Detailed Energy Audit

City of Dover
Dover, New Hampshire

February 27, 2009

Johnson Controls

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SECTION 1 Executive Summary

Johnson Controls, Inc. (hereinafter "JC") is assisting the City of Dover, NH (hereinafter "City") to reduce energy costs by implementing an energy performance contract. The goals of the project are to cut energy costs, provide capital upgrades, increase the energy efficiency and the reliability of City's mechanical and electrical systems, and to maintain or increase occupant comfort and well-being. This report provides the results of the Detailed Energy Audit.

JC wishes to thank the staff at the City specifically; Sharon Lucey, Gary Bannon, Pat McNulty, Barry Riordan and Ray Vermette for their invaluable assistance and generous time spent with the JC team during this study effort. Without their help and guidance, data collection and system understanding the audit process would have been significantly more difficult. The fact that there are staff who have been with the City for a large number of years, and who know the systems quite intimately is a huge asset both to City as well as a contractor such as JC.

Table 1 below provides an overall economic summary of the recommended measures. A detailed list of the measures is shown in Table 2. Note that the project cost does not include any utility incentives.

Table 1: Project Summary

Project Cost ……………………………………	**$2,423,485**
Estimated Rebates /Incentives	**$225,445**
Project Cost after Rebates/Incentives……	**$2,198,040**
Estimated Annual Savings…………………	**$256,990**
Estimated Capital Cost Avoidance	**$33,840**
Estimated Operational Savings	**$13,680**
Simple Payback, Years……………………..	**7.21**

Several Facility Improvement Measures ("FIMs") were identified as a result of the detailed energy audit conducted at the City. The table on the following page summarizes the various measures and their associated energy savings.

Findings

The major findings of this study are as follows:

- There are many opportunities to reduce operating costs at the City buildings. By implementing the recommendations outlined in this study, the City could reduce energy costs **by 22.7%** from calendar year 2007-2008 levels.

- The City's mechanical and electrical systems are in good condition, and are operated well, given system age, funding and staffing level constraints.
- The staff has been proactive identifying and implementing cost reduction and energy efficiency initiatives. However, several opportunities still exist for additional savings, mostly due to the availability of new technologies, or improvements to systems that may have been considered efficient at the time they were designed, but are no longer. Operational changes can also be made.
- The recommended measures will maintain or improve occupant comfort.
- By implementing the measures, the City will benefit from capital upgrades for equipment that is beyond its useful life, or in need of repair.

Recommendations

- **Lighting – Fixture Retrofit & Controls:** Retrofit old high energy consuming fixtures with appropriate less energy consuming fixtures without compromising quality and install new occupancy sensor to ensure that lights are not on during unoccupied hours of the day.
- **Building Envelope Improvements**: Improve the overall building weatherization through the installation of insulation, weather-stripping and air-sealing
- **Energy Management System - Upgrades:** Retrofit building controls, install ductless split system and equipment to enable more efficient operation through the application of building temperature setbacks and enhanced building control.
- **Water Conservation:** Retrofit existing plumbing fixtures with newer more efficient models.
- **Vending Machine Controls:** Install controls on the cold drink vending machines to improve the overall efficiency of the units.
- **Pool Cover:** Retrofit existing indoor pool with a new fully automatic pool cover to eliminate unnecessary evaporation and heat loss.
- **Ice Arena - Upgrades:** Retrofit several of the ice arenas mechanical systems to improve operational efficiency of the building systems. The scope of the retrofit includes the installation of a new high efficiency chiller, low-E ceiling, ice temperature controls and new dehumidification system at the Foster rink.
- **Power Factor Correction:** Install new capacitors that will enable the efficient use of energy at the facilities were proposed.
- **Transformers - Retrofit**: Retrofit existing transformers with new high efficiency models.
- **WWTP Aeration Blower – Retrofit:** Install new high efficiency aeration blowers at the WWTP.
- **Heating System Upgrade – Boiler Replacement *:** Install new high efficiency hot water fired boiler at the City of Dover Public Library.
  * *The Heating System Upgrade has already been commissioned.*

The table below provides a summary, by measure, of the energy and cost savings achievable by implementing the recommended measures.

Table 2: Project Savings Detail

Project Summary	
Facility Improvement Measures	**Estimated Savings, $/yr**
Lighting – Fixture Retrofit & Controls	$28,379
Building Envelope Improvements	$14,461
Energy Management System – Upgrades	$30,597
Water Conservation	$14,123
Vending Machine Controls	$936
Pool Cover	$13,223
Ice Arena - Upgrades	$95,015
Power Factor Correction	$7,188
Transformers – Retrofit	$18,385
WWTP Aeration Blower – Retrofit	33,432
Heating System Upgrade – Boiler Replacement	$1,251
Total Savings	**$256,990**

Environmental Impact

The table below provides a summary of the environmental impact of the recommended project and the reduction in green house gas (Carbon Dioxide, Sulfur Dioxide and Nitrogen Dioxide) emissions as a result of reduced electric, oil and gas usage at the facilities.

Table 3: Project Environmental Impact

Energy Project GHG Calculator *for the US*

Please provide data on expected energy consumption savings based on the project's characteristics for each different source.		**Total Reduced GHGs**	963.5	*tons CO_2-e*
Electricity				
		eGRID Subregion	NEWE / NPCC New England	
Enter location's Zip Code:	03820	Emission Factor	0.00037943	*tons CO_2-e/kWh*
kWh	875,990	Reduced GHGs	332.4	*tons CO_2-e*
Natural Gas				
		Emission Factor	0.0053	*tons CO_2-e/therms*
Therms	118,819	Reduced GHGs	631.1	*tons CO_2-e*

The project's reduced emissions would be equivalent to:

CO_2 sequestered by	24,704	tree seedlings grown for 10 years in an urban scenario	
CO_2 sequestered by	219	acres of pine or fir forests	
CO_2 emissions from	176	passenger vehicles	
CO_2 emissions from	2,241	barrels of oil consumed	
CO_2 emissions from the *energy* use of	85	homes for one year	
CO_2 emissions from burning	5	coal railcars	

Source:
All carbon equivalencies extracted directly from the EPA website.
"Greenhouse Gas Equivalencies Calculator." Clean Energy. U.S. Environmental Protection Agency. <www.epa.gov/cleanenergy/energy-resources/calculator.html> (Aug. 6, 2008).

The remainder of the report is organized as follows:

- Section 2 describes the facility profile, including the energy consumption profile, energy and water costs tables and a summary of buildings.
- Section 3 briefly describes the development of the energy usage baseline and basis for the energy unit costs used in the savings calculations.
- Section 4 contains detailed descriptions of the measures, including existing and proposed conditions, scope of work and a summary of the savings calculation. Where applicable, the existing conditions section contains charts that were developed from data recorded by the energy management system or portable loggers. The charts help to illustrate the problem or condition the particular measure will address.
- Section 5 provides a draft of the proposed Assured Performance Guarantee and the methodology JC will use to calculate the energy savings.
- Section 6 provides the commissioning plan for the proposed facility improvement measures
- Section 7 The appendices contain all the relevant charts derived from the energy management system and portable logger data, copies of the savings calculations, proposed system flow diagrams and new equipment catalog information. Additionally, this section includes the lighting audit, supplemental utility data and the useful life of the proposed equipment.

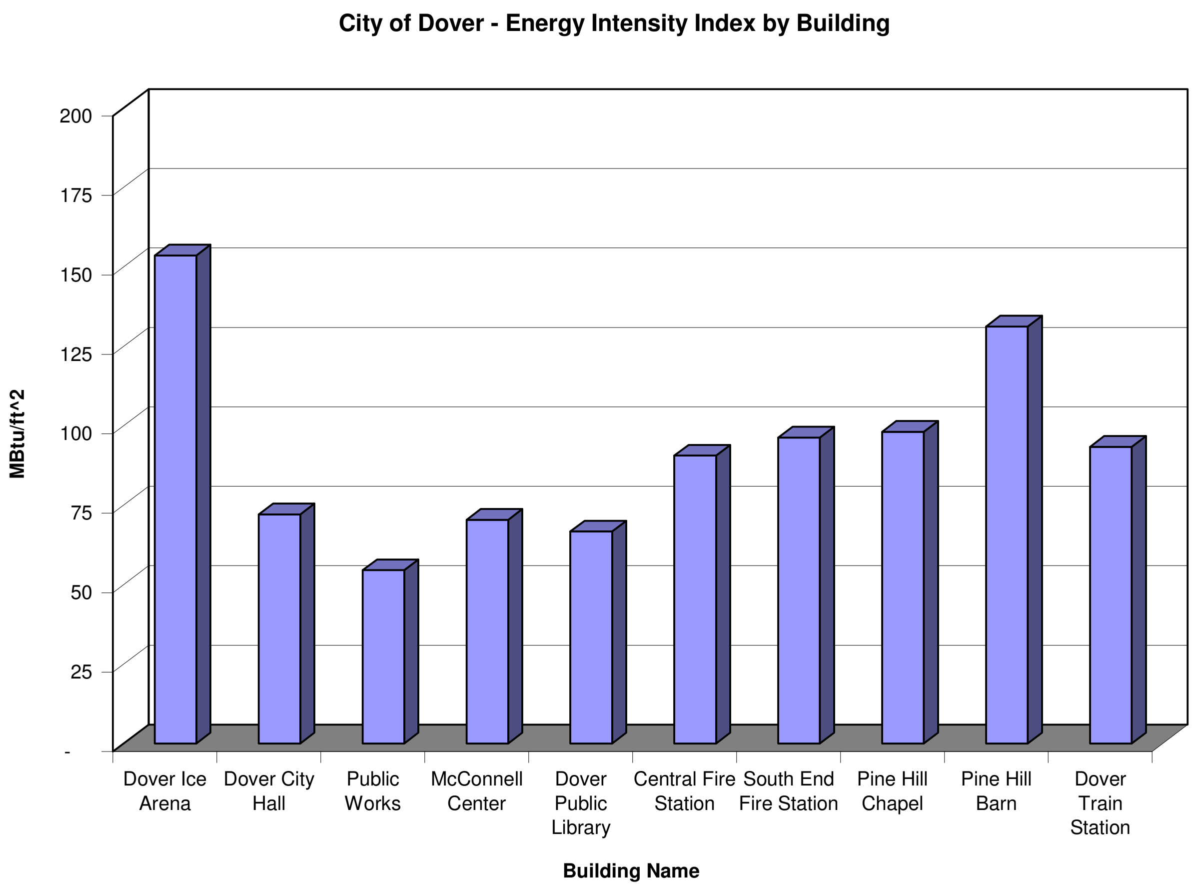
SECTION 2 - Facility Profile

Energy Consumption Profile

Energy Intensity

The energy use within the City of Dover buildings is diverse. During the detailed energy study the Johnson Controls engineering team evaluated the utility usage across all buildings for the purposes of identifying energy savings opportunities. Each of the buildings utility usage was aggregated and then divided by the conditioned square footage to determine the buildings energy intensity in MBtu/ft^2. The chart below illustrates the energy intensities for each of the buildings within the City of Dover; however it is important to note that for the Wastewater Treatment Facility, Indoor Pool and the Jenny Thompson Pool the energy intensity method of comparison does not provide a reasonable means for comparison due to their unique facility type.

Energy intensities for the Cities buildings ranged from a low of 23 MBtu/ft^2 for Veterans Hall to a high of roughly 600 Mbtu/ft^2 for the Indoor Pool. With an average intensity of 80 MBtu/ft^2 (excluding the pool(s), wastewater treatment facility and the ice arena) there were significant amount energy efficiency opportunities at each of the Cities buildings. Typically, efficient municipal facilities will have energy intensities of 50-60 MBtu/ft^2 and below depending on their occupancy and usage class.

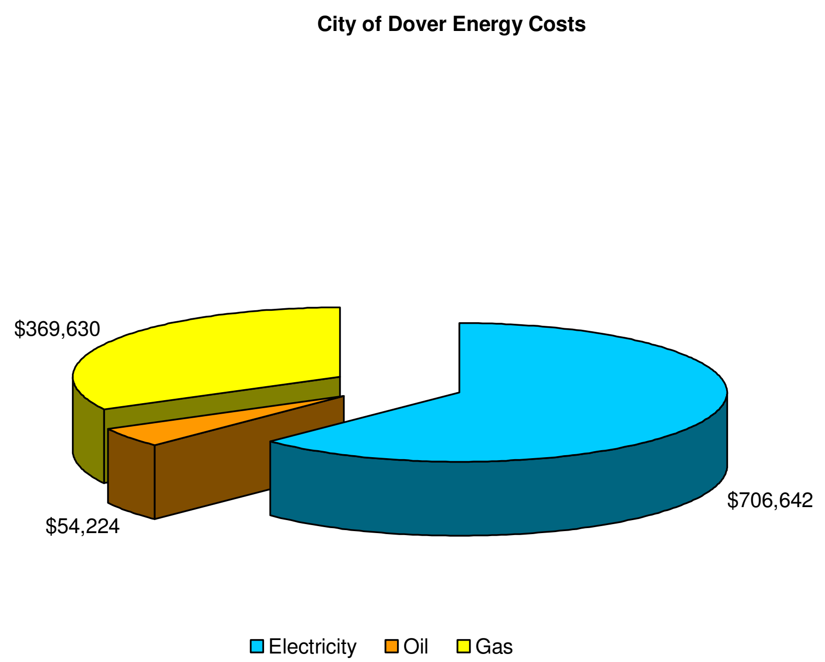


Utility Expenditures

The City utilizes electricity, natural gas, propane and oil to provide for heating, cooling, lighting and other building related processes. Electricity is supplied from Public Service of New Hampshire. Natural Gas was supplied from Northern Utilities (2006) and Metromedia (2007) and is now supplied from Santa Buckley. Propane at the South End Fire Station was supplied by DF Richard (2006) and Proulx Oil (2007) and is now supplied from Ferrell Gas. Heating Oil for several of the buildings was supplied from Hanscom (2006) and Down East Energy (2007) and is now supplied from Irving Oil.

The following chart depicts the City's utility expenditures from August 2007 through July 2008. During this period the City spent $1,131,579 for electricity, natural gas and oil. In terms of percentages, electricity comprises roughly 62% of the total utility expenditures, natural gas/propane makes up 33% and oil makes up the remaining 5%.

Additionally, Johnson Controls has completed a building by building summary and analysis of utility histories for each of the buildings evaluated as part of this study. Further building summary detail is provided on the following pages and a copy of each utility summary with it's energy profile is included in Appendix 2 as reference.



Energy and Water Costs Table

The following tables represent the utility usage for each of the Cities buildings evaluated as part of this study. A three year history is provided.

FY 2008 Utility Summary (August 2007 - July 2008)										
	Electricity			Natural Gas		Oil		Propane		Total
Building	kW	kWh	Cost ($)	Therms	Cost ($)	Therms	Cost ($)	Therms	Cost ($)	Cost ($)
Indoor Pool	55.0	423,000	$50,025	48,170	$69,230	-	$0	-	$0	$119,255
Dover Ice Arena	266.4	1,473,600	$177,702	143,267	$181,032	-	$0	-	$0	$358,734
Wate Water Treatment Facility	303.6	1,662,000	$197,687	-	$0	12,344	$20,573	-	$0	$218,260
Dover City Hall	86.5	437,890	$54,539	-	$0	17,316	$28,860	-	$0	$83,399
Public Works	74.8	340,200	$43,525	18,273	$20,618	-	$0	-	$0	$64,143
McConnell Center	187.8	959,000	$118,882	39,726	$56,083	-	$0	-	$0	$174,965
Dover Public Library	35.9	127,440	$17,143	8,985	$12,706	-	$0	-	$0	$29,849
Jenny Thompson Pool	15.3	86,730	$10,906	10,425	$14,062	-	$0	-	$0	$24,968
Central Fire Station	15.4	80,470	$10,068	3,596	$5,496	-	$0	-	$0	$15,564
South End Fire Station	13.2	70,101	$9,000	-	$0	-	$0	5,303	$9,374	$18,374
Pine Hill Chapel	-	10,262	$1,736	-	$0	1,117	$1,862	-	$0	$3,599
Pine Hill Barn	-	6,055	$1,212	-	$0	1,757	$2,928	-	$0	$4,140
Veterans Hall	-	*	*	675	$1,217	-	$0	-	$0	1,217
Dover Train Station	23.8	115,560	$14,108	526	$1,006	-	$0	-	$0	$15,114
Total	**1,077.8**	**5,792,308**	**$706,531**	**273,643**	**$361,450**	**32,534**	**$54,224**	**5,303**	**$9,374**	**$1,131,579**

* **Data not available**

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FY 2007 Utility Summary (August 2006 - July 2007)										
		Electricity		Natural Gas		Oil		Propane		Total
Building	kW	kWh	Cost ($)	Therms	Cost ($)	Therms	Cost ($)	Therms	Cost ($)	Cost ($)
Indoor Pool	56.5	287,000	$35,280	63,845	$90,527	-	$0	-	$0	$125,806
Dover Ice Arena	294.3	1,527,800	$183,902	161,778	$203,587	-	$0	-	$0	$387,489
Wate Water Treatment Facility	319.8	1,871,400	$220,130		$0	8,129	$13,783	-	$0	$233,913
Dover City Hall	71.2	364,720	$44,307		$0	14,630	$24,805	-	$0	$69,112
Public Works	82.0	350,800	$43,773	18,877	$28,237	-	$0	-	$0	$72,010
McConnell Center	135.5	685,136	$83,639	44,166	$67,093	-	$0	-	$0	$150,732
Dover Public Library	36.1	128,880	$16,744	8,706	$13,802	-	$0	-	$0	$30,546
Jenny Thompson Pool	13.2	67,450	$8,403	10,100	$11,793	-	$0	-	$0	$20,197
Central Fire Station	15.2	79,470	$9,794	3,540	$5,780	-	$0	-	$0	$15,574
South End Fire Station	13.6	73,799	$9,179		$0	-	$0	6,008	$10,831	$20,011
Pine Hill Chapel	-	10,474	$1,757		$0	1,238	$2,099	-	$0	$3,855
Pine Hill Barn	-	7,459	$1,278		$0	1,937	$3,284	-	$0	$4,562
Veterans Hall	-	*	*	877	$1,643	-	$0	-	$0	$1,643
Dover Train Station	20.5	98,010	$12,312	389	$865	-	$0	-	$0	$13,177
Total	**1,057.9**	**5,552,398**	**$670,499**	**312,278**	**$423,327**	**25,933**	**$43,971**	**6,008**	**$10,831**	**$1,148,627**

* **Data not available**

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FY 2006 Utility Summary (August 2005 - July 2006)										
		Electricity		Natural Gas		Oil		Propane		Total
Building	kW	kWh	Cost ($)	Therms	Cost ($)	Therms	Cost ($)	Therms	Cost ($)	Cost ($)
Indoor Pool	59.4	220,040	$31,518	68,133	$72,354	-	$0	-	$0	$103,873
Dover Ice Arena	281.3	1,460,000	$193,184	172,387	$181,068	-	$0	-	$0	$374,252
Wate Water Treatment Facility	324.1	1,953,600	$254,684		$0	8,956	$12,212	-	$0	$266,896
Dover City Hall	68.8	364,200	$81,602		$0	19,452	$26,495	-	$0	$108,098
Public Works	90.0	351,400	$49,227	19,377	$29,456	-	$0	-	$0	$78,683
McConnell Center	46.4	207,040	$28,247	-	$0	-	$0	-	$0	$28,247
Dover Public Library	37.7	133,440	$19,031	8,562	$10,068	-	$0	-	$0	$29,099
Jenny Thompson Pool	13.9	73,740	$9,656	8,489	$9,714	-	$0	-	$0	$19,370
Central Fire Station	15.5	81,250	$10,943	3,811	$6,127	-	$0	-	$0	$17,070
South End Fire Station	13.3	69,653	$9,529		$0	-	$0	6,336	$8,226	$17,756
Pine Hill Chapel	-	10,510	$1,832		$0	1,397	$1,905	-	$0	$3,737
Pine Hill Barn	-	8,309	$1,465		$0	1,785	$2,434	-	$0	$3,899
Veterans Hall	-	*	*	668	$1,333	-	$0	-	$0	$1,333
Dover Train Station	21.7	107,840	$14,640	389	$865	-	$0	-	$0	$15,505
Total	**972.0**	**5,041,022**	**$705,558**	**281,816**	**$310,985**	**31,590**	**$43,047**	**6,336**	**$8,226**	**$1,067,817**

* **Data not available**

Site Map

Since the buildings are not co-located a site map is not available for the buildings audited as part of this project.

Summary of Buildings

Consolidated Building Data							
Buildings Audited	Conditioned Square Footage	Occupancy Schedule	Building Use	Original Construction Date	Type of Heating System	Type of Cooling System	Metering Data
Indoor Pool	10,279	M-F 15.5 Hrs/Day Sat 16 Hrs Sun 14 Hrs	Pool	1968	HW Boiler	AHU	
Dover Ice Arena	126,084	16 Hrs/Day	Arena	1974/2001	AHU	AHU/Chiller	
Waste Water Treatment Facility		16 Hrs/Day		1991	HW Boiler	AHU	
Dover City Hall	44,844	13 Hrs/Day	Offices	1935	HW Boiler	Mixed	
Public Works	54,800	10 Hrs/Day	Offices/Vehicle Storage	2001	AHU/Boiler	AHU	
McConnell Center	103,000	17 Hrs/Day	Office	1904	Heat Pump	Heat Pump	
Dover Public Library	20,000	10 Hrs/Day	Library	1905/1988	HW Boiler	AHU	
Jenny Thompson Pool		12 Hrs/Day	Pool	1977	HW Boiler	None	
Central Fire Station	7,000	24/7	Public Svc	1899	HW Boiler	Split/Window AC	
South End Fire Station	8,000	24/7	Public Svc	1967	HW Boiler	Split/Window AC	
Pine Hill Chapel	1,500	8 Hrs/Day	Office	1911	Furnace	Split AC	
Pine Hill Barn	1,500	24/7 *	Office	1900	Furnace	None	
Veterans Hall	2,952	500 Hrs/Yr	Assembly	1920		None	
Dover Train Station	4,791	8 Hrs/Day	Public Svc	2001	AHU	AHU	

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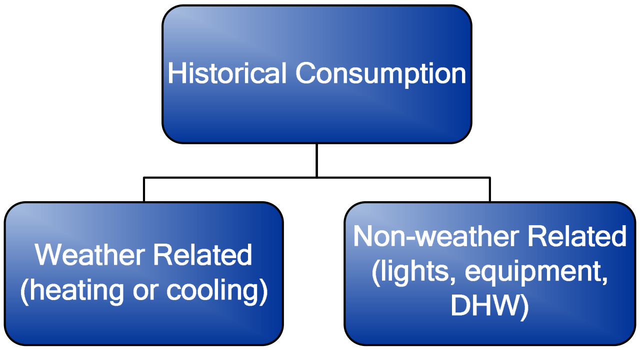
SECTION 3 - Utility Information

This section presents the utility rates that were used to determine existing and post-retrofit estimated utility costs. These utility rates will also be used to determine actual energy savings following installation of the measures in accordance with the measurement and verification methods described for each measure.

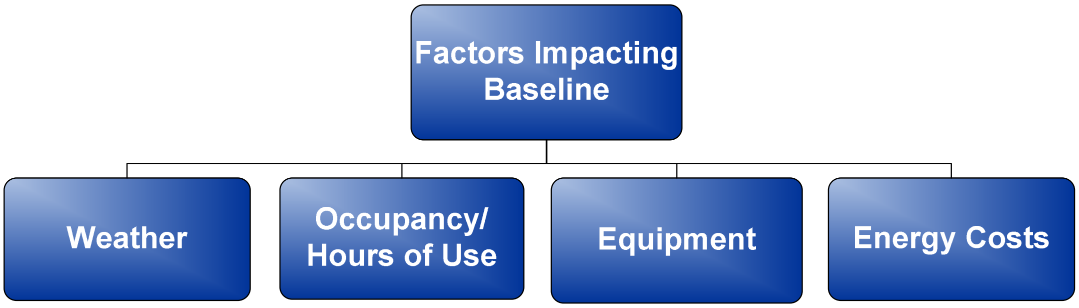
Two key elements comprise baseline data – weather-related usage and non-weather-related usage.



Baseline energy usage is compiled using historical utility data regarding the prior energy usage and conditions that affect that usage, such as weather, occupancy patterns, and building use and equipment.

As conditions, equipment, and usage change, the baseline may need to be adjusted periodically to account for those variables. The guaranteed energy cost savings are based on a reduction in energy units consumed from the current baseline, under the existing conditions. Changes in price or the existing conditions can result in either reductions or increases on the baseline energy use.

The projected energy savings are cost avoidance savings, and should not be viewed as an absolute reduction in the operating costs. The potential adjustments to the baseline are illustrated below.



The baseline has been structured in the following manner:

Financial baseline	The actual energy usage for the most recent complete fiscal year will be assumed to be the minimum budget and all savings are calculated from those figures.
Weather baseline	The weather data corresponding to the same fiscal year shall be the minimum heating degree days and cooling degree days.
Consumption baseline	The energy consumption during the same fiscal year shall be the figures from which savings are calculated.
Occupancy baseline	The occupancy schedules (run hours, ventilation rates, personnel levels, existing equipment, etc.) shall be the minimum values for projecting savings.

As such, Johnson Controls takes a snapshot of the facility as it operated during the most recent fiscal year. Because the City had a budget that met these conditions, this budget is the Baseline Budget or Financial Baseline to be used.

If, during the period of the energy performance contract, the weather is more severe than during this “study” period, the savings will actually be more than anticipated, but the City will need to budget funds for severity, as the increases in efficiency may not totally offset the severity index.

If the weather is less severe, resulting in an overall reduction in consumption, the savings will be adjusted to determine the level of savings that would have been achieved under normal weather conditions. The overall energy expense to the City in this scenario should actually be less than projections for an average winter.

In non-weather sensitive cases, such as lighting, savings will be based on the current occupancy hours and rate, even if the actual hours of operation change.

This approach allows the flexibility to operate the facilities as the City sees fit without jeopardizing the guarantee.

Rate Summary Table

The following charts and graphs identify the Base Year electrical and gas usage for the City of Dover. This utility data will be the basis from which Johnson Controls shall arrive at the baseline to determine the guaranteed savings.

City of Dover, New Hampshire
Utility Rate Summary (Based on FY 2008)

Rate Summary Table							
	Electricity		Natural Gas	Oil	Propane	Water**	Sewer**
Building	$/kW	$/kWh	$/Therm	$/Therm	$/Therm	$/HCF	$/HCF
Indoor Pool	$8.82	$0.104	$1.437	-	-	$3.75	$4.51
Dover Ice Arena	$7.09	$0.105	$1.264	-	-		
Waste Water Treatment Facility	$7.03	$0.119	-	$1.667	-		
Dover City Hall	-	$0.125	-	$1.667	-		
Public Works	-	$0.128	$1.128	-	-		
McConnell Center	$7.10	$0.107	$1.412	-	-		
Dover Public Library	-	$0.135	$1.414	-	-		
Jenny Thompson Pool	-	$0.126	$1.349	-	-		
Central Fire Station	-	$0.125	$1.528	-	-		
South End Fire Station	-	$0.128	-	-	$1.768		
Pine Hill Chapel	-	$0.169	-	$1.667	-		
Pine Hill Barn	-	$0.200	-	$1.667	-		
Veterans Hall[1]	-	$1.650	$1.803	-	-		
Dover Train Station	-	$0.122	$1.913	-	-		

***unblended cost if demand charges are available, if not blended cost**

[1] Since veterans Hall does not consume the minimum amount of electricity they are charged a fixed monthly amount which is reflected in the $/kWh price of electricity.

** Since water/sewer consumption data was not available for all the buildings, current rates were used for all the calculations.

Rebate and/or Subsidy Opportunities

Rebates are available through the local utilities for the retrofits proposed herein.

Estimated PSNH Incentives

Lighting

Estimated Utility Incentive (Estimated by ESCO)

Building	Fixtures	Controls
Indoor Pool	$1,360	$25
Ice Arena	$5,050	$1,325
City Hall	$1,735	$1,140
Public Works	$8,790	$2,720
Public Library	$3,060	$1,335
Totals	**$19,995**	**$6,545**

Total Estimated Lighting Incentive:	**$26,540**

VFD Installation

Motor Application / Name	Motor Size hp	Est. Incentive
Ice Arena – Floor Pump	25	$2,050
Ice Arena – Brine Pump	50	$3,100
Pool – New AHU	10	$1,350
Totals		**$6,500**

Incentive Summary

FIM	Incentive	% Expected	Total
Lighting	$26,540	100%	$26,540
VFD Installation	$6,500	100%	$6,500
Total	**$33,040**		**$33,040**

Custom Incentive
Dependent upon Energy (kWh &kW) and Cost Savings, Payback and Project Cost
Utility Representative decides amount, could be up to 35% of installed cost

Estimated Installed Cost: $900,000

Installed cost of equipment directly related to electrical savings

CUSTOM INCENTIVE	Incentive	% Expected	Total
Potential Custom Incentive:	$54,810	50%	**$27,405**

Custom incentives are estimated using utility guidelines; all measures must be submitted and pre-approved by utility before any rebates are granted. Above amount is estimated.

Estimated Grant Funds
Federal and State Energy grant funds are available via EPA, NHDES and NHPUC. RGGI programs to provide incentive and offset project cost for energy efficiency measures.

ESTIMATED GRANT FUNDS	Incentive	% Expected	Total
Federal and State Grants	$165,000	100%	**$165,000**

Estimated Northern Utilities Incentives

Large Business Customers

Includes all municipal buildings
Annual Gas Usage exceeds 40,000 therms
Must be on a firm Commercial Rate

Northern Utilities will pay 50% of the qualified installed cost, up to a maximum of $50,000 per master meter

Areas evaluated

Boiler/Burner
Improvements
Heating system improvements
Water heating system improvements
Gas-Fired process equipment
Control Improvements
Heat Recovery
Potential
Ceiling / Wall
Insulation
Gas Fired Steam Absorption Chillers

Estimated Installed Cost: $300,000

Installed equipment directly related to Natural Gas Savings

Northern Utilities (N.G.)		% Expected	Total
Potential Incentive:	$150,000	50%	**$75,000**

* *Customer gets the entire rebate.*

Developing the Baseline

In order to accurately assess performance of a FIM, it is necessary to be able to make comparisons of pre-retrofit and post-retrofit conditions of the facility under similar terms. The pre-retrofit baseline has been established by documenting conditions (in terms of unit energy consumption, energy efficiency, or other performance parameters) over a defined time period. The baseline will thus provide a yardstick for the pre-retrofit operation of the facility in terms of hours of use on a daily/monthly/yearly basis and the corresponding energy consumption performance for those hours of use. When possible, a baseline may be created from already-established energy consumption information as well. A facility may have historically recorded annual utility data by end use and utility type, which may be adequate to establish a baseline. Alternatively, a baseline may be established by using utility billing data for a utility type and knowledge of the various end uses, if the agreed-upon data are representative of pre-retrofit physical and operational conditions.

In order to develop a baseline for a facility, we must gain an understanding of the various utility types (electricity, natural gas, oil, central steam, etc.) used at the facility; whether the various utilities are metered on more than one utility (billing) meter per utility type; and whether the facility in question is a single- or a multi-building facility. Typically, a baseline is established for each utility type. For example, in an existing facility that has a constant volume HVAC system and is being considered for an energy saving retrofit, if the HVAC system is heated and cooled by electricity, then a single baseline is used to define its pre-retrofit operation and performance. If the HVAC system uses electric cooling and gas heating, then two baselines are required to define its pre-retrofit operation and performance: one for its electricity use and one for its gas use. If the project being considered addresses building(s) with multiple electric meters, multiple baselines would be necessary. An "all electricity use" facility with one utility meter and multiple buildings requires multiple baselines to identify the individual energy use pattern of each building. When we establish the baselines, the given conditions of a particular project may be simulated to lessen the complexity of baseline determination.

A baseline is the set of agreed-upon operating conditions, including hours, load(s), and other related values. The performance measurement is the measured value(s) of the (post-retrofit) operating condition(s) affected by the retrofit implementation. Energy savings are the result of the agreed-upon energy savings calculation, which is based on the difference between the performance measurement(s) and its associated baseline value(s). Energy cost savings is determined by applying the appropriate unit cost to the calculated energy savings. Total Dollar Savings is the sum of the energy cost savings from each retrofit and any other savings as identified herein.

The schematic sequence of calculations, for each day of each month, is as follows:

1. Sensible hourly loads for all zones are calculated component by component:
    (a) envelope loads are calculated using the Transfer Function Method
    (b) the radiant portion of instantaneous heat gains from lighting, equipment, process, and occupant loads are converted to hourly cooling loads using Room Transfer Function

(c) the convective portion of sensible instantaneous heat gains are calculated from instantaneous hourly values
(d) the sensible loads from air infiltration are calculated from daily average values
(e) duct losses are computed from duct specifications and hot and cold supply temperatures and ambient temperatures.

2. Latent hourly loads for all zones are obtained directly from (a) the latent portion of convective heat gains from equipment, occupants, indoor swimming pools, and process, and from (b) the latent load from air infiltration calculated on a daily average basis only; and from (c) latent duct losses computed from duct leakage and supply and ambient humidity ratios.
3. Where indoor temperature is not held constant, actual hourly Heat Extraction Rates are calculated from the sensible cooling loads in each zone, taking into account room air circulation and thermal mass of each zone. If indoor temperature is held constant, Heat Extraction Rates and Cooling Loads are assumed identical.
4. Hourly energy use for water heating is calculated by taking into account the actual usage schedules and storage effects during times of high demand. The energy requirements to meet water-heating loads can be modeled either through stand-alone water heaters or as part of a boiler plant that also meets space-heating loads.
5. System supply air requirements and cooling coil and heating coil loads are modeled next, as a function of occupancy ventilation needs; ventilation controls; hot and cold supply air controls, and thermostat or humidistat controls.
6. Heating and cooling energy to meet heating and cooling coil loads are simulated by using performance models of boilers, furnaces, chillers, DX-air equipment, air-air heat pumps and water-air heat pumps. Sensible and latent full-load capacities (total capacity only for heating equipment) are dependent on temperature and humidity ratio of ambient air and of the supply air stream at the coil. Wherever possible, manufacturer's data are used to characterize the capacity dependence on the applicable temperature and humidity conditions. Part-load performance of heating and cooling equipment is modeled using polynomial fits to part-load ratio. Wherever practical, functional forms and coefficient values are taken from DOE-2.1.
7. All energy requirements by auxiliary equipment (lighting, equipment, process, swimming pools) are separately calculated on an hourly basis and tabulated by fuel type.
8. After all hourly energy requirements are calculated, monthly consumption totals and demand are calculated and, if required, by the energy rates specified, broken down into appropriate time-of-use periods using the hourly profiles.
9. Energy rate calculations are performed on monthly data of consumption and demand (broken down by TOU for rates that so require). Virtually all types of commercial and industrial rates encountered in the U.S. and Canada can be modeled by Market Manager through a hierarchical rate classification scheme.
10. Measure calculations are done, if measures were used to specify scenarios, to separate the individual contribution of each measure to the overall savings of the measure package that contains the measure.

Adjustments to the Baseline

The following is a summary of how a baseline can be developed using utility data and regression analysis techniques. In all cases, modifications will be documented and mutually agreed upon with the customer.

Select a Tuning Period. First, Johnson Controls will identify a pre-retrofit time period that is representative of physical and operational conditions within the premises.

Identify Relationships of Consumption to Independent Variables. We will then apply a regression analysis calculation to each individual utility item during the selected tuning period against one or more independent variables. The resultant relationship of utility consumption as a function of time, weather, and other independent variable is represented by the regression analysis calculation.

Make Modifications to the Baseline. A modification will be made up of a number of units to be applied, a time period to apply the units, and a description of why the modification is being applied.

Use Annual Periodic Modifications. Johnson Controls uses annual periodic modifications to adjust the baseline consumption for anomalies that may have occurred during the tuning period due to operational procedures or abnormal conditions. Such "out-of-line" consumption periods may cause the regression equation to over- or under-predict consumption. Modifications help to fit the equation's predicted value to the actual value that occurred during the tuning period. We can then predict future consumption with a high degree of confidence once the predicted and actual tuning period consumption is matched properly.

Make Additional Modifications. Johnson Controls may also make modifications to the baseline to account for physical or operational changes within the premises that are beyond the scope of the approved conditions.

Calculate Utility Consumption Savings. Johnson Controls calculates an adjusted baseline by performing the regression analysis and applying to it any necessary modifications for each time period being evaluated. This adjusted baseline represents the utility consumption that would have occurred if the retrofits had not been implemented. Utility consumption savings are derived from the difference between the adjusted baseline consumption and the actual post-retrofit consumption for the same period.

Calculate Utility Cost Savings. Utility cost savings will be determined by applying the appropriate utility unit costs to the consumption units. Total dollar savings is calculated from the sum of the utility cost savings from each utility type and any other savings as identified.

Miscellaneous Adjustments. Johnson Controls understands that during the life of the contract, changes may occur in the use, operation and/or maintenance of facilities, systems and equipment, in ways that impact the baseline or affect the calculation of savings. We also understand that utility rates and billing methods may be modified by utilities during the course of the contract. In such cases, Johnson Controls will work with the customer to achieve mutually agreeable adjustments, refunds, and rebates.

Individual Facility Improvement Measures (FIM) Evaluation

A baseline will be developed for each building utilizing the data collected. This baseline must be within 2 percent of the actual utility data. This establishes the “as built” energy performance of the building. Modifications are implemented, one FIM at a time, with a resultant new energy profile. The model calculates the difference in usage should that FIM be implemented. In addition, the cost to install that FIM is determined using industry-standard estimating methods.

At this level, each FIM will be considered independently, as if only that FIM were implemented. This will provide a fair evaluation of the economic impact of each FIM. Cost savings will be calculated using the unit costs provided by the customer. The following factors will determine whether or not to include a particular FIM in the final model:

- Energy cost impact and simple payback
- Useful life
- Effect on building maintenance and operation cost
- Implementation time
- The customer’s priority list of improvements
- Positive effects on tenant comfort and system reliability

When selecting FIMs, evaluating each FIM independently does not reveal the bottom line energy savings that will occur if more than one FIM is implemented. Interaction between FIMs that will ultimately increase savings associated with each FIM. A final evaluation is performed, which includes all FIMs actually implemented so interactive energy savings can be calculated.

The interactions between FIMs can affect the actual energy savings, implementation costs and payback periods. For example, if a lighting retrofit and cooling system improvements are implemented in the same area, the lighting retrofit will reduce heat loads in the area and, therefore, increases the cooling savings. Our analysis will allow for the “cascading” of FIMs, namely recalculating the savings from the previous FIM results.

The final step in the detailed study is the preparation of a comprehensive report. All FIMs evaluated will be presented to the customer for consideration. The choosing of the project FIMs will be a joint effort between Johnson Controls and the customer. Different scenarios can be prepared to determine the most desirable and cost-effective solution. The final project installation will include those FIMs selected.

Factors that Necessitate Adjustment to the Baseline

During the initial energy baseline creation and during the ongoing performance management of the project, it may become necessary to adjust the energy baseline for factors or unique changes in the building's use, utility or for non-controllable variables. Common adjustments are for items such as:

- Additions or deletions of conditioned square footage.
- Major increases or decreases in building occupancy.
- Major changes in the weather.
- Major additions or deletions to the non-temperature sensitive loads in the facility such as computers, copiers, printers, etc.
- Changes resulting from the addition or replacement of equipment with more energy efficient equipment.
- Changes in production variables.
- Major changes in building operations outside of the energy baseline parameters.

Approach Johnson Controls' approach to energy baseline adjustments is to ONLY apply adjustments where it is both fair and equitable for both Johnson Controls and our customer. Our approach is not to claim savings for consumption or demand reduction that did not result from Johnson Controls or the energy conservation measures. Nor do we believe that we should be financially harmed by changes outside of our control that negatively impact the savings generated. Furthermore, our assured performance guarantee is designed for modifications versus cancellation. Rest assured that our assured performance guarantee will never be canceled due to changes but rather modified to reflect the adjustments to which our customers and Johnson Controls agree.

Methodology Johnson Controls' methodology to adjust our energy baseline for one or all of the above variables is accomplished as follows:

- Calculate the Impact: Johnson Controls models the change(s) to calculate the impact on the energy baseline.
- If a Utility Bill Comparison Savings Calculation Method was utilized on the project, then Johnson Controls takes advantage of the advanced features of the Metrix software to simulate the energy baseline change as a result of the interplay of the occupancy +/-, weather +/- and usage +/- changes.
- If a Measure Specific Comparison Savings Method was utilized on the project, then Johnson Controls computes the energy baseline calculation utilizing the changed variables and compares this with the actual measured calculation to determine the impact of the change(s).
- If a Stipulated Performance Measure was utilized, no change to the energy baseline is computed, as stipulated energy savings are agreed, upon contract signing, to have been considered achieved.

Customer Approval Once Johnson Controls has computed the impact of all adjustments to the energy baseline, this information is then provided to and reviewed with our customers. Our customers then either accept or reject our proposed adjustments. If our customer accepts the proposed adjustments, the energy baseline is adjusted accordingly and savings are computed and reported based upon the adjusted baseline. If our customer rejects the proposed adjustments, then Johnson Controls and our customer agree to a proposed course of action to resolve the adjustment issue. This might include utilizing an expert disinterested third party, agreeable to both Johnson Controls and our customer, to provide binding direction for adjustments. Upon such direction, Johnson Controls then computes the energy baseline utilizing the agreed upon adjustments and report savings accordingly.

SECTION 4 - Savings Opportunities Summary

On the following pages, we have described several Facility Improvement Measures ("FIM") deemed as viable energy conservation opportunities for the City of Dover. The recommended FIMs were selected from a long list of possible improvements, and were based on gaining the greatest benefit for the money spent. Please refer Page 87 for Facility Improvement Measures (FIMs) that were studied in detail and based on payback were not included in the final scope. Based on the information gathered during the Detailed Energy Audit and Johnson Controls' extensive experience with local government buildings throughout New England, the measures identified represent a significant reduction to base year utility expenditures for the City. We estimate that the successful implementation of these measures will result in a 23% reduction of the base year utility spend.

Listed below are assumptions that are common to all FIMs:

- Savings for all measures are interacted with each other. The proposed conditions from one measure may be the existing condition for another. In general, boiler replacement savings are considered and calculated first, then, other equipment modification and load reduction savings are taken next, with boiler savings as MMBtu.
- All savings are calculated using the present electricity rates in effect at each of the facilities.
- Unit operating conditions (air flow, kW, temperatures) were determined with field measurements whenever possible, and for a portion of the population. In some cases, particularly with air flows, if direct measurements were not possible either with hand-held anemometers or through the energy management system, baseline values were taken from original design drawing schedules. If those were not available, the filter bank size was observed and air flow was estimated based on a typical, 500 fpm design value.
- The retrofits will occur in the existing facility areas only. Any future building additions or renovations are not included at this point.
- All new systems will be designed and constructed according to applicable codes and standards.
- Asbestos abatement costs are not included in the project estimates. Any asbestos removal work that is required will become the responsibility of the City.
- Cost estimates are based on contractor quotes for the work concepts outlined herein. Cost estimates include an allowance for working within the City Buildings and the inherent difficulties associated with occupied buildings, plus disposal of removed equipment. No sales taxes are included. Detailed estimates include everything necessary for a complete, working installation, plus system check-out and start-up.
- Project costs are estimated based on standard, facility working conditions and normal, daytime work hours, with an allowance for some second and third shift work that may be required for work that occurs within spaces (or above the ceilings of spaces) that are normally occupied during the day.
- Prevailing wages are assumed.

FIM 1 & 2 Lighting – Fixture Retrofit & Controls

Detailed Description of Facility Improvement Measure

Johnson Controls has performed a survey of the interior lighting system at several City of Dover buildings and has found opportunities to capture energy savings, improve lighting quality and reduce maintenance costs.

As a result of the survey and analysis, Johnson Controls has developed a high efficiency lighting upgrade project that will provide the City of Dover with a retrofit of over 2,250 existing lighting fixtures resulting in an annual savings of 239,036 kWh and a reduction in electrical demand of 85 kW. For a detailed reference, a room-by-room lighting survey is included in the Appendix.

Existing Conditions

Lighting – Fixture Retrofit

The existing lighting system data utilized for this project was collected during site visits conducted by Johnson Controls in October, 2008. The hours of operation have been determined from schedules provided and/or verified by the City of Dover at the time of audit. The lighting demand (kW) per fixture, fixture quantities and recommended Facility Improvement Measures as listed, are based on the physical inspection of, and subsequent analysis by Johnson Controls.

In identifying the lighting improvement measure opportunities Johnson Controls has attempted to establish an accurate accounting of the various fixture styles, lamp and ballast types being used in the facility; the operating characteristics and various illumination requirements of the lighting system; long term energy and maintenance savings opportunities within the operating constraints of the existing system and immediate energy savings opportunities based on the impact of the Energy Policy Act of 1992 (EPACT).

The results of Johnson Controls' technical analysis indicate that the majority of energy savings opportunities result from conversion of existing T8 fixtures to more efficient lamps and ballasts. During the survey, opportunities were identified for the installation of occupancy sensors

Lighting – Fixture Controls

In the City of Dover's buildings, lighting loads in the offices, corridors, mechanical rooms, administrative offices, stairwells and other areas are currently controlled utilizing standard one way or two-way wall switches. Opportunity exists to improve the overall operation of the facilities lighting systems through the installation of occupancy sensors.

Proposed Conditions

Lighting – Fixture Retrofit

Johnson Controls, Inc. proposes to retrofit the lighting systems with new high efficiency fixtures. The proposed lighting retrofits have been identified and are included with this Detailed Energy Audit as an Appendix. In general, JC will retrofit all fixtures that are candidates for retrofit/replacement with new fixtures or new lamps and ballast combinations.

The proposed lighting system shall:

1. Provide the most energy efficient lighting available on a retrofit or replacement basis, using state-of-the-art components and technology.
2. Exceed all Federal Energy Policy Act of 1992 (EPACT) lamp and luminaire efficiency standards.
3. Provide maintained light levels, which meet or exceed current Illuminating Engineering Society (IES) recommendations, while addressing particular illumination requirements for specific area and task functions.
4. Provide a quality of light conducive to a productive, safe and aesthetically pleasing environment. Specifically, issues of color rendition and uniformity of illumination shall be addressed.
5. Provide a reduction in future maintenance requirements through the standardization, extended life cycle and reduction in quantity of system components.

Lighting – Fixture Controls

In order to implement appropriate fluorescent lighting control throughout the included buildings, Johnson Controls recommends the installation of the following occupancy sensor:

Type W- This is a dual technology sensor utilizing ultrasonic and passive infrared wall or ceiling switch sensor to be installed in small offices and various use areas. It will control 2-16 lighting fixtures, with loads ranging from 62 watts to 1000 watts.

In addition to the energy savings derived from the reduced operating hours, we assume that these occupancy sensors will reduce the fluorescent lighting kW demand. This presumes that there is a coincident factor of 20-30 percent of the controlled lights off at any time during on-peak hours. This is based on extensive practical experience in similar lighting control installations. Johnson Controls has not taken any credit for this demand reduction.

Savings Estimate

Savings Calculations

Savings calculations for lighting retrofits are generally calculated using the following methodology:

Baseline Energy Usage (kWh/yr)	=	Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts
Estimated Energy Usage (kWh/yr)	=	Proposed Fixture Watts x Op. Hours/yr x 1 kW/1000 Watts
Energy Savings (kWh/yr)	=	Baseline Energy Usage – Estimated Energy Usage

The following savings calculations represent the energy savings from the implementation of lighting controls on fixtures identified in the lighting tables in the Appendix. For lighting controls, the baseline fixture watts for determining savings have been based on the post-retrofit fixture wattage.

Baseline Energy Usage (kWh/yr)	=	Controlled Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts
Estimated Energy Usage (kWh/yr)	=	Controlled Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts x % hours “off”
Energy Savings (kWh/yr)	=	Baseline Energy Usage – Estimated Energy Usage

Table 1-1: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	-
Water and Sewer ($/yr)	-
Electricity (kWh/yr)	239,036
Electricity (kW)	85.0
Electricity ($/yr)	$30,369
Thermal Energy (MMBtu/yr)	(-1,539)
Thermal Energy ($/yr)	($1,990)
Total Savings ($/yr)	$28,379

Assumptions

The following specific assumptions were made:

- See calculations in Appendix 3 and line-by-line in Appendix 5

Operating Hours

In order to calculate the energy savings illustrated above, Johnson Controls relied on the kilowatt reduction achieved through its design and the facility's representation of the operating hours within the facility. Based on information gathered during interviews with the facility staff, an operating profile was determined to represent the majority of the lighting within the space considered for different areas as follows: (The following list provides a sample of operating hours used to determine energy savings. For area specific operating hours please refer to the room-by-room survey located in the Appendix hereto.)

Table 1-2

Representative Location(s)	Hours of Operation	
	Weekly	Annual
Admin, Offices	43	2,250
Conference	30	1,600
File Storage	19	1,000
General Storage	9.6	500
Offices – Other	30	1,600

Scope of Work

A detailed listing of the fixtures proposed and room-by-room retrofits is included in the Appendix 5.

The lighting retrofit proposed for the City of Dover includes:

- Retrofit existing T8 fixtures with Super T8 electronic fixtures; provide tandem wiring double fixtures and reflectors according to the room-by-room table in the Appendix. A summary of each proposed retrofit is given in the Appendix.

  As a standard for installing T8 lamps, Johnson Controls will provide a high-grade "super saver" lamp that carries a higher color rendering index (CRI of 75 or greater) and higher lumen output per watt than the current T12 lamp type in use. Johnson Controls has specified a 4' F32 (28watt) 4,100K lamp that will pass the Federal guidelines relating to hazardous waste, specifically minimal mercury content, as the standard. It is due in part to the higher lumen per watt rating and the use of new lamps and ballasts that the light output from newly retrofitted fixtures will produce a higher foot-candle average than the existing system. In addition, due to the longer rated life and the ability of the T8 tri-phosphor lamp to maintain its lumen levels longer, there are ongoing maintenance savings attributable to the project.

- Installation of switch mounted, wall and ceiling mounted "dual technology" occupancy sensors as outlined in the Appendix
- Retrofit of incandescent fixtures with compact fluorescent lamps as outlined in the Appendix
- Retrofit of mercury vapor fixtures with metal halide fixtures as outlined in the Appendix.
- Removal of fixtures and de-lamping as outlined in Appendix.
- Replace metal halide fixtures with new pulse start fixtures as outlined in Appendix.

Exclusions

- None noted

Hazardous Waste Disposal

All necessary and appropriate barrels and containers for proper packaging of all PCB-containing ballasts and mercury-containing lamps removed are included as part of this project. Johnson Controls and its subcontractors will assume no liability in the generation, ownership or responsibility for hazardous waste material, except to assist in the coordination of the packaging of material removed. As part of this program, Johnson Controls has included the cost for handling, recycling and disposal of ballast and lamp waste.

FIM 3 Building Envelope Improvements

Detailed Description of Facility Improvement Measure

Existing Conditions

Heat is lost from various locations throughout the buildings in the City due to infiltration. The heat losses and heat gains occur due to gaps and openings that allow the building's conditioned (heated or cooled) air to mix with the outside ambient air.

Throughout the buildings, many leaks were found that would allow heat to be lost during the winter and gained during the summer. These openings range from gaps around doors, exhaust pipes, rooftop ventilators and windows. Also, unsealed roof-wall joints and rooftop ventilator dampers stuck in the open position contribute to leakage in some buildings. Outside wind conditions also provide increased pressure gradients across the leakage surfaces, which allow for correspondingly increased leakage rates. Temperature gradients also create the "source to sink" flow, therefore, the greater the difference between the outside air and the indoor air temperature, the greater the rate of infiltration.

Proposed Conditions

Johnson Controls Inc. proposes that doors be weatherproofed, sweeps installed/ replaced and caulking be applied around structural leakage. During the door weatherproofing process, the hinges may need to be replaced to ensure proper mechanical functioning. Windows will be re-caulked around the rough-in perimeter, and locations along the soffit and fascia will be sealed. Roof penetrations, wall joints and any other envelope penetrations will be properly sealed.

Savings Estimate

The size of the cracks/openings is estimated based on visual inspection. The area of the opening is calculated based on the information obtained during the inspection process. The volume of air moving through the openings is then calculated using an ASHRAE developed equation. Local weather data including average temperature difference and wind speed are also used to calculate the air volume in CFM. The energy required to condition this volume is then calculated using the following equation.

Table 3-1: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	-
Water and Sewer ($/yr)	-
Electricity (kWh/yr)	4,486
Electricity (kW)	-
Electricity ($/yr)	$488
Thermal Energy (MMBtu/yr)	1,019
Thermal Energy ($/yr)	$13,973
Total Savings ($/yr)	$14,461

Assumptions

For assumptions please see detailed calculations in Appendix 3.

Scope of Work

The scope of work for this measure will include the following services. (The locations and length/area are shown separately.)

Door weather-stripping

Carrier Installation

- Carrier cut to length of jam
- Compression seal cut to length of carrier
- Snap compression seal into carrier
- Attach carrier to jamb
- Measure header length
- Cut carrier to length
- Assemble and install
- Caulk perimeter

Sweep Installation

- Measure door bottom
- Cut sweep to length
- Install sweep

- Caulk sweep

Adjust and check each operating unit of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

Roof Wall Joint Sealing

- Lift T-Bar drop ceiling tile from wall, and place aside
- Apply to roof/wall joint in as even a bead as possible.
- Replace T bar ceiling tile and clean area below ceiling of any dust or dirt.

Roof Top Ventilators

- Remove screws holding unit down.
- Tilt unit to gain access to damper.
- Damper blades to be lubricated and inspected for function.
- Adjust blades where necessary.
- Seal perimeter of damper with appropriate material depending on gap size.
- Replace screws where necessary with at least #10 x 2".

Locations and Quantity/Length

Indoor Pool

- Two (2) Single Commercial Doors to be weather-stripped
- One (1) Double Commercial Door to be weather-stripped
- Two (2) Overhead Doors to be weather-stripped

Dover Ice Arena

- Ten (10) Single Commercial Doors to be weather-stripped (exterior)
- Five (5) Double Commercial Doors to be weather-stripped (exterior)
- Seventeen (17) Single Commercial Doors to be weather-stripped (interior)
- Ten (10) Double Commercial Doors to be weather-stripped (interior)
- 192' Roof Level change to be sealed
- 3,120 Square feet of 4" Foam to be installed on underside of 2 x 6 Roof Deck and Interior 2 x 4 Wall of Attic Space (attic space above locker room addition)
- 120' Soffit to be sealed (attic space above locker room addition) *will be sealed when insulating roof deck
  * Fiberglass must be removed from attic space before installation of foam can commence.

Waste Water Treatment

- Five (5) Single Commercial Doors to be weather-stripped
- Three (3) Double Commercial Doors to be weather-stripped
- Three (3) Overhead Doors to be weather-stripped

Dover City Hall

- One (1) Single Commercial Door to be weather-stripped
- Five (5) Double Commercial Doors to be weather-stripped

Dover Public Works Facility

- Fourteen (14) Single Commercial Doors to be weather-stripped (exterior)
- One (1) Double Commercial Door to be weather-stripped (exterior)
- Four (4) Single Commercial Doors to be weather-stripped (interior)
- One (1) Double Commercial Door to be weather-stripped (interior)
- Twelve (12) Overhead Doors to be weather-stripped

McConnell Center

- Six (6) Single Commercial Doors to be weather-stripped
- Six (6) Double Commercial Doors to be weather-stripped
- Twelve (12) Roof Top Ventilators to be opened, perimeter sealed, dampers lubricated, 68 linear feet

Dover Public Library

- Four (4) Single Commercial Doors to be weather-stripped
- Three (3) Roof Top Ventilators to be opened, perimeter sealed, dampers lubricated, 16 linear feet

Central Fire Station

- Three (3) Single Commercial Doors to be weather-stripped
- Three (3) Overhead Doors to be weather-stripped

South Fire Station

- Three (3) Single Commercial Doors to be weather-stripped
- Three (3) Overhead Doors to be weather-stripped

Pine Hill Chapel

- One (1) Single Commercial Door to be weather-stripped
- Two (2) Double Commercial Doors to be weather-stripped
- Fourteen (14) Windows to be Caulked (inside)

Pine Hill Barn

- No improvements recommended

Veterans Hall

- Four (4) Single Commercial Doors to be weather-stripped

Dover Train Station

- No improvements recommended

FIM 4 Energy Management System - Upgrades

Detailed Description of Facility Improvement Measure

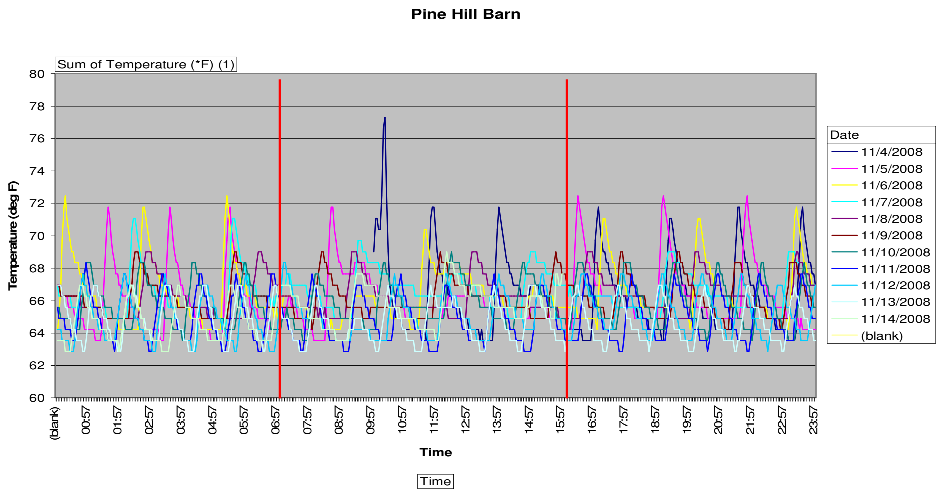
A total of six (of fourteen) City buildings are under the control of the building automation system; however there are some buildings with control systems that are operated manually. Although the operators are attentive to their duties, the installation of automated controls will ensure that the building is secured consistently in the unoccupied mode at night.

The objective of this measure is to retrofit non-functioning direct digital controls (DDC) and to install ductless split system to augment existing systems as further described herein, which will provide reliable occupancy and comfort control. Generally, overall occupied/unoccupied control will be overseen by the existing DDC system, but those controls in smaller spaces, such as offices will remain with pneumatic control if already equipped. Replacing complete controls on a room-by-room level is not cost-effective from an energy savings standpoint, but should be done whenever spaces are renovated. The benefits of replacing the controls and installing a ductless split system include improved occupant comfort, reducing maintenance staff time for trouble-shooting complaints, and significant energy savings.

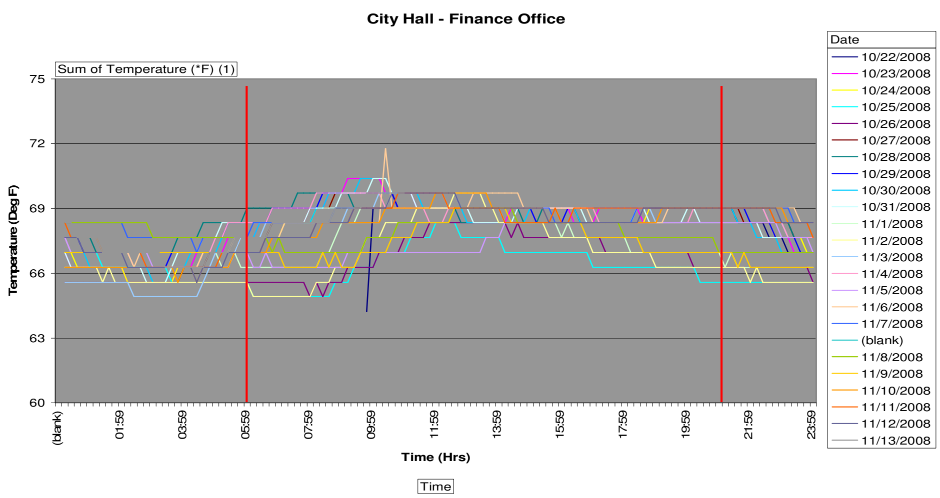
Existing Conditions

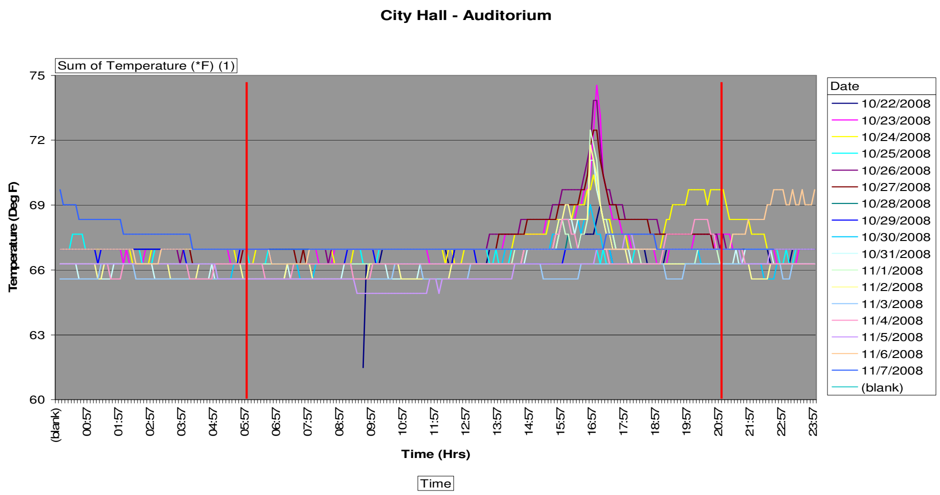
During the detailed audit, the buildings located in the City of Dover were evaluated for the purposes of identifying energy savings opportunities. Many of the buildings are presently under the control of the Siemens building automation system ("BAS"); however upon inspection many of the systems and equipment were not functioning as designed and thus wasting energy. The following provides a brief summary of the existing conditions identified during the detailed audit which were verified through facility staff surveys, physical inspection and/or data logging.

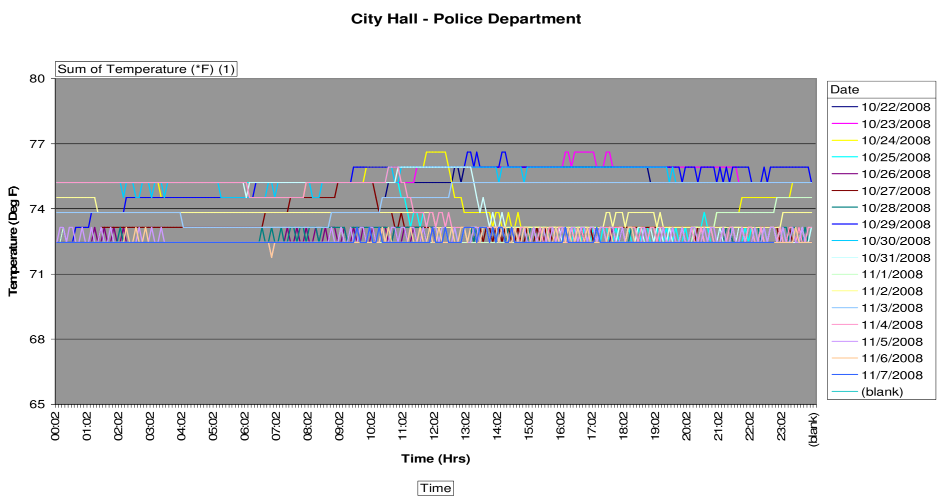
Pine Hill Barn – Audit shows that temperature is being maintained at 66-67°F, therefore opportunity to install additional temperature controls to enable night/unoccupied setback exists. The chart on the following page shows wide temperature swings across the logging period and also shows that the heating system is not being setback during unoccupied periods. Installation of new temperature controls would help alleviate this issue.



City Hall Controls – The Police Department is open 24/7 therefore opportunity to set back temperature in that space is limited. The building also has 1 AHU located in the Finance Office which is presently under the control of the Siemens system and is presently being setback from occupied temp of 70° to 65° during unoccupied hours. However, the occupancy schedule for this unit is less than optimal. The AHU is presently configured to cycle on at 3:00am and then turn off at 9:00pm. The chart below provides evidence that the AHU is being setback during unoccupied periods; however the control of the temperature setback is not optimal. Other areas, such as the auditorium, are not being set back; however temperature in the auditorium during the observation period did not drop below 65°F, which would indicate that the heating set point is not being adjusted based on occupancy schedules. Additionally, the building has 7 zones (steam radiation) in total that are under BAS control.

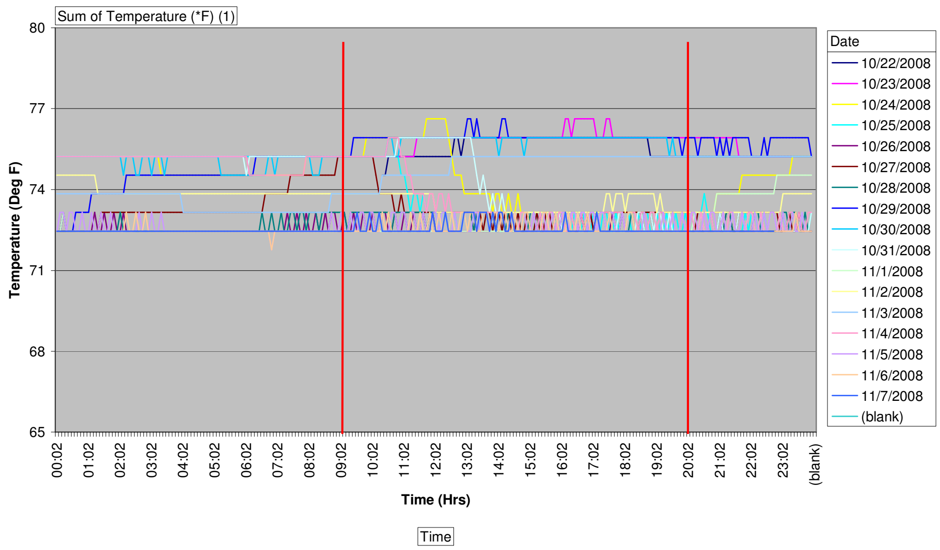






Public Library – The AHU which serves the new section at the public library is presently under the Siemens control system. According to the Siemens BAS, this AHU is being setback from 74°F to 65°F. During the audit data loggers were deployed within the new section of the library to determine the effectiveness of the setback program. The chart below provides data obtained for the new section of the library throughout the logging period. As evidenced below, the temperature is not being setback according to the programming in the BAS and therefore opportunity exists to control the space temperatures with the use of programmable thermostats. During the observation period, the boiler malfunctioned and was inoperable for a period of time. As such, we have relied on the data gathered during the initial day and observations of equipment. (Manual thermostat)

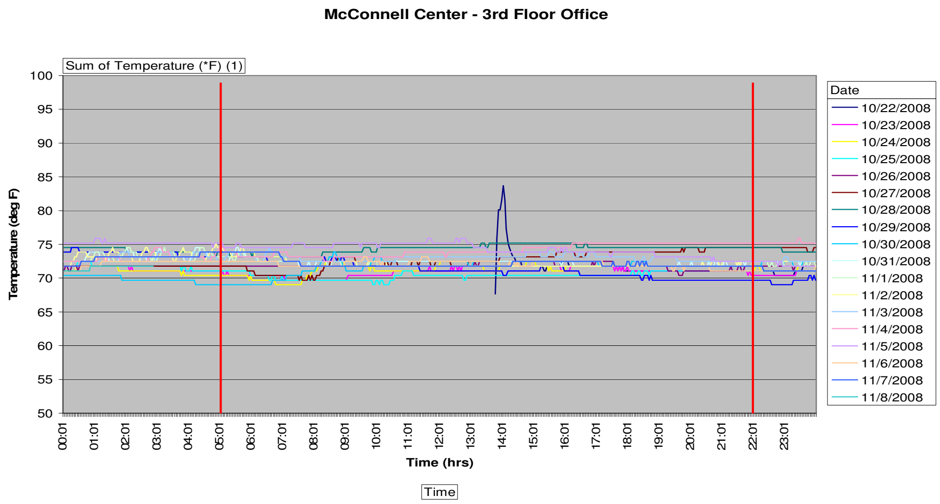
Public Library - 1st Floor (New section)



McConnell Center – The McConnell Center recently underwent a major renovation to enable more efficient space utilization and offer office spaces for several public programs. When renovated the heating and cooling systems within the building were upgraded to a water source heat pump system with a boiler and cooling tower to provide supplemental heat and heat rejection to the loop. Additionally, the building was configured with a large amount of fin-tube radiation to address heat losses around the perimeter of the building, specifically in areas with large amount of window spaces. During the audit it was observed that there are consistent temperature control issues within the McConnell Building that need to be addressed. A common compliant is that over heating within the spaces and simultaneous heating and cooling is occurring during the shoulder months.

This condition is caused primarily because the controls for the radiation and the heat pump systems are not configured with the right deadband settings. As a result, both systems are continually fighting each other to provide the right amount of cooling or heating depending on the spaces load and occupant requirements.

Additionally, data logging shows that the temperature in the spaces is not being set back during unoccupied periods (see chart below). Opportunity exists to improve the operation of the heating and cooling systems at the McConnell center through the implementation of proper deadband controls on the heat pumps and implementation of a night setback routine.



Pine Hill Chapel – The building has manual thermostats which are presently being turned down at the end of the day by the building occupants. Data logging shows that this is consistently being performed by the facility staff. (see chart below) Opportunity exists to install a programmable thermostat to ensure consistent implementation of the setback schedule. Presently, setback is occurring 80% of the time based on data logging.

South End Fire Station – This location is occupied 24/7 and has programmable thermostats with multiple zones to control the heating system. Therefore, opportunity for the installation of building controls is limited and not recommended. Additionally, during the detailed audit it was noted that when the fire trucks leave for a call the heating system remains operational and continues to provide heating when the overhead truck doors are opened, thus wasting heating energy. Opportunity exists to eliminate this condition by interlocking the heating system with the operation of the overhead doors.

Veterans Hall – Building is not under EMS controls, and occupancy for building is less than 500 hrs per yr. When building is not in use the heating systems are turned to the minimum set point.

Central Fire Station – This location is occupied 24/7 and has programmable thermostats with multiple zones to control the heating system. Therefore, opportunity for the installation of extensive building controls is limited and not recommended. Additionally, during the detailed audit it was noted that when the fire trucks leave for a call the heating system remains operational and continues to provide heating when the overhead truck doors are opened, thus wasting heating energy. Opportunity exists to eliminate this condition by interlocking the heating system with the operation of the overhead doors.

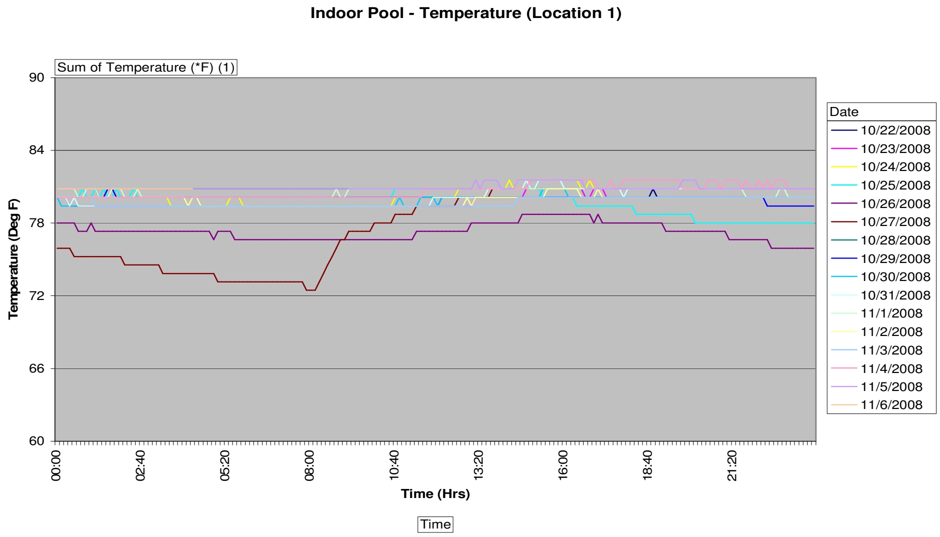
Jenny Thompson Pool – Building is not under EMS controls and does not have a heating system. There is no opportunity for implementation of control strategies.

Dover Indoor Pool – The Dover Indoor Pool is under control of the EMS system. At present the system maintains temperature and RH continuously without any setback in temperature. During the detailed audit, the temperature and RH were logged continuously for a period of 2 weeks to determine the actual operating conditions at the pool (see charts below). Based on this data logging it has become apparent that the EMS system is controlling the temperature well within the space, however there is presently no setback schedule enabled. Space temperature is maintained at 82-83°F and RH is enabled at 48-50%.

Air Handling System – Replacement/Temperature Setback

Conditioned air to the natatorium is supplied by a Dussault heating and ventilation unit with a heat recovery unit. This unit is original to the building and nearing the end of its useful life. Further, the manufacturer of this equipment is no longer in business and the availability of replacement parts is very limited. Based on information furnished by facility staff, this unit is in need of replacement. In its present configuration, the air handling unit does not provide adequate air changes per hour (ACH) as per building code. Current building code dictates that natatoriums operate with a minimum of 0.5 CFM of outside air per square foot of building area and a minimum of 5 ACH. Based on the present unit specifications and existing duct sizes it is estimated that the AHU is capable of meeting 4 ACH.

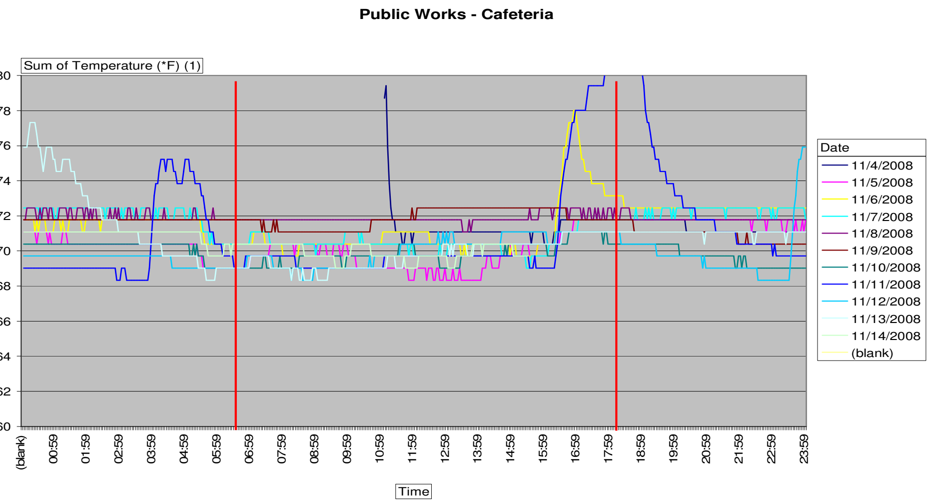
Opportunity exists to improve the operation of the air handling equipment and update old infrastructure. During periods of no occupancy, based on the temperature data it looks like the existing system is not controlling the air handling equipment to do setback (see chart below) and therefore it is recommended that the air handler be slowed down and the temperature of the space is setback.

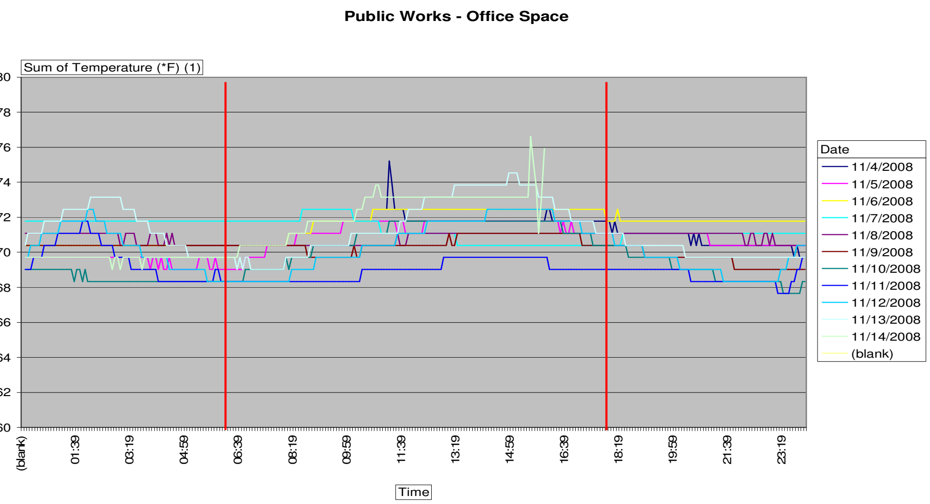


Pool Office – Eliminate Simultaneous Heating and Cooling

During the detailed audit all spaces within the pool building were evaluated for the purposes of identifying energy conservation opportunities. One area that presents opportunity is the pool office. At present, conditioned air (heated/cooled) is supplied via an air handler located in the closet mechanical room. In addition, fin-tube radiation is installed along the perimeter of the office to provide supplemental heating during the winter months. A thermostat located in the space provides temperature control for the AHU, however a separate thermostat provides temperature control for the fin-tube radiation. Based on JC walk-through, the fin-tube radiation is operational and provides supplemental heating when the air-conditioning is operational and providing cooling. Opportunity exists to eliminate this simultaneous heating and cooling by retrofitting the controls to enable proper operation of the system.

Dover Public Works – Building controls are installed at this location and based on field observations and data logging the existing system is not programmed properly to setback during unoccupied times. The EMS schedule for AHU-1 and AHU-2 is 5:00am to 4:00pm for occupied periods. Based on logging this setback is not taking place. The charts below provide data which further substantiates the fact that the air handling equipment is not being setback.





Ice Arena – A description of existing conditions for this location have been included within the Ice Arena FIM.

Dover Train Station – Presently, the mechanical systems located at the train station are not under the control of the Siemens BAS. Conditioned air is provided by an air handling unit located in the train station and according to facility staff, this air handler is operated via a programmable thermostat. During the detailed audit, the temperature setback programming of this thermostat was verified and at the time of the audit was operational.

In addition to the basic mechanical systems located at the train station, the platform is equipped with an electric resistance snow melt system. This system is located beneath approximately 200 sq ft of yellow safety markings at the edge of the platform. Operation of this system is controlled via a snow sensor mounted on a pole adjacent to the platform. At the time of the detailed audit, JC was informed that the snow melt sensor is not operational and the snow melt sensor had failed. Upon review of the three years utility data the electrical usage at the train station doubles during the winter months. It is estimated that approximately 30% of this additional usage is attributable to the winter/holiday lighting that is installed at the train station; however the remaining electrical usage is for the electric snow melt system. To eliminate this condition and reduce the amount of electrical usage at the train station it is recommended that the snow melt sensor be replaced as part of this project and a maintenance program be established to test and replace the sensor on a bi-annual basis.

Proposed Conditions

While comfort conditions in most spaces are kept within acceptable ranges (given the limitations of the existing controls systems), it appears that more energy-saving functions could be implemented in most mechanical systems, without loss of occupant comfort or jeopardizing any City programs. Rather than repair the existing, conventional controls, JCI will install direct digital control systems on the major HVAC systems in the buildings. Some areas may require minor programming, while others will require system upgrades to accommodate the proposed retrofit. Since the vast majority of the system is on the existing BAS most of the retrofits will be rudimentary. A description of the proposed retrofit follows.

Pine Hill Barn – Install a programmable thermostat to ensure consistent implementation of the setback schedule. The new temperature controls will be installed in place of the existing manually operated thermostats and programmed to setback the space temperature from 65°F to 60°F during unoccupied periods.

City Hall Controls – Since temperature controls are functioning as designed no retrofits are being considered for this building. However, it is recommended that the current BAS be evaluated and a basic controls optimization be performed at the building. This would include checking building set points, calibration of thermostats and verification of occupancy schedules for the 7 existing heating zones within the space. Installation of ductless split system to replace inefficient and labor intensive window air conditioners in approximately 10,000 square feet of City Hall building.

Public Library – Opportunity exists to control the space temperatures in the old areas of the library through the installation of 7 day programmable thermostats. These new temperature controls will be installed in place of the existing manually operated thermostats and programmed to setback the space temperature from 68°F to 60°F during unoccupied periods.

McConnell Center – it is recommended that the current BAS be evaluated and a basic controls optimization be performed at the building. This would include checking building set points, calibration of thermostats and verification of occupancy schedules for the existing heating zones within the space. Additionally, JC proposes to modify the programming of the Siemens BAS system to enable the proper deadband to prevent any unnecessary simultaneous heating and cooling in the spaces.

Pine Hill Chapel – Install a programmable thermostat to ensure consistent implementation of the setback schedule. Presently, setback is occurring 80% of the time based on data logging. These new temperature controls will be installed in place of the existing manually operated thermostats and programmed to setback the space temperature from 65°F to 60°F during unoccupied periods.

South End Fire Station – This location is occupied 24/7 and has programmable thermostats with multiple zones to control the heating system. Therefore, opportunity for the installation of building controls is limited and not recommended. However, during the detailed audit it was noted that when the fire trucks leave for a call the heating system remains operational and continues to provide heating when the overhead truck doors are opened, thus wasting heating energy. As part of this retrofit, JC will install controls necessary to eliminate this condition by interlocking the heating system with the operation of the overhead doors.

Veterans Hall – Building is not under EMS controls, and occupancy for building is less than 500 hrs per yr. When building is not in use the heating systems are turned to the minimum set point therefore modifications are not recommended.

Central Fire Station – This location is occupied 24/7 and has programmable thermostats with multiple zones to control the heating system. Therefore, opportunity for the installation of building controls is limited and not recommended. However, during the detailed audit it was noted that when the fire trucks leave for a call the heating system remains operational and continues to provide heating when the overhead truck doors are opened, thus wasting heating energy. As part of this retrofit, JC will install controls necessary to eliminate this condition by interlocking the heating system with the operation of the overhead doors.

Jenny Thompson Pool – Building is not under EMS controls and does not have a heating system, there is no opportunity for control.

Dover Indoor Pool – Several opportunities exist at the Dover Indoor pool which will garner energy savings through their implementation. A brief discussion of each follows.

Air Handling System – Replacement/Temperature Setback

As part of the recommended retrofit, JC will replace the Dussault air handler with a new high efficiency unit. The existing AHU will be removed and a new on will be installed in its place. To enable efficient operation the new air handler will be configured as follows.

New operation – during unoccupied hours

- Fan speed slowed to 50% during unoccupied hours (adjustable)

- Outside air damper will be closed, thus allowing recirculation air to condition the space
- Temperature in the space will be setback by 5°F during unoccupied periods (adjustable)

Pool Office – Eliminate Simultaneous Heating and Cooling

To eliminate the simultaneous heating and cooling present in the office, JC will retrofit the air handler and fin-tube radiation controls to prevent simultaneous operation during the cooling mode. This will be accomplished through the installation of a new sensor and control valve as required to prevent the fin tube radiation from becoming operable during cooling season.

Dover Public Works – The BAS system will be modified to enable the setback sequences to occur at the Public Works building. It is recommended that the current BAS be evaluated and a basic controls optimization be performed at the building. This would include checking building set points, calibration of thermostats and verification of occupancy schedules for the existing heating zones within the space. Additionally, a VFD will be installed on the air handling unit that serves the repair shop. Once installed, this VFD will enable the unit to be slowed down based on occupancy and thus garner energy savings.

Ice Arena – Improvements recommended for implementation at the Ice Arena are considered under another FIM.

Dover Train Station – Since the building is not under EMS controls, and occupancy for building is limited to the duration when trains are operating, limited opportunity exists for implementation of HVAC related energy conservation measures. When the building is not in use the heating systems are turned to the minimum set point through the use of a programmable thermostat.

To improve the operation of the electric snow melt system at the Train Station it is recommended that a new snow sensor be installed. The new sensor will be installed in place of the existing failed snow melt sensor which will enable proper operation of the system.

Savings Estimate

Table 4-1: Energy Savings Summary

Savings Summary	Pine Hill Barn & Chapel	City Hall	Public Library	McConnell Center	S. End Fire Station	Veterans Hall
Water & Sewer (kgal/yr)	-	-	-	-	-	-
Water and Sewer ($/yr)	-	-	-	-	-	-
Electricity (kWh/yr)	-	-	-	1,908	-	-
Electricity (kW)	-	-	-	-	-	-
Electricity ($/yr)	-	-	-	$118	-	-
Thermal Energy (MMBtu/yr)	38	121	71	447	-	-
Thermal Energy ($/yr)	$640	$2,023	$1,008	$6,308	-	-
Total Savings ($/yr)	$640	$2,023	$1,008	$6,426	-	-

Table 4-1: Energy Savings Summary

Savings Summary	Dover Train Station	Central Fire Station	Jenny Thompson Pool	Indoor Pool	Dover Public Works	Total
Water (kgal/yr)	-	-	-	-	-	
Water and Sewer ($/yr)	-	-	-	-	-	
Electricity (kWh/yr)	19,308	-	-	63,143	41,564	
Electricity (kW)	-	-	-	-	-	
Electricity ($/yr)	$2,357	-	-	$6,598	$5,318	
Thermal Energy (MMBtu/yr)	-	-	-	334	125	
Thermal Energy ($/yr)	-	-	-	$4,809	$1,418	
Total Savings ($/yr)	$2,357	-	-	$11,407	$6,736	$30,597

Assumptions

For specific assumptions please see the calculations in Appendix 3

Scope of Work

The City Buildings where JCI will install/retrofit controls include:

- **Pine Hill Barn**
  - Install 7 day programmable thermostat. If sufficient power (24VDC) is not available to thermostat a battery powered stat will be provided. New thermostat shall be equipped with tamper resistant locking enclosure.
  - Program new thermostat to maintain the following conditions
    - Occupied Periods: 6:30am to 4:00pm, temperature setting of 70°F
    - Unoccupied Periods: 4:00pm to 6:30am, temperature setting of 60°F
- **Pine Hill Chapel**
  - Install 7 day programmable thermostat. If sufficient power (24VDC) is not available to thermostat a battery powered stat will be provided. New thermostat shall be equipped with tamper resistant locking enclosure.
  - Program new thermostat to maintain the following conditions
    - Occupied Periods: 6:30am to 4:00pm, temperature setting of 70°F
    - Unoccupied Periods: 4:00pm to 6:30am, temperature setting of 60°F
- **City Hall**
  - Optimization of Siemens DDC building automation system to include
    - Verification of building set points
    - Calibration of DDC sensors
    - Verification of occupancy schedules and reprogramming as required
  - Replacement of faulty end devices, such as control valves and damper actuators is not included.
  - Installation of ductless split system to replace inefficient and labor intensive window air conditioners in approximately 10,000 square feet of City Hall building.
- **Public Library**
  - Install 7 day programmable thermostat in old library building. If sufficient power (24VDC) is not available to thermostat a battery powered stat will be provided. New thermostat shall be equipped with tamper resistant locking enclosure.
  - Program new thermostat to maintain the following conditions
    - M-W Occupied Periods: 8:30 am to 8:30 pm, temperature setting of 70°F
    - T/F Occupied Periods: 8:30 am to 5:30 pm, temperature setting of 70°F
    - Sat Occupied Periods: 8:30 am to 5:30 pm, temperature setting of 70°F
    - Sun Occupied Periods: 12:30 am to 5:00 pm, temperature setting of 70°F
    - All unoccupied periods the temperature will be set back to 60°F
- **McConnell Center**
  - Programming of Siemens BAS to prevent simultaneous heating and cooling
  - Programming of Siemens BAS to enable night setback capability.
    - M-F Occupied Periods: 5:30 am to 11:00 pm, temperature setting of 70°F
    - Sat Unoccupied
    - Sun Unoccupied

        - All unoccupied periods the temperature will be set back to 60°F
    - Optimization of Siemens DDC building automation system to include
        - Verification of building set points
        - Calibration of DDC sensors
        - Verification of occupancy schedules and reprogramming as required
    - Replacement of faulty end devices, such as control valves and damper actuators is not included.
- **Veterans Hall**
    - No controls scope at Veterans Hall
- **Dover Train Station**
    - Furnish and install new snow sensor.
    - Provide 4 spare sensors for replacement by City staff at a 2-yr interval.
    - Provide commissioning as necessary to ensure proper operation.
    - Implementation of this FIM is for replacement of the snow melt sensor only. At the time of installation JC will check the wiring and connections to validate proper operation. If wiring to the sensor is faulty JC will provide the City with an estimated cost prior to replacement of the sensor.
- **Jenny Thompson Pool**
    - No controls scope at the Jenny Thompson Pool
- **Dover Indoor Pool**
    - Provide and Install new PoolPac™ Air Handling unit for the Dover indoor pool
        - Disconnect old dehumidifier prepare for removal.
        - Remove and dispose of old humidifier and associated duct work.
        - Modify unit mounting pad to accommodated new dehumidifier.
        - Supply new dehumidifier sized to deliver 13,500 CFM of air with heat pipe heat recovery system. Unit to have internal economizer controls with minimum ventilation set point of 4,000 CFM to meet current ventilation code.
        - Supply and install new air distribution duct work similar to existing system sized for larger air flow.
        - Provide new reheat coil in supply air duct work and reconnect hot water piping.
        - Supply new hot water control valve for reheat coil and reuse existing Siemens control system.
        - Provide necessary power wiring to accommodate larger dehumidifier.
        - Air balance new air distribution system.
        - Provide documentation as required to secure building permits.
        - Start up system and provide operational training.
    - New operation – during unoccupied hours
        - Fan speed slowed to 50% during unoccupied hours (adjustable)
        - Outside air damper will be closed, thus allowing recirculation air to condition the space
        - Temperature in the space will be setback by 5°F during unoccupied periods (adjustable)
    - Pool Manager Office – eliminate simultaneous heating and cooling

        - To eliminate the simultaneous heating and cooling present in the office, JC will retrofit the air handler and fin-tube radiation controls to prevent simultaneous operation during the cooling mode. This will be accomplished through the installation of a new temperature sensor and control valve as required to prevent the fin tube radiation from becoming operable during cooling season.

- **Dover Public Works**
    - Program building automation system to enable setback sequences to properly occur at the DPW facility.
        - M-F Occupied Periods: 6:00 am to 5:00 pm, temperature setting of 68°F
        - Sat Unoccupied
        - Sun Unoccupied
        - All unoccupied periods the temperature will be set back to 60°F
    - Optimization of Siemens DDC building automation system to include
        - Verification of building set points
        - Calibration of DDC sensors
        - Verification of occupancy schedules and reprogramming as required
    - Replacement of faulty end devices, such as control valves and damper actuators is not included.
    - Maintenance Garage
        - Furnish and install new 10 HP VFD on HV-3 at the DPW facility (maintenance garage).
        - Programming to enable AHU to cycle to 50% speed during unoccupied periods. (see above occupancy schedule)
        - Install new programmable thermostat to enable occupied/unoccupied VFD operation.
- **Ice Arena**
    - Controls scope for this portion of the scope is included in the Ice Arena FIM

Exclusions

Where pneumatic devices are installed, JC has assumed that existing pneumatic line sets and end devices (e.g. sensors, actuators) are functional. Upon further inspection, should these items prove to be non functional and prohibit the implementation of the proposed retrofit JC will provide owner with a cost estimate to complete the repair.

Pursuant to discussions with the owner's representative, JCI has agreed to set an allowance for certain repairs as required per the retrofits contained herein. Should the amount of the repairs exceed the agreed to allowance JCI will immediately inform the customer in writing and provide an cost estimate for each repair. Upon review of additional work, customer will notify JCI in writing as to the appropriate course of action. (i.e. repair vs. no repair)

FIM 6 Water Conservation

Detailed Description of Facility Improvement Measure

Bathroom fixtures offer good water saving opportunities because any of these fixtures can be replaced or retrofitted with new low flow models to reduce the amount of water consumed per flush (toilets and urinals) or per minute (sinks). Reducing sink water usage also saves energy that would otherwise be used to make hot water.

Existing Conditions

An engineering survey of the staff and public restroom identified a total of 77 toilets, 22 urinals, 65 bathroom sinks, and 58 showers. 42 of the identified toilets are Ultra Low Flush (ULF) types that use 1.6 gallons per flush (gpf). The remaining 35 toilets use an average of 3.5 gpf. The 22 urinals are located in public and staff restrooms, 16 of which are high flow and 6 of which are low flow. All of the 64 sinks were found to be high-flow, using and average of 2.1 gpm. However, of 65 sinks, 18 were found to be non retrofittable. All of the 58 showers we found to be high-flow, using an average of 2.5 gpm. Below is a summary of the bathroom fixtures surveyed at each site.

Table 6 -1							
Domestic Fixture Summary – Existing Conditions							
Location	Public/Staff Toilets		Public/Staff Urinals		Public/Staff Sinks		Public/Staff Showers
	High Flow	Low Flow	High Flow	Low Flow	High Flow	Non Retro	Retrofit
Ice Arena	2	30	6	3	20	0	24
Jenny Thompson Pool	6	0	2	0	0	4	8
Indoor Pool	5	0	1	0	6	0	18
Public Works	0	5	0	2	6	0	2
City Hall	16	1	5	0	3	13	3
Public Library	4	2	2	0	6	0	0
Central Fire Dept.	1	1	0	1	3	0	1
South End Fire Dept.	0	3	0	0	3	0	2
Pine Hill Chapel	1	0	0	0	0	1	0
Totals	**35**	**42**	**16**	**6**	**47**	**18**	**58**

Proposed Conditions

The High Flow sink faucets, High Flow toilets, and High Flow urinals are good candidates for water-saving retrofits. JCI proposes to change out these high flow components with their low flow counterparts. The table below shows the measured baseline flow and proposed low flow for the various fixture types.

Table 6-2				
Fixture Rate of Utilization				
	Baseline		Proposed	
Toilets	3.5	gpf	1.6	gpf
Urinals	1.5	gpf	1.0	gpf
Sinks	2.1	gpm	0.5	gpm
Showers	2.5	gpm	1.5	gpm

Savings Estimate

Table 6-3: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	1,083
Water and Sewer ($/yr)	$12,098
Electricity (kWh/yr)	-
Electricity (kW)	-
Electricity ($/yr)	-
Thermal Energy (MMBtu/yr)	147
Thermal Energy ($/yr)	$ 2,025
Total Savings ($/yr)	$14,123

Assumptions

Domestic water savings depend on the amount of water used per toilet/urinal flush or sink use, the number of people using the bathrooms, and the frequency of use. Existing and proposed domestic water consumption was calculated based on the demographics information supplied by facility personnel and an example of the assumptions are listed in the table below.

Table 6-4 (Example from City Hall)		
Domestic Water Conservation, List of Assumptions		
	User Classification	
	Staff	**Visitor**
Number of Users	62	175
% Year Round Occupancy	66%	100%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	142	175
Total Flushes Per Day (Less Urinal Flushes)	140	172
% Men	35%	40%
Total Men	14	70
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	2%	2%
Total Flushes per Day to Urinals	2.5	3.5
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	61	70
%Taking Showers	70%	0
Shower (Minutes/Day/Person)	8.00	0.00
Total Shower Usage (Minutes/Day)	228	0
Total Number of Toilets	6	11
Total Number of Urinals	0	5
Total Number of Sinks	6	10
Total Number of Showers	2	0
Total Number of Toilets to be Retrofitted	5	11
Total Number of Urinals to be Retrofitted	0	5
Total Number of Sinks to be Retrofitted	1	2
Total Number of Showers to be Retrofitted	2	0
% Toilets Being Retrofitted	94%	
% Urinals Being Retrofitted	0%	100%
% Sinks Being Retrofitted	17%	20%
% Showers Being Retrofitted	100%	0%

Calculation Methodology:

Frequency of Use = number of users x % year-round occupancy x fixture uses/day/person

The following calculation for Program Savings can be applied to all Bathroom Fixtures:

Program Savings = Frequency of Use x (Baseline - Estimated Flow Rate) (gpm or gpf per fixture) x 365 days/year x % toilets/urinals/sinks/showers being retrofitted

Sink/Shower
Energy Savings = Water Savings (gal/yr) x 1/3 (hot water to sinks/showers) x 8.34 lb/gal x(120°F - 65°F) domestic hot water temp - city water temp x 1Btu/lb x l/ Boiler Efficiency (82%)* x 1Mlb/1,000,000 Btu

**Boiler Efficiency Varies Per Building*

Scope of Work

All non-ULF flushometer toilets identified for replacement will be replaced with new 1.6 gpf toilets and new flushometer valve retrofit kits, or valves if needed. All non-ULF tank toilets identified for replacement will be replaced with new 1.6 gpf toilets. The 16 urinals will have the flushometer valves retrofitted with new 1.0 gpf retrofit kits. All sink faucet aerators will be replaced with 0.5 gpm laminar faucet flow restrictors.

A typical toilet and flush valve retrofit includes the following major components:

- 1.6 gpf in kind china replacement with new retrofit kits or Sloan Regal flushometer valves if needed.
- New outlet seals
- New toilet seats with stainless steel hardware
- Installation of new sanitary floor flanges, or repair to such flanges other than installation of spanner flanges, and repair of wall carriers are not included in the scope of work.
- No architectural patching or painting is included in the scope of work.
- Structural damage caused by JCI's subcontractors will be corrected.

  NOTE: Control stops will be replaced as needed. In the event the control stop needs to be replaced, The City of Dover will be responsible for identifying and operating water system isolation valves. JCI will replace the stop once the water has been turned off. In such case, time is of the essence in shutting down risers and repairing stops. Stop repairs must be completed in a timeframe that allows JCI to complete the flushometer retrofits without a disruption in schedule.

A typical urinal flush valve retrofit or replacement includes the following components:

- Installation of new 1.0 gpf retrofit kit
- Installation of new Sloan Regal 1.0 gpf flushometer valve.

* *Dual flush toilets and urinals maybe available as an option at additional cost as the typical retrofit.*

A typical bathroom sink retrofit consists of removing existing aerator and installing a new pressure-compensating, laminar flow 0.5 gpm restrictor.

A typical showerhead replacement consists or removing existing showerhead and installing a new 1.5 gpm showerhead.

Below is a site by site breakdown of the proposed toilet, urinal, sink, and showerhead retrofit/replacement.

Ice Arena

- 2 Floor Mount Flushometer Toilets to be converted from 3.5 to 1.6 gpf
- 6 Urinals to be converted from 1.5 to 1.0 gpf
- 20 Sinks to be converted from 2.2 to 0.5 gpm
- 24 Showers to be converted from 2.5 to 1.5 gpm

Jenny Thompson Pool

- 6 Wall Mount Flushometer Toilets to be converted from 3.5 to 1.6 gpf
- 2 Urinals to be converted from 1.5 to 1.0 gpf
- 8 Showers to be converted from 2.5 to 1.5 gpm

Indoor Pool

- 5 Floor Mount Flushometer Toilets to be converted from 3.5 to 1.6 gpf
- 1 Urinals to be converted from 1.5 to 1.0 gpf
- 6 Sinks to be converted from 2.2 to 0.5 gpm
- 18 Showers to be converted from 2.5 to 1.5 gpm

Public Works

- 6 Sinks to be converted from 2.2 to 0.5 gpm
- 2 Showers to be converted from 2.5 to 1.5 gpm

City Hall

- 16 Floor Mount Flushometer Toilets to be converted from 3.5 to 1.6 gpf
- 5 Urinals to be converted from 1.5 to 1.0 gpf
- 3 Sinks to be converted from 1.73 to 0.5 gpm
- 3 Showers to be converted from 2.5 to 1.5 gpm

Public Library

- 3 Floor Mount Flushometer Toilets to be converted from 3.5 to 1.6 gpf
- 1 Floor Mount Tank Toilet to be converted from 3.5 to 1.6 gpf
- 2 Urinals to be converted from 1.5 to 1.0 gpf
- 6 Sinks to be converted from 2.2 to 0.5 gpm

Central Fire Department

- 1 Floor Mount Tank Toilet to be converted from 3.5 to 1.6 gpf
- 3 Sinks to be converted from 2.2 to 0.5 gpm
- 1 Shower to be converted from 2.5 to 1.5 gpm

South End Fire Department

- 3 Sinks to be converted from 2.2 to 0.5 gpm
- 2 Showers to be converted from 2.5 to 1.5 gpm

Pine Hill Chapel

- 1 Floor Mount Flushometer Toilet to be converted from 3.5 to 1.6 gpf

Exclusions

None Noted

FIM 9 Vending Machine Controls

Detailed Description of Facility Improvement Measure

The buildings throughout the City are equipped with refrigerated beverage vending machines. This measure addresses the inefficient control system that is standard on all units.

Existing Conditions

Johnson Controls has performed a detailed walk-through of the City buildings and has inventoried the applicable refrigerated vending machines that are located in these buildings. The following table denotes the quantities of refrigerated vending machines that are installed.

Table 9-1: Existing Conditions

Building Name	Vending Machine Quantity
Dover Pool	1
City Hall	2
DPW	1
Jenny Thompson Pool	1
Ice Arena	2
McConnell Building	2
South End Fire Station	1
Total	10

At present, all of these units run 24 hours a day throughout the year with the refrigeration compressors running 33 percent of the time irrespective of the facility or the equipment being occupied.

Proposed Conditions

Johnson Controls proposes to install vending machine controls (Vending Miser™) on all vending machines. The proposed system utilizes a custom passive infrared sensor, the controller powers down a vending machine when the area surrounding it is unoccupied and automatically re-powers the vending machine when the area is reoccupied. The intelligent controller develops optimal start-stop based upon the building occupancy, and modifies the time-out period accordingly.

Additionally, the unit monitors the ambient temperature while the vending machine is powered down. Using this information, the Vending Miser automatically powers up the vending machine refrigeration compressor at appropriate intervals, independent of occupancy, to ensure that the vended product stays cold. The controller also monitors electrical current used by the vending machine ensuring that it will never power down a vending machine while the compressor is running, so a high head pressure start never occurs. In addition, the current sensor also ensures that every time the vending machine is powered up, the cooling cycle is run to completion before again powering down the vending machine. This unique process also ensures a cold vended product. Vending Miser's unique approach to power management makes it the most advanced energy saver available:

- Equipment is powered up when anyone approaches the machine, and is powered down when the area is vacant.
- Product Integrity is Maintained; the controller measures ambient temperature and compressor current, re-powering the vending machine as needed to ensure that cold product temperature is maintained.
- Product is Always Available for Vending The customer never sees a powered down vending machine.

Savings Estimate

Table 9-2: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	-
Water and Sewer ($/yr)	-
Electricity (kWh/yr)	8,146
Electricity (kW)	-
Electricity ($/yr)	$936
Thermal Energy (MMBtu/yr)	-
Thermal Energy ($/yr)	-
Total Savings ($/yr)	$936

Scope of Work

The following work will be accomplished as part of this facility improvement measure.

- Provide and install Refrigerated Vending Machine Control
- Install 6 vending machine at the following locations

Table 9-3: Scope of Work

Building Name	Vending Machine Quantity
Dover Pool	1
City Hall	2
DPW	1
Ice Arena	2

- Electrical wiring necessary for a complete integration with building electrical system and vending machine
- Testing and Commissioning to ensure proper operation
- Operator training as required

Exclusions

None noted

FIM 10 Pool Cover

Detailed Description of Facility Improvement Measure

The indoor pool can be covered during off-hours, which will reduce evaporation to save water and energy. A cover will also reduce moisture and condensation in the building.

Existing Conditions

The main swimming pool is located on the main level of the Indoor Pool in the City of Dover, there is a secondary pool located in the same space which is primarily used for therapeutic purposes. The main pool, which is 43 feet by 76 feet, and the secondary pool which is 30 feet x 36 feet, lose a substantial amount of water and energy through evaporation. Four Peerless gas boilers rated at 520,000 Btu/hr each maintain the pool water temperature at 83°F. To heat the pool, water is fed from the boilers to an Everhot™ shell and tube heat exchanger located in the basement mechanical room.

The operating hours for the pool were determined through staff interviews during the walkthrough audit. For the vast majority of the year, the pool is open approximately 15-1/2 hours per day (5:30a – 9p), Monday through Friday, and 16 hours (7a-11p) on Saturday and 14 hrs (9a-11p) on Sunday. Based on this data the pool is operating for a total of 5,590 operating hours/year.

During non-operational hours, the pool is not covered. Water losses due to evaporation and people using the pool, result in the addition of city water on a fairly regular basis. As determined through the calculations, 64,345 gal/yr are lost to evaporation, while the pool is not in use. Once the pool is covered during the non-use periods, overall evaporation and latent heat gain will be significantly reduced.

Proposed Conditions

The evaporative losses can be significantly decreased by simply placing a barrier, in our case a pool cover, between the water and the indoor airspace, when the pool is not in use. A fully automatic pool cover was chosen for its ease of use. The unit will be wall mounted, 12 to 16 feet above the deck, with two operator controlled fully automatic pulley systems moving a single blanket (please see appendices for design sketches). The unit will take approximately one and a half minutes to completely deploy/retract. A control panel will be mounted on the wall approximately 20' from the pool storage reels so that the operator is clear from the operating cover.

The rate of evaporation was calculated from an industry-accepted formula published by the U.S. Department of Energy's, Reduce Swimming Pool Costs! (REPEC!) Department.

Savings Estimate

Table 10-1: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	62.4
Water and Sewer ($/yr)	$ 689
Electricity (kWh/yr)	45,256
Electricity (kW)	-
Electricity ($/yr)	$4,729
Thermal Energy (MMBtu/yr)	543
Thermal Energy ($/yr)	$7,805
Total Savings ($/yr)	$13,223

Scope of Work

The pool cover installation will consist of the following:

- Installation of a two fully automatic custom sized pool covers
  - 1 for main pool, mounted on the wall adjacent to the pool
  - 1 for ancillary pool
- Each pool cover will included the following
  - Pool blanket 2#/CFT closed cell polyethylene foam with laminated core
  - Deployer and 1/16" stainless steel deployer cables
  - Storage reel with wall mount brackets
  - Main control box with control panel, supplied with 120VAC, 20 A (control box to be mounted 20' from storage reel motors) All power systems will be complete with NEMA 6P enclosures.

Exclusions

- Tile work not related to the installation of the pool covers and pre-existing tile damage.

FIM 11 Ice Arena

Detailed Description of Facility Improvement Measure

Existing Conditions

The Dover Ice Arena, located on Portland Ave in Dover NH, is comprised of two ice rink floors, locker rooms, stands and various mechanical spaces. The new ice surface - Charles E. Holt Rink is in use year round, while the other ice surface - Robert H. Foster is shut down during the summer months until peak ice season begins in the fall. Both the ice rinks are served by a set of chillers - one Tecogen - Tecochill natural gas unit and one backup Acme reciprocating electric chiller. Both are piped to a common chilled brine storage tank which provides chilled brine to one or both of the ice rink floors.

Each chiller has a dedicated brine pump to circulate chilled brine to the storage tank and back to the respective chiller and operates only when it respective chiller is operating. Based on information furnished by facility staff, although old, the brine storage tank has an internal baffle installed between the cold and warm side of the tank to prevent stratification in the tank. Insulating values of this tank are poor and it is recommended that the tank be insulated to prevent unnecessary heat gain. Because of the poor insulation levels, the minor heat gain through the tank contributes to poor overall system efficiency and thus causes the chiller and ancillaries to operate longer than necessary.

In order for the Tecochill to be most effective (in terms of energy savings and payback), it is imperative that the excess heat from the gas engine be recovered and sent back to the building in the form of fluid to air and/or water for space heating, Zamboni flood water heating preheating and regeneration air to the Munters dehumidifier. In its present configuration, the heat recovery loop provides a maximum of 480,000 Btu/hr of supplemental heat to the areas directly adjacent to the Zamboni garage and provides pre-heating to the hot water tanks that serve the Zamboni in the old ice rink. During the detailed survey, it was noticed that little heat, if any, was being reclaimed. Inlet and outlet temperatures of the heat recovery loop were spot checked with an infrared temperature gun and substantiated that the amount of heat being recovered was marginal.

According to facility staff, the chiller is operated on a year round basis and during periods of low load the compressor is “unloaded”, however the chiller continually operates. Operating logs were analyzed for a three year period and indicated that the Tecochill chillers operate an average of 6,400 hrs per year. Operating data for the existing electric chillers was not available. This increases chiller and engine wear significantly as well as wasting a large amount of natural gas and electricity. Additionally, the overall maintenance budget for the Tecochill system is approximately $30,000 per year. Installation of new electric chiller would help to eliminate a portion of that annual maintenance expense.

The rink staff indicated that ice temperatures are adjusted by changing brine temperatures manually. As such, the Dover rink is about 25 years behind in control technology. For optimal operation, the ice floor temperatures should be controlled by ice temperature. Installation of infrared temperature controls and a variable speed drive on the floor pumps would be required to enable this mode of control.

Dehumidification for the old rink is served by electric refrigerated dehumidifiers in the 5 to 7.5 hp range. Refrigerated dehumidifiers work marginally in a close temperature range down to perhaps 45°F. Most refrigerated dehumidifiers will shut off on low temperature "safety" return air thermostats @ 40°F. As entering air temperatures decrease, refrigeration system suction pressures decrease and the compressors become increasingly less efficient increasing run times and power consumption. The new ice rink is served by a 10,000 cfm, Munters A30 model desiccant dehumidifier and is regenerated by natural gas.

The ceilings in both of the ice rinks are original to the building and do not provide any significant means of insulating value. Each ceiling is provided with fiberglass batts underneath a steel deck roof. During the summer months as the outside temperature rises, the roof deck heats up and thus energy transfer from the roof deck to the ceiling is increased. In its present state the ceiling acts as a warm plane radiating heat from the ceiling to the ice and thus causes the cooling load on the refrigeration equipment to rise unnecessarily. Opportunity exists to eliminate this heat gain and therefore improve the efficiency of the building. Installation of a Low-E ceiling would greatly reduce the heat gain on the ice surface.

In the older of the two rinks, the floor surface and dasher board system is flawed as installed, with the dasher board system mounted to the perimeter warm concrete, butting up to the flexible expansion joint. This flexible expansion joint remains in the field of play, presenting a non refrigerated area around the perimeter of the rink. The rink staff advised that steel plates are placed on the refrigerated floor to cover the expansion joint up to the dasher boards to provide a cold "bridge" from the cold floor to the dashers. The "bridge" requires additional labor to install/remove at the beginning and end of the season. A "bridge" such as this presents perimeter ice freeze/thaw issues as well as potential safety issues for skaters and rink staff. Further, to successfully make ice on a surface that is not refrigerated the ice floor needs to be set lower in temperature, thus driving the chiller to run longer. Each 1°F that we lower the brine or floor temperature results in a 4 to 8 % increase in chiller run time. Significant chiller energy savings would be realized if the floor/dasher issue described was resolved.

Proposed Conditions

A walkthrough survey was conducted and as a result of this survey the following facility improvement measures (FIM) have been identified for implementation at the Ice Arena.

FIM 11-1: Low E-ceiling

Both ice rinks would benefit greatly from low emissivity ceilings below the roof, above the sprinklers. Low emissivity ceilings are recognized (ASHRAE Refrigeration Handbook 2006 chapter 35) as a significant measure to reduce radiant heat (load) to the ice rink ice sheet. Ceiling radiant heat accounts for 28% of the load to the floor. A low emissivity ceiling can block up to approximately 90% of the radiant heat thus reducing the load on the refrigeration plant. These ceilings can be installed with or without ice "on". As part of this retrofit, Johnson Controls will install a Low-E ceiling in both of the ice rinks. The new ceiling will be installed below the existing ceiling and above the existing lighting system and thus provide an extra level of protection from the added heat gain throughout the year.

FIM 11-2: Ice temperature controls optimization

A more accurate method to measure and control the ice surface temperature would be the addition of non contact infrared sensors suspended above the ice rink floors, sending signals back to a DDC system which would then control the following; Chiller on/off operation, system circulating pumps and floor supply pumps. Ice temperatures would be selected based on time of day, rink occupancy, activity (hockey, figure or public skating). To enable this configuration, a new VFD will be installed on the floor pumps and their speed will be cycled based on actual ice floor temperature.

FIM 11-3: Dehumidification controls

JC proposes to install new desiccant based dehumidifiers for the Foster Rink. One of the key contributing factors to have a great ice surface is proper humidity control in the building envelope. Excess humidity also increases the refrigeration load on the ice plant. The most reliable and economical way of dealing with the humidity is through the use of a desiccant dehumidifier. This will provide an excellent ice surface during all weather conditions at a fraction of the operating cost of the old style mechanical dehumidifiers.

As part if this retrofit, a new desiccant based dehumidification system will be installed in the Foster Rink. The existing dehumidifier located on the North side of the rink closest to the Zamboni storage garage will be removed and replaced with the new unit.

FIM 11-4: Ice Max System

To improve the operations of the Dover Ice Arena and improve energy efficiency, Johnson Controls proposes the use of the Johnson Controls Icemax product. Icemax is a protein that is derived from a biotech fermentation process much like making beer, wine, yogurt or cheese. The active protein in

Icemax has been in use globally for 20 years and has been used in a wide array of applications, including snowmaking, cloud seeding, wastewater concentration, ice harvesting and thermal storage process cooling plants.

Icemax changes the molecular adhesion properties of water and will influence ice crystal size by producing finer and more tightly packed crystalline lattices. It increases the bond cohesion between ice crystals at higher temperatures and reduces the amount of heat required to be removed to reach the nucleation or freezing point of water. As a parts per million (ppm) additive to ice rink water, Icemax provides a cost effective way to generate a superior ice surface, reduce energy costs, and improve customer satisfaction. Some of the benefits of using Icemax follow.

Superior Ice Surface

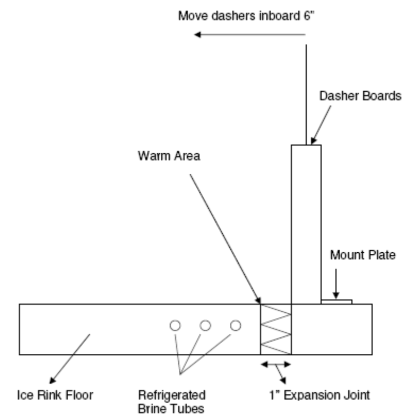
- Icemax will produce a tighter grained ice crystal that will behave much like de-ionized ice rink water, without the capital and maintenance costs of a DI plant.
- Icemax will help to remove impurities from the rink's source water, giving the ice a cleaner, smoother surface.
- Icemax will increase the bond cohesion between ice layers to give a better, stronger and more durable ice surface without the risk of ice layer delamination.

Energy Cost-Savings

- Reduces the heat load on the ice Icemax can produce a stronger ice layer bond even when cold water is used in the resurfacing equipment, allowing substantial energy cost-savings of 10%-20%.
- With Icemax, rink operators can run their base ice temperature 2 to 4 degrees higher to save energy, while still maintaining a quality ice surface.
- Use warm, rather than hot, water in the resurfacer ("Zamboni")
    - Reduces the heat load on the ice and the de-humidifiers

Icemax is shipped in sufficient quantity for 30 days of ice resurfacing. Since the product is biological it is required to be stored in the freezer to help protect the efficacy of the product. To properly use Icemax, a pouch of ice max is placed into the ice resurfacer during filling each time.

FIM 11-5: Move the dashers inboard



A drawing of the existing ice rink floor and dasher board system showing the relationship of the dashers, floor and expansion joint is shown below. It is standard in the industry for the dashers to either be mounted completely on the cold refrigerated floor or have the dashers straddle the expansion joint. From a safety standpoint having the expansion joint in the ice surface is not recommended.

As part of this retrofit the dashers will be moved inward by 6" and eliminate the need to install metal plates over the 1" expansion joint along the perimeter of the rink.

FIM 11-6: Installation of New Chiller

The existing Tecochill system provides low temperature brine for the ice making process at the Dover Ice Arena. As designed, the system provides cooling to most of the rink for the majority of the year with the existing electric chiller providing backup cooling during periods of high ice load or extreme summer temperatures. Presently, the Tecochill is operating with a 1.03 COP (with heat recovery) vs a 3.2 COP for a new electric chiller. As such, Johnson Controls proposes the replacement of the 30 year old Acme electric chiller with a new high efficiency unit. The existing Tecochill would remain installed as a backup in the event that both chillers are required for ice making (typically at startup when ice load is greatest). Further, many measures will be implemented to reduce the overall load on the ice sheet and as such the run time of the chiller system will be greatly reduced.

Proposed is a 120 ton high efficiency Carrier chiller with 3 compressors offering greater operational flexibility and part loading ability. The new chiller is 12' L x 3' w x 6' h and will be installed in the location of the existing Acme electric chiller. To accommodate the installation, the housekeeping pad will be modified and all piping will be removed and re-installed to accommodate the header arrangement of the new Carrier chiller. When installed, the new electric chiller will be interconnected with the existing building automation system and enabled for automatic operation. Chiller staging will be controlled by ice temperature and actual load vs the present "always on" operating conditions. Additionally, Johnson Controls will provide local operator control of the refrigeration plant to enable minor operational changes.

The Tecochill provides supplemental heating for the Zamboni resurfacing water and several fan coil units in the team areas adjacent to the rink. As part of this retrofit, the Tecochill will go from operating as the lead chiller to the backup. With that, the capability of providing heating to the Zamboni and other fan coils connected to the heat recovery loop is lost. As such, Johnson Controls proposes the installation of a new wall mounted condensing boiler to provide backup heating to the equipment connected to the heat recovery loop. The new boiler will be rated at 399,000 Btu/hr and will be installed on the wall in the Tecochill mechanical room. Gas piping will be run from a nearby gas line to the new boiler and venting will be via a 4" CPVC vent pipe which will be run through the sidewall.

From an operational perspective it is envisioned that the new chiller will provide a large majority of the cooling capacity for the ice rinks, especially given that other load reduction measures are being implemented at the rink.

Additionally, according to information furnished by facility staff, maintenance on the Tecochill is $30,000/yr and often requires frequent visits from a certified Tecochill maintenance technician. Since 2005, Tecochill has visited the site an average of 30 times per year. With the new electric chillers, it is expected that the overall maintenance costs will be reduced by approximately $10,000 per year.

Existing Maintenance Cost: $30,000

Proposed Maintenance Cost: $15,000 (Electric) (estimated)
Proposed Maintenance Cost: $ 5,000 (Tecochill) (estimated)
Total Proposed Maintenance Cost: $20,000

Net Operational Savings: $10,000

FIM 11-7: Pumping System – VFD on Pump

Savings Estimate

Table 11-1: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	-
Water and Sewer ($/yr)	-
Electricity (kWh/yr)	(31,670)
Electricity (kW)	(62)
Electricity ($/yr)	($8,614)
Thermal Energy (MMBtu/yr)	9,088
Thermal Energy ($/yr)	$112,131
Additional Spending ($/yr)	($8,765)
Operational Savings ($/yr)[1]	$10,776
Total Savings ($/yr)	$105,528

[1] Includes operational savings from moving Dashers ($776) and Chiller Replacement ($10,000)

Assumptions

Detailed calculations for each of the Facility Improvement Measures at the Ice Arena at included in the Appendix.

- Operating hours for the chiller system were obtained from data logs supplied by the Ice Arena facility staff. These hours were available from inspection of maintenance logs kept in accordance with the Tecochill service contract.
- Base on operating logs, operating hours for the Tecochill were determined to be
  - Average of 6,400 hours per year. (total hours over the 3.5 yr period)
- Average RH in the rinks is 50-70% (See charts in Appendix 3)
- Average temp in the rinks 45°F as determined through data logging (See charts in Appendix 3)

Scope of Work

FIM 11-1: Low E-ceiling

Johnson Controls, Inc. will furnish and install a new Low-E ceiling for both the Holt and Foster rinks. As part of this installation Johnson Controls will supply the following;

- Removal and re-installation of existing light fixtures
- Furnish and install new Low-E ceiling for the Charles E. Holt and Robert H. Foster Rinks
  - Aluma-zorb Low-E ceiling to be LAMTEC or equal
- Installation of ceiling support structure as per manufactures guidelines
- Electrical work as required for removal and re-installation of existing lighting

FIM 11-2: Ice Temperature Controls

Johnson Controls, Inc. will furnish and install a new ice temperature monitoring and control system for both the Holt and Foster rinks. As part of this installation Johnson Controls will supply the following;

- Furnish and install 2 infrared temperature sensors, 1 ea for the Holt and Foster Rinks respectively.
- Electrical and controls wiring to enable proper operation of the Infrared sensors
- Furnish and install 50 HP VFD for existing floor pump
- Electrical and controls wiring for proper operation of VFD
- Programming of VFD to enable motor speed control based on floor temperature.

FIM 11-3: Dehumidification System Controls

Johnson Controls, Inc. will furnish and install new desiccant based Dehumidification system for the Foster Ice Rink. As part of this installation Johnson Controls will supply the following;

- Removal and disposal of existing dehumidifier
- Provide new Arid Ice MS-2600 Desiccant Dehumidifier
- Furnish and install new desiccant based dehumidification system in the Charles E. Holt Ice rink.
  - New dehumidification system will be installed on the structural steel support structure located adjacent to the Zamboni storage room.

- Gas piping for regeneration of Desiccant
- Electrical and controls wiring to enable proper operation of the dehumidifiers
- Integration of new dehumidification system with existing building controls

FIM 11-4: Ice Max System

Johnson Controls, Inc. will provide Icemax for the Dover Ice Arena. As part of this installation Johnson Controls will supply the following;

- Provide 1-year supply of Johnson Controls Ice Max system which will enable ice temperature set point to be raised from 22°F to 26°F.
- Adjust set point of ice resurfacing water from 120°F to 80°F
- Icemax will be delivered monthly to the Dover Ice Arena staff for use in the ice resurfacer.

FIM 11-5: Move the dashers inboard

Johnson Controls, Inc. will retrofit the existing dasher boards at the Dover Ice Arena. As part of this installation Johnson Controls will supply the following;

- Furnish labor and materials necessary to remove the dashers in the Charles E. Holt rink and re-install them 6" inward.
- Coordination of installation will need to be accomplished with rink staff during the summer when the ice surface not active.

FIM 11-6: Installation of New Chiller

Johnson Controls, Inc. will furnish and install a new chiller for use at the Dover Ice Arena. The proposed system will is designed to provide higher efficiency production of ice for the rinks. As part of this installation Johnson Controls will supply the following;

- Chiller Installation
    - Removal and disposal of Carrier based (Acme) chiller
        - Including rigging out old chiller, rigging in new chiller
    - Removal and disposal of compressor oils and refrigerant
    - Removal and storage of system secondary refrigerant (ethylene glycol) from existing chiller
    - Provide and install new Carrier 120 ton Chiller model 30HXC206RA-6-TA or equal
        - Modify housekeeping pad to accommodate new chiller
    - Power and control hookup to existing systems
    - Piping new chiller to existing system glycol and water systems
    - Cold glycol piping insulation
    - Pipe labeling
    - Site supervision

    - Refill new chiller with stored glycol fluids
    - Piping and electrical materials
    - Provide electrical upgrades in mechanical room to accommodate single point power connection at new chiller. Upgrades to include new disconnect, power wiring and circuit breakers.
    - Provide new ventilation system upgrade to comply with ASHRAE 15 standards. Upgrade to include Power exhaust fan and duct, dampers with intake control and Leak detection sensors for room and vent line.
    - Boiler Installation - Install new Triangle Tube Prestige Solo 399 wall mounted gas fired condensing boiler (or equal) rated at 399,000 Btu/hr (input) to supply heating to existing fan coil units served by the Tecochill heat recovery loop.
        - Mounting of boiler in Tecochill mechanical room
        - 1” gas piping
        - 4” CPVC venting will be through the wall.
        - Electrical and Controls for operation of boiler
        - Installation of piping, isolation valves and insulation required for interconnection to the existing heat recovery loop.
- Energy Management System
    - Install Siemens AEM controller to enable basic (w/o graphics based UIE) local operator control
    - Replace CO2 Sensor in Foster Rink
    - Optimization of Siemens DDC building automation system to include
        - Verification of building set points
        - Calibration of DDC sensors
        - Verification of occupancy schedules and reprogramming as required
- Startup and commissioning of new chiller and boiler systems.

Exclusions

None noted

FIM 12 Power Factor Correction

Detailed Description of Facility Improvement Measure

Existing Conditions

The electrical system at the City of Dover, Ice Arena typically incurs a power factor penalty charge imposed by the local utility, Public Service of New Hampshire. This penalty is levied upon customers with power factors below 100%. A low power factor also reduces the amperage capacity of any facility's distribution system. High power factor has the following advantages: (1) eliminates utility power factor penalties; (2) reduces the heating losses of transformers and distribution equipment, prolonging life of the equipment; (3) stabilizes voltage levels; and (4) results in increased system capacity. It should be noted that the power factor is the ratio of actual power being used in a circuit, expressed in watts or kilowatts (kW), to the power which is apparently being drawn from the line, expressed in volt-amperes or kilovolt-amperes. The higher the power factor, the more effectively electrical power is being used.

During the field engineering survey, JC performed a review of the Ice Arenas electric utility bills. While reviewing PSNH account, it was found that the City of Dover incurred a monthly demand charge from PSNH due to a power factor less than 90%. This demand charge can be viewed as a penalty incurred by City of Dover Ice Arena for lagging (inductive) loads such as lighting or motors. The Ice Arena's monthly power factor during peak periods (as shown on the electric utility bills) is approximately 81-87%, and approximately 78-86% during off-peak periods. Raising the power factor to 90% or above would reduce the kVA demand charges imposed when the power factor is less than 90%.

Proposed Conditions

JCs experience has shown that the installation of capacitor banks will correct the system power factor. The installation of capacitor banks will correct the power factor to an average of 0.99 at all times, assuring that the penalty is significantly reduced and that the distribution system operating parameters are improved.

JC proposes to use existing billing data to determine complete load cycle in order to properly determine the operation of the switched bank of capacitors. New metering will be installed to closely monitor kW, kX, kVA, and true RMS power factor. From this data, the magnitude of avoided penalties can be determined. Utility meters and site-specific meters will be installed to determine the portion of system loss reduction associated with transformer and line losses.

Implementation of this FIM through the installation of fixed and switched capacitor banks will assure that the electrical system power factor will always average 98-99%, and the user will therefore avoid significant penalties. Additionally, the installation of these capacitor banks will reduce electrical system loss and improve ampacity and voltage levels throughout the complex. Power factor correction capacitors work, as reactive current generators “providing” needed reactive power (KVAR) to the power supply. By supplying their own source of reactive power, the facility frees the utility from having to supply it; therefore, the total amount of apparent power (KVA) supplied by the utility will be less.

Savings Estimate

The following is based on a review of PSNH Account during the period of August 2007 through July 2008. During that time, the Ice Arena operated with an average power factor of 81-87% on peak. Installation of new capacitors will increase the average power factor to above 90%. During summer months, when inductive loads are highest (creating lower power factors), the power factor will remain above 90%. Cost reduction is achieved by eliminating the penalty for operating below a 90% power factor.

Table 12-1: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	-
Water and Sewer ($/yr)	-
Electricity (kWh/yr)	67,810
Electricity (kW)	-
Electricity ($/yr)	$7,188
Thermal Energy (MMBtu/yr)	-
Thermal Energy ($/yr)	-
Total Savings ($/yr)	$7,188

Assumptions

See savings calculations in Appendix 3 for specific assumptions.

Scope of Work

The scope will include the following work:

- Furnish and install KVAR fixed capacitor power factor correction system in the main electrical room in accordance with the National and State Electrical Code.
- Startup, testing and commissioning

Exclusions

None Noted

FIM 13 Transformers – Retrofit

Detailed Description of Facility Improvement Measure

Energy savings can be obtained by replacing the standard efficiency transformers located at several City of Dover Buildings with new high efficiency transformers.

Existing Conditions

During the Detailed Energy Audit, JCI surveyed the City of Dover buildings for the purposes of identifying energy savings opportunities. While conducting the survey, JCI evaluated the electrical systems at each facility and determined that several of the existing transformers were of standard efficiency. These transformers are not designed to handle harmonic loads of today's modern facilities and suffer significant losses as a result. The most common efficiency for commercial and industrial transformers supplying linear loads (nameplate efficiency) in the 30-150kVA range is 95%. Further, conventional transformer losses, which are non-linear, increase by 2.7 times when feeding computer loads.

The nonlinear load loss multiplier reflects this increase in heat loss, which decreases the net transformer efficiency. Also, unlike most substation transformers that are vented to the exterior, building transformers are ventilated within the building they are located and their heat losses therefore add to the buildings cooling load. JCI performed on site loading tests on the transformers. The following table lists the transformers that were identified as prime candidates for replacement.

Table 13-1: Existing Conditions

Building	Location	Type	kVA
McConnell Center	Boiler Room	MLV	75
McConnell Center	Main Elec Room	KPLV1	75
McConnell Center	Main Elec Room	LV1S	45
McConnell Center	Room 251	LV2W	75
McConnell Center	Room 230A	LV2S	45
McConnell Center	Room 320A	LV3S	45
McConnell Center	Room 345A	LV3W	75
McConnell Center	Room Storage	LV4E	45
McConnell Center	Room Storage	HV3E	45
Waste Water	Primary Sediment	L4	30
Waste Water	Compost	T-5 / L-6	30
Waste Water	UV Building	#1	75

Waste Water	UV Building	#2	75
Waste Water	Blower Building	PP1	45
Waste Water	Garage Process Bldg	L5	30
Waste Water	Main Elec. Process Bldg	L1	30
Waste Water	Admin Bldg	T-3	37.5
Waste Water	Admin Bldg	T-2	30
Public Works	Main Elec Room	LP-A	30
Public Works	Welding Shop	LP-B	45
Public Works	Pole Barn	PB-1	75
Public Works	Mezzanine	LP-P	75
Public Works	Mezzanine	LP-C	30
Public Works	Mezzanine	LP-C	30
Ice Rink	New Elec. Room	NP2	75
Ice Rink	Old Elec. Room	-	75
Ice Rink	Old Elec. Room	PL1	45
Museum / Pool	Main Elec. Room	PP1	112.5
Museum / Pool	Main Elec. Room	RP1	112.5

Proposed Conditions

Opportunity exists to improve the energy efficiency of the electrical distribution systems in several of the buildings through the replacement of the transformers with new high efficiency units. The proposed transformers will be Powersmiths, High Efficiency K-Star Harmonic Mitigating units. They are Energy-Star rated and meet the new TP1 Law requiring replacement of transformers of 600 volts or under.

The IEEE Emerald book notes that a conventional transformer reaches its full load losses at half its nameplate load when feeding computer-type loads. Research carried out by Tom Key and Jih-Sheng Lai (IEEE Trans. On Industry App., NO. 5, Sept./Oct. 1996) points out that core losses double and eddy currents increase by a factor of 17 times, resulting in an almost tripling of losses when feeding 120V electronic equipment such as personal computers.

The Powersmiths approach starts with a higher efficiency (98%) and in addition treats the harmonic currents instead of simply surviving them. The energy savings resulting from the reduction in harmonic distortion and inherent reduction in losses are substantial enough to justify the Powersmiths approach. Using Powersmiths harmonic cancellation and K-Star transformers peak power consumption will be reduced by at least 10%, operating costs will be lowered, more capacity will be regained for pending projects and achieve a short ROI. Existing and projected harmonic power quality issues will be resolved with the installation of the proposed transformers.

For the retrofit, the existing transformers will be de-energized, removed and disposed of properly. New transformers will be installed in their place.

Savings Estimate

Table 13-2: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	-
Water and Sewer ($/yr)	-
Electricity (kWh/yr)	145,544
Electricity (kW)	26
Electricity ($/yr)	$18,385
Thermal Energy (MMBtu/yr)	-
Thermal Energy ($/yr)	-
Total Savings ($/yr)	$18,385

Note: For a summary by location see appendix

Assumptions

Savings were based on the difference of transformer losses measured on the field for existing units and losses quoted by the manufacturer for the replacement equipment. For additional assumptions see Appendix 3.

Scope of Work

The following will be accomplished Per Transformer Unit:

- Coordination with local facilities staff for shutdown of electrical service
- Shut off the main electric power to the transformer to be replaced.
- Disconnect the existing transformer and install replacement unit.
- Turn power back on.
- Inspect unit operation by performing electrical and harmonics testing.
- Removal and disposal of old transformers in accordance with local regulations.

Exclusions

Removal of any City of Dover property for access to transformer (e.g. material stored on or around transformer)

The following transformers will be replaced with Powersmiths high efficiency transformers as part of this facility improvement measure:

Table 13-3: Transformer Replacements

Building	Location	Type	kVA
McConnell Center	Boiler Room	MLV	75
McConnell Center	Main Elec Room	KPLV1	75
McConnell Center	Main Elec Room	LV1S	45
McConnell Center	Room 251	LV2W	75
McConnell Center	Room 230A	LV2S	45
McConnell Center	Room 320A	LV3S	45
McConnell Center	Room 345A	LV3W	75
McConnell Center	Room Storage	LV4E	45
McConnell Center	Room Storage	HV3E	45
Waste Water	Primary Sediment	L4	30
Waste Water	Compost	T-5 / L-6	30
Waste Water	UV Building	#1	75
Waste Water	UV Building	#2	75
Waste Water	Blower Building	PP1	45
Waste Water	Garage Process Bldg	L5	30
Waste Water	Main Elec. Process Bldg	L1	30
Waste Water	Admin Bldg	T-3	37.5
Waste Water	Admin Bldg	T-2	30
Public Works	Main Elec Room	LP-A	30
Public Works	Welding Shop	LP-B	45
Public Works	Pole Barn	PB-1	75
Public Works	Mezzanine	LP-P	75
Public Works	Mezzanine	LP-C	30
Public Works	Mezzanine	LP-C	30
Ice Rink	New Elec. Room	NP2	75
Ice Rink	Old Elec. Room	-	75
Ice Rink	Old Elec. Room	PL1	45

FIM 14 WWTP Aeration Blowers - Retrofit

Detailed Description of Facility Improvement Measure

Existing Conditions

On September 30, October 1, and October 16, 2008 JC visited and performed an extensive review of the Dover New Hampshire Wastewater Treatment Facility located on 484 Middle Road in Dover New Hampshire. Originally designed and constructed in 1988 through 1991 the treatment facility is a conventional activated sludge plant consisting of primary clarifiers, aeration tanks, and secondary clarification, with ultraviolet disinfection. The plant's liquid process and organic design capacity is as shown in the following Table 14-1:

Table 14-1

Unit Process Criteria – Design Year 2005	
Design Flows	
Average Daily Flow	4.7 MGD
Maximum Day Flow	13.8 MGD
Peak Hour Flow	16.8 MGD
Organic and Suspended Solids Loading	
Average Day BOD_5	7,170 pounds per day
Maximum Day BOD_5	10,930 pounds per day
Average Day TSS	6,680 pounds per day
Maximum Day TSS	14,480 pounds per day

The plant's NPDES Permit (No. NH0101311) provides the limits and conditions for discharging treated effluent into the Piscataqua River. Table 14-2 shows the limits established that the Dover facility must meet.

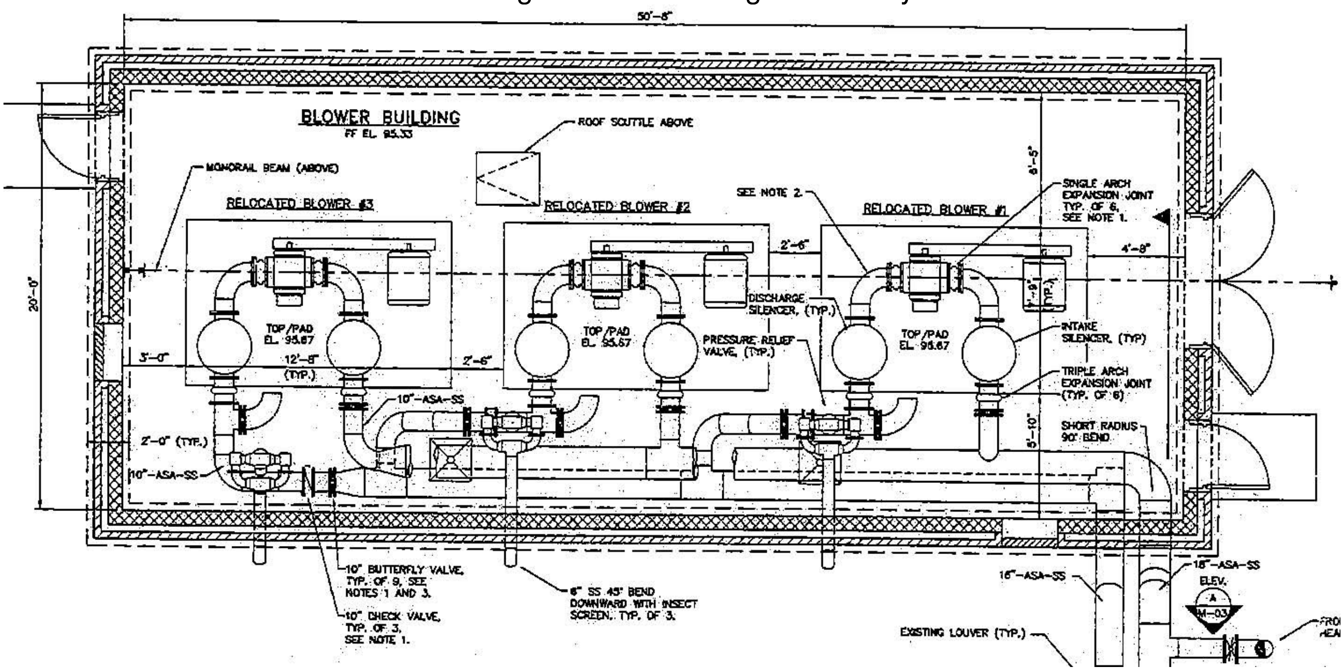
Table 14-2

NPDES Effluent Quality Limits	
Average Daily Flow	4.7 MGD
Monthly Average BOD_5	30 mg/L
Weekly Average BOD_5	45 mg/L
Daily Maximum BOD_5	50 mg/L
Monthly Average TSS	30 mg/L
Weekly Average TSS	45 mg/L
Daily Maximum TSS	50 mg/L
pH	6.0 to 8.0 SU
Fecal Coliform	14 fecal coliform per 100 milliliters

The purpose of the evaluation was to perform onsite investigations at the Dover, NH WWTF to gather adequate physical, process control, as built and compliance testing information to assess where replacement of process equipment can effect a sufficient reduction in energy usage. In addition JC would identify all process systems evaluated which do not meet the general intent of the audit and explain.

Activated Sludge Reactor (Aeration System): The primary energy users at the WWTF are the three (3) 125 HP positive displacement blowers providing dissolved oxygen to the reactor. The existing blowers are Dresser Roots Model 817 RCS-J positive displacement blowers powered by 125 HP 460 volt 3 phase motors. At the October 10, 2008 onsite visit only one of the three existing blowers was operational. This system was closely evaluated and a recommendation for blower replacement was made. Figure 14-1 below shows the existing layout of the blowers.

Figure 14-1: Existing Blower Layout



Other Systems Evaluated

Grit Removal: Grit removal at this facility is performed hydraulically by differential sedimentation, which allows the heavier solid particles to settle and permits the lighter putrescible solids to pass on to the Primary Clarifiers. This system is not an energy intensive process and was therefore eliminated as a candidate for further evaluation.

Primary Sedimentation: Primary Sedimentation is a process which uses detention time and surface area as a means to reduce the velocity of the incoming flow to permit gravity to settle putrescible solids and fine inorganic particles and allowing soluble BOD and buoyant organics to pass on to the Secondary Aeration Tanks. Although this system has primary sludge pumps and motors powering the clarifier mechanism it was determined that the pump motors, which were generally 5 HP and less are too small for a retrofit or replacement that could provide a reasonable return on investment. Therefore, this system was eliminated as a candidate for further evaluation.

