA-2000	EVCA-3000
Input, MBH	750	1000	1500	2000	3000
Gross Output, MBH	699	939	1420	1900	2910
Net Ratings, Water MBH*	608	817	1235	1652	2530
Thermal Efficiency	93.2%	93.9%	94.7%	95.0%	97.0%
Boiler Horsepower	21.1	28.1	42.1	56.2	86.9
Sq. Ft. per BHP	13.4	13.4	13.5	13.5	16.4
Width: "A"	28.25" (717.55)	28.25" (717.55)	28.25" (717.55)	28.25" (717.55)	38.13" (968.50)
Depth: "B"	54" (1372)	54" (1372)	54" (1372)	52" (1321)	76" (1930)
Height: "C"	60.938" (1548)	65.188" (1656)	79.438" (2018)	91.813" (2332)	87.50" (2222)
Gas Connection: "D" NPT	1-1/2" NPT	1-1/2" NPT	1-1/2" NPT	1-1/2" NPT	2" NPT
Water Inlet: "E" NPT	2-1/2" NPT	2-1/2" NPT	2-1/2" NPT	2-1/2" NPT	4" NPT
Water Outlet: "F" NPT	2" NPT	2" NPT	2" NPT	2" NPT	4" Victaulic
Air Inlet Connection: "G"	6" (152.4)	6" (152.4)	8" (203.2)	8" (203.2)	8" (203.2)
Vent Connection: "H"	4" (101.6)	6" (152.4)	6" (152.4)	6" (152.4)	8" (203.2)
Shipping Weight: lbs.	1401	1520	1736	1929	3354

*The NET AHRI Water Ratings shown are based on an allowance of 1.15°.

Dimensions are inches (mm)

HIGH EFFICIENCY COMMERCIAL BOILERS

CREST[®]

CONDENSING BOILER

SMART TOUCH[™]

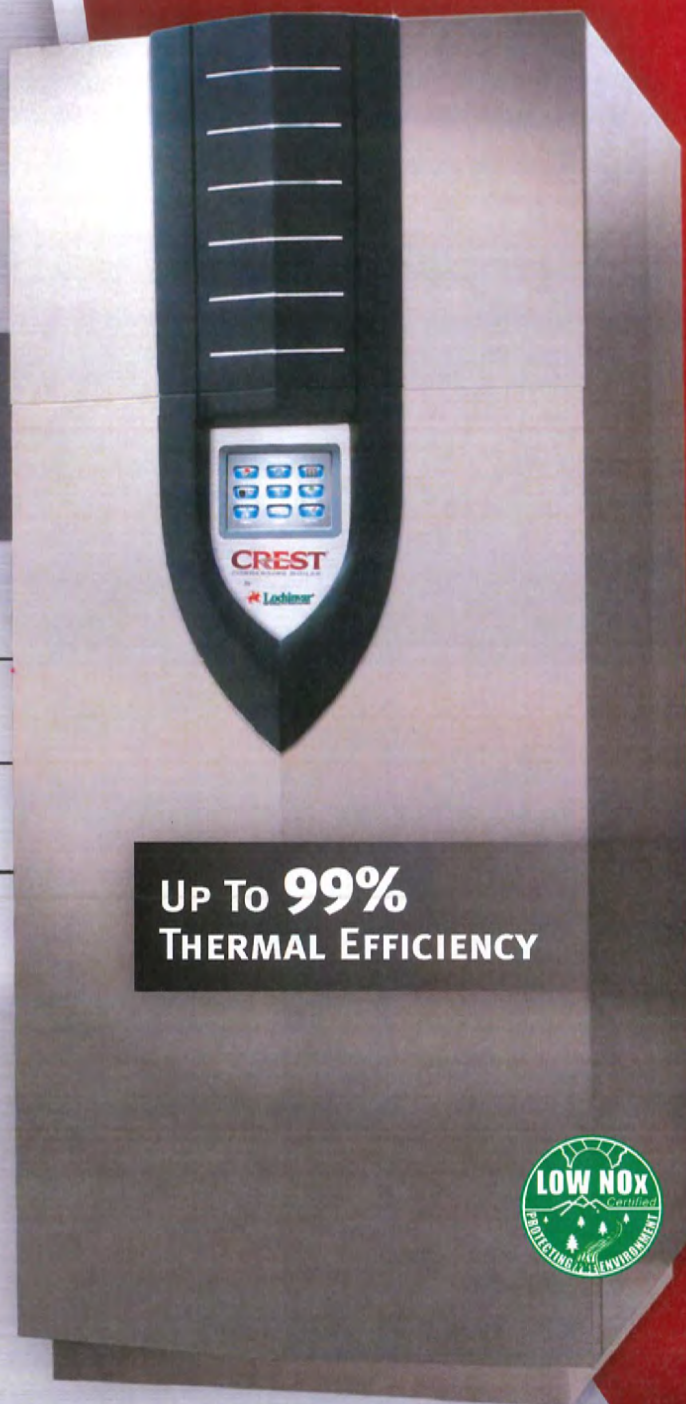
WITH MODBUS PROTOCOL,
CASCADING SEQUENCER AND
FRONT-END LOADING CAPABILITY

7 INPUTS FROM 1.5 TO 5.0 MILLION BTU/HR

FIRING RATE MODULATION UP TO 25:1

DIRECT-VENT FLEXIBILITY TO 100 FEET

FLEXIBLE FLOW RATES UP TO 350 GPM



UP TO **99%**
THERMAL EFFICIENCY



Lochinvar[®]
High Efficiency Water Heaters, Boilers and Pool Heaters

CREST[®]

CONDENSING BOILER

FIRE TUBE INNOVATION UP TO 5.0 MILLION BTU

Lochinvar[®] has taken the fire-tube concept in an innovative new direction with the CREST[®] modulating-condensing boiler. With sizes that range from 1.5 to 5.0 million Btu/hr, you have the opportunity to utilize Lochinvar leading-edge technology in your largest applications. With thermal efficiencies up to 99% in low water temperature applications, CREST is positioned to provide exceptional energy-saving performance.

The advanced CREST introduces a combustion system with a unique burner design with up to 25:1 turndown. The burner fires into an array of 316L stainless steel fire-tubes that transfer the heat to the surrounding water with exceptionally high efficiency.

CREST communicates seamlessly and in real time with building management systems by utilizing an on-board MODBUS protocol. The SMART TOUCH[™] control has a built-in cascading component that communicates with up to eight units, providing total command without an external control or complex and expensive control logic programming by the BMS integrator.

Yes, innovative fire-tube boiler technology integrated with our SMART TOUCH[™] operating control makes the CREST a genuine game-changer among commercial boilers.

ADVANCED NEGATIVE REGULATION TECHNOLOGY

CREST safely and reliably operates with supply gas pressure as low as 4 inches water column. Because Negative Regulation (Neg/Reg) technology draws fuel gas into a pre-mix combustion system instead of relying on utility pressure through the gas valve, operation is steady in low gas pressure systems or when peak demands occur on supply lines. Plus, Neg/Reg automatic fan speed control fine-tunes the correct fuel/air ratio entering the burner, providing even, consistent combustion for a cleaner burning flame achieving high combustion efficiency.

FULLY MODULATING UP TO 25:1 TURNDOWN

25:1 turndown means the burner can fire at a rate as low as 4% of its maximum input. For example, a 2 million Btu/hr CREST unit can modulate from 80,000 up to 2,000,000 Btu/hr depending on demand. High turndown greatly reduces "short cycling" when demand is low. All boiler systems are designed to provide enough heat to maintain a facility's heat loss on the coldest days. When the system is zoned, the CREST's high turndown works to match the actual system demand and, in return, reduces the customer's fuel bill and provides better comfort by load matching the heat loss of the system. Greater seasonal efficiencies will be realized due to the extremely large turndown offered by CREST.

As Low As 25 GPM* TO FULL 350 GPM FLOW RATES

CREST allows system designers tremendous flexibility to vary the flow rate through the boiler. It can service systems that operate with widely fluctuating flow rates depending on demand. CREST can be installed with primary/secondary piping or in a full-flow arrangement. Typical design techniques include full-flow systems or variable flow systems using variable frequency drives on the heating water pumps. In either case, CREST excels in these applications and allows the flow through the boiler to vary based on system demand.

* 25 GPM min. flow on FB1500-3000 models, 45 GPM on FB3500-4000 models and 50 GPM on FB5000.



THE CREST COMBUSTION SYSTEM

CREST's top-mounted, single micro metal fiber burner is actually "two combustion systems in one," each with its own blower/gas valve assembly to power the combustion process from air/gas intake to driving heat energy down and through the fire-tubes to exhaust venting through the bottom of the unit.

IN A 2 MILLION BTU/HR CREST BOILER

The upper portion of the burner fires first and, with 5:1 turndown, modulates from 80,000 to 400,000 Btu/hr.

When demand exceeds 400,000 Btu/hr., the lower portion of the burner fires and modulates from 320,000 to 1,600,000 Btu/hr.

With the entire burner firing at capacity, the total input is $400,000 + 1,600,000 = 2,000,000$ Btu/hr.

The CREST's patent-pending dual-system design is truly an industry first!

THE CREST HEAT EXCHANGER

HEAT ENERGY AND COMBUSTION PRODUCTS FLOW DOWNWARD INTO FIRE-TUBES FROM THE BURNER.

ENERGY FROM INSIDE FIRE-TUBES HEATS WATER FLOWING THROUGH THE HEATING VESSEL.

AS WATER IS HEATED, IT FLOWS UP THROUGH THE HEATING VESSEL AND OUT INTO THE SYSTEM.

COLD WATER RETURNING FROM THE SYSTEM ENTERS THE HEATING VESSEL TO MAXIMIZE EFFICIENCY.

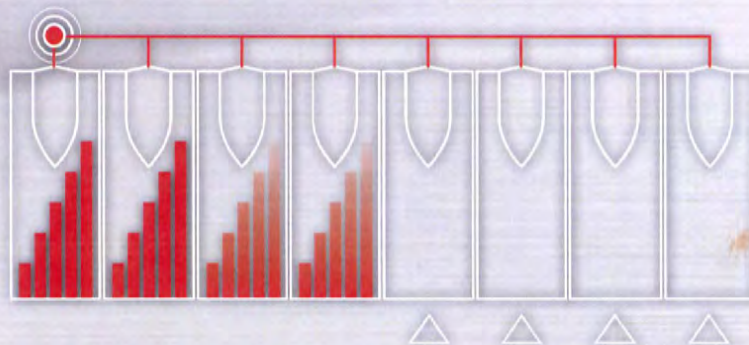
CONDENSATE IS DRAINED INTO A STAINLESS STEEL COLLECTOR, TO BE PIPED TO A SUITABLE FLOOR DRAIN.

THE FLUE OUTLET IS LOCATED AT THE BOTTOM OF THE UNIT.

BUILT-IN CASCADING SEQUENCER

Sequences up to an 8-boiler system using simple 2-wire daisy-chain connection, eliminating cost and uncertainty of separate "third party" sequencer. On demand, one boiler functions as the leader and modulates to capacity. Increasing load then "cascades" to additional "lag" boilers in sequence as needed. Lead-lag rotation shifts "first on" boiler role every 24 hours, distributing equal lead-lag runtimes to each unit.

CREST's ability to sequence up to eight units that each have as much as 25:1 turndown means that the combined system has the potential of operating with modulation of up to 200:1 turndown. A bank of eight 2.0M Btu CRESTs would be able to provide as little as 80,000 Btu/hr and as much as 16,000,000 Btu/hr of heating output. In addition, the CREST Cascade can be set for "Efficiency Optimization" with each boiler firing at the same low BTU/hr input rates to receive the benefits of the highest thermal efficiency.



UNEQUALED CONTROL AND MONITORING FUNCTIONS THAT ARE EASY TO USE

The CREST features Lochinvar's popular, all-in-one SMART TOUCH™ operating control. Amplified with an 8-inch touchscreen, the multi-color interface offers the best info-graphics and visual control content in the boiler industry today. It is smartly dressed with distinctive features and control parameters. It provides the operator with outstanding functionality, ease of operation and customized data retrieval. The CREST's SMART TOUCH control can be integrated directly into a Building Automation System via ModBus protocol and other communication protocols via a gateway device.

MODBUS COMMUNICATION

BUILDING MANAGEMENT SYSTEM CONTROL

PC CONNECTION

OUTDOOR RESET

NIGHT TEMPERATURE SETBACK

HOT WATER GENERATOR COMPATIBILITY

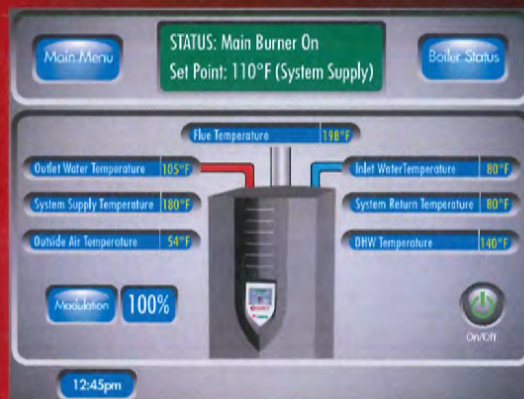
SYSTEM AND BOILER PUMP CONTROLS

FREEZE PROTECTION

PRODUCT SERVICE DUE INDICATOR

PASSWORD SECURITY

SMART TOUCH



DIRECT-VENTING UP TO 100 FEET

CREST offers 6 venting options and tremendous flexibility for placement of units within the building, because it permits direct-vent air intake and exhaust runs up to 100 equivalent feet using AL29-4C stainless steel (Category IV) vent pipe. Intake and exhaust runs can terminate horizontally through a sidewall or vertically through the roof. Additionally, CREST boilers installed in multiples of 2 or more can be common-vented, eliminating much of the time and material cost of venting multiple boilers individually.



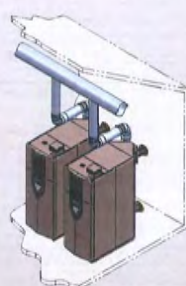
Room Air Vertical



Room Air Sidewall



Direct-Vent
Sidewall



Common-Vent*



Direct-Vent
Vertical



Vertical w/Sidewall Air

*Contact Lochinvar for information on common venting of CREST boilers.

THE INDUSTRY'S FIRST WAVE™ FIRE-TUBE BOILER IS ALSO THE INDUSTRY'S BEST

Through an extensive research and design program, Lochinvar has taken fire-tube boiler technology to a new level. The CREST® boiler features the Wave™ 316L stainless steel fire-tube. Each CREST Fire Tube has a larger input capacity than other industry fire-tubes, which means fewer tubes and welds. This exclusive, new design provides superior heat transfer in every fire-tube.



The Wave™ fire-tube employs a unique wave pattern that creates turbulence as the flue gas products flow down the tube, scrubbing the energy from the flue products. The Wave™ design also enhances the life of the heat exchanger by allowing the fire-tubes to flex, operating stress-free with none of the adverse effects suffered by traditional fire-tube boilers.

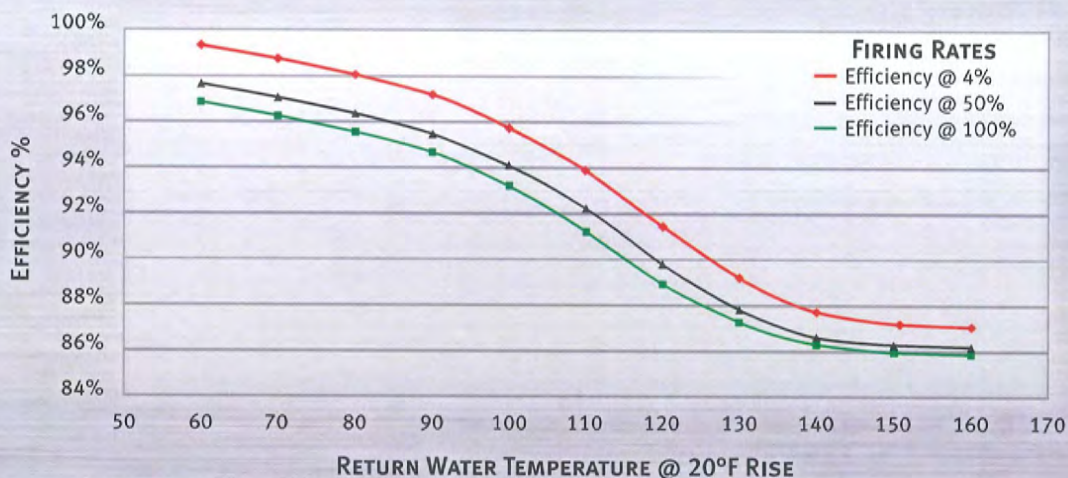
Each fire-tube is welded into the heat exchanger vessel and surrounded by water. The heat transfer process is enhanced by the water's counterflow. As the water flows up inside the vessel, the super-heated flue products flow down the fire-tube. With one pass, the heat is effectively captured from the flue products reaching condensing temperatures. At the top of the vessel, the combustion chamber is also water-backed for additional heat transfer.

Finally, the CREST heat exchanger can operate with flow rates from as low as 25 GPM* to 350 GPM, comfortably suited to a wide variety of boiler system designs.

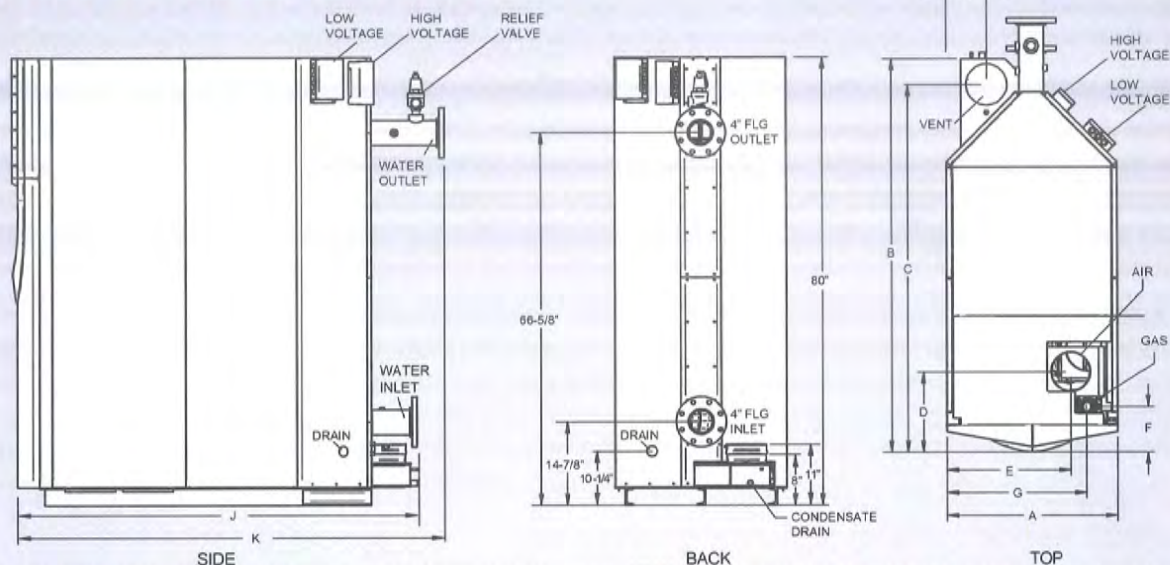
* 25 GPM min. flow on FB1500-3000 models, 45 GPM on FB3500-4000 models and 50 GPM on FB5000.



CREST BOILER EFFICIENCY



CREST® BOILER DIMENSIONS AND SPECIFICATIONS



CREST HEATING BOILER

Model Number	Input MBH Min.	Input MBH Max.	AHRI Thermal %	Output MBH	NET AHRI Rating MBH	Turndown
FBN1500	60	1,500	92.0%	1,380	1,200	25:1
FBN2000	80	2,000	92.0%	1,840	1,600	25:1
FBN2500	125	2,500	92.0%	2,300	2,000	20:1
FBN3000	150	3,000	92.0%	2,760	2,400	20:1
FBN3500	200	3,500	92.0%	3,220	2,800	18:1*
FBN4000	335	4,000	93.0%	3,720	3,235	12:1
FBN5000	500	5,000	93.0%	4,650	4,043	10:1

DIMENSIONS AND SPECIFICATIONS

A	B	C	D	E	F	G	H	J	K	Gas Conn.	Air Inlet	Vent Size	Operating Wt. (lbs.)	Shipping Wt. (lbs.)
30-3/4	71-1/2	65-3/4	14-3/8	22-3/8	8-1/2	25-1/4	7-1/4	72-5/8	77-5/8	1-1/2	7	7	2,496	1,900
30-3/4	71-1/8	65-1/8	14-7/8	22-3/8	8-1/4	25-3/8	5-3/4	71-7/8	76-7/8	1-1/2	8	8	3,054	2,150
34-1/4	76-3/8	70-1/4	17-3/4	26-1/8	9-3/4	27-3/8	6-1/4	78	83	2	8	9	3,652	2,560
40-1/2	83-5/8	76-3/8	17-3/8	31-3/8	9-7/8	34-3/4	8-1/2	82-1/8	87-1/8	2	10	10	4,126	2,920
40-1/2	83-1/4	75-5/8	17-1/4	31-3/8	9-7/8	34-3/4	7-1/4	81-1/8	86-1/8	2	10	10	4,744	3,225
53-1/2	109	100-3/4	31-1/4	40-3/4	14-1/2	45-3/4	12-1/2	109-1/4	108-1/4	2-1/2	12	12	6,900	4,750
53-1/2	109	100-3/4	28	40-3/4	11	45-1/2	9	109-1/4	108-1/4	2-1/2	14	14	8,000	5,550

Notes: Indoor installation only. All information subject to change. Change "N" to "L" for LP gas models and to "D" for dual fuel models.

For Low NOx on FB2500 - FB5000 models, consult factory. *Turndown rate reduced on LP gas models.

SMART TOUCH™ FEATURES

- ▶ **SMART TOUCH™ Touchscreen Operating Control**
- ▶ **Full-Color 8" Touchscreen LCD Display**
- ▶ **Built-in Cascading Sequencer for up to 8 Boilers**
- ▶ Cascade Multiple Sized Boilers
- ▶ Lead/Lag Cascade
- ▶ Efficiency Optimized Cascade
- ▶ **Front-End Loading Capability with Copperfin II and Powerfin Boilers**
- ▶ **Building Management System Integration with 0-10 VDC Input**
- ▶ **Modbus Communications**
- ▶ **Outdoor Reset Control with Outdoor Air Sensor**
- ▶ **Password Security**
- ▶ **Domestic Hot Water Prioritization**
 - ▶ DHW tank piped with priority in the boiler loop
 - ▶ DHW tank piped as a zone in the system with the pumps controlled by the Smart System
- ▶ DHW Modulation Limiting
- ▶ Separately Adjustable SH/DHW Switching Times
- ▶ Low Water Flow Safety Control & Indication
- ▶ Inlet & Outlet Temperature Readout
- ▶ Freeze Protection
- ▶ Service Reminder
- ▶ Time Clock
- ▶ **Data Logging**
 - ▶ Hours Running, Space Heating
 - ▶ Hours Running, Domestic Hot Water
 - ▶ Hours Running, Modulation Rate
 - ▶ Ignition Attempts
 - ▶ Last 10 Lockouts
- ▶ **Programmable System Efficiency Optimizers**
 - ▶ Night Setback
 - ▶ Anti-Cycling
 - ▶ Outdoor Air Reset Curve
 - ▶ Ramp Delay
 - ▶ Boost Temperature & Time
- ▶ **Three Pump Control**
 - ▶ System Pump
 - ▶ Boiler Pump
 - ▶ Domestic Hot Water Pump

High-Voltage Terminal Strip

- ▶ 120 VAC / 60 Hertz / 1 Phase Power Supply (FB1500-3500)
- ▶ 208 VAC / 60 Hertz / 3 Phase Power Supply (FB4000-5000)
- ▶ System Pump, Boiler Pump and DHW Pump Power

Low-Voltage Terminal Strip

- ▶ 24 VAC Auxiliary Device Relay
- ▶ Auxiliary Proving Switch Contacts
- ▶ Alarm on Any Failure Contacts
- ▶ Runtime Contacts
- ▶ DHW Thermostat Contacts
- ▶ Unit Enable/Disable Contacts
- ▶ System Sensor Contacts
- ▶ DHW Tank Sensor Contacts
- ▶ Outdoor Air Sensor Contacts
- ▶ Cascade Contacts
- ▶ 0-10 VDC BMS External Control Contact

OPTIONAL EQUIPMENT

- ▶ Alarm Bell
- ▶ BMS Gateway - BACnet or LonWorks
- ▶ Condensate Neutralization Kit
- ▶ SMART TOUCH PC Software
- ▶ Common Vent Kits
- ▶ Dual Fuel Gas Train
- ▶ Electrical Options (Shipped Loose):
 - 208V/3Ø/60Hz (Models FB1500-3500 only)
 - 480V/3Ø/60Hz
 - 600V/3Ø/60Hz
- ▶ Motorized Isolation Valve

CODES & REGISTRATIONS

- ▶ ANSI Z21.13/CSA Certified
- ▶ ASME certified, "H" Stamp / National Board
- ▶ California Code Compliant
- ▶ CSD1 / Factory Mutual / GE Gap Compliant
- ▶ South Coast Air Quality Management District Qualified
- ▶ Canadian Registration Number (CRN)
- ▶ AHRI Certified

STANDARD FEATURES

- ▶ Up to 93% Thermal Efficiency (AHRI)
- ▶ Up to 99% Thermal Efficiency in Low Temperature Applications
- ▶ Modulating Burner with up to 25:1 Turndown
- ▶ Direct-Spark Ignition
- ▶ Low-NOx Operation
- ▶ Sealed Combustion
- ▶ Low Gas Pressure Operation
- ▶ Vertical or Horizontal Venting
- ▶ Category IV Venting up to 100 Feet
- ▶ ASME "H" Stamped Heat Exchanger
- ▶ 316L Stainless Steel Fire Tubes
- ▶ 160 psi Working Pressure
- ▶ On/Off Switch
- ▶ Adjustable High Limit with Manual Reset
- ▶ Low Water Cutoff with Manual Reset & Test
- ▶ High & Low Gas Pressure Switches w/Manual Reset
- ▶ Low Air Pressure Switches
- ▶ Condensate Trap w/ Blocked Drain Switch
- ▶ Drain Valve
- ▶ System Sensor
- ▶ Outdoor Air Sensor
- ▶ Inlet & Outlet Temperature Sensors
- ▶ High Voltage Terminal Strip
- ▶ Low Voltage Terminal Strip
- ▶ Downstream Gas Test Cocks
- ▶ 50 psi ASME Relief Valve
- ▶ Temperature & Pressure Gauge
- ▶ Zero Clearances to Combustible Materials
- ▶ 10-Year Limited Warranty (See Warranty for Details)
- ▶ 1-Year Warranty on Parts (See Warranty for Details)

Registered Under U.S. Patent #8286594



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www.Lochinvar.com



ECM 8: Install High Efficiency Furnaces

ECM Overview

Ameresco proposes to replace the furnaces which serve the Activity Room and its surrounding offices at the Council on Aging – Hilton Center. The replacement furnaces will be premium efficiency. This measure will reduce energy costs by improved efficiency.

ECM Detail

Existing System

The Senior Center portion of the building is heated by two furnaces located in the attic above the Activity Room. These are 1980s style units manufactured by Williamson with an input of 160 MBH. Their burners are single stage and atmospheric draft. One of the furnaces serves the Activity Room; the other furnace serves the office and function room areas surrounding the Activity Room. The overall thermal efficiency of the furnaces is estimated to be 70%.

Direct expansion cooling coils are located downstream of each furnace. Condensate is pumped from a collection pan to a wastewater connection point in the attic.

The air distribution ductwork for the original furnaces is deteriorated and return duct branches are detached in a couple of instances. The trunk ductwork is metal and all takeoffs are flexible ductwork lying on the attic floor. Both ductwork systems lack balancing dampers for the supply; consequently, rooms further from the unit fail to provide the expected or sufficient air flow.

The original area is divided into two zones of heating and cooling. Each zone is controlled by a programmable thermostat (Aprilaire 8362). The units cycle on and off based on thermostat call and do not operate continuously.

Proposed System

Ameresco proposes to replace the furnaces which serve the Activity Room and surrounding offices at the Council on Aging – Hilton Center. The replacement furnaces will be premium efficiency. This measure will reduce energy costs by improved efficiency.



Figure 8.1: The existing furnaces at the Senior Center are standard efficiency and will be replaced in this measure

> Detailed Scope of Work

Remove the existing furnaces and replace with direct vent, condensing furnaces (2), Trane XT90 TUX1D120A9H51A, or equal). The proposed furnaces will have a minimum AFUE heating efficiency of 92.1%.

- Removals
 - Isolate NG feeds, close cocks and disconnect from units at union
 - Switch off electric feeds at CB
 - Disconnect and remove existing venting
 - Disconnect unit from discharge plenum
 - Disconnect unit from DX coil section
 - Disconnect controls- note thermostat wiring for reinstallation
 - Remove furnace, leaving DX coil, return plenum and condensate pump in place
- Furnish and install new furnaces (typical for two)
 - Furnish and install new unit, set in place
 - Furnish and install new transition supply and return ductwork
 - Connect to existing ¾" natural gas piping
 - Furnish and install new PVC vent and sealed combustion air through existing roof penetration; seal watertight
 - Furnish and install
 - Connect new unit to existing discharge plenum
 - Connect new unit to existing DX coil section
 - Furnish and install new condensate drain and drain to existing condensate transfer pump
 - Furnish and install new heating and cooling controller
 - Test fire unit
- Reattach all detached duct run-outs to its trunk and verify that air-flow to the run-out is restored.

Replacement of the existing ductwork is not included. Insulating existing ductwork is not included. Repair or replacement of attic hatch is not included. Replacement of existing coiling coil, drip pan, condensate pump or condensing unit is not included.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the Town 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

The furnaces will produce condensate which will be discharged to the wastewater system. Currently, heat losses to the attic maintain this space temperature well above freezing. Should modifications occur to drop the space temperature below freezing at any time, then the condensate removal system may require heat tracing.

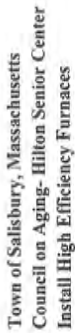
Appendix for ECM 8: Install High Efficiency Furnaces

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	8	
Measure Name:	Install High Efficiency Furnaces	
Measure Location:		
Engineers:		

Site Name:			COA	Summary
Item		Units	Savings	
Electricity				
Energy On-Peak		kWh		0
Energy Off-Peak		kWh		0
Energy Total		kWh	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	388	388
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



Assumptions:	Value	Unit	CELL	Description
Existing Heating Plant Efficiency	70.0%		R43	Baseline Furnace Efficiency
Proposed Heating Plant Efficiency	83.0%		R44	Proposed Furnace Efficiency
Percent Heating Load	66%		R45	% Served by Activity Room Furnaces

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Lawrence Municipal Airport, MA
I - L	Occupied hours as per the RFP data
M - P	Equipment operating hours after EMS is installed
Q	Interacted Occupied Heating loads (MBH)
R	Interacted Unoccupied Heating loads (MBH)
S	Heating = $-(\text{MIN}[(\text{col J}) - (\text{col K})], (\text{col M}) + (\text{col O}) \times \text{MIN}[(\text{col Q}) + (\text{internal gains})]) + \text{IF}[(\text{col I}) + (\text{col K})] > (\text{col M}) + (\text{col O}) \times ((\text{col I}) + (\text{col N}))$
T	Heating = $-(\text{col N}) + (\text{col J}) \times \text{MIN}[(\text{col R}) + (\text{internal gains})]) + \text{IF}[(\text{col I}) + (\text{col K})] < (\text{col M}) + (\text{col O}) \times ((\text{col I}) + (\text{col N})) + (\text{col M}) + (\text{col O}) \times ((\text{col I}) + (\text{col N}))$
U	Heating = $-(\text{MIN}[(\text{col I}) - (\text{col K})], (\text{col M}) + (\text{col O}) \times \text{MIN}[(\text{col Q}) + (\text{internal gains})]) + \text{IF}[(\text{col I}) + (\text{col K})] > (\text{col M}) + (\text{col O}) \times ((\text{col I}) + (\text{col N}))$
V	Heating = $-(\text{col N}) + (\text{col P}) \times \text{MIN}[(\text{col R}) + (\text{internal gains})]) + \text{IF}[(\text{col I}) + (\text{col K})] < (\text{col M}) + (\text{col O}) \times ((\text{col I}) + (\text{col N})) + (\text{col M}) + (\text{col O}) \times ((\text{col I}) + (\text{col N}))$
W	Heating = $-(\text{col N}) + (\text{col U}) - (\text{col V})$

Appendix for ECM 8: Install High Efficiency Furnaces

II. Manufacturer Specification Sheets

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TRANE®

Upflow/Horizontal Right or Upflow/Horizontal Left Condensing Gas Furnace

XT 90

TUX1B040A9H21B

TUX1B060A9H31B

TUX1B080A9H31B

TUX1C100A9H41B

TUX1D120A9H51B

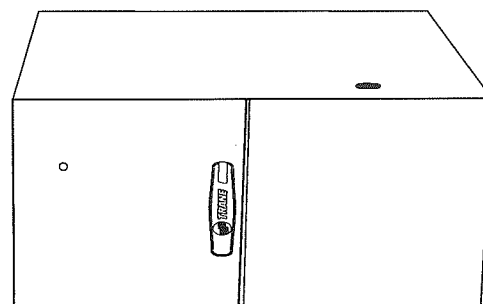
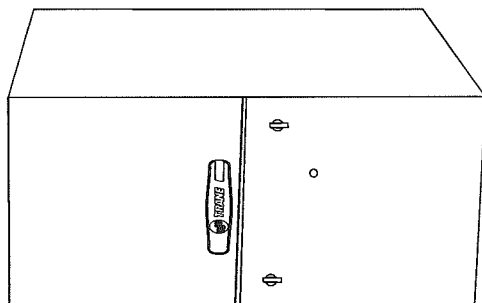
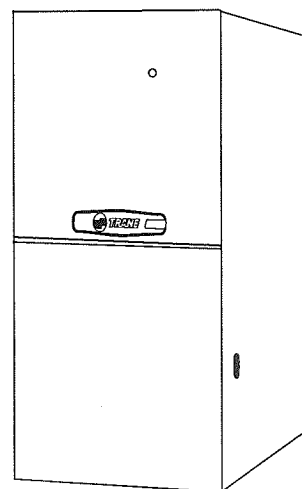
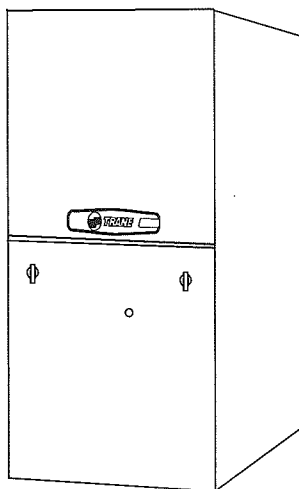
TDX1B040A9H21B

TDX1B060A9H31B

TDX1B080A9H31B

TDX1C100A9H41B

TDX1D120A9H51B





TRANE®

General Features

NATURAL GAS MODELS

Central Heating furnace designs are certified by the American and Canadian Gas Association for both natural and L.P. gas. Limit setting and rating data were established and approved under standard rating conditions using American National Standards Institute standards.

SAFE OPERATION

The Integrated System Control has solid state devices, which continuously monitor for presence of flame, when the system is in the heating mode of operation. Dual solenoid combination gas valve and regulator provide extra safety.

QUICK HEATING

Durable, cycle tested, heavy gauge **aluminized steel heat exchanger** quickly transfers heat to provide warm conditioned air to the structure. **Low energy power vent blower**, to increase efficiency and provide a positive discharge of gas fumes to the outside.

BURNERS

Multiport Inshot burners will give years of quiet and efficient service. All models can be converted to **L.P. gas** without changing burners.

INTEGRATED SYSTEM CONTROL

Exclusively designed operational program provides total control of furnace limit sensors, blowers, gas valve, flame control and includes self diagnostics for ease of service. Also contains connection points for E.A.C./humidifier.

AIR DELIVERY

The four speed, direct drive blower motor, has sufficient airflow for most heating and cooling requirements, will switch from heating to cooling speeds on demand from room thermostat. The blower door safety switch will prevent or terminate furnace operation when the blower door is removed.

STYLING

Heavy gauge steel and "wrap-around" cabinet construction is used in the cabinet with baked-on enamel finish for strength and beauty. The heat exchanger section of the cabinet is completely lined with foil faced fiberglass insulation. This results in quiet and efficient operation due to the excellent acoustical and insulating qualities of fiberglass. Built-in bottom pan and alternate bottom, left or right side return air connection provision.

FEATURES AND GENERAL OPERATION

The XT90 High Efficiency Gas Furnaces employ a Silicon Carbide Hot Surface Ignition system, which eliminates the waste of a constant burning pilot. The integrated system control lights the main burners upon a demand for heat from the room thermostat. Complete front service access.

- a. Low energy power venter
- b. Vent proving pressure switch.



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TUX1D120A9H51B	6
TDX1B040A9H21B	7
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TRANE®

Features and Benefits

XT 90 UPFLOW/HORIZONTAL RIGHT or LEFT STANDARD EQUIPMENT

- Convertible to horizontal with left or right airflow
- Power supply 115/1/60
- **Type 29-4C™** stainless steel secondary heat exchanger
- Silicon Nitride Hot surface igniter with adaptive heat up
- Integrated solid state control with self-diagnostics
- Single wire twinning
- Attractive color accents
- Hinged blower door
- Perfect Fit door latches
- Insulated blower door
- Gasketed blower door
- Internal filter rack
- Standard filter sizes
- Cleanable high velocity filters
- Heavy gauge aluminized steel heat exchanger
- Blower door safety switch
- Multi-port In-shot burners
- Complete front service access
- Alternate bottom/left/right return air
- Slide out blower assembly
- Constant torque ECM blower motor
- Adjustable fan off times
- Common vent capability
- Heavy gauge reinforced wrap-around steel cabinet
- Optional L.P. conversion kit
- Left/right gas connection
- Accessory hook-up capability
- Selectable cooling fan off eliminates need for BAY24X045 time delay relay
- 24 volt fuse
- Manual reset flame roll-out switches

XT90 Optional Equipment

OPTIONAL EQUIPMENT FOR CONDENSING UNITS (Check mark [✓] indicates accessories included).

For Comfort Controls, See price book pages	[]
CleanEffects™ Whole House Air Cleaner (14-1/2" Wide, Upflow / Side Return Furnace)	TFD145ALFR000A []
CleanEffects™ Whole House Air Cleaner (17-1/2" Wide, Upflow / Side Return Furnace)	TFD175ALFR000A []
CleanEffects™ Whole House Air Cleaner (21" Wide, Upflow / Side Return Furnace)	TFD210ALFR000A []
CleanEffects™ Whole House Air Cleaner (24-1/2" Wide, Upflow / Side Return Furnace)	TFD245ALFR000A []
CleanEffects™ Whole House Air Cleaner (14-1/2" Wide, Downflow Furnace)	TFD14DALFR000A []
CleanEffects™ Whole House Air Cleaner (17-1/2" Wide, Downflow Furnace)	TFD17DALFR000A []
CleanEffects™ Whole House Air Cleaner (21" Wide, Downflow Furnace)	TFD21DALFR000A []
CleanEffects™ Whole House Air Cleaner (24-1/2" Wide, Downflow Furnace)	TFD24DALFR000A []
Air Filter, "Perfect Fit" High Efficiency (14-1/2" Wide Gas Furnace)	TFM145A9FR0 []
Air Filter, "Perfect Fit" High Efficiency (17-1/2" Wide Gas Furnace)	TFM175A9FR0 []
Air Filter, "Perfect Fit" High Efficiency (21" Wide Gas Furnace)	TFM210A9FR0 []
Air Filter, "Perfect Fit" High Efficiency (24-1/2" Wide Gas Furnace)	TFM245A9FR0 []
Air Filter, "Perfect Fit" Standard Efficiency (14-1/2" Wide Gas Furnace)	TFP145A9FR0 []
Air Filter, "Perfect Fit" Standard Efficiency (17-1/2" Wide Gas Furnace)	TFP175A9FR0 []
Air Filter, "Perfect Fit" Standard Efficiency (21" Wide Gas Furnace)	TFP210A9FR0 []
Air Filter, "Perfect Fit" Standard Efficiency (24-1/2" Wide Gas Furnace)	TFP245A9FR0 []
Coil Enclosure (14-1/2" Wide Cabinets)	BAYCLE14A1422A []
Coil Enclosure (17-1/2" Wide Cabinets)	BAYCLE17A1722A []
Coil Enclosure (21" Wide Cabinets)	BAYCLE21A2130A []
Coil Enclosure (24-1/2" Wide Cabinets)	BAYCLE24A2430A []
High Altitude Switch	BAYHALT248 []
Downflow Subbase	BAYBASE205 []
Propane Conversion Kit	BAYLPKT210B []
Propane Conversion Kit (With Stainless Steel burners)	BAYLPSS210B []
Masonry Chimney Vent Kit	BAYVENT800B []
Filter Access Door Kit (Downflow models)	BAYFLTR206 []

**TRANE®**

General Data

PRODUCT SPECIFICATIONS ①

MODEL	TUX1B040A9H21B	TUX1B060A9H31B	TUX1B080A9H31B
TYPE	Upflow / Horizontal	Upflow / Horizontal	Upflow / Horizontal
RATINGS ②			
Input BTUH	40,000	60,000	80,000
Capacity BTUH (ICS) ③	38,000	56,000	74,000
AFUE	92.1	92.1	92.1
Temp. rise (Min.-Max.) °F.	30 - 60	30 - 60	35 - 65
BLOWER DRIVE			
Diameter - Width (In.)	10 x 7	10 x 7	10 x 8
No. Used	1	1	1
Speeds (No.)	4	4	4
CFM vs. in. w.g.	See Fan Performance Table	See Fan Performance Table	See Fan Performance Table
Motor HP ⑤	1/2	1/2	1/2
R.P.M.	1075	1075	1075
Volts / Ph / Hz	115/1/60	115/1/60	115/1/60
COMBUSTION FAN - Type			
Drive - No. Speeds	Centrifugal Direct - 1	Centrifugal Direct - 1	Centrifugal Direct - 1
Motor HP - RPM	1/55 - 3000	1/55 - 3000	1/24 - 3200
Volts / Ph / Hz	115/1/60	115/1/60	115/1/60
FLA	1.0	1.0	1.35
FILTER — Furnished?			
Type Recommended	Yes	Yes	Yes
Hi Vel. (No.-Size-Thk.)	High Velocity 1 - 17x25 - 1in.	High Velocity 1 - 17x25 - 1in.	High Velocity 1 - 17x25 - 1in.
VENT PIPE DIAMETER— Min (in.)⑥⑦	2 Round	2 Round	2 Round
HEAT EXCHANGER			
Type-Fired	Aluminized Steel	Aluminized Steel	Aluminized Steel
-Unfired			
Gauge (Fired)	20	20	20
ORIFICES — Main			
Nat. Gas. Qty. — Drill Size	2 — 45	3 — 45	4 — 45
L.P. Gas Qty. — Drill Size	2 — 56	3 — 56	4 — 56
GAS VALVE	Redundant - Single Stage	Redundant - Single Stage	Redundant - Single Stage
PILOT SAFETY DEVICE			
Type	Hot Surface Ignition	Hot Surface Ignition	Hot Surface Ignition
BURNERS — Type			
Number	Multiport Inshot 2	Multiport Inshot 3	Multiport Inshot 4
POWER CONN. — V / Ph / Hz ④	115/1/60	115/1/60	115/1/60
Ampacity (In Amps)	9.7	9.7	10.0
Max Overcurrent Protection (Amps)	15	15	15
PIPE CONN. SIZE (IN.)	1/2	1/2	1/2
DIMENSIONS			
Crated (In.)	H x W x D 41-3/4 x 19-1/2 x 30-1/2	H x W x D 41-3/4 x 19-1/2 x 30-1/2	H x W x D 41-3/4 x 19-1/2 x 30-1/2
WEIGHT			
Shipping (Lbs.) / Net (Lbs)	139 / 129	150 / 140	158 / 148

① Central Furnace heating designs are certified by AGA and CSA.

② For U.S. applications, above input ratings (BTUH) are up to 2,000 feet, derate 4% per 1,000 feet for elevations above 2,000 feet above sea level.

For Canadian applications, above input ratings (BTUH) are up to 4,500 feet, derate 4% per 1,000 feet for elevations above 4,500 feet above sea level.

③ Based on U.S. government standard tests.

④ The above wiring specifications are in accordance with National Electrical Code; however, installations must comply with local codes.

⑤ Constant torque ECM blower motor.

⑥ Refer to the Vent Length Table in the Installer's Guide or the Allowable Vent Length label on the furnace.

⑦ All "UX1 and "DX1 furnace models have a vent outlet diameter that equals 2".

**TRANE®**

General Data

PRODUCT SPECIFICATIONS ①

MODEL	TUX1C100A9H41B	TUX1D120A9H51B
TYPE	Upflow / Horizontal	Upflow / Horizontal
RATINGS ②		
Input BTUH	100,000	120,000
Capacity BTUH (ICS) ③	93,000	112,000
AFUE	92.1	92.1
Temp. rise (Min.-Max.) °F.	35 - 65	40 - 70
BLOWER DRIVE	DIRECT	DIRECT
Diameter - Width (In.)	11 x 10	11 x 10
No. Used	1	1
Speeds (No.)	4	4
CFM vs. in. w.g.	See Fan Performance Table	See Fan Performance Table
Motor HP ⑤	3/4	1
R.P.M.	1100	1100
Volts / Ph / Hz	115/1/60	115/1/60
COMBUSTION FAN - Type	Centrifugal	Centrifugal
Drive - No. Speeds	Direct - 1	Direct - 1
Motor HP - RPM	1/20- 3450	1/20- 3450
Volts / Ph / Hz	115/1/60	115/1/60
FLA	.71	.71
FILTER — Furnished?	Yes	Yes
Type Recommended	High Velocity	High Velocity
Hi Vel. (No.-Size-Thk.)	1 - 20x25 - 1in.	1 - 24x25 - 1in.
VENT PIPE DIAMETER— Min (in.)⑥⑦	2.5 Round	2.5 Round
HEAT EXCHANGER		
Type-Fired	Aluminized Steel	Aluminized Steel
-Unfired		
Gauge (Fired)	20	20
ORIFICES — Main		
Nat. Gas. Qty. — Drill Size	5 — 45	6 — 45
L.P. Gas Qty. — Drill Size	5 — 56	6 — 56
GAS VALVE	Redundant - Single Stage	Redundant - Single Stage
PILOT SAFETY DEVICE		
Type	Hot Surface Ignition	Hot Surface Ignition
BURNERS — Type	Multiport Inshot	Multiport Inshot
Number	5	6
POWER CONN. — V / Ph / Hz ④	115/1/60	115/1/60
Ampacity (In Amps)	12.4	14.5
Max Overcurrent Protection (Amps)	20	20
PIPE CONN. SIZE (IN.)	1/2	1/2
DIMENSIONS	H x W x D	H x W x D
Crated (In.)	41-3/4 x 23 x 30-1/2	41-3/4 x 26-1/2 x 30-1/2
WEIGHT		
Shipping (Lbs.) / Net (Lbs)	171 / 162	205 / 193

① Central Furnace heating designs are certified by AGA and CSA.

② For U.S. applications, above input ratings (BTUH) are up to 2,000 feet, derate 4% per 1,000 feet for elevations above 2,000 feet above sea level.
For Canadian applications, above input ratings (BTUH) are up to 4,500 feet, derate 4% per 1,000 feet for elevations above 4,500 feet above sea level.

③ Based on U.S. government standard tests.

④ The above wiring specifications are in accordance with National Electrical Code; however, installations must comply with local codes.

⑤ Constant torque ECM blower motor.

⑥ Refer to the Vent Length Table in the Installer's Guide or the Allowable Vent Length label on the furnace.

⑦ All *UX1 and *DX1 furnace models have a vent outlet diameter that equals 2".

**TRANE®**

General Data

PRODUCT SPECIFICATIONS ①

MODEL	TDX1B040A9H21B	TDX1B060A9H31B	TDX1B080A9H31B
TYPE	Downflow / Horizontal	Downflow / Horizontal	Downflow / Horizontal
RATINGS ②			
Input BTUH	40,000	60,000	80,000
Capacity BTUH (ICS) ③	38,000	56,000	74,000
AFUE	91.0	91.0	91.0
Temp. rise (Min.-Max.) °F.	30 - 60	30 - 60	35 - 65
BLOWER DRIVE			
Drive	DIRECT	DIRECT	DIRECT
Diameter - Width (In.)	10 x 7	10 x 8	10 x 8
No. Used	1	1	1
Speeds (No.)	4	4	4
CFM vs. in. w.g.	See Fan Performance Table	See Fan Performance Table	See Fan Performance Table
Motor HP ⑤	1/2	1/2	3/4
R.P.M.	1080	1075	1075
Volts / Ph / Hz	115/1/60	115/1/60	115/1/60
COMBUSTION FAN - Type			
Drive - No. Speeds	Centrifugal Direct - 1	Centrifugal Direct - 1	Centrifugal Direct - 1
Motor HP - RPM	1/55- 3000	1/55- 3000	1/25- 3200
Volts / Ph / Hz	115/1/60	115/1/60	115/1/60
FLA	1.14	1.0	1.35
FILTER — Furnished?			
Type Recommended	Yes	Yes	Yes
Hi Vel. (No.-Size-Thk.)	High Velocity 1 - 14x20 - 1in.	High Velocity 2 - 14x20 - 1in.	High Velocity 2 - 14x20 - 1in.
VENT PIPE DIAMETER— Min (in.)⑥⑦			
	2 Round	2 Round	2 Round
HEAT EXCHANGER			
Type-Fired	Aluminized Steel	Aluminized Steel	Aluminized Steel
-Unfired			
Gauge (Fired)	20	20	20
ORIFICES — Main			
Nat. Gas. Qty. — Drill Size	2 — 45	3 — 45	4 — 45
L.P. Gas Qty. — Drill Size	2 — 56	3 — 56	4 — 56
GAS VALVE			
	Redundant - Single Stage	Redundant - Single Stage	Redundant - Single Stage
PILOT SAFETY DEVICE			
Type	Hot Surface Ignition	Hot Surface Ignition	Hot Surface Ignition
BURNERS — Type			
Number	Multiport Inshot 2	Multiport Inshot 3	Multiport Inshot 4
POWER CONN. — V / Ph / Hz ④			
	115/1/60	115/1/60	115/1/60
Ampacity (In Amps)	9.7	9.7	12.4
Max Overcurrent Protection (Amps)	15	15	15
PIPE CONN. SIZE (IN.)			
	1/2	1/2	1/2
DIMENSIONS			
	H x W x D	H x W x D	H x W x D
Crated (In.)	41-3/4 x 19-1/2 x 30-1/2	41-3/4 x 19-1/2 x 30-1/2	41-3/4 x 19-1/2 x 30-1/2
WEIGHT			
Shipping (Lbs.) / Net (Lbs)	145 / 135	155 / 145	168 / 158

① Central Furnace heating designs are certified by AGA and CSA.

② For U.S. applications, above input ratings (BTUH) are up to 2,000 feet, derate 4% per 1,000 feet for elevations above 2,000 feet above sea level.

For Canadian applications, above input ratings (BTUH) are up to 4,500 feet, derate 4% per 1,000 feet for elevations above 4,500 feet above sea level.

③ Based on U.S. government standard tests.

④ The above wiring specifications are in accordance with National Electrical Code; however, installations must comply with local codes.

⑤ Constant torque ECM blower motor.

⑥ Refer to the Vent Length Table in the Installer's Guide or the Allowable Vent Length label on the furnace.

⑦ All *UX1 and *DX1 furnace models have a vent outlet diameter that equals 2".

**TRANE®**

General Data

PRODUCT SPECIFICATIONS ①

MODEL	TDX1C100A9H41B	TDX1D120A9H51B
TYPE	Downflow / Horizontal	Downflow / Horizontal
RATINGS ②		
Input BTUH	100,000	120,000
Capacity BTUH (ICS) ③	94,000	110,000
AFUE	91.0	91.0
Temp. rise (Min.-Max.) °F.	35 - 65	40 - 70
BLOWER DRIVE	DIRECT	DIRECT
Diameter - Width (In.)	11 x 10	11 x 10
No. Used	1	1
Speeds (No.)	4	4
CFM vs. in. w.g.	See Fan Performance Table	See Fan Performance Table
Motor HP ⑤	3/4	1
R.P.M.	1075	1075
Volts / Ph / Hz	115/1/60	115/1/60
COMBUSTION FAN - Type	Centrifugal	Centrifugal
Drive - No. Speeds	Direct - 1	Direct - 1
Motor HP - RPM	1/20- 3450	1/20- 3450
Volts / Ph / Hz	115/1/60	115/1/60
FLA	.71	.71
FILTER — Furnished?	Yes	Yes
Type Recommended	High Velocity	High Velocity
Hi Vel. (No.-Size-Thk.)	2 - 16x20 - 1in.	2 - 16x20 - 1in.
VENT PIPE DIAMETER— Min (in.)⑥⑦	2.5 Round	2.5 Round
HEAT EXCHANGER		
Type-Fired	Aluminized Steel	Aluminized Steel
-Unfired		
Gauge (Fired)	20	20
ORIFICES — Main		
Nat. Gas. Qty. — Drill Size	5 — 45	6 — 45
L.P. Gas Qty. — Drill Size	5 — 56	6 — 56
GAS VALVE	Redundant - Single Stage	Redundant - Single Stage
PILOT SAFETY DEVICE		
Type	Hot Surface Ignition	Hot Surface Ignition
BURNERS — Type	Multiport Inshot	Multiport Inshot
Number	5	6
POWER CONN. — V / Ph / Hz ④	115/1/60	115/1/60
Ampacity (In Amps)	12.4	15.5
Max Overcurrent Protection (Amps)	20	20
PIPE CONN. SIZE (IN.)	1/2	1/2
DIMENSIONS	H x W x D	H x W x D
Crated (In.)	41-3/4 x 23 x 30-1/2	41-3/4 x 26-1/2 x 30-1/2
WEIGHT		
Shipping (Lbs.) / Net (Lbs)	185 / 175	206 / 196

① Central Furnace heating designs are certified by AGA and CSA.

② For U.S. applications, above input ratings (BTUH) are up to 2,000 feet, derate 4% per 1,000 feet for elevations above 2,000 feet above sea level.

For Canadian applicaitons, above input ratings (BTUH) are up to 4,500 feet, derate 4% per 1,000 feet for elevations above 4,500 feet above sea level.

③ Based on U.S. government standard tests.

④ The above wiring specifications are in accordance with National Electrical Code; however, installations must comply with local codes.

⑤ Constant torque ECM blower motor.

⑥ Refer to the Vent Length Table in the Installer's Guide or the Allowable Vent Length label on the furnace.

⑦ All *UX1 and *DX1 furnace models have a vent outlet diameter that equals 2".