Secondary Clarification: Secondary Clarification is a process, which uses detention time and surface area to permit flocculation of activated sludge from the aeration tanks to settle forming a blanket of active organisms to be returned and reused at the beginning of the secondary treatment process. Secondary Clarification is performed through deferential settlement that permits active organisms to settle and be returned and the floatable scum and surface debris to be skimmed and removed from the plant. Although this system has scum pumps, waste sludge pumps and return sludge pumps none were found to be obsolete or inefficient. Each pump except for the scum pumps had variable frequency controls and none were found to be oversized. It was determined that pump replacement would not provide improvements in process control or effect a reduction in energy use, therefore, this system was eliminated as a candidate for further evaluation.

Disinfection: Disinfection is accomplished through high intensity Ultra Violet light which disrupts and lyses the cell membrane of both entercocci and fecal coliform bacteria and deactivates viruses. Although, an intense energy user this system is the most effective technology for deactivating bacteria, cysts, and viruses. There is at this time no replacement technology available to perform this task using less energy or without creating the chloramines associated with a hypochlorite system.

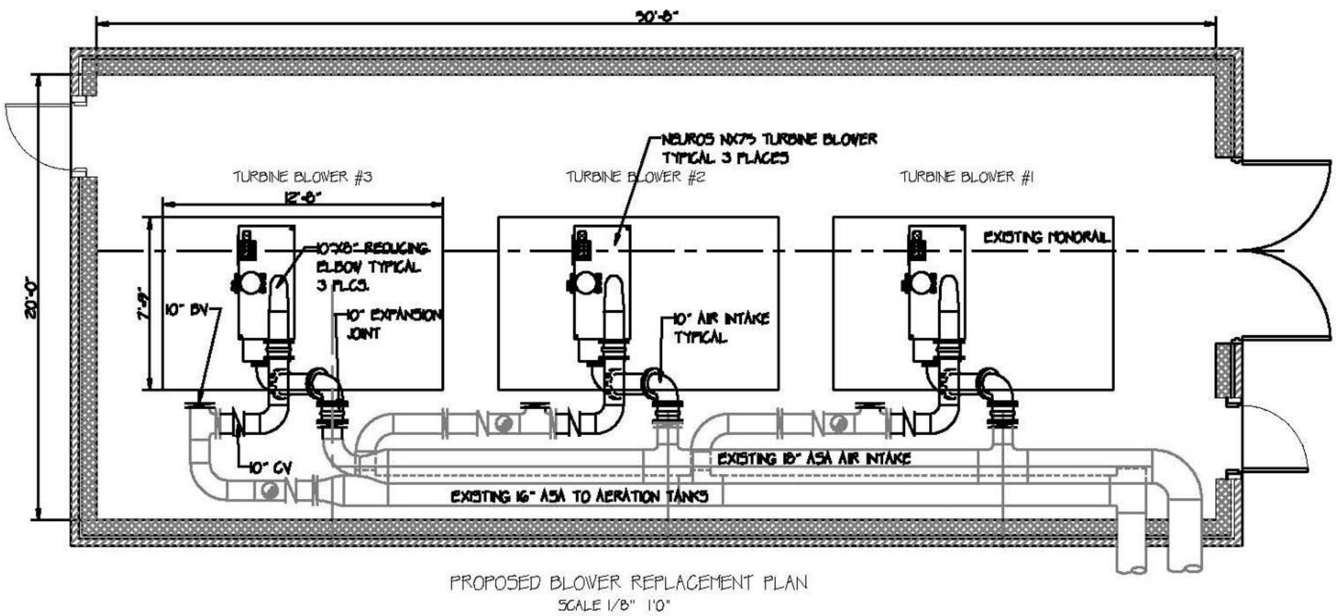
Sludge Management: Sludge management is currently performed using a blend of primary and secondary sludge that is pumped to gravity belt thickeners and belt filter presses. The final dewatered sludge is then moved to a compost facility on site where it is mixed with saw dust and/or wood chips and biologically stabilized to generate a Class A Biosolid suitable for soil enhancement. There are several issues with the system such as odor, the sludge has a relatively low percent solid content in the cake after pressing, its relatively labor intense, it is energy intensive and there is a low marketability of the product produced. The system could be overhauled with new technologically superior equipment that would save energy, increase solids content in the final cake, reduce the total energy required to operate, reduce odor and reduce labor intensity. This process system has significant potential for improvement and the potential for beneficial use of methane gas production for power generation however, the level of evaluation required to determine the form it would take to make the system financially viable far exceeds the scope of this audit. A further detailed evaluation should be performed under a separate agreement to determine the viability of a new design.

Odor Control: A separate odor control system for the secondary treatment aeration system was retrofitted to the WWTF in the late 1990's. This system utilizes a biological media system to filter the air retrieved from the head space of the aeration system. Because the system is biological it is temperature sensitive and requires a 300,000 BTU/Hour propane fired heat source to maintain a minimum temperature in order to keep the biology that removes sulfurous compounds viable. This system uses significant quantities of LP gas during the winter months to maintain the viability of the biology in the media. The intense use of an unregulated petroleum based fuel source exposes the WWTF to significant economic pressures due to the current unsettled oil markets. Retrofitting this system with a different technology could significantly reduce the financial liability of this system. Further discussion of this retrofit is provided in this report.

Proposed Conditions

As discussed herein, the greatest energy users at the WWTF are the three (3) 125 HP positive displacement blowers providing dissolved oxygen to the reactor. The existing blowers are Dresser Roots Model 817 RCS-J positive displacement blowers powered by 125 HP 460 volt 3 phase motors. Although, positive displacement blowers have been used successfully as the primary means of producing low pressure air for aeration system for many years, new technology has become available that performs the same service but with much less energy.

Figure 14-2 below shows the proposed conditions for Dover's Blower System.



Due to past advances in jet turbine propulsion technology new methods of aeration are now available that can replace older positive displacement blowers with high efficiency turbine blowers. Such is the case at the Dover WWTF. JC performed a detailed evaluation on replacing the three existing 125 HP Dresser Roots blowers with two 75 HP Neuros, HIS Turbine Blowers or equal.

Table 14-3 below provides the summary of the evaluation:

Table 14-3

Power Consumption Comparison between Existing and Proposed Blowers			
Blower	kWh/Day Used	Days/Yr.	kWh/Yr Used
Existing RCS-J Roots	2,250	365	821,192
Proposed NX75-C050	1,504	365	548,928
Estimated Annual kWh Saving =			272,264
Estimated annual savings in electricity @ $0.1228 kWh =			$33,432

As can be readily seen replacing the existing positive displacement blowers with Turbine Blowers can reduce electricity consumption by about 1/3rd making this a viable economic investment. This analysis does not include any government or utility grants or incentives that may be available for this type of project.

Blower Inlet Air

The existing inlet aeration header for the blowers takes a small portion of its air requirement from the odor control duct off the abandon Headworks odor scrubber system. This method of recycling air to the aeration system is customary in many applications. However, as recently discovered [through a meeting with the manufacturer's representative on Wednesday December 17, 2008] air that has even small to moderate concentrations of H_2S maybe deleterious to the sensitive mechanical and electronic parts of the High Speed Turbine Blowers presently proposed to replace the existing positive displacement blowers.

Due to the viable characteristics of headworks odor it was determined that the existing abandon chemical odor control scrubber be replaced with a canister of activated carbon designed to treat the odor and H_2S from the headworks. This canister would replace the existing abandon chemical scrubber and its ancillary supporting equipment still located in the Headworks Odor Control Room.

Replacing the abandon scrubber equipment will permit "Valving Off" the 8-inch line presently in service which takes and recycles the headworks air to the aeration system, there by allowing only fresh air to be taken in by the proposed high speed turbine blowers.

Savings Estimate

Table 14-4: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	-
Water and Sewer ($/yr)	-
Electricity (kWh/yr)	272,264
Electricity (kW)	62.2
Electricity ($/yr)	$33,432
Thermal Energy (MMBtu/yr)	-
Thermal Energy ($/yr)	-
Total Savings ($/yr)	$33,432

Assumptions

- Hours of operation for the existing and proposed case were determined through review of plant operational data
- Electrical loading of the blowers was determined through metering
- For detailed calculations see Appendix 3

Scope of Work

- Remove and Salvage existing Dresser Roots 125 HP Blowers
- Remove and Dispose of one Blower w/ VFDs and the second Blower with two speed control.
- Remove and Salvage 10-inch Butterfly Valves for reuse on new blowers
- Remove and Salvage existing 10-inch Wafer Check Valves for reuse on new blowers.
- Remove and dispose of existing 10-inch stainless steel inlet and discharge piping at existing blowers to the limits shown on Figure 2.
- Furnish and install 2 new turbine blowers as shown on Figure 2.
- Furnish and install new starters in the Blower MCC Panel
- Furnish and install new power connection between Blower MCC and Turbine's VDF located on the packaged skid.
- Furnish and install 4 new D.O. probes at the aeration tanks and connect into existing control wiring to the blower system and plant SCADA system.
    - New DO probes for each aeration train will be polled to determine average DO level through out the aeration system. This average level will control the operation of the new VFD controlled Turbine Blowers.

- New DO probes will permit operators to balance DO through out the system by controlling air flow via the butterfly valve on each of the 3-zones in each train.
- The recommended DO level to maintain through out the aeration tanks will be 1.5 to 2.5 mg/L.

- Carbon Filter – Calgon, Model HF 2000 with Centaur Carbon

  Installation of carbon filter will enable new blowers to utilize 100% fresh inlet air for aeration.
  - Location of new carbon filter to be determined and mutually agreed to
  - Carbon canister
  - Liquid tight flow control/regeneration valve
  - Carbon sample port
  - Flanged outlet
  - Polypropylene rain-tee with bird screen.
- Connect new turbine blowers to existing SCADA system.
- Manufacturer to provide minimum three days of onsite test and start up assistance
- Manufacturer to provide Operation and Maintenance Manual
- Manufacture to provide three year non prorated warranty for equipment defects and workmanship.

Exclusions

Installation of Carbon Filter has been budgeted at $52,000 subcontractor cost and is included in cash flow analysis. Prior to implementation of performance contract JCI will provide pricing for the installation. Should the work associated with installation of the carbon filter work required be greater than this amount JC will provide the customer with a detailed cost estimate prior to proceeding.

FIM 15 Heating System Upgrade – Boiler Replacement

* *The heating system upgrade has already been commissioned.*

Detailed Description of Energy Conservation Measure

The Dover Public Library utilizes hot water for heating that is supplied by a single cast iron sectional hot water boiler. The boiler was installed in over 20 years ago and has recently failed. Under this FIM, the existing boiler would be removed and replaced with a new high-efficiency gas-fired boiler. The intent of this FIM is to provide a higher level of energy efficiency for heating the building which at the same time would represent a capital upgrade that would defer maintenance and repair costs.

Existing Conditions

The existing boiler in the Dover Public Library is a HB Smith 450 Mills cast-iron sectional boiler with 17 sections. The boiler has an oil burner rated at 46.65 GPH at the maximum firing rate. The boiler nameplate indicates an output of 4,371 MBH, so the efficiency is estimated to be in the range of 70% (original design). The actual operating efficiency is likely to be lower than this due to the boilers' age.

Proposed Conditions

For the Dover Public Library boiler room, JCI will remove the existing older boiler. A new high-efficiency gas-fired boiler will be installed and will be properly sized (based on a heat loss calculation). Existing supply and return systems and gas supply piping will be reused with the new boiler.

Savings Estimate

Table 15-1: Energy Savings Summary

Savings Summary	
Water (kgal/yr)	-
Water and Sewer ($/yr)	-
Electricity (kWh/yr)	-
Electricity (kW)	-
Electricity ($/yr)	-
Thermal Energy (MMBtu/yr)	88
Thermal Energy ($/yr)	$1,251
Total Savings ($/yr)	$1,251

Assumptions

JCI used available capacity data for the existing boiler, along with the natural gas delivery history to estimate the average annual boiler loading.

Savings Calculations

JCI performed spreadsheet-based calculations to model the annual fuel usage and the savings for the boiler replacement based on long-term weather data for Concord, NH. The savings calculation spreadsheet for the boiler replacement is included in Appendix 3.

Scope of Work

JCI proposes to install a new properly sized hot water heating boiler in the existing boiler room, including all necessary specifications, contractor selection, construction management, checkout, startup, commissioning and training:

- The existing boiler will be demolished.
- Disconnect all gas piping, supply/return piping, electrical connections and breaching
- A new properly sized gas-fired hot water boiler will be installed and will be connected to existing distribution piping.
- Re-install all gas piping, supply/return piping, electrical connections and breaching
- Leak test new boiler
- Reconnect EMS control and monitoring points will be installed for the boiler system.
- Startup, commissioning and operator training

Energy Conservation Measures considered but not recommended

Description of Measure	Savings	Cost	Payback
Solar Photovoltaic Generation	$658	$91,454	139.0
Solar Thermal System	$5,521	$114,498	20.7
Micro - Hydro Turbine	$11,478	$657,158	120.0
Interlock Truck Bay Doors	$919	$20,410	22.2
Pipe Insulation	$213	$7,201	33.8
Totals	**$18,789**	**$1,890,721**	**100.6**

SECTION 5 – Measurement & Verification Plan

The following M&V plan will be implemented for the City of Dover, NH. The plan for each FIM will be reviewed and approved by the city, or a representative of the city. A proper M&V plan should be developed to obtain a balance between M&V costs and savings certainty. Our M&V plan will accurately identify and verify savings associated with each improvement, while balancing the M&V costs with savings expectations.

Our goal is to ensure that our customers are comfortable and in full agreement with the savings calculations and the methodology used to verify the savings.

The three widely accepted M&V references are:

- FEMP (Federal Energy Management Protocol)
- IPMVP (International Performance Measurement & Verification Protocol)
- ASHRAE Guideline 14

FIM 1: Lighting – Fixture Retrofit

IPMVP Option A

Pre-Installation Baseline:

Measure kW levels on a representative sample of circuits. Identify circuits/fixtures measured. Read actual lumen levels in areas affected by the retrofit; provide a table of pre-installation lumen readings for each. Hours of operation will be provided by facility representatives and will remain stipulated throughout the term of the contract. Facility representatives will notify JCI when long term changes in operation occur.

Post-Installation:

Measure kW levels on the same sample of circuits/fixtures as the “Pre-Installation Baseline”. Measure post installation lumen levels and provide the “Pre-Installation Baseline” table with the actual post- installation values added.

Duration of Measurement:

One Time Pre & Post Installation

Stipulated Variables:

Hours of operation for areas not affected by lighting controls. Hours of operation will be provided by facility representatives and agreed upon.

FIM 2: Lighting – Fixture Controls

IPMVP Option A

Pre-Installation Baseline:

Utilize occupancy sensor data loggers to log 5% of each area type by building to determine existing hours that lights are left on while areas are unoccupied. Identify lighting fixtures/circuits affected by the new lighting controls.

Post-Installation:

Use data collected during "Pre-Installation Baseline" to verify lighting control savings.

Duration of Measurement:

Four weeks before installation

Stipulated Variables:

Fixture wattages under control of each new occupancy sensor, based on detailed lighting audit.

FIM 3: Building Envelope Improvements

Non-Measured – Engineering Calculations

Pre-Installation Baseline:

Identify and record all building envelope issues to be repaired / improved.

Post-Installation:

Verify that approved "Scope of Work" for FIM 3 has been completed. Record any changes to the scope and adjust potential savings if necessary.

Duration of Measurement:

Not Required

Stipulated Variables:

None Required

FIM 4-1,2: Energy Management System - Upgrades

IPMVP Option A

Pre-Installation Baseline:

Record existing equipment (motor hp, heating / cooling capability), control strategies (occ. control, outside air delivery, humidity control capability), and areas associated with FIM 4.

Post-Installation:

Trending and totalization with FMS

Duration of Measurement:

One time before and after implementation, Annual review and optimization of FIM 4 control system

Stipulated Variables:

Hours of operation, pre-installation control strategies, equipment energy consumption pre & post retrofit

FIM 4-3: VFD on Fans

IPMVP Option A

Pre-Installation Baseline:

Identify existing operational schedules, strategies and control capacity for each fan associated with FIM 4-3. Record existing fan type, CFM and Load Profile for each fan associated with FIM 4-3. Measure fan kW, supply air and space temperatures.

Post-Installation:

Inspect all installed equipment for proper operation and control. Verify varied speed operation. Measure fan kW, supply air and space temperatures.

Minimum Duration of Measurement:

Annual inspection of all VFDs installed, confirm variable speed operation

Stipulated Variables:

Hours of Operation, motor power

FIM 4-4: Pool Dehumidification Control

IPMVP Option A

Pre-Installation Baseline:

Record existing equipment (motor hp, heating / cooling capability) and control strategies (occ. control, outside air delivery system, humidity control capability). Record humidity levels throughout facility.

Post-Installation:

Verify new equipment operation (motor hp, heating / cooling capability) approved control strategies (occ. control, outside air delivery, humidity control capability). Annual review of FIM operation and functionality, also identify overrides to approved control strategies. Track and trend humidity throughout facility through the building automation system.

Duration of Measurement:

Continual tracking and trending of humidity levels

Stipulated Variables:

Hours of operation, equipment energy consumption pre & post retrofit, pool operational temperatures

FIM 4-5: Repair Snowmelt Sensor

IPMVP Option A

Pre-Installation Baseline:

Measure power draw of snow melt system. Determine time-of-use for the system operated manually, which will then be stipulated for the remainder of the term.

Post-Installation:

Install data logger on snow melt system to determine post installation hours of operation

Minimum Duration of Measurement:

Annual testing of snow melt sensor system, replacement bi-annually of sensor

Stipulated Variables:

Pre-Installation hours of operation

Minimum Performance Period:

Annual inspection of solar hot water system

Considerations:

Savings are a function of severity of winter weather

FIM 6: Water Conservation

IPMVP Option A

Pre-Installation Baseline:

Flow measurement of sampling of fixtures associated with FIM 6. Record existing conditions of equipment

Post-Installation:

Flow measurement of same sampling of fixtures associated with FIM 6 as “Pre-Installation Baseline”. Record existing conditions of equipment

Minimum Duration of Measurement:
One-Time Pre and Post Installation

Stipulated Variables:
Pre-installation Operation, Occupancy

FIM 9: Vending Machine Controls

Non-Measured – Engineering Calculations

Pre-Installation Baseline:
None Required

Post-Installation:
Review installation of vending machine controllers to ensure FIM9 scope has been fully implemented

Minimum Duration of Measurement:
One-Time Pre and Post Installation

Stipulated Variables:
None Required

FIM 10: Pool Cover

Non-Measured – Engineering Calculations

Pre-Installation Baseline:
None

Post-Installation:
Inspection of installation

Minimum Duration of Measurement:
None Required, annual inspection of pool cover

Stipulated Variables:
Operational hours

FIM 11-1: Low Emissivity Ceiling ("Low-E ceiling")

Non-Measured – Engineering Calculations

Pre-Installation Baseline:
None Required

Post-Installation:
Verify that the new ceiling has been installed correctly

Duration of Measurement:
None Required

Stipulated Variables:
Pre-installation heat transfer variables for existing ceiling, Ice Emissivity values

FIM 11-2: Infrared Ice Surface Temperature Monitoring and Controls

IPMVP Option A

Pre-Installation Baseline:
Record existing ice temperature readings for a two – four week period

Post-Installation:
Record post-installation ice temperatures for a two – four week period.

Duration of Measurement:
One time before and after implementation, annual review of ice temperature sample

Stipulated Variables:
None Required

FIM 11-3: Dehumidification Controls

IPMVP Option A

Pre-Installation Baseline:
Record existing equipment (motor hp, heating / cooling capability) and control strategies (occ. control, outside air delivery system, humidity control capability). Record existing humidity levels

Post-Installation:
Verify new equipment operation (motor hp, heating / cooling capability) approved control strategies (occ. control, outside air delivery, humidity control capability). Annual review of FIM operation and functionality, also identify overrides to approved control strategies. Track and trend humidity levels through building automation system.

Duration of Measurement:

Annual tracking of humidity levels

Stipulated Variables:
Hours of operation, equipment energy consumption pre & post retrofit, operational temperatures

FIM 11-4: Icemax to Maintain Consistent Ice Surface

IPMVP Option A

Pre-Installation Baseline:
Record existing brine supply and return temperatures

Post-Installation:
Record post implementation brine supply and return temperatures.

Duration of Measurement:
Four weeks pre-installation and four weeks post installation

Stipulated Variables:
Chiller efficiency

Considerations:
Icemax is a chemical that is applied to the ice manually through the ice resurfacing machine. The ice resurfacing machine operator is responsible for adding the icemax to the hot water tank on the resurfacing machine. There is the possibility that the chemical will not be added to the resurfacing machine by accident, or the fill tank on the resurfacing machine may overflow during fill-up, diluting the chemical to a point where it has lost its potency and is no longer effective. The effectiveness of icemax will be acknowledged during the post-installation period and savings will be based on proper application of the chemical.

FIM 11-5: Move the dashers inboard

Non-Measured – Engineering Calculations

Pre-Installation Baseline:
Document the pre-existing condition of the dasher boards (scale drawings). Document the pre-installation brine supply temperature.

Post-Installation:
Verify proper retrofit of dasher boards; document the post-installation brine supply temperature

Minimum Duration of Measurement:
One-time pre & post installation (four weeks pre-installation & four weeks post-installation)

Stipulated Variables:

Pre-Installation supply temperature once measured

FIM 11-6: Cooling System Upgrade - Chiller Replacement

IPMVP Option C

Pre-Installation Baseline:

Unit energy input (MMbtu) will be calculated based on manufactures specifications. Measure chilled water flow, and temperature differential. Determine existing efficiency (COP based on manufactures specifications) and tons in weather bins, both occupied and unoccupied. Set natural gas baseline.

Post-Installation:

Measure unit energy input (kW, therm, MMbtu, etc…) chilled water flow, and temperature differential; record outside air temperature during all measurements. Monitor natural gas and electricity consumption for the facility.

Minimum Duration of Measurement:

Measurements will be taken at least two weeks before and four weeks after implementation when cooling is required. Ongoing kW/ton readings and annual inspection of equipment

Stipulated Variables:

COP of existing chiller based on manufacturers specifications, Load profile weather bins not measured, Operational hours

FIM 11-7: VFD on Pumps

IPMVP Option A

Pre-Installation Baseline:

Identify existing operational schedules, strategies and control capacity for each pump associated with FIM 11-7. Record existing pump type, operational flow and load profile for each pump associated with FIM 11-7. Measure pump motor kW.

Post-Installation:

Inspect all installed equipment for proper operation and control. Verify varied speed operation (varied flow). Measure Pump Motor kW.

Minimum Duration of Measurement:

Annual inspection of all VFDs installed, confirm variable speed operation

Stipulated Variables:

Hours of Operation, motor power

FIM 12: Power Factor Correction

IPMVP Option A

Pre-Installation Baseline:

Measurement and documentation of exiting power factor values for a representative amount of the equipment affected by FIM 12

Post-Installation:

Measurement and documentation of power factor values for the same representative amount of the equipment post-installation

Minimum Duration of Measurement:

One-time pre & post installation

Stipulated Variables:

Pre-Installation Power Factor once measured

FIM 13: Transformers - Retrofit

IPMVP Option A

Pre-Installation Baseline:

Measurement of pre-retrofit power, harmonics, PF and efficiency

Post-Installation:

Measurement of post- retrofit power, harmonics, PF and efficiency

Minimum Duration of Measurement:

At least two weeks pre and installation and post installation

Stipulated Variables:

Operational Hours, Input Power

Minimum Duration of Measurement:

One-time pre and post installation. Annual inspection of aeration blower system and O&M records

Stipulated Variables:

Pre-Installation loading, hours-of-operation

Considerations:

Operation and maintenance will be performed by The City of Dover in accordance with manufacture's specifications and recommendations.

FIM 14: Aeration Blower Update (WWTP)

IPMVP Option A

Pre-Installation Baseline:

Measure and record power draw and loading of existing system.

Post-Installation:

Measure and record power draw of new system.

Minimum Duration of Measurement:

One-time pre and post installation. Annual inspection of aeration blower system and O&M records

Stipulated Variables:

Pre-Installation loading, hours-of-operation

Considerations:

Operation and maintenance will be performed by The City of Dover in accordance with manufacture's specifications and recommendations.

FIM 15: Boiler Replacement

IPMVP Option A

Pre-Installation Baseline:

Past 24 months fuel use correlated to weather data with combustion efficiency stipulated at 78% (Boiler replaced during detailed audit, November 2008 as part of emergency repair).

Post-Installation:

Perform combustion efficiency test over a range of firing rates to ensure greater efficiency over old boiler

Minimum Duration of Measurement:

One week of variable load post-installation, annual combustion efficiency testing

Stipulated Variables:

Pre-installation boiler efficiency

SECTION 6 – Commissioning Plan

Purpose

The purpose of the commissioning plan is to provide direction for the commissioning process during construction. In particular, it provides details on issues such as scheduling, participation of various parties in this particular project, actual lines of reporting and approvals, coordination, etc. This plan will facilitate the commissioning, cleaning, and testing of the motors, VFDs, boilers, building controls and HVAC units, prior to and during start-up. For Johnson Controls, commissioning plan and guidelines please see Appendix 6.

The instructions contained herein are not intended to override any of the specific recommendations presented in the individual equipment manuals. In fact, by reference, the equipment manuals are made an active part of these instructions. Consequently, this document, together with the individual equipment manuals, must be followed as each system is brought into active service. The individual equipment manuals will contain detailed information that describes installation, checkout and start-up, safe operation, maintenance, and repairs.

The interaction of each item or system within the entire facility must be considered as each is activated. Due to interactions, certain compromises must be made as they arise. In some cases, the operating conditions are temporarily exceeded in order to ensure proper performance at the design level. In addition, there are periods when some of the safety devices are bypassed or temporarily rendered inoperative. This condition requires that a careful system of tags, checking, and follow-up documentation be imposed to restore all elements to their proper condition prior to start-up. It also requires rigorous monitoring of the systems during such testing.

Scheduling of these preparatory activities will be carefully coordinated with the construction phase to ensure an expeditious and well-organized start-up. No attempt is made here to establish the order in which these tasks are to be performed. This sequence is best established in the field, with due consideration being given to the status of construction, the availability of the required utilities, and responsible personnel.

The roles of the manufacturer's representative, system test conductor, contractor personnel, and operating staff must be clearly defined at each step. Precise lines of authority and communication at each level must be enforced to ensure the safety of all personnel and to limit chances for damaging expensive equipment and property. This plan does not provide a detailed explanation of required testing procedures. The detailed testing procedures, forms, checklists, etc. will be developed during the design phase and will be available on site during the construction and testing phase.

Commissioning Scope

Commissioning is a systematic process of ensuring that all FIMs perform interactively according to the design intent and the owner's operational needs. This is achieved by: 1) clearly documenting the design intent during the design phase, 2) verifying the design intent throughout construction, start-up, commissioning, and acceptance, and 3) verifying ongoing performance during the warranty and performance periods.
Initial commissioning begins prior to and during the design phase of the project. At this time, the project objectives are clearly defined and a review process is established to ensure that: 1) the design documents fully incorporate each FIMs operating and performance objectives and that the designs and specifications comply with all applicable codes, and 2) the project specifications fully define the testing and quality control requirements needed to ensure that the design intent has been achieved. In addition, JC develops an "initial" commissioning plan to outline the commissioning requirements of each FIM as well as the key performance factor that must be met in order to achieve measure acceptance. JC will also provide all pre-functional acceptance test and functional acceptance test forms for customer review and approval.

Commissioning during the construction phase of the project is intended to achieve the following specific objectives:

- Verify the proper operation of all system and equipment safety devices.
- Ensure that all applicable equipment and systems are installed in accordance with engineering drawings, manufacturer installation manuals, and applicable codes.
- Ensure that all equipment and systems receive adequate operational checkout by the installing contractors.
- Verify and document proper performance of equipment and systems.
- Ensure that a complete package of commissioning, as-built, and operating and maintenance documentation is left on site.
- Ensure that the operating and maintenance personnel are adequately trained.

After the design phase is complete, JC develops a final start-up and commissioning plan to detail the steps required to achieve the above objectives.

SECTION 7 – Project Schedule

Once final selection of facility improvement measures is completed Johnson Controls will prepare a detailed project schedule using Microsoft Project. This schedule will contain a FIM by FIM implementation matrix and outline specific project milestones such as; mobilization, construction meetings, material delivery, implementation and project commissioning, measurement and verification and closeout. At this time, Johnson Controls has contemplated a 9-12 month project delivery schedule depending on the mix of facility improvement measures.

SECTION 8 Appendix – Supporting Documentation

Appendix 1 – Sources of Information

Appendix 2 – Basic Data for Calculations

Appendix 3 – Calculations

Appendix 4 – Outline Specifications for All Equipment

Appendix 5 – Lighting Schedules

Appendix 6 – Commissioning Plan

Appendix 1
Sources of Information

Information used to develop this Detailed Audit Report was gathered from the following sources:

- Field Surveys and equipment inspections
- Facility Staff Interviews
- Data Logging

Reference Materials

- ASHRAE Journal
- Bin Maker Pro – Weather Bin Data
- Manufacturer Specific Data as Outlined in Facility Improvement Measure descriptions
    - Chiller Performance Data from Tecochill and Carrier
    - Facility plans and specifications furnished by City of Dover staff.

Conversions and Constants

1 kWh	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal #2 Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Appendix 2
Basic Data for Calculations – Utility Data

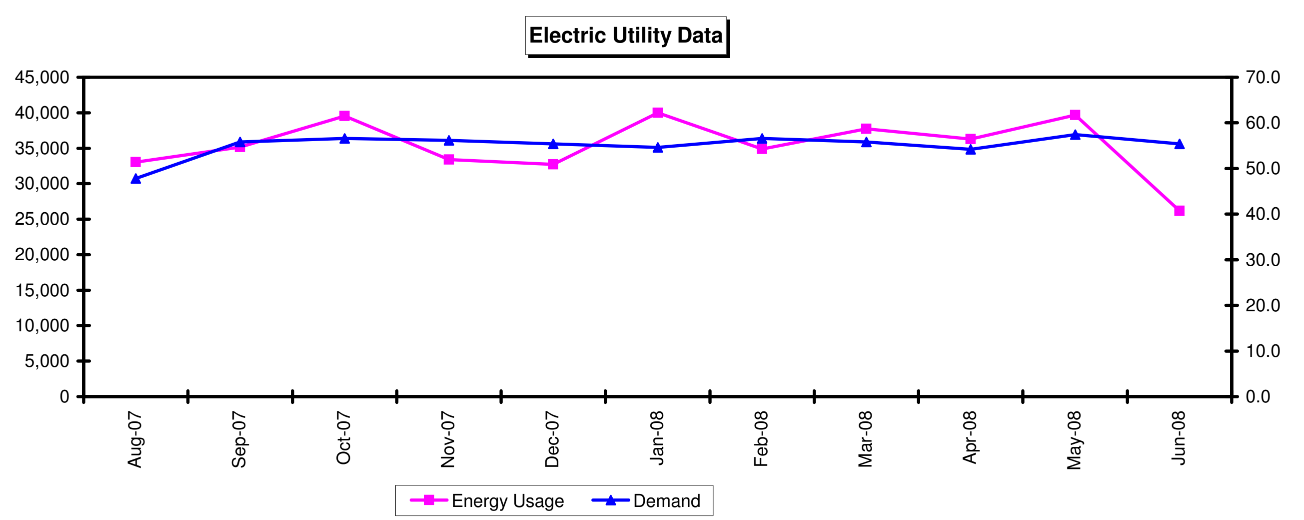
School Name:	Indoor Pool	Utility Company:	PSNH
Year Built:	1968	Old Acct. No.:	8000619-02-9-4
School Address:	9 Henry Law Ave	New Acct. N	8000619-02-9-4
	Dover, NH	Rate:	G, Three Phase
Phone Number:	516-6441	Date:	2/7/2009
Principal's Name:	Mick Arsenault		
Facility Area:	10,279 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

Billing Period	A: Demand Total (kW)	Demand Cost	B: Usage Total (kWh)	Usage Cost	kWh Unit Cost	C: Total Cost	D: Billing Days	E: Hours per month	F: Load Factor
2007/2008									
Aug-07	54.6	$493	34,440	$3,505	$0.102	$3,998	29	696	0.91
Sep-07	47.8	$432	33,040	$3,364	$0.102	$3,796	33	792	0.87
Oct-07	55.8	$504	35,160	$3,577	$0.102	$4,081	30	720	0.88
Nov-07	56.6	$511	39,520	$4,013	$0.102	$4,525	33	792	0.88
Dec-07	56.2	$507	33,400	$3,400	$0.102	$3,908	28	672	0.88
Jan-08	55.4	$480	32,720	$3,459	$0.106	$3,939	29	696	0.85
Feb-08	54.6	$473	40,000	$4,216	$0.105	$4,689	34	816	0.90
Mar-08	56.6	$491	34,880	$3,683	$0.106	$4,174	28	672	0.92
Apr-08	55.8	$484	37,720	$3,979	$0.105	$4,462	30	720	0.94
May-08	54.2	$470	36,280	$3,829	$0.106	$4,299	29	696	0.96
Jun-08	57.4	$498	39,680	$4,182	$0.105	$4,680	32	768	0.90
Jul-08	55.4	$480	26,160	$2,995	$0.114	$3,475	30	720	0.66
Avg./Totals:	**55.0**	**$5,823**	**423,000**	**$44,202**		**$50,025**	**365**	**8,760**	**0.88**

Energy Intensity (kWh/sq.ft.):	**41.15**	**Avg. Cost/kWh:**	**$0.104**
Blended Cost (inc.demand)/kWh:	**$0.118**	**Avg. Cost/kW:**	**$8.82**

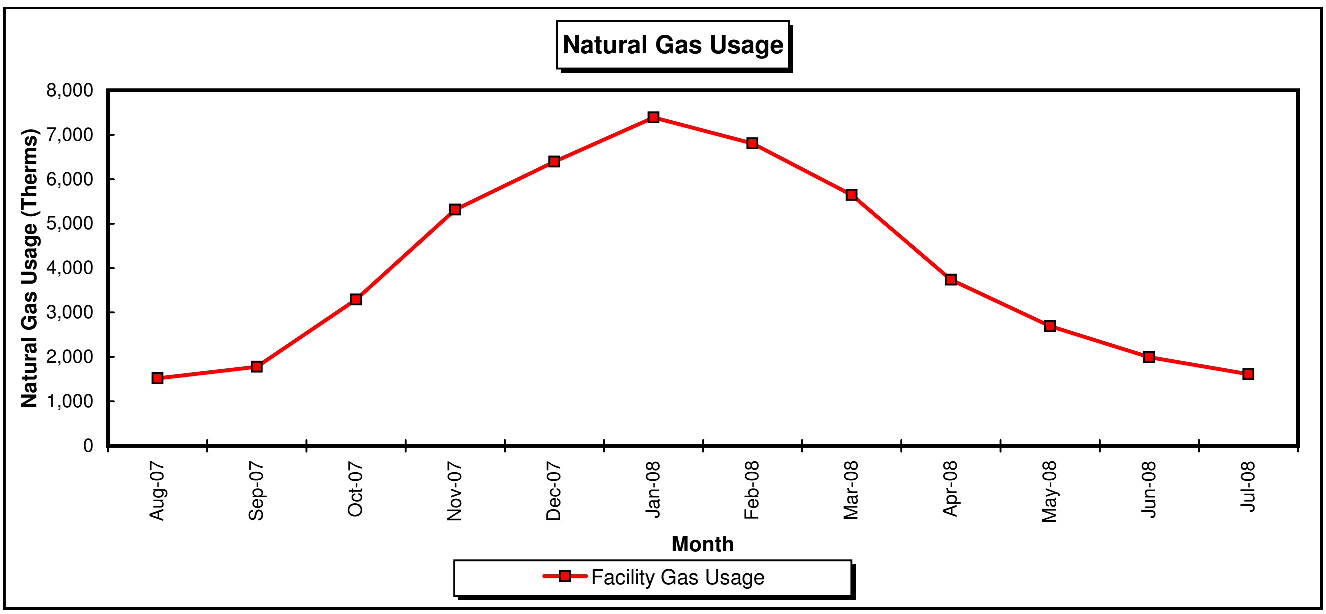
Table Formulas: Hours per Month = D x 24   Load Factor = B/(A x E)



School Name: Indoor Pool
Year Built: 1968
School Address: 9 Henry Law Ave
Dover, NH
Phone Number: 516-6441
Principal's Name: Mick Arsenault
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 579-752-000-7
Rate: 0
Date: 2/7/2009
Facility Area: 10,279 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	1,520	$1,543	$1.015	152	14.787
Sep-07	1,778	$4,037	$2.271	178	17.297
Oct-07	3,288	$5,919	$1.800	329	31.988
Nov-07	5,317	$7,429	$1.397	532	51.727
Dec-07	6,394	$8,525	$1.333	639	62.204
Jan-08	7,389	$9,891	$1.339	739	71.884
Feb-08	6,804	$8,979	$1.320	680	66.193
Mar-08	5,643	$7,726	$1.369	564	54.898
Apr-08	3,736	$5,563	$1.489	374	36.346
May-08	2,691	$4,175	$1.551	269	26.180
Jun-08	1,996	$3,054	$1.530	200	19.418
Jul-08	1,614	$2,387	$1.479	161	15.702
Totals:	**48,170**	**$69,230**		**4,817**	**468.625**
Energy Intensity (MBtu/sq. ft.):		**468.63**			
Avg. Cost $/Therm		**$1.437**			



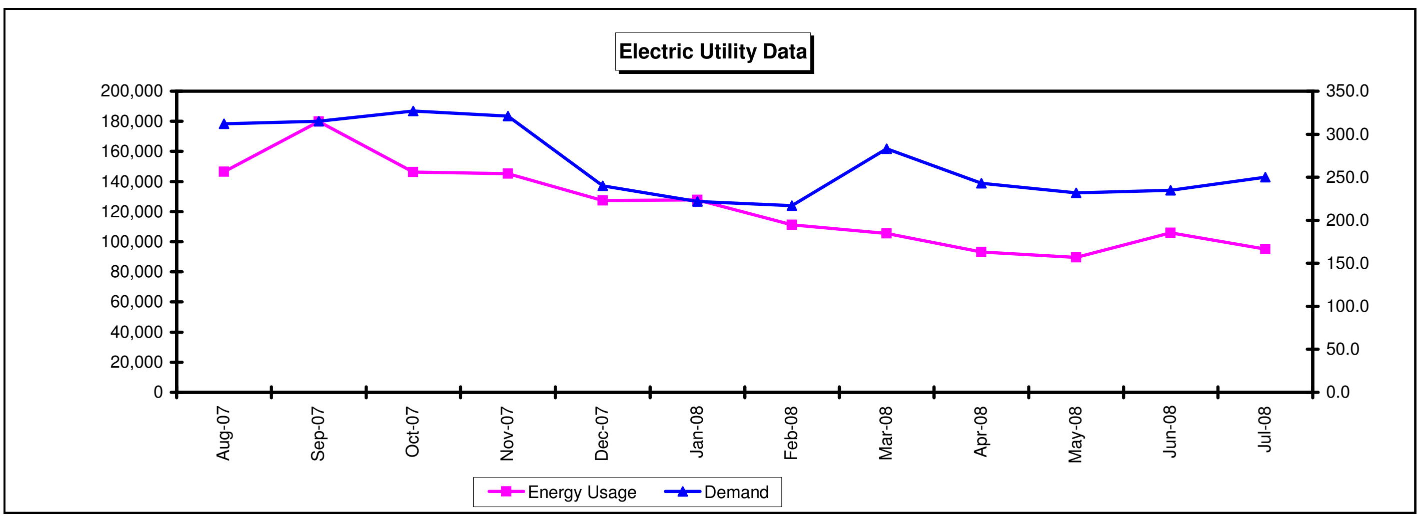
School Name: Dover Ice Arena
Year Built: 1974/2001
School Address: 110 Portland Ave
Dover, NH
Phone Number: 516-6060
Principal's Name: Patrick McNulty, Barry Rioxdan
Facility Area: 126,084 sq. ft.

Utility Company: PSNH
Old Acct. No.: 8000626-01-6-2
New Acct. N 8000626-01-6-2
Rate: GV
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	312.0	$2,241	146,400	$14,866	$0.102	$17,107	30	720	0.65
Sep-07	315.0	$2,262	179,800	$18,198	$0.101	$20,460	32	768	0.74
Oct-07	327.0	$2,347	146,200	$14,846	$0.102	$17,193	30	720	0.62
Nov-07	321.0	$2,305	145,200	$14,746	$0.102	$17,051	31	744	0.61
Dec-07	240.0	$1,644	127,400	$13,494	$0.106	$15,139	31	744	0.71
Jan-08	222.0	$1,523	127,800	$13,536	$0.106	$15,059	32	768	0.75
Feb-08	217.0	$1,489	111,200	$11,812	$0.106	$13,301	28	672	0.76
Mar-08	283.0	$1,934	105,600	$11,230	$0.106	$13,164	31	744	0.50
Apr-08	243.0	$1,664	93,200	$9,942	$0.107	$11,607	29	696	0.55
May-08	232.0	$1,590	89,600	$9,568	$0.107	$11,159	29	696	0.55
Jun-08	235.0	$1,770	106,000	$12,004	$0.113	$13,774	33	792	0.57
Jul-08	250.0	$1,880	95,200	$10,809	$0.114	$12,689	29	696	0.55
Avg./Totals:	**266.4**	**$22,651**	**1,473,600**	**$155,051**		**$177,702**	**365**	**8,760**	**0.63**
Energy Intensity (kWh/sq.ft.):			**11.69**		**Avg. Cost/kWh:**	**$0.105**			
Blended Cost (inc.demand)/kWh:			**$0.121**		**Avg. Cost/kW:**	**$7.09**			

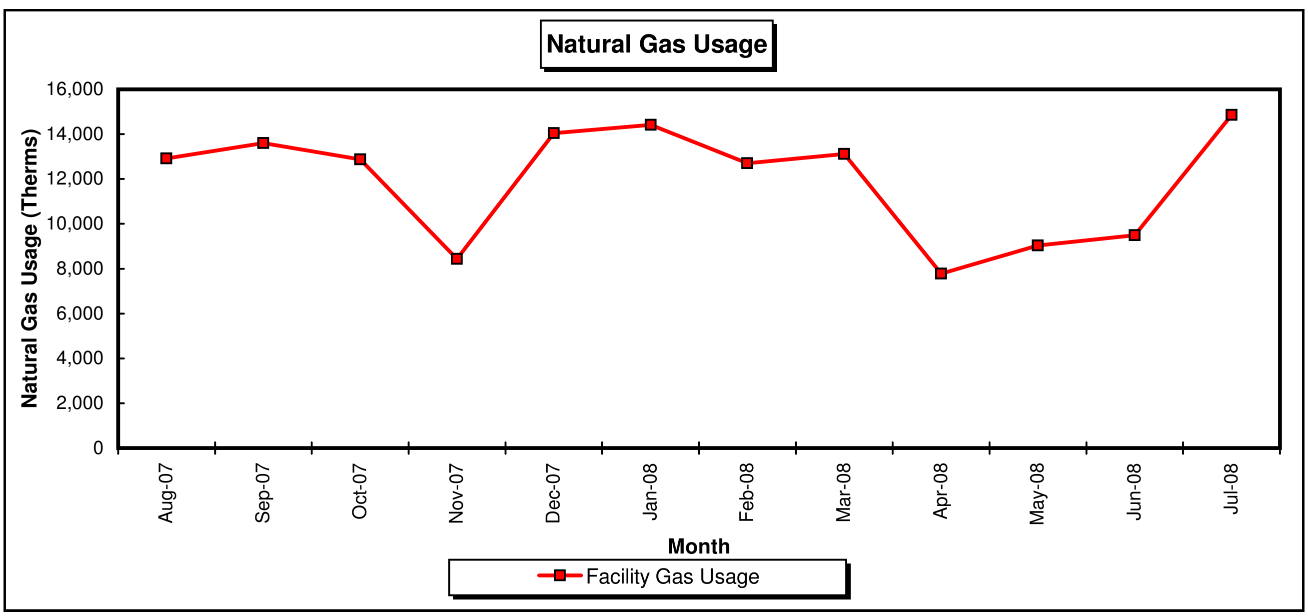
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	Dover Ice Arena
Year Built:	1974/2001
School Address:	110 Portland Ave
	Dover, NH
Phone Number:	516-6060
Principal's Name:	Patrick McNulty, Barry Rioxdan
Utility Company:	Northern Utilities/ Metromedia Energy
Account No.:	957-752-009-0
Rate:	0
Date:	2/7/2009
Facility Area:	126,084 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	12,923	$11,682	$0.904	1,292	10.250
Sep-07	13,597	$10,888	$0.801	1,360	10.784
Oct-07	12,869	$16,301	$1.267	1,287	10.207
Nov-07	8,430	$12,660	$1.502	843	6.686
Dec-07	14,039	$18,483	$1.317	1,404	11.135
Jan-08	14,419	$19,077	$1.323	1,442	11.436
Feb-08	12,708	$16,795	$1.322	1,271	10.079
Mar-08	13,110	$17,303	$1.320	1,311	10.398
Apr-08	7,784	$10,135	$1.302	778	6.174
May-08	9,038	$13,475	$1.491	904	7.168
Jun-08	9,495	$13,405	$1.412	950	7.531
Jul-08	14,855	$20,828	$1.402	1,486	11.782
Totals:	**143,267**	**$181,032**		**14,327**	**113.628**
Energy Intensity (MBtu/sq. ft.):		**117.04**			
Avg. Cost $/Therm		**$1.264**			



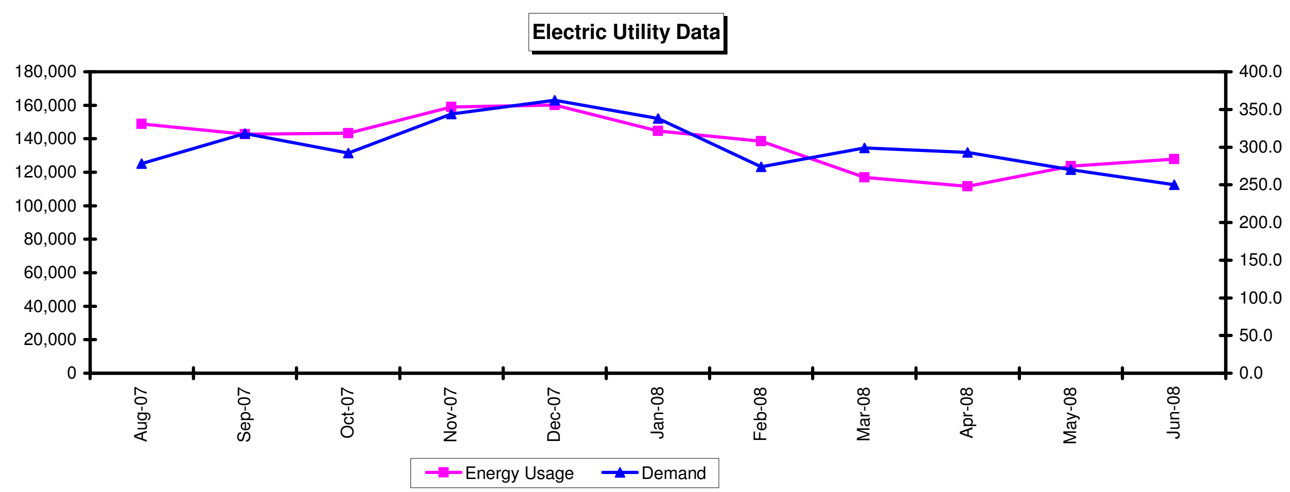
School Name:	Wate Water Treatment Facility	Utility Company:	PSNH
Year Built:	1991	Old Acct. No.:	8000672-03-5-5
School Address:	484 Middle Road	New Acct. N	8000672-03-5-5
	Dover, NH	Rate:	GV
Phone Number:	396-4008	Date:	2/7/2009
Principal's Name:	Ray Vermette		
Facility Area:	0 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	325.0	$2,333	144,600	$14,560	$0.101	$16,893	30	720	0.62
Sep-07	278.0	$2,000	148,800	$14,979	$0.101	$16,979	32	768	0.70
Oct-07	318.0	$2,284	142,800	$14,380	$0.101	$16,664	30	720	0.62
Nov-07	292.0	$2,099	143,400	$14,440	$0.101	$16,539	30	720	0.68
Dec-07	344.0	$2,468	159,000	$15,996	$0.101	$18,464	31	744	0.62
Jan-08	362.0	$2,465	160,200	$16,774	$0.105	$19,239	30	720	0.61
Feb-08	338.0	$2,304	144,600	$15,154	$0.105	$17,458	30	720	0.59
Mar-08	274.0	$1,873	138,600	$14,531	$0.105	$16,404	31	744	0.68
Apr-08	299.0	$2,041	117,000	$12,287	$0.105	$14,329	30	720	0.54
May-08	293.0	$2,001	111,600	$11,727	$0.105	$13,727	29	696	0.55
Jun-08	270.0	$1,846	123,600	$12,973	$0.105	$14,819	32	768	0.60
Jul-08	250.0	$1,880	127,800	$14,293	$0.112	$16,173	31	744	0.69
Avg./Totals:	**303.6**	**$25,594**	**1,662,000**	**$172,093**		**$197,687**	**366**	**8,784**	**0.63**

Energy Intensity (kWh/sq.ft.):	**-**	**Avg. Cost/kWh:**	**$0.104**
Blended Cost (inc.demand)/kWh:	**$0.119**	**Avg. Cost/kW:**	**$7.03**

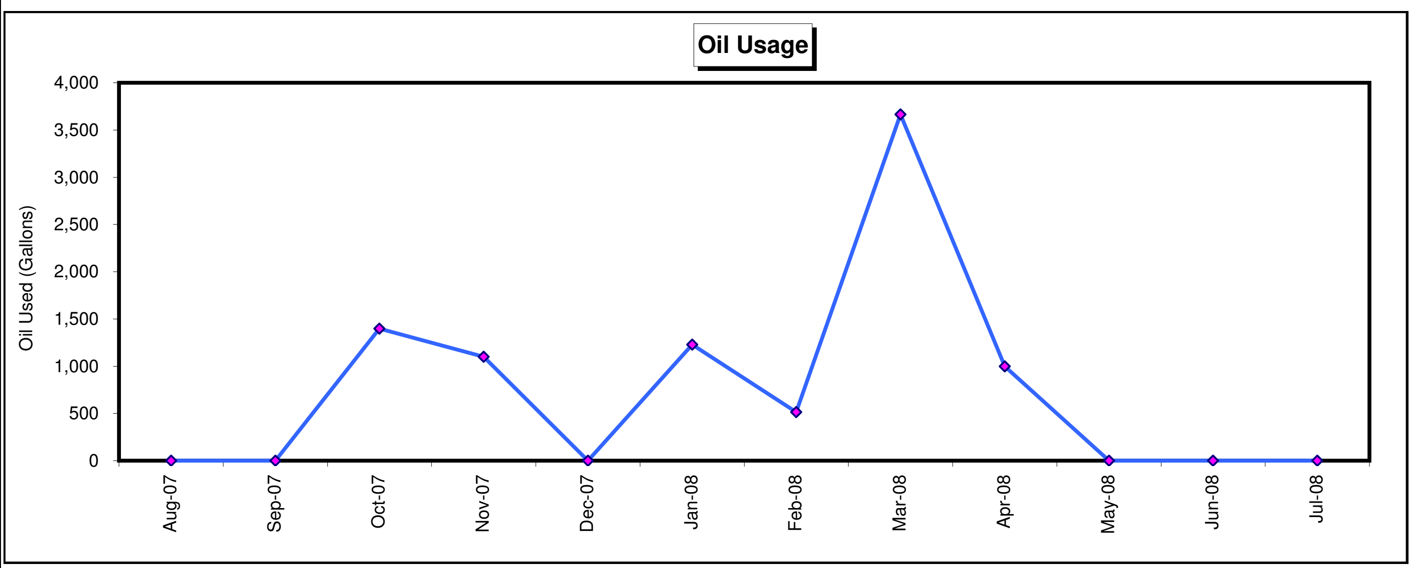
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	Wate Water Treatment Facility
Year Built:	1991
School Address:	484 Middle Road
	Dover, NH
Phone Number:	396-4008
Principal's Name:	Ray Vermette
Utility Company:	0
Account No.:	0
Rate:	0
Date:	2/7/2009
Facility Area:	0 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2007/2008					
Aug-07	0	$0	$0.000	0.0	
Sep-07	0	$0	$0.000	0.0	
Oct-07	1,398	$3,230	$2.310	193.8	
Nov-07	1,100	$2,541	$2.310	152.5	
Dec-07	0	$0	$0.000	0.0	
Jan-08	1,227	$2,834	$2.310	170.0	
Feb-08	516	$1,192	$2.310	71.5	
Mar-08	3,665	$8,466	$2.310	508.0	
Apr-08	1,000	$2,310	$2.310	138.6	
May-08	0	$0	$0.000	0.0	
Jun-08	0	$0	$0.000	0.0	
Jul-08	0	$0	$0.000	0.0	
Total	**8,906**	**$20,573**	**$2.31**	**1,234.4**	**$0.00**
Energy Intensity (MBtu/sq. ft.):		**-**			
Avg. Cost $/Gallon		**$2.310**			



School Name: Dover City Hall
Year Built: 1935
School Address: 288 Central Avenue
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Facility Area: 44,844 sq. ft.

Utility Company: PSNH
Old Acct. No.: 61-35-02648-0-2, 61-35-02789-0-1
New Acct. N 56906401021, 56395401037
Rate: 0
Date: 2/7/2009

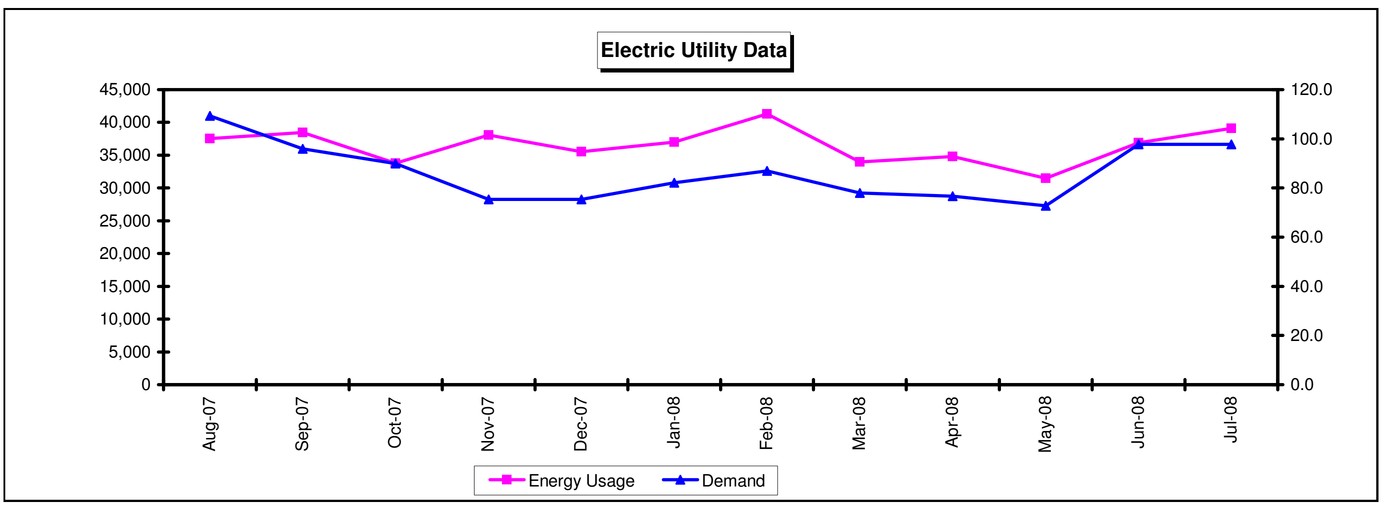
Includes only city Mgr bldg and police dept

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	109.3		37,530	$4,756	$0.127	$4,756	33	792	0.43
Sep-07	95.9		38,480	$4,730	$0.123	$4,730	31	744	0.54
Oct-07	89.9		33,780	$4,205	$0.124	$4,205	30	720	0.52
Nov-07	75.4		38,080	$4,505	$0.118	$4,505	31	744	0.68
Dec-07	75.4		35,510	$4,309	$0.121	$4,309	30	720	0.65
Jan-08	82.1		37,000	$4,574	$0.124	$4,574	31	744	0.61
Feb-08	86.9		41,270	$5,060	$0.123	$5,060	31	744	0.64
Mar-08	78.0		33,980	$4,225	$0.124	$4,225	29	696	0.63
Apr-08	76.7		34,780	$4,297	$0.124	$4,297	31	744	0.61
May-08	72.7		31,460	$3,917	$0.124	$3,917	30	720	0.60
Jun-08	97.8		36,920	$4,702	$0.127	$4,702	31	744	0.51
Jul-08	97.8		39,100	$5,259	$0.134	$5,259	30	720	0.56
Avg./Totals:	**86.5**	**$0**	**437,890**	**$54,539**		**$54,539**	**368**	**8,832**	**0.58**

Energy Intensity (kWh/sq.ft.):	**9.76**	**Avg. Cost/kWh:**	**$0.125**
Blended Cost (inc.demand)/kWh:	**$0.125**	**Avg. Cost/kW:**	**$0.00**

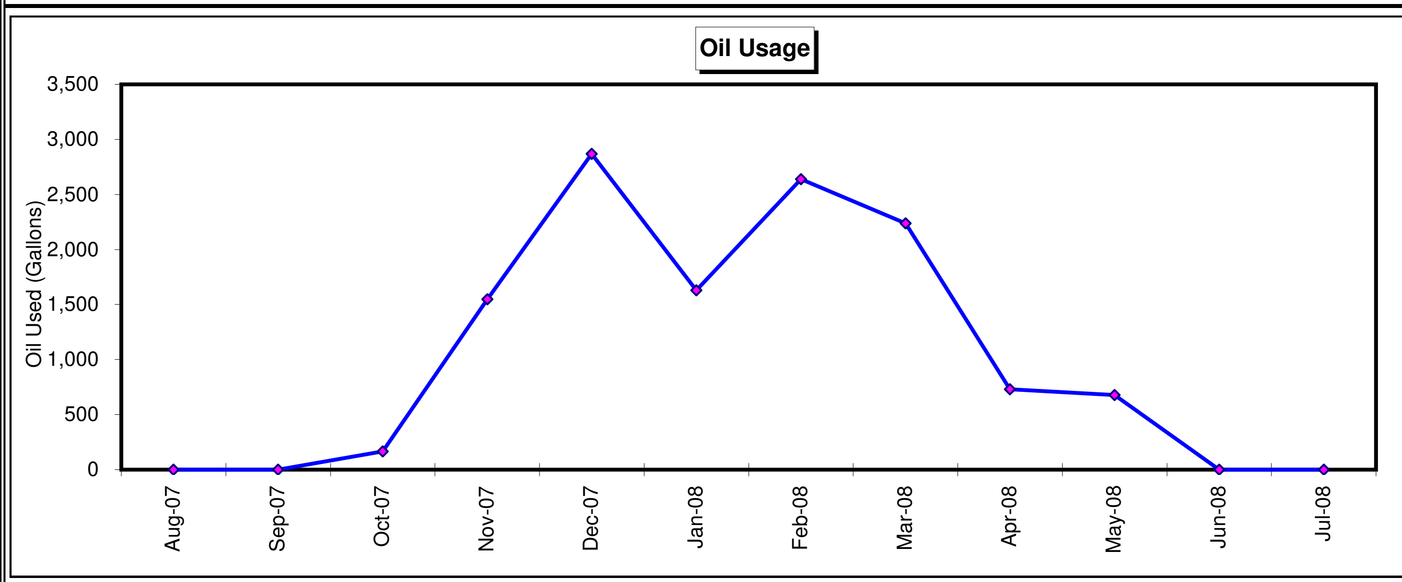
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Dover City Hall
Year Built: 1935
School Address: 288 Central Avenue
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Utility Company: Downeast Energy
Account No.: 306432
Rate: 0
Date: 2/7/2009
Facility Area: 44,844 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2007/2008					
Aug-07	0	$0	$0.000	0.0	$0.00
Sep-07	0	$0	$0.000	0.0	$0.00
Oct-07	166	$383	$2.310	23.0	$0.01
Nov-07	1,547	$3,572	$2.310	214.3	$0.08
Dec-07	2,869	$6,628	$2.310	397.7	$0.15
Jan-08	1,629	$3,763	$2.310	225.8	$0.08
Feb-08	2,638	$6,094	$2.310	365.6	$0.14
Mar-08	2,237	$5,168	$2.310	310.1	$0.12
Apr-08	729	$1,684	$2.310	101.1	$0.04
May-08	679	$1,568	$2.310	94.1	$0.03
Jun-08	0	$0	$0.000	0.0	$0.00
Jul-08	0	$0	$0.000	0.0	$0.00
Total	**12,494**	**$28,860**	**$2.31**	**1,731.6**	**$0.64**
Energy Intensity (MBtu/sq. ft.):		**38.61**			
Avg. Cost $/Gallon		**$2.310**			



School Name:	Public Works
Year Built:	2001
School Address:	271 Mast Rd
	Dover, NH
Phone Number:	396-3117
Principal's Name:	Bart Carson
Facility Area:	54,800 sq. ft.

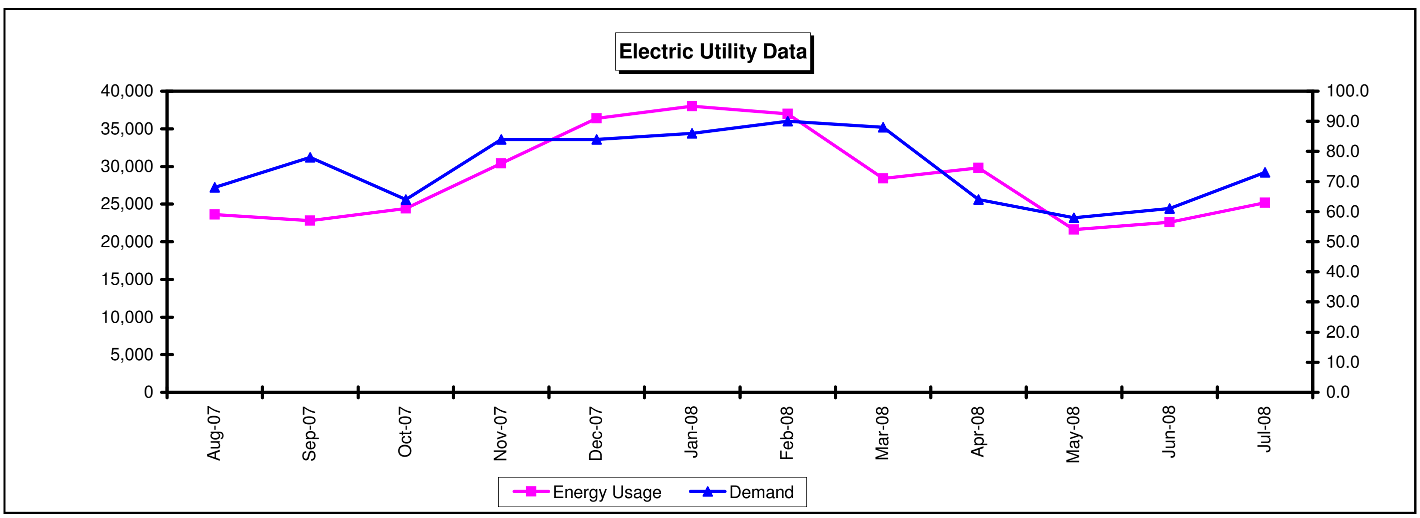
Utility Company: PSNH
Old Acct. No.: 61-10-09245-1-5
New Acct. N 56632841078
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	68.0		23,600	$2,988	$0.127	$2,988	32	768	0.45
Sep-07	78.0		22,800	$2,998	$0.131	$2,998	30	720	0.41
Oct-07	64.0		24,400	$3,032	$0.124	$3,032	30	720	0.53
Nov-07	84.0		30,400	$3,813	$0.125	$3,813	30	720	0.50
Dec-07	84.0		36,400	$4,526	$0.124	$4,526	31	744	0.58
Jan-08	86.0		38,000	$4,710	$0.124	$4,710	30	720	0.61
Feb-08	90.0		37,000	$4,641	$0.125	$4,641	30	720	0.57
Mar-08	88.0		28,400	$3,729	$0.131	$3,729	31	744	0.43
Apr-08	64.0		29,800	$3,666	$0.123	$3,666	29	696	0.67
May-08	58.0		21,600	$2,762	$0.128	$2,762	31	744	0.50
Jun-08	61.0		22,600	$3,130	$0.139	$3,130	30	720	0.51
Jul-08	73.0		25,200	$3,530	$0.140	$3,530	33	792	0.44
Avg./Totals:	**74.8**	**$0**	**340,200**	**$43,525**		**$43,525**	**367**	**8,808**	**0.52**

Energy Intensity (kWh/sq.ft.):	**6.21**	**Avg. Cost/kWh:**	**$0.128**
Blended Cost (inc.demand)/kWh:	**$0.128**	**Avg. Cost/kW:**	**$0.00**

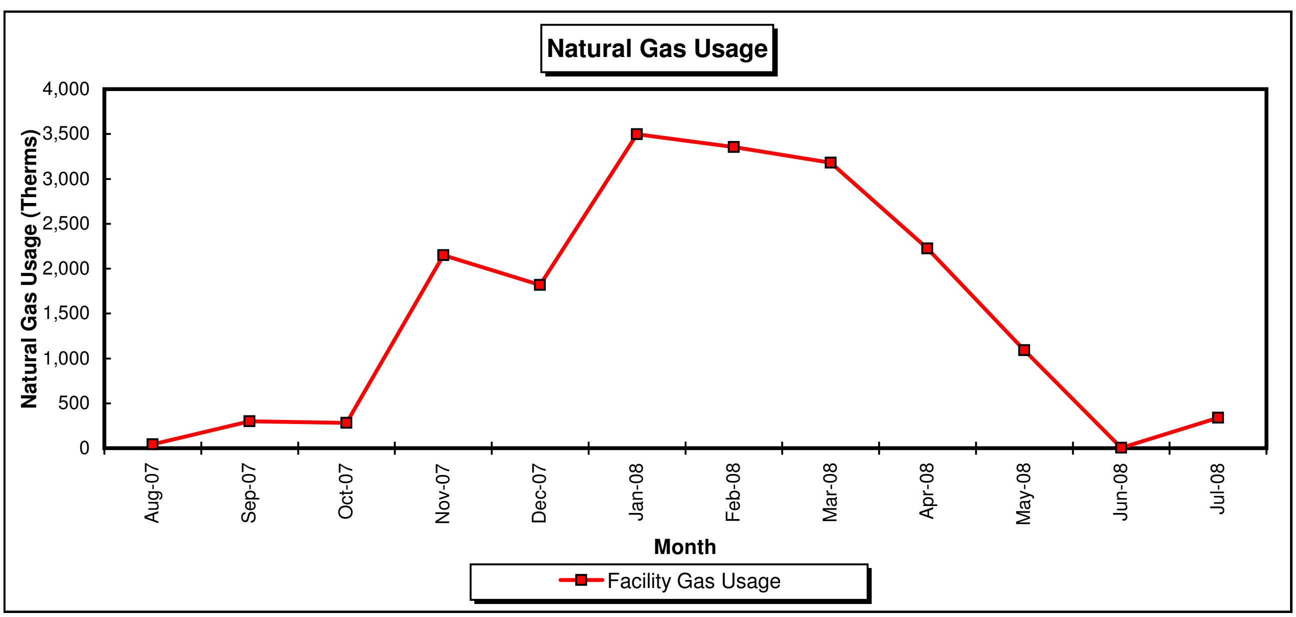
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Public Works
Year Built: 2001
School Address: 271 Mast Rd
Dover, NH
Phone Number: 396-3117
Principal's Name: Bart Carson
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 947-913-002-8
Rate: 0
Date: 2/7/2009
Facility Area: 54,800 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	42	$103	$2.487	4	0.076
Sep-07	298	$101	$0.338	30	0.544
Oct-07	281	$325	$1.155	28	0.513
Nov-07	2,150	$2,810	$1.307	215	3.923
Dec-07	1,817	$2,670	$1.470	182	3.316
Jan-08	3,496	$4,894	$1.400	350	6.380
Feb-08	3,356	$4,810	$1.433	336	6.124
Mar-08	3,179	$3,551	$1.117	318	5.801
Apr-08	2,224	$535	$0.241	222	4.058
May-08	1,090	$220	$0.202	109	1.989
Jun-08	2	$33	$16.575	0	0.004
Jul-08	338	$567	$1.678	34	0.617
Totals:	**18,273**	**$20,618**		**1,827**	**33.344**
Energy Intensity (MBtu/sq. ft.):		**34.34**			
Avg. Cost $/Therm		**$1.128**			



School Name: McConnell Center
Year Built: 1904
School Address: 61 Locust St
Dover, NH
Phone Number: 396-4026,516-6401
Principal's Name: Gary Bannon
Facility Area: 103,000 sq. ft.

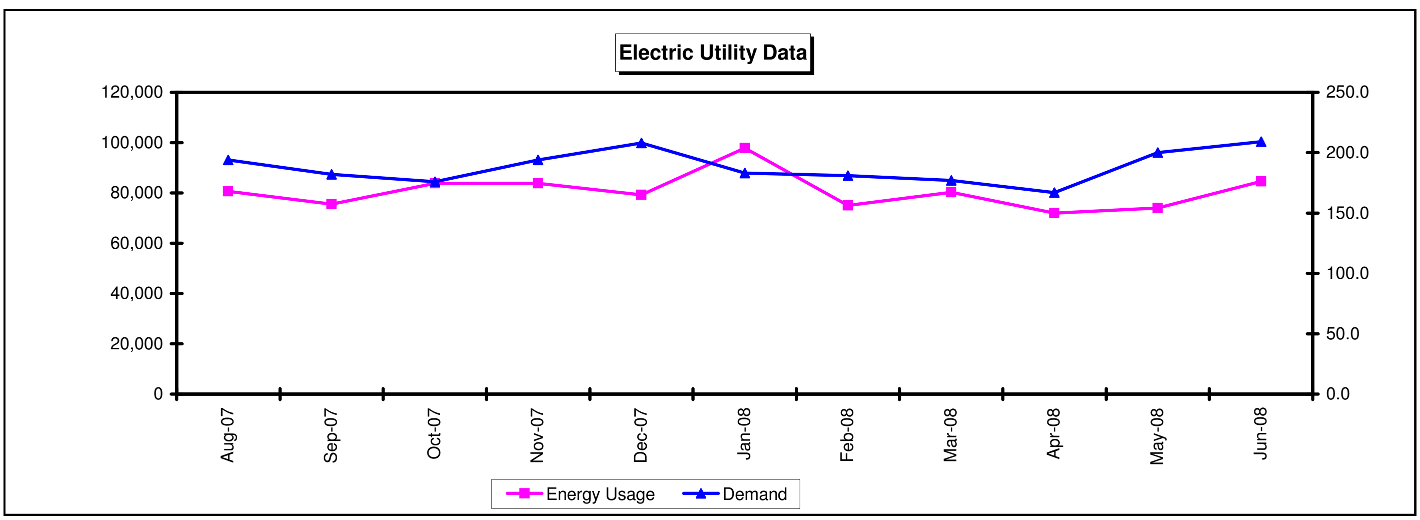
Utility Company: PSNH
Old Acct. No.: 61-35-06856-1-8, 61-35-08894-0-0
New Acct. N 8001869-04-5-5
Rate: GV
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	182.0	$1,319	72,400	$7,604	$0.105	$8,923	30	720	0.55
Sep-07	194.0	$1,407	80,600	$8,431	$0.105	$9,838	33	792	0.52
Oct-07	182.0	$1,319	75,600	$7,897	$0.104	$9,216	30	720	0.58
Nov-07	176.0	$1,277	83,800	$8,715	$0.104	$9,992	33	792	0.60
Dec-07	194.0	$1,404	83,800	$8,715	$0.104	$10,119	29	696	0.62
Jan-08	208.0	$1,429	79,200	$8,582	$0.108	$10,011	28	672	0.57
Feb-08	183.0	$1,261	97,800	$10,514	$0.108	$11,775	34	816	0.65
Mar-08	181.0	$1,247	75,000	$8,146	$0.109	$9,393	27	648	0.64
Apr-08	177.0	$1,220	80,200	$8,686	$0.108	$9,906	30	720	0.63
May-08	167.0	$1,153	72,000	$7,834	$0.109	$8,987	30	720	0.60
Jun-08	200.0	$1,375	74,000	$8,042	$0.109	$9,417	31	744	0.50
Jul-08	209.0	$1,577	84,600	$9,728	$0.115	$11,305	30	720	0.56
Avg./Totals:	**187.8**	**$15,989**	**959,000**	**$102,893**		**$118,882**	**365**	**8,760**	**0.59**

Energy Intensity (kWh/sq.ft.):	**9.31**	**Avg. Cost/kWh:**	**$0.107**
Blended Cost (inc.demand)/kWh:	**$0.124**	**Avg. Cost/kW:**	**$7.10**

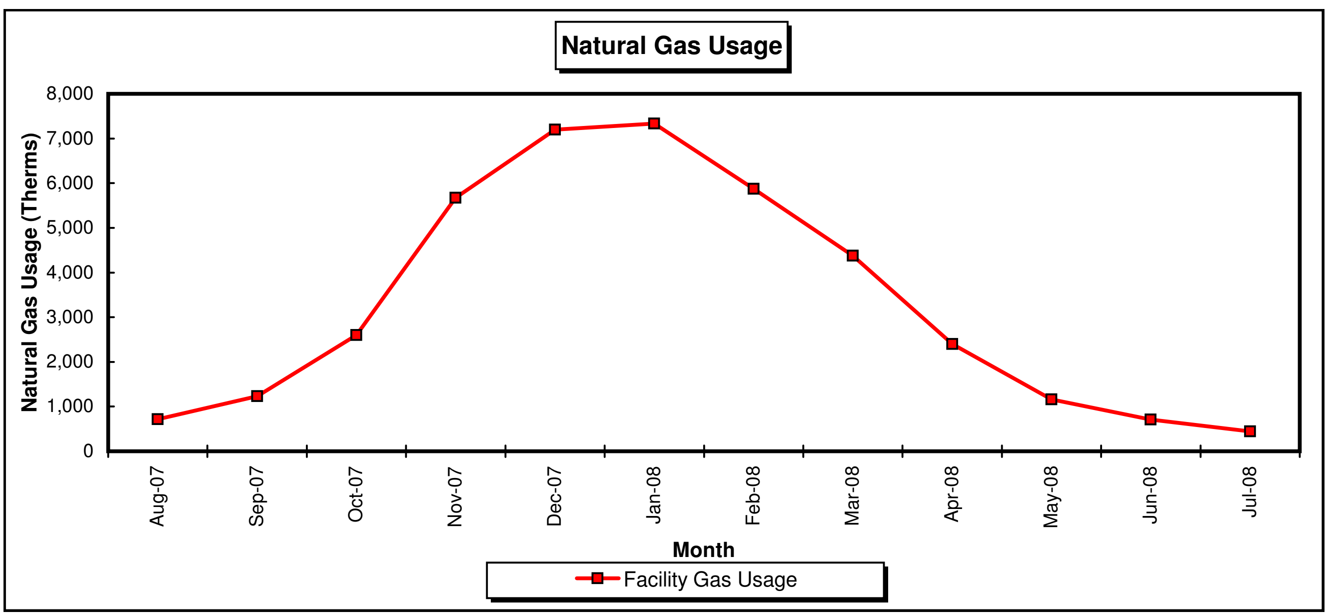
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	McConnell Center
Year Built:	1904
School Address:	61 Locust St
	Dover, NH
Phone Number:	396-4026,516-6401
Principal's Name:	Gary Bannon
Utility Company:	0
Account No.:	0
Rate:	0
Date:	2/7/2009
Facility Area:	103,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	719	$792	$1.101	72	0.698
Sep-07	1,234	$1,950	$1.581	123	1.198
Oct-07	2,603	$4,429	$1.701	260	2.527
Nov-07	5,670	$7,763	$1.369	567	5.505
Dec-07	7,197	$10,093	$1.402	720	6.987
Jan-08	7,335	$9,729	$1.326	734	7.121
Feb-08	5,876	$7,899	$1.344	588	5.705
Mar-08	4,377	$6,025	$1.376	438	4.250
Apr-08	2,400	$3,656	$1.523	240	2.330
May-08	1,162	$1,906	$1.640	116	1.128
Jun-08	709	$1,153	$1.626	71	0.688
Jul-08	444	$689	$1.551	44	0.431
Totals:	**39,726**	**$56,083**		**3,973**	**38.569**
Energy Intensity (MBtu/sq. ft.):		**39.73**			
Avg. Cost $/Therm		**$1.412**			



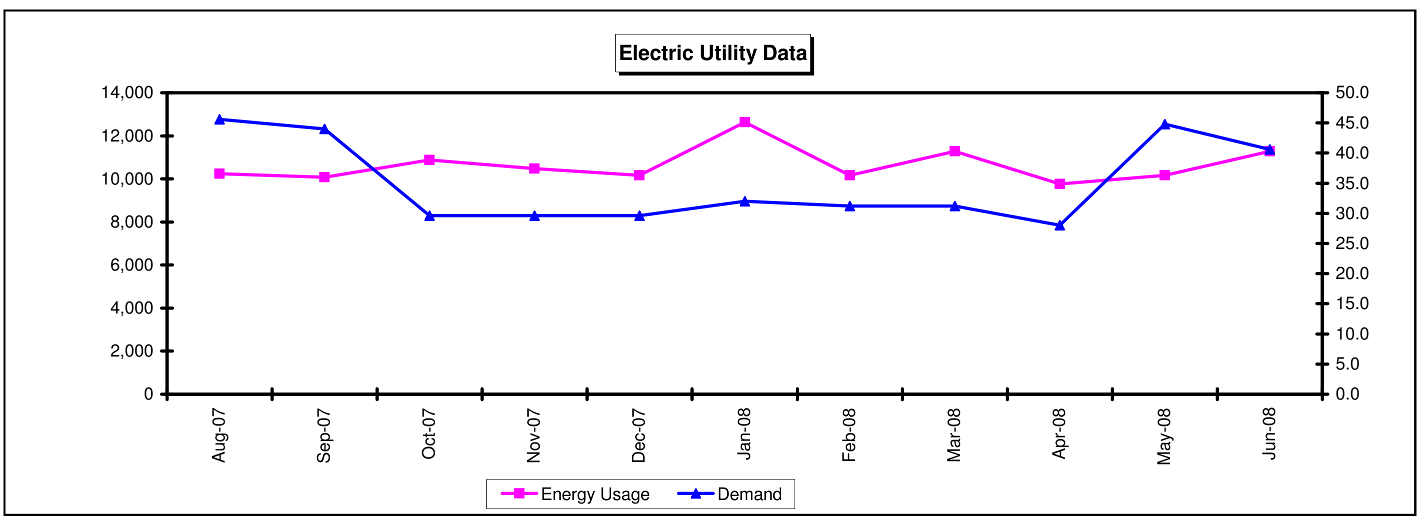
School Name:	Dover Public Library	Utility Company:	PSNH
Year Built:	1905/1988	Old Acct. No.:	61-35-06833-0-8
School Address:	73 Locust St	New Acct. N	56135401073
	Dover, NH	Rate:	0
Phone Number:	516-6050	Date:	2/7/2009
Principal's Name:	Cathy Beaudoin		
Facility Area:	20,000 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	44.8		10,320	$1,448	$0.140	$1,448	28	672	0.34
Sep-07	45.6		10,240	$1,447	$0.141	$1,447	32	768	0.29
Oct-07	44.0		10,080	$1,417	$0.141	$1,417	31	744	0.31
Nov-07	29.6		10,880	$1,367	$0.126	$1,367	33	792	0.46
Dec-07	29.6		10,480	$1,327	$0.127	$1,327	29	696	0.51
Jan-08	29.6		10,160	$1,326	$0.130	$1,326	29	696	0.49
Feb-08	32.0		12,640	$1,604	$0.127	$1,604	33	792	0.50
Mar-08	31.2		10,160	$1,339	$0.132	$1,339	27	648	0.50
Apr-08	31.2		11,280	$1,456	$0.129	$1,456	31	744	0.49
May-08	28.0		9,760	$1,270	$0.130	$1,270	29	696	0.50
Jun-08	44.8		10,160	$1,457	$0.143	$1,457	32	768	0.30
Jul-08	40.6		11,280	$1,684	$0.149	$1,684	31	744	0.37
Avg./Totals:	**35.9**	**$0**	**127,440**	**$17,143**		**$17,143**	**365**	**8,760**	**0.42**

Energy Intensity (kWh/sq.ft.):	**6.37**	**Avg. Cost/kWh:**	**$0.135**
Blended Cost (inc.demand)/kWh:	**$0.135**	**Avg. Cost/kW:**	**$0.00**

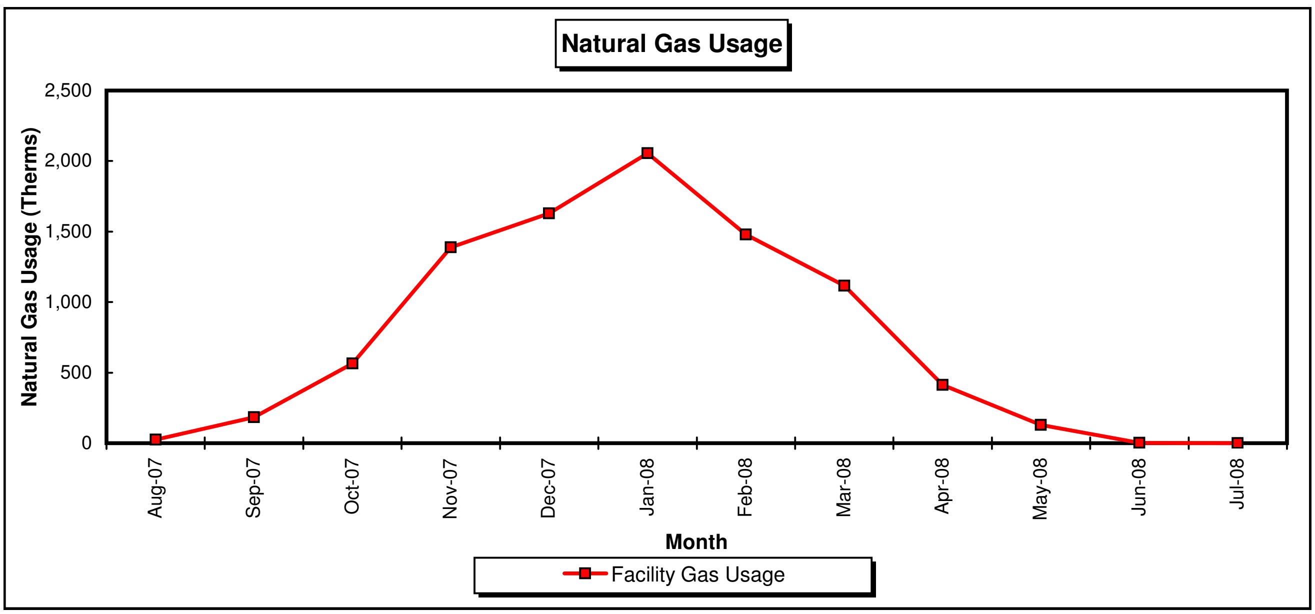
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Dover Public Library
Year Built: 1905/1988
School Address: 73 Locust St
Dover, NH
Phone Number: 516-6050
Principal's Name: Cathy Beaudoin
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 263-752-004-4
Rate: 0
Date: 2/7/2009
Facility Area: 20,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	25	$47	$1.899	3	0.125
Sep-07	184	$236	$1.282	18	0.920
Oct-07	565	$790	$1.398	57	2.825
Nov-07	1,389	$1,897	$1.366	139	6.945
Dec-07	1,628	$2,380	$1.462	163	8.140
Jan-08	2,056	$2,847	$1.385	206	10.280
Feb-08	1,478	$2,012	$1.361	148	7.390
Mar-08	1,116	$1,569	$1.406	112	5.580
Apr-08	413	$651	$1.576	41	2.065
May-08	129	$235	$1.825	13	0.645
Jun-08	2	$22	$11.050	0	0.010
Jul-08	0	$19	$0.000	0	0.000
Totals:	**8,985**	**$12,706**		**899**	**44.925**
Energy Intensity (MBtu/sq. ft.):		**46.27**			
Avg. Cost $/Therm		**$1.414**			



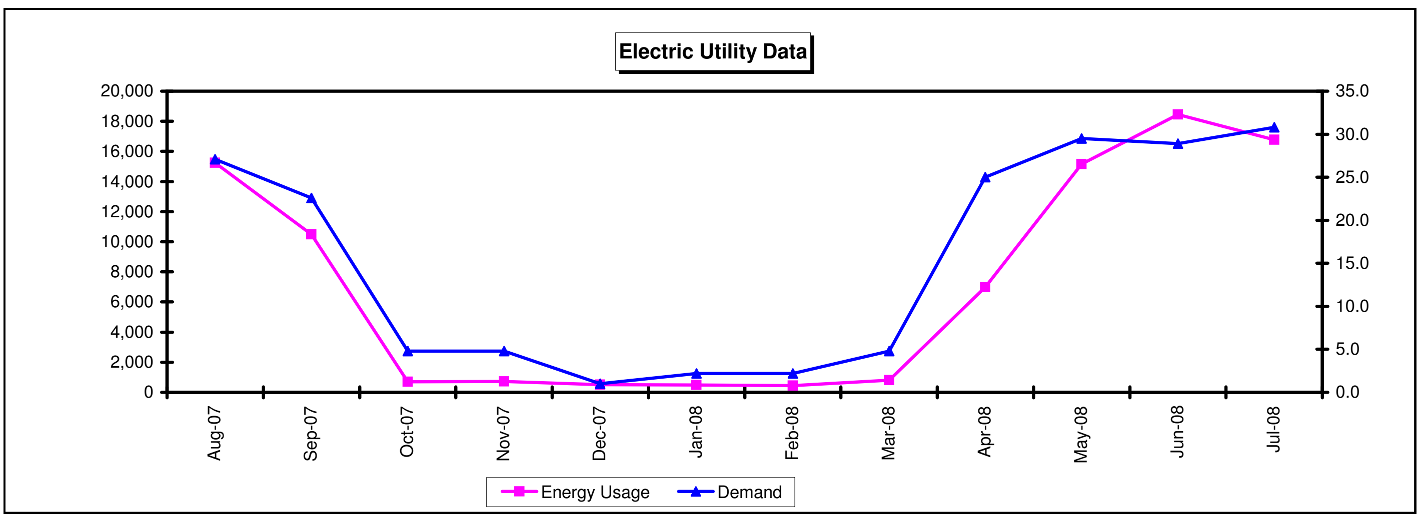
School Name:	Jenny Thompson Pool	Utility Company:	PSNH
Year Built:	1977	Old Acct. No.:	61-30-06136-0-3
School Address:	110 Portland Ave	New Acct. N	56072321037
	Dover, NH	Rate:	0
Phone Number:	516-6060	Date:	2/7/2009
Principal's Name:	Same as Arena		
Facility Area:	0 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	27.1		15,240	$1,781	$0.117	$1,781	30	720	0.78
Sep-07	22.6		10,490	$1,265	$0.121	$1,265	32	768	0.60
Oct-07	4.8		700	$118	$0.168	$118	30	720	0.20
Nov-07	4.8		720	$120	$0.167	$120	31	744	0.20
Dec-07	1.0		500	$98	$0.197	$98	32	768	0.65
Jan-08	2.2		480	$95	$0.198	$95	31	744	0.29
Feb-08	2.2		440	$89	$0.202	$89	28	672	0.30
Mar-08	4.8		800	$206	$0.257	$206	31	744	0.22
Apr-08	25.0		6,980	$878	$0.126	$878	29	696	0.40
May-08	29.5		15,160	$1,768	$0.117	$1,768	29	696	0.74
Jun-08	28.9		18,450	$2,329	$0.126	$2,329	33	792	0.81
Jul-08	30.8		16,770	$2,159	$0.129	$2,159	29	696	0.78
Avg./Totals:	**15.3**	**$0**	**86,730**	**$10,906**		**$10,906**	**365**	**8,760**	**0.50**

Energy Intensity (kWh/sq.ft.):	**-**	**Avg. Cost/kWh:**	**$0.126**
Blended Cost (inc.demand)/kWh:	**$0.126**	**Avg. Cost/kW:**	**$0.00**

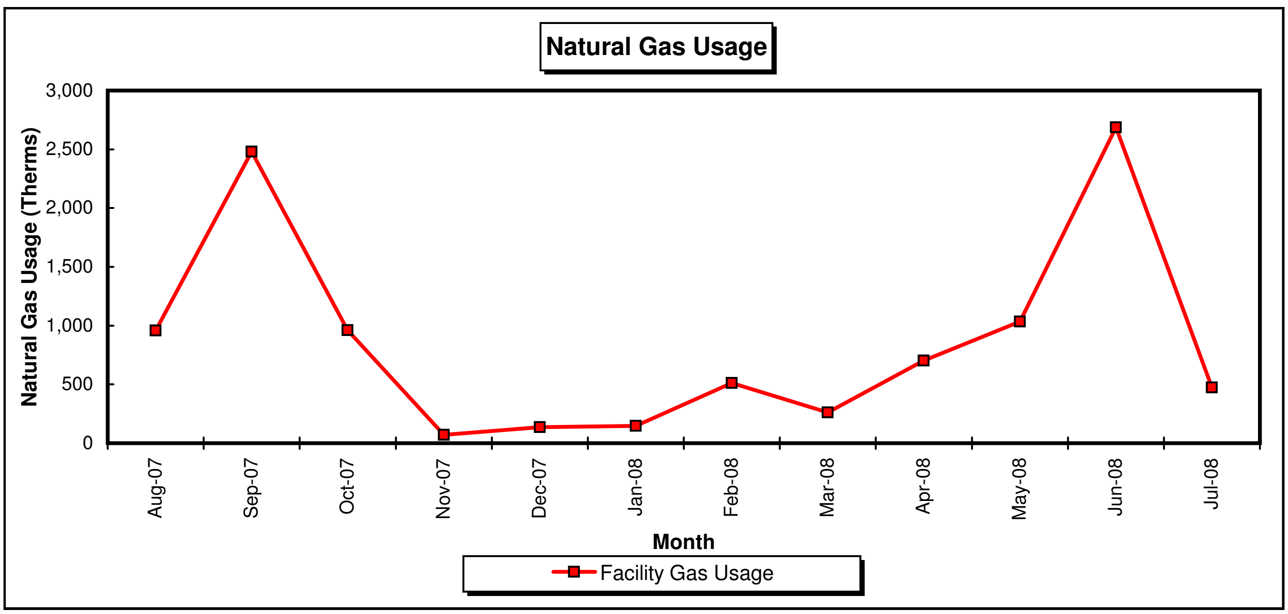
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	Jenny Thompson Pool
Year Built:	1977
School Address:	110 Portland Ave
	Dover, NH
Phone Number:	516-6060
Principal's Name:	Same as Arena
Utility Company:	Northern Utilities/ Metromedia Energy
Account No.:	398-413-008-7
Rate:	0
Date:	2/7/2009
Facility Area:	0 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	959	$1,001	$1.044	96	
Sep-07	2,479	$2,701	$1.090	248	
Oct-07	962	$945	$0.982	96	
Nov-07	71	$121	$1.706	7	
Dec-07	136	$220	$1.615	14	
Jan-08	146	$221	$1.516	15	
Feb-08	512	$319	$0.623	51	
Mar-08	262	$234	$0.893	26	
Apr-08	702	$930	$1.325	70	
May-08	1,034	$1,678	$1.623	103	
Jun-08	2,687	$4,944	$1.840	269	
Jul-08	475	$747	$1.573	48	
Totals:	**10,425**	**$14,062**		1,043	0.000
Energy Intensity (MBtu/sq. ft.):		**-**			
Avg. Cost $/Therm		**$1.349**			



School Name: Central Fire Station
Year Built: 1899
School Address: 9 Broadway
Dover, NH
Phone Number: 516-6150
Principal's Name: Perry Plummer
Facility Area: 7,000 sq. ft.

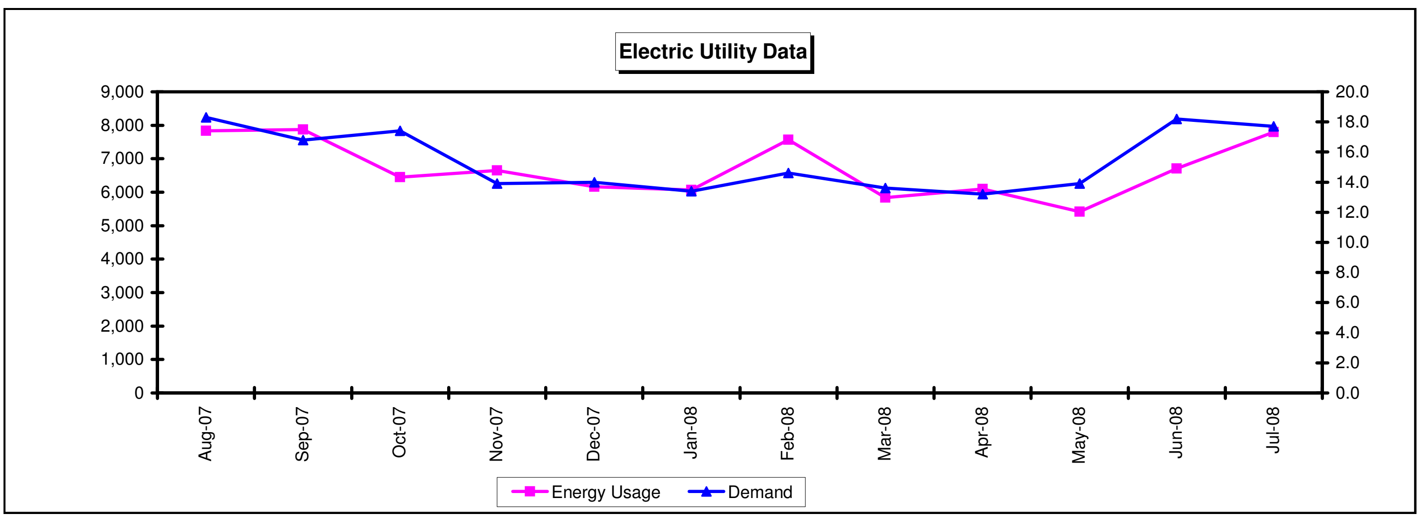
Utility Company: PSNH
Old Acct. No.: 61-35-01167-0-5
New Acct. N 56299411066
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	18.3		7,830	$959	$0.123	$959	29	696	0.61
Sep-07	16.8		7,870	$950	$0.121	$950	33	792	0.59
Oct-07	17.4		6,450	$813	$0.126	$813	30	720	0.51
Nov-07	13.9		6,650	$802	$0.121	$802	33	792	0.60
Dec-07	14.0		6,160	$753	$0.122	$753	28	672	0.65
Jan-08	13.4		6,070	$760	$0.125	$760	29	696	0.65
Feb-08	14.6		7,570	$926	$0.122	$926	34	816	0.64
Mar-08	13.6		5,840	$738	$0.126	$738	28	672	0.64
Apr-08	13.2		6,100	$761	$0.125	$761	30	720	0.64
May-08	13.9		5,420	$697	$0.129	$697	29	696	0.56
Jun-08	18.2		6,710	$868	$0.129	$868	32	768	0.48
Jul-08	17.7		7,800	$1,041	$0.133	$1,041	30	720	0.61
Avg./Totals:	**15.4**	**$0**	**80,470**	**$10,068**		**$10,068**	**365**	**8,760**	**0.60**

Energy Intensity (kWh/sq.ft.):	**11.50**	**Avg. Cost/kWh:**	**$0.125**
Blended Cost (inc.demand)/kWh:	**$0.125**	**Avg. Cost/kW:**	**$0.00**

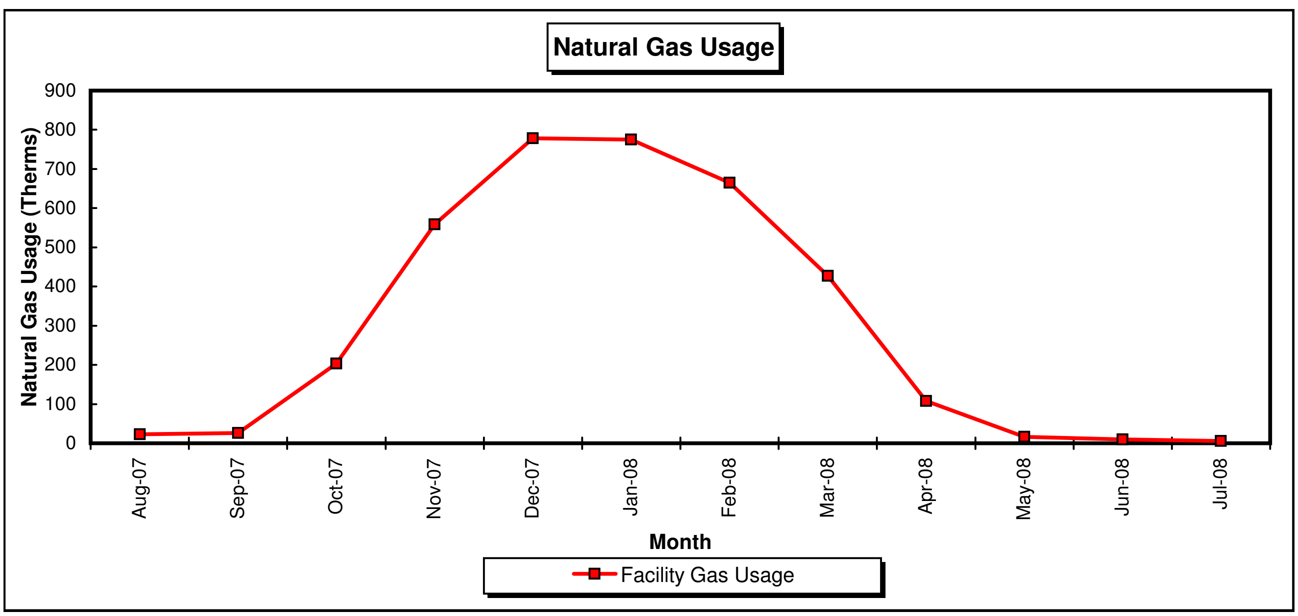
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	Central Fire Station
Year Built:	1899
School Address:	9 Broadway
	Dover, NH
Phone Number:	516-6150
Principal's Name:	Perry Plummer
Utility Company:	Northern Utilities/ Metromedia Energy
Account No.:	448-652-0026
Rate:	0
Date:	2/7/2009
Facility Area:	7,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	23	$45	$1.963	2	0.329
Sep-07	26	$56	$2.136	3	0.371
Oct-07	203	$260	$1.280	20	2.900
Nov-07	559	$743	$1.329	56	7.986
Dec-07	778	$1,228	$1.578	78	11.114
Jan-08	775	$1,215	$1.568	78	11.071
Feb-08	665	$1,012	$1.522	67	9.500
Mar-08	427	$639	$1.496	43	6.100
Apr-08	108	$189	$1.752	11	1.543
May-08	16	$46	$2.893	2	0.229
Jun-08	10	$36	$3.566	1	0.143
Jul-08	6	$28	$4.693	1	0.086
Totals:	**3,596**	**$5,496**		**360**	**51.371**
Energy Intensity (MBtu/sq. ft.):		**52.91**			
Avg. Cost $/Therm		**$1.528**			



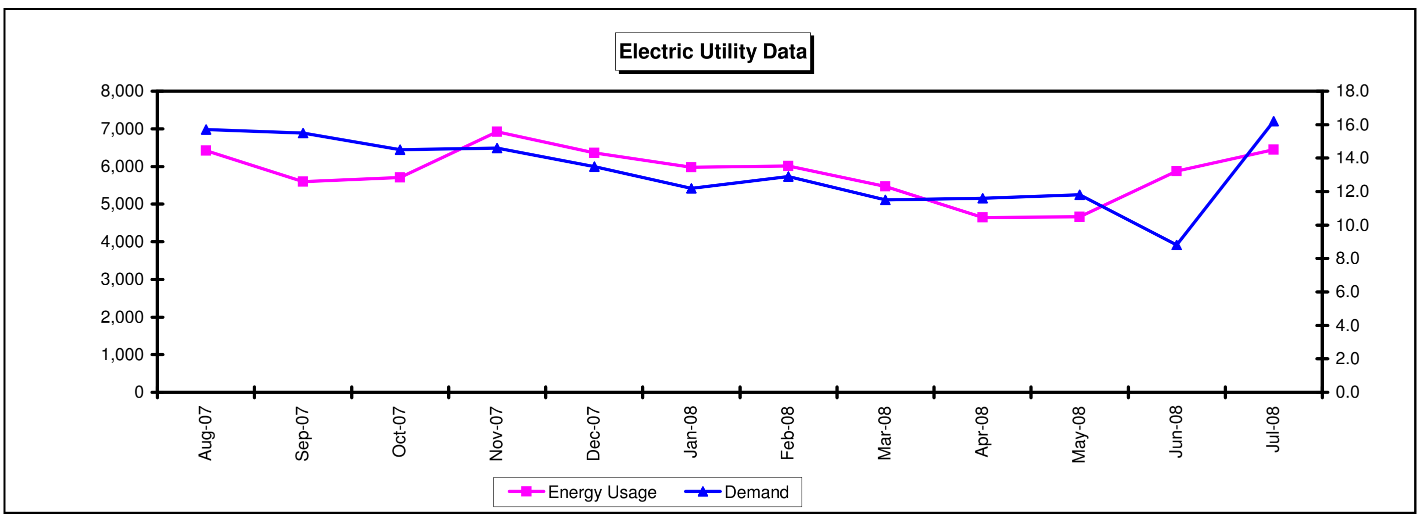
School Name:	South End Fire Station	Utility Company:	PSNH
Year Built:	1967	Old Acct. No.:	61-10-03228-0-1
School Address:	25 Durham Rd	New Acct. N	56847801073
	Dover, NH	Rate:	0
Phone Number:	516-6150	Date:	2/7/2009
Principal's Name:	Richard Driscoll		
Facility Area:	8,000 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	15.7		6,422	$805	$0.125	$805	32	768	0.53
Sep-07	15.5		5,597	$720	$0.129	$720	30	720	0.50
Oct-07	14.5		5,709	$723	$0.127	$723	30	720	0.55
Nov-07	14.6		6,924	$845	$0.122	$845	31	744	0.64
Dec-07	13.5		6,364	$801	$0.126	$801	30	720	0.65
Jan-08	12.2		5,978	$750	$0.125	$750	31	744	0.66
Feb-08	12.9		6,014	$759	$0.126	$759	30	720	0.65
Mar-08	11.5		5,469	$691	$0.126	$691	30	720	0.66
Apr-08	11.6		4,643	$606	$0.130	$606	29	696	0.58
May-08	11.8		4,662	$609	$0.131	$609	29	696	0.57
Jun-08	8.8		5,873	$801	$0.136	$801	31	744	0.90
Jul-08	16.2		6,446	$890	$0.138	$890	32	768	0.52
Avg./Totals:	**13.2**	**$0**	**70,101**	**$9,000**		**$9,000**	**365**	**8,760**	**0.62**

Energy Intensity (kWh/sq.ft.):	**8.76**	**Avg. Cost/kWh:**	**$0.128**
Blended Cost (inc.demand)/kWh:	**$0.128**	**Avg. Cost/kW:**	**$0.00**

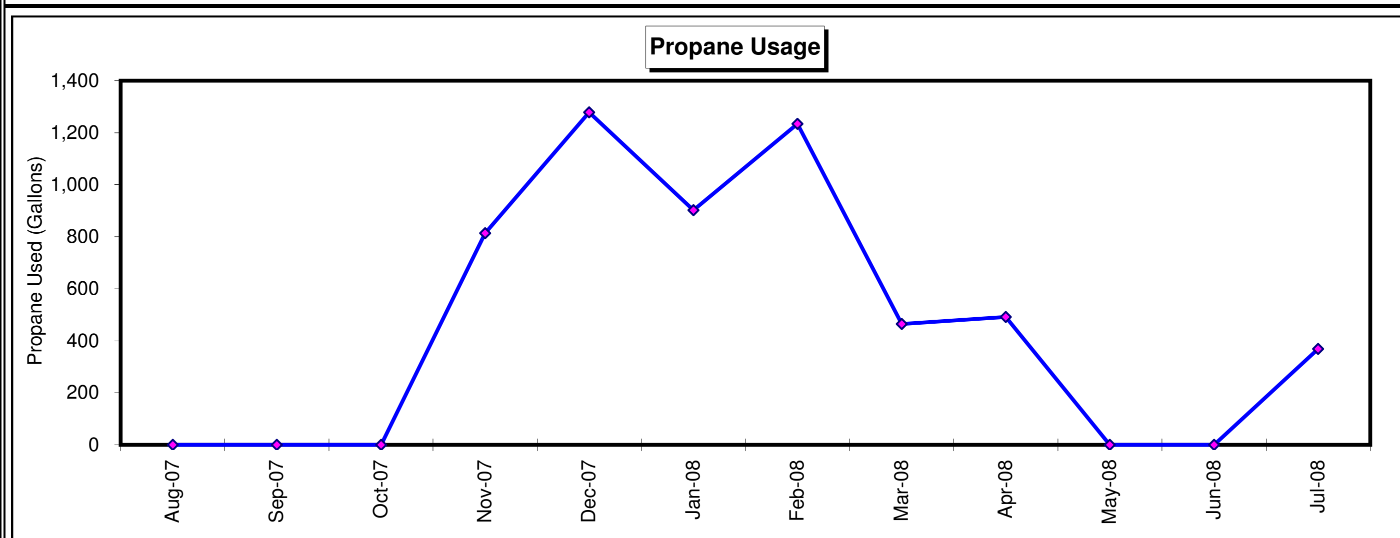
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: South End Fire Station
Year Built: 1967
School Address: 25 Durham Rd
Dover, NH
Phone Number: 516-6150
Principal's Name: Richard Driscoll
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 8,000 sq. ft.

ANNUAL PROPANE USAGE

Month	Propane Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2007/2008					
Aug-07	0	$0		0.0	$0.00
Sep-07	0	$0		0.0	$0.00
Oct-07	0	$0		0.0	$0.00
Nov-07	813	$1,373	$1.688	77.7	$0.17
Dec-07	1,278	$2,158	$1.688	122.1	$0.27
Jan-08	903	$1,524	$1.688	86.2	$0.19
Feb-08	1,234	$2,083	$1.688	117.9	$0.26
Mar-08	465	$785	$1.688	44.4	$0.10
Apr-08	491	$829	$1.688	46.9	$0.10
May-08	0	$0		0.0	$0.00
Jun-08	0	$0		0.0	$0.00
Jul-08	369	$622	$1.688	35.2	$0.08
Total	**5,553**	**$9,374**	**$1.69**	**530.3**	**$1.17**
Energy Intensity (MBtu/sq. ft.):		**66.29**			
Avg. Cost $/Gallon		**$1.688**			



School Name: Pine Hill Chapel
Year Built: 1911
School Address: 131 Central Ave
Dover, NH
Phone Number: 516-6480
Principal's Name: Nancy
Facility Area: 1,500 sq. ft.

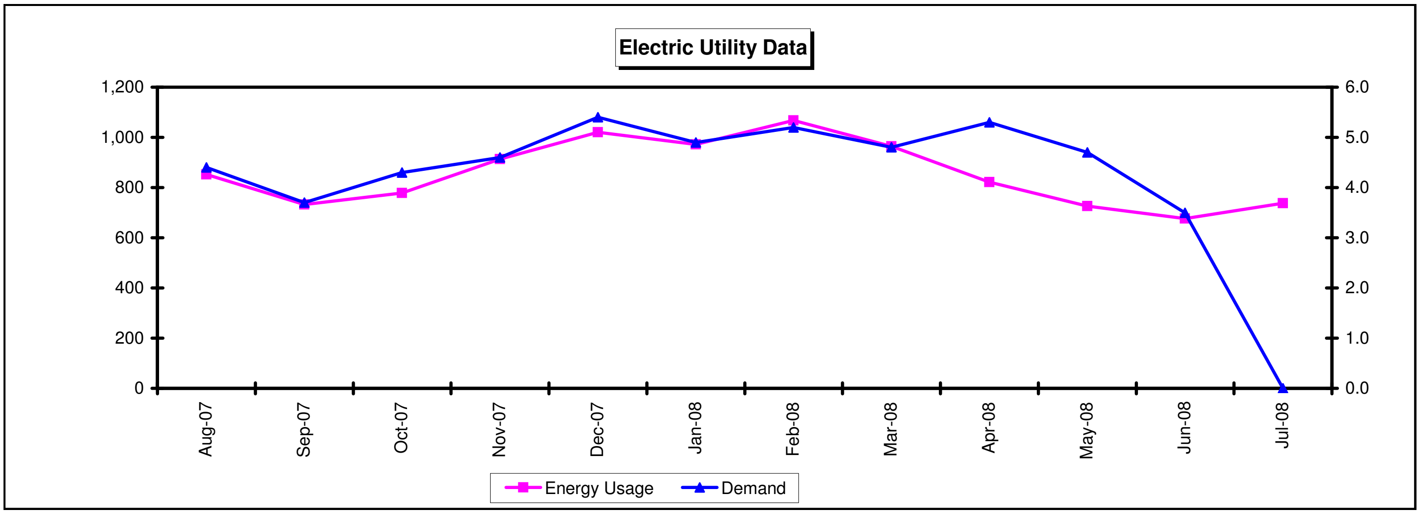
Utility Company: PSNH
Old Acct. No.: 61-35-05696-0-6
New Acct. N 56143521011
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	4.4		852	$143	$0.168	$143	33	792	0.24
Sep-07	3.7		732	$130	$0.178	$130	29	696	0.28
Oct-07	4.3		778	$135	$0.174	$135	31	744	0.24
Nov-07	4.6		914	$150	$0.164	$150	33	792	0.25
Dec-07	5.4		1,020	$165	$0.162	$165	29	696	0.27
Jan-08	4.9		972	$160	$0.165	$160	29	696	0.29
Feb-08	5.2		1,068	$173	$0.162	$173	32	768	0.27
Mar-08	4.8		964	$160	$0.166	$160	29	696	0.29
Apr-08	5.3		822	$146	$0.178	$146	30	720	0.22
May-08	4.7		726	$133	$0.183	$133	32	768	0.20
Jun-08	3.5		676	$127	$0.188	$127	29	696	0.28
Jul-08	-		738	$113	$0.154	$113	29	696	
Avg./Totals:	**4.2**	**$0**	**10,262**	**$1,736**		**$1,736**	**365**	**8,760**	**0.24**

Energy Intensity (kWh/sq.ft.):	**6.84**	**Avg. Cost/kWh:**	**$0.169**
Blended Cost (inc.demand)/kWh:	**$0.169**	**Avg. Cost/kW:**	**$0.00**

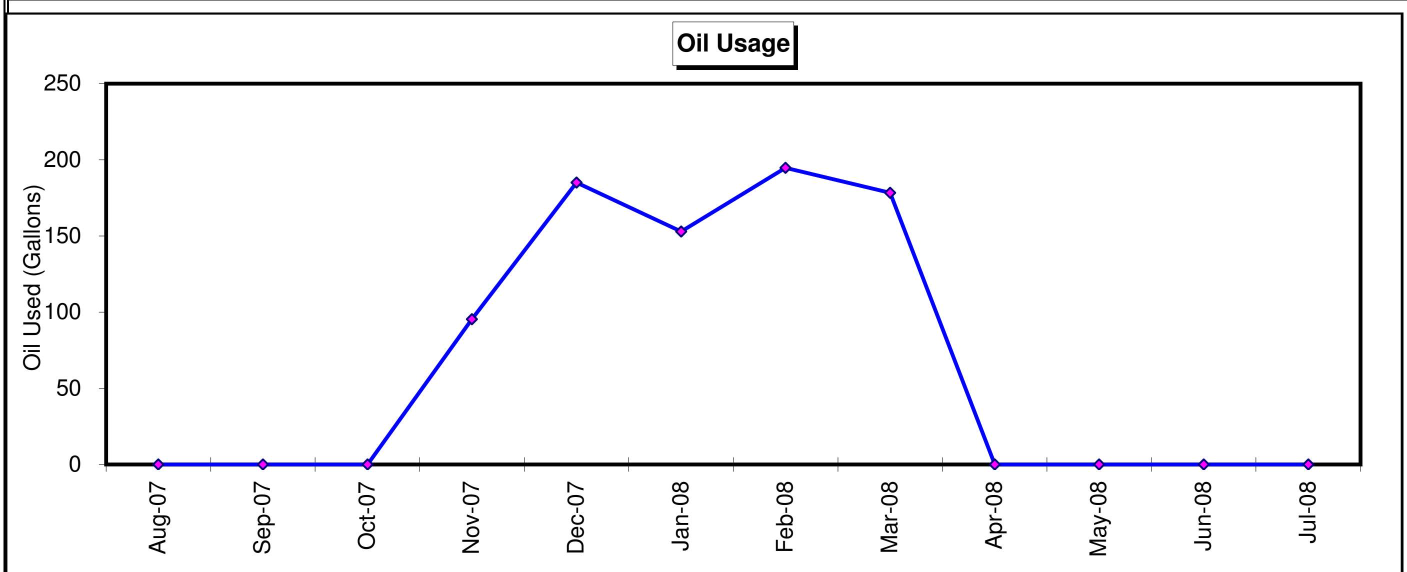
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Pine Hill Chapel
Year Built: 1911
School Address: 131 Central Ave
Dover, NH
Phone Number: 516-6480
Principal's Name: Nancy
Utility Company: Downeast Energy
Account No.: 306,440
Rate: 0
Date: 2/7/2009
Facility Area: 1,500 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2007/2008					
Aug-07	0	$0		0.0	$0.00
Sep-07	0	$0		0.0	$0.00
Oct-07	0	$0		0.0	$0.00
Nov-07	95	$220	$2.310	13.2	$0.15
Dec-07	185	$427	$2.310	25.6	$0.28
Jan-08	153	$353	$2.310	21.2	$0.24
Feb-08	195	$450	$2.310	27.0	$0.30
Mar-08	178	$412	$2.310	24.7	$0.27
Apr-08	0	$0		0.0	$0.00
May-08	0	$0		0.0	$0.00
Jun-08	0	$0		0.0	$0.00
Jul-08	0	$0		0.0	$0.00
Total	**806**	**$1,862**	**$2.31**	**111.7**	**$1.24**
Energy Intensity (MBtu/sq. ft.):		**74.49**			
Avg. Cost $/Gallon		**$2.310**			



School Name: Pine Hill Barn
Year Built: 1900
School Address: 131 Central Ave
Dover, NH
Phone Number: 396-3964
Principal's Name: Paul
Facility Area: 1,500 sq. ft.

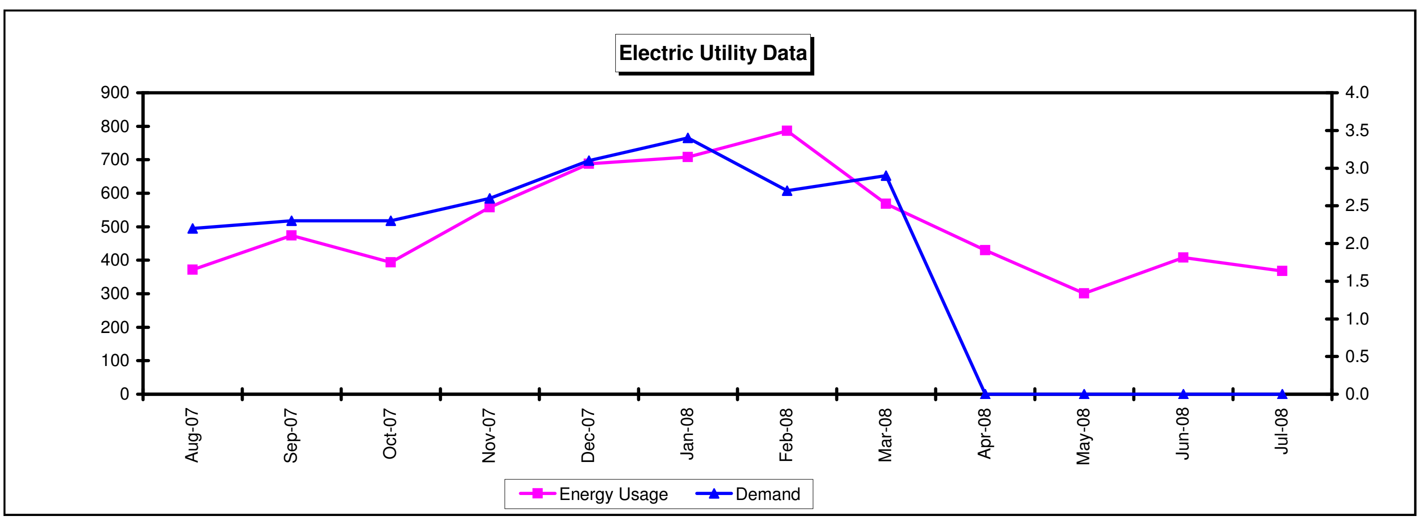
Utility Company: PSNH
Old Acct. No.: 61-35-05566-0-3, 61-35-05567-0-2
New Acct. N 56560290074, 56511290090
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07	2.2		372	$82	$0.221	$82	30	720	0.23
Sep-07	2.3		474	$97	$0.205	$97	32	768	0.27
Oct-07	2.3		394	$85	$0.215	$85	30	720	0.24
Nov-07	2.6		558	$109	$0.196	$109	33	792	0.27
Dec-07	3.1		688	$125	$0.182	$125	30	720	0.31
Jan-08	3.4		708	$130	$0.184	$130	28	672	0.31
Feb-08	2.7		786	$139	$0.177	$139	30	720	0.40
Mar-08	2.9		568	$114	$0.201	$114	33	792	0.25
Apr-08	-		430	$93	$0.216	$93	33	792	
May-08	-		301	$73	$0.244	$73	30	720	
Jun-08	-		408	$90	$0.221	$90	28	672	
Jul-08	-		368	$73	$0.199	$73	28	672	
Avg./Totals:	**1.8**	**$0**	**6,055**	**$1,212**		**$1,212**	**365**	**8,760**	**0.19**

Energy Intensity (kWh/sq.ft.):	**4.04**	**Avg. Cost/kWh:**	**$0.200**
Blended Cost (inc.demand)/kWh:	**$0.200**	**Avg. Cost/kW:**	**$0.00**

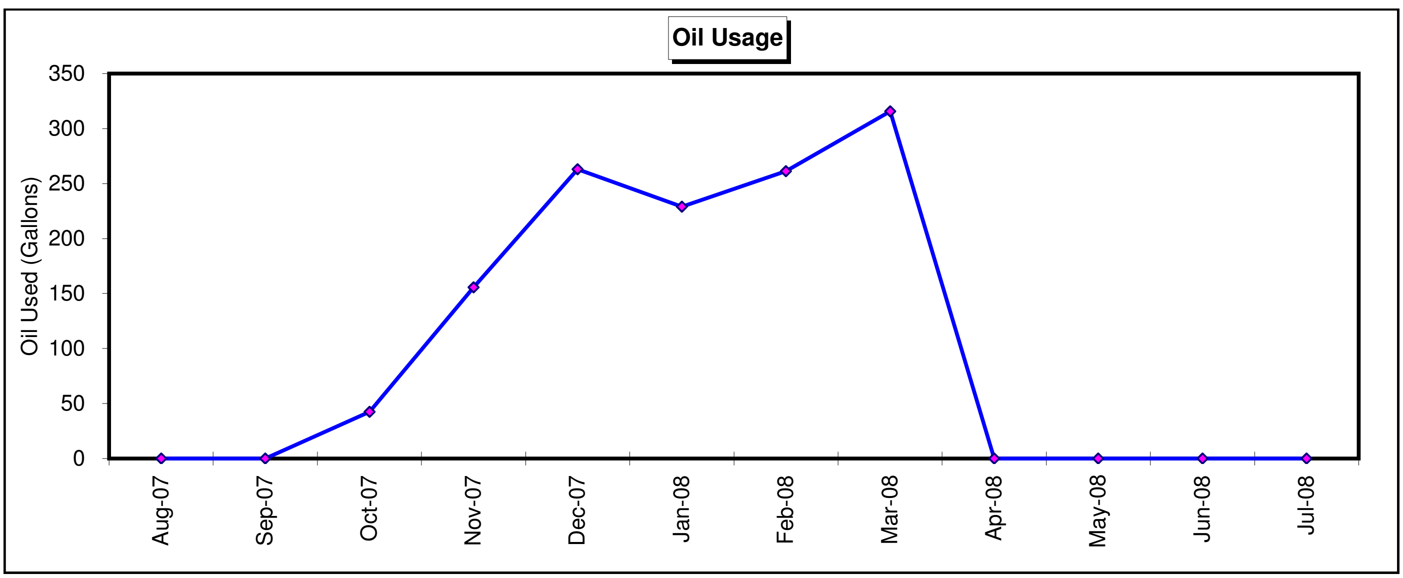
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Pine Hill Barn
Year Built: 1900
School Address: 131 Central Ave
Dover, NH
Phone Number: 396-3964
Principal's Name: Paul
Utility Company: Downeast Energy
Account No.: 306,458
Rate: 0
Date: 2/7/2009
Facility Area: 1,500 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2007/2008					
Aug-07	0	$0		0.0	$0.00
Sep-07	0	$0		0.0	$0.00
Oct-07	43	$98	$2.310	5.9	$0.07
Nov-07	156	$360	$2.310	21.6	$0.24
Dec-07	263	$608	$2.310	36.5	$0.41
Jan-08	229	$529	$2.310	31.7	$0.35
Feb-08	261	$604	$2.310	36.2	$0.40
Mar-08	316	$729	$2.310	43.8	$0.49
Apr-08	0	$0		0.0	$0.00
May-08	0	$0		0.0	$0.00
Jun-08	0	$0		0.0	$0.00
Jul-08	0	$0		0.0	$0.00
Total	**1,267**	**$2,928**	**$2.31**	**175.7**	**$1.95**
Energy Intensity (MBtu/sq. ft.):		**117.11**			
Avg. Cost $/Gallon		**$2.310**			



School Name: Veterans Hall
Year Built: 1920
School Address: 156 Back River Road
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Facility Area: 2,952 sq. ft.

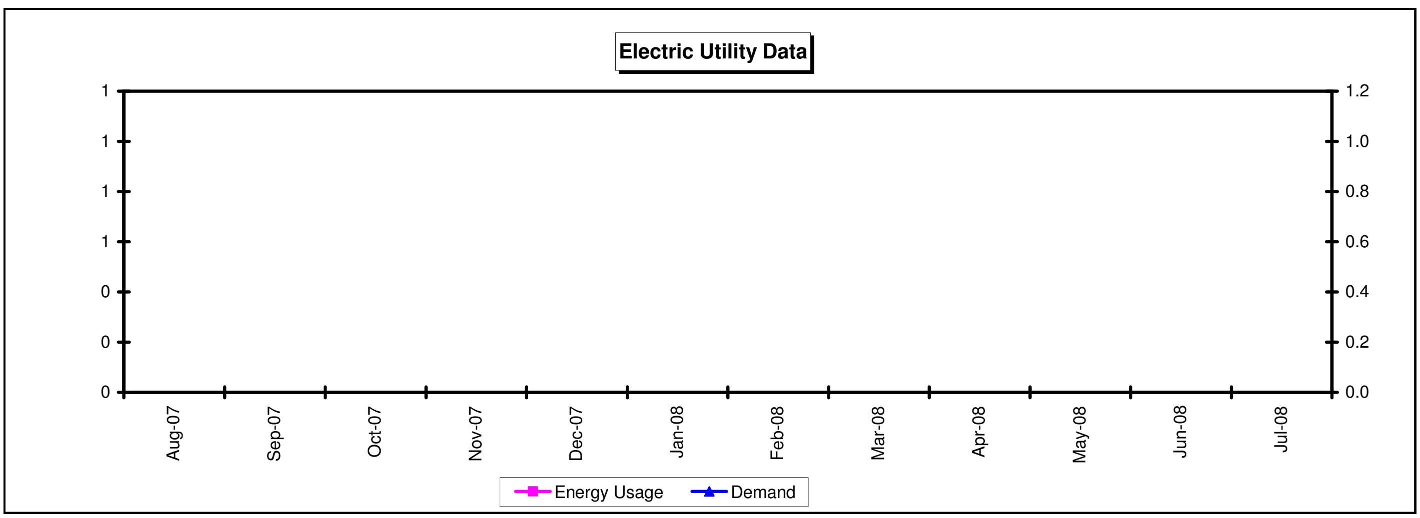
Utility Company: PSNH
Old Acct. No.: 61-10-11423-0-7
New Acct. N 56599551058
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07				$0	$0.000		30	720	
Sep-07				$0	$0.000		32	768	
Oct-07				$0	$0.000		30	720	
Nov-07				$0	$0.000		29	696	
Dec-07				$0	$0.000		32	768	
Jan-08				$0	$0.000		31	744	
Feb-08				$0	$0.000		29	696	
Mar-08				$0	$0.000		31	744	
Apr-08				$0	$0.000		29	696	
May-08				$0	$0.000		29	696	
Jun-08				$0	$0.000		33	792	
Jul-08				$0	$0.000		30	720	
Avg./Totals:	**0.0**	**$0**	**0**	**$0**		**$0**	**365**	**8,760**	

Energy Intensity (kWh/sq.ft.):	**0.00**	**Avg. Cost/kWh:**	**-**
Blended Cost (inc.demand)/kWh:	**-**	**Avg. Cost/kW:**	**-**

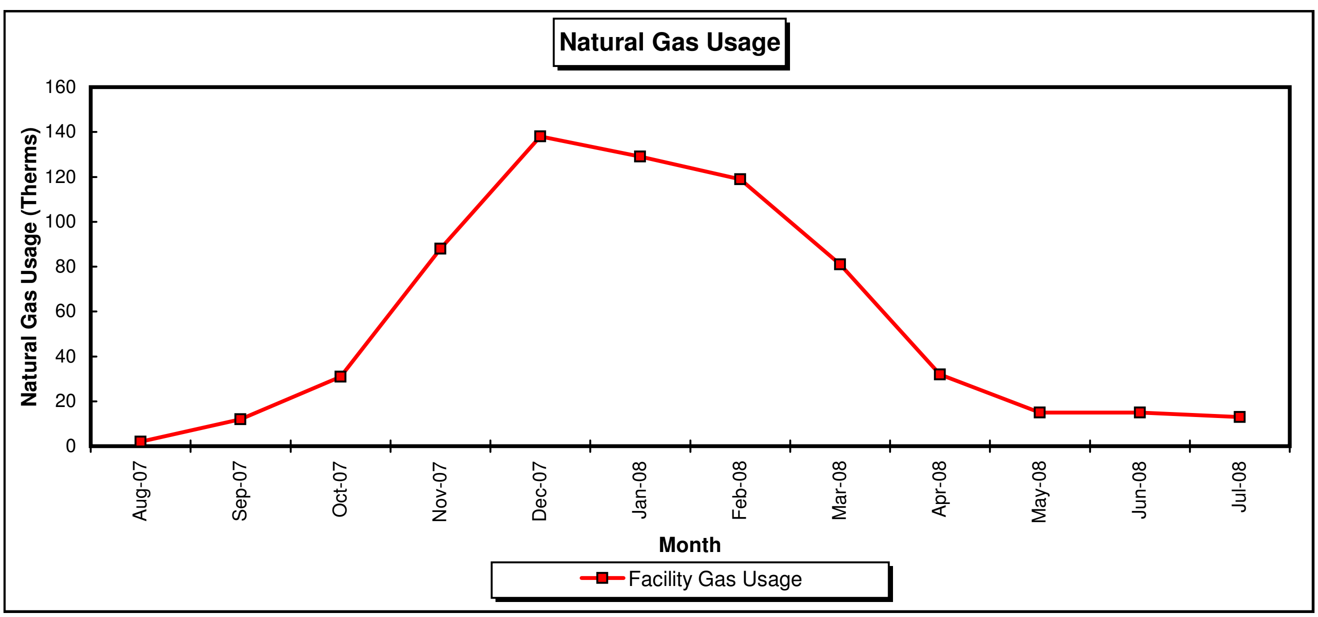
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Veterans Hall
Year Built: 1920
School Address: 156 Back River Road
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 2,952 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	2	$21	$10.515	0	0.068
Sep-07	12	$41	$3.425	1	0.407
Oct-07	31	$79	$2.548	3	1.050
Nov-07	88	$148	$1.678	9	2.981
Dec-07	138	$223	$1.612	14	4.675
Jan-08	129	$190	$1.472	13	4.370
Feb-08	119	$179	$1.502	12	4.031
Mar-08	81	$139	$1.711	8	2.744
Apr-08	32	$70	$2.203	3	1.084
May-08	15	$45	$2.973	2	0.508
Jun-08	15	$44	$2.943	2	0.508
Jul-08	13	$39	$3.015	1	0.440
Totals:	**675**	**$1,217**		**68**	**22.866**
Energy Intensity (MBtu/sq. ft.):		**23.55**			
Avg. Cost $/Therm		**$1.803**			



School Name: Dover Train Station
Year Built: 2001
School Address: 33 Chestnut Street
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Facility Area: 4,791 sq. ft.

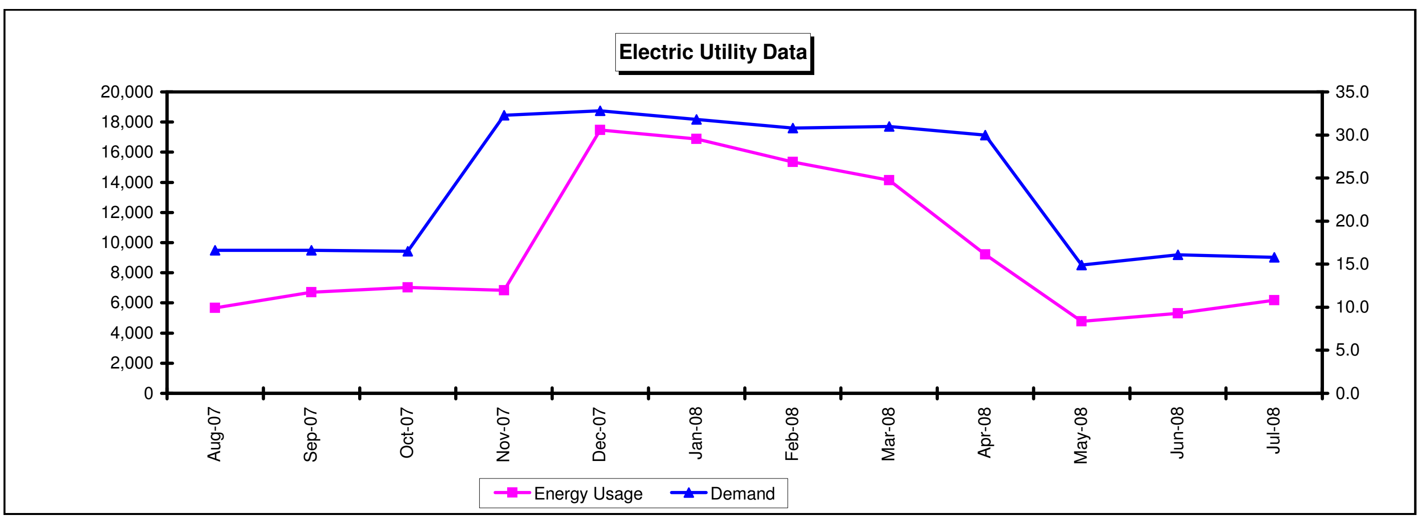
Utility Company: PSNH
Old Acct. No.: 61-35-04075-1-8, 61-35-04442-0-6
New Acct. N 56303841092, 56709941074
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total * (kW)	Demand Cost	Usage Total * (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008	* includes train parking lighting								
Aug-07	16.6		5,670	$479	$0.084	$479	33	792	0.43
Sep-07	16.6		6,710	$832	$0.124	$832	31	744	0.54
Oct-07	16.5		7,020	$862	$0.123	$862	30	720	0.59
Nov-07	32.3		6,830	$776	$0.114	$776	31	744	0.28
Dec-07	32.8		17,480	$2,057	$0.118	$2,057	30	720	0.74
Jan-08	31.8		16,880	$2,046	$0.121	$2,046	31	744	0.71
Feb-08	30.8		15,350	$1,878	$0.122	$1,878	31	744	0.67
Mar-08	31.0		14,150	$1,755	$0.124	$1,755	29	696	0.66
Apr-08	30.0		9,220	$1,234	$0.134	$1,234	31	744	0.41
May-08	14.9		4,770	$640	$0.134	$640	30	720	0.44
Jun-08	16.1		5,300	$705	$0.133	$705	31	744	0.44
Jul-08	15.8		6,180	$844	$0.137	$844	30	720	0.54
Avg./Totals:	**23.8**	**$0**	**115,560**	**$14,108**		**$14,108**	**368**	**8,832**	**0.54**

Energy Intensity (kWh/sq.ft.):	**24.12**	**Avg. Cost/kWh:**	**$0.122**
Blended Cost (inc.demand)/kWh:	**$0.122**	**Avg. Cost/kW:**	**$0.00**

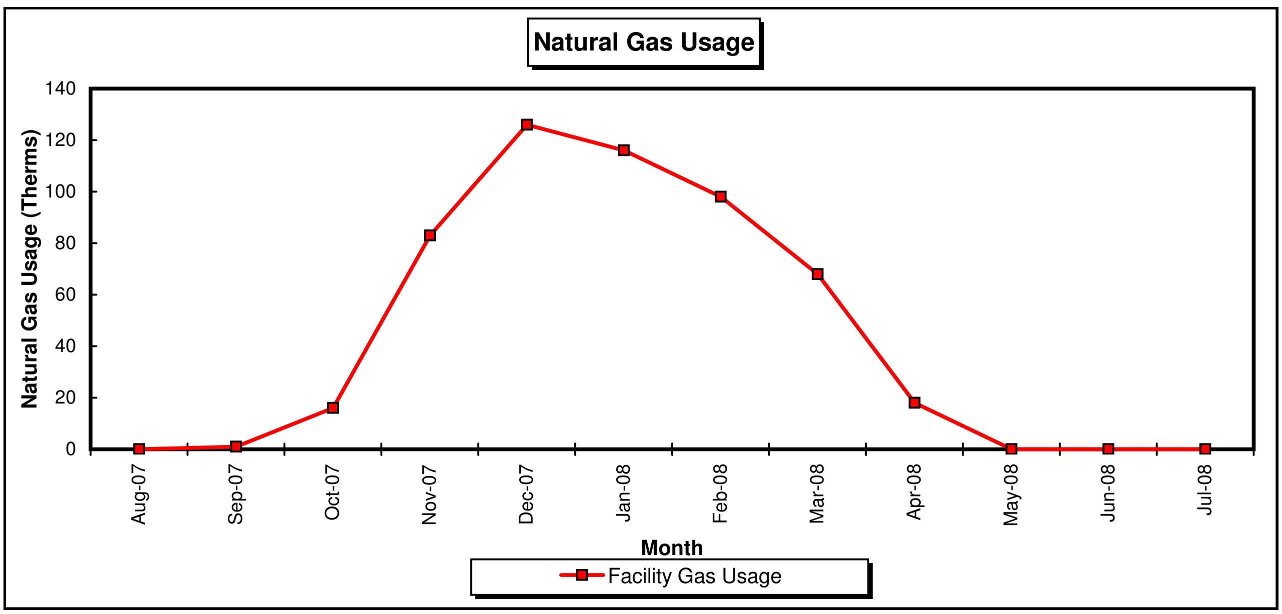
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Dover Train Station
Year Built: 2001
School Address: 33 Chestnut Street
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 4,791 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2007/2008					
Aug-07	0	$19		0	0.000
Sep-07	1	$20	$20.150	0	0.021
Oct-07	16	$42	$2.647	2	0.334
Nov-07	83	$137	$1.648	8	1.732
Dec-07	126	$214	$1.697	13	2.630
Jan-08	116	$186	$1.608	12	2.421
Feb-08	98	$163	$1.660	10	2.046
Mar-08	68	$121	$1.782	7	1.419
Apr-08	18	$48	$2.652	2	0.376
May-08	0	$19		0	0.000
Jun-08	0	$19		0	0.000
Jul-08	0	$19		0	0.000
Totals:	**526**	**$1,006**		**53**	**10.979**
Energy Intensity (MBtu/sq. ft.):		**11.31**			
Avg. Cost $/Therm		**$1.913**			



School Name: Indoor Pool
Year Built: 1968
School Address: 9 Henry Law Ave
Dover, NH
Phone Number: 516-6441
Principal's Name: Mick Arsenault
Facility Area: 10,279 sq. ft.

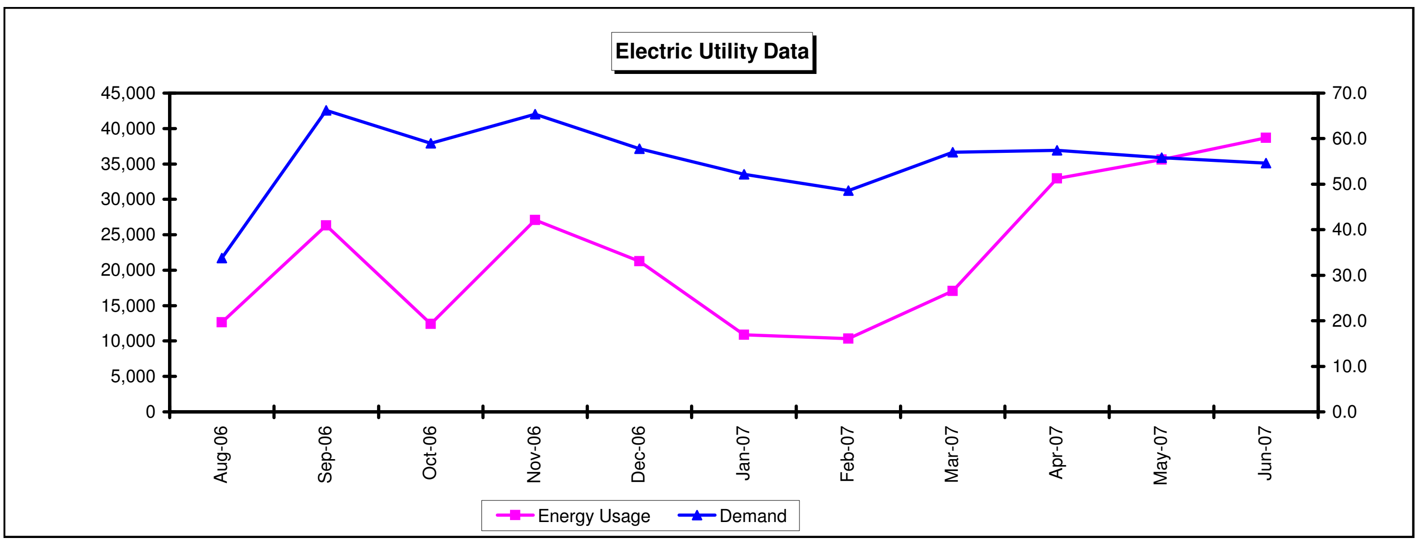
Utility Company: PSNH
Old Acct. No.: 8000619-02-9-4
New Acct. No.: 8000619-02-9-4
Rate: G, Three Phase
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	70.6	$638	41,760	$4,235	$0.101	$4,872	29	696	0.85
Sep-06	33.8	$305	12,640	$1,293	$0.102	$1,598	33	792	0.47
Oct-06	66.2	$598	26,320	$2,643	$0.100	$3,241	30	720	0.55
Nov-06	59.0	$533	12,400	$1,215	$0.098	$1,748	33	792	0.27
Dec-06	65.4	$591	27,080	$2,724	$0.101	$3,314	28	672	0.62
Jan-07	57.8	$501	21,280	$2,192	$0.103	$2,693	29	696	0.53
Feb-07	52.2	$453	10,880	$1,104	$0.101	$1,557	34	816	0.26
Mar-07	48.6	$421	10,320	$1,052	$0.102	$1,473	28	672	0.32
Apr-07	57.0	$494	17,080	$1,750	$0.102	$2,244	30	720	0.42
May-07	57.4	$498	32,960	$3,427	$0.104	$3,924	29	696	0.83
Jun-07	55.8	$484	35,600	$3,708	$0.104	$4,192	32	768	0.83
Jul-07	54.6	$473	38,680	$3,949	$0.102	$4,422	30	720	0.98
Avg./Totals:	**56.5**	**$5,988**	**287,000**	**$29,292**		**$35,280**	**365**	**8,760**	**0.58**

Energy Intensity (kWh/sq.ft.):	**27.92**	**Avg. Cost/kWh:**	**$0.102**
Blended Cost (inc.demand)/kWh:	**$0.123**	**Avg. Cost/kW:**	**$8.83**

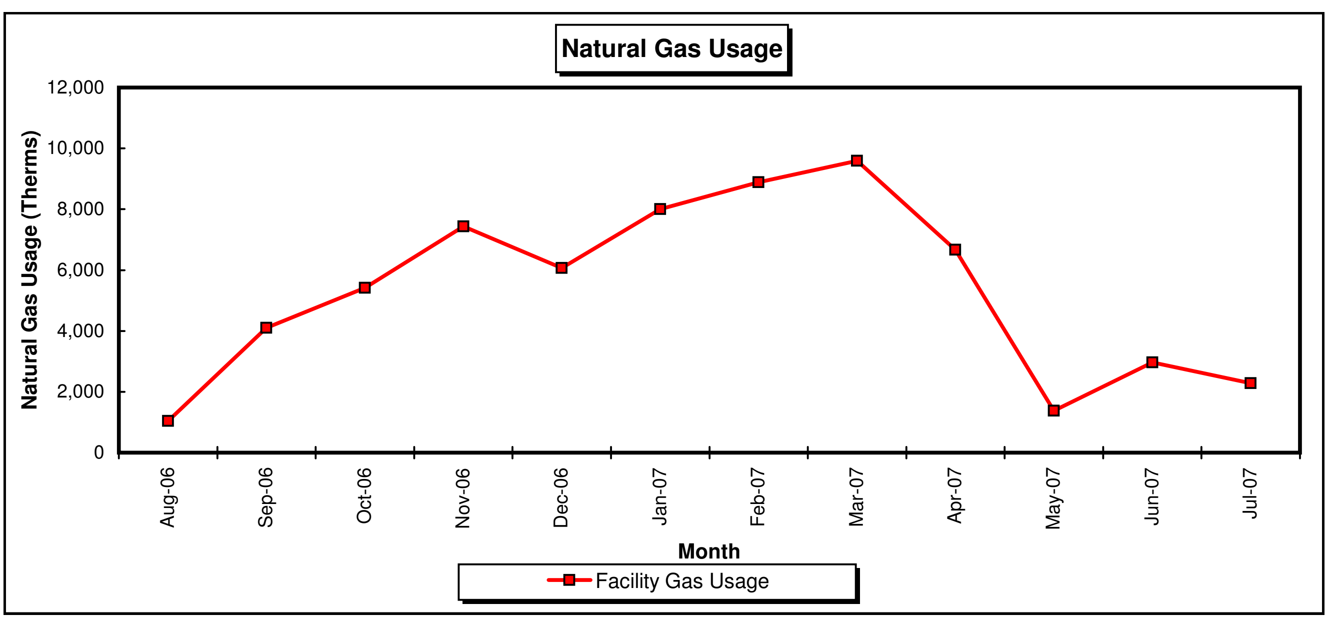
Table Formulas: Hours per Month = D x 24   Load Factor = B/(A x E)



School Name: Indoor Pool
Year Built: 1968
School Address: 9 Henry Law Ave
Dover, NH
Phone Number: 516-6441
Principal's Name: Mick Arsenault
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 579-752-000-7
Rate: 0
Date: 2/7/2009
Facility Area: 10,279 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	1,041	$1,122	$1.077	104	10.127
Sep-06	4,105	$4,205	$1.024	411	39.936
Oct-06	5,416	$5,837	$1.078	542	52.690
Nov-06	7,434	$9,238	$1.243	743	72.322
Dec-06	6,067	$9,415	$1.552	607	59.023
Jan-07	8,006	$12,035	$1.503	801	77.887
Feb-07	8,884	$12,804	$1.441	888	86.429
Mar-07	9,587	$15,645	$1.632	959	93.268
Apr-07	6,673	$11,997	$1.798	667	64.919
May-07	1,376	$2,112	$1.535	138	13.387
Jun-07	2,969	$3,291	$1.108	297	28.884
Jul-07	2,287	$2,492	$1.089	229	22.249
Totals:	**63,845**	**$90,193**		**6,385**	**621.121**
Energy Intensity (MBtu/sq. ft.):		**621.12**			
Avg. Cost $/Therm		**$1.413**			



School Name:	Dover Ice Arena
Year Built:	1974/2001
School Address:	110 Portland Ave Dover, NH
Phone Number:	516-6060
Principal's Name:	Patrick McNulty, Barry Rioxdan
Facility Area:	126,084 sq. ft.

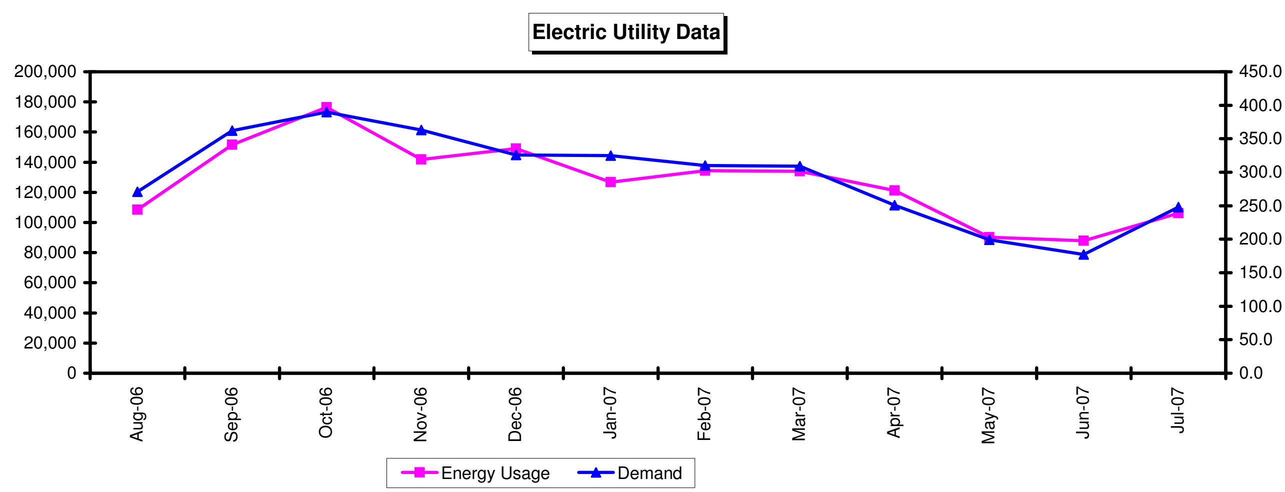
Utility Company: PSNH
Old Acct. No.: 8000626-01-6-2
New Acct. No.: 8000626-01-6-2
Rate: GV
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	271.0	$1,950	108,400	$11,191	$0.103	$13,141	30	720	0.56
Sep-06	362.0	$2,596	151,600	$15,557	$0.103	$18,153	32	768	0.55
Oct-06	390.0	$2,794	176,400	$18,085	$0.103	$20,880	30	720	0.63
Nov-06	363.0	$2,603	141,800	$14,547	$0.103	$17,150	31	744	0.53
Dec-06	326.0	$2,223	149,000	$15,439	$0.104	$17,662	31	744	0.61
Jan-07	325.0	$2,216	126,800	$13,365	$0.105	$15,581	32	768	0.51
Feb-07	310.0	$2,115	134,400	$14,182	$0.106	$16,297	28	672	0.65
Mar-07	309.0	$2,109	134,000	$14,140	$0.106	$16,249	31	744	0.58
Apr-07	251.0	$1,718	121,200	$12,842	$0.106	$14,561	29	696	0.69
May-07	199.0	$1,368	90,200	$9,616	$0.107	$10,984	29	696	0.65
Jun-07	177.0	$1,341	87,800	$9,262	$0.105	$10,603	33	792	0.63
Jul-07	248.0	$1,865	106,200	$10,778	$0.101	$12,643	29	696	0.62
Avg./Totals:	**294.3**	**$24,898**	**1,527,800**	**$159,004**		**$183,902**	**365**	**8,760**	**0.60**

Energy Intensity (kWh/sq.ft.):	**12.12**	**Avg. Cost/kWh:**	**$0.104**
Blended Cost (inc.demand)/kWh:	**$0.120**	**Avg. Cost/kW:**	**$7.05**

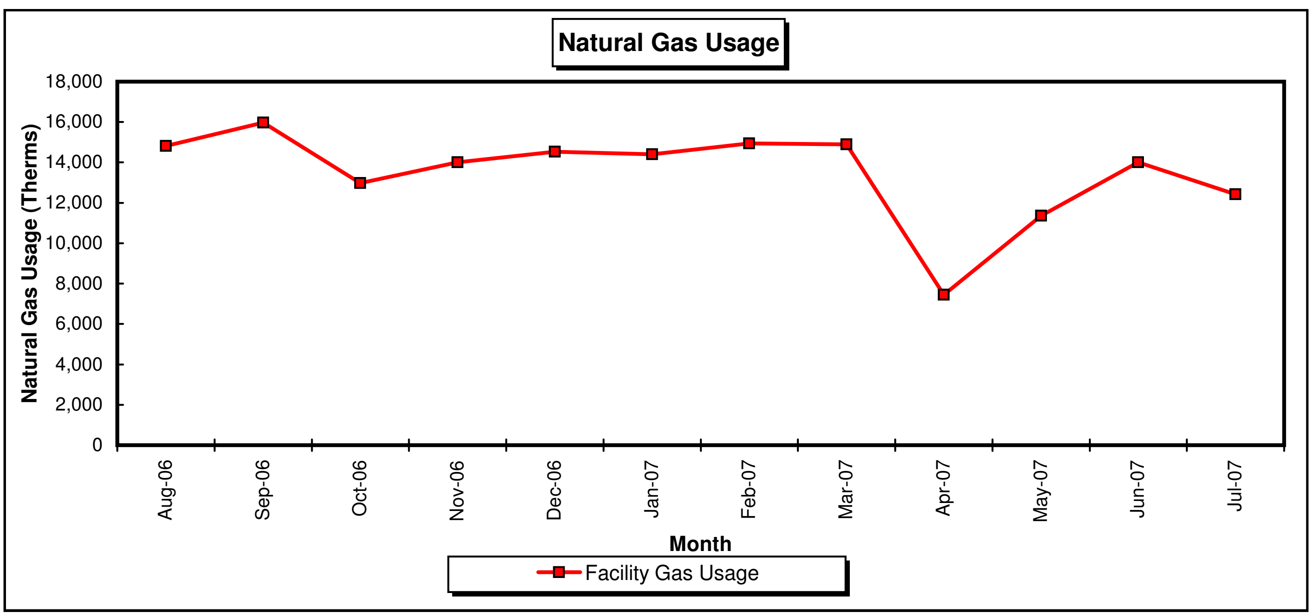
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	Dover Ice Arena
Year Built:	1974/2001
School Address:	110 Portland Ave
	Dover, NH
Phone Number:	516-6060
Principal's Name:	Patrick McNulty, Barry Rioxdan
Utility Company:	Northern Utilities/ Metromedia Energy
Account No.:	957-752-009-0
Rate:	0
Date:	2/7/2009
Facility Area:	126,084 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	14,819	$14,701	$0.992	1,482	11.753
Sep-06	15,969	$16,878	$1.057	1,597	12.665
Oct-06	12,971	$13,845	$1.067	1,297	10.288
Nov-06	14,006	$20,330	$1.452	1,401	11.108
Dec-06	14,537	$21,676	$1.491	1,454	11.530
Jan-07	14,396	$19,342	$1.344	1,440	11.418
Feb-07	14,934	$21,537	$1.442	1,493	11.844
Mar-07	14,897	$25,524	$1.713	1,490	11.815
Apr-07	7,443	$12,947	$1.740	744	5.903
May-07	11,365	$12,052	$1.060	1,137	9.014
Jun-07	14,014	$13,487	$0.962	1,401	11.115
Jul-07	12,427	$11,267	$0.907	1,243	9.856
Totals:	**161,778**	**$203,587**		**16,178**	**128.310**
Energy Intensity (MBtu/sq. ft.):		**132.16**			
Avg. Cost $/Therm		**$1.258**			



School Name:	Wate Water Treatment Facility
Year Built:	1991
School Address:	484 Middle Road Dover, NH
Phone Number:	396-4008
Principal's Name:	Ray Vermette
Facility Area:	0 sq. ft.

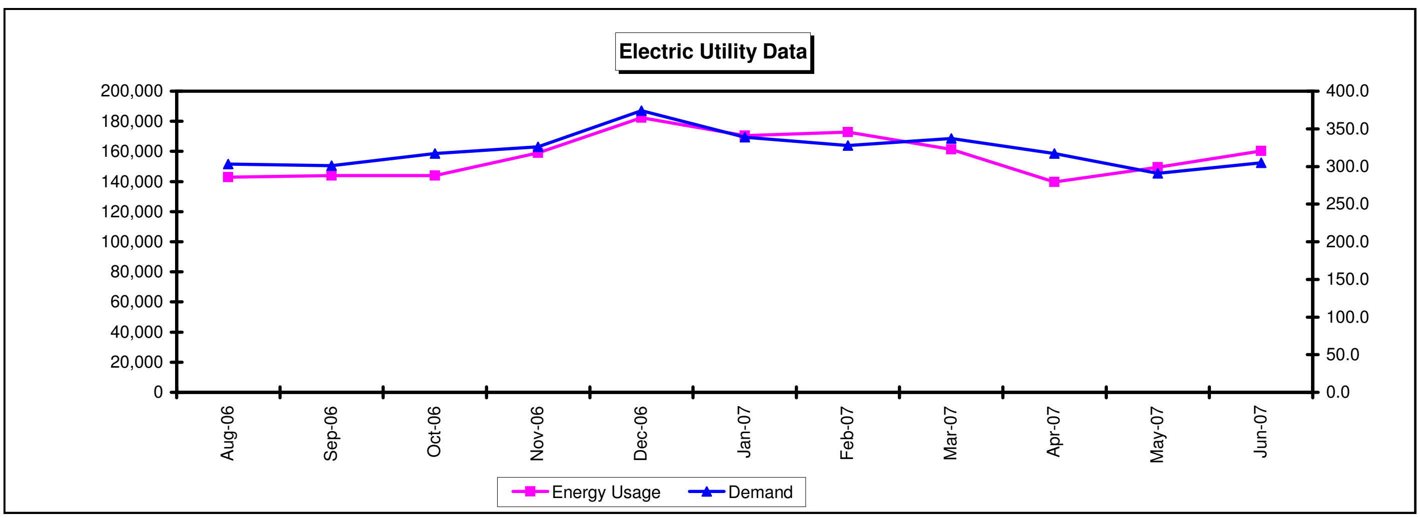
Utility Company: PSNH
Old Acct. No.: 8000672-03-5-5
New Acct. No.: 8000672-03-5-5
Rate: GV
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	300.0		145,200	$16,983	$0.117	$16,983	30	720	0.67
Sep-06	303.0		142,800	$16,754	$0.117	$16,754	32	768	0.61
Oct-06	301.0		144,000	$16,865	$0.117	$16,865	30	720	0.66
Nov-06	317.0		144,000	$16,965	$0.118	$16,965	30	720	0.63
Dec-06	326.0		159,000	$18,565	$0.117	$18,565	31	744	0.66
Jan-07	374.0		182,400	$21,612	$0.118	$21,612	30	720	0.68
Feb-07	339.0		170,400	$20,142	$0.118	$20,142	30	720	0.70
Mar-07	328.0		172,800	$20,332	$0.118	$20,332	31	744	0.71
Apr-07	337.0		161,400	$19,179	$0.119	$19,179	30	720	0.67
May-07	317.0		139,800	$16,781	$0.120	$16,781	29	696	0.63
Jun-07	291.0		149,400	$17,645	$0.118	$17,645	32	768	0.67
Jul-07	305.0	$0	160,200	$18,307	$0.114	$18,307	31	744	0.71
Avg./Totals:	**319.8**	**$0**	**1,871,400**	**$220,130**		**$220,130**	**366**	**8,784**	**0.67**

Energy Intensity (kWh/sq.ft.):	**-**	**Avg. Cost/kWh:**	**$0.118**
Blended Cost (inc.demand)/kWh:	**$0.118**	**Avg. Cost/kW:**	**$0.00**

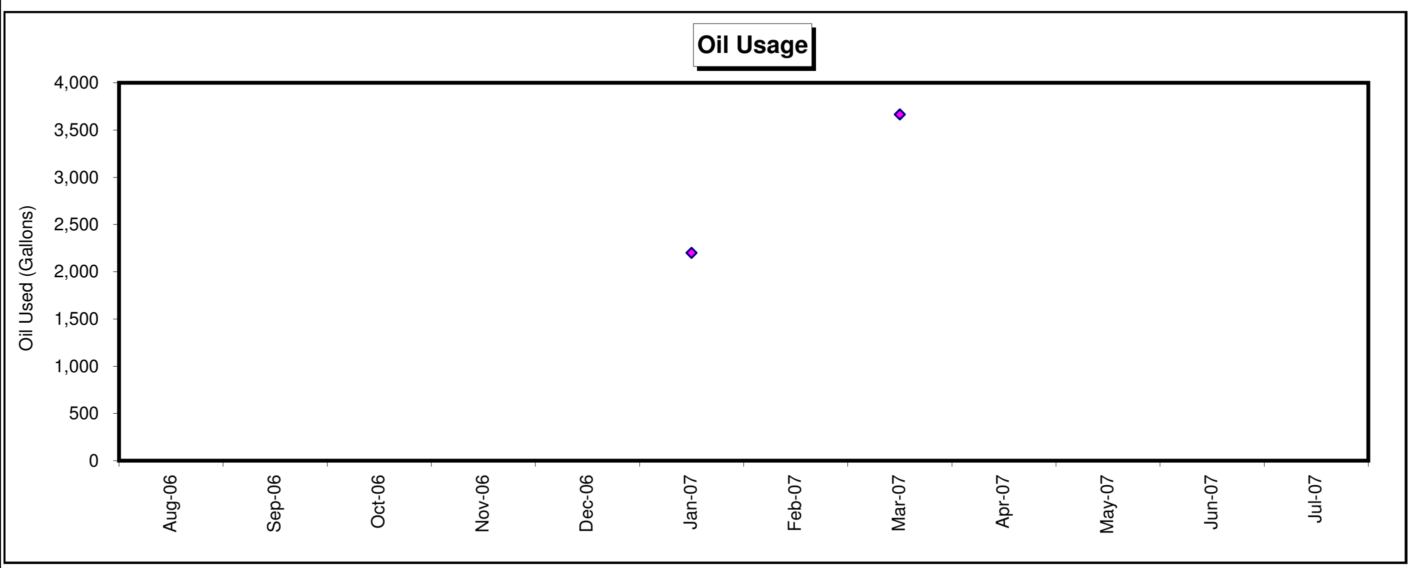
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Wate Water Treatment Facility
Year Built: 1991
School Address: 484 Middle Road
Dover, NH
Phone Number: 396-4008
Principal's Name: Ray Vermette
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 0 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2006/2007					
Aug-06			$0.000	0.00	$0.00
Sep-06			$0.000	0.00	$0.00
Oct-06			$0.000	0.00	$0.00
Nov-06			$0.000	0.00	$0.00
Dec-06			$0.000	0.00	$0.00
Jan-07	2,200	$5,170	$2.350	304.92	$0.00
Feb-07			$0.000	0.00	$0.00
Mar-07	3,665	$8,613	$2.350	508.00	$0.00
Apr-07			$0.000	0.00	$0.00
May-07			$0.000	0.00	$0.00
Jun-07			$0.000	0.00	$0.00
Jul-07			$0.000	0.00	$0.00
Total	**5,865**	**$13,783**	**$2.35**	**813**	**$0.00**
Energy Intensity (MBtu/sq. ft.):		**-**			
Avg. Cost $/Gallon		**$2.350**			



School Name:	Dover City Hall	Utility Company:	PSNH
Year Built:	1935	Old Acct. No.:	61-35-02648-0-2, 61-35-02789-0-1
School Address:	288 Central Avenue	New Acct. No.:	56906401021, 56395401037
	Dover, NH	Rate:	0
Phone Number:	396-4002	Date:	2/7/2009
Principal's Name:	Paul or Sharon		
Facility Area:	44,844 sq. ft.		

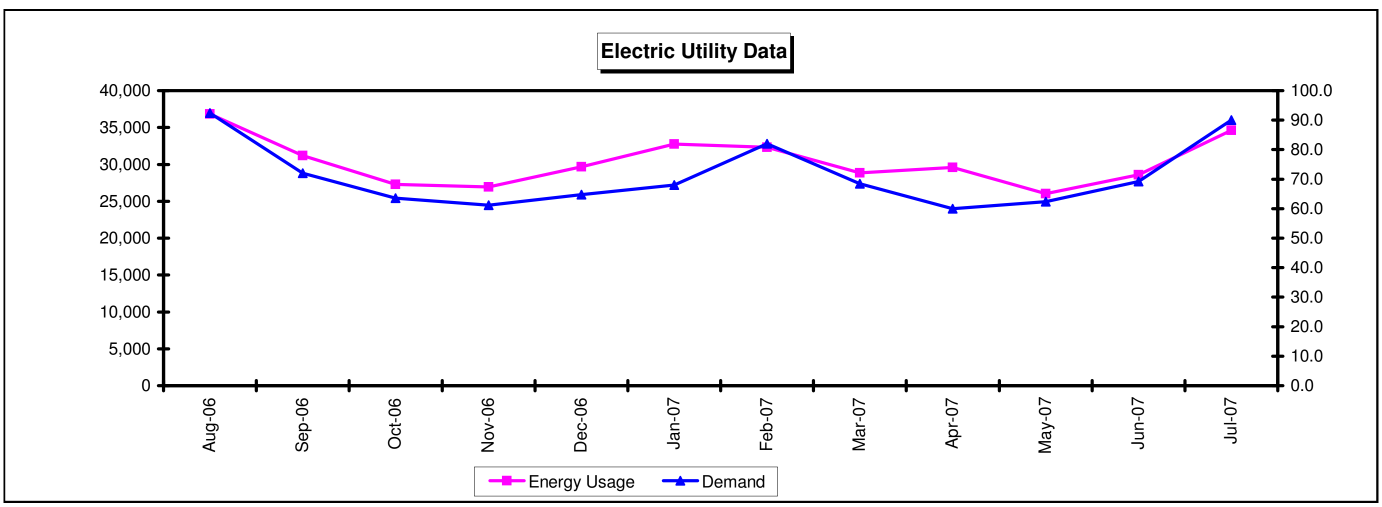
Includes only city Mgr bldg and police dept

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	92.4		36,840	$4,479	$0.122	$4,479	33	792	0.50
Sep-06	72.0		31,200	$3,753	$0.120	$3,753	31	744	0.58
Oct-06	63.6		27,280	$3,288	$0.121	$3,288	30	720	0.60
Nov-06	61.2		26,920	$3,234	$0.120	$3,234	31	744	0.59
Dec-06	64.8		29,680	$3,545	$0.119	$3,545	30	720	0.64
Jan-07	68.0		32,760	$3,941	$0.120	$3,941	31	744	0.65
Feb-07	82.0		32,320	$3,989	$0.123	$3,989	31	744	0.53
Mar-07	68.4		28,840	$3,530	$0.122	$3,530	28	672	0.63
Apr-07	60.0		29,600	$3,553	$0.120	$3,553	31	744	0.66
May-07	62.4		26,040	$3,193	$0.123	$3,193	30	720	0.58
Jun-07	69.2		28,600	$3,510	$0.123	$3,510	31	744	0.56
Jul-07	90.0		34,640	$4,292	$0.124	$4,292	30	720	0.53
Avg./Totals:	**71.2**	**$0**	**364,720**	**$44,307**		**$44,307**	**367**	**8,808**	**0.59**

Energy Intensity (kWh/sq.ft.):	**8.13**	**Avg. Cost/kWh:**	**$0.121**
Blended Cost (inc.demand)/kWh:	**$0.121**	**Avg. Cost/kW:**	**$0.00**

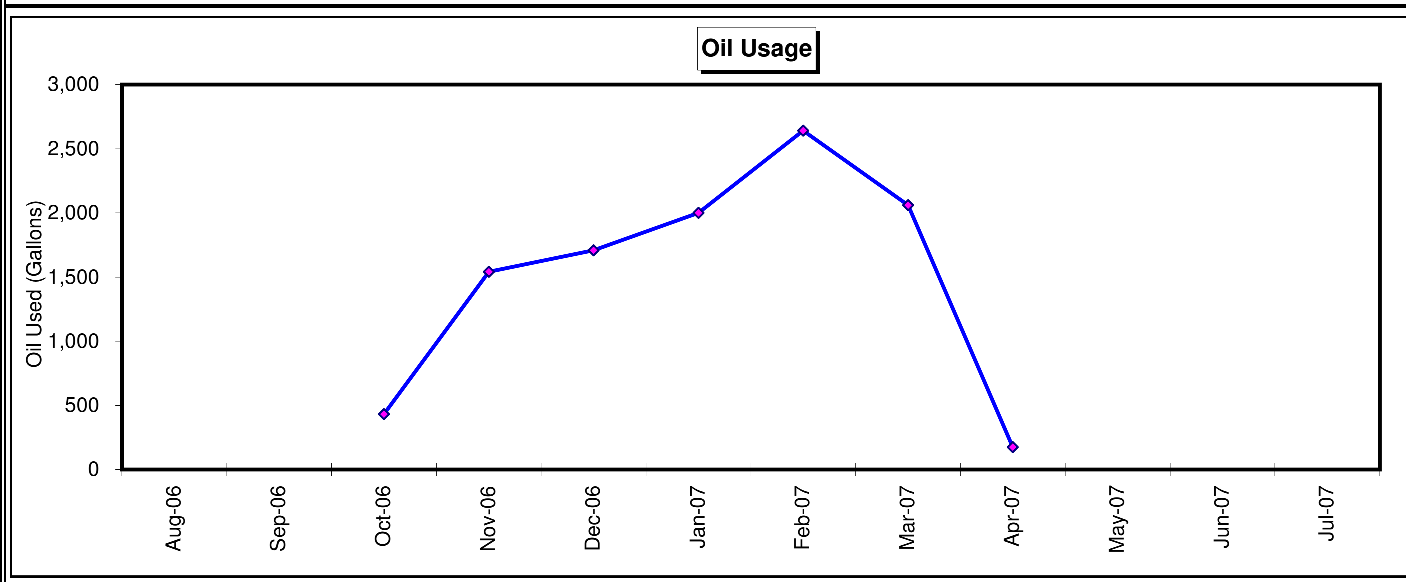
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Dover City Hall
Year Built: 1935
School Address: 288 Central Avenue
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Utility Company: Downeast Energy
Account No.: 306432
Rate: 0
Date: 2/7/2009
Facility Area: 44,844 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2006/2007					
Aug-06			$0.00	0.00	$0.00
Sep-06			$0.00	0.00	$0.00
Oct-06	430	$ 1,011	$2.35	59.63	$0.02
Nov-06	1,540	$ 3,620	$2.35	213.49	$0.08
Dec-06	1,709	$ 4,015	$2.35	236.81	$0.09
Jan-07	2,001	$ 4,703	$2.35	277.37	$0.10
Feb-07	2,642	$ 6,208	$2.35	366.11	$0.14
Mar-07	2,059	$ 4,838	$2.35	285.36	$0.11
Apr-07	175	$ 410	$2.35	24.20	$0.01
May-07			$0.00	0.00	$0.00
Jun-07			$0.00	0.00	$0.00
Jul-07			$0.00	0.00	$0.00
Total	**10,555**	**$ 24,805**	**$2.35**	**1,463**	**$0.55**
Energy Intensity (MBtu/sq. ft.):		**32.62**			
Avg. Cost $/Gallon		**$2.350**			



School Name: Public Works
Year Built: 2001
School Address: 271 Mast Rd
Dover, NH
Phone Number: 396-3117
Principal's Name: Bart Carson
Facility Area: 54,800 sq. ft.

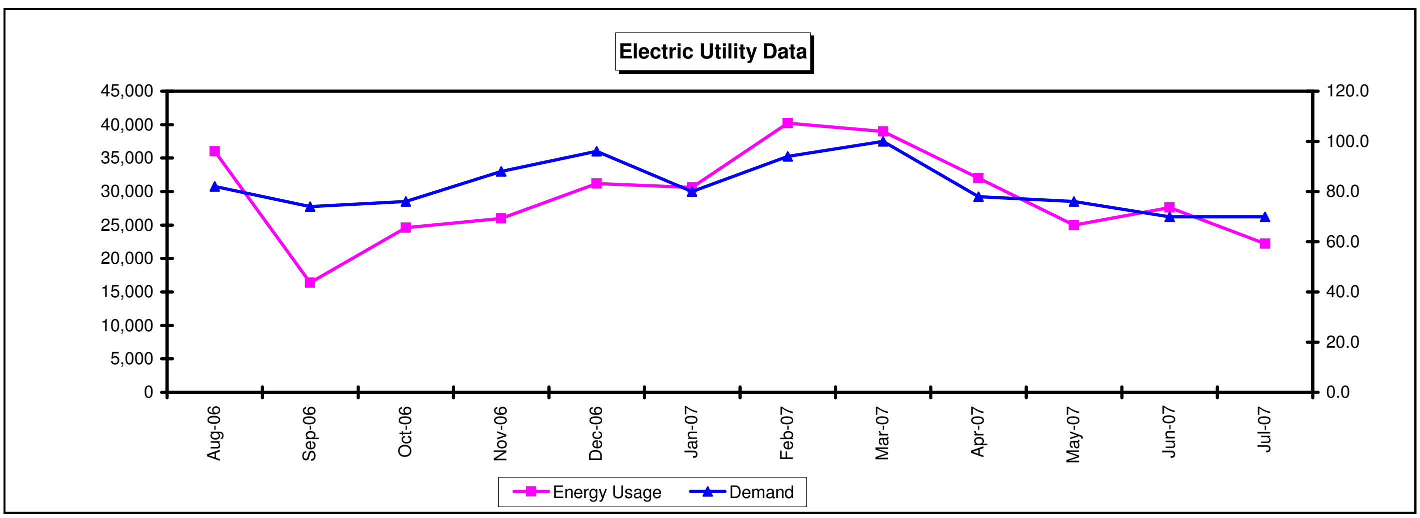
Utility Company: PSNH
Old Acct. No.: 61-10-09245-1-5
New Acct. No.: 56632841078
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	82.0		36,000	$4,320	$0.120	$4,320	32	768	0.57
Sep-06	74.0		16,400	$2,232	$0.136	$2,232	30	720	0.31
Oct-06	76.0		24,600	$3,096	$0.126	$3,096	30	720	0.45
Nov-06	88.0		26,000	$3,324	$0.128	$3,324	30	720	0.41
Dec-06	96.0		31,200	$3,919	$0.126	$3,919	31	744	0.44
Jan-07	80.0		30,600	$3,794	$0.124	$3,794	30	720	0.53
Feb-07	94.0		40,200	$4,903	$0.122	$4,903	30	720	0.59
Mar-07	100.0		39,000	$4,805	$0.123	$4,805	31	744	0.52
Apr-07	78.0		32,000	$3,929	$0.123	$3,929	29	696	0.59
May-07	76.0		25,000	$3,176	$0.127	$3,176	31	744	0.44
Jun-07	70.0		27,600	$3,410	$0.124	$3,410	30	720	0.55
Jul-07	70.0		22,200	$2,866	$0.129	$2,866	33	792	0.40
Avg./Totals:	**82.0**	**$0**	**350,800**	**$43,773**		**$43,773**	**367**	**8,808**	**0.48**

Energy Intensity (kWh/sq.ft.):	**6.40**	**Avg. Cost/kWh:**	**$0.125**
Blended Cost (inc.demand)/kWh:	**$0.125**	**Avg. Cost/kW:**	**$0.00**

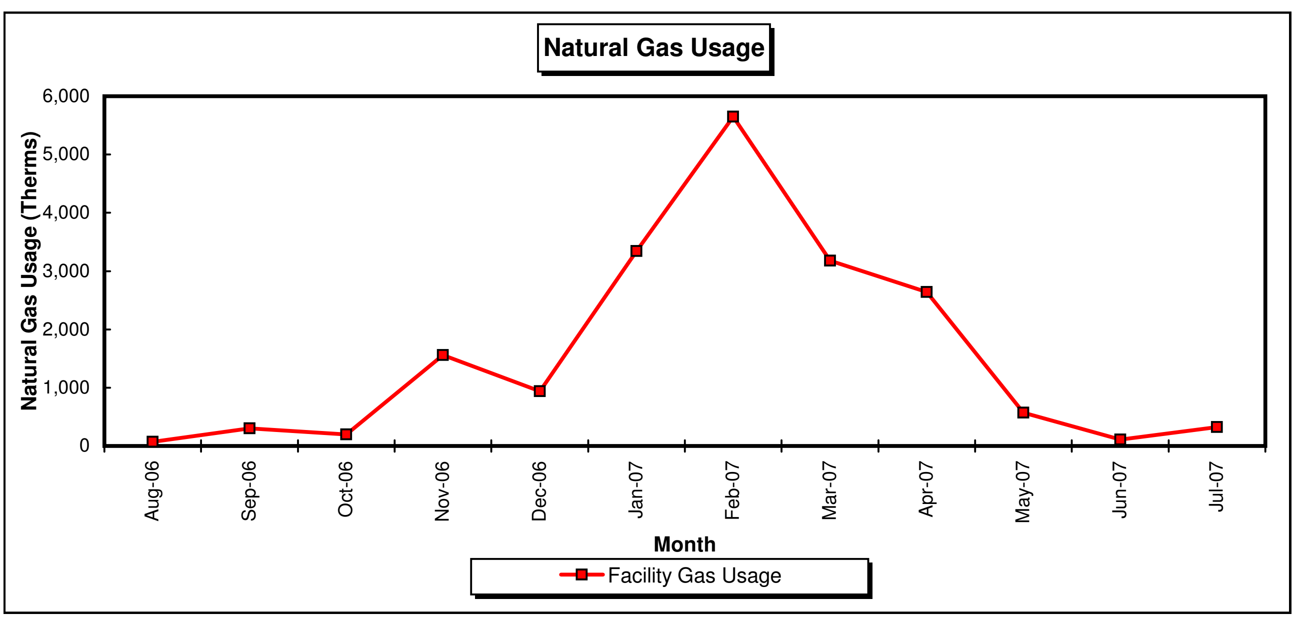
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Public Works
Year Built: 2001
School Address: 271 Mast Rd
Dover, NH
Phone Number: 396-3117
Principal's Name: Bart Carson
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 947-913-002-8
Rate: 0
Date: 2/7/2009
Facility Area: 54,800 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	74	$196	$2.655	7	0.135
Sep-06	302	$390	$1.291	30	0.551
Oct-06	196	$276	$1.406	20	0.358
Nov-06	1,557	$685	$0.440	156	2.841
Dec-06	938	$1,521	$1.621	94	1.712
Jan-07	3,342	$4,793	$1.434	334	6.099
Feb-07	5,646	$8,577	$1.519	565	10.303
Mar-07	3,177	$5,685	$1.789	318	5.797
Apr-07	2,641	$4,785	$1.812	264	4.819
May-07	570	$751	$1.317	57	1.040
Jun-07	110	$180	$1.636	11	0.201
Jul-07	324	$399	$1.232	32	0.591
Totals:	**18,877**	**$28,237**		**1,888**	**34.447**
Energy Intensity (MBtu/sq. ft.):		**35.48**			
Avg. Cost $/Therm		**$1.496**			



School Name: McConnell Center
Year Built: 1904
School Address: 61 Locust St
Dover, NH
Phone Number: 396-4026,516-6401
Principal's Name: Gary Bannon
Facility Area: 103,000 sq. ft.

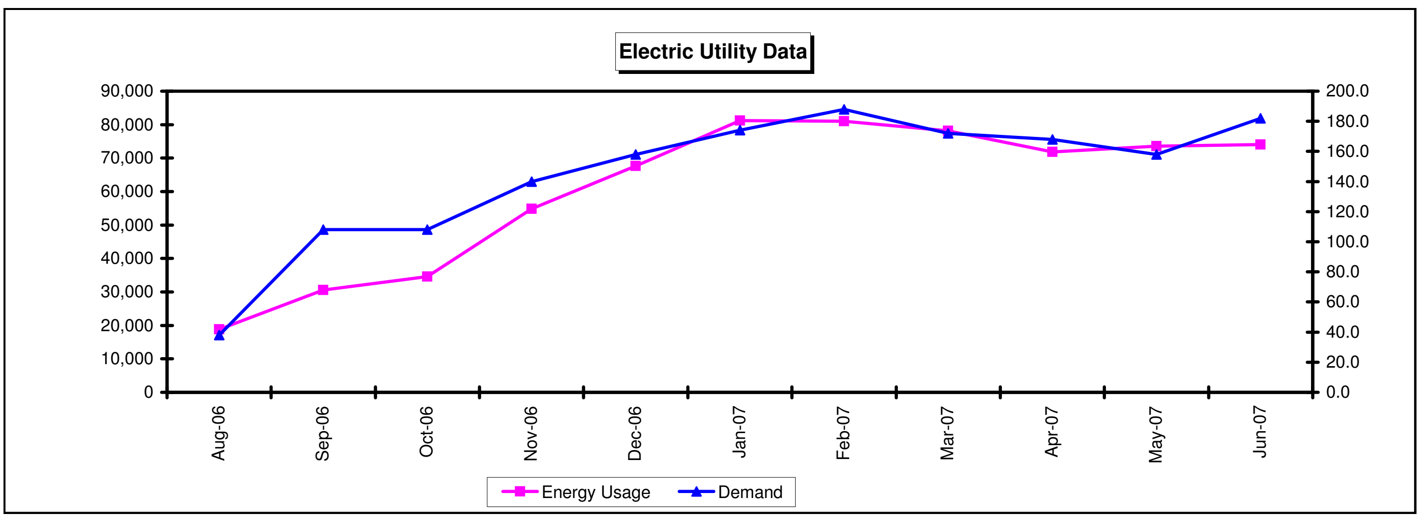
Utility Company: PSNH
Old Acct. No.: 61-35-06856-1-8, 61-35-08894-0-0
New Acct. No.: 8001869-04-5-5
Rate: GV
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	32.0		18,936	$2,233	$0.118	$2,233	30	720	0.82
Sep-06	38.0		18,800	$2,464	$0.131	$2,464	33	792	0.62
Oct-06	108.0		30,600	$3,940	$0.129	$3,940	30	720	0.39
Nov-06	108.0		34,600	$4,355	$0.126	$4,355	33	792	0.40
Dec-06	140.0		54,800	$6,671	$0.122	$6,671	29	696	0.56
Jan-07	158.0		67,600	$8,231	$0.122	$8,231	28	672	0.64
Feb-07	174.0		81,200	$9,776	$0.120	$9,776	34	816	0.57
Mar-07	188.0		81,000	$9,850	$0.122	$9,850	27	648	0.66
Apr-07	172.0		78,200	$9,446	$0.121	$9,446	30	720	0.63
May-07	168.0		71,800	$8,743	$0.122	$8,743	30	720	0.59
Jun-07	158.0		73,600	$8,865	$0.120	$8,865	31	744	0.63
Jul-07	182.0		74,000	$9,065	$0.123	$9,065	30	720	0.56
Avg./Totals:	**135.5**	**$0**	**685,136**	**$83,639**		**$83,639**	**365**	**8,760**	**0.59**

Energy Intensity (kWh/sq.ft.):	**6.65**	**Avg. Cost/kWh:**	**$0.122**
Blended Cost (inc.demand)/kWh:	**$0.122**	**Avg. Cost/kW:**	**$0.00**

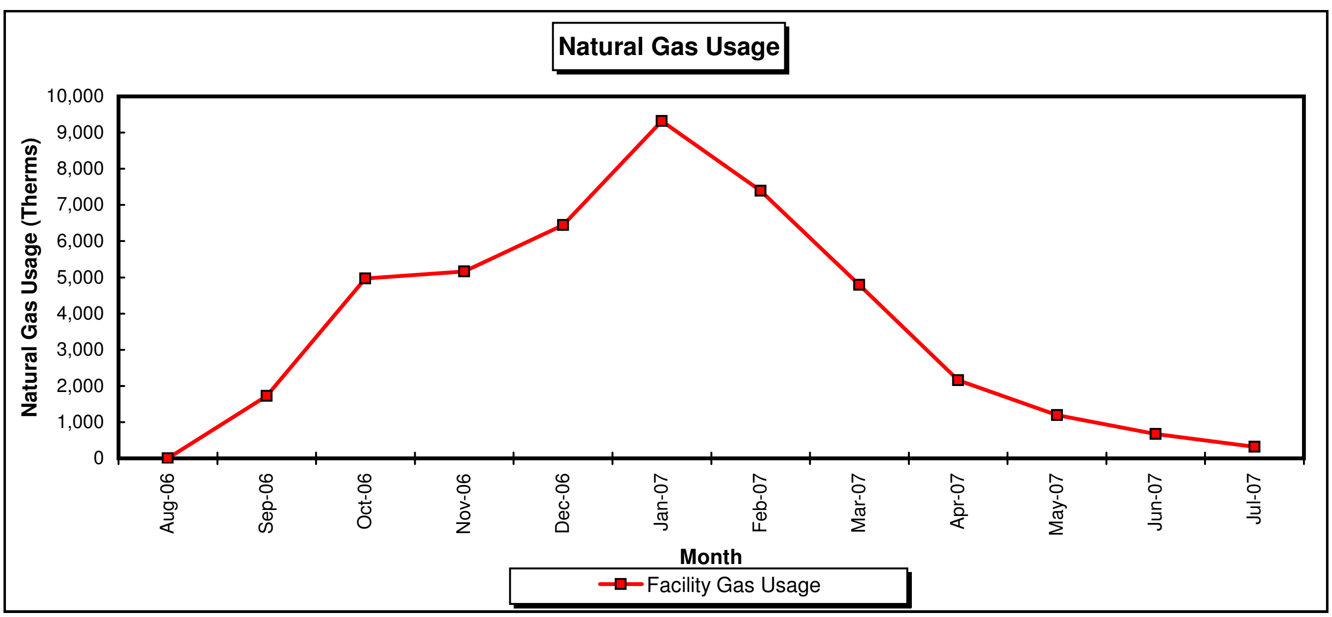
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: McConnell Center
Year Built: 1904
School Address: 61 Locust St
Dover, NH
Phone Number: 396-4026,516-6401
Principal's Name: Gary Bannon
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 103,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	0	$0	$0.000	0	0.000
Sep-06	1,728	$2,060	$1.192	173	1.678
Oct-06	4,965	$6,774	$1.364	497	4.820
Nov-06	5,166	$8,035	$1.555	517	5.016
Dec-06	6,450	$9,643	$1.495	645	6.262
Jan-07	9,319	$13,590	$1.458	932	9.048
Feb-07	7,394	$12,203	$1.650	739	7.179
Mar-07	4,796	$8,637	$1.801	480	4.656
Apr-07	2,160	$3,450	$1.597	216	2.097
May-07	1,196	$1,520	$1.271	120	1.161
Jun-07	672	$797	$1.186	67	0.652
Jul-07	320	$384	$1.200	32	0.311
Totals:	**44,166**	**$67,093**		**4,417**	**42.880**
Energy Intensity (MBtu/sq. ft.):		**44.17**			
Avg. Cost $/Therm		**$1.519**			



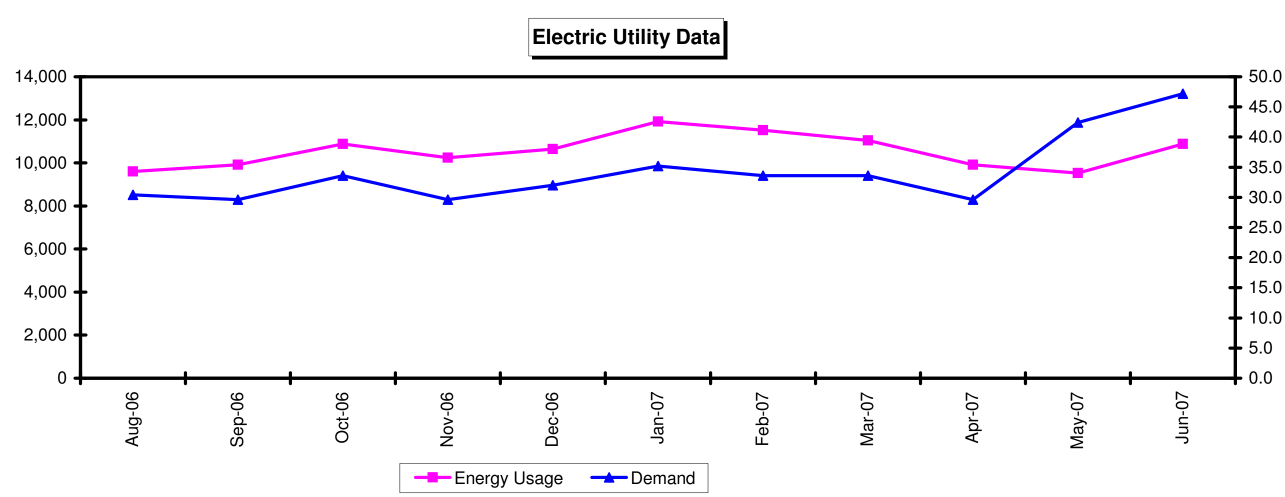
School Name:	Dover Public Library	Utility Company:	PSNH
Year Built:	1905/1988	Old Acct. No.:	61-35-06833-0-8
School Address:	73 Locust St Dover, NH	New Acct. No.:	56135401073
		Rate:	0
Phone Number:	516-6050	Date:	2/7/2009
Principal's Name:	Cathy Beaudoin		
Facility Area:	20,000 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	56.8		12,800	$1,448	$0.113	$1,740	28	672	0.34
Sep-06	30.4		9,600	$1,447	$0.151	$1,225	32	768	0.41
Oct-06	29.6		9,920	$1,417	$0.143	$1,252	31	744	0.45
Nov-06	33.6		10,880	$1,367	$0.126	$1,380	33	792	0.41
Dec-06	29.6		10,240	$1,327	$0.130	$1,286	29	696	0.50
Jan-07	32.0		10,640	$1,326	$0.125	$1,360	29	696	0.48
Feb-07	35.2		11,920	$1,604	$0.135	$1,517	33	792	0.43
Mar-07	33.6		11,520	$1,339	$0.116	$1,464	27	648	0.53
Apr-07	33.6		11,040	$1,456	$0.132	$1,414	31	744	0.44
May-07	29.6		9,920	$1,270	$0.128	$1,268	29	696	0.48
Jun-07	42.4		9,520	$1,457	$0.153	$1,313	32	768	0.29
Jul-07	47.2		10,880	$1,684	$0.155	$1,526	31	744	0.31
Avg./Totals:	**36.1**	**$0**	**128,880**	**$17,143**		**$16,744**	**365**	**8,760**	**0.42**

Energy Intensity (kWh/sq.ft.):	**6.44**	**Avg. Cost/kWh:**	**$0.133**
Blended Cost (inc.demand)/kWh:	**$0.130**	**Avg. Cost/kW:**	**$0.00**

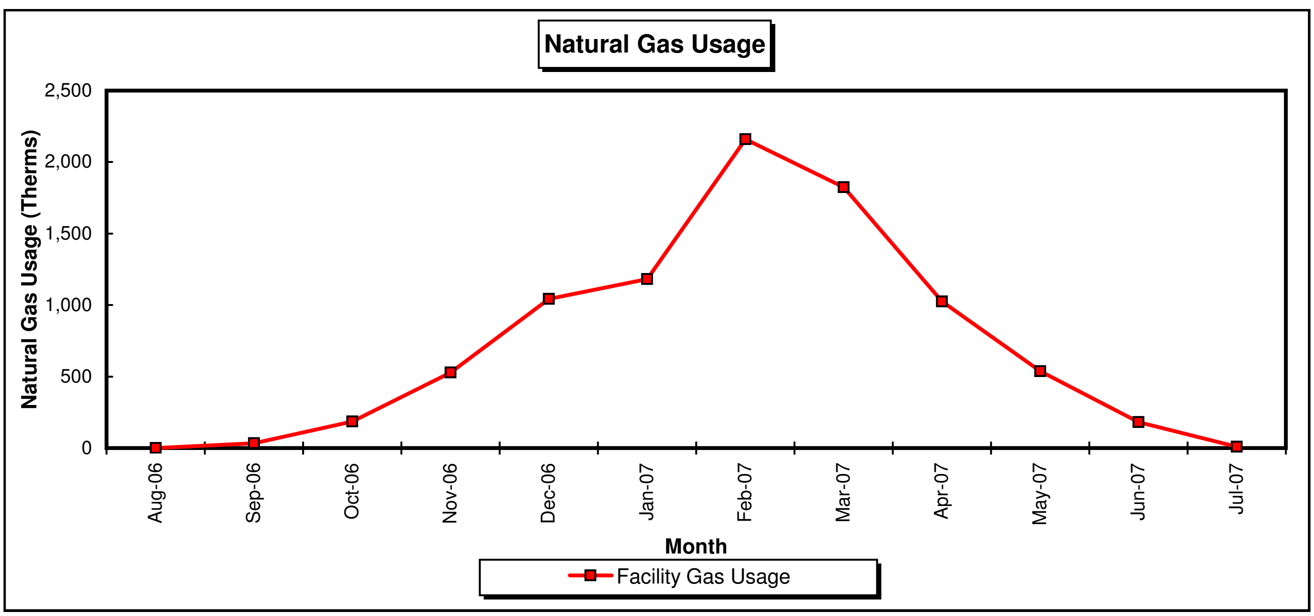
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Dover Public Library
Year Built: 1905/1988
School Address: 73 Locust St
Dover, NH
Phone Number: 516-6050
Principal's Name: Cathy Beaudoin
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 263-752-004-4
Rate: 0
Date: 2/7/2009
Facility Area: 20,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	0	$60	$0.000	0	0.000
Sep-06	34	$96	$2.837	3	0.170
Oct-06	185	$263	$1.420	19	0.925
Nov-06	528	$735	$1.393	53	2.640
Dec-06	1,043	$1,644	$1.576	104	5.215
Jan-07	1,181	$1,799	$1.523	118	5.905
Feb-07	2,159	$3,155	$1.462	216	10.795
Mar-07	1,824	$3,020	$1.656	182	9.120
Apr-07	1,024	$1,865	$1.821	102	5.120
May-07	537	$893	$1.663	54	2.685
Jun-07	182	$241	$1.323	18	0.910
Jul-07	9	$30	$3.348	1	0.045
Totals:	**8,706**	**$13,802**		**871**	**43.530**
Energy Intensity (MBtu/sq. ft.):		**44.84**			
Avg. Cost $/Therm		**$1.585**			



School Name: Jenny Thompson Pool
Year Built: 1977
School Address: 110 Portland Ave
Dover, NH
Phone Number: 516-6060
Principal's Name: Same as Arena
Facility Area: 0 sq. ft.

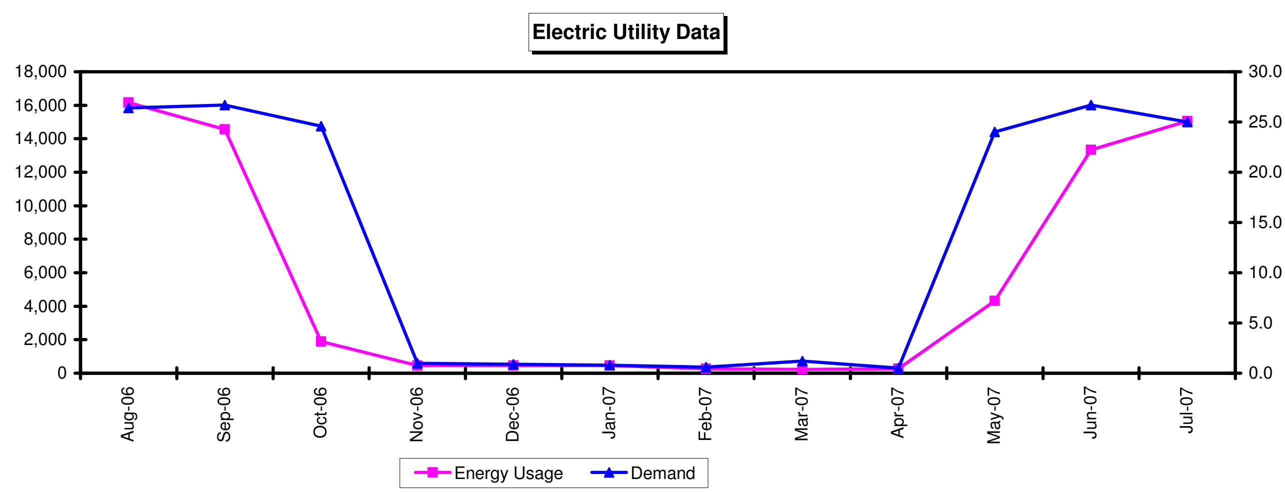
Utility Company: PSNH
Old Acct. No.: 61-30-06136-0-3
New Acct. No.: 56072321037
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	26.4		16,160	$1,877	$0.116	$1,877	30	720	0.85
Sep-06	26.7		14,560	$1,713	$0.118	$1,713	32	768	0.71
Oct-06	24.6		1,890	$385	$0.204	$385	30	720	0.11
Nov-06	1.0		460	$88	$0.192	$88	31	744	0.62
Dec-06	0.9		460	$88	$0.192	$88	32	768	0.67
Jan-07	0.8		460	$89	$0.194	$89	31	744	0.77
Feb-07	0.6		260	$58	$0.224	$58	28	672	0.64
Mar-07	1.2		230	$54	$0.233	$54	31	744	0.26
Apr-07	0.5		270	$60	$0.221	$60	29	696	0.78
May-07	24.0		4,310	$638	$0.148	$638	29	696	0.26
Jun-07	26.7		13,330	$1,609	$0.121	$1,609	33	792	0.63
Jul-07	25.0		15,060	$1,744	$0.116	$1,744	29	696	0.87
Avg./Totals:	**13.2**	**$0**	**67,450**	**$8,403**		**$8,403**	**365**	**8,760**	**0.60**

Energy Intensity (kWh/sq.ft.):	**-**	**Avg. Cost/kWh:**	**$0.125**
Blended Cost (inc.demand)/kWh:	**$0.125**	**Avg. Cost/kW:**	**$0.00**

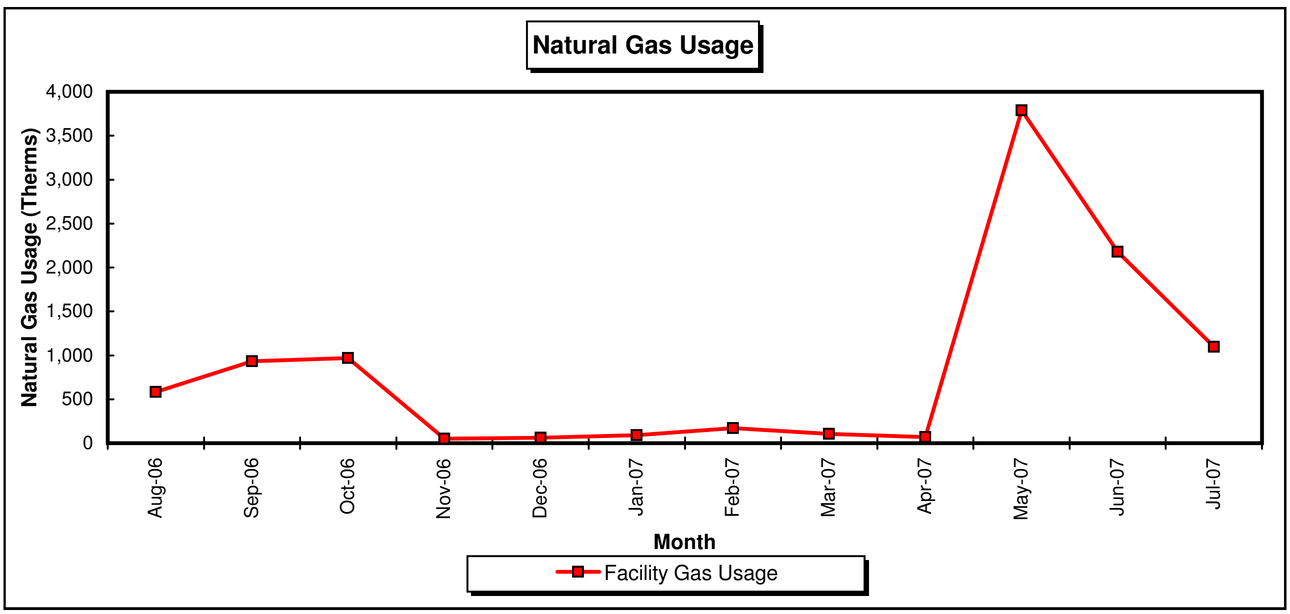
Table Formulas: Hours per Month = D x 24   Load Factor = B/(A x E)



School Name: Jenny Thompson Pool
Year Built: 1977
School Address: 110 Portland Ave
Dover, NH
Phone Number: 516-6060
Principal's Name: Same as Arena
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 398-413-008-7
Rate: 0
Date: 2/7/2009
Facility Area: 0 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	583	$655	$1.124	58	
Sep-06	933	$1,074	$1.152	93	
Oct-06	969	$1,120	$1.156	97	
Nov-06	50	$99	$1.982	5	
Dec-06	63	$123	$1.946	6	
Jan-07	90	$152	$1.691	9	
Feb-07	171	$282	$1.651	17	
Mar-07	107	$216	$2.014	11	
Apr-07	70	$150	$2.148	7	
May-07	3,788	$4,407	$1.164	379	
Jun-07	2,178	$2,370	$1.088	218	
Jul-07	1,098	$1,144	$1.042	110	
Totals:	**10,100**	**$11,793**		1,010	0.000
Energy Intensity (MBtu/sq. ft.):		**-**			
Avg. Cost $/Therm		**$1.168**			



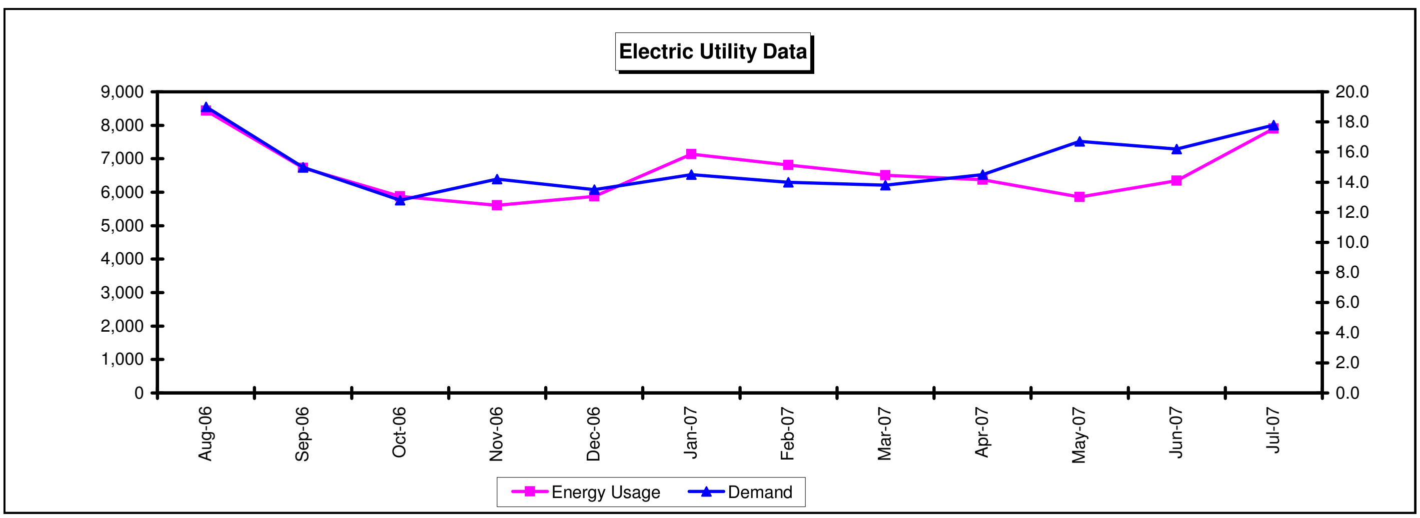
School Name:	Central Fire Station	Utility Company:	PSNH
Year Built:	1899	Old Acct. No.:	61-35-01167-0-5
School Address:	9 Broadway	New Acct. No.:	56299411066
	Dover, NH	Rate:	0
Phone Number:	516-6150	Date:	2/7/2009
Principal's Name:	Perry Plummer		
Facility Area:	7,000 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	19.0		8,440	$1,026	$0.122	$1,026	29	696	0.64
Sep-06	15.0		6,730	$821	$0.122	$821	33	792	0.57
Oct-06	12.8		5,880	$717	$0.122	$717	30	720	0.64
Nov-06	14.2		5,610	$699	$0.125	$699	33	792	0.50
Dec-06	13.5		5,880	$722	$0.123	$722	28	672	0.65
Jan-07	14.5		7,140	$872	$0.122	$872	29	696	0.71
Feb-07	14.0		6,810	$834	$0.122	$834	34	816	0.60
Mar-07	13.8		6,510	$801	$0.123	$801	28	672	0.70
Apr-07	14.5		6,370	$791	$0.124	$791	30	720	0.61
May-07	16.7		5,860	$752	$0.128	$752	29	696	0.50
Jun-07	16.2		6,340	$799	$0.126	$799	32	768	0.51
Jul-07	17.8		7,900	$962	$0.122	$962	30	720	0.62
Avg./Totals:	**15.2**	**$0**	**79,470**	**$9,794**		**$9,794**	**365**	**8,760**	**0.60**

Energy Intensity (kWh/sq.ft.):	**11.35**	**Avg. Cost/kWh:**	**$0.123**
Blended Cost (inc.demand)/kWh:	**$0.123**	**Avg. Cost/kW:**	**$0.00**

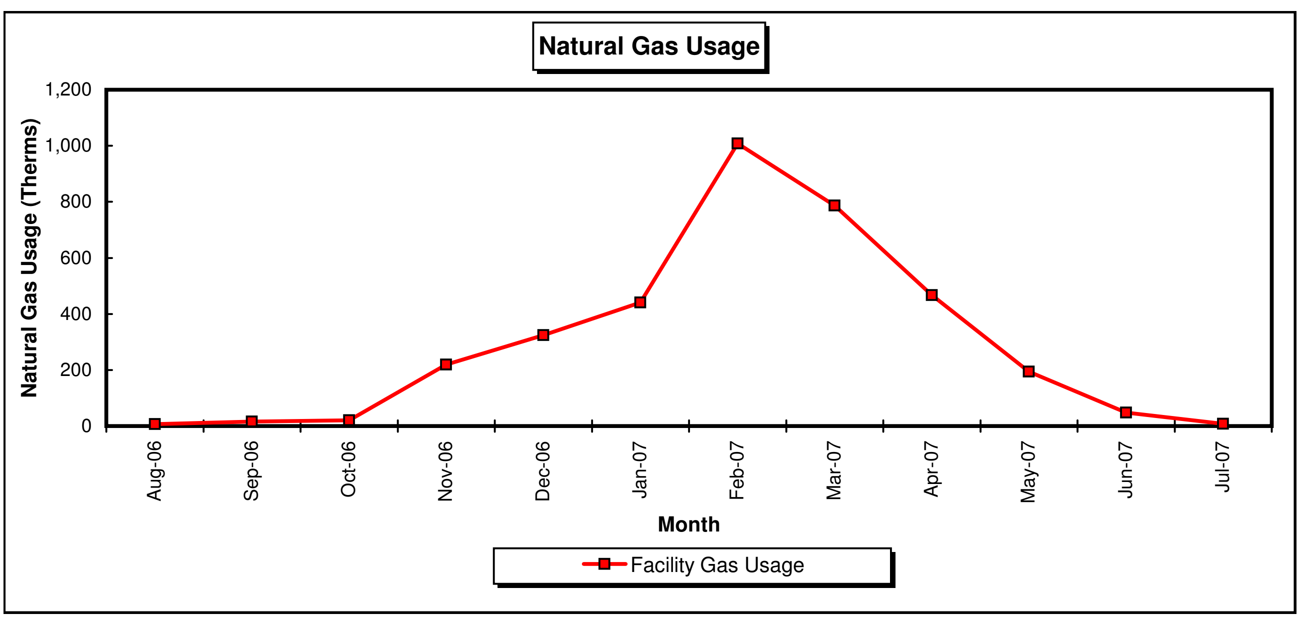
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Central Fire Station
Year Built: 1899
School Address: 9 Broadway
Dover, NH
Phone Number: 516-6150
Principal's Name: Perry Plummer
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 448-652-0026
Rate: 0
Date: 2/7/2009
Facility Area: 7,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	7	$27	$3.891	1	0.100
Sep-06	16	$39	$2.434	2	0.229
Oct-06	21	$46	$2.184	2	0.300
Nov-06	219	$324	$1.481	22	3.129
Dec-06	324	$529	$1.633	32	4.629
Jan-07	441	$688	$1.561	44	6.300
Feb-07	1,008	$1,490	$1.478	101	14.400
Mar-07	787	$1,322	$1.680	79	11.243
Apr-07	467	$865	$1.853	47	6.671
May-07	194	$340	$1.751	19	2.771
Jun-07	48	$80	$1.673	5	0.686
Jul-07	8	$29	$3.605	1	0.114
Totals:	**3,540**	**$5,780**		**354**	**50.571**
Energy Intensity (MBtu/sq. ft.):		**52.09**			
Avg. Cost $/Therm		**$1.633**			



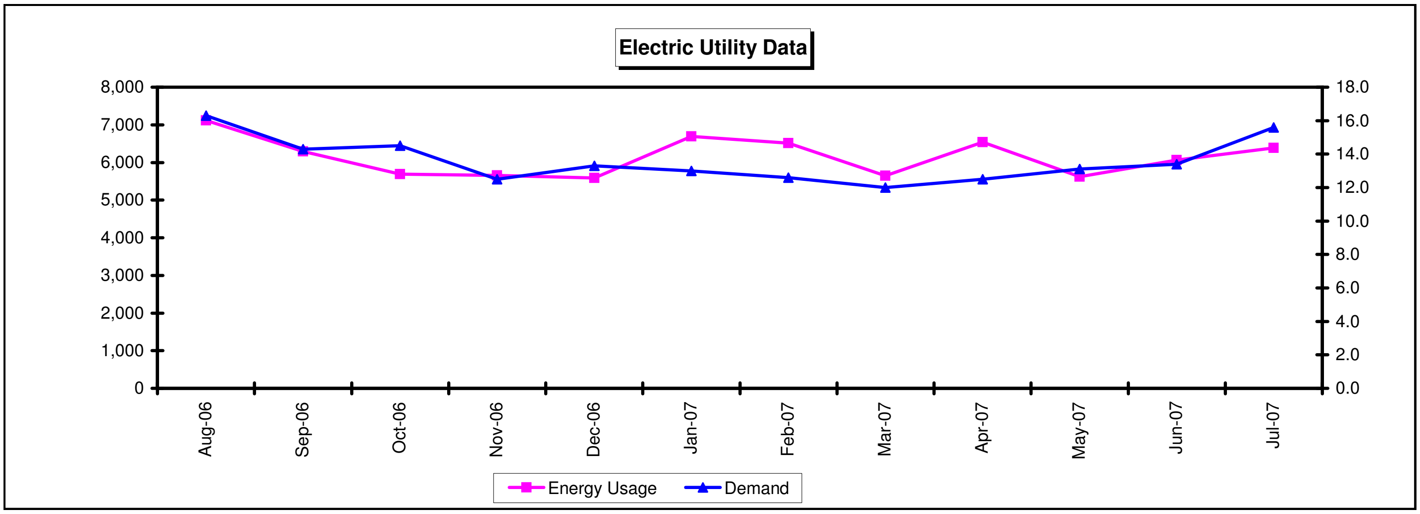
School Name:	South End Fire Station	Utility Company:	PSNH
Year Built:	1967	Old Acct. No.:	61-10-03228-0-1
School Address:	25 Durham Rd	New Acct. No.:	56847801073
	Dover, NH	Rate:	0
Phone Number:	516-6150	Date:	2/7/2009
Principal's Name:	Richard Driscoll		
Facility Area:	8,000 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	16.3		7,116	$878	$0.123	$878	32	768	0.57
Sep-06	14.3		6,292	$779	$0.124	$779	30	720	0.61
Oct-06	14.5		5,687	$718	$0.126	$718	30	720	0.54
Nov-06	12.5		5,659	$701	$0.124	$701	31	744	0.61
Dec-06	13.3		5,584	$699	$0.125	$699	30	720	0.58
Jan-07	13.0		6,694	$823	$0.123	$823	31	744	0.69
Feb-07	12.6		6,516	$802	$0.123	$802	30	720	0.72
Mar-07	12.0		5,644	$706	$0.125	$706	30	720	0.65
Apr-07	12.5		6,539	$804	$0.123	$804	29	696	0.75
May-07	13.1		5,623	$711	$0.126	$711	29	696	0.62
Jun-07	13.4		6,062	$759	$0.125	$759	31	744	0.61
Jul-07	15.6		6,383	$800	$0.125	$800	32	768	0.53
Avg./Totals:	**13.6**	**$0**	**73,799**	**$9,179**		**$9,179**	**365**	**8,760**	**0.62**

Energy Intensity (kWh/sq.ft.):	**9.22**	**Avg. Cost/kWh:**	**$0.124**
Blended Cost (inc.demand)/kWh:	**$0.124**	**Avg. Cost/kW:**	**$0.00**

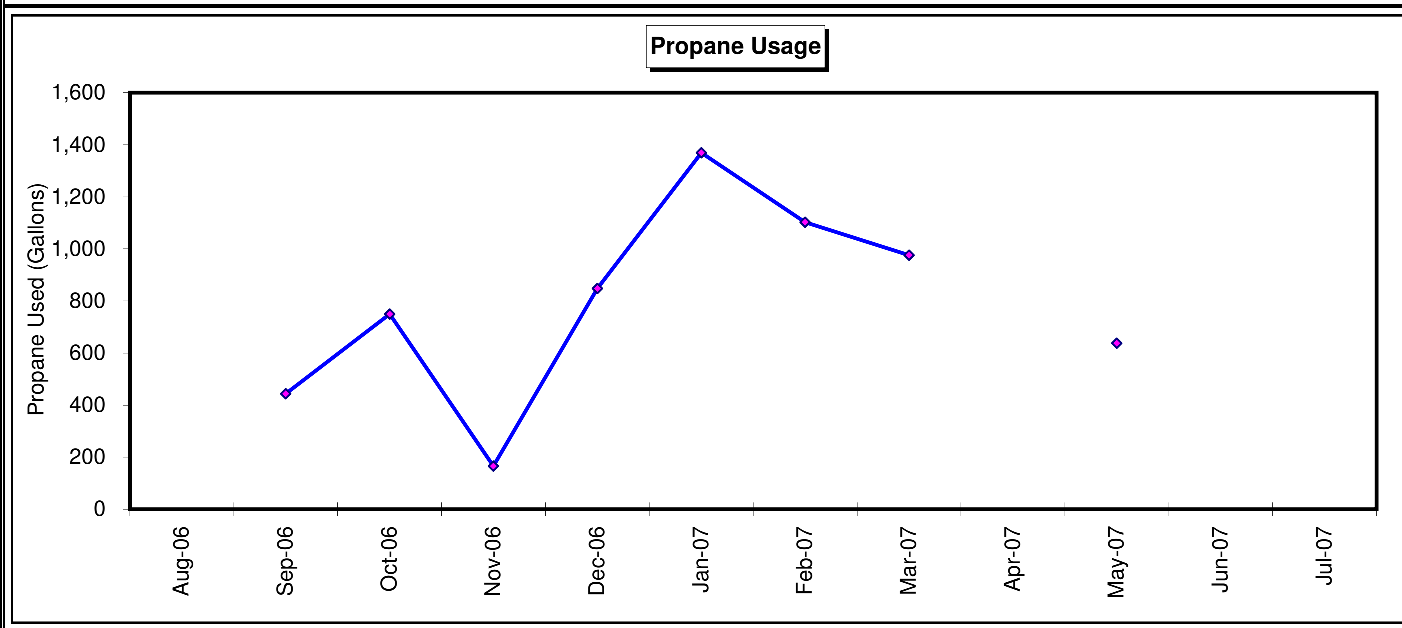
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: South End Fire Station
Year Built: 1967
School Address: 25 Durham Rd
Dover, NH
Phone Number: 516-6150
Principal's Name: Richard Driscoll
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 8,000 sq. ft.

ANNUAL PROPANE USAGE

Month	Propane Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2006/2007					
Aug-06		$ -	$0.00	0	$0.00
Sep-06	443	$ 705	$1.59	42	$0.09
Oct-06	750	$ 1,193	$1.59	72	$0.15
Nov-06	166	$ 265	$1.59	16	$0.03
Dec-06	848	$ 1,348	$1.59	81	$0.17
Jan-07	1,369	$ 2,176	$1.59	131	$0.27
Feb-07	1,102	$ 1,752	$1.59	105	$0.22
Mar-07	975	$ 1,551	$1.59	93	$0.19
Apr-07		$ 829	$0.00	0	$0.10
May-07	637	$ 1,013	$1.59	61	$0.13
Jun-07		$ -	$0.00	0	$0.00
Jul-07			$0.00	0	$0.00
Total	**6,291**	**$ 10,831**	**$1.72**	**601**	**$1.35**
Energy Intensity (MBtu/sq. ft.):		**75.09**			
Avg. Cost $/Gallon		**$1.722**			



School Name: Pine Hill Chapel
Year Built: 1911
School Address: 131 Central Ave
Dover, NH
Phone Number: 516-6480
Principal's Name: Nancy
Facility Area: 1,500 sq. ft.

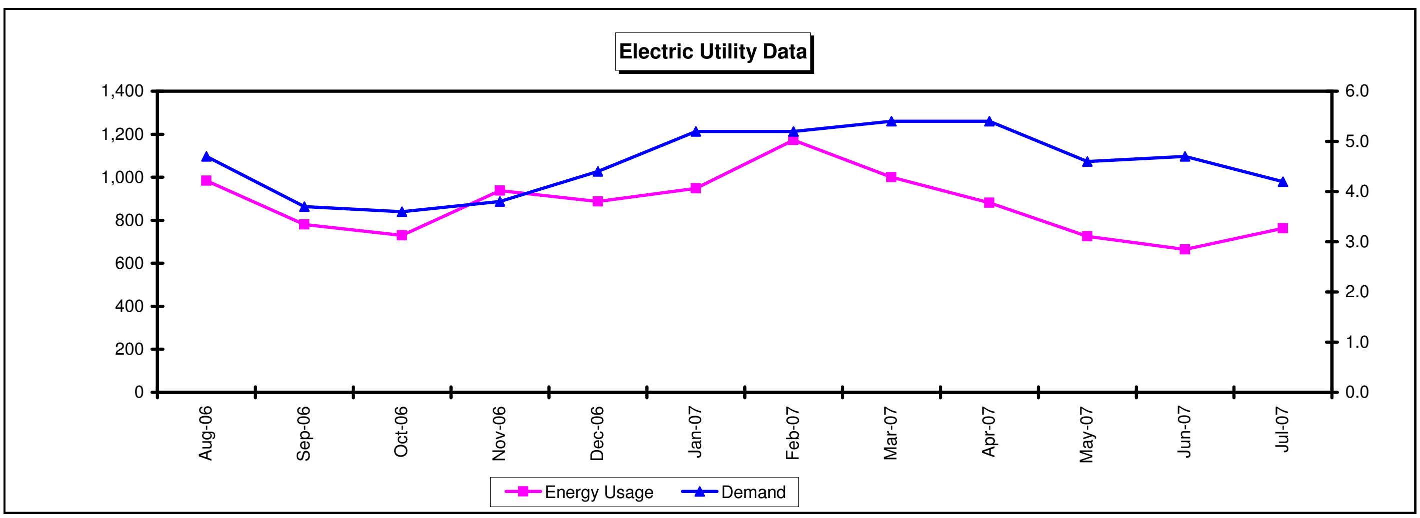
Utility Company: PSNH
Old Acct. No.: 61-35-05696-0-6
New Acct. No.: 56143521011
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	4.7		984	$158	$0.160	$158	33	792	0.26
Sep-06	3.7		780	$134	$0.172	$134	29	696	0.30
Oct-06	3.6		730	$128	$0.176	$128	31	744	0.27
Nov-06	3.8		938	$152	$0.162	$152	33	792	0.31
Dec-06	4.4		888	$146	$0.165	$146	29	696	0.29
Jan-07	5.2		948	$156	$0.165	$156	29	696	0.26
Feb-07	5.2		1,172	$183	$0.156	$183	32	768	0.29
Mar-07	5.4		1,000	$164	$0.164	$164	29	696	0.27
Apr-07	5.4		882	$150	$0.170	$150	30	720	0.23
May-07	4.6		726	$130	$0.178	$130	32	768	0.21
Jun-07	4.7		664	$122	$0.184	$122	29	696	0.20
Jul-07	4.2		762	$134	$0.175	$134	29	696	
Avg./Totals:	**4.6**	**$0**	**10,474**	**$1,757**		**$1,757**	**365**	**8,760**	**0.24**

Energy Intensity (kWh/sq.ft.):	**6.98**		**Avg. Cost/kWh:**	**$0.168**
Blended Cost (inc.demand)/kWh:	**$0.168**		**Avg. Cost/kW:**	**$0.00**

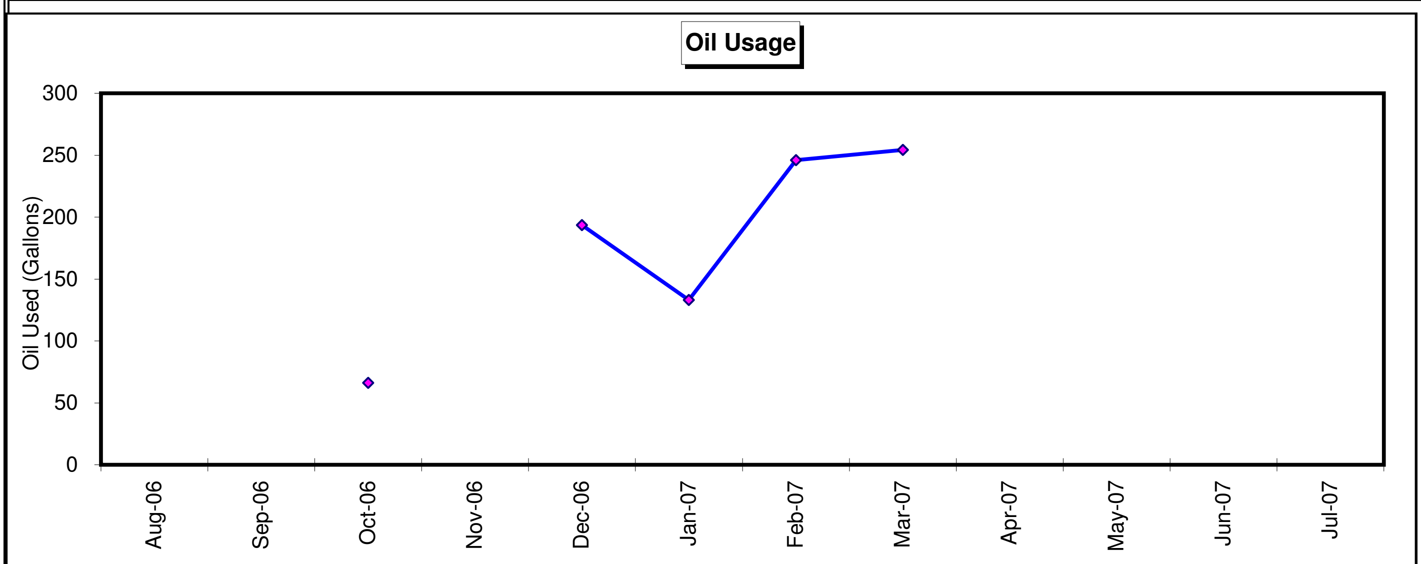
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	Pine Hill Chapel
Year Built:	1911
School Address:	131 Central Ave Dover, NH
Phone Number:	516-6480
Principal's Name:	Nancy
Utility Company:	Downeast Energy
Account No.:	306,440
Rate:	0
Date:	2/7/2009
Facility Area:	1,500 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2006/2007					
Aug-06			$0.00	0.00	$0.00
Sep-06			$0.00	0.00	$0.00
Oct-06	66	$ 155	$2.35	9.16	$0.10
Nov-06			$0.00	0.00	$0.00
Dec-06	194	$ 455	$2.35	26.83	$0.30
Jan-07	133	$ 313	$2.35	18.43	$0.21
Feb-07	246	$ 578	$2.35	34.10	$0.39
Mar-07	254	$ 598	$2.35	35.25	$0.40
Apr-07			$0.00	0.00	$0.00
May-07			$0.00	0.00	$0.00
Jun-07			$0.00	0.00	$0.00
Jul-07			$0.00	0.00	$0.00
Total	**893**	**$ 2,099**	**$2.35**	**124**	**$1.40**
Energy Intensity (MBtu/sq. ft.):		**82.51**			
Avg. Cost $/Gallon		**$2.350**			



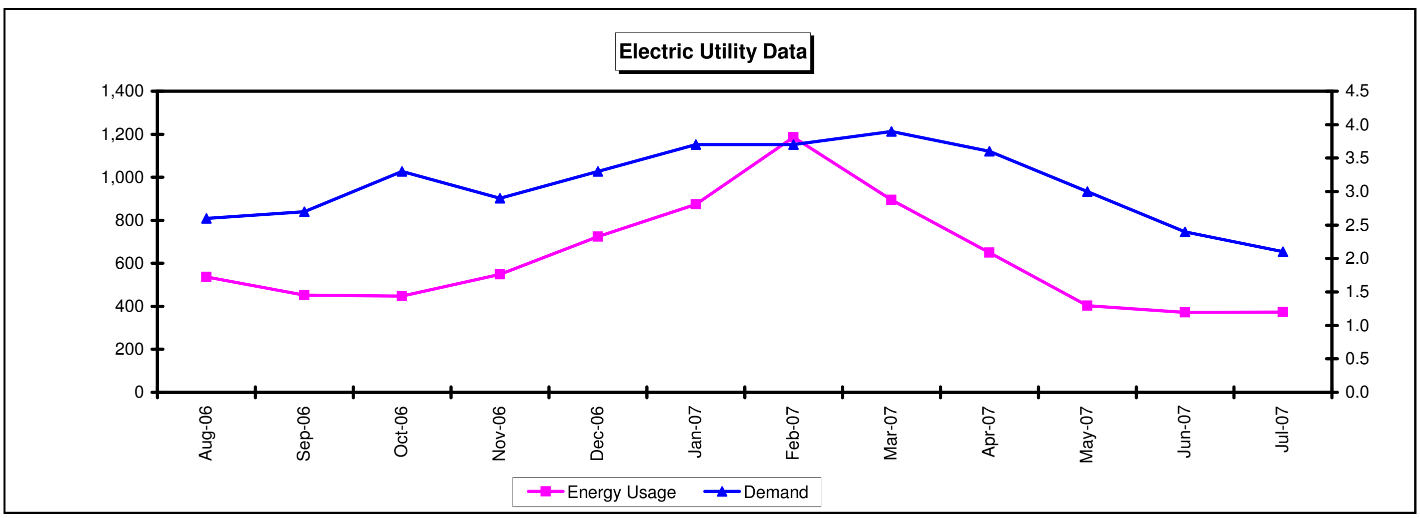
School Name:	Pine Hill Barn	Utility Company:	PSNH
Year Built:	1900	Old Acct. No.:	61-35-05566-0-3, 61-35-05567-0-2
School Address:	131 Central Ave	New Acct. No.:	56560290074, 56511290090
	Dover, NH	Rate:	0
Phone Number:	396-3964	Date:	2/7/2009
Principal's Name:	Paul		
Facility Area:	1,500 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007									
Aug-06	2.6		536	$98	$0.183	$98	30	720	0.29
Sep-06	2.7		452	$85	$0.188	$85	32	768	0.22
Oct-06	3.3		447	$84	$0.188	$84	30	720	0.19
Nov-06	2.9		549	$99	$0.181	$99	33	792	0.24
Dec-06	3.3		724	$119	$0.165	$119	30	720	0.30
Jan-07	3.7		874	$138	$0.158	$138	28	672	0.35
Feb-07	3.7		1,186	$175	$0.147	$175	30	720	0.45
Mar-07	3.9		894	$141	$0.157	$141	33	792	0.29
Apr-07	3.6		649	$112	$0.173	$112	33	792	
May-07	3.0		403	$79	$0.195	$79	30	720	
Jun-07	2.4		372	$74	$0.198	$74	28	672	
Jul-07	2.1		373	$75	$0.200	$75	28	672	
Avg./Totals:	**3.1**	**$0**	**7,459**	**$1,278**		**$1,278**	**365**	**8,760**	**0.19**

Energy Intensity (kWh/sq.ft.):	**4.97**	**Avg. Cost/kWh:**	**$0.171**
Blended Cost (inc.demand)/kWh:	**$0.171**	**Avg. Cost/kW:**	**$0.00**

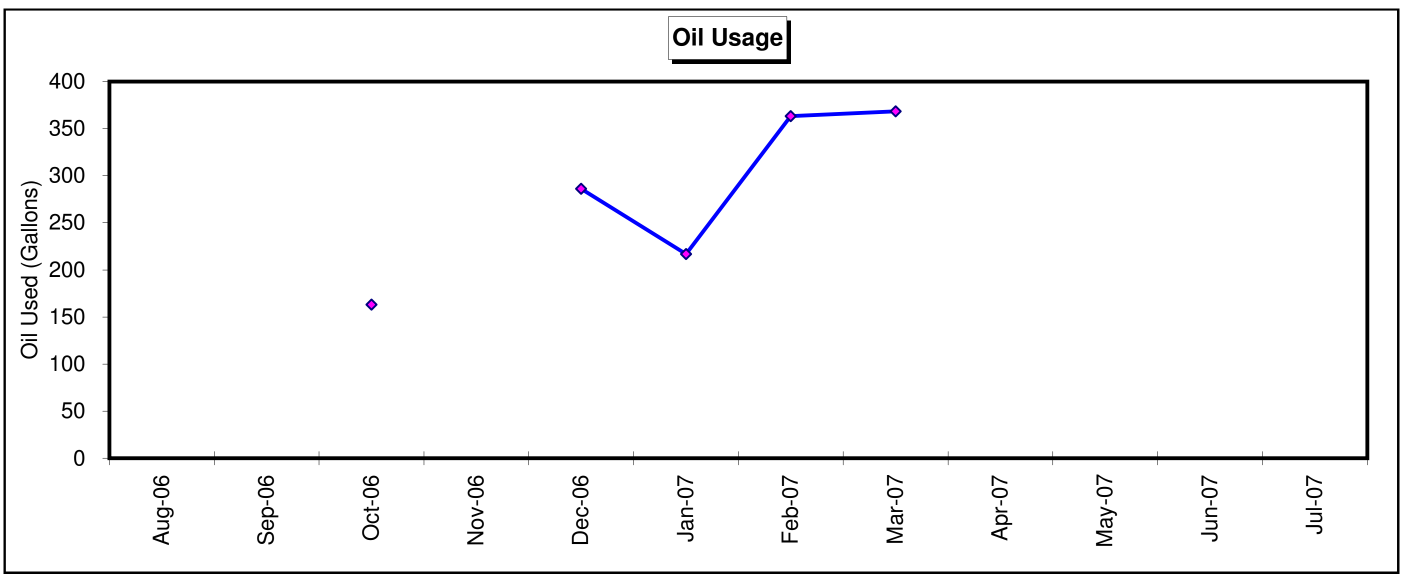
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Pine Hill Barn
Year Built: 1900
School Address: 131 Central Ave
Dover, NH
Phone Number: 396-3964
Principal's Name: Paul
Utility Company: Downeast Energy
Account No.: 306,458
Rate: 0
Date: 2/7/2009
Facility Area: 1,500 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2006/2007					
Aug-06			$0.00	0.00	$0.00
Sep-06			$0.00	0.00	$0.00
Oct-06	163	$ 384	$2.35	22.62	$0.26
Nov-06			$0.00	0.00	$0.00
Dec-06	286	$ 672	$2.35	39.64	$0.45
Jan-07	217	$ 509	$2.35	30.03	$0.34
Feb-07	363	$ 854	$2.35	50.34	$0.57
Mar-07	368	$ 866	$2.35	51.06	$0.58
Apr-07			$0.00	0.00	$0.00
May-07			$0.00	0.00	$0.00
Jun-07			$0.00	0.00	$0.00
Jul-07			$0.00	0.00	$0.00
Total	**1,398**	**$ 3,284**	**$2.35**	**194**	**$2.19**
Energy Intensity (MBtu/sq. ft.):		**129.13**			
Avg. Cost $/Gallon		**$2.350**			



School Name:	Veterans Hall
Year Built:	1920
School Address:	156 Back River Road Dover, NH
Phone Number:	396-4002
Principal's Name:	Paul or Sharon
Facility Area:	2,952 sq. ft.

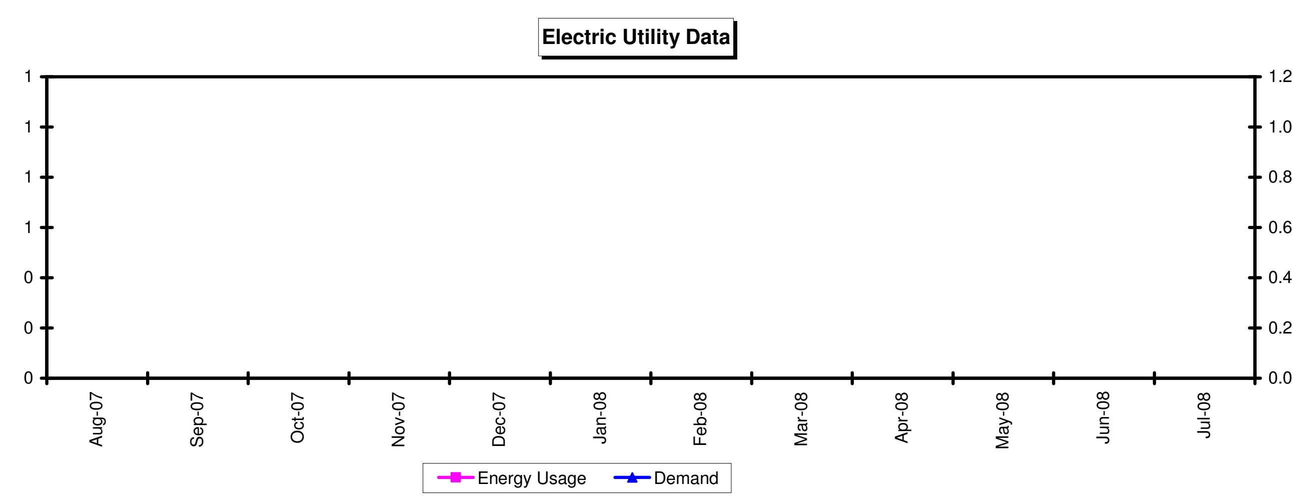
Utility Company: PSNH
Old Acct. No.: 61-10-11423-0-7
New Acct. No.: 56599551058
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2007/2008									
Aug-07				$0	$0.000		30	720	
Sep-07				$0	$0.000		32	768	
Oct-07				$0	$0.000		30	720	
Nov-07				$0	$0.000		29	696	
Dec-07				$0	$0.000		32	768	
Jan-08				$0	$0.000		31	744	
Feb-08				$0	$0.000		29	696	
Mar-08				$0	$0.000		31	744	
Apr-08				$0	$0.000		29	696	
May-08				$0	$0.000		29	696	
Jun-08				$0	$0.000		33	792	
Jul-08				$0	$0.000		30	720	
Avg./Totals:	**0.0**	**$0**	**0**	**$0**		**$0**	**365**	**8,760**	

Energy Intensity (kWh/sq.ft.):	**0.00**	**Avg. Cost/kWh:**	**-**
Blended Cost (inc.demand)/kWh:	**-**	**Avg. Cost/kW:**	**-**

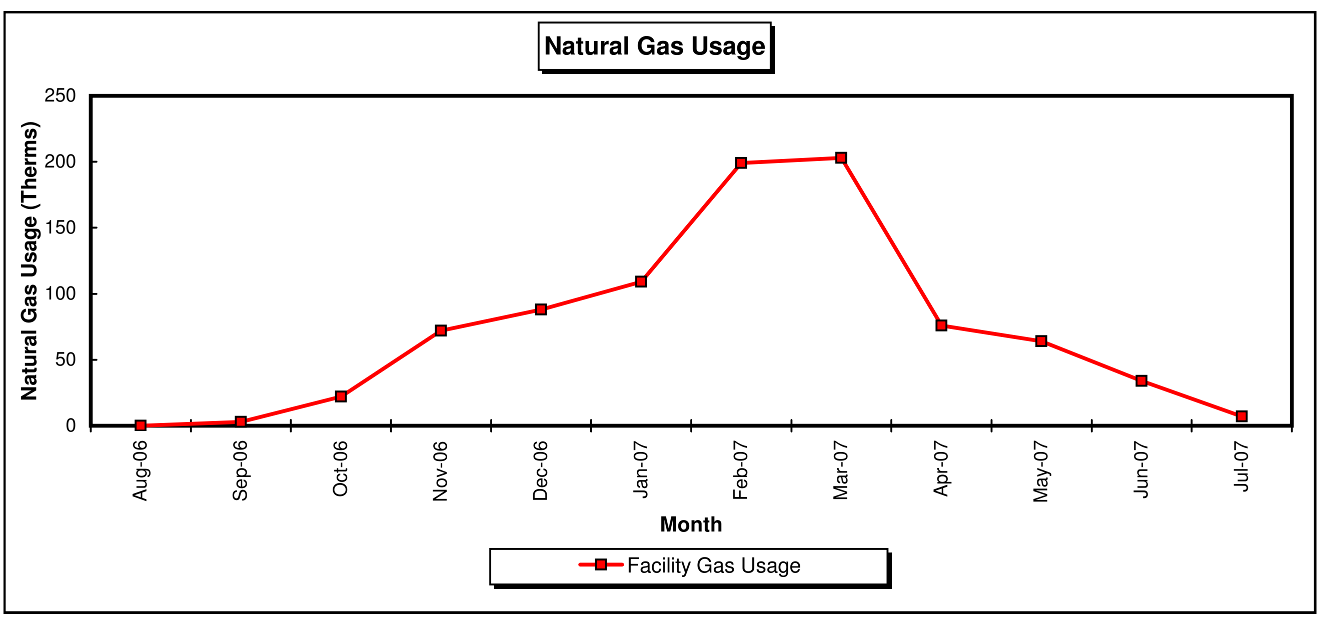
Table Formulas: Hours per Month = D x 24   Load Factor = B/(A x E)



School Name: Veterans Hall
Year Built: 1920
School Address: 156 Back River Road
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 2,952 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	0	$37	$0.000	0	0.000
Sep-06	3	$23	$7.500	0	0.102
Oct-06	22	$47	$2.144	2	0.745
Nov-06	72	$124	$1.726	7	2.439
Dec-06	88	$163	$1.854	9	2.981
Jan-07	109	$190	$1.744	11	3.692
Feb-07	199	$316	$1.586	20	6.741
Mar-07	203	$361	$1.780	20	6.877
Apr-07	76	$163	$2.147	8	2.575
May-07	64	$128	$2.005	6	2.168
Jun-07	34	$62	$1.834	3	1.152
Jul-07	7	$28	$3.936	1	0.237
Totals:	**877**	**$1,643**		**88**	**29.709**
Energy Intensity (MBtu/sq. ft.):		**30.60**			
Avg. Cost $/Therm		**$1.873**			



School Name: Dover Train Station
Year Built: 2001
School Address: 33 Chestnut Street
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Facility Area: 4,791 sq. ft.

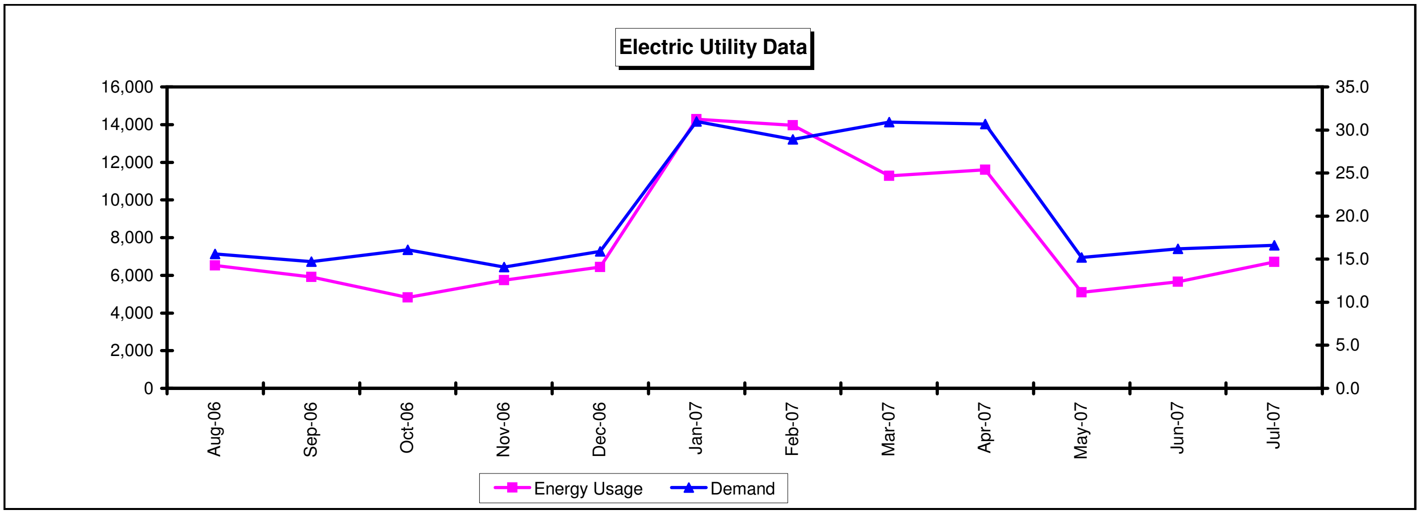
Utility Company: PSNH
Old Acct. No.: 61-35-04075-1-8, 61-35-04442-0-6
New Acct. No.: 56303841092, 56709941074
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total * (kW)	Demand Cost	Usage Total * (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2006/2007	* includes train parking lighting								
Aug-06	15.6		6,530	$814	$0.125	$814	33	792	0.53
Sep-06	14.7		5,910	$745	$0.126	$745	31	744	0.54
Oct-06	16.1		4,820	$639	$0.133	$639	30	720	0.42
Nov-06	14.1		5,740	$722	$0.126	$722	31	744	0.55
Dec-06	15.9		6,430	$806	$0.125	$806	30	720	0.56
Jan-07	31.0		14,280	$1,749	$0.122	$1,749	31	744	0.62
Feb-07	28.9		13,970	$1,703	$0.122	$1,703	31	744	0.65
Mar-07	30.9		11,270	$1,430	$0.127	$1,430	28	672	0.54
Apr-07	30.7		11,600	$1,464	$0.126	$1,464	31	744	0.51
May-07	15.2		5,100	$672	$0.132	$672	30	720	0.47
Jun-07	16.2		5,650	$737	$0.130	$737	31	744	0.47
Jul-07	16.6		6,710	$832	$0.124	$832	30	720	0.56
Avg./Totals:	**20.5**	**$0**	**98,010**	**$12,312**		**$12,312**	**367**	**8,808**	**0.53**

Energy Intensity (kWh/sq.ft.):	**20.46**	**Avg. Cost/kWh:**	**$0.126**
Blended Cost (inc.demand)/kWh:	**$0.126**	**Avg. Cost/kW:**	**$0.00**

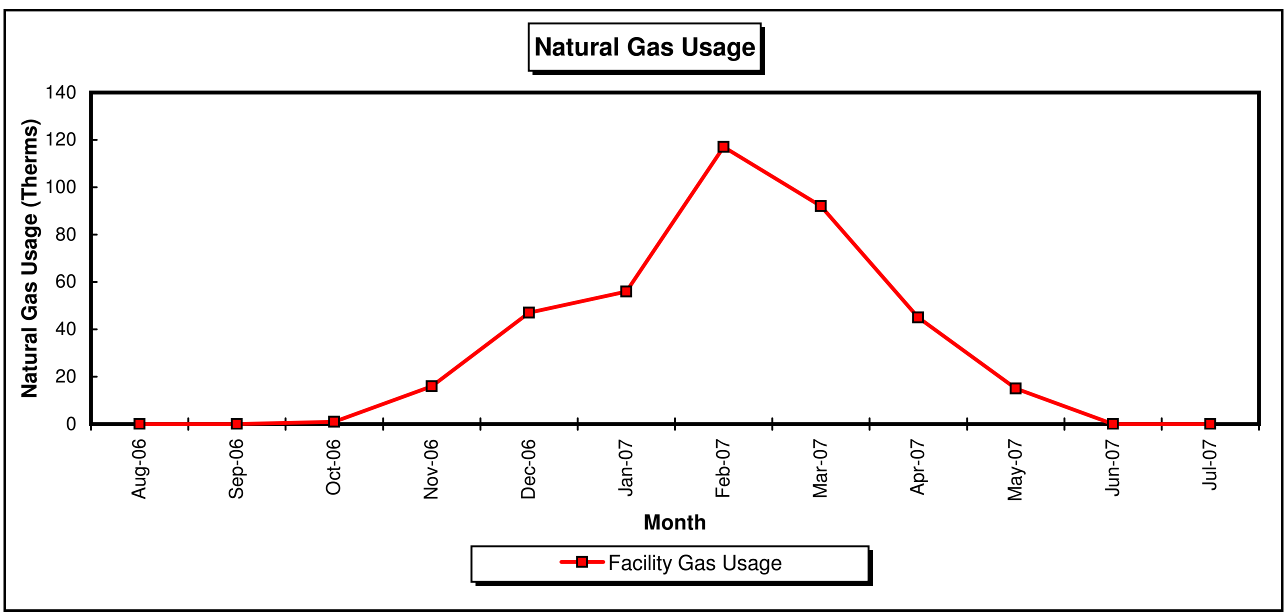
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Dover Train Station
Year Built: 2001
School Address: 33 Chestnut Street
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 4,791 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2006/2007					
Aug-06	0	$19	$0.000	0	0.000
Sep-06	0	$19	$0.000	0	0.000
Oct-06	1	$20	$20.000	0	0.021
Nov-06	16	$42	$2.637	2	0.334
Dec-06	47	$97	$2.056	5	0.981
Jan-07	56	$108	$1.929	6	1.169
Feb-07	117	$197	$1.684	12	2.442
Mar-07	92	$178	$1.938	9	1.920
Apr-07	45	$104	$2.318	5	0.939
May-07	15	$44	$2.943	2	0.313
Jun-07	0	$19	$0.000	0	0.000
Jul-07	0	$19	$0.000	0	0.000
Totals:	**389**	**$865**		**39**	**8.119**
Energy Intensity (MBtu/sq. ft.):		**8.36**			
Avg. Cost $/Therm		**$2.225**			



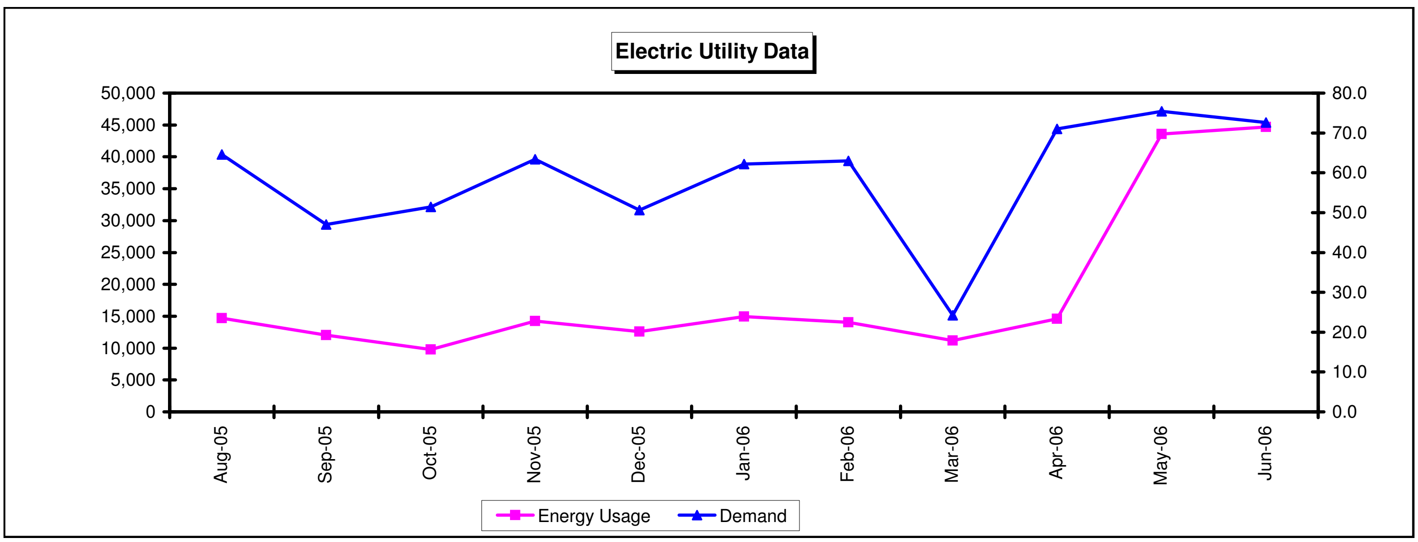
School Name:	Indoor Pool	Utility Company:	PSNH
Year Built:	1968	Old Acct. No.:	8000619-02-9-4
School Address:	9 Henry Law Ave	New Acct. No.:	8000619-02-9-4
	Dover, NH	Rate:	G, Three Phase
Phone Number:	516-6441	Date:	2/7/2009
Principal's Name:	Mick Arsenault		
Facility Area:	10,279 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	67.8	$0	13,640	$2,046	$0.150	$2,046	29	696	0.29
Sep-05	64.6	$0	14,680	$2,135	$0.145	$2,135	33	792	0.29
Oct-05	47.0	$0	12,040	$1,715	$0.142	$1,715	30	720	0.36
Nov-05	51.4	$0	9,760	$1,500	$0.154	$1,500	33	792	0.24
Dec-05	63.4	$0	14,240	$2,078	$0.146	$2,078	28	672	0.33
Jan-06	50.6	$0	12,600	$1,803	$0.143	$1,803	29	696	0.36
Feb-06	62.2	$0	14,960	$2,430	$0.162	$2,430	34	816	0.29
Mar-06	63.0	$0	14,040	$2,319	$0.165	$2,319	28	672	0.33
Apr-06	24.2	$0	11,200	$1,663	$0.148	$1,663	30	720	0.64
May-06	71.0	$0	14,600	$2,451	$0.168	$2,451	29	696	0.30
Jun-06	75.4	$0	43,600	$6,188	$0.142	$6,188	32	768	0.75
Jul-06	72.6	$0	44,680	$5,189	$0.116	$5,189	30	720	0.85
Avg./Totals:	**59.4**	**$0**	**220,040**	**$31,518**		**$31,518**	**365**	**8,760**	**0.42**

Energy Intensity (kWh/sq.ft.):	**21.41**	**Avg. Cost/kWh:**	**$0.143**
Blended Cost (inc.demand)/kWh:	**$0.143**	**Avg. Cost/kW:**	**$0.00**

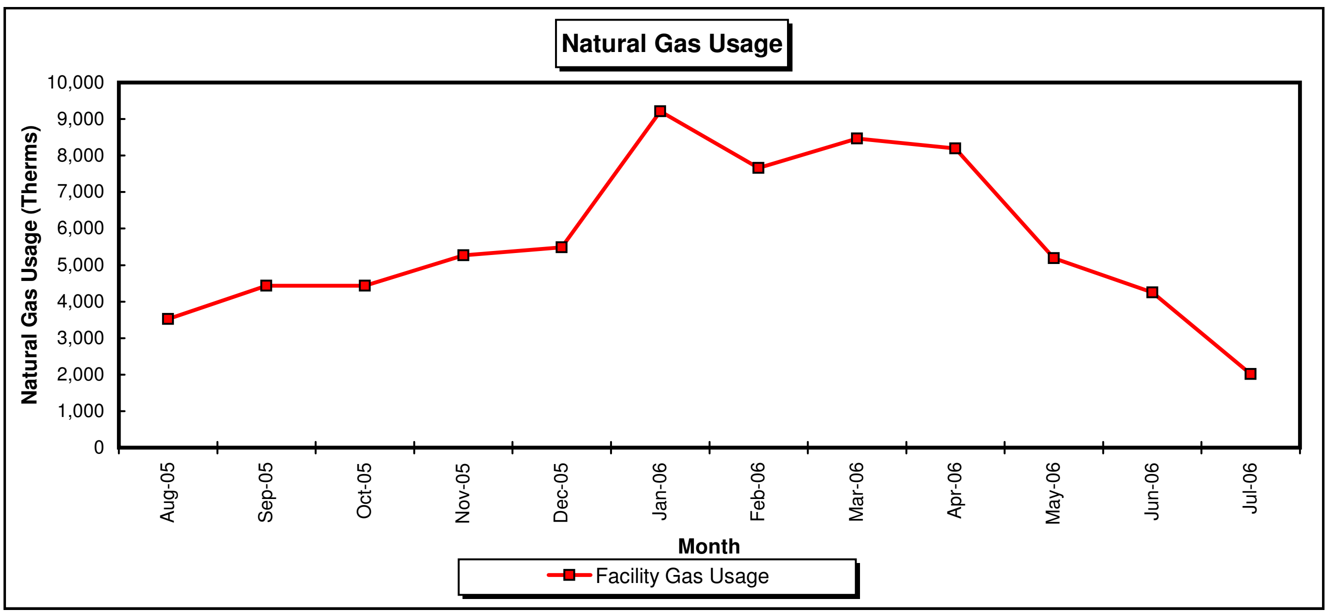
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Indoor Pool
Year Built: 1968
School Address: 9 Henry Law Ave
Dover, NH
Phone Number: 516-6441
Principal's Name: Mick Arsenault
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 579-752-000-7
Rate: 0
Date: 2/7/2009
Facility Area: 10,279 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05	3,524	$3,127	$0.887	352	34.283
Sep-05	4,431	$4,283	$0.967	443	43.107
Oct-05	4,438	$5,011	$1.129	444	43.175
Nov-05	5,264	$6,148	$1.168	526	51.211
Dec-05	5,488	$6,229	$1.135	549	53.390
Jan-06	9,207	$10,375	$1.127	921	89.571
Feb-06	7,660	$8,557	$1.117	766	74.521
Mar-06	8,466	$7,961	$0.940	847	82.362
Apr-06	8,192	$7,915	$0.966	819	79.696
May-06	5,189	$5,895	$1.136	519	50.482
Jun-06	4,255	$4,766	$1.120	426	41.395
Jul-06	2,019	$2,087	$1.034	202	19.642
Totals:	**68,133**	**$72,354**		**6,813**	**662.837**
Energy Intensity (MBtu/sq. ft.):		**662.84**			
Avg. Cost $/Therm		**$1.062**			



School Name: Dover Ice Arena
Year Built: 1974/2001
School Address: 110 Portland Ave
Dover, NH
Phone Number: 516-6060
Principal's Name: Patrick McNulty, Barry Rioxdan
Facility Area: 126,084 sq. ft.

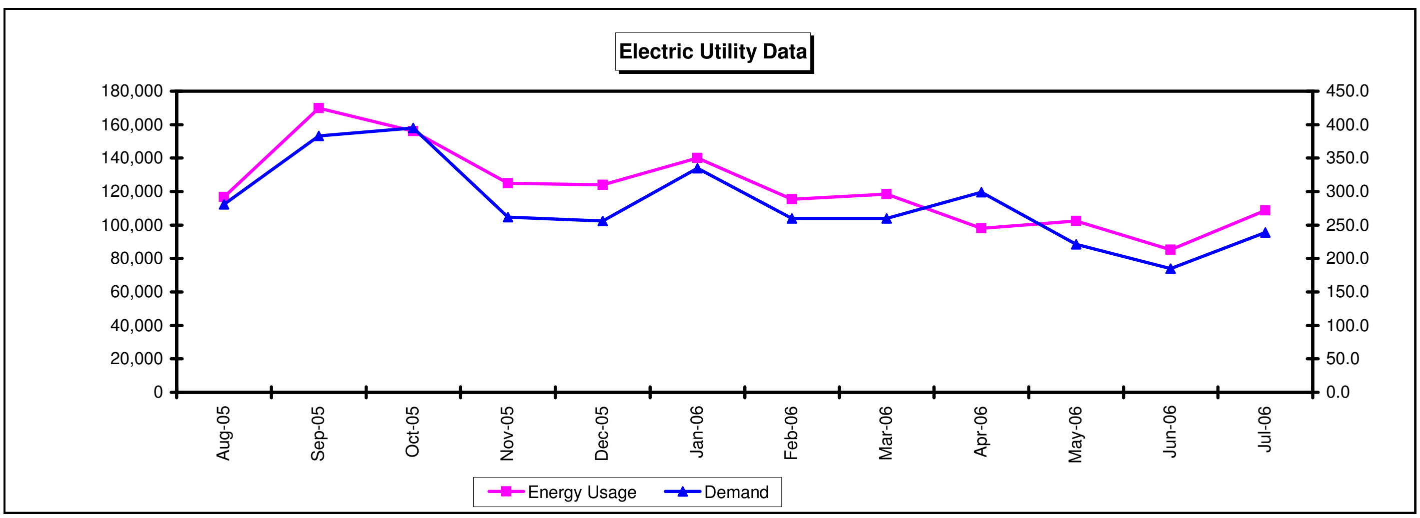
Utility Company: PSNH
Old Acct. No.: 8000626-01-6-2
New Acct. No.: 8000626-01-6-2
Rate: GV
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	281.0	$0	116,800	$14,740	$0.126	$14,740	30	720	0.58
Sep-05	383.0	$0	169,800	$21,080	$0.124	$21,080	32	768	0.58
Oct-05	395.0	$0	156,200	$19,781	$0.127	$19,781	30	720	0.55
Nov-05	262.0	$0	125,000	$15,423	$0.123	$15,423	31	744	0.64
Dec-05	256.0	$0	124,000	$15,268	$0.123	$15,268	31	744	0.65
Jan-06	335.0	$0	140,000	$17,596	$0.126	$17,596	32	768	0.54
Feb-06	260.0	$0	115,400	$17,596	$0.152	$17,596	28	672	0.66
Mar-06	260.0	$0	118,400	$16,963	$0.143	$16,963	31	744	0.61
Apr-06	299.0	$0	98,000	$14,809	$0.151	$14,809	29	696	0.47
May-06	221.0	$0	102,400	$14,676	$0.143	$14,676	29	696	0.67
Jun-06	185.0	$0	85,200	$12,269	$0.144	$12,269	33	792	0.58
Jul-06	239.0	$0	108,800	$12,984	$0.119	$12,984	29	696	0.65
Avg./Totals:	**281.3**	**$0**	**1,460,000**	**$193,184**		**$193,184**	**365**	**8,760**	**0.60**

Energy Intensity (kWh/sq.ft.):	**11.58**	**Avg. Cost/kWh:**	**$0.132**
Blended Cost (inc.demand)/kWh:	**$0.132**	**Avg. Cost/kW:**	**$0.00**

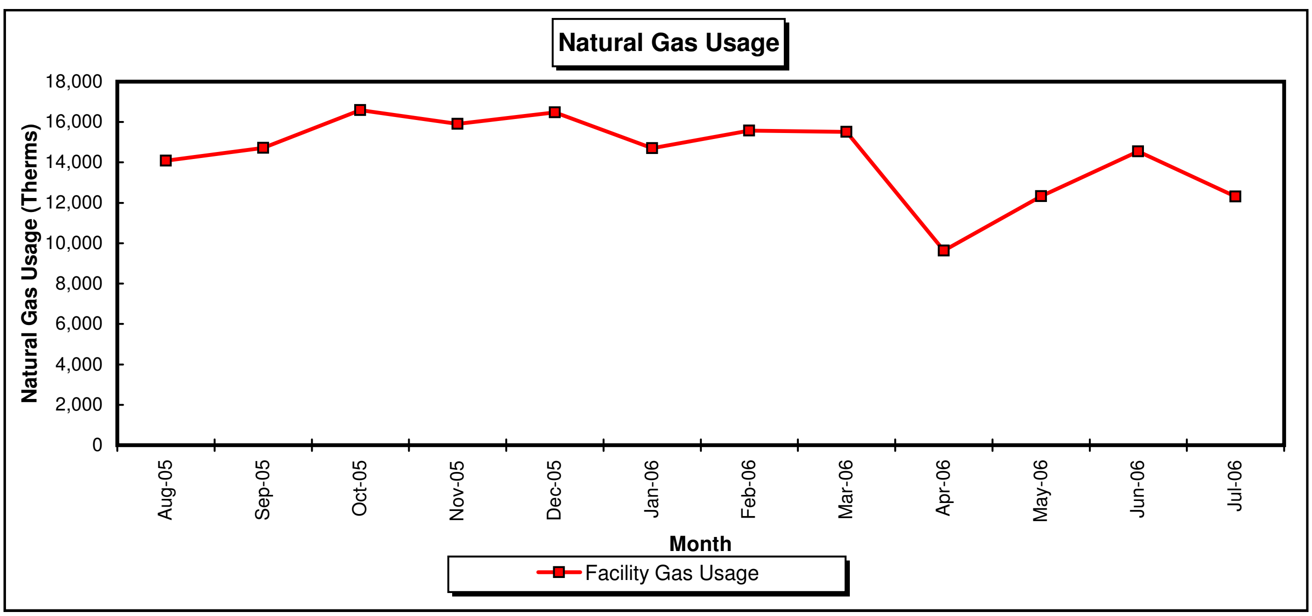
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Dover Ice Arena
Year Built: 1974/2001
School Address: 110 Portland Ave
Dover, NH
Phone Number: 516-6060
Principal's Name: Patrick McNulty, Barry Rioxdan
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 957-752-009-0
Rate: 0
Date: 2/7/2009
Facility Area: 126,084 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05	14,087	$13,054	$0.927	1,409	11.173
Sep-05	14,717	$15,861	$1.078	1,472	11.672
Oct-05	16,583	$19,001	$1.146	1,658	13.152
Nov-05	15,914	$18,010	$1.132	1,591	12.622
Dec-05	16,481	$18,288	$1.110	1,648	13.071
Jan-06	14,710	$16,350	$1.111	1,471	11.667
Feb-06	15,569	$14,861	$0.955	1,557	12.348
Mar-06	15,508	$14,315	$0.923	1,551	12.300
Apr-06	9,627	$10,721	$1.114	963	7.635
May-06	12,333	$13,860	$1.124	1,233	9.782
Jun-06	14,551	$14,495	$0.996	1,455	11.541
Jul-06	12,307	$12,252	$0.996	1,231	9.761
Totals:	**172,387**	**$181,068**		**17,239**	**136.724**
Energy Intensity (MBtu/sq. ft.):		**140.83**			
Avg. Cost $/Therm		**$1.050**			



School Name: Wate Water Treatment Facility
Year Built: 1991
School Address: 484 Middle Road
Dover, NH
Phone Number: 396-4008
Principal's Name: Ray Vermette
Facility Area: 0 sq. ft.

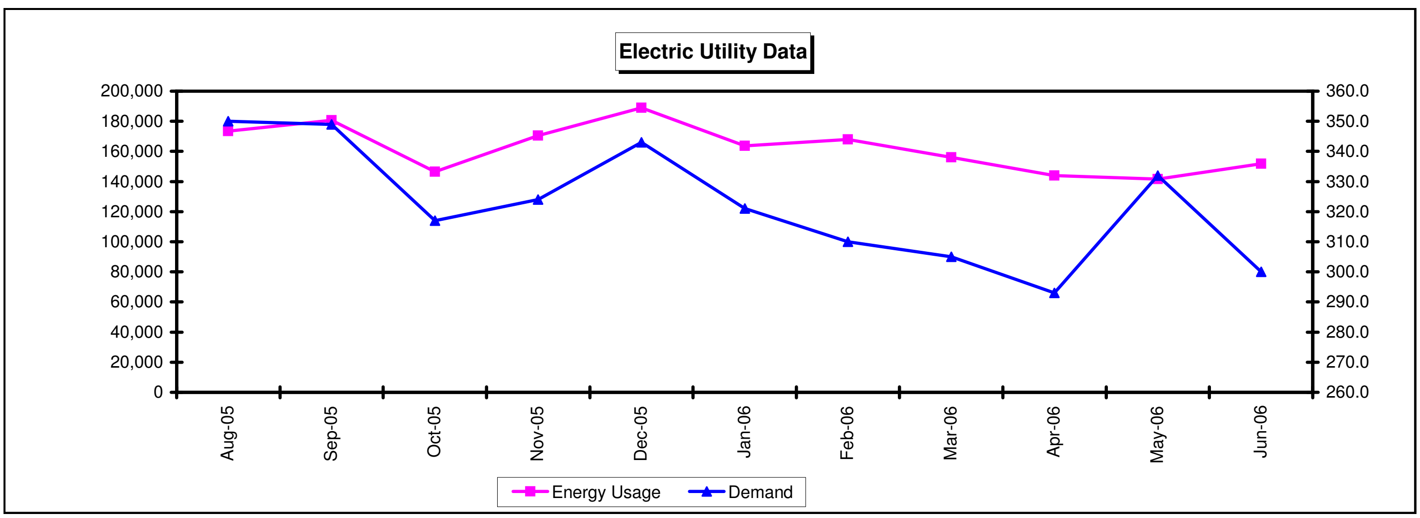
Utility Company: PSNH
Old Acct. No.: 8000672-03-5-5
New Acct. No.: 8000672-03-5-5
Rate: GV
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	345.0	$0	168,600	$20,503	$0.122	$20,503	30	720	0.68
Sep-05	350.0	$0	173,400	$21,041	$0.121	$21,041	32	768	0.65
Oct-05	349.0	$0	180,600	$21,774	$0.121	$21,774	30	720	0.72
Nov-05	317.0	$0	146,400	$17,974	$0.123	$17,974	30	720	0.64
Dec-05	324.0	$0	170,400	$20,508	$0.120	$20,508	31	744	0.71
Jan-06	343.0	$0	189,000	$22,589	$0.120	$22,589	30	720	0.77
Feb-06	321.0	$0	163,800	$22,898	$0.140	$22,898	30	720	0.71
Mar-06	310.0	$0	168,000	$23,316	$0.139	$23,316	31	744	0.73
Apr-06	305.0	$0	156,000	$21,809	$0.140	$21,809	30	720	0.71
May-06	293.0	$0	144,000	$20,242	$0.141	$20,242	29	696	0.71
Jun-06	332.0	$0	141,600	$20,284	$0.143	$20,284	32	768	0.56
Jul-06	300.0	$0	151,800	$21,745	$0.143	$21,745	31	744	0.68
Avg./Totals:	**324.1**	**$0**	**1,953,600**	**$254,684**		**$254,684**	**366**	**8,784**	**0.69**

Energy Intensity (kWh/sq.ft.):	**-**	**Avg. Cost/kWh:**	**$0.130**
Blended Cost (inc.demand)/kWh:	**$0.130**	**Avg. Cost/kW:**	**$0.00**

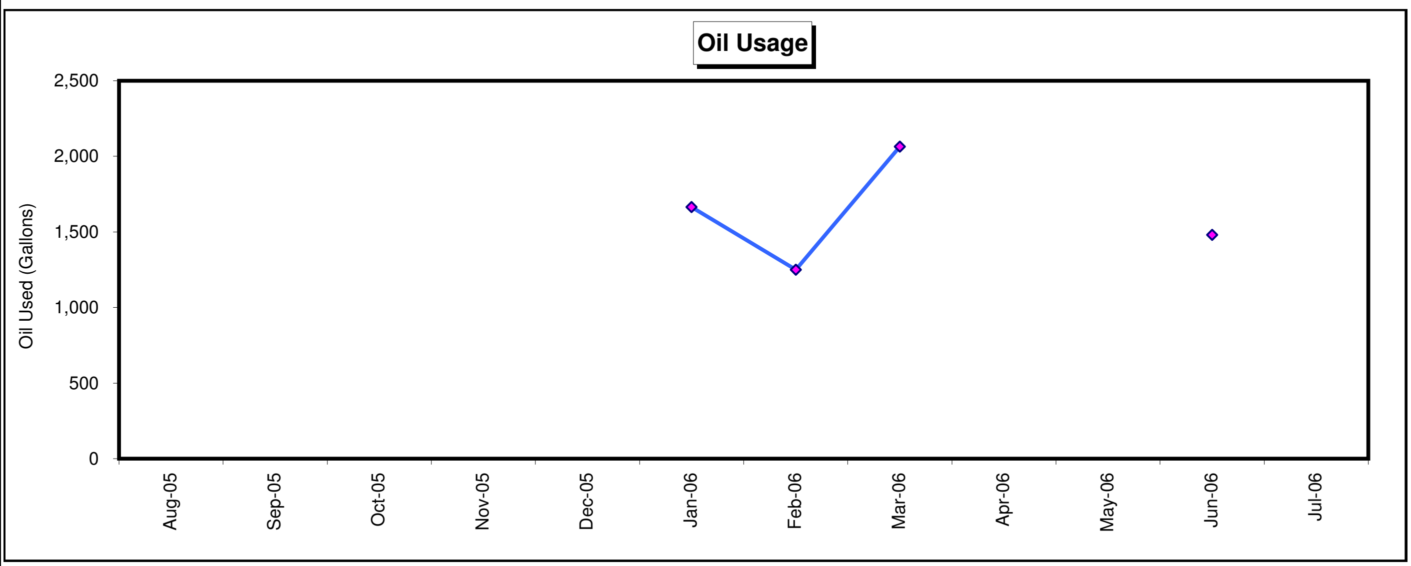
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Wate Water Treatment Facility
Year Built: 1991
School Address: 484 Middle Road
Dover, NH
Phone Number: 396-4008
Principal's Name: Ray Vermette
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 0 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2005/2006					
Aug-05			$0.000	0.0	$0.00
Sep-05			$0.000	0.0	$0.00
Oct-05			$0.000	0.0	$0.00
Nov-05			$0.000	0.0	$0.00
Dec-05			$0.000	0.0	$0.00
Jan-06	1,665	$3,147	$1.890	230.8	$0.00
Feb-06	1,250	$2,363	$1.890	173.3	$0.00
Mar-06	2,065	$3,903	$1.890	286.2	$0.00
Apr-06			$0.000	0.0	$0.00
May-06			$0.000	0.0	$0.00
Jun-06	1,481	$2,800	$1.890	205.3	$0.00
Jul-06			$0.000	0.0	$0.00
Total	**6,461**	**$12,212**	**$1.89**	**895.6**	**$0.00**
		-			
		$1.890			



School Name:	Dover City Hall	Utility Company:	PSNH
Year Built:	1935	Old Acct. No.:	61-35-02648-0-2, 61-35-02789-0-1
School Address:	288 Central Avenue	New Acct. No.:	56906401021, 56395401037
	Dover, NH	Rate:	0
Phone Number:	396-4002	Date:	2/7/2009
Principal's Name:	Paul or Sharon		
Facility Area:	44,844 sq. ft.		

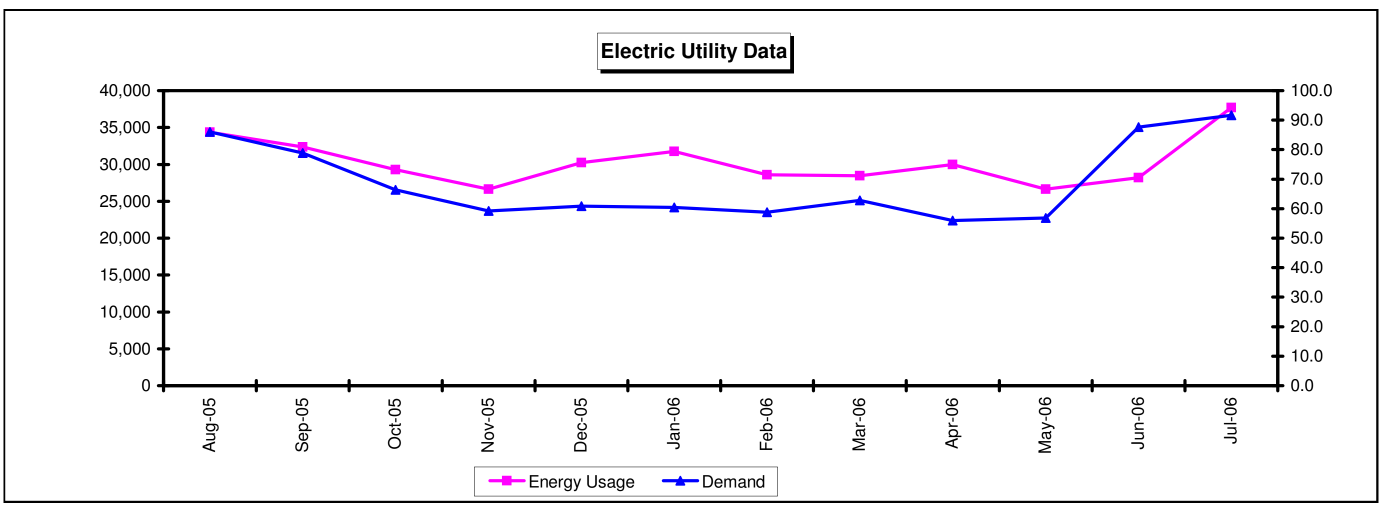
Includes only city Mgr bldg and police dept

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	86.0		34,360	$4,401	$0.128	$4,401	33	792	0.50
Sep-05	78.8		32,360	$4,129	$0.128	$4,129	31	744	0.55
Oct-05	66.4		29,280	$3,700	$0.126	$3,700	30	720	0.61
Nov-05	59.2		26,640	$3,358	$0.126	$3,358	31	744	0.60
Dec-05	60.8		30,240	$3,762	$0.124	$3,762	30	720	0.69
Jan-06	60.4		31,760	$3,924	$0.124	$3,924	31	744	0.71
Feb-06	58.8		28,600	$4,109	$0.144	$4,109	31	744	0.65
Mar-06	62.8		28,440	$4,119	$0.145	$4,119	28	672	0.67
Apr-06	56.0		29,960	$4,261	$0.142	$4,261	31	744	0.72
May-06	56.8		26,640	$3,844	$0.144	$3,844	30	720	0.65
Jun-06	87.6		28,200	$4,276	$0.152	$4,276	31	744	0.43
Jul-06	91.6		37,720	$37,720	$1.000	$37,720	30	720	0.57
Avg./Totals:	**68.8**	**$0**	**364,200**	**$81,602**		**$81,602**	**367**	**8,808**	**0.61**

Energy Intensity (kWh/sq.ft.):	**8.12**	**Avg. Cost/kWh:**	**$0.224**
Blended Cost (inc.demand)/kWh:	**$0.224**	**Avg. Cost/kW:**	**$0.00**

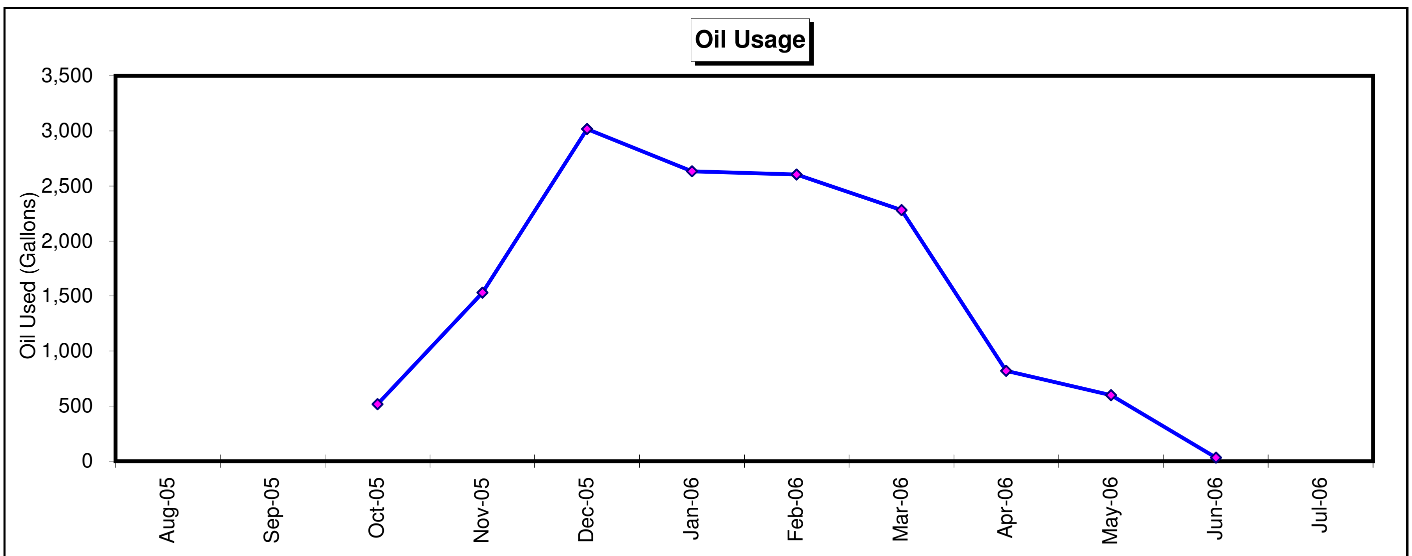
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	Dover City Hall
Year Built:	1935
School Address:	288 Central Avenue Dover, NH
Phone Number:	396-4002
Principal's Name:	Paul or Sharon
Utility Company:	Downeast Energy
Account No.:	306432
Rate:	0
Date:	2/7/2009
Facility Area:	44,844 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2005/2006					
Aug-05			$0.00	0.0	$0.00
Sep-05			$0.00	0.0	$0.00
Oct-05	518	$979	$1.89	71.8	$0.02
Nov-05	1,531	$2,893	$1.89	212.2	$0.06
Dec-05	3,018	$5,704	$1.89	418.3	$0.13
Jan-06	2,632	$4,974	$1.89	364.7	$0.11
Feb-06	2,604	$4,921	$1.89	360.9	$0.11
Mar-06	2,281	$4,311	$1.89	316.1	$0.10
Apr-06	819	$1,548	$1.89	113.5	$0.03
May-06	601	$1,135	$1.89	83.2	$0.03
Jun-06	32	$30	$0.95	4.4	$0.00
Jul-06			$0.00	0.0	$0.00
Total	**14,035**	**$26,495**	**$1.89**	**1,945.2**	**$0.59**
Energy Intensity (MBtu/sq. ft.):		**43.38**			
Avg. Cost $/Gallon		**$1.888**			



School Name: Public Works
Year Built: 2001
School Address: 271 Mast Rd
Dover, NH
Phone Number: 396-3117
Principal's Name: Bart Carson
Facility Area: 54,800 sq. ft.