**TRANE®**

Performance Data

FURNACE AIRFLOW (CFM) VS. STATIC PRESSURE (ins.w.g.)										
MODEL	SPEED TAP	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
*UX1B040A9H21B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	1159 938 844 772	1131 910 814 732	1102 881 783 691	1077 851 750 656	1052 820 717 621	1022 786 681 581	992 751 645 540	961 717 604 497	930 662 563 454
*UX1B060A9H31B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	1358 1196 1025 863	1327 1166 1000 830	1296 1135 975 797	1272- 1109 943 762	1248 1082 910 726	1215 1053 878 687	1182 1023 845 648	1122 989 813 601	1061 955 780 554
*UX1B080A9H31B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	1436 1334 1239 1160	1404 1308 1209 1131	1371 1281 1179 1101	1346 1250 1149 1070	1320 1219 1119 1039	1289 1193 1090 1007	1257 1167 1060 974	1214 1132 1030 940	1170 1097 999 905
*UX1C100A9H41B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	1888 1751 1530 1245	1852 1715 1491 1204	1815 1679 1452 1162	1776 1643 1415 1115	1737 1606 1378 1067	1698 1571 1336 1023	1659 1536 1293 979	1626 1493 1253 931	1593 1450 1212 882
*UX1D120A9H51B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	2153 1895 1777 1618	2121 1856 1743 1579	2089 1817 1708 1540	2056 1779 1673 1504	2023 1741 1637 1467	1983 1708 1601 1430	1943 1674 1564 1393	1907 1634 1524 1354	1870 1593 1484 1315
*DX1B040A9H21B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	1156 935 835 752	1128 859 803 726	1100 859 771 700	1072 828 736 648	1043 797 701 596	1012 757 652 554	981 717 602 511	917 679 569 471	852 641 536 431
*DX1B060A9H31B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	1337 1159 967 863	1314 1127 930 823	1291 1094 893 782	1257 1065 856 742	1223 1036 818 702	1187 997 774 657	1150 957 729 611	1090 920 690 571	1030 883 651 531
*DX1B080A9H31B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	1614 1322 1098 970	1585 1295 1067 934	1555 1267 1036 898	1489 1239 1003 868	1423 1211 970 837	1363 1180 933 794	1303 1149 896 750	1202 1111 864 712	1101 1072 831 674
*DX1C100A9H41B NOTE: Do NOT use the LOW speed tap for heating	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	1844 1748 1429 1203	1808 1716 1392 1134	1771 1683 1354 1124	1736 1648 1312 1077	1700 1612 1269 1029	1669 1574 1235 983	1638 1535 1200 937	1590 1497 1154 887	1542 1459 1108 837
*DX1D120A9H51B	4 - HIGH - Black 3 - MED-HIGH - Blue 2 - MED-LOW - Yellow 1 - LOW - Red	2162 1928 1782 1552	2127 1888 1743 1520	2091 1848 1703 1488	2049 1811 1665 1450	2006 1774 1626 1412	1964 1736 1582 1370	1922 1698 1537 1328	1849 1653 1500 1295	1775 1607 1462 1261

* May be "A" or "T"



TRANE®

Performance Data

CFM VS. TEMPERATURE RISE																		
MODEL	CFM (CUBIC FEET PER MINUTE)																	
	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100
*UX1B040A9H21B			56	48	42	37	33	30										
*UX1B060A9H31B					63	56	50	45	42	38	36	33	31	29				
*UX1B080A9H31B							67	61	56	51	48	44	42	39	37	35		
*UX1C100A9H41B										64	60	56	52	49	46	44	42	40
*UX1D120A9H51B											71	67	63	59	56	53	50	48

* May be "A" or "T"

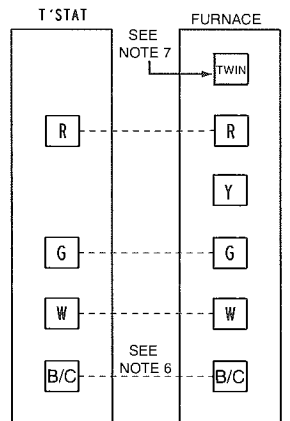
CFM VS. TEMPERATURE RISE																		
MODEL	CFM (CUBIC FEET PER MINUTE)																	
	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100
*DX1B040A9H21B			56	48	42	37	33	30										
*DX1B060A9H31B					63	56	50	45	42	38	36	33	31	29				
*DX1B080A9H31B							67	61	56	51	48	44	42	39	37	35		
*DX1C100A9H41B										64	60	56	52	49	46	44	42	40
*DX1D120A9H51B											71	67	63	59	56	53	50	48

* May be "A" or "T"

**TRANE®**

Field Wiring

FIELD WIRING DIAGRAM FOR 1 STAGE FURNACE 1 STAGE HEATING USING A 1 STAGE HEATING THERMOSTAT NO COOLING

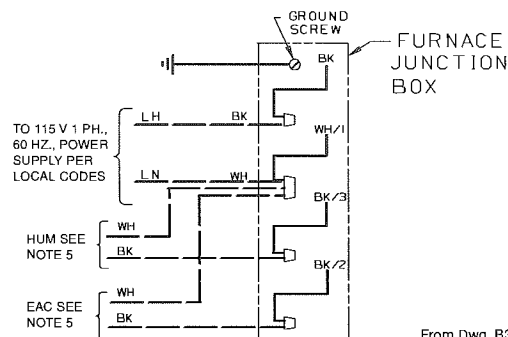


INTER-COMPONENT WIRING

----- 24 V. LINE V. } FIELD WIRING
 ----- 24 V. LINE V. } FACTORY WIRING

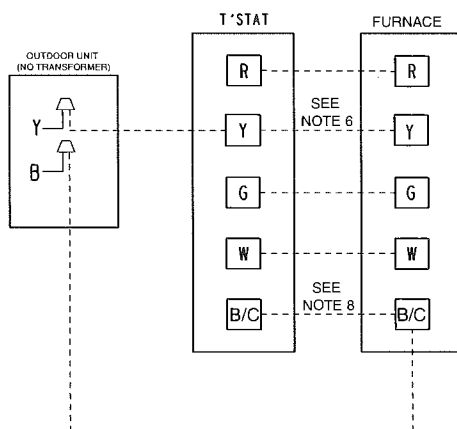
NOTES:

1. BE SURE POWER AGREES WITH EQUIPMENT NAMEPLATE(S).
2. LOW VOLTAGE (24V. WIRING) TO BE NO. 18 A.W.G. MIN.
3. GROUNDING OF EQUIPMENT MUST COMPLY WITH LOCAL CODES.
4. SET THERMOSTAT HEAT ANTICIPATOR PER UNIT WIRING DIAGRAM.
5. THESE LEADS PROVIDE 115 V. POWER FOR CONNECTION OF ELECTRONIC AIR CLEANER AND HUMIDIFIER MAX. LOAD 1.0 AMPS EACH.
6. THIS CONNECTION IS ONLY USED FOR THERMOSTATS REQUIRING CONNECTION TO THE 24 V. POWER SUPPLY. (COMMON)
7. SEE TWINNING CONNECTION DIAGRAMS FOR PROPER CONNECTIONS WHEN USING THIS FEATURE.



From Dwg. B341437 Rev. 1

FIELD WIRING DIAGRAM FOR 1 STAGE FURNACE 1 STAGE HEATING, 1 STAGE COOLING USING A 1 STAGE HEATING, 1 STAGE COOLING THERMOSTAT (OUTDOOR SECTION WITHOUT TRANSFORMER)

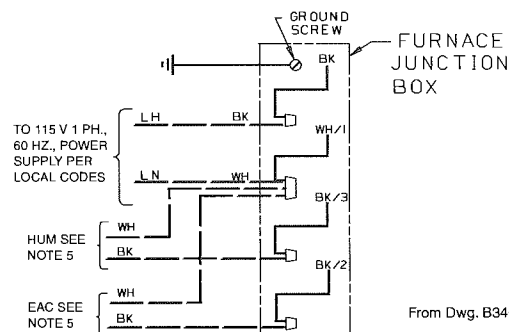


INTER-COMPONENT WIRING

----- 24 V. LINE V. } FIELD WIRING
 ----- 24 V. LINE V. } FACTORY WIRING

NOTES:

1. BE SURE POWER AGREES WITH EQUIPMENT NAMEPLATE(S).
2. LOW VOLTAGE (24 V. WIRING) TO BE NO. 18 A.W.G. MIN.
3. GROUNDING OF EQUIPMENT MUST COMPLY WITH LOCAL CODES.
4. SET THERMOSTAT HEAT ANTICIPATOR PER UNIT WIRING DIAGRAM.
5. THESE LEADS PROVIDE 115 V. POWER FOR CONNECTION OF ELECTRONIC AIR CLEANER AND HUMIDIFIER MAX. LOAD 1.0 AMPS EACH.
6. THE "Y" TERMINAL FROM THE THERMOSTAT MUST BE WIRED TO THE "Y" TERMINAL OF THE FURNACE CONTROL FOR PROPER BLOWER OPERATION DURING COOLING.
7. IGNITION CONTROL IS POLARITY SENSITIVE. HOT LEG OF 120 VOLT POWER SUPPLY MUST BE CONNECTED TO THE BLACK LINE POWER LEAD AS INDICATED ON THE WIRING DIAGRAM OR IGNITION LOCKOUT WILL OCCUR.
8. THIS CONNECTION IS ONLY USED FOR THERMOSTATS REQUIRING CONNECTION TO THE 24 V. POWER SUPPLY. (COMMON)

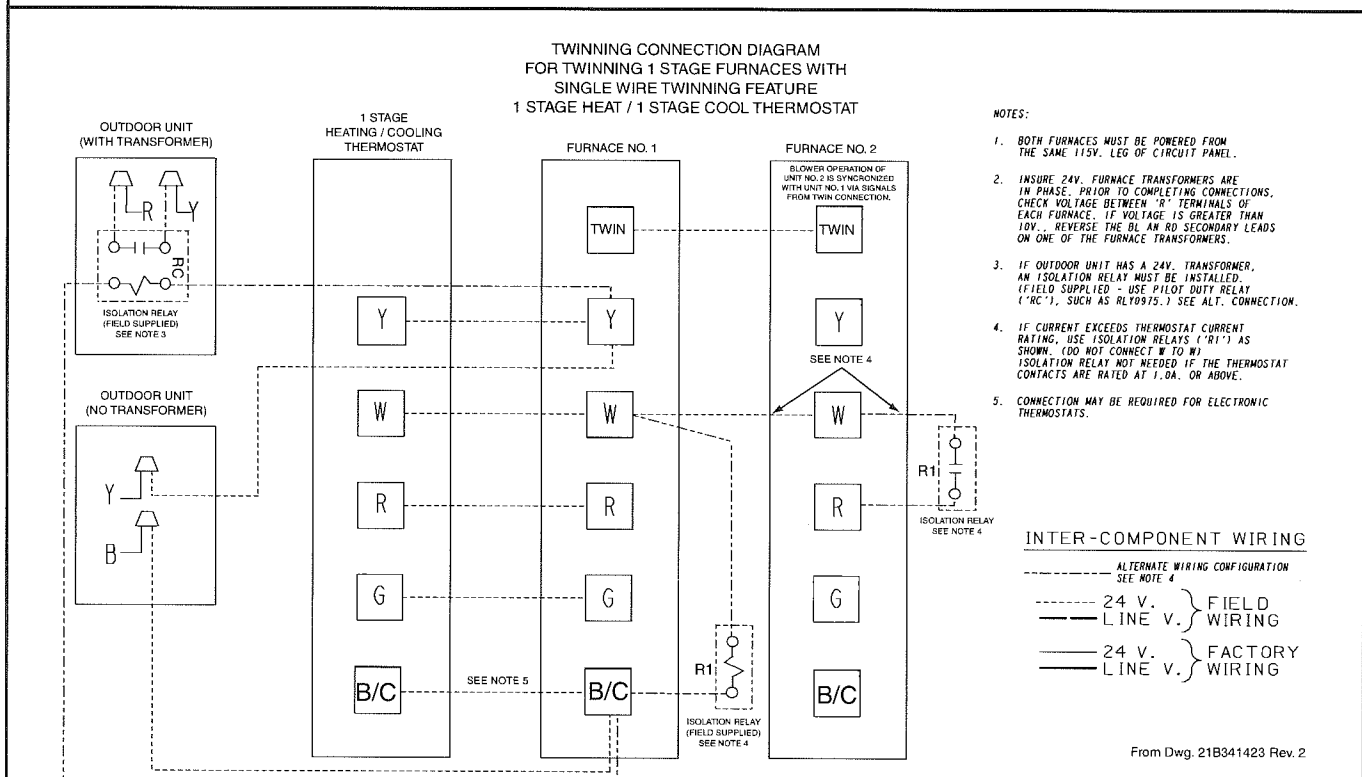
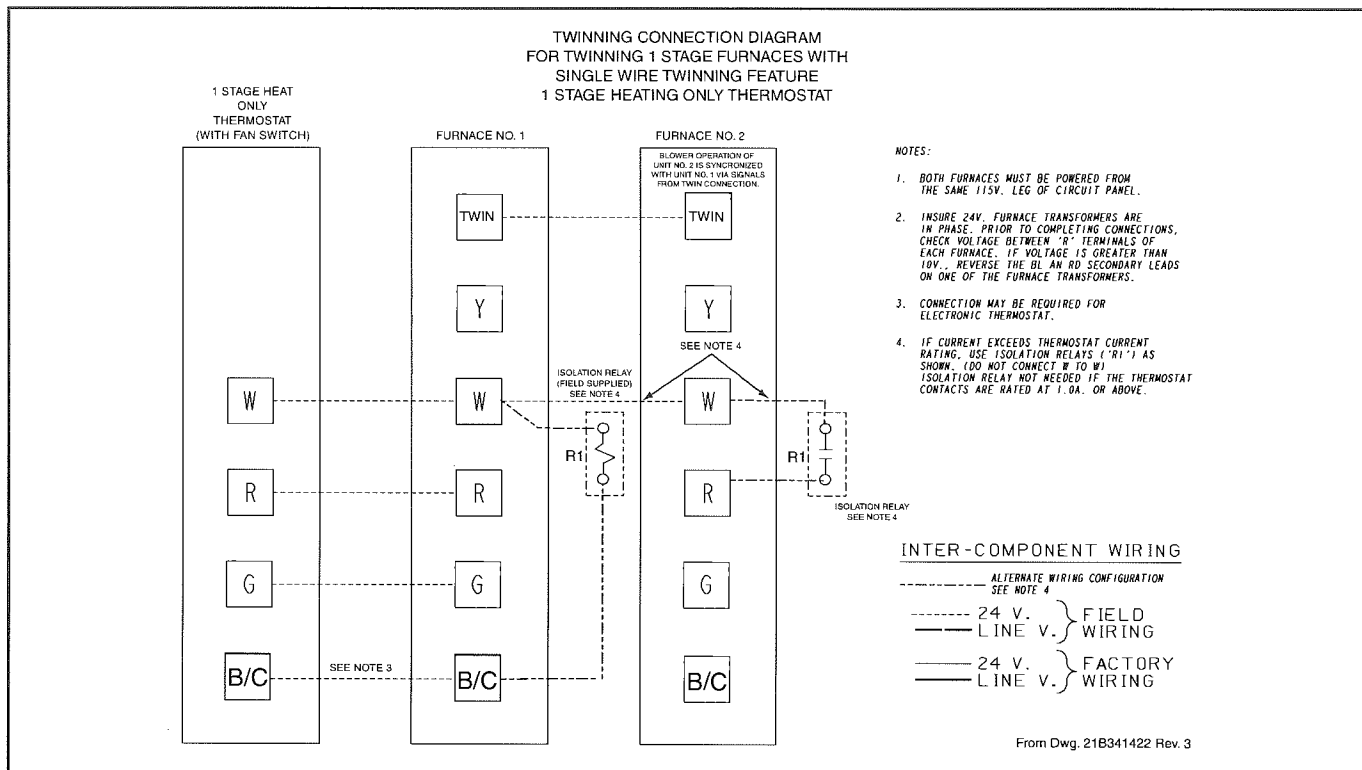


From Dwg. B340388 Rev. 2



TRANE®

Twinning



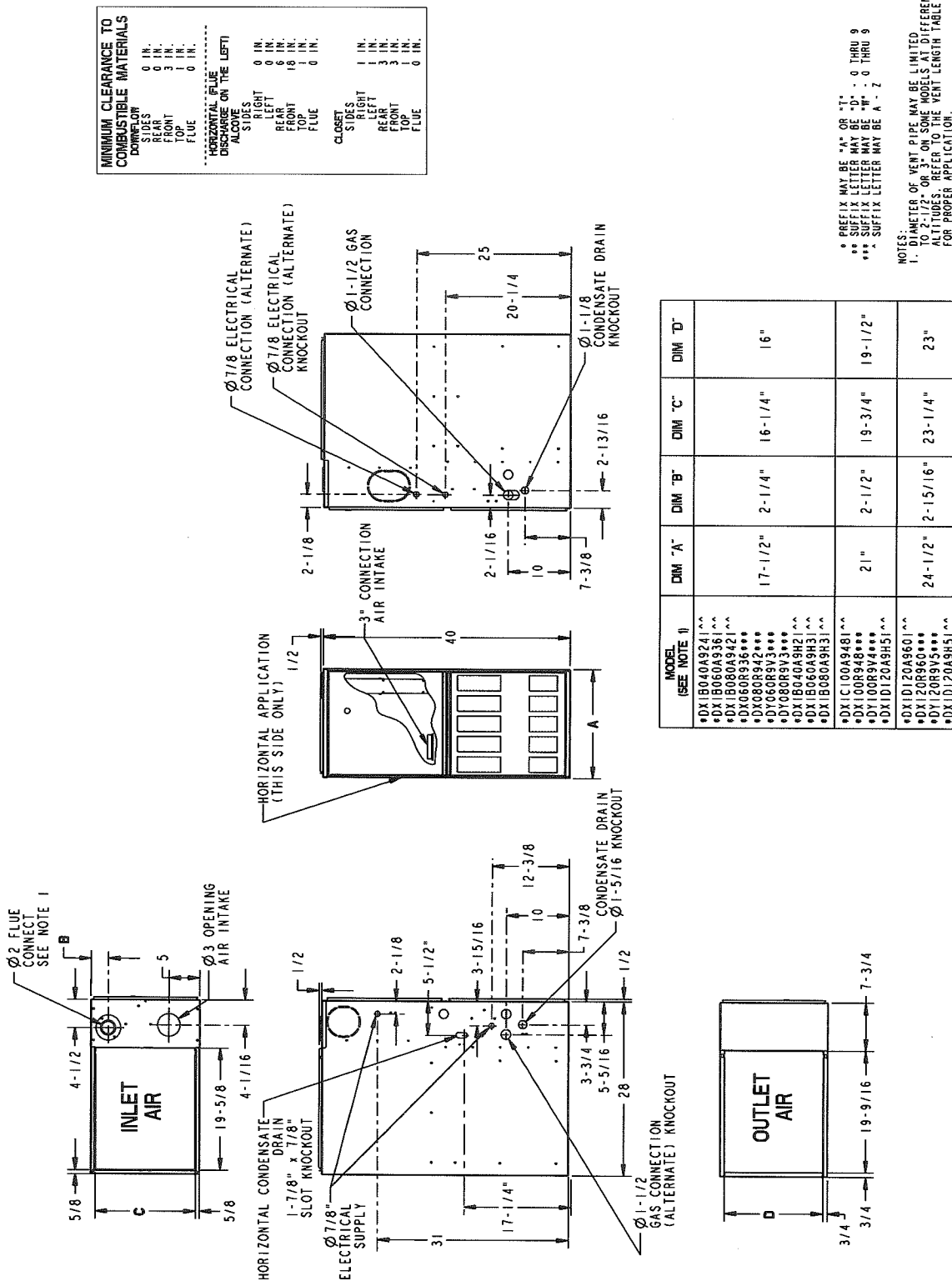




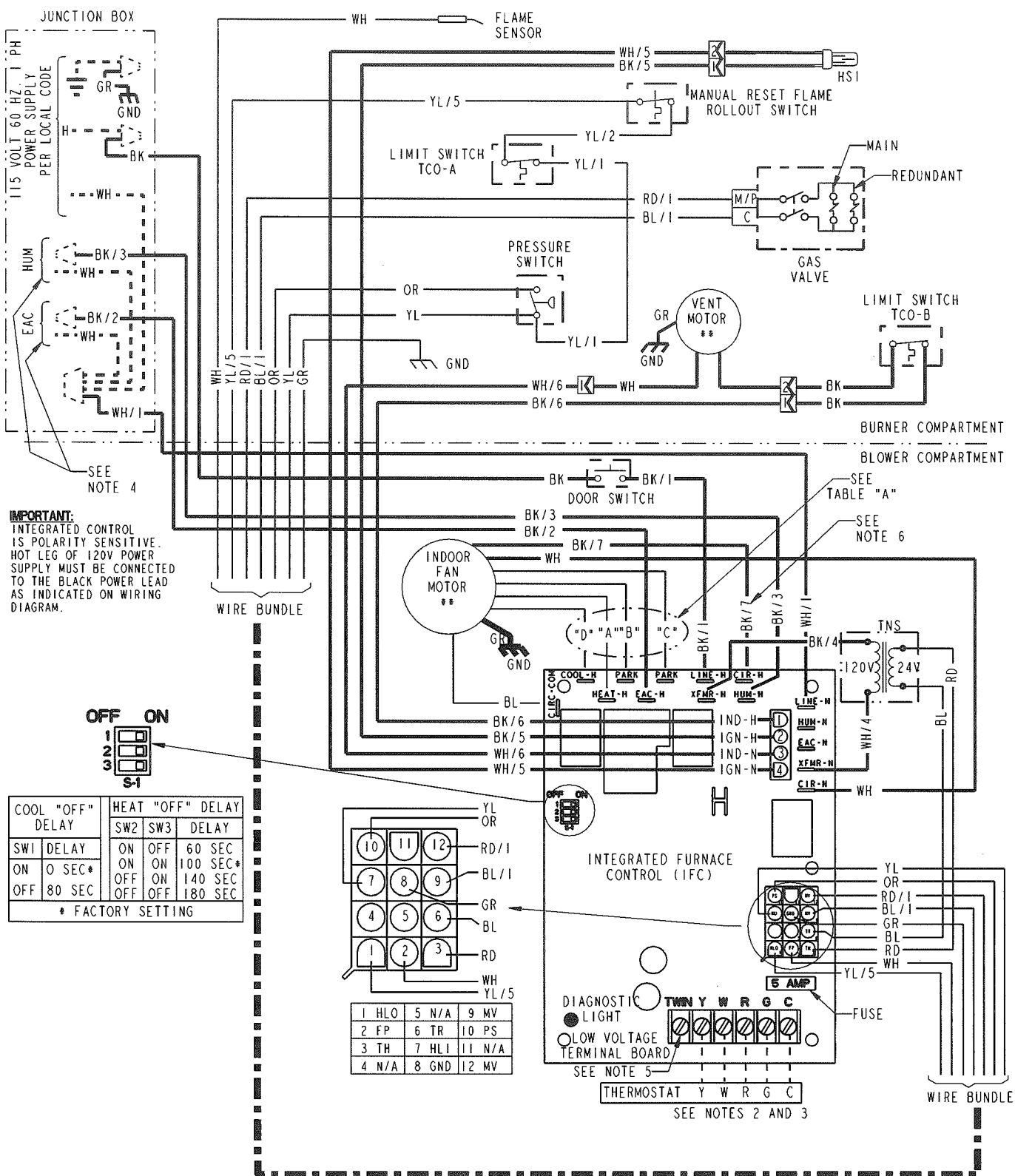
TRANE®

Dimensions

TDX1-H OUTLINE DRAWING (ALL DIMENSIONS ARE IN INCHES)



TUX1-H Wiring Diagram For Gas Furnaces



TUX1-H Schematic Diagram For Gas Furnaces

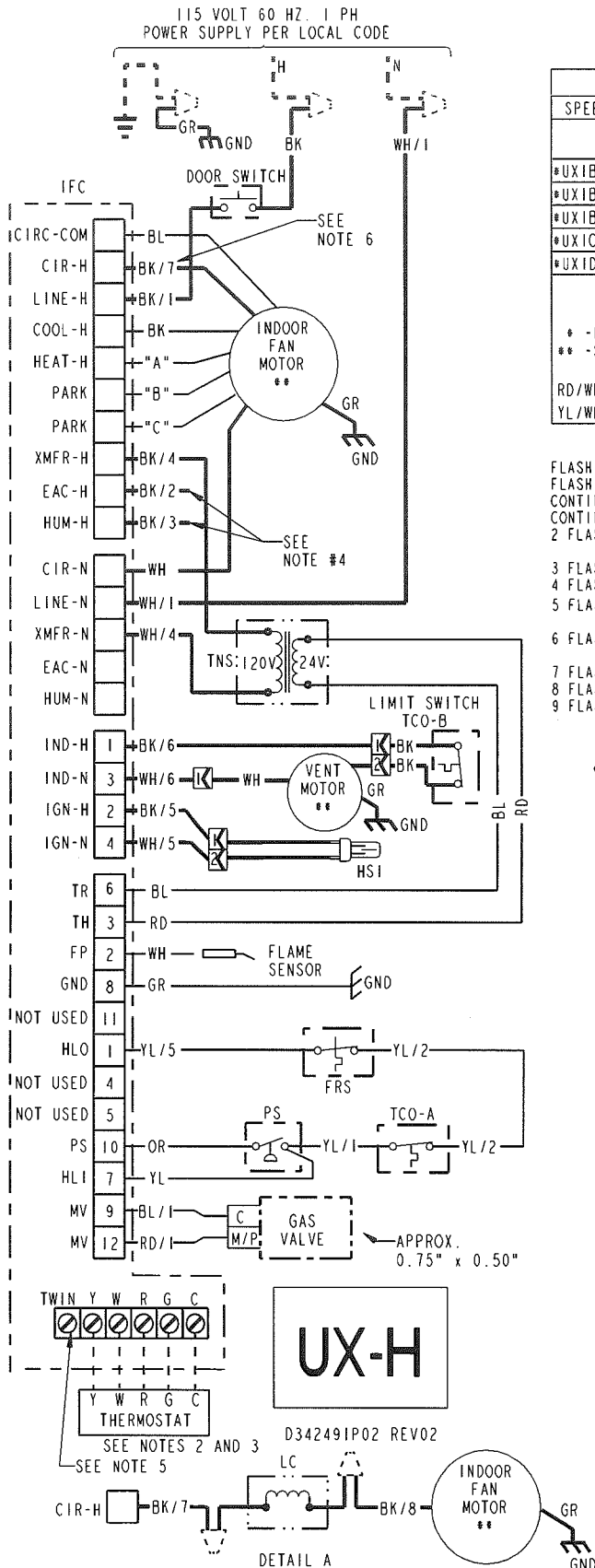


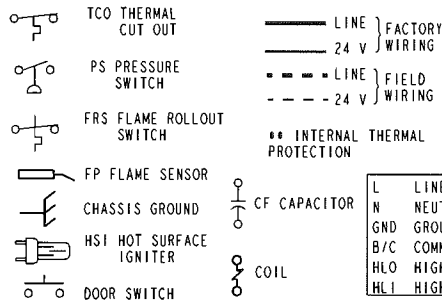
TABLE "A"				
SPEED TAPS FOR I.D. FAN MOTOR				
MODEL	HEAT "A"	PARK "B"	PARK "C"	COOL "D"
*UX1B040A9H21B**	RD/WH	BK/WH	YL/WH	BL/WH
*UX1B060A9H31B**	BL/WH	YL/WH	RD/WH	BK/WH
*UX1B080A9H31B**	BL/WH	YL/WH	RD/WH	BK/WH
*UX1C100A9H41B**	BL/WH	YL/WH	RD/WH	BK/WH
*UX1D120A9H51B**	BL/WH	YL/WH	RD/WH	BK/WH

* -PREFIX MAY BE "A" OR "T"
** -SUFFIX MAY BE "A" THROUGH "Z"

RD/WH= LOW=1 BL/WH= MED. HIGH=3
YL/WH= MED. LOW=2 BK/WH= HIGH=4

DIAGNOSTIC CODES

FLASHING SLOW: NORMAL - NO CALL FOR HEAT
FLASHING FAST: NORMAL - CALL FOR HEAT
CONTINUOUS ON: REPLACE IFC
CONTINUOUS OFF: CHECK POWER
2 FLASHES: EXTERNAL LOCKOUT (RETRIES OR RECYCLES EXCEEDED)
3 FLASHES: PRESSURE SWITCH ERROR
4 FLASHES: OPEN LIMIT DEVICE
5 FLASHES: FLAME SENSE WHEN NO FLAME SHOULD BE PRESENT
6 FLASHES: 115 VAC POWER REVERSED POLARITY OR POOR GROUNDING
7 FLASHES: GAS VALVE CIRCUIT ERROR
8 FLASHES: LOW FLAME SENSE SIGNAL
9 FLASHES: CHECK IGNITER



WARNING

HAZARDOUS VOLTAGE:
DISCONNECT ALL ELECTRICAL POWER INCLUDING REMOTE DISCONNECTS BEFORE SERVICING.
FAILURE TO DISCONNECT POWER BEFORE SERVICING CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

CAUTION

USE COPPER CONDUCTORS ONLY!
UNIT TERMINALS ARE NOT DESIGNED TO ACCEPT OTHER TYPES OF CONDUCTORS.
FAILURE TO DO SO MAY CAUSE DAMAGE TO THE EQUIPMENT.

INTEGRATED FURNACE CONTROL

REPLACE WITH PART CNT047111 OR EQUIVALENT
INPUT: 25 VAC, 60 HZ.
XFMR SEC. CURRENT: 450 MA.
MV OUTPUT: 1.5 A @ 24 VAC
IND OUTPUT: 2.2 FLA, 3.5 LRA @ 120 VAC
CIRC. BLOWER OUTPUT: 14.5 FLA, 14.5 LRA @ 120 VAC
HUMIDIFIER & AIR CLEANER
MAX. LOAD: 1.0 A @ 120 VAC
IGNITER OUTPUT: 2.0 A @ 120 VAC

BK	BLACK	GR	GREEN
WH	WHITE	BR	BROWN
YL	YELLOW	RD	RED
OR	ORANGE	BL	BLUE

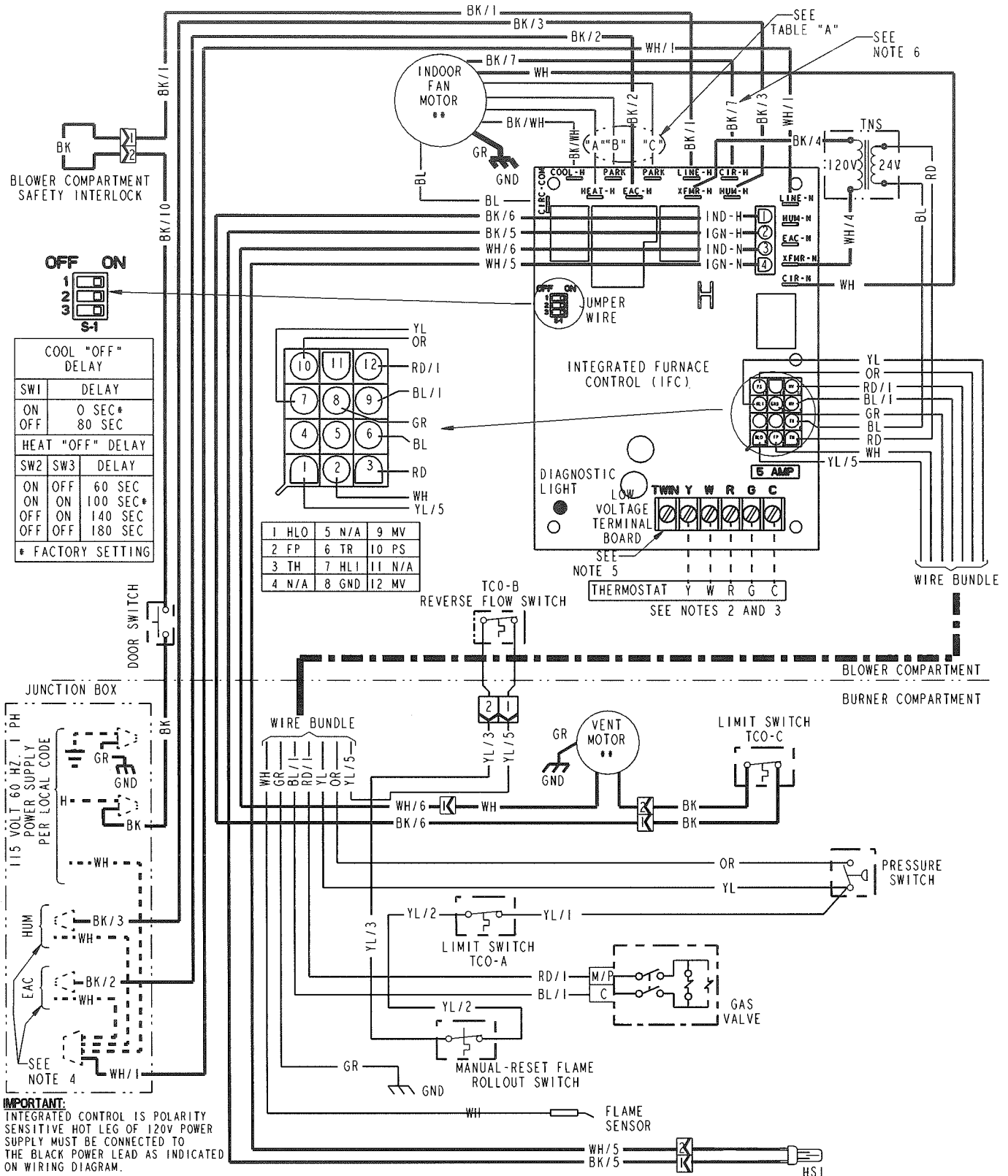
WIRE COLOR
BK/1
NUMBER ID (IF ANY)

L	LINE	TH	24 VAC (HOT)
N	NEUTRAL	TR	24 VAC (COMMON)
GND	GROUND	MV	MAIN GAS VALVE
B/C	COMMON	TNS	TRANSFORMER
HLO	HIGH LIMIT OUTPUT		
HLI	HIGH LIMIT INPUT		

NOTES:

- IF ANY OF THE ORIGINAL WIRING AS SUPPLIED WITH THIS FURNACE MUST BE REPLACED, IT MUST BE WITH WIRE HAVING A TEMPERATURE RATING OF AT LEAST 105 C.
- THERMOSTAT HEAT ANTICIPATOR SETTING: .38 AMPS
- FOR PROPER OPERATION OF COOLING SPEED, "Y" TERMINAL MUST BE CONNECTED TO THE ROOM THERMOSTAT.
- THESE LEADS PROVIDE 120V POWER CONNECTIONS FOR ELECTRONIC AIR CLEANER (EAC) AND HUMIDIFIER (HUM). MAX. LOAD: 1.0 AMPS EACH.
- WHEN TWINNING TWO FURNACES, BOTH UNITS MUST BE CONNECTED TO THE SAME 115 VAC PHASE CONNECT THE TWO UNITS 'TWIN' TERMINALS WITH 14 TO 22 AWG. WIRE.
- FOR MODELS USING 3/4 HP & 1 HP INDOOR FAN MOTOR, USE DETAIL A & TABLE A.

TDX1-H Wiring Diagram For Gas Furnaces



TDX1-H Schematic Diagram For Gas Furnaces

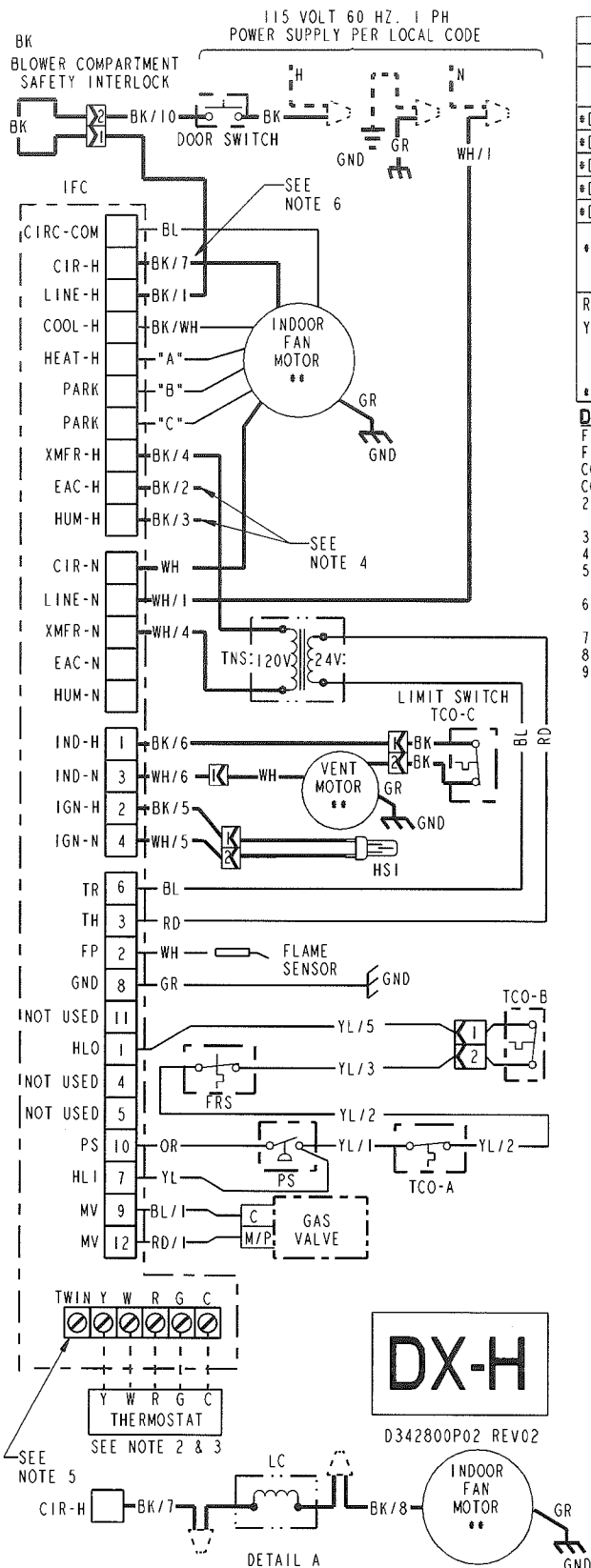


TABLE "A"				
SPEED TAPS FOR I.D. FAN MOTOR				
MODEL	HEAT "A"	PARK "B"	PARK "C"	BLOWER HP
*DXIB040A9H2IB**	YL/WH	BL/WH	RD/WH	1/2
*DXIB060A9H3IB**	BL/WH	YL/WH	RD/WH	1/2
*DXIB080A9H3IB**	BL/WH	YL/WH	RD/WH	3/4
*DXIC100A9H4IB**	BL/WH	YL/WH	RD/WH	3/4
*DXID120A9H5IB**	BL/WH	YL/WH	RD/WH	1

*DXIC100A9H4IA** LOW SPEED TAP
CAN NOT BE USED FOR HEATING

RD/WH = LOW=1 BL/WH = MED.HIGH=3
YL/WH = MED. LOW=2 BK /WH= HIGH=4

* - MAY BE PREFIX "A" OR "T"
** - MAY BE SUFFIX "A" THROUGH "Z"

DIAGNOSTIC CODES

FLASHING SLOW: NORMAL - NO CALL FOR HEAT
FLASHING FAST: NORMAL - CALL FOR HEAT
CONTINUOUS ON: REPLACE IFC
CONTINUOUS OFF: CHECK POWER
2 FLASHES: EXTERNAL LOCKOUT (RETRIES
OR RECYCLES EXCEEDED)
3 FLASHES: PRESSURE SWITCH ERROR
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SHOULD BE PRESENT
6 FLASHES: 115 VAC POWER REVERSED
POLARITY OR POOR GROUNDING
7 FLASHES: GAS VALVE CIRCUIT ERROR
8 FLASHES: LOW FLAME SENSE SIGNAL
9 FLASHES: CHECK IGNITER

WARNING

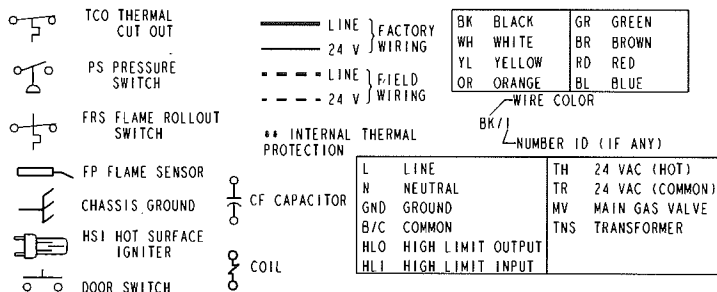
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SERVICING.
FAILURE TO DISCONNECT POWER BEFORE
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INJURY OR DEATH.

CAUTION

USE COPPER CONDUCTORS ONLY!
UNIT TERMINALS ARE NOT DESIGNED TO
ACCEPT OTHER TYPES OF CONDUCTORS.
FAILURE TO DO SO MAY CAUSE DAMAGE
TO THE EQUIPMENT.

INTEGRATED FURNACE CONTROL

REPLACE WITH PART CNT04711 OR
EQUIVALENT
INPUT: 25 VAC, 60 HZ.
XFMR SEC. CURRENT: 450 MA.
MV OUTPUT: 1.5 A @ 24 VAC
IND OUTPUT: 2.2 FLA, 3.5 LRA @ 120 VAC
CIRC. BLOWER OUTPUT: 14.5 FLA,
14.5 LRA @ 120 VAC
HUMIDIFIER & AIR CLEANER
MAX. LOAD: 1.0 A @ 120 VAC
IGNITER OUTPUT: 6.0 A @ 120 VAC



NOTES:

- IF ANY OF THE ORIGINAL WIRING AS SUPPLIED WITH THIS FURNACE MUST BE REPLACED, IT MUST BE WITH WIRE HAVING A TEMPERATURE RATING OF AT LEAST 105 C.
- THERMOSTAT HEAT ANTICIPATOR SETTING: .38 AMPS
- FOR PROPER OPERATION OF COOLING SPEED, "Y" TERMINAL MUST BE CONNECTED TO THE ROOM THERMOSTAT.
- THESE LEADS PROVIDE 120V POWER CONNECTIONS FOR ELECTRONIC AIR CLEANER (EAC) AND HUMIDIFIER (HUM). MAX. LOAD: 1.0 AMPS EACH.
- WHEN TWINNING TWO FURNACES, BOTH UNITS MUST BE CONNECTED TO THE SAME 115 VAC PHASE CONNECT THE TWO UNITS 'TWIN' TERMINALS WITH 14 TO 22 AWG. WIRE.
- FOR MODELS USING 3/4 HP & 1 HP INDOOR FAN MOTOR, USE DETAIL A & TABLE A.

DX-H

D342800P02 REV02



This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



TRANE®

Trane
6200 Troup Highway
Tyler, TX 75707
www.trane.com



Library	Unitary
Product Section	Furnaces
Product	Furnace
Model	TUX1-H
Literature Type	Product Data
Sequence	-
Date	06/10
File No.	22-1786-06
Supersedes	22-1786-05

Since **Trane** has a policy of continuous product and product data improvement, it reserves the right to change design and specifications without notice.

ECM 10: Oil to Gas Conversion

ECM Overview

Ameresco proposes to convert the Memorial Boys and Girls Club heating systems to natural gas from fuel oil. The Boys and Girls Club's two boilers will be switched to natural gas by replacement of the steam boiler's burner and replacement of the Clever Brook hot water boiler under ECM 5 Boiler Replacements. This conversion will provide immediate cost savings because natural gas is currently half the cost of fuel oil. In addition, natural gas requires less maintenance.

ECM Detail

Existing System

The original Maple Street Elementary School portion of the current Memorial facility is heated with a low pressure steam plant. The steam boiler is a cast iron sectional (H.B. Smith LO-28A-S-08) whose gross output is 1,955 MBH. Its burner is fired with number 2 fuel oil. This boiler was a replacement for the building's original, field erected boiler.

The original Memorial School portion of the facility which is utilized as the current Boys and Girls Club is heated by a hot water boiler plant. This plant is separate from the steam system. The hot water plant includes a fire-tube boiler (CB 548-200) whose gross output is 6,272 MBH and fired by number two fuel oil.

Fuel oil storage for both plants is provided by two underground storage tanks. Fuel oil supply and return piping is located underground from the tanks to each of the boiler rooms. Fuel oil is pumped to each burner by a pair of duplex pumps.



Figure 10.1: The existing oil-fired boiler burner at the Memorial will be replaced.

Table 10.1: Existing Boiler Specifications

Location	Service	Boiler Manuf.	Burner Manuf.	Oil Input Max GPH
Memorial Boys and Girls Club	Steam heating	HB Smith LO-28A-S-08	Carlin 801CRD	17.1
Memorial Boys and Girls Club	Hot water heating	Cleaver Brooks 548-200	Cleaver Brooks	56

Proposed System

Ameresco proposes to convert the Memorial Boys and Girls Club heating systems to natural gas from fuel oil. The Boys and Girls Club's two boilers will be switched to natural gas by replacement of the steam boiler's

burners and replacement of the Clever Brooks boiler under ECM 5. This conversion will provide immediate cost savings because natural gas is currently half the cost of fuel oil. In addition, natural gas requires less maintenance. The cost for replacing the Clever Brooks boiler is carried under ECM 5 along with the efficiency savings associated with that work. The cost of associated with running the gas line to the hot water boiler is included in this ECM. The savings associated with the fuel switch are carried under this ECM.

Table 10.2: Proposed Boiler Specifications

Location	Service	Boiler Manuf.	Proposed Burner Manuf., or equal	Natural Gas Input Max CFH
Memorial School	Steam heating	HB Smith LO-28A-S-08	Powerflame C2-G-20A	2500
Memorial School	Hot water heating	Cleaver Brooks 548-200	New Boiler - ECM 5	1500

> Detailed Scope of Work

- Steam Boiler Plant (HB Smith LO-28A-S-08, Carlin 801CRD (7.8 to 17.1 GPH, ¾ HP))
 - remove existing fuel oil service and burner
 - remove all fuel oil from the tank and existing boiler room piping
 - oil tank (5000 gallon): excavate and remove the tank, backfill with gravel, repave and dispose of the tanks per MA Regulations listed in 527 CMR 09
 - flush and clean existing underground fuel oil supply and return piping and abandon in place
 - remove all fuel oil piping and pumps in the boiler room
 - disconnect power to burner and remove feeder wires back to the panel
 - remove burner from boiler
 - Note: the scope of work for this ECM does not include the removal of unexpected hazardous waste such as contaminated soil. If any such materials should be discovered all work will stop and the Town will be notified to handle the cleanup.
 - install a replacement natural gas burner
 - install high pressure gas piping from the load side of the meter to the mechanical room; okay the piping up and across the roofs
 - install a gas train
 - set the burner in place of the existing, removed, burner and connect to gas train
 - install a Powerflame C2-G-20A (max input, 2499 CFH) or equal, burner
 - provide structural support for the burner from the floor
 - install new electric feed to the burner and new circuit breaker and the existing panel
 - test fire the unit, verifying proper operation and measuring combustion efficiency
 - provide training and all manuals to the Owner
 - chimney
 - install new chimney liner suitable for natural gas service
 - install new vent connector piping to the liner
 - repointing or repair of existing chimney is not included
 - combustion air
 - relocate the existing steam pipe vent and penetrate the roof

- replace the combustion air louver with code compliant “high/low” louvers; minimum free area = 4.34 SF each
- Hot Water Boiler Plant (Cleaver Brooks CB548-200 L-24235, burner input: 56 GPH)
 - remove existing fuel oil service
 - remove all fuel oil from the tank and existing boiler room piping
 - oil tank (5000 gallon): excavate and remove the tank, backfill with gravel, repave and dispose of tank per MA Regulations listed in 527 CMR 09
 - flush and clean existing underground fuel oil supply and return piping and abandon in place
 - remove all fuel oil piping and pumps in the boiler room
 - disconnect power to burner and remove feeder wires back to the panel
 - Note: the scope of work for this ECM does not include the removal of unexpected hazardous waste such as contaminated soil. If any such materials should be discovered all work will stop and the Town will be notified to handle the cleanup.
 - Asbestos containing material (ACM) shall be identified and removed prior to commencing mechanical work.
 - install a gas train
 - install gas train vents piping to outdoors
 - install high gas piping from the load side of the meter to the mechanical room
 - install a gas train
 - chimney
 - to be reused for existing domestic hot water heater only
 - Reinsulate all abated piping with fiberglass and all-service jacket (ASJ); reinsulate breeching with mineral wool with ASJ

Sizing Considerations

New burner will be sized according to existing boiler capacity, ASHRAE guidelines and input from Owner's personnel.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the Town 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

Maintenance cost reductions will occur due to switching to gas burner equipment and elimination of the fuel oil storage and delivery systems. The scope of work for this ECM does not include the removal of unexpected hazardous waste such as contaminated soil.

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Appendix for ECM 10: Oil to Gas Conversion

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	10	
Measure Name:	Oil to Gas Conversion	
Measure Location:		
Engineers:		

Site Name:			Memorial	Summary
Item	Units		Savings	
Electricity				
Energy On-Peak	kWh			0
Energy Off-Peak	kWh			0
Energy Total	kWh	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	-11,965		-11,965
Liquid Propane Gas (LPG)	Gallons			0
Steam	Mlbs			0
Fuel Oil, #2	Gallons	8,514		8,514
Fuel Oil, #4	Gallons			0
Fuel Oil, #6	Gallons			0
Miscellaneous	Misc			0
Water				0
Water savings school	kGallons			0
Sewer				0
Sewer savings school	kGallons			0

TMY-2 Weather Data for Lawrence Municipal Airport, MA													Existing Occupancy Schedule						Proposed EMS Operating Hours								Proposed		Savings
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 Peak Hrs.	UnOcc Peak Hrs.	Occ Off- Peak Hrs.	UnOcc Off- Peak Hrs.	Occ Peak Hrs.	UnOcc Peak Hrs.	Occ On- Peak Hrs.	UnOcc On- Peak Hrs.	Occ Off- Peak Hrs.	UnOcc Off- Peak Hrs.	Interacted Occ. Heat Load (MBH)	Interacted UnOcc. Heat Load (MBH)	Occ. Heat Usage (MMBTU)	UnOcc. Heat Usage (MMBTU)	Occ Cooling/Hr Energy Consump. (MMBTU)	UnOcc Cooling/Hr Energy Consump. (MMBTU)	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							
Cooling																													
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	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														
95 to 100	97.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0														
90 to 95	92.5	72.6	36.2	0	8	0	8	2	6	0	0	2	6	0	0														
85 to 90	87.5	69.7	33.7	0	70	16	86	24	62	0	0	24	62	0	0														
80 to 85	82.5	65.9	33.1	2	202	67	271	194	77	0	0	77	194	0	0														
75 to 80	77.5	66.8	31.4	30	272	146	448	127	321	0	0	127	321	0	0														
70 to 75	72.5	64.1	29.4	89	245	171	505	143	362	0	0	143	362	0	0														
65 to 70	67.5	61.8	27.7	235	275	283	793	224	569	0	0	224	569	0	0														
60 to 65	62.5	58.3	25.3	372	248	341	961	272	689	0	0	272	689	0	0														
Heating																													
55 to 60	57.5	52.8	21.9	244	210	228	682	193	489	0	0	193	489	0	0	(23)	(3)	6	2	6	2	6	2	(4)					
50 to 55	52.5	48.5	19.5	299	240	240	741	210	531	0	0	210	531	0	0	(82)	(3)	23	2	23	2	23	2	(10)					
45 to 50	47.5	43.8	17.0	247	176	206	629	178	451	0	0	178	451	0	0	(142)	(21)	33	12	33	12	33	12	(1)					
40 to 45	42.5	38.9	14.7	261	276	246	783	221	562	0	0	221	562	0	0	(202)	(79)	58	58	59	59	59	59	(2)					
35 to 40	37.5	33.8	12.5	339	311	357	1,007	285	722	0	0	285	722	0	0	(261)	(137)	97	129	99	131	99	131	(3)					
30 to 35	32.5	29.3	10.6	300	189	268	757	214	543	0	0	214	543	0	0	(321)	(195)	90	139	91	140	91	140	(3)					
25 to 30	27.5	24.8	8.9	179	85	136	400	113	287	0	0	113	287	0	0	(381)	(253)	56	95	57	96	57	96	(2)					
20 to 25	22.5	20.0	7.1	115	60	83	258	73	185	0	0	73	185	0	0	(440)	(312)	42	75	43	76	43	76	(2)					
15 to 20	17.5	14.9	5.4	106	39	73	218	62	156	0	0	62	156	0	0	(500)	(370)	40	76	41	77	41	77	(2)					
10 to 15	12.5	10.7	4.0	34	20	26	80	23	57	0	0	23	57	0	0	(559)	(428)	17	32	17	33	17	33	(1)					
5 to 10	7.5	5.2	2.4	19	24	18	61	17	44	0	0	17	44	0	0	(619)	(486)	14	28	14	28	14	28	(1)					
0 to 5	2.5	0.8	1.1	34	7	13	54	15	39	0	0	15	39	0	0	(679)	(544)	14	28	14	28	14	28	(1)					
-5 to 0	(2.5)	(3.7)	(0.2)	12	1	2	15	4	11	0	0	4	11	0	0	(738)	(602)	4	8	4	9	4	9	(10)					
-10 to -5	(7.5)	(8.4)	(1.5)	3	0	0	3	1	2	0	0	1	2	0	0	(798)	(661)	1	2	1	2	1	2	(10)					
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	(854)	(715)	0	0	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	(914)	(774)	0	0	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	(973)	(832)	0	0	0	0	0	0	-					
			2,920	2,920	2,920	8,760	2,477	6,283	0	0	0	2,477	6,283	0	0			494	686	501	696			(16)					

Assumptions:	Value	Unit	CELL	Description
Existing Heating Plant Efficiency	76.5%		R43	Baseline Boiler Efficiency
Proposed Heating Plant Efficiency	75.5%		R44	Proposed Boiler Efficiency
Percent Heating Load	100.0%		R45	% Served by Boilers

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Lawrence Municipal Airport, MA
I-L	Occupied hours as per the RFP data
M-P	Equipment operating hours after EMS is installed
Q	Interacted Occupied Heating loads (MBH)
R	Interacted Unoccupied Heating loads (MBH)
S	Heating = -MIN([col I] + [col K], [col M] + [col O]) x MIN([col Q] + internal gains, 0) + IF([col I] + [col K] > [col M] + [col O], ([col I] + [col K]) - [col M] + [col O])
T	Heating = -4([col N] + [col P]) x MIN([col R] + internal gains, 0) + IF([col I] + [col K] < [col M] + [col O], ([col I] + [col K]) - [col M] + [col O])
U	Heating = -MIN([col N] + [col P], [col K] + [col O]) x MIN([col Q] + internal gains, 0) - IF([col I] + [col K] > [col M] + [col O], ([col I] + [col K]) - [col M] + [col O])
V	Heating = -4([col N] + [col P]) x MIN([col R] + internal gains, 0) - IF([col I] + [col K] < [col M] + [col O], ([col I] + [col K]) - [col M] + [col O])
W	=if (col S < 0, col U, -1 col V)

Appendix for ECM 10: Oil to Gas Conversion

II. Manufacturer Specification Sheets

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Commercial Burners - Gas Fired



MODEL **301GAS**
Power Gas Burner

401,000 TO 1,100,000 BTUH

The 301GAS burner converts from propane to natural gas with just an orifice change - no conversion kit needed. Fires negative or positive chambers from 401,000 to 1,100,000 Btuh input. Time-tested solid state ignition and state-of-the-art microprocessor primary control technology. Diagnostic LED lights annunciate operating mode: Self-check, Flame-on, Recycle, Lockout and Latch-up. Factory-packaged with combustion control and gas train (assembled, shipped loose; also available as knockdown). Shipped completely pre-wired for easy installation and start-up (knockdown version also available). High-efficiency, compact flame pattern design ensures clean, quiet operation. Does not require a refractory liner - fires with or without a combustion chamber. Swing-away flanged door design.

Input	"B" Head/Tube 401,000 to 700,000 Btuh
	"C" Head/Tube 550,000 to 1,100,000 Btuh
Fuels	Natural Gas or Propane Gas
	Maximum Supply Pressure: 14 inches w.c.

Minimum Supply Pressure: 5.0 inches w.c.

Manifold Pressure: 3.5 inches w.c.

Control

Carlin 60200FR Microprocessor Control
4 sec. Trial for Ignition (TFI)
1.3 Sec. FFRT
Pre-purge and post-purge
Serviceman Reset Protection
Latch-up after three consecutive lockouts
Interrupted Duty Ignition
Recycle on Flame Failure

Electrical

Power: 120 vac/60Hz/1-Phase

Current: Approximately 2.5 amps

Limit Circuit Input: 120 vac/60 Hz

Motor: 1/6 HP, 3450 RPM, 60 Hz

Motor Frame: 48 Frame, "N" Flange

Fuel Valve Power: 120 vac/60 Hz

Ignition

Carlin Model 41800 solid state electronic ignition

Ignition Voltage: 9,000 volts

Orifice Selection

Contact Carlin

Agencies

UL Listed: US

ECM 11: Pipe Insulation

ECM Overview

The scope of work for this ECM is to insulate bare steam and hot water piping. Uninsulated steam or hot water piping is a major source of uncontrolled heat gain, which results in energy losses and can cause overheating.

The original portions of the Memorial Boys and Girls Club and the first floor of the Town Hall are heated by steam. This ECM will insulate the steam piping in the mechanical rooms of these two buildings. The Fire Department is heated with a hot water boiler plant and distribution system. This ECM will insulate bare hot water piping in the mechanical rooms of this building.

The hot water heating boiler plant at the Memorial Boys and Girls Club is insulated with asbestos containing material (ACM). This material will be removed and reinsulated as part of ECM 10's scope of work.



Figure 11.1: Bare steam piping at Town Hall will be insulated as part of this measure's scope of work.

ECM Detail

Existing System

Table 11.1 lists the approximate lengths of steam and hot water piping affected by this ECM. The counts of pipe elbows and intersections are embedded within these lengths (in linear feet, LF).

Table 11.1: Pipe Insulation Scope of Work

Location	Pipe Size (in)	Bare Steam (LF)	Bare Hot water (LF)
Fire Department	$\leq 1 \frac{1}{4}$		18
Fire Department	2		36
Town Hall	$1 \frac{1}{4}$		45
Town Hall	2		39
Town Hall	3		3
Memorial Boys and Girls Club	2	12	
Memorial Boys and Girls Club	4	12	
Memorial Boys and Girls Club	6	9	

Proposed System

- A. Furnish and install pipe insulation:
 - 1) Heating Hot Water Pipe Insulation
 - a Furnish and install 1" fiberglass insulation with all service jacket (ASJ) on pipe size less than 1 ½ in diameter with all service jacket (ASJ)
 - b Furnish and install 2" fiberglass insulation with all service jacket (ASJ) on pipe sizes greater than 1 diameter with all service jacket (ASJ)
 - 2) Steam Pipe Insulation
 - a Furnish and install 2" fiberglass insulation with all service jacket (ASJ) on pipe size less than 1 ½ in diameter with all service jacket (ASJ)
 - b Furnish and install 2 1/2" fiberglass insulation with all service jacket (ASJ) on pipe sizes greater than 1 diameter with all service jacket (ASJ)
- B. Memorial Hot Water Heating Plant
 - 1) Removal of ACM and reinsulating is included in ECM 10.