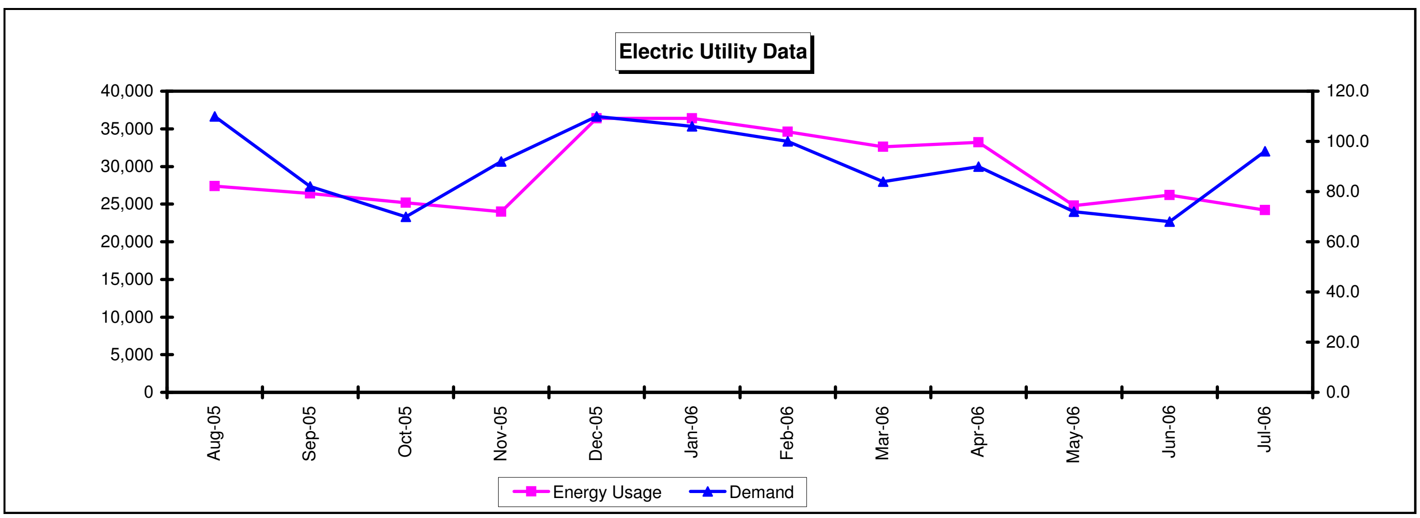
Utility Company: PSNH
Old Acct. No.: 61-10-09245-1-5
New Acct. No.: 56632841078
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	110.0		27,400	$3,825	$0.140	$3,825	32	768	0.32
Sep-05	82.0		26,400	$3,504	$0.133	$3,504	30	720	0.45
Oct-05	70.0		25,200	$3,283	$0.130	$3,283	30	720	0.50
Nov-05	92.0		24,000	$3,319	$0.138	$3,319	30	720	0.36
Dec-05	110.0		36,400	$4,804	$0.132	$4,804	31	744	0.44
Jan-06	106.0		36,400	$4,774	$0.131	$4,774	30	720	0.48
Feb-06	100.0		34,600	$5,187	$0.150	$5,187	30	720	0.48
Mar-06	84.0		32,600	$4,810	$0.148	$4,810	31	744	0.52
Apr-06	90.0		33,200	$4,932	$0.149	$4,932	29	696	0.53
May-06	72.0		24,800	$3,723	$0.150	$3,723	31	744	0.46
Jun-06	68.0		26,200	$3,872	$0.148	$3,872	30	720	0.54
Jul-06	96.0		24,200	$3,193	$0.132	$3,193	33	792	0.32
Avg./Totals:	**90.0**	**$0**	**351,400**	**$49,227**		**$49,227**	**367**	**8,808**	**0.45**

Energy Intensity (kWh/sq.ft.):	**6.41**	**Avg. Cost/kWh:**	**$0.140**
Blended Cost (inc.demand)/kWh:	**$0.140**	**Avg. Cost/kW:**	**$0.00**

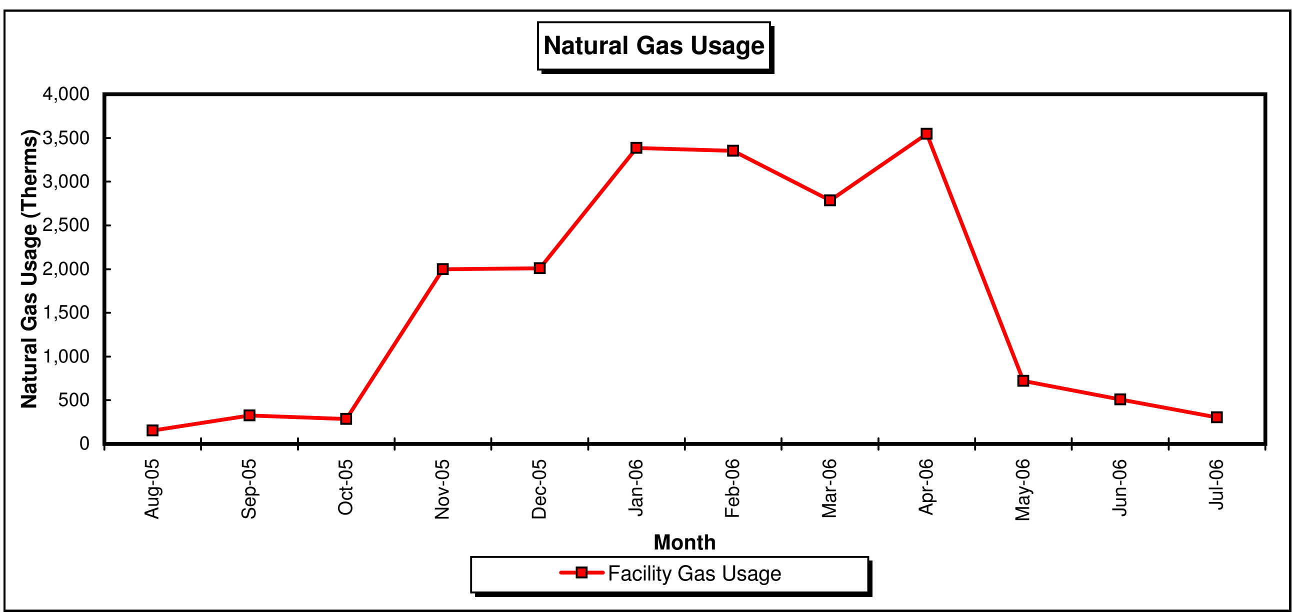
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Public Works
Year Built: 2001
School Address: 271 Mast Rd
Dover, NH
Phone Number: 396-3117
Principal's Name: Bart Carson
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 947-913-002-8
Rate: 0
Date: 2/7/2009
Facility Area: 54,800 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05	155	$280	$1.804	16	0.283
Sep-05	324	$362	$1.116	32	0.591
Oct-05	285	$496	$1.742	29	0.520
Nov-05	1,997	$3,182	$1.593	200	3.644
Dec-05	2,010	$3,291	$1.637	201	3.668
Jan-06	3,387	$5,525	$1.631	339	6.181
Feb-06	3,353	$4,895	$1.460	335	6.119
Mar-06	2,785	$4,018	$1.443	279	5.082
Apr-06	3,547	$5,197	$1.465	355	6.473
May-06	722	$1,030	$1.427	72	1.318
Jun-06	508	$740	$1.456	51	0.927
Jul-06	304	$441	$1.450	30	0.555
Totals:	**19,377**	**$29,456**		**1,938**	**35.359**
Energy Intensity (MBtu/sq. ft.):		**36.42**			
Avg. Cost $/Therm		**$1.520**			



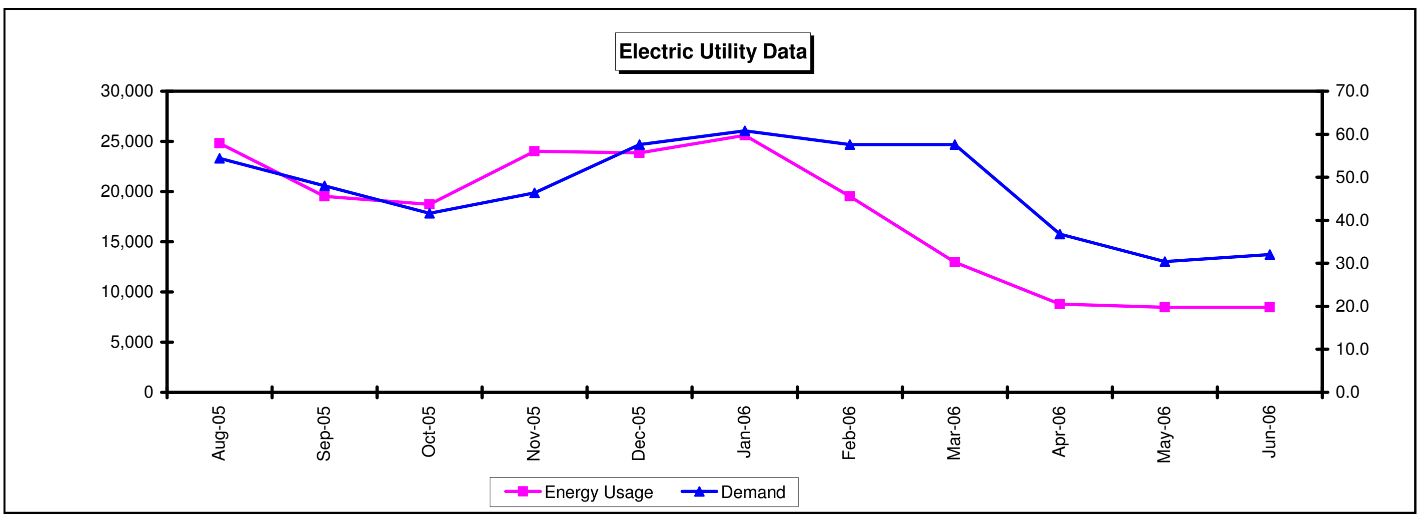
School Name:	McConnell Center	Utility Company:	PSNH
Year Built:	1904	Old Acct. No.:	61-35-06856-1-8,61-35-08894-0-0
School Address:	61 Loucust St	New Acct. No.:	8001869-04-5-5
	Dover, NH	Rate:	GV
Phone Number:	396-4026,516-6401	Date:	2/7/2009
Principal's Name:	Gary Bannon		
Facility Area:	103,000 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	33.6	$0	12,320	$1,606	$0.130	$1,606	30	720	0.51
Sep-05	54.4	$0	24,800	$3,122	$0.126	$3,122	33	792	0.58
Oct-05	48.0	$0	19,520	$2,499	$0.128	$2,499	30	720	0.56
Nov-05	41.6	$0	18,720	$2,363	$0.126	$2,363	33	792	0.57
Dec-05	46.4	$0	24,000	$2,974	$0.124	$2,974	29	696	0.74
Jan-06	57.6	$0	23,840	$3,041	$0.128	$3,041	28	672	0.62
Feb-06	60.8	$0	25,600	$3,741	$0.146	$3,741	34	816	0.52
Mar-06	57.6	$0	19,520	$2,940	$0.151	$2,940	27	648	0.52
Apr-06	57.6	$0	12,960	$2,102	$0.162	$2,102	30	720	0.31
May-06	36.8	$0	8,800	$1,414	$0.161	$1,414	30	720	0.33
Jun-06	30.4	$0	8,480	$1,325	$0.156	$1,325	31	744	0.37
Jul-06	32.0	$0	8,480	$1,120	$0.132	$1,120	30	720	0.37
Avg./Totals:	**46.4**	**$0**	**207,040**	**$28,247**		**$28,247**	**365**	**8,760**	**0.50**

Energy Intensity (kWh/sq.ft.):	**2.01**	**Avg. Cost/kWh:**	**$0.136**
Blended Cost (inc.demand)/kWh:	**$0.136**	**Avg. Cost/kW:**	**$0.00**

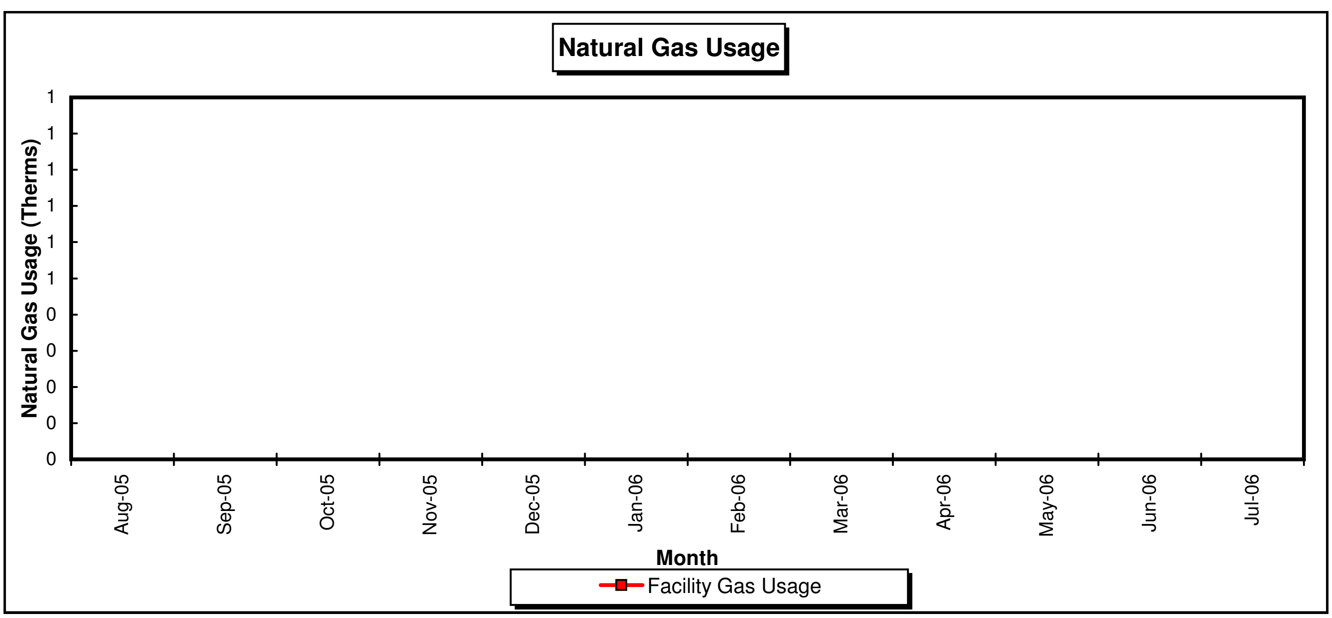
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: McConnell Center
Year Built: 1904
School Address: 61 Locust St
Dover, NH
Phone Number: 396-4026,516-6401
Principal's Name: Gary Bannon
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 103,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05			$0.000	0	0.000
Sep-05			$0.000	0	0.000
Oct-05			$0.000	0	0.000
Nov-05			$0.000	0	0.000
Dec-05			$0.000	0	0.000
Jan-06			$0.000	0	0.000
Feb-06			$0.000	0	0.000
Mar-06			$0.000	0	0.000
Apr-06			$0.000	0	0.000
May-06			$0.000	0	0.000
Jun-06			$0.000	0	0.000
Jul-06			$0.000	0	0.000
Totals:	**0**	**$0**		**0**	**0.000**
Energy Intensity (MBtu/sq. ft.):		**0.00**			
Avg. Cost $/Therm		**#DIV/0!**			



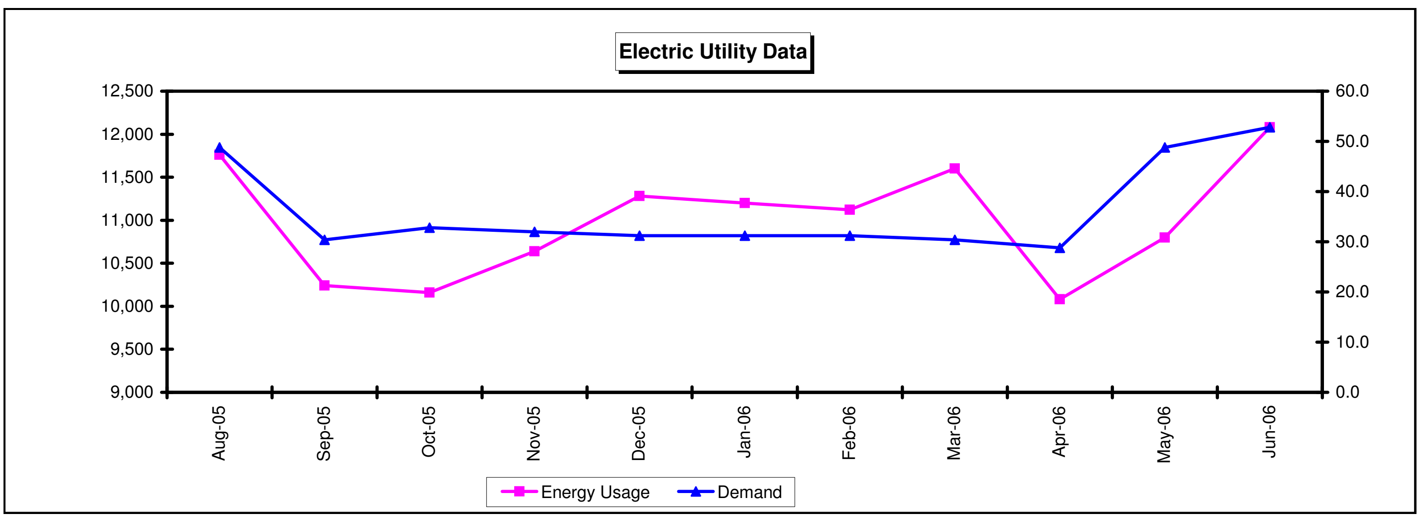
School Name:	Dover Public Library	Utility Company:	PSNH
Year Built:	1905/1988	Old Acct. No.:	61-35-06833-0-8
School Address:	73 Locust St	New Acct. No.:	56135401073
	Dover, NH	Rate:	0
Phone Number:	516-6050	Date:	2/7/2009
Principal's Name:	Cathy Beaudoin		
Facility Area:	20,000 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	54.4		12,480	$1,448	$0.116	$1,781	28	672	0.34
Sep-05	48.8		11,760	$1,447	$0.123	$1,660	32	768	0.31
Oct-05	30.4		10,240	$1,417	$0.138	$1,356	31	744	0.45
Nov-05	32.8		10,160	$1,367	$0.135	$1,365	33	792	0.39
Dec-05	32.0		10,640	$1,327	$0.125	$1,411	29	696	0.48
Jan-06	31.2		11,280	$1,326	$0.118	$1,475	29	696	0.52
Feb-06	31.2		11,200	$1,604	$0.143	$1,678	33	792	0.45
Mar-06	31.2		11,120	$1,339	$0.120	$1,668	27	648	0.55
Apr-06	30.4		11,600	$1,456	$0.126	$1,723	31	744	0.51
May-06	28.8		10,080	$1,270	$0.126	$1,517	29	696	0.50
Jun-06	48.8		10,800	$1,457	$0.135	$1,760	32	768	0.29
Jul-06	52.8		12,080	$1,684	$0.139	$1,637	31	744	0.31
Avg./Totals:	**37.7**	**$0**	**133,440**	**$17,143**		**$19,031**	**365**	**8,760**	**0.43**

Energy Intensity (kWh/sq.ft.):	**6.67**	**Avg. Cost/kWh:**	**$0.128**
Blended Cost (inc.demand)/kWh:	**$0.143**	**Avg. Cost/kW:**	**$0.00**

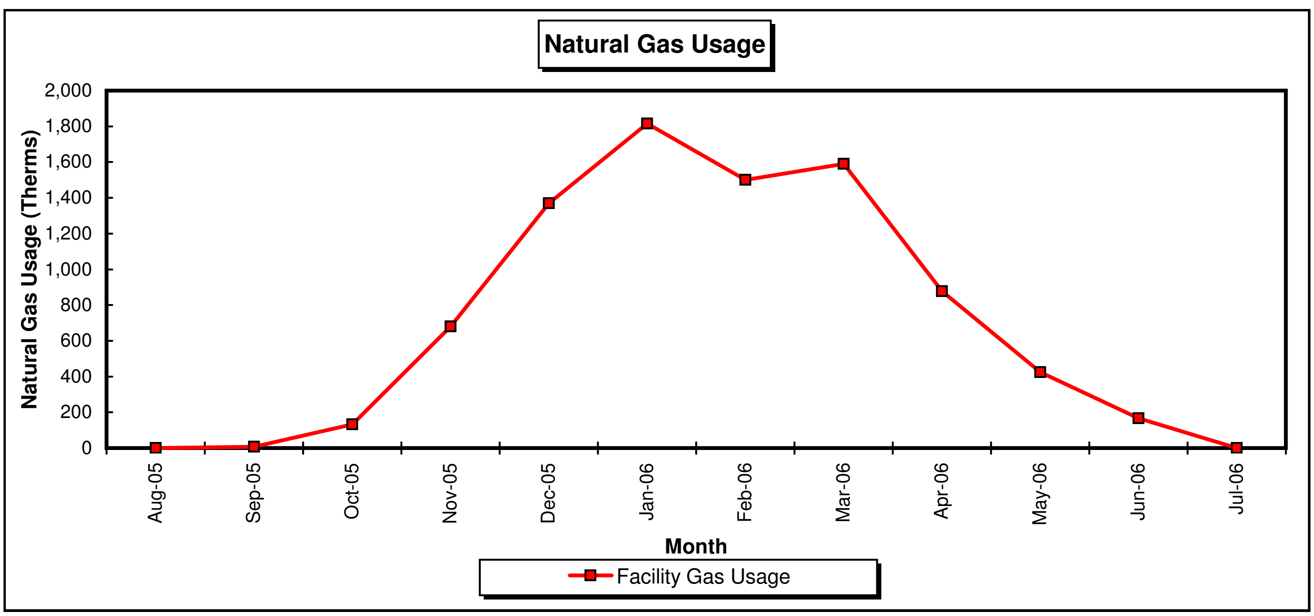
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Dover Public Library
Year Built: 1905/1988
School Address: 73 Locust St
Dover, NH
Phone Number: 516-6050
Principal's Name: Cathy Beaudoin
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 263-752-004-4
Rate: 0
Date: 2/7/2009
Facility Area: 20,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05	0	$60	$0.000	0	0.000
Sep-05	7	$69	$9.857	1	0.035
Oct-05	133	$234	$1.760	13	0.665
Nov-05	680	$860	$1.265	68	3.400
Dec-05	1,369	$1,638	$1.196	137	6.845
Jan-06	1,815	$2,135	$1.176	182	9.075
Feb-06	1,500	$1,661	$1.107	150	7.500
Mar-06	1,590	$1,586	$0.997	159	7.950
Apr-06	877	$971	$1.108	88	4.385
May-06	424	$549	$1.295	42	2.120
Jun-06	167	$245	$1.466	17	0.835
Jul-06	0	$60	$0.000	0	0.000
Totals:	**8,562**	**$10,068**		**856**	**42.810**
Energy Intensity (MBtu/sq. ft.):		**44.09**			
Avg. Cost $/Therm		**$1.176**			



School Name: Jenny Thompson Pool
Year Built: 1977
School Address: 110 Portland Ave
Dover, NH
Phone Number: 516-6060
Principal's Name: Same as Arena
Facility Area: 0 sq. ft.

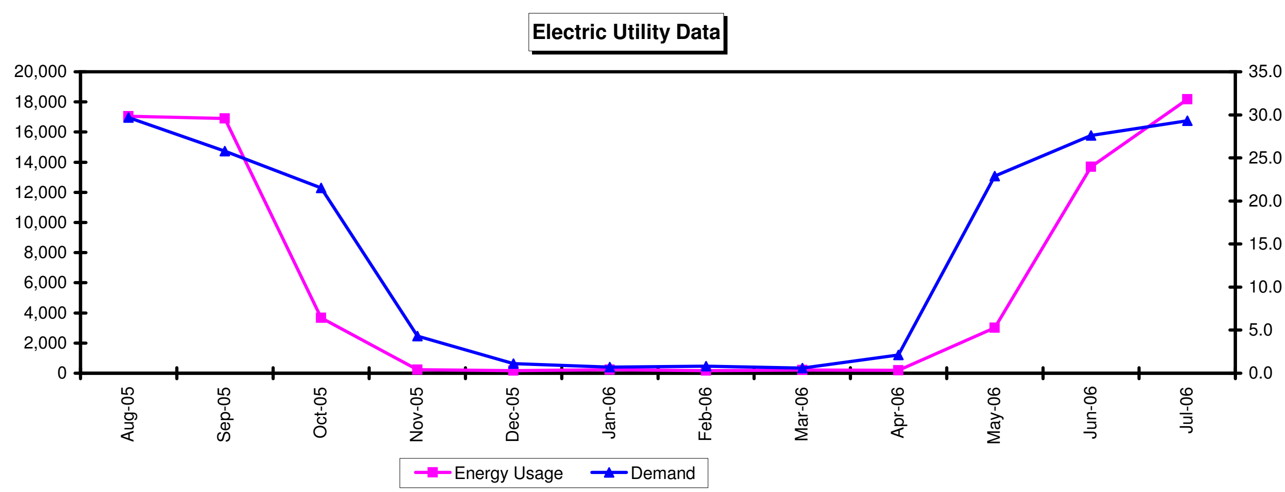
Utility Company: PSNH
Old Acct. No.: 61-30-06136-0-3
New Acct. No.: 56072321037
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	29.7		17,040	$2,090	$0.123	$2,090	30	720	0.80
Sep-05	25.8		16,910	$2,047	$0.121	$2,047	32	768	0.85
Oct-05	21.5		3,670	$574	$0.156	$574	30	720	0.24
Nov-05	4.3		240	$54	$0.223	$54	31	744	0.08
Dec-05	1.1		180	$44	$0.246	$44	32	768	0.21
Jan-06	0.7		230	$52	$0.226	$52	31	744	0.44
Feb-06	0.8		170	$46	$0.270	$46	28	672	0.32
Mar-06	0.6		210	$53	$0.252	$53	31	744	0.47
Apr-06	2.1		190	$49	$0.260	$49	29	696	0.13
May-06	22.9		3,020	$570	$0.189	$570	29	696	0.19
Jun-06	27.6		13,700	$1,970	$0.144	$1,970	33	792	0.63
Jul-06	29.3		18,180	$2,107	$0.116	$2,107	29	696	0.89
Avg./Totals:	**13.9**	**$0**	**73,740**	**$9,656**		**$9,656**	**365**	**8,760**	**0.44**

Energy Intensity (kWh/sq.ft.):	**-**	**Avg. Cost/kWh:**	**$0.131**
Blended Cost (inc.demand)/kWh:	**$0.131**	**Avg. Cost/kW:**	**$0.00**

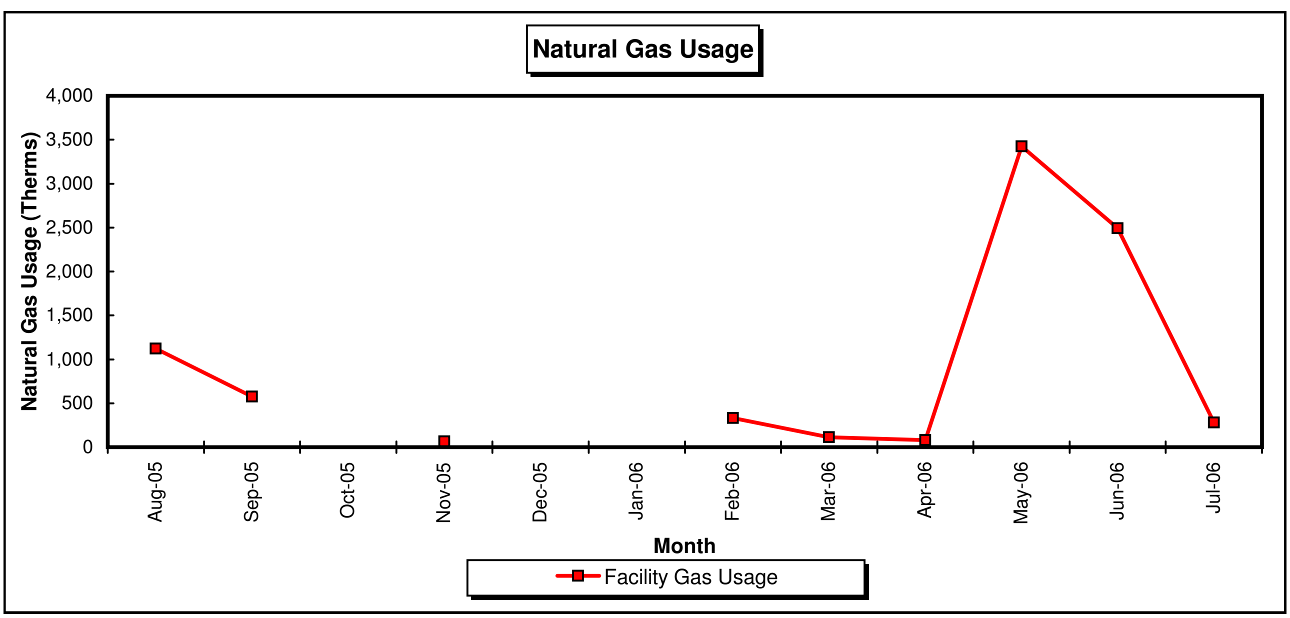
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	Jenny Thompson Pool
Year Built:	1977
School Address:	110 Portland Ave
	Dover, NH
Phone Number:	516-6060
Principal's Name:	Same as Arena
Utility Company:	Northern Utilities/ Metromedia Energy
Account No.:	398-413-008-7
Rate:	0
Date:	2/7/2009
Facility Area:	0 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05	1,123	$1,125	$1.002	112	
Sep-05	577	$695	$1.205	58	
Oct-05			$0.000	0	
Nov-05	65	$197	$3.024	7	
Dec-05			$0.000	0	
Jan-06			$0.000	0	
Feb-06	333	$549	$1.649	33	
Mar-06	114	$171	$1.496	11	
Apr-06	79	$151	$1.910	8	
May-06	3,426	$3,921	$1.145	343	
Jun-06	2,490	$2,557	$1.027	249	
Jul-06	282	$348	$1.235	28	
Totals:	**8,489**	**$9,714**		849	0.000
Energy Intensity (MBtu/sq. ft.):		**-**			
Avg. Cost $/Therm		**$1.144**			



School Name: Central Fire Station
Year Built: 1899
School Address: 9 Broadway
Dover, NH
Phone Number: 516-6150
Principal's Name: Perry Plummer
Facility Area: 7,000 sq. ft.

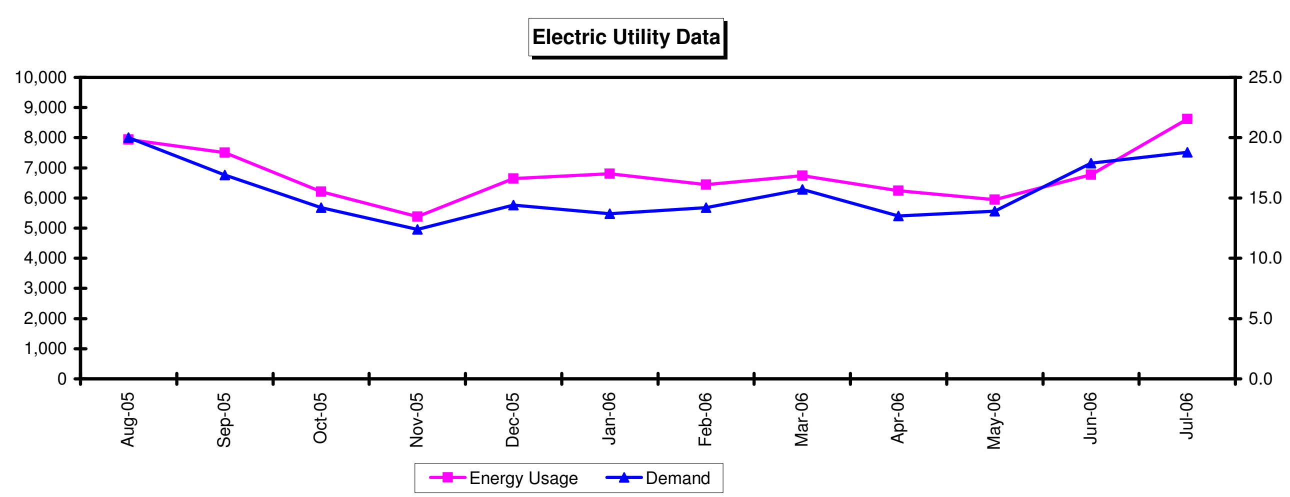
Utility Company: PSNH
Old Acct. No.: 61-35-01167-0-5
New Acct. No.: 56299411066
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	20.0		7,938	$1,027	$0.129	$1,027	29	696	0.57
Sep-05	16.9		7,506	$956	$0.127	$956	33	792	0.56
Oct-05	14.2		6,210	$795	$0.128	$795	30	720	0.61
Nov-05	12.4		5,382	$691	$0.128	$691	33	792	0.55
Dec-05	14.4		6,642	$843	$0.127	$843	28	672	0.69
Jan-06	13.7		6,804	$856	$0.126	$856	29	696	0.71
Feb-06	14.2		6,444	$942	$0.146	$942	34	816	0.56
Mar-06	15.7		6,744	$992	$0.147	$992	28	672	0.64
Apr-06	13.5		6,240	$911	$0.146	$911	30	720	0.64
May-06	13.9		5,950	$877	$0.147	$877	29	696	0.62
Jun-06	17.9		6,770	$1,012	$0.149	$1,012	32	768	0.49
Jul-06	18.8		8,620	$1,043	$0.121	$1,043	30	720	0.64
Avg./Totals:	**15.5**	**$0**	**81,250**	**$10,943**		**$10,943**	**365**	**8,760**	**0.61**

Energy Intensity (kWh/sq.ft.):	**11.61**		**Avg. Cost/kWh:**	**$0.135**
Blended Cost (inc.demand)/kWh:	**$0.135**		**Avg. Cost/kW:**	**$0.00**

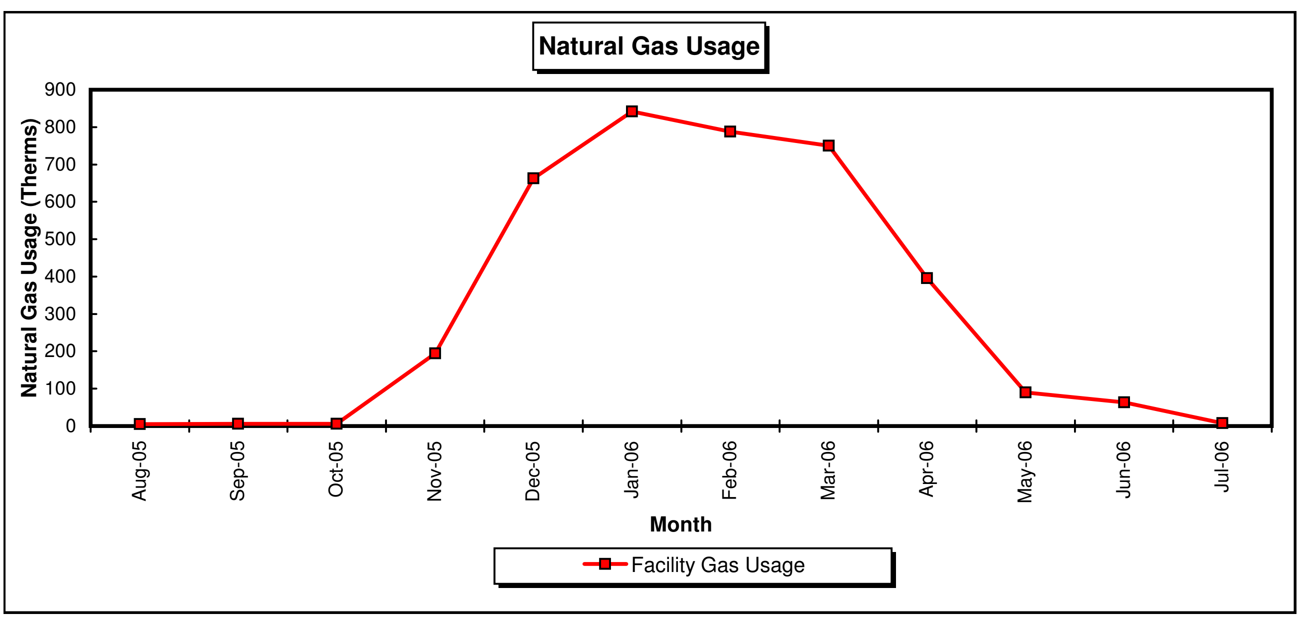
Table Formulas: Hours per Month = D x 24   Load Factor = B/(A x E)



School Name: Central Fire Station
Year Built: 1899
School Address: 9 Broadway
Dover, NH
Phone Number: 516-6150
Principal's Name: Perry Plummer
Utility Company: Northern Utilities/ Metromedia Energy
Account No.: 448-652-0026
Rate: 0
Date: 2/7/2009
Facility Area: 7,000 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05	5	$25	$5.036	1	0.071
Sep-05	6	$27	$4.552	1	0.086
Oct-05	6	$28	$4.622	1	0.086
Nov-05	194	$315	$1.625	19	2.771
Dec-05	663	$1,101	$1.660	66	9.471
Jan-06	842	$1,391	$1.652	84	12.029
Feb-06	788	$1,236	$1.568	79	11.257
Mar-06	750	$1,097	$1.463	75	10.714
Apr-06	396	$620	$1.565	40	5.657
May-06	90	$158	$1.758	9	1.286
Jun-06	63	$100	$1.591	6	0.900
Jul-06	8	$28	$3.558	1	0.114
Totals:	**3,811**	**$6,127**		**381**	**54.443**
Energy Intensity (MBtu/sq. ft.):		**56.08**			
Avg. Cost $/Therm		**$1.608**			



School Name: South End Fire Station
Year Built: 1967
School Address: 25 Durham Rd
Dover, NH
Phone Number: 516-6150
Principal's Name: Richard Driscoll
Facility Area: 8,000 sq. ft.

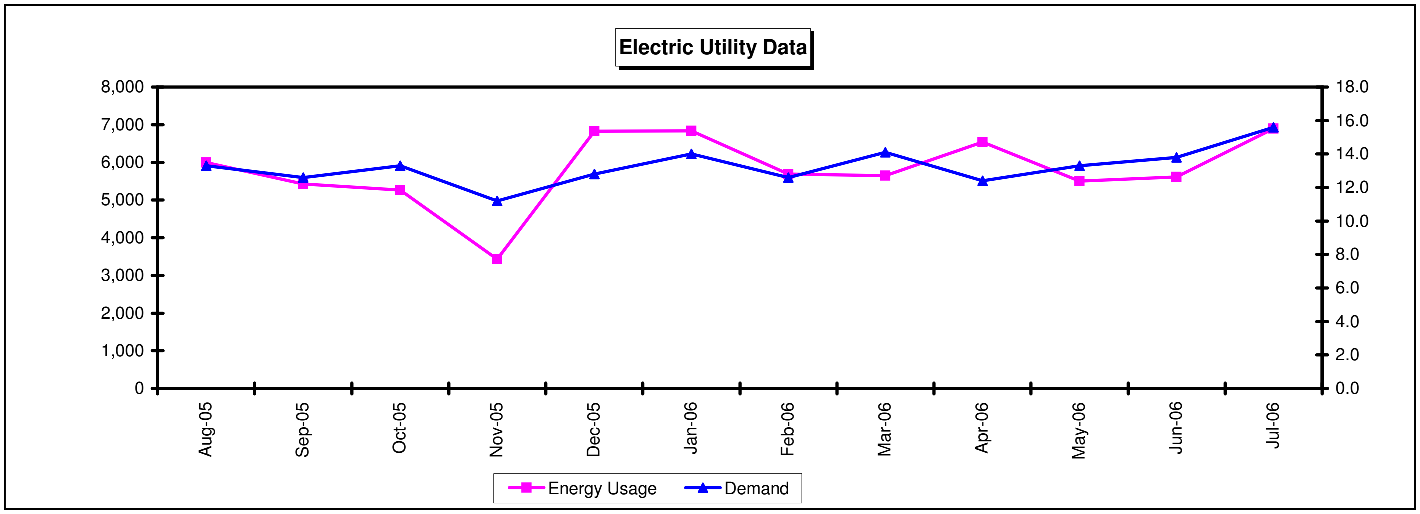
Utility Company: PSNH
Old Acct. No.: 61-10-03228-0-1
New Acct. No.: 56847801073
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	13.3		5,994	$773	$0.129	$773	32	768	0.59
Sep-05	12.6		5,424	$705	$0.130	$705	30	720	0.60
Oct-05	13.3		5,267	$694	$0.132	$694	30	720	0.55
Nov-05	11.2		3,433	$478	$0.139	$478	31	744	0.41
Dec-05	12.8		6,824	$859	$0.126	$859	30	720	0.74
Jan-06	14.0		6,834	$869	$0.127	$869	31	744	0.66
Feb-06	12.6		5,686	$841	$0.148	$841	30	720	0.63
Mar-06	14.1		5,644	$847	$0.150	$847	30	720	0.56
Apr-06	12.4		6,539	$949	$0.145	$949	29	696	0.76
May-06	13.3		5,503	$823	$0.150	$823	29	696	0.59
Jun-06	13.8		5,612	$841	$0.150	$841	31	744	0.55
Jul-06	15.6		6,893	$850	$0.123	$850	32	768	0.58
Avg./Totals:	**13.3**	**$0**	**69,653**	**$9,529**		**$9,529**	**365**	**8,760**	**0.60**

Energy Intensity (kWh/sq.ft.):	**8.71**	**Avg. Cost/kWh:**	**$0.137**
Blended Cost (inc.demand)/kWh:	**$0.137**	**Avg. Cost/kW:**	**$0.00**

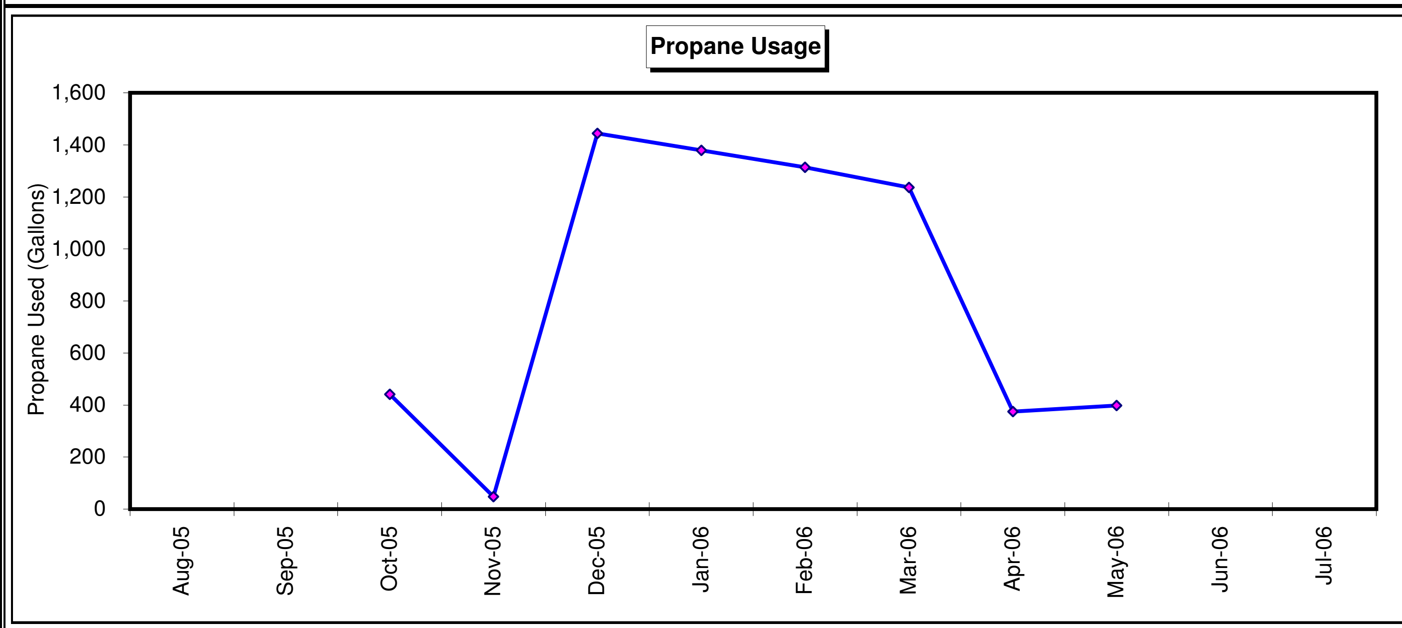
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name:	South End Fire Station
Year Built:	1967
School Address:	25 Durham Rd
	Dover, NH
Phone Number:	516-6150
Principal's Name:	Richard Driscoll
Utility Company:	0
Account No.:	0
Rate:	0
Date:	2/7/2009
Facility Area:	8,000 sq. ft.

ANNUAL PROPANE USAGE

Month	Propane Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2005/2006					
Aug-05		$0	$0.00	0.0	$0.00
Sep-05		$0	$0.00	0.0	$0.00
Oct-05	442	$547	$1.24	42.2	$0.07
Nov-05	48	$59	$1.24	4.5	$0.01
Dec-05	1,444	$1,791	$1.24	137.9	$0.22
Jan-06	1,379	$1,709	$1.24	131.7	$0.21
Feb-06	1,314	$1,629	$1.24	125.5	$0.20
Mar-06	1,236	$1,533	$1.24	118.1	$0.19
Apr-06	374	$464	$1.24	35.7	$0.06
May-06	398	$493	$1.24	38.0	$0.06
Jun-06		$0	$0.00	0.0	$0.00
Jul-06			$0.00	0.0	$0.00
Total	**6,634**	**$8,226**	**$1.24**	**633.6**	**$1.03**
Energy Intensity (MBtu/sq. ft.):		**79.19**			
Avg. Cost $/Gallon		**$1.240**			



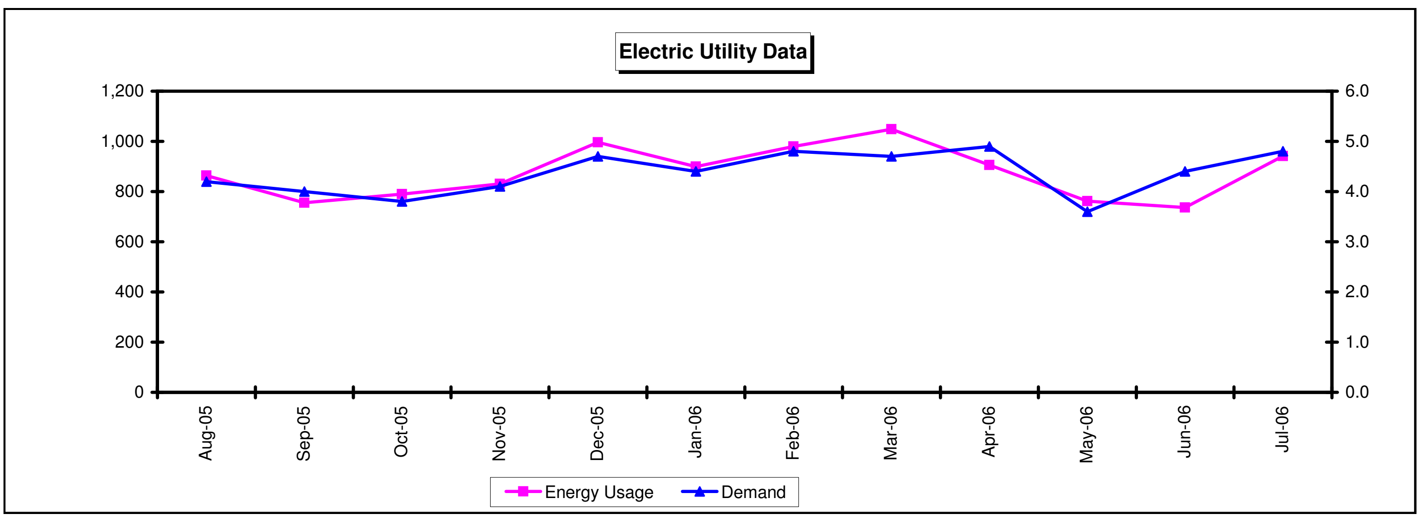
School Name:	Pine Hill Chapel	Utility Company:	PSNH
Year Built:	1911	Old Acct. No.:	61-35-05696-0-6
School Address:	131 Central Ave Dover, NH	New Acct. No.:	56143521011
		Rate:	0
Phone Number:	516-6480	Date:	2/7/2009
Principal's Name:	Nancy		
Facility Area:	1,500 sq. ft.		

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	4.2		864	$144	$0.167	$144	33	792	0.26
Sep-05	4.0		756	$132	$0.174	$132	29	696	0.27
Oct-05	3.8		790	$136	$0.172	$136	31	744	0.28
Nov-05	4.1		830	$140	$0.169	$140	33	792	0.26
Dec-05	4.7		996	$160	$0.161	$160	29	696	0.30
Jan-06	4.4		900	$148	$0.165	$148	29	696	0.29
Feb-06	4.8		980	$177	$0.180	$177	32	768	0.27
Mar-06	4.7		1,048	$186	$0.177	$186	29	696	0.32
Apr-06	4.9		906	$167	$0.184	$167	30	720	0.26
May-06	3.6		762	$147	$0.193	$147	32	768	0.28
Jun-06	4.4		736	$143	$0.195	$143	29	696	0.24
Jul-06	4.8		942	$153	$0.162	$153	29	696	
Avg./Totals:	**4.4**	**$0**	**10,510**	**$1,832**		**$1,832**	**365**	**8,760**	**0.25**

Energy Intensity (kWh/sq.ft.):	**7.01**	**Avg. Cost/kWh:**	**$0.174**
Blended Cost (inc.demand)/kWh:	**$0.174**	**Avg. Cost/kW:**	**$0.00**

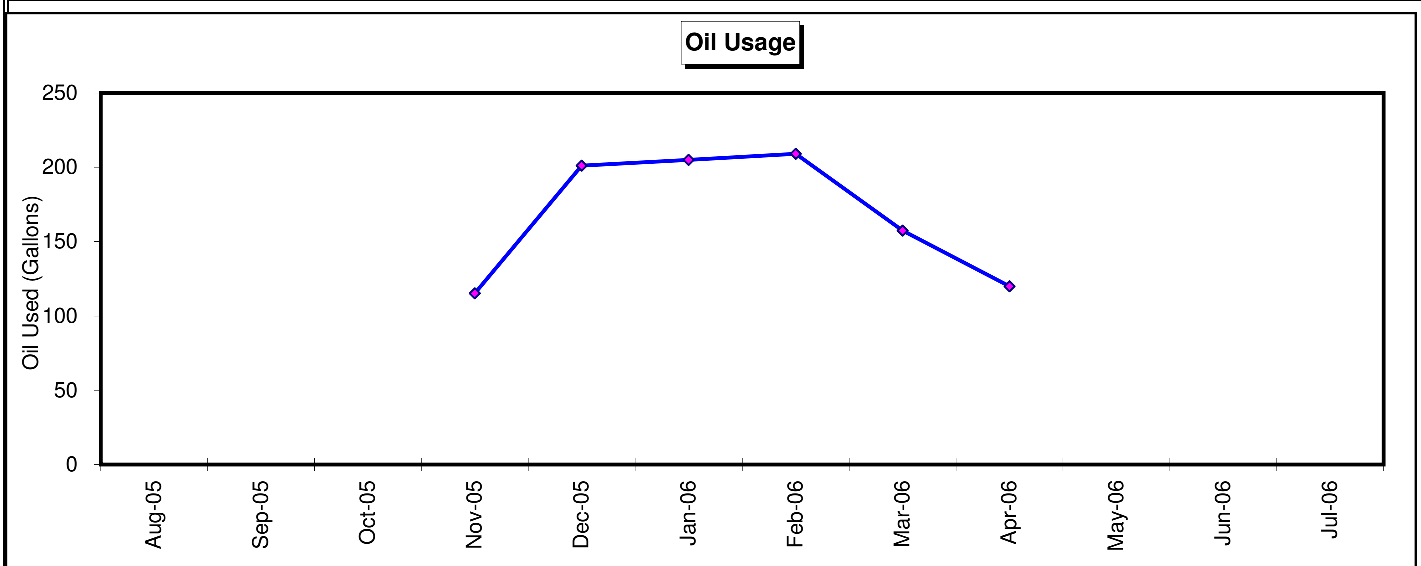
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Pine Hill Chapel
Year Built: 1911
School Address: 131 Central Ave
Dover, NH
Phone Number: 516-6480
Principal's Name: Nancy
Utility Company: Downeast Energy
Account No.: 306,440
Rate: 0
Date: 2/7/2009
Facility Area: 1,500 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2005/2006					
Aug-05			$0.00	0.0	$0.00
Sep-05			$0.00	0.0	$0.00
Oct-05			$0.00	0.0	$0.00
Nov-05	115	$218	$1.89	16.0	$0.15
Dec-05	201	$380	$1.89	27.9	$0.25
Jan-06	205	$388	$1.89	28.4	$0.26
Feb-06	209	$395	$1.89	29.0	$0.26
Mar-06	157	$297	$1.89	21.8	$0.20
Apr-06	120	$227	$1.89	16.6	$0.15
May-06			$0.00	0.0	$0.00
Jun-06			$0.00	0.0	$0.00
Jul-06			$0.00	0.0	$0.00
Total	**1,008**	**$1,905**	**$1.89**	**139.7**	**$1.27**
Energy Intensity (MBtu/sq. ft.):		**93.15**			
Avg. Cost $/Gallon		**$1.890**			



School Name:	Pine Hill Barn
Year Built:	1900
School Address:	131 Central Ave Dover, NH
Phone Number:	396-3964
Principal's Name:	Paul
Facility Area:	1,500 sq. ft.

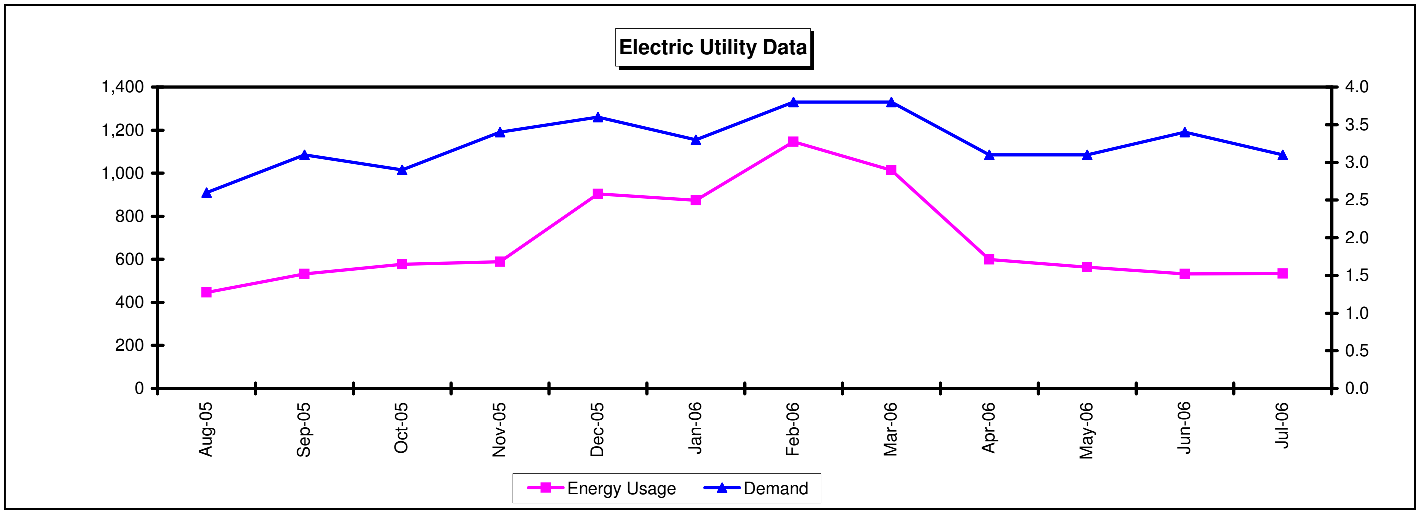
Utility Company: PSNH
Old Acct. No.: 61-35-05566-0-3, 61-35-05567-0-2
New Acct. No.: 56560290074, 56511290090
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05	2.6		446	$84	$0.188	$84	30	720	0.24
Sep-05	3.1		532	$97	$0.182	$97	32	768	0.22
Oct-05	2.9		577	$103	$0.178	$103	30	720	0.28
Nov-05	3.4		589	$104	$0.176	$104	33	792	0.22
Dec-05	3.6		904	$141	$0.156	$141	30	720	0.35
Jan-06	3.3		874	$138	$0.158	$138	28	672	0.39
Feb-06	3.8		1,146	$192	$0.167	$192	30	720	0.42
Mar-06	3.8		1,014	$174	$0.171	$174	33	792	0.34
Apr-06	3.1		599	$117	$0.194	$117	33	792	
May-06	3.1		563	$112	$0.198	$112	30	720	
Jun-06	3.4		532	$107	$0.202	$107	28	672	
Jul-06	3.1		533	$98	$0.183	$98	28	672	
Avg./Totals:	**3.3**	**$0**	**8,309**	**$1,465**		**$1,465**	**365**	**8,760**	**0.20**

Energy Intensity (kWh/sq.ft.):	**5.54**		**Avg. Cost/kWh:**	**$0.176**
Blended Cost (inc.demand)/kWh:	**$0.176**		**Avg. Cost/kW:**	**$0.00**

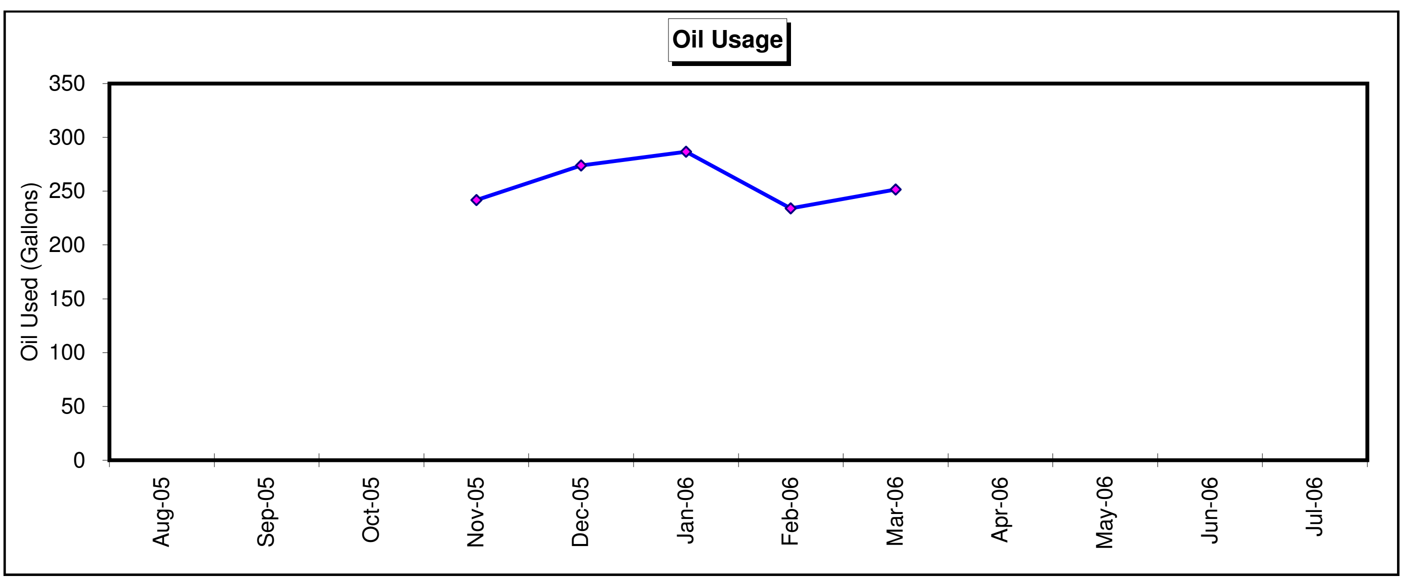
Table Formulas: Hours per Month = D x 24 Load Factor = B/(A x E)



School Name: Pine Hill Barn
Year Built: 1900
School Address: 131 Central Ave
Dover, NH
Phone Number: 396-3964
Principal's Name: Paul
Utility Company: Downeast Energy
Account No.: 306,458
Rate: 0
Date: 2/7/2009
Facility Area: 1,500 sq. ft.

ANNUAL #2 OIL USAGE

Month	Oil Usage Gallons	Total Cost $$$	Unit Cost $/Gallon	MMBTU	Cost per Square Foot
2005/2006					
Aug-05			$0.00	0.0	$0.00
Sep-05			$0.00	0.0	$0.00
Oct-05			$0.00	0.0	$0.00
Nov-05	242	$457	$1.89	33.5	$0.30
Dec-05	274	$518	$1.89	38.0	$0.35
Jan-06	287	$542	$1.89	39.7	$0.36
Feb-06	234	$442	$1.89	32.4	$0.29
Mar-06	252	$476	$1.89	34.9	$0.32
Apr-06			$0.00	0.0	$0.00
May-06			$0.00	0.0	$0.00
Jun-06			$0.00	0.0	$0.00
Jul-06			$0.00	0.0	$0.00
Total	**1,288**	**$2,434**	**$1.89**	**178.5**	**$1.62**
Energy Intensity (MBtu/sq. ft.):		**119.00**			
Avg. Cost $/Gallon		**$1.890**			



School Name: Veterans Hall
Year Built: 1920
School Address: 156 Back River Road
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Facility Area: 2,952 sq. ft.

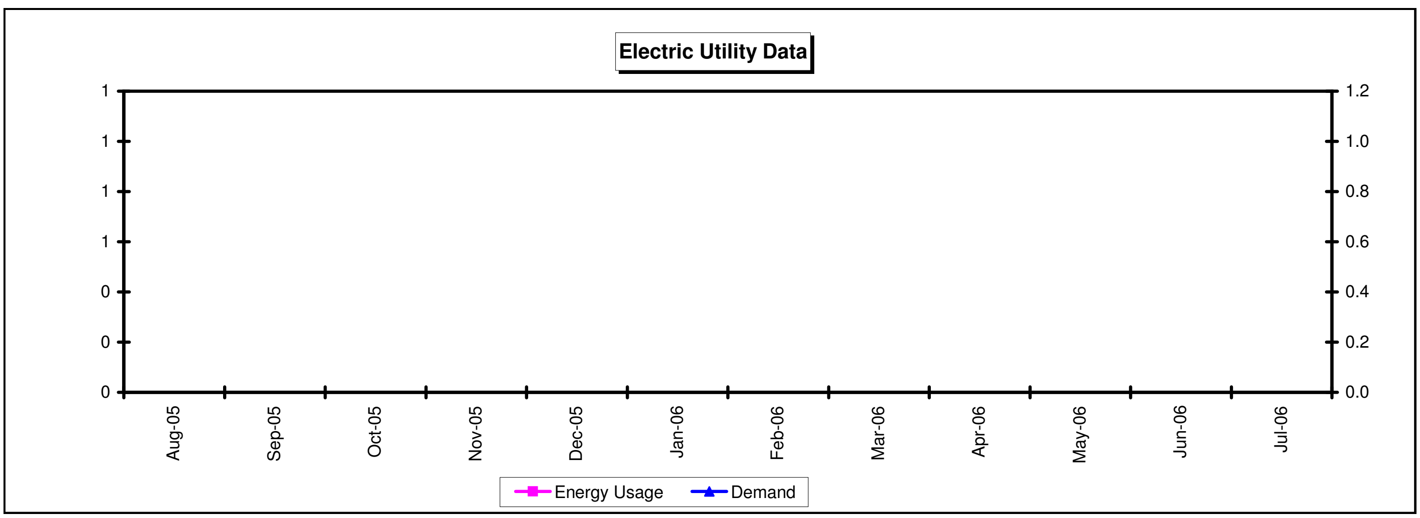
Utility Company: PSNH
Old Acct. No.: 61-10-11423-0-7
New Acct. No.: 56599551058
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total (kW)	Demand Cost	Usage Total (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006									
Aug-05				$0	$0.000		30	720	
Sep-05				$0	$0.000		32	768	
Oct-05				$0	$0.000		30	720	
Nov-05				$0	$0.000		29	696	
Dec-05				$0	$0.000		32	768	
Jan-06				$0	$0.000		31	744	
Feb-06				$0	$0.000		29	696	
Mar-06				$0	$0.000		31	744	
Apr-06				$0	$0.000		29	696	
May-06				$0	$0.000		29	696	
Jun-06				$0	$0.000		33	792	
Jul-06				$0	$0.000		30	720	
Avg./Totals:	**0.0**	**$0**	**0**	**$0**		**$0**	**365**	**8,760**	

Energy Intensity (kWh/sq.ft.):	**0.00**		**Avg. Cost/kWh:**	**-**
Blended Cost (inc.demand)/kWh:	**-**		**Avg. Cost/kW:**	**-**

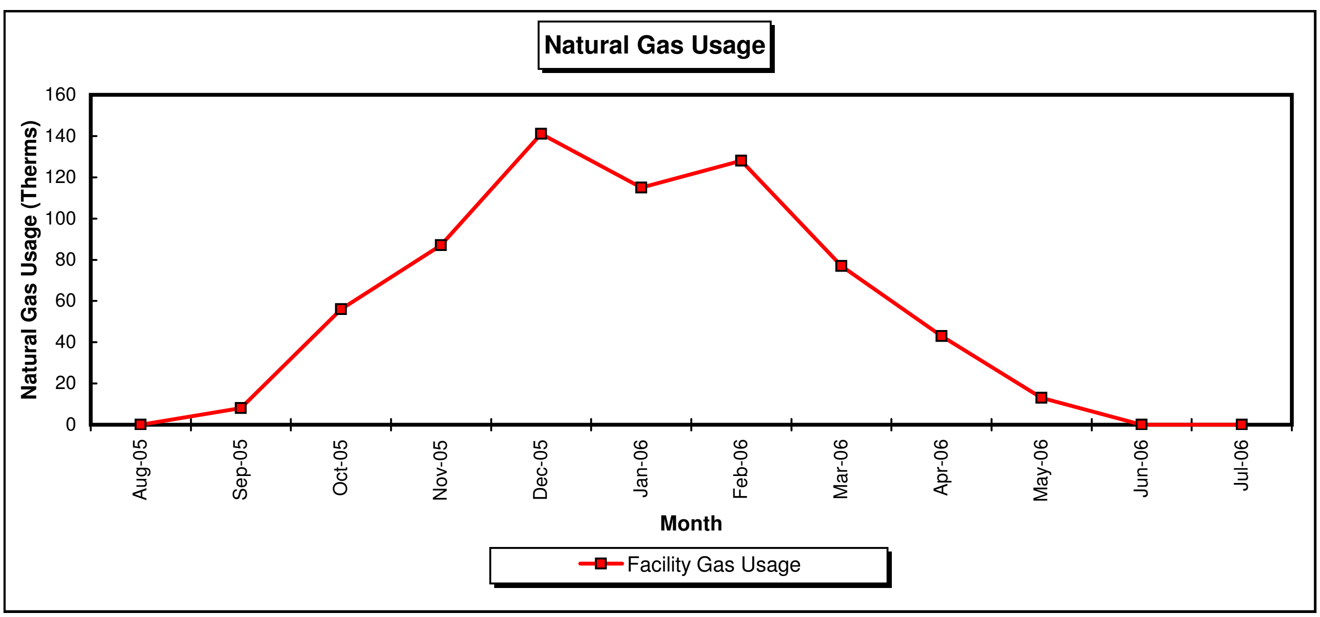
Table Formulas: Hours per Month = D x 24   Load Factor = B/(A x E)



School Name: Veterans Hall
Year Built: 1920
School Address: 156 Back River Road
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Utility Company: 0
Account No.: 0
Rate: 0
Date: 2/7/2009
Facility Area: 2,952 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05	0	$19	$0.000	0	0.000
Sep-05	8	$31	$3.840	1	0.271
Oct-05	56	$109	$1.951	6	1.897
Nov-05	87	$168	$1.927	9	2.947
Dec-05	141	$255	$1.809	14	4.776
Jan-06	115	$203	$1.767	12	3.896
Feb-06	128	$209	$1.636	13	4.336
Mar-06	77	$142	$1.850	8	2.608
Apr-06	43	$86	$2.004	4	1.457
May-06	13	$35	$2.728	1	0.440
Jun-06	0	$37	$0.000	0	0.000
Jul-06	0	$37	$0.000	0	0.000
Totals:	**668**	**$1,333**		**67**	**22.629**
Energy Intensity (MBtu/sq. ft.):		**23.31**			
Avg. Cost $/Therm		**$1.995**			



School Name: Dover Train Station
Year Built: 2001
School Address: 33 Chestnut Street
Dover, NH
Phone Number: 396-4002
Principal's Name: Paul or Sharon
Facility Area: 4,791 sq. ft.

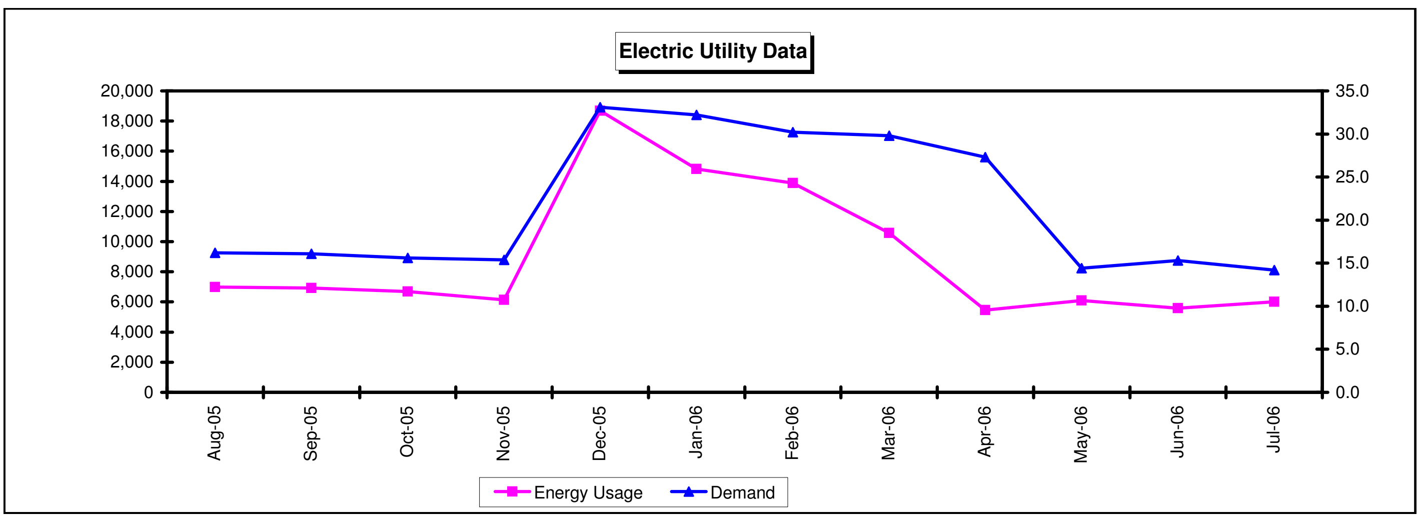
Utility Company: PSNH
Old Acct. No.: 61-35-04075-1-8, 61-35-04442-0-6
New Acct. No.: 56303841092, 56709941074
Rate: 0
Date: 2/7/2009

ANNUAL ELECTRIC UTILITY DATA

	A		B			C	D	E	F
Billing Period	Demand Total * (kW)	Demand Cost	Usage Total * (kWh)	Usage Cost	kWh Unit Cost	Total Cost	Billing Days	Hours per month	Load Factor
2005/2006	*** includes train parking lighting**								
Aug-05	16.2		6,990	$898	$0.128	$898	33	792	0.54
Sep-05	16.1		6,920	$890	$0.129	$890	31	744	0.58
Oct-05	15.6		6,690	$861	$0.129	$861	30	720	0.60
Nov-05	15.4		6,140	$800	$0.130	$800	31	744	0.54
Dec-05	33.1		18,680	$2,298	$0.123	$2,298	30	720	0.78
Jan-06	32.2		14,820	$1,871	$0.126	$1,871	31	744	0.62
Feb-06	30.2		13,890	$2,017	$0.145	$2,017	31	744	0.62
Mar-06	29.8		10,570	$1,590	$0.150	$1,590	28	672	0.53
Apr-06	27.3		5,450	$918	$0.168	$918	31	744	0.27
May-06	14.4		6,090	$902	$0.148	$902	30	720	0.59
Jun-06	15.3		5,590	$845	$0.151	$845	31	744	0.49
Jul-06	14.2		6,010	$750	$0.125	$750	30	720	0.59
Avg./Totals:	**21.7**	**$0**	**107,840**	**$14,640**		**$14,640**	**367**	**8,808**	**0.56**

Energy Intensity (kWh/sq.ft.):	**22.51**	**Avg. Cost/kWh:**	**$0.136**
Blended Cost (inc.demand)/kWh:	**$0.136**	**Avg. Cost/kW:**	**$0.00**

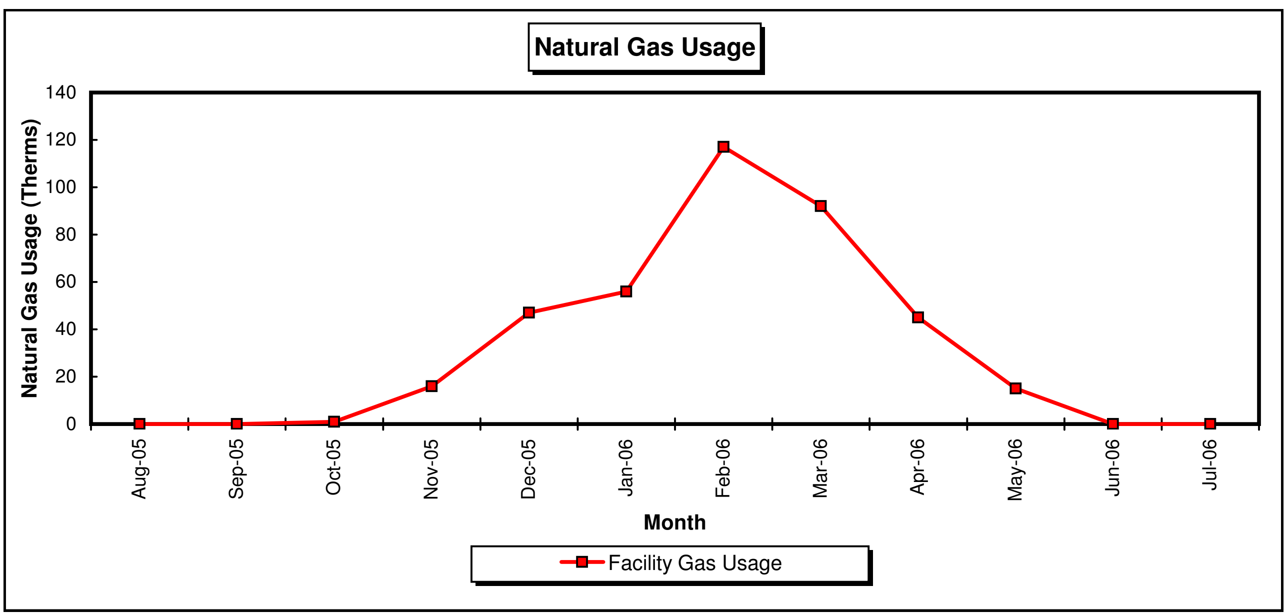
Table Formulas: Hours per Month = D x 24   Load Factor = B/(A x E)



School Name:	Dover Train Station
Year Built:	2001
School Address:	33 Chestnut Street
	Dover, NH
Phone Number:	396-4002
Principal's Name:	Paul or Sharon
Utility Company:	0
Account No.:	0
Rate:	0
Date:	2/7/2009
Facility Area:	4,791 sq. ft.

ANNUAL NATURAL GAS USAGE

Usage Period	Gas Usage (Therms)	Gas Cost	Unit Cost $/Therms	MMBTU	MBTU/SF
2005/2006					
Aug-05	0	$19	$0.000	0	0.000
Sep-05	0	$19	$0.000	0	0.000
Oct-05	1	$20	$20.000	0	0.021
Nov-05	16	$42	$2.637	2	0.334
Dec-05	47	$97	$2.056	5	0.981
Jan-06	56	$108	$1.929	6	1.169
Feb-06	117	$197	$1.684	12	2.442
Mar-06	92	$178	$1.938	9	1.920
Apr-06	45	$104	$2.318	5	0.939
May-06	15	$44	$2.943	2	0.313
Jun-06	0	$19	$0.000	0	0.000
Jul-06	0	$19	$0.000	0	0.000
Totals:	**389**	**$865**		**39**	**8.119**
Energy Intensity (MBtu/sq. ft.):		**8.36**			
Avg. Cost $/Therm		**$2.225**			



City of Dover, NH

Water & Sewer Consumption & Cost Baselines

Indoor Pool		12486 (Water & Sewer)				
2005 - 2006		**1st Qtr 2005**	**2nd Qtr 2005**	**3rd Qtr 2006**	**4th Qtr 2006**	**Totals**
Water	Usage (HCF)	437	336	353	452	1,578
	Cost	$1,171.16	$900.48	$1,044.88	$1,337.92	$4,454.44
Sewer	Usage (HCF)	437	336	353	452	1,578
	Cost	$1,752.37	$1,347.36	$1,457.89	$1,866.76	$6,424.38
2006 - 2007		**1st Qtr 2006**	**2nd Qtr 2006**	**3rd Qtr 2007**	**4th Qtr 2007**	**Totals**
Water	Usage (HCF)	413	272	441	423	1,549
	Cost	$1,222.48	$805.12	$1,375.92	$1,319.76	$4,723.28
Sewer	Usage (HCF)	413	272	441	423	1,549
	Cost	$1,705.69	$1,123.36	$1,913.94	$1,835.82	$6,578.81
2007 - 2008		**1st Qtr 2007**	**2nd Qtr 2007**	**3rd Qtr 2008**	**4th Qtr 2008**	**Totals**
Water	Usage (HCF)	282	244	210	256	992
	Cost	$879.84	$761.28	$741.30	$903.68	$3,286.10
Sewer	Usage (HCF)	282	244	210	256	992
	Cost	$1,223.88	$1,058.96	$921.90	$1,123.84	$4,328.58

Dover Ice Arena		11672 (Water) & 11673 (Sewer)				
2005 - 2006		**1st Qtr 2005**	**2nd Qtr 2005**	**3rd Qtr 2006**	**4th Qtr 2006**	**Totals**
Water	Usage (HCF)	356	623	709	508	2,196
	Cost	$954.08	$1,669.54	$2,098.64	$1,503.68	$6,225.94
Sewer	Usage (HCF)	3	4	17	20	44
	Cost	$12.03	$16.04	$70.21	$82.60	$180.88
2006 - 2007		**1st Qtr 2006**	**2nd Qtr 2006**	**3rd Qtr 2007**	**4th Qtr 2007**	**Totals**
Water	Usage (HCF)	366	706	910	709	2,691
	Cost	$1,083.36	$2,089.76	$2,839.20	$2,212.08	$8,224.40
Sewer	Usage (HCF)	3	1	16	24	44
	Cost	$12.39	$4.13	$69.44	$104.16	$190.12
2007 - 2008		**1st Qtr 2007**	**2nd Qtr 2007**	**3rd Qtr 2008**	**4th Qtr 2008**	**Totals**
Water	Usage (HCF)	447	838	789	625	2,699
	Cost	$1,394.64	$2,614.56	$2,785.17	$2,206.25	$9,000.62
Sewer	Usage (HCF)	3	4	17	27	51
	Cost	$13.02	$17.36	$74.63	$118.53	$223.54

City of Dover, NH

Water & Sewer Consumption & Cost Baselines

Dover City Hall		12977 (Water & Sewer)				
2005 - 2006		**1st Qtr 2005**	**2nd Qtr 2005**	**3rd Qtr 2006**	**4th Qtr 2006**	**Totals**
Water	Usage (HCF)	123	116	106	117	462
	Cost	$329.64	$310.88	$313.76	$346.32	$1,300.60
Sewer	Usage (HCF)	123	116	106	117	462
	Cost	$493.23	$465.16	$437.78	$483.21	$1,879.38
2006 - 2007		**1st Qtr 2006**	**2nd Qtr 2006**	**3rd Qtr 2007**	**4th Qtr 2007**	**Totals**
Water	Usage (HCF)	132	114	131	113	490
	Cost	$390.72	$337.44	$408.72	$352.56	$1,489.44
Sewer	Usage (HCF)	132	114	131	113	490
	Cost	$545.16	$470.82	$568.54	$490.42	$2,074.94
2007 - 2008		**1st Qtr 2007**	**2nd Qtr 2007**	**3rd Qtr 2008**	**4th Qtr 2008**	**Totals**
Water	Usage (HCF)	138	128	142	120	528
	Cost	$430.56	$399.36	$501.26	$423.60	$1,754.78
Sewer	Usage (HCF)	138	128	142	120	528
	Cost	$598.92	$555.52	$623.38	$526.80	$2,304.62

Dover Public Library		12886 NO Data Listed				
2005 - 2006		**1st Qtr 2005**	**2nd Qtr 2005**	**3rd Qtr 2006**	**4th Qtr 2006**	**Totals**
Water	Usage (HCF)					0
	Cost					$0.00
Sewer	Usage (HCF)					0
	Cost					$0.00
2006 - 2007		**1st Qtr 2006**	**2nd Qtr 2006**	**3rd Qtr 2007**	**4th Qtr 2007**	**Totals**
Water	Usage (HCF)					0
	Cost					$0.00
Sewer	Usage (HCF)					0
	Cost					$0.00
2007 - 2008		**1st Qtr 2007**	**2nd Qtr 2007**	**3rd Qtr 2008**	**4th Qtr 2008**	**Totals**
Water	Usage (HCF)					0
	Cost					$0.00
Sewer	Usage (HCF)					0
	Cost					$0.00

City of Dover, NH

Water & Sewer Consumption & Cost Baselines

Jenny Thompson Pool		11671 (Water& Sewer)				
2005 - 2006		1st Qtr 2005	2nd Qtr 2005	3rd Qtr 2006	4th Qtr 2006	Totals
Water	Usage (HCF)		1546			1,546
	Cost		$4,143.28			$4,143.28
Sewer	Usage (HCF)		1546			1,546
	Cost		$6,199.46			$6,199.46
2006 - 2007		1st Qtr 2006	2nd Qtr 2006	3rd Qtr 2007	4th Qtr 2007	Totals
Water	Usage (HCF)	75	100	14	0	189
	Cost	$222.00	$296.00	$43.68	$0.00	$561.68
Sewer	Usage (HCF)	3	23	6	0	32
	Cost	$12.39	$94.99	$26.04	$0.00	$133.42
2007 - 2008		1st Qtr 2007	2nd Qtr 2007	3rd Qtr 2008	4th Qtr 2008	Totals
Water	Usage (HCF)	85	99	29	0	213
	Cost	$265.20	$308.88	$102.37	$0.00	$676.45
Sewer	Usage (HCF)	2	20	3	0	25
	Cost	$8.69	$86.81	$13.17	$0.00	$108.67

Central Fire Station		11492 (Water & Sewer)				
2005 - 2006		1st Qtr 2005	2nd Qtr 2005	3rd Qtr 2006	4th Qtr 2006	Totals
Water	Usage (HCF)	25	29	23	22	99
	Cost	$67.00	$77.72	$68.08	$65.12	$277.92
Sewer	Usage (HCF)	25	29	23	22	99
	Cost	$100.25	$116.29	$94.99	$90.86	$402.39
2006 - 2007		1st Qtr 2006	2nd Qtr 2006	3rd Qtr 2007	4th Qtr 2007	Totals
Water	Usage (HCF)	26	22	25	22	95
	Cost	$76.96	$65.12	$78.00	$68.64	$288.72
Sewer	Usage (HCF)	26	22	25	22	95
	Cost	$107.38	$90.86	$108.50	$95.48	$402.22
2007 - 2008		1st Qtr 2007	2nd Qtr 2007	3rd Qtr 2008	4th Qtr 2008	Totals
Water	Usage (HCF)	25	30	23	23	101
	Cost	$78.00	$93.60	$81.19	$81.19	$333.98
Sewer	Usage (HCF)	25	30	23	23	101
	Cost	$108.50	$130.20	$100.97	$100.97	$440.64

City of Dover, NH

Water & Sewer Consumption & Cost Baselines

South End Fire Station		12311 (Water & Sewer)				
2005 - 2006		**1st Qtr 2005**	**2nd Qtr 2005**	**3rd Qtr 2006**	**4th Qtr 2006**	**Totals**
Water	Usage (HCF)	51	45	41	60	197
	Cost	$136.68	$120.60	$121.36	$177.60	$556.24
Sewer	Usage (HCF)	51	45	41	60	197
	Cost	$204.51	$180.45	$169.33	$247.80	$802.09
2006 - 2007		**1st Qtr 2006**	**2nd Qtr 2006**	**3rd Qtr 2007**	**4th Qtr 2007**	**Totals**
Water	Usage (HCF)	70	53	59	47	229
	Cost	$207.20	$156.88	$184.08	$146.64	$694.80
Sewer	Usage (HCF)	70	53	59	47	229
	Cost	$289.10	$218.89	$256.06	$203.98	$968.03
2007 - 2008		**1st Qtr 2007**	**2nd Qtr 2007**	**3rd Qtr 2008**	**4th Qtr 2008**	**Totals**
Water	Usage (HCF)	69	62	46	56	233
	Cost	$215.28	$193.44	$162.38	$197.68	$768.78
Sewer	Usage (HCF)	69	62	46	56	233
	Cost	$299.46	$269.08	$201.94	$245.84	$1,016.32

Pine Hill chapel		14328 (Water & Sewer)				
2005 - 2006		**1st Qtr 2005**	**2nd Qtr 2005**	**3rd Qtr 2006**	**4th Qtr 2006**	**Totals**
Water	Usage (HCF)	3	2	2	2	9
	Cost	$8.04	$5.36	$5.92	$5.92	$25.24
Sewer	Usage (HCF)	3	2	2	2	9
	Cost	$12.03	$8.02	$8.26	$8.26	$36.57
2006 - 2007		**1st Qtr 2006**	**2nd Qtr 2006**	**3rd Qtr 2007**	**4th Qtr 2007**	**Totals**
Water	Usage (HCF)	3	2	3	2	10
	Cost	$8.88	$5.92	$9.36	$6.24	$30.40
Sewer	Usage (HCF)	3	2	3	2	10
	Cost	$12.39	$8.26	$13.02	$8.68	$42.35
2007 - 2008		**1st Qtr 2007**	**2nd Qtr 2007**	**3rd Qtr 2008**	**4th Qtr 2008**	**Totals**
Water	Usage (HCF)	2	3	2	4	11
	Cost	$6.24	$9.36	$7.06	$14.12	$36.78
Sewer	Usage (HCF)	2	3	2	4	11
	Cost	$8.68	$13.02	$8.78	$17.56	$48.04

Appendix 3
Calculations

Appendix 3-1 Indoor Pool

Rate Sheet February 1, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.10	$/kWh
Electric Demand	$8.82	$/kW
Natural Gas	$1.44	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$14.37	$/MMBtu

Heating Efficiency (%)	83%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
468.6	140.5	609.1

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	85	85
Winter Inside Setpoint (F)	80	80

Total Building Sq Footage	10,279
Percent of Building Cooled	10%
Total Cooled Sq Footage	1,028

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
#2 gal Oil	=	139,000	Btu
1 gal Propane	=	91,600	Btu
1 CCF	=	103,400	Btu

Thermal Energy

Year	#2 OIL Usage (gal.)	Cost ($)	MMBTU	Unit Cost ($/MMBtu)	NATURAL GAS Usage (Therms)	Cost ($)	MMBTU	Unit Cost ($/MMBtu)	Overall MMBtu	Overall Cost	Overall $/MMBtu
Total			**0**	**$0.0**	**48,170**	**69,230**	**4,817**	**$14.4**	**4,817**	**69,230**	**$14.4**

Electricity

Year	Demand (kW)	Usage (kWh)	Cost ($)	Demand ($/kW)	Demand ($)	Energy ($)	Unblended ($/kWh)	Overall Electric	Overall Cost	Overall $/kWh
Total		**423,000**	**44,202**					**423,000**	**$44,202**	**$0.10**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	3	8	6

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Occupied
Sunday	Occupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	4
Dec	4

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	21.0	1.0
87.5	72.5	3.5
82.5	261.8	19.3
77.5	300.1	29.9
72.5	414.6	78.4
67.5	434.6	153.4
62.5	600.0	262.0
57.5	465.0	241.0
52.5	397.5	185.5
47.5	401.6	178.4
42.5	349.8	149.3
37.5	550.9	251.1
32.5	564.9	252.1
27.5	450.4	205.6
22.5	305.0	164.0
17.5	284.3	146.8
12.5	141.9	79.1
7.5	73.9	45.1
2.5	50.6	42.4
-2.5	28.5	27.5
-7.5	26.0	27.0
-12.5	6.9	7.1
-17.5	3.4	5.6

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations
2. Select one location in cell B2 from the drop-down list.
3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.
4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
Bldg Name	Dover Indoor Pool
Bdl Size	10,279

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	1,444	4,817	6,261
	MBtu/sq ft	140.5	468.6	609.1
Proposed	MMBtu/yr	1,034	3,830	4,864
	MBtu/sq ft	100.6	372.6	473.2
% Change	MMBtu/yr	409	987	1,396
	MBtu/sq ft	39.8	96.0	135.8

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 1	Lighting - Fixture Retrofit	3	9,844	$1,340	(13)	($181)			$1,158
FIM 2	Lighting - Fixture Control	0	252	$26					$26
FIM 3	Building Envelope Improvements - Weatherization		3	$0	86	$1,240			$1,240
FIM 4	Energy Management System - Upgrades								
FIM 4.1	Energy Management System - Building Controls		(6)	($1)	14	$204			$204
FIM 4.4	Pool Dehumidification - EMS & VFD's		63,143	$6,598	320	$4,605			$11,203
FIM 6	Water Conservation				36	$512	209	$2,307	$2,819
FIM 9	Vending Machine Controllers		1,453	$152					$152
FIM 10	Pool Covers		45,256	$4,729	543	$7,805			$13,223
	TOTALS	**3**	**119,945**	**$12,845**	**987**	**$14,185**	**209**	**$2,307**	**$30,026**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	10,279	423,000	44,202	4,817	69,230	$113,432	$11.04
AFTER PROJECT ENERGY USAGE:	10,279	303,055	$31,357	3,830	$55,045	$86,402	$8.41
AFTER PROJECT ENERGY SAVINGS:	10,279	119,945	$12,845	987	$14,185	$27,029	$2.63
ENERGY REDUCTION (%):		28.36%	29.06%	20.49%	20.49%	23.83%	23.83%

Title	**Lighting Fixture Retrofit and Controls**
Date	**February 1, 2009**
District	**Dover, NH**
School	**Dover Indoor Pool**

Summary *	Baseline	Proposed	Savings	$ Savings
kWh/yr	24,856	14,448	10,408	$1,088
kW	13.1	10.0	3.1	$321
MMBtu/yr		(13)	(13)	($187)
Total				$1,221

* *Includes both Lighting Retrofit & Lighting Controls*

Measures	Units	Baseline	Cooling Credit	Heating Debit	Proposed	Energy Savings	Cost Savings ($)	Total Savings ($)
Lighting Fixture Retrofit	kWh	24,856			14,773	10,084	$1,054	$1,374
	kW	13.1			10.1	3.0	$321	
Lighting Fixture Controls	kWh	14,773			14,513	260	$27	$27
	kW	10.1			10.0	0.1	NA	
Total	kWh	24,856	65		14,448	10,408	$1,088	$1,221
	kW	13.1			10.0	3.1	$321	
	MMBtu			(13)	(13)	(13)	($187)	

YES	Is Interaction Penalty Required ?	
75%	...PERCENTAGE OF LIGHT HEAT RETURNED TO HVAC (%HTRET)	
3.12	...TOTAL KW LIGHTING LOAD REDUCTION (KWRED)	
10,344	...TOTAL KWH LIGHTING LOAD REDUCTION (KWHRED)	
66	...AVERAGE LIGHTING HOURS PER WEEK (LITEHHRS)	= KWHRED/KWRED / WPY
12	... DEMAND MONTHS (CLGMONTHS)	
80%	...HEATING SYSTEM EFFICIENCY (EFF)	
1.10	....Avg. KW/TON OF CHILLER (KW/TON)	
0.0	....AVG. KW/TON OF SUPPORT EQUIPMENT (KWSUPT)	
3,635	...HEATING HRS/YR FROM WEATHER DATA (HHPY)	
2,570	...COOLING HRS/YR FROM WEATHER DATA (CHPY)	
1,304	...WINTER HEATING COINCIDENT HRS (HTGCOHRS)	= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
883	...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)	= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
50	...WEEKS/YEAR OF BUILDING OPERATION (WPY)	
10%	...PERCENT OF AREA AIR CONDITIONED (%COOLED)	

(Heating Debit)	(KWRED * 3413 * %HTRET * HTGCOHRS) / BTUs/UNIT / EFF =================================	(13)	**MMBTU**
	FUEL SAVED * COST / MMBTU ==	($187)	**$**
(Cooling Credit)	(KWRED * 3413 * %HTRET * CLGCOHRS * %COOLED) / 12000 * KW/TON ===========	65	**KWH**
	MMBTU SAVED * COOLCOST ===	$7	**$**

TOTAL INTERACTION =========== ($180) **$**

Formulas:

Baseline Energy Usage (kWh/yr) = ∑(Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)
Estimated Energy Usage (kWh/yr) = ∑(Proposed Fixture Watts x Op. Hours/yr x 1 kW/1000 Watts)
Energy Savings (kWh/yr) = Baseline Energy Usage – Estimated Energy Usage

Title	Building Envelope Improvements
Date	February 1, 2009
District	Dover, NH
School	Dover Indoor Pool

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	3	$0
kW				
MMBtu/yr	-	-	89	$1,278
Total				$1,278

INPUT DATA

Area of Cracks	1.9
Area Air-Conditioned	10%
Area Heated	60%
Winter Occupied Set Point	80.0
Winter Unoccupied Set Point	80.0
Summer Occupied Set Point	85.0
Summer Unoccupied Set Point	85.0
Balance Point	55.0
MMBtu to Btu factor	1,000,000
Cooling Efficiency EER	10.0
Heating Efficiency %	83%
$/kwh unblended	$0.10
$/gallon of fuel	NA

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	427
Infiltration (CFM) Summer	71

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	4	20	1/16	1/12	=	0.417
RTV's	-	0	1/6	1/12	=	-
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	2	104	1/6	1/12	=	1.444
Seal Bulkheads	-	0	1/16	1/12	=	-
					Total =	1.861

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration Existing Occupied	Existing Unoccupied	Cooling/Heating Btu saved	Output Ton-Hours or MMBtu	kWh Saved	Input MMBtuSaved
Cooling										
90-95	92.5	75.9	21	1	12,118	577	12,696	1	1	
85-90	87.5	73.0	73	4	13,946	673	14,619	1	1	
80-85	82.5	70.3	262	19	-	-	-	-	-	
75-80	77.5	67.5	300	30	-	-	-	-	-	
70-75	72.5	64.4	415	78	-	-	-	-	-	
65-70	67.5	61.3	435	153	-	-	-	-	-	
60-65	62.5	56.7	600	262	-	-	-	-	-	
Heating										
55-60	57.5	52.3	465	241	4,830,084	2,503,334	7,333,418	7		8.8
50-55	52.5	47.0	398	186	5,046,486	2,355,027	7,401,513	7		8.9
45-50	47.5	42.2	402	178	6,025,920	2,676,311	8,702,231	9		10.5
40-45	42.5	37.9	350	149	6,054,917	2,583,835	8,638,753	9		10.4
35-40	37.5	33.6	551	251	10,808,396	4,927,176	15,735,572	16		19.0
30-35	32.5	29.4	565	252	12,386,973	5,528,773	17,915,746	18		21.6
25-30	27.5	24.8	450	206	10,915,731	4,983,729	15,899,460	16		19.2
20-25	22.5	20.4	305	164	8,096,306	4,353,424	12,449,730	12		15.0
15-20	17.5	15.4	284	147	8,201,622	4,234,258	12,435,880	12		15.0
10-15	12.5	10.0	142	79	4,421,085	2,465,680	6,886,765	7		8.3
5-10	5.5	6.2	74	45	2,540,815	1,552,004	4,092,818	4		4.9
0-5	0.0	0.6	51	42	1,869,710	1,565,017	3,434,727	3		4.1
-5-0	0.0	0.0	29	28	1,052,578	1,015,645	2,068,222	2		2.5

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	EMS-Temperature Setback
Date	February 1, 2009
District	Dover, NH
School	Dover Indoor Pool

Summary	Baseline	Proposed	Savings	Savings
kWh/yr	32	38	(6)	($1)
kW			0	$0
MMBtu/yr	395	380	15	$211
Total				$211

Input Variables

	Existing	Proposed
Summer Occupied Setpoint	85	85
Summer Unoccupied Setpoint	85	80
Winter Occupied Setpoint	85	85
Winter Unoccupied Setpoint	85	80
Bulding Area	10,279	
Exterior Wall Area	1,542	
Roof Area	2,056	
Average R-value of Wall	10	
Average R-Value of Roof	24	
Boiler Efficiency (%)	83%	
Cooling System Efficiency (kW/ton)	1.10	

Assumptions and Constants:	
Building Balance Point	80
Default Wall R-Value	10
Default Roof R-Value	24
Building Infiltration- Air Changes Per Hour	0.4

Overall UA Value	240
Infiltration CFM	685

				Existing Case				Proposed Case			
Bin Temp	Hours Unoccupied	Occupied	Total Hours	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu
102.5	0	0	0	0	0	0	0	0	0	0	0
97.5	0	0	0	0	0	0	0	0	0	0	0
92.5	1	21	22	0	0	15	0	0	0	15	0
87.5	4	73	76	0	0	17	0	0	0	19	0
82.5	19	262	281	0	0	0	0	0	0	4	0
77.5	30	300	330	1	2	0	3	1	2	0	3
72.5	78	415	493	1	5	0	7	1	4	0	7
67.5	153	435	588	2	8	0	12	2	7	0	11
62.5	262	600	862	5	14	0	23	4	13	0	21
57.5	241	465	706	5	14	0	23	4	13	0	21
52.5	186	398	583	5	14	0	22	4	13	0	21
47.5	178	402	580	5	16	0	26	5	15	0	25
42.5	149	350	499	5	16	0	25	5	15	0	24
37.5	251	551	802	9	28	0	45	9	27	0	43
32.5	252	565	817	10	32	0	51	10	31	0	49
27.5	206	450	656	9	28	0	45	9	27	0	43
22.5	164	305	469	7	22	0	35	7	21	0	34
17.5	147	284	431	7	22	0	34	7	21	0	33
12.5	79	142	221	4	12	0	19	4	12	0	18
7.5	45	74	119	2	7	0	11	2	7	0	11
2.5	42	51	93	2	6	0	9	2	6	0	9
-2.5	28	29	56	1	4	0	6	1	4	0	6
	2,515	6,169	8684	80	248	32	395	77	239	38	380

Formulas:

For both Existing and Proposed Case:
Envelope Load MMBtu = (UA x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6
Infiltration Load MMBtu = (1.08 x Infiltration CFM x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6

Where
UA = 1/R-Value of Wall x Wall Area + 1/R-Value of Roof x Roof Area
Infiltration CFM = Building Area x 10 Feet Average Height x Building Air Changes Per Hour/60

Cooling kWh = (Envelope + Infiltration Load) x 10^6/12000 x kW/Ton Cooling Efficiency (Loads for Hours above Balance Point only)
Heating MMBtu = (Envelope + Infiltration Load)/ Heating Efficiency (Loads for Hours below Balance Point only)

Title	**Pool Dehumidification - EMS & VFD's**
Date	**February 1, 2009**
District	**Dover, NH**
School	**Dover Indoor Pool**

Summary	Existing	Proposed	Savings	Savings
kWh/yr	168,812	103,716	65,096	$6,802
kW				
MMBtu/yr	3,764	3,434	330	$4,747
Total				$11,550

$/kW	$8.82
$/kWh	$0.10
$/MMBtu	$14.37

Johnson Controls, Inc. Savings Calculation - Pool Building EMS & VFD's
Indoor Pool, Dover, NH

		Existing	Proposed	
Building: Building				
Unit #: Pool HVAC	Pool Enclosure Occupied Based On Schedule	Y	Y	*Y = Yes, N = No*
Area Served: Pool Enclosure	Manual Or Automatic Pool Covers	Y	Y	*Y = Included, N = Not Included*
System Type: SZCV	Fan Motor Efficiency Levels	P	P	*S = Standard, H = High, P = Premium*
Annual Time Period: All	Fan Control Strategy For Unoccupied Periods	N	Y	*Y = Included, N = Not Included*
	Unoccupied Periods - Supply/Return Fan Control	C	V	*C = Cycling, V = VFD*
	Unoccupied Periods - Exhaust Fan Control	C	V	*C = Cycling, V = VFD*
	Temperature Setback For Unoccupied Periods	N	Y	*Y = Included, N = Not Included*

Summary Of Estimated Annual Energy Usage Existing HVAC Systems And Controls	**Daily Time Period**	**System Mode**	**Fans Total Annual kWh**	**Heating Total Annual MMBtu**	**Pool Water Heating Annual MMBtu**	**Total Annual MMBtu**	**Pool Makeup Water kGal**
	12 M - 8 AM	Occupied	43,566	700	502	1,202	56
	8 AM - 4 PM	Occupied	43,566	581	602	1,183	67
	4 PM - 12 AM	Occupied	43,559	607	502	1,109	56
	All	Unoccupied	38,121	235	35	270	4
		Totals	**168,812**	**2,123**	**1,641**	**3,764**	**183**

Summary Of Estimated Annual Energy Usage Existing HVAC Systems With Existing Pool Cover And New VFD's And Controls	**Daily Time Period**	**System Mode**	**Fans Total Annual kWh**	**Heating Total Annual MMBtu**	**Pool Water Heating Annual MMBtu**	**Total Annual MMBtu**	**Pool Makeup Water kGal**
	12 M - 8 AM	Occupied	31,931	610	502	1,112	56
	8 AM - 4 PM	Occupied	31,999	522	602	1,124	67
	4 PM - 12 AM	Occupied	31,927	534	502	1,036	56
	All	Unoccupied	7,860	125	35	161	4
		Totals	**103,716**	**1,792**	**1,641**	**3,434**	**183**

Summary Of Estimated Annual Energy Savings With Existing Pool Cover And New VFD's And Controls	**Daily Time Period**	**System Mode**	**Fans Total Annual kWh**	**Heating Total Annual MMBtu**	**Pool Water Heating Annual MMBtu**	**Total Annual MMBtu**	**Pool Makeup Water kGal**
	12 M - 8 AM	Occupied	11,635	89	0	89	0
	8 AM - 4 PM	Occupied	11,567	59	0	59	0
	4 PM - 12 AM	Occupied	11,632	73	0	73	0
	All	Unoccupied	30,261	110	0	110	0
		Totals	**65,096**	**330**	**0**	**330**	**0**

Johnson Controls, Inc.
Estimated Annual Energy Usage - Existing HVAC System And Controls

I. **Pool Data And Calculated Evaporation Rates**

Pool Data And Calculated Evaporation Rates:

Pool Enclosure Air Conditions	Pool #	Pool Usage	Pool Area - SF	Pool Water Temp.	Total Evaporation Rates: Lbs/Hr Still Water	Lbs/Hour With Activity	Lbs/Hour With Pool Covered	Maximum Activity Factor	Percent Evaporation With Pool Cover In Place
86 °F 60% RH	1	General	4,500	84 °F	128	128	13	1	10%
		Totals	**4,500**		**128**	**128**	**13**		

Estimated Pool Water Evaporation Rates By Daily Time Period

	Estimated Activity Level	Evaporation Rate Lbs/Hr
12 M To 8 AM	1.25	160
8 AM To 4 PM	1.5	192
4 PM To 12 M	1.25	160
(For Occupied Hours Only)		

Pool Water Heating Parameters:

Estimated Average City Water Temperature:	55 °F
Weighted Average Pool Makeup Water Temperature:	84 °F
Pool Water Heater Efficiency:	83%
(Existing Boiler)	

Ventilation Air Requirements:

Total Pool Area - Square Feet:	4,500	Observation Area - Square Feet:	0
Total Wet Deck Area - Square Feet:	870	Observation Area - # SF Per Person:	6.67
Total Pool And Wet Deck Area - Square Feet:	5,370	Observation Area - Total # People:	0
Fresh Air CFM Per Square Foot:	0.50	Fresh Air CFM Per Person:	10
Fresh Air CFM Required For Pool/Wet Deck Area:	2,685	Fresh Air CFM Required For Observation Area:	0
Total Design Minimum Fresh Air CFM:	2,685	*(Occupied Hours Only)*	

Johnson Controls, Inc.
Estimated Annual Energy Usage - Existing HVAC System And Controls

IV. **Estimated Annual Energy Use - Existing HVAC System And Controls**

Building:	*Building*
HVAC System:	*Pool HVAC*
Annual Time Period:	*All*
Weather Data Location:	Dover, NH

Outside Air Temp. Concord Deg. F	Daily Time Period 12 AM To 8 AM System Hours	Pool Water Evaporation Rate Lbs/Hour	Total Fresh Air CFM	Mixed Air Temp.	Reheat MMBtu	Space Heating MMBtu	Supply And Return Fans: % Of Design System Airflow CFM	Average Total Input kW	Total kWh	Exhaust Fans: % Of Design System Airflow CFM	Average Total Input kW	Total kWh	System Total MMBtu	Fans Total kWh
95 / 99	0	160	11,913	95 °F	0	0	100%	7.5	0	100%	7.5	0	0	0
90 / 94	0	160	12,132	91 °F	0	0	100%	7.5	0	100%	7.5	0	0	0
85 / 89	0	160	9,094	87 °F	0	0	100%	7.5	0	100%	7.5	0	0	0
80 / 84	2	160	7,223	84 °F	0	0	100%	7.5	15	100%	7.5	15	0	30
75 / 79	9	160	6,183	82 °F	1	0	100%	7.5	67	100%	7.5	67	1	134
70 / 74	49	160	5,855	81 °F	4	0	100%	7.5	366	100%	7.5	366	4	731
65 / 69	161	160	5,486	79 °F	18	0	100%	7.5	1,201	100%	7.5	1,201	18	2,402
60 / 64	300	160	4,719	78 °F	37	0	100%	7.5	2,238	100%	7.5	2,238	37	4,476
55 / 59	286	160	3,988	78 °F	36	16	100%	7.5	2,134	100%	7.5	2,134	52	4,267
50 / 54	228	160	3,469	78 °F	29	15	100%	7.5	1,701	100%	7.5	1,701	44	3,402
45 / 49	201	160	3,125	78 °F	26	15	100%	7.5	1,499	100%	7.5	1,499	42	2,999
40 / 44	172	160	2,889	78 °F	24	15	100%	7.5	1,283	100%	7.5	1,283	38	2,566
35 / 39	293	160	2,731	77 °F	42	28	100%	7.5	2,186	100%	7.5	2,186	71	4,372
30 / 34	295	160	2,685	76 °F	46	31	100%	7.5	2,201	100%	7.5	2,201	78	4,401
25 / 29	237	160	2,685	75 °F	41	28	100%	7.5	1,768	100%	7.5	1,768	68	3,536
20 / 24	202	160	2,685	75 °F	37	25	100%	7.5	1,507	100%	7.5	1,507	63	3,014
15 / 19	178	160	2,685	74 °F	36	24	100%	7.5	1,328	100%	7.5	1,328	60	2,656
10 / 14	91	160	2,685	73 °F	20	13	100%	7.5	679	100%	7.5	679	33	1,358
5 / 9	55	160	2,685	72 °F	13	9	100%	7.5	410	100%	7.5	410	21	821
0 / 4	61	160	2,685	71 °F	15	10	100%	7.5	455	100%	7.5	455	25	910
-5 / -1	40	160	2,685	70 °F	10	7	100%	7.5	298	100%	7.5	298	17	597
-10 / -6	40	160	2,685	69 °F	11	7	100%	7.5	298	100%	7.5	298	18	597
-15 / -11	11	160	2,685	68 °F	3	2	100%	7.5	82	100%	7.5	82	5	164
-20 / -16	9	160	2,685	67 °F	3	2	100%	7.5	67	100%	7.5	67	5	134
	2,920	**466,470** **Total Pounds**			**451**	**249**			**21,783**			**21,783**	**700**	**43,566**

Johnson Controls, Inc.
Estimated Annual Energy Usage - Existing HVAC System And Controls

IV. **Estimated Annual Space Cooling Energy Use - Existing HVAC System And Controls (Continued)**

Building:	Building
HVAC System:	Pool HVAC
Annual Time Period:	All
Weather Data Location:	Dover, NH

Outside Air Temp. Bangor Deg. F	Daily Time Period 8 AM To 4 PM System Hours	Pool Water Evaporation Rate Lbs/Hour	Total Fresh Air CFM	Mixed Air Temp.	Reheat MMBtu	Space Heating MMBtu	Supply And Return Fans: % Of Design System Airflow CFM	Average Total Input kW	Total kWh	Exhaust Fans: % Of Design System Airflow CFM	Average Total Input kW	Total kWh	System Total MMBtu	Fans Total kWh
95 / 99	0	192	14,296	96 °F	0	0	100%	7.5	0	100%	7.5	0	0	0
90 / 94	18	192	14,558	92 °F	0	0	100%	7.5	134	100%	7.5	134	0	269
85 / 89	62	192	10,912	87 °F	0	0	100%	7.5	463	100%	7.5	463	0	925
80 / 84	207	192	8,667	84 °F	8	0	100%	7.5	1,544	100%	7.5	1,544	8	3,088
75 / 79	224	192	7,419	82 °F	16	0	100%	7.5	1,671	100%	7.5	1,671	16	3,342
70 / 74	253	192	7,026	79 °F	27	0	100%	7.5	1,887	100%	7.5	1,887	27	3,775
65 / 69	216	192	6,583	78 °F	29	0	100%	7.5	1,611	100%	7.5	1,611	29	3,223
60 / 64	264	192	5,662	77 °F	39	0	100%	7.5	1,969	100%	7.5	1,969	39	3,939
55 / 59	171	192	4,785	77 °F	26	10	100%	7.5	1,276	100%	7.5	1,276	35	2,551
50 / 54	183	192	4,162	77 °F	28	12	100%	7.5	1,365	100%	7.5	1,365	40	2,730
45 / 49	168	192	3,750	76 °F	27	13	100%	7.5	1,253	100%	7.5	1,253	39	2,507
40 / 44	160	192	3,467	76 °F	26	14	100%	7.5	1,194	100%	7.5	1,194	40	2,387
35 / 39	237	192	3,278	75 °F	41	23	100%	7.5	1,768	100%	7.5	1,768	64	3,536
30 / 34	251	192	3,142	75 °F	46	27	100%	7.5	1,872	100%	7.5	1,872	73	3,745
25 / 29	189	192	3,008	74 °F	36	22	100%	7.5	1,410	100%	7.5	1,410	58	2,820
20 / 24	116	192	2,919	74 °F	23	15	100%	7.5	865	100%	7.5	865	38	1,731
15 / 19	111	192	2,858	73 °F	24	15	100%	7.5	828	100%	7.5	828	39	1,656
10 / 14	41	192	2,809	72 °F	9	6	100%	7.5	306	100%	7.5	306	15	612
5 / 9	21	192	2,765	71 °F	5	3	100%	7.5	157	100%	7.5	157	8	313
0 / 4	15	192	2,737	71 °F	4	2	100%	7.5	112	100%	7.5	112	6	224
-5 / -1	6	192	2,737	70 °F	2	1	100%	7.5	45	100%	7.5	45	3	90
-10 / -6	5	192	2,741	69 °F	1	1	100%	7.5	37	100%	7.5	37	2	75
-15 / -11	2	192	2,730	68 °F	1	0	100%	7.5	15	100%	7.5	15	1	30
-20 / -16	0	192	2,728	67 °F	0	0	100%	7.5	0	100%	7.5	0	0	0
	2,920	**559,764** **Total Pounds**			**417**	**164**			**21,783**			**21,783**	**581**	**43,566**

Johnson Controls, Inc.
Estimated Annual Energy Usage - Existing HVAC System And Controls

II. Pool HVAC Equipment Specifications And Operating Parameters

Indoor And Outdoor Design Conditions:

OA	DB	MCWB	Enthalpy	Moisture
Conditions	90 °F	71 °F	34.7 Btu/Lb	83.3 Gr/Lb
Space	DB	RH	Enthalpy	Moisture
Conditions	86 °F	60% RH	38.6 Btu/Lb	114 Gr/Lb

Existing Heating & Ventilating Units - Design Airflow And Heating Data:

Quantity: 1

	Per Unit	Total
Total Supply Air CFM:	15,000	15,000
Estimated Minimum Fresh Air CFM:	3,000	3,000
Heating Coil Total Capacity MBH:	448	448
Design Discharge Air Temperature:	120 °F	120 °F
Estimated MBH To Heat Fresh Air:	301	301
Estimated Space Heating Capacity - MBH:	147	147

Daily/Weekly Occupancy Schedule:

			Percent Occupied Times By Daily Time Period		
Weekday	Start	End	12 AM To 8 AM	8 AM To 4 PM	4 PM To 12 AM
Monday	5:30 AM	9:00 PM	31%	100%	63%
Tuesday	5:30 AM	9:00 PM	31%	100%	63%
Wednesday	5:30 AM	9:00 PM	31%	100%	63%
Thursday	5:30 AM	9:00 PM	31%	100%	63%
Friday	5:30 AM	9:00 PM	31%	100%	63%
Saturday	7:00 AM	11:00 PM	13%	100%	88%
Sunday	9:00 AM	11:00 PM	0%	88%	88%
Operating Percentage - Annual Total			24%	98%	70%
Annual Occupied Hours Per Period			704	2,868	2,034
Total Annual Occupied Hours			5,605	64%	

Annual Months Of Operation At Above Weekly Schedule:

Month	System	Heating
January	100%	100%
February	100%	100%
March	100%	100%
April	100%	100%
May	100%	100%
June	90%	90%
July	90%	90%
August	90%	90%
September	100%	100%
October	100%	100%
November	100%	100%
December	100%	100%

Johnson Controls, Inc.
Estimated Annual Energy Usage - Existing HVAC System And Controls

III. Pool HVAC Equipment Specifications And Operating Parameters (Continued)

Pool Enclosure Supply And Exhaust Fans - Design Fan Motor Data:

	Pool Enclosure Heating And Ventilating Unit Fans: Supply Fan #1	Pool Enclosure Exhaust Fans: Exhaust Fan #1
Motor Nameplate HP	10	10
Motor Design RPM (1800/3600)	1800	1800
Motor Type (ODP/TEFC)	ODP	ODP
Efficiency Level (S/H/P)	P	P
Estimated Load Factor	90%	90%
Fan Motor Full Load BHP	9.0	9.0
Motor Efficiency	90.0%	90.0%
VFD (Yes/No)	No	No
VFD Losses	0%	0%
Fan Motor Full Load Input kw	7.5	7.5
Fan Motor Minimum Input kw	1.5	1.5
Total Full Load Input kw:	7.5	7.5
Total Minimum Input kw (With VFD Control):	1.5	1.5

Unoccupied Operation - Minimum Space Airflow Setpoints:

Minimum % Of Design Ventilation Air	Minimum Percent Supply Air Volume	Minimum Percent Exhaust Air Volume	Occupied Minimum Percent Supply Air Volume
0%	20%	20%	75%

Estimated Pool Enclosure Heat Loss Parameters:

Existing H&V Unit - Total Space Heating Capacity:	82
Existing Radiant Heat - Total Space Heating Capacity:	147
Existing Systems - Total Space Heating Capacity:	229
Estimated Peak Load Factor:	80%
Estimated Peak Space Heating Load MBH:	183
Estimated Space Heating Balance Point OAT:	60 °F
Design Indoor Temperature:	86 °F
Design Outdoor Temperature:	-7 °F
Design Temperature Difference:	93 °F
Enclosure U*A Value:	1,967
Unoccupied Periods - Indoor Temperature:	75 °F

Outdoor Design Conditions:

Dover, NH	Dry Bulb	Wet Bulb	Moisture Level
Summer - ASHRAE .4%	90 °F	71 °F	85.3 Gr/Lb
Winter - ASHRAE 99.6%	-7 °F	-8 °F	1.9 Gr/Lb

Johnson Controls, Inc.
Estimated Annual Energy Usage - Existing HVAC System And Controls

IV. Estimated Annual Space Cooling Energy Use - Existing HVAC System And Controls (Continued)

Building: Building
HVAC System: Pool HVAC
Annual Time Period: All
Weather Data Location: Dover, NH

Outside Air Temp. Bangor Deg. F	Daily Time Period 4 PM To 12 AM System Hours	Pool Water Evaporation Rate Lbs/Hour	Total Fresh Air CFM	Mixed Air Temp.	Reheat MMBtu	Space Heating MMBtu	Supply And Return Fans: % Of Design System Airflow CFM	Supply And Return Fans: Average Total Input kW	Supply And Return Fans: Total kWh	Exhaust Fans: % Of Design System Airflow CFM	Exhaust Fans: Average Total Input kW	Exhaust Fans: Total kWh	System Total MMBtu	Fans Total kWh
95 / 99	0	160	11,913	95 °F	0	0	100%	7.5	0	100%	7.5	0	0	0
90 / 94	4	160	12,132	91 °F	0	0	100%	7.5	30	100%	7.5	30	0	60
85 / 89	14	160	9,094	87 °F	0	0	100%	7.5	104	100%	7.5	104	0	209
80 / 84	72	160	7,223	84 °F	2	0	100%	7.5	537	100%	7.5	537	2	1,074
75 / 79	97	160	6,183	82 °F	6	0	100%	7.5	724	100%	7.5	724	6	1,447
70 / 74	191	160	5,855	81 °F	17	0	100%	7.5	1,425	100%	7.5	1,425	17	2,850
65 / 69	211	160	5,486	79 °F	24	0	100%	7.5	1,574	100%	7.5	1,574	24	3,148
60 / 64	298	160	4,719	78 °F	36	0	100%	7.5	2,223	100%	7.5	2,223	36	4,446
55 / 59	249	160	3,988	78 °F	31	14	100%	7.5	1,858	100%	7.5	1,858	45	3,715
50 / 54	172	160	3,469	78 °F	22	12	100%	7.5	1,283	100%	7.5	1,283	33	2,566
45 / 49	211	160	3,125	78 °F	28	16	100%	7.5	1,574	100%	7.5	1,574	44	3,148
40 / 44	167	160	2,889	78 °F	23	14	100%	7.5	1,246	100%	7.5	1,246	37	2,492
35 / 39	272	160	2,731	77 °F	39	26	100%	7.5	2,029	100%	7.5	2,029	66	4,058
30 / 34	271	160	2,685	76 °F	42	29	100%	7.5	2,022	100%	7.5	2,022	71	4,043
25 / 29	230	160	2,685	75 °F	39	27	100%	7.5	1,716	100%	7.5	1,716	66	3,432
20 / 24	151	160	2,685	75 °F	28	19	100%	7.5	1,126	100%	7.5	1,126	47	2,253
15 / 19	142	160	2,685	74 °F	28	19	100%	7.5	1,059	100%	7.5	1,059	48	2,119
10 / 14	89	160	2,685	73 °F	19	13	100%	7.5	664	100%	7.5	664	32	1,328
5 / 9	43	160	2,685	72 °F	10	7	100%	7.5	321	100%	7.5	321	17	642
0 / 4	17	160	2,685	71 °F	4	3	100%	7.5	127	100%	7.5	127	7	254
-5 / -1	10	160	2,685	70 °F	3	2	100%	7.5	75	100%	7.5	75	4	149
-10 / -6	8	160	2,685	69 °F	2	1	100%	7.5	60	100%	7.5	60	4	119
-15 / -11	1	160	2,685	68 °F	0	0	100%	7.5	7	100%	0.0	0	0	7
-20 / -16	0	160	2,685	67 °F	0	0	100%	7.5	0	100%	7.5	0	0	0
	2,920	**466,470 Total Pounds**			**405**	**202**			**21,783**			**21,776**	**607**	**43,559**

Johnson Controls, Inc.
Estimated Annual Energy Usage - Existing HVAC System And Controls

IV. Estimated Annual Space Cooling Energy Use - Existing HVAC System And Controls (Continued)

Building: Building
HVAC System: Pool HVAC
Annual Time Period: All
Weather Data Location: Dover, NH

Outside Air Temp. Bangor Deg. F	Daily Time Period All Unocc. Hours System Hours	Pool Water Evaporation Rate Lbs/Hour	Total Fresh Air CFM	Reheat MMBtu	Space Heating MMBtu	Supply And Return Fans: % Of Design System Airflow CFM	Supply And Return Fans: Average Total Input kW	Supply And Return Fans: Total kWh	Exhaust Fans: % Of Design System Airflow CFM	Exhaust Fans: Average Total Input kW	Exhaust Fans: Total kWh	System Total MMBtu	Fans Total kWh
95 / 99	0	13	953	0	0	100%	7.5	0	100%	7.5	0	0	0
90 / 94	1	13	971	0	0	100%	7.5	7	100%	7.5	7	0	15
85 / 89	4	13	727	0	0	100%	7.5	26	100%	7.5	26	0	52
80 / 84	19	13	578	0	0	100%	7.5	144	100%	7.5	144	0	287
75 / 79	30	13	495	0	0	100%	7.5	223	100%	7.5	223	0	446
70 / 74	78	13	468	1	0	100%	7.5	585	100%	7.5	585	1	1,169
65 / 69	153	13	439	1	0	100%	7.5	1,144	100%	7.5	1,144	1	2,288
60 / 64	262	13	377	3	0	100%	7.5	1,955	100%	7.5	1,955	3	3,909
55 / 59	241	13	319	2	14	100%	7.5	1,798	100%	7.5	1,798	16	3,596
50 / 54	186	13	277	2	12	100%	7.5	1,384	100%	7.5	1,384	14	2,768
45 / 49	178	13	250	2	14	100%	7.5	1,331	100%	7.5	1,331	16	2,661
40 / 44	149	13	231	2	13	100%	7.5	1,113	100%	7.5	1,113	15	2,227
35 / 39	251	13	219	3	24	100%	7.5	1,873	100%	7.5	1,873	27	3,747
30 / 34	252	13	209	3	27	100%	7.5	1,881	100%	7.5	1,881	30	3,762
25 / 29	206	13	201	3	24	100%	7.5	1,534	100%	7.5	1,534	26	3,068
20 / 24	164	13	195	2	21	100%	7.5	1,223	100%	7.5	1,223	23	2,447
15 / 19	147	13	191	2	20	100%	7.5	1,095	100%	7.5	1,095	22	2,190
10 / 14	79	13	187	1	12	100%	7.5	590	100%	7.5	590	13	1,181
5 / 9	45	13	184	1	7	100%	7.5	337	100%	7.5	337	8	673
0 / 4	42	13	182	1	7	100%	7.5	316	100%	7.5	316	8	632
-5 / -1	28	13	182	0	5	100%	7.5	205	100%	7.5	205	5	410
-10 / -6	27	13	183	1	5	100%	7.5	201	100%	7.5	201	5	403
-15 / -11	7	13	182	0	1	100%	7.5	53	100%	7.5	53	2	106
-20 / -16	6	13	182	0	1	100%	7.5	42	100%	7.5	42	1	84
	2,555	**32,653 Total Pounds**		**29**	**206**			**19,060**			**19,060**	**235**	**38,121**

HVAC System Analysis - Pool Cover
Estimated Annual Energy Usage - Proposed HVAC System And Controls

		Proposed	
Building: Building			
Unit #: Pool HVAC	Pool Enclosure Occupied Based On Schedule	Y	*Y = Yes, N = No*
Area Served: Pool Enclosure	Manual Or Automatic Pool Covers	Y	*Y = Included, N = Not Included*
System Type: SZCV	Fan Motor Efficiency Levels	P	*S = Standard, H = High, P = Premium*
Annual Time Period: All	Fan Control Strategy For Unoccupied Periods	Y	*Y = Included, N = Not Included*
	Unoccupied Periods - Supply/Return Fan Control	V	*C = Cycling, V = VFD*
	Unoccupied Periods - Exhaust Fan Control	V	*C = Cycling, V = VFD*
	Temperature Setback For Unoccupied Periods	Y	*Y = Included, N = Not Included*

Summary Of Estimated Annual Energy Usage **Existing HVAC Systems With Proposed Pool Cover And VFD's And Controls**	**Daily Time Period**	**System Mode**	**Fans Total Annual kWh**	**Heating Total Annual MMBtu**	**Pool Water Heating Annual MMBtu**	**Total Annual MMBtu**	**Pool Makeup Water kGal**
	12 M - 8 AM	Occupied	31,931	610	502	1,112	56
	8 AM - 4 PM	Occupied	31,999	522	602	1,124	67
	4 PM - 12 AM	Occupied	31,927	534	502	1,036	56
	All	Unoccupied	7,860	125	35	161	4
		Totals	**103,716**	**1,792**	**1,641**	**3,434**	**183**

HVAC System Analysis - Pool Cover
Estimated Annual Energy Usage - Proposed HVAC System And Controls

VII. Estimated Annual Energy Use - Proposed HVAC System And Controls

Building:	Building
HVAC System:	*Pool HVAC*
Annual Time Period:	*All*
Weather Data Location:	Dover, NH

Outside Air Temp. Bangor Deg. F	**Daily Time Period 12 AM To 8 AM System Hours**	**Pool Water Evaporation Rate Lbs/Hour**	**Total Fresh Air CFM**	**Mixed Air Temp.**	**Reheat MMBtu**	**Space Heating MMBtu**	**Supply And Return Fans: % Of Design System Airflow CFM**	**Supply And Return Fans: Average Total Input kW**	**Supply And Return Fans: Total kWh**	**Exhaust Fans: % Of Design System Airflow CFM**	**Exhaust Fans: Average Total Input kW**	**Exhaust Fans: Total kWh**	**System Total MMBtu**	**Fans Total kWh**
95 / 99	0	160	11,913	95 °F	0	0	79%	3.9	0	100%	7.7	0	0	0
90 / 94	0	160	12,132	91 °F	0	0	81%	4.1	0	100%	7.7	0	0	0
85 / 89	0	160	9,094	87 °F	0	0	75%	3.2	0	100%	7.7	0	0	0
80 / 84	2	160	7,223	84 °F	0	0	75%	3.2	6	100%	7.7	15	0	22
75 / 79	9	160	6,183	82 °F	1	0	75%	3.2	29	100%	7.7	69	1	98
70 / 74	49	160	5,855	81 °F	4	0	75%	3.2	159	100%	7.7	377	4	536
65 / 69	161	160	5,486	79 °F	18	0	75%	3.2	522	100%	7.7	1,238	18	1,761
60 / 64	300	160	4,719	78 °F	37	0	75%	3.2	973	100%	7.7	2,307	37	3,281
55 / 59	286	160	3,988	78 °F	36	10	75%	3.2	928	100%	7.7	2,200	46	3,127
50 / 54	228	160	3,469	78 °F	29	10	75%	3.2	740	100%	7.7	1,753	39	2,493
45 / 49	201	160	3,125	78 °F	26	10	75%	3.2	652	100%	7.7	1,546	36	2,198
40 / 44	172	160	2,889	78 °F	24	10	75%	3.2	558	100%	7.7	1,323	33	1,881
35 / 39	293	160	2,731	77 °F	42	18	75%	3.2	951	100%	7.7	2,253	60	3,204
30 / 34	295	160	2,685	76 °F	46	20	75%	3.2	957	100%	7.7	2,269	66	3,226
25 / 29	237	160	2,685	75 °F	41	18	75%	3.2	769	100%	7.7	1,823	58	2,592
20 / 24	202	160	2,685	75 °F	37	16	75%	3.2	655	100%	7.7	1,554	54	2,209
15 / 19	178	160	2,685	74 °F	36	15	75%	3.2	578	100%	7.7	1,369	51	1,946
10 / 14	91	160	2,685	73 °F	20	8	75%	3.2	295	100%	7.7	700	28	995
5 / 9	55	160	2,685	72 °F	13	5	75%	3.2	178	100%	7.7	423	18	601
0 / 4	61	160	2,685	71 °F	15	6	75%	3.2	198	100%	7.7	469	21	667
-5 / -1	40	160	2,685	70 °F	10	4	75%	3.2	130	100%	7.7	308	15	437
-10 / -6	40	160	2,685	69 °F	11	5	75%	3.2	130	100%	7.7	308	16	437
-15 / -11	11	160	2,685	68 °F	3	1	75%	3.2	36	100%	7.7	85	5	120
-20 / -16	9	160	2,685	67 °F	3	1	75%	3.2	29	100%	7.7	69	4	98
	2,920	**466,470 Total Pounds**			**451**	**160**			**9,474**			**22,457**	**610**	**31,931**

HVAC System Analysis - Pool Cover
Estimated Annual Energy Usage - Proposed HVAC System And Controls

V. Pool Data And Calculated Evaporation Rates

Pool Data And Calculated Evaporation Rates:

Pool Enclosure Air Conditions	Pool #	Pool Usage	Pool Area - SF	Pool Water Temp.	Total Evaporation Rates: Lbs/Hr Still Water	Total Evaporation Rates: Lbs/Hour With Activity	Total Evaporation Rates: Lbs/Hour With Pool Covered	Maximum Activity Factor	Percent Evaporation With Pool Cover In Place
86 °F 60% RH	1	General	4,500	84 °F	128	128	13	1	10%
		Totals	**4,500**		**128**	**128**	**13**		

Estimated Pool Water Evaporation Rates By Daily Time Period

	Estimated Activity Level	Evaporation Rate Lbs/Hr
12 M To 8 AM	1.25	160
8 AM To 4 PM	1.5	192
4 PM To 12 M	1.25	160
(For Occupied Hours Only)		

Pool Water Heating Parameters:

Estimated Average City Water Temperature:	55 °F
Weighted Average Pool Makeup Water Temperature:	84 °F
Pool Water Heater Efficiency:	83%
(AO Smith Burkay Legend Boilers)	

Ventilation Air Requirements:

Total Pool Area - Square Feet:	4,500	Observation Area - Square Feet:	0
Total Wet Deck Area - Square Feet:	870	Observation Area - # SF Per Person:	6.67
Total Pool And Wet Deck Area - Square Feet:	5,370	Observation Area - Total # People:	0
Fresh Air CFM Per Square Foot:	0.50	Fresh Air CFM Per Person:	10
Fresh Air CFM Required For Pool/Wet Deck Area:	2,685	Fresh Air CFM Required For Observation Area:	0
Total Design Minimum Fresh Air CFM:	2,685	*(Occupied Hours Only)*	

HVAC System Analysis - Pool Cover
Estimated Annual Energy Usage - Proposed HVAC System And Controls

VII. Estimated Annual Space Cooling Energy Use - Proposed HVAC System And Controls (Continued)

Building:	Building
HVAC System:	Pool HVAC
Annual Time Period:	All
Weather Data Location:	Dover, NH

Outside Air Temp. Bangor Deg. F	**Daily Time Period 8 AM To 4 PM System Hours**	**Pool Water Evaporation Rate Lbs/Hour**	**Total Fresh Air CFM**	**Mixed Air Temp.**	**Reheat MMBtu**	**Space Heating MMBtu**	**Supply And Return Fans: % Of Design System Airflow CFM**	**Supply And Return Fans: Average Total Input kW**	**Supply And Return Fans: Total kWh**	**Exhaust Fans: % Of Design System Airflow CFM**	**Exhaust Fans: Average Total Input kW**	**Exhaust Fans: Total kWh**	**System Total MMBtu**	**Fans Total kWh**
95 / 99	0	192	14,296	96 °F	0	0	95%	6.7	0	100%	7.7	0	0	0
90 / 94	18	192	14,558	92 °F	0	0	97%	7.0	127	100%	7.7	138	0	265
85 / 89	62	192	10,912	87 °F	0	0	75%	3.2	201	100%	7.7	477	0	678
80 / 84	207	192	8,667	84 °F	8	0	75%	3.2	672	100%	7.7	1,592	8	2,264
75 / 79	224	192	7,419	82 °F	16	0	75%	3.2	727	100%	7.7	1,723	16	2,449
70 / 74	253	192	7,026	79 °F	27	0	75%	3.2	821	100%	7.7	1,946	27	2,767
65 / 69	216	192	6,583	78 °F	29	0	75%	3.2	701	100%	7.7	1,661	29	2,362
60 / 64	264	192	5,662	77 °F	39	0	75%	3.2	857	100%	7.7	2,030	39	2,887
55 / 59	171	192	4,785	77 °F	26	6	75%	3.2	555	100%	7.7	1,315	32	1,870
50 / 54	183	192	4,162	77 °F	28	8	75%	3.2	594	100%	7.7	1,407	36	2,001
45 / 49	168	192	3,750	76 °F	27	8	75%	3.2	545	100%	7.7	1,292	35	1,837
40 / 44	160	192	3,467	76 °F	26	9	75%	3.2	519	100%	7.7	1,231	35	1,750
35 / 39	237	192	3,278	75 °F	41	15	75%	3.2	769	100%	7.7	1,823	56	2,592
30 / 34	251	192	3,142	75 °F	46	17	75%	3.2	814	100%	7.7	1,930	63	2,745
25 / 29	189	192	3,008	74 °F	36	14	75%	3.2	613	100%	7.7	1,454	50	2,067
20 / 24	116	192	2,919	74 °F	23	9	75%	3.2	376	100%	7.7	892	33	1,268
15 / 19	111	192	2,858	73 °F	24	10	75%	3.2	360	100%	7.7	854	33	1,214
10 / 14	41	192	2,809	72 °F	9	4	75%	3.2	133	100%	7.7	315	13	448
5 / 9	21	192	2,765	71 °F	5	2	75%	3.2	68	100%	7.7	162	7	230
0 / 4	15	192	2,737	71 °F	4	2	75%	3.2	49	100%	7.7	115	5	164
-5 / -1	6	192	2,737	70 °F	2	1	75%	3.2	19	100%	7.7	46	2	66
-10 / -6	5	192	2,741	69 °F	1	1	75%	3.2	16	100%	7.7	38	2	55
-15 / -11	2	192	2,730	68 °F	1	0	75%	3.2	6	100%	7.7	15	1	22
-20 / -16	0	192	2,728	67 °F	0	0	75%	3.2	0	100%	7.7	0	0	0
	2,920	**559,764 Total Pounds**			**417**	**105**			**9,542**			**22,457**	**522**	**31,999**

HVAC System Analysis - Pool Cover
Estimated Annual Energy Usage - Proposed HVAC System And Controls

VI. Pool HVAC Equipment Specifications And Operating Parameters

Indoor And Outdoor Design Conditions:

OA	DB	MCWB	Enthalpy	Moisture
Conditions	90 °F	71 °F	34.7 Btu/Lb	83.3 Gr/Lb
Space	DB	RH	Enthalpy	Moisture
Conditions	86 °F	60% RH	38.6 Btu/Lb	114 Gr/Lb

Existing Heating & Ventilating Units - Design Airflow And Heating Data:

Quantity: 1

	Per Unit	Total
Total Supply Air CFM:	15,000	15,000
Estimated Minimum Fresh Air CFM:	3,000	3,000
Heating Coil Total Capacity MBH:	448	448
Design Discharge Air Temperature:	120 °F	- - -
Estimated MBH To Heat Fresh Air:	301	301
Estimated Space Heating Capacity - MBH:	147	147

Daily/Weekly Occupancy Schedule:

			Percent Occupied Times By Daily Time Period		
Weekday	Start	End	12 AM To 8 AM	8 AM To 4 PM	4 PM To 12 AM
Monday	5:30 AM	9:00 PM	31%	100%	63%
Tuesday	5:30 AM	9:00 PM	31%	100%	63%
Wednesday	5:30 AM	9:00 PM	31%	100%	63%
Thursday	5:30 AM	9:00 PM	31%	100%	63%
Friday	5:30 AM	9:00 PM	31%	100%	63%
Saturday	7:00 AM	11:00 PM	13%	100%	88%
Sunday	9:00 AM	11:00 PM	0%	88%	88%
Operating Percentage - Annual Total			24%	98%	70%
Annual Occupied Hours Per Period			704	2,868	2,034
Total Annual Occupied Hours			5,605	64%	

Annual Months Of Operation At Above Weekly Schedule:

Month	System	Heating
January	100%	100%
February	100%	100%
March	100%	100%
April	100%	100%
May	100%	100%
June	90%	90%
July	90%	90%
August	90%	90%
September	100%	100%
October	100%	100%
November	100%	100%
December	100%	100%

HVAC System Analysis - Pool Cover
Estimated Annual Energy Usage - Proposed HVAC System And Controls

VII. Estimated Annual Space Cooling Energy Use - Proposed HVAC System And Controls (Continued)

Building:	Building
HVAC System:	Pool HVAC
Annual Time Period:	All
Weather Data Location:	Dover, NH

							Supply And Return Fans			Exhaust Fans			
Outside Air Temp. Bangor Deg. F	Daily Time Period 4 PM To 12 AM System Hours	Pool Water Evaporation Rate Lbs/Hour	Total Fresh Air CFM	Mixed Air Temp.	Reheat MMBtu	Space Heating MMBtu	% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	Total kWh	System Total MMBtu
95 / 99	0	160	11,913	95 °F	0	0	79%	3.9	0	100%	7.7	0	0
90 / 94	4	160	12,132	91 °F	0	0	81%	4.1	16	100%	7.7	31	0
85 / 89	14	160	9,094	87 °F	0	0	75%	3.2	45	100%	7.7	108	0
80 / 84	72	160	7,223	84 °F	2	0	75%	3.2	234	100%	7.7	554	2
75 / 79	97	160	6,183	82 °F	6	0	75%	3.2	315	100%	7.7	746	6
70 / 74	191	160	5,855	81 °F	17	0	75%	3.2	620	100%	7.7	1,469	17
65 / 69	211	160	5,486	79 °F	24	0	75%	3.2	685	100%	7.7	1,623	24
60 / 64	298	160	4,719	78 °F	36	0	75%	3.2	967	100%	7.7	2,292	36
55 / 59	249	160	3,988	78 °F	31	9	75%	3.2	808	100%	7.7	1,915	40
50 / 54	172	160	3,469	78 °F	22	7	75%	3.2	558	100%	7.7	1,323	29
45 / 49	211	160	3,125	78 °F	28	10	75%	3.2	685	100%	7.7	1,623	38
40 / 44	167	160	2,889	78 °F	23	9	75%	3.2	542	100%	7.7	1,284	32
35 / 39	272	160	2,731	77 °F	39	17	75%	3.2	883	100%	7.7	2,092	56
30 / 34	271	160	2,685	76 °F	42	18	75%	3.2	879	100%	7.7	2,084	61
25 / 29	230	160	2,685	75 °F	39	17	75%	3.2	746	100%	7.7	1,769	56
20 / 24	151	160	2,685	75 °F	28	12	75%	3.2	490	100%	7.7	1,161	40
15 / 19	142	160	2,685	74 °F	28	12	75%	3.2	461	100%	7.7	1,092	41
10 / 14	89	160	2,685	73 °F	19	8	75%	3.2	289	100%	7.7	684	27
5 / 9	43	160	2,685	72 °F	10	4	75%	3.2	140	100%	7.7	331	14
0 / 4	17	160	2,685	71 °F	4	2	75%	3.2	55	100%	7.7	131	6
-5 / -1	10	160	2,685	70 °F	3	1	75%	3.2	32	100%	7.7	77	4
-10 / -6	8	160	2,685	69 °F	2	1	75%	3.2	26	100%	7.7	62	3
-15 / -11	1	160	2,685	68 °F	0	0	75%	3.2	3	100%	0.0	0	0
-20 / -16	0	160	2,685	67 °F	0	0	75%	3.2	0	100%	7.7	0	0
	2,920	**466,470 Total Pounds**			**405**	**130**			**9,477**			**22,449**	**534**

HVAC System Analysis - Pool Cover
Estimated Annual Energy Usage - Proposed HVAC System And Controls

VI. Pool HVAC Equipment Specifications And Operating Parameters (Continued)

Pool Enclosure Supply And Exhaust Fans - Design Fan Motor Data:

	Pool Enclosure Heating And Ventilating Unit Fans: Supply Fan #1	Pool Enclosure Exhaust Fans: Exhaust Fan #1
Motor Nameplate HP	10	10
Motor Design RPM (1800/3600)	1800	1800
Motor Type (ODP/TEFC)	ODP	ODP
Efficiency Level (S/H/P)	P	P
Estimated Load Factor	90%	90%
Fan Motor Full Load BHP	9.0	9.0
Motor Efficiency	90.0%	90.0%
VFD (Yes/No)	Yes	Yes
VFD Losses	3%	3%
Fan Motor Full Load Input kw	7.7	7.7
Fan Motor Minimum Input kw	1.5	1.5
Total Full Load Input kw:	7.7	7.7
Total Minimum Input kw (With VFD Control):	1.5	1.5

Unoccupied Operation - Minimum Space Airflow Setpoints:

Minimum % Of Design Ventilation Air	Minimum Percent Supply Air Volume	Minimum Percent Exhaust Air Volume
0%	20%	20%

Estimated Pool Enclosure Heat Loss Parameters:

Existing H&V Units - Total Space Heating Capacity:	147
Estimated Peak Load Factor:	80%
Estimated Peak Space Heating Load MBH:	117
Estimated Space Heating Balance Point OAT:	60 °F
Design Indoor Temperature:	86 °F
Design Outdoor Temperature:	-7 °F
Design Temperature Difference:	93 °F
Enclosure U*A Value:	1,262
Unoccupied Periods - Indoor Temperature:	75 °F

Outdoor Design Conditions:

Dover, NH	Dry Bulb	Wet Bulb	Moisture Level
Summer - ASHRAE .4%	90 °F	71 °F	85.3 Gr/Lb
Winter - ASHRAE 99.6%	-7 °F	-8 °F	1.9 Gr/Lb

HVAC System Analysis - Pool Cover
Estimated Annual Energy Usage - Proposed HVAC System And Controls

Estimated Annual Space Cooling Energy Use - Proposed HVAC System And Controls (Continued)

Building:	Building
HVAC System:	Pool HVAC
Annual Time Period:	All
Weather Data Location:	Dover, NH