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

Energy cost savings will be realized as a result of the implementation of this ECM.

Appendix for ECM 11: Pipe Insulation

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	11	
Measure Name:	Pipe Insulation	
Measure Location:		
Engineers:		

Site Name:					
Item	Units	Fire Savings	TownHall Savings	Memorial Savings	Summary
Electricity					
Energy On-Peak	kWh				0
Energy Off-Peak	kWh				0
Energy Total	kWh	0	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					
Natural Gas (NG)	Therms		335		335
Liquid Propane Gas (LPG)	Gallons				0
Steam	Mlbs				0
Fuel Oil, #2	Gallons	113		245	358
Fuel Oil, #4	Gallons				0
Fuel Oil, #6	Gallons				0
Miscellaneous	Misc				0
Water					
Water Savings	kGallons				0
Sewer					
Sewer Savings	kGallons				0

Energy Audit Report: Piping System Analysis																	
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)	Piping		Pipe Conductivity γ (Btu/hr-ft²-°F)	Cold Fluid		Insulation		Existing Heat Loss (MMBtu)	Proposed Heat Loss (MMBtu)	Savings (MMBtu)	
							Inside Pipe Diameter (inches)	Outside Pipe Diameter (inches)		Insulation Thickness (inches)	Insulation Conductivity γ (Btu/hr-ft²-°F)	Insulation Thickness (inches)	Insulation Conductivity γ (Btu/hr-ft²-°F)				
Boiler Room	1	Water	170.0	3,362	5.0	18.0	1.05	1.32	0.65	227.0	75.0	1.00	0.0225	1.0	0.93	1,857	2,742
Boiler Room	2	Water	170.0	3,362	5.0	36.0	2.07	2.38	0.65	227.0	75.0	1.00	0.0225	2.0	0.93	16,612	12,880
Totals						54.0										21,212	15,623

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	$U = (Existing\ Transmission + Radiation\ Heat\ Loss) \times [col\ E] \div [P26] \div 1,000$
U	$U = (Proposed\ Transmission + Radiation\ Heat\ Loss) \times [col\ E] \div [P26] \div 1,000$
V	$U = [col\ T] - [col\ U]$

Item	Value	Units	Cell Ref	Remarks
Heating System Efficiency	81.0%		P26	From Baseline

Location	Existing Piping Details					Existing Insulation Details					Proposed Insulation Details					Proposed Heat Loss (MBtu)	Existing Heat Loss (MBtu)	Savings (MBtu)
	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-ft²-°F)	Cold Fluid Temperature (°F)	Conductivity (Btu/hr-ft²-°F)	Insulation Thickness (inches)	Insulation Emissivity	Insulation Conductivity (Btu/hr-ft²-°F)			
Boiler Room (LPS)	1 1/4	Steam	212.0	2,775	5.0	45.0	1.38	1.66	0.65	227.0	75.0	1.00	0.0	0.93	0.0225	17,609	3,966	13,704
Boiler Room (LPS)	2	Steam	212.0	2,775	5.0	39.0	2.07	2.38	0.65	227.0	75.0	1.00	0.0	0.93	0.0225	21,835	4,130	17,705
Boiler Room (LPS)	3	Steam	212.0	2,775	5.0	3.0	3.07	3.50	0.65	227.0	75.0	1.00	0.0	0.93	0.0225	2,475	404	2,072
Totals						87.0										41,919	8,439	33,480

Cell Ref.	Comment	Value	Units	Cell Ref.	Remarks
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] ÷ [P26] ÷ 1,000				
U	= (Proposed Transmission + Radiation Heat Loss) x [col E] ÷ [P26] ÷ 1,000				
V	= [col T] - [col U]				

Existing Piping Details										Existing Insulation Details					Proposed Insulation Details					Savings	
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-ft²-F)	Cold Fluid Temperature (°F)	Insulation Conductivity (Btu/hr-ft²-F)	Insulation Thickness (inches)	Insulation Emissivity	Insulation Conductivity (Btu/hr-ft²-F)	Insulation Thickness (inches)	Insulation Emissivity	Insulation Conductivity (Btu/hr-ft²-F)	Existing Heat Loss (MBtu)	Proposed Heat Loss (MBtu)	Savings (MBtu)
Boiler room (old)	2	Steam	212.0	2,976	5.0	12.0	2.07	2.38	0.65	227.0	75.0	0.0225	2.5	0.93	0.0225	2.5	0.93	0.0225	7,909	1,496	6,413
Boiler room (old)	4	Steam	212.0	2,976	5.0	12.0	4.03	4.50	0.65	227.0	75.0	0.0225	3.0	0.93	0.0225	3.0	0.93	0.0225	14,966	2,007	12,959
Boiler Room (new)	6	Steam	212.0	2,976	5.0	9.0	6.07	6.63	0.65	227.0	75.0	0.0225	3.0	0.93	0.0225	3.0	0.93	0.0225	16,546	1,969	14,577
Totals						33.0													39,441	5,472	33,969

Item	Value	Units	Cell Ref	Remarks
Heating System Efficiency	76.5%		P26	From Baseline

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	$\text{Heat Loss} = (\text{Existing Transmission} + \text{Radiation Heat Loss}) \times [(\text{col E}) \div (\text{P26})] \div 1,000$
U	$\text{Heat Loss} = (\text{Proposed Transmission} + \text{Radiation Heat Loss}) \times [(\text{col E}) \div (\text{P26})] \div 1,000$
V	$\text{Savings} = [(\text{col T})] - [(\text{col U})]$

Appendix for ECM 11: Pipe Insulation

II. Manufacturer Specification Sheets

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Johns Manville

Pipe & Equipment Insulations

Micro-Lok®

Fiber Glass Pipe Insulation

Description

Micro-Lok fiber glass pipe insulation is made from glass fibers bonded with a thermosetting resin and produced in 36" (0.92 m) lengths. Jacketed with a reinforced vapor retarder facing and a factory-applied, longitudinal acrylic adhesive closure system, Micro-Lok is designed for application temperatures from 0°F to 850°F (-18°C to 454°C). Section joints are sealed with butt strips which are supplied from the factory. **Micro-Lok** may be painted with a latex paint after installation.

The factory-installed tape system permits installation at ambient temperatures down to 20°F (-7°C), and will not soften or separate when exposed to high ambient temperatures and humidity.

Uses

Micro-Lok fiber glass pipe insulation is suitable for installation over hot, cold, concealed and exposed piping systems with operating temperatures up to 850°F (454°C). Weather-protective jacketing is required for outdoor applications. Pipes operating below ambient temperatures require all joints to be sealed with the factory-applied, self-seal lap and butt strips.



Operating Temperature Limits: 0°F to 850°F (-18°C to 454°C)

Specification Compliance

ASTM C 1136 (Jacketing) (Replaces HH-B-100B, Type I & II)

ASTM C 547 Type I (Replaces HH-I-558B, Form D, Type III, Class 12, Class 13 up to 850°F [454°C])

MIL-I-22344C

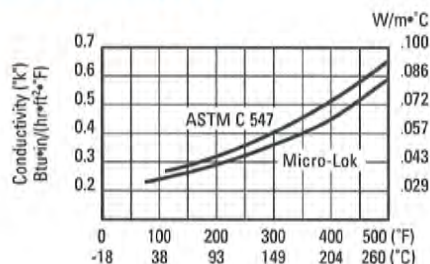
New York City MEA # 330-85-M

NFPA 90A & 90B, FHC 25/50

Physical Properties

Service Temp. Range	0°F to 850°F (-18°C to 454°C)
Moisture Sorption	<5% by weight
Alkalinity	<0.6% expressed as Na ₂ O
Corrosivity	Does not accelerate
Capillarity	Negligible (after 24 hours)
Shrinkage	None
Fungi & Bacteria Resistance	Does not breed or promote
Surface Burning Characteristics	Composite FHC 25/50 per ASTM E 84, UL 723, NFPA 255, CAN/ULC S102-M88
Limited Combustibility	NFPA 259
Jacketing	ASTM C 1136 (Type I)
Water Vapor Permeance (ASTM E 96 - Procedure A)	.02 perms max.
Burst Strength (ASTM D 774)	50 Beach Units (1.5 Joules min.)
Tensile Strength (ASTM D 828)	45 lbs./in. (7.9N/mm) width min. (MD) 30 lbs./in. (5.23N/mm) width min. (CD)

Thermal Conductivity ("k")



Mean Temperature	°F	75	100	200	300	400	500
	°C	24	38	93	149	204	260
Btu-in/(hr-ft²-°F)		.23	.24	.29	.36	.45	.59
W/m°C		.033	.035	.042	.052	.065	.085

ASTM Test Methods & Guidelines

- C 356 Linear Shrinkage
- C 411 Hot Surface Performance
- C 547 Pipe Insulation
- C 585 Simplified Dimensional Standards for Nesting
[Except 3/4" (20 mm) IPS, 1" (25 mm) IPS, and 1 5/8" (41mm) CT]
- C 1136 Vapor Barrier Jacketing (Type I)

Micro-Lok®

Fiber Glass Pipe Insulation

Size Availability

Insulation Thickness		Iron Pipe Size Range		Copper Tubing Size Range	
in.	mm	in.	mm	in.	mm
1/2	13	1/2 - 6	13 - 152	5/8 - 4 1/8 ⁵	16 - 105
1	25	1/2 - 24	13 - 610	5/8 - 6 1/8	16 - 156
1 1/2	38	1/2 - 24	13 - 610	5/8 - 6 1/8	16 - 156
2	51	1/2 - 24	13 - 610	1 1/8 - 6 1/8	29 - 156
2 1/2	64	1 - 24	25 - 610	1 3/8 - 6 1/8	35 - 156
3	76	1 - 24	25 - 610	1 3/8 - 6 1/8	35 - 156
3 1/2	89	1 1/2 - 24 ¹	38 - 610	—	—
4	102	3 - 24 ²	76 - 610	—	—
4 1/2	114	3 - 24 ³	76 - 610	—	—
5	127	3 - 20 ⁴	76 - 508	—	—

Notes:

- ¹ 2 1/2" and 23" IPS not available in this insulation thickness.
- ² 22" and 23" IPS not available in this insulation thickness.
- ³ 21", 22" and 23" IPS not available in this insulation thickness.
- ⁴ 19" IPS not available in this insulation thickness.
- ⁵ 3 5/8" CTS not available in this insulation thickness.

Qualifications for Use

A sufficient thickness of insulation must be used to keep the maximum surface temperature of Micro-Lok below 150°F (66°C). In addition, at operating temperatures above 500°F (260°C), Micro-Lok pipe insulation must be applied in a thickness ranging from 2" (51 mm) minimum to 6" (152 mm) maximum.

During initial heat-up to operating temperatures above 350°F (177°C), an acrid odor and some smoke may be given off as the organic binders used in the fiber glass pipe insulation begin to decompose. When this occurs, caution should be exercised to ventilate the area well. This loss of binder does not directly affect the thermal performance of the pipe insulation, but the compressive strength and resiliency of the product are reduced. For applications with excessive physical abuse or vibration at high temperatures, consult your local Performance Materials Division Market Development Manager for alternate material recommendations.

Application Recommendations.*

Micro-Lok Pipe Insulation and Butt Strips.

1. Do not apply Micro-Lok if air temperature is below 20°F (-7°C) or above 130°F (54°C) due to the effect of temperature on tape performance. We recommend stapling when application falls outside this temperature range.

When stapling, we recommend mastic be applied over staples to prevent moisture penetration.

2. If stored below 20°F (-7°C) or above 130°F (54°C), insulation cartons should stand within the recommended temperature range for 24 hours prior to application.

3. Once release paper is removed, both adhesive and lap must be kept free of dirt and water, and the lap sealed immediately.

4. When adhered, the lap and butt strips must be pressurized by rubbing firmly with a plastic squeegee or the back of a knife blade to ensure positive closure.

* For complete application recommendations and installation instructions, see Micro-Lok brochure, CI-32.



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P.O. Box 158
Defiance, OH 43512
(800) 334-2399
Fax: (419) 784-7866

Western Region and Canada
P.O. Box 5108
Denver, CO 80217
(800) 368-4431
Fax: (303) 978-4661



Johns Manville

Performance Materials Division
P.O. Box 5108
Denver, CO 80217-5108
Product Information: (800) 654-3103
pic@jm.com
www.jmpipeinsulation.com

CI-34 11-06 (Replaces 9-06)



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The physical and chemical properties of Micro-Lok® fiber glass pipe insulation represent typical, average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Numerical flame spread and smoke developed ratings are not intended to reflect hazards presented by this or any other materials under actual fire conditions. Check with the Regional Sales Office nearest you to assure current information. **All Johns Manville products are sold subject to Johns Manville's Limited Warranty and Limitation of Remedy. For a copy of the Johns Manville Limited Warranty and Limitation of Remedy, and information on other Johns Manville thermal insulations and systems, call (800) 654-3103.**



Johns Manville

Pipe & Equipment Insulations

Zeston® 2000 PVC

Insulated Fitting Covers and Jacketing

Description

Zeston 2000 fitting covers are designed to insulate and to provide a protective covering for pipe fittings. The fitting covers are supplied with Hi-Lo® Temp Formaldehyde-free™ fiber glass insulation inserts from the factory. Zeston PVC jacketing provides a protective covering for insulated or bare pipes. Zeston 2000 PVC fitting covers and jacketing are manufactured from high-impact, gloss white, UV-resistant, polyvinyl chloride which provides a simple, quickly installed system.

Available Shapes and Sizes

Fitting Covers. Zeston 2000 Series PVC fitting covers are available for the following: 45° and 90° (0.8 and 1.6 rad.) short and long radius elbows, tees and valves, flanges, reducers, end caps, soil pipe hubs, traps and mechanical groove-type fittings.

Jacketing. Zeston PVC jacketing is available in rolls in thicknesses of 10, 15, 20 and 30 mil (0.3, 0.4, 0.5 and 0.8 mm).

Cut & Curled™ Jacketing. Zeston PVC Cut & Curled jacketing is available in thicknesses of 20 or 30 mil (0.5 mm or 0.8 mm) (30 mil [0.8 mm] recommended for outdoor applications). It is available in factory-cut sizes to fit up to 30" (762 mm) O.D. All sections of Zeston PVC Cut & Curled jacketing are 48" (1219 mm) in length and are factory curled to fit snugly.

Uses

Zeston 2000 PVC fitting covers and jacketing are ideally suited for indoor or outdoor use on chilled water, hot water, steam and other piping systems in commercial, institutional, and industrial applications. The fitting covers, when combined with Zeston PVC jacketing and Perma-Weld® solvent welding adhesive, form a completely sealed system which meets the requirements of the USDA and FDA for applications in food, beverage, and pharmaceutical facilities.

Qualifications for Use

General

- Install the appropriate Hi-Lo Temp fiber glass insert by wrapping it completely around the pipe fitting without overly compressing it or leaving any voids. Ensure that the insulation insert covers all exposed surfaces. The Zeston PVC fitting cover should then be installed over the pipe fitting and fiber glass insert by securing the throat using either serrated tacks, Perma-Weld adhesive or Zeston Z-Tape.

Hot Systems

- PVC covers must be kept below 150°F (66°C) by use of proper insulation thickness.
- PVC covers should be kept away from contact with, or exposure to, sources of direct or radiated heat.
- For fittings where operating temperatures exceed 250°F (121°C), or where pipe insulation thickness is greater than 1½" (38 mm), two or more layers of Hi-Lo Temp insulation inserts are required beneath fitting cover.

Cold Systems

- An approved vapor retarder mastic compatible with PVC must be applied between pipe insulation and fitting cover, and on fitting cover throat overlap seam.



Operating Temperature Limits:

PVC: Up to 150°F (66°C)

Insert: 0°F to 450°F (-18°C to +232°C)

Flame Spread: 25 or less (up to 30 mil [0.8 mm])

Smoke Developed: 50 or less (up to 30 mil [0.8 mm])

Grade: Weatherable

Color: White

Finish: Gloss

- For fittings where operating temperature is below 45°F (7°C) or where the pipe insulation thickness is greater than 1½" (38 mm), two or more layers of Hi-Lo Temp insulation inserts are required beneath fitting cover.

Refrigerant Systems and Cold Systems in Severe Ambient Conditions

- Mitred pipe insulation segments. Fabricated or premolded insulation shapes may be used in lieu of Hi-Lo Temp insulation inserts.
- An intermediate vapor retarder compatible with PVC is required to completely seal the insulation prior to installing the Zeston 2000 PVC fitting cover. Care should be taken to ensure that the vapor barrier mastic is applied between the pipe insulation and the fitting cover, and on fitting cover throat overlap seam.

Totally Sealed Systems (USDA Approval)

- System requires that 20 or 30 mil (0.5 mm or 0.8 mm) Zeston PVC jacketing is applied to pipe insulation in conjunction with Zeston PVC fitting covers.
- All circumferential and longitudinal seams of jackets and fitting covers should be sealed with Zeston Perma-Weld solvent welding adhesive. Circumferential seams should be a minimum 1" (25 mm) overlap, and longitudinal seams should be 1½" to 2" (38 mm to 51 mm) overlap.
- Upon completion, all seams should visually be checked for seal and touched up, if necessary.
- Slip joints are required periodically between fixed supports and on continuous long runs of straight piping. Slip joints are achieved by increasing circumferential overlap to 8 to 10 inches (203 mm to 254 mm) and applying a flexible white caulking in the overlap area to maintain a sealed system.

Zeston® 2000 PVC

Insulated Fitting Covers and Jacketing

Physical Properties of Zeston 2000 PVC

Property	Value	ASTM Test Method
Specific Gravity	1.48	D 792
Tensile Strength at Yield, psi (kPa)	6,000 (41,370)	D 638
Elongation at Yield (MD), %	3.0	D 638
Tensile Modulus, psi (kPa)	470,000 (3,240,650)	D 638
Flexural Strength, psi (kPa)	11,600 (79,982)	D 638 (min. 0.125" [3 mm] thick specimen)
Flexural Modulus, psi (kPa)	460,000 (3,171,700)	D 790
Flame Spread	25 or less (up to 30 mil [0.8 mm])	E 84
Smoke Developed	50 or less (up to 30 mil [0.8 mm])	E 84
Electrical Conductance	Non-Conductor	D 257
Gardner—SPI Impact,	10 mil (0.3 mm) 1.3	D 3679
in. lb./mil by Ductile Failure	15 mil (0.4 mm) 1.4	(4 lb. [1.8 kg] weight;
	20 mil (0.5 mm) 1.5	8 lb. [3.6 kg] for 30 mil [0.8 mm])
	30 mil (0.8 mm) 1.6	

Note: Chemical resistance data available on request.

General Properties of Hi-Lo® Temp Formaldehyde-free™ Fiber Glass Insulation Insert

Thermal conductivity	Mean Temperature		"k"	
	°F	°C	Btu•in/ (hr•ft²•°F)	W/m•°C
	75	24	.28	.040
	150	66	.34	.049
	300	149	.45	.065
Temperature limits	0°F to 450°F (-18°C to +232°C)			
Sanitary	Odorless. Will not absorb odors. Provides no food for insects, rodents, or mildew.			
Vibration resistant	Will not settle or separate.			
Fire safety	Meets most requirements of federal, state and local codes. Accepted for commercial, institutional, industrial, and residential projects in all parts of U.S. The fiber glass inserts have UL 25/50 rating and are non-combustible per ASTM E 136.			

Specification Compliance

USDA, Agriculture Canada
New York City MEA #7-87
ICBO
SBCCI
BOCA
ASTM D 1784, Class 16354-C
L-P-535E*, Composition A, Type II, Grade GU
L-P-1035A*, Composition A, Type II, Grade GU
Canada: CGSB 51-GP-53M
CAN/ULC S102-M88

* Impact strength determined by Gardner-SPI test method rather than Izod, since Gardner is more appropriate for PVC sheeting materials.

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Fax: (303) 978-4661



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Denver, CO 80202
(800) 654-3103
specJM.com

CI-55 8-08 (Replaces 5-08)

The physical and chemical properties of Zeston® Insulated Fitting Covers and Jacketing listed herein represent typical, average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. Numerical flame spread and smoke developed ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions. Check with the Regional Sales Office nearest you to assure current information. **All Johns Manville products are sold subject to Johns Manville's standard Terms and Conditions including Limited Warranty and Limitation of Remedy. For a copy of the Johns Manville standard Terms and Conditions, Limited Warranty and Limitation of Remedy, and information on other Johns Manville thermal insulations and systems, call (800) 654-3103.**

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ECM 12: Steam Trap Replacement

ECM Overview

Ameresco proposes to replace and/or repair steam traps at the Memorial Boys and Girls Club. The proposed replacement and/or repair of steam traps will improve the overall steam use and heating system efficiencies. Steam distribution is accomplished at low pressure with thermal energy waste due to failing traps. Properly functioning steam traps pass air and drain condensate formed in the steam distribution system and prevent live steam from exiting. This measure will address approximately 30 existing steam traps, and the improvement will result in energy and maintenance cost savings for the Town of Salisbury.



Fig 12.1 This end-of-main steam trap will be rebuilt or replaced as part of the scope of this measure.

ECM Detail

Existing System

The steam heating systems consist of low-pressure steam and condensate distribution piping, steam control valves, terminal equipment (steam coils, converters, radiators, heaters, etc.) and steam traps. The original Maple Street Elementary School portion of the facility is heated with low pressure steam. Low pressure steam is distributed from the steam boiler plant through three distribution pipes: first and second floors east, first and second floors west, and the Gymnasium and Stage. The air handling unit which serves the Gymnasium is located in a mechanical space above the Stage; this unit has not operated in many years and is not included in the scope of work.

The original Maple Street Elementary School portion of the facility is heated with low pressure steam. Low pressure steam is distributed from the steam boiler plant through three distribution pipes: first and second floors east, first and second floors west, and the Gymnasium and Stage. First floor steam and condensate distribution is located in a perimeter trench. Access panels in the floor near terminal units and at the end of the lines permit steam trap replacements (Fig 12.2). Condensate is returned to the boiler plant by gravity flow. Recently, sections of condensate returns have been replaced to maintain the system's operation. Overall, the steam distribution system is in poor, but



Fig 12.2 Trench access panel to service and end-of-main steam trap. The trap will be rebuilt or replaced as part of the scope of this measure.

serviceable, condition. Steam traps have not been maintained and are leaking steam.

Properly functioning steam traps pass air and drain condensate formed in the steam distribution systems and prevent live steam from exiting. The condensate is trapped and removed via various types of steam traps, each with a specific function and range of applications. Steam traps of differing design perform the task of removing condensate from various components such as drip legs, heating coils, and converters. These traps require periodic maintenance to assure proper operation.

Unit ventilators steam traps are the Trane 55 AL and are likely to be original. Steam trap maintenance has been on an as-needed basis. The estimated steam trap failure rate for the facility is 10%.

The quantities and sizes of the traps to be replaced are approximately as listed in the table below. Steam traps can generally be considered in need of testing and possible replacement when they are three years old, and are at the end of their useful life after five years.

Table 12.1: Steam Trap Quantities

Facility	1/2" and 3/4" Thermostatic	3/4" Float & Thermostatic
Memorial Boys and Girls Club	7	23

Proposed System

Ameresco proposes to replace and/or repair the steam traps at the identified buildings to improve the overall steam use and heating system efficiencies. The scope of work will consist of replacing all of the existing traps with new or retrofit traps. With this method, all failed traps are assured to be replaced. The malfunctioning F&T traps will be repaired where possible or replaced with properly sized equivalents, while the malfunctioning thermostatic traps will be fitted with new components. Steam trap housings will be reused wherever possible with only the critical parts being retrofitted with new elements. Thermostatic traps will be retrofit with new drop-in elements. If repairs to the existing thermostatic traps are not feasible, at Ameresco's discretion, the trap will be replaced with a new trap.

Ameresco did not observe any major issues that would merit a significant allowance for piping repair. A small allowance for minor improvements was carried and is limited to the immediate piping connected to the traps (within 2 linear feet). Major repairs to the existing steam and condensate piping are excluded from the scope.

Excluded from the scope of work is any asbestos abatement and repair of existing steam/condensate piping. Based on visual inspections, asbestos surrounding the steam traps was not present. Repair of damaged or missing insulation is not included in the scope of work.

The scope of work does not include the Gymnasium air handling unit above the stage, which is not in use.

Table 12.2: Steam Trap List

Quantity	Size (in)	Type	Product, or Equal
10	¾	Trane Float & Thermostatic	Tunstall 1RK-TR-55AL
8	¾	B&J Float & Thermostatic	Tunstall 1FT-BJ-15
5	¾	Hoffman Float & Thermostatic	Tunstall 1FP-HF-15
7	½ and ¾	Thermostatic	Tunstall Class 1 Capsule Repair Kit

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

Steam heating system efficiency will be improved by the imitation of this measure.

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Appendix for ECM 12: Steam Trap Replacement

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	12	
Measure Name:	Steam Trap Replacement	
Measure Location:		
Engineers:		

Site Name:			Memorial	Summary
Item		Units	Savings	
Electricity				
Energy On-Peak		kWh		0
Energy Off-Peak		kWh		0
Energy Total		kWh	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				
Natural Gas (NG)		Therms		0
Liquid Propane Gas (LPG)		Gallons		0
Steam		Mlbs		0
Fuel Oil, #2		Gallons	467	467
Fuel Oil, #4		Gallons		0
Fuel Oil, #6		Gallons		0
Miscellaneous		Misc		0
Water				
Water Savings		kGallons		0
Sewer				
Sewer Savings		kGallons		0

Town of Salisbury, Massachusetts
Sparhawk/Memorial School-Boys and Girls Club
Steam Trap Replacement

Function	Trap Type	Quantity	Trap Orifice Diameter (Inches)	Steam Pressure (Psig)	Quantity of Traps Failed Open	Quantity of Traps Leaking Open	Failed Trap Steam Loss (lbs/hr)	Leaking Trap Steam Loss (lbs/hr)	Heating System Operating Hours	Blow-by Steam (Mlb/yr)	Blow-by Steam (MMBTU)
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]
Drip	Bucket	0	2/16	5	0.0	0.0	0.0	0.0	2,976	0	0
Drip	FT	13	3/16	5	1.6	1.6	15.4	3.8	2,976	20	26
Hvac	3/4" FT	0	3/16	5	0.0	0.0	0.0	0.0	2,976	0	0
Hvac	1" FT	10	3/16	5	1.3	1.3	11.8	3.0	2,976	15	20
Hvac	1-1/4" FT	0	5/16	5	0.0	0.0	0.0	0.0	2,976	0	0
Hvac	1-1/2" FT	0	6/16	5	0.0	0.0	0.0	0.0	2,976	0	0
Hvac	2" FT	0	8/16	5	0.0	0.0	0.0	0.0	2,976	0	0
Rad	Thermo.	7	4/16	5	0.9	0.9	10.9	2.7	2,976	14	19
Venturi	Venturi	0	4/16	5	0.0	0.0	0.0	0.0	2,976	0	0
Totals		30			3.8	3.8	38.1	9.5		50	65

Item	Value	Units	Cell Ref	Remarks
Failed Trap Discharge Coefficient	0.25		[D22]	A function of hole size and geometry
Leaking Trap Discharge Coefficient	0.25		[D23]	A function of hole size and geometry
% of Failed Steam Traps	13%		[D24]	Estimated
% of Leaking Steam Traps	13%		[D25]	Estimated
% of Time Blow-by	35%		[D26]	Estimated
Heating System Efficiency	77%		[D27]	From Baseline
Enthalpy of Steam	1,000.0	Btu/lb	[D28]	Based on operating steam pressure

Cell Ref.	Comment
A	Equipment steam trap serves
B	Type of trap
C	Quantity of traps
D	Diameter of trap orifice
E	Operating steam pressure at steam trap
F	Quantity of traps failed
G	Quantity of traps leaking
H	$= 3600 \div 70 \times \text{PI}0 \div 4 \times [D22] \times [D]^2 \times ([E] + 14.7) \times [F]$
I	$= 3600 \div 70 \times \text{PI}0 \div 4 \times [D22] \times [D]^2 \times ([E] + 14.7) \times [F]$
J	Hours the heating system is on.
K	$= ([H] + [I]) \times [J] \times [D26] \div 1,000$
L	$= [K] \times 1,000 \times [D28] \div 1,000,000 \div [D27]$

Appendix for ECM 12: Steam Trap Replacement

II. Manufacturer Specification Sheets

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Tunstall Steam Trap Capsules®

Submittal Data

Project:

Engineer:

Contractor:

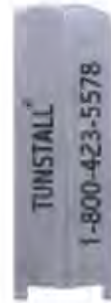
Representative/Supplier:



Post & Spring Style



Thread Type



Installation Tool

Features:

- 100% Stainless Steel Thermostatic Capsule, TIG Welded Construction
- Stainless Steel Spring (If Required)
- Stainless Steel Seat
- Stainless Steel Bellows
- EPDM Gasket Rated to 300°F (Saturated Steam)
- 36 Month Warranty

Specifications

Spring Type

For low pressure steam radiator traps vacuum to 45 psig. Stainless steel bellows with corrosion resistant stainless steel plug and seat. All parts calibrated inside a heavy duty stainless steel capsule (housing) with a stainless steel spring inserted on a stainless steel post at the top of capsule (housing). The seat projection to be unthreaded to facilitate easy installation where the orifice in the trap body has no threads.

Thread Type

For low pressure steam radiator traps vacuum to 45 psig. Stainless steel bellows with corrosion resistant stainless steel plug and seat. All parts calibrated inside a heavy duty stainless steel capsule (housing). The seat projection to be threaded to facilitate easy installation where the orifice in the trap body is threaded. TC Tool to be provided for ease of installation.

New steam trap covers may be necessary to facilitate the capsule installation and will be provided as required.

Tunstall



Float & Thermostatic Steam Traps

Series TA-FT

Operation

Tunstall Associates, Inc. produces a full line of Float & Thermostatic Steam Traps containing a float valve mechanism which modulates to discharge condensate continuously, while non-condensable gases are released by a separate internal balanced pressure thermostatic air vent (The Tunstall Capsule®).

The "H" pattern body on all ¾", 1" (15, 30, 75 & 125 psig) and 1-1/4" (15 & 30 psig) has been designed to offer maximum installation flexibility.

For larger sizes 1-1/2", 2" (15, 30, 75 & 125 psig) and 1-1/4" (75 & 125 psig), the inlet and outlet taps are located in the cover. This design allows for higher capacities and direct retrofits for older piping systems. All Tunstall float and thermostatic traps can be serviced without disturbing system piping.



Features

- Variety of piping connections.
- Stainless steel balanced pressure thermostatic air vent (Tunstall Capsule®).
- All stainless steel internal components
- Wide selection ¾"-2" @ 15, 30, 75 & 125 psig differential pressures.
- Designed to withstand water hammer & high load demands.
- Designed for In-line repair.
- Made in the U.S.A.

Construction

Tunstall float and thermostatic traps feature all stainless steel interiors, heavy duty trap housings, easy access to internal parts and convenient piping connections.

Materials of Construction

Body & Cover	Cast Iron-ASTMA 126CI B
Valve Head	Stainless Steel
Valve Seat	Stainless Steel
Valve Seat Gasket	Stainless Steel
Float	Stainless Steel
Bracket & Lever Assembly	Stainless Steel
Thermostatic Air Vent	Tunstall Capsule® Stainless Steel
Cover Bolts	Carbon Steel Grade 5
Cover Gasket	Non-Asbestos
Draining Plug	Stainless Steel



FLOAT & THERMOSTATIC STEAM TRAPS SERIES "TA-FT"

Engineering Specifications

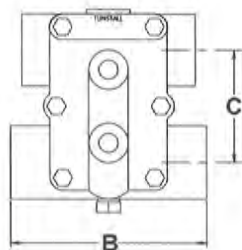
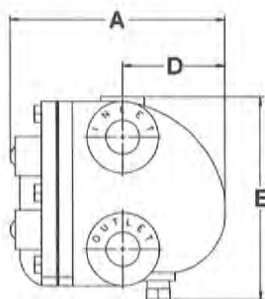
CAPACITIES*

lbs. Condensate per hour

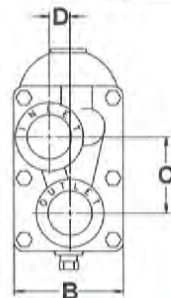
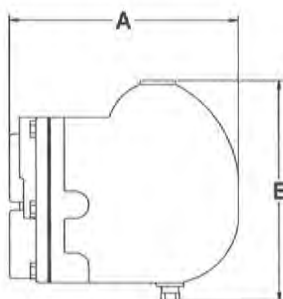
DIFFERENTIAL PRESSURE (PSI)

Model	Size NPT	PSIG Orifice	1/4	1/2	1	2	5	10	15	20	25	30	40	50	75	100	125
TA-FT3-15	3/4"	.218	279	369	489	650	785	1000	1075								
TA-FT4-15	1"	.218	279	369	489	650	785	1000	1075								
TA-FT5-15	1 1/4"	.312	600	770	980	1240	1640	2000	2340								
TA-FT6-15	1 1/2"	.500	1100	1700	2400	3300	5000	6600	7600								
TA-FT5-15	2"	.625	2300	2800	3600	4650	6900	9000	10900								
TA-FT3-30	3/4"	.218	279	369	489	650	785	1000	1075	1210	1300	1370					
TA-FT4-30	1"	.218	279	369	489	650	785	1000	1075	1210	1300	1370					
TA-FT5-30	1 1/4"	.228	375	500	690	910	1200	1500	1680	1800	1900	2000					
TA-FT6-30	1 1/2"	.390	1000	1300	1700	2300	3400	4600	5500	6000	6600	7000					
TA-FT8-30	2"	.500	1300	1800	2500	3400	5200	6800	7800	8600	9300	10000					
TA-FT3-75	3/4"	.166	160	213	280	365	520	700	795	875	930	970	1120	1230	1450		
TA-FT4-75	1"	.166	160	213	280	365	520	700	795	875	930	970	1120	1230	1450		
TA-FT5-75	1 1/4"	.312	550	725	960	1300	1900	2650	3050	3400	3700	4000	4400	4750	5400		
TA-FT6-75	1 1/2"	.312	550	725	960	1300	1900	2650	3050	3400	3700	4000	4400	4750	5400		
TA-FT8-75	2"	.421	850	1100	1500	2000	3100	4150	4750	5200	5500	5800	6400	6800	7700		
TA-FT3-125	3/4"	.125	100	135	175	230	330	415	500	585	620	685	750	830	970	1110	1190
TA-FT4-125	1"	.125	100	135	175	230	330	415	500	585	620	685	750	830	970	1110	1190
TA-FT5-125	1 1/4"	.246	400	520	680	890	1300	1700	2050	2300	2500	2700	3000	3200	3800	4200	4500
TA-FT6-125	1 1/2"	.246	400	520	680	890	1300	1700	2050	2300	2500	2700	3000	3200	3800	4200	4500
TA-FT8-125	2"	.332	550	375	880	1225	1950	2600	3000	3250	3500	3800	4200	4600	5500	6100	6600

All 3/4", 1",
1 1/4", TA-FT-15, TA-FT-30



All 1 1/2", 2",
1 1/4", TA-FT-75, TA-FT-125



Model	Size	DIMENSIONS (Inches)					Weight (lbs)
		A	B	C	D	E	
TA-FT3-15	3/4"	6.25	5.50	3.31	3.00	5.75	9
TA-FT4-15	1"	6.25	5.50	3.31	3.00	5.75	9
TA-FT5-15	1 1/4"	6.25	5.75	3.00	3.81	5.75	9 1/2
TA-FT6-15	1 1/2"	8.50	4.25	3.00	0.70	8.40	18
TA-FT8-15	2"	9.81	4.94	4.94	0.12	9.12	26
TA-FT3-30	3/4"	6.25	5.50	3.31	3.00	5.75	9
TA-FT4-30	1"	6.25	5.50	3.31	3.00	5.75	9
TA-FT5-30	1 1/4"	6.25	5.75	3.00	3.81	5.75	9 1/2
TA-FT6-30	1 1/2"	8.50	4.25	3.00	0.70	8.40	18
TA-FT8-30	2"	9.81	4.94	4.94	0.12	9.12	26
TA-FT3-75	3/4"	6.25	5.50	3.31	3.00	5.75	9
TA-FT4-75	1"	6.25	5.50	3.31	3.00	5.75	9
TA-FT5-75	1 1/4"	8.50	4.25	3.00	0.70	8.40	18
TA-FT6-75	1 1/2"	8.50	4.25	3.00	0.70	8.40	18
TA-FT8-75	2"	9.81	4.94	4.94	0.12	9.12	26
TA-FT3-125	3/4"	6.25	5.50	3.31	3.00	5.75	9
TA-FT4-125	1"	6.25	5.50	3.31	3.00	5.75	9
TA-FT5-125	1 1/4"	8.50	4.25	3.00	0.70	8.40	18
TA-FT6-125	1 1/2"	8.50	4.25	3.00	0.70	8.40	18
TA-FT8-125	2"	9.81	4.94	4.94	0.12	9.12	26

Tunstall Associates, Inc.
118 Exchange Street · Chicopee, MA 01013

Tunstall

Phone (413) 594-8695 · Fax (413) 598-8109
www.tunstall-inc.com

ECM 13: Variable Frequency Drives

ECM Overview

Ameresco proposes to install a variable speed drive and associated controls to control the airflow from the rooftop unit which serves the offices and conference room at the Hilton Senior Center. The results will be that airflow will be better distributed between the two zones in addition to saving fan electrical energy.

ECM Detail

Existing System

The Council on Aging offices and conference room are heated and cooled by a “rooftop unit”, i.e., a single package, heating and air-conditioning unit (Rheem RKKB-A102CL22E) located at the rear of the Council on Aging building at grade. This unit’s design flow rate is 3,400 ft.³ per minute and its supply fan capacity is two horsepower.

There are two zones of heating ventilating and air conditioning (HVAC), each controlled by a programmable thermostat. The offices and corridor are one zone; the conference room is the other zone. The existing thermostats and associated zone dampers are designed to vary airflow in each zone to control its temperature.

However, the rooftop unit provides a constant flow rate of air whenever it's operating. If airflow is closed to either of two zones while open to the other, then the unit's entire airflow will be diverted to the other zone. The “single zone on” case results in excessive flow rate for either zone, approximately twice what it should experience. This airflow over-supply results in excessively rapid heating or cooling and causes the system to operate with considerable noise.

Proposed System

Ameresco proposes to install a variable speed drive and associated controls to reduce the airflow from the rooftop unit when only one of the two zones is calling for heating or air-conditioning. The results will be that temperature is more accurately controlled and the appropriate airflow will be distributing to each zone. A more comfortable environment will result in each of the two zones in addition to saving fan electrical energy.



Figure 13.1: The supply fan in this unit will be controlled by a variable frequency drive for improved comfort and energy savings.

- *Detailed Scope of Work Summary*

- The two zone dampers will be verified to operate correctly as 2-position (open or closed) dampers as called for by each of the existing zone thermostats
- A variable frequency drive (VFD) for the rooftop unit's supply fan (2 HP, 208/3) will be installed in its control cabinet or the return air section
- A direct digital controller will be installed to implement the following logic:
 - The maximum speed of the VFD shall be determined when both dampers are fully opened, but set at 90% of full speed (adj)
 - The VFD speed shall be reduced to 45% (adj) when one damper is open and the other is closed
 - When both dampers are closed the RTU shall be off, as per the current control
 - Note: this ECM's scope does not include damper repair or replacement

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the engineering maintenance 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 office and conference room environments will be more closely control the temperature ends experience less heating and ventilating systems noise.

Appendix for ECM 13: Variable Frequency Drives

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	13	
Measure Name:	Variable Frequency Drives	
Measure Location:		
Engineers:		

Site Name:			COA	Summary
Item		Units	Savings	
Electricity				
Energy On-Peak		kWh	3,090	3,090
Energy Off-Peak		kWh	0	0
Energy Total		kWh	3,090	3,090
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

TMY-2 Weather Data for Lawrence Municipal Airport, 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/Hr Energy Consump. (MMBTU)	UnOcc Cooling/Hr Energy Consump. (MMBTU)	Peak Cool/Heat Fan Usage (kW/h)	Off-Peak Cool/Heat Fan Usage (kW/h)	Proposed VFD Load Percentage (%)	Occ Cool/Heat Fan Usage (kW/h)	UnOcc Cool/Heat Fan Usage (kW/h)	HVAC Fan Savings (Off-Peak kW/h)	HVAC Fan Savings (Peak kW/h)				
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	263	205	0	0	0	0	0	80%	0	0	0	0			
	100 to 105	102.5	0.0	0	0	0	0	0	0	0	0	237	184	0	0	0	0	0	80%	0	0	0	0			
	95 to 100	97.5	0.0	0	0	0	0	0	0	0	0	211	164	0	0	0	0	0	80%	0	0	0	0			
	90 to 95	92.5	72.6	0	8	0	8	2	6	0	0	184	143	0	4	0	0	0	80%	2	0	2	0			
	85 to 90	87.5	33.7	0	70	16	86	23	63	0	0	158	123	1	2	39	123	0	80%	21	0	19	0			
	80 to 85	82.5	68.9	33.1	2	202	67	73	198	0	0	132	102	3	6	124	0	80%	65	0	59	0				
	75 to 80	77.5	66.8	31.4	30	272	146	120	328	0	0	105	82	4	8	204	0	50%	26	0	178	0				
	70 to 75	72.5	64.1	89	245	171	505	135	370	0	0	79	61	3	7	231	0	50%	29	0	201	0				
	65 to 70	67.5	61.8	27.7	235	283	793	212	581	0	0	53	41	3	7	362	0	50%	46	0	316	0				
	60 to 65	62.5	58.3	372	248	341	961	257	704	0	0	26	20	2	4	439	0	50%	56	0	383	0				
Heating																										
	55 to 60	57.5	52.8	21.9	210	228	682	183	499	0	0	144	(5)	0	2	311	0	50%	40	0	272	0				
	50 to 55	52.5	48.5	254	202	240	741	198	543	0	0	(45)	(14)	2	9	338	0	50%	43	0	295	0				
	45 to 50	47.5	43.8	17.0	247	176	206	168	461	0	0	176	(23)	5	14	287	0	50%	37	0	312	0				
	40 to 45	42.5	38.9	14.7	261	246	783	210	573	0	0	(68)	(32)	9	25	357	0	50%	46	0	312	0				
	35 to 40	37.5	33.8	12.5	339	311	357	270	737	0	0	(80)	(41)	17	42	460	0	50%	59	0	401	0				
	30 to 35	32.5	29.3	10.6	300	189	268	203	554	0	0	(91)	(50)	16	39	346	0	80%	181	0	165	0				
	25 to 30	27.5	24.8	8.9	179	85	136	400	107	293	0	(103)	(60)	10	24	183	0	80%	95	0	87	0				
	20 to 25	22.5	20.0	7.1	115	60	258	69	189	0	0	(114)	(69)	8	18	118	0	80%	62	0	56	0				
	15 to 20	17.5	14.9	5.4	106	39	73	58	160	0	0	(126)	(78)	7	17	100	0	80%	52	0	48	0				
	10 to 15	12.5	10.2	4.0	20	26	80	21	59	0	0	(138)	(87)	3	7	37	0	80%	19	0	17	0				
	5 to 10	7.5	5.2	2.4	19	24	18	16	45	0	0	(149)	(96)	3	6	28	0	80%	15	0	13	0				
	0 to 5	2.5	0.8	1.1	34	7	13	14	40	0	0	(161)	(106)	3	6	25	0	80%	13	0	12	0				
	(-5 to 0)	(2.5)	(3.7)	(0.2)	12	1	2	4	11	0	0	(172)	(115)	1	2	7	0	80%	4	0	3	0				
	(-10 to -5)	(7.5)	(14.5)	(1.5)	3	0	3	1	2	0	0	(184)	(124)	0	0	1	0	80%	1	0	1	0				
	(-15 to -10)	(12.5)	0.0	0	0	0	0	0	0	0	0	(195)	(133)	0	0	0	0	80%	0	0	0	0				
	(-20 to -15)	(17.5)	0.0	0	0	0	0	0	0	0	0	(207)	(142)	0	0	0	0	80%	0	0	0	0				
	(-25 to -20)	(22.5)	0.0	0	0	0	0	0	0	0	0	(218)	(151)	0	0	0	0	80%	0	0	0	0				
				2 920	2 920	2 920	8 760	2 346	6 414	0	0			101	247	3 909	0		909	0		1 080				

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Lawrence Municipal Airport, 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	$= (-\text{col } 11 + \text{col } J) \times \text{P47} \times \text{P44} \times (\text{col } 5) \div \text{P45}$

Appendix for ECM 13: Variable Frequency Drives

II. Manufacturer Specification Sheets

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HITACHI
Inspire the Next

VARIABLE FREQUENCY DRIVE **L300P** Series

for Fan and Pump Applications



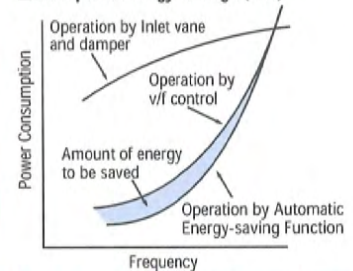
Hitachi's L300P Series Variable Frequency Drives Increased Energy Savings for Your

WIDE RANGE OF APPLICATION SPECIFIC FUNCTIONS

•AUTOMATIC ENERGY-SAVING FUNCTION

With its Automatic Energy-saving Function, the L300P delivers "real-time" energy-saving operation for your fan and pump applications. The function insures that motor operates at minimum current in response to the torque required by the load.

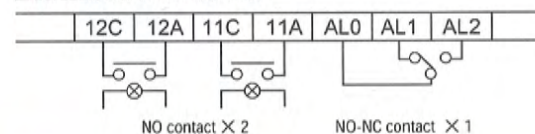
■ Example of Energy Savings (Fan)



•ENHANCED INPUT/OUTPUT TERMINALS

Three relay output terminals are provided as standard for flexible interface to external control systems.

■ INTELLIGENT RELAY OUTPUTS

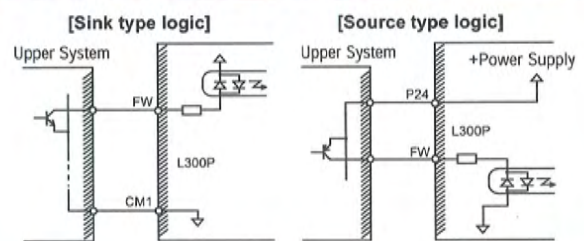


•ANALOG OUTPUT MONITOR

In addition to PWM monitor(FM), programmable analog output monitors are also available for both voltage(0–10VDC) and current(4–20mA) at AM and AMI terminals of the L300P.

•INTELLIGENT INPUT/OUTPUT TERMINAL SYSTEM

The L300P features an intelligent control terminal system, which allows necessary drive I/O functions to be freely programmed. Input terminals can be selected for either sink or source type logic.



•EASY-TO-USE OPERATOR PANEL

L300P's digital operator panel supports various monitoring functions.

- Output frequency
- Output current
- Rotation direction
- Process variable, PID feedback
- Intelligent input terminal status
- Intelligent output terminal status
- Scaled output frequency
- Output voltage
- Power
- Cumulative RUN time
- Cumulative power-on time
- Trip event
- Trip history
- Warning code

Frequency Drive Delivers Fan and Pump Applications!

FOR OPTIMAL OPERATION



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ISO 14001
EC97J1095



ISO 9001
JQA-1153

Hitachi variable frequency drives (inverters) in this brochure are produced at the factory registered under the ISO 14001 standard for environmental management system and the ISO 9001 standard for inverter quality management system.

EASE OF MAINTENANCE

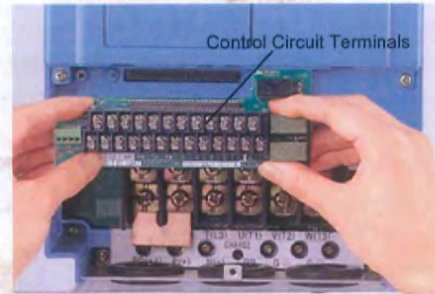
•EASY-REMOVABLE COOLING FAN AND DC BUS CAPACITOR

Cooling fan(s) and DC bus capacitors can be easily changed in the field. A fan ON/OFF function can be activated to provide longer cooling fan life.



•REMOVABLE CONTROL CIRCUIT TERMINALS

Eliminates control rewiring when field replacing the L300P.



COMPACT DESIGN

The L300P's compact size helps economize panel space. Installation area is reduced by approximately 30% from that of our previous series. (Comparison of 11kW (15HP))



USER-FRIENDLY OPERATION

•EASE OF OPERATION WITH DIGITAL OPERATOR (OPE-SR)

Output frequency can be controlled by the integral potentiometer provided as standard on the OPE-SR. The OPE-SR can be removed for remote control, and has an easy-to-see 4-digit display and LEDs to indicate the unit being monitored (i.e. frequency, amps, power, etc.). A multilingual operator (English, French, German, Italian, Spanish, and Portuguese) with copy function (SRW-0EX) and a digital operator without potentiometer (OPE-S) are also available as options.

•USER SELECTION OF COMMAND FUNCTIONS ("Quick Menu")

You can select frequently used commands and store them for fast reference.

•BUILT-IN RS485

RS485 is provided as standard for ASCII serial communication.

•PROGRAMMING SOFTWARE

Optional PC drive configuration software which runs on Windows® Operating System.



ENVIRONMENTAL FRIENDLINESS

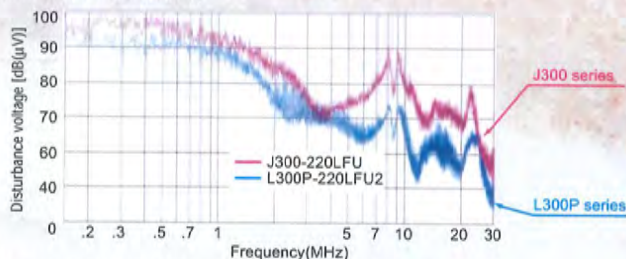
•EMI FILTER

EMI filters to meet European EMC (EN61800-3, EN55011) and low-voltage directive (EN50178) are available for system conformance.

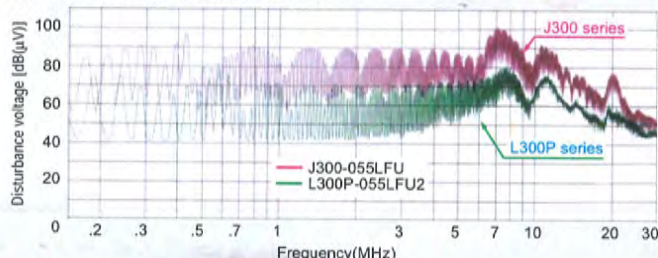
•REDUCED NOISE FROM MAIN CIRCUIT POWER SUPPLY AND CONTROL CIRCUIT POWER SUPPLY

Disturbance voltage of the main circuit power supply and of the control circuit power supply has been improved by approximately 15dB(μ V) and 20dB(μ V) respectively compared to our previous model(J300), resulting in significant reductions to noise interference with sensors and other peripheral devices.

- Disturbance voltage of the main circuit power supply (It does not comply with European EMC directive. To meet the EMC directive, please use an EMI filter.)



- Disturbance voltage of the control circuit power supply (Disturbance voltage of terminal L or CM1)



•HARMONICS MITIGATION

Terminals for the connection of a DC Reactor are provided as standard for harmonics suppression.

•CONTROL OF VOLTAGE OF MICRO SERGE

Suppressing the motor terminal voltage less than $2xE$ [V] by improving the control method of PWM output.

Input voltage: 400VAC (In the case)

Motor terminal voltage: $1,131V(400V \times \sqrt{2} \times 2)$

•IMPROVEMENT OF ENVIRONMENT

The printed circuit board inside an inverter is varnish coating specification as standard.

PROTECTION FOR VARIOUS INSTALLATION ENVIRONMENTS

Standard enclosure protection for the L300P is IP20 (NEMA1*). For IP54 (NEMA12), please contact Hitachi sales office.

*NEMA-1 applies up to 30kW. An optional wire-entry conduit box is required for 37kW to 75kW models to meet NEMA 1 rating.

GLOBAL PERFORMANCE

•CONFORMITY TO GLOBAL STANDARDS

CE, UL, c-UL, C-Tick approvals.

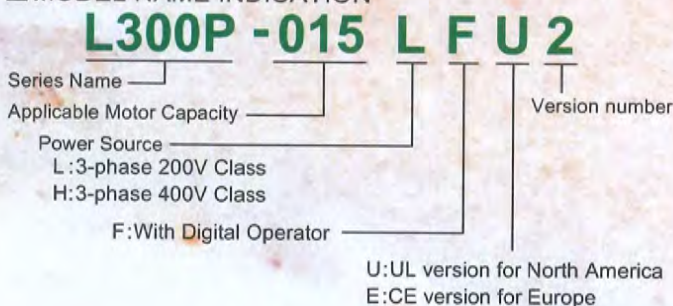


•NETWORK COMPATIBILITY

The L300P can communicate with DeviceNet™, PROFIBUS®, LONWORKS®, Modbus® RTU*1, and Ethernet™*2 with communication options.

*1, *2: Being planned

■MODEL NAME INDICATION



■MODEL CONFIGURATION

Applicable Motor Capacity in kW (HP)	3-phase 200V class	3-phase 400V class
1.5(2)	L300P-015LFU2	L300P-015HFU2/E2
2.2(3)	L300P-022LFU2	L300P-022HFU2/E2
3.7(5)	L300P-037LFU2	L300P-040HFU2/E2
5.5(7.5)	L300P-055LFU2	L300P-055HFU2/E2
7.5(10)	L300P-075LFU2	L300P-075HFU2/E2
11(15)	L300P-110LFU2	L300P-110HFU2/E2
15(20)	L300P-150LFU2	L300P-150HFU2/E2
18.5(25)	L300P-185LFU2	L300P-185HFU2/E2
22(30)	L300P-220LFU2	L300P-220HFU2/E2
30(40)	L300P-300LFU2	L300P-300HFU2/E2
37(50)	L300P-370LFU2	L300P-370HFU2/E2
45(60)	L300P-450LFU2	L300P-450HFU2/E2
55(75)	L300P-550LFU2	L300P-550HFU2/E2
75(100)	L300P-750LFU2	L300P-750HFU2/E2
90(125)		L300P-900HFU2/E2
110(150)		L300P-1100HFU2/E2
132(175)		L300P-1320HFU2/E2

- Windows is a registered trademark of Microsoft Corp. in the U.S. and other countries.
- DeviceNet is a trademark of Open DeviceNet Vendor Association.
- PROFIBUS is a registered trademark of Profibus Nutzer Organization.