						Supply And Return Fans			Exhaust Fans				
Outside Air Temp. Bangor Deg. F	Daily Time Period All Unocc. Hours System Hours	Pool Water Evaporation Rate Lbs/Hour	Total Fresh Air CFM	Reheat MMBtu	Space Heating MMBtu	% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	Total kWh	System Total MMBtu	Fans Total kWh
95 / 99	0	13	953	0	0	20%	1.5	0	20%	1.5	0	0	0
90 / 94	1	13	971	0	0	20%	1.5	2	20%	1.5	2	0	3
85 / 89	4	13	727	0	0	20%	1.5	5	20%	1.5	5	0	11
80 / 84	19	13	578	0	0	20%	1.5	30	20%	1.5	30	0	59
75 / 79	30	13	495	0	0	20%	1.5	46	20%	1.5	46	0	92
70 / 74	78	13	468	0	0	20%	1.5	121	20%	1.5	121	0	241
65 / 69	153	13	439	1	0	20%	1.5	236	20%	1.5	236	1	472
60 / 64	262	13	377	1	0	20%	1.5	403	20%	1.5	403	1	806
55 / 59	241	13	319	1	5	20%	1.5	371	20%	1.5	371	7	741
50 / 54	186	13	277	1	5	20%	1.5	285	20%	1.5	285	7	571
45 / 49	178	13	250	1	6	20%	1.5	274	20%	1.5	274	8	549
40 / 44	149	13	231	1	6	20%	1.5	230	20%	1.5	230	7	459
35 / 39	251	13	219	2	12	20%	1.5	386	20%	1.5	386	14	773
30 / 34	252	13	209	2	14	20%	1.5	388	20%	1.5	388	16	776
25 / 29	206	13	201	2	12	20%	1.5	316	20%	1.5	316	15	633
20 / 24	164	13	195	2	11	20%	1.5	252	20%	1.5	252	13	505
15 / 19	147	13	191	2	11	20%	1.5	226	20%	1.5	226	12	451
10 / 14	79	13	187	1	6	20%	1.5	122	20%	1.5	122	7	243
5 / 9	45	13	184	1	4	20%	1.5	69	20%	1.5	69	4	139
0 / 4	42	13	182	1	4	20%	1.5	65	20%	1.5	65	5	130
-5 / -1	28	13	182	0	3	20%	1.5	42	20%	1.5	42	3	85
-10 / -6	27	13	183	0	3	20%	1.5	42	20%	1.5	42	3	83
-15 / -11	7	13	182	0	1	20%	1.5	11	20%	1.5	11	1	22
-20 / -16	6	13	182	0	1	20%	1.5	9	20%	1.5	9	1	17
	2,555	**32,653 Total Pounds**		**21**	**104**			**3,930**			**3,930**	**125**	**7,860**

Title	**Water Conservation**
Date	**February 1, 2009**
District	**Dover, NH**
School	**Dover Indoor Pool**

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr				$0
kW				
MMBtu/yr			37	$528
kGal/yr	487	272	215	$2,379
Total				$2,907

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	8	50
% Year Round Occupancy	66%	100%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	18	50
Total Flushes Per Day (Less Urinal Flushes)	18	49
% Men	35%	40%
Total Men	2	20
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	2%	2%
Total Flushes per Day to Urinals	0.3	1.0
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	8	20
%Taking Showers	35%	1
Shower (Minutes/Day/Person)	8.00	8.00
Total Shower Usage (Minutes/Day)	15	400
Total Number of Toilets	0	5
Total Number of Urinals	0	1
Total Number of Sinks	0	6
Total Number of Showers	0	18
Total Number of Toilets to be Retrofitted	0	5
Total Number of Urinals to be Retrofitted	0	1
Total Number of Sinks to be Retrofitted	0	6
Total Number of Showers to be Retrofitted	0	18
% Toilets Being Retrofitted	100%	
% Urinals Being Retrofitted	0%	100%
% Sinks Being Retrofitted	0%	100%
% Showers Being Retrofitted	0%	100%

Input and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$14.4
Average Cold Water Temp, (^{o}F)	55
Boiler Efficiency (%)	83%

Formulas & Assumptions:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.
2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person
3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.
4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.
5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.
6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].
7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	365	365

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
Use Type	Fixture Type	Baseline	Estimated	Baseline	Estimated	Baseline	Estimated	Water Estimated	Fuel Estimated	Water Estimated	Fuel Estimated
		Flushes/Day, Min/Day		(gpf, gpm)		(gal/yr)	(gal/yr)	(gal/yr)	(MMBtu/yr)	($/yr)	($/yr)
Staff	Toilet	18	18	3.5	1.6	23,078	10,550	12,528	-	138	-
	Urinal	0	0	1.5	1.0	176	117	59	-	1	-
	Sink	8	8	2.2	0.5	6,328	1,438	4,889	1.1	54	15
	Showers	15	15	2.5	1.5	13,422	8,053	5,369	1.2	59	17
Visitors	Toilet	49	49	3.5	1.6	62,598	28,616	33,982	-	375	-
	Urinal	1	1	1.5	1.0	548	365	183	-	2	-
	Sink	20	20	2.2	0.5	16,060	3,650	12,410	3	137	-
	Showers	400	400	2.5	1.5	365,000	219,000	146,000	32	1,612	-

Title	**Vending Machine Controls**
Date	**February 1, 2009**
District	**Dover, NH**
School	**Dover Indoor Pool**

Summary	Existing	Proposed	Savings	Savings
kWh/yr	3,262	1,764	1,498	$157
kW			0	
MMBtu/yr	0	0	0	$0
Total				$157

$/kW	**$8.82**
$/kWh	**$0.10**
$/MMBtu	**$14.37**

Input Data:

Vending Machine Information

									Existing Operation		Compressor Duty Cycle		Machine Location is Occupied		Number of Controllers Required	
Site:	$ / kWh	Room	Type	Qty.	Volts	Amps	Lighting * Watts/ unit	Lighting Found	Hrs/Day	Days/Yr.	Existing Normal	Proposed Nite	Hrs/Day	Days/Yr.	Beverage	Snack
Dover Indoor Pool	$ 0.10	Registration Area	Vending Machine	1	115	10.5	80	On	24	365	33%	12.0%	8	365	0	0
Dover Indoor Pool	$ 0.10														0	0
Dover Indoor Pool	$ 0.10														0	0
Dover Indoor Pool	$ 0.10														0	0
Dover Indoor Pool	$ 0.10														0	0
Dover Indoor Pool	$ 0.10														0	0
Dover Indoor Pool	$ 0.10														0	0
Dover Indoor Pool	$ 0.10														0	0
Dover Indoor Pool	$ 0.10														0	0
Dover Indoor Pool	$ 0.10														0	0
			Totals:				* Lighting watts is included in the volt / amp data and Total kW								0	0

Calculations & Output Data:

	Lighting Savings							**Compressor Savings**							
Site		Ltg. Watts	Existing Hrs/Yr.	Existing Hrs/Yr.	Existing Lighting kWh/yr.	Proposed Lighting kWh/Yr.	Lighting Savings kwh	Comp. kW	Present Hrs/Yr.	Proposed Hrs/Yr.	Existing Compressor kWh/yr.	Proposed kWh/Yr.	Comp. Savings kwh	Total Savings kwh	$
Dover Indoor Pool	Vending Machine	80	8,760	3,621	701	290	411	0.886	2,891	1,664	2,561	1,475	1,087	1,498	$ 157
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Indoor Pool	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
					701	290	411				2,561	1,475	1,087	**1,498**	**$ 157**

Methodology & Summary: **Assumptions and Formulae:**

Present Electricity Use = Lighting (kWh) + Compressor (kWh)

Lighting kWh =Lighting Watts / 1000 x # units x Hours per Day x Days per Year

Compressor kWh = (Volts x Amps x 0.80 power factor / 1000 - Lighting Watts) x # units x Hours per Day x Days per Year x Duty Cycle

Proposed Electricity Use = Lighting kWh with Control + Compressor kWh with Control

Lighting kWh with Control = Lighting watts per unit /1000 x # units x (Occupied Hours per Year + Unoccupied Hours x Nite Duty Cycle)

Proposed Compressor Run Hours = (Occupied Hours x Existing Duty Cycle) + (Unoccupied Hours x Unoccupied Duty Cycle)

Compressor kWh with Control = (Volts x Amps x 0.80 PF -Lighting Watts) / 1000 x # Units x Proposed Compressor Hours per Year

Electricity Cost Savings = Electricity Savings x Electricity Unit Cost

	Lighting	Comp.	Total		
	701	2,561	3,262	kWh	
Proposed Annual Electricity Use:	290	1,475	1,764	kWh	
Total Annual Savings:	411	1,087	1,498	kWh	$ 157
			46% reduction		

Title	**Pool Covers**
Date	**February 1, 2009**
District	**Dover, NH**
School	**Dover Indoor Pool**

Summary	Existing	Proposed	Savings	Savings
kWh/yr			46,656	$4,875
kW				
MMBtu/yr			560	$8,046
Total				$13,632

$/kW	**$8.82**
$/kWh	**$0.10**
$/MMBtu	**$14.37**

Input

Existing Condition

Amb. Temp Bin deg. F (Hartford, CT)	Ave Temp deg. F	M.C.W.B deg. F	Total Bin Hours	Occupied On-Peak Hours	Un Occupied On Peak Hours	Occupied Off-Peak Hours	Un Occupied Off Peak Hours	Occupied Evaporative Load (LB/H)	Un-Occupied Evaporative Load (LB/H)	Occupied Evaporative Load (MBH)	Un-Occupied Evaporative Load (MBH)	Occupied Evaporation Heat Loss (MBTU)	Un-Occupied Evaporation Heat Loss (MBTU)	Occupied Dehumidification on Load (tons)	Occupied Dehumidification Energy Consumption (kWh)	Un-Occupied Dehumidification on Load (tons)	Un-Occupied Dehumidification Energy Consumption (kWh)
A	**B**	**C**	**D**														
Cooling																	
95-100	97.5	72.0	3	2	-	-	1	224	224	234	234	(489)	(213)	19.5	41	19.5	18
90-95	92.5	71.0	31	22	-	-	9	224	224	234	234	(5,056)	(2,204)	19.5	421	19.5	184
85-90	87.5	69.0	112	78	-	-	34	224	224	234	234	(18,265)	(7,962)	19.5	1522	19.5	663
80-85	82.5	68.0	258	180	-	-	78	224	224	234	234	(42,075)	(18,340)	19.5	3506	19.5	1528
75-80	77.5	66.0	409	285	-	-	124	224	224	234	234	(66,700)	(29,075)	19.5	5558	19.5	2423
70-75	72.5	63.0	617	430	-	-	187	224	224	234	234	(100,621)	(43,861)	19.5	8385	19.5	3655
65-70	67.5	59.0	732	510	-	-	222	224	224	234	234	(119,376)	(52,036)	19.5	9948	19.5	4336
60-65	62.5	55.0	706	492	-	-	214	224	224	234	234	(115,136)	(50,187)	19.5	9595	19.5	4182
Heating				-													
55-60	57.5	50.0	710	494	-	-	216	224	224	234	234	(115,788)	(50,472)	19.5	9649	19.5	4206
50-55	52.5	45.0	678	472	-	-	206	224	224	234	234	(110,569)	(48,197)	19.5	9214	19.5	4016
45-50	47.5	41.0	616	429	-	-	187	224	224	234	234	(100,458)	(43,790)	19.5	8372	19.5	3649
40-45	42.5	37.0	676	471	-	-	205	224	224	234	234	(110,243)	(48,055)	19.5	9187	19.5	4005
35-40	37.5	32.0	771	537	-	-	234	224	224	234	234	(125,736)	(54,808)	19.5	10478	19.5	4567
30-35	32.5	27.0	825	575	-	-	250	224	224	234	234	(134,542)	(58,647)	19.5	11212	19.5	4887
25-30	27.5	22.0	565	393	-	-	172	224	224	234	234	(92,141)	(40,164)	19.5	7678	19.5	3347
20-25	22.5	17.0	388	270	-	-	118	224	224	234	234	(63,276)	(27,582)	19.5	5273	19.5	2298
15-20	17.5	13.0	269	187	-	-	82	224	224	234	234	(43,869)	(19,122)	19.5	3656	19.5	1594
10-15	12.5	8.0	178	124	-	-	54	224	224	234	234	(29,029)	(12,653)	19.5	2419	19.5	1054
5-10	5.5	4.0	106	74	-	-	32	224	224	234	234	(17,287)	(7,535)	19.5	1441	19.5	628
0-5	2.5	1.0	101	70	-	-	31	224	224	234	234	(16,471)	(7,180)	19.5	1373	19.5	598
			8751									-1427129	-622082	390	118927	390	51840

-2049210

Proposed

Occupied Evaporation Load (LB/H)	Un-Occupied Evaporation Load (LB/H)	Occupied Evaporation Load (MBH)	Un-Occupied Evaporation Load (MBH)	Occupied Evaporation Heat Loss (MBTU)	Un-Occupied Evaporation Heat Loss (MBTU)	Occupied De-humidification on Load (tons)	Occupied De-humidification Energy Consumption (kWh)	Un-Occupied De-humidification on Load (tons)	Un-Occupied Dehumidification Energy Consumption (kWh)
224	22	234	23	(489.25)	(21.33)	19.5	41	2.0	2
224	22	234	23	(5,055.54)	(220.37)	19.5	421	2.0	18
224	22	234	23	(18,265.16)	(796.17)	19.5	1522	2.0	66
224	22	234	23	(42,075.10)	(1,834.04)	19.5	3506	2.0	153
224	22	234	23	(66,700.45)	(2,907.46)	19.5	5558	2.0	242
224	22	234	23	(100,621.46)	(4,386.06)	19.5	8385	2.0	366
224	22	234	23	(119,375.86)	(5,203.56)	19.5	9948	2.0	434
224	22	234	23	(115,135.74)	(5,018.74)	19.5	9595	2.0	418
224	22	234	23	-	-	-	0	0.0	0
224	22	234	23	(115,788.06)	(5,047.17)	19.5	9649	2.0	421
224	22	234	23	(110,569.45)	(4,819.69)	19.5	9214	2.0	402
224	22	234	23	(100,458.38)	(4,378.95)	19.5	8372	2.0	365
224	22	234	23	(110,243.28)	(4,805.48)	19.5	9187	2.0	400
224	22	234	23	(125,736.05)	(5,480.80)	19.5	10478	2.0	457
224	22	234	23	(134,542.47)	(5,864.67)	19.5	11212	2.0	489
224	22	234	23	(92,141.21)	(4,016.41)	19.5	7678	2.0	335
224	22	234	23	(63,275.73)	(2,758.17)	19.5	5273	2.0	230
224	22	234	23	(43,869.00)	(1,912.24)	19.5	3656	2.0	159
224	22	234	23	(29,028.56)	(1,265.35)	19.5	2419	2.0	105
224	22	234	23	(17,286.67)	(753.52)	19.5	1441	2.0	63
224	22	234	23	(16,471.26)	(717.98)	19.5	1373	2.0	60
4696	470	4918	492	-1427129	-62208	390	118927	39	5184

-1489337 Post Retro kwh 124111

Assumptions	Value	Unit
Pool Area (Length x Width)	4437	SF
Pool Length		Length
Pool Width		Width
Activity Factor (Ashrae 1999 Applications p. 4.6)	0.8	
Air Temperature	85	F
Relative Humidity	50%	
Water Temperature	82	F
Sat Pressure at Room Air Dew Point (Psychometrics)	0.62	in. Hg
Sat Vapor Pressure at Surface Water Temp	1.25	in. Hg
Enthalpy of Evaporation	1047.15	btu/lb
Overall Heating Plant Efficiency	83%	
Redution in Pool Evaporation Due to Cover	90%	
EER of Pool Dehumidification Unit	12.0	
General pool hours are from 8:00 AM - 8:00 PM, Thu-Tues	117	Hours/Week

mbtu Saved		559,874
mmBtu's Saved		560
Total Gas Saved $	**$**	**8,046**
kWh Saved		**46,656**
Cost per kWh	$	0.1045
Total Electric Saved	$	4,875
Total Savings	**$**	**12,922**

* Total savings includes water savings of 64.3 kgals that is worth $710

Appendix 3-2 Dover Ice Arena

Rate Sheet February 2, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.11	$/kWh
Electric Demand	$7.09	$/kW
Natural Gas	$1.24	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$12.42	$/MMBtu

Heating Efficiency (%)	80%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
114.1	39.7	153.8

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	65	65
Winter Inside Setpoint (F)	68	68

Total Building Sq Footage	126,084
Percent of Building Cooled	90%
Total Cooled Sq Footage	113,476

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	139,000	Btu
1 gal Propane	=	91,600	Btu
1 CCF	=	103,400	Btu

Thermal Energy

	#2 OIL				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total			**0**	**$0.0**	**143,847**	**178,677**	**14,385**	**$12.4**	**14,385**	**178,677**	**$12.4**

Electricity

Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total	**266**	**1,468,200**	**155,051**					**1,468,200**	**$155,051**	**$0.11**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	2	8	6

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Occupied
Sunday	Occupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	4
Dec	4

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	21.0	1.0
87.5	72.5	3.5
82.5	261.5	19.5
77.5	299.0	31.0
72.5	408.5	84.5
67.5	414.5	173.5
62.5	562.5	299.5
57.5	429.3	276.8
52.5	369.0	214.0
47.5	376.5	203.5
42.5	328.3	170.8
37.5	514.3	287.8
32.5	528.0	289.0
27.5	420.8	235.3
22.5	279.8	189.3
17.5	262.0	169.0
12.5	130.5	90.5
7.5	67.0	52.0
2.5	43.0	50.0
-2.5	23.5	32.5
-7.5	21.0	32.0
-12.5	5.5	8.5
-17.5	2.3	6.8

Instructions

1 Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations
2. Select one location in cell B2 from the drop-down list.
3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.
4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 9, 2009
District Name	Dover, NH
Bldg Name	Dover Ice Arena
Bdl Size	126,084

Show entire FIM List

Sow only Selected FIM's

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	5,011	14,385	19,396
	MBtu/sq ft	39.7	114.1	153.8
Proposed	MMBtu/yr	4,577	4,972	9,549
	MBtu/sq ft	36.3	39.4	75.7
% Change	MMBtu/yr	434	9,412	9,847
	MBtu/sq ft	3.4	74.7	78.1

FIM #	PROPOSED MEASUES	Electricity Savings kW	kWh/yr	$/yr	Thermal MMBtu/yr	$/yr	Water kgal/yr	$/yr		Total Savings $/yr
FIM 1	Lighting - Fixture Retrofit	11.5	49,892	$6,264	(73)	($905)				$5,359
FIM 2	Lighting - Fixture Control	4.7	12,612	$1,337						$1,337
FIM 3	Building Envelope Improvements - Weatherization		3,597	$381	346	$4,292				$4,673
FIM 6	Water Conservation				51	$635	232	$2,557		$3,192
FIM 9	Vending Machine Controllers		2,906	$308						$308
FIM 11	Ice Arena - Upgrades	(61.8)	(31,670)	($8,614)	9,088	$112,131				$95,015
FIM 11.1	Low emissivity celling (e-ceiling)		163,865	$17,370					$17,370	
FIM 11.2	Infrared Ice Surface Temperature Monitoring and Controls		29,206	$3,096					$3,096	
FIM 11.3	Dehumidification Controls		26,117	$2,768					$2,768	
FIM 11.4	Icemax to Maintain Quality Ice Surface		70,138	$7,435	310	$3,096			$2,029	
FIM 11.5	Move the Dashers Inboard									
FIM 11.6	Cooling System Upgrade - Chiller Replacement	(61.8)	(421,591)	($49,946)	8,778	$109,035			$59,090	
FIM 11.7	Pumping System - VFD on Pumps		100,596	$10,663					$10,663	
FIM 11.8	Controls Upgrade									
FIM 12	Power Factor Correction		67,810	$7,188						$7,188
FIM 13	Energy Efficient Transformers	4.7	22,071	$2,955						$2,955
	TOTALS	**(40.8)**	**127,218**	**$9,819**	**9,412**	**$116,154**	**232**	**$2,557**		**$120,028**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	126,084	1,468,200	155,051	14,385	178,677	$333,728	$2.65
AFTER PROJECT ENERGY USAGE:	126,084	1,340,982	$145,232	4,972	$62,523	$207,755	$1.65
AFTER PROJECT ENERGY SAVINGS:	126,084	127,218	$9,819	9,412	$116,154	$125,973	$1.00
ENERGY REDUCTION (%):		8.66%	6.33%	65.43%	65.01%	37.75%	37.75%

Title	**Lighting Fixture Retrofit and Controls**
Date	**February 9, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary *	Baseline	Proposed	Savings	$ Savings
kWh/yr	155,125	90,688	64,438	$6,830
kW	36.7	20.0	16.7	$1,006
MMBtu/yr			(75)	($933)
Total				$6,903

* *Includes both Lighting Retrofit & Lighting Controls*

Measures	Units	Baseline	Cooling Credit	Heating Debit	Proposed	Energy Savings	Cost Savings ($)	Total Savings ($)
Lighting Fixture Retrofit	kWh	139,810			92,004	47,806	$5,067	$6,073
	kW	36.7			24.8	11.8	$1,006	
Lighting Fixture Controls	kWh	15,315			2,313	13,002	$1,378	$1,378
	kW	24.8			20.0	4.9	NA	
Total	kWh	155,125	3,629		90,688	64,438	$6,830	$6,903
	kW	36.7			20.0	16.7	$1,006	
	MMBtu			(75)	(75)	(75)	($933)	

YES Is Interaction Penalty Required ?

75%	...PERCENTAGE OF LIGHT HEAT RETURNED TO HVAC (%HTRET)	
16.70	...TOTAL KW LIGHTING LOAD REDUCTION (KWRED)	
60,809	...TOTAL KWH LIGHTING LOAD REDUCTION (KWHRED)	
70	...AVERAGE LIGHTING HOURS PER WEEK (LITEHHRS)	= KWHRED/KWRED / WPY
12	... DEMAND MONTHS (CLGMONTHS)	
80%	...HEATING SYSTEM EFFICIENCY (EFF)	
1.10	....Avg. KW/TON OF CHILLER (KW/TON)	
	....AVG. KW/TON OF SUPPORT EQUIPMENT (KWSUPT)	
3,371	...HEATING HRS/YR FROM WEATHER DATA (HHPY)	
2,469	...COOLING HRS/YR FROM WEATHER DATA (CHPY)	
1,405	...WINTER HEATING COINCIDENT HRS (HTGCOHRS)	= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
1,029	...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)	= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
52	...WEEKS/YEAR OF BUILDING OPERATION (WPY)	
90%	...PERCENT OF AREA AIR CONDITIONED (%COOLED)	

(Heating Debit)	(KWRED * 3413 * %HTRET * HTGCOHRS) / BTUs/UNIT / EFF =================================	(75)	**MMBTU**
	FUEL SAVED * COST / MMBTU ===	($933)	**$**
(Cooling Credit)	(KWRED * 3413 * %HTRET * CLGCOHRS * %COOLED) / 12000 * KW/TON ===========	3629	**KWH**
	MMBTU SAVED * COOLCOST ===	385	**$**

TOTAL INTERACTION =========== -548 **$**

Formulas:

Baseline Energy Usage (kWh/yr) = ∑(Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)
Estimated Energy Usage (kWh/yr) = ∑(Proposed Fixture Watts x Op. Hours/yr x 1 kW/1000 Watts)
Energy Savings (kWh/yr) = Baseline Energy Usage – Estimated Energy Usage

Title	**Building Envelope Improvements**
Date	**February 2, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	3,708	$393
kW				
MMBtu/yr	-	-	356	$4,425
Total				$4,818

INPUT DATA

Area of Cracks	14.8
Area Air-Conditioned	40%
Area Heated	40%
Winter Occupied Set Point	68.0
Winter Unoccupied Set Point	68.0
Summer Occupied Set Point	65.0
Summer Unoccupied Set Point	65.0
Balance Point	55.0
Conversion factor (1MMBtu)	1,000,000
Cooling Efficiency EER	10.9
Heating Efficiency %	80%
$/kwh unblended	$0.11
$/MMBtu of fuel	$12.42

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	2266
Infiltration (CFM) Summer	2266

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	20	20	1/16	1/12	=	2.083
RTV's	37	20	1/32	1/12	=	0.052
Roof/ Wall Joint	1	192	1/6	1/12	=	2.667
OH Door	-	0	1/6	1/12	=	-
Seal Bulkheads	1	120	1	1/12	=	10.000
					Total =	14.802

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu saved	Output Ton-Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
Cooling										
90-95	92.5	75.9	21	1	1,413,613	67,315	1,480,928	123.4	136	
85-90	87.5	73.0	73	4	3,992,998	192,765	4,185,763	348.8	384	
80-85	82.5	70.3	262	20	11,201,812	835,317	12,037,128	1,003.1	1,103	
75-80	77.5	67.5	299	31	9,148,707	948,528	10,097,235	841.4	926	
70-75	72.5	64.4	409	85	7,499,492	1,551,303	9,050,794	754	830	
65-70	67.5	61.3	415	174	2,536,548	1,061,740	3,598,287	300	330	
60-65	62.5	56.7	563	300	-	-	-	-	-	
Heating										
55-60	57.5	52.3	429	277	11,032,606	7,113,043	18,145,650	18.1		22.7
50-55	52.5	47.0	369	214	14,000,276	8,119,401	22,119,677	22.1		27.6
45-50	47.5	42.2	377	204	18,892,845	10,211,671	29,104,516	29.1		36.4
40-45	42.5	37.9	328	171	20,489,126	10,658,091	31,147,217	31.1		38.9
35-40	37.5	33.6	514	288	38,393,054	21,482,939	59,875,993	59.9		74.8
30-35	32.5	29.4	528	289	45,881,837	25,113,354	70,995,191	71.0		88.7
25-30	27.5	24.8	421	235	41,711,679	23,321,860	65,033,538	65.0		81.3
20-25	22.5	20.4	280	189	31,157,314	21,077,826	52,235,140	52.2		65.3
15-20	17.5	15.4	262	169	32,387,035	20,890,874	53,277,909	53.3		66.6
10-15	12.5	10.0	131	91	17,728,909	12,294,761	30,023,670	30.0		37.5
5-10	5.5	6.2	67	52	10,250,224	7,955,397	18,205,621	18.2		22.8
0-5	0.0	0.6	43	50	7,157,410	8,322,570	15,479,980	15.5		19.3
-5-0	0.0	0.0	24	33	3,911,608	5,409,670	9,321,278	9.3		11.7

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	**Water Conservation**
Date	**February 2, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Savings Summa	Existing	Proposed	Savings	$ Savings
kWh/yr				$0
kW				$0
MMBtu/yr			52.7	$655
kGal/yr	558	320	239	$2,636
Total				$3,291

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	7	100
% Year Round Occupancy	66%	100%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	16	100
Total Flushes Per Day (Less Urinal Flushes)	16	98
% Men	35%	40%
Total Men	2	40
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	2%	2%
Total Flushes per Day to Urinals	0.3	2.0
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	7	40
%Taking Showers	20%	1
Shower (Minutes/Day/Person)	8.00	8.00
Total Shower Usage (Minutes/Day)	7	560
Total Number of Toilets	1	31
Total Number of Urinals	0	9
Total Number of Sinks	1	19
Total Number of Showers	0	24
Total Number of Toilets to be Retrofitted	0	2
Total Number of Urinals to be Retrofitted	0	6
Total Number of Sinks to be Retrofitted	1	19
Total Number of Showers to be Retrofitted	0	24
% Toilets Being Retrofitted	6%	
% Urinals Being Retrofitted	0%	67%
% Sinks Being Retrofitted	100%	100%
% Showers Being Retrofitted	0%	100%

Input and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$12.4
Average Cold Water Temp, (^{o}F)	55
Boiler Efficiency (%)	80%

Formulas:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.
2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person
3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.
4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.
5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.
6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].
7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	365	365

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
Use Type	Fixture Type	Baseline Flushes/Day, Min/Day	Estimated	Baseline (gpf, gpm)	Estimated	Baseline (gal/yr)	Estimated (gal/yr)	Water Estimated (gal/yr)	Fuel Estimated (MMBtu/yr)	Water Estimated ($/yr)	Fuel Estimated ($/yr)
Staff	Toilet	16	16	3.5	1.6	1,262	577	685	-	8	-
	Urinal	0	0	1.5	1.0	-	-	-	-	-	-
	Sink	7	7	2.2	0.5	5,537	1,258	4,278	1.0	47	12
	Showers	7	7	2.5	1.5	-	-	-	-	-	-
Visitors	Toilet	98	98	3.5	1.6	7,825	3,577	4,248	-	47	-
	Urinal	2	2	1.5	1.0	730	487	243	-	3	-
	Sink	40	40	2.2	0.5	32,120	7,300	24,820	6	274	-
	Showers	560	560	2.5	1.5	511,000	306,600	204,400	46	2,257	-

Title	**Vending Machine Controls**
Date	**February 2, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary	Existing	Proposed	Savings	Savings
kWh/yr	6,524	3,529	2,995	$ 318
kW			-	
MMBtu/yr	-	-	-	$ -
Total				$ 318

$/kW	$7.09
$/kWh	$0.11
$/MMBtu	$12.42

Input Data:

Vending Machine Information

Site:	$ / kWh	Room	Type	Qty.	Volts	Amps	Lighting * Watts/ unit	Lighting Found	Existing Operation Hrs/Day	Existing Operation Days/Yr.	Compressor Duty Cycle Existing Normal	Compressor Duty Cycle Proposed Nite	Machine Location is Occupied Hrs/Day	Machine Location is Occupied Days/Yr.	Number of Controllers Required Beverage	Number of Controllers Required Snack
Dover Ice Arena	$ 0.11	Hallway Outside of Holt	Vending Machine	1	115	10.5	80	On	24	365	33%	12.0%	8	365	0	0
Dover Ice Arena	$ 0.11	Hallway Outside of Holt	Vending Machine	1	115	10.5	80	On	24	365	33%	12.0%	8	365	0	0
Dover Ice Arena	$ 0.11														0	0
Dover Ice Arena	$ 0.11														0	0
Dover Ice Arena	$ 0.11														0	0
Dover Ice Arena	$ 0.11														0	0
Dover Ice Arena	$ 0.11														0	0
Dover Ice Arena	$ 0.11														0	0
Dover Ice Arena	$ 0.11														0	0
Dover Ice Arena	$ 0.11														0	0
			Totals:				* Lighting watts is included in the volt / amp data and Total kW								0	0

Calculations & Output Data:

Site	Lighting Savings	Ltg. Watts	Existing Hrs/Yr.	Existing Hrs/Yr.	Existing Lighting kWh/yr.	Proposed Lighting kWh/Yr.	Lighting Savings kwh	Compressor Savings Comp. kW	Present Hrs/Yr.	Proposed Hrs/Yr.	Existing Compressor kWh/yr.	Proposed kWh/Yr.	Comp. Savings kwh	Total Savings kwh	$
Dover Ice Arena	Vending Machine	80	8,760	3,621	701	290	411	0.886	2,891	1,664	2,561	1,475	1,087	1,498	$ 159
Dover Ice Arena	Vending Machine	80	8,760	3,621	701	290	411	0.886	2,891	1,664	2,561	1,475	1,087	1,498	$ 159
Dover Ice Arena	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Ice Arena	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Ice Arena	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Ice Arena	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Ice Arena	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Ice Arena	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Ice Arena	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover Ice Arena	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
					1,402	579	822				5,122	2,949	2,173	**2,995**	**$ 318**

Methodology & Summary: **Assumptions and Formulae:**

Present Electricity Use = Lighting (kWh) + Compressor (kWh)

Lighting kWh =Lighting Watts / 1000 x # units x Hours per Day x Days per Year

Compressor kWh = (Volts x Amps x 0.80 power factor / 1000 - Lighting Watts) x # units x Hours per Day x Days per Year x Duty Cycle

Proposed Electricity Use = Lighting kWh with Control + Compressor kWh with Control

Lighting kWh with Control = Lighting watts per unit /1000 x # units x (Occupied Hours per Year + Unoccupied Hours x Nite Duty Cycle)

Proposed Compressor Run Hours = (Occupied Hours x Existing Duty Cycle) + (Unoccupied Hours x Unoccupied Duty Cycle)

Compressor kWh with Control = (Volts x Amps x 0.80 PF -Lighting Watts) / 1000 x # Units x Proposed Compressor Hours per Year

Electricity Cost Savings = Electricity Savings x Electricity Unit Cost

	Lighting	Comp.	Total		
	1,402	5,122	6,524	kWh	
Proposed Annual Electricity Use:	579	2,949	3,529	kWh	
Total Annual Savings:	822	2,173	2,995	kWh	$ 318
			46%	reduction	

Title	**Low emissivity ceiling (e-ceiling)**
Date	**February 2, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary	Existing	Proposed	Savings	Savings
kWh/yr			168,933	$ 17,907
kW				
MMBtu/yr				
Total				

Rink 1 (old)

Constants or Assumptions Pre-Retrofit

Ceiling Emissivity		0.90		
Ice Emissivity		0.95		
Proposed Emissivity		0.10		
Existing Ceiling Area over Ice (minus s		16593	sq ft	
Proposed Low-E Coverage		16593	sq ft	
Temp Ice Rankine	483	23	degrees F	
Temp Ceiling Rank	500	40	degrees F	yr round avg

Q Before= A * Fci * Sigma (Tc cubed - Ti Cubed)

Fci = (1/Fci + (1/emiss of Ceiling - 1) + Ac/Ai (1/emiss of Ice - 1)) $^{-1}$

Stefan Boltzman Constant	0.0000000017
Fci	0.6800
1/Fci	1.4706
1/emiss of Ceiling - 1	0.1111
Ac/Ai	1.0000
1/emiss of Ice -1	0.0526
Fci without Low E Ceiling	0.6119
Q	140,542
Tons per Hour	**11.7**
Tons per Hour Saved	9.89
Hours	5,200
Ton Hours	51,443
kw/ton	0.77
kwh Saved with Low E	39,611

Constants or Assumptions Post-Retrofit

Ceiling Emissivity	0.90	
Ice Emissivity	0.95	
Proposed Emissivity	0.10	
Existing Ceiling Area over Ice (minus s	16593	sq ft
Proposed Low-E Coverage	16593	sq ft
Temp Ice Rankine	483	
Temp Ceiling Rankine	500	

Q After= A * Fci * Sigma (Tc cubed - Ti Cubed)

Fci = (1/Fci + (1/emiss of Ceiling - 1) + Ac/Ai (1/emiss of Ice - 1)) $^{-1}$

Stefan Boltzman Constant	0.0000000017
Fci	0.6800
1/Fci	1.4706
1/emiss of Ceiling - 1	9.0000
Ac/Ai	1.0000
1/emiss of Ice -1	0.0526
Fci of Low E Ceiling	0.0950
Q	21,827
Tons per Hour	**1.82**

Rink 2 (New)

Constants or Assumptions Pre-Retrofit

Ceiling Emissivity	0.90			
Ice Emissivity	0.95			
Proposed Emissivit	0.10			
Existing Ceiling Area over Ice (minus s		16593	sq ft	
Proposed Low-E Coverage		16593	sq ft	
Temp Ice Rankine	484	24	degrees F	
Temp Ceiling Rank	500	40	degrees F	yr round avg

Q Before= A * Fci * Sigma (Tc cubed - Ti Cubed)

Fci = (1/Fci + (1/emiss of Ceiling - 1) + Ac/Ai (1/emiss of Ice - 1)) $^{-1}$

Stefan Boltzman Constant	0.0000000017
Fci	0.6800
1/Fci	1.4706
1/emiss of Ceiling - 1	0.1111
Ac/Ai	1.0000
1/emiss of Ice -1	0.0526
Fci without Low E Ceiling	0.6119
Q	132,674
Tons per Hour	**11.1**
Tons per Hour Saved	9.34
Hours	8,016
Ton Hours	74,862
kw/ton	0.77
kwh Saved with Low E	57,644

Constants or Assumptions Post-Retrofit

Ceiling Emissivity	0.90	
Ice Emissivity	0.95	
Proposed Emissivit	0.10	
Existing Ceiling Area over Ice (minus s	16593	sq ft
Proposed Low-E Coverage	16593	sq ft
Temp Ice Rankine	484	
Temp Ceiling Rankine	500	

Q After= A * Fci * Sigma (Tc cubed - Ti Cubed)

Fci = (1/Fci + (1/emiss of Ceiling - 1) + Ac/Ai (1/emiss of Ice - 1)) $^{-1}$

Stefan Boltzman Constant	0.0000000017
Fci	0.6800
1/Fci	1.4706
1/emiss of Ceiling - 1	9.0000
Ac/Ai	1.0000
1/emiss of Ice -1	0.0526
Fci of Low E Ceiling	0.0950
Q	20605.26225
Tons per Hour	1.717105188

Estimated Load Profile And Pump Speed Required			
Daily Time Period	OA Temp.	Existing Cooling Load	Proposed Cooling Load
12 AM	60 °F	70%	51%
To 8 AM	30 °F	60%	52%
8 AM	60 °F	100%	84%
To 4 PM	30 °F	95%	86%
4 PM To	60 °F	100%	75%
12 AM	30 °F	90%	76%

Outside Air Temp				**Daily Time Period 12:00 AM to 8:00 AM**			**Daily Time Period 8:00 AM to 4:00 PM**			**Daily Time Period 4:00 PM to 12:00 AM**		
Bin Deg. F			***OAT Deg. F***	**System Hours**	**New Electric Ton-Hrs**	**New Elec Cons kWh**	**System Hours**	**New Electric Ton-Hrs**	**New Elec Cons kWh**	**System Hours**	**New Electric Ton-Hrs**	**New Elec Cons kWh**
95	/	99	*97 °F*	0	-	-	0	-	-	0	-	-
90	/	94	*92 °F*	0	-	-	18	1,362	953	4	269	788
85	/	89	*87 °F*	0	-	-	62	4,691	3,281	14	940	2,713
80	/	84	*82 °F*	2	92	50	207	15,662	10,954	72	4,836	9,059
75	/	79	*77 °F*	9	413	226	224	16,948	11,854	97	6,515	9,803
70	/	74	*72 °F*	49	2,250	1,233	253	19,142	13,389	191	12,828	11,072
65	/	69	*67 °F*	161	7,392	4,051	216	16,343	11,431	211	14,171	9,453
60	/	64	*62 °F*	300	13,773	7,549	264	19,974	13,971	298	20,014	11,554
55	/	59	*57 °F*	286	10,700	7,476	171	11,485	9,308	249	14,607	7,716
50	/	54	*52 °F*	228	8,530	5,960	183	12,290	9,961	172	10,090	8,258
45	/	49	*47 °F*	201	7,520	5,254	168	11,283	9,145	211	12,377	7,581
40	/	44	*42 °F*	172	6,435	4,496	160	10,746	8,709	167	9,796	7,220
35	/	39	*37 °F*	293	13,698	7,659	237	18,131	12,901	272	18,496	10,694
30	/	34	*32 °F*	295	13,791	7,711	251	19,202	13,663	271	18,428	11,326
25	/	29	*27 °F*	237	11,080	6,195	189	14,459	10,288	230	15,640	8,528
20	/	24	*22 °F*	202	9,444	5,280	116	8,874	6,314	151	10,268	5,234
15	/	19	*17 °F*	178	8,322	4,653	111	8,492	6,042	142	9,656	5,009
10	/	14	*12 °F*	91	4,254	2,379	41	3,137	2,232	89	6,052	1,850
5	/	9	*7 °F*	55	2,571	1,438	21	1,607	1,143	43	2,924	948
0	/	4	*2 °F*	61	2,852	1,595	15	1,148	816	17	1,156	677
-5	/	-1	*-3 °F*	40	1,870	1,046	6	459	327	10	680	271
-10	/	-6	*-8 °F*	40	1,870	1,046	5	383	272	8	544	226
-15	/	-11	*-13 °F*	11	514	288	2	153	109	1	68	90
-20	/	-16	*-18 °F*	9	421	235	0	-	-	0	-	-
												362,952

Title	**Infrared Ice Surface Temperature Monitoring and**
Date	**February 2, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary	Existing	Proposed	Savings	Savings
kWh/yr			30,109	$ 3,192
kW				
MMBtu/yr				
Total				$ 3,192

Input

Ice Rink Heat Loads - Indoor Rinks as % of Total Refrigeration Load - Ice Temperature Dependent Loads

From ASHRAE Chapter 34 Refrigeration Handbook:

Type of Load	% of Total Load
Conductive Loads:	
Ice Resurfacing	29%
Ground Heat	2%
Convective Loads:	
Rink Air Temp	16%
Rink Humidity	18%
Radiant Loads:	
Ceiling Radiation	29%
Lighting Radiation	2%
Total	**97%**

Non-Ice Temperature Dependent Loads

Conductive Loads:

Ice Resurfacing:

Calc @ 21 deg F ice surface:

$Q = 8.33\ Vf[1.0(t_f-32) + 144 + 0.49(32-t_i)]$

Vf = flood water volume		150 gal
t_f = flood water temp		150 deg F
t_i = ice temp		21 deg F
Q =	334,104	

Calc @ 24 deg F ice surface:

$Q = 8.33\ Vf[1.0(t_f-32) + 144 + 0.49(32-t_i)]$

Vf = flood water volume		150 gal
t_f = flood water temp		150 deg F
t_i = ice temp		24 deg F
Q =	332,267	

% Decrease in Ice Resurfacing Load 0.55%

Ground Heat:

Assume a 2% Decrease in Ground Heat Gain Loads

Convective Loads:

Calc @ 21 deg F ice surface:

$Q = h(t_a-t_i) + [K(X_a-X_i)(1226\ Btu/lb)(10\ lb/mol)]$

h = 0.6 + 0.00318V =		0.918
V = air velocity		100 ft/min
ta = air temperature		40 deg F
t_i = ice temp		21 deg F
X_a= mole fraction H2O vapor		0.0066
X_i= mole fraction H2O		0.0036
K= mass ht coeff		0.17 $lb/h*ft^2$
Q =	28.69668	

Calc @ 24 deg F ice surface:

$Q = h(t_a-t_i) + [K(X_a-X_i)(1226\ Btu/lb)(10\ lb/mol)]$

h = 0.6 + 0.00318V =		0.918
V = air velocity		100 ft/min
ta = air temperature		40 deg F
t_i = ice temp		24 deg F
X_a= mole fraction H2O vapor		0.0066
X_i= mole fraction H2O		0.0036
K= mass ht coeff		0.17 $lb/h*ft^2$

Q =	25.94268
% decrease in convective load	9.60%

Radiant Loads:

Calc @ 21 deg F ice surface:

$Q = A_c*f_{ci}*sig*(T_c**4 - T_i**4)$

$fci = [1/Fci + (1/e_c -1) + A_c/A_i * (1/e_i - 1)]**-1$

Fci =	0.68	
ec = ceiling emissivity	0.9	
Ac = ceiling area	18,000	ft^2
Ai = ice area	17,000	ft^2
ei = ice emissivity	0.95	
sig = Stefan Boltzman	1.71E-09	
fci =	0.611	
t_i = ice temp	479	deg R
tc = ceiling temp	520	deg R
Q =	385,747	

Calc @ 24 deg F ice surface:

$Q = A_c*f_{ci}*sig*(T_c**4 - T_i**4)$

$fci = [1/Fci + (1/e_c -1) + A_c/A_i * (1/e_i - 1)]**-1$

Fci =	0.68	
ec = ceiling emissivity	0.9	
Ac = ceiling area	18,000	ft^2
Ai = ice area	17,000	ft^2
ei = ice emissivity	0.95	
sig = Stefan Boltzman	1.71E-09	
fci =	0.611	
t_i = ice temp	481	deg R
tc = ceiling temp	520	deg R
Q =	369,077	
% decrease in radiant load		4.32%

Weighted Average Calculation of Overall Decrease in Heat Load for 3 deg F Increase in Ice Temp:

	% of Total Load	% Decrease from Above	kWh Savings
Conductive Loads:			
Ice Resurfacing	29%	0.55%	1,572
Ground Heat	2%	2.0%	
Convective Loads:			
Rink Air Temp	16%	9.60%	2
Rink Humidity	18%	9.60%	2
Radiant Loads:			
Ceiling Radiation	29%	4.32%	14,266
Lighting Radiation	2%	4.32%	14,266
Non-Temp Dependent Loads	3%	0.00%	
Weighted Average		**4.79%**	

Notes: Ground Heat Load Reduction Assumed at 2%
Lighting Radiation Load Savings Assumed equal to Ceiling Radation
Convective Load Savings Due to Air Temp and Humidity Assumed Equal

Title	**Dehumidification Controls**
Date	**February 2, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary	Existing	Proposed	Savings	Savings
kWh/yr			26,925	$ 2,854
kW				
MMBtu/yr				
Total				$ 2,854

$/kW	**$7.09**
$/kWh	**$0.11**
$/MMBtu	**$12.42**

Rink 1:

Existing Rink Dehumidification		Number	Power *	Hrs/Yr		
Packaged Dehumidifier		2	6.90 kW *	5585	77,066	kWhr/yr
Total					**77,066**	kWhr/yr

* Need to confirm kW for existing dehumidifier

Proposed Rink Dehumidification						
Dessicant Dehumidifier		1	8.98 kW *	5585	50,141	kWhr/yr
Total					**50,141**	kWhr/yr

* Assumes new dessicant dehumidifier operates only 60% of the time

Title	**Icemax to Maintain Quality Ice Surface**
Date	**February 2, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary	Existing	Proposed	Savings	Savings
kWh/yr			72,307	$ 7,665
kW				
MMBtu/yr	520	200	320	$ 3,975
Total				$ 11,639

Input

CURRENT ESTIMATED REFRIGERATION POWER CONSUMPTION

Proposed Chiller connected kWh	803,412	Post all Ice Plant Improvements
Annual Hours of Operation	8,760	
Existing Ice Temperature	22	Degrees F
Exisitng kWh	803,412	

ESTIMATED REFRIGERATION POWER CONSUMPTION WITH LPA

Percentage of Savings Factor Due to Degree F Rise:	9.0%	
Annual Hours of Operation	8,760	
Proposed Average Ice Temperature	26	Degrees F
Proposed kWh	731,105	
kWh Saved	72,307	

Thermal Savings from the ability to use cold flood water

Existing

					500*gpm*dt	Heater eff 80%	ual Gas Usage on Site
Zamboni	**Zamboni Gallons per Day**	**Average GPM**	**Inlet**	**Outlet**	**Btuh Output**	**Btuh Input**	**Annual Therms**
Load Analysis	2385	1.66	55	120	53817.2043	67271.50538	5200

Proposed

					500*gpm*dt	80%	
Zamboni	**Zamboni Gallons per Day**	**Average GPM**	**Inlet**	**Outlet**	**Btuh Output**	**Btuh Input**	**Annual Therms**
Load Analysis	2385	1.66	55	80	20698.92473	25873.65591	2000

Therms Saved
3200

Title	Cooling System Upgrade - Chiller
Date	February 2, 2009
District	Dover, NH
Building	Dover Ice Arena

Summary	Existing	Proposed	Savings	Savings
kWh/yr	-	434,630	(434,630)	(46,071)
kW	-	63.70	(64)	(5,420)
MMBtu/yr	9,923	873	9,050	112,408
Total			$	60,917

$/kW	$7.09
$/kWh	$0.11
$/MMBtu	$12.42

Input

	Dimensions											
	Width	Length	Area	Qty of Ice				Material	Specific Heat Btu/lb-F	Temperature Initial (F)	Final (F)	Density or Weight
	ft	ft	ft^2	ft^3	gal of water	lbs water		6" Concrete S	0.16	35	20	150 lb/ft^3
Rink 1	85	200	17,000	2,125	15,895	132,813		Supply Water	1	52	32	62.5 lb/ft^3
Rink 2	85	200	17,000	2,125	15,895	132,813		Ice	0.49	32	24	-
								Ethylene Gly	0.83	40	15	32,000 lb

Average Ice Thickness (inches)	1.5 in
Concrete Thickness	6 in
Estimated System Losses	15%
Time period to make 1.5" ice	48 hr
Zamboni Usage per hr	1.5

Latent heat of freezing water	144 Btu/lb
Building and Pumping Load	66.0 tons
System Losses	15%
Mass of Water	132,813 lb
Mass of Concrete	1,275,000 lb

Refrigeration Load at Startup

$q_R = (\text{Sys Losses})(q_F + q_C + q_{SR} + q_{HL})$

where;

q_R	= refrigeration requirement	**127.9 tons**
q_F	= water chilling and freezing	38.7 tons
q_C	= concrete chilling load	5.3 tons
q_{SR}	= refrigeration to cool secondary coolant	1.2 tons
q_{HL}	= building and pumping heat load	66.0 tons

Ice resurfacing Load

$Q_f = 8.33 \times V_f\ (1.0 \times (t_f\text{-}32\ F) + 144 + 0.49 \times (32\text{-}t_i)$

Assumption: 140 gallons of the 180 gallons of hot water is actually used for resurfacing

where;

Q_f	= heat load per flood	**32.2 tons**
V_f	= flood water volume	140.0 gal
t_f	= flood water temperature	120.0 F
t_i	= ice temperature	55.0 F

Ice Rink Heat Loads		
Conductive Loads:		
Ice Resurfacing	32.2 tons	29%
System pump work		
Ground Heat	2.5 tons	2%
Heater Heat Gain		
Skaters	3.6 tons	3%
Convective Heat Loads:		
Rink Air Temperature	17.1 tons	16%
Rink Humidity	19.8 tons	18%
Radiant Loads:		
Ceiling radiation	32.1 tons	29%
Lighting radiation	2.6 tons	2%
Total	**109.9 tons**	

Convective Loads

h	$= 0.6 + 0.00318V$	
where;		
h	= convective heat transfer coefficiency (Btu/hr-ft^2-F)	0.6159
V	= air velocity over the ice, (ft/min)	5
$Q_{cv} = h \times (t_a - t_i) + ((K)(X_a - X_i)(1226\ Btu/lb)(18\ lb/mol))$		
where;		
Q_{cv}	= convective load	**36.9 tons**
Q_{cv}	= Convective heat load, Btu/hr - ft^2	26.04
h	= convective heat transfer coefficient	0.6159
K	= mass heat transfer coefficient	0.17
t_a	= air temperature, F	45
t_i	= ice temperature	21
X_a	= mole fraction of water vapor in air, lb mol/lb mol	0.0066
X_i	= mole fraction of water in saturated ice, lb/mol/lb mol	0.0036

Skater Load

Total Skaters	24
Load per Person (Btu/hr)	1,800
Total Heat Gain	43,200

Ground Heat

Estimate of U value	0.05
Heat Loss	29,750

Lighting

# Fixtures	40
Watts per Fixture	190
Lighting adj factor	1.20
Total Heat Gain	31,099

Radiant Loads

$Q = A_c \times f_{ci} \times \sigma \times (T_c^4 - T_i^4)$

$f_{ci} = [1/F_{ci} + (1/\varepsilon_c - 1) + A_c/A_i \times (1/\varepsilon_i - 1)]^{-1}$

where;		
Q	= radiant load	**32.1 tons**
F_{ci}	= angle factor, ceiling to ice interface	0.68
e_c	= ceiling emissivity	0.9
A_c	= ceiling area	18,000 ft^2
A_i	= ice area	17,000 ft^2
e_i	= ice emissivity	0.95
sig	= Stefan Boltzman	1.71E-09
f_{ci}	= gray body configuration factor, ceiling to ice surface	0.611
t_i	= ice temp, deg R	479 R
t_c	= ceiling temp, deg R	520 R

Months	Zamboni - # of Cuts* Rink 1	Heating MMBtu
Jan	264	25.0
Feb	264	25.0
Mar	264	25.0
Apr	264	25.0
May		0.0
Jun		0.0
Jul		0.0
Aug		0.0
Sep	264	25.0
Oct	264	25.0
Nov	264	25.0
Dec	264	25.0
		200.4

Existing Condition

*Assumes 8 cuts M-F, 13 Sat/Sun

Building: Ice Rink Building
System: Chiller Water System
Area Served: All
Unit Type: Tecochill
Annual Time Period: All
Scheduling Control In Place (Y/N): Y

Equipment Data:
Tecochill Capacity (Tons) 85

Daily/Weekly Occupancy Schedule:

Schedule And Percent Occupied Times By Daily Time Period			12 AM To	8 AM To	4 PM To
Weekday	**Start**	**End**	**8 AM**	**4 PM**	**12 AM**
Monday:	5:00 AM	11:00 PM	20%	80%	80%
Tuesday:	5:00 AM	11:00 PM	20%	80%	80%
Wednesday:	5:00 AM	11:00 PM	20%	80%	80%
Thursday:	5:00 AM	11:00 PM	20%	80%	80%
Friday:	5:00 AM	11:00 PM	20%	80%	80%
Saturday:	5:00 AM	11:00 PM	20%	100%	100%
Sunday:	5:00 AM	11:00 PM	20%	100%	100%
Operating Percentage - Annual Total			20%	86%	86%

Estimated Load Profile And Pump Speed Required

Daily Time Period	OA Temp.	Existing Cooling Load	Proposed Cooling Load
12 AM	60 ℉	65%	62%
To 8 AM	30 ℉	55%	52%
8 AM	60 ℉	100%	95%
To 4 PM	30 ℉	90%	86%
4 PM To	60 ℉	90%	86%
12 AM	30 ℉	80%	76%

Outside Air Temperature Setpoints For Pump Operation:
Pump Outside Air "Lockout" Temperature 70 ℉
Pump Outside Air "Lockon" Temperature 30 ℉

Annual Months Of Operation At Above Weekly Schedule:

Month	System	Rink 1 (old)	Rink 2 (new)
January	100%	100%	100%
February	100%	100%	100%
March	89%	89%	89%
April	89%	89%	89%
May	44%	0%	89%
June	44%	0%	89%
July	44%	0%	89%
August	44%	0%	89%
September	89%	89%	89%
October	89%	89%	89%
November	100%	100%	100%
December	100%	100%	100%

ASHRAE Estimate of Cooling Load (per sheet)		
	7 months per year operation	
Ice Recreation Center	170	240
tons required	100	71
	8months to year round operation	
Ice Recreation Center	140	190
tons required	121	89

Equipment Data

Chiller 1 Compressor 1
Compressor 2
Chiller 2 Compressor 1
Compressor 2

Brine Pumps — Operating Notes

GPM	Head	HP	BHP	kW
725		25	0	18.63
725		15	0	11.18

Condenser Water Pumps — Operating Notes

GPM	Head	HP	kW
300	77	10	7.45
300	77	10	7.45

Floor Pumps — Operating Notes

GPM	Head	HP	kW
500	125	20	14.90
700	125	50	37.25

Outside Air Temp. Bin Deg. F	OAT	Daily Time Period 12 AM To 8 AM System Hours	Tecochill Ton-Hrs	Heat Recovery MMBtu	Gas Cons MMBtu	Daily Time Period 8 AM To 4 PM System Hours	Tecochill Ton-Hrs	Heat Recovery MMBtu	Gas Cons MMBtu	Daily Time Period 4 PM To 12 AM System Hours	Tecochill Ton-Hrs	Heat Recovery MMBtu	Gas Cons MMBtu	Total Tecochill Ton-Hrs	Total Heat Recovery MMBtu	Total Gas Cons MMBtu
95 / 99	97 °F	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-
90 / 94	92 °F	0	-	-	-	18	1,530	3	29	4	306	1	6	1,836	3	35
85 / 89	87 °F	0	-	-	-	62	5,270	10	101	14	1,071	2	19	6,341	12	121
80 / 84	82 °F	2	111	0	2	207	17,595	33	338	72	5,508	10	100	23,214	43	440
75 / 79	77 °F	9	497	1	8	224	19,040	36	366	97	7,421	13	134	26,958	49	508
70 / 74	72 °F	49	2,707	4	42	253	21,505	40	414	191	14,612	25	264	38,824	69	719
65 / 69	67 °F	161	8,895	12	137	216	18,360	34	353	211	16,142	28	292	43,397	74	782
60 / 64	62 °F	300	16,575	23	255	264	22,440	42	431	298	22,797	39	344	61,812	104	1,030
55 / 59	57 °F	286	13,371	22	194	171	14,535	27	236	249	19,049	33	287	46,954	82	717
50 / 54	52 °F	228	10,659	52	155	183	15,555	87	253	172	13,158	68	198	39,372	208	606
45 / 49	47 °F	201	9,397	46	136	168	14,280	80	232	211	16,142	84	243	39,818	210	612
40 / 44	42 °F	172	8,041	39	117	160	13,600	76	221	167	12,776	66	193	34,417	182	530
35 / 39	37 °F	293	13,698	67	199	237	20,145	113	328	272	20,808	108	314	54,651	288	840
30 / 34	32 °F	295	13,791	68	200	251	21,335	120	347	271	20,732	107	312	55,858	295	860
25 / 29	27 °F	237	11,080	54	161	189	16,065	90	261	230	17,595	91	265	44,740	236	687
20 / 24	22 °F	202	9,444	46	137	116	9,860	55	160	151	11,552	60	174	30,855	161	471
15 / 19	17 °F	178	8,322	41	121	111	9,435	53	153	142	10,863	56	164	28,620	150	438
10 / 14	12 °F	91	4,254	21	62	41	3,485	20	57	89	6,809	35	103	14,548	76	221
5 / 9	7 °F	55	2,571	13	37	21	1,785	10	29	43	3,290	17	50	7,646	40	116
0 / 4	2 °F	61	2,852	14	41	15	1,275	7	21	17	1,301	7	20	5,427	28	82
-5 / -1	-3 °F	40	1,870	9	27	6	510	3	8	10	765	4	12	3,145	16	47
-10 / -6	-8 °F	40	1,870	9	27	5	425	2	7	8	612	3	9	2,907	15	43
-15 / -11	-13 °F	11	514	3	7	2	170	1	3	1	77	0	1	761	4	11
-20 / -16	-18 °F	9	421	2	6	0	-	-	-	0	-	-	-	421	2	6
														612,519	2,345	9,923

2,908,192

Chiller Performance Curve

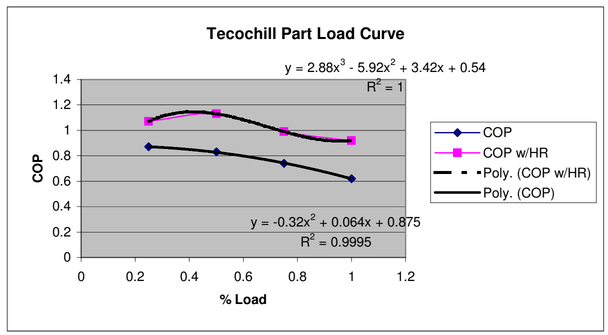
Techochill Performance Data

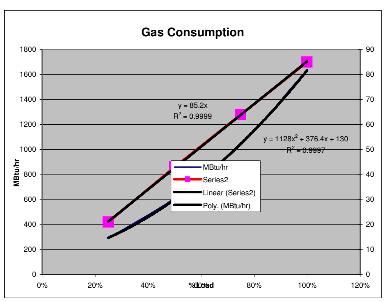
(From Teco-Chill Factory Test Report)

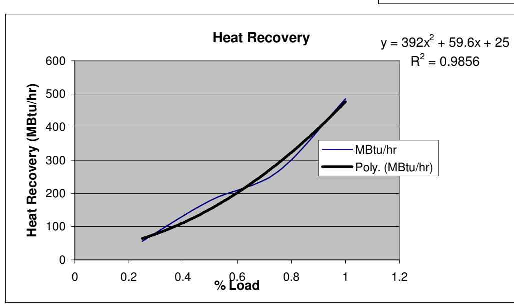
Dover Ice Rink Chiller	tons	COP	COP w/HR
100%	85	0.62	0.92
75%	64	0.74	0.99
50%	43	0.83	1.13
25%	21	0.87	1.07
APLV COP			0.77
APLV COP w HR			1.03

Gas Consumption Performance	tons	MBtu/hr
100%	85	1638
75%	64	1036
50%	43	611
25%	21	291

Heat Recovery Performance	tons	MBtu/hr
100%	85	485
75%	64	265
50%	43	178
25%	21	56







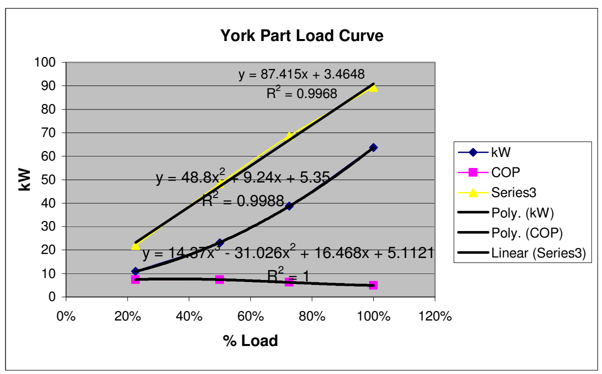
Proposed Electric Chiller Tons **89.4**

Outside Air Temp. Bin Deg. F			OAT	Daily Time Period 12 AM To 12 AM System Hours	Electric Ton-Hrs	Thermal Heat MMBtu	Electric kWh	Daily Time Period 8 AM To 4 PM System Hours	Electric Ton-Hrs	Thermal Heat MMBtu	Electric kWh	Daily Time Period 4 PM To 12 AM System Hours	Electric Ton-Hrs	Thermal Heat MMBtu	Electric kWh	Total for 24 hrs Electric Ton-Hrs	Thermal Heat MMBtu	Electric kWh
95	/	99	97 °F	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-
90	/	94	92 °F	0	-	-	-	18	1,530	-	1,140	4	306	-	213	1,836	-	1,353
85	/	89	87 °F	0	-	-	-	62	5,270	-	3,926	14	1,071	-	745	6,341	-	4,671
80	/	84	82 °F	2	111	-	65	207	17,595	-	13,106	72	5,508	-	3,834	23,214	-	17,005
75	/	79	77 °F	9	497	-	291	224	19,040	-	14,183	97	7,421	-	5,165	26,958	-	19,638
70	/	74	72 °F	49	2,707	-	1,582	253	21,505	-	16,019	191	14,612	-	10,171	38,824	-	27,771
65	/	69	67 °F	161	8,895	-	5,197	216	18,360	-	13,676	211	16,142	-	11,236	43,397	-	30,109
60	/	64	62 °F	300	16,575	-	9,684	264	22,440	-	16,715	298	22,797	-	15,868	61,812	-	42,268
55	/	59	57 °F	286	13,371	-	9,232	171	13,082	-	10,827	249	16,932	-	13,259	43,384	-	33,318
50	/	54	52 °F	228	10,659	-	7,360	183	14,000	82	11,587	172	11,696	-	9,159	36,355	82	28,106
45	/	49	47 °F	201	9,397	-	6,489	168	12,852	75	10,637	211	14,348	-	11,236	36,597	75	28,361
40	/	44	42 °F	172	8,041	-	5,552	160	12,240	72	10,130	167	11,356	-	8,893	31,637	72	24,575
35	/	39	37 °F	293	13,698	-	9,458	237	18,131	106	15,006	272	18,496	-	14,484	50,324	106	38,948
30	/	34	32 °F	295	13,791	-	9,523	251	19,202	112	15,892	271	18,428	-	14,431	51,421	112	39,846
25	/	29	27 °F	237	11,080	-	7,651	189	14,459	84	11,967	230	15,640	-	12,247	41,178	84	31,865
20	/	24	22 °F	202	9,444	-	6,521	116	8,874	52	7,345	151	10,268	-	8,041	28,586	52	21,906
15	/	19	17 °F	178	8,322	-	5,746	111	8,492	50	7,028	142	9,656	-	7,561	26,469	50	20,335
10	/	14	12 °F	91	4,254	-	2,938	41	3,137	18	2,596	89	6,052	-	4,739	13,443	18	10,273
5	/	9	7 °F	55	2,571	-	1,775	21	1,607	9	1,330	43	2,924	-	2,290	7,102	9	5,395
0	/	4	2 °F	61	2,852	-	1,969	15	1,148	7	950	17	1,156	-	905	5,155	7	3,824
-5	/	-1	-3 °F	40	1,870	-	1,291	6	459	3	380	10	680	-	532	3,009	3	2,204
-10	/	-6	-8 °F	40	1,870	-	1,291	5	383	2	317	8	544	-	426	2,797	2	2,034
-15	/	-11	-13 °F	11	514	-	355	2	153	1	127	1	68	-	53	735	1	535
-20	/	-16	-18 °F	9	421	-	291	0	-	-	-	0	-	-	-	421	-	291
																580,992	**673**	**434,630**

Chiller Performance Curve

York Performance Data (YCWL0094HE)

Dover Ice Rink Chiller	tons	kW	COP	kW/ton
100%	89.4	63.7	4.92	0.71
73%	68.6	38.8	6.21	0.57
50%	48.3	23.1	7.39	0.48
23%	21.9	10.9	7.42	0.50



Title	**Pumping System - VFD on Pumps**
Date	**February 2, 2009**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary	Baseline	Proposed	Savings	Savings
kWh/yr	-	-	103,707	$10,993
kW	-	-	-	$0
MMBtu/yr			-	$0
Total				$10,993

Building: Ice Rink Building
System: Chiller Water System
Area Served: All
Unit Type: Brine Pump & Floor Pump
Annual Time Period: All
Scheduling Control In Place (Y/N): Y

Design Pump Motor Data:

Motor Nameplate HP:	75
Estimated Load Factor:	80%
Pump Motor Full Load BHP:	60.0
Motor Efficiency:	92.0%
Pump Motor Full Load Input kw:	48.7
With VFD:	
VFD Losses:	3%
Pump Motor Full Load Input kw:	50.2
Pump Motor Minimum Input kw:	12.5

Daily/Weekly Occupancy Schedule:

Schedule And Percent Occupied Times By Daily Time Period			12 AM To 8 AM	8 AM To 4 PM	4 PM To 12 AM
Weekday	**Start**	**End**			
Monday:	5:00 AM	11:00 PM	20%	80%	80%
Tuesday:	5:00 AM	11:00 PM	20%	80%	80%
Wednesday:	5:00 AM	11:00 PM	20%	80%	80%
Thursday:	5:00 AM	11:00 PM	20%	80%	80%
Friday:	5:00 AM	11:00 PM	20%	80%	80%
Saturday:	5:00 AM	11:00 PM	20%	100%	100%
Sunday:	5:00 AM	11:00 PM	20%	100%	100%
Operating Percentage - Annual Total			20%	86%	86%
Annual Operating Hours Per Period			1,170	2,013	2,013
Total Annual Pump Operating Hours			5,196	59%	

Estimated Load Profile And Pump Speed Required

Daily Time Period	OA Temp.	Percent Cooling Load	Pump Percent Speed
12 AM	60 °F	50%	70%
To 8 AM	30 °F	20%	50%
8 AM	60 °F	90%	100%
To 4 PM	30 °F	60%	80%
4 PM To	60 °F	80%	100%
12 AM	30 °F	40%	60%

Outside Air Temperature Setpoints For Pump Operation:

Pump Outside Air "Lockout" Temperature	70 °F
Pump Outside Air "Lockon" Temperature	30 °F

Annual Months Of Operation At Above Weekly Schedule:

Month	System	Rink 1 (old)	Rink 2 (new)
January	100%	100%	100%
February	100%	100%	100%
March	89%	89%	89%
April	89%	89%	89%
May	44%	0%	89%
June	44%	0%	89%
July	44%	0%	89%
August	44%	0%	89%
September	89%	89%	89%
October	89%	89%	89%
November	100%	100%	100%
December	100%	100%	100%

Building:	Ice Rink Building
HVAC System:	Chiller Water System
Annual Time Period:	All
Weather Data Location:	Dover, NH

Outside Air Temp. Bin Deg. F	Daily Time Period 12 AM To 8 AM System Hours	Pump Energy Savings 12 AM To 8 AM Pump Percent Speed With VFD	CW Pump kW Saved	CW Pump Total kWh Saved	Daily Time Period 8 AM To 4 PM System Hours	Pump Energy Savings 8 AM To 4 PM Pump Percent Speed With VFD	CW Pump kW Saved	CW Pump Total kWh Saved	Daily Time Period 4 PM To 12 AM System Hours	Pump Energy Savings 4 PM To 12 AM Pump Percent Speed With VFD	CW Pump kW Saved	CW Pump Total kWh Saved
95 / 99	0	70%	0.0	0	0	100%	0.0	0	0	100%	0.0	0
90 / 94	0	70%	0.0	0	7	100%	-1.5	-10	7	100%	-1.5	-10
85 / 89	0	70%	0.0	0	26	100%	-1.5	-38	26	100%	-1.5	-38
80 / 84	0	70%	31.4	6	91	100%	-1.5	-138	91	100%	-1.5	-138
75 / 79	1	70%	31.4	25	98	100%	-1.5	-147	98	100%	-1.5	-147
70 / 74	5	70%	31.4	145	125	100%	-1.5	-188	125	100%	-1.5	-188
65 / 69	15	70%	31.4	472	116	100%	-1.5	-175	116	100%	-1.5	-175
60 / 64	33	70%	31.4	1,032	148	100%	-1.5	-223	148	100%	-1.5	-223
55 / 59	33	68%	32.9	1,100	110	98%	1.4	159	110	96%	4.3	471
50 / 54	29	65%	35.1	1,004	132	95%	6.1	806	132	89%	12.9	1,705
45 / 49	28	61%	36.1	1,015	132	91%	10.4	1,381	132	83%	20.3	2,688
40 / 44	27	58%	36.1	966	125	88%	14.5	1,804	125	76%	26.6	3,320
35 / 39	50	55%	36.1	1,804	192	85%	18.2	3,505	192	69%	31.9	6,147
30 / 34	53	51%	36.1	1,926	209	81%	21.7	4,535	209	63%	36.1	7,560
25 / 29	224	50%	36.1	8,101	186	80%	23.0	4,265	186	60%	36.1	6,705
20 / 24	192	50%	36.1	6,942	114	80%	23.0	2,621	114	60%	36.1	4,121
15 / 19	174	50%	36.1	6,272	111	80%	23.0	2,550	111	60%	36.1	4,009
10 / 14	90	50%	36.1	3,266	41	80%	23.0	942	41	60%	36.1	1,481
5 / 9	55	50%	36.1	1,986	21	80%	23.0	482	21	60%	36.1	758
0 / 4	61	50%	36.1	2,203	15	80%	23.0	345	15	60%	36.1	542
-5 / -1	40	50%	36.1	1,445	6	80%	23.0	138	6	60%	36.1	217
-10 / -6	40	50%	36.1	1,445	5	80%	23.0	115	5	60%	36.1	181
-15 / -11	11	50%	36.1	397	2	80%	23.0	46	2	60%	36.1	72
-20 / -16	9	50%	36.1	325	0	80%	0.0	0	0	60%	0.0	0
	1,170			**41,877**	**2,013**			**22,775**	**2,013**			**39,055**

Title	**Power Factor Correction**
Date	**39846**
District	**Dover, NH**
Building	**Dover Ice Arena**

Summary	Existing	Proposed	Savings	Savings
kWh/yr			69,907	$7,410
kW				
MMBtu/yr				
Total				$7,410

Input

KVAR AMERICA SURVEY DATA: Dover Arena

	0.11		INITIAL	OPTIMIZED	INITIAL	OPTIMIZED	LEAD	RUN	AMP
RATE PER KWHR:	Phase	Volts	AMPS	AMPS	PF	PF	AMPS	TIME	SAVING
BRINE PUMP	3	480	33	26	0.77	0.99	23	12	21.2%
ELECTRIC CHILLER (Brine Pump #2)	3	480	21	16	0.80	0.99	9	2	23.8%
COMPRESSOR #1	3	480	60	46	0.80	0.99	39	2	23.3%
COMPRESSOR #2	3	480	60	46	0.80	0.99	39	2	23.3%
HOLT FLOOR	3	480	54	38	0.69	0.99	44	16	29.6%
OUTSIDE AIR FAN	3	480	10	9	0.73	0.95	9	16	10.0%
CONDENSER "A"	3	480	12	5	0.77	0.98	8	4	58.3%
CONDENSER "B"	3	480	12	5	0.77	0.98	8	4	58.3%
FOSTER FLOOR	3	480	50	40	0.62	0.99	39	12	20.0%
Data Summary			**312**	**231**		**0.99**			26.0%

EstimatedCost / KWH: **$0.11**

Dover Arena	PHASE	VOLTS	INITIAL AMPS	OPTIMIZED AMPS	AMPS SAVED	INITIAL P.F.	OPTIMIZED P.F.	MOTOR RUNTIME YEARLY	POWER BILL SAVINGS
BRINE PUMP	3	480	33	26	7	0.77	0.99	4,380	2,803.84
ELECTRIC CHILLER (Brine Pump #2)	3	480	21	16	5	0.80	0.99	730	333.79
COMPRESSOR #1	3	480	60	46	14	0.80	0.99	730	934.61
COMPRESSOR #2	3	480	60	46	14	0.80	0.99	730	934.61
HOLT FLOOR	3	480	54	38	16	0.69	0.99		0.00
OUTSIDE AIR FAN	3	480	10	9	1	0.73	0.95	5,840	534.07
CONDENSER "A"	3	480	12	5	7	0.77	0.98	1,460	934.61
CONDENSER "B"	3	480	12	5	7	0.77	0.98	1,460	934.61
FOSTER FLOOR	3	480	50	40	10	0.62	0.99		0.00
TOTALS			**312**	**231**	**81**				**7,410.16**

Title	Energy Efficient Transformers
Date	39846
District	Dover, NH
Building	Dover Ice Arena

Summary	Existing	Proposed	Savings	Savings
kWh/yr			22,754	$2,630
kW			4.89	$416
MMBtu/yr				
Total				$3,046

Input

TRANSFORMER COUNT	Facility	Location	Transformer Designation	kVA	REPLACE
1	Ice Rink	New Elec Room	NP2	75	1
2	Ice Rink	Old Elec Room		75	1
3	Ice Rink	Old Elec Room	PL1	45	1

ADJUSTMENTS

% Load during normal operating hours	% Load outside operating hours	Equipment operating hrs/ day	Equipment operating days/yr	Load Power Factor	Existing Transformer Efficiency (Normal Operation)	Existing Transformer Efficiency (Outside op. hrs)	Powersmiths Efficiency (Normal Operation)	Powersmiths Efficiency (Outside op. hrs)	A/C System Performance (kW/ton)
30.0%	18.0%	14.0	300	0.95	94.5%	91.8%	98.5%	98.4%	0.575
30.0%	18.0%	14.0	300	0.95	94.5%	91.8%	98.5%	98.4%	0
18.0%	10.0%	14.0	300	0.95	91.2%	85.5%	98.0%	97.2%	0

Existing Transformer Losses

kW Losses (Normal Operation)	kW Losses (Outside op. hrs)	Annual additional kWh from transformers	kW Loses	kW Dollars	Annual Cost of Transformer Losses	Additional Tons of Cooling (on peak)	Annual additional kWh from A/C	Annual Cost of Associated A/C
1.2	1.1	10,436	2.39	$203.03	$ 1,212	0.35	1,705	$ 198
1.2	1.1	10,436	2.39	$203.03	$ 1,212	-	-	$ -
0.7	0.7	6,429	1.47	$124.96	$ 745	-	-	$ -
			6	**531**	**3168**			

Powersmiths Transformer Losses

kW Losses (Normal Operation)	kW Losses (Outside op. hrs)	Annual additional kWh from transformers	kW Loses	kW Dollars	Annual Cost of Powersmiths Losses	Additional Tons of Cooling (on peak)	Annual additional kWh from A/C	Annual Cost of Associated A/C
0.32	0.21	2,329	0.54	$45.63	$ 274	0.09	380	$ 45
0.32	0.21	2,329	0.54	$45.63	$ 274	-	-	$ -
0.15	0.12	1,213	0.28	$23.67	$ 142	-	-	$ -
			1	**115**	**691**		**380**	

Compare Transformer Performance

Existing Transformer Annual Operating Cost Total	Powersmiths Annual Operating Cost Total	Annual Dollar Savings with Powersmiths	Annual kWh Savings With Powersmiths	Annual Peak Ton Cooling Reduction	kW SAVINGS	kWh SAVINGS	kW $ SAVINGS	kWh $ SAVINGS	TOTAL ELC $ SAVINGS
$ 1,409	$ 319	$ 1,090	9431	0.26	1.85	9,431.18	157.39	1,090.14	1,247.53
$ 1,212	$ 274	$ 937	8107	-	1.85	8,106.90	157.39	937.07	1,094.46
$ 745	$ 142	$ 603	5216	-	1.19	5,215.57	101.28	603.17	704.46
$ 3,366	**$ 735**	**$ 2,630**	**22,754**	**0.26**	**4.89**	**22,753.65**	**416.07**	**2,630.38**	**3,046.45**

Appendix 3-3 Waste Water Treatment Plant

Rate Sheet		
February 1, 2009		
Utility		Unit
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.10	$/kWh
Electric Demand	$7.03	$/kW
Natural Gas		$/therm
#2 Oil	$2.31	$/Gallon
Thermal Rate	$16.62	$/MMBtu

Heating Efficiency (%)	84%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall

Fuel Split	%
Natural Gas	0%
Oil	100%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	78
Winter Inside Setpoint (F)	72	68

Total Building Sq Footage	
Percent of Building Cooled	80%
Total Cooled Sq Footage	-

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	139,000	Btu
1 gal Propane	=	91,600	Btu
1 CCF	=	103,400	Btu

Thermal Energy	#2 OIL				NATURAL GAS						
Year	Usage (gal.)	Cost ($)	MMBTU	Unit Cost ($/MMBtu)	Usage (Therms)	Cost ($)	MMBTU	Unit Cost ($/MMBtu)	Overall MMBtu	Overall Cost	Overall $/MMBtu
Total	8,906	20,573	1,238	$16.6			0	$0.0	1,238	20,573	$16.6

Electricity									
Year	Demand (kW)	Usage (kWh)	Cost ($)	Demand ($/kW)	Demand ($)	Energy ($)	Unblended ($/kWh)	Overall Electric	Overall Cost	Overall $/kWh
Total		1,662,000	172,093					1,662,000	$172,093	$0.10

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	4	8	4

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Unoccupied
Sunday	Unoccupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	3
Dec	3

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	14.3	7.7
87.5	49.3	26.7
82.5	174.3	106.7
77.5	197.1	132.9
72.5	265.6	227.4
67.5	287.1	300.9
62.5	401.8	460.2
57.5	311.4	394.6
52.5	265.4	317.6
47.5	252.0	328.0
42.5	220.4	278.6
37.5	352.2	449.8
32.5	349.1	467.9
27.5	270.5	385.5
22.5	190.5	278.5
17.5	177.5	253.5
12.5	87.1	133.9
7.5	46.1	72.9
2.5	35.6	57.4
-2.5	20.8	35.2
-7.5	20.1	32.9
-12.5	5.7	8.3
-17.5	3.2	5.8

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations

2. Select one location in cell B2 from the drop-down list.

3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.

4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.

5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.

6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	**Summary of Energy Efficiency Improvements**
Date	**February 1, 2009**
District Name	**Dover, NH**
Bldg Name	**Waste Water Treatment Plant**
Bdl Size	

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	5,672	1,238	6,910
	MBtu/sq ft			
Proposed	MMBtu/yr	4,613	1,168	5,781
	MBtu/sq ft			
% Change	MMBtu/yr	1,060	70	1,130
	MBtu/sq ft			

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 3	Building Envelope Improvements - Weatherization		173	$18	70	$1,159			$1,177
FIM 13	Energy Efficient Transformers	9.2	38,077	$4,717					$4,717
FIM 14	Aeration Blower Upgrade	62.2	272,264	$33,432					$33,432
	TOTALS	**71.3**	**310,515**	**$38,167**	**70**	**$1,159**			**$39,327**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:		1,662,000	172,093	1,238	20,573	$192,666	
AFTER PROJECT ENERGY USAGE:		1,351,485	$133,925	1,168	$19,414	$153,339	
AFTER PROJECT ENERGY SAVINGS:		310,515	$38,167	70	$1,159	$39,327	
ENERGY REDUCTION (%):		18.68%	22.18%	5.63%	5.63%	20.41%	

Title	**Building Envelope Improvements**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Waste Water Treatment Plant**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	178	$18
kW				
MMBtu/yr	-	-	72	$1,195
Total				$1,214

INPUT DATA

Area of Cracks	3.0
Area Air-Conditioned	40%
Area Heated	40%
Winter Occupied Set Point	72.0
Winter Unoccupied Set Point	68.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	78.0
Balance Point	55.0
Conversion factor (1MMBtu)	1,000,000
Cooling Efficiency EER	10.9
Heating Efficiency %	84%
$/kwh unblended	$0.10
$/MMBtu of fuel	$16.62

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	456
Infiltration (CFM) Summer	456

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	11	20	1/16	1/12	=	1.146
RTV's	0	0	1/6	1/12	=	-
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	3	132	1/6	1/12	=	1.833
Seal Bulkheads	-	0	1/16	1/12	=	-
					Total =	2.979

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu saved	Output Ton-Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
Cooling										
90-95	92.5	75.9	14	8	130,204	55,108	185,312	15.4	17	
85-90	87.5	73.0	49	27	327,797	125,031	452,828	37.7	42	
80-85	82.5	70.3	174	107	729,846	236,584	966,430	80.5	89	
75-80	77.5	67.5	197	133	339,938	-	339,938	28.3	31	
70-75	72.5	64.4	266	227	-	-	-	-	-	
65-70	67.5	61.3	287	301	-	-	-	-	-	
60-65	62.5	56.7	402	460	-	-	-	-	-	
Heating										
55-60	57.5	52.3	311	395	2,224,728	2,041,105	4,265,833	4.3		5.1
50-55	52.5	47.0	265	318	2,550,128	2,424,930	4,975,058	5.0		5.9
45-50	47.5	42.2	252	328	3,041,274	3,313,031	6,354,305	6.4		7.6
40-45	42.5	37.9	220	279	3,202,577	3,500,568	6,703,146	6.7		8.0
35-40	37.5	33.6	352	450	5,986,852	6,758,320	12,745,172	12.7		15.2
30-35	32.5	29.4	349	468	6,793,699	8,183,239	14,976,938	15.0		17.8
25-30	27.5	24.8	271	385	5,931,098	7,691,121	13,622,219	13.6		16.2
20-25	22.5	20.4	191	278	4,646,566	6,242,109	10,888,675	10.9		13.0
15-20	17.5	15.4	178	254	4,765,905	6,306,956	11,072,861	11.1		13.2
10-15	12.5	10.0	87	134	2,551,843	3,662,474	6,214,318	6.2		7.4
5-10	5.5	6.2	46	73	1,509,398	2,245,578	3,754,976	3.8		4.5
0-5	0.0	0.6	36	57	1,263,682	1,922,127	3,185,809	3.2		3.8
-5-0	0.0	0.0	21	35	737,940	1,179,120	1,917,060	1.9		2.3

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	**Energy Efficient Transformers**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Waste Water Treatment Plant**

Summary	Existing	Proposed	Savings	Savings
kWh/yr			39,255	$4,065
kW			9.5	$798
MMBtu/yr				
Total				$4,863

Input

TRANSFORMER COUNT	Facility	Location	Transformer Designation	kVA	REPLACE
-2	Waste Water	Primary Sediment	L4	30	1
-1	Waste Water	Compost	T-5 / L-6	30	1
0	Waste Water	UV Building	#1	75	1
1	Waste Water	UV Building	#2	75	1
2	Waste Water	Blower Building	PP1	45	1
3	Waste Water	Garage Process Bldg	L5	30	1
4	Waste Water	Main Elec Process Bldg	L1	30	1
5	Waste Water	Admin Bldg	T-3	37.5	1
6	Waste Water	Admin Bldg	T-2	30	1
7	Waste Water	Butler Bldg		15	1

ADJUSTMENTS

% Load during normal operating hours	% Load outside operating hours	equipment operating hrs/ day	equipment operating days/yr	Load Power Factor	Existing Efficiency (Normal Operation)	Existing Efficiency (Outside op. hrs)	Powersmiths Efficiency (Normal Operation)	Powersmiths Efficiency (Outside op. hrs)	A/C System Performance (kW/ton)
30%	18.0%	14.0	365	0.95	94.3%	91.5%	97.8%	97.7%	0
30%	18.0%	14.0	365	0.95	94.3%	91.5%	97.8%	97.7%	0
30%	18.0%	14.0	365	0.95	94.5%	91.8%	98.5%	98.4%	0
30%	18.0%	14.0	365	0.95	94.5%	91.8%	98.5%	98.4%	0
30%	18.0%	14.0	365	0.95	94.1%	91.2%	98.2%	98.0%	0
30%	18.0%	14.0	365	0.95	94.3%	91.5%	97.8%	97.7%	0
30%	18.0%	14.0	365	0.95	94.3%	91.5%	97.8%	97.7%	0
30%	18.0%	14.0	365	0.95	95.4%	93.1%	98.3%	98.1%	0.55
30%	18.0%	14.0	365	0.95	94.3%	91.5%	97.8%	97.7%	0.55
30%	18.0%	14.0	365	0.95	92.1%	88.6%	97.3%	97.1%	0

Existing Transformer Losses

Existing kW Losses (Normal Operation)	Existing kW Losses (Outside op. hrs)	Existing Annual additional kWh from transformers	KW Loses	KW DOLLARS	Existing Annual Cost of Transformer Losses	Existing Additional Tons of Cooling (on peak)	Existing Annual additional kWh from A/C	Existing Annual Cost of Associated A/C
0.5	0.5	4,400	1.00	$84.18	$ 572	-	-	$ -
0.5	0.5	4,400	1.00	$84.18	$ 572	-	-	$ -
1.2	1.1	10,517	2.39	$201.31	$ 1,366	-	-	$ -
1.2	1.1	10,517	2.39	$201.31	$ 1,366	-	-	$ -
0.8	0.7	6,837	1.55	$130.86	$ 888	-	-	$ -
0.5	0.5	4,400	1.00	$84.18	$ 572	-	-	$ -
0.5	0.5	4,400	1.00	$84.18	$ 572	-	-	$ -
0.5	0.5	4,400	1.00	$84.18	$ 572	0.15	687	$ 89
0.5	0.5	4,400	1.00	$84.18	$ 572	0.15	687	$ 89
0.4	0.3	3,067	0.69	$58.57	$ 399	-	-	$ -
			13.00	**$1,097.09**	**$ 7,451**			

Powersmiths Transformer Losses

Powersmiths kW Losses (Normal Operation)	Powersmiths Transformer kW Losses (Outside op. hrs)	Powersmiths Annual additional kWh from transformers	KW Loses	KW DOLLARS	Annual Cost of Powersmiths Losses	Powersmiths Additional Tons of Cooling (on peak)	Powersmiths Annual additional kWh from A/C	Powersmiths Annual Cost of Associated A/C
0.19	0.12	1,421	0.31	$26.42	$ 187	-	-	$ -
0.19	0.12	1,421	0.31	$26.42	$ 187	-	-	$ -
0.32	0.21	2,431	0.54	$45.24	$ 319	-	-	$ -
0.32	0.21	2,431	0.54	$45.24	$ 319	-	-	$ -
0.23	0.15	1,754	0.39	$32.68	$ 230	-	-	$ -
0.19	0.12	1,421	0.31	$26.42	$ 187	-	-	$ -
0.19	0.12	1,421	0.31	$26.42	$ 187	-	-	$ -
0.19	0.12	1,421	0.31	$26.42	$ 187	0.05	222	$ 29
0.19	0.12	1,421	0.31	$26.42	$ 187	0.05	222	$ 29
0.12	0.08	895	0.20	$16.62	$ 118	-	-	$ -
			3.54	**$298.33**	**$ 2,105**		**444**	

Compare Transformer Performance

Existing Annual Operating Cost Total	POWERSMITHS Annual Operating Cost Total	Annual Dollar Savings with Powersmiths	Annual kWh Savings With Powersmiths	Annual Peak Ton Cooling Reduction	kW SAVINGS	kWh SAVINGS	kW $ SAVINGS	kWh $ SAVINGS	TOTAL ELC $ SAVINGS
$ 572	$ 187	$ 385	2979	-	0.68		57.72	-	$ 57.72
$ 572	$ 187	$ 385	2979	-	0.68	2,979.19	57.72	308.48	$ 366.20
$ 1,366	$ 319	$ 1,047	8086	-	1.85	8,086.29	155.97	837.30	$ 993.26
$ 1,366	$ 319	$ 1,047	8086	-	1.85	8,086.29	155.97	837.30	$ 993.26
$ 888	$ 230	$ 658	5083	-	1.16	5,083.36	98.12	526.36	$ 624.47
$ 572	$ 187	$ 385	2979	-	0.68	2,979.19	57.72	308.48	$ 366.20
$ 572	$ 187	$ 385	2979	-	0.68	2,979.19	57.72	308.48	$ 366.20
$ 661	$ 216	$ 445	3445	0.09	0.68	3,444.69	57.72	356.68	$ 414.40
$ 661	$ 216	$ 445	3445	0.09	0.68	3,444.69	57.72	356.68	$ 414.40
$ 399	$ 118	$ 281	2172	-	0.50	2,172.24	41.92	224.93	$ 266.84
$ 7,630	**$ 2,163**	**$ 5,466**	**42,234**	**0.19**	**9.47**	**39,255.14**	**798.27**	**4,064.69**	**$4,862.96**

Title	**Aeration Blower Upgrade**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Waste Water Treatment Plant**

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr			280,685	$29,064
kW			64.1	$5,403
MMBtu/yr				
Total				$34,466

$/kW	**$7.03**
$/kWh	**$0.10**
$/MMBtu	**$16.62**

POWER CONSUMPTION COMPARISON BETWEEN EXISTING AND PROPOSED BLOWERS

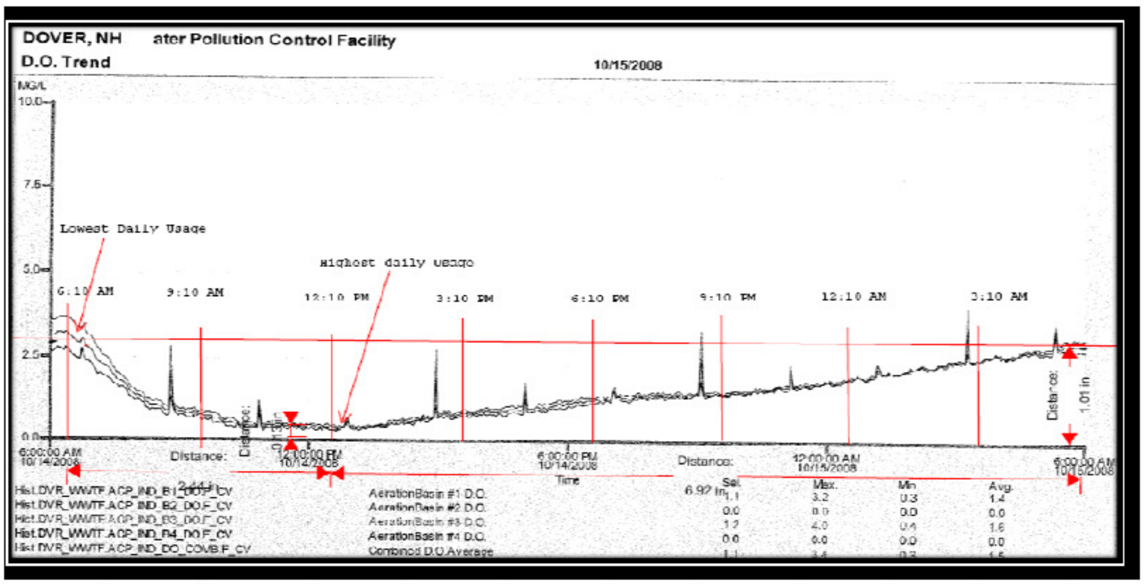
						6:10 AM to 9:10 AM					9:10 AM to 12:10 PM					12:10 PM to 3:10 PM					3:10 PM to 6:10 9M					
Blower Description	Total Number of Units including Stand-By	HP	Voltage	Motor Efficiency	Power Factor	Running Speed %	Load Hours	Number Blowers Operating	Amp Draw	Estimated kWH @	Running Speed %	Load Hours	Number Blowers Operating	Amp Draw	Estimated kWH @	Running Speed %	Load Hours	Number Blowers Operating	Amp Draw	Estimated kWH @	Running Speed %	Load Hours	Number Blowers Operating	Amp Draw	Estimated kWH @	
RCS-J Roots	3	125	460	94.5%	0.98	70%	3	2	177	414	70%	3	2	177	414	100%	3	1	126	296	100%	3	1	126	296	
NX75-C050	3	75	460	95.0%	0.98	77%	3	2	117	273	69%	3	2	104	244	61%	3	2	92	215	52%	3	2	79	185	

						6:10 PM to 9:10 PM					9:10 PM to 12:10 AM					12:10 AM to 3:10 AM					3:10 AM to 6:10 AM					
Blower Description	Total Number of Units including Stand-By	HP	Voltage	Motor Efficiency	Power Factor	Running Speed %	Load Hours	Number Blowers Operating	Amp Draw	Estimated kWH @	Running Speed %	Load Hours	Number Blowers Operating	Amp Draw	Estimated kWH @	Running Speed %	Load Hours	Number Blowers Operating	Amp Draw	Estimated kWH @	Running Speed %	Load Hours	Number Blowers Operating	Amp Draw	Estimated kWH @	Total kWH Used per Day
RCS-J Roots	3	125	460	94.5%	0.98	70%	3	1	88	207	70%	3	1	88	207	70%	3	1	88	207	70%	3	1	88	207	2,250
NX75-C050	3	75	460	95.0%	0.98	88%	3	1	66	156	71%	3	1	54	126	55%	3	1	41	97	52%	3	2	79	185	1,481

ESTIMATED POWER CONSUMPTION FOR EXISTING AND PROPOSED BLOWERS

DISSOLVED OXYGEN GRAPH RIGHT SIDE											
Y Axis High	Y Axis Low	X Axis Length	Total Y Axis Diferential	Y Axis Interval Diferential	X Axis Interval Diferential	Y Axis Diferential @ 3 Hours	Y Axis Diferential @ 6 Hours	Y Axis Diferential @ 9 Hours	Y Axis Diferential @ 12 Hours	Y Axis Diferential @ 15 Hours	Y Axis Diferential @ 18 Hours
1.01	0.13	6.92	0.88	0.13	1.15	0.15	0.29	0.44	0.59	0.73	0.88
Minimum Output	Maximum Output										
Average Minimum Q (MGD)	Average Maximum Q (MGD)				% of Total Y Differential =	16.7%	33.3%	50.0%	66.7%	83.3%	100.0%
1.12	2.81		1.69		Estimated Q Based on Q Min & Q Max =	2.53	2.25	1.97	1.68	1.40	1.12

DISSOLVED OXYGEN GRAPH LEFT SIDE											
Y Axis High	Y Axis Low	X Axis Length	Total Y Axis Diferential	Y Axis Interval Diferential	X Axis Interval Diferential	Y Axis Diferential @ 3 Hours	Y Axis Diferential @ 6 Hours				
1.01	0.13	2.44	0.88	0.36	1.22	0.44	0.88				
Minimum Output	Maximum Output										
Average Minimum Q (MGD)	Average Maximum Q (MGD)				% of Total Y Differential =	50.0%	100.0%				
1.12	2.81		1.69		Estimated Q Based on Q Min & Q Max =	1.97	2.81				



Time	Influent Flow MGD	Average Primary Effluent BOD_5 mg/L	BOD_5 to Aeration Tanks lbs/day	Aeration Tanks Effluent BOD_5 lbs/day	SCFM Required	# NX75-C050 Blowers Required	Running Speed	# NX75-C050 Blowers Required	# RCS-J Blowers Required	Running Speed	# RCS-J Blowers Required
6:10 AM	2.81	133.40	3,126	422	2,708	1.55	77.4%	2	1.23	70.0%	2
9:10 AM	2.53	133.40	2,813	370	2,417	1.38	69.1%	2	1.10	70.0%	2
12:10 PM	2.25	133.40	2,500	319	2,126	1.21	60.7%	2	0.96	100.0%	1
3:10 PM	1.97	133.40	2,186	268	1,832	1.05	52.4%	2	0.83	100.0%	1
6:10 PM	1.68	133.40	1,873	216	1,541	0.88	88.1%	1	0.70	70.0%	1
9:10 PM	1.40	133.40	1,559	165	1,250	0.71	71.4%	1	0.57	70.0%	1
12:10 AM	1.12	133.40	1,246	115	959	0.55	54.8%	1	0.43	70.0%	1
3:10 AM	1.97	133.40	2,186	268	1,832	1.05	52.4%	2	0.83	100.0%	1

NX75-C050 Max. SCFM/Blower =	1,750	100%
NX75-C050 Min. SCFM/Blower =	875	50%
RCS-J Roots High Speed SCFM/Blower =	2,206	100%
RCS-J Roots Low Speed SCFM/Blower =	1,544	70%

Appendix 3-4 Dover City Hall

Rate Sheet February 1, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.12	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	NA	$/therm
#2 Oil	$2.31	$/Gallon
Thermal Rate	$16.65	$/MMBtu

Heating Efficiency (%)	86%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
38.6	33.3	72.0

Fuel Split	%
Natural Gas	0%
Oil	100%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	80
Winter Inside Setpoint (F)	72	65

Total Building Sq Footage	44,844
Percent of Building Cooled	60%
Total Cooled Sq Footage	26,906

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy	#2 OIL				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total	**12,494**	**$28,860**	**1,733**	**$16.7**			**0**	**$0.0**	**1,733**	**28,860**	**$16.7**

Electricity									
Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**437,890**	**54,539**					**437,890**	**$54,539**	**$0.12**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	1	8	4

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Unoccupied
Sunday	Unoccupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	3
Dec	3

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	14.3	7.7
87.5	49.3	26.7
82.5	173.8	107.3
77.5	194.7	135.3
72.5	252.5	240.5
67.5	243.9	344.1
62.5	321.4	540.6
57.5	235.0	471.0
52.5	204.8	378.2
47.5	199.5	380.5
42.5	177.2	321.8
37.5	276.1	525.9
32.5	274.6	542.4
27.5	212.1	443.9
22.5	141.0	328.0
17.5	134.6	296.4
12.5	65.2	155.8
7.5	32.5	86.5
2.5	20.7	72.3
-2.5	11.1	44.9
-7.5	9.8	43.2
-12.5	2.8	11.2
-17.5	0.8	8.2

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations
2. Select one location in cell B2 from the drop-down list.
3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.
4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
Bldg Name	Dover City Hall
Bdl Size	44,844

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	1,495	1,733	3,227
	MBtu/sq ft	33.3	38.6	72.0
Proposed	MMBtu/yr	1,376	1,546	2,922
	MBtu/sq ft	30.7	34.5	65.2
% Change	MMBtu/yr	118	186	305
	MBtu/sq ft	2.6	4.2	6.8

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 1	Lighting - Fixture Retrofit	7.1	24,581	$3,062	(16)	($265)			$2,797
FIM 2	Lighting - Fixture Control	5.0	7,494	$933					$933
FIM 3	Building Envelope Improvements - Weatherization		101	$13	61	$1,014			$1,026
FIM 4	Energy Management System - Upgrades								
FIM 4.2	Energy Management System - Optimal Start				121	$2,023			$2,023
FIM 6	Water Conservation				20	$333	293	$3,237	$3,570
FIM 9	Vending Machine Controllers		2,542	$317					$317
	TOTALS	**12.1**	**34,718**	**$4,324**	**186**	**$3,105**	**293**	**$3,237**	**$10,666**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	44,844	437,890	54,539	1,733	28,860	$83,399	$1.86
AFTER PROJECT ENERGY USAGE:	44,844	403,172	$50,214	1,546	$25,755	$75,970	$1.69
AFTER PROJECT ENERGY SAVINGS:	44,844	34,718	$4,324	186	$3,105	$7,429	$0.17
ENERGY REDUCTION (%):		7.93%	7.93%	10.76%	10.76%	8.91%	8.91%

Title	**Lighting Fixture Retrofit and Controls**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover City Hall**

Summary *	Baseline	Proposed	Savings	$ Savings
kWh/yr	72,230	39,163	33,067	$4,118
kW	23.3	10.8	12.5	$0
MMBtu/yr		(16)	(16)	($273)
Total				$3,845

* *Includes both Lighting Retrofit & Lighting Controls*

Measures	Units	Baseline	Cooling Credit	Heating Debit	Proposed	Energy Savings	Cost Savings ($)	Total Savings ($)
Lighting Fixture Retrofit	kWh	72,230			47,514	24,717	$3,078	$3,078
	kW	23.3			16.0	7.4	$0	
Lighting Fixture Controls	kWh	47,514			39,788	7,726	$962	$962
	kW	16.0			10.8	5.1	NA	
Total	kWh	72,230	625		39,163	33,067	$4,118	$3,845
	kW	23.3			10.8	12.5	$0	
	MMBtu			(16)	(16)	(16)	($273)	

YES Is Interaction Penalty Required ?

75%	...PERCENTAGE OF LIGHT HEAT RETURNED TO HVAC (%HTRET)	
12.47	...TOTAL KW LIGHTING LOAD REDUCTION (KWRED)	
32,442	...TOTAL KWH LIGHTING LOAD REDUCTION (KWHRED)	
52	...AVERAGE LIGHTING HOURS PER WEEK (LITEHHRS)	= KWHRED/KWRED / WPY
12	... DEMAND MONTHS (CLGMONTHS)	
86%	...HEATING SYSTEM EFFICIENCY (EFF)	
1.10	....Avg. KW/TON OF CHILLER (KW/TON)	
0.0	....AVG. KW/TON OF SUPPORT EQUIPMENT (KWSUPT)	
1,763	...HEATING HRS/YR FROM WEATHER DATA (HHPY)	
1,485	...COOLING HRS/YR FROM WEATHER DATA (CHPY)	
442	...WINTER HEATING COINCIDENT HRS (HTGCOHRS)	= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
356	...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)	= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
50	...WEEKS/YEAR OF BUILDING OPERATION (WPY)	
60%	...PERCENT OF AREA AIR CONDITIONED (%COOLED)	

(Heating Debit)	(KWRED * 3413 * %HTRET * HTGCOHRS) / BTUs/UNIT / EFF ===	(16)	**MMBTU**
	FUEL SAVED * COST / MMBTU ===	($273)	**$**
(Cooling Credit)	(KWRED * 3413 * %HTRET * CLGCOHRS * %COOLED) / 12000 * KW/TON ==============================	625	**KWH**
	MMBTU SAVED * COOLCOST ===	$78	**$**

TOTAL INTERACTION =================== ($195) **$**

Formulas:

Baseline Energy Usage (kWh/yr) = ∑(Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)
Estimated Energy Usage (kWh/yr) = ∑(Proposed Fixture Watts x Op. Hours/yr x 1 kW/1000 Watts)
Energy Savings (kWh/yr) = Baseline Energy Usage – Estimated Energy Usage

Title	Building Envelope Improvements
Date	February 1, 2009
District	Dover, NH
Building	Dover City Hall

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	104	$13
kW				
MMBtu/yr	-	-	63	$1,045
Total				$1,058

INPUT DATA

Area of Cracks	1.1
Area Air-Conditioned	60%
Winter Occupied Set Point	72.0
Winter Unoccupied Set Point	65.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	80.0
Balance Point	55.0
Btu/gallons of heating fuel	138,700
Cooling Efficiency EER	10.0
Heating Efficiency %	86%
$/kwh unblended	$0.12
$/gallon of fuel	$2.31

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	439
Infiltration (CFM) Summer	263

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	11	20	1/16	1/12	=	1.146
RTV's	-	0	1/6	1/12	=	-
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	-	0	1/6	1/12	=	-
Seal Bulkheads	-	0	1/16	1/12	=	-
					Total =	1.146

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration: Existing Occupied	Existing Unoccupied	Cooling/Heating Btu saved	Output Ton-Hours or Oil Gallons	kWh Saved	Input Gallons Saved
Cooling										
90-95	92.5	75.9	14	8	75,118	27,408	102,525	9	10	
85-90	87.5	73.0	49	27	189,114	56,947	246,061	21	25	
80-85	82.5	70.3	174	107	419,771	76,209	495,980	41	50	
75-80	77.5	67.5	195	135	193,720	-	193,720	16	19	
70-75	72.5	64.4	253	241	-	-	-	-	-	
65-70	67.5	61.3	244	344	-	-	-	-	-	
60-65	62.5	56.7	321	541	-	-	-	-	-	
Heating										
55-60	57.5	52.3	235	471	1,613,877	1,673,557	$3,287,434	24		27.6
50-55	52.5	47.0	205	378	1,892,232	2,239,229	4,131,461	30		34.6
45-50	47.5	42.2	200	380	2,315,763	3,154,091	5,469,854	39		45.9
40-45	42.5	37.9	177	322	2,476,747	3,429,591	$5,906,338	43		49.5
35-40	37.5	33.6	276	526	4,512,246	6,851,066	11,363,313	82		95.3
30-35	32.5	29.4	275	542	5,137,793	8,351,019	$13,488,813	97		113.1
25-30	27.5	24.8	212	444	4,472,039	7,884,817	12,356,856	89		103.6
20-25	22.5	20.4	141	328	3,305,875	6,603,947	9,909,822	71		83.1
15-20	17.5	15.4	135	296	3,474,409	6,669,976	10,144,385	73		85.0
10-15	12.5	10.0	65	156	1,836,497	3,875,840	5,712,337	41		47.9
5-10	5.5	6.2	32	87	1,023,113	2,438,722	3,461,835	25		29.0
0-5	0.0	0.6	21	72	705,751	2,226,471	2,932,222	21		24.6
-5-0	0.0	0.0	11	45	378,380	1,382,730	1,761,110	13		14.8

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	**Optimal Start Controls**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover City Hall**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr			0	$0
kW			0	$0
MMBtu/yr	195	69	125	$2,086
Total				$2,086

Input Variables

Total CFM	35875
Winter Occupied Setpoint	72
Return/Room Air Temp	67
Winter Unoccupied Setpoint	60
Return/Room Air Temp	60
Dute Cycle During Warm-Up	80%
Warm-Up Hours Before Occ.	2
Bulding Area	44844
Exterior Wall Area	12706
Roof Area	22422
Boiler Efficiency (%)	86%

Assumptions and Constants:	
Building Balance Point	55
Default Wall R-Value	10
Default Roof R-Value	24
Building Infiltration- Air Changes Per Hour	0.3

Overall UA Value	2218
Infiltration CFM	2242

Bin Temp	01-08 Hours	09-16 Hours	17-24 Hours	Warm-Up Hours	Total Hours	Baseline Heating MMBtu	Envelope Loss/Gain Btu/Hr	Infiltration Loss/Gain Btu/Hr	Heating Btu/Hr	Proposed Heating MMBtu	Proposed Hours
92.5	-	-	-	-	0	-	0	0	0	-	0
87.5	-	-	-	-	0	-	0	0	0	-	0
82.5	-	-	-	-	0	-	0	0	0	-	0
77.5	-	-	-	-	0	-	0	0	0	-	0
72.5	-	-	-	-	0	-	0	0	0	-	0
HEATING					0	-	0	0	0	-	0
67.5	161	168	242	29	571	12	0	0	0	0	0
62.5	296	274	272	53	842	23	0	0	0	0	0
57.5	280	217	262	50	759	22	0	0	0	0	0
52.5	210	238	272	38	720	16	43245	47221	90465	4	9
47.5	175	194	189	31	558	14	54333	59329	113661	4	10
42.5	144	209	183	26	536	11	65421	71436	136858	4	9
37.5	213	264	311	38	788	16	76510	83544	160054	7	16
32.5	247	229	261	44	737	19	87598	95652	183250	9	22
27.5	219	98	108	39	425	17	98686	107760	206446	9	22
22.5	192	60	57	34	309	15	109775	119868	229643	9	21
17.5	176	25	33	31	234	14	120863	131976	252839	9	21
12.5	91	14	19	16	124	7	131951	144084	276035	5	12
5.5	55	5	2	10	62	4	147475	161035	308510	4	8
0	61	2	0	11	63	5	159672	174353	334026	4	10
				450	6728	195	1095528	1196259	2291787	69	160

Formulas:

Baseline MMBtu = 1.08 x CFM x % Speed at Warm-up x (Occupied Temperature Setpoint - Room Air Temperature) x Warm-Up Hours
Proposed MMBtu = Actual Heating Energy Required to Reach Temperature Setpoint During Warm-Up Cycle

Total Btu/Hr Required during Warm-Up Cycle:
Envelope Load Btu/Hr = (UA x (∑(OAT-Occupied Setpoint)
Infiltration Load Btu/Hr = (1.08 x Infiltration CFM x (∑(OAT-Occupied Setpoint)
Total Actual Heating Energy (MMBtu) Required Durng Watm-Up Cycle = (Envelope Load + Infiltration Load)/10^6 x Warm-Up Hours

Where
UA = 1/R-Value of Wall x Wall Area + 1/R-Value of Roof x Roof Area
Infiltration CFM = Building Area x 10 Feet Average Height x Building Air Changes Per Hour/60
Warm-Up Hours= Hours Before Occupancy Unit Ventilators Turned to Occupied Mode

Heating MMBtu Savings= (Baseline MMBtu - Proposed MMBtu) / Heating System Efficiency

Title	**Water Conservation**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover City Hall**

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr				$0
kW				
MMBtu/yr			20.6	$344
kGal/yr	604	302	302.2	$3,337
Total				$3,681

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	62	175
% Year Round Occupancy	66%	100%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	142	175
Total Flushes Per Day (Less Urinal Flushes)	140	172
% Men	35%	40%
Total Men	14	70
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	2%	2%
Total Flushes per Day to Urinals	2.5	3.5
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	61	70
%Taking Showers	70%	0
Shower (Minutes/Day/Person)	8.00	0.00
Total Shower Usage (Minutes/Day)	228	0
Total Number of Toilets	6	11
Total Number of Urinals	0	5
Total Number of Sinks	6	10
Total Number of Showers	2	0
Total Number of Toilets to be Retrofitted	5	11
Total Number of Urinals to be Retrofitted	0	5
Total Number of Sinks to be Retrofitted	1	2
Total Number of Showers to be Retrofitted	2	0
% Toilets Being Retrofitted	94%	
% Urinals Being Retrofitted	0%	100%
% Sinks Being Retrofitted	17%	20%
% Showers Being Retrofitted	100%	0%

Input and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$16.7
Average Cold Water Temp, (°F)	55
Boiler Efficiency (%)	86%

Formulas & Assumptions:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.
2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person
3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.
4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.
5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.
6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].
7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	365	365

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
Use Type	Fixture Type	Baseline Flushes/Day, Min/Day	Estimated	Baseline (gpf, gpm)	Estimated	Baseline (gal/yr)	Estimated (gal/yr)	Water Estimated (gal/yr)	Fuel Estimated (MMBtu/yr)	Water Estimated ($/yr)	Fuel Estimated ($/yr)
Staff	Toilet	140	140	3.5	1.6	168,331	76,951	91,379	-	1,009	-
	Urinal	2	2	1.5	1.0	-	$0	-	-	-	-
	Sink	61	61	2.2	0.5	8,173	1,858	6,316	1.3	70	22
	Showers	228	228	2.5	1.5	208,042	124,825	83,217	17.5	919	291
Visitors	Toilet	172	172	3.5	1.6	206,204	94,264	111,939	-	1,236	-
	Urinal	4	4	1.5	1.0	1,916	1,278	639	-	7	-
	Sink	70	70	2.2	0.5	11,242	2,555	8,687	2	96	-
	Showers	0	0	2.5	1.5	-	-	-	-	-	-

Title	**Vending Machine Controls**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover City Hall**

Summary	Existing	Proposed	Savings	Savings
kWh/yr	6,524	3,903	2,621	$326
kW			0	
MMBtu/yr	0	0	0	$0
Total				$326

$/kW	$0.00
$/kWh	$0.12
$/MMBtu	$16.65

Input Data:

Vending Machine Information

Site:	$ / kWh	Room	Type	Qty.	Volts	Amps	Lighting * Watts/ unit	Lighting Found	Existing Operation Hrs/Day	Existing Operation Days/Yr.	Compressor Duty Cycle Existing Normal	Compressor Duty Cycle Proposed Nite	Machine Location is Occupied Hrs/Day	Machine Location is Occupied Days/Yr.	Number of Controllers Required Beverage	Number of Controllers Required Snack
Dover City Hall	$ 0.12	Hallway	Vending Machine	1	115	10.5	80	On	24	365	33%	12.0%	10	365	0	0
Dover City Hall	$ 0.12	Vending Area	Vending Machine	1	115	10.5	80	On	24	365	33%	12.0%	10	365	0	0
Dover City Hall	$ 0.12														0	0
Dover City Hall	$ 0.12														0	0
Dover City Hall	$ 0.12														0	0
Dover City Hall	$ 0.12														0	0
Dover City Hall	$ 0.12														0	0
Dover City Hall	$ 0.12														0	0
Dover City Hall	$ 0.12														0	0
Dover City Hall	$ 0.12														0	0
			Totals:				* Lighting watts is included in the volt / amp data and Total kW								0	0

Calculations & Output Data:

Site	Lighting Savings	Ltg. Watts	Existing Hrs/Yr.	Existing Hrs/Yr.	Existing Lighting kWh/yr.	Proposed Lighting kWh/Yr.	Lighting Savings kwh	Compressor Savings Comp. kW	Present Hrs/Yr.	Proposed Hrs/Yr.	Existing Compressor kWh/yr.	Proposed kWh/Yr.	Comp. Savings kwh	Total Savings kwh	$
Dover City Hall	Vending Machine	80	8,760	4,263	701	341	360	0.886	2,891	1,818	2,561	1,610	951	1,311	$ 163
Dover City Hall	Vending Machine	80	8,760	4,263	701	341	360	0.886	2,891	1,818	2,561	1,610	951	1,311	$ 163
Dover City Hall	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover City Hall	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover City Hall	0	0	0	0	0	0	$0	0.000	0	0	0	0	0	0	$ 0
Dover City Hall	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover City Hall	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover City Hall	0	0	0	0	0	0	$0	0.000	0	0	0	0	0	0	$ 0
Dover City Hall	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Dover City Hall	0	0	0	0	0	0	$0	0.000	0	0	0	0	0	0	$ 0
					1,402	682	719				5,122	3,221	1,902	**2,621**	**$ 326**

Methodology & Summary: **Assumptions and Formulae:**

Present Electricity Use = Lighting (kWh) + Compressor (kWh)

Lighting kWh =Lighting Watts / 1000 x # units x Hours per Day x Days per Year

Compressor kWh = (Volts x Amps x 0.80 power factor / 1000 - Lighting Watts) x # units x Hours per Day x Days per Year x Duty Cycle

Proposed Electricity Use = Lighting kWh with Control + Compressor kWh with Control

Lighting kWh with Control = Lighting watts per unit /1000 x # units x (Occupied Hours per Year + Unoccupied Hours x Nite Duty Cycle)

Proposed Compressor Run Hours = (Occupied Hours x Existing Duty Cycle) + (Unoccupied Hours x Unoccupied Duty Cycle)

Compressor kWh with Control = (Volts x Amps x 0.80 PF -Lighting Watts) / 1000 x # Units x Proposed Compressor Hours per Year

Electricity Cost Savings = Electricity Savings x Electricity Unit Cost

	Lighting	Comp.	Total		
	1,402	5,122	6,524	kWh	
Proposed Annual Electricity Use:	682	3,221	3,903	kWh	
Total Annual Savings:	719	1,902	2,621	kWh	$ 326
			40% reduction		

Appendix 3-5 Public Works Facility

Rate Sheet		
	February 1, 2009	
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.13	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	$1.13	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$11.31	$/MMBtu

Heating Efficiency (%)	82%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
33.4	21.2	54.6

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	80
Winter Inside Setpoint (F)	72	68

Total Building Sq Footage	54,800
Percent of Building Cooled	25%
Total Cooled Sq Footage	13,700

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy

	#2 OIL				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total			**0**	**$0.0**	**18,314**	**20,722**	**1,831**	**$11.3**	**1,831**	**20,722**	**$11.3**

Electricity

Year	Demand (kW)	Usage (kWh)	Cost ($)	Demand ($/kW)	Demand ($)	Energy ($)	Unblended ($/kWh)	Overall Electric	Overall Cost	Overall $/kWh
Total	**75**	**340,200**	**43,525**					**340,200**	**$43,525**	**$0.13**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	1	8	1

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Unoccupied
Sunday	Unoccupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	3
Dec	3

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	13.2	8.8
87.5	45.5	30.5
82.5	154.5	126.5
77.5	168.8	161.3
72.5	201.5	291.5
67.5	187.5	400.5
62.5	241.7	620.3
57.5	168.4	537.6
52.5	159.4	423.6
47.5	145.1	434.9
42.5	136.1	362.9
37.5	206.3	595.7
32.5	207.7	609.3
27.5	156.8	499.2
22.5	104.6	364.4
17.5	100.6	330.4
12.5	42.8	178.2
7.5	22.0	97.0
2.5	16.3	76.7
-2.5	8.4	47.6
-7.5	7.7	45.3
-12.5	2.5	11.5
-17.5	0.8	8.2

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations

2. Select one location in cell B2 from the drop-down list.

3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.

4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.

5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.

6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
Bldg Name	Public Works Building
Bdl Size	54,800

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	1,161	1,831	2,993
	MBtu/sq ft	21.2	33.4	54.6
Proposed	MMBtu/yr	578	1,530	2,109
	MBtu/sq ft	10.6	27.9	38.5
% Change	MMBtu/yr	583	301	884
	MBtu/sq ft	10.6	5.5	16.1

FIM #	PROPOSED MEASURES	Electricity Savings kW	Electricity Savings kWh/yr	Electricity Savings $/yr	Thermal MMBtu/yr	Thermal $/yr	Water kgal/yr	Water $/yr	Total Savings $/yr
FIM 1	Lighting - Fixture Retrofit	30.2	79,734	$10,201	(37)	($415)			$9,786
FIM 2	Lighting - Fixture Control	15.0	21,549	$2,757					$2,757
FIM 3	Building Envelope Improvements - Weatherization		268	$34	201	$2,270			$2,304
FIM 4	Energy Management System - Upgrades								
FIM 4.1	Energy Management System - Building Controls				11	$121			$121
FIM 4.3	Air Handling Unit Upgrade - VFD on Fan		41,564	$5,318	115	$1,297			$6,615
FIM 6	Water Conservation				12	$136	55	$603	$740
FIM 9	Vending Machine Controllers		1,245	$159					$159
FIM 13	Energy Efficient Transformers		26,363	$3,373					$3,373
	TOTALS	**45.2**	**170,724**	**$21,842**	**301**	**$3,409**	**55**	**$603**	**$25,854**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	54,800	340,200	43,525	1,831	20,722	$64,246	$1.17
AFTER PROJECT ENERGY USAGE:	54,800	169,476	$21,682	1,530	$17,313	$38,995	$0.71
AFTER PROJECT ENERGY SAVINGS:	54,800	170,724	$21,842	301	$3,409	$25,251	$0.46
ENERGY REDUCTION (%):		50.18%	50.18%	16.45%	16.45%	39.30%	39.30%

Title	Lighting Fixture Retrofit and Controls
Date	February 1, 2009
District	Dover, NH
Building	Public Works Building

Summary *	Baseline	Proposed	Savings	$ Savings
kWh/yr	199,991	93,377	106,614	$13,640
kW	71.2	23.6	47.6	$0
MMBtu/yr			(39)	($437)
Total				$13,203

* *Includes both Lighting Retrofit & Lighting Controls*

Measures	Units	Baseline	Cooling Credit	Heating Debit	Proposed	Energy Savings	Cost Savings ($)	Total Savings ($)
Lighting Fixture Retrofit	kWh	199,991			116,686	83,305	$10,658	$10,658
	kW	71.2			39.4	31.8	$0	
Lighting Fixture Controls	kWh	116,686			94,003	22,683	$2,902	$2,902
	kW	39.4			23.6	15.8	$0	
Total	kWh	199,991	626		93,377	106,614	$13,640	$13,203
	kW	71.2			23.6	47.6	$0	
	MMBtu			(39)	(39)	(39)	($437)	

YES Is Interaction Penalty Required ?

75%	...PERCENTAGE OF LIGHT HEAT RETURNED TO HVAC (%HTRET)	
47.61	...TOTAL KW LIGHTING LOAD REDUCTION (KWRED)	
105,988	...TOTAL KWH LIGHTING LOAD REDUCTION (KWHRED)	
45	...AVERAGE LIGHTING HOURS PER WEEK (LITEHHRS)	= KWHRED/KWRED / WPY
12	... DEMAND MONTHS (CLGMONTHS)	
82%	...HEATING SYSTEM EFFICIENCY (EFF)	
1.10	....Avg. KW/TON OF CHILLER (KW/TON)	
0.0	....AVG. KW/TON OF SUPPORT EQUIPMENT (KWSUPT)	
1,317	...HEATING HRS/YR FROM WEATHER DATA (HHPY)	
1,181	...COOLING HRS/YR FROM WEATHER DATA (CHPY)	
260	...WINTER HEATING COINCIDENT HRS (HTGCOHRS)	= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
224	...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)	= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
50	...WEEKS/YEAR OF BUILDING OPERATION (WPY)	
25%	...PERCENT OF AREA AIR CONDITIONED (%COOLED)	

(Heating Debit)	(KWRED * 3413 * %HTRET * HTGCOHRS) / BTUs/UNIT / EFF =================================	(39)	**MMBTU**
	FUEL SAVED * COST / MMBTU ==	($437)	**$**
(Cooling Credit)	(KWRED * 3413 * %HTRET * CLGCOHRS * %COOLED) / 12000 * KW/TON ===========	626	**KWH**
	MMBTU SAVED * COOLCOST ==	$80	**$**

TOTAL INTERACTION =========== ($357) **$**

Formulas:

Baseline Energy Usage (kWh/yr) = ∑(Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)
Estimated Energy Usage (kWh/yr) = ∑(Proposed Fixture Watts x Op. Hours/yr x 1 kW/1000 Watts)
Energy Savings (kWh/yr) = Baseline Energy Usage – Estimated Energy Usage

Title	**Building Envelope Improvements**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Public Works Building**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	283	$36
kW				
MMBtu/yr	-	-	211	$2,389
Total				$2,426

INPUT DATA

Area of Cracks	8.7
Area Air-Conditioned	25%
Area Heated	40%
Winter Occupied Set Point	72.0
Winter Unoccupied Set Point	68.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	80.0
Balance Point	55.0
Conversion factor (1MMBtu)	1,000,000
Cooling Efficiency EER	10.9
Heating Efficiency %	82%
$/kwh unblended	$0.13
$/MMBtu of fuel	$11.31

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	1337
Infiltration (CFM) Summer	835

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	16	20	1/16	1/12	=	1.667
RTV's	6	20	1/16	1/12	=	0.104
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	12	668	1/8	1/12	=	6.958
Seal Bulkheads	-	0	1/16	1/12	=	-
					Total =	8.729

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu saved	Output Ton-Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
Cooling										
90-95	92.5	75.9	13	9	220,559	99,082	319,641	26.6	29	
85-90	87.5	73.0	46	30	554,619	206,139	760,758	63.4	70	
80-85	82.5	70.3	154	127	1,184,556	285,405	1,469,961	122.5	135	
75-80	77.5	67.5	169	161	532,869	-	532,869	44.4	49	
70-75	72.5	64.4	202	291	-	-	-	-	-	
65-70	67.5	61.3	187	401	-	-	-	-	-	
60-65	62.5	56.7	242	620	-	-	-	-	-	
Heating										
55-60	57.5	52.3	168	538	3,524,684	8,148,596	11,673,280	11.7		14.2
50-55	52.5	47.0	159	424	4,488,133	9,477,048	13,965,181	14.0		17.0
45-50	47.5	42.2	145	435	5,131,329	12,870,115	18,001,444	18.0		22.0
40-45	42.5	37.9	136	363	5,796,420	13,357,844	19,154,265	19.2		23.4
35-40	37.5	33.6	206	596	10,275,016	26,226,693	36,501,709	36.5		44.5
30-35	32.5	29.4	208	609	11,841,787	31,225,059	43,066,846	43.1		52.5
25-30	27.5	24.8	157	499	10,074,386	29,183,115	39,257,502	39.3		47.9
20-25	22.5	20.4	105	364	7,470,893	23,937,211	31,408,105	31.4		38.3
15-20	17.5	15.4	101	330	7,916,457	24,083,911	32,000,368	32.0		39.0
10-15	12.5	10.0	43	178	3,675,272	14,277,530	17,952,802	18.0		21.9
5-10	5.5	6.2	22	97	2,108,469	8,754,676	10,863,145	10.9		13.2
0-5	0.0	0.6	16	77	1,691,260	7,531,638	9,222,898	9.2		11.2
-5-0	0.0	0.0	8	48	874,630	4,670,956	5,545,586	5.5		6.8
		0.0								

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	**EMS-Temperature Setback**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Public Works Building**

Summary	Baseline	Proposed	Savings	Savings
kWh/yr	0	0	0	$0
kW			0	$0
MMBtu/yr	65	54	11	$127
Total				$127

Input Variables

	Existing	Proposed
Summer Occupied Setpoint	-	-
Summer Unoccupied Setpoint	-	-
Winter Occupied Setpoint	68	68
Winter Unoccupied Setpoint	68	60
Bulding Area	3,000	
Exterior Wall Area	450	
Roof Area	600	
Average R-value of Wall	10	
Average R-Value of Roof	24	
Boiler Efficiency (%)	82%	
Cooling System Efficiency (kW/ton)	1.10	

Assumptions and Constants:	
Building Balance Point	55
Default Wall R-Value	10
Default Roof R-Value	24
Building Infiltration- Air Changes Per Hour	0.4

Overall UA Value	70
Infiltration CFM	200

				Existing Case				Proposed Case			
Bin Temp	Hours Unoccupied	Occupied	Total Hours	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu
102.5	0	0	0	0	0	0	0	0	0	0	0
97.5	0	0	0	0	0	0	0	0	0	0	0
92.5	9	13	22	0	0	0	0	0	0	0	0
87.5	30	46	76	0	0	0	0	0	0	0	0
82.5	127	154	281	0	0	0	0	0	0	0	0
77.5	161	169	330	0	0	0	0	0	0	0	0
72.5	291	202	493	0	0	0	0	0	0	0	0
67.5	401	187	588	0	0	0	0	0	0	0	0
62.5	620	242	862	0	0	0	0	0	0	0	0
57.5	538	168	706	0	0	0	0	0	0	0	0
52.5	424	159	583	1	2	0	3	0	1	0	2
47.5	435	145	580	1	3	0	4	1	2	0	3
42.5	363	136	499	1	3	0	4	1	2	0	3
37.5	596	206	802	2	5	0	9	1	4	0	7
32.5	609	208	817	2	6	0	10	2	5	0	8
27.5	499	157	656	2	6	0	9	2	5	0	8
22.5	364	105	469	1	5	0	7	1	4	0	6
17.5	330	101	431	2	5	0	8	1	4	0	7
12.5	178	43	221	1	3	0	4	1	2	0	4
7.5	97	22	119	1	2	0	3	0	1	0	2
2.5	77	16	93	0	1	0	2	0	1	0	2
-2.5	48	8	56	0	1	0	1	0	1	0	1
	6,197	2,487	8684	13	40	0	65	11	33	0	54

Formulas:

For both Existing and Proposed Case:
Envelope Load MMBtu = (UA x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6
Infiltration Load MMBtu = (1.08 x Infiltration CFM x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6

Where
UA = 1/R-Value of Wall x Wall Area + 1/R-Value of Roof x Roof Area
Infiltration CFM = Building Area x 10 Feet Average Height x Building Air Changes Per Hour/60

Cooling kWh = (Envelope + Infiltration Load) x 10^6/12000 x kW/Ton Cooling Efficiency (Loads for Hours above Balance Point only)
Heating MMBtu = (Envelope + Infiltration Load)/ Heating Efficiency (Loads for Hours below Balance Point only)

Title	EMS- AHU Controls
Date	1-Feb-09
District	Dover, NH
Building	Public Works Building

Summary	Baseline	Proposed	Savings	Savings
kWh/yr	84,739	38,557	46,183	$5,909
kW			0	$0
MMBtu/yr	527	400	127	$1,442
Total				$7,350

$/kW	$0.00
Avg kWh	$0.13
$/MMBtu	$11.31

Input Variables

Air Handling Unit

			Existing System	Proposed System
Existing System			CAV	VAV
AHU CFM			10000	10000
Min OA %			20%	20%
Min VAV Flow %			40%	40%
Preheat Coil Temperature			40	40
Cooling Coil Temperature			62	62
Winter Mode				
Discharge Air Temp Winter Set Point			95	95
Unoccupied Temperature Setback Reduction			68	60
Return Air Temperature			85	85
Summer Mode				
Discharge Air Temp Summer Set Point			62	62
Discharge Air Humidity (Grains/Lbs)			60	60
Unoccupied Temperature Setback Increase			0	0
Return Air Temperature			72	72
Average Room Humidity Ratio:			65	65
Unoccupied Hour Min OA%			20%	20%
Cooling System Efficiency (kWh/ton):			1.10	
Boiler Efficiency:			82%	
Fan Data				
Unoccupied Hour Operation				
Fan Controls				VFD
	Motor hp	kW	Metered?	load factor
Supply Fan	10	7.46		100%
Return Fan				
Exhaust Fan				
	10.0	7.5		

Formulas:

For Both Existing and Proposed Case:
Cooling kWh = (Sensible Cooling Btu/Hr + Latent Cooling Btu/Hr)/12000 x Cooling kW/Ton x Bin Hours
Where:
Sensible Cooling Btu/Hr = 1.08 x Mixed Air CFM x (MAT-Cooling Coil Temperature)
Latent Cooling Btu/Hr = 0.68 x Mixed Air CFM x (MARH - Discharge Air RH Setpoint)

Heating MMBtu = ((Preheat Btu/Hr + Reheat Btu/Hr)/10^6)/Boiler Efficiency x Bin Hours
Where:
Preheat Btu/Hr = 1.08 x Mixed Air CFM x (Preheat Coil Temperature - MAT)
Reheat Btu/Hr (Cooling Season) = 1.08 x Mixed Air CFM x (Summer DAT - Cooling Coil Temperature)
Reheat Btu/Hr (Heating Season) = 1.08 x Mixed Air CFM x (Winter DAT - Max (Preheat Coil Temperature, MAT))

Where:
Mixed Air CFM = Total Supply CFM x % Fan Speed
MAT or Mixed Air Temperature = OA CFM/ Mixed Air CFM x OAT + RA CFM/Mixed Air CFM x RAT
MARH or Mixed Air RH = OA CFM/ Mixed Air CFM x OA RH + RA CFM/Mixed Air CFM x RA RH
% Fan Speed = 100% for CAV Systems, Varies between Min VAV Flow % to 100% Based on OAT for VAV Systems

Fan kWh = Fan kW x Hours Where Fan kW is determined by % Supply CFM using fan curve below

Assumptions and Constants:				
Building Balance Point			55	55

BASELINE CASE - OCCUPIED

Bin Temp	MCWB	Humidity Ratio (Grains/lb)	Hours Unoccupied	Occupied	Total Hours	Airflow OA CFM	RA CFM	MAT	MARH (grains/lb)	Preheat Btu/Hr	Sensible Cooling Btu/Hr	Latent Cooling Btu/Hr	Reheat Btu/Hr	Cooling kWh	Heating MMBtu	% Fan Speed	Fan kWh
92	71.2	82.5	9	13	22	2000	8000	76	69	0	151200	57800	0	253	0	100%	99
87	70.9	87.2	30	46	76	2000	8000	75	69	0	140400	64192	0	854	0	100%	340
82	68.2	80.8	127	154	281	2000	8000	74	68	0	129600	55488	0	2621	0	100%	1152
77	65.7	76.1	161	169	330	2000	8000	73	67	0	118800	49096	0	2597	0	100%	1259
72	63.6	73.9	291	202	493	2000	8000	72	67	0	108000	46104	0	2847	0	100%	1503
67	60.9	69.5	401	187	588	10000	0	67	70	0	54000	64600	0	2038	0	100%	1399
62	57	60.7	620	242	862	10000	0	62	61	0	0	4760	0	105	0	100%	1803
57	52.3	50.1	538	168	706	6667	3333	62	55	0	0	0	0	0	0	100%	1256
52	47.5	40.8	424	159	583	2000	8000	68	60	0	0	0	291600	0	57	100%	1189
47	42.8	33.3	435	145	580	2000	8000	67	59	0	0	0	302400	0	54	100%	1082
42	38.3	27.5	363	136	499	2000	8000	66	58	0	0	0	313200	0	52	100%	1015
37	33.7	22.4	596	206	802	2000	8000	65	56	0	0	0	324000	0	82	100%	1539
32	29.5	19.5	609	208	817	2000	8000	64	56	0	0	0	334800	0	85	100%	1549
27	24.8	15.2	499	157	656	2000	8000	63	55	0	0	0	345600	0	66	100%	1170
22	20	11.6	364	105	469	2000	8000	62	54	0	0	0	356400	0	45	100%	780
17	15.4	9.2	330	101	431	2000	8000	61	54	0	0	0	367200	0	45	100%	751
12	10.7	7.1	178	43	221	2000	8000	60	53	0	0	0	378000	0	20	100%	319
7	6.1	5.6	97	22	119	2000	8000	59	53	0	0	0	388800	0	10	100%	164
2	1.3		77	16	93	2000	8000	58	52	0	0	0	399600	0	8	100%	121
-3	-3.1		48	8	56	2000	8000	57	52	0	0	0	410400	0	4	100%	63
		Totals	6,197	2,487	8,684					-	702,000	342,040	4,212,000	11,316	527		18,555

BASELINE CASE - UNOCCUPIED

Bin Temp	MCWB	Humidity Ratio (Grains/lb)	Hours Unoccupied	Occupied	Total Hours	Airflow OA CFM	RA CFM	MAT	MARH (grains/lb)	Preheat Btu/Hr	Sensible Cooling Btu/Hr	Latent Cooling Btu/Hr	Reheat Btu/Hr	Cooling kWh	Heating MMBtu	% Fan Speed	Fan kWh
92	71.2	82.5	9	13	22	2000	8000	76	69	0	151200	57800	0	122	0	100%	66
87	70.9	87.2	30	46	76	2000	8000	75	69	0	140400	64192	0	392	0	100%	227
82	68.2	80.8	127	154	281	2000	8000	74	68	0	129600	55488	0	1503	0	100%	944
77	65.7	76.1	161	169	330	2000	8000	73	67	0	118800	49096	0	1756	0	100%	1203
72	63.6	73.9	291	202	493	2000	8000	72	67	0	108000	46104	0	2885	0	100%	2174
67	60.9	69.5	401	187	588	10000	0	67	70	0	54000	64600	0	1983	0	100%	2988
62	57	60.7	620	242	862	10000	0	62	61	0	0	4760	0	0	0	100%	4627
57	52.3	50.1	538	168	706	6667	3333	62	55	0	0	0	0	0	0	100%	4011
52	47.5	40.8	424	159	583	2000	8000	68	60	0	0	0	0	0	0	100%	3160
47	42.8	33.3	435	145	580	2000	8000	67	59	0	0	0	0	0	0	100%	3244
42	38.3	27.5	363	136	499	2000	8000	66	58	0	0	0	0	0	0	100%	2707
37	33.7	22.4	596	206	802	2000	8000	65	56	0	0	0	0	0	0	100%	4444
32	29.5	19.5	609	208	817	2000	8000	64	56	0	0	0	0	0	0	100%	4546
27	24.8	15.2	499	157	656	2000	8000	63	55	0	0	0	0	0	0	100%	3724
22	20	11.6	364	105	469	2000	8000	62	54	0	0	0	0	0	0	100%	2719
17	15.4	9.2	330	101	431	2000	8000	61	54	0	0	0	0	0	0	100%	2465
12	10.7	7.1	178	43	221	2000	8000	60	53	0	0	0	0	0	0	100%	1329
7	6.1	5.6	97	22	119	2000	8000	59	53	0	0	0	0	0	0	100%	724
2	1.3		77	16	93	2000	8000	58	52	0	0	0	0	0	0	100%	572
-3	-3.1		48	8	56	2000	8000	57	52	0	0	0	0	0	0	100%	355
		Totals	6,197	2,487	8,684					-	702,000	342,040	-	8,641	0		46,228

PROPOSED CASE - OCCUPIED

Bin Temp	MCWB	Humidity Ratio (Grains/lb)	Hours Unoccupied	Occupied	Total Hours	Airflow OA CFM	RA CFM	MAT	MARH (grains/lb)	Preheat Btu/Hr	Sensible Cooling Btu/Hr	Latent Cooling Btu/Hr	Reheat Btu/Hr	Cooling kWh	Heating MMBtu	% Fan Speed	Fan kWh
92	71.2	82.5	9	13	22	2000	8000	76	69	0	151200	57800	0	253	0	100%	100
87	70.9	87.2	30	46	76	2000	7000	75	70	0	129600	60792	0	795	0	90%	271
82	68.2	80.8	127	154	281	2000	6000	75	69	0	108000	48688	0	2219	0	80%	698
77	65.7	76.1	161	169	330	2000	5000	73	68	0	86400	38896	0	1938	0	70%	556
72	63.6	73.9	291	202	493	2000	4000	72	68	0	64800	32504	0	1798	0	60%	461
67	60.9	69.5	401	187	588	5000	0	67	70	0	27000	32300	0	1019	0	50%	279
62	57	60.7	620	242	862	4000	0	62	61	0	0	1904	0	42	0	40%	219
57	52.3	50.1	538	168	706	2667	1333	62	55	0	0	0	0	0	0	40%	153
52	47.5	40.8	424	159	583	2000	2600	63	54	0	0	0	157464	0	31	46%	196
47	42.8	33.3	435	145	580	2000	3200	62	53	0	0	0	183168	0	32	52%	237
42	38.3	27.5	363	136	499	2000	3800	62	52	0	0	0	208872	0	35	58%	287
37	33.7	22.4	596	206	802	2000	4400	61	52	0	0	0	234576	0	59	64%	550
32	29.5	19.5	609	208	817	2000	5000	61	52	0	0	0	260280	0	66	70%	685
27	24.8	15.2	499	157	656	2000	5600	60	52	0	0	0	285984	0	55	76%	628
22	20	11.6	364	105	469	2000	6200	60	52	0	0	0	311688	0	40	82%	501
17	15.4	9.2	330	101	431	2000	6800	60	52	0	0	0	337392	0	41	88%	569
12	10.7	7.1	178	43	221	2000	7400	59	53	0	0	0	363096	0	19	94%	282
7	6.1	5.6	97	22	119	2000	8000	59	53	0	0	0	388800	0	10	100%	167
2	1.3		77	16	93	2000	8000	58	52	0	0	0	399600	0	8	100%	124
-3	-3.1		48	8	56	2000	8000	57	52	0	0	0	410400	0	4	100%	64
		Totals	6,197	2,487	8,684					0	567,000	272,884	3,541,320	8,064	400		7,028

PROPOSED CASE - UNOCCUPIED

Bin Temp	MCWB	Humidity Ratio (Grains/lb)	Hours Unoccupied	Occupied	Total Hours	Airflow OA CFM	RA CFM	MAT	MARH (grains/lb)	Preheat Btu/Hr	Sensible Cooling Btu/Hr	Latent Cooling Btu/Hr	Reheat Btu/Hr	Cooling kWh	Heating MMBtu	% Fan Speed	Fan kWh
92	71.2	82.5	9	13	22	2000	8000	76	69	0	151200	57800	0	122	0	100%	67
87	70.9	87.2	30	46	76	2000	7000	75	70	0	129600	60792	0	362	0	90%	181
82	68.2	80.8	127	154	281	2000	6000	75	69	0	108000	48688	0	1253	0	80%	572
77	65.7	76.1	161	169	330	2000	5000	73	68	0	86400	38896	0	1277	0	70%	532
72	63.6	73.9	291	202	493	2000	4000	72	68	0	64800	32504	0	1731	0	60%	667
67	60.9	69.5	401	187	588	5000	0	67	70	0	27000	32300	0	991	0	50%	597
62	57	60.7	620	242	862	4000	0	62	61	0	0	1904	0	0	0	40%	562
57	52.3	50.1	538	168	706	2667	1333	62	55	0	0	0	0	0	0	40%	487
52	47.5	40.8	424	159	583	2000	2600	63	54	0	0	0	0	0	0	46%	522
47	42.8	33.3	435	145	580	2000	3200	62	53	0	0	0	0	0	0	52%	710
42	38.3	27.5	363	136	499	2000	3800	62	52	0	0	0	0	0	0	58%	766
37	33.7	22.4	596	206	802	2000	4400	61	52	0	0	0	0	0	0	64%	1588
32	29.5	19.5	609	208	817	2000	5000	61	52	0	0	0	0	0	0	70%	2009
27	24.8	15.2	499	157	656	2000	5600	60	52	0	0	0	0	0	0	76%	1999
22	20	11.6	364	105	469	2000	6200	60	52	0	0	0	0	0	0	82%	1746
17	15.4	9.2	330	101	431	2000	6800	60	52	0	0	0	0	0	0	88%	1867
12	10.7	7.1	178	43	221	2000	7400	59	53	0	0	0	0	0	0	94%	1174
7	6.1	5.6	97	22	119	2000	8000	59	53	0	0	0	0	0	0	100%	738
2	1.3		77	16	93	2000	8000	58	52	0	0	0	0	0	0	100%	583
-3	-3.1		48	8	56	2000	8000	57	52	0	0	0	0	0	0	100%	362
		Totals	6,197	2,487	8,684					-	567,000	272,884	-	5,736	0		17,729

Title	**Water Conservation**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Public Works Building**

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr				
kW				
MMBtu/yr			12.4	$140
kGal/yr	118	62	56.3	$622
Total				$762

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	37	25
% Year Round Occupancy	66%	100%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	85	25
Total Flushes Per Day (Less Urinal Flushes)	84	25
% Men	35%	40%
Total Men	9	10
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	2%	2%
Total Flushes per Day to Urinals	1.5	0.5
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	36	10
%Taking Showers	50%	0
Shower (Minutes/Day/Person)	8.00	0.00
Total Shower Usage (Minutes/Day)	97	0
Total Number of Toilets	4	1
Total Number of Urinals	2	0
Total Number of Sinks	5	1
Total Number of Showers	2	0
Total Number of Toilets to be Retrofitted	0	0
Total Number of Urinals to be Retrofitted	0	0
Total Number of Sinks to be Retrofitted	5	1
Total Number of Showers to be Retrofitted	2	0
% Toilets Being Retrofitted	0%	
% Urinals Being Retrofitted	0%	0%
% Sinks Being Retrofitted	100%	100%
% Showers Being Retrofitted	100%	0%

Input and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$11.3
Average Cold Water Temp, (°F)	55
Boiler Efficiency (%)	82%

Formulas & Assumptions:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.