STANDARD SPECIFICATIONS

Item		200V Class														
Model	UL version	015LFU2	022LFU2	037LFU2	055LFU2	075LFU2	110LFU2	150LFU2	185LFU2	220LFU2	300LFU2	370LFU2	450LFU2	550LFU2	750LFU2	
L300P-XXX	CE version	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Enclosure (*2)		IP20 (NEMA 1) (*1)														
Applicable motor (4-pole, kW(HP)) (*3)		1.5(2)	2.2(3)	3.7(5)	5.5(7.5)	7.5(10)	11(15)	15(20)	18.5(25)	22(30)	30(40)	37(50)	45(60)	55(75)	75(100)	
Rated capacity (kVA)	200V	2.5	3.6	5.7	8.3	11	15.2	20.0	25.2	29.4	39.1	48.4	58.5	72.7	93.5	
	240V	3.1	4.3	6.8	9.9	13.3	18.2	24.1	30.3	35.3	46.9	58.1	70.2	87.2	112.2	
Rated input voltage		3-phase (3-wire) 200–240V (±10%), 50/60Hz														
Rated input current (A)		8.3	12	18	26	35	48	64	80	94	124	154	186	231	297	
Required power supply capacity (kVA)		3	4.4	7.4	11	15	22	30	37	44	60	74	90	110	150	
Rated output voltage (*4)		3-phase (3-wire) 200–240V (Corresponding to input voltage)														
Rated output current (continuous)(A)		7.5	10.5	16.5	24	32	44	58	73	85	113	140	169	210	270	
Control method		Line to line sine wave PWM														
Output frequency range (*5)		0.1–400Hz														
Frequency accuracy		Digital: ±0.01% of the maximum frequency, Analog: ±0.2%(25±10°C)														
Frequency resolution		Digital setting: 0.01Hz, Analog setting: (Maximum frequency)/4,000 (0 terminal: 12-bit 0–10V, 02 terminal: 12-bit –10–+10V)														
V/f characteristics		V/f optionally variable, V/f control (Constant torque, reduced torque)														
Overload capacity		120% for 60sec., 150% for 0.5sec.														
Acceleration/deceleration time		0.01–3,600sec. (Linear/curve, accel./decel. selection), Two-stage accel./decel.														
Braking	Dynamic braking (Short-time) (*6)	Built-in BRD circuit(optional resistor)							External dynamic braking unit (option)							
	DC braking	Performs at start; under set frequency at deceleration, or via an external input (braking force, time, and operating frequency).														
Input signal	Frequency setting	Operator	Up and Down keys													
		Potentiometer	Potentiometer													
		External signal	DC 0–10V, –10–+10V (input impedance 10kΩ), 4–20mA (input impedance 100Ω)													
		External port	RS-485 interface													
	Forward/reverse	Operator	Run key/Stop key (FW/RV can be set by function command.)													
		External signal	FW RUN/STOP (NO contact), RV set by terminal assignment (NO/NC selection), 3-wire input available													
	Start/stop	External port	Set by RS-485													
		Intelligent input terminals (Assign five functions to terminals)	RV(Reverse), CF1-CF4(Multispeed command), JG(Jogging), DB(External DC braking), SET(Second motor constants setting), 2CH(Second accel./decel.), FRS(Free-run stop), EXT(External trip), USP(Unattended start protection), CS(Change to/from commercial power supply), SFT(Software lock), AT(Analog input selection), RS(Reset), STA(3-wire start), STP(3-wire stop), F/R(3-wire fwd./rev.), PID(PID On/Off), PIDC(PID reset), UP/DWN(Remote-controlled accel./decel.) UDC(Remote-controlled data clearing), SF1-SF7(Multispeed bit command 1-7), OLR(Overload limit change), ROK(RUN Permissive) and NO(Not selected)													
Output signal	Thermistor input	One terminal(PTC)														
	Intelligent output terminals	Assign three functions to two NO contacts and one NO-NC combined contact (RUN, FA1, FA2, OL, OD, AL, FA3, IP, UV, RNT, ONT RMD and THM)														
	Intelligent monitor output terminals	Analog voltage, analog current, PWM output														
Display monitor		Output frequency, output current, scaled value of output frequency, trip history, I/O terminal condition, input power, output voltage														
Other user-settable parameters		V/f free-setting (up to 7 points), frequency upper/lower limit, frequency jump, accel./decel. curve selection, manual torque boost value and frequency adjustment, analog meter tuning, starting frequency, carrier frequency, electronic thermal protection level, external frequency output zero/span reference, external frequency input bias start/end, analog input selection, retry after trip, reduced voltage soft start, overload restriction, automatic energy-saving														
Carrier frequency range		0.5–12kHz														
Protective functions		Over-current protection, overload protection, braking resistor overload protection, over-voltage protection, EEPROM error, under-voltage error, CT(Current transformer) error, CPU error, external trip, USP error, ground fault, input over-voltage protection, instantaneous power failure, option 1 connection error, option 2 connection error, inverter thermal trip, phase failure detection, IGBT error, thermistor error														
Environmental conditions	Ambient operating /storage temperature(*7)/humidity	–10–40°C(*9) / –20–65°C / 25–90%RH (No condensation)														
	Vibration (*8)	5.9m/s ² (0.6G), 10–55Hz										2.9m/s ² (0.3G), 10–55Hz				
	Location	Altitude 1,000m or less, indoors (no corrosive gases or dust)														
Color		Blue										Gray (Bezel for digital operator is blue)				
Options		EMI filters, input/output reactors, DC reactors, radio noise filters, braking resistors, braking units, LCR filter, communication cables, Network interface cards														
Operator		OPE-SR(4-digit LED with potentiometer) / OPE-SRE(4-digit LED with potentiometer, English overlay) Optional: OPE-S(4-digit LED), SRW-0EX(Multilingual (English, French, German, Italian, Spanish, and Portuguese) operator with copy function), ICS-1.3(Cable for operators(1m, 3m))														
Weight kg (lbs.)		3.5 (7.7)	3.5 (7.7)	3.5 (7.7)	3.5 (7.7)	5 (11)	5 (11)	5 (11)	12 (26.4)	12 (26.4)	12 (26.4)	20 (44)	30 (66)	30 (66)	50 (110)	

*1: Up to 30kW.

An optional conduit box is required for 37kW to 55kW to meet NEMA 1.

*2: The protection method conforms to JEM 1030 / NEMA(U.S.).

*3: The applicable motor refers to Hitachi standard 3-phase motor (4-pole). To use other motors, care must be taken to prevent the rated motor current (50Hz) from exceeding the rated output current of the inverter.

*4: The output voltage decreases as the main power supply voltage decreases except for the use of AVR function.

*5: To operate the motor beyond 50/60Hz, please consult with the motor manufacturer about the maximum allowable rotation speed.

*6: Braking resistor is not integrated in the inverter. Please install optional braking resistor or dynamic braking unit when large braking torque is required.

*7: Storage temperature refers to the temperature in transportation.

*8: Conforms to the test method specified in JIS C0040(1999).

*9: When using the inverter from 40° to 50°C ambient, the output current of the inverter must be derated (see the next section on derating curves).

Item		400V Class										
Model L300P-XXX	UL version	015HFU2	022HFU2	040HFU2	055HFU2	075HFU2	110HFU2	150HFU2	185HFU2	220HFU2	300HFU2	
	CE version	015HFE2	022HFE2	040HFE2	055HFE2	075HFE2	110HFE2	150HFE2	185HFE2	220HFE2	300HFE2	
Enclosure (*2)		IP20 (NEMA 1) (*1)										
Applicable motor (4-pole, kW(HP)) (*3)		1.5(2)	2.2(3)	4.0(5)	5.5(7.5)	7.5(10)	11(15)	15(20)	18.5(25)	22(30)	30(40)	
Rated capacity (kVA)	400V	2.6	3.6	5.9	8.3	11	15.2	20.0	25.6	29.7	39.4	
	480V	3.1	4.4	7.1	9.9	13.3	18.2	24.1	30.7	35.7	47.3	
Rated input voltage		3-phase (3-wire) 380-480V (±10%), 50/60Hz										
Rated input current (A)		4.2	5.8	9.5	13	18	24	32	41	47	63	
Required power supply capacity (kVA)		3	4.4	8	11	15	22	30	37	44	60	
Rated output voltage (*4)		3-phase (3-wire) 380-480V (Corresponding to input voltage)										
Rated output current (continuous)(A)		3.8	5.3	8.6	12	16	22	29	37	43	57	
Control method		Line to line sine wave PWM										
Output frequency range (*5)		0.1-400Hz										
Frequency accuracy		Digital: ±0.01% of the maximum frequency, Analog: ±0.2%(25±10°C)										
Frequency resolution		Digital setting: 0.01Hz, Analog setting: (Maximum frequency)/4,000 (0 terminal: 12-bit 0-10V, 02 terminal: 12-bit -10-+10V)										
V/f characteristics		V/f optionally variable, V/f control (Constant torque, reduced torque)										
Overload capacity		120% for 60sec., 150% for 0.5sec.										
Acceleration/deceleration time		0.01-3,600sec. (Linear/curve, accel./decel. selection), Two-stage accel./decel.										
Braking	Dynamic braking (Short-time) (*6)	Built-in BRD circuit(optional resistor)							External dynamic braking unit (option)			
	DC braking	Performs at start; under set frequency at deceleration, or via an external input (braking force, time, and operating frequency).										
Input signal	Frequency setting	Operator	Up and Down keys									
		Potentiometer	Potentiometer									
		External signal	DC 0-10V, -10-+10V (input impedance 10kΩ), 4-20mA (input impedance 100Ω)									
		External port	RS-485 interface									
	Forward/ reverse	Operator	Run key/Stop key (FW/RV can be set by function command.)									
		External signal	FW RUN/STOP (NO contact), RV set by terminal assignment (NO/NC selection), 3-wire input available									
	Start/stop	External port	Set by RS-485									
	Intelligent input terminals (Assign five functions to terminals)		RV(Reverse), CF1-CF4(Multispeed command), JG(Jogging), DB(External DC braking), SET(Second motor constants setting), 2CH(Second accel./decel.), FRS(Free-run stop), EXT(External trip), USP(Unattended start protection), CS(Change to/from commercial power supply), SFT(Software lock), AT(Analog input selection), RS(Reset), STA(3-wire start), STP(3-wire stop), F/R(3-wire fwd./rev.), PID(PID On/Off), PIDC(PID reset), UP/DWN(Remote-controlled accel./decel.) UDC(Remote-controlled data clearing), SF1-SF7(Multispeed bit command 1-7), OLR(Overload limit change), ROK(RUN Permissive) and NO(Not selected)									
Thermistor input		One terminal(PTC)										
Output signal	Intelligent output terminals	Assign three functions to two NO contacts and one NO-NC combined contact (RUN, FA1, FA2, OL, OD, AL, FA3, IP, UV, RNT, ONT RMD and THM)										
	Intelligent monitor output terminals	Analog voltage, analog current, PWM output										
Display monitor		Output frequency, output current, scaled value of output frequency, trip history, I/O terminal condition, input power, output voltage										
Other user-settable parameters		V/f free-setting (up to 7 points), frequency upper/lower limit, frequency jump, accel./decel. curve selection, manual torque boost value and frequency adjustment, analog meter tuning, starting frequency, carrier frequency, electronic ther- mal protection level, external frequency output zero/span reference, external frequency input bias start/end, analog input selection, retry after trip, reduced voltage soft start, overload restriction, automatic energy-saving										
Carrier frequency range		0.5-12kHz										
Protective functions		Over-current protection, overload protection, braking resistor overload protection, over-voltage protection, EEPROM error, under-voltage error, CT(Current transformer) error, CPU error, external trip, USP error, ground fault, input over- voltage protection, instantaneous power failure, option 1 connection error, option 2 connection error, inverter thermal trip, phase failure detection, IGBT error, thermistor error										
Environmental conditions	Ambient operating /storage temperature(*7)/humidity	-10-40°C(*9) / -20-65°C / 25-90%RH (No condensation)										
	Vibration (*8)	5.9m/s² (0.6G), 10-55Hz										
	Location	Altitude 1,000m or less, indoors (no corrosive gases or dust)										
Color		Blue										
Options		EMI filters, input/output reactors, DC reactors, radio noise filters, braking resistors, braking units, LCR filter, communi- cation cables, Network interface cards										
Operator		OPE-SR(4-digit LED with potentiometer) / OPE-SRE(4-digit LED with potentiometer, English overlay) Optional: OPE-S(4-digit LED), SRW-0EX(Multilingual (English, French, German, Italian, Spanish, and Portuguese) operator with copy function), ICS-1,3(Cable for operators(1m, 3m))										
Weight kg (lbs.)		3.5 (7.7)	3.5 (7.7)	3.5 (7.7)	3.5 (7.7)	5 (11)	5 (11)	5 (11)	12 (26.4)	12 (26.4)	12 (26.4)	

*1: Up to 30kW.

An optional conduit box is required for 37kW to 55kW to meet NEMA 1.

*2: The protection method conforms to JEM 1030 / NEMA(U.S.).

*3: The applicable motor refers to Hitachi standard 3-phase motor (4-pole).

To use other motors, care must be taken to prevent the rated motor current (50Hz) from exceeding the rated output current of the inverter.

*4: The output voltage decreases as the main power supply voltage decreases except for the use of AVR function.

*5: To operate the motor beyond 50/60Hz, please consult with the motor manufacturer about the maximum allowable rotation speed.

*6: Braking resistor is not integrated in the inverter. Please install optional braking resistor or dynamic braking unit when large braking torque is required.

*7: Storage temperature refers to the temperature in transportation.

*8: Conforms to the test method specified in JIS C0040(1999).

*9: When using the inverter from 40° to 50°C ambient, the output current of the inverter must be derated (see the next section on derating curves).

STANDARD SPECIFICATIONS

Item			400V Class						
Model L300P-XXX		UL version	370HFU2	450HFU2	550HFU2	750HFU2	900HFU2	1100HFU2	1320HFU2
		CE version	370HFE2	450HFE2	550HFE2	750HFE2	900HFE2	1100HFE2	1320HFE2
Enclosure (*2)			IP20 (NEMA 1) (*1)			IP00			
Applicable motor (4-pole, kW(HP)) (*3)			37(50)	45(60)	55(75)	75(100)	90 (125)	110 (150)	132 (175)
Rated capacity (kVA)		400V	48.4	58.8	72.7	93.5	110.8	135.0	159.3
		480V	58.1	70.1	87.2	112.2	133.0	162.1	191.2
Rated input voltage			3-phase (3-wire) 380–480V (±10%), 50/60Hz						
Rated input current (A)			77	94	116	149	176	215	253
Required power supply capacity (kVA)			74	90	110	150	180	220	264
Rated output voltage (*4)			3-phase (3-wire) 380-480V (Corresponding to input voltage)						
Rated output current (continuous)(A)			70	85	105	135	160	195	230
Control method			Line to line sine wave PWM						
Output frequency range (*5)			0.1–400Hz						
Frequency accuracy			Digital: ±0.01% of the maximum frequency, Analog: ±0.2%(25±10°C)						
Frequency resolution			Digital setting: 0.01Hz, Analog setting: (Maximum frequency)/4,000 (0 terminal: 12-bit 0–10V, 02 terminal: 12-bit –10–+10V)						
V/f characteristics			V/f optionally variable, V/f control (Constant torque, reduced torque)						
Overload capacity			120% for 60sec., 150% for 0.5sec.						
Acceleration/deceleration time			0.01–3.600sec. (Linear/curve, accel./decel. selection), Two-stage accel./decel.						
Braking	Dynamic braking (Short-time) (*6)		External dynamic braking unit (option)						
	DC braking		Performs at start; under set frequency at deceleration, or via an external input (braking force, time, and operating frequency).						
Input signal	Frequency setting	Operator	Up and Down keys						
		Potentiometer	Potentiometer						
		External signal	DC 0–10V, –10–+10V (input impedance 10kΩ), 4–20mA (input impedance 100Ω)						
		External port	RS-485 interface						
	Forward/ reverse	Operator	Run key/Stop key (FW/RV can be set by function command.)						
		External signal	FW RUN/STOP (NO contact), RV set by terminal assignment (NO/NC selection), 3-wire input available						
		External port	Set by RS-485						
	Intelligent input terminals (Assign five functions to terminals)		RV(Reverse), CF1-CF4(Multispeed command), JG(Jogging), DB(External DC braking), SET(Second motor constants setting), 2CH(Second accel./decel.), FRS(Free-run stop), EXT(External trip), USP(Unattended start protection), CS(Change to/from commercial power supply), SFT(Software lock), AT(Analog input selection), RS(Reset), STA(3-wire start), STP(3-wire stop), F/R(3-wire fwd./rev.), PID(PID On/Off), PIDC(PID reset), UP/DWN(Remote-controlled accel./decel.) UDC(Remote-controlled data clearing), SF1-SF7(Multispeed bit command 1-7), OLR(Overload limit change), ROK(RUN Permission) and NO(Not selected)						
	Thermistor input		One terminal(PTC)						
	Output signal	Intelligent output terminals		Assign three functions to two NO contacts and one NO-NC combined contact (RUN, FA1, FA2, OL, OD, AL, FA3, IP, UV, RNT, ONT, RMD and THM)					
Intelligent monitor output terminals		Analog voltage, analog current, PWM output							
Display monitor			Output frequency, output current, scaled value of output frequency, trip history, I/O terminal condition, input power, output voltage						
Other user-settable parameters			V/f free-setting (up to 7 points), frequency upper/lower limit, frequency jump, accel./decel. curve selection, manual torque boost value and frequency adjustment, analog meter tuning, starting frequency, carrier frequency, electronic thermal protection level, external frequency output zero/span reference, external frequency input bias start/end, analog input selection, retry after trip, reduced voltage soft start, overload restriction, automatic energy-saving						
Carrier frequency range			0.5–12kHz			0.5–8kHz			
Protective functions			Over-current protection, overload protection, braking resistor overload protection, over-voltage protection, EEPROM error, under-voltage error, CT(Current transformer) error, CPU error, external trip, USP error, ground fault, input over-voltage protection, instantaneous power failure, option 1 connection error, option 2 connection error, inverter thermal trip, phase failure detection, IGBT error, thermistor error						
Environmental conditions	Ambient operating /storage temperature(*7)/humidity		–10–40°C(*9) / –20–65°C / 25–90%RH (No condensation)						
	Vibration (*8)		2.9m/s² (0.3G), 10–55Hz						
	Location		Altitude 1,000m or less, indoors (no corrosive gases or dust)						
Color			Gray (Bezel for digital operator is blue)						
Options			EMI filters, input/output reactors, DC reactors, radio noise filters, braking resistors, braking units, LCR filter, communication cables, Network interface cards						
Operator			OPE-SR(4-digit LED with potentiometer) / OPE-SRE(4-digit LED with potentiometer, English overlay) Optional: OPE-S(4-digit LED), SRW-0EX(Multilingual (English,French, German, Italian, Spanish, and Portuguese) operator with copy function), ICS-1,3(Cable for operators(1m, 3m))						
Weight kg (lbs.)			20 (44)	30 (66)	30 (66)	30 (66)	60 (132)	60 (132)	80 (176)

*1: Up to 30kW.

An optional conduit box is required for 37kW to 55kW to meet NEMA 1.

*2: The protection method conforms to JEM 1030 / NEMA(U.S.).

*3: The applicable motor refers to Hitachi standard 3-phase motor (4-pole).
To use other motors, care must be taken to prevent the rated motor current (50Hz) from exceeding the rated output current of the inverter.

*4: The output voltage decreases as the main power supply voltage decreases except for the use of AVR function.

*5: To operate the motor beyond 50/60Hz, please consult with the motor manufacturer about the maximum allowable rotation speed.

*6: Braking resistor is not integrated in the inverter. Please install optional braking resistor or dynamic braking unit when large braking torque is required.

*7: Storage temperature refers to the temperature in transportation.

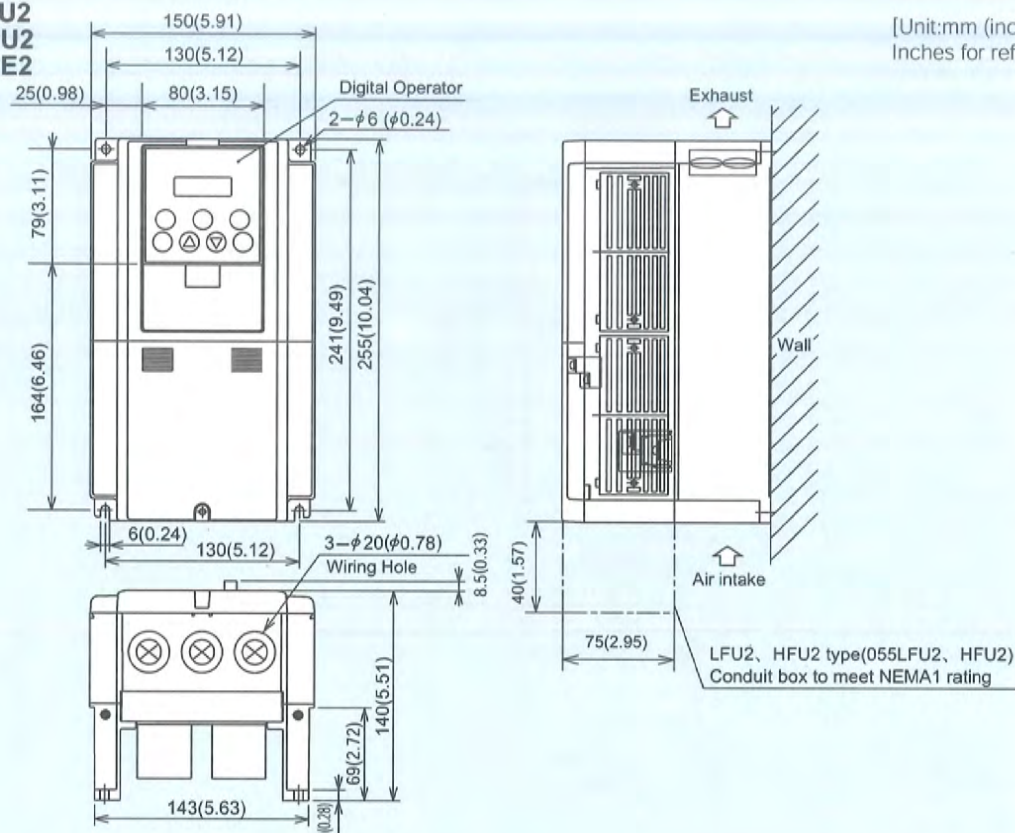
*8: Conforms to the test method specified in JIS C0040(1999).

*9: When using the inverter from 40° to 50°C ambient, the output current of the inverter must be derated (see the next section on derating curves).

DIMENSIONS

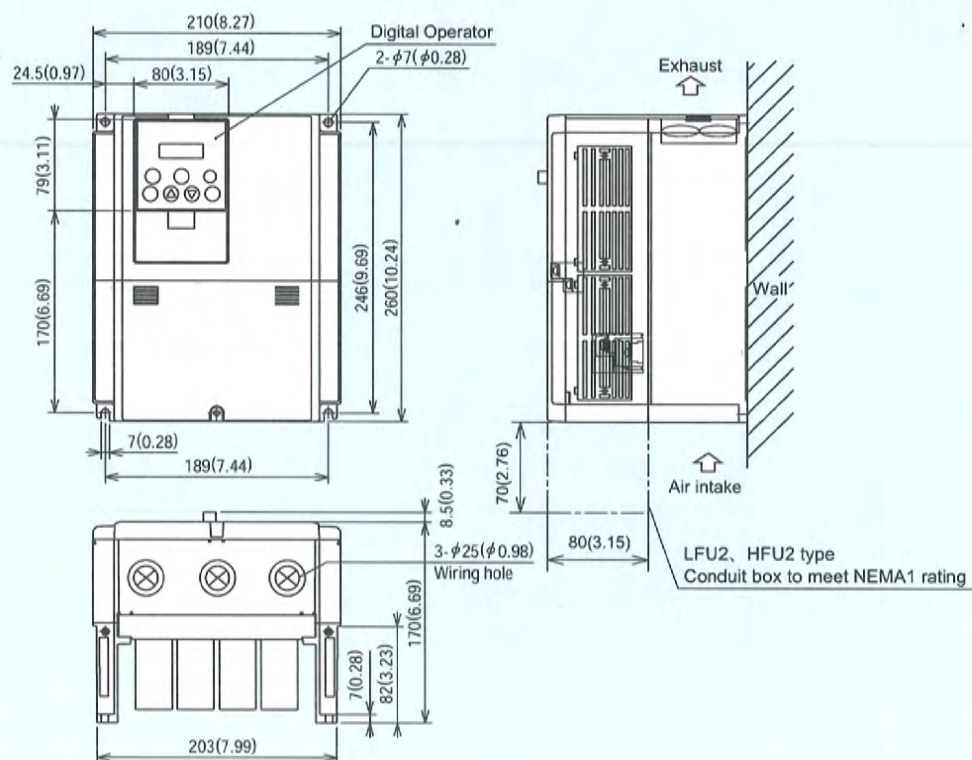
● L300P-015-055LFU2 015-055HFU2 015-055HFE2

[Unit:mm (inch)]
Inches for reference only



● L300P-075-150LFU2, 075-150HFE2, 075-150HFU2

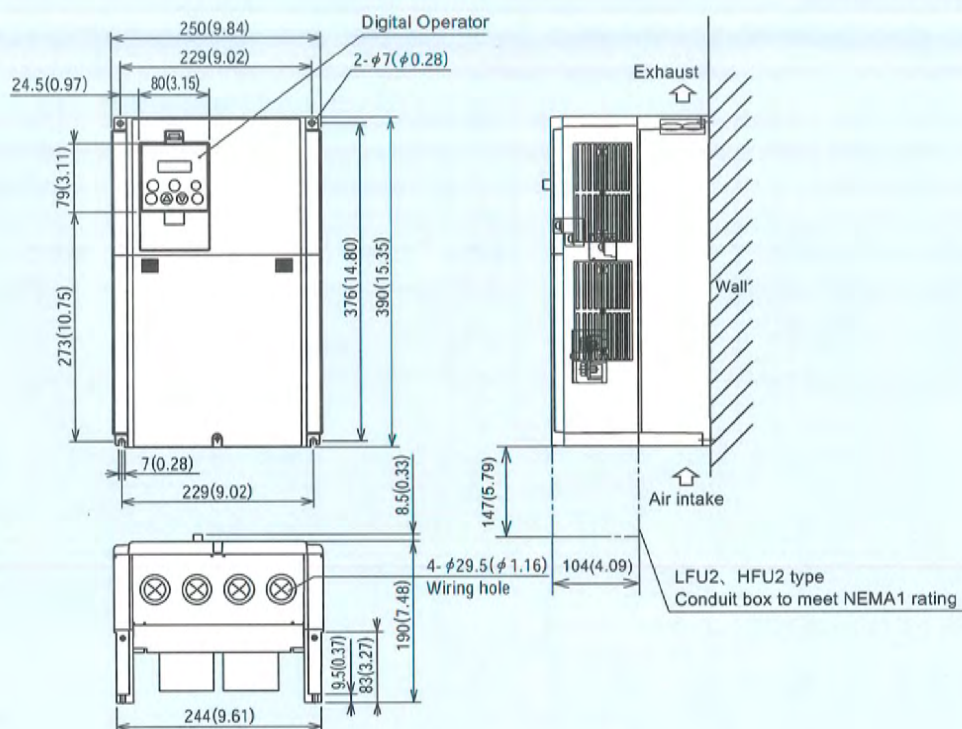
[Unit:mm (inch)]
Inches for reference only



DIMENSIONS

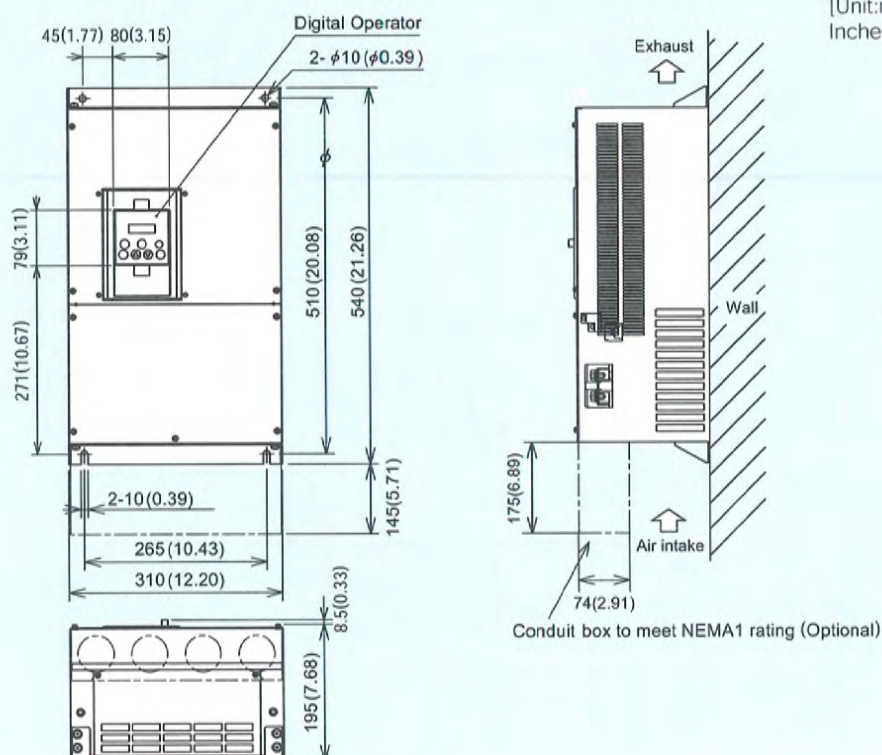
● L300P-185-300LFU2, 185-300HFE2, 185-300HFU2

[Unit:mm (inch)]
Inches for reference only

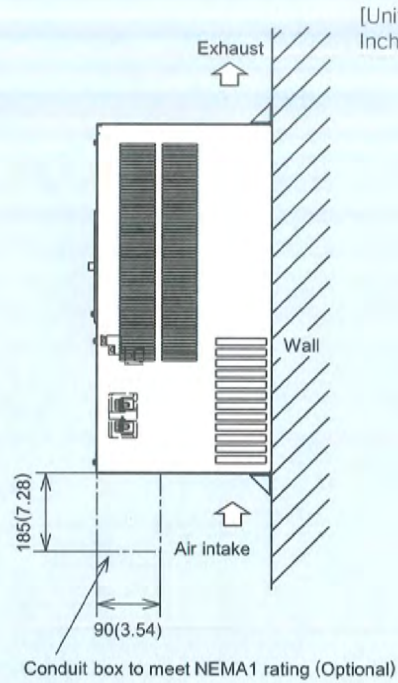
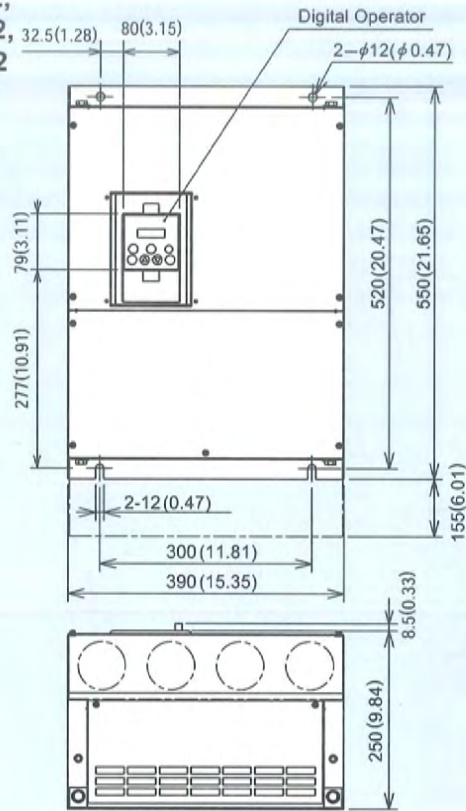


● L300P-370LFU2, 370HFE2, 370HFU2

[Unit:mm (inch)]
Inches for reference only

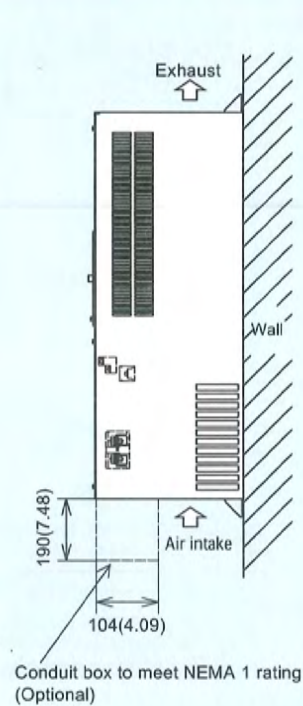
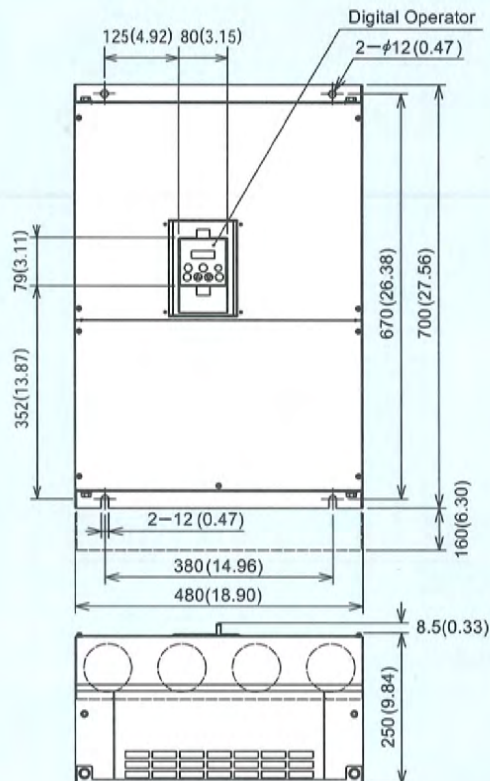


● L300P-450-550LFU2,
450-750HFE2,
450-750HFU2



[Unit:mm (inch)]
Inches for reference only

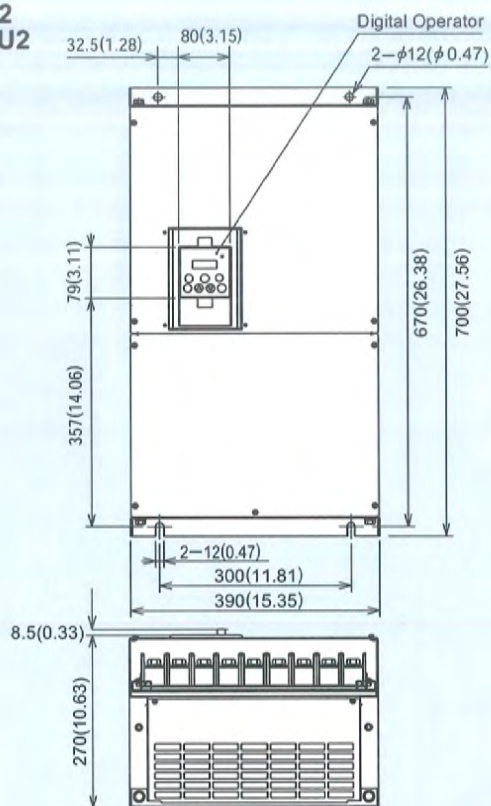
● L300P-750LFU2



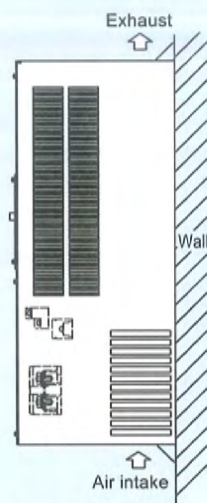
[Unit:mm (inch)]
Inches for reference only

DIMENSIONS

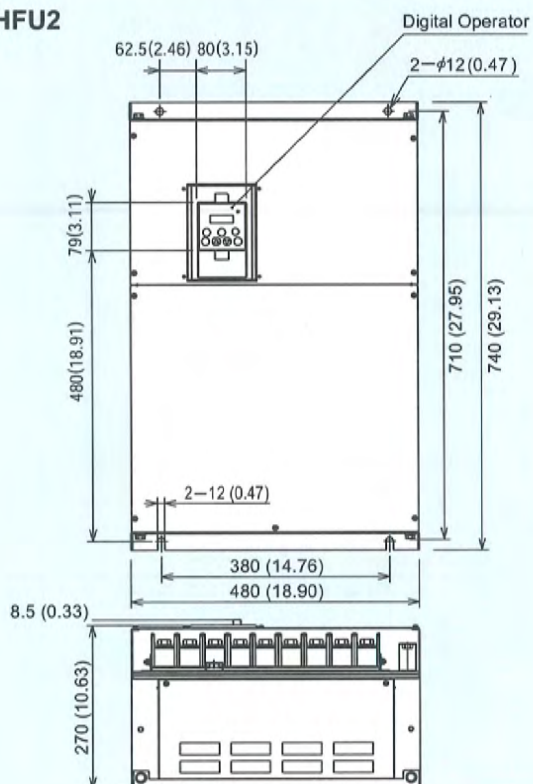
● L300P-900HFE2, HFU2 -1100HFE2, HFU2



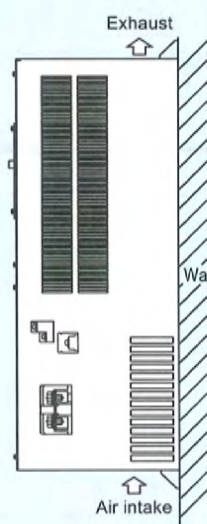
[Unit:mm (inch)]
Inches for reference only



● L300P-1320HFE2, HFU2



[Unit:mm (inch)]
Inches for reference only



OPERATION and PROGRAMMING

L300P Series can be easily operated with the digital operator (OPE-SR) provided as standard. The Digital operator can also be detached and used for remote-control. A multilingual (English, French, German Italian, Spanish, and Portuguese) operator with copy function (SRW-0EX) or a digital operator without potentiometer (OPE-S) is also available as an option. (For US version, OPE-SRE (English overlay with potentiometer) is provided as standard.)

Parameter Display

Displays frequency, motor current, rotational speed of the motor, and an alarm code.

Monitor LEDs

Shows drive's status.

RUN Key

Press to run the motor.

STOP/RESET Key

Press to stop the drive or reset an alarm.

Function Key

Press to set or monitor a parameter value.



Power LED

Lights when the power input to the drive is ON.

Display Unit LEDs

Indicates the unit associated with the parameter display.

Potentiometer

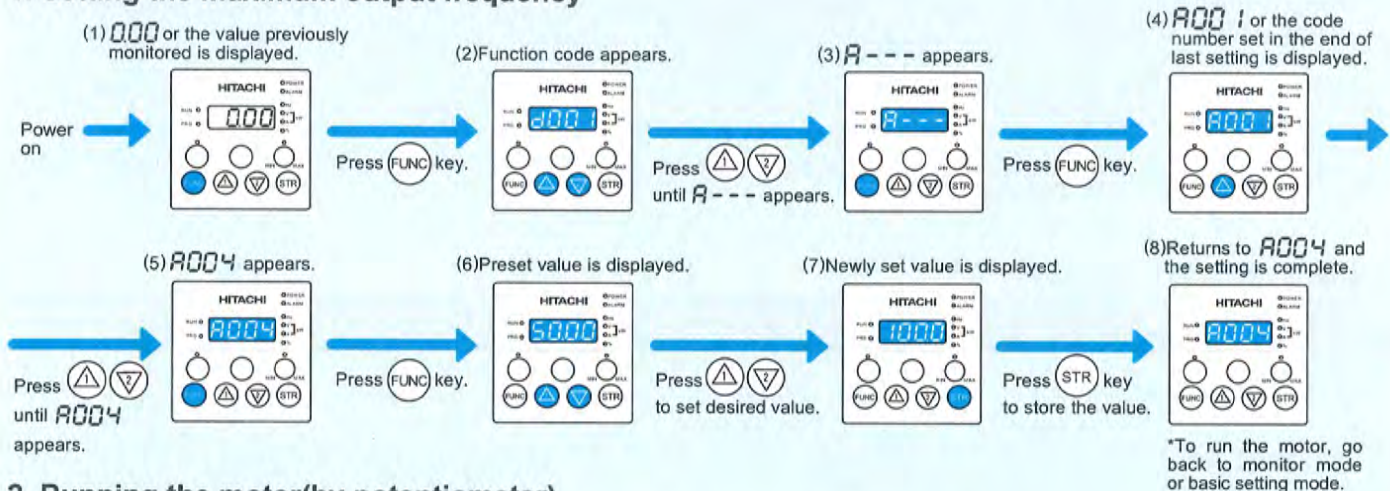
Store Key

Press to write the new value to the EEPROM.

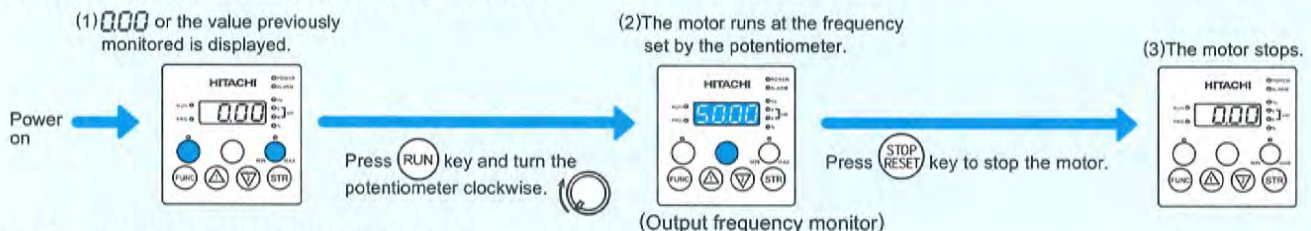
Up/Down Keys

Press up or down to sequence through parameters and functions shown on the display, and increment/decrement values.

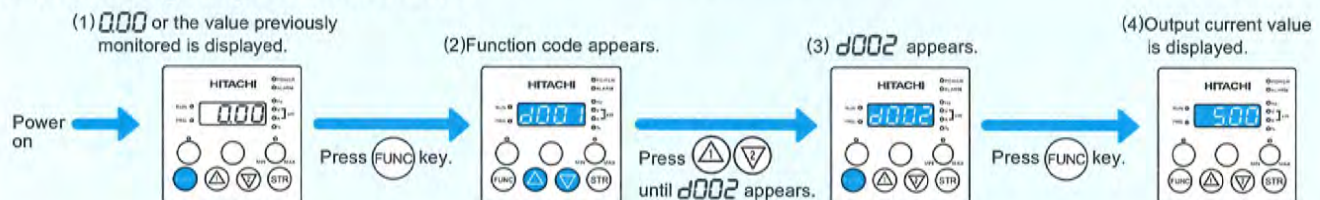
1. Setting the maximum output frequency



2. Running the motor (by potentiometer)



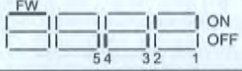
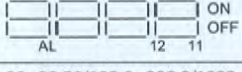
3. Monitoring output current value



FUNCTION LIST

Monitoring Functions and Main Profile Parameters

○ = Allowed
× = Not permitted

Code	Name	Description	Default Setting		Run-time Setting	Run-time Data Edit (Enabled at 003)
-FE(CE)	-FU2(UL)					
d001	Output frequency monitor	0.00–99.99/100.0–400.0Hz	–	–	–	–
d002	Output current monitor	0.0–999.9A	–	–	–	–
d003	Motor rotational direction monitor	F(Forward) / o(Stop) / r(Reverse)	–	–	–	–
d004	Process variable (PV), PID feedback monitor	0.00–99.99/100.0–999.9/1000.–9999./1000–9999/[100–[999(10,000–99,900)	–	–	–	–
d005	Intelligent input terminal status	 (Example) Terminal FW, 2 and 1 : ON Terminal 5, 4, and 3 : OFF	–	–	–	–
d006	Intelligent output terminal status	 (Example) Terminal 12 and 11 : ON AL : OFF	–	–	–	–
d007	Scaled output frequency monitor	0.00–99.99/100.0–999.9/1000.–9999./1000–3996(10,000–39,960)	–	–	–	–
d013	Output voltage monitor	0.0–600.0V	–	–	–	–
d014	Power monitor	0.0–999.9kW	–	–	–	–
d016	Cumulative RUN time monitor	0.–9999./1000–9999/[100–[999(10,000–99,900)hr	–	–	–	–
d017	Cumulative power-on time monitor	0.–9999./1000–9999/[100–[999(10,000–99,900)hr	–	–	–	–
d080	Trip count monitor	0.–9999./1000–6553(10,000–65,530)	–	–	–	–
d081 d086	Trip monitor 1–6	Displays trip event information	–	–	–	–
d090	Warning monitor	Warning code	–	–	–	–
F001	Output frequency setting	0.0, Starting frequency to maximum frequency / maximum frequency for second motor	0.00Hz	0.00Hz	○	○
F002	Acceleration time (1) setting	0.01–99.99/100.0–999.9/1000.–3600. sec.	30.00s	60.00s	○	○
F202	Acceleration time (1) setting for second motor	0.01–99.99/100.0–999.9/1000.–3600. sec.	30.00s	60.00s	○	○
F003	Deceleration time (1) setting	0.01–99.99/100.0–999.9/1000.–3600. sec.	30.00s	60.00s	○	○
F203	Deceleration time (1) setting for second motor	0.01–99.99/100.0–999.9/1000.–3600. sec.	30.00s	60.00s	○	○
F004	Motor rotational direction setting	00(Forward) / 01 (Reverse)	00	00	×	×
A---	A Group: Standard functions					
b---	b Group: Fine tuning functions					
C---	C Group: Intelligent terminal functions					
H---	H Group: Motor constants functions					
P---	P Group: Expansion card functions					
U---	U Group: User-selectable menu functions					

A Group: Standard Functions

○ = Allowed
× = Not permitted

Code	Name	Description	Default Setting		Run-time Setting	Run-time Data Edit (Enabled at 003)
-FE(CE)	-FU2(UL)					
A001	Frequency source setting	00(Potentiometer) / 01(Terminals) / 02(Operator) / 03(RS485) / 04 (Expansion card 1) / 05(Expansion card 2)	01	01	×	×
A002	Run command source setting	01(Terminals) / 02(Operator) / 03(RS485) / 04 (Expansion card 1) / 05(Expansion card 2)	01	01	×	×
A003	Base frequency setting	30.00Hz–Maximum frequency	50.	60.	×	×
A203	Base frequency setting for second motor	30.00Hz–Maximum frequency for second motor	50.	60.	×	×
A004	Maximum frequency setting	30.00–400.0Hz	50.	60.	×	×
A204	Maximum frequency setting for second setting	30.00–400.0Hz	50.	60.	×	×
A005	AT selection	00(Selection between O and OI at AT) / 01(Selection between O and O2 at AT)	00	00	×	×
A006	O2 selection	00(Independent) / 01(Only positive) / 02(Both positive and negative)	00	00	×	×
A011	O-L input active range start frequency	0.00–400.0Hz	0.00	0.00	×	○
A012	O-L input active range end frequency	0.00–400.0Hz	0.00	60.00	×	○
A013	O-L input active range start voltage	0.–100. %	0.	0.	×	○
A014	O-L input active range end voltage	0.–100. %	100.	100.	×	○
A015	O-L input start frequency enable	00(External frequency output zero reference) / 01(0Hz)	01	01	×	○
A016	External frequency filter time constant	1.–30. (Sampling time = 2 msec.)	8.	8.	×	○
A019	Multispeed operation selection	00(Binary: up to 16-stage speed at 4 terminals) / 01(Bit: up to 6-stage speed at 5 terminals)	00	00	×	×
A020	Multispeed frequency setting (0)	0.00, Starting frequency to maximum frequency	0.00	0.00	○	○
A220	Multispeed frequency setting (0) for second motor	0.00, Starting frequency to maximum frequency for second motor	0.00	0.00	○	○
A021 A035	Multispeed frequency setting (1–15)	0.00, Starting frequency to maximum frequency	0.00	0.00	○	○
A038	Jog frequency setting	0.00, Starting frequency to 9.99Hz	1.00	1.00	○	○
A039	Jog stop mode	00(Free-run stop/disable during RUN) / 01(Deceleration to stop/ disable during RUN) / 02(DC braking to stop/ disable during RUN) / 03(Free-run stop/ enable during RUN) / 04(Deceleration to stop/ enable during RUN) / 05(DC braking to stop/ enable during RUN)	00	00	×	○

○ = Allowed
 × = Not permitted

Code		Name	Description	Default Setting		Run-time Setting	Runtime Data Edit (Enabled at 031)
				-FE(CE)	-FU2(UL)		
V/f Characteristic	A041	Torque boost method selection	00(Manual torque boost) / 01(Automatic torque boost)	00	00	×	×
	A241	Torque boost method selection for second motor	00(Manual torque boost) / 01(Automatic torque boost)	00	00	×	×
	A042	Manual torque boost value	0.0–20.0%	1.0	1.0	○	○
	A242	Manual torque boost value for second motor	0.0–20.0%	1.0	1.0	○	○
	A043	Manual torque boost frequency adjustment	0.0–50.0%	5.0	5.0	○	○
	A243	Manual torque boost frequency adjustment for second motor	0.0–50.0%	5.0	5.0	○	○
	A044	V/f characteristic curve selection	00(VC) / 01(VP 1.7th power) / 02(V/f free-setting)	00	01	×	×
	A244	V/f characteristic curve selection for second motor	00(VC) / 01(VP 1.7th power) / 02(V/f free-setting)	00	01	×	×
	A045	V/f gain setting	20–100	100	100	○	○
DC Braking	A051	DC braking enable	00(Disabled) / 01(Enabled)	00	00	×	○
	A052	DC braking frequency setting	0.00–60.00Hz	0.50	0.50	×	○
	A053	DC braking wait time	0.0–5.0sec.	0.0	0.0	×	○
	A054	DC braking force setting	0–70.0%	0	0	×	○
	A055	DC braking time setting	0.0–60.0sec.	0.0	0.0	×	○
	A056	DC braking edge or level detection	00(Edge) / 01(Level)	01	01	×	○
	A057	DC braking force setting at the starting point	0–70.0%	0	0	×	○
	A058	DC braking time setting at the starting point	0.0–60.0sec.	0.0	0.0	×	○
	A059	DC braking carrier frequency setting	0.5–12kHz (To be derated) (0.5–8kHz) ^{(*)1}	3.0	3.0	×	×
Upper/Lower Limit and Jump Frequency	A061	Frequency upper limit setting	0.00, Starting frequency to maximum frequency	0.00	0.00	×	○
	A261	Frequency upper limit setting for second motor	0.00, Starting frequency to maximum frequency for second motor	0.00	0.00	×	○
	A062	Frequency lower limit setting	0.00, Starting frequency to maximum frequency	0.00	0.00	×	○
	A262	Frequency lower limit setting for second motor	0.00, Starting frequency to maximum frequency for second motor	0.00	0.00	×	○
	A063	Jump frequency (1) setting	0.00–99.99/100.0–400.0Hz	0.00	0.00	×	○
	A064	Jump frequency width (1) setting	0.00–10.00Hz	0.50	0.50	×	○
	A065	Jump frequency (2) setting	0.00–99.99/100.0–400.0Hz	0.00	0.00	×	○
	A066	Jump frequency width (2) setting	0.00–10.00Hz	0.50	0.50	×	○
	A067	Jump frequency (3) setting	0.00–99.99/100.0–400.0Hz	0.00	0.00	×	○
	A068	Jump frequency width (3) setting	0.00–10.00Hz	0.50	0.50	×	○
PID Control	A069	Acceleration hold frequency setting	0.00–99.99/100.0–400.0Hz	0.00	0.00	×	○
	A070	Acceleration stop time setting	0.0–60.0sec.	0.0	0.0	×	○
	A071	PID function enable	00(Disable) / 01(Enable)	00	00	×	○
	A072	PID proportional gain	0.2–5.0	1.0	1.0	○	○
	A073	PID integral gain	0.0–3600.0sec.	1.0	1.0	○	○
	A074	PID differential gain	0.0–100.0sec.	0.0	0.0	○	○
AVR Function	A075	Process variable scale conversion	0.01–99.99%	1.00	1.00	×	○
	A076	Process variable source setting	00(at OI) / 01(at O)	00	00	×	○
Operation Mode and Accel./Decel. Function	A081	AVR function selection	00(Always ON) / 01(Always OFF) / 02(OFF during deceleration)	00	00	×	×
	A082	AVR voltage selection	200/215/220/230/240, 380/400/415/440/460/480V	230/400	230/460	×	×
	A085	Operation mode selection	00(Normal operation) / 01(Energy-saving operation)	00	00	×	×
	A086	Energy saving mode tuning	0.0–100.0sec.	50.0	50.0	○	○
	A092	Acceleration time (2)	0.01–99.99/100.0–999.9/1000.–3600.sec.	15.00	15.00	○	○
	A292	Acceleration time (2) for second motor	0.01–99.99/100.0–999.9/1000.–3600.sec.	15.00	15.00	○	○
	A093	Deceleration time (2)	0.01–99.99/100.0–999.9/1000.–3600.sec.	15.00	15.00	○	○
	A293	Deceleration time (2) for second motor	0.01–99.99/100.0–999.9/1000.–3600.sec.	15.00	15.00	○	○
	A094	Select method to switch to second accel./decel. profile	00(2CH input from terminal) / 01(Transition frequency)	00	00	×	×
	A294	Select method to switch to second accel./decel. profile for second motor	00(2CH input from terminal) / 01(Transition frequency)	00	00	×	×
	A095	Accel(1) to Accel(2) frequency transition point	0.00–99.99/100.0–400.0Hz	0.00	0.00	×	×
	A295	Accel(1) to Accel(2) frequency transition point for second motor	0.00–99.99/100.0–400.0Hz	0.00	0.00	×	×
	A096	Decel(1) to Decel(2) frequency transition point	0.00–99.99/100.0–400.0Hz	0.00	0.00	×	×
	A296	Decel(1) to Decel(2) frequency transition point for second motor	0.00–99.99/100.0–400.0Hz	0.00	0.00	×	×
External Frequency Tuning	A097	Acceleration curve selection	00(Linear) / 01(S-curve) / 02(U-shape) / 03(Reverse U-shape)	00	00	×	×
	A098	Deceleration curve selection	00(Linear) / 01(S-curve) / 02(U-shape) / 03(Reverse U-shape)	00	00	×	×
	A101	OI-L input active range start frequency	0.00–400.0Hz	0.00	0.00	×	○
	A102	OI-L input active range end frequency	0.00–400.0Hz	0.00	60.00	×	○
	A103	OI-L input active range start voltage	0–100.0%	20	20	×	○
	A104	OI-L input active range end voltage	0–100.0%	100	100	×	○
	A105	OI-L input start frequency enable	00(External frequency output zero reference) / 01(0Hz)	01	01	×	○
	A111	O2-L input active range start frequency	–400.0–400.0Hz	0.00	0.00	×	○
Accel./Decel. Curve	A112	O2-L input active range end frequency	–400.0–400.0Hz	0.00	0.00	×	○
	A113	O2-L input active range start voltage	–100.–100.0%	–100	–100	×	○
	A114	O2-L input active range end voltage	–100.–100.0%	100	100	×	○
	A131	Acceleration curve constants setting	01(Smallest deviation)-10(Largest deviation)	02	02	×	○
	A132	Deceleration curve constants setting	01(Smallest deviation)-10(Largest deviation)	02	02	×	○

(*)1 90kW and over

B Group : Fine Tuning Functions

○ = Allowed
 × = Not permitted

Code			Name	Description	Default Setting		Run-time Setting	Run-time Data Edit (Enabled at b031)
					-FE(CE)	-FU2(UL)		
Restart after Instantaneous Power Failure	b001	Selection of automatic restart mode	00(Alarm output after trip, automatic restart disable) / 01(Restart at 0Hz) / 02(Resume operation after frequency matching) / 03(Resume previous frequency after frequency matching, then decelerate to stop and display trip information)		00	00	×	○
	b002	Allowable instantaneous power failure time	0.3~25.0sec.		1.0	1.0	×	○
	b003	Time delay enforced before motor restart	0.3~100.0sec.		1.0	1.0	×	○
	b004	Instantaneous power failure and under-voltage trip enable	00(Disable) / 01(Enable) / 02(Disable during stop and ramp to stop)		00	00	×	○
	b005	Number of restarts after instantaneous power failure and under-voltage trip	00(16 times) / 01(Always restart)		00	00	×	○
	b006	Phase loss detection enable	00(Disable) / 01(Enable)		01	01	×	○
	b007	Restart frequency setting	0.00~99.99/100.0~400.0Hz		0.00	0.00	×	○
Electronic Thermal	b012	Level of electronic thermal setting	0.20*rated current-1.20*rated current		Rated current	Rated current	×	○
	b212	Level of electronic thermal setting for second motor	0.20*rated current-1.20*rated current		Rated current	Rated current	×	○
	b013	Electronic thermal characteristics	00(Reduced torque) / 01(Constant torque) / 02(V/f free-setting)		01	00	×	○
	b213	Electronic thermal characteristics for second motor	00(Reduced torque) / 01(Constant torque) / 02(V/f free-setting)		01	00	×	○
	b015	Free-setting electronic thermal frequency (1)	0~400 Hz		0.	0.	×	○
	b016	Free-setting electronic thermal current (1)	0.0~1000.A		0.0	0.0	×	○
	b017	Free-setting electronic thermal frequency (2)	0~400 Hz		0.	0.	×	○
	b018	Free-setting electronic thermal current (2)	0.0~1000.A		0.0	0.0	×	○
	b019	Free-setting electronic thermal frequency (3)	0~400 Hz		0.	0.	×	○
b020	Free-setting electronic thermal current (3)	0.0~1000.A		0.0	0.0	×	○	
Overload Restriction	b021	Overload restriction operation mode	00(Disable) / 01(Enable during accel./constant speed) / 02(Enable during constant speed)		01	01	×	○
	b022	Overload restriction setting	0.50*rated current-1.50*rated current		Rated current* 1.20	Rated current* 1.10	×	○
	b023	Deceleration rate at overload restriction	0.10~30.00		1.00	15.00	×	○
	b024	Overload restriction operation mode (2)	00(Disable) / 01(Enable during accel./ constant speed) / 02(Enable at constant speed)		01	01	×	○
	b025	Overload restriction setting (2)	0.50*rated current~1.50*rated current		Rated current* 1.20	Rated current* 1.20	×	○
	b026	Deceleration rate at overload restriction (2)	0.10~30.00		1.00	1.00	×	○
Software Lock	b031	Software lock mode selection	00(All parameters except b031 are locked when SFT from terminal is on) / 01(All parameters except b031 and output frequency F001 are locked when SFT from terminal is on) / 02(All parameters except b031 are locked) / 03(All parameters except b031 and output frequency F001 are locked) / 10(Run-time data edit mode)		01	01	×	○
Others	b034	RUN/ power-on warning time	0~9999/1000~6553(10,000~65,530)hr (Output to intelligent terminal)		0.	0.	×	○
	b035	Rotational direction restriction	00(Enable for both directions) / 01(Enable for forward) / 02(Enable for reverse)		00	00	×	×
	b036	Reduced voltage soft start selection	00(Short)-06(Long)		06	06	×	○
	b037	Function code display restriction	00(All) / 01(Utilized functions) / 02(User-selected functions only)		00	00	×	○
	b080	AM terminal analog meter adjustment	0~255		180	180	○	○
	b081	FM terminal analog meter adjustment	0~255		60	60	○	○
	b082	Start frequency adjustment	0.10~9.99Hz		0.50	0.50	×	○
	b083	Carrier frequency setting	0.5~12.0kHz (To be derated) (0.5~8kHz)(*1)		3.0	3.0	×	○
	b084	Initialization mode	00(Trip history clear) / 01(Parameter initialization) / 02(Trip history clear and parameter initialization)		00	00	×	×
	b085	Country code for initialization	00(Japanese version) / 01(European version) / 02(North American version)		01	02	×	×
	b086	Frequency scaling conversion factor	0.1~99.9		1.0	1.0	○	○
	b087	STOP key enable	00(Enable) / 01(Disable)		00	00	×	○
	b088	Resume on free-run stop cancellation mode	00(Restart at 0Hz) / 01(Resume operation after frequency matching)		00	00	×	○
	b090	Dynamic braking usage ratio	0.0~100.0%		0.0	0.0	×	○
	b091	Stop mode selection	00(Deceleration and stop) / 01(Free-run stop)		00	00	×	×
	b092	Cooling fan control	00(Fan is always ON) / 01(Fan is ON during RUN including 5min. after power-on and stop)		00	00	×	×
	b095	Dynamic braking control	00(Disable) / 01(Enable during run) / 02(Enable during stop)		00	00	×	○
	b096	Dynamic braking activation level	330-380/660-760V		360/720	360/720	×	○
	b098	Thermistor for thermal protection control	00(Disable) / 01(PTC enable) / 02(NTC enable)		00	00	×	○
	b099	Thermistor for thermal protection level setting	0.0~9999Ω		3000	3000	×	○
Free-setting V/f pattern	b100	Free-setting V/f frequency (1)	0~Free-setting V/f frequency (2)		0.0	0.0	×	×
	b101	Free-setting V/f voltage (1)	0.0~800.0V		0.0	0.0	×	×
	b102	Free-setting V/f frequency (2)	0~Free-setting V/f frequency (3)		0.0	0.0	×	×
	b103	Free-setting V/f voltage (2)	0.0~800.0V		0.0	0.0	×	×
	b104	Free-setting V/f frequency (3)	0~Free-setting V/f frequency (4)		0.0	0.0	×	×
	b105	Free-setting V/f voltage (3)	0.0~800.0V		0.0	0.0	×	×
	b106	Free-setting V/f frequency (4)	0~Free-setting V/f frequency (5)		0.0	0.0	×	×
	b107	Free-setting V/f voltage (4)	0.0~800.0V		0.0	0.0	×	×
	b108	Free-setting V/f frequency (5)	0~Free-setting V/f frequency (6)		0.0	0.0	×	×
	b109	Free-setting V/f voltage (5)	0.0~800.0V		0.0	0.0	×	×
	b110	Free-setting V/f frequency (6)	0~Free-setting V/f frequency (7)		0.0	0.0	×	×
	b111	Free-setting V/f voltage (6)	0.0~800.0V		0.0	0.0	×	×
	b112	Free-setting V/f frequency (7)	0~400.Hz		0.0	0.0	×	×
	b113	Free-setting V/f voltage (7)	0.0~800.0V		0.0	0.0	×	×

(*1) 90kW and over

●C Group: Intelligent Terminal Functions

○ = Allowed
× = Not permitted

Code	Name	Description	Default Setting -FE(CE)	-FU2(UL)	Run-time Setting	Run-time Data Lock (Fixed at 001)
Intelligent Input Terminal Setting	C001 Terminal (1) function	01(RV:Reverse) / 02(CF1:Multispeed(1)) / 03(CF2:Multispeed(2)) / 04(CF3:Multispeed(3)) / 05(CF4:Multispeed(4)) / 06(JG:Jogging) / 07(DB:External DC braking) / 08(SET:Second motor constants setting) / 09(2CH:Second accel./decel.) / 11(FRS:Free-run stop) / 12(EXT:External trip) / 13(USP:Unattended start protection) / 14(CS:Change to/from commercial power supply) / 15(SFT:Software lock) / 16(AT:Analog input selection) / 18(RS:Reset) / 20(STA:3-wire start) / 21(STP:3-wire hold) / 22(F/R:3-wire fwd./rev.) / 23(PID:PID On/Off) / 24(PIDC:PID reset) / 27(UP:Remote-controlled accel.) / 28(DWN:Remote-controlled decel.) / 29(UDC:Remote-controlled data clearing) / 31(OPE:Operator control) / 32(SF1:Multispeed bit command(1)) / 33(SF2:Multispeed bit command(2)) / 34(SF3:Multispeed bit command(3)) / 35(SF4:Multispeed bit command(4)) / 36(SF5:Multispeed bit command(5)) / 37(SF6:Multispeed bit command(6)) / 38(SF7:Multispeed bit command(7)) / 39(OLR:Overload limit change) / 49(ROK: RUN permissive)(*)1 / 255(NO:Not selected)	18	18	×	○
	C002 Terminal (2) function		16	16	×	○
	C003 Terminal (3) function		03	13	×	○
	C004 Terminal (4) function		02	02	×	○
	C005 Terminal (5) function		01	01	×	○
Intelligent Input Terminal State Setting	C011 Terminal (1) active state	00(NO) / 01(NC)	00	00	×	○
	C012 Terminal (2) active state	00(NO) / 01(NC)	00	00	×	○
	C013 Terminal (3) active state	00(NO) / 01(NC)	00	01	×	○
	C014 Terminal (4) active state	00(NO) / 01(NC)	00	00	×	○
	C015 Terminal (5) active state	00(NO) / 01(NC)	00	00	×	○
Intelligent Output Terminal Setting	C019 Terminal FW active state	00(NO) / 01(NC)	00	00	×	○
	C021 Terminal (11) function	00(RUN:Run signal) / 01(FA1:Frequency arrival signal (at the set frequency)) / 02(FA2:Frequency arrival signal (at or above the set frequency)) / 03(OL:Overload advance notice signal) / 04(OD:Output deviation for PID control) / 05(AL:Alarm signal) / 06(FA3:Frequency arrival signal (only at the set frequency)) / 08(IP:Instantaneous power failure signal) / 09(UV:Under-voltage signal) / 11(RNT:RUN time over) / 12(ONT:Power-on time over) / 13(THM:Thermal alarm) / 27(RMD: Operator RUN command signal)(*)1	01	01	×	○
	C022 Terminal (12) function		00	00	×	○
	C026 Alarm relay terminal function		05	05	×	○
	C027 FM signal selection	00(Output frequency) / 01(Output current) / 03(Digital output frequency-only at C027) / 04(Output voltage) / 05(Power) / 06(Thermal load ratio) / 07(LAD frequency)	00	00	×	○
Intelligent Output Terminal State and Output Level Setting	C028 AM signal selection		00	00	×	○
	C029 AMI signal selection		00	00	×	○
	C031 Terminal (11) active state	00(NO) / 01(NC)	00	00	×	○
	C032 Terminal (12) active state	00(NO) / 01(NC)	00	00	×	○
	C036 Alarm relay terminal active state	00(NO) / 01(NC)	01	01	×	○
Serial Communication	C040 Overload signal output mode	00(During accel./decel) / 01(At constant speed)	01	01	×	○
	C041 Overload level setting	0.00*rated current-2.00*rated current	Rated current	Rated current	×	○
	C042 Arrival frequency setting for acceleration	0.00-99.99/100.0-400.0Hz	0.0	0.0	×	○
	C043 Arrival frequency setting for deceleration	0.00-99.99/100.0-400.0Hz	0.0	0.0	×	○
	C044 PID deviation level setting	0.0-100.0%	3.0	3.0	×	○
Analog Meter Setting	C061 Electronic thermal warning level setting	0-100%	80	80	×	○
	C070 Data command method	02(Operator) / 03(RS485) / 04 (Expansion card 1) / 05(Expansion card 2)	02	02	×	×
	C071 Communication speed selection	03(2400bps) / 04(4800bps) / 05(9600bps) / 06(19200bps)	04	04	×	○
	C072 Node allocation	1-32	1	1	×	○
	C073 Communication data length selection	7(7-bit) / 8(8-bit)	7	7	×	○
Others	C074 Communication parity selection	00(No parity) / 01(Even) / 02(Odd)	00	00	×	○
	C075 Communication stop bit selection	1(1-bit) / 2(2-bit)	1	1	×	○
	C078 Communication wait time	0-1000 msec.	0.0	0.0	×	○
	C081 O input span calibration	0-9999/1000-6553(10,000-65,530)	Factory set	Factory set	○	○
	C082 OI input span calibration	0-9999/1000-6553(10,000-65,530)	Factory set	Factory set	○	○
Others	C083 O2 input span calibration	0-9999/1000-6553(10,000-65,530)	Factory set	Factory set	○	○
	C085 Thermistor input tuning	0.0-1000	105	105	○	○
	C086 AM terminal offset tuning	0.0-10.0V	0.0	0.0	○	○
	C087 AMI terminal meter tuning	0-255	80	80	○	○
	C088 AMI terminal offset tuning	0-20.0mA	Factory set	Factory set	○	○
Others	C091 Debug mode enable	00(No display) / 01(Display)	00	00	×	○
	C101 UP/DOWN memory mode selection	00(Clear previous frequency) / 01(Keep previous frequency)	00	00	×	○
	C102 Reset mode selection	00(Cancel trip state when reset signal turns ON) / 01(Cancel trip state when reset signal turns OFF) / 02(Cancel trip state when reset signal turns ON(Enable during trip state))	00	00	○	○
	C103 Restart frequency after reset	00(Restart at 0Hz) / 01(Resume operation after frequency matching)	00	00	×	○
	C121 O input zero calibration	0-9999/1000-6553(10,000-65,530)	Factory set	Factory set	○	○
Others	C122 OI input zero calibration	0-9999/1000-6553(10,000-65,530)	Factory set	Factory set	○	○
	C123 O2 input zero calibration	0-9999/1000-6553(10,000-65,530)	Factory set	Factory set	○	○

●H Group: Motor Constants Functions

H003	Motor capacity	0.20-75.0(kW) (-160(kW))(*2)	Factory set	Factory set	×	×
H203	Motor capacity for second motor	0.20-75.0(kW) (-160(kW))(*2)	Factory set	Factory set	×	×
H004	Motor poles setting	2/4/6/8	4	4	×	×
H204	Motor poles setting for second motor	2/4/6/8	4	4	×	×
H006	Motor stabilization constant	0-255	100	100	○	○
H206	Motor stabilization constant for second motor	0-255	100	100	○	○

●P Group: Expansion Card Functions

P001	Operation mode on Expansion card 1 error	00(Trip) / 01(Continuous operation)	00	00	×	○
P002	Operation mode on Expansion card 2 error	00(Trip) / 01(Continuous operation)	00	00	×	○
P031	Accel./decel time input selection	00(operation)/01(option1)/02(option2)	00	00	×	×
P044	DeviceNet comm watchdog timer	0.00-99.99s	1.00	1.00	×	×
P045	Inverter action on DeviceNet comm error	00(trip)/01(trip after deceleration stop)/02(Invalid)/03(free-run)/04(deceleration stop)	01	01	×	×
P046	DeviceNet polled I/O Output instance number	20,21,100	21	21	×	×
P047	DeviceNet polled I/O Input instance number	70,71,101	71	71	×	×
P048	Input action on DeviceNet idle mode	00(trip)/01(trip after deceleration stop)/02(Invalid)/03(free-run)/04(deceleration stop)	01	01	×	×
P049	Motor poles setting for RPM	0-38(even only)	0	0	×	×
P050	Output frequency on analog reference signal loss	00(Output freq.forced to 0Hz; 500ms wait to recover)/01(Output forced 0Hz; no wait to recover)/02(Output freq.forced to max.freq.A004)/03(Output freq.forced to A020/A220)	00	00	×	×

●U Group: User-selectable Menu Functions

U001	User selected functions	no / d001-P002	no	no	×	○
U012						

(*)1 For UL version only (*2) 90kW and over

Main Circuit Terminals

Terminal Description

Terminal Symbol	Terminal Name
R(L1), S(L2), T(L3)	Main power supply input terminals
U(T1), V(T2), W(T3)	Inverter output terminals
PD(+1), P(+)	DC reactor connection terminals
P(+), RB(RB)	External braking resistor connection terminals
P(+), N(-)	External braking unit connection terminals
⊕(G)	Ground connection terminal
R0(R0), T0(T0)	Control power supply input terminals

Terminal Arrangement

■015-055 LFU2, HFU2, HFE2

R0 (R0)	T0 (T0)	R (L1)	S (L2)	T (L3)	U (T1)	V (T2)	W (T3)
PD (+1)	P (+)	N (-)	RB (RB)	⊕ (G)	⊕ (G)		

■110-150HFE2, 075-150HFU2/LFU2

R (L1)	S (L2)	T (L3)	U (T1)	V (T2)	W (T3)	R0 (R0)	T0 (T0)
PD (+1)	P (+)	N (-)	RB (RB)	⊕ (G)	⊕ (G)		

■185-370LFU2
185-750HFE2, HFU2

R0 (R0)	T0 (T0)	⊕ (G)	R (L1)	S (L2)	T (L3)	PD (+1)	P (+)	N (-)	U (T1)	V (T2)	W (T3)	⊕ (G)
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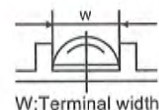
■220, 300, 450, 550, 750LFU2
900-1320HFE2/HFU2

R0 (R0)	T0 (T0)	R (L1)	S (L2)	T (L3)	PD (+1)	P (+)	N (-)	U (T1)	V (T2)	W (T3)	⊕ (G)
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Screw Diameter and Terminal Width

Model	Main Circuit Terminals									R0, T0 Terminals
	015-037 LFU2 HFE2/HFU2	055LFU2 HFE2/HFU2	075LFU2 HFE2/HFU2	110-150LFU2 HFE2/HFU2	185LFU2,185-370 HFE2/HFU2	220-370LFU2, 450-750HFE2/HFU2	450-550 LFU2	750LFU2, 1320HFE2/HFU2	900-1100 HFE2/HFU2	All models
Screw diameter	M4	M5	M5	M6	M6	M8	M10	M10	M10	M4
Terminal width (mm)	13	13	17.5	17.5	18	23	35	40	29	9

*For ground screw of 200, 300, 450, 550 LFU2, M6 is used. For 900-1320HFE/HFU2, M8 is used.



Control Circuit Terminals

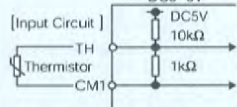
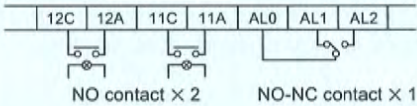
Terminal Arrangement

H	O2	AM	FM	TH	FW	5	4	3	2	1	AL1	
L	O	OI	AMI	P24	PLC	CM1	12C	12A	11C	11A	AL0	AL2

Screw diameter M3, Terminal width 6.4mm

Control Circuit Terminals

● Terminal Description []: Default setting (CE/UL)

			Symbol	Name	Explanation of Terminals	Ratings
Analog	Power Supply		L	Common Terminal for Analog Power Source	Common terminal for H, O, O2, OI, AM, and AMI. Do not ground.	—
			H	Power Source for Frequency Setting	Power supply for frequency command input	DC 10V, 20mA max.
	Frequency Setting		O	Frequency Command Terminal	Maximum frequency is attained at DC 10V in DC 0–10V range. Set the voltage at A014 to command maximum frequency below DC 10V.	Input impedance: 10kΩ, Allowable input voltage range: DC –0.3–+12V
			O2	Frequency Command Extra Terminal	O2 signal is added to the frequency command of O or OI in DC 0–±10V range. By changing configuration, frequency command can be input also at O2 terminal.	Input impedance: 10kΩ, Allowable input voltage range: DC 0–±12V
			OI	Frequency Command Terminal	Maximum frequency is attained at DC 20mA in DC 4–20mA range. When the intelligent terminal configured as AT is on, OI signal is enabled.	Input impedance: 100Ω, Allowable input voltage range: DC 0–24mA
	Monitor Output		AM	Analog Output Monitor (Voltage)	Selection of one function from: Output frequency, output current, torque, output voltage, input power, electronic thermal load ratio, and LAD frequency.	DC 0–10V, 2mA max.
			AMI	Analog Output Monitor (Current)		DC 4–20mA, 250Ω max.
Analog Input	Sensor		TH	Thermistor Input Terminals	The inverter trips when the external thermistor detects abnormal temperature. Common terminal is CM1. [Recommended thermistor characteristics] Allowable rated power: 100mW or over. Impedance in the case of abnormal temperature: 3kΩ Note: Thermal protection level can be set between 0 and 9999Ω.	Allowable input voltage range 
Digital	Monitor Output		FM	Digital Monitor (Voltage)	[DC0–10V output (PWM output)] Selection of one function from: Output frequency, output current, torque, output voltage, input power, electronic thermal load ratio, and LAD frequency. [Digital pulse output (Pulse voltage DC 0/10V)] Outputs the value of output frequency as digital pulse (duty 50%)	Digital output frequency range: 0–3.6kHz, 1.2mA max.
	Power Supply		P24	Power Terminal for Interface	Internal power supply for input terminals. In the case of source type logic, common terminal for contact input terminals.	DC 24V, 100mA max.
			CM1	Common Terminal for Interface	Common terminal for P24, TH, and FM. In the case of sink type logic, common terminal for contact input terminals. Do not ground.	—
	Contact Input	Run Command	FW	Forward Command Input	The motor runs forward when FW terminal is ON, and stops when FW is OFF.	[Input ON condition] Voltage between each terminal and PLC: DC 18V min.
		Functions	1 [RS/RS]	Intelligent Input Terminals	Assign 5 functions to terminals. (Refer to the standard specifications for the functions.)	[Input OFF condition] Voltage between each terminal and PLC: DC 3V max. Input impedance between each terminal and PLC: 4.7Ω
			2 [AT/AT]			
			3 [CF2/USP]			
			4 [CF1/CF1]			
			5 [RV/RV]			
		Common Terminal	PLC	Common Terminal for Intelligent Input Terminals, Common Terminal for External Power Supply for PLCs, etc.	Select sink or source logic with the short-circuit bar on the control terminals. Sink logic: Short P24 to PLC / Source logic: Short CM1 to PLC. When applying external power source, remove the short-circuit bar and connect PLC terminal to the external device.	Allowable maximum voltage between each terminal and PLC: DC 27V
	Relay Output	State/Alarm	12C [RUN/RUN]	Intelligent Output Terminals	Assign 3 functions to two NO contacts and one NO-NC contact. (Refer to the standard specifications for the functions.) Intelligent relay output terminals 	Maximum capacity of relays 11,12: AC 250V, 5A(R load)/1A(I load) DC 30V, 5A(R load)/1A(I load) AL1–AL0: AC 250V, 2A(R load)/0.2A(I load) DC 30V, 8A(R load)/0.6A(I load) AL2–AL0: AC 250V, 1A(R load)/0.2A(I load) DC 30V, 1A(R load)/0.2A(I load) Minimum capacity of relays 11,12: DC 1V, 1mA AL1–AL0, AL2–AL0: AC100V, 10mA DC5V, 100mA
			12A [RUN/RUN]			
			11C [FA1/FA1]			
			11A [FA1/FA1]			
			AL0 [AL/AL]			
			AL1 [AL/AL]			
			AL2 [AL/AL]			

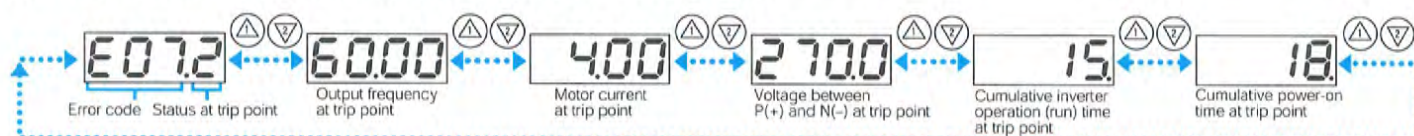
PROTECTIVE FUNCTIONS

Name	Cause(s)	Display on digital operator	Display on remote operator/copy unit ERR1****
Over-current protection	The inverter output was short-circuited, or the motor shaft is locked or has a heavy load. These conditions cause excessive current for the inverter, so the inverter output is turned off.	While at constant speed	E01 OC.Drive
		During deceleration	E02 OC.Drive
		During acceleration	E03 OC.Accel
		Others	E04 Over.C
Overload protection(*1)	When a motor overload is detected by the electronic thermal function, the inverter trips and turns off its output.	E05	Over.L
Braking resistor overload protection	When the regenerative braking resistor exceeds the usage time allowance or an over-voltage caused by the stop of the BRD function is detected, the inverter trips and turns off its output.	E06	OL.BRD
Over-voltage protection	When the DC bus voltage exceeds a threshold, due to regenerative energy from the motor, the inverter trips and turns off its output.	E07	Over.V
EEPROM error(*2)	When the built-in EEPROM memory has problems due to noise or excessive temperature, the inverter trips and turns off its output.	E08	EEPROM
Under-voltage error	A decrease of internal DC bus voltage below a threshold results in a control circuit fault. This condition can also generate excessive motor heat or cause low torque. The inverter trips and turns off its output.	E09	Under.V
CT(Current transformer) error	If a strong source of electrical interference is close to the inverter or abnormal operations occur in the built-in CT(Current transformer), the inverter trips and turns off its output.	E10	CT
CPU error	When a malfunction in the built-in CPU has occurred, the inverter trips and turns off its output.	E11	CPU1
External trip	When a signal to an intelligent input terminal configured as EXT has occurred, the inverter trips and turns off its output.	E12	EXTERNAL
USP error	An error occurs when power is cycled while the inverter is in RUN mode if the Unattended Start Protection (USP) is enabled. The inverter trips and does not go into RUN mode until the error is cleared.	E13	USP
Ground fault	The inverter is protected by the detection of ground faults between the inverter output and the motor during power-up tests. This feature protects the inverter only.	E14	GND.Flt.
Input over-voltage protection	When the input voltage is higher than the specified value, it is detected 60 seconds after power-up and the inverter trips and turns off its output.	E15	OV.SRC
Instantaneous power failure	When power is cut for more than 15msec., the inverter trips and turns off its output. If power failure continues, the error will be cleared. The inverter restarts if it is in RUN mode when power is cycled.	E16	Inst.P-F
Inverter thermal trip	When the inverter internal temperature is higher than the specified value, the thermal sensor in the inverter module detects the higher temperature of the power devices and trips, turning off the inverter output.	E21	OH.FIN
Gate array error	Communication error has occurred between CPU and gate array.	E23	GA
Missing phase	One of three lines of 3-phase power supply is missing.	E24	PH.Fail
IGBT error	When instantaneous over-current has occurred, the inverter trips and turns off its output to protect main circuit element.	E30	IGBT
Thermistor error	When the thermistor inside the motor detects temperature higher than the specified value, the inverter trips and turns off its output.	E35	TH
Expansion card 1 connection error	An error has been detected in an expansion card or at its connecting terminals.	E60-E69	OP1 0-9
Expansion card 2 connection error		E70-E79	OP2 0-9
Out of operation due to under-voltage	Due to insufficient voltage, the inverter has turned off its output and been trying to restart. If it fails to restart, it goes into the under-voltage error.	--U	UV.WAIT

(*1)You can clear the error by pressing the Start / Reset key 10 seconds after the trip occurred.

(*2)If an EEPROM error **E08** occurs, be sure to confirm the parameter data values are still correct.

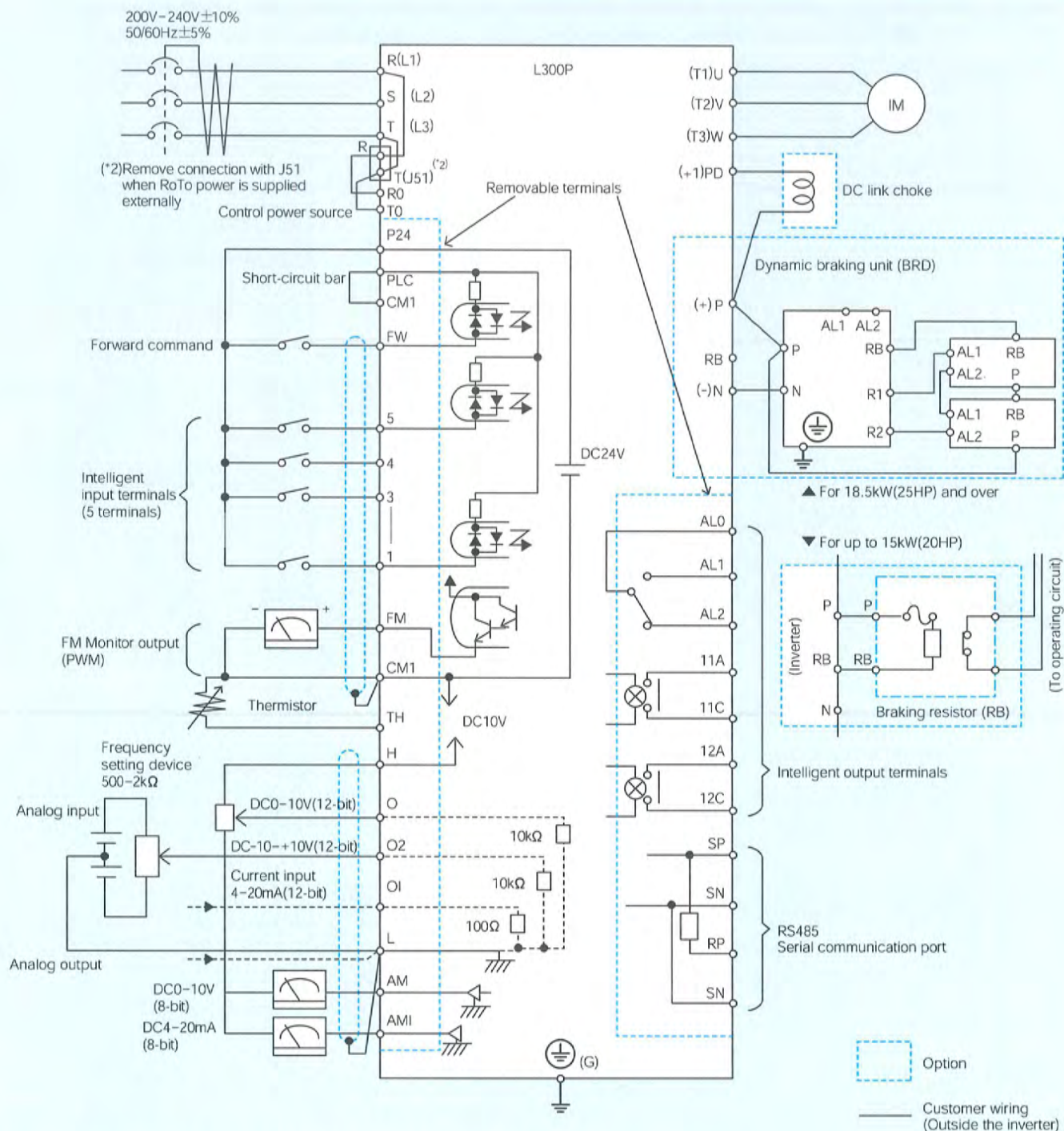
<How to access the details about the present fault>



CONNECTING DIAGRAM

SOURCE TYPE LOGIC

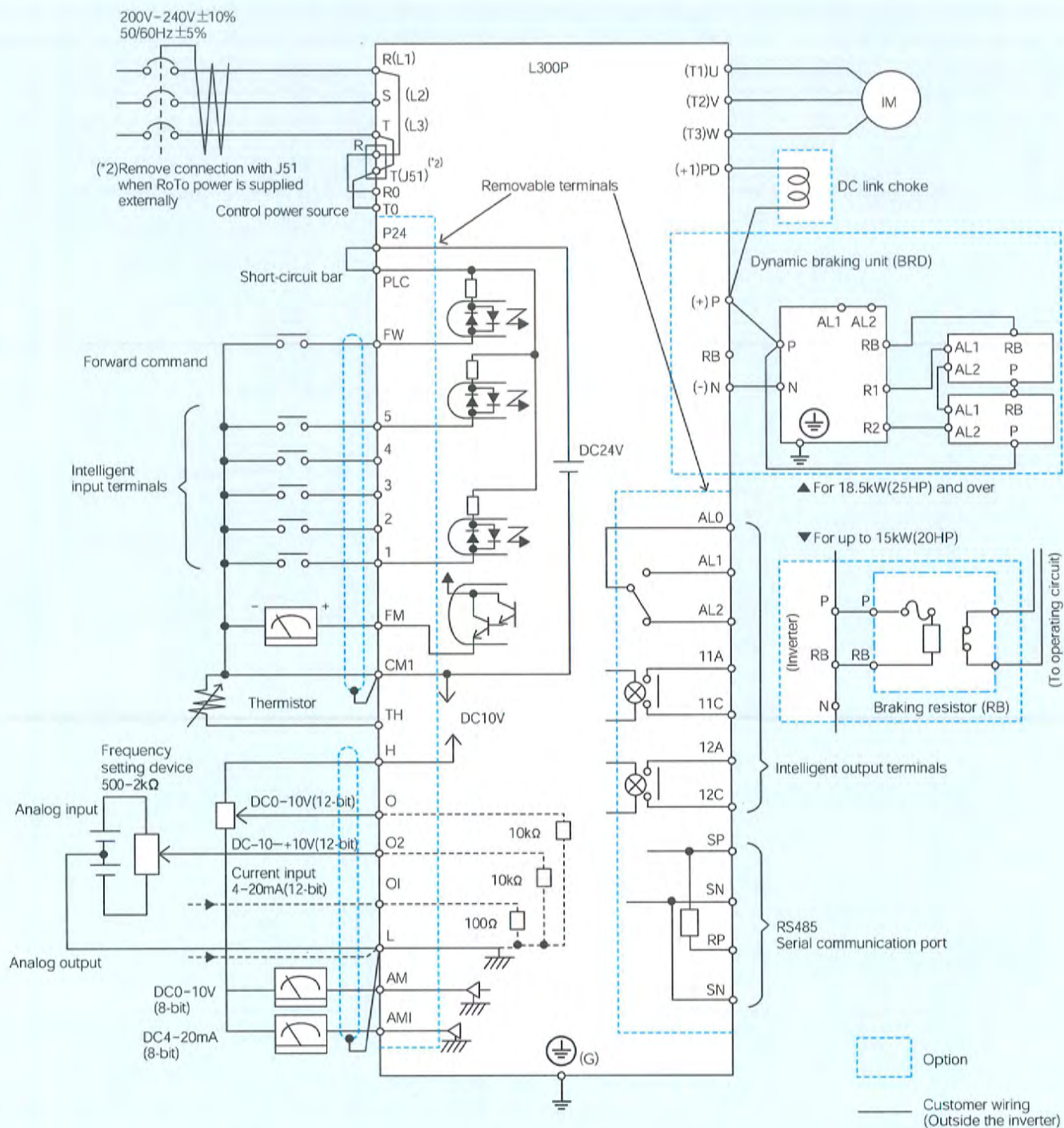
In case of 400V class,
place a transformer for operating circuit
to receive 200V.



Terminal Name	FW, 1, 2, 3, 4, 5	FM, TH	H, O, O2, OI, AM, AMI
Common	P24	CM1	L

SINK TYPE LOGIC

In case of 400V class,
place a transformer for operating circuit
to receive 200V.

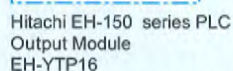


Terminal Name	FW, 1, 2, 3, 4, 5, FM, TH	H, O, O2, OI, AM, AMI
Common	CM1	L

(1) Sink type logic

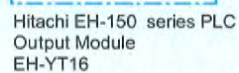


L300P



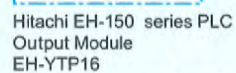
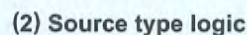
1.300P

(1) Sink type logic



L300P

(Note: Remove short-circuit bar between P24 and PLC.)

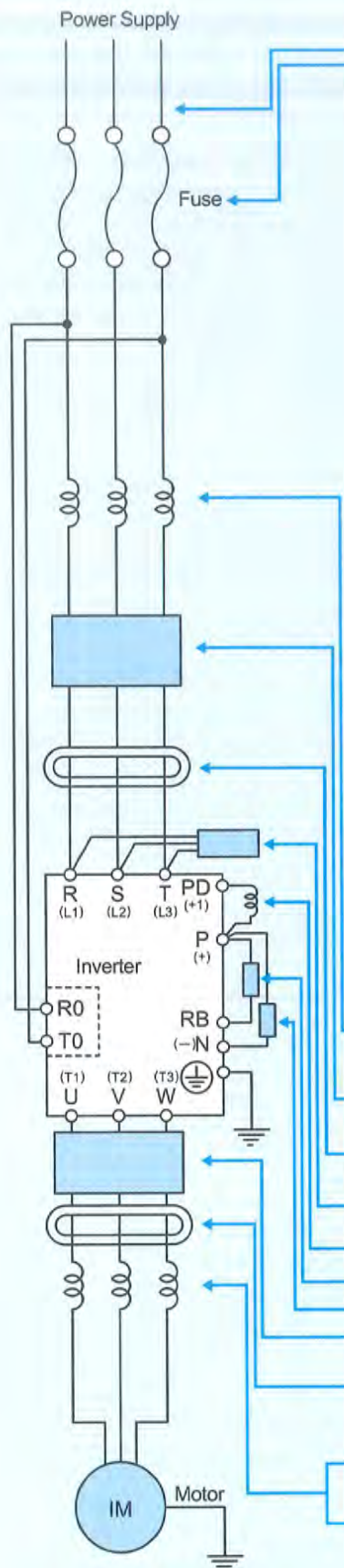


L300P

(Note: Remove short-circuit bar between P24 and PLC.)

22

WIRING and ACCESSORIES



Input Voltage	Motor Output (kW(HP))	Model	Wiring		Signal Lines	Fuse (Class J)
			Power Lines			
			AWG	mm²		
200V	1.5(2)	L300P-015LFU2	AWG 14	2.1	0.75mm² shielded wire	10
	2.2(3)	L300P-022LFU2	AWG 14	2.1		15
	3.7(5)	L300P-037LFU2	AWG 10	5.3		20
	5.5(8)	L300P-055LFU2	AWG 8	8.4		30
	7.5(10)	L300P-075LFU2	AWG 6	13.3		40
	11(15)	L300P-110LFU2	AWG 4	21.2		60
	15(20)	L300P-150LFU2	AWG 2	33.6		70
	18.5(25)	L300P-185LFU2	AWG 4 *2	21.2 *2		90
	22(30)	L300P-220LFU2	AWG 1/0	53.5		100
	30(40)	L300P-300LFU2	AWG 2 *2	33.8 *2		150
	37(50)	L300P-370LFU2	AWG 1 *2	42.4 *2		175
	45(60)	L300P-450LFU2	AWG 1 *2(75°C)	42.4 *2		200
	55(75)	L300P-550LFU2	AWG 2/0 *2	67.4 *2		250
	75(100)	L300P-750LFU2	AWG 3/0 *2	85.0 *2		300
400V	1.5(2)	L300P-015HFU2	AWG 18	0.8	0.75mm² shielded wire	10
	2.2(3)	L300P-022HFU2	AWG 16	1.3		10
	3.7(5)	L300P-040HFU2	AWG 14	2.1		15
	5.5(8)	L300P-055HFU2	AWG 12	3.3		15
	7.5(10)	L300P-075HFU2	AWG 10	5.3		20
	11(15)	L300P-110HFU2	AWG 8	8.4		30
	15(20)	L300P-150HFU2	AWG 6	13.3		35
	18.5(25)	L300P-185HFU2	AWG 6	13.3		50
	22(30)	L300P-220HFU2	AWG 4	21.2		50
	30(40)	L300P-300HFU2	AWG 3	26.7		70
	37(50)	L300P-370HFU2	AWG 4 *2	21.2 *2		80
	45(60)	L300P-450HFU2	AWG 1	42.4		100
	55(75)	L300P-550HFU2	AWG 2 *2	33.8 *2		125
	75(100)	L300P-750LFU2	AWG 1 *2	42.4 *2		150
	90(125)	L300P-900LFU2	AWG 1 *2(75°C)	42.4 *2		200
	110(150)	L300P-1100LFU2	AWG 2/0 *2	67.4 *2		225
	132(175)	L300P-1320LFU2	AWG 2/0 *2	67.4 *2		300

Note 1: Wire wiring connection must be made by a UL and c-UL listed closed-loop terminal connector sized for the wire gauge involved. Connector must be fixed using the crimping tool specified by the connector manufacturer.
 Note 2: Be sure to use bigger wires for power lines if the distance exceeds 20m(66ft).

Name	Function
Input side AC reactor	This is useful in suppressing harmonics induced on the power supply lines, or when the main power voltage imbalance exceeds 3% (and power source capacity is more than 500kVA), or to smooth out line fluctuations. It also improves the power factor.
EMI filter	This filter reduces the conducted noise in the power supply wiring between the inverter and the power distribution system. Connect it to the inverter primary (input side).
Radio noise filter	Electrical noise interference may occur on nearby equipment such as a radio receiver. This magnetic choke filter helps reduce radiated noise (can also be used on output).
Radio noise filter (Capacitive filter)	This capacitive filter reduces radiated noise from the main power wires in the inverter input side.
DC link choke	The choke suppresses harmonics generated by the inverter. However, it will not protect the input diode bridge rectifier.
Braking resistor	Braking components are useful for increasing the inverter's control torque for high duty-cycle (on-off) applications, and improving the decelerating capability.
Braking unit	
Output side noise filter	Reduces radiated noise from wiring in the inverter output side.
Radio noise filter	Electrical noise interference may occur on nearby equipment such as a radio receiver. This magnetic choke filter helps reduce radiated noise (can also be used on input).
AC reactor	This reactor reduces the vibration in the motor caused by the inverter's switching waveforms, by smoothing the waveforms to approximate commercial power quality. It is also useful when wiring from the inverter to the motor is more than 10m in length, to reduce harmonics.
LCR filter	Sine wave shaping filter for the output side.

Note: An EMI filter is required for European EMC directive and C-Tick, but the others are not for this purpose.

ACCESSORIES

● OPERATOR

Model	Potentiometer	Remote Control	Installation in L300P	Copy Function	Multilingual
OPE-S		○	○		
OPE-SR/SRE	○	○	○ (Standard for L300P)(OPE-SRE: Standard for L300P UL version)		
SRW-0EX		○	○	○	○

*OPE-SRE: English overlay

● CABLE FOR OPERATOR

Model	Cable Length
ICS-1	1m (3.3ft)
ICS-3	3m (9.8ft)

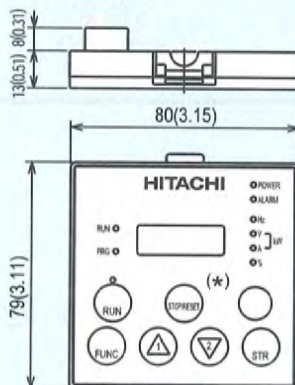
■ REMOTE OPERATOR SRW-0EX(Optional)



■ DIMENSIONS

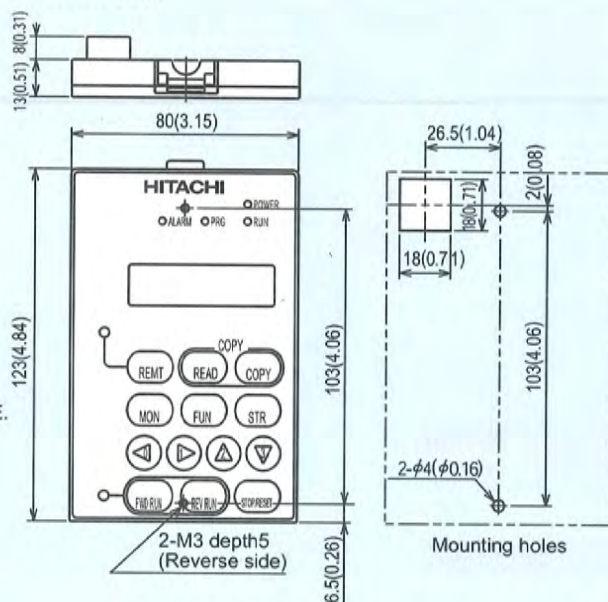
[Unit:mm (inch)]
Inches for reference only

● OPE-S(R)



*Potentiometer is installed only in ORE-SR/SRE.

● SRW-0EX



● ICS-1, 3

(Cables for OPE-S/SR/SRE and SRW-0EX)



Model Name	Cable Length
ICS-1	1m (3.3ft)
ICS-3	3m (9.8ft)

EXPANSION CARD

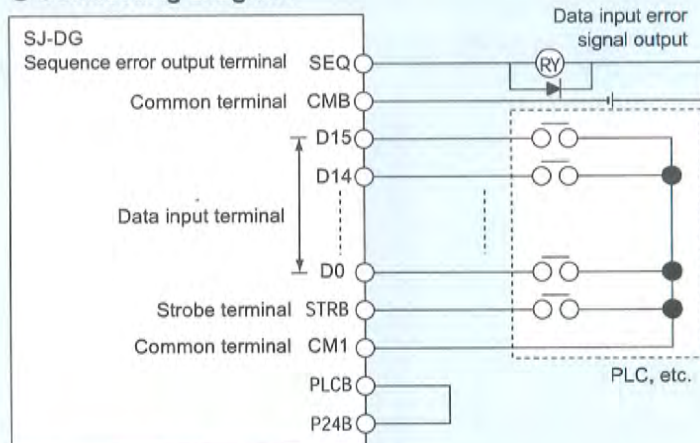
Up to two expansion cards can be installed inside the L300P.

Digital Input Expansion Card

SJ-DG

Output frequency, acceleration time, deceleration time, and torque limit can be set by a digital output device such as PLC, etc. (Binary or BCD)

Connecting Diagram



Data Bit Configuration

Item	Mode 1	Mode 2
D15	Data classification code	Setting data
D14		
D13		
D12		
D11		
D10		
D9		
D8		
D7	Setting data Data can be set by either 16-bit binary or 4-digit BCD. [Input data is divided into upper 8-bit and lower 8-bit.]	Data can be set by either 16-bit binary or 4-digit BCD.
D6		
D5		
D4		
D3		
D2		
D1		
D0		

*Data input mode is selected by the dip switch on the expansion card.

Standard Specifications

Item		Specification	
Input	Data setting signal	NO contact input (sink/ source compatible)	D0,D1, ... between D15 and PLCB
	Strobe signal		Between STRB and PLCB
Output	Sequence error signal (Data input error signal)	Open collector output (sink/ source compatible)	DC+27V 50mA max., between SEQ and CMB
Power supply	Power supply for interface	DC+24V 90mA max., between P24B and CM1	

DeviceNet™ Expansion Card

SJ-DN

Specifications

General data	Applicable DeviceNet specification		Volume 1-Relesse 2.0	Volume 2-Relesse 2.0
	Vendor name		Hitachi, Ltd.	Vendor ID=74
Physical conformance data	Device profile name		Slave DC Drive	Profile No.=13
	Network consumption current		50mA	
	Connector type		Open connector	
	Isolation of physical layer		Yes	
	Support LED		Module status / network status	
	MAC ID setting		By digital operator	
	Default MAC ID		63	
	Transmission baud rate setting		By digital operator	
	Support transmission baud rate		125k/250k/500k	
	Pre-defined master/slave connection set		Group 2 only server	
Communication data	UCMM Support		None	
	Support connection		Explicit message connection, Polled I/O connection	
	Explicit message fragmentation		Yes	

Connector specifications

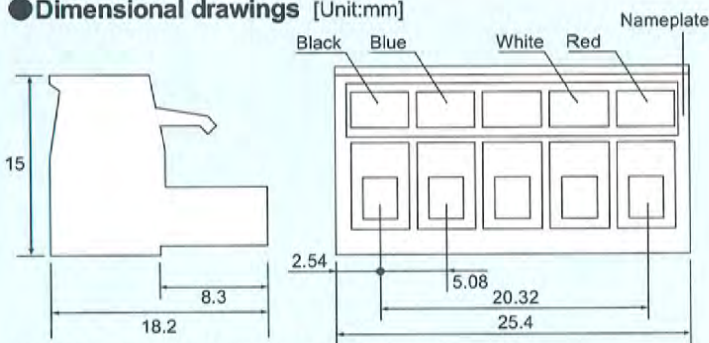
Manufacturer	Model Code
Phoenix Contact	MSTB 2.5/5-ST-5.08AU

Cable connection

No	Signal	Cable color
1	V-	Black
2	CAN_L	Blue
3	Drain	-
4	CAN_H	White
5	V+	Red

Note: Communication power supply (24VDC) is required in system configuration.

Dimensional drawings [Unit:mm]



DeviceNet is a trademark of Open DeviceNet Vendor Association.

PROFIBUS® Expansion Card

SJ-PBT

Specifications

Support profile	Variable Speed Drive (Order no. 3.072)
Transmission method	RS-485
Connector type	Open connector (6 poles)
Support file	GSD file
ASIC chip	VPC3+ (Made by Profichip)
Maximum bus length	100m at 12Mbps, 1200m at 9.6kbps(No router used for both conditions)
Maximum number of connectable nodes	126 (Router used), 32(No router used)
Termination support	Yes (Bus topology termination enable)
Support baud rate	9.6kbps to 12Mbps (Baud rate auto-detecting function equipped)
Communication specification	Master/slave
Support LED	Fieldbus ON/Off-line Fieldbus diagnosis Communication Status

Connector specifications

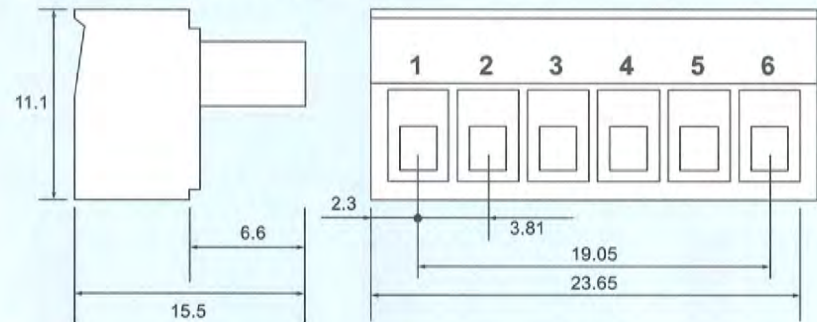
Manufacturer	Model Code
Phoenix Contact	MC 1.5/6-ST-3.81

Cable connection

No	Signal name	Function
1	NET-A	NET-A input connection
2	NET-B	NET-B input connection
3	Shield	Cable shield connection
4	NET-A	NET-A input connection
5	NET-B	NET-B input connection
6	Shield	Cable shield connection

Note: PROFIBUS is a registered trademark of Profibus Nutzer Organization.

Dimensional drawings [Unit: mm]



LONWORKS® Expansion Card

SJ-LW

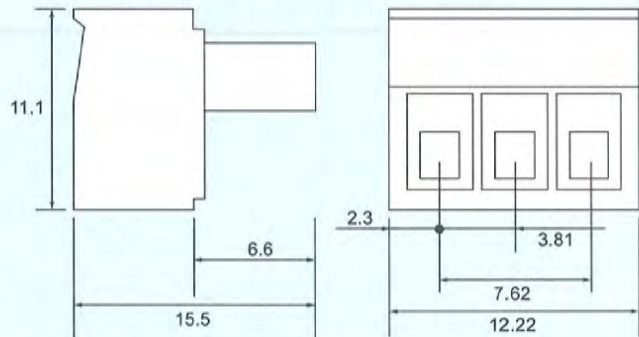
Specifications

Device Class	Variable Speed Drive
Transmission method	FTT-10A (Free Topology Twisted Pair Transceiver)
Connector type	Open connector
LonMark Object Support	0000-Node Object 6010-Variable Speed Motor Drive
Support file	XIF
Neuron Chip	TMPN3120FE5M
Max. bus length	2700m
Max. length between nodes	500m
Max. nodes number	32,385
Termination support	FT (Free topology termination enable) NO (Termination disable) BUS (Bus topology termination enable)
Support transmission baudrate	78kbps (Fixed)
Data type	Pier to Pier
Support LED	Power /Inverter LON diagnosis/ Service Communication Status

Connector specifications

Manufacturer	Model Code
Phoenix Contact	MC 1.5/3-ST-3.81

Dimensional drawings [Unit: mm]



•LONWORKS is a registered trademark of Echelon Corporation

Cable connection

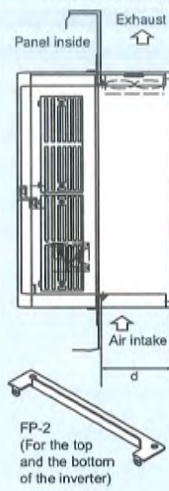
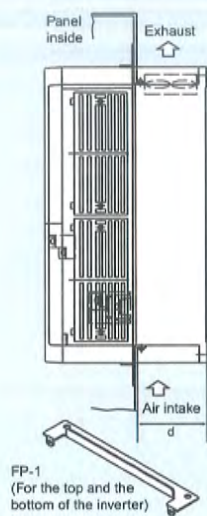
No	Signal name	Function
1	Shield	Cable shield connection
2	NET-A	NET-A input connection
3	NET-B	NET-B input connection

Note: Network function must be supported by the software of the inverter used with SJ-DN, SJ-PBT, or SJ-LW.
For the detail, please contact Hitachi sales office.

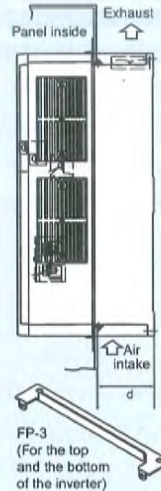
FOR COMPACT PANEL

Heat accumulation in the panel can be reduced by arranging inverter heat sink outside.

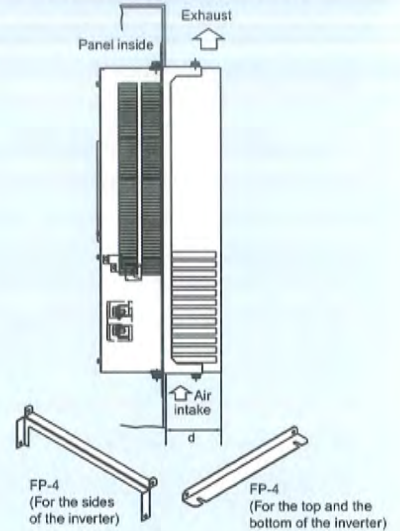
● L300P-015-055LFU2, HFU2/E2 ● L300P-075-150LFU2, HFU2 -110-150HFE2



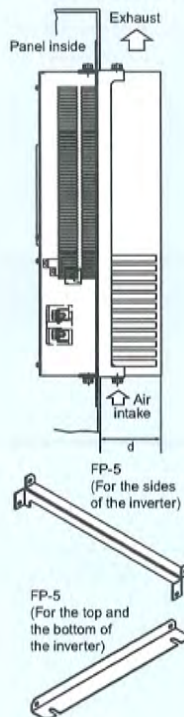
● L300P-185-300LFU2, HFU2/E2



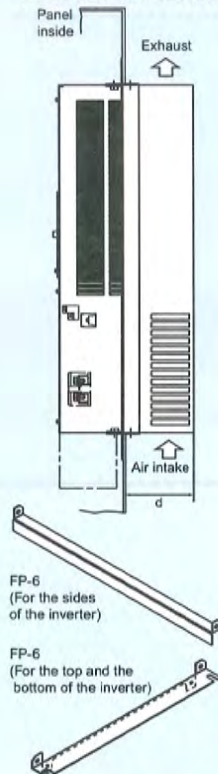
● L300P-370LFU2, HFU2/E2



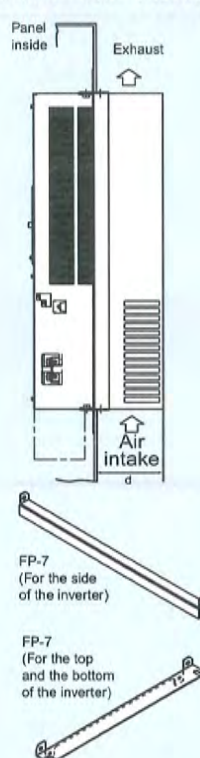
● L300P-450-550LFU2 -450-750HFU2/E2



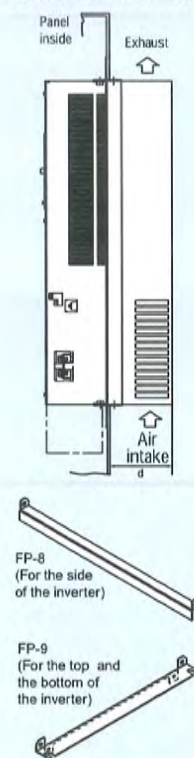
● L300P-750LFU2



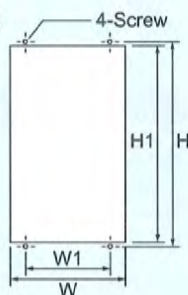
● L300P-900-1100HFU2/E2



● L300P-1320HFU2/E2



● Panel cutout

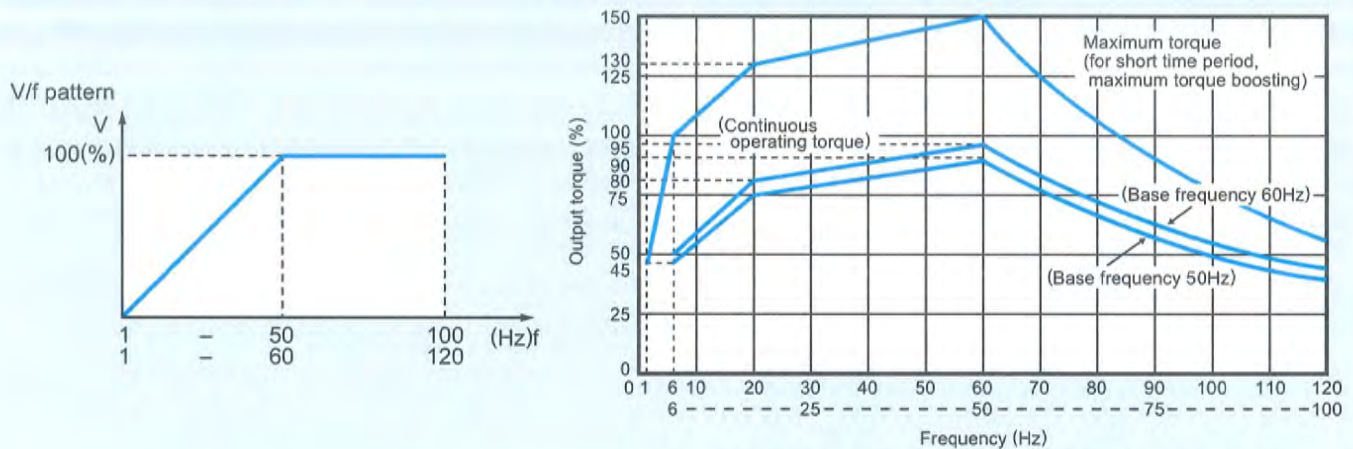


Model	W	W1	H	H1	Screw	d
L300P-015-055LFU2, HFU2/E2	146	130	280	260	M6	62
L300P-075-150LFU2, HFU2 -110-150HFE2	206	189	285	265	M6	82
L300P-185-300LFU2, HFU2/E2	249	229	415	395	M6	83
L300P-370LFU2, HFU2/E2	320	300	524	505	M8	92
L300P-450-550LFU2, HFU2/E2 -450-750HFU2/E2	400	380	550	520	M10	102.7
L300P-750LFU2	490	510	710	670	M10	131
L300P-900-1100HFU2/E2	400	420	710	690	M10	141
L300P-1320HFU2/E2	490	510	750	710	M10	137

[Unit: mm]

TORQUE CHARACTERISTICS

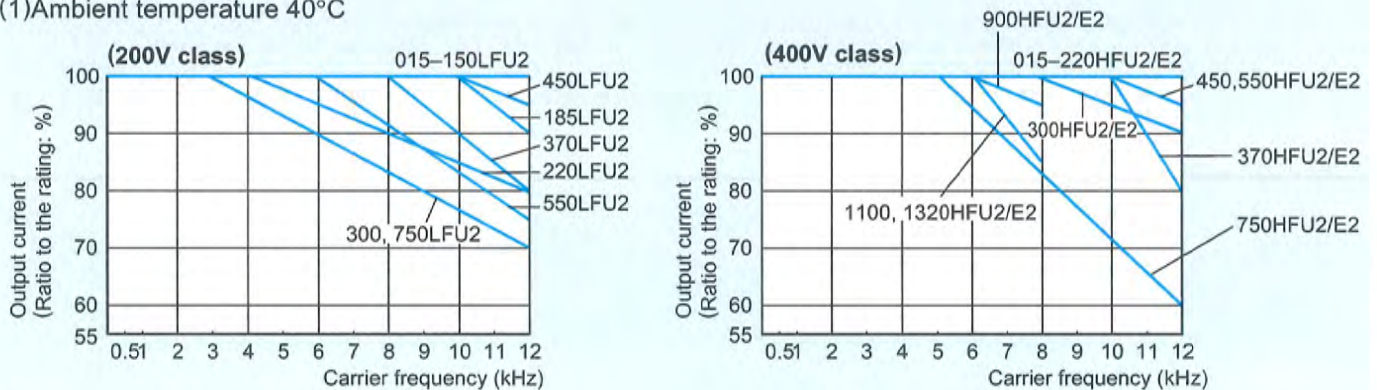
● Typical torque performance based on V/f pattern (top) is shown below.