2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person

3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.

4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.

5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.

6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].

7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	365	365

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
Use Type	Fixture Type	Baseline Flushes/Day, Min/Day	Estimated	Baseline (gpf, gpm)	Estimated	Baseline (gal/yr)	Estimated (gal/yr)	Water Estimated (gal/yr)	Fuel Estimated (MMBtu/yr)	Water Estimated ($/yr)	Fuel Estimated ($/yr)
Staff	Toilet	84	84	3.5	1.6	-	0	-	-	-	-
	Urinal	1	1	1.5	1.0	-	$0	-	-	-	-
	Sink	36	36	1.7	0.5	23,013	6,651	16,362	3.6	181	41
	Showers	97	97	2.5	1.5	88,682	53,209	35,473	7.8	392	88
Visitors	Toilet	25	25	3.5	1.6	-	-	-	-	-	-
	Urinal	1	1	1.5	1.0	-	-	-	-	-	-
	Sink	10	10	1.7	0.5	6,315	1,825	4,490	1	50	-
	Showers	0	0	2.5	1.5	-	-	-	-	-	-

Title	**Vending Machine Controls**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Public Works Building**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	3,262	1,952	1,311	$ 168
kW			-	
MMBtu/yr	-	-	-	$ -
Total				$ 168

$/kW	$0.00
$/kWh	$0.13
$/MMBtu	$11.31

Input Data:

Vending Machine Information

Site:	$ / kWh	Room	Type	Qty.	Volts	Amps	Lighting * Watts/ unit	Lighting Found	Existing Operation Hrs/Day	Existing Operation Days/Yr.	Compressor Duty Cycle Existing Normal	Compressor Duty Cycle Proposed Nite	Machine Location is Occupied Hrs/Day	Machine Location is Occupied Days/Yr.	Number of Controllers Required Beverage	Number of Controllers Required Snack
Public Works Building	$ 0.13	Break Area	Vending Machine	1	115	10.5	80	On	24	365	33%	12.0%	10	365	0	0
Public Works Building	$ 0.13														0	0
Public Works Building	$ 0.13														0	0
Public Works Building	$ 0.13														0	0
Public Works Building	$ 0.13														0	0
Public Works Building	$ 0.13														0	0
Public Works Building	$ 0.13														0	0
Public Works Building	$ 0.13														0	0
Public Works Building	$ 0.13														0	0
Public Works Building	$ 0.13														0	0
			Totals:				* Lighting watts is included in the volt / amp data and Total kW								0	0

Calculations & Output Data:

Site	Lighting Savings	Ltg. Watts	Existing Hrs/Yr.	Existing Hrs/Yr.	Existing Lighting kWh/yr.	Proposed Lighting kWh/Yr.	Lighting Savings kwh	Compressor Savings Comp. kW	Present Hrs/Yr.	Proposed Hrs/Yr.	Existing Compressor kWh/yr.	Proposed kWh/Yr.	Comp. Savings kwh	Total Savings kwh	$
Public Works Building	Vending Machine	80	8,760	4,263	701	341	360	0.886	2,891	1,818	2,561	1,610	951	1,311	$ 168
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
Public Works Building	0	0	0	0	0	0	0	0.000	0	0	0	0	0	0	$ 0
					701	341	360				2,561	1,610	951	1,311	$ 168

Methodology & Summary: **Assumptions and Formulae:**

Present Electricity Use = Lighting (kWh) + Compressor (kWh)

Lighting kWh =Lighting Watts / 1000 x # units x Hours per Day x Days per Year

Compressor kWh = (Volts x Amps x 0.80 power factor / 1000 - Lighting Watts) x # units x Hours per Day x Days per Year x Duty Cycle

Proposed Electricity Use = Lighting kWh with Control + Compressor kWh with Control

Lighting kWh with Control = Lighting watts per unit /1000 x # units x (Occupied Hours per Year + Unoccupied Hours x Nite Duty Cycle)

Proposed Compressor Run Hours = (Occupied Hours x Existing Duty Cycle) + (Unoccupied Hours x Unoccupied Duty Cycle)

Compressor kWh with Control = (Volts x Amps x 0.80 PF -Lighting Watts) / 1000 x # Units x Proposed Compressor Hours per Year

Electricity Cost Savings = Electricity Savings x Electricity Unit Cost

	Lighting	Comp.	Total		
	701	2,561	3,262	kWh	
Proposed Annual Electricity Use:	341	1,610	1,952	kWh	
Total Annual Savings:	360	951	1,311	kWh	$ 168
			40%	reduction	

Title	Energy Efficient Transformers
Date	February 1, 2009
District	Dover, NH
Building	Public Works Building

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr			27,750	$3,550
kW			-	$0
MMBtu/yr				
Total				$3,550

Input

TRANSFORMER COUNT	Facility	Location	TRANSFORMER	kVA	REPLACE
2	Public Works	Main Elec Room	LP-A	30	1
3	Public Works	Welding Shop	LP-B	45	1
4	Public Works	Pole Barn	PB-1	75	1
5	Public Works	Mezzanine	LP-P	75	1
6	Public Works	Mezzanine	LP-C	30	1

ADJUSTMENTS

% Load during normal operating hours	% Load outside operating hours	equipment operating hrs/ day	equipment operating days/yr	Load Power Factor	Existing Efficiency (Normal Operation)	Existing Efficiency (Outside op. hrs)	Powersmiths Efficiency (Normal Operation)	Powersmiths Efficiency (Outside op. hrs)	A/C System Performance (kW/ton)
30%	18.0%	14.0	300	0.95	94.3%	91.5%	97.8%	97.7%	0
30%	18.0%	14.0	300	0.95	94.1%	91.2%	98.2%	98.0%	0
18%	10.0%	14.0	300	0.95	91.8%	86.5%	98.4%	97.7%	0
18%	10.0%	14.0	300	0.95	91.8%	86.5%	98.4%	97.7%	0
18%	10.0%	14.0	300	0.95	91.5%	86.0%	97.7%	96.7%	0

Existing Transformer Losses

Existing kW Losses (Normal Operation)	Existing kW Losses (Outside op. hrs)	Existing Annual additional kWh from transformers	KW Loses	KW DOLLARS	Existing Annual Cost of Transformer Losses	Existing Additional Tons of Cooling (on peak)	Existing Annual additional kWh from A/C	Existing Annual Cost of Associated A/C
0.5	0.5	4,363	1.00	$59.87	$ 598	-	-	$ -
0.8	0.7	6,783	1.55	$93.07	$ 930	-	-	$ -
1.1	1.1	9,902	2.26	$135.73	$ 1,356	-	-	$ -
1.1	1.1	9,902	2.26	$135.73	$ 1,356	-	-	$ -
0.5	0.5	4,122	0.94	$56.50	$ 565	-	-	$ -
			8.02	**$480.90**	**$ 4,805**			

Powersmiths Transformer Losses

Powersmiths kW Losses (Normal Operation)	Powersmiths Transformer kW Losses (Outside op. hrs)	Powersmiths Annual additional kWh from transformers	KW Loses	KW DOLLARS	Annual Cost of Powersmiths Losses	Powersmiths Additional Tons of Cooling (on peak)	Powersmiths Annual additional kWh from A/C	Powersmiths Annual Cost of Associated A/C
0.19	0.12	1,360	0.31	$18.79	$ 188	-	-	$ -
0.23	0.15	1,683	0.39	$23.24	$ 233	-	-	$ -
0.21	0.17	1,660	0.38	$22.85	$ 229	-	-	$ -
0.21	0.17	1,660	0.38	$22.85	$ 229	-	-	$ -
0.12	0.10	960	0.22	$13.22	$ 132	-	-	$ -
			1.68	**$100.94**	**$ 1,010**		**-**	

Compare Transformer Performance

Existing Annual Operating Cost Total	POWERSMITHS Annual Operating Cost Total	Annual Dollar Savings with Powersmiths	Annual kWh Savings With Powersmiths	Annual Peak Ton Cooling Reduction	kW SAVINGS	kWh SAVINGS	kW $ SAVINGS	kWh $ SAVINGS	TOTAL ELC $ SAVINGS
$ 598	$ 188	$ 410	3003	-	0.68	3,003.34	-	384.24	$ 384.24
$ 930	$ 233	$ 410	5101	-	1.16	5,100.84	-	652.59	$ 652.59
$ 1,356	$ 229	$ 1,128	8242	-	1.88	8,242.22	-	1,054.50	$ 1,054.50
$ 1,356	$ 229	$ 1,128	8242	-	1.88	8,242.22	-	1,054.50	$ 1,054.50
$ 565	$ 132	$ 432	3162	-	0.72	3,161.87	-	404.52	$ 404.52
$ 4,805	**$ 1,010**	**$ 3,795**	**27,750**	**-**	**6.33**	**27,750.50**	**-**	**3,550.35**	**$ 3,550.35**

Appendix 3-6 McConnell Center

Rate Sheet February 10, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.11	$/kWh
Electric Demand	$7.10	$/kW
Natural Gas	$1.41	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$14.12	$/MMBtu

Heating Efficiency (%)	85%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (℉)	55 ℉

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
38.6	31.8	70.3

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	78
Winter Inside Setpoint (F)	72	72

Total Building Sq Footage	103,000
Percent of Building Cooled	90%
Total Cooled Sq Footage	92,700

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy

	#2 OIL				NATURAL GAS						
Year	**Usage**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total			**0**	**$0.0**	**39,726**	**56,083**	**3,973**	**$14.1**	**3,973**	**56,083**	**$14.1**

Electricity

Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**959,000**	**102,893**					**959,000**	**$102,893**	**$0.11**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	2	8	7

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Unoccupied
Sunday	Unoccupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	3
Dec	3

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	15.4	6.6
87.5	53.0	23.0
82.5	193.2	87.8
77.5	221.5	108.5
72.5	307.8	185.2
67.5	314.8	273.2
62.5	427.9	434.1
57.5	327.0	379.0
52.5	270.4	312.6
47.5	271.5	308.5
42.5	232.7	266.3
37.5	371.3	430.8
32.5	366.3	450.7
27.5	286.9	369.1
22.5	193.9	275.1
17.5	182.8	248.2
12.5	94.8	126.2
7.5	47.5	71.5
2.5	30.1	62.9
-2.5	17.0	39.0
-7.5	15.4	37.6
-12.5	4.0	10.0
-17.5	1.6	7.4

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations

2. Select one location in cell B2 from the drop-down list.

3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.

4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.

5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.

6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 10, 2009
District Name	Dover, NH
Bldg Name	McConnell Center
Bdl Size	103,000

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	3,273	3,973	$7,246
	MBtu/sq ft	31.8	38.6	$70
Proposed	MMBtu/yr	3,067	3,447	$6,515
	MBtu/sq ft	29.8	33.5	$63
% Change	MMBtu/yr	206	525	731
	MBtu/sq ft	2.0	5.1	7.1

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 3	Building Envelope Improvements - Weatherization		115	$12	78	$1,106			$1,119
FIM 4	Energy Management System - Upgrades								
FIM 4.1	Energy Management System - Building Controls		1,098	$118	447	$6,308			$6,426
FIM 13	Energy Efficient Transformers	11.8	59,043	$7,340					$7,340
	TOTALS	**11.8**	**60,256**	**$7,470**	**525**	**$7,414**			**$14,884**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	Thermal Energy MMBtu/yr	Thermal Energy $/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	103,000	959,000	102,893	3,973	56,083	$158,976	$1.54
AFTER PROJECT ENERGY USAGE:	103,000	898,744	$95,424	3,447	$48,668	$144,092	$1.40
AFTER PROJECT ENERGY SAVINGS:	103,000	60,256	$7,470	525	$7,414	$14,884	$0.14
ENERGY REDUCTION (%):		6.28%	7.26%	13.22%	13.22%	9.36%	9.36%

Title	**Building Envelope Improvements**
Date	**February 10, 2009**
District	**Dover, NH**
Building	**McConnell Center**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	$119	$13
kW				
MMBtu/yr	-	-	$81	$1,140
Total				$1,153

INPUT DATA

Area of Cracks	2.8
Area Air-Conditioned	90%
Area Heated	90%
Winter Occupied Set Point	72.0
Winter Unoccupied Set Point	72.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	78.0
Balance Point	55.0
Conversion factor (1MMBtu)	1,000,000
Cooling Efficiency EER	10.9
Heating Efficiency %	0.9
$/kwh unblended	$0.11
$/MMBtu of fuel	$14.12
	#DIV/0!

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	30%
Windward Diversity	50%

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	971
Infiltration (CFM) Summer	971

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	18	20	1/16	1/12	=	1.875
RTV's	12	68	1/6	1/12	=	0.944
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	-	0	1/6	1/12	=	-
Sweeps only (Doors)	-	0	1/16	1/12	=	-
					Total =	2.819

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu saved	Output Ton-Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
Cooling										
90-95	92.5	75.9	15	7	89,414	30,314	119,728	10.0	11	
85-90	87.5	73.0	53	23	225,333	68,659	293,993	24.5	27	
80-85	82.5	70.3	193	88	516,870	124,325	641,195	53.4	59	
75-80	77.5	67.5	222	108	244,006	-	244,006	20.3	22	
70-75	72.5	64.4	308	185	-	-	-	-	-	
65-70	67.5	61.3	315	273	-	-	-	-	-	
60-65	62.5	56.7	428	434	-	-	-	-	-	
Heating										
55-60	57.5	52.3	327	379	1,492,281	1,729,498	3,221,779	3.2		3.8
50-55	52.5	47.0	270	313	1,659,735	1,918,148	3,577,883	3.6		4.2
45-50	47.5	42.2	271	309	2,093,054	2,379,104	4,472,157	4.5		5.3
40-45	42.5	37.9	233	266	2,160,651	2,472,170	4,632,821	4.6		5.5
35-40	37.5	33.6	371	431	4,030,961	4,677,000	8,707,961	8.7		10.2
30-35	32.5	29.4	366	451	4,553,833	5,602,622	10,156,455	10.2		11.9
25-30	27.5	24.8	287	369	4,018,309	5,168,969	9,187,278	9.2		10.8
20-25	22.5	20.4	194	275	3,021,134	4,285,225	7,306,359	7.3		8.6
15-20	17.5	15.4	183	248	3,136,017	4,256,575	7,392,592	7.4		8.7
10-15	12.5	10.0	95	126	1,775,605	2,362,792	4,138,398	4.1		4.9
5-10	5.5	6.2	48	71	994,586	1,495,943	2,490,529	2.5		2.9
0-5	0.0	0.6	30	63	681,816	1,425,542	2,107,359	2.1		2.5
-5-0	0.0	0.0	17	39	385,418	883,529	1,268,947	1.3		1.5

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	**EMS-Temperature Setback**
Date	**February 10, 2009**
District	**Dover, NH**
Building	**McConnell Center**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	5,301	4,170	1,132	$121
kW				
MMBtu/yr	2,692	2,231	461	$6,503
Total				$6,625

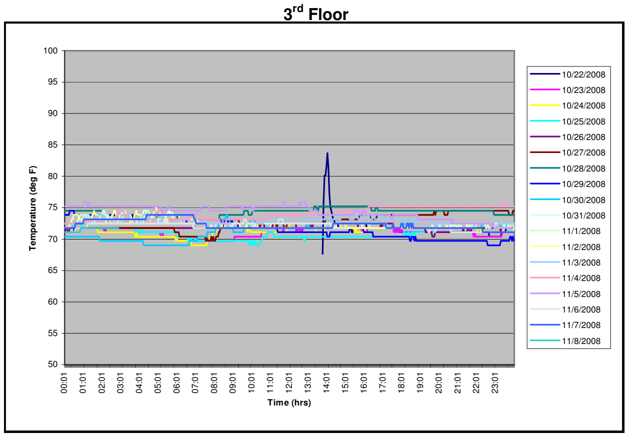
Input Variables

	Existing	Proposed
Summer Occupied Setpoint	72	74
Summer Unoccupied Setpoint	78	78
Winter Occupied Setpoint	72	72
Winter Unoccupied Setpoint	72	60
Bulding Area	103,000	
Exterior Wall Area	15,450	
Roof Area	20,600	
Average R-value of Wall	10	
Average R-Value of Roof	10	
Boiler Efficiency (%)	85%	
Cooling System Efficiency (kW/ton)	1.10	
	10	

Assumptions and Constants:	
Building Balance Point	55
Default Wall R-Value	10
Default Roof R-Value	24
Building Infiltration- Air Changes Per Hour	0.4

Overall UA Value	3605
Infiltration CFM	6867

3rd Floor



				Existing Case				Proposed Case			
Bin Temp	Hours Unoccupied	Occupied	Total Hours	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu
102.5	0	0	0	0	0	0	0	0	0	0	0
97.5	0	0	0	0	0	0	0	0	0	0	0
92.5	7	15	22	1	3	415	0	1	3	384	0
87.5	23	53	76	4	8	1051	0	3	7	944	0
82.5	88	193	281	9	18	2449	0	7	15	2058	0
77.5	108	222	330	4	9	1231	0	3	6	783	0
72.5	185	308	493	1	1	155	0	0	0	0	0
67.5	273	315	588	0	0	0	0	0	0	0	0
62.5	434	428	862	0	0	0	0	0	0	0	0
57.5	379	327	706	0	0	0	0	0	0	0	0
52.5	313	270	583	41	84	0	147	27	56	0	99
47.5	309	271	580	51	105	0	184	38	78	0	136
42.5	266	233	499	53	109	0	191	42	85	0	149
37.5	431	371	802	100	205	0	359	81	167	0	292
32.5	451	366	817	116	239	0	418	97	199	0	348
27.5	369	287	656	105	216	0	379	89	184	0	321
22.5	275	194	469	84	172	0	301	72	148	0	258
17.5	248	183	431	85	174	0	305	74	152	0	266
12.5	126	95	221	47	98	0	170	42	86	0	151
7.5	71	48	119	28	57	0	100	25	51	0	88
2.5	63	30	93	23	48	0	84	21	42	0	74
-2.5	39	17	56	15	31	0	54	13	27	0	48
	4,458	4,226	8684	767	1578	5301	2692	635	1307	4170	2231

Calculations:

For both Existing and Proposed Case:

Envelope Load MMBtu = (UA x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6

Infiltration Load MMBtu = (1.08 x Infiltration CFM x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6

Where

UA = 1/R-Value of Wall x Wall Area + 1/R-Value of Roof x Roof Area

Infiltration CFM = Building Area x 10 Feet Average Height x Building Air Changes Per Hour/60

Cooling kWh = (Envelope + Infiltration Load) x 10^6/12000 x kW/Ton Cooling Efficiency (Loads for Hours above Balance Point only)

Heating MMBtu = (Envelope + Infiltration Load)/ Heating Efficiency (Loads for Hours below Balance Point only)

Title	**Energy Efficient Transformers**
Date	**February 10, 2009**
District	**Dover, NH**
Building	**McConnell Center**

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr			60,869	$6,531
kW			12.2	$1,036
MMBtu/yr				
Total				$7,567

TRANSFORMER COUNT	Facility	Location	Transformer Designation	kVA	REPLACE
1	McConnell Center	Boiler Room	MLV	75	1
2	McConnell Center	Main Elec Room	KPLV1	75	1
3	McConnell Center	Main Elec Room	LV1S	45	1
4	McConnell Center	Room 251	LV2W	75	1
5	McConnell Center	Room 230A	LV2S	45	1
6	McConnell Center	Room 320A	LV3S	45	1
7	McConnell Center	Room 345A	LV3W	75	1
8	McConnell Center	Room Storage	LV4E	45	1

ADJUSTMENTS

% Load during normal operating hours	% Load outside operating hours	equipment operating hrs/ day	equipment operating days/yr	Load Power Factor	Existing Efficiency (Normal Operation)	Existing Efficiency (Outside op. hrs)	Powersmiths Efficiency (Normal Operation)	Powersmiths Efficiency (Outside op. hrs)	A/C System Performance (kW/ton)
25%	15.0%	14.0	300	0.95	93.7%	90.4%	98.5%	98.2%	0.5
25%	15.0%	14.0	300	0.95	93.7%	90.4%	98.5%	98.2%	0.5
25%	15.0%	14.0	300	0.95	93.2%	89.7%	98.2%	97.9%	0.5
25%	15.0%	14.0	300	0.95	93.7%	90.4%	98.5%	98.2%	0.5
25%	15.0%	14.0	300	0.95	93.2%	89.7%	98.2%	97.9%	0.5
25%	15.0%	14.0	300	0.95	93.2%	89.7%	98.2%	97.9%	0.5
25%	15.0%	14.0	300	0.95	93.7%	90.4%	98.5%	98.2%	0.5
25%	15.0%	14.0	300	0.95	93.2%	89.7%	98.2%	97.9%	0.5

Existing Transformer Losses

Existing kW Losses (Normal Operation)	Existing kW Losses (Outside op. hrs)	Existing Annual additional kWh from transformers	KW Loses	KW DOLLARS	Existing Annual Cost of Transformer Losses	Existing Additional Tons of Cooling (on peak)	Existing Annual additional kWh from A/C	Existing Annual Cost of Associated A/C
1.2	1.1	10,187	2.33	$198.37	$ 1,222	0.34	1,447	$ 174
1.2	1.1	10,187	2.33	$198.37	$ 1,222	0.34	1,447	$ 174
0.8	0.7	6,618	1.51	$128.87	$ 794	0.22	940	$ 113
1.2	1.1	10,187	2.33	$198.37	$ 1,222	0.34	1,447	$ 174
0.8	0.7	6,618	1.51	$128.87	$ 794	0.22	940	$ 113
0.8	0.7	6,618	1.51	$128.87	$ 794	0.22	940	$ 113
1.2	1.1	10,187	2.33	$198.37	$ 1,222	0.34	1,447	$ 174
0.8	0.7	6,618	1.51	$128.87	$ 794	0.22	940	$ 113
			15.36	**$1,308.97**	**$ 8,066**			

Powersmiths Transformer Losses

Powersmiths kW Losses (Normal Operation)	Powersmiths Transformer kW Losses (Outside op. hrs)	Powersmiths Annual additional kWh from transformers	KW Loses	KW DOLLARS	Annual Cost of Powersmiths Losses	Powersmiths Additional Tons of Cooling (on peak)	Powersmiths Annual additional kWh from A/C	Powersmiths Annual Cost of Associated A/C
0.27	0.19	2,017	0.46	$39.50	$ 245	0.08	286	$ 35
0.27	0.19	2,017	0.46	$39.50	$ 245	0.08	286	$ 35
0.20	0.14	1,463	0.34	$28.66	$ 178	0.06	208	$ 25
0.27	0.19	2,017	0.46	$39.50	$ 245	0.08	286	$ 35
0.20	0.14	1,463	0.34	$28.66	$ 178	0.06	208	$ 25
0.20	0.14	1,463	0.34	$28.66	$ 178	0.06	208	$ 25
0.27	0.19	2,017	0.46	$39.50	$ 245	0.08	286	$ 35
0.20	0.14	1,463	0.34	$28.66	$ 178	0.06	208	$ 25
			3.20	**$272.62**	**$ 1,690**		**1,977**	

Compare Transformer Performance

Existing Annual Operating Cost Total	POWERSMITHS Annual Operating Cost Total	Annual Dollar Savings with Powersmiths	Annual kWh Savings With Powersmiths	Annual Peak Ton Cooling Reduction	kW SAVINGS	kWh SAVINGS	kW $ SAVINGS	kWh $ SAVINGS	TOTAL ELC $ SAVINGS
$ 1,396	$ 280	$ 1,116	9331	0.26	1.86	9,330.61	158.79	1,001.10	$ 1,159.90
$ 1,396	$ 280	$ 1,116	9331	0.26	1.86	9,330.61	158.79	1,001.10	$ 1,159.90
$ 907	$ 203	$ 704	5887	0.17	1.18	5,886.57	100.17	631.58	$ 731.75
$ 1,396	$ 280	$ 1,116	9331	0.26	1.86	9,330.61	158.79	1,001.10	$ 1,159.90
$ 907	$ 203	$ 704	5887	0.17	1.18	5,886.57	100.17	631.58	$ 731.75
$ 907	$ 203	$ 704	5887	0.17	1.18	5,886.57	100.17	631.58	$ 731.75
$ 1,396	$ 280	$ 1,116	9331	0.26	1.86	9,330.61	158.79	1,001.10	$ 1,159.90
$ 907	$ 203	$ 704	5887	0.17	1.18	5,886.57	100.17	631.58	$ 731.75
$ 9,212	**$ 1,930**	**$ 7,282**	**60,869**	**1.71**	**12.16**	**60,868.69**	**1,035.86**	**6,530.74**	**$ 7,566.60**

Appendix 3-7 Dover Public Library

Rate Sheet February 1, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.13	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	$1.41	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$14.14	$/MMBtu

Heating Efficiency (%)	78%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
44.9	21.7	66.7

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	80
Winter Inside Setpoint (F)	70	68

Total Building Sq Footage	20,000
Percent of Building Cooled	40%
Total Cooled Sq Footage	8,000

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy

	#2 OIL				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total			**0**	**$0.0**	**8,985**	**12,706**	**899**	**$14.1**	**899**	**12,706**	**$14.1**

Electricity

Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**127,440**	**17,143**					**127,440**	**$17,143**	**$0.13**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	0	7	3

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Occupied
Sunday	Unoccupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	3
Dec	3

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	14.8	7.2
87.5	51.0	25.0
82.5	178.4	102.6
77.5	198.4	131.6
72.5	250.3	242.7
67.5	229.7	358.3
62.5	293.4	568.6
57.5	206.6	499.4
52.5	184.8	398.2
47.5	180.3	399.7
42.5	162.8	336.2
37.5	249.3	552.7
32.5	248.8	568.2
27.5	191.3	464.8
22.5	123.4	345.6
17.5	119.5	311.5
12.5	56.3	164.7
7.5	27.2	91.8
2.5	15.6	77.4
-2.5	7.7	48.3
-7.5	6.3	46.7
-12.5	1.8	12.2
-17.5	0.0	9.0

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations

2. Select one location in cell B2 from the drop-down list.

3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.

4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.

5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.

6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
Bldg Name	Dover Public Library
Bdl Size	20,000

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	435	899	1,333
	MBtu/sq ft	21.7	44.9	66.7
Proposed	MMBtu/yr	322	717	1,039
	MBtu/sq ft	16.1	35.9	52.0
% Change	MMBtu/yr	113	181	294
	MBtu/sq ft	5.6	9.1	14.7

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 1	Lighting - Fixture Retrofit	8.2	26,207	$3,525	(16)	($224)			$3,302
FIM 2	Lighting - Fixture Control		6,871	$924					$924
FIM 3	Building Envelope Improvements - Weatherization		26	$4	27	$385			$389
FIM 4	Energy Management System - Upgrades								
FIM 4.1	Energy Management System - Building Controls				71	$1,008			$1,008
FIM 6	Water Conservation				10	$144	123	$1,363	$1,507
FIM 15	Heating System Upgrade - Boiler Replacement				88	$1,251			$1,251
	TOTALS	**8.2**	**33,104**	**$4,453**	**181**	**$2,564**	**123**	**$1,363**	**$8,380**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	20,000	127,440	17,143	899	12,706	$29,849	$1.49
AFTER PROJECT ENERGY USAGE:	20,000	94,336	$12,690	717	$10,141	$22,831	$1.14
AFTER PROJECT ENERGY SAVINGS:	20,000	33,104	$4,453	181	$2,564	$7,017	$0.35
ENERGY REDUCTION (%):		25.98%	25.98%	20.18%	20.18%	23.51%	23.51%

Title	**Lighting Fixture Retrofit and Controls**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover Public Library**

Summary *	Baseline	Proposed	Savings	$ Savings
kWh/yr	83,163	49,062	34,101	$4,587
kW	30.4	18.8	11.6	$0
MMBtu/yr		(16)	(16)	($231)
Total				$4,357

* *Includes both Lighting Retrofit & Lighting Controls*

Measures	Units	Baseline	Cooling Credit	Heating Debit	Proposed	Energy Savings	Cost Savings ($)	Total Savings ($)
Lighting Fixture Retrofit	kWh	83,163			56,555	26,608	$3,579	$3,579
	kW	30.4			21.9	8.5	$0	
Lighting Fixture Controls	kWh	56,555			49,471	7,084	$953	$953
	kW	21.9			18.8	3.1	NA	
Total	kWh	83,163	409		49,062	34,510	$4,642	$4,412
	kW	30.4			18.8	11.6	$0	
	MMBtu			(16)	(16)	(16)	($231)	

YES Is Interaction Penalty Required ?

75%	...PERCENTAGE OF LIGHT HEAT RETURNED TO HVAC (%HTRET)	
11.58	...TOTAL KW LIGHTING LOAD REDUCTION (KWRED)	
33,692	...TOTAL KWH LIGHTING LOAD REDUCTION (KWHRED)	
58	...AVERAGE LIGHTING HOURS PER WEEK (LITEHHRS)	= KWHRED/KWRED / WPY
12	... DEMAND MONTHS (CLGMONTHS)	
78%	...HEATING SYSTEM EFFICIENCY (EFF)	
1.10	....Avg. KW/TON OF CHILLER (KW/TON)	
0.0	....AVG. KW/TON OF SUPPORT EQUIPMENT (KWSUPT)	
1,575	...HEATING HRS/YR FROM WEATHER DATA (HHPY)	
1,423	...COOLING HRS/YR FROM WEATHER DATA (CHPY)	
429	...WINTER HEATING COINCIDENT HRS (HTGCOHRS)	= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
376	...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)	= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS
50	...WEEKS/YEAR OF BUILDING OPERATION (WPY)	
40%	...PERCENT OF AREA AIR CONDITIONED (%COOLED)	

(Heating Debit)	(KWRED * 3413 * %HTRET * HTGCOHRS) / BTUs/UNIT / EFF =================================	(16)	**MMBTU**
	FUEL SAVED * COST / MMBTU ==	($231)	**$**
(Cooling Credit)	(KWRED * 3413 * %HTRET * CLGCOHRS * %COOLED) / 12000 * KW/TON ===========	409	**KWH**
	MMBTU SAVED * COOLCOST ==	$55	**$**
	TOTAL INTERACTION ===========	($176)	**$**

Formulas:

Baseline Energy Usage (kWh/yr) = ∑(Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)
Estimated Energy Usage (kWh/yr) = ∑(Proposed Fixture Watts x Op. Hours/yr x 1 kW/1000 Watts)
Energy Savings (kWh/yr) = Baseline Energy Usage – Estimated Energy Usage

Title	**Building Envelope Improvements**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover Public Library**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	0	0	27	$4
kW				
MMBtu/yr	0	0	28	$397
Total				$401

INPUT DATA

Area of Cracks	0.6
Area Air-Conditioned	50%
Area Heated	70%
Winter Occupied Set Point	70.0
Winter Unoccupied Set Point	68.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	80.0
Balance Point	55.0
Conversion factor (1MMBtu)	1,000,000
Cooling Efficiency EER	10.9
Heating Efficiency %	78%
$/kwh unblended	$0.13
$/MMBtu of fuel	$14.14

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	171
Infiltration (CFM) Summer	122

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	4	20	1/16	1/12	=	0.417
RTV's	3	16	1/6	1/12	=	0.222
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	-	0	1/6	1/12	=	-
Seal Bulkheads	-	0	1/16	1/12	=	-
					Total =	0.639

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu saved	Output Ton-Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
Cooling										
90-95	92.5	75.9	15	7	21,675	7,146	28,821	2.4	3	
85-90	87.5	73.0	51	25	54,556	14,857	69,414	5.8	6	
80-85	82.5	70.3	178	103	120,154	20,326	140,480	11.7	13	
75-80	77.5	67.5	198	132	55,032	-	55,032	4.6	5	
70-75	72.5	64.4	250	243	-	-	-	-	-	
65-70	67.5	61.3	230	358	-	-	-	-	-	
60-65	62.5	56.7	293	569	-	-	-	-	-	
Heating										
55-60	57.5	52.3	207	499	286,525	581,683	868,208	0.9		1.1
50-55	52.5	47.0	185	398	358,755	684,714	1,043,469	1.0		1.3
45-50	47.5	42.2	180	400	449,957	909,061	1,359,019	1.4		1.7
40-45	42.5	37.9	163	336	496,587	951,126	1,447,713	1.4		1.9
35-40	37.5	33.6	249	553	898,807	1,870,096	2,768,903	2.8		3.5
30-35	32.5	29.4	249	568	1,035,191	2,237,535	3,272,726	3.3		4.2
25-30	27.5	24.8	191	465	901,697	2,088,068	2,989,766	3.0		3.8
20-25	22.5	20.4	123	346	650,257	1,744,429	2,394,686	2.4		3.1
15-20	17.5	15.4	119	312	695,929	1,745,148	2,441,077	2.4		3.1
10-15	12.5	10.0	56	165	358,978	1,014,187	1,373,165	1.4		1.8
5-10	5.5	6.2	27	92	194,919	636,207	831,126	0.8		1.1
0-5	0.0	0.6	16	77	121,266	583,754	705,020	0.7		0.9
-5-0	0.0	0.0	8	48	59,905	364,249	424,154	0.4		0.5

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	**EMS-Temperature Setback**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover Public Library**

Summary	Baseline	Proposed	Savings	Savings
kWh/yr	648	648	0	$0
kW				
MMBtu/yr	463	390	74	$1,039
Total				$1,039

Input Variables

	Existing	Proposed
Summer Occupied Setpoint	74	74
Summer Unoccupied Setpoint	80	80
Winter Occupied Setpoint	70	70
Winter Unoccupied Setpoint	68	60
Bulding Area	20,000	
Exterior Wall Area	3,000	
Roof Area	4,000	
Average R-value of Wall	10	
Average R-Value of Roof	24	
Boiler Efficiency (%)	78%	
Cooling System Efficiency (kW/ton)	1.10	

Assumptions and Constants:	
Building Balance Point	55
Default Wall R-Value	10
Default Roof R-Value	24
Building Infiltration- Air Changes Per Hour	0.4

Overall UA Value	467
Infiltration CFM	1333

				Existing Case				Proposed Case			
Bin Temp	Hours Unoccupied	Occupied	Total Hours	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu
102.5	0	0	0	0	0	0	0	0	0	0	0
97.5	0	0	0	0	0	0	0	0	0	0	0
92.5	7	15	22	0	1	64	0	0	1	64	0
87.5	25	51	76	0	1	153	0	0	1	153	0
82.5	103	178	281	1	3	310	0	1	3	310	0
77.5	132	198	330	0	1	121	0	0	1	121	0
72.5	243	250	493	0	0	0	0	0	0	0	0
67.5	358	230	588	0	0	0	0	0	0	0	0
62.5	569	293	862	0	0	0	0	0	0	0	0
57.5	499	207	706	0	0	0	0	0	0	0	0
52.5	398	185	583	4	14	0	23	3	9	0	15
47.5	400	180	580	6	18	0	30	4	13	0	22
42.5	336	163	499	6	19	0	32	5	15	0	25
37.5	553	249	802	12	36	0	61	10	30	0	50
32.5	568	249	817	14	42	0	72	12	36	0	61
27.5	465	191	656	13	39	0	66	11	33	0	57
22.5	346	123	469	10	31	0	53	9	27	0	46
17.5	312	119	431	10	32	0	54	9	28	0	48
12.5	165	56	221	6	18	0	30	5	16	0	27
7.5	92	27	119	3	10	0	18	3	9	0	16
2.5	77	16	93	3	9	0	15	3	8	0	13
-2.5	48	8	56	2	6	0	10	2	5	0	9
	5,694	2,990	8684	90	278	648	463	76	235	648	390

Formulas:

For both Existing and Proposed Case:
Envelope Load MMBtu = (UA x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6
Infiltration Load MMBtu = (1.08 x Infiltration CFM x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6

Where
UA = 1/R-Value of Wall x Wall Area + 1/R-Value of Roof x Roof Area
Infiltration CFM = Building Area x 10 Feet Average Height x Building Air Changes Per Hour/60

Cooling kWh = (Envelope + Infiltration Load) x 10^6/12000 x kW/Ton Cooling Efficiency (Loads for Hours above Balance Point only)
Heating MMBtu = (Envelope + Infiltration Load)/ Heating Efficiency (Loads for Hours below Balance Point only)

Title	Water Conservation
Date	February 1, 2009
District	Dover, NH
Building	Dover Public Library

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr				$0
kW				
MMBtu/yr			10	$148
kGal/yr	210	83	127	$1,405
Total				$1,553

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	13	150
% Year Round Occupancy	66%	100%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	30	150
Total Flushes Per Day (Less Urinal Flushes)	29	147
% Men	35%	40%
Total Men	3	60
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	2%	2%
Total Flushes per Day to Urinals	0.5	3.0
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	13	60
%Taking Showers	100%	0
Shower (Minutes/Day/Person)	8.00	0.00
Total Shower Usage (Minutes/Day)	68	0
Total Number of Toilets	5	1
Total Number of Urinals	0	2
Total Number of Sinks	2	4
Total Number of Showers	0	0
Total Number of Toilets to be Retrofitted	3	1
Total Number of Urinals to be Retrofitted	0	2
Total Number of Sinks to be Retrofitted	2	4
Total Number of Showers to be Retrofitted	0	0
% Toilets Being Retrofitted	67%	
% Urinals Being Retrofitted	0%	100%
% Sinks Being Retrofitted	100%	100%
% Showers Being Retrofitted	0%	0%

Inputs and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$14.1
Average Cold Water Temp (^{o}F)	55
Boiler Efficiency (%)	78%

Formulas & Assumptions:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.
2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person
3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.
4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.
5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.
6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].
7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	365	365

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
Use Type	Fixture Type	Baseline Flushes/Day, Min/Day	Estimated	Baseline (gpf, gpm)	Estimated	Baseline (gal/yr)	Estimated (gal/yr)	Water Estimated (gal/yr)	Fuel Estimated (MMBtu/yr)	Water Estimated ($/yr)	Fuel Estimated ($/yr)
Staff	Toilet	29	29	3.5	1.6	25,001	11,429	13,572	-	150	-
	Urinal	1	1	1.5	1.0	-	-	-	-	-	-
	Sink	13	13	2.2	0.5	10,282	2,337	7,945	1.8	88	26
	Showers	68	68	2.5	1.5	-	-	-	-	-	-
Visitors	Toilet	147	147	3.5	1.6	125,195	57,232	67,963	-	751	-
	Urinal	3	3	1.5	1.0	1,643	1,095	548	-	6	-
	Sink	60	60	2.2	0.5	48,180	10,950	37,230	9	411	-
	Showers	0	0	2.5	1.5	-	-	-	-	-	-

Title	**Boiler/Burner Replacement**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover Public Library**

Summary	Existing	Proposed	Savings	Savings
kWh/yr				
kW				
MMBtu/yr	0	0	91	$1,289
Total				$1,289

Heating System Efficiency	
Current Boiler Combustion Efficiency (%)	78%
Proposed Boiler Combustion Efficiency (%)	85%
Current Boiler Radiant Jacket Losses (%)	6%
Proposed Boiler Radiant Jacket Losses (%)	4%
Current Boiler Distribution Losses (%)	3%
Proposed Boiler Distribution Losses (%)	3%
Oil Usage Information	
Annual Fuel Consumption (MMBtu)	0
Proposed Oil Savings from other measures (MMBtu)	0
Estimated Non-Boiler Oil Consumption (MMBtu)	0
Gas Usage Information	
Annual Gas Consumption (MMBtu)	899
Proposed Gas Savings from other measures (MMBtu)	0
Estimated Non-Boiler Gas Consumption (MMBtu)	0
Calculation	
Net Applicable Fuel Usage (MMBtu)	899
Current Boiler Fuel-to-Heat Efficiency (%)	71%
Proposed Boiler Fuel-to-Heat Efficiency (%)	79%
Fuel Savings (MMBtu)	91

Formulas:

Net Applicable Fuel Usage (MMBtu) = (Current Oil Consumption - Proposed Oil Savings from other measures - Non-Boiler Oil Consumption)+ (Current Gas Consumption - Proposed Gas Savings from other measures - Non-Boiler Gas Consumption)

Fuel-to-Heat Efficiency = Boiler Combustion Efficiency x (1-Boiler Radiant Jacket Losses) x (1-Boiler Distribution Losses)

Fuel Savings = Net Appliable Fuel Usage - (Net Applicable Fuel Usage x (Current Fuel-to-Heat Efficiency/Proposed Fuel-to-Heat Efficiency))

Appendix 3-8 Jenny Thompson Pool

Rate Sheet February 10, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.13	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	$1.26	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$12.63	$/MMBtu

Heating Efficiency (%)	80%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)		
Winter Inside Setpoint (F)		

Total Building Sq Footage	
Percent of Building Cooled	
Total Cooled Sq Footage	-

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy

	#2 OIL				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total			**0**	**$0.0**	**10,537**	**13,313**	**1,054**	**$12.6**	**1,054**	**13,313**	**$12.6**

Electricity

Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**86,730**	**10,906**					**86,730**	**$10,906**	**$0.13**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	0	8	4

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Occupied
Sunday	Occupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	0
Feb	0
Mar	0
Apr	0
May	0
Jun	4
Jul	4
Aug	4
Sep	0
Oct	0
Nov	0
Dec	0

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	11.5	10.5
87.5	53.0	23.0
82.5	181.5	99.5
77.5	223.5	106.5
72.5	222.0	271.0
67.5	166.5	421.5
62.5	145.5	716.5
57.5	69.0	637.0
52.5	24.5	558.5
47.5	5.5	574.5
42.5	1.5	497.5
37.5	0.0	802.0
32.5	0.0	817.0
27.5	0.0	656.0
22.5	0.0	469.0
17.5	0.0	431.0
12.5	0.0	221.0
7.5	0.0	119.0
2.5	0.0	93.0
-2.5	0.0	56.0
-7.5	0.0	53.0
-12.5	0.0	14.0
-17.5	0.0	9.0

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations
2. Select one location in cell B2 from the drop-down list.
3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.
4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 10, 2009
District Name	Dover, NH
Bldg Name	Jenny Thompson Pool
Bdl Size	

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	296	1,054	1,350
	MBtu/sq ft			
Proposed	MMBtu/yr	296	1,029	1,325
	MBtu/sq ft			
% Change	MMBtu/yr		24	24
	MBtu/sq ft			

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 6	Water Conservation				24	$309	137	$1,508	$1,817
	TOTALS				**24**	**$309**	**137**	**$1,508**	**$1,817**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:		86,730	10,906	1,054	13,313	$24,219	
AFTER PROJECT ENERGY USAGE:		86,730	$10,906	1,029	$13,004	$23,910	
AFTER PROJECT ENERGY SAVINGS:				24	$309	$309	
ENERGY REDUCTION (%):				2.32%	2.32%	1.28%	

Title	Water Conservation
Date	February 10, 2009
District	Dover, NH
Building	Jenny Thompson Pool

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr				$0
kW				
MMBtu/yr			25.2	$319
kGal/yr	333	192	141	$1,554
Total				$1,873

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	8	150
% Year Round Occupancy	66%	100%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	18	150
Total Flushes Per Day (Less Urinal Flushes)	18	147
% Men	35%	40%
Total Men	2	60
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	2%	2%
Total Flushes per Day to Urinals	0.3	3.0
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	8	60
%Taking Showers	35%	1
Shower (Minutes/Day/Person)	8.00	8.00
Total Shower Usage (Minutes/Day)	15	1,200
Total Number of Toilets	0	6
Total Number of Urinals	0	2
Total Number of Sinks	0	4
Total Number of Showers	0	8
Total Number of Toilets to be Retrofitted	0	6
Total Number of Urinals to be Retrofitted	0	2
Total Number of Sinks to be Retrofitted	0	0
Total Number of Showers to be Retrofitted	0	8
% Toilets Being Retrofitted	100%	
% Urinals Being Retrofitted	100%	
% Sinks Being Retrofitted	0%	
% Showers Being Retrofitted	100%	

Input and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$12.6
Average Cold Water Temp (^oF)	55
Boiler Efficiency (%)	80%

Calculations & Assumptions:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.
2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person
3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.
4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.
5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.
6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].
7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	92	92

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
Use Type	Fixture Type	Baseline Flushes/Day, Min/Day	Estimated	Baseline (gpf, gpm)	Estimated	Baseline (gal/yr)	Estimated (gal/yr)	Water Estimated (gal/yr)	Fuel Estimated (MMBtu/yr)	Water Estimated ($/yr)	Fuel Estimated ($/yr)
Staff	Toilet	18	18	3.5	1.6	5,817	2,659	3,158	-	35	-
	Urinal	0	0	1.5	1.0	44	30	15	-	0	-
	Sink	8	8	2.2	0.5	-	-	-	-	-	-
	Showers	15	15	2.5	1.5	3,383	2,030	1,353	0.3	15	4
Visitors	Toilet	147	147	3.5	1.6	47,334	21,638	25,696	-	284	-
	Urinal	3	3	1.5	1.0	414	276	138	-	2	-
	Sink	60	60	2.2	0.5	-	-	-	-	-	-
	Showers	1,200	1,200	2.5	1.5	276,000	165,600	110,400	25	1,219	315

Appendix 3-9 Central Fire Station

Rate Sheet February 1, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.13	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	$1.53	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$15.28	$/MMBtu

Heating Efficiency (%)	80%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
51.4	39.2	90.6

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	76
Winter Inside Setpoint (F)	72	70

Total Building Sq Footage	7,000
Percent of Building Cooled	50%
Total Cooled Sq Footage	3,500

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy

	#2 OIL				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total			**0**	**$0.0**	**3,596**	**5,496**	**360**	**$15.3**	**360**	**5,496**	**$15.3**

Electricity

Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**80,470**	**10,068**					**80,470**	**$10,068**	**$0.13**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	8	8	8

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Occupied
Sunday	Occupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	4
Dec	4

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0	0
92.5	22	0
87.5	76	0
82.5	281	0
77.5	330	0
72.5	493	0
67.5	588	0
62.5	862	0
57.5	706	0
52.5	583	0
47.5	580	0
42.5	499	0
37.5	802	0
32.5	817	0
27.5	656	0
22.5	469	0
17.5	431	0
12.5	221	0
7.5	119	0
2.5	93	0
-2.5	56	0
-7.5	53	0
-12.5	14	0
-17.5	9	0

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations
2. Select one location in cell B2 from the drop-down list.
3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.
4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
	Central Fire Station
Bdl Size	7,000

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	275	360	634
	MBtu/sq ft	39.2	51.4	90.6
Proposed	MMBtu/yr	274	306	580
	MBtu/sq ft	39.2	43.7	82.9
% Change	MMBtu/yr	0	53	54
	MBtu/sq ft	0.1	7.6	7.7

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 3	Building Envelope Improvements - Weatherization		145	$18	50	$768			$786
FIM 6	Water Conservation				3	$50	20	$222	$272
	TOTALS		**145**	**$18**	**53**	**$818**	**20**	**$222**	**$1,058**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	7,000	80,470	10,068	360	5,496	$15,564	$2.22
AFTER PROJECT ENERGY USAGE:	7,000	80,325	$10,050	306	$4,679	$14,728	$2.10
AFTER PROJECT ENERGY SAVINGS:	7,000	145	$18	53	$818	$836	$0.12
ENERGY REDUCTION (%):		0.18%	0.18%	14.88%	14.88%	5.37%	5.37%

Title	Building Envelope Improvements
Date	February 1, 2009
District	Dover, NH

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	150	$19
kW				
MMBtu/yr			52	$792
Total				$810

INPUT DATA

Area of Cracks	2.1
Area Air-Conditioned	50%
Area Heated	90%
Winter Occupied Set Point	72.0
Winter Unoccupied Set Point	70.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	76.0
Balance Point	55.0
Conversion Factor (MMBtu)	1,000,000
Cooling Efficiency EER	10.9
Heating Efficiency %	80%
$/kwh unblended	$0.13
$/MMbtu of fuel	$15.28

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	739
Infiltration (CFM) Summer	411

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	3	20	1/16	1/12	=	0.313
RTV's	-	0	1/6	1/12	=	-
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	3	132	1/6	1/12	=	1.833
Seal Bulkheads	-	0	1/16	1/12	=	-
					Total =	2.146

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu saved	Output Ton-Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
Cooling										
90-95	92.5	75.9	7	0	57,442	-	57,442	5	5	
85-90	87.5	73.0	65	0	387,735	-	387,735	32	36	
80-85	82.5	70.3	207	0	780,461	-	780,461	65	72	
75-80	77.5	67.5	262	0	406,753	-	406,753	34	37	
70-75	72.5	64.4	388	0	-	-	-	-	-	
65-70	67.5	61.3	328	0	-	-	-	-	-	
60-65	62.5	56.7	449	0	-	-	-	-	-	
Heating										
55-60	57.5	52.3	373	0	4,321,176	-	4,321,176	4		5.4
50-55	52.5	47.0	312	0	4,849,834	-	4,849,834	5		6.1
45-50	47.5	42.2	344	0	6,719,346	-	6,719,346	7		8.4
40-45	42.5	37.9	304	0	7,160,276	-	7,160,276	7		9.0
35-40	37.5	33.6	410	0	11,293,723	-	11,293,723	11		14.1
30-35	32.5	29.4	340	0	10,714,965	-	10,714,965	11		13.4
25-30	27.5	24.8	233	0	8,278,471	-	8,278,471	8		10.3
20-25	22.5	20.4	147	0	5,789,979	-	5,789,979	6		7.2
15-20	17.5	15.4	120	0	5,210,822	-	5,210,822	5		6.5
10-15	12.5	10.0	55	0	2,589,093	-	2,589,093	3		3.2
5-10	5.5	6.2	27	0	1,433,572	-	1,433,572	1		1.8
0-5	0.0	0.6	9	0	517,379	-	517,379	1		0.6
-5-0	0.0	0.0	3	0	172,460	-	172,460	0		0.2

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	**Water Conservation**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Central Fire Station**

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr				$0
kW				$0
MMBtu/yr			3	$51
kGal/yr	42	22	21	$229
Total				$280

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	5	0
% Year Round Occupancy	100%	0%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	18	0
Total Flushes Per Day (Less Urinal Flushes)	17	0
% Men	80%	40%
Total Men	4	0
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	4%	0%
Total Flushes per Day to Urinals	0.7	0.0
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	8	0
%Taking Showers	70%	0
Shower (Minutes/Day/Person)	8.00	0.00
Total Shower Usage (Minutes/Day)	28	0
Total Number of Toilets	2	0
Total Number of Urinals	1	0
Total Number of Sinks	3	0
Total Number of Showers	1	0
Total Number of Toilets to be Retrofitted	1	0
Total Number of Urinals to be Retrofitted	0	0
Total Number of Sinks to be Retrofitted	3	0
Total Number of Showers to be Retrofitted	1	0
% Toilets Being Retrofitted	50%	
% Urinals Being Retrofitted	0%	0%
% Sinks Being Retrofitted	100%	0%
% Showers Being Retrofitted	100%	0%

Input and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$15.3
Average Cold Water Temp, (^{o}F)	55
Boiler Efficiency (%)	80%

Formulas & Assumptions:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.
2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person
3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.
4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.
5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.
6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].
7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	365	365

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
Use Type	Fixture Type	Baseline Flushes/Day, Min/Day	Estimated	Baseline (gpf, gpm)	Estimated	Baseline (gal/yr)	Estimated (gal/yr)	Water Estimated (gal/yr)	Fuel Estimated (MMBtu/yr)	Water Estimated ($/yr)	Fuel Estimated ($/yr)
Staff	Toilet	17	17	3.5	1.6	10,731	4,906	5,825	-	64	-
	Urinal	1	1	1.5	1.0	-	-	-	-	-	-
	Sink	8	8	2.2	0.5	6,023	1,369	4,654	1.1	51	16
	Showers	28	28	2.5	1.5	25,550	15,330	10,220	2.3	113	35
Visitors	Toilet	0	0	3.5	1.6	-	-	-	-	-	-
	Urinal	0	0	1.5	1.0	-	-	-	-	-	-
	Sink	0	0	2.2	0.5	-	-	-	-	-	-
	Showers	0	0	2.5	1.5	-	-	-	-	-	-

Appendix 3-10 South Fire Station

Rate Sheet	February 10, 2009	
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.13	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	NA	$/therm
Propane	$1.69	$/Gallon
Thermal Rate	$17.68	$/MMBtu

Heating Efficiency (%)	80%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
66.3	29.9	96.2

Fuel Split	%
Natural Gas	0%
Oil	100%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	80
Winter Inside Setpoint (F)	70	65

Total Building Sq Footage	8,000
Percent of Building Cooled	50%
Total Cooled Sq Footage	4,000

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy	PROPANE				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total	**5,553**	**9,374**	**530**	**$17.7**			**0**	**$0.0**	**530**	**9,374**	**$17.7**

Electricity										
Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**70,101**	**9,000**					**70,101**	**$9,000**	**$0.13**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	8	8	8

	Occupancy Pattern
Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Occupied
Sunday	Occupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	4
Dec	4

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	22.0	0.0
87.5	76.0	0.0
82.5	281.0	0.0
77.5	330.0	0.0
72.5	493.0	0.0
67.5	588.0	0.0
62.5	862.0	0.0
57.5	706.0	0.0
52.5	583.0	0.0
47.5	580.0	0.0
42.5	499.0	0.0
37.5	802.0	0.0
32.5	817.0	0.0
27.5	656.0	0.0
22.5	469.0	0.0
17.5	431.0	0.0
12.5	221.0	0.0
7.5	119.0	0.0
2.5	93.0	0.0
-2.5	56.0	0.0
-7.5	53.0	0.0
-12.5	14.0	0.0
-17.5	9.0	0.0

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations
2. Select one location in cell B2 from the drop-down list.
3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.
4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 10, 2009
District Name	Dover, NH
Bldg Name	South End Fire Station
Bdl Size	8,000

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	239	530	770
	MBtu/sq ft	29.9	66.3	96.2
Proposed	MMBtu/yr	239	477	716
	MBtu/sq ft	29.9	59.6	89.5
% Change	MMBtu/yr	0	53	54
	MBtu/sq ft	0.0	6.7	6.7

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 3	Building Envelope Improvements - Weatherization		40	$5	52	$910			$916
FIM 6	Water Conservation				2	$35	9	$96	$130
	TOTALS		**40**	**$5**	**53**	**$945**	**9**	**$96**	**$1,046**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	8,000	70,101	9,000	530	9,374	$18,374	$2.30
AFTER PROJECT ENERGY USAGE:	8,000	70,061	$8,995	477	$8,429	$17,424	$2.18
AFTER PROJECT ENERGY SAVINGS:	8,000	40	$5	53	$945	$950	$0.12
ENERGY REDUCTION (%):		0.06%	0.06%	10.08%	10.08%	5.17%	5.17%

Title	Building Envelope Improvements
Date	February 10, 2009
District	Dover, NH
Building	South End Fire Station

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	73	$9
kW				
MMBtu/yr	-	-	94	$1,655
Total				$1,665

INPUT DATA

Area of Cracks	2.1
Area Air-Conditioned	30%
Area Heated	80%
Winter Occupied Set Point	65.0
Winter Unoccupied Set Point	60.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	80.0
Balance Point	55.0
Btu/gallons of heating fuel	95,500
Cooling Efficiency EER	10.9
Heating Efficiency %	80%
$/kwh unblended	$0.13
$/gallon of fuel	$1.69

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	657
Infiltration (CFM) Summer	246

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	3	20	1/16	1/12	=	0.31
RTV's	-	0	1/6	1/12	=	-
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	3	132	1/6	1/12	=	1.83
Seal Bulkheads	-	0	1/16	1/12	=	-
					Total =	2.15

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration: Existing Occupied	Existing Unoccupied	Cooling/Heating Btu saved	Output Ton-Hours or Oil Gallons	kWh Saved	Input Gallons Saved
Cooling										
90-95	92.5	75.9	22	0	64,992	-	64,992	5	6	
85-90	87.5	73.0	76	0	163,837	-	163,837	14	15	
80-85	82.5	70.3	281	0	381,408	-	381,408	32	35	
75-80	77.5	67.5	330	0	184,436	-	184,436	15	17	
70-75	72.5	64.4	493	0	-	-	-	-	-	
65-70	67.5	61.3	588	0	-	-	-	-	-	
60-65	62.5	56.7	862	0	-	-	-	-	-	
Heating										
55-60	57.5	52.3	706	0	2,254,752	-	2,254,752	24		29.5
50-55	52.5	47.0	583	0	3,103,212	-	3,103,212	32		40.6
45-50	47.5	42.2	580	0	4,322,141	-	4,322,141	45		56.6
40-45	42.5	37.9	499	0	4,780,969	-	4,780,969	50		62.6
35-40	37.5	33.6	802	0	9,391,608	-	9,391,608	98		122.9
30-35	32.5	29.4	817	0	11,306,764	-	11,306,764	118		148.0
25-30	27.5	24.8	656	0	10,475,337	-	10,475,337	110		137.1
20-25	22.5	20.4	469	0	8,487,791	-	8,487,791	89		111.1
15-20	17.5	15.4	431	0	8,717,738	-	8,717,738	91		114.1
10-15	12.5	10.0	221	0	4,940,655	-	4,940,655	52		64.7
5-10	5.5	6.2	119	0	3,015,066	-	3,015,066	32		39.5
0-5	0.0	0.6	93	0	2,574,123	-	2,574,123	27		33.7
-5-0	0.0	0.0	56	0	1,550,009	-	1,550,009	16		20.3

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	Water Conservation
Date	February 10, 2009
District	Dover, NH
Building	South End Fire Station

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr				$0
kW				
MMBtu/yr			2	$36
kGal/yr	19	10	9	$99
Total				$134

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	3	0
% Year Round Occupancy	100%	0%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	11	0
Total Flushes Per Day (Less Urinal Flushes)	10	0
% Men	80%	40%
Total Men	2	0
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	4%	0%
Total Flushes per Day to Urinals	0.4	0.0
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	5	0
%Taking Showers	70%	0
Shower (Minutes/Day/Person)	8.00	0.00
Total Shower Usage (Minutes/Day)	17	0
Total Number of Toilets	3	0
Total Number of Urinals	0	0
Total Number of Sinks	3	0
Total Number of Showers	2	0
Total Number of Toilets to be Retrofitted	0	0
Total Number of Urinals to be Retrofitted	0	0
Total Number of Sinks to be Retrofitted	3	0
Total Number of Showers to be Retrofitted	2	0
% Toilets Being Retrofitted	0%	
% Urinals Being Retrofitted	0%	0%
% Sinks Being Retrofitted	100%	0%
% Showers Being Retrofitted	100%	0%

Input and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$17.7
Average Cold Water Temp, (^{o}F)	55
Boiler Efficiency (%)	80%

Calculations & Assumptions:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.

2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person

3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.

4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.

5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.

6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].

7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	365	365

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
		Baseline	Estimated	Baseline	Estimated	Baseline	Estimated	Water Estimated	Fuel Estimated	Water Estimated	Fuel Estimated
Use Type	Fixture Type	Flushes/Day, Min/Day		(gpf, gpm)		(gal/yr)	(gal/yr)	(gal/yr)	(MMBtu/yr)	($/yr)	($/yr)
Staff	Toilet	10	10	3.5	1.6	-	-	-	-	-	-
	Urinal	0	0	1.5	1.0	-	-	-	-	-	-
	Sink	5	5	2.2	0.5	3,614	821	2,792	0.6	31	11
	Showers	17	17	2.5	1.5	15,330	9,198	6,132	1.4	68	24
Visitors	Toilet	0	0	3.5	1.6	-	-	-	-	-	-
	Urinal	0	0	1.5	1.0	-	-	-	-	-	-
	Sink	0	0	2.2	0.5	-	-	-	-	-	-
	Showers	0	0	2.5	1.5	-	-	-	-	-	-

Appendix 3-11 Pine Hill Chapel

Rate Sheet February 1, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.17	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	NA	$/therm
#2 Oil	$2.31	$/Gallon
Thermal Rate	$16.65	$/MMBtu

Heating Efficiency (%)	80%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
74.5	23.3	97.9

Fuel Split	%
Natural Gas	0%
Oil	100%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	78
Winter Inside Setpoint (F)	70	65

Total Building Sq Footage	1,500
Percent of Building Cooled	30%
Total Cooled Sq Footage	450

Conversion Factors			
1 kWh	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal #2 Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy	**#2 OIL**				**NATURAL GAS**						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total	**806**	**1,862**	**112**	**$16.7**			**0**	**$0.0**	**112**	**1,862**	**$16.7**

Electricity										
Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**10,262**	**1,736**					**10,262**	**$1,736**	**$0.17**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

	Number of Occupied Hours Between		
	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	1	7	0

	Occupancy Pattern
Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Unoccupied
Sunday	Unoccupied
Building Balance Point	55 F

Occupied Months	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	3
Dec	3

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	11.3	10.8
87.5	38.8	37.3
82.5	129.6	151.4
77.5	140.2	189.8
72.5	162.0	331.0
67.5	149.4	438.6
62.5	191.6	670.4
57.5	131.1	574.9
52.5	128.8	454.2
47.5	113.3	466.7
42.5	108.9	390.1
37.5	163.3	638.7
32.5	165.3	651.7
27.5	123.5	532.5
22.5	82.9	386.1
17.5	79.9	351.1
12.5	31.8	189.2
7.5	16.7	102.3
2.5	13.6	79.4
-2.5	7.0	49.0
-7.5	6.5	46.5
-12.5	2.2	11.8
-17.5	0.8	8.2

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations
2. Select one location in cell B2 from the drop-down list.
3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.
4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
Bldg Name	Pine Hill Chapel
Bdl Size	1,500

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	35	112	147
	MBtu/sq ft	23.3	74.5	97.9
Proposed	MMBtu/yr	35	68	103
	MBtu/sq ft	23.3	45.1	68.4
% Change	MMBtu/yr	0	44	44
	MBtu/sq ft	0.0	29.5	29.5

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 3	Building Envelope Improvements - Weatherization		17	$3	31	$509			$512
FIM 4	Energy Management System - Upgrades								
FIM 4.1	Energy Management System - Building Controls				13	$221			$221
FIM 6	Water Conservation				0	$7	6	$70	$77
	TOTALS		**17**	**$3**	**44**	**$737**	**6**	**$70**	**$810**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	1,500	10,262	1,736	112	1,862	$3,599	$2.40
AFTER PROJECT ENERGY USAGE:	1,500	10,245	$1,733	68	$1,126	$2,859	$1.91
AFTER PROJECT ENERGY SAVINGS:	1,500	17	$3	44	$737	$740	$0.49
ENERGY REDUCTION (%):		0.17%	0.17%	39.56%	39.56%	20.55%	20.55%

Title	**Building Envelope Improvements**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Pine Hill Chapel**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	18	$3
kW				
MMBtu/yr	-	-	31	$524
Total				$527

INPUT DATA

Area of Cracks	1.1
Area Air-Conditioned	20%
Area Heated	50%
Winter Occupied Set Point	70.0
Winter Unoccupied Set Point	65.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	78.0
Balance Point	55.0
Btu/gallons of heating fuel	138,700
Cooling Efficiency EER	10.9
Heating Efficiency %	80%
$/kwh unblended	$0.17
$/gallon of fuel	$2.31

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	214
Infiltration (CFM) Summer	86

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	5	20	1/16	1/12	=	0.521
RTV's	-	0	1/6	1/12	=	-
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	-	0	1/6	1/12	=	-
Window Caulking (interior)	14	229	1/32	1/12	=	0.596
					Total =	1.117

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours -Occupied	Total Bin Hours -Unoccupied	Btu Gain/Loss through Infiltration: Existing Occupied	Existing Unoccupied	Cooling/ Heating Btu saved	Output Ton-Hours or Oil Gallons	kWh Saved	Input Gallons Saved
Cooling										
90-95	92.5	73.7	11	11	11,535	8,639	20,175	2	2	
85-90	87.5	70.6	39	37	28,994	19,613	48,607	4	4	
80-85	82.5	69.4	130	151	61,034	37,772	98,806	8	9	
75-80	77.5	66.8	140	190	27,193	-	27,193	2	2	
70-75	72.5	64.9	162	331	-	-	-	-	-	
65-70	67.5	61.9	149	439	-	-	-	-	-	
60-65	62.5	57.5	192	670	-	-	-	-	-	
Heating										
55-60	57.5	52.6	131	575	227,096	597,426	824,522	6		7.4
50-55	52.5	47.4	129	454	312,305	786,693	1,098,998	8		9.9
45-50	47.5	43.3	113	467	353,100	1,131,767	1,484,867	11		13.4
40-45	42.5	38.7	109	390	414,981	1,216,171	1,631,152	12		14.7
35-40	37.5	34.2	163	639	735,598	2,433,548	3,169,146	23		28.6
30-35	32.5	29.9	165	652	858,974	2,934,714	3,793,688	27		34.2
25-30	27.5	24.5	124	532	727,433	2,766,764	3,494,197	25		31.5
20-25	22.5	20.1	83	386	545,780	2,273,551	2,819,330	20		25.4
15-20	17.5	15.4	80	351	581,472	2,310,610	2,892,081	21		26.1
10-15	12.5	10.6	32	189	253,602	1,376,112	1,629,714	12		14.7
5-10	5.5	6.1	17	102	149,419	843,249	992,669	7		8.9
0-5	0.0	1.4	14	79	131,634	715,374	847,007	6		7.6
-5-0	0.0	-3.4	7	49	67,765	441,439	509,205	4		4.6

Formulas:

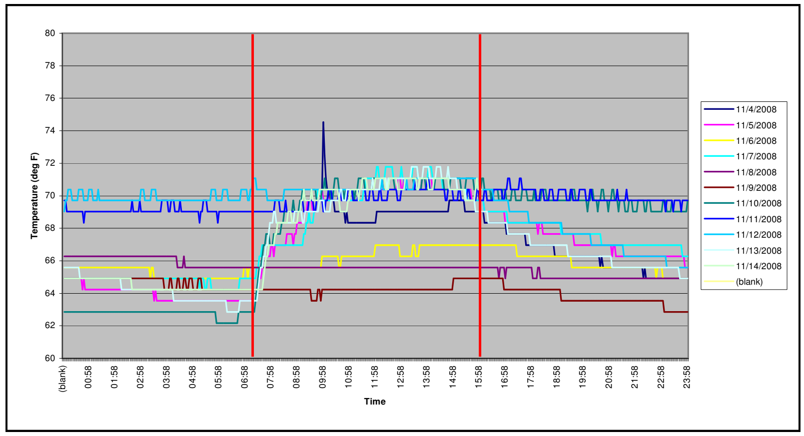
Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	**EMS-Temperature Setback**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Pine Hill Chapel**

Summary	Baseline	Proposed	Savings	Savings
kWh/yr	165	165	0	$0
kW				
MMBtu/yr	112	98	14	$228
Total				$228

Input Variables

	Existing	Proposed
Summer Occupied Setpoint	74	74
Summer Unoccupied Setpoint	78	78
Winter Occupied Setpoint	70	70
Winter Unoccupied Setpoint	65	60
Bulding Area	1,500	
Exterior Wall Area	225	
Roof Area	300	
Average R-value of Wall	5	
Average R-Value of Roof	24	
Boiler Efficiency (%)	80%	
Cooling System Efficiency (kW/ton)	1.10	



Assumptions and Constants:	
Building Balance Point	55
Default Wall R-Value	10
Default Roof R-Value	24
Building Infiltration- Air Changes Per Hour	1.7

Overall UA Value	58
Infiltration CFM	420

				Existing Case				Proposed Case			
Bin Temp	Hours Unoccupied	Occupied	Total Hours	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu
102.5	0	0	0	0	0	0	0	0	0	0	0
97.5	0	0	0	0	0	0	0	0	0	0	0
92.5	11	11	22	0	0	17	0	0	0	17	0
87.5	37	39	76	0	0	41	0	0	0	41	0
82.5	151	130	281	0	1	84	0	0	1	84	0
77.5	190	140	330	0	0	23	0	0	0	23	0
72.5	331	162	493	0	0	0	0	0	0	0	0
67.5	439	149	588	0	0	0	0	0	0	0	0
62.5	670	192	862	0	0	0	0	0	0	0	0
57.5	575	131	706	0	0	0	0	0	0	0	0
52.5	454	129	583	0	4	0	5	0	3	0	4
47.5	467	113	580	1	5	0	7	0	4	0	5
42.5	390	109	499	1	5	0	8	1	4	0	6
37.5	639	163	802	1	10	0	15	1	9	0	13
32.5	652	165	817	2	12	0	17	1	11	0	15
27.5	532	124	656	1	11	0	16	1	10	0	14
22.5	386	83	469	1	9	0	13	1	8	0	12
17.5	351	80	431	1	9	0	13	1	9	0	12
12.5	189	32	221	1	5	0	8	1	5	0	7
7.5	102	17	119	0	3	0	4	0	3	0	4
2.5	79	14	93	0	3	0	4	0	2	0	4
-2.5	49	7	56	0	2	0	2	0	2	0	2
	6,695	1,989	8684	10	81	165	112	9	71	165	98

Formulas:

For both Existing and Proposed Case:

Envelope Load MMBtu = (UA x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6

Infiltration Load MMBtu = (1.08 x Infiltration CFM x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6

Where

UA = 1/R-Value of Wall x Wall Area + 1/R-Value of Roof x Roof Area

Infiltration CFM = Building Area x 10 Feet Average Height x Building Air Changes Per Hour/60

Cooling kWh = (Envelope + Infiltration Load) x 10^6/12000 x kW/Ton Cooling Efficiency (Loads for Hours above Balance Point only)

Heating MMBtu = (Envelope + Infiltration Load)/ Heating Efficiency (Loads for Hours below Balance Point only)

Title	**Water Conservation**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Pine Hill Chapel**

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr				
kW				
MMBtu/yr			0.4	$6.9
kGal/yr	11	4	6.5	$72.1
Total				$79.0

Bathroom Fixture Analysis	User Classification	
	Staff	Visitor
Number of Users	3	0
% Year Round Occupancy	66%	0%
Toilet (Flushes/Day/Person)	3.50	1.00
Total Flushes Per Day	7	0
Total Flushes Per Day (Less Urinal Flushes)	7	0
% Men	35%	40%
Total Men	1	0
% Men Flushes to Urinals	5%	5%
% of Total Flushes to Urinals	2%	0%
Total Flushes per Day to Urinals	0.1	0.0
Sink (Minutes/Day/Person)	1.50	0.40
Total Sink Usage (Minutes/Day)	3	0
%Taking Showers	0%	0
Shower (Minutes/Day/Person)	8.00	0.00
Total Shower Usage (Minutes/Day)	0	0
Total Number of Toilets	1	0
Total Number of Urinals	0	0
Total Number of Sinks	1	0
Total Number of Showers	0	0
Total Number of Toilets to be Retrofitted	1	0
Total Number of Urinals to be Retrofitted	0	0
Total Number of Sinks to be Retrofitted	1	0
Total Number of Showers to be Retrofitted	0	0
% Toilets Being Retrofitted	100%	
% Urinals Being Retrofitted	0%	0%
% Sinks Being Retrofitted	100%	0%
% Showers Being Retrofitted	0%	0%

Input and Constants	
Water Cost ($/kgal)	$5.01
Sewage Cost ($/kgal)	$6.03
Combined Cost ($/kgal)	$11.0
Fuel Cost ($/MMBtu)	$16.7
Average Cold Water Temp, (^{o}F)	55
Boiler Efficiency (%)	80%

Formulas & Assumptions:

1) Number of Users, Year Round Occupancy, % Men, Total Number of Toilets, Urinals, Sinks and Showers determined from data provided by City and data obtained by JCI during the field engineering survey.
2) Frequency of Use is based on the Bathroom Fixture Supplemental Table and is equal to Number of Users X % Year Round Occupancy X Fixture Uses/Day/Person
3) Estimated and Measured Frequency of Use are stipulated to be equal to the Baseline Frequency of Use.
4) Baseline, Estimated and Measured Rate of Utilization is based on the manufacturer's rated gallons/flush or gallons/minute flow rates for each fixture type.
5) Annual Consumption of Retrofitted Fixtures (gal/yr) = Frequency of Use X 365 day/yr X Rate of Utilization X % Toilets/Urinals /Sinks/Showers Being Retrofitted.
6) Program Savings (gal/yr) = Baseline Annual Consumption (gal/yr) - [Estimated Annual Consumption or Measured Annual Consumption (gal/yr)].
7) Annual Cost Reduction ($/yr) = Water Savings from Toilets, Urinals, Sinks and Showers: (Program Savings (gal/yr) X Applicable Water/Sewer Rate ($/1,000 gal)) + Energy Savings from Sinks or Showers: (Program Savings (gal/yr) X 1/3 (Hot Water to Sinks/Showers) X 8.34lb/gal X 65F X 1 Btu/lb F

	Baseline	Proposed
Utilization Days	365	365

Domestic Fixtures		Frequency of Use (Water) (2), (3)		Rate of Utilization (Water) (4)		Annual Consumption of Retrofitted Fixtures (5)		Program Savings (6)		Annual Cost Reduction (7)	
		Baseline	Estimated	Baseline	Estimated	Baseline	Estimated	Water Estimated	Fuel Estimated	Water Estimated	Fuel Estimated
Use Type	Fixture Type	Flushes/Day, Min/Day		(gpf, gpm)		(gal/yr)	(gal/yr)	(gal/yr)	(MMBtu/yr)	($/yr)	($/yr)
Staff	Toilet	7	7	3.5	1.6	8,654	3,956	4,698	-	52	-
	Urinal	0	0	1.5	1.0	-	-	-	-	-	-
	Sink	3	3	2.2	0.5	2,373	539	1,834	0.4	20	7
	Showers	0	0	2.5	1.5	-	-	-	-	-	-
Visitors	Toilet	0	0	3.5	1.6	-	-	-	-	-	-
	Urinal	0	0	1.5	1.0	-	-	-	-	-	-
	Sink	0	0	2.2	0.5	-	-	-	-	-	-
	Showers	0	0	2.5	1.5	-	-	-	-	-	-

Appendix 3-12 Pine Hill Barn

Rate Sheet February 1, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.20	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	NA	$/therm
#2 Oil	$2.31	$/Gallon
Thermal Rate	$16.65	$/MMBtu

Heating Efficiency (%)	80%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
117.2	13.8	131.0

Fuel Split	%
Natural Gas	0%
Oil	100%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	78
Winter Inside Setpoint (F)	65	65

Total Building Sq Footage	1,500
Percent of Building Cooled	0%
Total Cooled Sq Footage	-

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy	#2 OIL				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total	**1,267**	**2,928**	**176**	**$16.7**			**0**	**$0.0**	**176**	**2,928**	**$16.7**

Electricity									
Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**6,055**	**1,212**					**6,055**	**$1,212**	**$0.20**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	1	8	0

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Unoccupied
Sunday	Unoccupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	3
Dec	3

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	12.9	9.1
87.5	44.3	31.7
82.5	148.0	133.0
77.5	160.1	169.9
72.5	184.6	308.4
67.5	168.7	419.3
62.5	215.2	646.8
57.5	146.2	559.8
52.5	144.3	438.7
47.5	126.9	453.1
42.5	122.4	376.6
37.5	183.1	618.9
32.5	185.4	631.6
27.5	138.4	517.6
22.5	92.4	376.6
17.5	89.3	341.7
12.5	35.3	185.7
7.5	18.5	100.5
2.5	14.8	78.2
-2.5	7.5	48.5
-7.5	7.0	46.0
-12.5	2.4	11.6
-17.5	0.8	8.2

Instructions

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4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
Bldg Name	Pine Hill Barn
Bdl Size	1,500

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	21	176	196
	MBtu/sq ft	13.8	117.2	131.0
Proposed	MMBtu/yr	21	151	171
	MBtu/sq ft	13.8	100.4	114.2
% Change	MMBtu/yr		25	25
	MBtu/sq ft		16.8	16.8

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 4	Energy Management System - Upgrades								
FIM 4.1	Energy Management System - Building Controls				25	$419			$419
	TOTALS				**25**	**$419**			**$419**

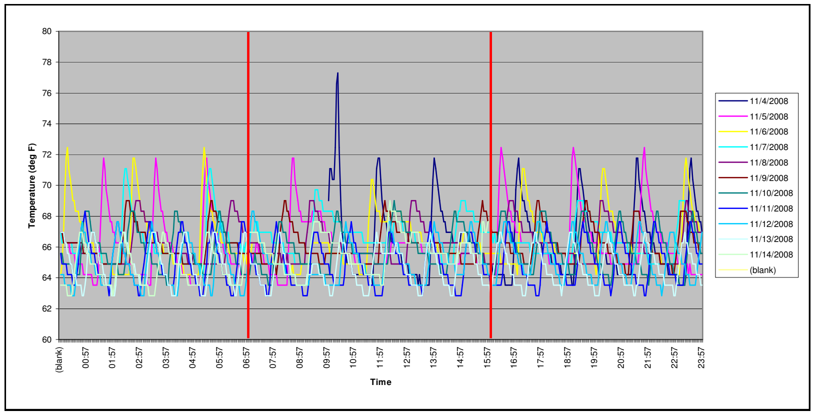
PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	1,500	6,055	1,212	176	2,928	$4,140	$2.76
AFTER PROJECT ENERGY USAGE:	1,500	6,055	$1,212	151	$2,509	$3,721	$2.48
AFTER PROJECT ENERGY SAVINGS:	1,500			25	$419	$419	$0.28
ENERGY REDUCTION (%):				14.30%	14.30%	10.11%	10.11%

Title	**EMS-Temperature Setback**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Pine Hill Barn**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr				
kW				
MMBtu/yr	182	156	26	$431
Total				$431

Input Variables

	Existing	Proposed
Summer Occupied Setpoint	74	74
Summer Unoccupied Setpoint	78	78
Winter Occupied Setpoint	66	66
Winter Unoccupied Setpoint	66	60
Bulding Area	1,500	
Exterior Wall Area	225	
Roof Area	300	
Average R-value of Wall	10	
Average R-Value of Roof	24	
Boiler Efficiency (%)	80%	
Cooling System Efficiency (kW/ton)	1.10	



Assumptions and Constants:	
Building Balance Point	55
Default Wall R-Value	10
Default Roof R-Value	24
Building Infiltration- Air Changes Per Hour	2.9

Overall UA Value	35
Infiltration CFM	735

				Existing Case				Proposed Case			
Bin Temp	Hours Unoccupied	Occupied	Total Hours	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu	Envelope Loss/Gain MMBtu	Infiltration Loss/Gain MMBtu	Cooling kWh	Heating MMBtu
102.5	0	0	0	0	0	0	0	0	0	0	0
97.5	0	0	0	0	0	0	0	0	0	0	0
92.5	9	13	22	0	0	28	0	0	0	28	0
87.5	32	44	76	0	1	68	0	0	1	68	0
82.5	133	148	281	0	1	141	0	0	1	141	0
77.5	170	160	330	0	0	43	0	0	0	43	0
72.5	308	185	493	0	0	0	0	0	0	0	0
67.5	419	169	588	0	0	0	0	0	0	0	0
62.5	647	215	862	0	0	0	0	0	0	0	0
57.5	560	146	706	0	0	0	0	0	0	0	0
52.5	439	144	583	0	6	0	8	0	4	0	5
47.5	453	127	580	0	9	0	11	0	6	0	8
42.5	377	122	499	0	9	0	12	0	8	0	10
37.5	619	183	802	1	18	0	24	1	15	0	20
32.5	632	185	817	1	22	0	28	1	19	0	24
27.5	518	138	656	1	20	0	26	1	18	0	23
22.5	377	92	469	1	16	0	21	1	14	0	19
17.5	342	89	431	1	17	0	22	1	15	0	20
12.5	186	35	221	0	9	0	12	0	9	0	11
7.5	101	18	119	0	6	0	7	0	5	0	7
2.5	78	15	93	0	5	0	6	0	4	0	6
-2.5	48	8	56	0	3	0	4	0	3	0	4
	6,446	2,238	8684	6	142	280	182	5	123	280	156

Formulas:

For both Existing and Proposed Case:
Envelope Load MMBtu = (UA x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6
Infiltration Load MMBtu = (1.08 x Infiltration CFM x (∑(OAT-Occupied Setpoint) x Occupied Hours + ∑(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10^6

Where
UA = 1/R-Value of Wall x Wall Area + 1/R-Value of Roof x Roof Area
Infiltration CFM = Building Area x 10 Feet Average Height x Building Air Changes Per Hour/60

Cooling kWh = (Envelope + Infiltration Load) x 10^6/12000 x kW/Ton Cooling Efficiency (Loads for Hours above Balance Point only)
Heating MMBtu = (Envelope + Infiltration Load)/ Heating Efficiency (Loads for Hours below Balance Point only)

Appendix 3-13 Veterans Hall

Rate Sheet February 1, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.19	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	$1.80	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$18.03	$/MMBtu

Heating Efficiency (%)	80%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
67.5	0.2	67.7

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	80
Winter Inside Setpoint (F)	70	65

Total Building Sq Footage	1,000
Percent of Building Cooled	0%
Total Cooled Sq Footage	-

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy	**#2 OIL**				**NATURAL GAS**						
Year	**Usage (gal.)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**MMBTU**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total			**0**	**$0.0**	**675**	**1,217**	**68**	**$18.0**	**68**	**1,217**	**$18.0**

Electricity										
Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**67**	**111**					**67**	**$111**	**$1.65**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	0	4	0

Occupancy Pattern

	Occupancy Pattern
Monday	Unoccupied
Tuesday	Occupied
Wednesday	Unoccupied
Thursday	Occupied
Friday	Unoccupied
Saturday	Unoccupied
Sunday	Unoccupied

Building Balance Point: 55 F

Occupied Months

Month	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	4
Dec	4

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	2.6	19.4
87.5	8.9	67.1
82.5	29.6	251.4
77.5	32.0	298.0
72.5	36.1	456.9
67.5	30.9	557.1
62.5	37.7	824.3
57.5	24.4	681.6
52.5	26.1	556.9
47.5	24.0	556.0
42.5	22.9	476.1
37.5	33.9	768.1
32.5	35.9	781.1
27.5	27.0	629.0
22.5	16.6	452.4
17.5	15.9	415.1
12.5	5.9	215.1
7.5	3.0	116.0
2.5	2.1	90.9
-2.5	0.9	55.1
-7.5	0.7	52.3
-12.5	0.3	13.7
-17.5	0.0	9.0

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations
2. Select one location in cell B2 from the drop-down list.
3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.
4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.
5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.
6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
Bldg Name	Veteran's Hall
Bdl Size	1,000

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	0	68	68
	MBtu/sq ft	0.2	67.5	67.7
Proposed	MMBtu/yr	0	50	50
	MBtu/sq ft	0.2	49.7	50.0
% Change	MMBtu/yr		18	18
	MBtu/sq ft		17.8	17.8

FIM #	PROPOSED MEASUES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	$/yr	MMBtu/yr	$/yr	kgal/yr	$/yr	$/yr
FIM 3	Building Envelope Improvements - Weatherization				18	$320			$320
	TOTALS				**18**	**$320**			**$320**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	1,000	67	111	68	1,217	$1,327	$1.33
AFTER PROJECT ENERGY USAGE:	1,000	67	$111	50	$897	$1,007	$1.01
AFTER PROJECT ENERGY SAVINGS:	1,000			18	$320	$320	$0.32
ENERGY REDUCTION (%):				26.31%	26.31%	24.12%	24.12%

Title	**Building Envelope Improvements**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Veteran's Hall**

Summary	Baseline	Proposed	Savings	$ Savings
kWh/yr	-	-	-	$0
kW				
MMBtu/yr	-	-	18	$330
Total				$330

INPUT DATA

Area of Cracks	0.4
Area Air-Conditioned	0%
Area Heated	80%
Winter Occupied Set Point	70.0
Winter Unoccupied Set Point	65.0
Summer Occupied Set Point	74.0
Summer Unoccupied Set Point	80.0
Balance Point	55.0
Conversion factor (1MMBtu)	1,000,000
Cooling Efficiency EER	10.9
Heating Efficiency %	80%
$/kwh unblended	$0.19
$/MMBtu of fuel	$18.03

CALCULATIONS

Wind Speed (FPM)	766
Infiltration (CFM) Winter	128
Infiltration (CFM) Summer	0

Work to be completed	No. of Units	Perimeter (ft)	Crackage (in)	Conversion to feet		Product
Exit Doors	4	20	1/16	1/12	=	0.417
RTV's	-	0	1/6	1/12	=	-
Roof/ Wall Joint	-	0	1/6	1/12	=	-
OH Door	-	0	1/6	1/12	=	-
Seal Bulkheads	-	0	1/16	1/12	=	-
					Total =	0.417

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	60%
Windward Diversity	50%

Ambient Temp Bin deg. F	Average Temp deg. F	Wet Bulb Temperature deg. F	Total Bin Hours-Occupied	Total Bin Hours-Unoccupied	Btu Gain/Loss through Infiltration Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu saved	Output Ton-Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
Cooling										
90-95	92.5	75.9	3	19	-	-	-	-	-	
85-90	87.5	73.0	9	67	-	-	-	-	-	
80-85	82.5	70.3	30	251	-	-	-	-	-	
75-80	77.5	67.5	32	298	-	-	-	-	-	
70-75	72.5	64.4	36	457	-	-	-	-	-	
65-70	67.5	61.3	31	557	-	-	-	-	-	
60-65	62.5	56.7	38	824	-	-	-	-	-	
Heating										
55-60	57.5	52.3	24	682	42,081	704,445	746,526	0.7		0.9
50-55	52.5	47.0	26	557	63,047	959,242	1,022,289	1.0		1.3
45-50	47.5	42.2	24	556	74,416	1,340,872	1,415,288	1.4		1.8
40-45	42.5	37.9	23	476	86,622	1,476,367	1,562,989	1.6		2.0
35-40	37.5	33.6	34	768	151,638	2,911,046	3,062,684	3.1		3.8
30-35	32.5	29.4	36	781	185,303	3,498,551	3,683,854	3.7		4.6
25-30	27.5	24.8	27	629	158,135	3,250,546	3,408,681	3.4		4.3
20-25	22.5	20.4	17	452	108,475	2,649,802	2,758,276	2.8		3.4
15-20	17.5	15.4	16	415	114,725	2,717,475	2,832,200	2.8		3.5
10-15	12.5	10.0	6	215	46,412	1,556,541	1,602,953	1.6		2.0
5-10	5.5	6.2	3	116	26,666	951,151	977,817	1.0		1.2
0-5	0.0	0.6	2	91	20,671	813,855	834,526	0.8		1.0
-5-0	0.0	0.0	1	55	8,268	493,943	502,212	0.5		0.6

Formulas:

Wind Speed (FPM) = Average Wind Speed (MPH) x 5860 / 60
Infiltration (CFM) Winter = Wind Speed (FPM) x Area of Cracks (ft2) x Area Heated (%) x Windward Diversity (%)
Infiltration (CFM) Summer = Wind Speed (FPM) x Area of Cracks (ft2) x Area Air Conditioned (%) x Windward Diversity (%)
Existing Occupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
Existing Unoccupied Btu Saved = 1.08 x Infilteration (CFM) Summer/Winter x delta T x Bin Unoccupied Hours x Correction Factor
Output Ton-Hours = Cooling Btu's saved / 12,000 (1 Ton = 12,000 Btu)
Output Gas MMBtu = Heating Btu's Saved / 1,000,000 (1MMBtu = 1,000,000 Btu)
KWh Saved = Output Ton-Hours * 12 / Energy Effficiency Ratio (EER)
MMBtu Saved = Output MMBtu / Boiler Efficiency

Appendix 3-14 Dover Train Station

Rate Sheet February 1, 2009		
Utility		**Unit**
Water	$5.01	$/kgal
Sewer	$6.03	$/kgal
Electric - Unblended	$0.12	$/kWh
Electric Demand	$0.00	$/kW
Natural Gas	$1.91	$/therm
#2 Oil	NA	$/Gallon
Thermal Rate	$19.13	$/MMBtu

Heating Efficiency (%)	80%
Cooling Efficiency (kW/ton)	1.10

Cold Water Temp (°F)	55 °F

Energy Use Index (MBtu/SF)		
Thermal	Electric	Overall
11.0	82.3	93.3

Fuel Split	%
Natural Gas	100%
Oil	0%

Building Setpoint	Occupied	Unoccupied
Summer Inside Setpoint (F)	74	78
Winter Inside Setpoint (F)	72	68

Total Building Sq Footage	4,791
Percent of Building Cooled	90%
Total Cooled Sq Footage	4,312

Conversion Factors			
1 kW	=	3,413	Btu/hr
1 MMBtu	=	1,000,000	Btu
1 Therm	=	100,000	Btu
1 gal Oil	=	138,700	Btu
1 gal Propane	=	95,500	Btu
1 CCF	=	100,000	Btu

Thermal Energy	#2 OIL				NATURAL GAS						
Year	**Usage (gal.)**	**Cost ($)**	**Usage (MMBtu)**	**Unit Cost ($/MMBtu)**	**Usage (Therms)**	**Cost ($)**	**Usage (MMBtu)**	**Unit Cost ($/MMBtu)**	**Overall MMBtu**	**Overall Cost**	**Overall $/MMBtu**
Total			**0**	**$0.0**	**526**	**1,006**	**53**	**$19.1**	**53**	**1,006**	**$19.1**

Electricity										
Year	**Demand (kW)**	**Usage (kWh)**	**Cost ($)**	**Demand ($/kW)**	**Demand ($)**	**Energy ($)**	**Unblended ($/kWh)**	**Overall Electric**	**Overall Cost**	**Overall $/kWh**
Total		**115,560**	**14,108**					**115,560**	**$14,108**	**$0.12**

Weather Data for Major Northeast Locations

Select Location: **Concord NH**

Number of Occupied Hours Between

	Midnight - 8 AM	8 AM - 4 PM	4 PM - Midnight
Working Days	0	8	0

Occupancy Pattern

Monday	Occupied
Tuesday	Occupied
Wednesday	Occupied
Thursday	Occupied
Friday	Occupied
Saturday	Unoccupied
Sunday	Unoccupied

Building Balance Point: 55 F

Occupied Months

	Weeks/Month
Jan	4
Feb	4
Mar	4
Apr	4
May	4
Jun	4
Jul	4
Aug	4
Sep	4
Oct	4
Nov	4
Dec	4

OUTPUT

DB Temp	Occupied Hours	Unoccupied Hours
97.5	0.0	0.0
92.5	12.9	9.1
87.5	44.3	31.7
82.5	147.9	133.1
77.5	160.0	170.0
72.5	180.7	312.3
67.5	154.3	433.7
62.5	188.6	673.4
57.5	122.1	583.9
52.5	130.7	452.3
47.5	120.0	460.0
42.5	114.3	384.7
37.5	169.3	632.7
32.5	179.3	637.7
27.5	135.0	521.0
22.5	82.9	386.1
17.5	79.3	351.7
12.5	29.3	191.7
7.5	15.0	104.0
2.5	10.7	82.3
-2.5	4.3	51.7
-7.5	3.6	49.4
-12.5	1.4	12.6
-17.5	0.0	9.0

Instructions

1. Based on the given inputs (in yellow), the output table on the right will present the bin data that is tied into or can be copied into the different calculations

2. Select one location in cell B2 from the drop-down list.

3. Select the number of hours in the three 8-hour bins in cells B7, C7 and D7. For example, if a building is occupied from 7 AM to 7 PM, the inputs will be 1,8 and 3 respectively. A 24 x 7 building will be 8,8 and 8.

4. Select between occupied and unoccupied in cells B10 thru B16 for Monday thru Sunday.

5. Select the number of weeks that the building is occupied in cells G7 thru G18. If the building is not occupied then the input will be 0. If it is occupied all month, then the input will be 4.

6. All the inputs can be selected from drop-down menus. Do NOT punch in any values manually.

Title	Summary of Energy Efficiency Improvements
Date	February 1, 2009
District Name	Dover, NH
Bldg Name	Dover Train Station
Bdl Size	4,791

		Electricity	Thermal	All Utilities
Existing	MMBtu/yr	394	53	447
	MBtu/sq ft	82.3	11.0	93.3
Proposed	MMBtu/yr	329	53	381
	MBtu/sq ft	68.6	11.0	79.5
% Change	MMBtu/yr	66		66
	MBtu/sq ft	13.8		13.8

FIM #	PROPOSED MEASUES	Electricity Savings kW	Electricity Savings kWh/yr	Electricity Savings $/yr	Thermal MMBtu/yr	Thermal $/yr	Water kgal/yr	Water $/yr	Total Savings $/yr
FIM 4	Energy Management System -Upgrades								
FIM 4.5	Repair Snow Melt Sensor		19,308	$2,357					$2,357
	TOTALS		**19,308**	**$2,357**					**$2,357**

PROPOSED PROJECT EFFECT SUMMARY	TOTAL SQ FT	ELECTRIC kWh/yr	ELECTRIC $/yr	'hermal Energy MMBtu/yr	$/yr	Total $/yr	COST PER FT PER YR
EXISTING ENERGY USAGE:	4,791	115,560	14,108	53	1,006	$15,114	$3.15
AFTER PROJECT ENERGY USAGE:	4,791	96,252	$11,751	53	$1,006	$12,757	$2.66
AFTER PROJECT ENERGY SAVINGS:	4,791	19,308	$2,357			$2,357	$0.49
ENERGY REDUCTION (%):		16.71%	16.71%			15.60%	15.60%

Title	**Repair Snow Melt Sensor**
Date	**February 1, 2009**
District	**Dover, NH**
Building	**Dover Train Station**

Summary	Existing	Proposed	Savings	$ Savings
kWh/yr			19,905	$ 2,430
kW				
MMBtu/yr				

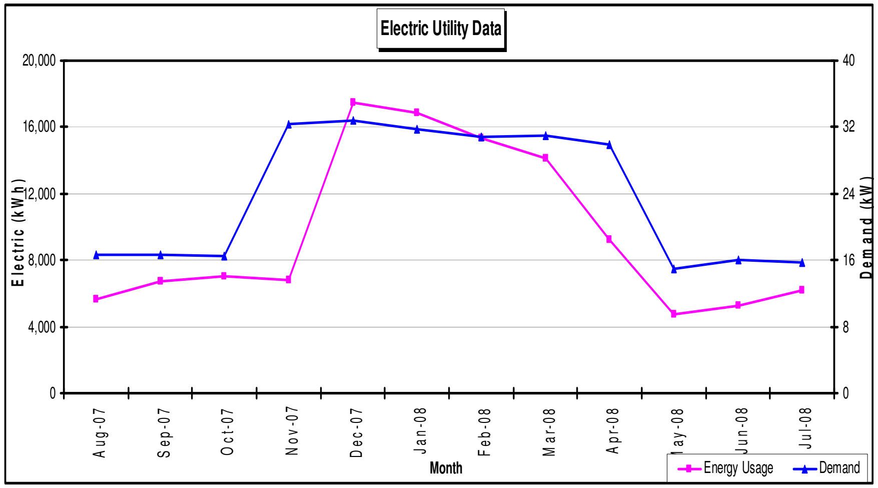
$/kW	**$0.00**
$/kWh	**$0.12**
$/MMBtu	**$19.13**

Input

Average summer electric usage (kWh) (May ~ October)	5,942	kWh
Average summer demand (kW)	16.1	kW

From the graph, it can be seen that there is a step change in the demand and consumption during the winter months.

Average winter electric usage (kWh) (December ~ March)	15,965	kWh
Average winter demand (kW)	31.6	kW



During the winter, the train station turns on their christmas lights and it looks like the snow melt system is turned on and not turned off after every snow storm. The snow melt system has a snow melt sensor that is supposed to turn on the system when it starts snowing, but it is evident from the graph on the right that the sensor has failed and is not in working condition.

<u>Proposed System:</u>

ASHRAE - HVAC Application - Chapter 49, Table 3 indicates that for Boston, MA - Annual heating flux requirement (Melting) is 7,694 Btu/sq ft and for Burlington, VT is 13,182 Btu/sq ft
Annual heating flux requirement (Idling) is 77,992 Btu/Sq ft and for Burlington, VT is 147,122 Btu/Sq ft. For Dover, NH lets assume it takes 30% more heat than Boston, MA

Annual heating flux requirement (Melting+Idling) for Dover, NH	111,392	Btu/sq ft	
Dover train station snow melting system area	200	sq ft	***assumed***
Annual heating flux requirement (Melting+Idling)	22,278,360	Btu	
Back and edge heat losses	25%		
Total annual heating flux requirement (Btu)	27,847,950	Btu	
Total annual heating flux requirement (in kWh)	8,159	kWh for 4 months	
Total annual heating flux requirement per month (in kWh)	2,040	kWh per month	
Assume 30% of the electric consumption is required for christmas lights & other winter applications	3,007	kWh	
Winter electric consumption (kWh)	5,047	kWh	
Baseline electric consumption (kWh)	5,942	kWh	
Total winter electric consumption per month (kWh)	10,989	kWh	
Winter electric savings (kWh)	4,976	kWh	
Annual electric savings (kWh) <for 4 months>	19,905	kWh	
Annual electric cost savings (@ $0.122/kWh)	**$ 2,430**		

Appendix 4
Outline Specifications for All Equipment

Johnson Controls

Appendix 4-1,2 Lighting – Fixture Retrofit & Controls

Philips Marathon® Energy Saver Universal Family

featuring ALTO® Lamp Technology

Ideal for table lamps, wall sconces, ceiling fixtures, surface mounted light fixtures and hanging lamps

Extensive Range of Uses
Available in 60/75/100 watt incandescent lamp equivalents for use in a variety of applications

Provides Soft, White Light

Amalgam Technology
Provides stable light output over a broad range of temperatures

Super Long Life
–The 20 and 25W Universal have 15,000 hours rated average life[1]! The longest lasting Marathon® Compact Fluorescent

–The 14W Universal has 12,000 hours rated average life[1]

Energy Savings
Saves up to 75% in electricity costs compared to standard incandescent lamps

Featuring ALTO® Lamp Technology
Low mercury and TCLP[2]-compliant

1) Average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Use in recessed cans or totally enclosed indoor fixtures would result in reduced lamp life.

2) The TCLP is the US EPA's Toxicity Characteristic Leaching Procedure.

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A Division of Philips Electronics Ltd.

Printed in USA 6/05 P-3754-C

Philips Marathon® Energy Saver Universal

Electrical, Technical and Ordering Data (Subject to change without notice)

	Product Number	Description	Volts	Nom. Watts	Approx. Incand. Equiv.	Base	Color Temp. (Kelvin)	CRI	Approx. Initial Lumens[1]	MOL (In.)	Rated Avg. Life (Hrs.)[2]	Lamp Current (mAmps)	Power Factor	Min. Starting Temp.[3]	Max. Ambient Temp.
Box	14691-0	Universal SLS 14 ALTO	120	14	60A19	Med	2700	82	860	4.9	12,000	230	.50-.60	-22F/-30C	60F/140F
Box	13077-3	Universal SLS 20 ALTO	120	20	75A19	Med	2700	82	1200	5.6	15,000	285	.50-.60	-22F/-30C	60F/140F
Box	13574-9	Universal SLS 25 ALTO	120	25	100A19	Med	2700	82	1750	6.2	15,000	335	.50-.60	-22F/-30C	60F/140F

Shipping Data (Subject to change without notice)

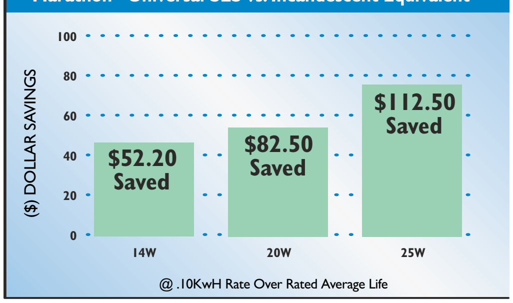
	Product Number	SKU UPC (0-46677)	Outer Bar Code (5-00-46677)	Case Qty.	Case Weight (lbs.)	Case Cube (cu. ft.)	Pallet Qty.	SKUs Per Layer	Layers High	SKU Dimensions (W x D x H) (In.)	Case Dimensions (W x D x H) (In.)	Pallet Dimensions (W x D x H) (In.)
Box	14691-0	13075-6	13075-1	6	2	0.17	2016	336	6	2.2 x 2.2 x 5.3	7.0 x 5.0 x 6.0	42.4 x 38.5 x 42.0
Box	13077-3	13077-0	13077-5	6	2	0.20	2016	336	6	2.2 x 2.2 x 6.0	7.0 x 5.0 x 7.0	42.4 x 38.5 x 47.3
Box	13574-9	13574-4	13574-9	6	2	0.8	2016	336	6	2.2 x 2.2 x 6.5	7.0 x 5.0 x 7.3	49.4 x 38.5 x 47.9

1) Approximate initial lumens. The lamp lumen output is based upon lamp performance after 100 hours of operating life under standard laboratory conditions.
2) Average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Use in recessed cans or totally enclosed indoor fixtures could result in reduced lamp life.
3) Suitable for indoor or outdoor use down to -22° F. UL listed for damp locations. Outdoor use requires an enclosed or weather-protected fixture.

	Bulb Type	Wattage Comparison*	Table/Floor Lamp	Outdoor Postlight	Wall Sconce	Surface Mount	Reading Lamp	Border Lights	Recessed Fixture	Open Hanging	Vanity Strip
	Mini Deco. Twister	11=40, 15=60, 20=75, 27=100	●		●		●			●	
	Deco. Twister	42=150	●		●		●			●	
	Circline Adapter	22=90, 28=120	●							●	
●	R20 Reflector	12=50							●	●	
●	R30/R40 Reflector	16=65, 20=85							●	●	
●	PAR38 Reflector	20=75							●	●	
●	Soft White Plus	16=60, 20=75	●	●	●		●	●		●	
●	Bug-A-Way	16=60		●						●	
●	Deco. Candelabra	9=40		●	●		●				
●	Deco. Medium Base	12=60		●	●		●				
●	Vanity Globe	12=40								●	●
●	Décor Globe	16=60, 20=100								●	●
●	Universal	14=60, 20=75, 25=100	●	●	●	●	●	●	●	●	
	3-Way	34-26-18=150-100-50	●								
●	Outdoor	15=60, 18=75		●				●		●	

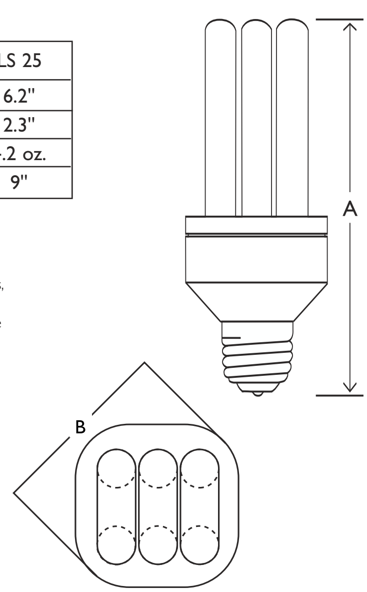
*Chart comparison shows Marathon wattages and their equivalent to standard incandescent bulb wattages(s).
● This product utilizes ALTO® Lamp Technology.

Energy Cost Savings Over Life,
Marathon® Universal SLS vs. Incandescent Equivalent



Lamp Dimensions

	SLS 14	SLS 20	SLS 25
MOL **A**	4.9"	5.6"	6.2"
Max. Diameter **B**	2.3"	2.3"	2.3"
Weight	3.6 oz.	3.9 oz.	4.2 oz.
Lamp Harp Fit	7"	8"	9"



CAUTION: Risk of electric shock—do not use where directly exposed to water, rain or snow. Do not use with dimmers.

Before using this product with electronic timing or photocell devices, check to determine whether device is compatible with electronic compact fluorescent lamps. Use with incompatible devices will cause premature lamp failure.

This product complies with Part 18 of the FCC rules. These products may cause interference with radios, cordless telephones, and remote control devices. Interference may cease after a brief 90 second lamp warm-up period. If interference continues, relocate the lamp away from the device or plug into a different outlet.

**These lamps are better for the environment because of their reduced mercury content. All Philips ALTO® Lamps give you end-of-life options which can simplify and reduce your lamp disposal costs depending on your state and local regulations.

PHILIPS

F32T8 ADV841 ALTO

Product family description
High performance, extra low mercury

Features/Benefits

- Ultimate System solution
- High lumens enable multiple system options to maximize energy savings and reduce lighting costs.
- Fully dimmable without burn-in.
- Better for the environment
- Only 1.7mg of mercury with ALTO II™ Technology
- Reduced impact on the environment without sacrificing performance
- Warranty period: 36 months

Applications

- Ideal for applications requiring maximum light output.

Notes

- Rated average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Lamp life is appreciably longer if lamps are started less frequently. (202)
- Average life under engineering data with lamps turned off and restarted once every 12 operating hours. (241)
- Approximate Initial Lumens. The lamp lumen output is based upon lamp performance after 100 hours of operating life, when the output is measured during operation on a reference ballast under standard laboratory conditions. (203)
- For expected lamp lumen output, commercial ballast manufacturers can advise the appropriate Ballast Factor for each of their ballasts when they are informed of the designated lamp. The Ballast Factor is a multiplier applied to the designated lamp lumen output. (204)
- Design Lumens are the approximate lamp lumen output at 40% of the lamp's Rated Average Life. This output is based upon measurements obtained during lamp operation on a reference ballast under standard laboratory conditions. (208)
- Design lumens rated at 3 hours per start on Instant Start ballast. (239)
- Exclusive to Philips Lighting Company.

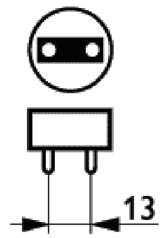
Product data	
Product Number	139899
Full product name	F32T8 ADV841 ALTO

PHILIPS

Product data	
Ordering Code	F32T8/ADV841/ALTO
Pack type	1 Lamp
Pieces per Sku	1
Skus/Case	25
Pack UPC	046677139896
EAN2US	
Case Bar Code	50046677139891
Successor Product number	
Base	Medium Bi-Pin [Medium Bi-Pin Fluorescent]
Base Information	Green Base
Bulb	T8
Packing Type	1LP [1 Lamp]
Packing Configuration	25
Type	F32T8
Feature	ALTO II™
Ordering Code	F32T8/ADV841/ALTO
Pack UPC	046677139896
Case Bar Code	50046677139891
Energy Saving	Energy Saving
Rated Avg Life [12-Hr Prog St]	36000 hr
Rated Avg Life [12-Hr Inst St]	30000 hr
Rated Avg Life [3-Hr Prog St]	30000 hr
Rated Avg Life [3-Hr Inst St]	24000 hr
Watts	32W
Mercury (Hg) Content	1.7 mg
Picogram per Lumen Hour	24 p/LuHr
Color Code	Advantage 841 [CCT of 4100K]
Color Rendering Index	85 Ra8
Color Designation	Advantage 841
Color Temperature	4100 K
Initial Lumens	3100 Lm
Design Mean Lumens	3000 Lm
Nominal Length [inch]	48
Product Number	139899

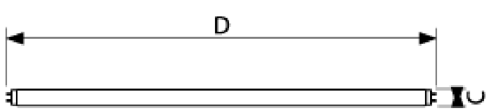
PHILIPS

F-T8-Adv Med Bipin/GB

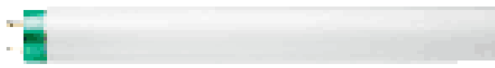


Base Medium Bi-Pin

Energy Saving Energy Saving



F-T8-Adv Med Bipin



F32T8 28W ADV841 EW ALTO

Product family description
High performance, long life, environmentally-responsible lamps. F32T8/EW 30 and 25 watt Econ-o-watt Fluorescent lamp.

Features/Benefits

- Replace standard 32 watt T8 lamps with Philips ALTO® Energy Advantage 30 watt T8 lamps and save 2 watts per lamp instantly.
- Operates on any standard Instant Start system.
- Low mercury: TCLP* compliant.
- Energy efficient.
- Long Life.
- Sustainable lighting solution; less mercury and fewer lamps in landfills, combined with energy efficiency and long life reduces the impact on the environment.
- Our Green End-Caps mean you are using environmentally-responsible lamps.
- HI-VISION® Phosphor combined with Philips exclusive cathode guard delivers: 95% lumen manitenance; reduced lamp-end blackening.
- 85 CRI for TL80 lamps.

Applications

- Replace standard 32 watt T8 lamps with Philips ALTO® Energy Advantage 30 watt T8 and save 2 watts per lamp instantly.

Notes

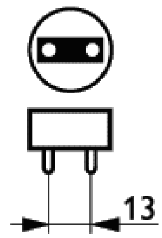
- Rated average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Lamp life is appreciably longer if lamps are started less frequently. (202)
- Average life under engineering data with lamps turned off and restarted once every 12 operating hours.(241)
- Approximate Initial Lumens. The lamp lumen output is based upon lamp performance after 100 hours of operating life, when the output is measured during operation on a reference ballast under standard laboratory conditions. (203)
- For expected lamp lumen output, commercial ballast manufacturers can advise the appropriate Ballast Factor for each of their ballasts when they are informed of the designated lamp. The Ballast Factor is a multiplier applied to the designated lamp lumen output. (204)
- Design Lumens are the approximate lamp lumen output at 40% of the lamp's Rated Average Life. This output is based upon measurements obtained during lamp operation on a reference ballast under standard laboratory conditions. (208)

PHILIPS

Product data	
Product Number	147348
Full product name	F32T8 28W ADV841 EW ALTO
Ordering Code	F32T8/ADV841/EW/LL ALTO
Pack type	1 Lamp
Pieces per Sku	1
Skus/Case	25
Pack UPC	046677147341
EAN2US	
Case Bar Code	50046677147346
Successor Product number	
Base	Medium Bi-Pin [Medium Bi-Pin Fluorescent]
Base Information	Green Base
Bulb	T8
Execution	Econ-o-watt
Packing Type	1LP [1 Lamp]
Packing Configuration	25
Name Type	F32T8
Feature	ALTO®
Ordering Code	F32T8/ADV841/EW/LL ALTO
Pack UPC	046677147341
Case Bar Code	50046677147346
Energy Saving Product	Energy Saving
Rated Avg Life [12-Hr Prog St]	36000 hr
Rated Avg Life [12-Hr Inst St]	30000 hr
Rated Avg Life [3-Hr Prog St]	30000 hr
Rated Avg Life [3-Hr Inst St]	24000 hr
Watts	28W
Mercury (Hg) Content	3.5 mg
Color Code	Advantage 841 [CCT of 4100K]
Color Rendering Index	85 Ra8
Color Designation	Advantage 841
Color Temperature	4100 K
Initial Lumens	2725 Lm
Design Mean Lumens	2560 Lm
Nominal Length [inch]	48
Product Number	147348

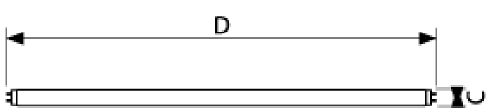
PHILIPS

F-T8-ISA Med Bipin/GB



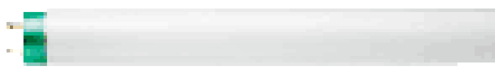
Base Medium Bi-Pin

Energy Saving Product Energy Saving



F-T8-ISA Med Bipin

6/8/2007



F17T8 ADV841 ALTO

Product family description
High performance, long life, environmentally-responsible lamps.

Features/Benefits

- 3100 lumens is 10% more than standard T8 lamps.
- Low mercury: TCLP* compliant.
- Sustainable lighting solutions; Less mercury and fewer lamps in landfills, combined with energy efficiency and long life reduces the impact on the environment.
- HI-VISION® Phosphor combined with Philips exclusive cathode guard delivers: 95% lumen maintenance; reduced lamp-end blackening.
- Our Green End-Caps mean you are using environmentally-responsible lamps.
- 85 CRI.
- Higher lumens enables multiple system options to maximize energy saving and reduce lighting costs.
- Fully dimmable withouth burn-in.

Applications

- Ideal fot T8 applications requiring maximum light output and long life. Ideal for light harvesting.

Notes

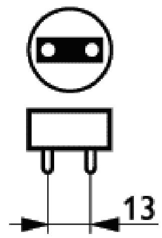
- Rated average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Lamp life is appreciably longer if lamps are started less frequently. (202)
- Average life under engineering data with lamps turned off and restarted once every 12 operating hours. (241)
- Approximate Initial Lumens. The lamp lumen output is based upon lamp performance after 100 hours of operating life, when the output is measured during operation on a reference ballast under standard laboratory conditions. (203)
- For expected lamp lumen output, commercial ballast manufacturers can advise the appropriate Ballast Factor for each of their ballasts when they are informed of the designated lamp. The Ballast Factor is a multiplier applied to the designated lamp lumen output. (204)
- Design Lumens are the approximate lamp lumen output at 40% of the lamp's Rated Average Life. This output is based upon measurements obtained during lamp operation on a reference ballast under standard laboratory conditions. (208)
- Design lumens rated at 3 hours per start on Instant Start ballast. (239)
- Exclusive to Philips Lighting Company.

PHILIPS

Product data	
Product Number	204859
Full product name	F17T8 ADV841 ALTO
Ordering Code	F17T8/ADV841 ALTO
Pack type	1 Lamp
Pieces per Sku	1
Skus/Case	25
Pack UPC	046677204853
EAN2US	
Case Bar Code	50046677204858
Successor Product number	
Base	Medium Bi-Pin [Medium Bi-Pin Fluorescent]
Base Information	Green Base
Bulb	T8
Packing Type	1LP [1 Lamp]
Packing Configuration	25
Name Type	F17T8
Feature	ALTO®
Ordering Code	F17T8/ADV841 ALTO
Pack UPC	046677204853
Case Bar Code	50046677204858
Energy Saving Product	Energy Saving
Rated Avg Life [12-Hr Prog St]	36000 hr
Rated Avg Life [12-Hr Inst St]	30000 hr
Rated Avg Life [3-Hr Prog St]	30000 hr
Rated Avg Life [3-Hr Inst St]	24000 hr
Watts	17W
Mercury (Hg) Content	3.5 mg
Color Code	Advantage 841 [CCT of 4100K]
Color Rendering Index	85 Ra8
Color Designation	Advantage 841
Color Temperature	4100 K
Initial Lumens	1500 Lm
Design Mean Lumens	1455 Lm
Nominal Length [inch]	24
Product Number	204859

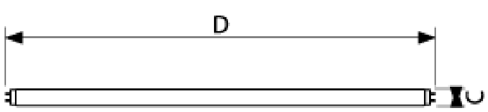
PHILIPS

F-T8-Adv Med Bipin/GB



Base Medium Bi-Pin

Energy Saving Product Energy Saving



F-T8-Adv Med Bipin

Marathon™
ENERGY SAVER
FLOOD—R30 AND R40

Ideal for recessed light fixtures in both residential and commercial applications

- **Popular Flood Reflector Shape**
- **Provides Smooth, Even Light Without Hot Spots**
- **Super Long Life**
  Lasts 5 years, based on 3–4 hours average daily usage, 7 days per week (up to 4 times longer than standard incandescent flood lamps)
- **Energy Savings**
  Saves up to 75% in electricity costs compared to standard incandescent flood lamps
- **Removable Lens**
  Allows flexibility in lighting design
- **ENERGY STAR® Qualified**
  For more information on ENERGY STAR, visit www.energystar.gov

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PHILIPS

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1-800-555-0050
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A Division of Philips Electronics North America Corporation

Printed in USA 5/03 P-3756-B

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www.lighting.philips.com/nam
A Division of Philips Electronics Ltd.

Marathon™ Flood—R30 and R40

Electrical, Technical and Ordering Data (Subject to change without notice)

Product Number	Description	Volts	Nom. Watts	Approx. Incand. Equiv./Lumen	Base	Std. Pkg. Qty.	Color Temp (Kelvin)	CRI	Approx. Initial Lumens	MOL (In.)	Rated Avg. Life (Hrs.)[1]	Lamp Current (mAmps)	Power Factor	Min. Starting Temp.[2]	Max. Ambient Temp.	Lumen Maint.[3]
37246-6	Flood SLS/R30 15	120	15	65BR30FL/635	Med.	6	2700K	82	500	6.0	8000	230	0.55 to 0.62	-10°F/-20°C	140°F/60°C	80%
37248-2	Flood SLS/R30 20	120	20	65BR30FL/635	Med.	6	2700K	82	575	6.0	8000	285	0.55 to 0.62	-10°F/-20°C	140°F/60°C	80%
37256-5	Flood SLS/R40 15	120	15	65BR40FL/635	Med.	6	2700K	82	625	6.6	8000	230	0.55 to 0.62	-10°F/-20°C	140°F/60°C	80%
37262-3	Flood SLS/R40 20	120	20	85BR40FL/925	Med.	6	2700K	82	825	6.6	8000	285	0.55 to 0.62	-10°F/-20°C	140°F/60°C	80%

Shipping Data (Subject to change without notice)

Product Number	SKU UPC (0-46677)	Outer Bar Code (5-00-46677)	Case Qty.	Case Weight (lbs.)	Case Cube (cu. ft.)	Pallet Qty.	SKUs Per Layer	Layers High	SKU Dimensions (W x D x H) (In.)	Case Dimensions (W x D x H) (In.)	Pallet Dimensions (W x D x H) (In.)
37246-6	22035-8	37246-5	6	3	0.39	960	120	8	3.8 x 3.8 x 5.9	12.0 x 8.0 x 7.0	49.8 x 42.2 x 49.0
37248-2	22038-9	37248-9	6	3	0.39	960	120	8	3.8 x 3.8 x 5.9	12.0 x 8.0 x 7.0	49.8 x 42.2 x 49.0
37256-5	22037-2	37256-4	6	4	0.69	432	72	6	4.8 x 4.8 x 5.9	15.0 x 10.0 x 8.0	46.3 x 41.2 x 45.8
37262-3	22039-6	37262-6	6	4	0.69	432	72	6	4.8 x 4.8 x 5.9	15.0 x 10.0 x 8.0	46.3 x 41.2 x 45.8

1) Lamps operated in extreme environments will have reduced life (i.e., recessed or enclosed lighting fixtures with elevated line voltage).
2) Suitable for indoor or outdoor use down to -10°F. UL listed for damp locations. Outdoor use requires an enclosed or weather-protected fixture.
3) Percentage of initial lumens at 40% of rated average life (3200 hours).

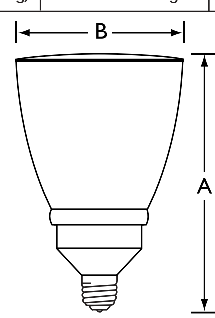
Marathon.

Bulb Type	Bulb Shape	Wattage Comparison*	Table/Floor Lamps	Outdoor Post Lights	Wall Sconce	Surface Mount	Enclosed Indoor Fixture	Reading Lamp	Border Lights	Recessed Lighting	Open Hanging	Bare Bulb	Vanity Strip
UNIVERSAL		15/20/25 = 60/75/100	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
DECO. TWISTER		15/20/23 = 60/75/90	✓		✓			✓			✓	✓	
MINI-DECO. TWISTER		15 = 60	✓		✓			✓			✓	✓	
HOUSEHOLD		20 = 75	✓	✓	✓			✓			✓	✓	
MINI-HOUSEHOLD		16 = 60	✓	✓	✓			✓	✓		✓	✓	
3-WAY		18/26/34 = 60/90/150	✓										
DIMMABLE		15/20/23 = 60/75/90	✓		✓					✓		✓	
TABLE		34 = 120	✓		✓			✓					
OUTDOOR		15 = 60 18 = 75		✓							✓	✓	
BUG-A-WAY		15 = 60		✓							✓	✓	
FLOOD		15 = 65 20 = 85								✓	✓	✓	
REFLECTOR FLOOD		16 = 65								✓	✓	✓	
DIMMABLE FLOOD		20 = 85								✓	✓	✓	
DÉCOR GLOBE		16 = 75 20 = 100									✓	✓	✓
VANITY GLOBE		12 = 40									✓	✓	✓

*Comparison shows Marathon wattage(s) and their equivalent to standard incandescent bulb wattages(s).

Lamp Dimensions

SLS/R30	SLS/R30 15	SLS/R30 20
MOL **A**	6.0"/152mm	6.0"/152mm
Max. Diameter **B**	3.8"/95mm	3.8"/95mm
Weight (oz./g)	5.7 oz./161g	6.1 oz./172g
SLS/R40	SLS/R40 15	SLS/R40 20
MOL **A**	6.6"/168mm	6.6"/168mm
Max. Diameter **B**	4.8"/121mm	4.8"/121mm
Weight (oz./g)	5.6 oz./186g	6.9 oz./195g



CAUTION: Risk of electric shock—do not use where directly exposed to water, rain or snow. Do not use with dimmers. For dimming circuits use Marathon R30 or R40 Dimmable Flood.

Before using this product with electronic timing or photocell devices, check to determine whether device is compatible with electronic compact fluorescent lamps. Use with incompatible devices will cause premature lamp failure.

This product complies with Part 18 of the FCC rules. These products may cause interference with radios, cordless telephones, and remote control devices. Interference may cease after a brief 90 second lamp warm-up period. If interference continues, relocate the lamp away from the device or plug into a different outlet.

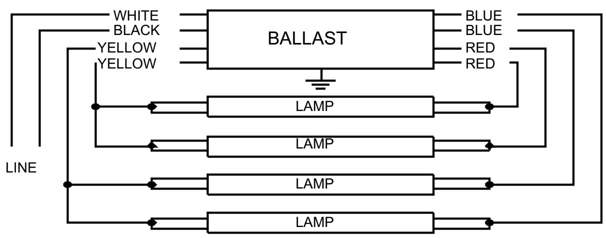
PHILIPS

IOP4P32LWSC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F32T8/ES (25W)	3	25	60/16	0.52	62	0.85	10	0.99	1.6	1.37
* F32T8/ES (25W)	4	25	60/16	0.65	77	0.65	10	0.99	1.6	0.84

Wiring Diagram

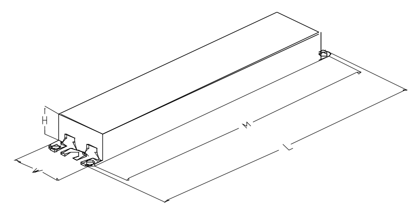


Diag. 66

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

Revised 08/03/2005

Data is based upon tests performed by Advance Transformer in a controlled environment and representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice. All specifications are nominal unless otherwise noted.

ADVANCE TRANSFORMER CO.
O'HARE INTERNATIONAL CENTER · 10275 WEST HIGGINS ROAD · ROSEMONT, IL 60018
Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071
Corporate Offices: Phone: 800-322-2086

IOP4P32LWSC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be __________ (Instant or Programmed) Start.

2.2 Instant start ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail. Programmed Start ballast shall provide semi-independent lamp operation.

2.3 Instant start ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz through 52 kHz to avoid interference with infrared devices and eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 or 0.71 for Low Watt, 0.87 or 0.88 for Normal Light Output, and 1.18 for High Light.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) Instant Start IntelliVolt or 0F (-18C) Programmed Start IntelliVolt for standard T8 lamps and 60F (16C) for energy-saving T8 lamps.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to prevent striation on energy savings lamps.

2.14 Programmed start ballasts shall provide lamp EOL protection circuitry.

2.15 Instant Start Ballasts - Remote or tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder. For tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp (normal and LW) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps.

Programmed Start 3&4-lamp (normal light) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Programmed Start 3&4-lamp (LW) - Tandem wiring allowed to a maximum of 10 feet between ballast and lamp holder for standard T8 lamps and energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9001:2000 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

Note: Consult lamp manufacturers for applications with Ballast Factor > 1.2

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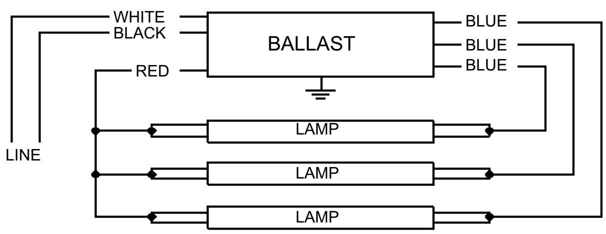
IOP-3P32-SC@120V

Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F32T8/ES (25W)	2	25	60/16	0.42	49	1.00	10	0.99	1.6	2.04
* F32T8/ES (25W)	3	25	60/16	0.55	65	0.87	10	0.99	1.6	1.34

Wiring Diagram

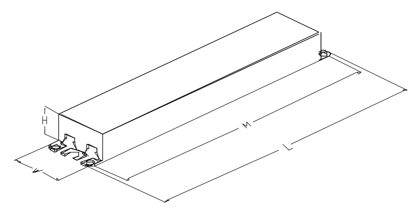


Diag. 65

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

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Corporate Offices: Phone: 800-322-2086

IOP-3P32-SC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be __________ (Instant or Programmed) Start.

2.2 Instant start ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail. Programmed Start ballast shall provide semi-independent lamp operation.

2.3 Instant start ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz through 52 kHz to avoid interference with infrared devices and eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 or 0.71 for Low Watt, 0.87 or 0.88 for Normal Light Output, and 1.18 for High Light.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) Instant Start IntelliVolt or 0F (-18C) Programmed Start IntelliVolt for standard T8 lamps and 60F (16C) for energy-saving T8 lamps.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to prevent striation on energy savings lamps.

2.14 Programmed start ballasts shall provide lamp EOL protection circuitry.

2.15 Instant Start Ballasts - Remote or tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder. For tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp (normal and LW) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps.

Programmed Start 3&4-lamp (normal light) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Programmed Start 3&4-lamp (LW) - Tandem wiring allowed to a maximum of 10 feet between ballast and lamp holder for standard T8 lamps and energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9001:2000 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

Note: Consult lamp manufacturers for applications with Ballast Factor > 1.2

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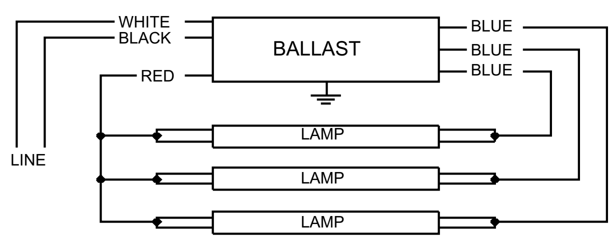
ADVANCE

IOP3P32LWSC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F32T8/ES (25W)	2	25	60/16	0.36	43	0.86	10	0.99	1.6	2.00
* F32T8/ES (25W)	3	25	60/16	0.49	58	0.77	10	0.99	1.6	1.33

Wiring Diagram

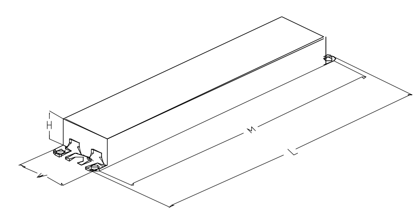


Diag. 65

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

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Data is based upon tests performed by Advance Transformer in a controlled environment and representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice. All specifications are nominal unless otherwise noted.

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IOP3P32LWSC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be __________ (Instant or Programmed) Start.

2.2 Instant start ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail. Programmed Start ballast shall provide semi-independent lamp operation.

2.3 Instant start ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz through 52 kHz to avoid interference with infrared devices and eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 or 0.71 for Low Watt, 0.87 or 0.88 for Normal Light Output, and 1.18 for High Light.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) Instant Start IntelliVolt or 0F (-18C) Programmed Start IntelliVolt for standard T8 lamps and 60F (16C) for energy-saving T8 lamps.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to prevent striation on energy savings lamps.

2.14 Programmed start ballasts shall provide lamp EOL protection circuitry.

2.15 Instant Start Ballasts - Remote or tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder. For tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp (normal and LW) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps.

Programmed Start 3&4-lamp (normal light) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Programmed Start 3&4-lamp (LW) - Tandem wiring allowed to a maximum of 10 feet between ballast and lamp holder for standard T8 lamps and energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9001:2000 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

Note: Consult lamp manufacturers for applications with Ballast Factor > 1.2

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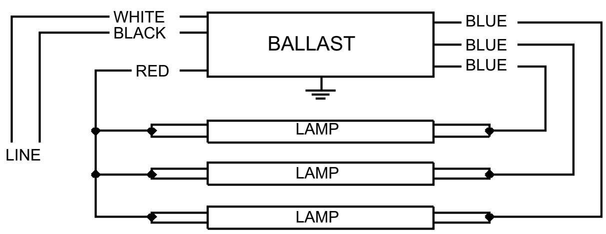
IOP3P32HL90CSC@120

Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
* F32T8	2	32	-20/-29	0.67	80	1.38	10	0.99	1.7	1.73
F32T8	3	32	-20/-29	0.91	110	1.18	10	0.99	1.6	1.07

Wiring Diagram



Diag. 65

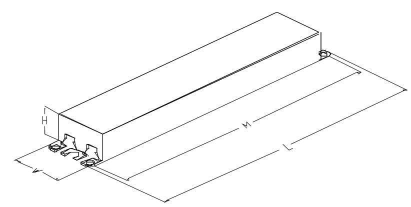
The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.
Black	25	63.5
White	25	63.5
Blue	31	78.7
Red	37	94
Yellow		0
Gray		0
Violet		0

	in.	cm.
Yellow/Blue		0
Blue/White		0
Brown		0
Orange		0
Orange/Black		0
Black/White		0
Red/White		0

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

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IOP3P32HL90CSC@120	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be __________ (Instant or Programmed) Start.

2.2 Ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail.

2.3 Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz and 52 kHz to avoid interference with infrared devices, eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 for Low Watt, 0.87 for Normal Light Output, and 1.18 for High Light for Instant Start ballasts or 0.71 for Low Watt and 0.88 for Normal Light Output for Programmed Start ballasts.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) on Instant Start Ballasts or 0F (-18C) Programmed Start ballasts for standard T8 lamps and 60F (16C) for energy-saving T8 lamps. Consult lamp manufacturer for temperature versus light output characteristics.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to reduce striation on energy-saving T8 lamps.

2.14 Programmed Start ballasts shall provide lamp EOL protection circuitry.

2.15 Ballast can be Remote or Tandem wired as follows:

Instant Start ballasts - Remote or Tandem wiring allowed to a maximum of 20 feet between ballast and lamp socket. For Tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp ballast - Remote or Tandem wiring allowed to a maximum of 10 feet between ballast and lamp socket for energy-saving T8 lamps or 20 feet for standard T8 lamps. For Tandem wiring, BLUE lamp must be in same fixture as the ballast.

Programmed Start 3 & 4-lamp (Normal Light) ballast - Remote or Tandem wiring allowed to a maximum of 10 feet between ballast and lamp socket for energy-saving T8 lamps or 20 feet for standard T8 lamps. For Tandem wiring, RED and YELLOW lamps must be in the same fixture as the ballast.

Programmed Start 3 & 4-lamp (Low Watt) ballast - Remote or Tandem wiring allowed to a maximum of 10 feet between ballast and lamp socket for all T8 lamps. For Tandem wiring, RED and YELLOW lamps must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18,

Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
3.6 Ballast shall comply with UL Type CC rating.
3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other
4.1 Ballast shall be manufactured in a factory certified to ISO 9002 Quality System Standards.
4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.
4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.
4.4 Ballast shall be Advance part # ______________ or approved equal.

NOTE: The use of Optanium 2.0 (IOP) models is recommended to reduce striation in energy-saving T8 lamps (25W, 28W or 30W). Remote or tandem wiring of energy-saving T8 lamps (25W, 28W or 30W) is only recommended for Optanium 2.0 (IOP) models.

Consult lamp manufacturer for applications with Ballast Factor > 1.2

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ADVANCE

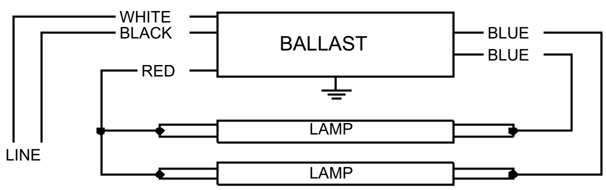
IOP-2P32-SC@120V

Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F32T8/ES (25W)	1	25	60/16	0.23	27	1.05	10	0.99	1.6	3.89
* F32T8/ES (25W)	2	25	60/16	0.37	44	0.87	10	0.99	1.6	1.98

Wiring Diagram

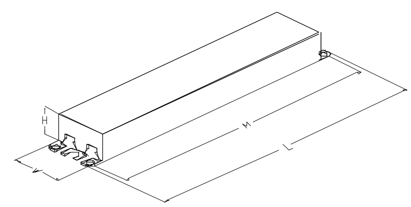


Diag. 64

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

Revised 08/03/2005

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Corporate Offices: Phone: 800-322-2086

IOP-2P32-SC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be __________ (Instant or Programmed) Start.

2.2 Instant start ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail. Programmed Start ballast shall provide semi-independent lamp operation.

2.3 Instant start ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz through 52 kHz to avoid interference with infrared devices and eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 or 0.71 for Low Watt, 0.87 or 0.88 for Normal Light Output, and 1.18 for High Light.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) Instant Start IntelliVolt or 0F (-18C) Programmed Start IntelliVolt for standard T8 lamps and 60F (16C) for energy-saving T8 lamps.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to prevent striation on energy savings lamps.

2.14 Programmed start ballasts shall provide lamp EOL protection circuitry.

2.15 Instant Start Ballasts - Remote or tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder. For tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp (normal and LW) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps.

Programmed Start 3&4-lamp (normal light) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Programmed Start 3&4-lamp (LW) - Tandem wiring allowed to a maximum of 10 feet between ballast and lamp holder for standard T8 lamps and energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9001:2000 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

Note: Consult lamp manufacturers for applications with Ballast Factor > 1.2

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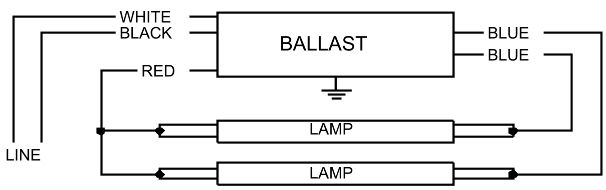
IOP2P32LWSC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F32T8/ES (25W)	1	25	60/16	0.20	24	0.90	10	0.99	1.6	3.75
* F32T8/ES (25W)	2	25	60/16	0.32	38	0.77	10	0.99	1.6	2.03

Wiring Diagram

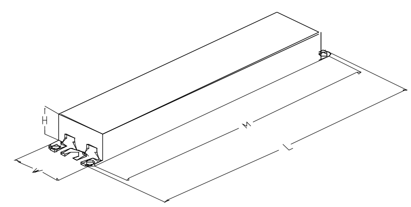


Diag. 64

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

Revised 08/03/2005

Data is based upon tests performed by Advance Transformer in a controlled environment and representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice. All specifications are nominal unless otherwise noted.

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Corporate Offices: Phone: 800-322-2086

IOP2P32LWSC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be ___________ (Instant or Programmed) Start.

2.2 Instant start ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail. Programmed Start ballast shall provide semi-independent lamp operation.

2.3 Instant start ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz through 52 kHz to avoid interference with infrared devices and eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 or 0.71 for Low Watt, 0.87 or 0.88 for Normal Light Output, and 1.18 for High Light.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) Instant Start IntelliVolt or 0F (-18C) Programmed Start IntelliVolt for standard T8 lamps and 60F (16C) for energy-saving T8 lamps.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to prevent striation on energy savings lamps.

2.14 Programmed start ballasts shall provide lamp EOL protection circuitry.

2.15 Instant Start Ballasts - Remote or tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder. For tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp (normal and LW) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps.

Programmed Start 3&4-lamp (normal light) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Programmed Start 3&4-lamp (LW) - Tandem wiring allowed to a maximum of 10 feet between ballast and lamp holder for standard T8 lamps and energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9001:2000 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

Note: Consult lamp manufacturers for applications with Ballast Factor > 1.2

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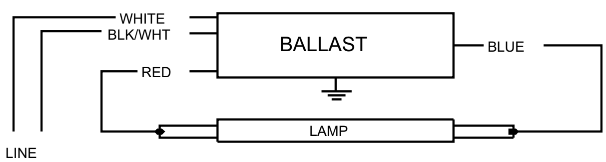
IOP-1P32-SC@120V

Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
* F17T8	1	17	-20/-29	0.14	16	0.90	10	0.99	1.5	5.63
F25T8	1	25	-20/-29	0.20	23	0.88	10	0.99	1.5	3.83
F32T8	1	32	-20/-29	0.25	28	0.87	10	0.99	1.5	3.11
F32T8/ES (25W)	1	25	60/16	0.20	23	0.87	10	0.99	1.5	3.78
F32T8/ES (28W)	1	28	60/16	0.22	25	0.87	10	0.99	1.5	3.48
F32T8/ES (30W)	1	30	60/16	0.23	27	0.87	10	0.99	1.5	3.22

Wiring Diagram

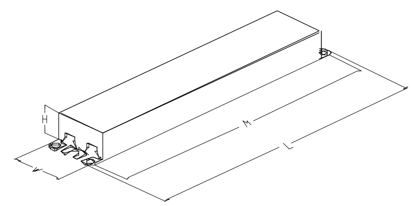


Diag. 63

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

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IOP-1P32-SC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be ___________ (Instant or Programmed) Start.

2.2 Instant start ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail. Programmed Start ballast shall provide semi-independent lamp operation.