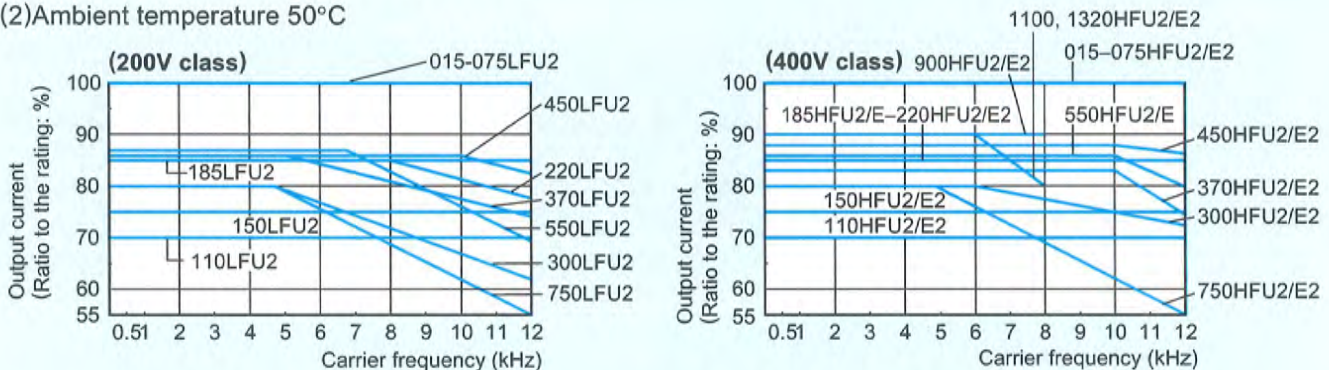
DERATING DATA

The L300P series can be used at ambient temperature of -10°C to 50°C . However, when using at 40°C or over, derating is required.

(1) Ambient temperature 40°C



(2) Ambient temperature 50°C



FOR CORRECT OPERATION

● Application to Motors

[Application to general-purpose motors]

Operating frequency	The overspeed endurance of a general-purpose motor is 120% of the rated speed for 2 minutes (JIS C4,004). For operation at higher than 60Hz, it is required to examine the allowable torque of the motor, useful life of bearings, noise, vibration, etc. In this case, be sure to consult the motor manufacturer as the maximum allowable rpm differs depending on the motor capacity, etc.
Torque characteristics	The torque characteristics of driving a general-purpose motor with an inverter differ from those of driving it using commercial power (starting torque decreases in particular). Carefully check the load torque characteristic of a connected machine and the driving torque characteristic of the motor.
Motor loss and temperature increase	An inverter-driven general-purpose motor heats up quickly at lower speeds. Consequently, the continuous torque level(output) will decrease at lower motor speeds. Carefully check the torque characteristics vs speed range requirements.
Noise	When run by an inverter, a general-purpose motor generates noise slightly greater than with commercial power.
Vibration	When run by an inverter at variable speeds, the motor may generate vibration, especially because of (a) unbalance of the rotor including a connected machine, or (b) resonance caused by the natural vibration frequency of a mechanical system. Particularly, be careful of (b) when operating at variable speeds a machine previously fitted with a constant speed motor. Vibration can be minimized by (1) avoiding resonance points using the frequency jump function of the inverter, (2) using a tire-shaped coupling, or (3) placing a rubber shock absorber beneath the motor base.
Power transmission mechanism	Under continued, low-speed operation, oil lubrication can deteriorate in a power transmission mechanism with an oil-type gear box (gear motor) or reducer. Check with the motor manufacturer for the permissible range of continuous speed. To operate at more than 60 Hz, confirm the machine's ability to withstand the centrifugal force generated.

[Application to special motors]

Gear motor	The allowable rotation range of continuous drive varies depending on the lubrication method or motor manufacturer. (Particularly in case of oil lubrication, pay attention to the low frequency range.)
Brake-equipped motor	For use of a brake-equipped motor, be sure to connect the braking power supply from the primary side of the inverter.
Pole-change motor	There are different kinds of pole-change motors (constant output characteristic type, constant torque characteristic type, etc.), with different rated current values. In motor selection, check the maximum allowable current for each motor of a different pole count. At the time of pole changing, be sure to stop the motor.
Submersible motor	The rated current of a submersible motor is significantly larger than that of the general-purpose motor. In inverter selection, be sure to check the rated current of the motor. Also see: Application to the 400V-class motor.
Explosion-proof motor	Inverter drive is not suitable for a safety-enhanced explosion-proof type motor. The inverter should be used in combination with a pressure-proof explosion-proof type motor. *Explosion-proof verification is not available for L300P Series. For explosion-proof operation, use other series of motors.
Synchronous (MS) motor High-speed (HFM) motor	In most cases, the synchronous (MS) motor and the high-speed (HFM) motor are designed and manufactured to meet the specifications suitable for a connected machine. As to proper inverter selection, consult the manufacturer.
Single-phase motor	A single-phase motor is not suitable for variable-speed operation by an inverter drive. Therefore, use a three-phase motor.

[Application to the 400V-class motor]

A system applying a voltage-type PWM inverter with IGBT may have surge voltage at the motor terminals resulting from the cable constants including the cable length and the cable laying method. Depending on the surge current magnification, the motor coil insulation may be degraded. In particular, when a 400V-class motor is used, a longer cable is used, and critical loss can occur, take the following countermeasures:

- (1) install the LCR filter between the inverter and the motor,
- (2) install the AC reactor between the inverter and the motor, or
- (3) enhance the insulation of the motor coil.

● Notes on Use

[Drive]

Run/Stop	Run or stop of the inverter must be done with the keys on the operator panel or through the control circuit terminals. Do not operate by installing an electromagnetic contactor (Mg) in the main circuit.
Emergency motor stop	When the protective function is operating or the power supply stops, the motor enters the free run stop state. When an emergency stop is required or when the motor should be kept stopped, use of a mechanical brake should be considered.
High-frequency operation	A max. 400Hz can be selected on the L300P Series. However, a two-pole motor can attain up to approx. 24,000 rpm, which is extremely dangerous. Therefore, carefully make selection and settings by checking the mechanical strength of the motor and connected machines. Consult the motor manufacturer when it is necessary to drive a standard (general-purpose) motor above 60 Hz.

[Installation location and operating environment]

Avoid installation in areas of high temperature, excessive humidity, or where moisture can easily collect, as well as areas that are dusty, subject to corrosive gasses, mist of liquid for grinding, or salt. Install the inverter away from direct sunlight in a well-ventilated room that is free of vibration. The inverter can be operated in the ambient temperature range from -10 to 50°C. (Carrier frequency and output current must be reduced in the range of 40 to 50°C.)

Main power supply

Installation of an AC reactor on the input side	In the following examples involving a general-purpose inverter, a large peak current flows on the main power supply side, and may destroy the converter module. Where such situations are foreseen or the connected equipment must be highly reliable, install an AC reactor between the power supply and the inverter. Also, where influence of indirect lightning strike is possible, install a lightning conductor. (A) The unbalance factor of the power supply is 3% or higher. (Note) (B) The power supply capacity is at least 10 times greater than the inverter capacity (the power supply capacity is 500 kVA or more). (C) Abrupt power supply changes are expected. Examples: (1) Several inverters are interconnected with a short bus. (2) A thyristor converter and an inverter are interconnected with a short bus. (3) An installed phase advance capacitor opens and closes. In cases (A), (B) and (C), it is recommended to install an AC reactor on the main power supply side. Note: Example calculation with $V_{RS} = 205V$, $V_{ST} = 201V$, $V_{TR} = 200V$ V_{RS}: R-S line voltage, V_{ST}: S-T line voltage, V_{TR}: T-R line voltage $\text{Unbalance factor of voltage} = \frac{\text{Max. line voltage (min.)} - \text{Mean line voltage}}{\text{Mean line voltage}} \times 100$ $= \frac{V_{RS} - (V_{RS} + V_{ST} + V_{TR})/3}{(V_{RS} + V_{ST} + V_{TR})/3} \times 100 = \frac{205 - 202}{202} \times 100 = 1.5 (\%)$
Using a private power generator	An inverter run by a private power generator may overheat the generator or suffer from a deformed output voltage waveform of the generator. Generally, the generator capacity should be five times that of the inverter (kVA) in a PWM control system, or six times greater in a PAM control system.

Notes on Peripheral Equipment Selection

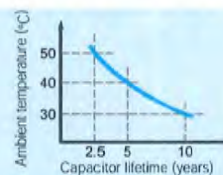
Wiring connections	(1) Be sure to connect main power wires with R(L1), S(L2), and T(L3) (input) terminals and motor wires to U(T1), V(T2), and W(T3) terminals (output). (Incorrect connection will cause an immediate failure.) (2) Be sure to provide a grounding connection with the ground terminal (⓪).				
Wiring between inverter and motor	<table border="1"> <tr> <td>Electromagnetic contactor</td><td>When an electromagnetic contactor is installed between the inverter and the motor, do not perform on-off switching during running operation.</td></tr> <tr> <td>Thermal relay</td><td> When used with standard applicable output motors (Hitachi standard three-phase squirrel-cage four-pole motors), the L300P Series does not need a thermal relay for motor protection due to the internal electronic protective circuit. A thermal relay, however, should be used: - during continuous running outside a range of 30 to 60 Hz. - for motors exceeding the range of electronic thermal adjustment (rated current). - when several motors are driven by the same inverter; install a thermal relay for each motor. - The RC value of the thermal relay should be more than 1.1 times the rated current of the motor. Where the wiring length is 10 m or more, the thermal relay tends to turn off readily. In this case, provide an AC reactor on the output side or use a current sensor. </td></tr> </table>	Electromagnetic contactor	When an electromagnetic contactor is installed between the inverter and the motor, do not perform on-off switching during running operation.	Thermal relay	When used with standard applicable output motors (Hitachi standard three-phase squirrel-cage four-pole motors), the L300P Series does not need a thermal relay for motor protection due to the internal electronic protective circuit. A thermal relay, however, should be used: - during continuous running outside a range of 30 to 60 Hz. - for motors exceeding the range of electronic thermal adjustment (rated current). - when several motors are driven by the same inverter; install a thermal relay for each motor. - The RC value of the thermal relay should be more than 1.1 times the rated current of the motor. Where the wiring length is 10 m or more, the thermal relay tends to turn off readily. In this case, provide an AC reactor on the output side or use a current sensor.
Electromagnetic contactor	When an electromagnetic contactor is installed between the inverter and the motor, do not perform on-off switching during running operation.				
Thermal relay	When used with standard applicable output motors (Hitachi standard three-phase squirrel-cage four-pole motors), the L300P Series does not need a thermal relay for motor protection due to the internal electronic protective circuit. A thermal relay, however, should be used: - during continuous running outside a range of 30 to 60 Hz. - for motors exceeding the range of electronic thermal adjustment (rated current). - when several motors are driven by the same inverter; install a thermal relay for each motor. - The RC value of the thermal relay should be more than 1.1 times the rated current of the motor. Where the wiring length is 10 m or more, the thermal relay tends to turn off readily. In this case, provide an AC reactor on the output side or use a current sensor.				
Installing a circuit breaker	Install a circuit breaker on the main power input side to protect inverter wiring and ensure personal safety. Choose an inverter-compatible circuit breaker. The conventional type may malfunction due to harmonics from the inverter. For more information, consult the circuit breaker manufacturer.				
Wiring distance	The wiring distance between the inverter and the remote operator panel should be 20 meters or less. When this distance is exceeded, use CVD-E (current-voltage converter) or RCD-E (remote control device). Shielded cable should be used on the wiring. Beware of voltage drops on main circuit wires. (A large voltage drop reduces torque.)				
Earth leakage relay	If the earth leakage relay (or earth leakage breaker) is used, it should have a sensitivity level of 15 mA or more (per inverter).				
Phase advance capacitor	Do not use a capacitor for power factor improvement between the inverter and the motor because the high-frequency components of the inverter output may overheat or damage the capacitor.				

High-frequency Noise and Leakage Current

- (1) High-frequency components are included in the input/output of the inverter main circuit, and they may cause interference in a transmitter, radio, or sensor if used near the inverter. The interference can be minimized by attaching noise filters (option) in the inverter circuitry.
- (2) The switching action of an inverter causes an increase in leakage current. Be sure to ground the inverter and the motor.

Lifetime of Primary Parts

Because a smoothing capacitor deteriorates as it undergoes internal chemical reaction, it should normally be replaced every five years. Be aware, however, that its life expectancy is considerably shorter when the inverter is subjected to such adverse factors as high temperatures or heavy loads exceeding the rated current of the inverter. The approximate lifetime of the capacitor is as shown in the figure at the right when it is used 12 hours daily (according to the "Instructions for Periodic Inspection of General-Purpose Inverter" (JEMA)). Also, such moving parts (cooling fan) should be replaced. Maintenance inspection and parts replacement must be performed by only specified trained personnel.



Precaution for Correct Usage

- Before use, be sure to read through the Instruction Manual to insure proper use of the inverter.
- Note that the inverter requires electrical wiring; a trained specialist should carry out the wiring.
- The inverter in this catalog is designed for general industrial applications. For special applications in fields such as aircraft, outer space, nuclear power, electrical power, transport vehicles, clinics, and underwater equipment, please consult with us in advance.
- For application in a facility where human life is involved or serious losses may occur, make sure to provide safety devices to avoid a serious accident.
- The inverter is intended for use with a three-phase AC motor. For use with a load other than this, please consult with us.

ECM 14: Vending Machine Controls

ECM Overview

Ameresco proposes to install vending machine controllers on drink and snack vending machines at the Memorial Boys and Girls Club, Council on Aging - Hilton Center, and Town Hall. Each controller will save energy used by the 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.

ECM Detail

Existing System

Vending machines were found at 3 buildings throughout the Town of Salisbury. The vending machines are typically stocked with soda, juice, water, and snacks, and are cooled and illuminated year-round regardless of occupancy. Since many of the identified buildings are not constantly occupied, the refrigerated and illuminated vending machines consume more energy than needed.

Ameresco identified the following vending machines for VendingMiser™ or SnackMiser™ controller installation:

Table 14.1 List of existing vending machines to be controlled

Building	Snack Machines	Drink Quantity
Council on Aging- Hilton Senior Center	0	1
Town Hall	0	1
Memorial School-Boys and Girls Club	0	1
Total	0	3

Proposed System

Ameresco proposes to install a VendingMiser™ or SnackMiser™ controller, or equal, on the beverage vending machines in the Memorial Boys and Girls Club, Council on Aging - Hilton Center, and Town Hall to save energy during unoccupied periods. This device controls the vending machine operation without compromising product quality. The controller is external to the vending machine, therefore not requiring vendor maintenance. Major soft drink manufacturers have approved the controller for use on refrigerated vending machines offering their products.



Figure 14.1: Beverage machines at the Hilton Center

The controller employs infrared sensing technology to interrupt power to a vending machine when the surrounding area is unoccupied. For refrigerated machines, regardless of occupancy, the controller automatically enables the vending machine periodically 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 the Youth Center is not constantly occupied, the vending machines there consume more energy than needed.

According to the manufacturer's representative, if switched off, this product's resumes normal operation once its power is restored.



Figure 14.2: Drink and snack vending machines in the will be controlled and set back by the new controllers, resulting in electrical savings for the Town.

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the Town 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

The new vending machine controls will save energy without detracting from the performance of the machines.

Appendix for ECM 14: Vending Machine Controls

I. Energy Savings Calculations

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Town of Salisbury, Massachusetts		
Energy and Demand Savings Summary		
Measure ID:	14	
Measure Name:	Vending Machine Controls	
Measure Location:		
Engineers:		

Site Name:			COA	TownHall	Memorial	Summary
Item	Units		Savings	Savings	Savings	
Electricity						
Energy On-Peak	kWh		2,518	2,628	2,248	7,395
Energy Off-Peak	kWh					0
Energy Total	kWh		2,518	2,628	2,248	7,395
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		-56	-51	0	-106
Liquid Propane Gas (LPG)	Gallons		0	0	0	0
Steam	Mlbs		0	0	0	0
Fuel Oil, #2	Gallons		0	0	-36	-36
Fuel Oil, #4	Gallons		0	0	0	0
Fuel Oil, #6	Gallons		0	0	0	0
Miscellaneous	Misc		0	0	0	0
Water						0
Water Savings	kGallons					0
Sewer						0
Sewer Savings	kGallons					0

Town of Salisbury, Massachusetts
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	Annual Electric Savings
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]
Council on Aging- Hilton Senior Center	0	1	0.43	8,760	3,741	3,415	1,458	12	2,282
Town Hall	0	1	0.43	8,760	3,741	3,046	1,301	12	2,440
Sparhawk/Memorial School-Boys and Girls Club	0	1	0.43	8,760	3,741	3,524	1,505	12	2,236
	0	4	1.71		14,962		8,004		6,958

Item	Value	Units	cell ref	Remarks
Existing Annual Hours of Operation per Machine	8,760	Hrs.	[C62]	Vending Machines are constantly plugged
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 Draw	80	watts	[C65]	Average power draw, with cycling
Refrigerated Drink Machine Average Power Draw	427	watts	[C66]	Average power draw, with cycling

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]

Town of Salisbury, Massachusetts
Vending Machine Controls
Interactive Savings Calculation



A	Savings		Heating Penalty				Cooling Benefit			
	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
Council on Aging- Hilton Senior Center		2,282	100.0%	6.0	70.0%	(5.6)	100.0%	4.0	3.22	0.8
Town Hall		2,440	100.0%	6.0	82.0%	(5.1)	95.0%	4.0	4.10	0.6
Sparhawk/Memorial School-Boys and Girls Club		2,236	100.0%	6.0	76.5%	(5.0)	5.0%	4.0	2.93	0.0
Totals	0.0	6,958				(15.6)				1.5

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 14: 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 NO_x, 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™.



Schedule
Contract GS-35F-0031R



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

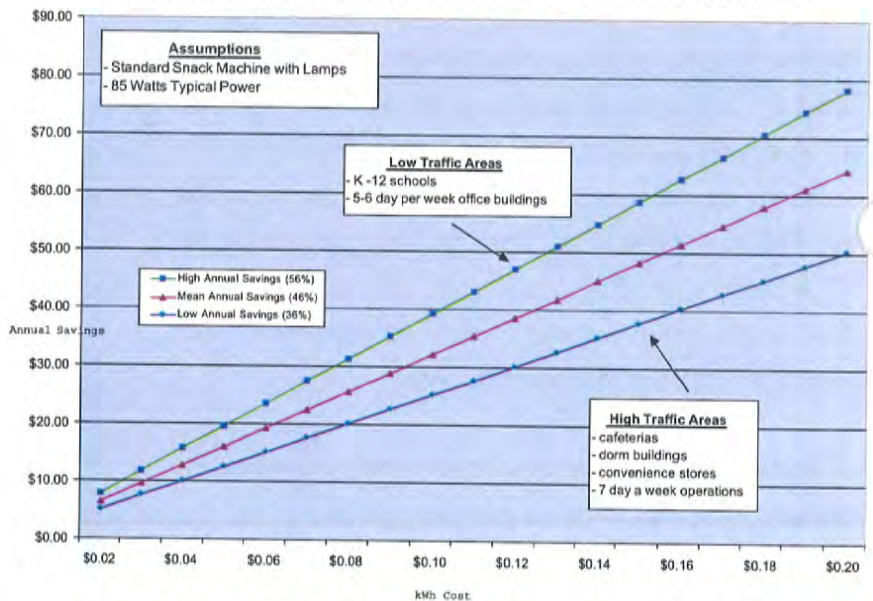
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2 lb. (incl. power cable)

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.



Schedule
Contract GS-35F-0031R



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™.

Frequently Asked Questions

Will VendingMiser® keep my drinks cold?

Absolutely - VendingMiser® has been tested and accepted for use by both major bottlers.

Is the VendingMiser® easy to install?

Yes! VendingMiser® is a simple external plug-and-play product. The VendingMiser® can be installed on the wall with simple hand tools or it can be attached to the vending machine without tools using the new Easy-Install system. The Easy-Install System allows quick installation in 5 minutes.

Is VendingMiser® safe for all machines?

Yes! VendingMiser® is compatible with all types of cold drink vending machines. In fact, by reducing run time of the machines, VendingMiser® reduces maintenance costs.

Has VendingMiser® been field tested?

Tens of thousands of VendingMisers® are operational in the field. Typical energy savings have been independently documented to be between 35% and 45%. Measurement and verification test results as well as testimonials are available on the website.

Are there any locations not appropriate for VendingMiser®?

VendingMiser's® savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings. Our VM2IQ is more appropriate for this type of location and will typically save up to 35% energy use.

Technical Specifications

ELECTRICAL SPECIFICATIONS

Input Voltage: 115 Volts (230 Volts available)
Input Frequency: 50/60 Hz
Maximum Load: 12 Amps (Steady-State)
Power Consumption: Less than 1 Watt (Standby)

ENVIRONMENTAL SPECIFICATIONS

Operating Temp: -15°C to 75°C
Storage Temp: -40°C to 85°C
Relative Humidity: 95% Maximum (Non-Condensing)

COMPATIBILITY

Vending Machines: Any machine, except those containing perishable goods such as dairy products.

INACTIVITY TIMEOUTS

Occupancy Timeout: 15 minutes
Auto Repower: One to three hours, dynamically adjusted, based on ambient temperature

DIMENSIONS

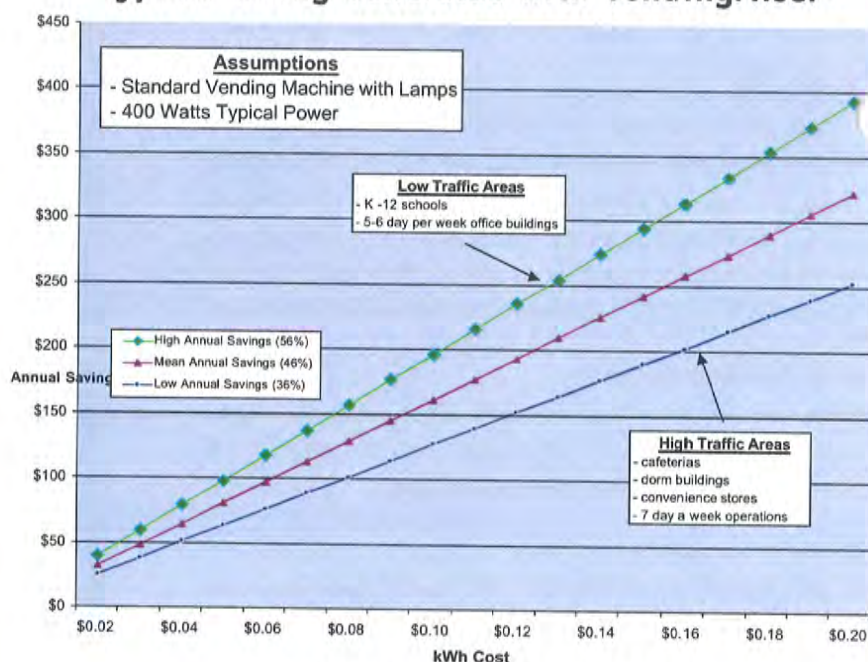
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety: UL/C-UL Listed
Information Technology Equipment (ITE) 9T79



Typical Saving Generated with VendingMiser®



VendingMiser® Products

VM150	VendingMiser® with PIR Sensor
VM151	VendingMiser® only
VM160	Weatherproof VendingMiser® with PIR Sensor
VM161	Weatherproof VendingMiser® only
VM170	Easy-Install VendingMiser® with PIR Sensor
VM171	Easy-Install VendingMiser® only
VM180	Weatherproof Easy-Install VendingMiser w/PIR sensor
VM181	Weatherproof Easy-Install VendingMiser only

For more information about VendingMiser contact

Optimum Energy Products Ltd. Toll free 1.877.766.5412 or online www.VendingMiserStore.com

ECM 15: Weatherization Improvements

ECM Overview

Ameresco proposes to reduce uncontrolled air infiltration at a number of buildings. Entry door weather-stripping is proposed for all buildings. Other air sealing measures to be applied in selected buildings include includes roof wall joint foam application, window air sealing, exhaust hatch air sealing, soffits air sealing, and overhead door weather-stripping. The proposed air sealing will reduce heat loss and increase occupant by reducing drafts. All of the buildings were surveyed and evaluated, but measures are excluded at some buildings due to long payback.



Figure 15.1: Window weather-stripping is proposed for Town Hall to reduce air infiltration.

ECM Detail

Existing System

Outdoor air infiltration can be a significant part of the 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 careful weather-stripping and other air sealing methods. A few of the major sources of infiltration are exterior doors, windows, roofs and roof/wall interfaces.

Ameresco evaluated the exterior of each building and found many areas that were in need of improved weatherstripping or air sealing.

Doors - These are generally the main source of air leakage. Weatherstripping is typically worn and/or missing. Also, older doors do not close tight or latch correctly as when first installed. Weather-stripping is used to seal these gaps, that is more durable than the original, factory OEM product.

Soffits - These are generally defined as exterior overhang areas that are connected to the interior space through openings in the building walls and roof lines. Proper sealing of these is often missed during original construction, or compromised during subsequent installation of lighting or security devices. Significant savings can be realized by sealing these with spray foam and rigid foam board as required. However, some

roof line soffits are designed to be open to allow proper ventilation in an attic space. In this case the air barrier should be at the attic floor.

Exterior or Roof Wall Penetrations - Any time an exterior hole is made to accommodate a pipe, ductwork, door, or window assembly, there is a chance for air leakage if gaps are not properly sealed or if the sealant material has broken down. For example, at the Council of Aging offices and conference room, there are roof vent penetrations through the spray foam insulation installed in rafter bays. These vents are not appropriate for this “warm roof” insulation system and are air leakage sources into the conditioned space.

Roof-Wall Interface - This is the most often-missed area in a building during construction. It occurs above the ceiling tiles where the wall assembly meets the roof deck. Most wall assemblies are not fully completed above the ceiling line. Air leakage and thermal losses are best resolved at this interface with the application of spray foam. At the wastewater treatment plant, for example, air sealing is proposed for a portion of the roof wall interface.

Attics and Walls - Most of these areas are already addressed (that can be easily reached). However, what is generally missed is proper air sealing of penetrations (wiring, ductwork, shaft-ways, top-plates, hatches, walk-up stairs and doors). It is also very typical to find penetrations cut into the attic to provide access to devices or resolve issues encountered over the years. For example, Town Hall’s attic hatch is a source of excessive air infiltration.

Windows – Windows are installed within wall penetrations and sealed with caulking to provide an air tight fit. Over time this caulking at joints and perimeters can deteriorate and be a major source of air infiltration. Town Hall’s windows are examples of leaking windows that can be improved. On the other hand, the single pane windows at the Boys and Girls Club are so deteriorated that they would not be worth the investment of air sealing.

Appendix III contains details of the existing condition of each building building’s envelope along with description of proposed improvements.

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, soffits, duct penetrations, windows, 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 15.1 shows the buildings that will receive air sealing strategies. New weather-stripping and door sweeps will be installed to exterior doors which will conform to existing aesthetics as best as possible. Q-lon weather-stripping or equal with like colors will be used on main doors.

Proposed work excludes repair to any existing damage of the building infrastructure (i.e. mortar, brick, paint 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. Touch-up painting is not included in this ECM's scope of work.

Table 15.1: Proposed Weatherization Measures

Location	Description	Quantity	Units
Fire Department	weather-strip 30x68 entry doors	2	EA
Fire Department	window caulking	3	EA
Fire Department	weather-strip Overhead Doors top	3	EA
Council on Aging - Hilton Center	weather-strip 60x68 entry doors	3	EA
Council on Aging - Hilton Center	weather-strip 30x68 entry doors	2	EA
Council on Aging - Hilton Center	block and air seal overhangs	4	EA
Town Hall	weather-strip 60x68 entry doors	1	EA
Town Hall	weather-strip 30x68 entry doors	2	EA
Town Hall	air seal roof/wall joint	15	EA
Town Hall	weather-strip window 6 over 6 Original balance	18	EA
Town Hall	weather-strip window custom front 2nd story arched	1	EA
Town Hall	weather-strip window custom front 2nd story side lights	2	EA
Waste Water Treatment Plant	weather-strip 30x68 entry doors - sweeps	1	EA
Waste Water Treatment Plant	window caulking	140	LF
Waste Water Treatment Plant	block and air seal overhangs	1	EA
Waste Water Treatment Plant	air seal roof/wall joint	70	LF
Memorial Boys and Girls Club	weather-strip 60x68 entry doors	5	EA
Memorial Boys and Girls Club	weather-strip 30x68 entry doors	3	EA

Equipment, Design and Construction Documentation

Equipment will be identified in submittals provided for approval prior to procurement. Documents will be submitted to the Town 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

The weatherization measures detailed above will reduce drafts as well as heating and cooling load and will result in more even and stable temperatures in the occupied spaces, reducing user complaints and dissatisfaction.

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Appendix for ECM 15: Weatherization Improvements

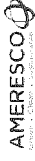
I. Energy Savings Calculations

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Town of Salisbury, Massachusetts	
Energy and Demand Savings Summary	
Measure ID:	15
Measure Name:	Weatherization Improvements
Measure Location:	
Engineers:	

Site Name:			Fire	COA	TownHall	Sewer	Memorial	Summary
Item	Units		Savings	Savings	Savings	Savings	Savings	
Electricity								
Energy On-Peak	kWh		7	11	17	4,122	20	4,175
Energy Off-Peak	kWh							0
Energy Total	kWh		7	11	17	4,122	20	4,175
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			124	228			351
Liquid Propane Gas (LPG)	Gallons							0
Steam	Mlbs							0
Fuel Oil, #2	Gallons		145				94	239
Fuel Oil, #4	Gallons							0
Fuel Oil, #6	Gallons							0
Miscellaneous	Misc							0

Town of Salisbury, Massachusetts
Fire Department
Weatherization Improvements



TMY-2 Weather Data for Lawrence Municipal Airport, MA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	Operating Hours				Savings																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
				E	F	G	H	I	J	K	L	M	N	O	P	UnOcc. Cooling Savings (MMBTU)	Occ. Cooling Savings (MMBTU)	UnOcc. Heating Savings (MMBTU)	Occ. Heating Savings (MMBTU)	UnOcc. Heating Savings (MMBTU)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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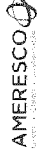
Cell Ref.	Comment	Value	Unit	CELL	Description
A-H	TMY-2 Weather Data for Lawrence Municipal Airport, MA				
I - L	Occupied hours as per the RFP data				
M	Total Crack area of windows and doors				
N	Average wind speed during the cooling and heating seasons				
O	$= \frac{1.08 \times \text{[col M]} \times \text{[col N]} \times 5286}{60 \times \text{P56}}$	1.45 SF		P43	Door Crack Area
P	$= \frac{1.08 \times \text{[col O]} \times (\text{Q60} - \text{[col B]})}{1000 \times \text{P51}}$	0.00 SF		P44	Window Crack Area
Q	$= \frac{1.08 \times \text{[col O]} \times (\text{Q61} - \text{[col B]})}{1000 \times \text{P51}}$	0.00 SF		P45	Roof Crack Area
R	$= \frac{1.08 \times \text{[col P]} \times (\text{[col J]} + \text{[col K]})}{1000 \times \text{P52} \times \text{P53}}$	0.00 SF		P46	Soffit Crack Area
S	$= \frac{1.08 \times \text{[col P]} \times (\text{[col J]} + \text{[col K]})}{1000 \times \text{P52} \times \text{P53}}$	0.00 SF		P47	Attics Crack Area
T	$= \frac{1.08 \times \text{[col P]} \times (\text{[col J]} + \text{[col K]})}{1000 \times \text{P52} \times \text{P53}}$	0.00 SF		P48	Wall Crack Area
U	$= \frac{1.08 \times \text{[col Q]} \times (\text{[col J]} + \text{[col K]})}{1000 \times \text{P51}}$	0.00 SF		P49	Roof/Wall Intersection Crack Area
		1.45 SF		P50	Total Area
		81.0%		P51	Existing Boiler Plant Efficiency
		2.93 COP		P52	Existing Cooling Plant Efficiency
		26.7%		P53	Percent Building Cooled
		8.5 MPH		P54	Average Winter Wind Speed
		7.0 MPH		P55	Average Summer Wind Speed
		10.0%		P56	Crack Area Windward Diversity

Average Space Temperatures - After Implementation of EMS			
		Heating	Description
Occupied	Q60	75.0	average temperature for all areas
UnOccupied	Q61	80.0	

Cell Ref.	Comment
A-H	HWY-2 Weather Data for Lawrence Municipal Airport, 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	$= [\text{col M}] \times [\text{col N}] \times 5286 - 60 \times \text{P56}$
P	$= [1.08 \times [\text{col O}]] \times (\text{Q60} - [\text{col B}]) \div 1000 \times \text{P51}$
Q	$= [1.08 \times [\text{col O}]] \times (\text{Q61} - [\text{col B}]) \div 1000 \times \text{P51}$
R	$[\text{col P}] \times ([\text{col I}] + [\text{col K}]) \div 1000 \times \text{P53} \times \text{P53}$
S	$[\text{col Q}] \times ([\text{col I}] + [\text{col L}]) \div 1000 \times \text{P52} \times \text{P53}$
T	$[\text{col P}] \times ([\text{col I}] + [\text{col K}]) \div 1000 \times \text{P51}$
U	$[\text{col Q}] \times ([\text{col I}] + [\text{col L}]) \div 1000 \times \text{P51}$

Average Space Temperatures - After implementation of EMS			
	Cooling	Heating	Description
Occupied	75.0	Q60	Q60
UnOccupied	80.0	Q61	Q61
			average temperature for all areas

Town of Salisbury, Massachusetts
Town Hall
Weatherization Improvements



TMY-2 Weather Data for Lawrence Municipal Airport, MA																				
Operating Hours																				
Savings																				
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W./B deg. F	M.C. Enthalpy Btu/lbm	E (0-08 Hours)	F (09-16 Hours)	G (17-24 Hours)	H Total Bin Hours	I Occ On-Peak Hrs.	J UnOcc On-Peak Hrs.	K Occ Off-Peak Hrs.	L UnOcc Off-Peak Hrs.	M Total Crack Area (ft ²)	N Average Wind Speed (MPH)	O Infiltration Flow Rate (CFM)	P Occ. Heating / Cooling Savings (MBH)	Q UnOcc. Heating / Cooling Savings (MBH)	R Occ. Cooling Savings (MMBTU)	S UnOcc. Cooling Savings (MMBTU)	T Occ. Heating Savings (MMBTU)	U UnOcc. Heating Savings (MMBTU)
Cooling																				
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	2.1	7.0	130	5	4	0	0		
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	2.1	7.0	130	4	3	0	0		
95 to 100	97.5	0.0	0.0	0	0	0	0	0	0	0	0	2.1	7.0	130	3	2	0	0		
90 to 95	92.5	72.6	36.2	0	8	8	8	2	6	0	0	2.1	7.0	130	2	2	0	0		
85 to 90	87.5	69.7	33.7	0	70	16	86	19	67	0	0	2.1	7.0	130	2	1	0	0		
80 to 85	82.5	68.9	33.1	2	202	67	271	59	212	0	0	2.1	7.0	130	1	0	0	0		
75 to 80	77.5	66.8	31.4	30	272	146	448	97	351	0	0	2.1	7.0	130	0	0	0	0		
70 to 75	72.5	64.1	29.4	89	245	171	505	110	395	0	0	2.1	7.0	130	0	0	0	0		
65 to 70	67.5	61.8	27.7	235	275	283	793	172	621	0	0	2.1	7.0	130	0	0	0	0		
60 to 65	62.5	58.3	25.3	372	248	341	961	209	752	0	0	2.1	7.0	130	0	0	0	0		
Heating																				
55 to 60	57.5	52.8	21.9	244	210	228	682	148	534	0	0	2.1	8.5	158	2	0			0	0
50 to 55	52.5	48.5	19.5	299	202	240	741	161	580	0	0	2.1	8.5	158	3	0			1	0
45 to 50	47.5	43.8	17.0	247	176	206	629	137	492	0	0	2.1	8.5	158	4	1			1	1
40 to 45	42.5	38.9	14.7	261	276	246	783	170	613	0	0	2.1	8.5	158	5	2			1	2
35 to 40	37.5	33.8	12.5	339	311	357	1,007	219	788	0	0	2.1	8.5	158	6	3			2	3
30 to 35	32.5	29.3	10.6	300	189	268	757	164	593	0	0	2.1	8.5	158	7	4			1	3
25 to 30	27.5	24.8	8.9	179	85	136	400	87	313	0	0	2.1	8.5	158	8	5			1	2
20 to 25	22.5	20.0	7.1	115	60	83	258	56	202	0	0	2.1	8.5	158	8	6			1	2
15 to 20	17.5	14.9	5.4	106	39	73	218	47	171	0	0	2.1	8.5	158	9	6			1	1
10 to 15	12.5	10.7	4.0	34	20	26	80	17	63	0	0	2.1	8.5	158	10	7			0	1
5 to 10	7.5	5.2	2.4	19	24	18	61	13	48	0	0	2.1	8.5	158	11	8			0	0
0 to 5	2.5	0.8	1.1	34	7	13	54	12	42	0	0	2.1	8.5	158	12	9			0	0
-5 to 0	(2.5)	(3.7)	(0.2)	12	1	2	15	5	12	0	0	2.1	8.5	158	13	10			0	0
-10 to -5	(7.5)	(8.4)	(1.5)	3	0	0	3	1	2	0	0	2.1	8.5	158	14	11			0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	2.1	8.5	158	14	12			0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	2.1	8.5	158	15	12			0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	2.1	8.5	158	16	13			0	0
				2,920	2,920	2,920	8,760	1,903	6,857	0	0						0	0	8	14

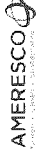
Cell Ref.	Comment
A-H	TMY-2 Weather Data for Lawrence Municipal Airport, MA
I - L	Occupied hours as per the RFP data
M	Total Crack area of windows and doors
N	Average wind speed during the cooling and heating seasons
O	$\sum [col M] \times [col N] \times 5286 \div 60 \times P56$
P	$\sum [col O] \times [col Q60 - [col B]] \div 1000 \div P51$
Q	$\sum [col P] \times [col O] \times [col Q61 - [col B]] \div 1000 \div P51$
R	$[col P] \times ([col I] + [col K]) \div 1,000 \div P52 \times P53$
S	$[col Q] \times ([col I] + [col K]) \div 1,000 \div P52 \times P53$
T	$[col P] \times ([col I] + [col K]) \div 1,000 \div P51$
U	$[col Q] \times ([col I] + [col K]) \div 1,000 \div P51$

Assumptions:	Value	Unit	CELL	Description
Door Crack Area	0.40 SF	SF	P43	
Window Crack Area	1.60 SF	SF	P44	
Roof Crack Area	0.00 SF	SF	P45	
Soffits Crack Area	0.00 SF	SF	P46	
Attics Crack Area	0.11 SF	SF	P47	
Wall Crack Area	0.00 SF	SF	P48	
Roof/Wall Intersection Crack Area	0.00 SF	SF	P49	
Total Area	2.11 SF	SF	P50	
Existing Boiler Plant Efficiency	82.0%		P51	
Existing Cooling Plant Efficiency	4.10 COP		P52	
Percent Building Cooled	80.0%		P53	
Average Winter Wind Speed	8.5 MPH	MPH	P54	
Average Summer Wind Speed	7.0 MPH	MPH	P55	
Crack Area Windward Diversity	10.0%		P56	

Average Space Temperatures - After Implementation of EMS			
	Cooling	Heating	Description
Occupied	75.0	72.0	Q60
UnOccupied	80.0	55.0	Q61
			average temperature for all areas

TMY-2 Weather Data for Lawrence Municipal Airport, MA												
Operating Hours										Savings		
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbm	01-08 Hours	09-16 Hours	17-24 Hours	Total Bin Hours	Occ On-Peak Hrs.	UnOcc On-Peak Hrs.	UnOcc Off-Peak Hrs.	Occ Off-Peak Hrs.	UnOcc Off-Peak Hrs.
B	C	D	E	F	G	H	I	J	K	L	M	N
Q	P	O	R	S	T	U	V	W	X	Y	Z	AA
AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN
AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA
BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN
BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA
CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN
CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA
DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN
DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA
EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN
EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA
FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN
FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA
GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN
GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA
HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN
HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA
IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN
IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA
JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	IL	IM	JN
JO	JP	JQ	JR	JS	JT	JU	JV	JW	JX	JY	JZ	KA
KB	KC	KD	KE	KF	KG	KH	KI	KJ	KK	KL	KM	KN
KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA
LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN
LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA
MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN
MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA
MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN
MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NO
NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ			

Town of Salisbury, Massachusetts
Sparhawk/Memorial School-Boys and Girls Club
Weatherization Improvements



TMY-2 Weather Data for Lawrence Municipal Airport, MA																										
Operating Hours																										
Savings																										
Amb. Temp Bin deg. F	Ave Temp deg. F	M.C.W.B deg. F	M.C. Enthalpy Btu/lbma	E	F	G	H	Total Bin Hours	I	UnOce On- Peak Hrs.	J	K	UnOce Off- Peak Hrs.	L	M	N	Average Wind Speed (MPH)	Infiltration Flow Rate (CFM)	Occ. Heating / Cooling Savings (MBH)	P	UnOcc. Heating Cooling Savings (MBH)	Q	Occ. Cooling Savings (MMBTU)	UnOcc. Cooling Savings (MMBTU)	Occ. Heating Savings (MMBTU)	UnOcc. Heating Savings (MMBTU)
Cooling																										
105 to 110	107.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	1.6	7.0	101	101	4	3	0	0	0	0	0	0
100 to 105	102.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	1.6	7.0	101	101	3	2	0	0	0	0	0	0
95 to 100	97.5	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	1.6	7.0	101	101	2	2	0	0	0	0	0	0
90 to 95	92.5	72.6	36.2	0	8	8	8	8	2	6	6	0	0	0	1.6	101	101	2	1	0	0	0	0	0	0	0
85 to 90	87.5	69.7	33.7	0	70	16	86	24	24	62	62	0	0	0	1.6	7.0	101	101	1	1	0	0	0	0	0	0
80 to 85	82.5	68.9	33.1	2	202	67	271	68.9	77	194	194	0	0	0	1.6	7.0	101	101	1	0	0	0	0	0	0	0
75 to 80	77.5	66.8	30	30	272	146	448	127	146	321	321	0	0	0	1.6	7.0	101	101	0	0	0	0	0	0	0	0
70 to 75	72.5	64.1	29.4	89	245	171	505	143	143	245	245	0	0	0	1.6	7.0	101	101	0	0	0	0	0	0	0	0
65 to 70	67.5	61.8	27.7	235	275	283	793	224	224	569	569	0	0	0	1.6	7.0	101	101	0	0	0	0	0	0	0	0
60 to 65	62.5	58.3	25.3	372	248	341	961	272	272	689	689	0	0	0	1.6	7.0	101	101	0	0	0	0	0	0	0	0
Heating																										
55 to 60	57.5	52.8	21.9	244	210	228	682	193	193	489	489	0	0	0	1.6	8.5	123	123	0	0	0	0	0	0	0	0
50 to 55	52.5	48.5	19.5	299	202	240	741	210	210	531	531	0	0	0	1.6	8.5	123	123	1	0	0	0	0	0	0	0
45 to 50	47.5	43.8	17.0	247	176	206	629	178	178	451	451	0	0	0	1.6	8.5	123	123	2	0	0	0	0	0	0	0
40 to 45	42.5	38.9	14.7	261	276	246	783	221	221	562	562	0	0	0	1.6	8.5	123	123	2	1	0	0	0	0	0	0
35 to 40	37.5	33.8	12.5	339	311	357	1,007	285	285	722	722	0	0	0	1.6	8.5	123	123	3	2	1	0	0	0	0	0
30 to 35	32.5	29.3	10.6	300	189	268	757	214	214	543	543	0	0	0	1.6	8.5	123	123	4	2	1	0	0	0	0	0
25 to 30	27.5	24.8	8.9	179	85	136	400	113	113	287	287	0	0	0	1.6	8.5	123	123	4	3	1	0	0	0	0	0
20 to 25	22.5	20.0	7.1	115	60	83	258	73	73	185	185	0	0	0	1.6	8.5	123	123	5	4	1	0	0	0	0	0
15 to 20	17.5	14.9	5.4	106	39	73	218	62	62	156	156	0	0	0	1.6	8.5	123	123	6	4	0	0	0	0	0	0
10 to 15	12.5	10.7	4.0	34	20	26	80	23	23	57	57	0	0	0	1.6	8.5	123	123	6	5	0	0	0	0	0	0
5 to 10	7.5	5.2	2.4	19	7	18	61	17	17	44	44	0	0	0	1.6	8.5	123	123	7	6	0	0	0	0	0	0
0 to 5	2.5	0.8	1.1	34	7	13	54	15	15	39	39	0	0	0	1.6	8.5	123	123	8	6	0	0	0	0	0	0
-5 to 0	(2.5)	(3.7)	(0.2)	12	1	2	15	4	4	11	11	0	0	0	1.6	8.5	123	123	8	7	0	0	0	0	0	0
-10 to -5	(7.5)	(8.4)	(1.5)	3	0	0	3	1	1	2	2	0	0	0	1.6	8.5	123	123	9	7	0	0	0	0	0	0
-15 to -10	(12.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	1.6	8.5	123	123	10	8	0	0	0	0	0	0
-20 to -15	(17.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	1.6	8.5	123	123	10	9	0	0	0	0	0	0
-25 to -20	(22.5)	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	1.6	8.5	123	123	11	9	0	0	0	0	0	0
				2,920	2,920	2,920	8,760	2,477	2,477	6,283	6,283	0	0	0									0	0	5	8

Cell Ref.	Comment
A-H	TMY-2 Weather Data for Lawrence Municipal Airport, 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	$= \frac{[\text{col M}] \times [\text{col N}] \times 5286 \div 60 \times \text{P56}}{1.08 \times [\text{col O}] \times (\text{Q60} - [\text{col B}]) \div 1000 \div \text{P51}}$
P	$= 1.08 \times [\text{col O}] \times (\text{Q61} - [\text{col B}]) \div 1000 \div \text{P51}$
Q	$= [\text{col P}] \times ([\text{col I}] + [\text{col K}]) \div 1,000 \div \text{P52} \times \text{P53}$
R	$= [\text{col Q}] \times ([\text{col J}] + [\text{col L}]) \div 1,000 \div \text{P52} \times \text{P53}$
S	$= [\text{col P}] \times ([\text{col I}] + [\text{col K}]) \div 1,000 \div \text{P51}$
T	$= [\text{col Q}] \times ([\text{col J}] + [\text{col L}]) \div 1,000 \div \text{P51}$
U	

Assumptions:	Value	Unit	CELL	REF	Description
Door Crack Area	1.64 SF		P43		
Window Crack Area	0.00 SF		P44		
Roof Crack Area	0.00 SF		P45		
Soffits Crack Area	0.00 SF		P46		
Attics Crack Area	0.00 SF		P47		
Wall Crack Area	0.00 SF		P48		
Roof/Wall Intersection Crack Area	0.00 SF		P49		
Total Area	1.64 SF		P50		
Existing Boiler Plant Efficiency	76.5%		P51		
Existing Cooling Plant Efficiency	2.93 COP		P52		
Percent Building Cooled	80.0%		P53		
Average Winter Wind Speed	8.5 MPH		P54		
Average Summer Wind Speed	7.0 MPH		P55		
Crack Area Windward Diversity	10.0%		P56		

Average Space Temperatures - After Implementation of EMS					Description
Occupied	Cooling	Heating			
	75.0	59.1	Q60		average temperature for all areas
UnOccupied	80.0	49.0	Q61		

Appendix for ECM 15: Weatherization Improvements

II. Manufacturer Specification Sheets

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"Page content is subject to Confidentiality Restrictions"

CONTENTS

The Weatherization Materials Information package includes the following data sheets:

- Weather Stripping Materials
 - Visco Weatherseal Products
 - DS050 – Door Weather Stripping
 - OBS296 – Offset Head Nylon Brush Door Gasket
 - FS325 – Wool Pile Brush Astragal with Fin
 - FS300 – Wool Pile Brush Sweep with Fin
 - TS100 – Door Triple Sweep
 - TS150 – Door Triple Sweep
 - BS196 – Brush Door Sweep
 - Schlegel Systems
 - QDS375/ QFS375 – Q-LON Surface Mount Weatherseal
 - QDST675 – Q-LON Surface Mount Weatherseal
 - PF102 – POLYFLEX Surface Mount Weatherseal
 - PF114 – POLYFLEX Surface Mount Weatherseal
 - PF512 – POLYFLEX Surface Mount Weatherseal
 - National Garage Door
 - JUMBO SEAL – 2” Vinyl
 - Weatherseal Retainer – 2” Flat Retainer
 - Vinyl Bottom Seal Insert – Single T Style
- Sealants
 - DOW FROTH-PAK Foam Insulation
 - Todol Products – EZ Flo Gun Foam
 - DuPont AIRTITE Siliconized Acrylic Caulk
 - Venture Tape – 1585CW-2 Sheathing Tape
- Systems / Sealants for Fire-Rated Rooms
 - A/D FIREBARRIER
 - A/D FIREBARRIER SprayAcrylic
 - A/D FIREBARRIER Acrylic Sealant
 - A/D FIREBARRIER Mineral Wool
- Insulating Materials
 - DOW THERMAX Sheathing
 - National Fiber Cel-Pak Class 1 Cellulose Insulation

DS080 - Light Duty (Rounded) Door Weatherstripping

Construction: PVC rigid vinyl. Mitered corners ensure a secure fit with slotted mounting holes for easy adjustment.

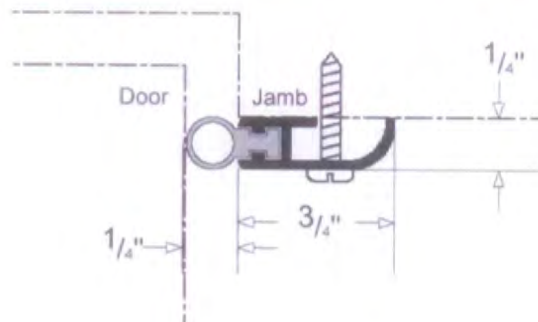
Insert: 1/4" flexible, bubble type neoprene or vinyl insert.

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.

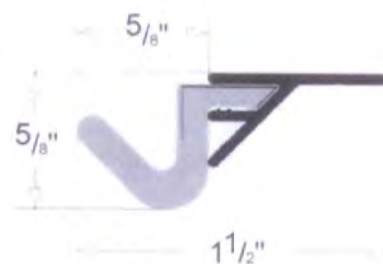
Insert: Soft cell foam insert. Foam has thermoplastic cover and will not deteriorate.

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.

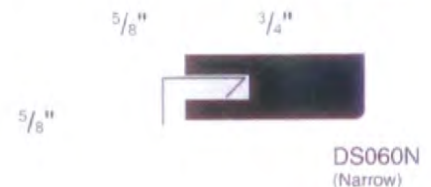
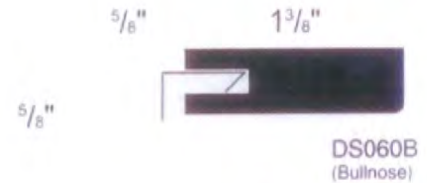
Insert: Q-Lon soft cell foam insert. Foam has thermoplastic cover and will not deteriorate.

Finish: Brown or White foam. Wood is primed, PVC is white.

Lengths: 1-3' piece and 2-7' pieces. Specify wood or PVC.

DS060-AL-B

MODEL	DESCRIPTION	Q-Lon		INSERT	
DS060	Door Weatherstripping	WH	White	B	Bullnose
		BR	Brown	Q	Quarter Round 1 ³ / ₈
				N	Narrow 3/4



OBS-296 - Offset Head Nylon Brush Door Gasket

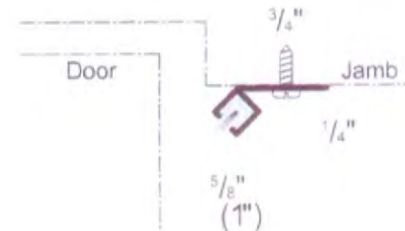
Construction: Extruded aluminum.

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 1/8" 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.

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	Wool Pile Brush	AL	Aluminum	58 .500 inch 7 2-7ft. pieces
		BR	Bronze	1 .880 inch 8 2-8ft. pieces
		WH	White	

FS300 - Wool Pile Brush Sweep With Fin

Construction: Extruded Aluminum

Insert: .500" or .880" Wool Pile Brush.

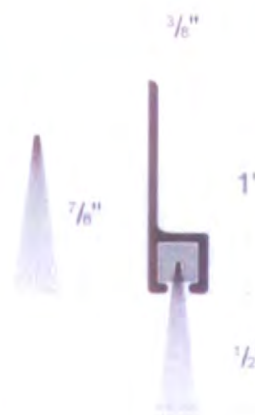
Finish: Aluminum, Bronze or White

Standard Lengths: 36, 42, 48 inches.

Custom lengths also available.

FS-300-AL-58-36

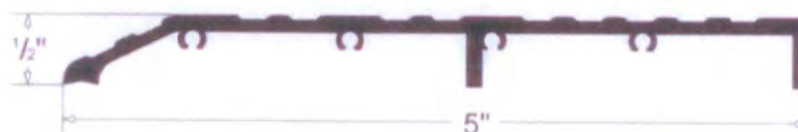
MODEL	DESCRIPTION	FINISH	BRUSH SIZE	LENGTH
FS300	Wool Pile Sweep	AL	Aluminum	58 .500 inch 36 36 inches
		BR	Bronze	1 .880 inch 42 42 inches
		WH	White	48 48 inches
		LF		Specify Length


TB-550

• 5" Flat Threshold (Tile Back)

• 1/2" Rise

• Available in lengths up to 12ft.



TS100 Door Triple Sweep

Construction: Extruded Aluminum

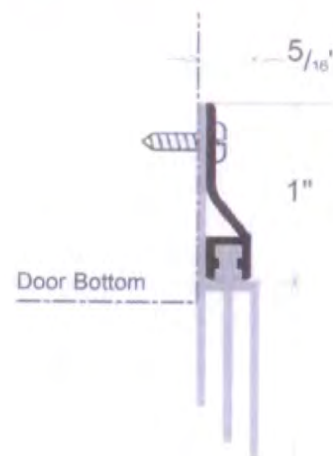
Insert: 3/4" Vinyl Insert

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

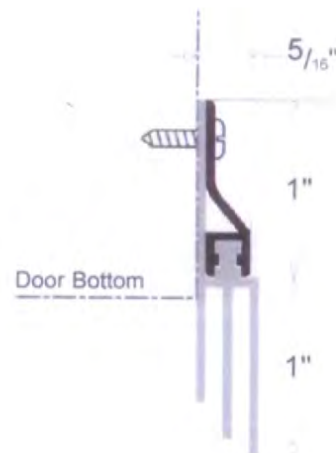
Insert: 1" Vinyl Insert

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

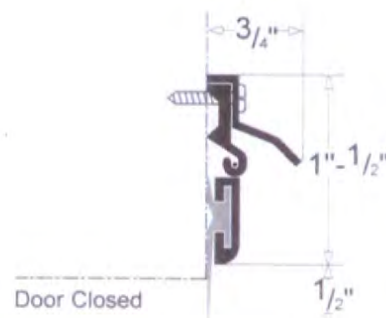
Action: Cam Activated

Finish: Satin Aluminum

Lengths: 36" or 48"

DB215-36

MODEL	DESCRIPTION	LENGTH
DB215	Automatic	36 36 Inches
	Door Bottom	48 48 Inches



**Approved for Sound Abatement Program.*

BS-196 - Brush Door Sweep

Construction: Extruded Aluminum

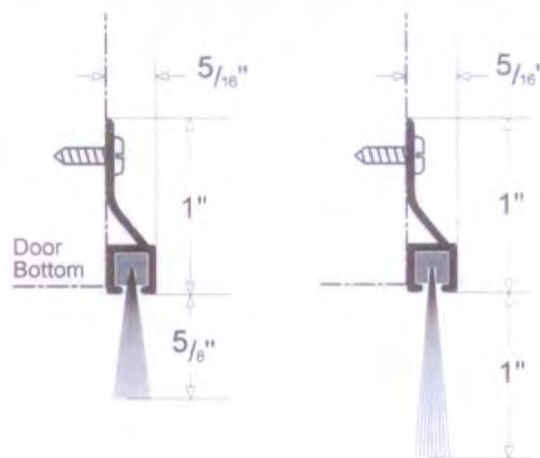
Insert: $\frac{5}{8}$ " or 1" Nylon Brush Strip

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: $\frac{5}{8}$ " 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: $\frac{3}{4}$ " 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.

T-SLOT: APTUS® TPE Weatherseals continued

Project Submittals: ALC, 10

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 coil



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)

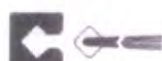
POCKET: Textile Skirting Weatherseals

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)

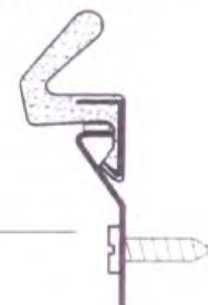
QDST-675

U32



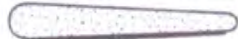
Width:
580" (14.7mm)
Reach:
675" (17.1mm)

Replacement Door Seal



Q-LON Corner Seals

U16



Width:
1.313" (33.4mm)

U61



Reach:
218" (5.5mm)

Width:
1.688" (42.9mm)

Reach:
218" (5.5mm)

U76



Width:
1.75" (44.5mm)

Reach:
375" (9.5mm)

SURFACE: Surface Mount Textile Weatherseals

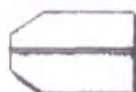
FIN-SEAL® Door Sweep



Adhesive Back Pile Weatherstripping



Metal Back Pile Weatherstripping



FIN-SEAL® Corner Seal



POLY-BOND® Corner Seal

SURFACE: POLYFLEX® Surface Mount Weatherseals

PF-102



PF-114



PF-512



APTUS® Panel Seal

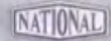
AP-PANEL



Footprint:
430" (10.9mm)

Reach:
250" (6.0mm)

Style 25 - "JUMBO SEAL" - 1 1/2" Vinyl or Brush



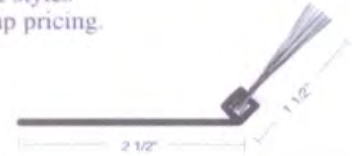
- Heavy aluminum extrusion with VINYL
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



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

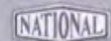
- Heavy aluminum extrusion with BRUSH
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



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



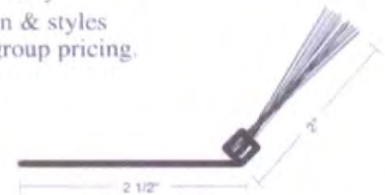
- Heavy aluminum extrusion with VINYL
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



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

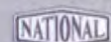
- Heavy aluminum extrusion with BRUSH
- Sold as full cartons only.
- Combine full carton & styles of jumbo seal for group pricing.



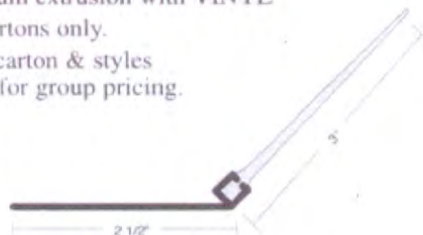
10 Pieces per Carton, combine Jumbo Seal sizes and styles for best pricing.

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

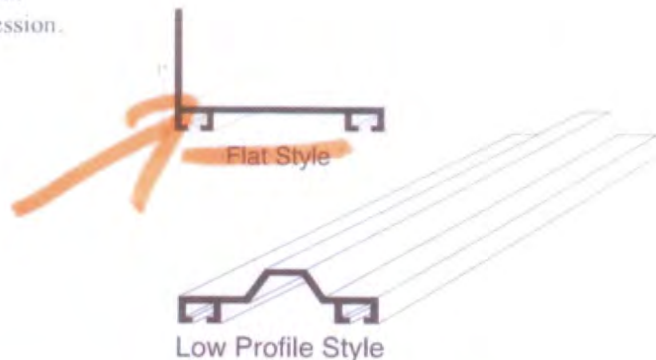
NATIONAL

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



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
148106	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
148206	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

NATIONAL

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" Single 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 F - Flat Retainer



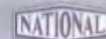
STYLE "T"

Style T - Tongue & Groove 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

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

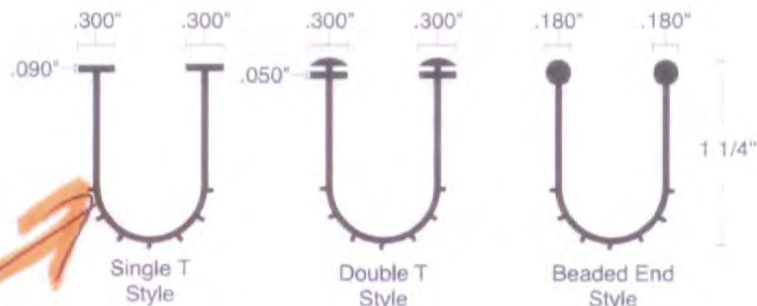
Vinyl Bottom Seal Inserts



Vinyl Bottom Seal Inserts

- Provides better conformity to irregular floor situations.
- Stays flexible below Zero°
- 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

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

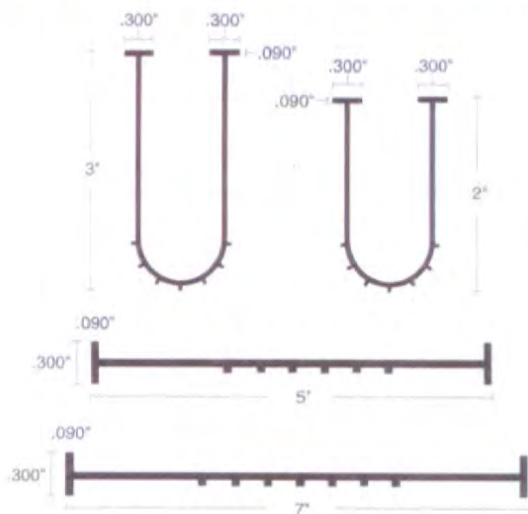
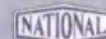
**"We Do Not Use Cheap Materials
1st Quality Only"**

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

W

Vinyl Double-Wide Bottom Inserts



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



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
<i>Kits</i>	
FROTH-PAK™ 200	200
FROTH-PAK™ 620	620
<i>Refillable Cylinders (commercial use)</i>	
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 in the variations in application methods and types.

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



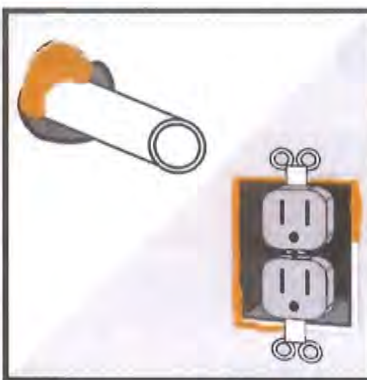
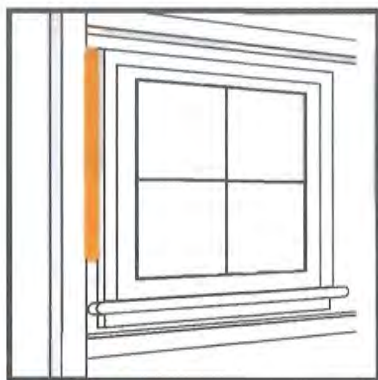
Pur Pistol



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 stressskin 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 diisocyanate (MDI) CAS 101-68-8. Chlorodifluoroethane 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 humidity	9 gals./can or 1800 cu. inches
Density	1.2 Lbs /cu ft
Cell structure	excessively closed, approx. 80%
Compression load deflection (10% compression)	8.5 Lbs./in ²
Minimum can temperature	40°F (5°C)
Minimum surface temperature	32°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 84	Flame spread index: 25 Smoke 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

DuPont Home Global [change]

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DuPont™ Caulk



DuPont™ Caulk Home

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Kitchen & Bath

Windows, Doors &
Siding SealantDuPont™ Paintable
Premier SiliconeDuPont™ Window &
Door Premier SiliconeDuPont™ Window &
Door Choice SiliconeDuPont™ Window,
Doors, & Siding
Silicone w/ Kevlar®DuPont™ Painters
Caulk w/ Speed Dry™
TechnologyDuPont™ AIRTITE®
Siliconized Acrylic
Caulk

Aluminum & Metal

Driveway & Roofing

Concrete & Masonry

Paintable Caulk

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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.



» 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 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

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FIREBARRIER SPRAYACRYLIC

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 inhibitors. 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 ft² (6.3 m²) 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

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.

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 1/2 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

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.



Head Office: 420 Tapscott Road, Scarborough, Ontario, M1B 1Y4
Tel: (800) 263-4087 or (416) 292-2361 Fax: (416) 298-5887
www.adfire.com



FIREBARRIER MINERAL WOOL

1. PRODUCT NAME

A/D FIREBARRIER Mineral Wool

2. PRODUCT DESCRIPTION

Pre-formed, semi-rigid, non-combustible mineral wool insulation. The mineral wool is pre-cut 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"

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% @1050°F (551°C); <1% @1200°F(649°C)
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

- 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/ft³ (64 kg/m³) 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 – Quick Reference Guide –
Spray Application of SprayAcrylic**

Hoses	50 ft of 1/4 in. (I.D.) Blue Max
Whip line	6 ft - 1/4" (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



Warnock Hersey
Hi



Head Office: 420 Tapscott Road, Scarborough, Ontario, M1B 1Y4
Tel: (800) 263-4087 or (416) 292-2361 Fax: (416) 298-5887
www.adfire.com





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).

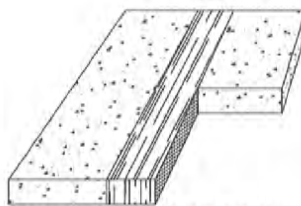
Shelf Life: When stored at or below 110°F (43°C) and above 40°F (5°C), A/D FIREBARRIER Acrylic Sealant has a shelf life of one year from date of manufacture.

Note: Protect from freezing.

Table 2 - Thickness and Compression Data

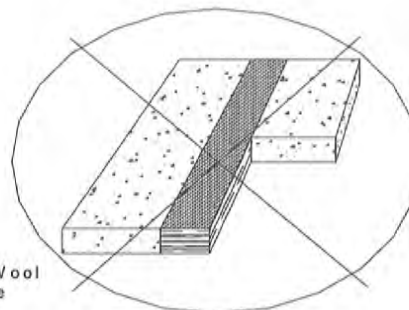
Nominal Batt Thickness,		Maximum Width of Opening for 25% compression, in. (mm)		Maximum Width of Opening for 33% compression, in. (mm)	
in.	mm	in.	mm	in.	mm
1	25	3/4	19	5/8	17
1.5	38	1-1/8	29	1	25
2	50	1-1/2	38	1-5/16	34
3	75	2-1/4	57	2	51
4	100	3	75	2-5/8	68
5 (4 + 1)	125 (100 + 25)	3-3/4	95	3-5/16	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



Always install A/D FIREBARRIER Mineral Wool so that it is compressed perpendicular to the grain.

INCORRECT



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DOW

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 ESR-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.

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

TABLE 1: SIZES, R-VALUES AND EDGE TREATMENTS FOR THERMAX™ SHEATHING

NOMINAL BOARD THICKNESS ⁽¹⁾ , IN.	R-VALUE ⁽²⁾	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.

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

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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.



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

Cel-Pak	3.8
Rockwool	2.9
Fiberglass	2.2

- 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 15: Weatherization Improvements

III. Weatherization Building Envelope Report

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2. BOYS AND GIRLS CLUB



ASSESSMENT FINDINGS

➤ See pictures on the following pages for visual support of the text below.

- Doors

- Entry Doors – the existing weather stripping is weak and is not properly stopping air infiltration/ exfiltration at the door systems. Many of the door systems do not have any existing weather stripping. There are doors in the building that are in complete disrepair and need to be replaced or repaired by others; substantial operational door repairs or replacement are not included in this Report.

- Windows

The window systems throughout the building are in poor condition. Many of the compression seal windows are operating reasonably well, but there are issues with glazing seals in frames and glass is broken in a number of locations. The best course of action for the windows in the building is replacement; window retrofit options are included in the Report with the understanding that window replacement may not be a viable option in this project.

- Compression Seal Window Systems (Awning and Hopper) – there is no existing weather stripping at the single pane compression seal windows throughout the building. The windows are allowing significant air infiltration/ exfiltration.
- Casing/ Inoperable Joints – there is no existing sealant at the perimeter of many of the window systems. The missing sealant is allowing unwanted air leaks at the perimeter of the window frames.

WEATHERIZATION RECOMMENDATIONS

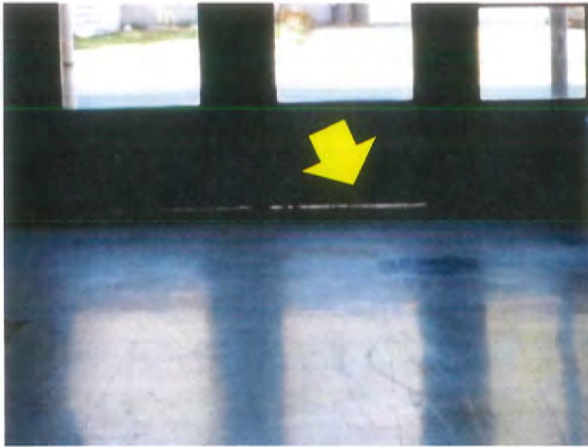
- Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale for a measure, the installation process and the materials used to complete the measure.
- For specifications that vary from the Installation Factsheets or where measures do not have Installation Factsheets notes are included at the square bullets.
- Highlighted floor plans provide the locations for installation. The 2nd story floor plan was not provided and a highlighted 2nd story floor plan is not included in the Report.

2. BOYS AND GIRLS CLUB

Air Leakage Control Measures

- Door Weather Stripping
- Door repairs or replacement noted on the floor plans is to be executed by others.
- Awning Window Weather Stripping
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Install weather stripping and caulking components as included in the line items of the Investment and Savings Summary.
- Hopper Window Weather Stripping
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Install weather stripping and caulking components as included in the line items of the Investment and Savings Summary.
- Window Caulking

2. BOYS AND GIRLS CLUB



Doors – daylight at the bottom of the door system is a direct pathway for unwanted air infiltration/ exfiltration.



Doors – air leakage shown by smoke tracer testing at the door system; there is no existing weather stripping at this door.



Doors – this door at the rear of the building is in complete disrepair; the door is not operable and should be replaced by others.



Windows – the window systems in the building are in poor operational and aesthetic condition.



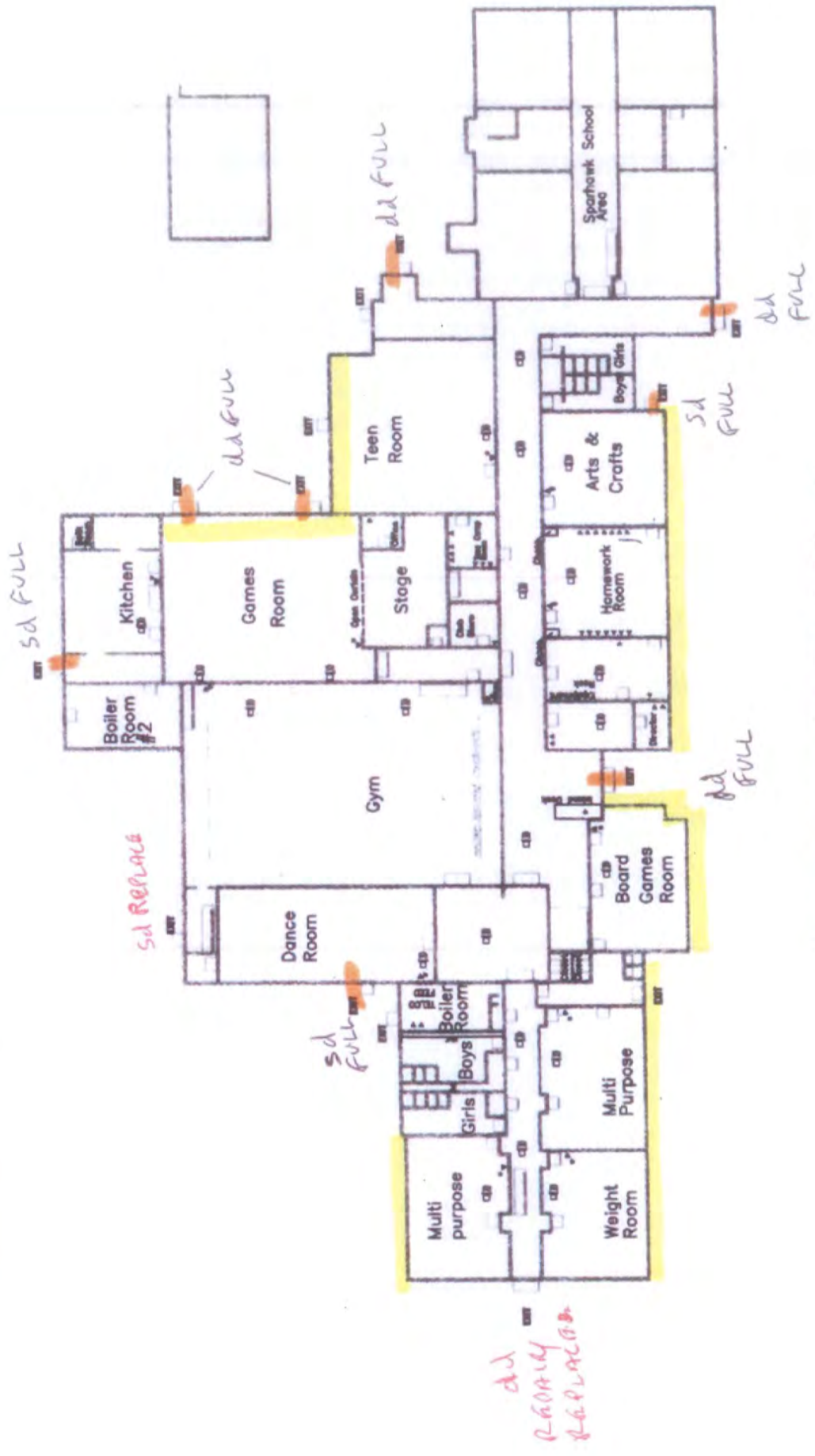
Windows – air leakage shown by smoke tracer testing at the operable sash of an awning window.



Windows – air leakage shown by smoke tracer testing at the inoperable/ casing joint of a 2nd story window system.

Window Weatherization/
Caulking

Door Weather Stripping
sd - single door, dd - double door
full - all sides
REPAIR/REPLACE - work to be done by others



Memorial Boys and Girls Club First Floor Plan
NTS

2nd story floor plan was not provided.

2. COMFORT STATION



ASSESSMENT FINDINGS

➤ See pictures on the following pages for visual support of the text below.

There are no weatherization recommendations for the Comfort Station due to low energy use profile of the building and the resulting long return profile of building envelope measures.

- Attic/ Roof
 - Attic – there are a lot of damaged ceiling areas in the primary air barrier surface above the drop ceiling. There is no existing insulation at the top of the building.

2. COMFORT STATION



Attic – the attic assembly is not controlling air and heat adequately.



Attic – the ceiling surface above the drop ceiling is the primary air barrier at the top of the building and should be the surface that is insulated. The holes in the surface and lack of insulation lead to excessive energy loss.

2. COUNCIL ON AGING



ASSESSMENT FINDINGS

➤ See pictures on the following pages for visual support of the text below.

- Attics/Roofs
 - Attic/ Roof Original Building – the attic/ roof above the original section of the building is the most significant point of air and heat loss in the building. The existing attic assembly has fiberglass batt insulation installed directly above the drop ceiling with no air barrier in place. The mechanical equipment and ductwork is located on the winter-cold-side of the insulation in this system.
 - Roof Addition Section – the roof of the addition section of the building is insulated with ~6” of closed cell spray polyurethane foam directly on the underside of the roof surface. The insulation is cut out below four roof vents; this is not the proper use of an attic/ roof ventilation system. The underside of the roof surface is the boundary of the conditioned space in this section of the building; the breaks in the insulation and the roof vents are allowing conditioned air to escape the building and are wasting the excellent air barrier and insulation properties of the closed cell spray polyurethane foam. It is not a code requirement to vent this style of insulation system.
- Doors
 - Entry Doors – the door systems in the addition are new architectural-style doors; the existing weather stripping is a pile-style that does not create a compression seal with the door and allows unwanted air leakage. The condition of the weather stripping at the original section of the building varies by door system.
 - Storage Closet Door – the storage closet should be considered “outside” of the conditioned space of the building because it is not heated. The double door that connects the storage closet and the building is a point of unwanted air and heat transfer.

WEATHERIZATION RECOMMENDATIONS

➤ Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale for a measure, the installation process and the materials used to complete the measure.

2. COUNCIL ON AGING

- 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

- Block Roof Ventilation – Offices
 - There is no Installation Factsheet for this measure.
 - Install Dow Thermax Sheathing rigid insulation in the breaks in the spray polyurethane foam currently being used as vents; seal the perimeter of the insulated sheathing blocking using closed cell spray polyurethane foam.
- Door Weather Stripping
 - Full door weather stripping is not recommended at all door systems.
 - Bulb Weather Stripping is installed with adhesive on the door jamb when hardware prevents installation of a mechanical fastened weather stripping or when mechanical fastened weather stripping is not desirable for aesthetic reasons.

Thermal Upgrade Measures

- Roof Insulation
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Attic/ Roof Prep includes creating adequate access to the work space; removing debris or insulation from the attic space as needed to create a safe work zone; creating a staging system in the attic to reach the underside of the roof; installing blocking at the roof-wall intersection to create an effective seal at the joint when insulation is installed.
 - Install 3" of closed cell spray polyurethane foam to the underside of the roof surface.
 - Install ignition barrier fire protection paint over all exposed areas of foam insulation.
- Building Code interpretation and input will be required from the local authorities related to the required fire protection barrier over the spray polyurethane foam insulation.

2. COUNCIL ON AGING



Attic/ Roof Original Building – the attic and roof at the original section of the building is the most significant point of air, heat and energy loss from the building.



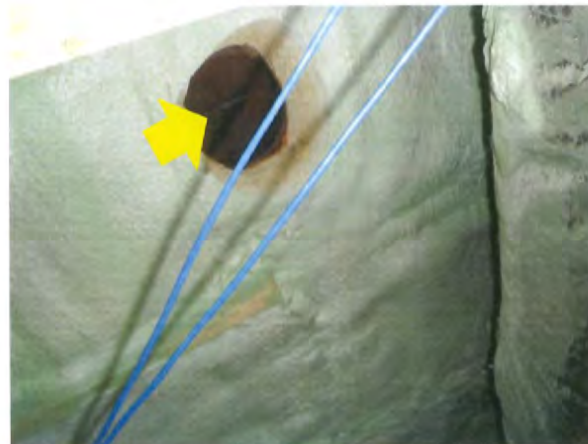
Attic/ Roof Original Building – the existing insulation is fiberglass batt on the back of the drop ceiling; there is no air barrier in this assembly and insulation coverage is poor.



Attic/ Roof Original Building – the mechanical equipment is located in the attic space.



Attic/ Roof Addition – the underside of the roof is insulated with ~6" of closed cell spray polyurethane foam in the addition; fire protection paint is installed.



Attic/ Roof Addition – the roof is vented in the addition section with standard roof vents; this is an incorrect use of attic ventilation. These penetrations do not vent an attic; they pull conditioned air out of the building.



Attic/ Roof Addition – exterior view of the roof vents in the addition section; this roof should not be vented and does not need to be vented under the building code.

2. COUNCIL ON AGING



Storage Room – the Storage Room is unheated and very cold; this shed/ storage area should be isolated from the interior conditioned spaces of the building at the door.



Storage Room – the double door to the Storage Room is the primary point of unwanted air and heat transfer between the conditioned space and the unheated storage room.

HILTON
SENIOR
CENTER
ADDITIONS AND
ALTERATIONS

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Radiation 9

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Scale: 40 Squares

EXISTING
BUILDING PLAN
AND NEW
CONSTRUCTION
NOTES

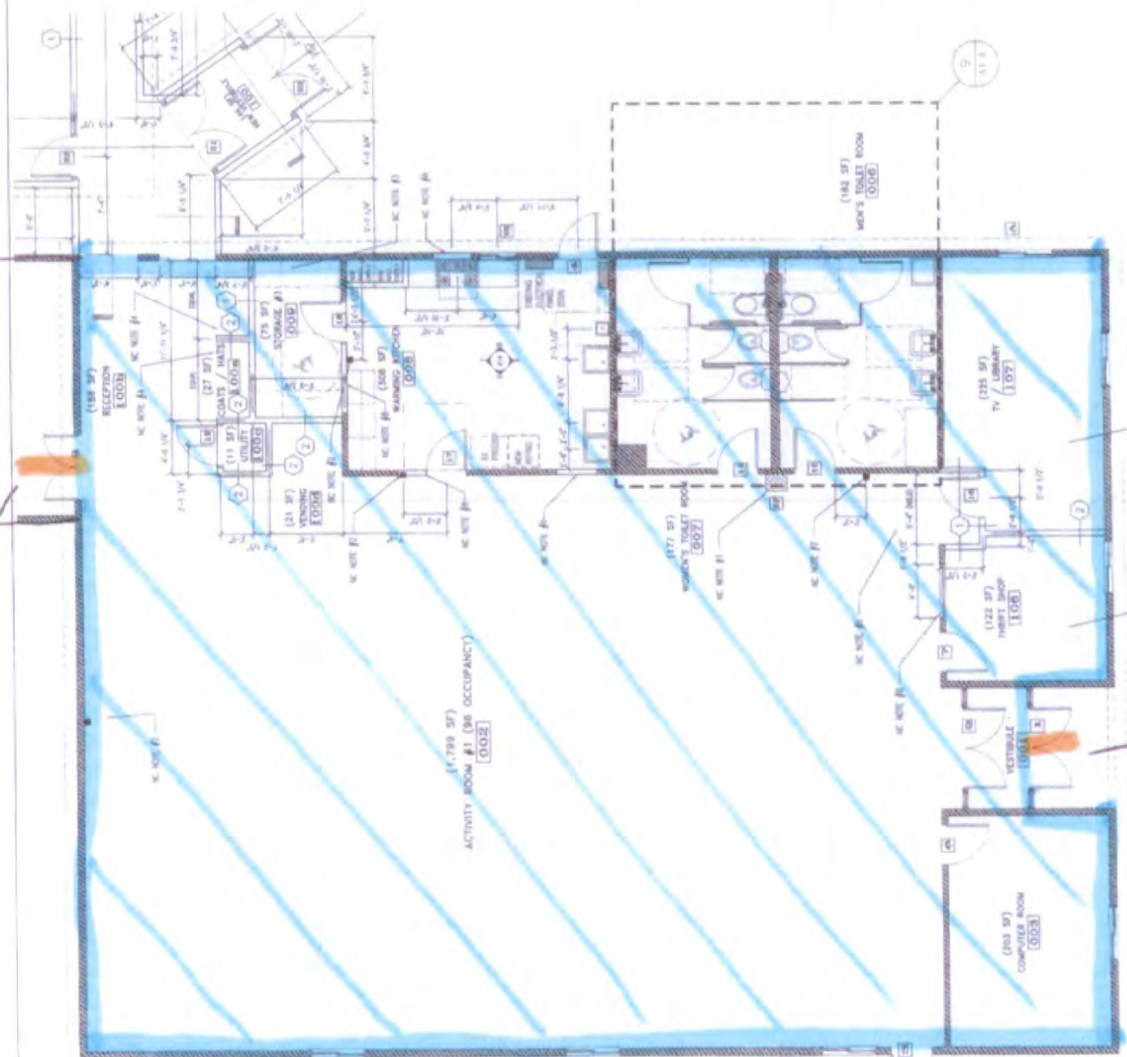
A1.1

Roof insulation

Block / Seal Roof Vent

Door Weather Stripping

Sd- single door
dd- double door
Fw- all sides
+ RIGIO- install rigid insul.
on the cold side
SW- sweep, AST- astragal
Sg- side bulb adhered @
jamb
TB- top bulb adhered @
jamb



NEW CONSTRUCTION EXISTING BUILDING PLAN

did

S_6, T_6, S_W, A_{ST}

**HILTON
SENIOR
CENTER
ADDITIONS AND
ALTERATIONS**

CLARK/STEELE/NOVO
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Sheet

Date: 10/1/10

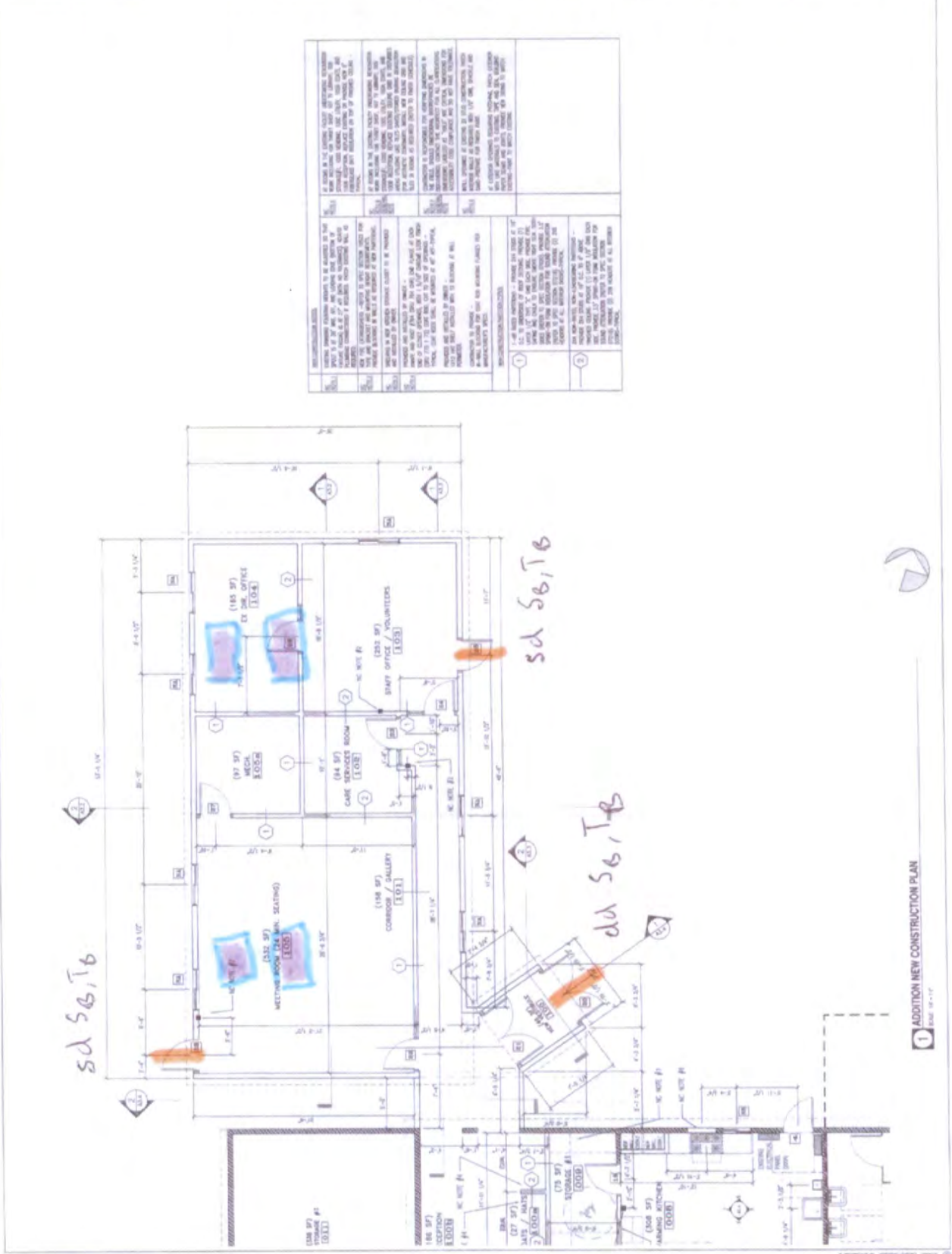
Revisions

1. 10/1/10

Scale: As Shown

**ADDITION
NEW
CONSTRUCTION
PLAN AND
NOTES**

A1.2



1 ADDITION NEW CONSTRUCTION PLAN

Scale: 1/8" = 1'-0"

2. TOWN HALL



ASSESSMENT FINDINGS

➤ See pictures on the following pages for visual support of the text below.

- Attics/Roofs
 - Attic – the Town Hall attic is insulated on the flat surface of the plaster ceiling with fiberglass batt insulation. There are very few air barrier weaknesses in the original plaster ceiling; the access hatch at the top of the front stairs is a bypass that allows unwanted air transfer between the unconditioned attic space and the conditioned space below. The landing area around the access hatch is a weak point in the insulation of the attic; insulation is installed on top of old attic flooring and the coverage is poor.
- Doors
 - Entry Doors – the existing weather stripping is weak and is not properly stopping air infiltration/ exfiltration at many of the door systems. The front door system is particularly weak; occupants reported that the area around the front door is excessively cold from drafts.
- Windows
 - Double Hung (Compression Jamb) – the double hung windows on the 2nd story appear that they were retrofit with compression jamb balances during the renovation of the 2nd story. The window systems are leaking at the joint between the compression jamb and the interior casing and at the bottom of the lower sash. At some window systems daylight can be seen between the sill and the lower sash.
 - Double Hung (Original Balances) – the windows that still have the original balance systems are leaking air at the perimeter of the upper sash, the perimeter of the lower sash and at the pulley balance system.
 - Window AC Unit – the cable and server room is continuously air conditioned by a window unit; the AC unit is installed in a propped open double hung window. This strategy of installing an AC unit that is needed all year creates excessive air leakage pathways around the unit and through the gap between the raised lower sash and the top sash.

2. TOWN HALL

WEATHERIZATION RECOMMENDATIONS

- Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale for a measure, the installation process and the materials used to complete the measure.
- 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

- Attic Bypass Air Sealing
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Install a gasket at the perimeter of the attic access hatch; laminate Dow Thermax Sheathing to the back of the hatch.
- Door Weather Stripping
 - Full door weather stripping is not recommended at all door systems.
 - Bulb Weather Stripping is installed with adhesive on the door jamb when hardware prevents installation of a mechanical fastened weather stripping or when mechanical fastened weather stripping is not desirable for aesthetic reasons.
- Double Hung Window Weatherization (Compression Jamb)
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Install weather stripping and caulking components as included in the line items of the Investment and Savings Summary.
- Double Hung Window Weatherization (Wood)
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Install weather stripping and caulking components as included in the line items of the Investment and Savings Summary.
- Window AC Unit Panel

Thermal Upgrade Measures

- Attic Flat Insulation
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Remove existing attic flooring as needed to install additional insulation properly at the landing area around the access hatch.
 - Install 5.5" fiberglass batt insulation on the plaster surface at the area around the access hatch.

2. TOWN HALL



Access Hatch and Insulation – the access hatch is a bypass that allows unwanted air leaks (yellow); the insulation should be on the plaster surface not on flooring (blue).



Doors – the front double door system is allowing excessive air leakage and makes the front entryway cold; the weather stripping is weak and a “cap” at former hardware is needed.



Windows – air leakage shown by smoke tracer testing at the joint between the compression jamb and the window casing; air is leaking into the building behind the jamb.



Windows – air leakage shown by smoke tracer testing at the bottom of the lower sash of the 2nd story compression jamb double hung system.

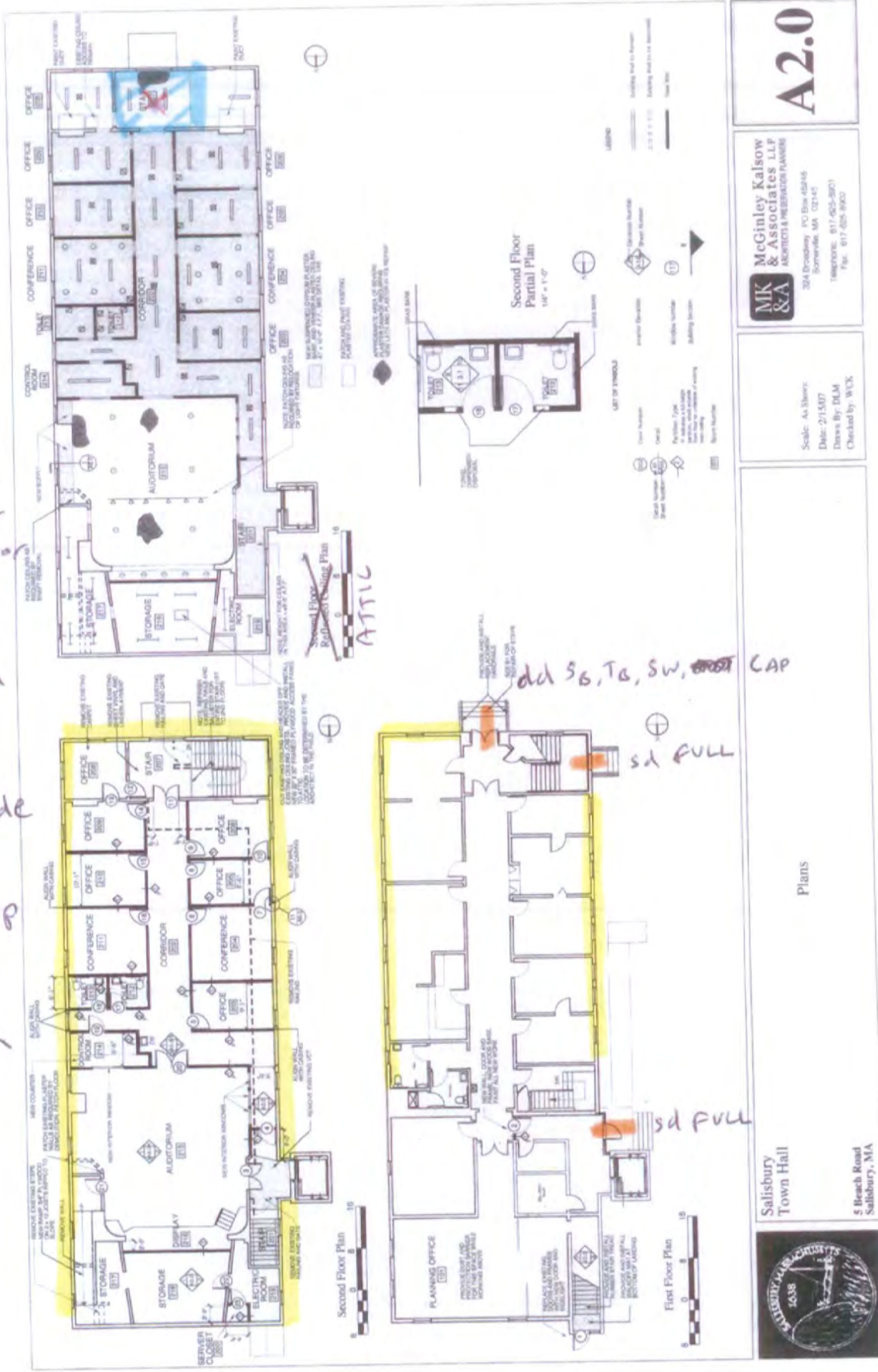


Windows – air leakage shown by smoke tracer testing at the bottom of the lower sash of the 1st story double hung system.



Window AC Unit – the cable/ server room is cooled by a window unit; there is excessive air leakage at pathways around the window propped open to receive the AC unit.

- * Access Hatch
- Remove Flooring/ Insulate
- Door Weather Strapping
- sd - single door
- dd - double door
- Full - all sides
- SW - sweep
- CAP - custom cap
- Ss - jamb, adhered bulb @ side
- Ts - jamb, adhered bulb @ top
- Window Weatherization



A2.0

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Salisbury Town Hall
5 Beach Road
Salisbury, MA



2. DEPARTMENT OF PUBLIC WORKS



B|E Retrofit recommends a strategy in fleet facilities that isolates the office 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 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 fleet facility and that this strategy delivers reliable energy savings that are not dependent on major behavior changes by the building occupants.

ASSESSMENT FINDINGS

➤ See pictures on the following pages for visual support of the text below.

- Attics/Roofs
 - Attic/ Roof Office Space – fiberglass batt insulation is suspended on framing above the drop ceiling of the office spaces of the building. There is no air barrier in this assembly; as a result there is excessive heat loss from the office spaces through the roof.
 - Attic/ Roof Garage – there is a drop ceiling above the garage bays; the area above the drop ceiling was not inspected because of the height. It is assumed that fiberglass batt is laid on the back of the drop ceiling without an air barrier; this is not an optimal system and results in the same air and heat loss patterns as in the office spaces. B|E Retrofit does not recommend addressing the weaknesses in the assembly above the garage bays because of high costs to retrofit and the poor return profile on work in a garage space that is not regularly heated for occupant comfort.
- Compartmentalization
 - Doors – the two distinct interior environments in the building – the office and the garage – should be isolated. The doors connecting the two spaces are the primary point of unwanted air transfer between the two spaces.
 - Former Sliding Window – a sliding window in the office on the left side of the building that was once used for communication between the garage and the offices is still allowing air transfer between the garage and the office. A prior attempt to seal this window was partially successful, but can still be improved.

2. DEPARTMENT OF PUBLIC WORKS

WEATHERIZATION RECOMMENDATIONS

- Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale for a measure, the installation process and the materials used to complete the measure.
- For specifications that vary from the Installation Factsheets or where measures do not have Installation Factsheets notes are included at the square bullets.
- Floor plans were not provided for this building; highlighted floor plans are not included in the Report.

Air Leakage Control Measures

- Compartmentalization – Door Weather Stripping
- Compartmentalization – Sliding Window Block/ Seal
 - There is no Installation Factsheet for this measure.
 - Install Dow Thermax White Finish rigid insulation to cover the sliding window from the office side; seal the perimeter of the rigid insulation to the wall system for an air-tight seal.

Thermal Upgrade Measures

- Roof/ Wall Insulation
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Attic/ Roof Prep includes creating adequate access to the work space; removing debris or insulation from the attic space as needed to create a safe work zone; installing blocking at the roof-wall intersection to create an effective seal at the joint when insulation is installed.
 - Install 3" of closed cell spray polyurethane foam to the underside of the roof surface.
 - Install 2" of closed cell spray polyurethane foam to the vertical wall above the drop ceiling that isolates the garage and the office spaces.
 - Install ignition barrier fire protection paint over all exposed areas of foam insulation.
- Building Code interpretation and input will be required from the local authorities related to the required fire protection barrier over the spray polyurethane foam insulation.

2. DEPARTMENT OF PUBLIC WORKS



Attic/ Roof Office Space – there is no air barrier in the attic/ roof insulation system; this is allowing excessive air and heat loss.



Attic/ Roof Office Space – fiberglass is suspended on the framing without an air barrier in place; this assembly is allowing excessive air and heat loss.



Attic/ Roof Office Space – fiberglass is suspended on the framing without an air barrier in place; this assembly is allowing excessive air and heat loss.



Attic/ Roof Garage – the space above the drop ceiling was not inspected due to its height; the assembly is assumed to be fiberglass batt directly on the drop ceiling.



Interior Isolation Wall – the wall and door systems that separate the garage from the office needs to isolate air transfer between the two different interior environments.



Interior Isolation/ Doors – the door systems between the garage and the office are allowing unwanted air transfer between the two spaces.

2. FIRE STATION



B|E Retrofit typically 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 and that this strategy delivers reliable energy savings that are not dependent on major behavior changes by the building occupants.

The conditions at the Salisbury Fire Station and requests from Ameresco demand a modified approach for this building. Isolation doors between the garage and the office/ living spaces were propped open during our visit; it appears that the use of the building is not consistent with the optimal situation of completely isolating the office/ living spaces from the garage. Ameresco has requested that insulation above the garage be included in the Recommendations Report.

As a result, B|E Retrofit is recommending an approach for the Salisbury Fire Station that treats the weaknesses in the entire shell of the building – the office/ living spaces and the garage. It is a hybrid approach that isolates some office/ living spaces from the garage and allows others to remain “connected” based on the use of the building. In this context, we are recommending to address the weaknesses in the attic above the garage and at the overhead doors.

ASSESSMENT FINDINGS

➤ See pictures on the following pages for visual support of the text below.

- Attics/Roofs
 - Attic/ Roof Office Space – fiberglass batt insulation is suspended on framing above the drop ceiling of the office/ living spaces of the building. There is no air barrier in this assembly; as a result there is excessive heat loss from the office spaces through the roof. The renovated kitchen has a hard sheetrock ceiling,
 - Attic/ Roof Garage – the ceiling of the garage is a perforated metal panel with fiberglass batt. This is a bad insulation system because there is no air barrier; air can leak through the panels and then directly through the air permeable “filter-glass.” This condition drastically reduces the thermal performance of fiberglass.

2. FIRE STATION

- Doors
 - Entry Doors – the weather stripping at select entry doors is not performing effectively and is allowing unwanted infiltration/ exfiltration at the perimeter of the doors.
 - Overhead Doors – the weather stripping at the overhead doors is damaged and is not stopping air leaks at the sides and top of the door systems. The existing weather stripping is not caulked to the brick wall – this condition is allowing air to leak “behind” the weather stripping and into the building.
- Compartmentalization
 - Doors – the two distinct interior environments in the building – the office/ living spaces and the garage – should be isolated (when realistic with the use patterns of the building). The doors connecting the two spaces are the primary point of unwanted air transfer between the two spaces.

WEATHERIZATION RECOMMENDATIONS

- Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale for a measure, the installation process and the materials used to complete the measure.
- 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

- Attic Air Barrier/ Insulation – Garage
 - There is no Installation Factsheet for this measure.
 - Install Dow Thermax Sheathing rigid insulation on the attic side of the existing perforated panel ceiling between the truss system that the panels are fastened to; seal the perimeter of the Thermax Sheathing to the framing of the truss system (the air barrier becomes a combination of the wood truss system and the Thermax Sheathing); re-install the existing fiberglass in the attic on top of the Thermax air barrier surface.
- Building Code interpretation and input will be required from the local authorities related to this application of the Thermax Sheathing.
- Door Weather Stripping
- Overhead Door Weather Stripping
 - There is no Installation Factsheet for this measure.
 - Install heavy duty weather strip with aluminum carrier at the sides and top of the overhead door systems; caulk the weather strip carrier to the wall.
- Compartmentalization – Door Weather Stripping

2. FIRE STATION

Thermal Upgrade Measures

- Roof Insulation
 - Review the Installation Factsheet; variations from the Factsheet are below.
 - Attic/ Roof Prep includes creating adequate access to the work space; removing debris or insulation from the attic space as needed to create a safe work zone; installing blocking at the roof-wall intersection to create an effective seal at the joint when insulation is installed.
 - Install 3" of closed cell spray polyurethane foam to the underside of the roof surface.
 - Install ignition barrier fire protection paint over all exposed areas of foam insulation.
- Building Code interpretation and input will be required from the local authorities related to the required fire protection barrier over the spray polyurethane foam insulation.
- Attic Air Barrier/ Insulation – Garage *[See Above Under Air Leakage Control Measures]*

2. FIRE STATION



Attic/ Roof Office Space – there is no air barrier in the attic insulation system; this is allowing excessive air and heat loss; the heating wires highlight ice dam problems.



Attic/ Roof Office Space – fiberglass is suspended on the framing without an air barrier in place; this assembly is allowing excessive air and heat loss causing ice dams.



Attic/ Roof Office Space – fiberglass is suspended on the framing without an air barrier in place; this assembly is allowing excessive air and heat loss.



Attic/ Roof Garage – fiberglass batt insulation is installed on the perforated panel ceiling; there is not air barrier in this assembly.



Attic/ Roof Garage – fiberglass batt insulation is installed on the perforated panel ceiling; close view of the ceiling panel from below.



Attic/ Roof Garage – fiberglass batt insulation is installed on the perforated panel ceiling; close view of the fiberglass from the attic side.

2. FIRE STATION



Interior Isolation – the front office spaces to the dispatch room and the main entry door were propped open during our visit.



Overhead Doors – the existing weather stripping at the overhead door systems is not performing well.

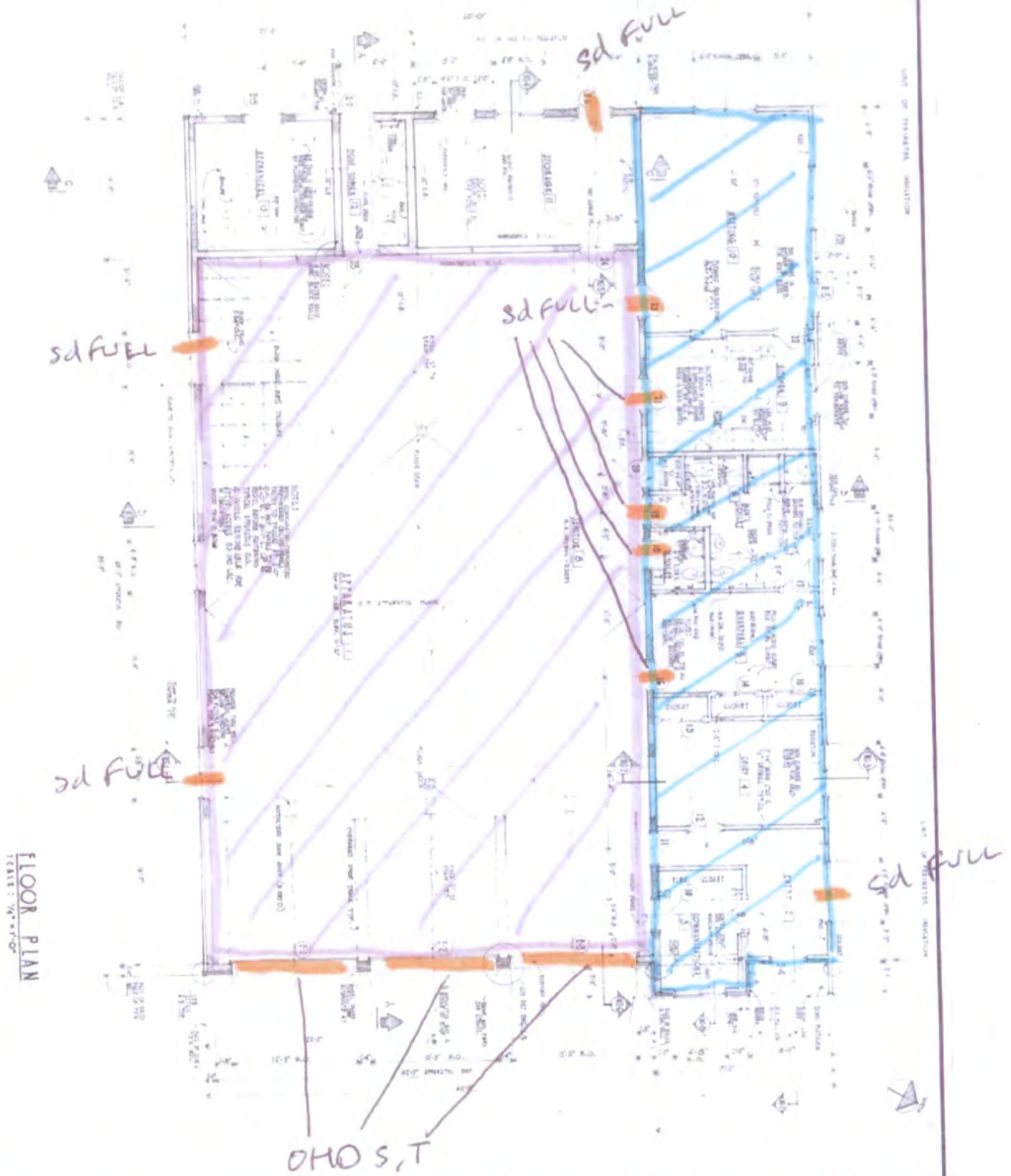


Overhead Doors – the existing frame that the overhead door weather stripping is mounted on is not caulked to the wall; air can leak behind the wood, "around" the weather stripping and into the building.

— Door Weather Stripping sd - single door, OHD - overhead door
 Full - all sides, S - sides, T - top
— Roof Insulation

Salisbury, MA - Building Envelope Report, 40

— Attic Air Barrier / Insulation



FLOOR PLAN
SCALE: 1/8" = 1'-0"

A-1

FLOOR PLAN

**FIRE STATION
SALISBURY, MASS.**

JOHN W. DALY - ARCHITECT
NANTUCKET, NEW HAMPSHIRE
MAY 22, 1975



2. POLICE STATION



ASSESSMENT FINDINGS

➤ See pictures on the following pages for visual support of the text below.

There are no weatherization recommendations for the Police Station due to severe durability problems with the building, most notably recurring black mold problems and rain penetration through the wall system. Building envelope tightening measures could make these conditions worse. The durability problems need to be solved before addressing any building envelope energy measures.

- Attic/ Roof
 - Attic Above Old Fire Station – there are a lot of damaged ceiling areas in the area over the old fire apparatus room (currently Chief's office area), which are weaknesses in the assembly that is serving as the primary air barrier. There is no existing heat in this space, so fixing the issues and re-insulating would not save any energy. As a result, repairing the ceiling may fit better under a renovation-style project for a general construction firm than an energy project.
- Windows
 - Vinyl Double Hung Windows – the windows are in very bad condition; the officers reported extreme drafts and “whistling” through the windows during windy conditions. The windows are poor operationally. There is no effective way to retrofit these windows; replacement is the only viable solution for the window systems.

2. POLICE STATION



Attic – area of damaged ceiling above the drop ceiling; the breaks in the ceiling paneling lead to excessive air and heat loss.



Attic – the existing insulation is fiberglass batt suspended on strapping; there is no air barrier in this assembly leading to excessive air and heat loss.



Mold – area of recurring mold problem; the officers reported that mold gets "painted over" this is a bad solution for the durability of the building and occupant health.

2. SEWER TREATMENT PLANT



ASSESSMENT FINDINGS

- See pictures on the following pages for visual support of the text below.
 - Attics/Roofs
 - Roof-Wall Intersection – there is a 16” gap at the roof-wall intersection of the pitched roof on the left side of the building (view from parking lot). This large gap is leading to excessive infiltration/ exfiltration.
 - Exterior Shell
 - Soffit Overhang – the overhang at the front door is a direct pathway for air infiltration/ exfiltration. An overhang creates a weak point in the building envelope; imperfections in the exterior finish materials, including intersections with the wall and roof assembly and light fixtures combine with gaps above the plane of the door systems (the outer boundary of the conditioned space) and lead to unwanted air leakage.
 - Doors
 - Entry Doors – the door bottom sweeps are weak at the front double door system.
 - Windows
 - Casing/ Inoperable Joint – sealant is missing at the header of the window systems on the left side of the building. The joint at the top of the window system is allowing unwanted air leakage.

WEATHERIZATION RECOMMENDATIONS

- Installation Factsheets, provided for the measures below at the bold round bullets, provide the rationale for a measure, the installation process and the materials used to complete the measure.
- 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. SEWER TREATMENT PLANT

Air Leakage Control Measures

- Roof-Wall Intersection Air Sealing
- Soffit Overhang Air Sealing
- Door Weather Stripping
 - Full door weather stripping is not recommended at all door systems.
- Window Caulking

2. SEWER TREATMENT PLANT



Roof-Wall Intersection – exterior view of the roof-wall intersection at the pitched roof section of the building; this joint is an air leakage pathway.



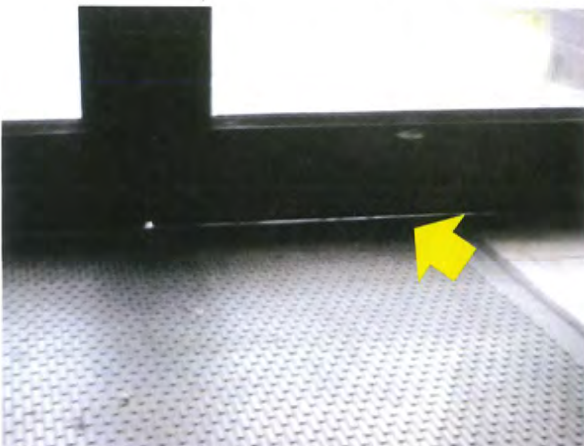
Roof-Wall Intersection – large gap at the roof-wall intersection (shown at left) is a pathway for air leakage through imperfections in the exterior overhang and finish.



Soffit Overhang – a large gap above the entry door (arrow); this is a pathway into the building through imperfections in the exterior soffit finish and the recessed lights.



Soffit Overhang – view from below the drop ceiling of the exterior overhang shown at the left.