2.3 Instant start ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz through 52 kHz to avoid interference with infrared devices and eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 or 0.71 for Low Watt, 0.87 or 0.88 for Normal Light Output, and 1.18 for High Light.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) Instant Start IntelliVolt or 0F (-18C) Programmed Start IntelliVolt for standard T8 lamps and 60F (16C) for energy-saving T8 lamps.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to prevent striation on energy savings lamps.

2.14 Programmed start ballasts shall provide lamp EOL protection circuitry.

2.15 Instant Start Ballasts - Remote or tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder. For tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp (normal and LW) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps.

Programmed Start 3&4-lamp (normal light) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Programmed Start 3&4-lamp (LW) - Tandem wiring allowed to a maximum of 10 feet between ballast and lamp holder for standard T8 lamps and energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9001:2000 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

Note: Consult lamp manufacturers for applications with Ballast Factor > 1.2

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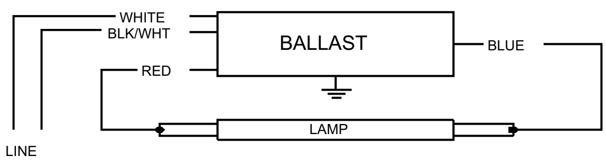
IOP1P32LWSC@120V

Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
* F17T8	1	17	-20/-29	0.13	15	0.80	10	0.99	1.5	5.33
F25T8	1	25	-20/-29	0.17	21	0.78	10	0.99	1.5	3.71
F32T8	1	32	-20/-29	0.22	25	0.77	10	0.99	1.5	3.08
F32T8/ES (25W)	1	25	60/16	0.17	21	0.77	10	0.99	1.5	3.67
F32T8/ES (28W)	1	28	60/16	0.19	22	0.77	10	0.99	1.5	3.50
F32T8/ES (30W)	1	30	60/16	0.20	24	0.77	10	0.99	1.5	3.21

Wiring Diagram

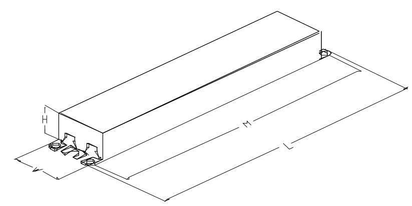


Diag. 63

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

Revised 08/23/2006

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IOP1P32LWSC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be __________ (Instant or Programmed) Start.

2.2 Ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail.

2.3 Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz and 52 kHz to avoid interference with infrared devices, eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 for Low Watt, 0.87 for Normal Light Output, and 1.18 for High Light for Instant Start ballasts or 0.71 for Low Watt and 0.88 for Normal Light Output for Programmed Start ballasts.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) on Instant Start Ballasts or 0F (-18C) Programmed Start ballasts for standard T8 lamps and 60F (16C) for energy-saving T8 lamps. Consult lamp manufacturer for temperature versus light output characteristics.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to reduce striation on energy-saving T8 lamps.

2.14 Programmed Start ballasts shall provide lamp EOL protection circuitry.

2.15 Ballast can be Remote or Tandem wired as follows:

Instant Start ballasts - Remote or Tandem wiring allowed to a maximum of 20 feet between ballast and lamp socket. For Tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp ballast - Remote or Tandem wiring allowed to a maximum of 10 feet between ballast and lamp socket for energy-saving T8 lamps or 20 feet for standard T8 lamps. For Tandem wiring, BLUE lamp must be in same fixture as the ballast.

Programmed Start 3 & 4-lamp (Normal Light) ballast - Remote or Tandem wiring allowed to a maximum of 10 feet between ballast and lamp socket for energy-saving T8 lamps or 20 feet for standard T8 lamps. For Tandem wiring, RED and YELLOW lamps must be in the same fixture as the ballast.

Programmed Start 3 & 4-lamp (Low Watt) ballast - Remote or Tandem wiring allowed to a maximum of 10 feet between ballast and lamp socket for all T8 lamps. For Tandem wiring, RED and YELLOW lamps must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9002 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

4.4 Ballast shall be Advance part # _______________ or approved equal.

NOTE: The use of Optanium 2.0 (IOP) models is recommended to reduce striation in energy-saving T8 lamps (25W, 28W or 30W). Remote or tandem wiring of energy-saving T8 lamps (25W, 28W or 30W) is only recommended for Optanium 2.0 (IOP) models.

Consult lamp manufacturer for applications with Ballast Factor > 1.2

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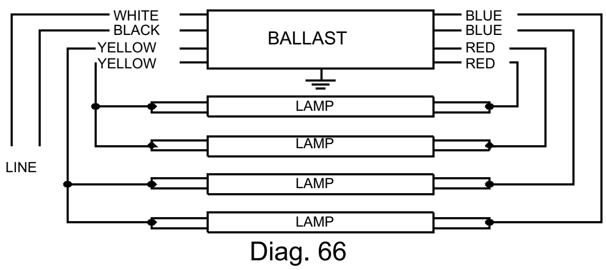
IOP-4P32-SC@120V

Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F32T8/ES (25W)	3	25	60/16	0.59	70	0.97	10	0.99	1.6	1.39
* F32T8/ES (25W)	4	25	60/16	0.73	87	0.87	10	0.99	1.6	1.00

Wiring Diagram

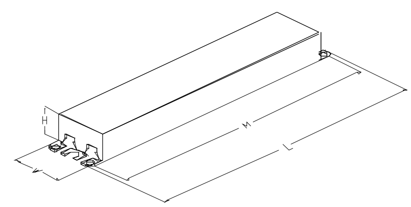


Diag. 66

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

Revised 08/03/2005

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Corporate Offices: Phone: 800-322-2086

IOP-4P32-SC@120V	
Brand Name	OPTANIUM 2.0
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Parallel
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be __________ (Instant or Programmed) Start.

2.2 Instant start ballast shall provide Independent Lamp Operation (ILO) for Instant Start ballasts allowing remaining lamp(s) to maintain full light output when one or more lamps fail. Programmed Start ballast shall provide semi-independent lamp operation.

2.3 Instant start ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency between 42 kHz through 52 kHz to avoid interference with infrared devices and eliminate visible flicker and avoid Article Surveillance System, such as anti-theft devices.

2.6 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.7 Ballast shall have a minimum ballast factor for primary lamp application as follows: 0.77 or 0.71 for Low Watt, 0.87 or 0.88 for Normal Light Output, and 1.18 for High Light.

2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.

2.10 Ballast shall have a Class A sound rating for all 4-foot lamps and smaller.

2.11 Ballast shall have a minimum starting temperature of -20F (-29C) Instant Start IntelliVolt or 0F (-18C) Programmed Start IntelliVolt for standard T8 lamps and 60F (16C) for energy-saving T8 lamps.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall contain an anti-striation circuitry to prevent striation on energy savings lamps.

2.14 Programmed start ballasts shall provide lamp EOL protection circuitry.

2.15 Instant Start Ballasts - Remote or tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder. For tandem wiring, any lamp can be remote mounted.

Programmed Start 2-lamp (normal and LW) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps.

Programmed Start 3&4-lamp (normal light) - Tandem wiring allowed to a maximum of 20 feet between ballast and lamp holder for standard T8 lamps and 10 feet between ballast and lamp holder for energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Programmed Start 3&4-lamp (LW) - Tandem wiring allowed to a maximum of 10 feet between ballast and lamp holder for standard T8 lamps and energy saving lamps. RED and YELLOW must be in the same fixture as the ballast.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

3.7 Ballast shall meet NEMA/CEE High Performance T8 Lighting System Specifications.

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9001:2000 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a 90 C designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90 C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

Note: Consult lamp manufacturers for applications with Ballast Factor > 1.2

Revised 08/03/2005

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sensorswitch™

PASSIVE DUAL TECHNOLOGY
LOW VOLTAGE
WIDE VIEW SENSORS

TECHNICAL DATA

TYPICAL APPLICATIONS

- Classrooms
- Large Storage Rooms
- Large Conference Rooms
- Hallways

SENSOR HIGHLIGHTS

- Corner Mount Dual Technology
- 120º by 40ft. PIR Coverage for Small Motions
- Patented PIR/Microphonics™
- Optional Photocell Daylight Override
- Optional Photocell On/Off
- Optional Isolated SPDT Relay

FEATURES

- Time Delay: 30 sec. to 20 minutes selectable in 2.5 min. increments
- Green LED Indicator
- Programable w/o removing cover

SPECIFICATIONS

- Size: Rectangular, 3.0" x 3.6" x 1.75"
- Sensor Weight: 6 Ounces
- Sensor Color: White
- Mounting Height: 8 to 10 Feet
- Relative Humidity: 20 to 90% non-condensing
- Operating Temp: 14º to 85º F
- Storage Temp: -14º to 160º F
- UL and CUL Listed
- 5 Year Warranty
- Made in U.S.A.

LOW TEMP/HI HUMIDITY(-LT)

- Conformally Coated PCB
- Operates down to -4º F
- Corrosion resistant from moisture

WV-PDT SERIES

WV-BR (Bracket)

Programmable Edition!

Classrooms are the ideal application for the *WV-PDT* 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 feet away, and combines overlapping Microphonic™ 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* is also used in corridors due to its ability to view up to 70 feet for walking motions, or large open storage areas where obstructions may block the PIR's ability to view. For large lecture halls, multiple *WV-PDTs* may be wired together, or along with any other low voltage sensors.

SENSOR OPERATIONS

The *WV-PDT* combines PIR (Passive Infrared) with Microphonics™ technology to literally "See & Hear" the occupant. The PIR first detects motion, initiating the lights to an "On" condition. The Microphonics™ then engages, detecting occupant "noise". Automatic Gain Control (AGC) allows the sensor to self adapt by ignoring constant background noise, and then detect only noise changes typical of human activity. An internal timer, factory set at 10 minutes, keeps the lights "On" during brief periods of no activity. This timer is selectable at 2.5 minute increments from 30 seconds to 20 minutes, and is reset every time occupancy is detected. Once the lights turn "Off", a 10 second grace period allows for the occupant to voice re-activate the lights back "On" if needed. This state-of-the-art design allows the sensor to adapt to its environment, eliminating the need for manual field adjustments. The *WV-PDT* is powered with 12 to 24 volts AC or DC (Red & Black wire inputs), and has one DC output (White wire). When occupancy is detected, this output goes high and can drive up to 200 mA of connected load. The *WV-PDT* typically operates with a PP-20 or MP-20 Power Pack enabling complete 20 Amp circuits to be controlled.

PHOTOCELL OPTIONS (WV-16-P and WV-16-PF)

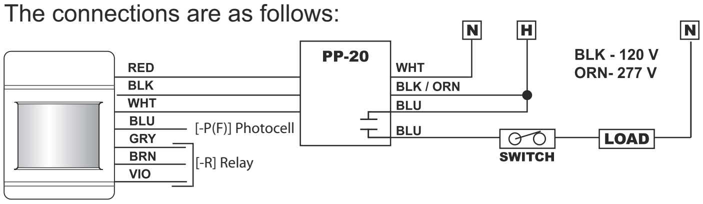
The *WV-PDT* offers two Photocell options for spaces with abundant natural light. It is ideal for public spaces with windows like vestibules, corridors, or bathrooms; however it is not recommended for work spaces where occupants set light levels manually. Each photocell option utilizes a set-point value that is programable by the user via a digital push button sequence. The **Photocell Daylight Override** (–P) option simply inhibits the lights from turning on, however once the lights are on, the photocell function is disabled until the sensor times out. The **Photocell On/Off** (–PF) option has full control of the lights; turning them on when the level is below the set-point and off when adequate ambient light is present. For more specific information on the operation of Photocell On/Off control and/or dimming, see the CM-PC-ADC Technical Data Sheet information.

CATALOG INFORMATION

MODEL #	DESCRIPTION	TEMPERATURE	OP. VOLTAGE	CURRENT
WV-PDT	Passive Dual Technology Wide View	14° to 160° F	12 to 24 VAC/VDC	3 mA
Add suffix				
-R	SPDT Relay, 1 Amp		12 to 24 VAC/VDC	13 mA
-P(F)	Photocell - Daylight Override (On/Off)		12 to 24 VAC/VDC	3 mA
-RP(F)	Relay & Override Photocell (On/Off)		12 to 24 VAC/VDC	13 mA
-LT	Low Temp/High Humidity	-4° to 160° F		
Accessory				
WV-BR	Ceiling Mount Bracket			

INPUT\OUTPUT

Wire lead connections are Class II, 18 to 22 AWG. The *WV-PDT* uses 3 leads (Red, Black, and White); the Photocell option adds a Blue lead, and the Relay Option adds 3 leads (Brown, Gray, and Violet). The connections are as follows:



Do Not Wire Hot

INSTALLATION CONSIDERATION

The *WV-PDT's* rear enclosure is beveled so as to be corner mounted at 8 to 10 feet (see tilt settings). Ideally, the sensor should mount, as shown below, in the corner above the entrance door or in the corner along the same wall as the entrance. If the room is large and multiple sensors are needed, mount the second sensor in the opposite corner, however tilt sensor forward to ensure that the PIR collector beams are not viewing out the door. For mounting heights above 10 feet, use the *WV-BR* and mount sensor to angled side to provide an initial 30º lookdown. The PDT line of sensors, unlike any other occupancy sensor, self adjusts to its environment. The Automatic Gain Control (AGC) feature allows the sensor to tune out constant background noise. However, changing noise signals like talking, shuffling of papers, and general human activities are readily detected. Avoid locating the sensor near Wall Clocks that make "Clicking Noises" every minute.

STANDARD WV-PDT

RED - 12 to 24 VAC/VDC
BLACK - Common
WHITE - Output (HI DC for Occupancy)

RELAY OPTION WV-PDT-R

BROWN - Center tap of relay(SPDT)
GRAY - Contacts Closed during Occupancy
VIOLET - Contacts Open during Occupancy

PHOTOCELL OPTION WV-PDT-P(F)

BLUE - Photocell Output (High: Occ/Low Light)
Use Blue wire from sensor in place of White Wire. For multi-level control, use 2 Power Packs and connect White to primary, and Blue to Daylight Load.

INTERNAL LOW VOLTAGE RELAY OPTION

Dry Contact Closure (-R) is provided through a SPDT, 1 Amp, 40 volt relay. The relay coil is energized and changes state when ALL connected sensors register "Unoccupied". Only one sensor per zone (if multiple sensors) needs to have this relay. Sensor must be powered from either a Power Pack, or Class 2 transformer.

CEILING MOUNT BRACKET (WV-BR)

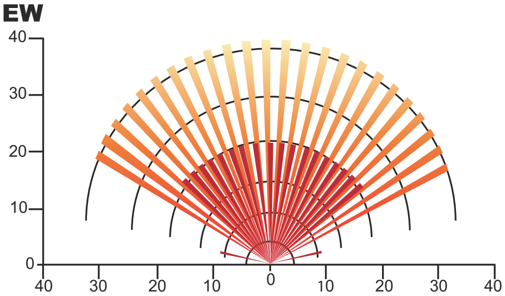
The *WV-BR* Ceiling Mount Bracket allows the *WV-PDT* to be mounted from the ceiling in rooms where mounting to the wall is not possible.

WV-BR

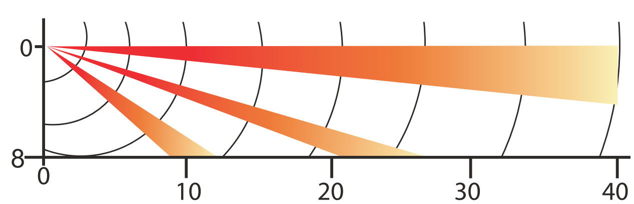
TILT ADJUSTMENT

Mt. Ht.	Position
7' - 8'	Vertical
8' - 9'	Center
9' - 10'	Forward
Above 10'	Use WV-BR

TOP VIEW



SIDE VIEW



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

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revised 12/07/2005

PIR CORNER OR WALL MOUNTED LOW VOLTAGE WIDE VIEW SENSORS

TECHNICAL DATA

TYPICAL APPLICATIONS
- Classrooms w/o Obstructions
- Large Conference Rooms
- Large Open Spaces
- Hallways

SENSOR HIGHLIGHTS
- Corner Mount PIR Sensor
- 120º by 40ft. Coverage for Small Motion
- Optional Photocell Daylight Override
- Optional Photocell On/Off
- Optional Isolated SPDT Relay
- Programable w/o removing cover

FEATURES
- Time Delay: 30 sec. to 20 minutes selectable in 2.5 min. increments
- Green LED Indicator

SPECIFICATIONS
- Size: Rectangular, 3.0” x 3.6” x 1.75”
- Sensor Weight: 5 Ounces
- Sensor Color: White
- Mounting Height: 8 to 10 Feet
- Relative Humidity: 20 to 90% non-condensing
- Operating Temp: 14º to 85º F
- Storage Temp: -14º to 160º F
- UL and CUL Listed
- 5 Year Warranty
- Made in U.S.A.

LOW TEMP/HI HUMIDITY(-LT)
- Conformally Coated PCB
- Operates down to -40º F
- Corrosion resistant from moisture

WV-16 SERIES

WV-BR (Bracket)

Programmable Edition!

Able to fit in the palm of your hand, the *WV-16* Wide View Sensor unobtrusively mounts in a corner near the ceiling detecting small motions up to 40 feet away, and large motions up to 70 feet away. The unique "Tilting feature" allows this sensor to be mounted anywhere from 8 to 10 feet with excellent long-range coverage. In 30 by 30 ft. classrooms with no obstructions, this is all the sensor you will need. In corridors, the *WV-16* is mounted flat against the wall and volumetrically views up to 70 feet. (For specific long narrow hallway applications, see HW-13 Technical Data Sheet). When corner or wall mounting is not possible, use ceiling bracket *WV-BR* accessory to locate the *WV-16* on the ceiling where desired. By using multiple Wide Views in combination with the CM-9 PIR ceiling sensor, odd shaped rooms or corridors are also easily covered. For rooms with obstructions, the WV-PDT or CM-PDT-10 Dual Technology sensors should be used.

SENSOR OPERATIONS
The *WV-16* detects changes in the Infrared energy given off by occupants as they move within the sensors field-of-view. This unique sensor is powered with 12 to 24 VAC/VDC (Red & Black wire inputs), and has one DC output (White wire). When occupancy is detected, this output goes high and can drive up to 200 mA of connected load. The *WV-16* typically operates with a PP-20 or MP-20 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 no activity. This timer is selectable at 2.5 minute increments from 30 seconds to 20 minutes, and is reset every time occupancy is detected. This state-of-the-art design requires no manual field adjustments.

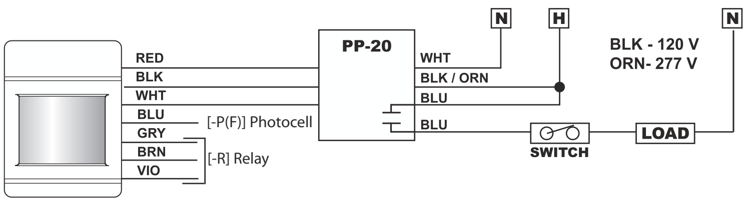
PHOTOCELL OPTIONS (WV-16-P and WV-16-PF)
The *WV-16* offers two Photocell options for spaces with abundant natural light. It is ideal for public spaces with windows like vestibules, corridors, or bathrooms; however it is not recommended for work spaces where occupants set light levels manually. Each photocell option utilizes a set-point value that is programable by the user via a digital push button sequence. The **Photocell Daylight Override** (–P) option simply inhibits the lights from turning on, however once the lights are on, the photocell function is disabled until the sensor times out. The **Photocell On/Off** (–PF) option has full control of the lights; turning them on when the level is below the set-point and off when adequate ambient light is present. For more specific information on the operation of Photocell On/Off control and/or dimming, see the CM-PC-ADC Technical Data Sheet information.

CATALOG INFORMATION

MODEL #	DESCRIPTION	TEMPERATURE	OP. VOLTAGE	CURRENT
WV-16	Passive Infrared Wide View Sensor	14° to 160° F	12 to 24 VAC/VDC	3 mA
Add suffix				
-R	SPDT Relay, 1 Amp		12 to 24 VAC/VDC	13 mA
-P(F)	Photocell - Daylight Override (On/Off)		12 to 24 VAC/VDC	3 mA
-RP(F)	Relay & Override Photocell (On/Off)		12 to 24 VAC/VDC	13 mA
-LT	Low Temp/High Humidity	-40° to 160° F		
Accessory				
WV-BR	Ceiling Mount Bracket			

INPUT\OUTPUT

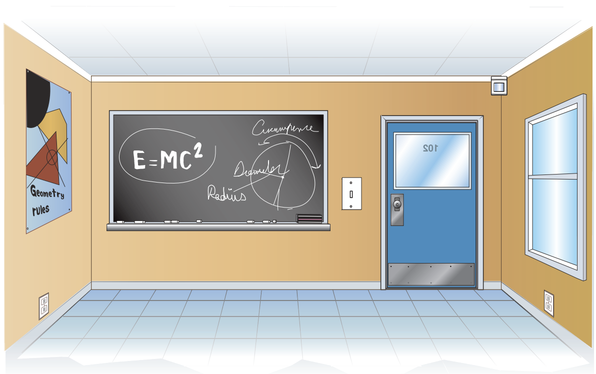
Wire lead connections are Class II, 18 to 22 AWG. The *WV-16* uses 3 leads (Red, Black, and White); the Photocell options add a Blue lead, and the Relay Option adds 3 leads (Brown, Gray, and Violet). The connections are as follows:



Do Not Wire Hot

INSTALLATION CONSIDERATION

The *WV-16's* rear enclosure is beveled so as to be corner mounted at 8 to 10 feet (see tilt settings). Always mount sensor in a corner above the entrance door or in a corner along the same wall as the entrance. If the room is large and multiple sensors are needed, mount the second sensor in the opposite corner, however tilt sensor forward to ensure that the PIR collector beams are not viewing out the door. For mounting heights above 10 feet, use the *WV-BR* and mount sensor to angled side to provide an initial 30° look down.



STANDARD WV-16

RED - 12 to 24 VAC/VDC
BLACK - Common
WHITE - Output (HI DC for Occupancy)

RELAY OPTION WV-16-R

BROWN - Center tap of relay (SPDT)
GRAY - High when Occupancy Contacts Closed
VIOLET - High when Occupancy Contacts Open

PHOTOCELL OPTION WV-16-P(F)

BLUE - Photocell Output (High: Occ/Low Light)
Use Blue wire from sensor in place of White Wire. For multi-level control, use 2 Power Packs and connect White to primary, and Blue to Daylight Load.

INTERNAL LOW VOLTAGE RELAY OPTION

Dry Contact Closure (-R) is provided through a SPDT, 1 Amp, 40 volt relay. The relay coil is energized and changes state when ALL sensors connected register "Unoccupied". Only one sensor per zone (if multiple sensors) needs to have this relay. Sensor must be powered from either a Power Pack, or Class 2 transformer.

CEILING MOUNT BRACKET (WV-BR)

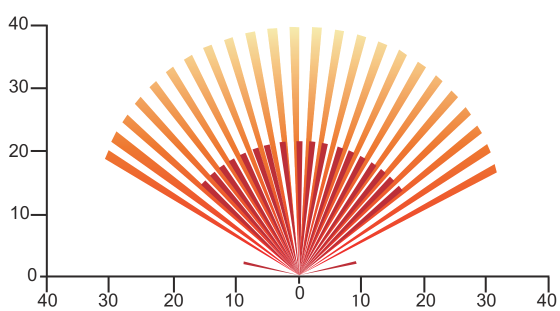
The *WV-BR* Ceiling Mount Bracket allows the *WV-16* to be mounted in the corner of the area from the ceiling for conditions where mounting to the wall is not possible.

WV-BR

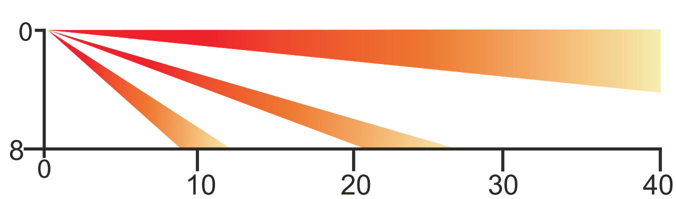
TILT ADJUSTMENT

Mt. Ht.	Position
7' - 8'	Vertical
8' - 9'	Center
9' - 10'	Forward
Above 10'	Use WV-BR

TOP VIEW



SIDE VIEW



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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.

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revised 11/29/2005

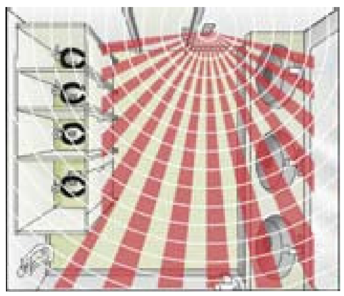
WSD-PDT Series

Programmable Edition!

Dual Technology in a Wall Switch Sensor! The *WSD-PDT Series* is by far the most powerful Decorator occupancy sensor ever invented. The combination of Passive Infrared and patented Microphonics™ detection, allows this sensor to literally *"See & Hear"* its occupants. The *WSD-PDT* is the ideal solution for restrooms with stalls, private offices where the occupant turns his back to the sensor, or storage rooms with obstructions. Additionally, the WSD Series sensors have several On Modes and Switch Modes that can be programmed using the front push-button.

SENSOR OPERATIONS

Sensors with Passive Dual Technology (PDT) 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 lighting "On. The sensor is line powered and can switch line voltage (see specifications). An internal timer, factory set at 10 minutes, keeps the lights "On" during brief periods of no activity. 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.



Bathrooms (WSD-PDT-V)

- Senses partitioned spaces
- Most inexpensive sensor approach
- Voice sound activation prevents lights out condition

OPERATIONAL MODES

On Modes (*Default)

Automatic On* - The sensor automatically turns the lights on when the sensor detects occupancy.

Reduced Turn-On - The sensor is set to initially only detect large motions, effectively ignoring any reflected PIR signals while still sensing occupants when they enter the room. Once on, the sensor returns to maximum sensitivity.

Switch Modes (*Default)

Predictive Off* - Pressing the switch overrides the lights off and temporarily disables the occupancy detection. After an exit time delay (default 10 seconds) the occupancy detection reactivates and monitors for an additional grace period time (default 5 seconds). If no occupancy is detected during this period, the sensor will revert to Automatic On operation. If occupancy is detected, the sensor will remain in Permanent Off mode requiring the switch to be pressed again in order to restore the sensor to Automatic On.

Permanent Off - Pressing the push-button switch will turn the lights off. The lights will remain off regardless of occupancy until the switch is pressed again, restoring the sensor to Automatic On mode.

Switch Disable - Prevents user from manually turning off the lights via the push-button.

TYPICAL APPLICATIONS

- Private Offices where occupant turns back to sensor
- Restroom with Stalls
- Storage rooms with shelving

FEATURES

- Patented Dual Technology with PIR/Microphonics™ Detection
- Self Contained Relay, no Power Pack needed
- Patented Bi-Polar Wiring: Interchangeable hot & load wires
- Intrinsically Grounded
- No Minimum Load
- Time Delay: 30 sec. to 20 minutes
- Push-Button Programmable
- Three-Way & Multi-Level Switching
- Green LED Activity Indicator

AVAILABLE OPTIONS

- Vandal-Resistant Lens (-V)
- Photocell Daylight Override (-P)
- Low Temp/Hi Humidity (-LT)

SPECIFICATIONS

- Size: 4.2" H x 1.8" W x 1.5" D (10.67cm x 4.57cm x 3.81cm)
- Sensor Weight: 5 Ounces
- Colors: Ivory, White, Gray, Almond
- Mounting Height: 30 to 48 inches
- Relative Humidity: 20 to 90% non-condensing
- Operating Temp: 14° to 85° F (-10° to 29° C)
- Storage Temp: -14° to 160° F (-26° to 71° C)
- Load Rating (1 phase only):
  - 120 VAC @ 800 W
  - 277 VAC @ 1200 W
  - 347 VAC @ 1500 W
- Frequency: 50/60 Hz (Timers are 1.2 x for 50 Hz)
- UL, CUL, & CSA Listed
- CA 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 -4° F (-20°C)

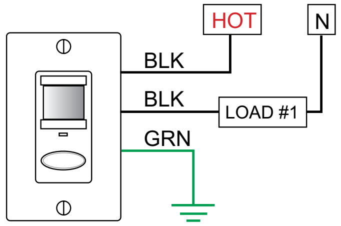
Model Numbering System: WSD-PDT-[LENS]-[PHOTOCELL]-[VOLTAGE]-[COLOR*]-[TEMP/HUMIDITY]

SERIES #	LENS	PHOTOCELL	VOLTAGE	COLOR	TEMP/HUMIDITY
WSD-PDT	Blank = Standard -V = Vandal Resistant	Blank = No Photocell -P = w/Photocell	Blank = 120-277 VAC -3 = 347 VAC**	-I = Ivory -W = White -G = Gray -A = Almond	Blank = 14° to 85° F -LT = -4° to 85° F

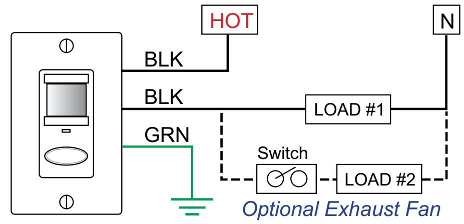
**347 VAC: Plate not provided

*Must specify color

TYPICAL WIRING DIAGRAM (DO NOT WIRE HOT)



Note: Connection to Ground required for sensor to function!

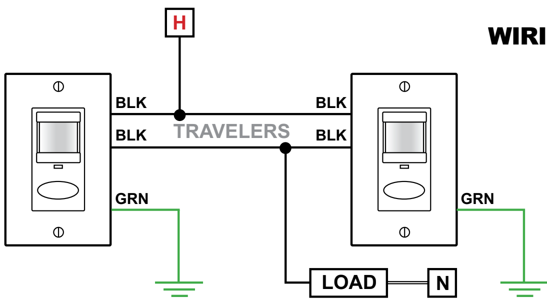


Note: Black wires are replaced with Red wires for 347 VAC.

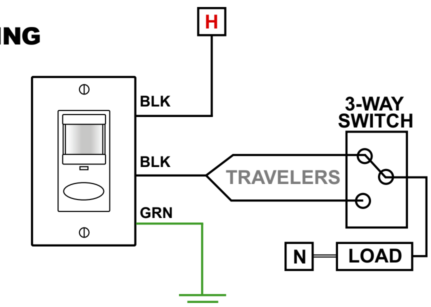
WIRING TO A LIGHT AND A FAN

One of the sensor's Black wires connects to the Hot (Line) power feed. The sensor's other Black wire connects to the Light and the Toggle Switch controlling the Exhaust Fan. The sensor's Green wire connects to Ground. When the sensor is in the Occupied Mode, the Exhaust Fan may be overridden Off by the Toggle Switch.

WIRING FOR 3-WAY SWITCHING



Travelers are used to wire sensors in parallel. If only one sensor is needed to view space, 3-way switch is non-functional.



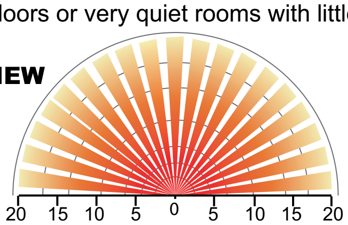
PHOTOCELL DAYLIGHT OVERRIDE OPTION (WSD-PDT-P)

The *WSD-PDT* offers a Photocell Daylight Override option (-P) for spaces with abundant natural light. Ideal for public places with windows like vestibules, corridors, or bathrooms; this option inhibits the lights from turning on if there is sufficient daylight available. Once the lights turn on, however, the photocell function is disabled until the sensor's occupancy timer expires and turns the lights off.

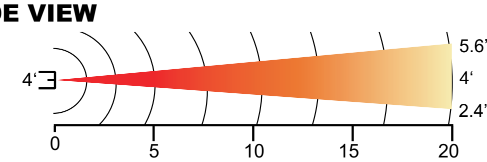
AREA OF COVERAGE

The PIR collector beams view out horizontally in a wall-to-wall pattern. The beams will see out to 50 feet, however, their effectiveness in the *Standard* product is 20 feet for small hand or body motions and 10 feet for the *Vandal Resisitant* products. The Microphonics™ will detect normal human activity up to 20 feet, but will detect greater distances in spaces with hard floors or very quiet rooms with little or no background noise.

TOP VIEW



SIDE VIEW



STANDARD vs. VANDAL RESISTANT LENS

The Standard lens provides maximum PIR detection sensing small movements up to 20 feet, and large motions up to 50 feet. This lens should be used in typical offices or rooms where occupants work for extended periods of time. The Vandal Resistant lens should be used in high abuse or public areas, where occupants simply come and go and make larger types of motions. Copy rooms, small public restrooms, storage or janitor's closets are ideal applications. A sensor with a Vandal Resistant lens will have its PIR detection range reduced by 50%, however the Microphonics™ range is not affected.

WARNING

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

Attention: Risque d'incendie : Pauissance 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).

WARRANTY: Sensor Switch, Inc. warrants these products to be free of defects in manufacture and workmanship for a period of sixty 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.

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120/277 VOLT MINI POWER PACKS AND SLAVE PACKS

TECHNICAL DATA

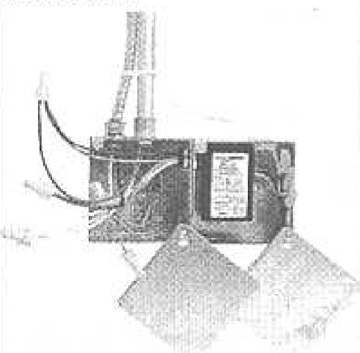
TYPICAL APPLICATIONS
- Used with Low Voltage Sensors
- Multiple Sensors
- Multiple Loads

POWER PACK HIGHLIGHTS
- Dual Voltage Transformer
- Self-Contained Relay
- Powers up to 14 sensors

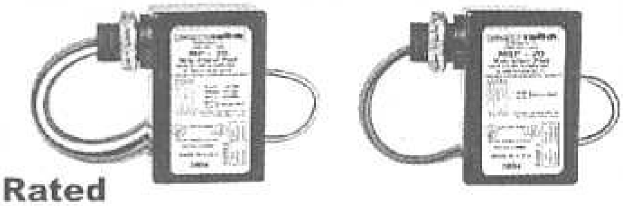
SPECIFICATIONS
- Size:(1/2" inch chase nipple not inc.) MP-20 & MSP-20: $4^{1}/_{8}$" x 3" x $1^{7}/_{8}$"
- Mounting: 1/2" inch chase nipple
- Operating Voltage: 120, 240, or 277 VAC
- Each Relay: 20 Amps
- 1 HP Motor Load
- Output Voltage: 15 VDC, 150 mA
- Class II: 18 AWG, up to 2,000 ft.
- Plenum 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.



MP-20
MSP-20



Plenum Rated

Mini Power Packs are the heart of the Low Voltage Sensor System. The *MP-20* transforms 120, 240 or 277 Volts to class II 15 VDC to power the remote sensors. Although Plenum Rated, the elongated mounting nipple allows for the *MP-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 *MP-20*. Multi-circuit control can be handled by multiple *MP-20's* and Slave Packs (*MSP-20*) may be configured. *MP-20's* can be wired continuously hot (line side), or on the switch leg (load side) without nuisance delays upon turn "On".

MINI POWER PACK OPERATION
The Mini Power Pack consists of a transformer and a relay. The tranformer has a dual primary high voltage input, accepting 120, 240, or 277 VAC. The secondary voltage provides power to Sensor Switch low voltage heads. When the sensor head detects motion, they electronically signal the power pack to close the relay(s) connected to the lighting system.

LOW VOLTAGE OPERATION AND TEST
The Low Voltage Wires are color coded Red (15 VDC), Black (Common), and White (Occupancy Signal). With no sensors connected, touch the Red wire 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 MP-20	14	8
1 MP-20 w/MSP-20	7	6
2 MP-20	28	16

Note 1: Only three relays may be controlled with one Mini Power Pack. If more than three circuits are required, multiple MiniPower Packs must be used.
Note 2: Only one "Sensor with Relay" is required in most cases. See Technical Data on Low Voltage Sensors and SPDT EMS Interface Option.

SYSTEMS CONSIDERATIONS
The local override switch may be upstream or downstream of an *MP-20*. However, if an *MSP-20* Auxiliary Relay 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 *MP-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, *MP-20* must be wired before dimmer, or *MSP-20* may be wired after dimmer.

CATALOG INFORMATION

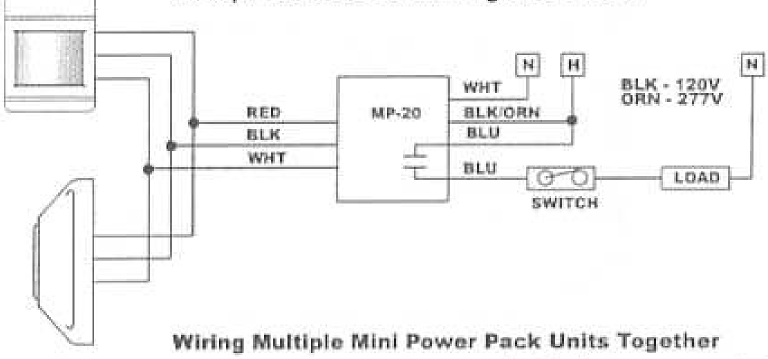
MODEL#	DESCRIPTION	OUTPUT VOLTAGE	OUTPUT CURRENT
MP-20	Power Pack with 20 Amp Relays	15 to 24 VDC	70 to 110 mA
MSP-20	Slave Pack with 20 Amp Relays	N/A	40 mA(consumption)

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

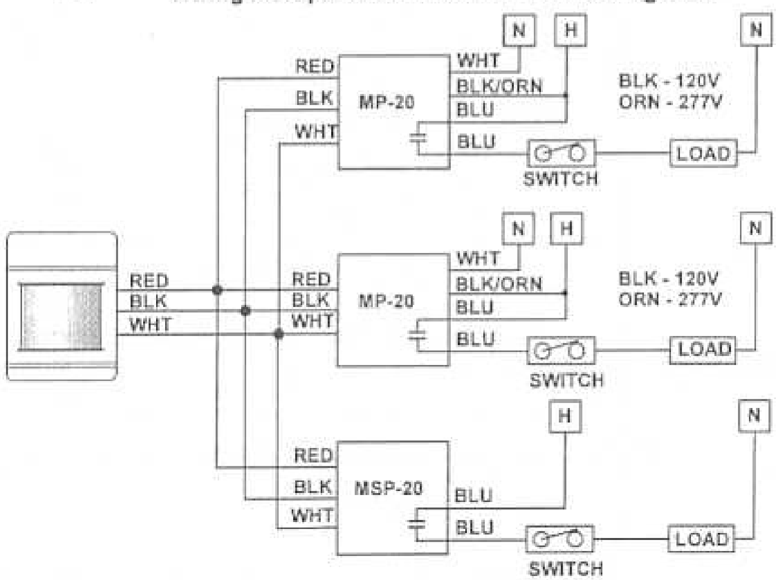
TYPICAL WIRING DIAGRAMS - DO NOT WIRE HOT

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.

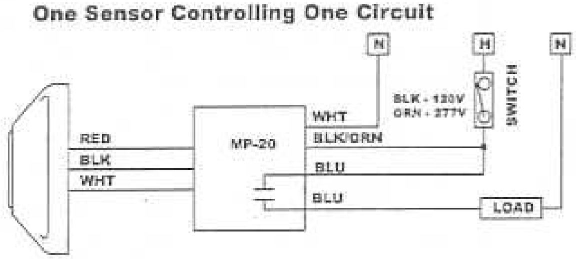
Multiple Sensors Controlling One Circuit



Wiring Multiple Mini Power Pack Units Together



One Sensor Controlling One Circuit



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LOW VOLTAGE PASSIVE INFRARED
HALLWAY SENSOR

TECHNICAL DATA

TYPICAL APPLICATIONS

- Hallway Sensing

FEATURES

- PIR Occupancy Detection
- Coverage up to 130 Feet
- Communicates with Other Sensors
- Programmable w/o removing cover
- Time Delay: 30 sec. to 20 minutes, selectable in 2.5 min. increments
- Green LED Activity Indicator
- 100 Hr. Burn-in Timer Mode

AVAILABLE OPTIONS

- Isolated Low Voltage Relay (-R)
- Photocell Daylight Override (-P)
- Low Temp/Hi Humidity (-LT)

SPECIFICATIONS

- Size: Rectangular, 3.0” x 3.6” x 1.75” (7.62 cm x 9.14 cm x 4.45 cm)
- Sensor Weight: 4 Ounces
- Sensor Color: White
- Mounting: 7 to 10 ft in Corner or Ceiling using bracket (WV-BR)
- Relative Humidity: 20 to 90% non-condensing
- Operating Temp: 14º to 160º F (-10° to 29° C)
- Storage Temp: -14º to 160º F (-26° to 71° C)
- Operating Voltage:12 - 24 VAC/VDC
- UL and CUL Listed
- 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 -40º F(-40º C)

HW-13 SERIES

Programmable Edition!

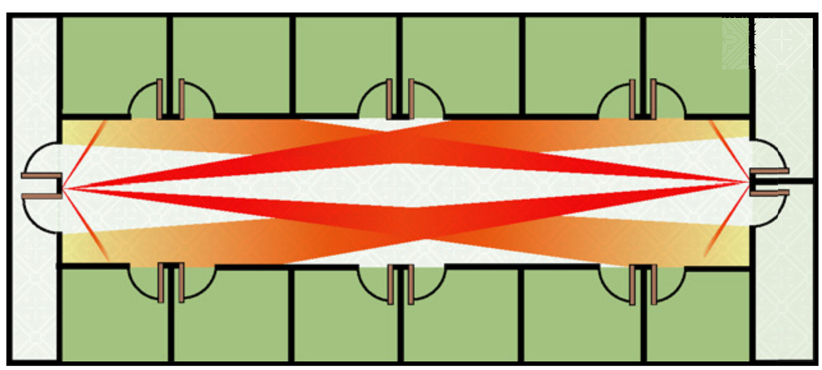
Long narrow Passive Infrared (PIR) detection is provided by the *HW-13* for control of Hallway lighting. Typically mounted at either end of a long corridor, the HW-13 detects occupants entering the hallway up to 130 feet away. Detection at these distances is for entrances at right angles to the beam pattern. Wired in parallel, the *HW-13* may be used with other low voltage sensors. For example, a CM-10 ceiling sensor may be in a vestibule at one end while the *HW-13* is at the other. The *HW-13* is best mounted at 7 feet.

SENSOR OPERATIONS

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 to 24 VAC/VDC and typically operates with a PP-20 or MP-20 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 no activity. This timer is selectable at 2.5 minute increments from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected. This state-of-the-art design requires no manual field adjustments.

PASSIVE INFRARED DETECTION TECHNOLOGY

The *HW-13* has one main PIR collector beam. Motions are detected as occupants cross into or out of this beam. PIR detects motions across the beam much better than motions directly into the beam; therefore care must be taken to make sure the sensor is not viewing out the end of the corridor where crossing traffic provides stronger detection signals than occupants entering directly at the sensor. Positioning sensors at both ends and ensuring that they do not view out of the corridor will provide proper performance.



CATALOG INFORMATION

MODEL #	DESCRIPTION	TEMPERATURE	OP. VOLTAGE	CURRENT
HW-13	Passive Infrared Hallway Sensor	14° to 160° F	12 to 24 VAC/VDC	4 mA
Add suffix				
-R	SPDT Relay, 1 Amp			16 mA
-P	Photocell - Daylight Override			4 mA
-RP	Relay & Photocell			16 mA
-LT	Low Temp/High Humidity	-40° to 160° F		
Accessory				
WV-BR	Ceiling Mount Bracket			

PHOTOCELL DAYLIGHT HARVESTING OPTION (HW-13-P)

This series offers a Photocell (-P) option for daylight harvesting in spaces with abundant natural light. This option is ideal for public spaces with windows like vestibules, corridors, or bathrooms. As the daylight levels change in the room, the -P option insures that an adequate light level is maintained according to a programmable threshold value called a set-point. The Photocell option provides two modes of operation; one simply inhibits the lights from turning on, while the other has full On/Off control of the lights. For more detailed information on the operation of Photocell control, see the CM-PC Technical Data Sheet.

INTERNAL LOW VOLTAGE RELAY OPTION (HW-13-R)

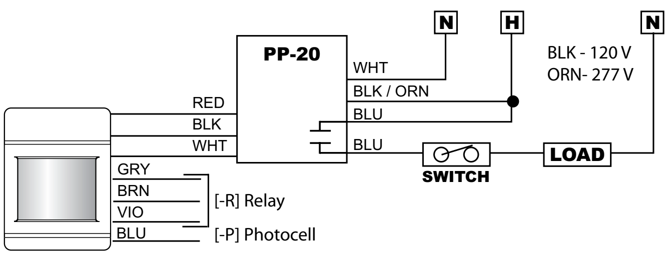
To enable a sensor to interface with a building management system, the -R option provides dry contact closure via a SPDT, 1 Amp, 40 Volt relay. The relay coil is energized and changes state when ALL connected sensors register “Unoccupied”. When using multiple sensors, only one sensor per zone needs to have a relay.
Note: Sensor must have power at all times for the relay to function .

WIRING INSTRUCTIONS

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

STANDARD HW-13
RED - 12 to 24 VAC/VDC
BLACK - Common
WHITE - Output (HI DC for Occupancy)

TYPICAL WIRING DIAGRAM - DO NOT WIRE HOT



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 - Photocell output (High: Occupied & Low Light)
Use Blue wire from sensor in place of White wire. For multi-level control, use 2 Power Packs and connect White to primary load and Blue to daylight load.

CEILING MOUNT BRACKET (WV-BR)

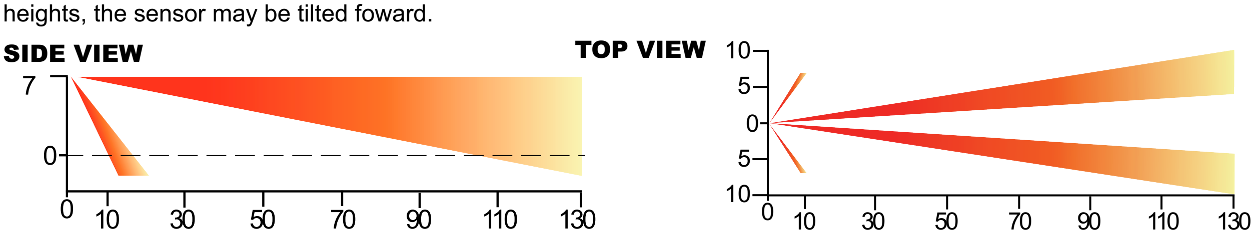
The WV-BR Ceiling Mount Bracket allows the *HW-13* to be ceiling mounted for conditions where mounting to the wall is not possible. **Note:** View shown is when the sensor is installed fully vertically. Tilting will aim view pattern down.

WV-BR
Ceiling Bracket

FIELD OF VIEW vs. TILT ADJUSTMENT

The *HW-13* has three tilt adjustments. At 7 feet mounting, the sensor should be installed fully vertical. At higher mounting heights, the sensor may be tilted foward.

SIDE VIEW **TOP VIEW**



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TYPICAL APPLICATIONS
- Partitioned Cubical Spaces
- Restroom with Stalls
- Library Study Carrels & Stacks

FEATURES
- Patented Dual Technology with PIR/Microphonics™ Detection
- Communicates with Other Sensors
- Time Delay: 30 sec. to 20 minutes
- Push-Button Programmable
- Green LED Indicator
- 100 Hr. Lamp Burn-in Timer Mode

AVAILABLE OPTIONS
- Isolated SPDT Relay (-R)
- On/Off Photocell (-P)
- Auto Dimming Cntl. Photocell (-ADC)
- Low Temp/Hi Humidity (-LT)

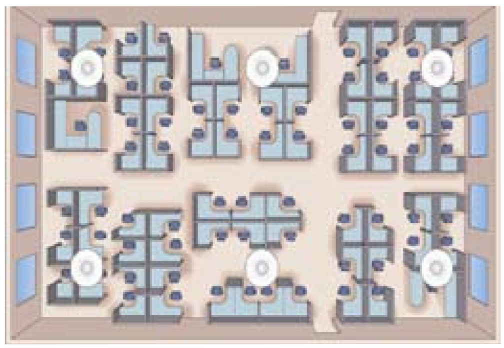
SPECIFICATIONS
- Size: Circular, 4.55" Dia., 1.55" Deep (11.56 cm Dia., 3.94 cm Deep)
- Sensor Weight: 5 Ounces
- Sensor Color: White
- Mounting: Ceiling Tile Surface, Round Fixture or Junction Box
- Relative Humidity: 20 to 90% non-condensing
- Operating Temp: 14° to 160° F (-10° to 71° C)
- Storage Temp: -14° to 160° F (-26° to 71° C)
- 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 -4° F(-20° C)

CM-PDT SERIES

w/ Enhanced Daylighting Control Options!

Open area office lighting control is made cost effective with the use of the *CM-PDT Series* Passive Dual Technology occupancy sensor. This small, yet powerful sensor provides line of sight PIR detection of small motion in a circular pattern and combines overlapping Microphonics™ coverage for detection of occupants working in their cubical space. By installing multiple *CM-PDTs* on 30 foot centers, large zones are created (typically one per circuit of lighting). The lighting is then controlled in blocks similar to manual switching, only no one will ever have to remember to turn off the lights! Restrooms with stalls, large storage areas with shelving, and libraries with study carrels are also easily and cost effectively controlled by the *CM-PDT*.



SENSOR OPERATIONS
Sensors with Passive Dual Technology (PDT) 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 DC output goes high and can drive up to 200 mA of connected load. The sensor is powered with 12 to 24 VAC/VDC and typically operates with a PP-20 or MP-20 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 no activity. This timer is selectable at 2.5 minute increments from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected.

DAYLIGHTING CONTROL OPTIONS
For spaces with abundant natural light from windows or skylights, this series offers an On/Off Photocell (-P) option and an Automatic Dimming Control (-ADC) Photocell option. The -P option is ideal for public areas like vestibules, corridors, or restrooms; while the -ADC option is perfect for classrooms and private offices. As the daylight levels change in the room, both options insure that an adequate light level is maintained according to a programmable set-point value. The -P option provides two modes of operation; one simply inhibits the lights from turning on, while the other has full On/Off control of the lights. The -ADC option allows the sensor to control a dimmable ballast. It also provides a secondary dim time-out that enables the lights to go to a dim setting after one time-out and then turn fully off after a second time-out. For more detailed information on these daylighting control features, see the CM-PC-ADC Technical Data Sheet.

SENSORS vs. LIGHTING PANELS
Lower cost, convenience, reliability, and greater energy savings are all provided by installing *CM-PDTs* rather than computer based lighting control panels. No programming, no confusing overrides, no chance of turning off while the area is still occupied, and no reason for leaving the lights on in "anticipation" of occupants! Real time detection of occupancy always outperforms a pre-programmed time clock. All this at a fraction of the total installed cost of a lighting panel!

CATALOG INFORMATION

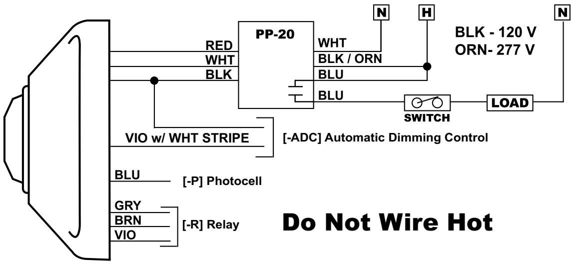
MODEL #	DESCRIPTION	TEMPERATURE	OP. VOLTAGE	CURRENT
CM-PDT	Dual Technology Ceiling Mount Sensor	14° to 160° F	12 to 24 VAC/VDC	4 mA
Add suffix				
-R	SPDT Relay, 1 Amp			16 mA
-P	On/Off Photocell			4 mA
-RP	Relay & On/Off Photocell			16 mA
-ADC	Automatic Dimming Control Photocell			4 mA
-LT	Low Temp/High Humidity	-4° to 160° F		

WIRING INSTRUCTIONS

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

STANDARD CM-9

RED - 12 to 24 VAC/VDC
BLACK - Common
WHITE - Output (HI DC for Occupancy)



INTERNAL LOW VOLTAGE RELAY OPTION

To enable a sensor to interface with a building management system, the -R option provides dry contact closure via a SPDT, 1 Amp, 40 Volt relay. The relay coil is energized and changes state when ALL connected sensors register "Unoccupied". When using multiple sensors, only one sensor per zone needs to have a relay.

Note: Sensor must have power at all times for the relay to function .

MOUNTING CONSIDERATIONS

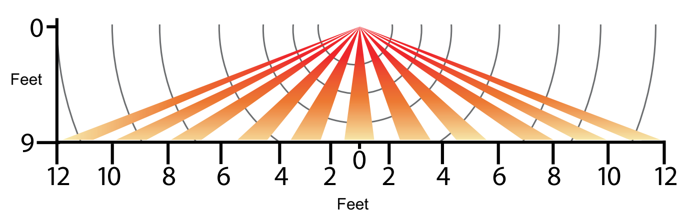
The *CM-PDT* is provided with 2 self tapping mounting screws. The sensor typically mounts directly to the ceiling tile, or to the metallic grid. However, if desired, the mounting holes are slotted to line up with a standard round or rectangular box (screws not provided).

Note: The ceiling tile provides insulation from stray plenum noises. Only penetrate tile to allow for mounting screws and wires (3 small holes).

FIELD OF VIEW

The *CM-PDT's* dome lens provides a maximum viewing angle of 56° in a complete 360° conical pattern. The Microphonics™ detects normal human activity up to 20 feet, but will detect greater distances in spaces with hard floors or very quiet rooms with little or no background noise. Place the sensor along the entrance door wall to prevent it from viewing out into the hallway. Avoid locating the sensor near HVAC air diffusers because the "noise" generated from air flow will decrease the sensitivity of the Microphonics™ sensor.

SIDE VIEW



RELAY OPTION (-R)

GRAY / BROWN - Connected during Occupied state
VIOLET / BROWN - Connected during Unoccupied state
Note: Relay is energized during Unoccupied state

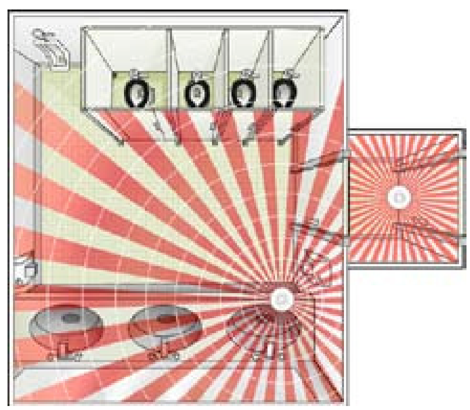
PHOTOCELL OPTION (-P)

BLUE - Photocell output (High: Occupied & Low Light)
Use Blue wire from sensor in place of White wire. For multi-level control, use 2 Power Packs and connect White to primary load and Blue to daylight load.

AUTOMATIC DIMMING CONTROL (-ADC)

VIOLET/WHITE striped - Connect to Violet wire from 0-10 VDC dimmable ballast. Also connect ballast Gray wire to sensor Black wire. **Note:** If both the -P and the -ADC options are selected the "Inhibit" mode of the -P option is not available.

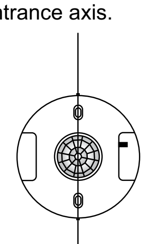
Multi-Stall Restroom w/Vestibule



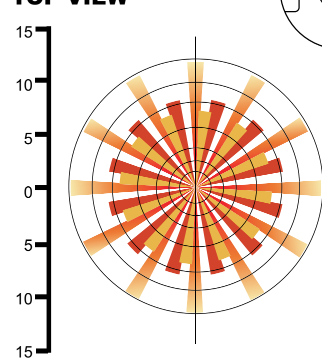
PIR used with PDT

- CM-9 PIR in vestibule initiating the light "On"
- Microphonics™ in CM-PDT is activated by the CM-9.
- CM-PDT detects occupants in stalls

Note: For maximum distance place the sensor so that the screw axis is positioned with the entrance axis.



TOP VIEW



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revised 06/13/2006

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LOW VOLTAGE PASSIVE INFRARED STANDARD CEILING MOUNT SENSOR

TECHNICAL DATA

TYPICAL APPLICATIONS

- Private Offices
- Storage Closet
- Conference Room
- Restroom w/o stalls

FEATURES

- PIR Occupancy Detection
- Communicates with Other Sensors
- Time Delay: 30 sec. to 20 minutes, selectable in 2.5 min increments
- Green LED Activity Indicator
- 100 Hr. Burn-in Timer Mode

AVAILABLE OPTIONS

- Isolated Low Voltage Relay (-R)
- Photocell Daylight Override (-P)
- Automatic Dimming Control (-ADC)
- 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: 14º to 160º F (-10° to 71° C)
- Storage Temp: -14º to 160º F (-26° to 71° C)
- UL and CUL Listed
- 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 -40º F(-40º C)

CM-9 SERIES

w/ Enhanced Photocell & Dimming Options!

The *CM-9 Series* sensor offers amazing performance and sensitivity to small motions for a standard Passive Infrared (PIR) Ceiling Mount Sensor. Ideal for small rooms with drop ceilings and areas without obstructions, the *CM-9* is a snap to install. Its light weight allows surface mounting to drop ceilings or a ceiling grid. The *CM-9* sensor can cover entire private offices or smaller rooms by itself, however it is also the ideal lead sensor for odd shaped rooms. For example a *CM-9* in a restroom vestibule can communicate with a CM-PDT Dual Technology sensor in a main stall area. Another application is a *CM-9* controlling an entrance hall to a classroom and communicating with a WV-PDT controlling the main room. In both cases the lights would be activated "On" by the *CM-9*. For mounting above 15 feet, see the CM-6 Technical Data Sheet.

SENSOR OPERATIONS

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 to 24 VAC/VDC and typically operates with a PP-20 or MP-20 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 no activity. This timer is selectable at 2.5 minute increments from 30 seconds to 20 minutes, and is reset every time occupancy is re-detected. This state-of-the-art design requires no manual field adjustments.

PHOTOCELL DAYLIGHT OVERRIDE / DIMMING OPTIONS

This series offers a Photocell (-P) option for spaces with abundant daylight and an Automatic Dimming Control (-ADC) option for use with dimmable ballasts. These options are ideal for public spaces with windows like vestibules, corridors, or bathrooms. As the daylight levels change in the room, both options insure that an adequate light level is maintained according to a programmable set-point value. The Photocell option provides two modes of operation; one simply inhibits the lights from turning on, while the other has full On/Off control of the lights. The -ADC option allows the sensor to control a dimmable ballast. It also provides a secondary dim time-out that enables the lights to go to a dim setting after one time-out and then turn fully off after a second time-out. For more detailed information on the operation of Photocell control and/or dimming, see the CM-PC-ADC Technical Data Sheet.

INTERNAL LOW VOLTAGE RELAY OPTION (CM-9-R)

To enable a sensor to interface with a building management system, the -R option provides dry contact closure via a SPDT, 1 Amp, 40 Volt relay. The relay coil is energized and changes state when ALL connected sensors register "Unoccupied". When using multiple sensors, only one sensor per zone needs to have a relay.
Note: Sensor must have power at all times for the relay to function .

CATALOG INFORMATION

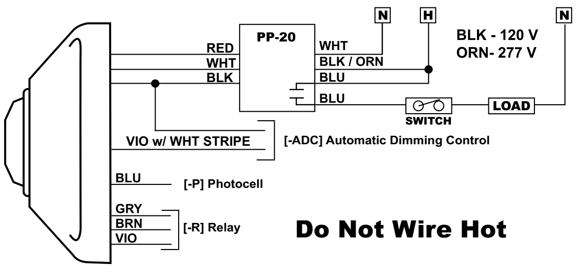
MODEL #	DESCRIPTION	TEMPERATURE	OP. VOLTAGE	CURRENT
CM-9	Passive Infrared Ceiling Mount Sensor	14° to 160° F	12 to 24 VAC/VDC	4 mA
Add suffix				
-R	SPDT Relay, 1 Amp			16 mA
-P	Photocell Daylight Override			4 mA
-RP	Relay & Photocell			16 mA
-ADC	Automatic Dimming Control			4 mA
-LT	Low Temp/High Humidity	-40° to 160° F		

WIRING INSTRUCTIONS

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

STANDARD CM-9

RED - 12 to 24 VAC/VDC
BLACK - Common
WHITE - Output (HI DC for Occupancy)



Do Not Wire Hot

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)

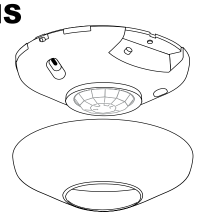
BLUE - Photocell output (High: Occupied & Low Light)
Use Blue wire from sensor in place of White wire. For multi-level control, use 2 Power Packs and connect White to primary load and Blue to daylight load.

AUTOMATIC DIMMING CONTROL (-ADC)

VIOLET/WHITE striped - Connect to Violet wire from 0-10 VDC dimmable ballast. Also connect ballast Gray wire to sensor Black wire. (Note: -ADC option disables Photocell inhibit mode of -P option.)

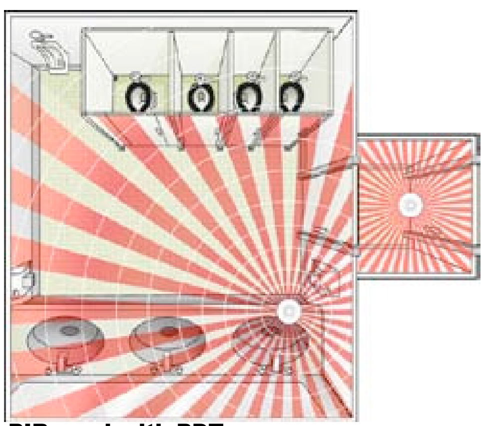
MOUNTING CONSIDERATIONS

The *CM-9* is provided with 2 self tapping mounting screws. The sensor typically mounts directly to the ceiling tile or metallic grid. If desired, the mounting holes are slotted to line up with a standard round or rectangular box (screws not provided).



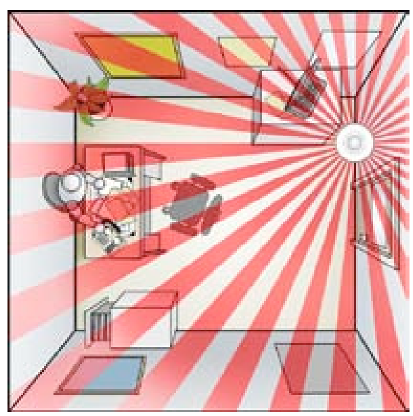
INSTALLATION CONSIDERATION

In smaller spaces like 12' x12' (3.66 x 3.66 m) private offices, it is best to locate the *CM-9* along the entrance wall so that the occupant breaks the collector beams upon entrance, while passersby do not falsely trip the unit (see field-of-view diagram). The discrete outer beams used for intial detection can be aligned for maximum coverage.



PIR used with PDT

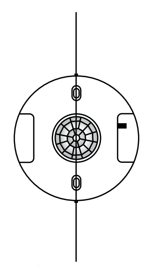
- CM-9 PIR in vestibule initiating the light "On"
- Microphonics™ in CM-PDT is activated by the CM-9.
- CM-PDT detects occupants in stalls



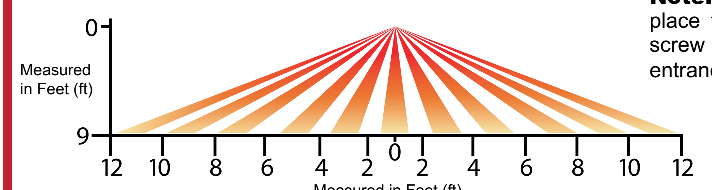
Small Office

- Mount sensor near entrance wall viewing entire room without seeing out doorway
- Low Voltage sensors provide easiest installation in drop Ceilings.

Note: Heat producing sources controlled by the sensor must not be in the view pattern of the sensor.
Symptom: Sensor cycles or appears to continually stay "On".
Solution: Move sensor or mask lens segments that view the source.

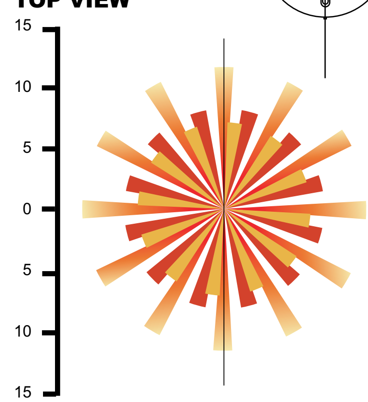


SIDE VIEW



Note: For maximum distance place the sensor so that the screw axis is aligned with the entrance axis.

TOP VIEW



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

LOW VOLTAGE
HIGH MOUNTING CEILING SENSOR

sensorswitch™

TECHNICAL DATA

TYPICAL APPLICATIONS

- High Mounting (15-45ft)
- Warehouse
- Gymnasiums
- Racquetball Courts

SENSOR HIGHLIGHTS

- Ceiling Mount PIR Sensor
- 360º Coverage
- 15-20ft Radius above 15ft
- Optional Isolated SPDT Relay

FEATURES

- Time Delay: 30 sec. to 20 minutes
  Selectable in 2.5 min increments
- Green LED Indicator

SPECIFICATIONS

- Size: Circular, 4.55" Dia., 1.36" Deep
- Sensor Weight: 6 Ounces
- Sensor Color: White
- Mounting: Ceiling Tile Surface
- Optional: Round or J-Box
- Relative Humidity: 20 to 90%
  non-condensing
- Operating Temp: 14º to 160º F
- Storage Temp: -14º to 160º F
- UL and CUL Listed
- 5 Year Warranty
- Made in U.S.A.

LOW TEMP/HI HUMIDITY(-LT)

- Conformally Coated PCB
- Operates down to -40º F

CM-6 SERIES

Programmable Edition!

The *CM-6* sensor was specifically designed for High Mounting applications (15 - 45 feet). Above 15 feet, the *CM-6* provides Passive Infrared (PIR) detection in a 30 to 40 foot diameter area. Multiple sensors may be used together to provide coverage as needed. For freezer applications, use the CM-6-LT for cold temperature and corrosion resistant characteristics. For lower mounting applications, refer to CM-9 or CM-10 technical data.

SENSOR OPERATIONS

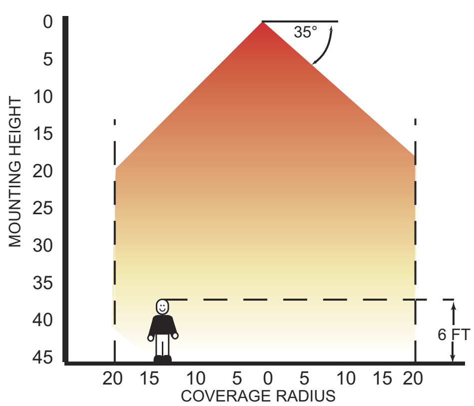
The *CM-6* typically operates with a PP-20 or MP-20 Power Pack. However, this unique sensor accepts 12 to 24 volts AC or DC (Red & Black wires), and outputs the DC component (White wire). When occupancy is detected, the output goes high and can drive up to a 200 mA of connected load. When used with the Power Packs, complete 20 amp circuits can be controlled. The*CM-6* detects changes in the Infrared energy given off by occupants as they move within the sensors field-of-view. An internal timer in the sensor, typically set at 10 minutes, keeps the lights "On" during periods of no activity. This state-of-the-art design allows the sensor to adapt to it's enviroment, eliminating the need for manual field adjustments.

CONTROLLING HID BI-LEVEL LIGHTING

In Gymnasiums or Warehouses where control of HID Bi-Level Lighting is desired, refer to PP-20-SH Power Pack. This Power Pack provides for a Start-to-High Timer, which brings the lamps to full "On" for up to 20 minutes upon initial power up. The Power Pack must be on the same power circuit as the fixtures to sense the initial power on condition. Some Electronic HID fixtures have this Start-to-High feature built in. In this case, the standard PP-20 or MP-20 Power Pack may be used to switch fixtures from Hi to Low. Consult fixture manufacturer.

TYPICAL APPLICATIONS

The *CM-6* can be used in warehouses, or gymnasiums where the sensors are mounted on a 30 to 40 foot grid pattern, connecting to power packs through low voltage cable. If any one sensor detects occupants, all the lights will turn "On". In Raquetball Courts, it is preferred to locate the sensor near the entrance (furthest from the wall).



Note: Heat producing sources controlled by the sensor must not be in the view pattern of the sensor. Symptom: Sensor cycles or appears to continually stay "On". Solution: Move sensor or mask lens segments that view the source.

CATALOG INFORMATION

MODEL #	DESCRIPTION	TEMPERATURE	OP. VOLTAGE	CURRENT
CM-6	Passive Infrared Ceiling Mount Sensor	14° to 160° F	12 to 24 VAC/VDC	3 mA
Add suffix				
-R	SPDT Relay, 1 amp		12 to 24 VAC/VDC	13 mA
-LT	Low Temp/High Humidity	-40° to 160° F		

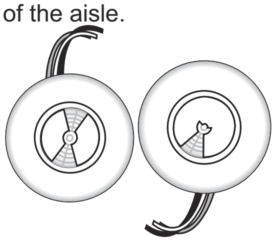
STANDARD CM-6
RED-12 to 24 VAC/VDC
BLACK-Common
WHITE-Output (HI DC for Occupancy)

RELAY OPTION CM-6-R
BROWN-Center tap of relay(SPDT)
GRAY-During Occupancy Contacts Closed
VIOLET-During Occupancy Contacts Open

INTERNAL LOW VOLTAGE RELAY OPTION
Dry Contact Closure (-R) is provided through a SPDT, 1 amp, 40 volt relay. Relay coil is energized changing state when ALL sensors connected register “Unoccupied”. Only one sensor per zone (if multiple sensors) needs to have this relay. Sensor must be powered from either a Power Pack, or Class 2 transformer.

MASKING KIT
The sensor views a 360° circular pattern. The kit provided may be used to mask off half of the viewing for end of aisle, or trim the side viewing to create a rectangular pattern for center of aisle. Shown below is the masking for the center of aisle and the end of the aisle.

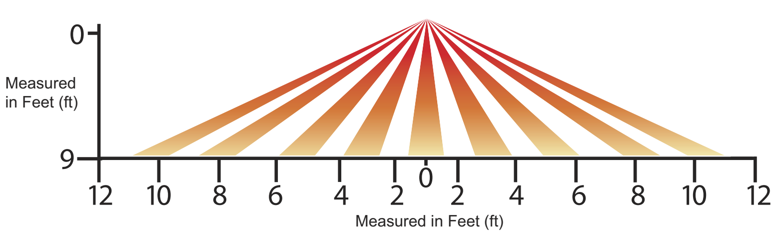
CENTER OF AISLE



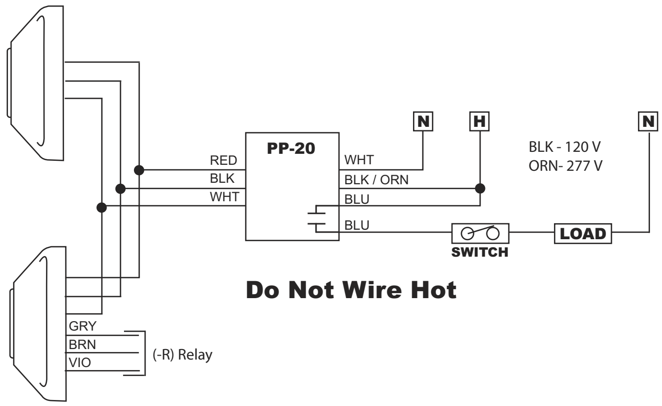
END OF AISLE

FIELD OF VIEW
The *CM-6* lens views in 5 separate 360° coneshaped patterns. The outermost (fifth) cone viewing at a 54° angle is only effective up to a 12-15 foot mounting height and is therefore not typically considered in High Bay applications. The fourth cone views at a 45° angle and is effective up to 20 feet. The inner three cones viewing at a maximum 30° angle continually maintain their effectiveness. The geometric effect is that the *CM-6* maintains a 15 to 20 foot radius up to a 45 foot mounting height. From 35 to 45 feet, the *CM-6* will generally only detect major motions such as a forklift truck. However, in colder environments, the *CM-6* may maintain very sensitive detection in all cones up to greater heights.

LOW VIEW

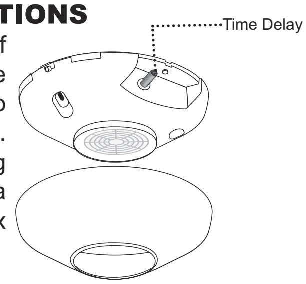


INPUT/OUTPUT
Wire lead connections are Class II, 18 to 22 AWG. The *CM-6* uses 3 leads (Red, Black, and White); the Relay Option adds 3 leads (Brown, Gray, and Violet). The wire colors are as follows:

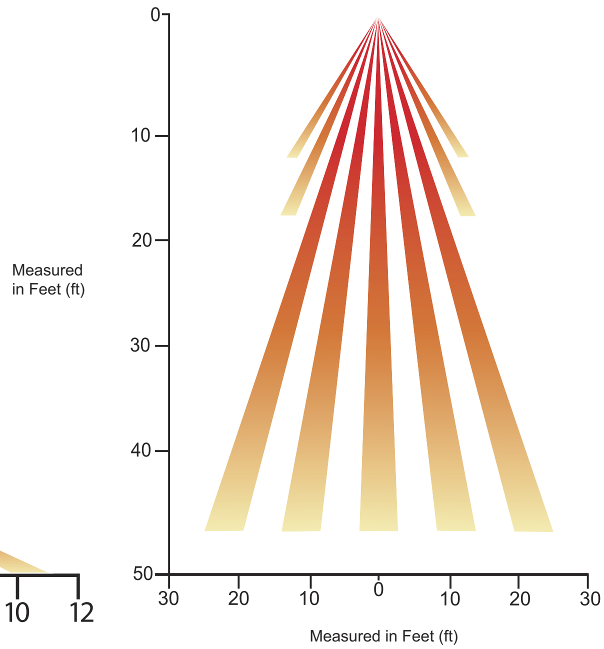


Do Not Wire Hot

MOUNTING CONSIDERATIONS
The *CM-6* is provided with 2 self tapping mounting screws. The sensor typically mounts directly to the ceiling tile, or to the metallic grid. However, if desired, the mounting holes are slotted to line up with a standard round, or rectangular box (screws not provided).



HIGH VIEW



sensorswitch™

SENSOR SWITCH, INC.
900 Northrop Rd., Wallingford, CT 06492
(203) 265-2842 info@sensorswitch.com
www.sensorswitch.com

Appendix 4-3 Building Envelope Improvements

DOOR SEAL | KERF

Q-LON® QDS 650 DOOR SEAL

Schlegel®

SUPERIOR WEATHER PROTECTION BACKED BY THE SCHLEGEL STORM SHIELD GUARANTEE

QDS 650

PRODUCT APPLICATIONS
Compression Seal/Swing Door

MATERIAL
Polyethylene Clad Urethane Foam

KERF WIDTH
.125" (3.2mm)

KERF DEPTH
.438" (11.1mm)

COMPRESSION
Recommended 50%
Minimum 10%
Maximum 60%

RABBET DEPTH
2-1/8" (54mm)

COMPRESSION SET
Less than 5% when compressed to 50% of its original reach for 22 hrs. at 158° F (70° C).

INSTALLATION
One profile seals the strike side, hinge side and header.

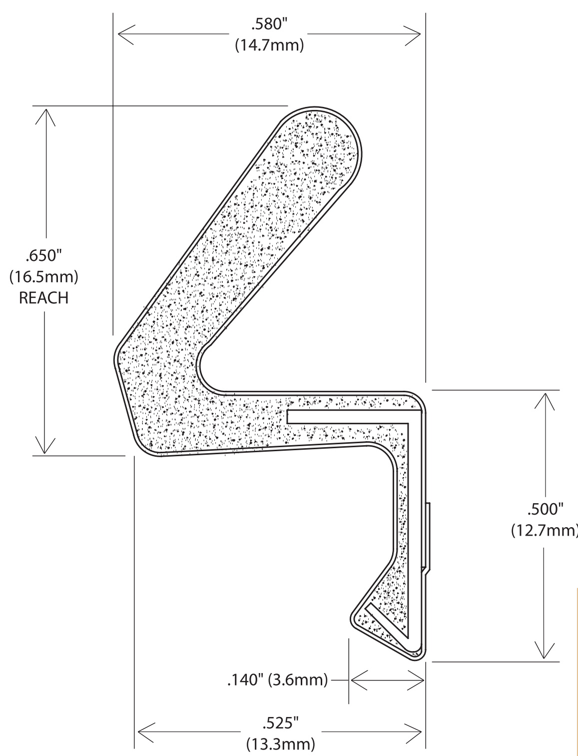
FIRE RATING
Category H Edge Sealing System and Category J Gasketing for use with Category B wood doors rated 20 minutes fire tested without hose stream and Category B wood and plastic-covered composite doors rated up to 90 minutes.

STANDARD PACK
37" (.94m) 250 pcs./carton
82" (2.08m) 125 pcs./carton
86" (2.18m) 100 pcs./carton
97" (2.46m) 125 pcs./carton
120" (3.05m) 125 pcs./carton
144" (3.66m) 125 pcs./carton

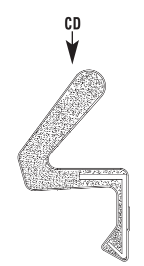
COLORS
Grey, black, white, bronze, beige

COLOR/LENGTH	PART NO.	COLOR/LENGTH	PART NO.
Grey 37" (.94m)	U8331-03700	White 97" (2.46m)	U8333-09700
Grey 82" (2.08m)	U8331-08200	White 120" (3.05m)	U8333-12000
Grey 86" (2.18m)	U8331-08600	White 144" (3.66m)	U8333-14400
Grey 97" (2.46m)	U8331-09700	Bronze 37" (.94m)	U8334-03700
Grey 120" (3.05m)	U8331-12000	Bronze 82" (2.08m)	U8334-08200
Grey 144" (3.66m)	U8331-14400	Bronze 86" (2.18m)	U8334-08600
Black 37" (.94m)	U8332-03700	Bronze 97" (2.46m)	U8334-09700
Black 82" (2.08m)	U8332-08200	Bronze 120" (3.05m)	U8334-12000
Black 86" (2.18m)	U8332-08600	Bronze 144" (3.66m)	U8334-14400
Black 97" (2.46m)	U8332-09700	Beige 37" (.94m)	U8336-03700
Black 120" (3.05m)	U8332-12000	Beige 82" (2.08m)	U8336-08200
Black 144" (3.66m)	U8332-14400	Beige 86" (2.18m)	U8336-08600
White 37" (.94m)	U8333-03700	Beige 97" (2.46m)	U8336-09700
White 82" (2.08m)	U8333-08200	Beige 120" (3.05m)	U8336-12000
White 86" (2.18m)	U8333-08600	Beige 144" (3.66m)	U8336-14400

NOTE: Other lengths available upon request.
Tolerance +/- 1" (25.4mm)



CD=COMPRESSION DIRECTION



ACTUAL SIZE

CLASSIFIED UL
UP TO 90 MINUTES

Covered under Storm Shield Guarantee program. Guaranteed for the life of your door.

Q-LON® QDS 650 DOOR SEAL

Q-LON Door Seal is made of an open-cell urethane foam core and clad in an embossed polyethylene, U.V. stablized, paint-resistant liner for kerf applications.

Schlegel®

QDS 650

	LINEAL SHRINKAGE	
	%	Q-LON PERFORMANCE
Q-LON door seals	0.10	—
Knock-off door seals	1.10	11.0 times better
TPE magnetic seals	0.40	4.0 times better

	COMPRESSION SET	
	%	Q-LON PERFORMANCE
Q-LON door seals	5	—
Knock-off door seals	17	3.4 times better
Closed-cell foam seals	13	2.6 times better
TPE compression seals	25	5.0 times better
TPE magnetic seals	50	10.0 times better

PRODUCT HIGHLIGHTS

FEATURE	BENEFIT
Highly engineered embossed polyethylene liner	Resists paints and varnishes. Long lasting. Maintains an attractive appearance.
UV stabilized	Stable in sunlight (UV stable). Tested up to 5,000 Kj/m^2 with no visible degradation.
Resilient urethane open-celled foam	Shape and resiliency are retained over time. Offers excellent all-temperature sealing performance. No corner leaks. Seal conforms to uneven surfaces.
Fully wrapped insert	Offers maximum protection against wood preservatives.

Q-LON DOOR SEAL TEST DATA

WATER INFILTRATION Passed water penetration tests at 25 mph (40km/h) and 34 mph (55km/h) ASTM E-331 standard test method.

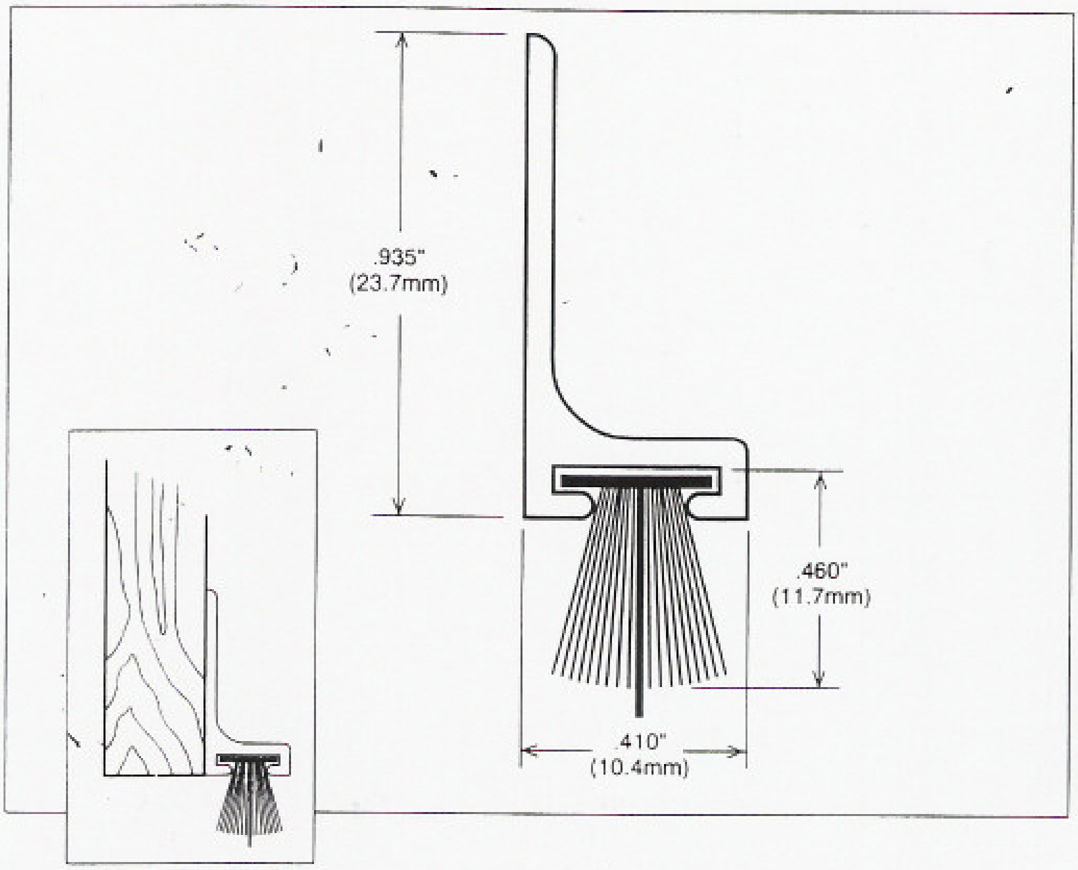
WATER ABSORPTION No visible effects in degradation; water absorption negligible after being submerged in water for 24 hours and then exposed to -30° F (-34° C) for one week. Compressed 50% upon removal from the freezer. (Tested at Schlegel Testing Laboratories.)

Schlegel®

Schlegel Systems, Inc.
1555 Jefferson Road
Rochester, New York
14692-3197

800.586.0354 Toll free
585.427.9993 Fax

www.schlegel.com
e-mail: bpdproducts@schlegel.com



Door Sweep

Mounts on interior or exterior face of door. Fills gaps from 1/16" to 5/16". (1.6mm to 7.9mm).

Part Name: Door Sweep

Application: Swing Door

Material: Aluminum.
Also available in anodized bronze aluminum.

Compression: Recommended 30%
Minimum 10%
Maximum 50%

Installation: Mounts on interior or exterior face of door

Standard Pack: 50 pieces per carton

Colors: Mill or bronze

LENGTH/COLOR	PART NO.
36" (.91m) Mill	7595-276A-5
84" (2.13m) Mill	7595-276D-9
144" (3.66m) Mill	7595-276C-1
36" (.91m) Bronze	7595-330A-8
84" (2.13m) Bronze	7595-330D-2
144" (3.66m) Bronze	7595-330C-4

Prepunched holes for easy installation and adjustment. Includes screws.

Schlegel®
1-800-586-0354
Rapid Response Fax 1-716-427-9993
bpssproducts@schlegel.com

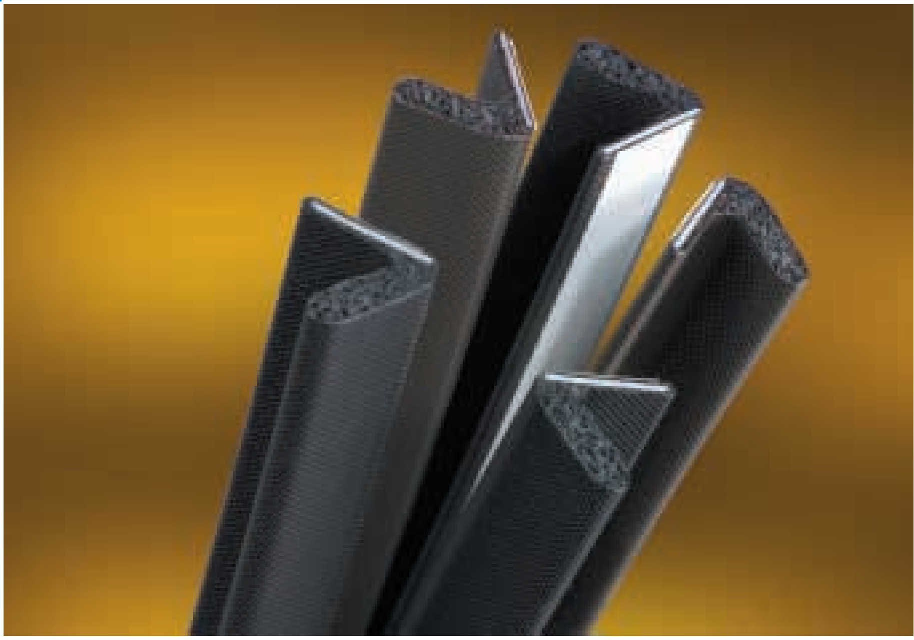
DOOR SEAL | SURFACE

Q-LON® QFS 375 DOOR SEAL (ADHESIVE BACKED)

Schlegel®

SUPERIOR WEATHER PROTECTION BACKED BY THE SCHLEGEL STORM SHIELD GUARANTEE

QFS 375



PRODUCT APPLICATIONS
Compression Seal/Fire-Rated Door

MATERIAL
Polyethylene Clad Urethane Foam

STOP WIDTH
.500" (12.7mm)

COMPRESSION
Recommended 50%
Minimum 20%
Maximum 60%

COMPRESSION SET
Less than 5% when compressed to 50% of its original reach for 22 hrs. at 158° F (70° C).

INSTALLATION
Profile seals the strike side, hinge side and header.

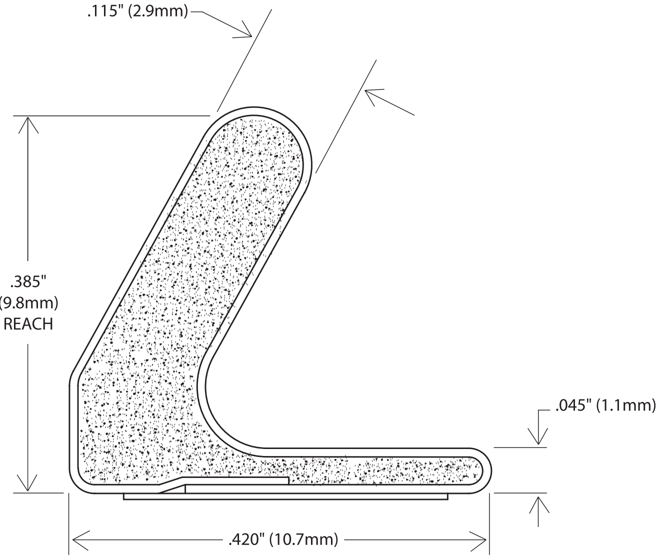
FIRE RATING
Category H Edge Sealing System and Category J Gasketing for use with Category B wood doors rated 20 minutes fire tested without hose stream and Category B wood and plastic-covered composite doors rated up to 90 minutes. Also for use with Listed steel frames and/or Classified steel covered composite, hollow metal doors rated up to 3 hours. These seals comply with the requirements of Underwriters Laboratories UL 10C and UBC 7-2-97, GVYI, file #R14384.

STANDARD PACK
39" (.99m) 300 pcs./carton,
all others 150 pcs./carton.

COLORS
Black, white, bronze

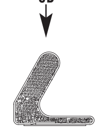
COLOR/LENGTH	PART NO.
Black 39" (.99m)	U9862T03900
Black 86" (2.18m)	U9862T08600
White 39" (.99m)	U9863T03900
White 86" (2.18m)	U9863T08600
Bronze 39" (.99m)	U9864T03900
Bronze 86" (2.18m)	U9864T08600

NOTE: Other lengths available upon request.
Tolerance +/- 1" (25.4mm)



UL CLASSIFIED
UP TO 3 HOURS

CD=COMPRESSION DIRECTION



ACTUAL SIZE

Covered under Storm Shield Guarantee program. Guaranteed for the life of your door.

Q-LON® QFS 375 DOOR SEAL (ADHESIVE BACKED)

Q-LON Door Seal is made of an open-cell urethane foam core and clad in an embossed polyethylene, U.V. stablized, paint-resistant liner for kerfless applications.

Schlegel®

QFS 375

	LINEAL SHRINKAGE	
	%	Q-LON PERFORMANCE
Q-LON door seals	0.10	—
Knock-off door seals	1.10	11.0 times better
TPE magnetic seals	0.40	4.0 times better

	COMPRESSION SET	
	%	Q-LON PERFORMANCE
Q-LON door seals	5	—
Knock-off door seals	17	3.4 times better
Closed-cell foam seals	13	2.6 times better
TPE compression seals	25	5.0 times better
TPE magnetic seals	50	10.0 times better

PRODUCT HIGHLIGHTS

FEATURE	BENEFIT
Highly engineered embossed polyethylene liner	Resists paints and varnishes. Long lasting. Maintains an attractive appearance.
UV stabilized	Stable in sunlight (UV stable). Tested up to 5,000 Kj/m^2 with no visible degradation.
Resilient urethane open-celled foam	Shape and resiliency are retained over time. Offers excellent all-temperature sealing performance. No corner leaks. Seal conforms to uneven surfaces.
Applied to surface with Pressure Sensitive Adhesive	Mounts to any surface with high quality adhesive.

Q-LON DOOR SEAL TEST DATA

WATER INFILTRATION Passed water penetration tests at 25 mph (40km/h) and 34 mph (55km/h) ASTM E-331 standard test method.

WATER ABSORPTION No visible effects in degradation; water absorption negligible after being submerged in water for 24 hours and then exposed to -30° F (-34° C) for one week. Compressed 50% upon removal from the freezer. (Tested at Schlegel Testing Laboratories.)

Schlegel®

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e-mail: bpdproducts@schlegel.com

Appendix 4-4 Energy Management System – Upgrades

FIELD-SELECTABLE 4-20mA/0-10VDC OUTPUT

3 Year Warranty

CDE

Compact duct unit

CWE

CO_2 with optional resistive temperature output in a compact wall unit

NEW! All Products Meet CE Requirements

Economy Wall and Duct CO_2 Sensors

The **CDE/CWE** are non-dispersive infrared (NDIR) analyzers designed for measuring environmental CO_2 concentration in ventilation systems and indoor living spaces. Their measurement range of 0-2000ppm makes them compliant with ASHRAE and other standards for ventilation control

The CWE/CDE Series provides a user-selectable 4-20mA or 0-10VDC output for versatility. Microprocessor-based digital electronics and a unique self-calibration algorithm improves long-term stability and accuracy.

APPLICATIONS

- Controlling ventilation in response to occupancy
- Facilitating compliance with ASHRAE 62.1-2004 standard for air quality
- Office buildings, conference rooms, schools, retail stores, etc.

Microprocessor design increases accuracy and reduces installation time

- Non-dispersive infrared technology repeatable to ±20 ppm ±1% of measured value
- Innovative self-calibration algorithm...easy to maintain
- 5-year calibration interval (recommended)
- Low ambient sensitivity
- Alarm relay with setpoint for direct ventilation control
- Output 4-20mA/0-10V for flexible control system interface
- 3-year factory warranty from date of purchase

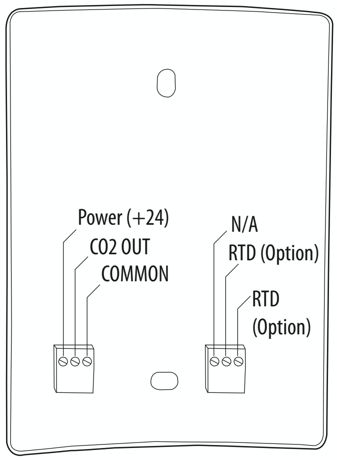
SPECIFICATIONS

Input Power	20 to 30VDC/24AC; 100mA Maximum
Analog Output	4-20mA, (clipped and capped)/0-10VDC (selectable)
Operating Temperature Range	0° to 50°C (32° to 122°F)
Housing Material	High impact ABS plastic
Sensor Type	Non-dispersive infrared, diffusion sampling
Measurement Range	0-2000 ppm
Accuracy	±30 ppm ±5% of measured value
Repeatability	±20 ppm ±1% of measured value
Response Time	<60 seconds for 90% step change

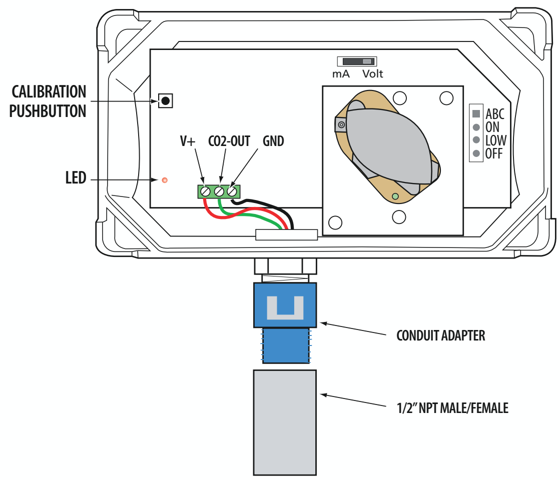
EMC Conformance: EN 61000-6-3:2001 Class B, EN 61000-6-1:2001, EN 61000-3-2:2000, EN 61000-3-3:2001, EMC Test Methods: CISPR 22:1997 (Amended A1:2000, A2:2002) Class B, IEC 61000-4-2:2002, IEC 61000-4-3:2006, IEC 61000-4-4:2004, IEC 61000-4-5:2001, IEC 61000-4-6:2004, IEC 61000-4-8:2001, IEC 61000-4-11:2004.
EMC Special Note: Connect this product to a DC distribution network or an AC/DC power adaptor with proper SURGE PROTECTION (EN 61000-6-1:2001 specification requirements).

APPLICATION/WIRING DIAGRAMS

CWE Wall Mount

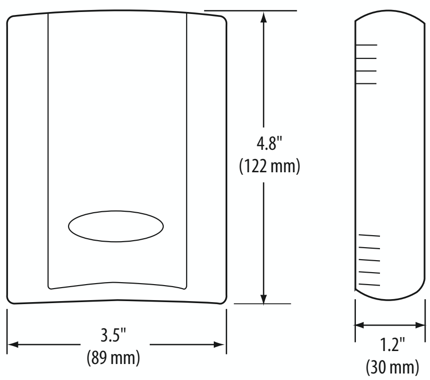


CDE Duct Mount

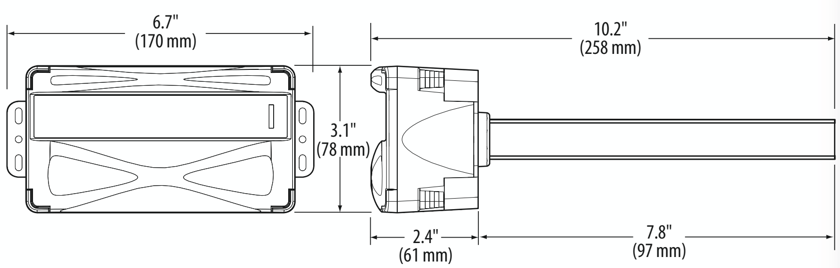


DIMENSIONAL DRAWINGS

CWE Wall Mount



CDE Duct Mount



ORDERING INFORMATION

CE *all models*

Duct Mount

CDE *(No Options)*

Wall Mount

Sensor Type

CWE ☐

- **SB** = 100R Platinum, RTD
- **SC** = 1k Platinum, RTD
- **SD** = 10k T2, RTD, Thermistor
- **SE** = 2.2k, Thermistor
- **SF** = 3k, Thermistor
- **SG** = 10k CPC, Thermistor
- **SH** = 10k T3, Thermistor
- **SJ** = 10k Dale, Thermistor
- **SK** = 10k w/11k shunt, Thermistor
- **SM** = 20k NTC, Thermistor
- **SN** = 1800 ohm, Thermistor
- **SR** = 10k US, Thermistor
- **SS** = 10k 3A221, Thermistor
- **ST** = 100k, Thermistor

Example:
CW E | SH

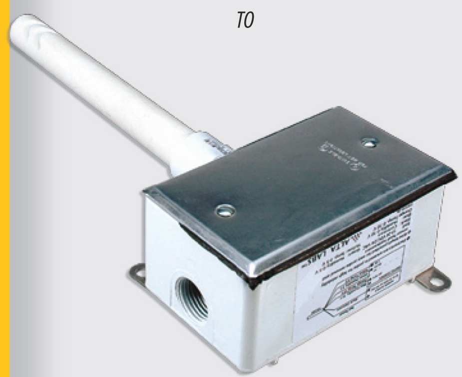
ACCESSORIES

Calibration kits and gases...see page 218.
Handheld meters...see page 208.

SLEEK DESIGN, PREVENTS SOLAR OVERHEATING

5 Year Warranty

TO



Available with transmitter or RTD/thermistor resistive outputs, in a weather resistant housing

Outdoor Temperature Sensors

The **TO Series** outdoor temperature sensors feature a sleek, weather resistant design, and provide easy installation. The durable probe is encased in a radiation shield to prevent solar heating. Choose from a variety of RTD, thermistor or transmitter outputs to suit any application.

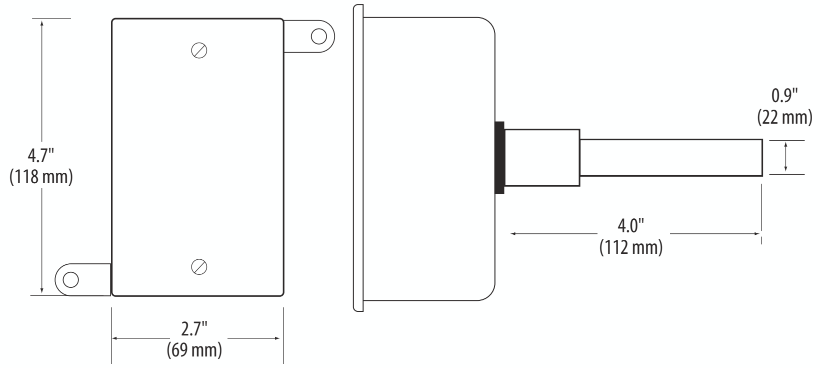
- Outdoor temperature measurement...features sleek design and prevents solar heating
- Available with transmitter, RTDs, or thermistors

SPECIFICATIONS

Wiring	22AWG; 2-wire:RTD/Thermistor, 4-20mA; 3-wire: Voltage output models
Junction Box	Weatherproof
Transmitter:	
Input Power	4-20mA version - Loop powered 12-30VDC only, 30mA max; 0-5/0-10V versions - 12-30VDC/24VAC, 15mA max
Temp Output	2-wire, loop powered 4-20mA; 3-wire, 0-5V/0-10VDC
Sensor Type	Solid-state, integrated circuit (Transmitter)
Accuracy	±0.5°C (±1°F) typical
Ranges	0° to 50°C (32° to 122°F), -40° to 50°C (-40° to 122°F)
Linitemp:	
Input Power	5 to 30VDC
Output	1µA/°C or 10mV/°C
Operating Temperature	-25° to 105°C (-13° to 221°F)
Accuracy Calibration Error:	1.5°C (35°F) typical; 2.5°C (37°F) max. at 25°C (77°F)*
Error over Temperature:	1.8°C typical (35°F); 3.0°C (34°F) max. over 0° to 70°C (32° to 158°F) range 2.0°C (35°F) typical, 3.5°C (38°F) max. over -25° to 105°C (-13° to 221°F) range

**Room temperature error documented on each unit.*

DIMENSIONAL DRAWING



Class	Pt RTD		THERMISTOR								
Type	**100 Ohm**	**1000 Ohm**	**2.2k**	**3k**	**10k** Type 2	**10k** Type 3	**10k** Dale	**10k** 3A221	**10k** "G" US	**20k**	**100k**
Accuracy	±0.3°C	±0.3°C	±0.2°C	±0.2°C	±1.0°C	±0.2°C	±0.2°C	±1.1°C	±0.2°C	Consult	Consult
	0.0385 curve	0.0385 curve	0/70°C	0/70°C	-50/150°C	0/50°C	-20/70°C	0/70°C	0/70°C	Factory	Factory
Temp. Response*	PTC	PTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC

*PTC: Positive Temperature Coefficient
*NTC: Negative Temperature Coefficient

STANDARD RTD AND THERMISTOR VALUES (Ohms Ω)

°C	°F	100 Ohm	1000 Ohm	2.2k	3k	10k Type 2	10k Type 3	10k Dale	10k 3A221	10k "G" US	20k	100k
-50	-58	80.306	803.06	154,464	205,800	692,700	454,910	672,300	-	441,200	1,267,600	-
-40	-40	84.271	842.71	77,081	102,690	344,700	245,089	337,200	333,562	239,700	643,800	3,366,000
-30	-22	88.222	882.22	40,330	53,730	180,100	137,307	177,200	176,081	135,300	342,000	1,770,000
-20	-4	92.160	921.60	22,032	29,346	98,320	79,729	97,130	96,807	78,910	189,080	971,200
-10	14	96.086	960.86	12,519	16,674	55,790	47,843	55,340	55,252	47,540	108,380	553,400
0	32	100.000	1000.00	7,373	9,822	32,770	29,588	32,660	32,639	29,490	64,160	326,600
10	50	103.903	1039.03	4,487	5,976	19,930	18,813	19,900	19,901	18,780	39,440	199,000
20	68	107.794	1077.94	2,814	3,750	12,500	12,272	12,490	12,493	12,260	24,920	124,900
25	77	109.735	1097.35	2,252	3,000	10,000	10,000	10,000	10,000	10,000	20,000	100,000
30	86	111.673	1116.73	1,814	2,417	8,055	8,195	8,056	8,055	8,194	16,144	80,580
40	104	115.541	1155.41	1,199	1,598	5,323	5,593	5,326	5,324	5,592	10,696	53,260
50	122	119.397	1193.97	811.5	1,081	3,599	3,894	3,602	3,600	3,893	7,234	36,020
60	140	123.242	1232.42	561.0	747	2,486	2,763	2,489	2,486	2,760	4,992	24,880
70	158	127.075	1270.75	395.5	527	1,753	1,994	1,753	1,751	1,990	3,512	17,510
80	176	130.897	1308.97	284.0	378	1,258	1,462	1,258	1,255	1,458	2,516	12,560
90	194	134.707	1347.07	207.4	-	919	1,088	917	915	1,084	1,833	9,164
100	212	138.506	1385.06	153.8	-	682	821	679	678	816.8	1,356	6,792
110	230	142.293	1422.93	115.8	-	513	628	511	509	623.6	1,016	5,108
120	248	146.068	1460.68	88.3	-	392	486	389	388	481.8	770	3,894
130	266	149.832	1498.32	68.3	-	303	380	301	299	376.4	591	3,006

To compute Linitemp Temperature:
2-Wire version (1μA/°C)
μA reading - 273.15=Temperature in °C
3-Wire version (10mV/°C)
mV reading/10 - 273.15 = Temperature in °C

ORDERING INFORMATION

RTD/Thermistor Models

TO [Sensor Type] [Output: RØ] [Cal Certificate]

Sensor Type
- **B** = 100R Platinum, RTD
- **C** = 1k Platinum, RTD
- **D** = 10k T2, Thermistor
- **E** = 2.2k, Thermistor
- **F** = 3k, Thermistor
- **G** = 10k CPC, Thermistor
- **H** = 10k T3, Thermistor
- **J** = 10k Dale, Thermistor
- **K** = 10k w/11k shunt,Thermistor
- **M** = 20k NTC, Thermistor
- **N** = 1800 ohm, Thermistor
- **P** = 10mV/°C, Linitemp
- **R** = 10k US, Thermistor
- **S** = 10k 3A221, Thermistor
- **T** = 100k, Thermistor

Output
- **RØ** = Resistive Output

Cal Certificate
- **0** = None
- **1** = 1 point Cal validation
- **2** = 2 point Cal validation

Example:
TO [C] [RØ] [2]

NOTE: For 4-20mA transmitter output, order any TO with the 100Ω platinum RTD and accessory AA10xx . See page 209.

Temperature Transmitter Models

CE

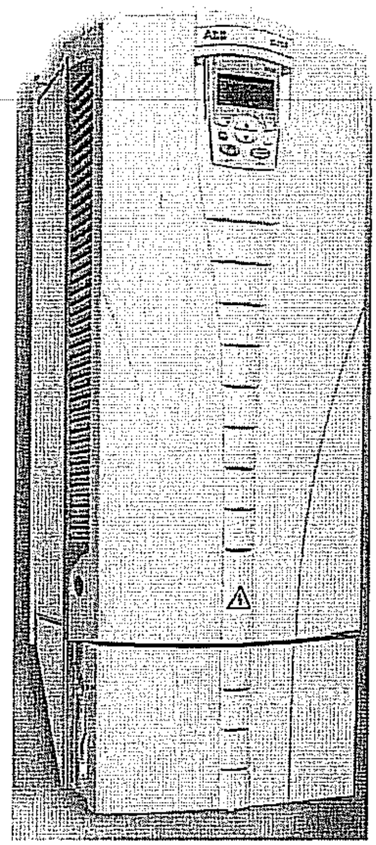
TOA [Output] [Range] [Cal Certificate]

Output
- **M** = 4-20mA
- **V** = 0-5/0-10VDC

Range
- **1** = -40 to 50°C (-40° to 122°F)
- **2** = 0° to 50°C (32° to 122°F)

Cal Certificate
- **0** = None
- **1** = 1 point Cal validation
- **2** = 2 point Cal validation

Example:
TOA [M] [1] [0]



The ACH550 is an adjustable frequency AC drive designed specifically for the HVAC market that achieves the ultimate in flexible motor control performance. Offering two modes of motor control: Scalar (V/Hz) and Sensorless Vector, the ACH550 provides accurate speed control for any standard squirrel cage motor.

With drives ranging from 1 to 550 HP, the ACH550 series features an 'intuitively obvious' multi-lingual, graphic display-panel that also provides an assistant to aid users in start-up. The control panel can be mounted on the cover of the drive, or remotely, and can upload, store, and download parameters.

The ACH550 comes equipped with an extensive library of preprogrammed HVAC application macros that, at the touch of a button, allow rapid configuration of inputs, outputs, and parameters for specific HVAC applications to maximize convenience and minimize start-up time.

The ACH550 can be used for the simplest to the most demanding HVAC applications. Two internal option slots can be configured with additional relay outputs as well as a host of different communication bus adapters.

The ACH550 has a 110% short term overload rating for one (1) minute out of ten (10) and is capable of >130% short-term overload rating for 2 seconds out of each minute.

FEATURES

Standard Features

UL, cUL labeled, CE marked & BTL listed (BACnet Testing Lab)
EMI/RFI Filter (1st Environment, Restricted Distribution)
Start-Up Assistants
Maintenance Assistants
Diagnostic Assistants
Real Time Clock
- Includes Day, Date and Time

Operator Panel Parameter Backup (read/write)
Full Graphic and Multilingual Display
for Operator Control, Parameter Set-Up and Operating Data Display:
- Output Frequency (Hz)
- Speed (RPM)
- Motor Current
- Calculated % Motor Torque
- Calculated Motor Power (kW)
- DC Bus Voltage
- Output Voltage
- Heatsink Temperature
- Elapsed Time Meter (resettable)
- KWh (reset-able)
- Input / Output Terminal Monitor
- PID Actual Value (Feedback) & Error
- Fault Text
- Warning Text
- Three (3) Scalable Process Variable Displays
- User Definable Engineering Units

Two (2) Programmable Analog Inputs
Six (6) Programmable Digital Inputs
Two (2) Programmable Analog Outputs
Up to six (6) Programmable Relay Outputs (Three (3) Standard)
Adjustable Filters on Analog Inputs and Outputs
Mathematical Functions on Analog Reference Signals
All Control Inputs Isolated from Ground and Power
Three (3) Resident Serial Communication Protocols
- Johnson Controls N2
- Siemens Buildings Technologies FLN (P1)
- Modbus RTU

Input Speed Signals
- Current 0 (4) to 20 mA
- Voltage 0 (2) to 10 VDC
- Increase/Decrease Reference Contacts (Floating Point)
- Serial Communications

Start/Stop
- 2 Wire (Dry Contact Closure)
- 3 Wire (Momentary Contact)
- Application of Input Power
- Application of Reference Signal (PID Sleep/Wake-Up)
- Serial Communications

Start Functions
- Ramp
- Flying Start
- Premagnetization (DC brake) on Start
- Automatic Torque Boost
- Automatic Torque Boost with Flying Start
- Auto Restart (Reset) – Customer Selectable and Adjustable

Stop Functions
- Ramp or Coast to Stop
- Emergency Stop
- DC Braking / Hold at Stop
- Flux Braking

Accel/Decel
- Two (2) sets of Independently Adjustable Ramps
- Linear or Adjustable 'S' Curve Accel/Decel Ramps

HVAC Specific Application Macros
Separate Safeties (2) and Run Permissive Inputs
Damper Control
Override Input (Fire Mode)
Timer Functions
- Four (4) Daily Start/Stop Time Periods
- Four (4) Weekly Start/Stop Time Periods
- Four Timers for Collecting Time Periods and Overrides

Seven (7) Preset Speeds
Supervision Functions
Adjustable Current Limit
Electronic Reverse
Automatic Extended Power Loss Ride Through (Selectable)
Programmable Maximum Frequency to 500 Hz
PID Control
- Two (2) Integral Independent Programmable PID Setpoint Controllers (Process and External)
- External Selection between Two (2) Sets of Process PID Controller Parameters
- PID Sleep/Wake-Up

Motor Control Features
- Scalar (V/Hz) and Vector Modes of Motor Control
- V/Hz Shapes
- Linear
- Squared
- Energy Optimization
- IR Compensation
- Slip Compensation
- Three (3) Critical Frequency Lockout Bands

Preprogrammed Protection Circuits
- Overcurrent
- Short Circuit
- Ground Fault
- Overvoltage
- Undervoltage
- Input Phase Loss
- Output Device (IGBT) Overtemperature
- Adjustable Current Limit Regulator
- UL508C approved Electronic Motor Overload (I^2T)

Programmable Fault Functions for Protection Include
- Loss of Analog Input
- Panel Loss
- External Fault
- Motor Thermal Protection
- Stall
- Underload
- Motor Phase Loss
- Ground Fault

5% Input Impedance
- 5% Impedance with Internal Reactor(s)
- Patented Swinging Choke Design for Superior Harmonic Mitigation in frame sizes (R1 to R4)

Available Options

3 Relay Extension Module (OREL-01)
115/230 V Digital input Interface Card (OHDI-01)
Embedded Fieldbus Protocols
- BACnet (MS/TP)

Fieldbus Adapter Modules
- LonWorks
- Profibus
- DeviceNet

DriveWindow Light Start-up, Operation, Programming and Diagnostic Tool
Computer Based Training (CBT) Tool
Fan Replacement Kit

SPECIFICATIONS

Input Connection

Input Voltage (U_1) .... 208/220/230/240 VAC 3-phase +/-10%
208/220/230/240 VAC 1-phase +/-10%
380/400/415/440/460/480 VAC 3-phase +/-10%
500/575/600 VAC 3-phase +/- 10%
Frequency: .... 48 - 63 Hz
Line Limitations: .... Max +/-3% of nominal phase to phase input voltage
Fundamental Power Factor (cosφ): .... 0.98 at nominal load
Connection: .... U_1, V_1, W_1 (U_1, V_1, 1-phase)

Output (Motor) Connection

Output Voltage: .... 0 to U_1, 3-phase symmetrical, U2 at the field weakening point
Output Frequency: .... -500 to 500 Hz
Frequency Resolution: .... 0.01 Hz
Continuous Output Current:
Variable Torque: .... 1.0 * I_{2N} (Nominal rated output current, Variable Torque)
Short Term Overload Capacity:
Variable Torque: .... 1.1 * I_{2N}, (1 min/10 min)
Peak Overload Capacity:
Variable Torque: .... 1.35 * I_{2N}, (2 sec/1 min)
Base Motor Frequency Range: .... 10 to 500 Hz
Switching Frequency: .... 1, 4, 8 or 12 kHz
Acceleration Time: .... 0.1 to 1800 s
Deceleration Time: .... 0.1 to 1800 s
Efficiency: .... 0.98 at nominal power level
Short Circuit Withstand Rating: .... 100,000 AIC (UL) w/o fuses
Connection: .... U_2, V_2, W_2

Enclosure

Style: .... UL (NEMA) Type 1, Type 12, or Type 3R

Agency Approval

Listing and Compliance: .... UL, cUL, CE, BTL (BACnet Testing Laboratory)

Ambient Conditions, Operation

Air Temperature: .... -15° to 40°C (5° to 104°F), above 40°C the maximum output current is de-rated 1% for every additional 1°C (up to 50°C (122°F) maximum limit.
Relative Humidity: .... 5 to 95%, no condensation allowed, maximum relative humidity is 60% in the presence of corrosive gasses
Contamination Levels:
IEC: .... 60721-3-1, 60721-3-2 and 60721-3-3
Chemical Gasses: .... 3C1 and 3C2
Solid Particles: 3S2
Installation Site Altitude: .... 0 to 1000 m (3300 ft) above sea level. At sites over 1000 m (3300 ft) above sea level, the maximum power is de-rated 1% for every additional 100 m (330 ft). If the installation site is higher than 2000 m (6600 ft) above sea level, please contact your local ABB distributor or representative for further information
Vibration: .... Max 3.0 mm (0.12 in) 2 to 9 Hz, Max 10 m/s^2 (33 ft/s^2) 9 to 200 Hz sinusoidal

Ambient Conditions, Storage (in Protective Shipping Package)

Air Temperature: .... -40° to 70°C (-40° to 158°F)
Relative Humidity: .... Less than 95%, no condensation allowed
Vibration: .... In accordance with ISTA 1A and 1B specifications
Shock (IEC 60086-2-29): .... Max 100 m/s^2 (330 ft/s^2) 11 ms

Ambient Conditions, Transportation (in Protective Shipping Package)

Air Temperature: .... -40° to 70°C (-40° to 158°F)
Relative Humidity: .... Less than 95%, no condensation allowed
Atmospheric Pressure: .... 60 to 106 kPa (8.7 to 15.4 PSI)
Vibration: .... Max 3.5 mm (0.14 in) 2 to 9 Hz, Max 15 m/s^2 (49 ft/s^2) 9 to 200 Hz sinusoidal
Shock (IEC 60086-2-29): .... Max 100 m/s^2 (330 ft/s^2) 11 ms
Free Fall: .... R1: 76 cm (30 in)
.... R2: 61 cm (24 in)
.... R3: 46 cm (18 in)
.... R4 31 cm (12 in)
.... R5 & 6: 25 cm (10 in)

Cooling Information

Cooling Method: .... Integral fan(s)
Power Loss: .... Approximately 3% of rated power

SPECIFICATIONS (Continued)

Analog Inputs

Quantity	Two (2) programmable
Voltage Reference:	0 (2) to 10 V, 250kOhm, single ended
Current Reference:	0 (4) to 20 mA, 100Ohm, single ended
Potentiometer:	10 VDC, 10 mA (1K to 10KOhms)
Input Updating Time	8 ms
Terminal Block Size	2.3mm^2 / 14AWG

Reference Power Supply

Reference Voltage	+10 VDC, 1% at 25°C (77°F)
Maximum Load	10 mA
Applicable Potentiometer	1 kOhm to 10 kOhm
Terminal Block Size	2.3mm^2 / 14AWG

Analog Outputs

Quantity	Two (2) programmable current outputs
Signal Level	0 (4) to 20 mA
Accuracy	+/- 1% full scale range at 25°C (77°F)
Maximum Load Impedance	500 Ohms
Output Updating Time	2 ms
Terminal Block Size	2.3mm^2 / 14AWG

Digital Inputs

Quantity	Six (6) programmable digital inputs
Isolation	Isolated as one group
Signal Level	24 VDC, (10V Logic 0)
Input Current	15 mA at 24 VDC
Input Updating Time:	4 ms
Terminal Block Size	2.3mm^2 / 14AWG

Internal Power Supply

Primary Use	Internal supply for digital inputs
Voltage:	+24 VDC, max 250 mA
Maximum Current:	250 mA
Protection:	Short circuit protected

Relay Outputs

Quantity	Three (3) programmable relay (Form C) outputs
Switching Capacity:	8 A at 24 VDC or 250 VAC, 0.4 A at 120 VDC
Max Continuous Current:	2A RMS
Contact Material:	Silver Cadmium Oxide (AgCdO)
Isolation Test Voltage	4 kVAC, 1 minute
Output Updating Time	12 ms
Terminal Block Size	2.3mm^2 / 14AWG

Protections

Single Phase	Protected (input & output)
Overcurrent Trip Limit:	3.5 x I_{2N} instantaneous
Adjustable Current Regulation Limit:	1.1 x I_{2N} (RMS) max.
Overvoltage Trip Limit:	1.30 x U_N
Undervoltage Trip Limit:	0.65 x U_N
Overtemperature (Heatsink):	+115°C (+239°F)
Auxiliary Voltage:	Short Circuit Protected
Ground Fault:	Protected
Short Circuit:	Protected
Microprocessor fault:	Protected
Motor Stall Protection:	Protected
Motor Overtemperature Protection (I2t):	Protected
Input Power Loss of Phase:	Protected
Loss of Reference:	Protected
Short Circuit Current Rating:	100,000 RMS symmetrical Amperes
Input Line Impedance:	5% impedance with standard internal choke(s) Swinging Choke (R1 to R4)

Notes

U_1 = Input Voltage
U_2 = Output Voltage
U_N = Nominal Motor Voltage
f_N = Nominal Motor Frequency
P_N = Power – Normal Duty (HP)
I_{2N} = Nominal Motor Current Normal Duty

M-SERIES

RESIDENTIAL AND SELECT COMMERCIAL

AIR CONDITIONERS AND HEAT PUMPS

MS | MSY | MSZ | MXZ

Mr. SLIM®

Split-ductless A/C and Heat Pumps

MITSUBISHI ELECTRIC
HVAC Advanced Products Division
#1 IN INNOVATION

www.mrslim.com

Mr. Slim® Split-ductless Systems: Redefining Comfort

Comfort is a concept many of us notice only when we're either uncomfortable or very relaxed. But at Mitsubishi Electric HVAC Advanced Products Division, all we think about is comfort. Our industry-leading Mr. Slim split-ductless cooling and heating systems reflect this thinking. At home or at work our Mr. Slim systems are designed to make any space inviting and comfortable.

Maybe your home has a room that's always too hot or too cold. Or, perhaps, you're looking for a way to control the climate effectively in multiple rooms in your office building such as in conference rooms. No matter what your cooling and heating needs may be, Mr. Slim systems are the perfect way to transform your home or workplace into a tranquil and productive environment.

Mr. SLIM®
Split-ductless A/C and Heat Pumps

MITSUBISHI ELECTRIC
HVAC Advanced Products Division

Good for the environment and your bottom line.

- **Eco-friendly refrigerant:** Environmentally-friendly R410A refrigerant offers zero Ozone Depletion Potential (ODP) and allows for higher heat transfer coefficient (COP). This innovative feature means a reduction in equipment size, a reduction in piping size and higher pressure for greater performance. Smaller equipment also means less impact on the environment at the end of the product's life cycle.
- **Standard compliance:** All Mitsubishi Electric HVAC products follow standards and guidelines as set forth by the Energy Star, EPA, ARI, UL, ASHRAE, ETL and ISO.
- **Recycling design:** Our air conditioners are specially designed to allow for easy cleaning, efficient disassembly and more practical recycling. The number of parts used in indoor units has been reduced by adopting modular components, a process which also simplifies materials separation for recycling. To date as much as 84 percent of the materials used to build a Mr. Slim system is recyclable.
- **Smart energy usage:** Mitsubishi Electric INVERTER zoning systems smartly deliver only the amount of capacity needed unlike a typical full-power ON system. Individual indoor air handlers are installed within the zone. These air handlers measure the load for that specific zone and deliver for added efficiency only the capacity needed directly to the space, as compared to energy lost in long duct runs. If the zone is not being used, you do not have to condition the space. Smarter sensing technology and microprocessors enhance the system's ability to measure room temperature accurately for added comfort, performance and efficiency.
- **Minimal impact on landfills:** All air-conditioning products use long-life washable filters.

What is Mr. Slim Split-ductless Technology?

For decades split-ductless air-conditioning and heat pump systems have been the primary solution for cooling and heating interior spaces around the world. Our quiet and powerful Mr. Slim systems have three main components: an indoor unit, an outdoor unit and a remote controller. Installation is as simple as mounting the indoor and outdoor units, connecting the refrigerant lines and making a few electrical connections. An easy installation for your authorized contractor means you will be quickly enjoying the comfort Mr. Slim systems provide.

Why Mr. Slim Systems?

Mitsubishi Electric is without exception the industry leader in split-ductless air-conditioning technology. Our innovations have defined cutting-edge technology for over 28 years. Compare, and you'll see that no one surpasses the Mr. Slim brand's performance for quiet, easy-to-use and energy-efficient operation. And because our split-ductless technology carries the Mitsubishi Electric name, you know every product is built to last. The bottom line is Mr. Slim systems deliver the ultimate in comfort control for your home or office. It's true today and will be comfortably evident for years to come.

Where Can Mr. Slim Products Be Used?

Mr. Slim split-ductless systems are specifically designed to improve the comfort level in an uncomfortably hot or cold room of an existing building. Because Mr. Slim Systems don't require ductwork, they're the perfect cooling and heating systems for renovating older buildings – even those with plaster walls and brick facades that were constructed before air conditioning was available. The versatility and variety of applications for Mr. Slim systems are virtually unlimited. They're an excellent choice for almost any spot-cooling or heating situation, including enclosed sunrooms, upstairs bedrooms, new additions, bonus rooms and finished basements.

Mr. Slim systems are equipped with an anti-allergen filter that helps prevent the circulation of air with contaminants. And because the indoor units can be controlled by zone, it's easy to set the controls for the exact room temperature you want within any given space.

How does it work?

Mr. Slim cooling and heating solutions are perfect for almost any space because their innovative engineering optimizes the capabilities of the INVERTER technology and R410A refrigerant for more efficient systems with smaller indoor and outdoor units. R410A refrigerant is environmentally friendly and does not deplete the ozone. The systems themselves are also made of recyclable materials. To find out more about Mr. Slim split-ductless products or to locate an authorized Diamond Dealer near you, visit **www.mrslim.com**.

INVERTER

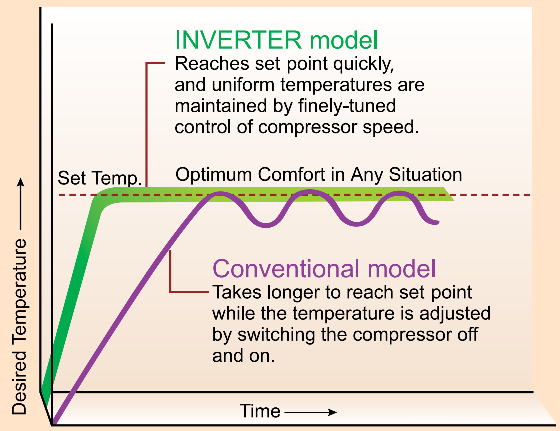
INVERTER Technology for Superior Year-round Comfort and Performance

Certain straight-cool and all heat pump outdoor units use Mitsubishi Electric's INVERTER-driven compressor technology (Variable Frequency Drive) to provide exceptional, high-speed cooling and heating performance. Thanks to high rotation speeds, desired temperatures are reached more quickly than with conventional systems so you can enjoy your ideal level of comfort without delay.

Like a car's cruise control, the system varies the compressor speed, which reduces power consumption for extra energy savings. The system adjusts itself precisely to the level needed to maintain a consistently comfortable indoor environment. Precise rotation speed control allows the system to maintain a comfortable, consistent room temperature.

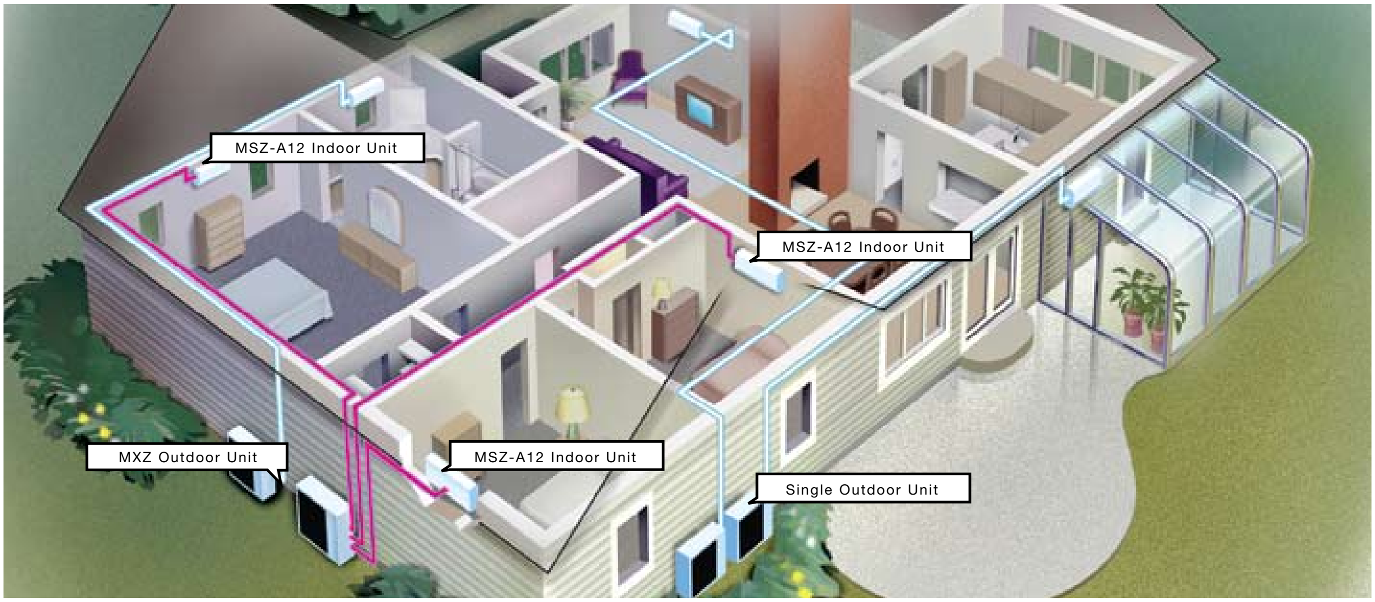
High-speed Performance When You Need It

High rotation compressor speeds cool and heat a room quickly, saving both energy and cash. The compressor speed is controlled to maximize efficiency, changing speeds according to the cooling and heating load of a room.



Extra Energy Savings

For optimum performance INVERTER technology delivers only the energy needed to satisfy the cooling and heating load in a room reducing energy consumption. Our CITY MULTI® VRFZ residential and commercial product line also employs INVERTER technology. Like Mr. Slim products the CITY MULTI INVERTER-driven systems give you increased performance capabilities and design flexibility, making Mitsubishi Electric products the best choice for any of your cooling and heating applications. Visit www.mehvac.com for more information about CITY MULTI technology.



Comfort is a home that's cool and dry in the summer and cozy and warm in the winter. This environment is what you get with the Mr. Slim system: perfect year-round comfort. The M-Series systems install easily. Mounted high on the wall, the indoor unit blends into most room environments without taking up any window space. These systems also feature automatic cooling/heating changeover, which automatically switches the system between cooling and heating to compensate for fluctuating temperatures. They're nearly silent because their fans deliver air quietly and continuously with only a gentle whoosh for constant circulation and filtration. (This capability is the reason Mr. Slim systems were the first choice for thousands of churches, schools and libraries across the U.S.) Our M-Series systems are the perfect way to cool or heat any room in your home. M-Series INVERTER systems provide high-speed and efficient cooling and heating performance to keep your home consistently cozy year-round.

Superior INVERTER Technology

Now you can benefit from technology that outperforms conventional systems with Mitsubishi Electric's INVERTER technology. Precise rotation speed control helps you keep temperatures consistent. At high rotation speeds you get faster cooling and heating. At low rotation speeds the temperature is efficiently maintained, and starting currents are kept at low levels so they don't affect other appliances. Pulse Amplitude Modulation (PAM) keeps efficiency high by ensuring that the system effectively **uses 98 percent of input power supply**.

No Ductwork Required

Mr. Slim systems require no ductwork, just a small, three-inch opening for two refrigerant lines and control and power wiring to connect the indoor and outdoor units. This feature allows for quicker installation, less mess, and a better-looking and more comfortable space. If you are adding on a room, you don't have to tie into an existing system to steal cool or warm air from other areas in the home. This advanced technology means better room control and increased comfort plus greater efficiency.

Total, Healthy Comfort

The POWERFUL mode is available to cool or heat any desired space quickly by lowering the set temperature in cooling mode or raising the set temperature in heating mode by seven degrees. It increases the fan speed for 15 minutes. Auto changeover maintains consistent temperature in a room by automatically sensing whether the space needs cooling or heating. For challenging cooling environments, low-ambient temperature control means our systems perform effectively in cooling mode even when the external temperatures dip to as low as 14 degrees Fahrenheit. Even more important you can benefit from our anti-allergen filter. Using blue enzymes, this filter helps minimize germs, bacteria, and viruses.

Control Technology

With the new A-Control system the indoor unit is powered through the outdoor unit. Three polarity sensitive wires plus a ground conductor run from the outdoor to the indoor unit providing both power and communication. Advanced wireless remote control is standard on all M-Series models. On the INVERTER-driven units, an option for a wired wall controller is available.

System Control in the Palm of Your Hand

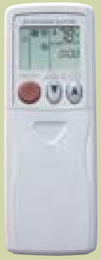
Mr. Slim's M-Series offers a comprehensive remote controller that controls temperature, fan speed and more. Choose from four modes: COOL, HEAT, AUTO and DRY. The controller also has a 12-hour ON/OFF timer for one-button control of your personal comfort. Our new MSY(Z)-A24/D30/D36NA models add the WIDE VANE button to evenly distribute airflow to a wider angle (150 deg.) from right to left, maintaining a comfortable temperature across a wide area. The M-Series INVERTER models can tie into the P-Series wired controller and CITY MULTI® M-NET with adapter to give an *on-the-wall* controller option.

Warm Air, No Drafts

Our hot-start technology provides warmth from the beginning. The fan increases in speed as the coil is warmed, reducing drafts so when you want warm air, you'll get it.

M-Series MSY(Z)-D30NA Model Indoor Unit

Features	Benefits
INVERTER TECHNOLOGY	Maximizes energy savings by making sure only the energy needed to cool or heat an area is used.
NO DUCTWORK	Installs quickly and easily, having no need for major construction and remodeling
ZONE CONTROL	Realizes maximum control and energy efficiency by cooling and heating only those spaces desired
ADVANCED MICROPROCESSOR CONTROLS	Creates a comfortable environment no matter what conditions are outside with our advanced self-monitoring controls
CONVENIENT WIRELESS REMOTE CONTROL	Offers comfort control in the palm of your hand with our remote controller
WASHABLE LONG-LIFE ANTI-ALLERGEN FILTERS	Improves air quality and saves money by being washable rather than replaceable
AUTO COOL/HEAT CHANGEOVER	Switches automatically from cooling to heating
ENVIRONMENTALLY FRIENDLY	Uses R410A, an environmentally-friendly refrigerant.



Wireless M-Series Remote Controller

M-Series MUY(Z)-D30NA Model Outdoor Unit

More Efficiency, More Capacity

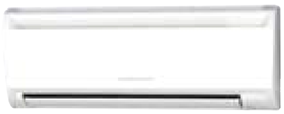
The M-Series product line now includes the MSZ-FD09/12NA model series with the highest ductless system rating in the industry at ***23 SEER*** while being extremely quiet at a low 22dB(A) for the indoor unit. The MSY(Z)-D30/36NA systems bring the largest capacity to date for the M-Series at 2.5 and 3 tons respectively.
For detailed information see the next page.

Cutting-edge Technology

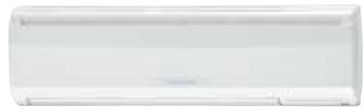
In every aspect of the Mr. Slim system, technology is utilized to make the units more energy-efficient and environmentally friendly while providing innovative comfort control. Our technology includes expanded filter systems, wide vane airflow, the i-see™ sensor and increased energy-efficiency (in select systems).
Refer to the next page for more detailed information.

M-Series Wireless
Remote Controller

M-SERIES WALL-MOUNTED A/C LINEUP
(cooling only)



MS Non-INVERTER
Air Conditioners
9,500 to 12,000 Btu/h
[pg. 10]



MSY INVERTER
Air Conditioners
15,000 to 34,600 Btu/h
[pgs. 10 - 11]

NEW Large Capacity

MSY(Z)-D30/36NA
INVERTER Air Conditioners
and Heat Pumps
30,700 to 34,600 Btu/h
[pgs. 11 and 13]

Multiple Filters for Cleaner, Healthier Air

Mr. Slim M-Series indoor units use a sophisticated multipart filter system to remove contaminants such as allergens, viruses and bacteria from the air as it circulates.

The hybrid catechin filter absorbs odor-causing gases. A blue-enzyme anti-allergen filter reduces germs, bacteria and viruses and helps trap dust, pollens, mites and other particles; the filter uses an enzyme catalyst to help break down the sulfur atom bonds in allergen proteins, transforming them into non-allergen proteins.

A hybrid-coating process makes the catechin filter washable and – if properly maintained with monthly cleanings – effective for more than 10 years.

The MSZ-FD09/12NA indoor units incorporate the M-Series standard Catechin filter plus two more filters for triple filtration. The second filter, a Blue-Enzyme filter, is a fibrous material, and its enzymes render allergens harmless. The third filter, a Platinum Catalyst Deodorizing filter, that has a ceramic surface absorption element and uses nanotechnology for high power odor absorption. This combination of filter types provides a complete air purifying system along with the ultimate comfort solution.

Energy Efficiency

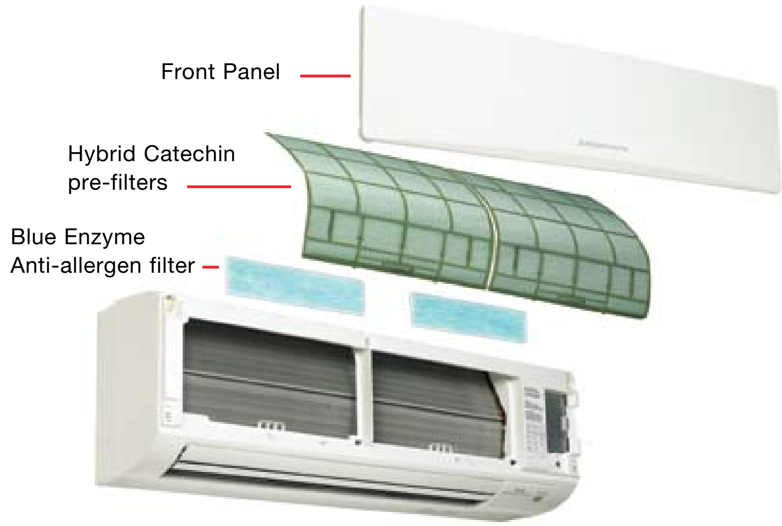
MSZ-FD09/12NA systems produce the highest ductless system ratings in the industry at ***23 SEER*** while being extremely quiet at a low 22dB(A) for the indoor unit.

The increased energy efficiency, ***up to 35 percent over standard Mr. Slim M-Series systems and 70 percent over industry standard requirement of 13 SEER***, is a result of a new powerful magnet rotor that allows for lower current input. With the increased energy efficiency and SEER ratings the MSZ-FD models are ***ENERGY STAR® Tier 2 certified***.

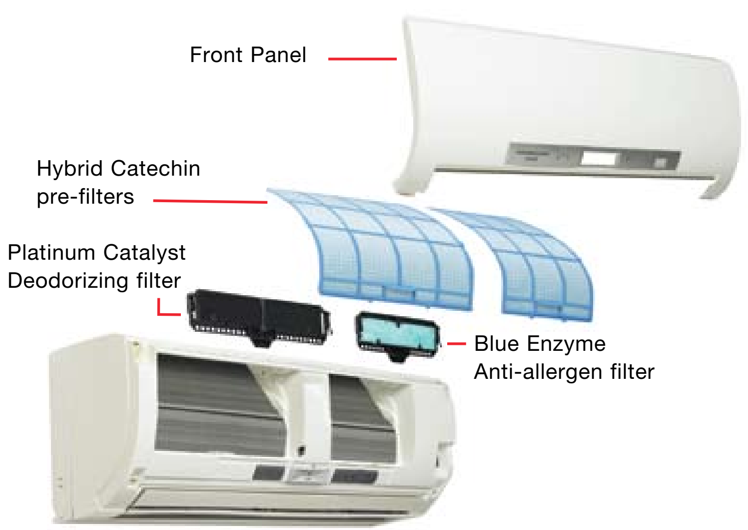
High Heat from Low Energy

Even at 17° F the MSZ-FD09NA models produce 12,500 Btu/h of heat while the MSZ-FD12NA reaches to 13,600 Btu/h. All of this while being extremely energy-efficient.

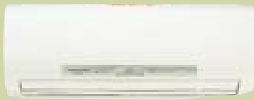
STANDARD FILTER SYSTEM (MS(Y)-D30NA MODEL SHOWN)



ENHANCED FILTER SYSTEM (MSZ-FD09/12NA MODELS)

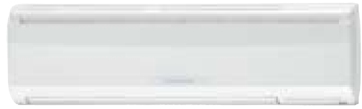


NEW Up to 23 SEER

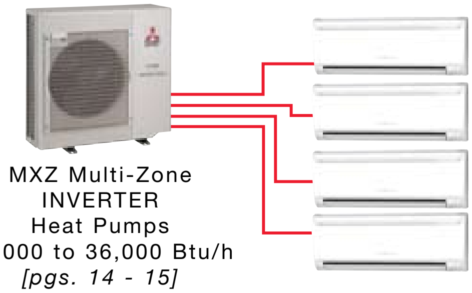


MSZ-FD09/12NA
High-Efficiency
INVERTER Heat Pumps
9,000 and 12,000 Btu/h
[pg. 12]

M-SERIES WALL-MOUNTED HEAT PUMP LINEUP
(cooling and heating)



MSZ INVERTER
Heat Pumps
9,000 to 33,200 Btu/h
[pgs. 12 - 13]



MXZ Multi-Zone
INVERTER
Heat Pumps
20,000 to 36,000 Btu/h
[pgs. 14 - 15]

Excellent Air Distribution

With the WIDE VANE or SWING mode, available on the MSY(Z)-A24/D30/36NA, there is an option for seven horizontal airflow directions that provide 150 degrees of airflow for greater conditioned air circulation.