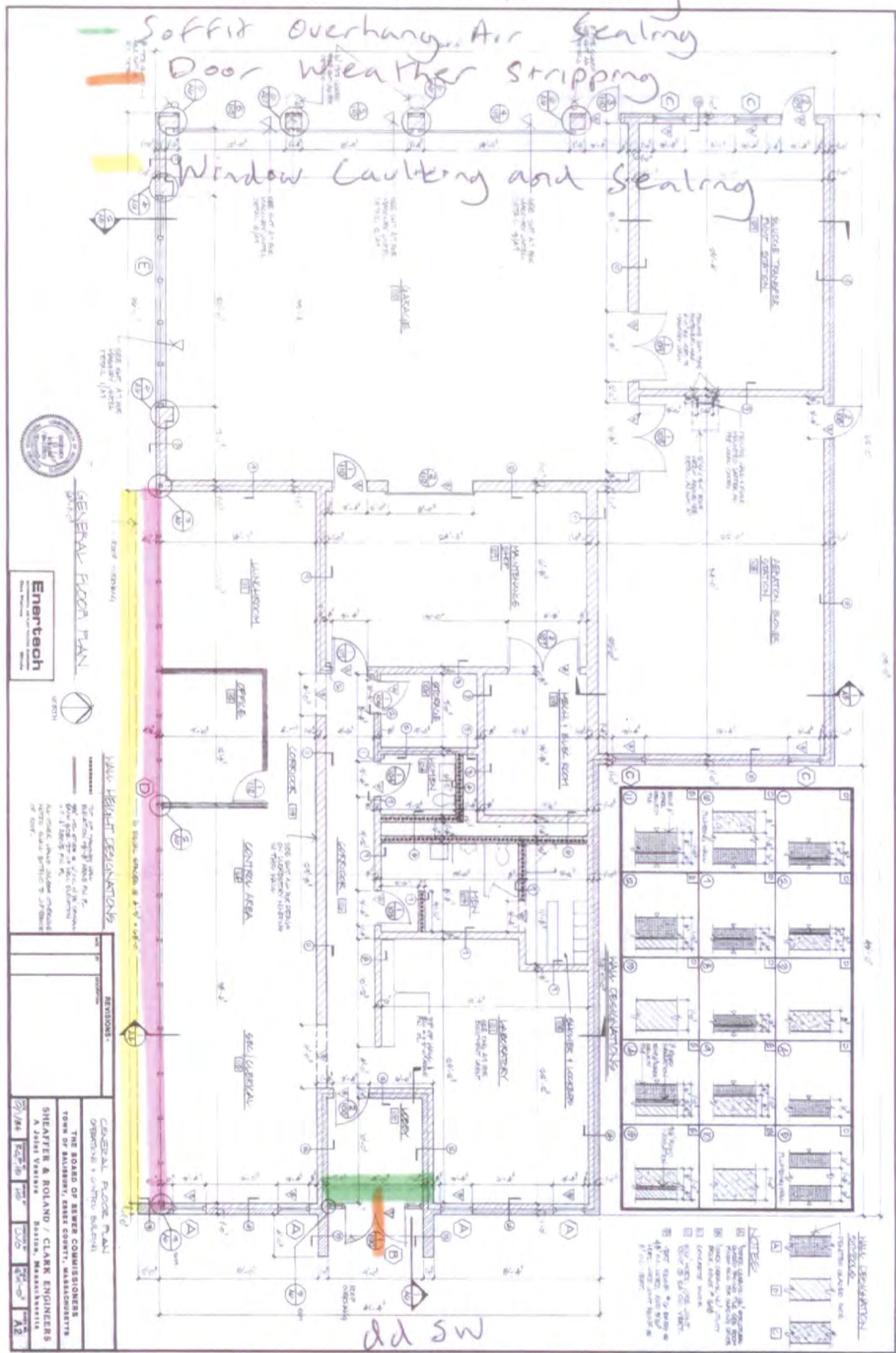


Doors – daylight at the base of the door system is a direct pathway for unwanted air leakage in and out of the building.



Windows – air leakage shown by smoke tracer testing at the header casing joint of the window system on the left side of the building.

Roof-Wall Intersection Air Sealing
Soffit Overhang Air Sealing
Door Weather Stripping
Window Caulking and Sealing



Enertech

GENERAL FLOOR PLAN
REVISIONS
DATE
BY
DESCRIPTION

GENERAL FLOOR PLAN
TOWN OF SALISBURY, MASSACHUSETTS
SHEAFFER & ROLAND / CLARK ENGINEERS
A JAMES WHITE COMPANY
DATE: 01/14/10
BY: JWB
CHECKED: JWB
APPROVED: JWB

NOTES
1. SEE ELEVATIONS FOR WINDOW SIZES
2. SEE ELEVATIONS FOR DOOR SIZES
3. SEE ELEVATIONS FOR WALL SIZES
4. SEE ELEVATIONS FOR ROOF SIZES
5. SEE ELEVATIONS FOR FLOOR SIZES
6. SEE ELEVATIONS FOR CEILING SIZES
7. SEE ELEVATIONS FOR STAIR SIZES
8. SEE ELEVATIONS FOR ELEVATION SIZES
9. SEE ELEVATIONS FOR SECTION SIZES
10. SEE ELEVATIONS FOR DETAIL SIZES
11. SEE ELEVATIONS FOR ANNOTATION SIZES
12. SEE ELEVATIONS FOR TITLE SIZES
13. SEE ELEVATIONS FOR SCALE SIZES
14. SEE ELEVATIONS FOR ORIENTATION SIZES
15. SEE ELEVATIONS FOR NORTH SIZES
16. SEE ELEVATIONS FOR INDEX SIZES
17. SEE ELEVATIONS FOR SHEET SIZES
18. SEE ELEVATIONS FOR PROJECT SIZES
19. SEE ELEVATIONS FOR CLIENT SIZES
20. SEE ELEVATIONS FOR ARCHITECT SIZES
21. SEE ELEVATIONS FOR ENGINEER SIZES
22. SEE ELEVATIONS FOR DATE SIZES
23. SEE ELEVATIONS FOR PROJECT NAME SIZES
24. SEE ELEVATIONS FOR PROJECT ADDRESS SIZES
25. SEE ELEVATIONS FOR PROJECT PHONE SIZES
26. SEE ELEVATIONS FOR PROJECT FAX SIZES
27. SEE ELEVATIONS FOR PROJECT EMAIL SIZES
28. SEE ELEVATIONS FOR PROJECT WEBSITE SIZES
29. SEE ELEVATIONS FOR PROJECT CONTACT SIZES
30. SEE ELEVATIONS FOR PROJECT NOTES SIZES

Section 4: Financial Results/ Recommendations

Project Specifics

Ameresco initially completed a preliminary energy audit and provided the Town of Salisbury 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)	20 years
Estimated Financing Interest Rate	3.50%
Estimated Construction Period Interest Rate	1.75%
Capital Cost	\$1,047,325
Estimated Rebates	\$44,395
Net Assumed Capital Cost	\$1,002,930
Guaranteed Cost Savings / Year 1	\$90,214 ¹
Assumed Utility Escalation Rate	3.00%
Net Excess Cumulative Cash Flow	\$702,200

The following table summarizes the ECMs referenced in Section 3 and included in the recommended project scope.

¹ Includes a non-escalated \$21,000 per year in expected rent increase the Town will require from the Boy's and Girl's Club to offset the cost of the retrofits planned for the Memorial School. These savings are shown in ECM 5.

MVPC - Town of Salisbury														
Energy Conservation Measures (ECMs)														
Facility	1	2	3	4	5	8	10	11	12	13	14	15		
Lighting System Improvements	Lighting Controls		X											
	New Energy Management Systems		X	X										
	Attic Insulation			X	X									
	Boiler Replacements													
	Install High Efficiency Furnaces													
	Oil to Gas Conversion													
	Pipe Insulation													
	Steam Trap Replacement													
Weatherization Improvements	Variable Frequency Drives									X	X	X		
	Vending Machine Controls													
Fire Department														
Department of Public Works	X	X	X											
Beach Services - Comfort Station	X													
Council on Aging- Hilton Senior Center	X		X			X				X	X	X		
Town Hall	X	X	X					X			X	X		
Sewage Treatment Plant	X	X	X									X		
Sparhawk/Memorial School-Boys and Girls Club	X		X		X		X	X	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	\$ 142,806
2	Lighting Controls	\$ 13,683
3	New Energy Management Systems	\$ 129,100
4	Attic Insulation	\$ 16,841
5	Boiler Replacements	\$ 201,232
8	Install High Efficiency Furnaces	\$ 33,737
10	Oil to Gas Conversion	\$ 147,549
11	Pipe Insulation	\$ 5,280
12	Steam Trap Replacement	\$ 11,063
13	Variable Frequency Drives	\$ 4,992
14	Vending Machine Controls	\$ 1,046
15	Weatherization Improvements	\$ 11,999
		\$ 719,327

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 MVPC solicitation, resulting in the below fees:

Table 4.4: Indirect Pricing

Ecm #	ECM Name	Ameresco Fee Percentage from MVPC Solicitation	Ameresco Fee
1	Lighting System Improvements	39.15%	\$ 55,909
2	Lighting Controls	39.15%	\$ 5,357
3	New Energy Management Systems	43.39%	\$ 56,010
4	Attic Insulation	41.27%	\$ 6,950
5	Boiler Replacements	48.23%	\$ 97,044
8	Install High Efficiency Furnaces	48.23%	\$ 16,269
10	Oil to Gas Conversion	48.23%	\$ 71,155
11	Pipe Insulation	48.23%	\$ 2,546
12	Steam Trap Replacement	48.23%	\$ 5,335
13	Variable Frequency Drives	39.76%	\$ 1,985
14	Vending Machine Controls	38.55%	\$ 403
15	Weatherization Improvements	41.27%	\$ 4,951
			\$ 323,915

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 \$4,084, and is based upon the inclusion of the following buildings:

Facility Name	Occupied Area (SF)
Fire Department	7,350
Department of Public Works	5,600
Beach Services - Comfort Station	1,250
Council on Aging- Hilton Senior Center	6,492
Town Hall	9,704
Sewage Treatment Plant	6,000
Sparhawk/Memorial School-Boys and Girls Club	54,357
Totals	90,753

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	\$ 27,775
2	Lighting Controls	\$ 6,415
3	New Energy Management Systems	\$ 4,975
5	Boiler Replacements	\$ 4,000
8	Install High Efficiency Furnaces	\$ 1,000
14	Vending Machine Controls	\$ 230
		\$ 44,395

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 \$17,864, 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 direction from the Town for a potential bond financing. The ultimate rate may vary based on the Town's credit rating or the ultimate financing structure, but Ameresco does not guarantee it will be less than or equal to the assumed 3.50% interest rate used in the pro forma cash flow.

The financing term is based on 20-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 Salisbury 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 Salisbury, 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 Salisbury 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 Salisbury 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. In addition, Ameresco has not included any permit fees as it is expected the Town will not charge itself for its own permits.

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Section 4: Financial Results



Table 4.6: Cost and Savings by Measure

ECM #	ECM Name	Annual kW	Total kWh	Natural Gas (Therms)	#2 Fuel Oil (Gallons)	Energy Savings	O&M Savings	Total Project Savings	Total Project Costs	SPB
1	Lighting System Improvements	525	101,155	(332)	(370)	\$ 12,524	\$ 1,389	\$ 13,913	\$ 199,611	14.35
2	Lighting Controls	-	11,941	(68)	(11)	\$ 1,495	-	\$ 1,495	\$ 19,139	12.80
3	New Energy Management Systems	-	18,970	6,088	2,362	\$ 17,908	-	\$ 17,908	\$ 185,940	10.38
4	Attic Insulation	-	-	-	238	\$ 833	-	\$ 833	\$ 23,839	28.63
5	Boiler Replacements	-	-	(2,253)	2,859	\$ 7,557	\$ 21,500	\$ 29,057	\$ 299,236	10.30
8	Install High Efficiency Furnaces	-	-	388	-	\$ 485	-	\$ 485	\$ 50,171	103.39
10	Oil to Gas Conversion	-	-	(11,965)	8,514	\$ 16,784	\$ 1,500	\$ 18,284	\$ 219,572	12.01
11	Pipe Insulation	-	-	335	358	\$ 1,670	-	\$ 1,670	\$ 7,871	4.71
12	Steam Trap Replacement	-	-	-	467	\$ 1,634	-	\$ 1,634	\$ 16,463	10.07
13	Variable Frequency Drives	-	3,090	-	-	\$ 470	-	\$ 470	\$ 7,000	14.88
14	Vending Machine Controls	-	7,395	(106)	(36)	\$ 754	-	\$ 754	\$ 1,456	1.93
15	Weatherization Improvements	-	4,175	351	239	\$ 1,695	-	\$ 1,695	\$ 17,027	10.05
		525	146,726	(7,562)	14,619	\$ 63,809	\$ 24,389	\$ 88,198	\$ 1,047,325	11.87

ECM 5 includes a non-escalated \$21,000 per year in expected rent increase the Town will require from the Boy's and Girl's Club to offset the cost of the retrofits planned for the Memorial School.

Table 4.7: Project Pro-Forma

MVPC - Town of Salisbury - Pro-Forma

Initial Project Costs:	
Implementation costs	\$ 1,047,325
Total Initial Project Costs	\$ 1,047,325
Utility Rebates	\$ 44,395
Net Project Costs after rebates	\$ 1,002,930

Financial Assumptions	
Term of Project (yrs)	20.0 yrs
Term of Financing (yr)	20.0 yrs
Estimated Financing Rate	3.50%
Payments per year (frequency)	4
Discount Rate	3.50%
Average Energy escalation rate (annual)	3.00%
Average Cost escalation rate (annual)	3.00%
Project Simple Payback	11.87

Pro-forma	Initial Values	Year									
		1	2	3	4	5	6	7	8	9	10
1 Annual energy costs without improvements	\$ 269,167	\$ 277,242	\$ 285,559	\$ 294,126	\$ 302,950	\$ 312,038	\$ 321,399	\$ 331,041	\$ 340,973	\$ 351,202	\$ 361,738
2 Annual energy costs with improvements	\$ 205,358	\$ 211,519	\$ 217,864	\$ 224,400	\$ 231,132	\$ 238,066	\$ 245,208	\$ 252,565	\$ 260,142	\$ 267,946	\$ 275,984
3 Annual energy cost savings (1-2)	\$ 63,809	\$ 65,723	\$ 67,695	\$ 69,726	\$ 71,817	\$ 73,972	\$ 76,191	\$ 78,477	\$ 80,831	\$ 83,256	\$ 85,754
4 O&M Savings	\$ 24,389	\$ 24,491	\$ 24,596	\$ 24,703	\$ 24,814	\$ 24,929	\$ 25,047	\$ 25,168	\$ 25,293	\$ 25,422	\$ 25,555
5 Total Project Savings	\$ 88,198	\$ 90,214	\$ 92,290	\$ 94,429	\$ 96,632	\$ 98,901	\$ 101,238	\$ 103,645	\$ 106,124	\$ 108,678	\$ 111,308
6 Payments for financing equipment	\$ 5,561	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185
7 Payments for Ongoing Services	\$ 5,561	\$ 5,728	\$ 5,899	\$ 6,076	\$ 6,259	\$ 6,446	\$ 6,640	\$ 6,839	\$ 7,044	\$ 7,255	\$ 7,473
8 Net annual benefits	\$ 13,301	\$ 13,301	\$ 15,206	\$ 17,168	\$ 19,188	\$ 21,269	\$ 23,413	\$ 25,621	\$ 27,895	\$ 30,238	\$ 32,650
9 Cumulative cash flow	\$ 702,200	\$ 13,301	\$ 28,507	\$ 45,675	\$ 64,863	\$ 86,132	\$ 109,545	\$ 135,166	\$ 163,061	\$ 193,299	\$ 225,949
10 Net Present Value of cash flow	\$ 458,836										
11 Interest Rate	3.50%										
12 Discount Rate	3.50%										

Line #	11	12	13	14	15	16	17	18	19	20	Totals
1	\$ 372,590	\$ 383,768	\$ 395,281	\$ 407,139	\$ 419,353	\$ 431,934	\$ 444,892	\$ 458,239	\$ 471,986	\$ 486,145	\$ 7,449,595
2	\$ 284,264	\$ 292,792	\$ 301,575	\$ 310,623	\$ 319,941	\$ 329,540	\$ 339,426	\$ 349,609	\$ 360,097	\$ 370,900	\$ 5,683,592
3	\$ 88,326	\$ 90,976	\$ 93,705	\$ 96,517	\$ 99,412	\$ 102,394	\$ 105,466	\$ 108,630	\$ 111,889	\$ 115,246	\$ 1,766,003
4	\$ 25,691	\$ 25,832	\$ 25,977	\$ 26,126	\$ 26,280	\$ 26,439	\$ 26,602	\$ 26,770	\$ 26,943	\$ 27,121	\$ 513,799
5	\$ 114,018	\$ 116,808	\$ 119,682	\$ 122,643	\$ 125,692	\$ 128,833	\$ 132,068	\$ 135,400	\$ 138,832	\$ 142,367	\$ 2,279,802
6	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 71,185	\$ 1,423,700
7	\$ 7,697	\$ 7,928	\$ 8,166	\$ 8,411	\$ 8,663	\$ 8,923	\$ 9,191	\$ 9,467	\$ 9,751	\$ 10,043	\$ 153,901
8	\$ 35,135	\$ 37,695	\$ 40,331	\$ 43,047	\$ 45,844	\$ 48,725	\$ 51,692	\$ 54,748	\$ 57,896	\$ 61,139	\$ 702,200
9	\$ 261,084	\$ 298,779	\$ 339,111	\$ 382,157	\$ 428,001	\$ 476,726	\$ 528,418	\$ 583,166	\$ 641,062	\$ 702,200	
10											
11											
12											

Notes:

- 1 This Proforma Cash Flow reflects an estimated financing rate of 3.5%. 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.

Final Investment Grade Audit

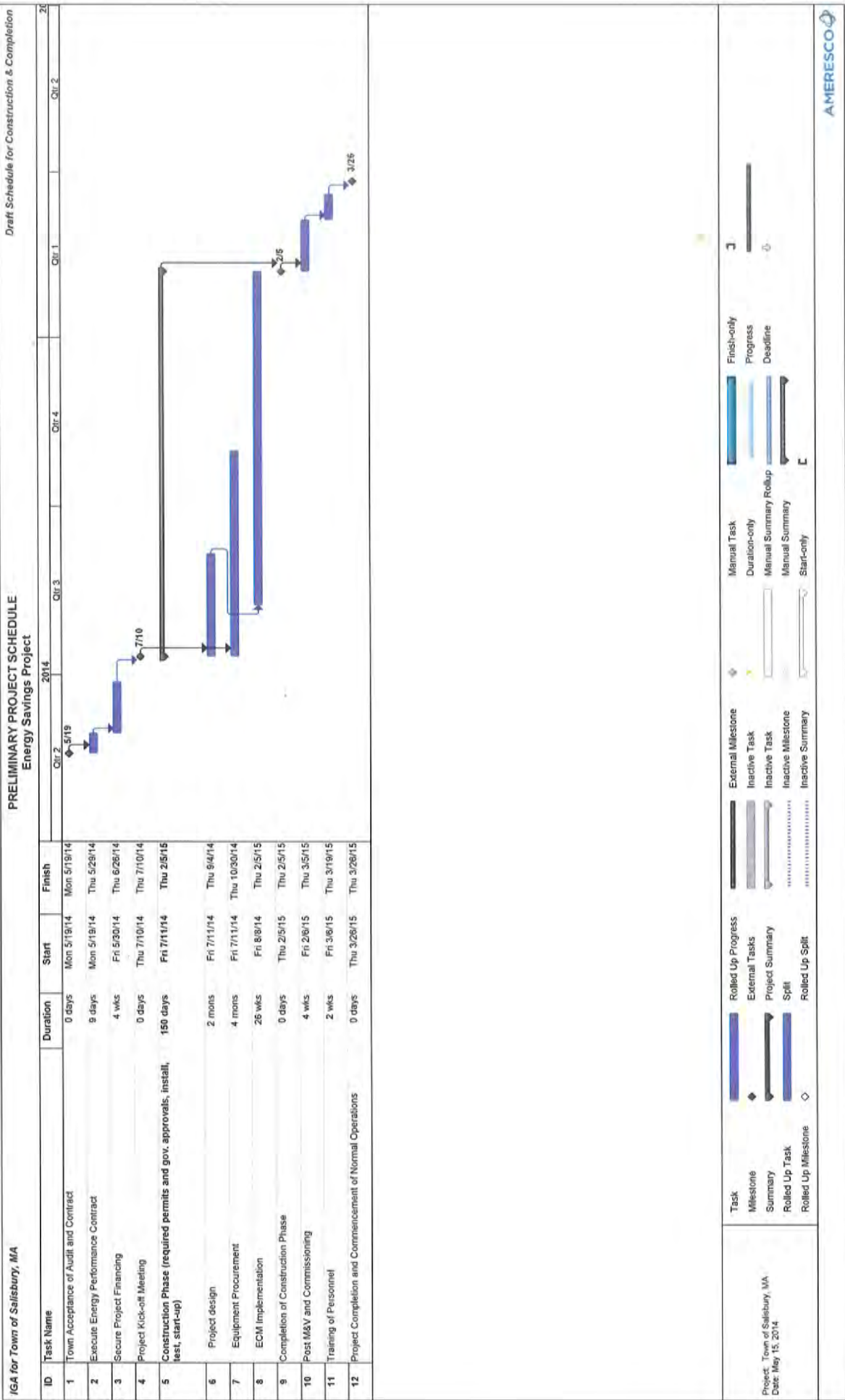
Page content is subject to Confidentiality Restrictions

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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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 2: Lighting Controls	Lighting Controls	Verify operation of all sensors as completed. Time delays and/or sensitivity settings will be set.	Electrical Contractor Ameresco	Visual inspection of controls to ensure that they are installed and functioning properly.	Electrical Contractor Ameresco	Results of visual inspection of lighting controls will be provided in spreadsheet format for a statistically significant sample indicating type of device, location, fixture served, and operating status. FPT Reports will be completed for each system.
ECM 3: 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: Attic 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.	Ameresco	FPT Reports will be completed for each system.
ECM 5: Boiler Replacements	Boilers, Burners and Controls.	Start-up reports from installing contractors. Boiler tuning sheets	Mechanical Contractor Ameresco	Functional testing will be conducted and include the operation of the boilers and burners as well as tie ins to controls. See sample FT's in the Appendix.	Mechanical Contractor Ameresco	FPT Reports will be provided for each boiler.
ECM 8: Install High Efficiency Furnaces	Furnaces and Controls.	Start-up reports from installing contractors. Pre-functional check sheets	Mechanical Contractor Ameresco	Functional testing will be conducted and include the operation of the furnaces as well as tie ins to controls. See sample FT's in the Appendix.	Mechanical Contractor Ameresco	FPT Reports will be provided for each furnace.
ECM 10: Oil to Gas Conversion	Boilers, Burners and Controls.	Start-up reports from installing contractors. Boiler tuning sheets	Mechanical Contractor Ameresco	Functional testing will be conducted and include the operation of the boilers and burners as well as tie ins to controls. See sample FT's in the Appendix.	Mechanical Contractor Ameresco	FPT Reports will be provided for each boiler.
ECM 11: Pipe Insulation	Insulation	Pre-functional check sheets 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 12: Steam Trap Replacement	Steam traps	Inspect construction progress for conformance to project specifications.	Ameresco	Functional testing will be conducted on all steam traps at commissioning.	Plumbing Contractor Ameresco	FPT Reports will be provided for all steam traps.
ECM 13: 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 14: 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 15: Weatherization Improvements	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.

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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 2: Lighting Controls	Lighting Controls	None	Provide training on repair or maintenance on new technologies.	Facility Engineers Facility Technicians O&M Personnel
ECM 3: New Energy Management Systems	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: Attic Insulation	Attic Insulation	Review of O&M	Typical installation review	Facility Technicians O&M Personnel
ECM 5: Boiler Replacements	New Boilers and Burners	4 hours of training to evaluate the new heating equipment and review of the control sequences.	Review of the boiler components, demonstrate the control sequences, show how to change the setpoint and troubleshoot alarms.	Facility Engineers Facility Technicians O&M Personnel
ECM 8: Install High Efficiency Furnaces	New Furnaces	4 hours of training to evaluate the new heating equipment and review of the control sequences.	Review of the furnace components, demonstrate the control sequences, show how to change the setpoint and troubleshoot alarms.	Facility Engineers Facility Technicians O&M Personnel
ECM 10: Oil to Gas Conversion	New Burners	4 hours of training to evaluate the new heating equipment and review of the control sequences.	Review of the burner components, demonstrate the control sequences, show how to change the setpoint and troubleshoot alarms.	Facility Engineers Facility Technicians O&M Personnel
ECM 11: Pipe Insulation	Pipe Insulation	None	0.5 hour of hands on training to discuss reinstalling insulation during maintenance operations	Facility Technicians O&M Personnel

Section 6: Commissioning Plan



ECM	Equipment/ Systems	Classroom Training	Hands on Instruction	Personnel Groups Trained
ECM 12: Steam Trap Replacement	Steam Traps	None	1 hour, review scope of work and visit sample locations	Facility Engineers Facility Technicians O&M Personnel
ECM 13: 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 14: Vending Machine Controls	Control Units	None	0.5 hour of hands on training to discuss unit operation and sensor operation	Facility Technicians O&M Personnel
ECM 15: Weatherization Improvements	Weather-stripping	None	0.5 hour of hands on training to discuss reinstalling weather-stripping during maintenance operations	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)										Watt Per Fixture
Item	Building	Location	Qty	Lamp/Ballast Type	Amps	Voltage	PF	Total Watts		
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 10°F 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 10°F below the current space temperature for cooling valves and 10°F 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 10°F 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.

$$\text{SP (setpoint)} = \text{SP (at the sensor from Step 4)} \times (1 / (\text{fraction of flow from Step 3})^2)$$

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.

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 post-installation 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 2: Lighting Controls	Baseline parameters based on lighting audit.	Commissioning of system to ensure sensing device is calibrated to perform as designed.	See ECM 1	Pre- and Post-retrofit operating hours of each usage group. Interactive effects.	Adjust savings to measured results if beyond +/- 10% from energy audit values. Annual inspection of a sampling of the lighting controls to verify they are still operational.
ECM 3: New Energy Management Systems	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. Annual inspection of schedules and set-points.
ECM 4: Attic 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 5: Boiler Replacements	Baseline parameters are based on industry information and the energy audit	Measurement of combustion efficiency of newly installed systems.	Post construction measurements of combustion efficiency.	Baseline system efficiency. Facility load and run hours.	Adjust savings to measured results if measured combustion efficiencies are beyond +/- 3% from equipment proposed in energy audit. Annual inspection of the boilers to verify they are operational and properly maintained.
ECM 6: Install High Efficiency Furnaces	Baseline parameters are based on industry information and the energy audit	Measurement of combustion efficiency of newly installed systems.	Post construction measurements of combustion efficiency.	Baseline system efficiency. Facility load and run hours.	Adjust savings to measured results if measured combustion efficiencies are beyond +/- 3% from equipment proposed in energy audit. Annual inspection of the furnaces to verify they are operational and properly maintained.
ECM 10: Oil to Gas Conversion	Baseline parameters are based on industry information and the energy audit	Commissioning of system to ensure installed to perform as designed.	N/A	Pre- and post-system efficiencies. Facility load and run hours.	Annual inspection of the burners to verify they are operational and properly maintained.
ECM 11: 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 12: Steam Trap Replacement	Baseline parameters are based on industry information and the energy audit	Commissioning of system to ensure installed to perform as designed.	N/A	Pre-retrofit failure rates. Operating hours. Steam loss rates.	Annual inspection of installed systems to identify ability to maintain persistence of savings.

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 13: 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 14: Vending Machine Controls	Survey the machines to verify counts.	Verify controllers are in place and being used	N/A	Operating Run Hours and machine energy use.	Annual inspection of installed systems to identify ability to maintain persistence of savings.
ECM 15: Weatherization Improvements	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 1: Lighting System Improvements

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = LightingSavings - Heat + Cool$$

$$LightingSavings = DemandSavings + EnergySavings$$

$$DemandSavings = BaselineDemand - PostDemand$$

$$EnergySavings = BaselineEnergy - PostEnergy$$

$$BaselineDemand = \sum_{buildings} \sum_{fixtures} (kW_{Base} \times \$ / kW)$$

$$PostDemand = \sum_{buildings} \sum_{fixtures} (kW_{retro} \times \$ / kW)$$

$$BaselineEnergy = \sum_{buildings} \sum_{fixtures} (kW_{Base} \times Hrs_{Base(peak/offpeak)} \times \$ / kWh_{(peak/offpeak)})$$

$$PostEnergy = \sum_{buildings} \sum_{fixtures} (kW_{Retro} \times Hrs_{Base(peak/offpeak)} \times \$ / kWh_{(peak/offpeak)})$$

$$Heat =$$

$$\sum_{buildings} \sum_{fixtures} \left(\frac{(kW_{Base} - kW_{Retro}) \times Hrs_{Base} \times \frac{Mths_{heat}}{12months} \times 3,413 \text{ btu} / kWh \times Util}{Boiler_{Eff} \times 1,000,000 \text{ btu} / mmbtu} \times \$ / mmbtu \right)$$

$$Cool =$$

$$\sum_{buildings} \sum_{fixtures} \left(\frac{(kW_{Base} - kW_{Retro}) \times Hrs_{Base(peak/offpeak)} \times \frac{Mths_{cool}}{12months} \times Util \times Cool\%}{Cool_{Eff}} \times \$ / kWh_{(peak/offpeak)} \right)$$

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
- 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

Salisbury - Lighting Sample Counts*									
Post Description	Town Hall	k/Memorial School Boys and Girls	Beach Services Comfort Station	Department of Public Works	Sewer Treatment Plant	on Aging-Hilton Senior Center	Total Sample Count	Total Fixture Count	
2L4' T8 28w/ELEE HI/NEW-8'		16					16	179	
2L4' T8 28w/ELEE LO	9	1		1	2	1	14	69	
20W COMPACT SI	3	5		1		1	10	24	
4L4' T8 28w/ELEE LO	7	3					10	24	
2L2' T8 15w/ELEE HI/RFL	6				1	5	12	39	
2L4' T8 28w/ELEE HI/RFL	1	1			5	8	15	99	
3L4' T8 28w/ELEE LO 2 BAL	9						9	19	
23W COMPACT SI DIM RFL	8						8	12	
2L4' T8 28w/ELEE LO/NEW-8'		10					10	20	
1L4' T8 28w/ELEE HI/NEW		15					15	86	
3 WATT LED/NEW EXIT BATTERY		5				1	6	8	
4L4' T8 28w/ELEE LO/NEW-8'		12					12	36	
2L4' T8 28w/ELEE HI/NEW		6					6	8	
6L4' T8 28w/ELEE HI/NEW		7					7	10	
2L4' T8 28w/ELEE LO/RFL			8				8	13	
2L4' T8 28w/ELEE				8			8	13	
4L4' T8 28w/ELEE LO 2 BAL				7			7	10	
172 WATT LED/NEW				4	6		10	20	
102 WATT LED/NEW					9		9	19	
Grand Total	43	81	8	21	23	16	192	708	

* Sample based on FEMP Guidelines with 90% Confidence, 20% Precision, & Coefficient Variation = 0.5.

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ECM 2: Lighting Controls

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = EnergySavings - Heat + Cool$$

$$EnergySavings = BaselineEnergy - PostEnergy$$

$$BaselineEnergy = \sum_{buildings} \sum_{fixtures} \left(kW_{Retro} \times Hrs_{Base(peak/offpeak)} \times \$/kWh_{(peak/offpeak)} \right)$$

$$PostEnergy = \sum_{buildings} \sum_{fixtures} \left(kW_{Retro} \times Hrs_{Retro(peak/offpeak)} \times \$/kWh_{(peak/offpeak)} \right)$$

$$Heat =$$

$$\sum_{buildings} \sum_{fixtures} \left(\frac{kW_{Retro} \times (Hrs_{Base} - Hrs_{Retro}) \times \frac{Mths_{heat}}{12months} \times 3,413 \text{ btu}/kWh \times Util}{Boiler_{Eff} \times 1,000,000 \text{ btu}/mmbtu} \times \$/mmbtu \right)$$

$$Cool =$$

$$\sum_{buildings} \sum_{fixtures} \left(\frac{kW_{Retro} \times (Hrs_{Base(peak/offpeak)} - Hrs_{Retro(peak/offpeak)}) \times \frac{Mths_{cool}}{12months} \times Util \times Cool\%}{Cool_{Eff}} \times \$/kWh_{(peak/offpeak)} \right)$$

Where:

- kW_{Retro} - Retrofit fixture kW, as per lighting audit calculation included in the energy audit, subject to metering described below
- Hrs_{Base} - Baseline fixture operating hours broken out into peak and offpeak, as per lighting audit calculation included in the energy audit
- Hrs_{Retro} - Retrofit 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 energy audit
- $Mths_{heat}$ - Number of months the heating penalty will occur, as per lighting audit calculation included in the energy audit

$M_{ths_{cool}}$	- 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 in ECM-1. The energy savings for lighting sensors connected to the ECM-1 samples will be compared to the energy audit using the metered input power. Hours of operation will remain per the energy audit. If the total sample values are within 10% of 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.

All measurements for this ECM will be from those completed for ECM-1. The lighting controls audit calculation will be update using the resulting ECM-1 lighting wattages per its M&V plan. Interactive savings are stipulated and will not be part of the comparison.

ECM 3: Integrated and New Energy Management Systems

Energy Savings Calculation Methodology

Savings Algorithm:

$$\text{Savings} = \text{Motors} + \text{Heating} + \text{Cooling}$$

$$\text{Motors} = \text{ElecBase} - \text{ElecPost}$$

$$\text{ElecBase} = \sum_{\text{buildings}} \left(kW_{\text{Base}} \times Hrs_{\text{Base}(\text{peak / offpeak})} \times \$/kWh_{(\text{peak / offpeak})} \right)$$

$$\text{ElecPost} = \sum_{\text{buildings}} \left(kW_{\text{Base}} \times Hrs_{\text{Retro}(\text{peak / offpeak})} \times \$/kWh_{(\text{peak / offpeak})} \right)$$

$$\text{Heating} = \text{HeatBase} - \text{HeatPost}$$

$$\text{HeatBase} =$$

$$\sum_{\text{buildings}} \left[\sum_{\text{Bin}}^{\text{Heating}} \left(\frac{\text{Load}_{\text{OccBase}} \times Hrs_{\text{OccBase}} + \text{Load}_{\text{UnoccBase}} \times Hrs_{\text{UnoccBase}}}{\text{Eff} \times 1,000 \text{ mbtu} / \text{mmBtu}} \right) \times \$/\text{mmBtu} \right]$$

$$\text{HeatPost} =$$

$$\sum_{\text{buildings}} \left[\sum_{\text{Bin}}^{\text{Heating}} \left(\frac{\text{Load}_{\text{OccRetro}} \times Hrs_{\text{OccRetro}} + \text{Load}_{\text{UnoccRetro}} \times Hrs_{\text{UnoccRetro}}}{\text{Eff} \times 1,000 \text{ mbtu} / \text{mmBtu}} \right) \times \$/\text{mmBtu} \right]$$

$$\text{Cooling} = \text{CoolBase} - \text{CoolPost}$$

$$\text{CoolBase} =$$

$$\sum_{\text{buildings}} \left[\sum_{\text{Bin}}^{\text{Cooling}} \left(\frac{\text{Load}_{\text{OccBase}} \times Hrs_{\text{OccBase}(\text{peak / offpeak})} + \text{Load}_{\text{UnoccBase}} \times Hrs_{\text{UnoccBase}(\text{peak / offpeak})}}{\text{COP} \times 3.413 \text{ mbtu} / \text{kWh}} \right) \times \$/kWh_{(\text{peak / offpeak})} \right]$$

$$\text{CoolPost} =$$

$$\sum_{\text{buildings}} \left[\sum_{\text{Bin}}^{\text{Cooling}} \left(\frac{\text{Load}_{\text{OccRetro}} \times Hrs_{\text{OccRetro}(\text{peak / offpeak})} + \text{Load}_{\text{UnoccRetro}} \times Hrs_{\text{UnoccRetro}(\text{peak / offpeak})}}{\text{COP} \times 3.413 \text{ mbtu} / \text{kWh}} \right) \times \$/kWh_{(\text{peak / offpeak})} \right]$$

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 – (Memorial School Only)

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 and Boiler Controls

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.

ECM 4: Attic Insulation

Energy Savings Calculation Methodology

Savings Algorithm:

$$\text{Savings} = \text{Baseline} - \text{PostInstallation}$$

Baseline =

$$\sum_{\text{Building}} \left(\sum_{\text{Bin}}^{\text{Heating}} \left(\frac{\text{Load}_{\text{BaseOcc}} \times \text{Hrs}_{\text{Occ(peak/offpeak)}} + \text{Load}_{\text{BaseUnocc}} \times \text{Hrs}_{\text{Unocc(peak/offpeak)}}}{\text{Eff} \times 1,000 \text{ mbtu/mmbtu}} \right) \times \$/\text{mmbtu} \right. \\ \left. + \sum_{\text{Bin}}^{\text{Cooling}} \left(\frac{\text{Load}_{\text{BaseOcc}} \times \text{Hrs}_{\text{Occ(peak/offpeak)}} + \text{Load}_{\text{BaseUnocc}} \times \text{Hrs}_{\text{Unocc(peak/offpeak)}}}{\text{COP} \times 3.413 \text{ mbtu/kWh}} \right) \times \$/\text{kWh}_{\text{(peak/offpeak)}} \right)$$

PostInstallation =

$$\sum_{\text{Building}} \left(\sum_{\text{Bin}}^{\text{Heating}} \left(\frac{\text{Load}_{\text{RetroOcc}} \times \text{Hrs}_{\text{Occ(peak/offpeak)}} + \text{Load}_{\text{RetroUnocc}} \times \text{Hrs}_{\text{Unocc(peak/offpeak)}}}{\text{Eff} \times 1,000 \text{ mbtu/mmbtu}} \right) \times \$/\text{mmbtu} \right. \\ \left. + \sum_{\text{Bin}}^{\text{Cooling}} \left(\frac{\text{Load}_{\text{RetroOcc}} \times \text{Hrs}_{\text{Occ(peak/offpeak)}} + \text{Load}_{\text{RetroUnocc}} \times \text{Hrs}_{\text{Unocc(peak/offpeak)}}}{\text{COP} \times 3.413 \text{ mbtu/kWh}} \right) \times \$/\text{kWh}_{\text{(peak/offpeak)}} \right)$$

$$\text{Load}_{\text{Base/RetroOcc/Unocc}} = (\text{Trans}_{\text{Base/RetroOcc/Unocc}})$$

Where:

- Trans - The transmission 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 5: Boiler Replacements

Energy Savings Calculation Methodology

Savings Algorithm:

$$\text{Savings} = \text{Baseline} - \text{PostInstallation}$$

$$\text{Baseline} = \frac{\text{Usage}_{\text{Current}} \times \text{Eff}_{\text{Retro}}}{\text{Eff}_{\text{Base}}} \times \$/\text{mmbtu}_{\text{Base}}$$

$$\text{PostInstallation} = \text{Usage}_{\text{Current}} \times \$/\text{mmbtu}_{\text{Post}}$$

Where:

- Eff_{Base} - Base heating system efficiency, as per calculation in the energy audit
- $\text{Eff}_{\text{Retro}}$ - Retrofit heating system efficiency, as per calculation in the energy audit, subject to metering plan below
- $\text{Usage}_{\text{Current}}$ - Actual metered fuel usage in mmbtu for new boilers, minimum of the proposed usage in the energy audit. Actual metered fuel usage for the affected boilers only shall be provided by the Town or utility and must be from utility grade meters.
- $\$/\text{mmbtu}_{\text{Base}}$ - Baseline unit cost of fossil fuel, as per Unit Prices section below
- $\$/\text{mmbtu}_{\text{Post}}$ - Proposed unit cost of fossil fuel, as per Unit Prices section below

Metering Plan

As part of the commissioning process, the combustion efficiency of the newly installed boilers will be measured and compared to the expected values for the new boilers per the proposed equipment in the energy audit. If the measurement is within 3% of the energy audit combustion efficiency values no change will be made. If the measurement value is not within 3%, Ameresco will either take corrective action for them to be within this limit, or will utilize the measured values. For condensing boilers these measurements will be taken over a range of return water temperatures during a period of not more than a week. For non-condensing boilers these measurements will be taken one time during a burner cycle, after steady state firing has been reached.

Ameresco will use a calibrated portable flue gas analyzer (Testo or equivalent) to measure combustion efficiency for each new boiler. Boilers will only be tested once they have reached steady state firing, which shall be defined as having continuously fired on high fire for at least 15 minutes and the return water temperature remains constant, plus or minus 2.5°F, for 15 minutes. For steam boilers, the return water requirement is replaced with 15 minutes of continuous steam production as indicated by continuously rising or constant steam pressure greater than 1psi. Once steady state is reached, the operational boiler's combustion efficiency will be measured with at least two additional measurements taken at least 5 minutes apart with the boiler remaining in continuous high fire operation. Only one boiler shall be operated at a time in order to assist steady state operation. This process shall be repeated for each new boiler.

For non-condensing boilers, the above measurement procedure shall only need to be performed once. For condensing boilers, the above measurement procedure shall be repeated so as to perform measurements at multiple steady state return water temperatures between 100°F and 140°F. At least 3 return water states shall be measured with at least 5°F between states.

The measurements for all new boilers associated with a single boiler plant will be averaged together to represent the measured combustion efficiency for each new boiler plant. The difference between the energy audit boiler calculation efficiency and the measured combustion efficiency will be subject to the 3% hurdle.

ECM 8: Install High Efficiency Furnaces

Energy Savings Calculation Methodology

Savings Algorithm:

$$\text{Savings} = \text{Baseline} - \text{PostInstallation}$$

$$\text{Baseline} = \frac{\text{Usage}_{\text{Current}} \times \text{Eff}_{\text{Retro}}}{\text{Eff}_{\text{Base}}} \times \$/\text{mmbtu}_{\text{Base}}$$

$$\text{PostInstallation} = \text{Usage}_{\text{Current}} \times \$/\text{mmbtu}_{\text{Post}}$$

Where:

- Eff_{Base} - Base heating system efficiency, as per calculation in the energy audit
- $\text{Eff}_{\text{Retro}}$ - Retrofit heating system efficiency, as per calculation in the energy audit, subject to metering plan below
- $\text{Usage}_{\text{Current}}$ - Actual metered fuel usage in mmbtu for new furnaces, minimum of the proposed usage in the energy audit. Actual metered fuel usage for the affected furnaces only shall be provided by the Town or utility and must be from utility grade meters.
- $\$/\text{mmbtu}_{\text{Base}}$ - Baseline unit cost of fossil fuel, as per Unit Prices section below
- $\$/\text{mmbtu}_{\text{Post}}$ - Proposed unit cost of fossil fuel, as per Unit Prices section below

Metering Plan

As part of the commissioning process, the combustion efficiency of the newly installed furnaces will be measured and compared to the expected values for the new furnaces per the proposed equipment in the energy audit. If the measurement is within 3% of the energy audit combustion efficiency values no change will be made. If the measurement value is not within 3%, Ameresco will either take corrective action for them to be within this limit, or will utilize the measured values. These measurements will be taken one time during a burner cycle, after steady state firing has been reached.

Ameresco will use a calibrated portable flue gas analyzer (Testo or equivalent) to measure combustion efficiency for each new furnace. Furnaces will only be tested once they have reached steady state firing, which shall be defined as having continuously fired for at least 5 minutes and the discharge air temperature remains constant, plus or minus 2.5°F, for 5 minutes. Once steady state is reached, the furnaces' combustion efficiency will be measured with at least two additional measurements taken at least 5 minutes apart with the furnace remaining in continuous heating operation. This process shall be repeated for each new furnace.

The measurements for all new furnaces will be averaged together to represent the measured combustion efficiency. The difference between the energy audit proposed furnace combustion efficiency and the measured combustion efficiency will be subject to the 3% hurdle.

ECM 10: Oil to Gas Conversion

Energy Savings Calculation Methodology

Savings Algorithm:

$$\text{Savings} = \text{Baseline} - \text{PostInstallation}$$

$$\text{Baseline} = \frac{\text{Usage}_{\text{Current}} \times \text{Eff}_{\text{Retro}}}{\text{Eff}_{\text{Base}}} \times \$/\text{mmbtu}_{\text{Base}}$$

$$\text{PostInstallation} = \text{Usage}_{\text{Current}} \times \$/\text{mmbtu}_{\text{Post}}$$

Where:

- Eff_{Base} - Base heating system efficiency, as per calculation in the energy audit
- $\text{Eff}_{\text{Retro}}$ - Retrofit heating system efficiency, as per calculation in the energy audit
- $\text{Usage}_{\text{Current}}$ - Actual metered fuel usage in mmbtu for new burners, minimum of the proposed usage in the energy audit. Actual metered fuel usage for the affected burners only shall be provided by the Town or utility and must be from utility grade meters.
- $\$/\text{mmbtu}_{\text{Base}}$ - Baseline unit cost of fossil fuel, as per Unit Prices section below
- $\$/\text{mmbtu}_{\text{Post}}$ - Proposed unit cost of fossil fuel, as per Unit Prices section below

Metering Plan

No measurements will be taken for this ECM.

ECM 11: Pipe Insulation

Energy Savings Calculation Methodology

Savings Algorithm:

$$Savings = \sum_{Heat} (Baseline_{Heat} - PostInstallation_{Heat})$$

$$Baseline_{Heat} = \sum_{Pipes} \left(\frac{LossRate_{Base} \times Hrs}{Eff \times 1000 \text{ mbtu} / \text{mmbtu}} \right) \times \$ / \text{mmbtu}$$

$$PostInstallation_{Heat} = \sum_{Pipes} \left(\frac{LossRate_{Retro} \times Hrs}{Eff \times 1000 \text{ mbtu} / \text{mmbtu}} \right) \times \$ / \text{mmbtu}$$

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
- \$/mmbtu - Unit cost of fossil fuel, as per Unit Prices section below

Metering Plan

No measurements will be taken for this ECM.

ECM 12: Steam Trap Replacement**Energy Savings Calculation Methodology****Savings Algorithm:**

$$Savings = Baseline - PostInstallation$$

$$Baseline = SteamLoss_{Base} \times \$ / mmbtu$$

$$PostInstallation = SteamLoss_{Post} \times \$ / mmbtu$$

Where:

SteamLoss_{Base} - Base energy lost due to steam traps (mmbtu), as per calculation in energy audit

SteamLoss_{Post} - Retrofit energy lost due to steam traps (mmbtu), as per calculation in energy audit

\$/mmbtu - Unit cost of fossil fuel, as per Unit Prices section below

Metering Plan

No measurements will be taken for this ECM.

ECM 13: Variable Frequency Drives

Energy Savings Calculation Methodology

Savings Algorithm:

$$\text{Savings} = \text{Baseline} - \text{PostInstallation}$$

$$\text{Baseline} = \sum_{\text{Building}} \left(\text{kW} \times \text{Hours}_{(\text{peak} / \text{offpeak})} \times \$ / \text{kWh}_{(\text{peak} / \text{offpeak})} \right)$$

$$\text{Postinstallation} = \sum_{\text{Building}} \left(\text{Usage}_{(\text{peak} / \text{offpeak})} \times \$ / \text{kWh}_{(\text{peak} / \text{offpeak})} \right)$$

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, subject to metering described below
- Usage - Energy usage of each motor with VFD control, broken out into peak and offpeak, as per calculation in the energy audit, subject to metering described 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

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 14: Vending Machine Controls

Energy Savings Calculation Methodology

Savings Algorithm:

$$\text{Savings} = \text{EnergySavings} - \text{Heat} + \text{Cool}$$

$$\text{EnergySavings} =$$

$$\sum_{\text{machine}} \left(\text{kW} \times (\text{Hrs}_{\text{Base}(\text{peak / offpeak})} - \text{Hrs}_{\text{Retro}(\text{peak / offpeak})}) \times \frac{\$/\text{kWh}_{(\text{peak / offpeak})}}{\text{kWh}_{(\text{peak / offpeak})}} \right)$$

$$\text{Heat} =$$

$$\sum_{\text{machine}} \left(\frac{\text{kW} \times (\text{Hrs}_{\text{Base}} - \text{Hrs}_{\text{Retro}}) \times \frac{\text{Mths}_{\text{heat}}}{12\text{months}} \times 3,413\text{btu}/\text{kWh} \times \text{Util}}{\text{Boiler}_{\text{Eff}} \times 1,000,000\text{btu}/\text{mmbtu}} \times \frac{\$/\text{mmbtu}}{\text{mmbtu}} \right)$$

$$\text{Cool} =$$

$$\sum_{\text{machine}} \left(\frac{\text{kW} \times (\text{Hrs}_{\text{Base}(\text{peak / offpeak})} - \text{Hrs}_{\text{Retro}(\text{peak / offpeak})}) \times \frac{\text{Mths}_{\text{cool}}}{12\text{months}} \times \text{Util} \times \text{Cool}\%}{\text{Cool}_{\text{Eff}}} \times \frac{\$/\text{kWh}_{(\text{peak / offpeak})}}{\text{kWh}_{(\text{peak / offpeak})}} \right)$$

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 15: Weatherization Improvements

Energy Savings Calculation Methodology

Savings Algorithm:

$$\text{Savings} = \text{Baseline} - \text{PostInstallation}$$

Baseline =

$$\sum_{\text{Building}} \left(\sum_{\text{Bin}}^{\text{Heating}} \left(\frac{\text{Load}_{\text{BaseOcc}} \times \text{Hrs}_{\text{Occ(peak/offpeak)}} + \text{Load}_{\text{BaseUnocc}} \times \text{Hrs}_{\text{Unocc(peak/offpeak)}}}{\text{Eff} \times 1,000 \text{ mbtu/mmbtu}} \right) \times \$/\text{mmbtu} \right. \\ \left. + \sum_{\text{Bin}}^{\text{Cooling}} \left(\frac{\text{Load}_{\text{BaseOcc}} \times \text{Hrs}_{\text{Occ(peak/offpeak)}} + \text{Load}_{\text{BaseUnocc}} \times \text{Hrs}_{\text{Unocc(peak/offpeak)}}}{\text{COP} \times 3.413 \text{ mbtu/kWh}} \right) \times \$/\text{kWh}_{(\text{peak/offpeak})} \right)$$

PostInstallation =

$$\sum_{\text{Building}} \left(\sum_{\text{Bin}}^{\text{Heating}} \left(\frac{\text{Load}_{\text{RetroOcc}} \times \text{Hrs}_{\text{Occ(peak/offpeak)}} + \text{Load}_{\text{RetroUnocc}} \times \text{Hrs}_{\text{Unocc(peak/offpeak)}}}{\text{Eff} \times 1,000 \text{ mbtu/mmbtu}} \right) \times \$/\text{mmbtu} \right. \\ \left. + \sum_{\text{Bin}}^{\text{Cooling}} \left(\frac{\text{Load}_{\text{RetroOcc}} \times \text{Hrs}_{\text{Occ(peak/offpeak)}} + \text{Load}_{\text{RetroUnocc}} \times \text{Hrs}_{\text{Unocc(peak/offpeak)}}}{\text{COP} \times 3.413 \text{ mbtu/kWh}} \right) \times \$/\text{kWh}_{(\text{peak/offpeak})} \right)$$

$$\text{Load}_{\text{Base/RetroOcc/Unocc}} = (\text{Infil}_{\text{Base/RetroOcc/Unocc}})$$

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.

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 2: Lighting Controls

Ameresco will perform a yearly site inspection of a sampling of the lighting controls to ensure that the sensors are in place and operational. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 3: New Energy Management Systems – Direct Digital Controls

Ameresco will inspect the energy management system 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

- 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.
- 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 3: New Energy Management Systems – Programmable Thermostats and Boiler Controls

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 4: Attic Insulation

Ameresco will perform a yearly site inspection of the installed attic insulation to ensure it is in place as installed. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 5: Boiler Replacements

Ameresco will perform a yearly site inspection of the new boilers and burners to verify they are operational. Ameresco will also inspect available maintenance logs to verify proper maintenance is occurring. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 8: Install High Efficiency Furnaces

Ameresco will perform a yearly site inspection of the new furnaces to verify they are operational. Ameresco will also inspect available maintenance logs to verify proper maintenance is occurring. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 10: Oil to Gas Conversion

Ameresco will perform a yearly site inspection of the new burners to verify they are operational. Ameresco will also inspect available maintenance logs to verify proper maintenance is occurring. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 11: 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 12: Steam Trap Replacement

Ameresco will perform a yearly site inspection of a sampling of the installed steam traps to ensure they are in operation. If the steam systems are operational during the site visit, thermographic images will be taken to verify trap operation. The observations during this inspection will be made part of the Annual Reconciliation Report.

ECM 13: 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 14: 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 15: Weatherization Improvements

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.

Operations and Maintenance Savings

$$AnnualSavings = \$MAINT / year \times (1 + Esc)^{(CurrentYear-2013)}$$

The agreed upon maintenance savings breakdown per measure is as follows:

ECM	\$MAINT/year
ECM 1: Lighting System Improvements	\$1,389
ECM 5: Boiler Replacements - Fire Station	\$500
ECM 5: Boiler Replacements - Memorial School	\$21,000 (no escalation)
ECM 10: Oil to Gas Conversion	\$1,500
Totals	\$24,389

ECM 1 O&M savings are based on reduced material replacements costs due to replacing old lamps and ballasts with new.

ECM 5 O&M savings for the Fire Station are based on reducing the annual cost to clean the oil burners, change filters and tuning.

ECM 5 O&M savings for the Memorial School are based on an expected rent increase the Town will require from the Boy's and Girl's Club to offset the cost of the retrofits planned for the Memorial School. This amount will remain constant for the term of the contract and will not be escalated.

ECM 10 O&M savings are based on reducing the annual cost to clean the oil burners, change filters and tuning.

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:

$$\begin{aligned}\$/kW &= \text{Base}_{kW} \times (1 + \text{Esc})^{(\text{CurrentYear} - 2012)} \\ \$/kWh_{\text{peak}} &= \text{Base}_{kWh_{\text{peak}}} \times (1 + \text{Esc})^{(\text{CurrentYear} - 2012)} \\ \$/kWh_{\text{offpeak}} &= \text{Base}_{kWh_{\text{offpeak}}} \times (1 + \text{Esc})^{(\text{CurrentYear} - 2012)}\end{aligned}$$

The base for each location is listed in the following table.

Fossil Fuel Costs:

$$\begin{aligned}\$/\text{mmbtu}_{\text{gas}} &= \frac{\text{Base}_{\text{gas}}}{100 \text{mbtu}/\text{Therm}} \times (1 + \text{Esc})^{(\text{CurrentYear} - 2012)} \\ \$/\text{mmbtu}_{\text{oil}} &= \frac{\text{Base}_{\text{oil}}}{138.7 \text{mbtu}/\text{Gal}} \times (1 + \text{Esc})^{(\text{CurrentYear} - 2012)}\end{aligned}$$

The base for each location is listed in the following table.

Utility Escalation:

$$\text{Esc} = 3.0\%/\text{yr}$$

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 Table:

Facility	\$/kW	\$/kWhpeak	\$/kWhoffpeak	\$/Therm Natural Gas	\$/Gal Propane	\$/Gal #2 Oil
Fire Department	\$-	\$0.1523	\$0.1523	\$1.088		\$3.50
Department of Public Works	\$-	\$0.1523	\$0.1523	\$1.088		
Beach Services - Comfort Station	\$-	\$0.1523	\$0.1523	\$1.088		
Council on Aging- Hilton Senior Center	\$-	\$0.1523	\$0.1523	\$1.251		
Town Hall	\$-	\$0.1523	\$0.1523	\$1.251		
Sewage Treatment Plant	\$6.0	\$0.1001	\$0.1001	\$1.251	\$4.233	
Memorial School-Boys and Girls Club	\$6.0	\$0.1019	\$0.1019	\$1.088		\$3.50

Utility Rates for Thermal Savings:

The following table presents the fuels to be used for each ECM having thermal savings.

ECM

	Fire	DPW	Beach	COA	Town Hall	Sewer	Memorial
ECM 1: Lighting System Improvements		G	G	G	G	E	O
ECM 2: Lighting Controls	O	G			G	E	
ECM 3: New Energy Management Systems	O	G		G	G	E	O
ECM 4: Attic Insulation	O						
ECM 5: Boiler Replacements	O _{Pre} /G _{Post}						
ECM 8: Install High Efficiency Furnaces				G			
ECM 10: Oil to Gas Conversion						O _{Pre} /G _{Post}	
ECM 11: Pipe Insulation	O				G	O	
ECM 12: Steam Trap Replacement						O	
ECM 13: Variable Frequency Drives							
ECM 14: Vending Machine Controls				G	G	G	O
ECM 15: Weatherization Improvements	O			G	G	E	O

Gas = G

Oil = O

Electric = E

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