Quiet Operation

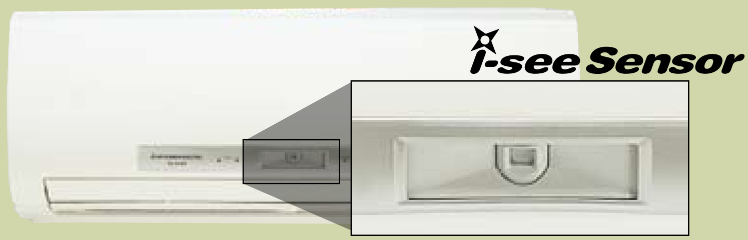
Do you hear that? No? You barely hear our systems because Mr. Slim indoor units operate with nearly a whisper of sound. A police siren, for example, has a sound level of 118 decibels; a circular saw produces 107 decibels of sound. A vacuum cleaner in your home creates 74 decibels of noise. Even a library environment is at 33 decibels while a whisper-tone voice produces 35 decibels. Certain Mr. Slim units operates as low as 22 decibels in low speed and others range from 26 to 34 decibels in low speed, all lower than a whisper-tone voice.

Did you hear that? We hope you did.

source: Friends of Albuquerque's Environmental Story (http://www.cabq.gov/aes/s5noise.html)

i-see™ Sensor (MSZ-FD09/12NA models only)

The i-see sensor detects the always troublesome regions of temperature closer to the ceiling and the floor. The i-see sensor also controls the airflow up to a wide 150° lateral angle for ultimate comfort (90° angle in cooling mode) by scanning the room and making adjustments based on the ambient temperature readings. Through this process the MSZ-FD09/12NA systems achieve superior cooling/heating performance with extremely efficient operation.



Multi-zone Heat Pump System Attributes

Multi-zone systems mean that people can enjoy their ideal level of comfort no matter where they are in the home. Each zone operates independently. People in the kitchen, master bedroom or living room can all enjoy the temperatures that makes them feel most comfortable.

If you're looking for a complete comfort solution for several different rooms, the MXZ multi-zone system is the right choice for you. You can use up to 19 different indoor unit combinations so the system is flexible enough to conform to your particular cooling and heating needs with up to four rooms from one outdoor unit.

Lifestyle photo courtesy of
Mitsubishi Digital Electronics America, Inc.
Visit mitsubishitv.com for details.

(MS-A12WA MODEL SHOWN)

MS/MSY COOLING-ONLY

M-SERIES Specifications

INVERTER

Model Name			NON-INVERTER		INVERTER	
	Indoor Unit		MS-A09WA	MS-A12WA	MSY-A15NA	MSY-A17NA
	Outdoor Unit		MU-A09WA	MU-A12WA	MUY-A15NA	MUY-A17NA
Cooling *1	Rated Capacity	Btu/h	9,500	12,000	15,000	16,200
	Capacity Range	Btu/h	-	-	3,100-15,000	3,100-16,200
	Total Input	W	870	1,070	1,690 (210-1,690)	2,070 (210-2,070)
	Energy Efficiency	SEER	13		16	
	Moisture Removal	Pints/h	2.7	3.2	4.7	5.1
	Sensible Heat Factor		0.68	0.70	0.65	
Power Supply	Phase, Cycle, Voltage		1 Phase, 60Hz, 115V *2		1 Phase, 60Hz, 208/230V *2	
Voltage	Indoor - Outdoor L1 N / S1-S2		AC 115V		AC 208-230V	
	Indoor - Outdoor L2 / S2-S3		AC 115V		DC12-24V	
	Indoor - Remote Controller		Wireless Type		Wireless Type (Optional Wired Controller: DC12V)	
Indoor Unit	MCA	A	1.2		1.0	
	Fan Motor	F.L.A.	0.95		0.76	
	Airflow (Lo-Med-Hi)	DRY (CFM)	183-261-335	222-286-406	268-328-381	
		WET (CFM)	162-233-300	198-254-363	240-293-342	
	Sound Pressure Level (Lo-Med-Hi)	dB(A)	26-32-40	33-38-45	34-40-45	34-40-46
	External Finish Color		Munsell No. 1.0Y 9.2/0.2		Munsell No. 1.0Y 9.2/0.2	
	Dimension Unit	W: In.	30-11/16		30-11/16	
		D: In.	8-1/4		8-1/4	
		H: In.	11-3/4		11-3/4	
	Weight Unit	Lbs.	23		23	
	Field Drainpipe Size O.D.	In.	5/8		5/8	
Outdoor Unit	MCA	A	14	16	14	
	Max. Fuse Size	(Time Delay) A	15	20	15	
	Fan Motor	F.L.A.	0.63	0.93	0.52	
	Compressor	Model (Type)	Single Rotary		DC INVERTER-driven Twin Rotary	
		R.L.A.	9.3	10.82	10.1	
		L.R.A.	47	56	12	
	Airflow	CFM	1,083	1,327	1,249	
	Refrigerant Control		Capillary Tube		Linear Expansion Valve	
	Sound Pressure Level (Cooling) *1	dB(A)	47	52	50	52
	External Finish Color		Munsell No. 3Y 7.8/1.1		Munsell No. 3Y 7.8/1.1	
	Dimensions	W: In.	31-1/2	33-7/16	31-1/2	
		D: In.	11-1/4	11-7/16	11-1/4	
		H: In.	21-5/8	23-13/16	21-5/8	
	Weight	Lbs.	78	96	88	
Remote Controller	Type		Wireless Remote		Wireless Remote (Optional Wired Controller)	
Refrigerant	Type		R410A		R410A	
	Charge	Lbs., Oz.	2, 5	3, 1	2, 7	
	Oil	Type (Fl. Oz.)	NE022 (10.8)		NE022 (15.2)	
Refrigerant Pipe	Gas Side O.D.	In.	3/8	1/2	1/2	
	Liquid Side O.D.		1/4		1/4	
	Height Difference (Max.)	Ft.	35		40	
	Length (Max.)		65		65	
Connection Method	Indoor/Outdoor		Flared/Flared		Flared/Flared	

NOTES: Test conditions are based on ARI 210/240.

*1 Rating conditions (cooling) - Indoor D.B. 80° F (27° C), W.B. 67° F (19° C); Outdoor: D.B. 95° F (35° C), W.B. 75° F (24° C).

*2 Indoor units receive power from outdoor units through field-supplied interconnected wiring.

Specifications are subject to change without notice.

LIMITED WARRANTY | Six-year warranty on compressor. One-year warranty on parts.

(MS-A12WA MODEL SHOWN)

MSY COOLING-ONLY (CONT.)

M-SERIES Specifications

Model Name	Indoor Unit		MSY-A24NA	MSY-D30NA	MSY-D36NA
	Outdoor Unit		MUY-A24NA	MUY-D30NA	MUY-D36NA
Cooling *1	Rated Capacity	Btu/h	22,000	30,700	34,600
	Capacity Range	Btu/h	4,400-22,000	9,800-30,700	9,800-34,600
	Total Input	W	2,880 (290-2,880)	3,380 (620-3,380)	4,240 (620-4,240)
	Energy Efficiency	SEER	16		15.1
	Moisture Removal	Pints/h	7.3	9.9	11.9
	Sensible Heat Factor		0.63	0.64	0.62
Power Supply	Phase, Cycle, Voltage		1 Phase, 60Hz, 208/230V *2		
Voltage	Indoor - Outdoor S1-S2		AC 208-230V		
	Indoor - Outdoor S2-S3		DC12-24		
	Indoor - Remote Controller		Wireless Type (Optional Wired Controller: DC12V)		
Indoor Unit	MCA	A	1.0		
	Fan Motor	F.L.A.	0.76		
	Airflow (Lo-Med-Hi) *1	DRY (CFM)	296-431-568	389-639-848	
		WET (CFM)	265-385-508	350-576-763	
	Sound Pressure Level (Lo-Med-Hi) *1	dB(A)	34-40-49	32-42-49	
	External Finish Color		Munsell No. 1.0Y 9.2/0.2		
	Dimension Unit	W: In.	43-5/16	46-1/16	
		D: In.	10-1/4	11-5/8	
		H: In.	12-13/16	14-3/8	
	Weight Unit	Lbs.	37	40	
	Field Drainpipe Size O.D.	In.	5/8		
Outdoor Unit	MCA	A	17	21	
	MOCP	A	20	25	
	Fan Motor	F.L.A.	0.93		
	Compressor	Model (Type)	DC INVERTER-driven Twin Rotary		
		R.L.A.	10.1	16	
		L.R.A.	16	20	
	Airflow	CFM	1,729	1,941	
	Refrigerant Control		Linear Expansion Valve		
	Sound Pressure Level (Cooling) *1	dB(A) *1	55		
	External Finish Color		Munsell No. 3Y 7.8/1.1		
	Dimensions	W: In.	33-1/16	33-1/16	
		D: In.	13	13	
		H: In.	33-7/16	33-7/16	
	Weight	Lbs.	128	126	
Remote Controller	Type		Wireless Remote		
Refrigerant	Type		R410A		
	Charge	Lbs., Oz.	4		
	Oil	Type (Fl. Oz.)	NE022 (15.2)	NE022 (29)	
Refrigerant Pipe	Gas Side O.D.	In.	5/8		
	Liquid Side O.D.	In.	1/4	3/8	
	Height Difference (Max.)	Ft.	50		
	Length (Max.)	Ft.	100		
Connection Method	Indoor/Outdoor		Flared/Flared		

NOTES: Test conditions are based on ARI 210/240.
*1 Rating conditions (cooling) - Indoor D.B. 80° F (27° C), W.B. 67º F (19° C); Outdoor: D.B. 95º F (35° C), W.B. 75º F (24° C).
*2 Indoor units receive power from outdoor units through field-supplied interconnected wiring.
Specifications are subject to change without notice.

LIMITED WARRANTY | Six-year warranty on compressor. One-year warranty on parts.

(MSZ-FD12NA MODEL SHOWN)

MSZ HEAT PUMP

M-SERIES Specifications

Model Name	Indoor Unit		MSZ-A09NA	MSZ-FD09NA	MSZ-A12NA	MSZ-FD12NA
	Outdoor Unit		MUZ-A09NA	MUZ-FD09NA	MUZ-A12NA	MUZ-FD12NA
Cooling *1	Rated Capacity	Btu/h	9,000	9,000	12,000	12,000
	Capacity Range	Btu/h	5,500-9,000	2,800-9,000	5,700-12,000	2,800-12,000
	Total Input	W	690 (390-690)	650 (160-650)	1,170 (395-1,170)	960 (160-960)
	Energy Efficiency	SEER	17	23	17	22
	Moisture Removal	Pints/h	2.3	2.1	3.2	2.9
	Sensible Heat Factor		0.71	0.76	0.70	0.73
Heating at 47º F *2	Rated Capacity	Btu/h	10,900	10,900	13,600	13,600
	Capacity Range	Btu/h	5,200-12,600	3,000-18,000	5,200-13,600	3,000-21,000
	Total Input	W	860 (350-1,100)	750 (150-2,400)	1,160 (350-1,160)	980 (150-2,400)
	HSPF (Region IV)	Btu/h/W	8.2	10.55	8.2	10.55
Heating at 17º F *3	Capacity	Btu/h	7,700	12,500	8,300	13,600
	Total Input	W	880	1,730	930	1,780
Power Supply	Phase, Cycle, Voltage		1 Phase, 60Hz, 208/230V *4			
Voltage	Indoor - Outdoor S1-S2		AC 208-230V			
	Indoor - Outdoor S2-S3		DC12-24V			
	Indoor - Remote Controller		Wireless Type (Optional Wired Controller: DC12V)			
Indoor Unit	MCA	A	1.0			
	Fan Motor	F.L.A.	0.76			
	Airflow (Cool) (Lo-Med-Hi) *1	DRY (CFM)	152-229-307	162-226-339	152-240-353	162-226-381
		WET (CFM)	134-205-275	144-202-307	134-215-318	144-202-350
	Airflow (Heat) (Lo-Med-Hi) *2	DRY (CFM)	159-222-307	166-240-367	159-240-353	166-240-399
	Sound Pressure Level (Cooling) (Lo-Med-Hi) *1	dB(A)	22-33-38	22-31-39	22-34-42	22-33-43
	Sound Level Pressure (Heating) (Lo-Med-Hi) *2		22-33-38	22-31-40	22-34-42	22-33-43
	External Finish Color		Munsell No. 1.0Y 9.2/0.2			
	Dimension Unit	W: In.	30-11/16	31-7/16	30-11/16	31-7/16
		D: In.	8-1/4	10-1/8	8-1/4	10-1/8
		H: In.	11-3/4	11-5/8	11-3/4	11-5/8
	Weight Unit	Lbs.	23	27	23	27
	Field Drainpipe Size O.D.	In.	5/8			
Outdoor Unit	MCA	A	12			
	MOCP	A	15			
	Fan Motor	F.L.A.	0.52	0.56	0.52	0.56
	Compressor	Model (Type)	DC INVERTER-driven Twin Rotary			
		R.L.A.	7.8	8.6	7.8	8.6
		L.R.A.	9.2	10.8	9.2	10.8
	Airflow	CFM	1,129	1,102/1,187	1,094	1,102/1,187
	Refrigerant Control		Linear Expansion Valve			
	Defrost Method		Reverse Cycle			
	Sound Pressure Level	dB(A) *1	48			
	External Finish Color		Munsell No. 3Y 7.8/1.1			
	Dimensions	W: In.	31-1/2			
		D: In.	11-1/4			
		H: In.	21-5/8			
	Weight	Lbs.	75	80	82	80
Remote Controller	Type		Wireless Remote (Optional Wired Controller)			
Refrigerant	Type		R410A			
	Charge	Lbs., Oz.	2	2, 9	2, 5	2, 9
	Oil	Type (Fl. Oz.)	NE022 (10.8)	NE022 (29)	NE022 (10.8)	NE022 (29)
Refrigerant Pipe	Gas Side O.D.	In.	3/8			
	Liquid Side O.D.	In.	1/4			
	Height Difference (Max.)	Ft.	40			
	Length (Max.)	Ft.	65			
Connection Method	Indoor/Outdoor		Flared/Flared			

NOTES: Test conditions are based on ARI 210/240.

*1 Rating conditions (cooling)-Indoor: D.B. 80º F (27º C), W.B. 67º F (19º C); Outdoor: D.B. 95º F (35º), W.B. 75º F (24º C).

*2 Rating conditions (heating)-Indoor: D.B. 70º F (21º C), W.B. 60º F (16º C); Outdoor: D.B. 47º F (8º C), W.B. 43º F (6º C).

*3 Rating conditions (heating)-Indoor: D.B. 70º F (21º C), W.B. 60º F (16º C); Outdoor: D.B. 17º F (-8º C), W.B. 15º F (-9º C).

*4 Indoor units receive power from outdoor units through field-supplied interconnected wiring.

Specifications are subject to change without notice.

LIMITED WARRANTY | Six-year warranty on compressor. One-year warranty on parts.

(MSY(Z)-D30NA MODEL SHOWN)

MSZ HEAT PUMP (CONT.)

M-SERIES Specifications

Model Name	Indoor Unit		MSZ-A15NA	MSZ-A17NA	MSZ-A24NA	MSZ-D30NA	MSZ-D36NA
	Outdoor Unit		MUZ-A15NA	MUZ-A17NA	MUZ-A24NA	MUZ-D30NA	MUZ-D36NA
Cooling *1	Rated Capacity	Btu/h	15,000	16,200	22,000	30,700	33,200
	Capacity Range	Btu/h	3,100-15,000	3,100-16,200	4,400-22,000	9,800-30,700	9,800-33,200
	Total Input	W	1,690 (210-1,690)	2,070 (210-2,070)	2,880 (290-2,880)	3,850 (620-3,850)	4,360 (620-4,360)
	Energy Efficiency	SEER	16		16	14.5	
	Moisture Removal	Pints/h	4.7	5.1	7.3	9.9	11.3
	Sensible Heat Factor		0.65		0.63	0.64	0.62
Heating at 47° F *2	Rated Capacity	Btu/h	18,000	20,100	23,200	32,600	35,200
	Capacity Range	Btu/h	3,400-20,900		3,600-24,400	8,700-34,000	8,700-36,000
	Total Input	W	1,790 (250-2,330)	2,150 (250-2,330)	2,350 (260-2,570)	3,360 (520-3,600)	3,840 (520-4,100)
	HSPF (Region IV)	Btu/h/W	8.2	8.2	8.2		
Heating at 17° F *3	Capacity	Btu/h	13,000		15,200	20,800	22,800
	Total Input	W	1,740		1,960	2,620	3,000
Power Supply	Phase, Cycle, Voltage		1 Phase, 60Hz, 208/230V *4				
Voltage	Indoor - Outdoor S1-S2		AC 208-230V				
	Indoor - Outdoor S2-S3		DC12-24				
	Indoor - Remote Controller		Wireless Type (Optional Wired Controller: DC12V)				
Indoor Unit	MCA	A	1.0				
	Fan Motor	F.L.A.	0.76				
	Airflow (Cool) (Lo-Med-Hi) *1	DRY (CFM)	268-328-381		296-431-568	389-639-848	
		WET (CFM)	240-293-342		265-385-508	350-576-763	
	Airflow (Heat) (Lo-Med-Hi) *2	DRY (CFM)	254-314-381		296-486-568	445-639-848	
	Sound Pressure Level (Cooling) (Lo-Med-Hi) *1	dB(A)	34-40-45	34-40-46	34-40-49	32-42-49	
	Sound Level Pressure (Heating) (Lo-Med-Hi) *2	dB(A)	34-38-44		34-40-48	34-42-49	
	External Finish Color		Munsell No. 1.0Y 9.2/0.2				
	Dimension Unit	W: In.	30-11/16	30-11/16	43-5/16	46-1/16	
		D: In.	8-1/4	8-1/4	10-1/4	11-5/8	
		H: In.	11-3/4	11-3/4	12-13/16	14-3/8	
	Weight Unit	Lbs.	23	23	37	40	
	Field Drainpipe Size O.D.	In.	5/8				
Outdoor Unit	MCA	A	14		17	21	
	MOCP	A	15		20	25	
	Fan Motor	F.L.A.	0.52	0.52	0.93		
	Compressor	Model (Type)	DC INVERTER-driven Twin Rotary				
		R.L.A.	10.1			16	
		L.R.A.	12		16	20	
	Airflow	CFM	1,249		1,729	1,941	
	Refrigerant Control		Linear Expansion Valve				
	Defrost Method		Reverse Cycle				
	Sound Pressure Level	dB(A) *1	50	52	55	56	
	External Finish Color		Munsell No. 3Y 7.8/1.1				
	Dimensions	W: In.	31-1/2		33-1/16		
		D: In.	11-1/4		13		
		H: In.	21-5/8		33-7/16	33-7/16	
	Weight	Lbs.	88		128	141	
Remote Controller	Type		Wireless Remote				
Refrigerant	Type		R410A				
	Charge	Lbs., Oz.	2, 7		4	4, 10	
	Oil	Type (Fl. Oz.)	NE022 (15.2)		NEO 22(15.2)	NE022 (29)	
Refrigerant Pipe	Gas Side O.D.	In.	1/2		5/8	5/8	
	Liquid Side O.D.	In.	1/4			3/8	
	Height Difference (Max.)	Ft.	40		50		
	Length (Max.)	Ft.	65		100		
Connection Method	Indoor/Outdoor		Flared/Flared				

NOTES: Test conditions are based on ARI 210/240.

*1 Rating conditions (cooling)-Indoor: D.B. 80º F (27º C), W.B. 67º F (19º C); Outdoor: D.B. 95º F (35º), W.B. 75º F (24º C).

*2 Rating conditions (heating)-Indoor: D.B. 70º F (21º C), W.B. 60º F (16º C); Outdoor: D.B. 47º F (8º C), W.B. 43º F (6º C).

*3 Rating conditions (heating)-Indoor: D.B. 70º F (21º C), W.B. 60º F (16º C); Outdoor: D.B. 17º F (-8º C), W.B. 15º F (-9º C).

*4 Indoor units receive power from outdoor units through field-supplied interconnected wiring.

Specifications are subject to change without notice.

LIMITED WARRANTY | Six-year warranty on compressor. One-year warranty on parts.

(MSZ-A12NA MODEL SHOWN)

MXZ-MULTI INVERTER HEAT PUMP

M-SERIES Specifications

INVERTER R410A

Model Name	Outdoor Unit			MXZ-2A20NA *5	MXZ-3A30NA *6	MXZ-4A36NA *7
Indoor Unit	Cooling *1	Rated Capacity	Btu/h	20,000	28,400	36,000
		Capacity Range	Btu/h	7,800-20,000	12,600-28,400	12,600-36,400
		Total Input	W	2,150 (630-2,150)	3,250 (1,000-3,250)	3,820 (1,000-3,900)
	Heating at 47° F *2	Rated Capacity	Btu/h	22,000	28,600	36,000
		Capacity Range	Btu/h	8,500-22,000	11,400-36,000	11,400-43,000
		Total Input	W	1,780 (520-1,780)	2,180 (740-2,880)	3,100 (740-4,350)
	Heating at 17° F *3	Capacity	Btu/h	14,500	18,800	24,600
		Total Input	W	1,500	2,120	3,340
Power Supply	Phase,Cycle,Voltage			1 Phase, 60Hz, 208-230V *8		
Voltage	Indoor - Outdoor S1-S2			AC 208-230V		
	Indoor - Outdoor S2-S3			DC12-24V		
Outdoor Unit *4	MCA		A	15		19
	MOCP		A	20		
	Fan Motor		F.L.A.	0.96	0.93	
	Compressor		Model (Type)	DC INVERTER-driven Twin Rotary		
			R.L.A.	10.1	11	14.4
			L.R.A.	15		
	Airflow (Cooling/Heating) *1/*2		CFM	1,485/1,640	1,365/1,605	2,068/2,068
	Refrigerant Control			Linear Expansion Valve		
	Defrost Method			Reverse Cycle		
	Sound Pressure Level (Cooling/Heating) *1/*2		dB(A)	49/51	49/49	54/57
	External Finish Color			Munsell No. 5Y 8/1	Munsell No. 3Y 7.8/1.1	
	Dimensions		W: In.	33-1/16	35-7/16	
			D: In.	13 (+1-3/16)	12-5/8 (+1-3/16)	
			H: In.	27-15/16	35-7/16	
	Weight		Lbs.	130	148	150
Remote Controller	Type			Wireless Remote		
Refrigerant	Type			R410A		
	Charge		Lbs., Oz.	5/15	7/11	8/13
	Oil		Type (Fl. Oz.)	NEO22 (23.7)	NEO22 (29.4)	
Refrigerant Pipe	Gas Side O.D.		In.	A, B: 3/8	A: 1/2; B, C: 3/8	A: 1/2; B, C, D: 3/8
	Liquid Side O.D.			1/4		
	Height Difference (Max.)		Ft.	49/33 *9		
	Length (Max.)			164 (A+B)	230 (A+B+C)	230 (A+B+C+D)
	Length (Each Outdoor Unit)			82		
Connection Method	Indoor/Outdoor			Flared/Flared		

NOTES: Test conditions are based on ARI 210/240. One indoor unit is turned off during low-speed testing under the new test conditions. **Systems actually exhibit higher energy efficiencies during normal operation.**

*1 Rating conditions (cooling)-Indoor: D.B. 80° F (27° C), W.B. 67° F (19° C); Outdoor: D.B. 95° F (35°), W.B. 75° F (24° C).

*2 Rating conditions (heating)-Indoor: D.B. 70° F (21° C), W.B. 60° F (16° C); Outdoor: D.B. 47° F (8° C), W.B. 43° F (6° C).

*3 Rating conditions (heating)-Indoor: D.B. 70° F (21° C), W.B. 60° F (16° C); Outdoor: D.B. 17° F (-8° C), W.B. 15° F (-9° C).

*4 Refer to pages 12 and 13 for Indoor Unit specifications.

*5 Data from combination of Indoor Units MSZ-A09NA and MSZ-A12NA.

*6 Data from combination of Indoor Units MSZ-A09NA, MSZ-A09NA and MSZ-A12NA.

*7 Data from combination of four MSZ-A09NA Indoor Units.

*8 Indoor units receive power from outdoor units through field-supplied interconnected wiring.

*9 49' Applies to installations where the outdoor unit is installed below the indoor unit.

Power factor equals 97 percent.

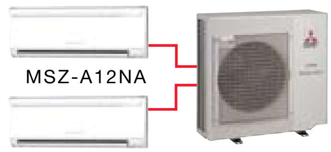
Specifications are subject to change without notice.
LIMITED WARRANTY | Six-year warranty on compressor. One-year warranty on parts. (Diamond Dealers add one year to parts warranty.)

MXZ-3A30NA Combinations

Indoor Unit Combinations (Unit A + Unit B + Unit C)	Cooling Capacity (Btu/h) / Heating Capacity (Btu/h)				Power Usage (W)	Energy Efficiency		Current (A)		Port Adapter Requirements	
	Unit A	Unit B	Unit C	Total		SEER	HSPF	208V	230V	Size	Quantity and Port Adapter Part No.
MSZ-A09NA + MSZ-A09NA	9,000	9,000	–	18,000	1,800	16.0	10.0	8.92	8.07	N.A.	
	10,900	10,900	–	21,800	1,700			8.43	7.62		
MSZ-A09NA + MSZ-A12NA	9,000	12,000	–	21,000	2,000	16.0	10.0	9.91	8.96	N.A	
	10,900	13,600	–	24,500	1,980			9.81	8.87		
MSZ-A09NA + MSZ-A15NA	9,000	15,000	–	24,000	2,500	16.0	10.0	12.39	11.21	N.A.	
	10,100	16,900	–	27,000	2,200			10.90	9.86		
MSZ-A09NA + MSZ-A17NA	9,000	16,200	–	25,200	2,700	16.0	10.0	13.38	12.10	N.A.	
	9,300	17,700	–	27,000	2,200			10.90	9.86		
MSZ-A09NA + MSZ-A24NA	7,600	20,400	–	28,000	3,200	16.0	10.0	15.86	14.34	3/8 X 5/8" or 1/2 X 5/8"	(1) PAC-SG76RJ-E or (1) MAC-A456JP-E
	7,300	19,700	–	27,000	1,980			9.81	8.87		
MSZ-A12NA + MSZ-A12NA	12,000	12,000	–	24,000	2,500	16.0	10.0	12.39	11.21	N.A.	
	13,500	13,500	–	27,000	2,200			10.90	9.86		
MSZ-A12NA + MSZ-A15NA	11,500	14,500	–	26,000	2,800	16.0	10.0	13.88	12.55	N.A.	
	12,000	15,000	–	27,000	2,160			10.71	9.68		
MSZ-A12NA + MSZ-A17NA	10,800	15,200	–	26,000	2,800	16.0	10.0	13.88	12.55	N.A.	
	11,200	15,800	–	27,000	2,140			10.61	9.59		
MSZ-A15NA + MSZ-A15NA	13,000	13,000	–	26,000	2,800	16.0	10.0	13.88	12.55	3/8 X 1/2"	(1) MAC-A454JP-E
	13,500	13,500	–	27,000	2,120			10.51	9.50		
MSZ-A15NA + MSZ-A17NA	12,200	13,800	–	26,000	2,800	16.0	10.0	13.88	12.55	3/8 X 1/2"	(1) MAC-A454JP-E
	12,700	14,300	–	27,000	2,110			10.46	9.46		
MSZ-A17NA + MSZ-A17NA	13,000	13,000	–	26,000	2,800	16.0	10.0	13.88	12.55	3/8 X 1/2"	(1) MAC-A454JP-E
	13,500	13,500	–	27,000	2,100			10.41	9.41		
MSZ-A09NA + MSZ-A09NA + MSZ-A09NA	9,000	9,000	9,000	27,000	2,860	16.0	10.0	14.18	12.82	1/2 X 3/8"	(1) MAC-A455JP-E
	9,500	9,500	9,500	28,500	2,180			10.80	9.77		
MSZ-A09NA + MSZ-A09NA + MSZ-A12NA	8,500	8,500	11,400	28,400	3,250	16.0	10.0	16.11	14.57	1/2 X 3/8"	(1) MAC-A455JP-E
	8,600	8,600	11,400	28,600	2,180			10.80	9.77		
MSZ-A09NA + MSZ-A09NA + MSZ-A15NA	7,750	7,750	12,900	28,400	3,250	16.0	10.0	16.11	14.57	N.A.	
	7,800	7,800	13,000	28,600	2,180			10.80	9.77		
MSZ-A09NA + MSZ-A09NA + MSZ-A17NA	7,300	7,300	13,800	28,400	3,250	16.0	10.0	16.11	14.57	N.A.	
	7,350	7,350	13,900	28,600	2,180			10.80	9.77		

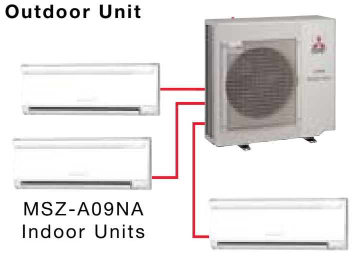
Specifications are subject to change without notice.

MXZ-2A20NA (2:1)
Outdoor Unit



(Two indoor units must be installed.)

MXZ-3A30NA (3:1, 2:1)
Outdoor Unit



(At least two indoor units must be installed.)

- Refer to combination chart for port adaptor references -

MXZ-4A36NA (4:1, 3:1) Outdoor Unit

(At least three indoor units must be installed.)

MXZ-2A20NA Combinations

Indoor Unit (Unit A + Unit B) Combinations	Cooling Capacity (Btu/h) / Heating Capacity (Btu/h) Unit A	Unit B	Total	Power Usage (W)	Energy Efficiency SEER	HSPF	Current (A) 208V	230V
MSZ-A09NA + MSZ-A09NA	9,000	9,000	18,000	1,740	16.0	8.5	8.62	7.8
	10,900	10,900	21,800	1,820			9.02	8.16
MSZ-A09NA + MSZ-A12NA	8,500	11,500	20,000	2,150	16.0	8.5	10.66	9.64
	9,500	12,500	22,000	1,780			8.82	7.98
MSZ-A09NA + MSZ-A15NA*	7,500	12,500	20,000	2,150	16.0	8.5	10.66	9.64
	8,250	13,750	22,000	1,780			8.82	7.98
MSZ-A12NA + MSZ-A12NA	10,000	10,000	20,000	2,150	16.0	8.5	10.66	9.64
	11,000	11,000	22,000	1,780			8.82	7.98

*Port Adapter size = 3/8" x 1/2", Qty = 1, Part No. = MAC-A454JP-E

Specifications are subject to change without notice.

MXZ-4A36NA Combinations

Indoor Unit Combinations (Unit A + Unit B + Unit C + Unit D)	Cooling Capacity (Btu/h) / Heating Capacity (Btu/h) Unit A	Unit B	Unit C	Unit D	Total	Power Usage (W)	Energy Efficiency SEER	HSPF	Current (A) 208V	230V	Port Adapter Requirements Size	Quantity and Port Adapter Part No.
MSZ-A09NA + MSZ-A09NA + MSZ-A09NA	9,000	9,000	9,000	–	27,000	2,860	16.0	8.5	14.18	12.82	N.A.	
	10,800	10,800	10,800	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A09NA + MSZ-A12NA	9,000	9,000	12,000	–	30,000	3,270	16.0	8.5	16.21	14.66	N.A.	
	10,000	10,000	12,400	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A09NA + MSZ-A15NA	8,800	8,800	14,500	–	32,100	3,500	16.0	8.5	17.35	15.69	N.A.	
	8,900	8,900	14,600	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A09NA + MSZ-A17NA	8,200	8,200	15,700	–	32,100	3,500	16.0	8.5	17.35	15.69	N.A.	
	8,400	8,400	15,600	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A09NA + MSZ-A24NA	6,900	6,900	18,300	–	32,100	3,500	16.0	8.5	17.35	15.69	3/8 X 5/8″ or 1/2 X 5/8″	(1) PAC-SG76RJ-E or (1) MAC-A456JP-E
	7,800	7,800	16,800	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A12NA + MSZ-A12NA	8,700	11,700	11,700	–	32,100	3,500	16.0	8.5	17.35	15.69	N.A.	
	9,400	11,500	11,500	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A12NA + MSZ-A15NA	8,000	10,700	13,400	–	32,100	3,500	16.0	8.5	17.35	15.69	N.A.	
	8,300	10,400	13,700	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A12NA + MSZ-A17NA	7,600	10,100	14,400	–	32,100	3,500	16.0	8.5	17.35	15.69	N.A.	
	7,900	9,900	14,600	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A15NA + MSZ-A15NA	7,500	12,300	12,300	–	32,100	3,500	16.0	8.5	17.35	15.69	3/8 X 1/2″	(1) MAC-A454JP-E
	7,600	12,400	12,400	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A15NA + MSZ-A17NA	7,100	11,700	13,300	–	32,100	3,500	16.0	8.5	17.35	15.69	3/8 X 1/2″	(1) MAC-A454JP-E
	7,200	11,900	13,300	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A17NA + MSZ-A17NA	6,700	12,700	12,700	–	32,100	3,500	16.0	8.5	17.35	15.69	3/8 X 1/2″	(1) MAC-A454JP-E
	7,000	12,700	12,700	–	32,400	2,700			13.38	12.10		
MSZ-A12NA + MSZ-A12NA + MSZ-A12NA	10,700	10,700	10,700	–	32,100	3,500	16.0	8.5	17.35	15.69	N.A.	
	10,800	10,800	10,800	–	32,400	2,700			13.38	12.10		
MSZ-A12NA + MSZ-A12NA + MSZ-A15NA	9,900	9,900	12,300	–	32,100	3,500	16.0	8.5	17.35	15.69	N.A.	
	9,700	9,700	13,000	–	32,400	2,700			13.38	12.10		
MSZ-A12NA + MSZ-A12NA + MSZ-A17NA	9,400	9,400	13,300	–	32,100	3,500	16.0	8.5	17.35	15.69	N.A.	
	9,300	9,300	13,800	–	32,400	2,700			13.38	12.10		
MSZ-A12NA + MSZ-A15NA + MSZ-A15NA	9,100	11,500	11,500	–	32,100	3,500	16.0	8.5	17.35	15.69	3/8 X 1/2″	(1) MAC-A454JP-E
	9,000	11,700	11,700	–	32,400	2,700			13.38	12.10		
MSZ-A09NA + MSZ-A09NA + MSZ-A09NA + MSZ-A09NA	9,000	9,000	9,000	9,000	36,000	3,820	16.0	8.5	18.55	16.78	1/2 X 3/8″	(1) MAC-A455JP-E
	9,000	9,000	9,000	9,000	36,000	3,100			15.05	13.61		
MSZ-A09NA + MSZ-A09NA + MSZ-A09NA + MSZ-A12NA	8,300	8,300	8,300	11,100	36,000	3,820	16.0	8.5	18.55	16.78	1/2 X 3/8″	(1) MAC-A455JP-E
	8,300	8,300	8,300	11,100	36,000	3,100			15.05	13.61		
MSZ-A09NA + MSZ-A09NA + MSZ-A09NA + MSZ-A15NA	7,700	7,700	7,700	12,900	36,000	3,820	16.0	8.5	18.55	16.78	N.A.	
	7,700	7,700	7,700	12,900	36,000	3,100			15.05	13.61		
MSZ-A09NA + MSZ-A09NA + MSZ-A12NA + MSZ-A12NA	7,700	7,700	10,300	10,300	36,000	3,820	16.0	8.5	18.55	16.78	1/2 X 3/8″	(1) MAC-A455JP-E
	7,700	7,700	10,300	10,300	36,000	3,100			15.05	13.61		

*Port Adapter size = 3/8" x 1/2", Qty = 1, Part No. = MAC-A454JP-E

Specifications are subject to change without notice.

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Split-ductless A/C and Heat Pumps

Provides personalized comfort control for every room.

ARI Performance Certified
ARI Standard 210/240

Mitsubishi Electric Shizuoka Works acquired ISO 9001 certification under Series 9000 of the International Standard Organization (ISO), based on a review of quality warranties for the production of air-conditioning equipment. The plant also acquired environmental management system standard ISO 14001 certification.

ENERGY STAR PARTNER

ISO 9001

ISO 14001

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HVAC Advanced Products Division

Mitsubishi Electric Advanced Products Division
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Suwanee, GA 30024

Phone: 888-467-7546 Fax: 800-658-1458

Form No. MSBROM-09-08-20M SP

For more information visit www.mrslim.com

Appendix 4-6 Water Conservation

Johnson Controls

Royal® Model Flushometer

110 111

Description
Exposed Water Closet Flushometer, for floor mounted or wall hung top spud bowls.

Flush Cycle
☐ Model 110 Water Saver (3.5 gpf/13.2 Lpf)
☐ Model 111 Low Consumption (1.6 gpf/6.0 Lpf)

Specifications
Quiet, Exposed, Diaphragm Type, Chrome Plated Closet Flushometer with the following features:

- PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass
- ADA Compliant Metal Oscillating Non-Hold-Open Handle with Triple Seal Handle Packing
- 1" I.P.S. Screwdriver Bak-Chek™ Angle Stop
- Free Spinning Vandal Resistant Stop Cap
- Adjustable Tailpiece
- High Back Pressure Vacuum Breaker Flush Connection with One-piece Bottom Hex Coupling Nut
- Spud Coupling and Flange for 1½" Top Spud
- Sweat Solder Adapter with Cover Tube and Cast Set Screw Wall Flange
- High Copper, Low Zinc Brass Castings for Dezincification Resistance
- Non-Hold-Open Handle, Fixed Metering Bypass and No External Volume Adjustment to Ensure Water Conservation
- Flush Accuracy Controlled by CID™ Technology
- Diaphragm, Handle Packing, Stop Seat and Vacuum Breaker to be molded from PERMEX™ Rubber Compound for Chloramine Resistance

Valve Body, Cover, Tailpiece and Control Stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be in compliance to the applicable sections of ASSE 1037, ANSI/ASME 112.19.6, and Military Specification V-29193.

Variations

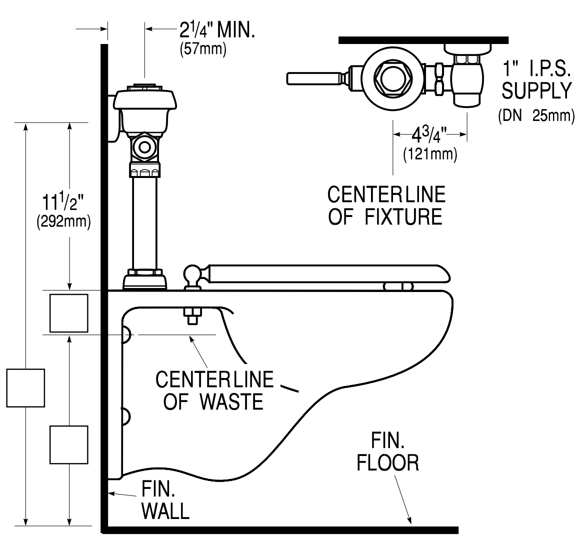
☐	**HL-3**	3" Metal Oscillating Push Button on Front of Valve (does not meet ADA requirements)
☐	**TP**	Trap Primer
☐	**YG**	Extended Bumper on Angle Stop (for seat with cover)
☐	**YO**	Bumper on Angle Stop (for open front seat without cover)

See Accessories Section of the Sloan catalog for details on these and other Flushometer variations.

® Certified

® Listed by I.A.P.M.O.

This space for Architect/Engineer approval



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SLOAN
Made in the U.S.A.
SLOAN VALVE COMPANY • 10500 SEYMOUR AVE. • FRANKLIN PARK, IL. 60131
Ph: 1-800-9-VALVE-9 or 1-847-671-4300 • Fax: 1-800-447-8329 or 1-847-671-4380
http://www.sloanvalve.com

KOHLER®

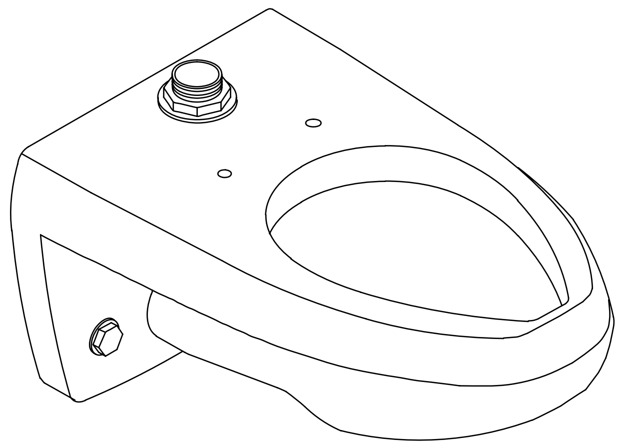
KINGSTON™

BOWL
K-4330

ADA

Features

- *1-1/2″ top spud*
- *Vitreous china*
- *Elongated bowl*
- *Wall-mount*
- *1.6 gpf (6 lpf)*
- *ADA compliant when installed at required height of 17″-19″ from floor to top of seat*
- *With bedpan lugs (-L)*
- *Siphon jet*
- *12-3/8″ (31.4 cm) x 11-3/8″ (28.9 cm) water area*



Codes/Standards Applicable

Specified model meets or exceeds the following:

- *ADA*
- *ASME A112.19.2*
- *ASME A112.19.6*
- *ICC/ANSI A117.2*
- *Energy Policy Act of 1992 (EPACT)*
- *IAPMO/UPC*
- *CSA B125*

Colors/Finishes

- 0: White
- Other: Refer to Price Book for additional colors/finishes

Accessories

- 0: White
- Other: Refer to Price Book for additional colors/finishes

Specified Model

Model	Description	Colors/Finishes	
K-4330	Elongated bowl toilet	❑ 0 White	❑ Other_____
K-4330-L	Elongated bowl toilet with bedpan lugs	❑ 0 White	❑ Other_____

Recommended Accessories			
K-4670-C	Lustra™ open front seat	❑ 0 White	❑ Other_____
K-4670-CA	Lustra™ open front seat (with anti-microbial agent)	❑ 0 White	

Product Specification:

The elongated bowl shall be wall-mount with a 1-1/2″ top spud. Bowl shall be made of vitreous china. Bowl shall have 12-3/8″ (31.4 cm) x 11-3/8″ (28.9 cm) water area. Bowl shall be 1.6 gpf (6 lpf). Bowl shall be ADA compliant when installed at required height of 17″ (43.2 cm) - 19″ (48.3 cm) from the floor to the top of the seat. Bowl shall have bedpan lugs (-L). Bowl shall have siphon jet. Bowl shall be Kohler Model K-4330-______

USA: 1-800-4-KOHLER
Canada: 1-800-964-5590
kohler.com

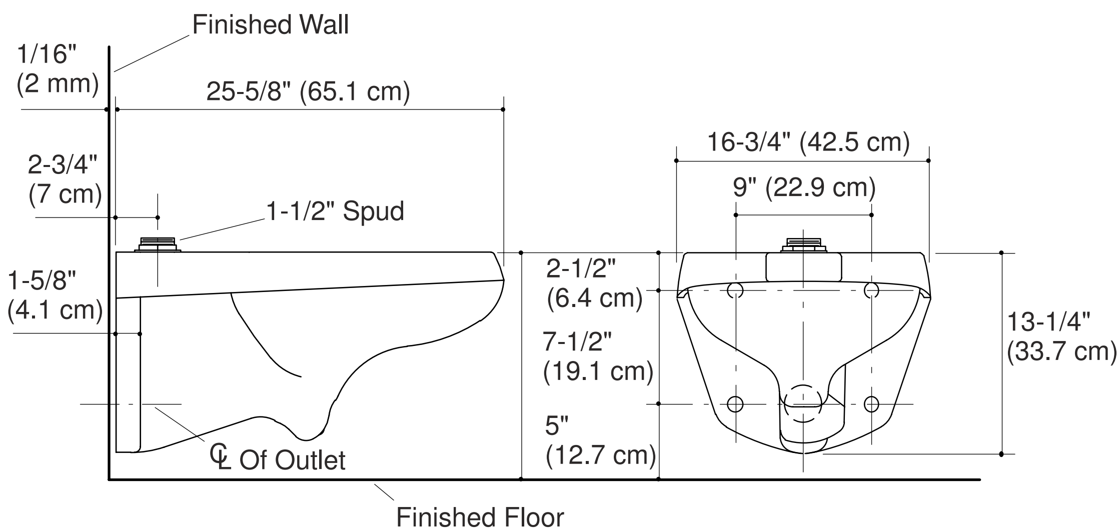
KINGSTON™

Technical Information

ADA compliant	
Fixture:	
Configuration	top spud, elongated
Water per flush	1.6 gallons (6 L)*
Spud size	1-1/2″
Passageway	2-1/4″ (5.7 cm)
Water area	12-3/8″ (31.4 cm) x 11-3/8″ (28.9 cm)
Water depth from rim	5-1/4″ (13.3 cm)
Seat post hole centers	5-1/2″ (14 cm)
* Designed to flush with 1.6 (6 L) gallons of water when installed with a 1.6 (6 L) gpf flush valve.	
Included components:	
Spud	18357
Flush valve requirements: Refer to manufacturer and local codes.	

Installation Notes

Install this product according to the installation guide.

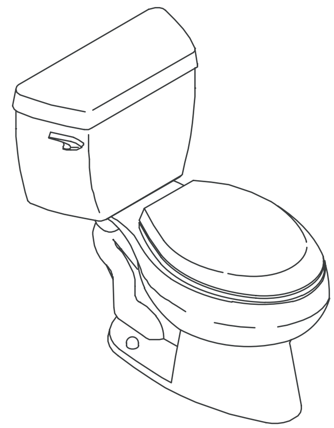


Product Diagram

KOHLER®

WELLWORTH™

TOILET
K-3432



Features

- *1.6 gpf (6 lpf)*
- *Ingenium™ flushing system*
- *2″ (5.1 cm) glazed trapway*
- *Combination toilet*
- *Less seat and supply*
- *With Insuliner® insulated tank lining (-U)*
- *With tank cover locks (-T)*
- *Includes polished chrome trip lever*
- *Elongated vitreous china bowl*
- *10″ (25.4 cm) rough-in*
- *11-1/8″ (28.3 cm) x 9-1/4″ (23.5 cm) water area*
- *With right-hand trip lever (-RA)*
- *With bedpan lugs (-L)*

Codes/Standards Applicable

Specified model meets or exceeds the following:

- *ASME A112.19.6*
- *ASME A112.19.2*
- *Energy Policy Act of 1992 (EPACT)*
- *IAPMO/UPC*
- *CSA B45*
- *CSA International*

Colors/Finishes

- 0: White
- Other: Refer to Price Book for additional colors/finishes

Accessories:

- 0: White
- CP: Polished Chrome
- PB: Polished Brass
- Other: Refer to Price Book for additional colors/finishes

Specified Model

Model	Description	Colors/Finishes	
K-3432	Elongated bowl toilet (left-hand trip lever)	❑ 0 White	❑ Other_____
K-3432-U	Toilet with Insuliner tank (left-hand trip lever)	❑ 0 White	❑ Other_____
K-3432-T	Toilet with tank cover locks (left-hand trip lever)	❑ 0 White	❑ Other_____
K-3432-UT	Toilet with Insuliner tank and tank cover locks (LH trip lever)	❑ 0 White	❑ Other_____
K-4273-L/K4620	Toilet with bedpan lugs (left-hand trip lever)	❑ 0 White	❑ Other_____
K-3432-RA	Elongated bowl toilet (right-hand trip lever)	❑ 0 White	❑ Other_____
K-3432-TR	Toilet with tank cover locks (right-hand trip lever)	❑ 0 White	❑ Other_____
K-3432-UR	Toilet with Insuliner tank (right-hand trip lever)	❑ 0 White	❑ Other_____
K-3432-RZ	Toilet with Insuliner tank and tank cover locks (RH trip lever)	❑ 0 White	❑ Other_____
K-4273-L/K-4620-RA	Toilet with bedpan lugs (right-hand trip lever)	❑ 0 White	❑ Other_____
Recommended Accessories and Optional Accessories on Page 2			

Product Specification:

The elongated combination toilet shall be 10″ (25.4 cm) rough-in. Toilet shall be made of vitreous china. Toilet shall have 11-1/8″ (28.3 cm) x 9-1/4″ (23.5 cm) water area. Toilet shall be 1.6 gpf (6 lpf) with Ingenium™ flushing system. Toilet shall have 2″ (5.1 cm) glazed trapway. Toilet shall include polished chrome trip lever. Toilet shall be less seat and supply. Toilet shall have right-hand trip lever (-RA). Toilet shall have bedpan lugs (-L). Toilet shall have Insuliner® insulated tank lining (-U). Toilet shall have tank cover locks (-T). Toilet shall be Kohler Model K-3432-_______-_______.

USA: 1-800-4-KOHLER
Canada: 1-800-964-5590
kohler.com

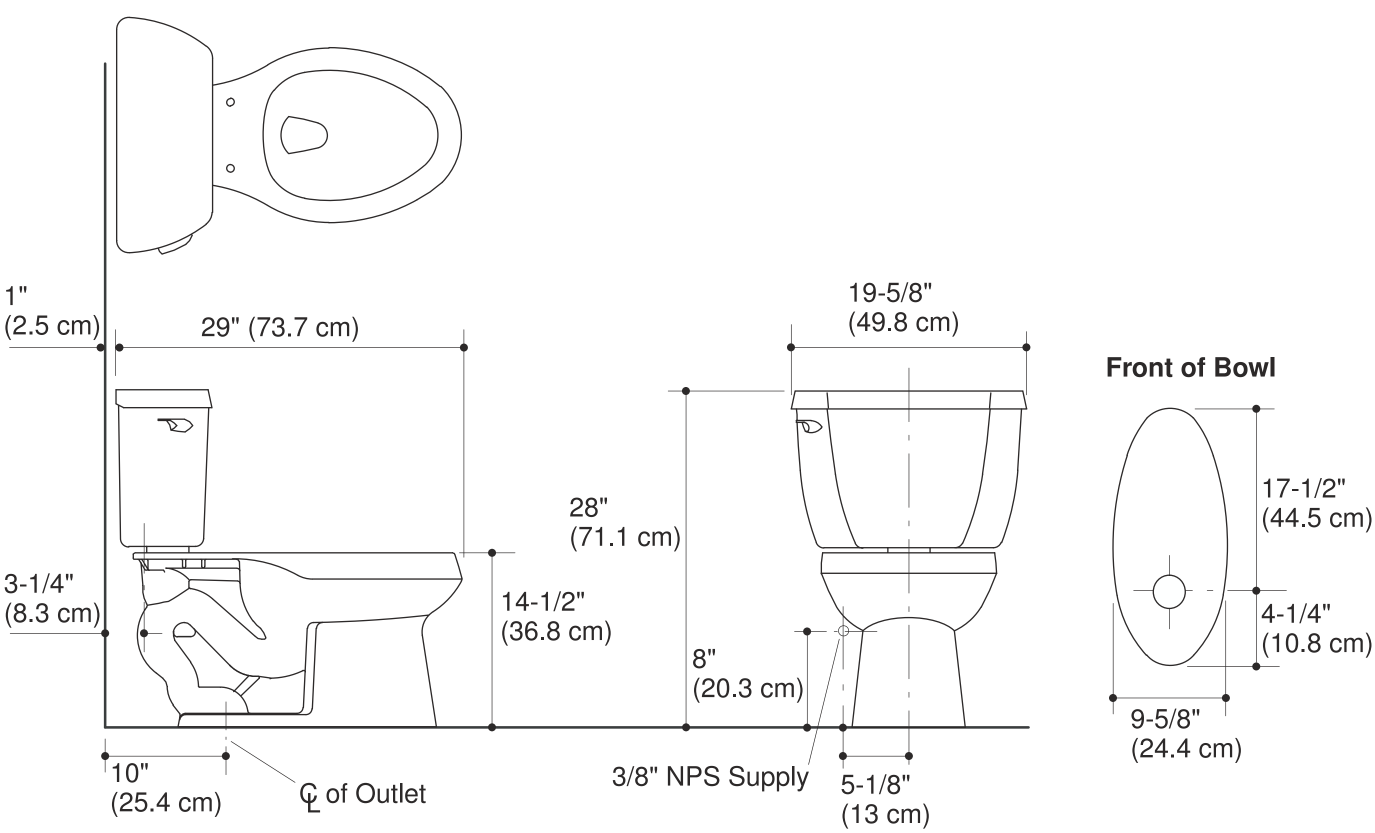
WELLWORTH™

Recommended Accessories				
K-4664	Brevia™ seat with cover	❑ White		❑ Other_____
K-4653	French Curve™ seat with cover	❑ White		❑ Other_____
K-7637	Angle supply with stop	❑ CP	❑ PB	❑ Other_____

Optional Accessories			
K-9404-L	Trip lever, left-hand (non-CP)	❑ PB	❑ Other_____
K-9404-R	Trip lever, right-hand (non-CP)	❑ PB	❑ Other_____

Installation Notes

Install this product according to the installation guide.



Product Diagram

THE BOLD LOOK OF KOHLER®

KOHLER®

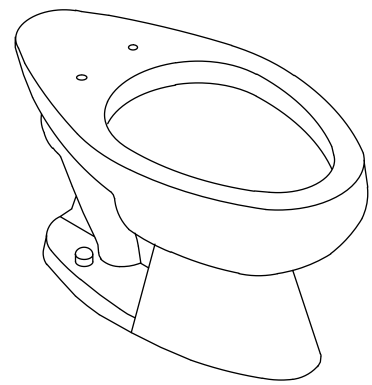
WELLCOMEᵀᴹ

Features

- *Vitreous china*
- *Elongated bowl*
- *With bedpan lugs (-L)*
- *2-1/4″ (5.7 cm) passageway*
- *11-3/8″ (28.9 cm) x 10-3/8″ (26.4 cm) water area*
- *11″ (27.9 cm) minimum rough-in*
- *1-1/2″ rear spud*
- *1.6 gpf (6 lpf)*
- *26″ (66 cm) x 14-1/2″ (36.8 cm) x 14-3/4″ (37.5 cm)*

BOWL

K-4349



Codes/Standards Applicable

Specified model meets or exceeds the following:

- *ASME A112.19.2*
- *IAPMO/UPC*
- *CSA B45*

Colors/Finishes

- 0: White
- Other: Refer to Price Book for additional colors/finishes

Accessories:

- 0: White
- Other: Refer to Price Book for additional colors/finishes

Specified Model

Model	Description	Colors/Finishes	
K-4349	Elongated bowl toilet	❑ 0	❑ Other_____
K-4349-L	Elongated bowl toilet with bedpan lugs	❑ 0	❑ Other_____

Recommended Accessories			
K-4670-C	Lustraᵀᴹ open front seat	❑ 0	❑ Other_____
K-4670-CA	Lustra open front seat with anti-microbial agent	❑ 0	

Product Specification

The elongated bowl shall be 11″ (27.9 cm) minimum rough-in with 1-1/2″ rear spud. Bowl shall be made of vitreous china. Bowl shall be 1.6 gpf (6 lpf). Bowl shall have 2-1/4″ (5.7 cm) passageway. Bowl shall have 11-3/8″ (28.9 cm) by 10-3/8″ (26.4 cm) water area. Bowl shall be 26″ (66 cm) in length, 14-1/2″ (36.8 cm) in width, and 14-3/4″ (37.5 cm) in height. Bowl shall have bedpan lugs (-L). Bowl shall be Kohler Model K-4349-_______-_______.

USA: 1-800-4-KOHLER
Canada: 1-800-964-5590
kohler.com

WELLCOMME™

Technical Information

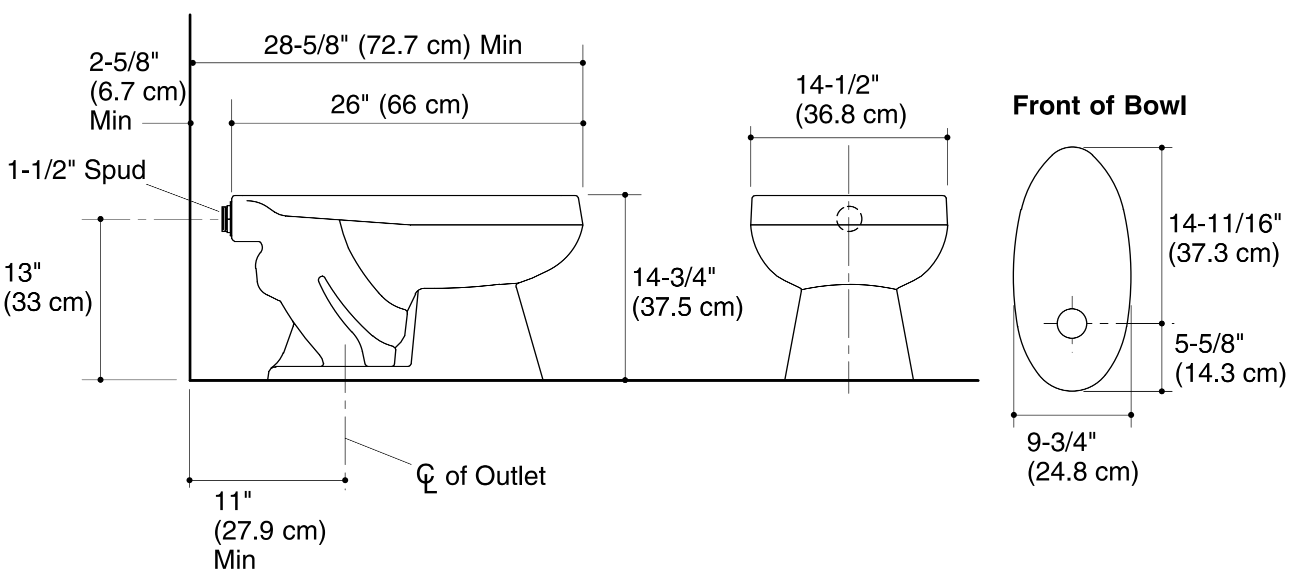
Fixture:	
Configuration	Rear spud, elongated
Water per flush	1.6 gal (6 L)*
Spud size	1-1/2″
Passageway	2-1/4″ (5.7 cm)
Water area	11-3/8″ (28.9 cm) x 10-3/8″ (26.4 cm)
Water depth from rim	6″ (15.2 cm)
Seat post hole centers	5-1/2″ (14 cm)
* Designed to flush with 1.6 gal (6 L) of water when installed with a 1.6 gpf (6 lpf) valve.	

Included components:	
Spud	18357
Bolt caps (pair)	52048

Installation Notes

Install this product according to the installation guide.

Refer to manufacturer and local codes for flush valve requirements.



Product Diagram

Royal® Model Flushometer

186
186-1.0
186-0.5

Description
Exposed Urinal Flushometer, for ¾" top spud urinals.

Flush Cycle
☐ Model 186 Water Saver (1.5 gpf/5.7 Lpf)
☐ Model 186-1.0 Low Consumption (1.0 gpf/3.8 Lpf)
☐ Model 186-0.5 (0.5 gpf/1.9 Lpf)

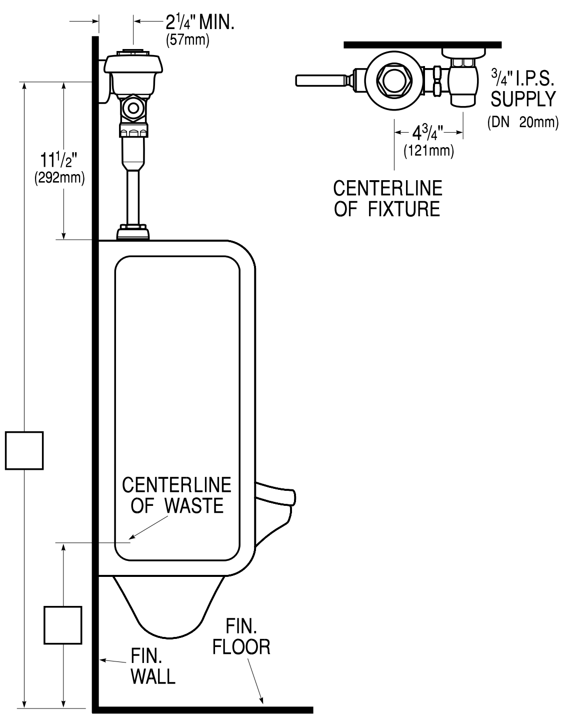
Specifications
Quiet, Exposed, Diaphragm Type, Chrome Plated Urinal Flushometer with the following features:

- PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass
- ADA Compliant Metal Oscillating Non-Hold-Open Handle with Triple Seal Handle Packing
- ¾" I.P.S. Screwdriver Bak-Chek™ Angle Stop
- Free Spinning Vandal Resistant Stop Cap
- Adjustable Tailpiece
- High Back Pressure Vacuum Breaker Flush Connection with One-piece Bottom Hex Coupling Nut
- Spud Coupling and Flange for ¾" Top Spud
- Sweat Solder Adapter with Cover Tube and Cast Set Screw Wall Flange
- High Copper, Low Zinc Brass Castings for Dezincification Resistance
- Non-Hold-Open Handle, Fixed Metering Bypass and No External Volume Adjustment to Ensure Water Conservation
- Flush Accuracy Controlled by CID™ Technology
- Diaphragm, Handle Packing, Stop Seat and Vacuum Breaker to be molded from PERMEX™ Rubber Compound for Chloramine Resistance

Valve Body, Cover, Tailpiece and Control Stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be in compliance to the applicable sections of ASSE 1037, ANSI/ASME 112.19.6, and Military Specification V-29193.

Variations
☐ **HL-3** 3" Metal Oscillating Push Button on front of valve (does not meet ADA requirements

See Accessories Section of the Sloan catalog for details on these and other Flushometer variations.



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http://www.sloanvalve.com

Appendix 4-9 Vending Machine Controls

VendingMISER®

Reduce energy costs

The Miser family is a line of occupancy-based energy control products. The VendingMiser® patented technology represents a breakthrough in the power control of cold beverage vending machines. It reduces energy consumption by an average of 46% and decreases per machine maintenance by $40-$80 per year. All while maintaining the temperature of the vended product. VendingMiser® typically has a short average payback of between one and two years.*

How the VendingMiser reduces energy consumption

Utilizing a Passive Infrared (PIR) Sensor, VendingMiser® powers down a vending machine when the area surrounding it is vacant. VendingMiser® also monitors the room's temperature, and automatically re-powers the vending machine at one to three hour intervals, independent of occupancy, to ensure that the vended product stays cold.

VendingMiser's® electrical current sensor will never power down a vending machine while the compressor is running, eliminating compressor short cycling. In addition, when the vending machine is powered up, the cooling cycle is allowed to run to completion before again powering down. For a series of up to 4 machines, VendingMiser® can utilize its unique embedded Sensor Repeater, which allows it to be controlled from the PIR sensor of any other Miser in the bank.

Beyond cold drink vending

Other cooled product vending machines, such as refrigerated candy machines, can also be controlled by VendingMiser®. Non-cooled product machines can be controlled to reduce energy costs by our companion product, SnackMiser™. VendingMiser® is made in the USA.

VENDINGMISERS® BENEFIT THE ENVIRONMENT AND REDUCE ENERGY COSTS

One VendingMiser® reduces greenhouse gas emissions by 2200 lbs. of CO_2 and 3600 grams of NOx each year.**

The average annual energy costs for a cold drink vending machine is $300 per year. With the VendingMiser® you can save an average of $150 per year, per machine.***

* Based on electric rate and occupancy.

** Based on occupancy and the Energy Information Administration's national average of greenhouse gas emissions and electricity generation.

*** Based on our current customers.

For more information about the VendingMiser® by USA Technologies
800-770-8539 • www.usatech.com

Frequently Asked Questions

Will VendingMiser® keep my drinks cold?
Absolutely - VendingMiser® has been tested and accepted for use by both major bottlers.

Is the VendingMiser® easy to install?
Yes! VendingMiser® is a simple external plug-and-play product. The VendingMiser® can be installed on the wall with simple hand tools or it can be attached to the vending machine without tools using the new Easy-Install system. The Easy-Install System allows quick installation in 5 minutes.

Is VendingMiser® safe for all machines?
Yes! VendingMiser® is compatible with all types of cold drink vending machines. In fact, by reducing run time of the machines, VendingMiser® reduces maintenance costs.

Has VendingMiser® been field tested?
Tens of thousands of VendingMisers® are operational in the field. Typical energy savings have been independently documented to be between 35% and 45%. Measurement and verification test results as well as testimonials are available on the website.

Are there any locations not appropriate for VendingMiser®?
VendingMiser's® savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings.

Technical Specifications

ELECTRICAL SPECIFICATIONS

Input Voltage:	115 Volts (230 Volts available)
Input Frequency:	50/60 Hz
Maximum Load:	12 Amps (Steady-State)
Power Consumption:	Less than 1 Watt (Standby)

ENVIRONMENTAL SPECIFICATIONS

Operating Temp:	-15°C to 75°C
Storage Temp:	-40°C to 85°C
Relative Humidity:	95% Maximum (Non-Condensing)

COMPATIBILITY

Vending Machines:	Any machine, except those containing perishable goods such as dairy products.

INACTIVITY TIMEOUTS

Occupancy Timeout:	15 minutes
Auto Repower:	One to three hours, dynamically adjusted, based on ambient temperature

DIMENSIONS

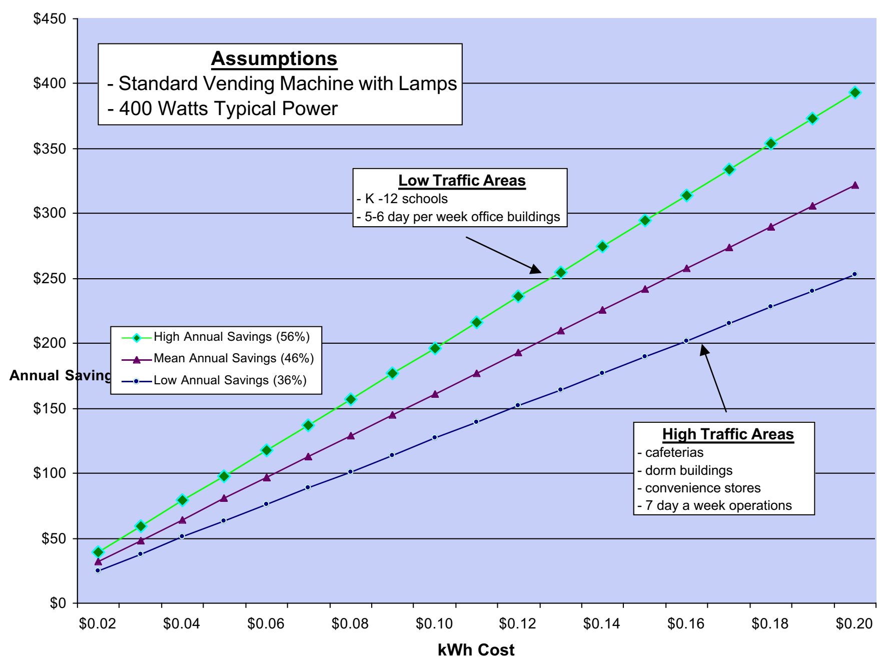
Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

UL LISTED c UL LISTED

Typical Saving Generated with VendingMiser®



VendingMiser® Products

VM150	VendingMiser® with PIR Sensor
VM151	VendingMiser® only
VM160	Weatherproof VendingMiser® with PIR Sensor
VM161	Weatherproof VendingMiser® only
VM170	Easy-Install VendingMiser® with PIR Sensor
VM171	Easy-Install VendingMiser® only
VM180	Weatherproof Easy-Install VendingMiser w/PIR sensor
VM181	Weatherproof Easy-Install VendingMiser only

For more information about the VendingMiser® by USA Technologies
800-770-8539 • www.usatech.com

Appendix 4-10 Pool Cover

ALTA
ENTERPRISES, INC.
(800) 624-1235

RT1 BOX 3760
ALTA, WYOMING 83422
(307) 353-2407
FAX (307) 353-8118

POOL BLANKETS

AND

AUTOMATIC REEL SYSTEMS

Description ~ Operation ~ Specifications ~ Maintenance

INDEX

INTRODUCTION

Pool operators agree that pool blankets save money by conserving energy. Pool operators also agree that the blanket must be used to in order to save money.

Automatic reel systems make using the blanket easy, thereby assuring daily use.

The perfect blanket is light enough to be easy to use, floats high so any water on top will run off, is strong enough to be serviceable for several years, and should insulate to avoid heat loss during night setbacks.

The perfect reel is easy to use requiring little or no muscle, can be operated by one person, and is all stainless steel so that it will last.

The Alta blanket/reel combination meets all these criteria and it is reasonable priced.

The auto reel is located high on the wall at about 10 to 14 feet so that it is completely off the deck and no deck space is lost to reel storage

The auto reel is activated using a hand held, two directional controller (similar to a garage door controller.) or by wall mounted switches.

Typically, the "on" or "off" process will take approximately two minutes per section of blanket, and can be done by one person.

THE AUTO REEL MAKES USING A GOOD BLANKET EASY!

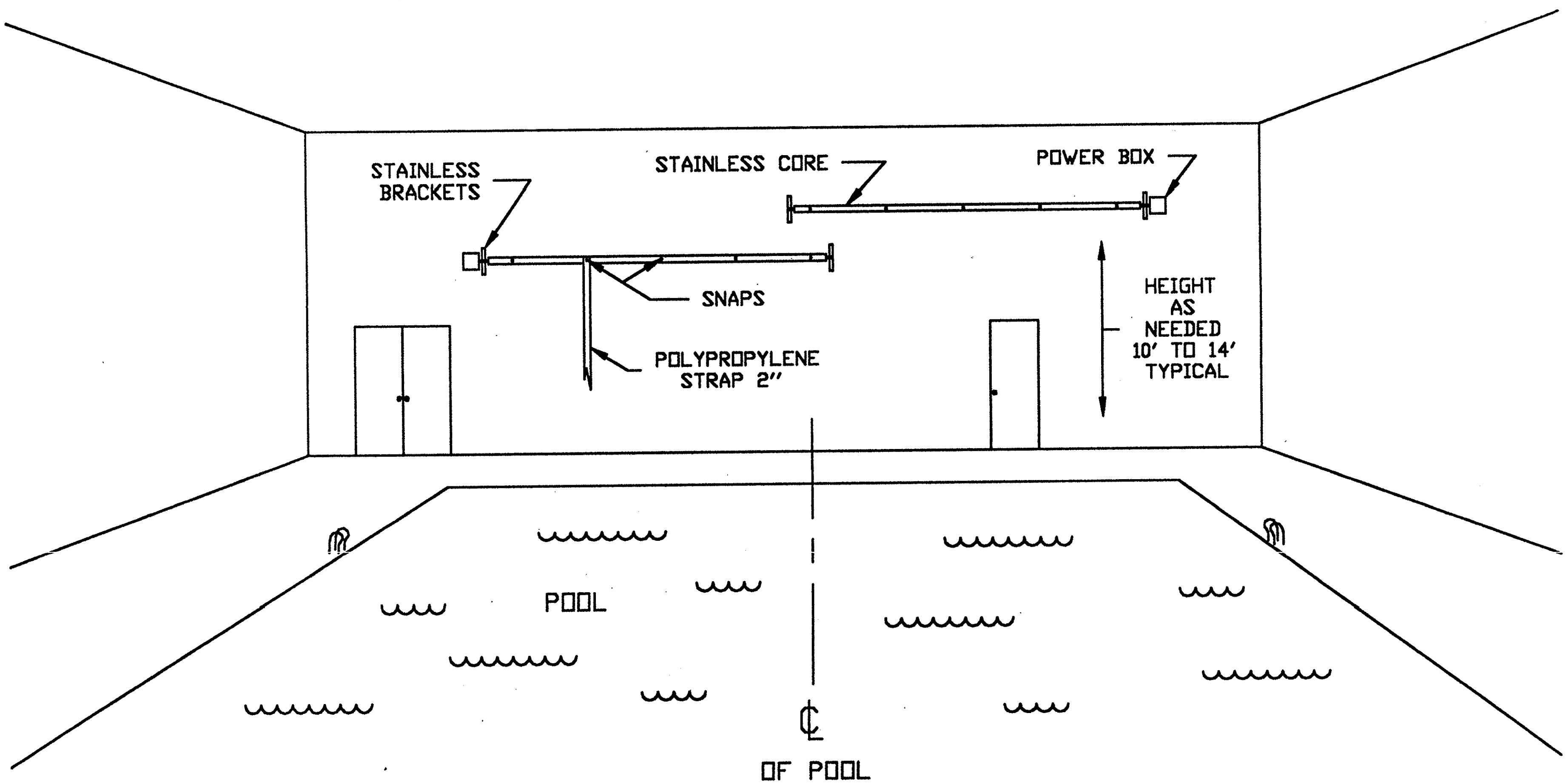
LEVELS of AUTOMATION

There are three levels of reel system automation:

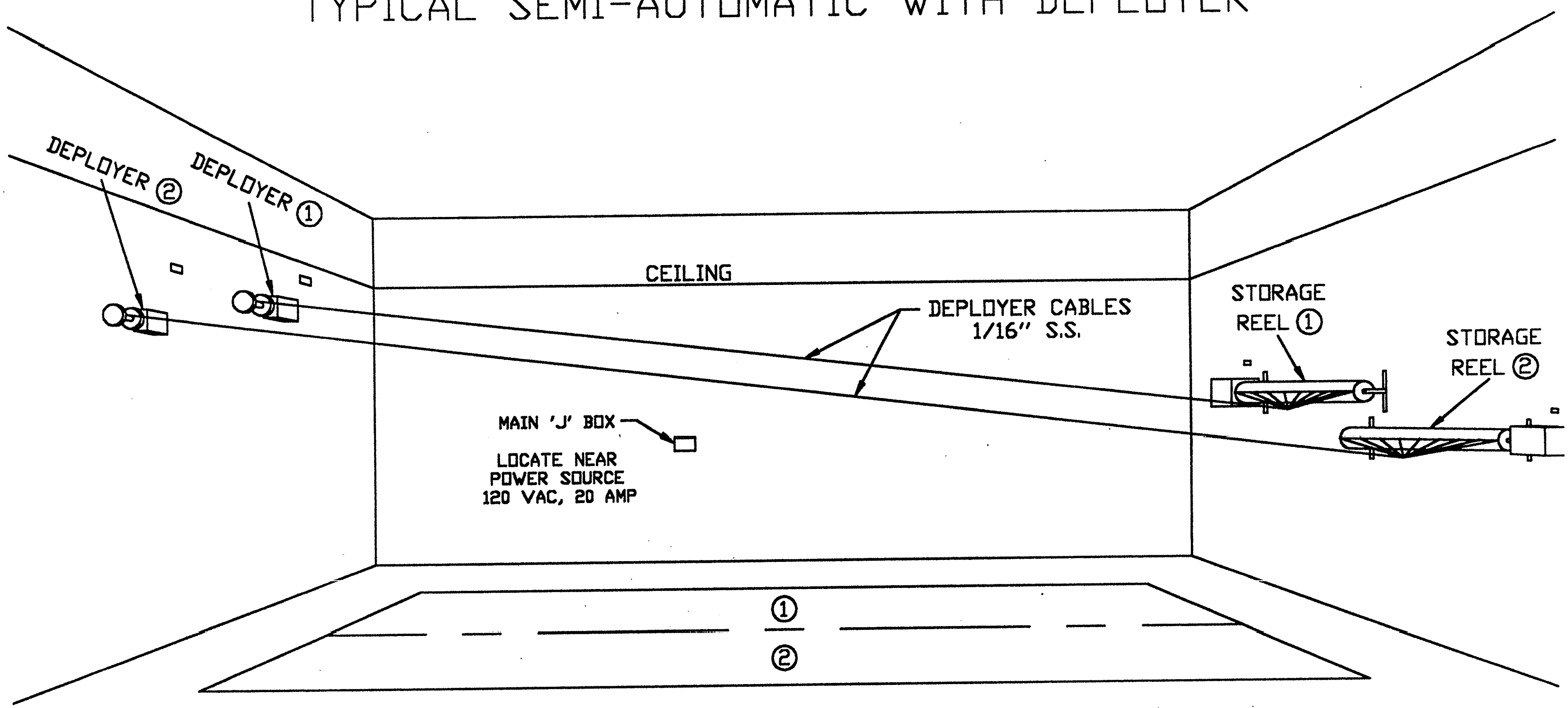
1. Semi-Automatic
2. Semi-Automatic with Deployer
3. Fully Automatic

Drawings and operating details of each follow.

TYPICAL SEMI-AUTOMATIC INSTALLATION

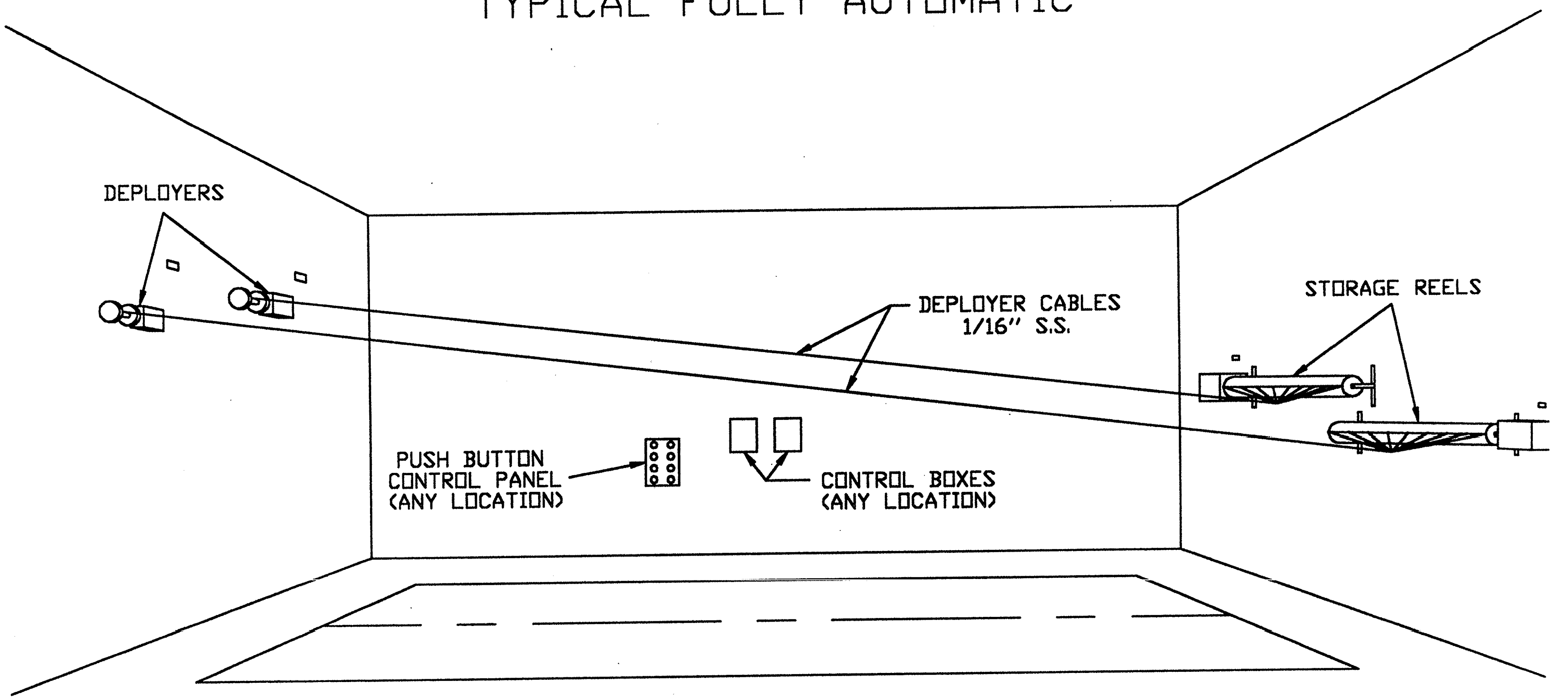


TYPICAL SEMI-AUTOMATIC WITH DEPLOYER

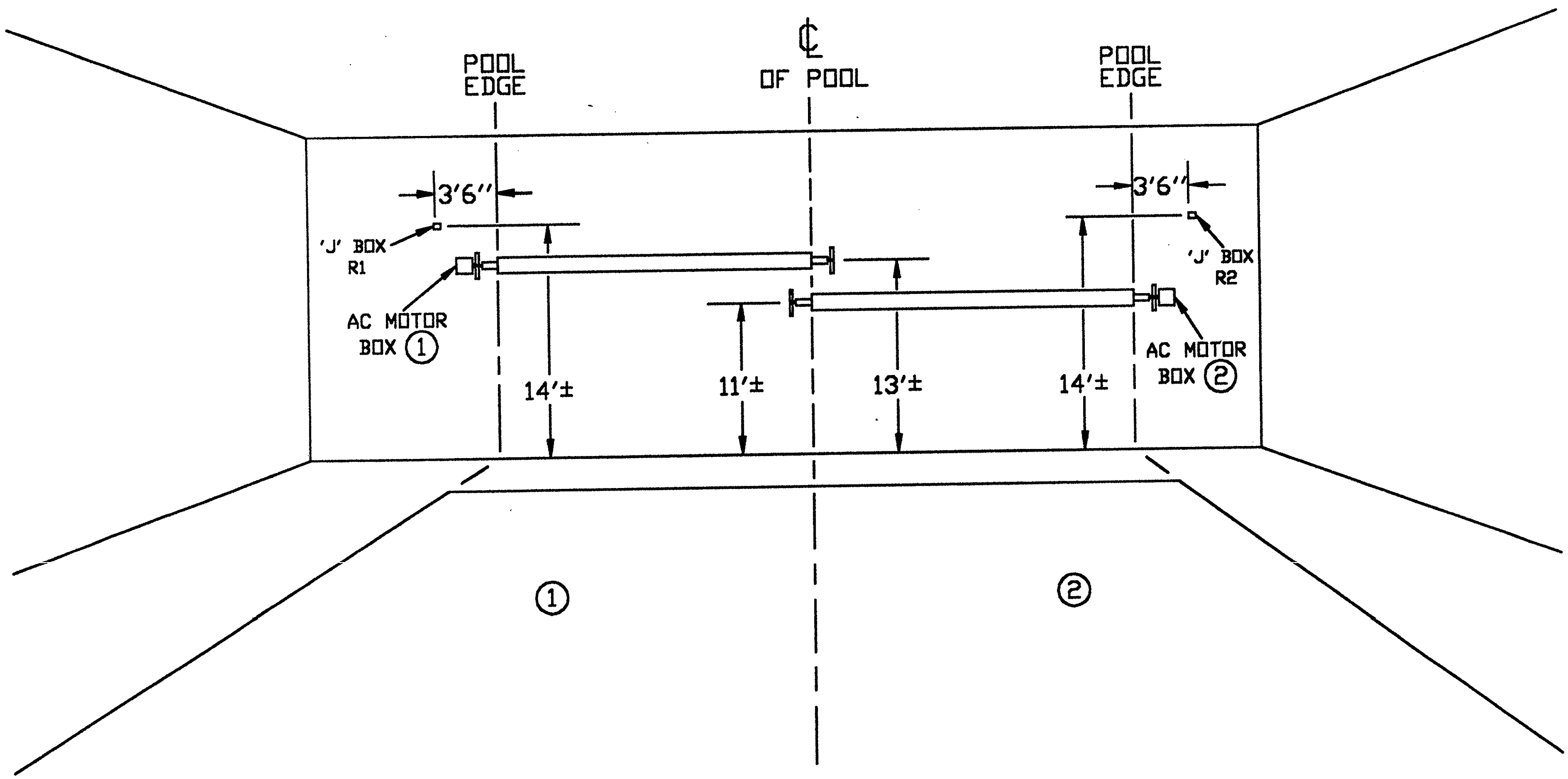


NOTE: "MAIN 'J' BOX" MUST BE AT LEAST 20' FROM STORAGE REEL MOTORS.

TYPICAL FULLY AUTOMATIC

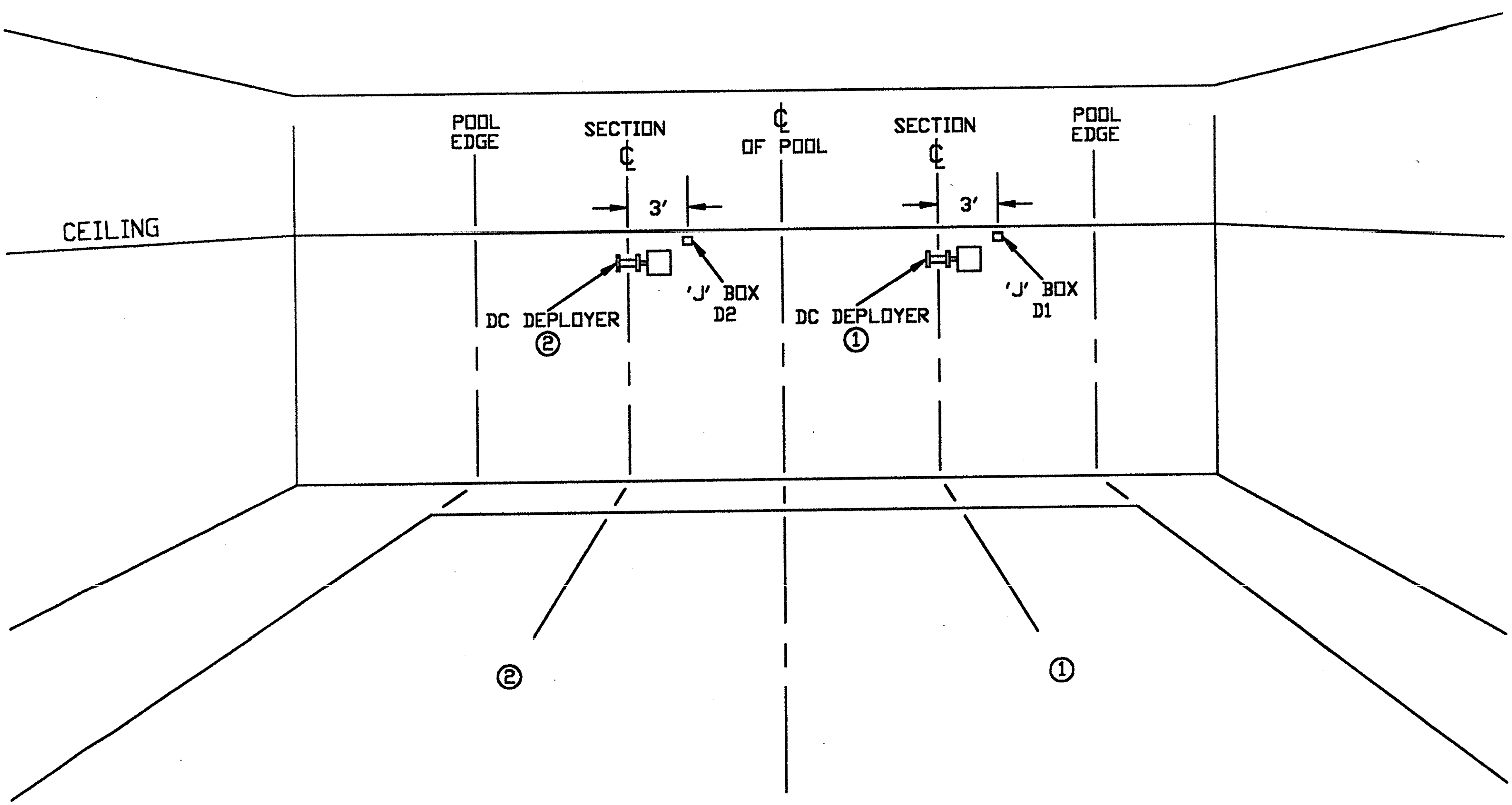


TYPICAL STORAGE REELS



5

TYPICAL DEPLOYERS



OPERATION of blanket using:

SEMI-AUTOMATIC reel system

ONTO POOL

1. Push "down" button to unwind blanket about 10 to 15 feet.
2. Using corner grommets, pull blanket out onto pool, allowing far side to fold under and skim across the pool.
3. Push "down" button and walk blanket out length of pool using corner grommet as pull joint.
4. Unfold leading edge and adjust for fit.
5. Repeat for additional sections using appropriate controller.

OFF POOL

1. Push "up" button and guide blanket as it rolls onto core to insure straight roll without telescoping.
2. Repeat for additional sections using appropriate controller.

<u>NEVER ALLOW ANY ONE IN WATER WHEN ANY PORTION OF BLANKET IS ON THE POOL</u>

SEMI-AUTOMATIC reel system with Deployer

ONTO POOL

1. Using "down" controller (s) , push button and hold down while blanket deploys. Release button when blanket is fully deployed. (DO ALL SECTIONS SIMULTANEOUSLY.)

2. Push buttons individually to adjust for exact fit.

OFF POOL

1. Using "up" controller, push button and hold down while blanket winds onto storage reel. Release button when blanket is fully wound onto reel. Guide blanket as needed as it rolls onto reel to avoid telescoping. (DO ALL SECTIONS SIMULTANEOUSLY.)

FULLY AUTOMATIC reel system

ONTO POOL

1. Push "deploy" buttons and hold down until blanket stops deploying.

OFF POOL

1. Push "retract" buttons and hold down until blanket stops retracting.

<u>SWIMMING UNDER THE BLANKET WILL CAUSE DROWNING</u>

ENERGY SAVINGS GUIDELINES

1. Keep the blanket on the pool as long as possible.

2. Turn off exhaust fans 30 to 45 minutes after blanket goes on (manually or with timer or humidistat.)

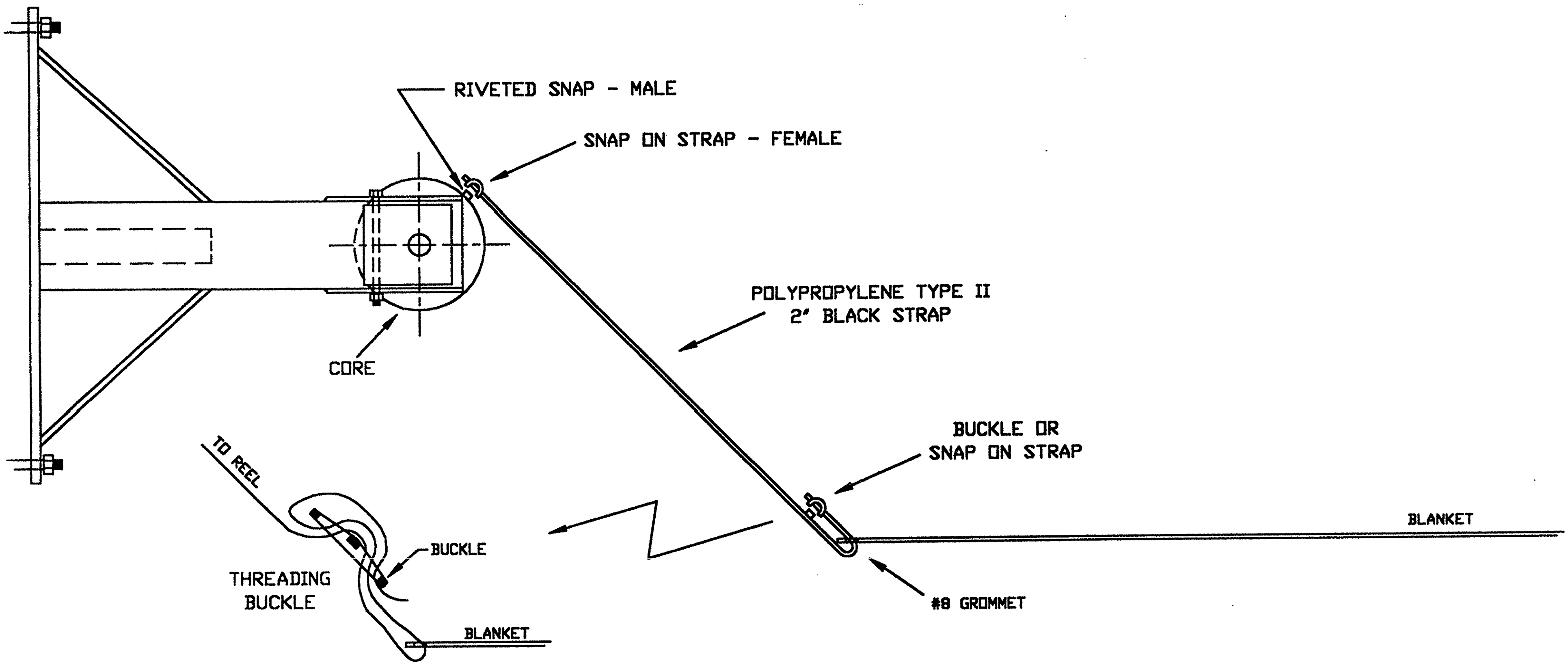
3. Turn down air thermostat to between 60° and 65° F. when blanket goes on.

4. Expect a 2° to 3° F. pool water temperature rise the first night the blanket is on. Adjust pool water thermostat to maintain desired temperature.

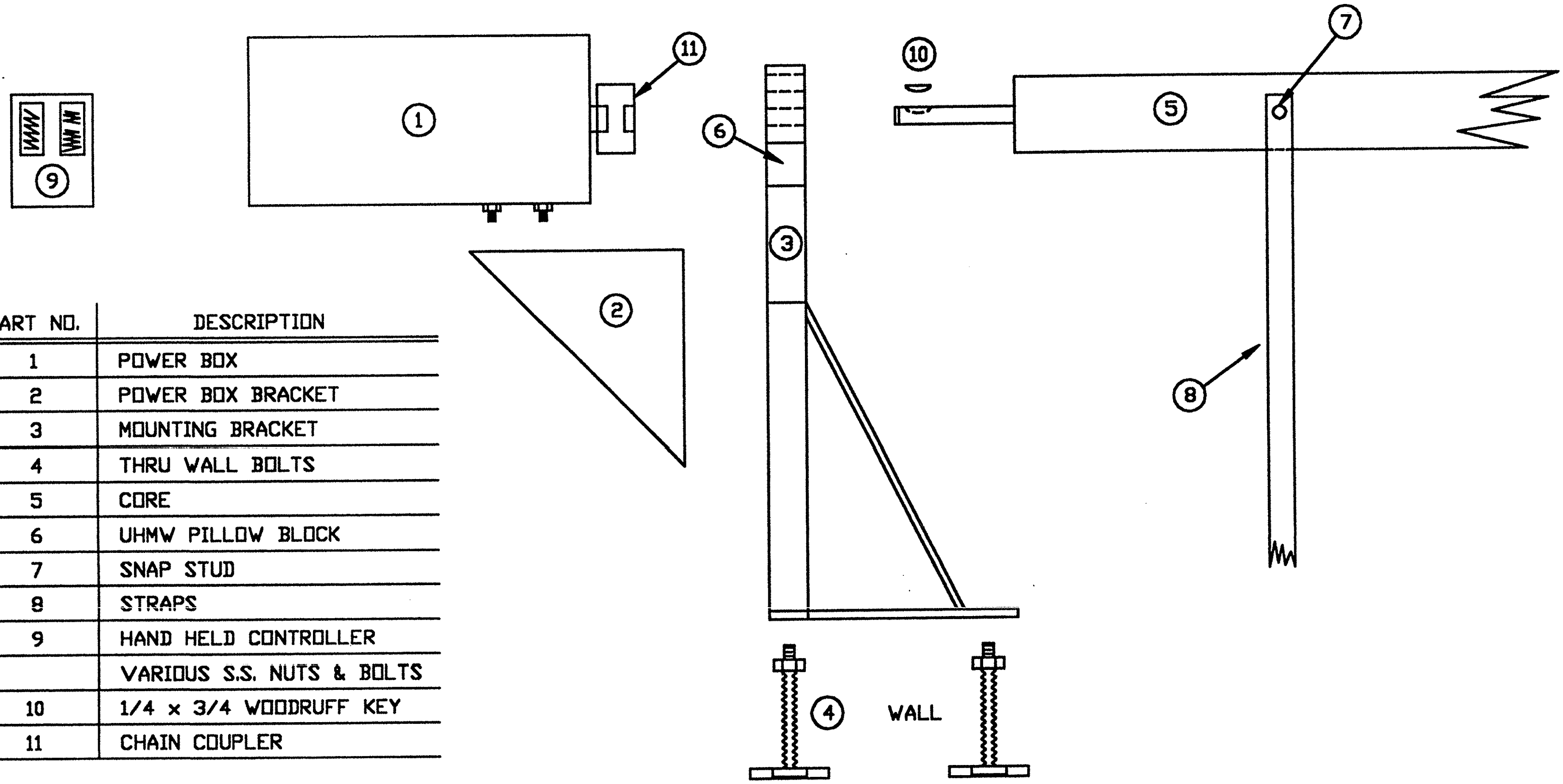
5. Chemical loss will be reduced—adjust accordingly.

6. Make-up water will be reduced—adjust accordingly.

The blanket also reduces or eliminates humidity/condensation, making working conditions in the pool environment more comfortable. Building and fixtures will last longer and require less maintenance. Cleaning time will be reduced—consider switching to main draw only when blanket in on the pool.

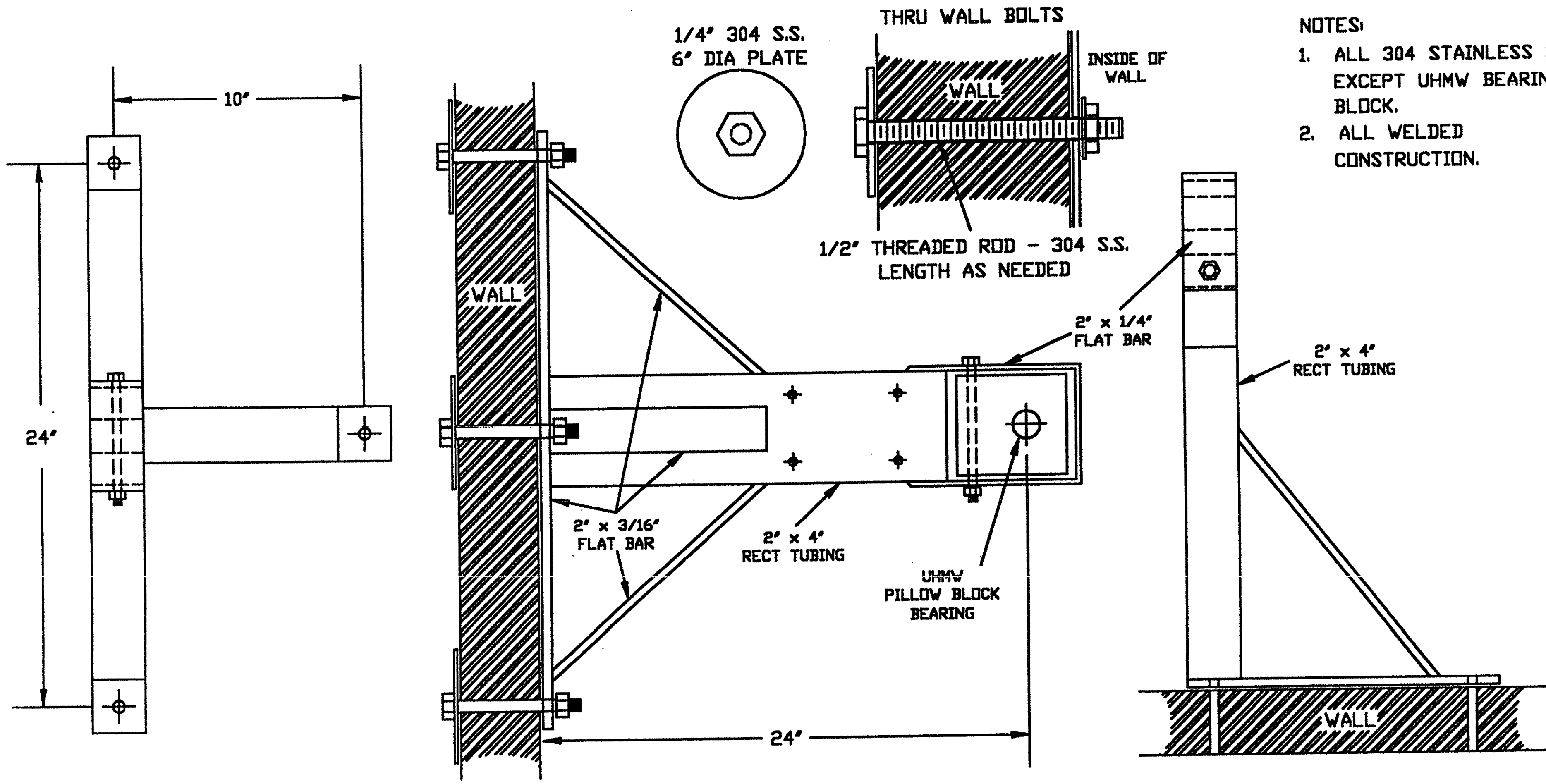


TYPICAL BLANKET TO CORE CONNECTION



PART NO.	DESCRIPTION
1	POWER BOX
2	POWER BOX BRACKET
3	MOUNTING BRACKET
4	THRU WALL BOLTS
5	CORE
6	UHMW PILLOW BLOCK
7	SNAP STUD
8	STRAPS
9	HAND HELD CONTROLLER
	VARIOUS S.S. NUTS & BOLTS
10	1/4 x 3/4 WOODRUFF KEY
11	CHAIN COUPLER

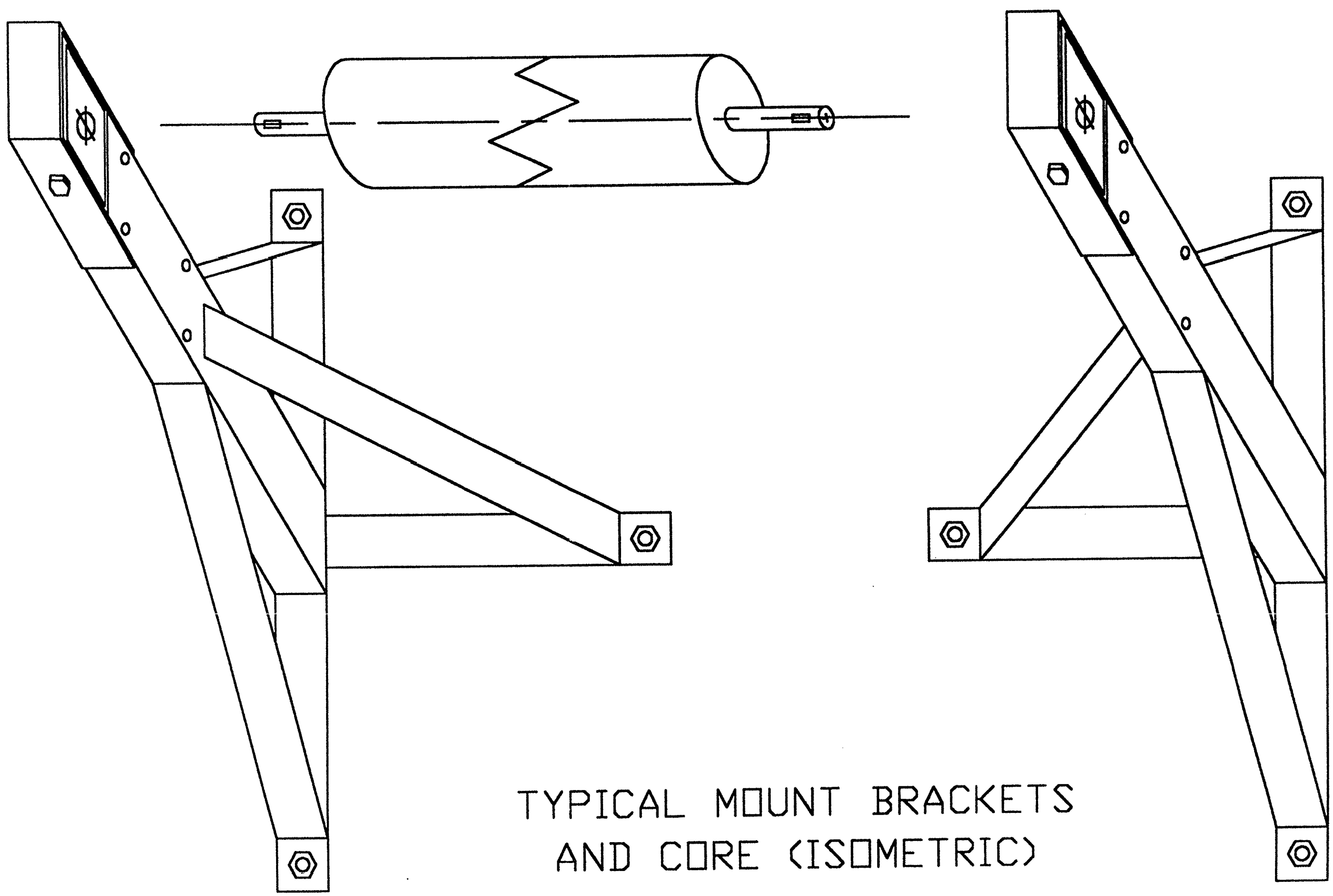
AUTO REEL SCHEMATIC AND PARTS LIST



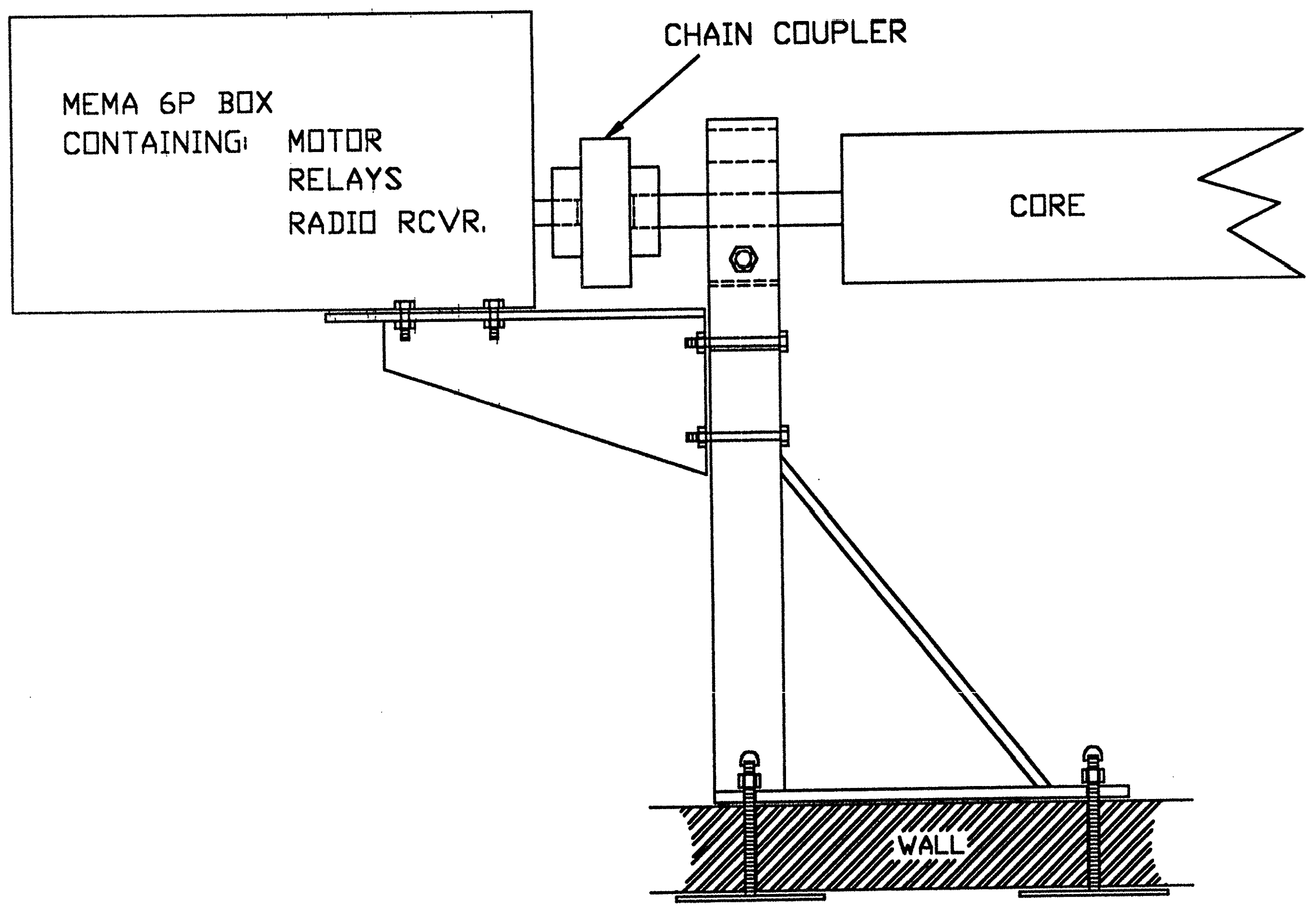
NOTES:

1. ALL 304 STAINLESS STEEL EXCEPT UHMW BEARING BLOCK.
2. ALL WELDED CONSTRUCTION.

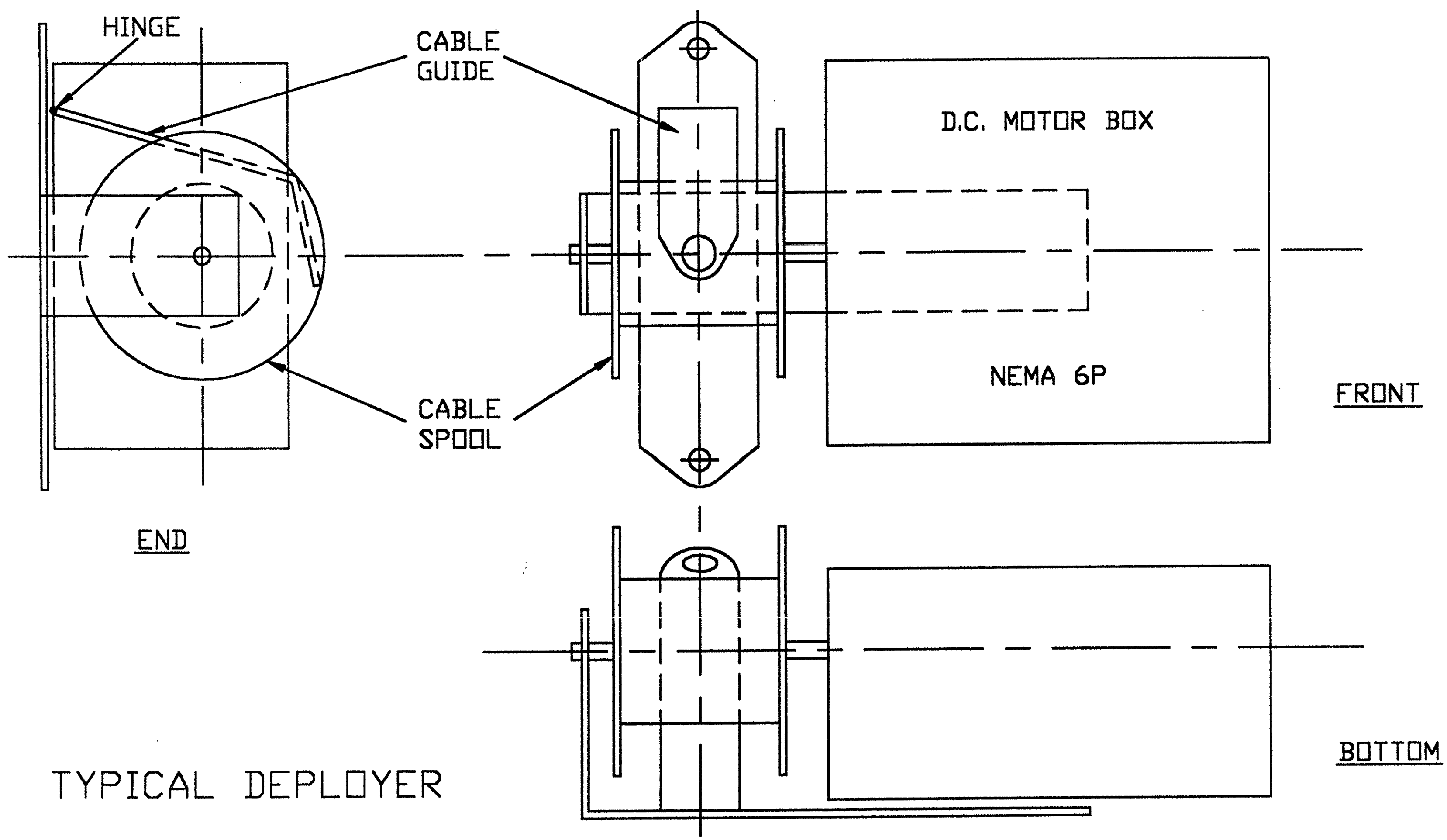
TYPICAL WALL MOUNT BRACKET W/ THRU BOLT



TYPICAL MOUNT BRACKETS
AND CORE (ISOMETRIC)
NOT TO SCALE



TYPICAL WALL MOUNT BRACKET WITH POWER BOX ATTACHED



TYPICAL DEPLOYER

AUTOMATIC REEL SYSTEM

Questions and Answers

1. Q—What are the advantages of a wall mount automatic reel?

A—The wall mount automatic reel system allows you to on/off the blanket easily with one person and it is faster than the deck reels. It also gives you full utilization of your deck space because it is mounted 10 feet up on the wall.

2. Q—Will the auto reel save me more money?

A—Yes and no. Since it is definitely a one person operation, it will save labor on larger pools. The blanket itself, however, is what generates the cost savings due to lower energy (utility) bills. The reel will neither increase nor decrease your energy savings directly.

3. Q—Is it cost effective?

A—The deck reel systems are less expensive and therefore yield a more rapid payoff. The wall mount auto systems are more expensive, but still yield a good payoff. Either way, they are definitely cost effective.

4. Q—Can I put someone else's blanket on the automatic reel?

A—Yes, but why? Seriously, our blankets are designed to work with the auto reel systems and the combination should be maintained.

5. Q—What if I have a problem?

A—The "automatic" portion of the reel can be bypassed to use "manual" operation in case of malfunction. The electrical components are warranted for 5 years so if you have a problem, it is our problem for 5 years. During the 5 years, we'll replace the complete power box or supply you with the parts within 4 days to get the system back in operation. After the 5 years, we'll do the same, but will charge for the parts. All parts are standard, off the shelf items. There is no magic on the parts side.

6. Q—How will it fail?

A—First, it shouldn't. If it does, it will most likely be a relay or radio problem, either of which can be quickly identified and the malfunctioning part easily replaced.

7. Q—Who does the installation?

A—We prefer to do the installation.

8. Q—Who does the electrical work?

A—To assure compliance with local codes, a local electrical contractor should do the wiring. Each reel draws 7.9 AMPS of 110V AC power, so it generally a quick job for the electrician. We suggest a dedicated 20 AMP circuit for each reel.

9. Q—Will my wall hold the system, and what about the bolt holes in the wall?

A—This is something that we cannot answer. Please consult your architect or structural engineer.. We will drill holes and hang the system on the wall where you say it is okay to do so. All holes in the wall are thoroughly caulked and we will gladly work with the architect/structural engineer of your choice.

10. Q—Will the system rust or corrode?

A—No. All metal parts are stainless steel and all the electrical parts are contained in an airtight/watertight/corrosion proof sealed box (NEMA 6P) All openings through the box are gasketed and sealed.

11. Q—How much maintenance is required?

A—All you have to do is keep the straps adjusted correctly.

12. Q—Can the level of automation be upgraded?

A—Yes. It will be less expensive to decide on the level of automation before the initial installation, but upgrades are possible.

WALL MOUNTING
the Reel System

QUESTIONS & CONSIDERATIONS

1. Is the wall strong enough to carry the blanket and reel system?

2. How thick is the wall and are through-wall bolts acceptable as an attachment method?

3. Is the wall flat and what is the wall construction i.e., tile brick, block, sheet rock wood, etc.?

4. What is on the backside of the wall—is it accessible?

5. Please provide pictures (Polaroid is fine) of the wall where the reel system is to be mounted.

6. Note doors, windows, beams and any other structural factors that should be avoided or considered when locating the wall mounted reel system and/or deployer.

WALL MOUNT

AUTOMATIC REEL SPECIFICATIONS

SERIES 7000 - REGULAR AUTO: Wall brackets shall be 2"x 4" rectangular tubing and 3/16" x 2" flat bar, all stainless steel. All structural components shall be welded to commercial standards. Each bracket shall attach to the wall using three (3) ½" stainless steel through-wall bolts.* The reel core shall be all stainless steel with a 4 ½" minimum diameter and .120 wall thickness. Core length shall exceed blanket section width by at least 24" to assure convenient use. The core shall rotate on a 1" stainless steel shaft in a high density plastic bearing block which shall be self-lubricating, self-aligning, and totally non-corrosive to insure free turning with minimum friction. Each reel shall be fitted with 115V gear motor developing 700 in. lbs. torque at 27 RPM and a control system to allow remote operation (see page 21.) Complete power system shall be contained in a NEMA 6P enclosure.

SERIES 7000- HEAVY AUTO: Wall brackets shall be 2"x 4" rectangular tubing and 3/16" x 2" flat bar, all stainless steel. All structural components shall be welded to commercial standards. Each bracket shall attach to the wall using three (3) ½" stainless steel through-wall bolts.* The reel core shall be all stainless steel with a 4 ½" minimum diameter and .120 wall thickness.** Core length shall exceed blanket section width by at least 24" to assure convenient use. The core shall rotate on a 1" stainless steel shaft in a high density plastic bearing block which shall be self-lubricating, self-aligning, and totally non-corrosive to insure free turning with minimum friction. Each reel shall be fitted with 115V gear motor developing 1105 in. lbs. torque at 22 RPM and a control system to allow remote operation (see page 21.) Complete power system shall be contained in a NEMA 6P enclosure.

To assure local code compliance, the customer or the electrician of his choice shall provide final electrical connection for either of the above.

*If through-wall bolts cannot be used, alternate attachment methods are available.

**On blanket sections in excess of 23 feet wide and/or 90 feet long, core shall be 5 9/16" diameter and .109 wall thickness.

DEPLOYER SPECIFICATIONS

Each deployer shall be all stainless steel construction. All structural components shall be welded to commercial standards. Each deployer shall be powered by a DC gear motor which powers a spool onto which a 1/16" stainless cable (aircraft cable) is wound. The deployer shall be electronically connected to the storage reel and operate in unison with the storage reel.

All electrical components shall be contained in a NEMA 6P enclosure.

CONTROL SYSTEM

SPECIFICATIONS
for
Levels of Automation

SEMI-AUTOMATIC: Each reel system shall be fitted with a radio remote control receiver and two (2) hand held controllers (one for daily use and another for backup use.) Radio frequency adjustment shall insure isolated operation. Each hand held controller shall have one "up" and one "down" button.

SEMI-AUTOMATIC with DEPLOYER: Each reel system shall be fitted with a radio remote control receiver and four (4) hand held controllers (two for daily use and 2 others for backup use.) Each hand held controller shall have one "up" or one "down" button. Radio frequency adjustment shall insure simultaneous operation of multiple reel installations.

FULLY AUTOMATIC: Each reel system shall be operated by a control box and a wall mounted push button operator station. Each station shall contain "deploy", "retract" and "manual" control buttons. Each reel system shall have a radio control unit as a backup which is similar to that of semi-automatic with deployer systems. Each control box contains a "smart box" that knows where the blanket is as it goes on or off the pool. The "smart box" also knows where to stop the blanket when fully deployed or retracted.

"HOT-STOP" INSULATING POOL BLANKET

250 SERIES
SPECIFICATIONS

GENERAL REQUIREMENTS:

- The pool blankets shall be sized to exactly fit the pool with a minimum of exposed water.
- Each section of blanket shall be sized for convenient daily operation.
- All material shall be UV, corrosion, mildew, oil and rot resistant.
- All ends and edges shall be reinforced as well as all pull grommets.

SPECIFIC REQUIREMENTS:

Blanket material shall be 2#/CFT closed cell polyethylene foam laminated between one layer of reinforced 10 x 10 polyethylene sheeting and another of 12 x 12 polyethylene sheeting. The two sided foam shall be double sewn, edge to edge, to build the correct size blanket. All ends and edges shall be reinforced, full perimeter, with poly-tape binding which shall be double sewn. Pockets for stiffener bars shall be sewn full width of all blanket sections, at no more than 5 foot intervals down the full length of each blanket section. Blanket shall be warranted for 5 years.

MIMIMUM SPECIFICATIONS:

K factor (per inch)	.25
R factor (per inch)	4.0
Thickness	1/8" +/- 10%
Tensile strength	380 lbs.
Tear strength	77 lbs.
Cold flex	-30 degrees F.
Mesh count	12x12/sq. in. 1080 Denier Top Side 10x10/sq. in. 950 Denier Bottom Side
Weight	1/8" @ 101#/MSF
Burst strength	575 lbs. (Mullen)
Permeability	Non-permeable

WARRANTY

BLANKET: The Series 250 blankets shall remain serviceable for five (5) years. Specifically excluded are vandalism, abusive use and acts of God. Customer obligation shall be limited to freight charges only. **Do not super chlorinate with the blanket on the pool.**

REELS: The reel system structural components shall carry a lifetime warranty. The electrical components shall remain serviceable for five (5) years. Specifically excluded are vandalism, abusive use and acts of God. Customer obligation shall be limited to freight charges only.

CARE and MAINTENANCE

- **DO NOT** super chlorinate with blanket on the pool
- Keep **straps** adjusted to **even lengths**—use buckles to adjust. This adjustment is **vital** and insures a straight roll-up without telescoping.
- Check all nuts and bolts for tightness every six months.

SAFETY

(MUST READ)

- Never swim under the blanket
- Never allow swimming under the blanket
- Never allow swimming while the blanket is on the pool.
- Never allow swimming when *any portion* of the blanket is on the pool.
- Swimming under the blanket will cause drowning.

TROUBLE SHOOTING
REEL SYSTEMS

SEMI-AUTOMATIC with or without DEPLOYER:

1. Check hand held controller for match with power box.
2. Change to backup controllers and/or change batteries.
3. Check power "on" and check other reel systems for operation.
4. If still not working, open cover on power box.
5. If light #1 (inbound power) is not on, no power is reaching the system—check breakers.
6. If light #1 is on, check relays and radio transformer on circuit board for positive seating, and try again.
7. If still not working, system can be operated using "manual" switch. When the manual switch is engaged, light #2 (power to motor) should come on. If system operates, radio is bad, call us for replacement.
8. If light #2 does not come on, in one direction, but does in other direction, the relays are not working—call us for replacements.
9. If light #2 comes on, but the system does not work, the motor/brake are not operating—call us for replacements

SEMI-AUTOMATIC with Deployer:

1. If reel operates up and down, but deployer does not operate <u>at all</u>--replace fuse in control box.
2. If reel operates up and down, but deployer does not have enough "power" to pull blanket across pool—rotate 'C.L.' (current limit) knob on DC circuit board in control box clockwise about $1/100^{th}$ of a turn. Repeat until "power" is adequate—DO NOT OVER ADJUST. (If blanket "sticks" to deck, wind up before adjusting 'C.L.' second time.)

FULLY AUTOMATIC:

1. If the fully automatic reel system will not work, check power supply. If power supply is not the problem, contact us.

CONTACT US AT (800) 624-1235

TO REPLACE POWER BOX

Have certified electrician disconnect power supply to power box.

1. Loosen nuts holding power box to power box bracket—**DO NOT REMOVE**—two turns is enough with a 9/16" wrench.

2. Loosen set screw for woodruff key in chain coupler on core side of one inch shaft—**NOT MOTOR SHAFT SIDE** with a 5/32" allen wrench.

3. Slide power box away from core about ½ inch—this will expose woodruff key.

4. Tap out woodruff key using small hammer or pliers—remove and save.

5. **CAREFULLY** slide core away from power box to clear shaft from chain coupler.

6. Remove nuts using 9/16" wrench holding power box to power box bracket and remove box—it weighs approximately **65 lbs., so BE CAREFUL**.

7. Replace with new power box and reverse procedure to complete installation.

Have certified electrician reconnect power supply to power box.

Appendix 4-11 Ice Arena - Upgrades

www.lamtec.com

LAMTEC®
CORPORATION

WMP-F

POLYPROPYLENE / SCRIM / FOIL

Meets ASTM C1136, Type I, II, III, IV

FACING COMPOSITION	DESCRIPTION	VALUES (ENGLISH)	VALUES (METRIC)
White Film	Polypropylene	0.0015 inch	38.1 micron
Adhesive	Flame Resistant		
Reinforcing	Bi-directional Fiberglass	4 / inch (MD) 4 / inch (XD)	16 / 100 mm (MD) 16 / 100 mm (XD)
Foil	Aluminum	0.0003 inch	7.6 micron

PHYSICAL PROPERTIES	TEST METHOD	VALUES (ENGLISH)	VALUES (METRIC)
Basis Weight	Scale	17 lbs / 1000 ft^2	83 g / m^2
Permeance (WVTR)	ASTM E96 Procedure A	0.02 perm (grains/hr·ft^2·in Hg)	1.15 ng / N·s
Bursting Strength	ASTM D774	90 psi	6.3 kg / cm^2
Puncture Resistance	ASTM C1136	130 beach units	3.9 Joules
Tensile Strength	ASTM C1136	45 lbs/inch width (MD) 45 lbs/inch width (XD)	7.9 kN / m (MD) 7.9 kN / m (XD)
Caliper / Thickness	Micrometer	0.008 inch	203 micron
Accelerated Aging	30 Days @ 95% RH, 120°F (49°C)	No Corrosion No Delamination	No Corrosion No Delamination
Low Temperature Resistance	ASTM D1790 -40°F (-40°C)	Remains Flexible No Delamination	Remains Flexible No Delamination
High Temperature Resistance	4 hours @ 240°F (116°C)	Remains Flexible No Delamination	Remains Flexible No Delamination
Water Immersion	24 hours @ 73°F (23°C)	No Delamination	No Delamination
Mold Resistance	ASTM C665 / C1338	No Growth	No Growth
Dimensional Stability	ASTM D1204	0.25%	0.25%
Emissivity (Foil)	ASTM E408	0.03	0.03
Light Reflectance (Film)	ASTM C523	85%	85%

FIRE TESTING

	ASTM E84 / UL 723		CAN ULC-S102M	
	Film Side	Foil Side	Film Side	Foil Side
Flame Spread	10	5	10	5
Smoke Developed	20	10	20	10

FM APPROVED

c UL us CLASSIFIED

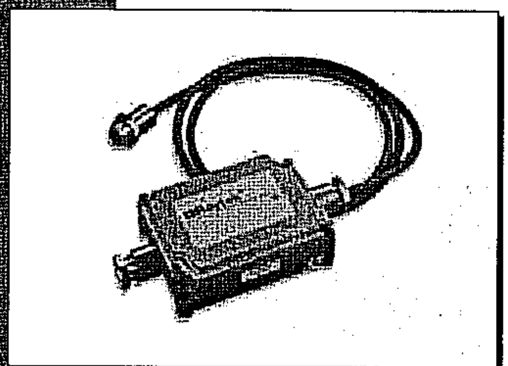
Physical Properties based upon statistical averages, Weight / Thickness +/- 10%

Lamtec Corporation 700 Bartley-Chester Road P.O. Box 37 Flanders, New Jersey 07836-0037 USA

Phone: (973) 584-5500 (800) 852-6832 Fax: (973) 584-5178 (888) 852-6832

MI

Miniature Infrared Sensor



Operating Instructions

Raytek®

Noncontact Temperature Measurement

Rev. E 10/2004
54301

3.4 Environmental Specifications

Ambient Temperature	
MIH sensing head	0 to 180°C (32 to 356°F)
MIC sensing head	0 to 125°C (32 to 257°F)
MID sensing head	0 to 85°C (32 to 185°F)
MID with air cooling	-18 to 200°C (0 to 392°F)
Electronics box	0 to 65°C (32 to 150°F)
Storage Temperature	-18 to 85°C (0 to 185°F)
Rating (Head)	IP 65 (NEMA-4), only for models with an optical resolution of 10:1
Rating (Box)	IP 65 (NEMA-4)
Relative Humidity	10% to 95% non-condensing
EMI	IEC 801-3, level 3 max. cable length 3 m (118 in.)
Vibration (Head)	IEC 68-2-6: 3G's, 11 to 200 Hz, any axis
Shock (Head)	IEC 68-2-27: 50G's, 11 ms, any axis
Weight (Head)	50 g (2 oz.) with 1 m cable, stainless steel
Weight (Box)	270 g (10 oz.), die-cast zinc
Head Cable Material	
MID/MIC	PUR (Polyurethane), Halogen free, Silicone free
MIH	Teflon

Teflon develops poisonous gasses when it comes into contact with flames!

3 Technical Data

3.1 Measurement Specifications

Temperature Range

LT	-40 to 600°C (-40 to 1112°F)
	for J-Thermocouple: -25 to 600°C (-13 to 1112°F)

Spectral Response

LT	8 to 14 µm

Response Time

All models	150 ms (95% response)

Accuracy

LT	± 1% or ± 1°C (± 2°F) whichever is greater
LT	± 2°C (± 4°F) for target temp. < – 20°C (4°F)
TC outputs	± 1% or ± 2.5°C (± 5°F) whichever is greater

At ambient temperature 23°C ±5°C (73°F ±9°F)

Repeatability

All models	± 0.5% or ± 0.5°C (± 1°F) whichever is greater

3.2 Optical Specifications

Optical Resolution D:S

MID, MIC	2:1 or 10:1
MIH	10:1

At 90% energy in minimum and distance 400 mm (15.7 in.)

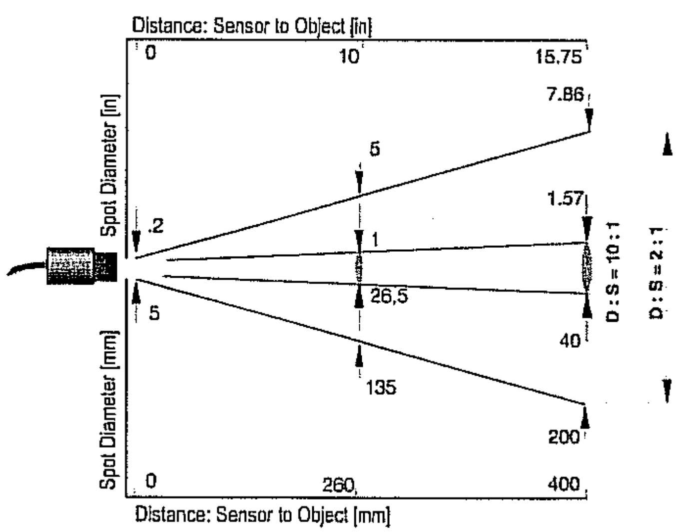


Figure 1: Spot Size Chart

Temperature Resolution

LT	± 0.1 K (± 0.2°F)*
	± 0.25 K (± 0.5°F)**

At ambient temperature 23°C ± 5°C (73°F ± 9°F)

* For a zoomed temperature span of 300°C (600°F)
** For the full temperature range of the unit

Temperature Coefficient

MIC	± 0.05 K per K or ± 0,05% / K whichever is greater, at ambient: 23 to 125°C (73 to 185°F)
MIH	± 0.05 K per K or ± 0,05% / K whichever is greater, at ambient: 23 to 180°C (73 to 356°F)
MIC, MIH	± 0.1 K per K or ± 0.1% per K whichever is greater, at ambient: 0 to 23°C (32 to 73°F)
MID	± 0.15 K per K or ± 0.15% per K whichever is greater, at ambient: 0 to 85°C (32 to 185°F)
Box	± 0.1 K per K or ± 0.1% per K whichever is greater

Thermal Shock (within 20 min.)

LT	± 3.5 K at $\Delta T_{ambient}$ = 25 K (45°F) at target temperature of 50°C (45°F)

Emissivity

All models	0.100 to 1.100

Transmission

All models	0.100 to 1.000

We are pleased to submit on the following:

One (1) Carrier model 30HXC206RA-6--TA Water Cooled Screw Chiller, 460v/3ph, including:

- Triple screw compressors
- Microprocessor controls
- Dual independent refrigerant circuits
- Standard factory charge R134a refrigerant
- Standard pass cooler
- Suction service valves
- Across the line starter
- Factory brine option for chilled water temperatures to 15-deg. F.
- Factory non-fused disconnect
- Control voltage transformer
- Head insulation kit
- Vibration isolation mounting pads
- Condenser water temperature thermisters with wells
- Factory start-up and first year warranty labor
- Complete unit 2-5 year parts and labor warranty

Note on loss of refrigerant warranty coverage – Refrigerant loss from the chiller is only covered if the loss occurs as a result of a catastrophic failure of a component of the chiller covered under warranty and the refrigerant loss occurs over a very short time. An example of a refrigerant loss not covered is a leaking fitting where the refrigerant is lost over a period of weeks or months and no component of the chiller has failed. If a terminal on a compressor goes bad and we loose the charge in a matter of minutes or hours then the refrigerant and the compressor replacement would be covered under warranty.

Date:	Supersedes:	30HXC076-271 WATER-COOLED LIQUID CHILLER	30HXC	Rev: -8SB

JOB NAME:	LOCATION:	
BUYER:	BUYER P.O. #	CARRIER #
UNIT NUMBER:	MODEL NUMBER:	
PERFORMANCE DATA CERTIFIED BY:		DATE:

DESCRIPTION

Packaged water-cooled liquid chillers are factory wired, piped, and charged with HFC-134a.

FEATURES

Cooler is mechanically cleanable shell-and-tube type with removable heads. It is tested and stamped in accordance with ASME Code for a refrigerant working side pressure of 235 psig (1620 kPa) and a minimum water side pressure of 300 psig (2068 kPa) (250 psig [1720 kPa] in Canada).

Compressor is semi-hermetic twin screw design with refrigerant gas cooled motor and integral oil filter and discharge gas muffler.

Complete thermal and electrical protection is provided.

Water-cooled condenser is mechanically cleanable shell-and-tube type with removable heads and is tested and stamped in accordance with ASME Code for a refrigerant working side pressure of 235 psig (1620 kPa) and a minimum water side pressure of 300 psig (2068 kPa) (250 psig [1720 kPa)] in Canada).

Each refrigerant circuit includes oil separator, high side pressure relief device, liquid and discharge line shutoff valve, filter drier, moisture indicating sight glass, expansion valve.

Microprocessor control includes keypad, system status (including temperatures, pressures and % loading) and the alarm conditions.

Automatic circuit lead/lag.

Capacity control based on leaving chilled water temperature with return water temperature sensing.

7-day time scheduling of pump(s) and chiller.

30 Series Chillers Performance Summary

Project Name: Untitled — 1/4/2008
Company Name: Carrier Northeast — 3:18:04 PM

	Untitled
Location	
Buyer P.O.	
Date	1/4/2008
Version 2.92	
Unit Size	30HXC206***6****
Capacity, Tons	125.2
Compressor Input Power, kw	138.0
Unit Input Power, kw	138.0
Capacity control steps	8
Minimum Capacity, %	13.0
Input kw/Ton	1.102
Unit EER	10.89
Refrigerant	R134a
Cooler Data	
Fluid Type	Calcium chloride
Fluid concentration, %	21.0
Fluid Entering Temperature, °F	19.6
Fluid Leaving Temperature, °F	15.0
Fluid Flow Rate, gpm	750.0
Fluid Pressure Drop, ft wg	37.2
Fluid Velocity, ft/s	7.9
Fouling Factor, (hr-sqft-F)/Btu	0.0001
Foul. Fact. Temp. Adj., °F	.31
Saturated Suction Temp., °F	
Circuit A	13.6
Circuit B	12.8
Outside Surface Area, sqft	418.9
Condenser Data	
Fluid Type	Propylene glycol
Fluid concentration, %	40.0
Fluid Entering Temperature, °F	75.0
Fluid Leaving Temperature, °F	84.3
Fluid Flow Rate, gpm	450.0
Fluid Pressure Drop, ft wg	14.2
Fluid Velocity, ft/s	4.6
Fouling Factor, (hr-sqft-F)/Btu	0.00025
Foul. Fact. Temp. Adj., °F	.94
Saturated Discharge Temp., °F	
Circuit A	88.2
Circuit B	90.2
Outside Surface Area, sqft	445.9
Factory Options	
Flow Control Type	EXV
Chiller Electrical Data	
Nameplate Voltage, volts	460
Elec. Power Frequency, hertz	60
Minimum circuit amps	263
MOCP, amps	350
Max Instant. Current Flow (ICF), amps	819

50° Ambient
- Chiller

30 Series Chillers Performance Summary

Project Name: Untitled
Company Name: Carrier Northeast

1/4/2008
3:18:04 PM

Factory Installed Options

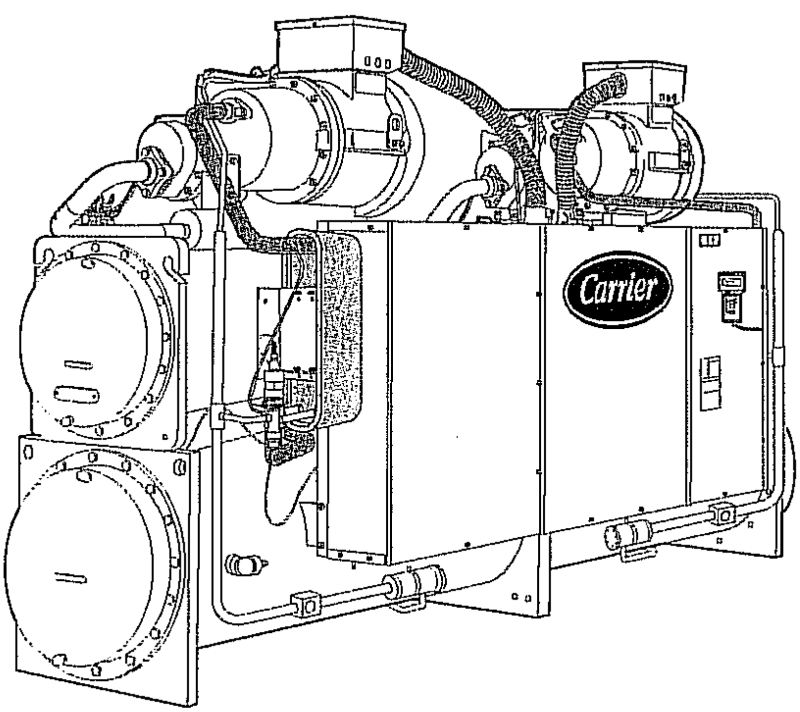
Suction Service Valve	Yes
Evaporator Passes	Standard
Condenser Passes	Standard
Start option	Across the line
Minimum load control	None
Control transformer	Field installed
ARI Rating	Outside the scope of ARI Standard 550/590-2003.

Product Data

30HXA,HXC076-271 Condenserless and Water-Cooled Liquid Chillers 50/60 Hz

75 to 265 Tons (264 to 931 kW)

ComfortLink™



ASHRAE 90.1 COMPLIANT

Water-cooled and condenserless chillers designed from the ground up to meet the needs of today and tomorrow:
- Unit fits through a standard door with no disassembly required
- Chlorine-free HFC-134a refrigerant
- Dual independent refrigerant circuits
- Smooth compression using twin screw compressors
- ARI certified efficiencies to 0.53 kW/ton

Features/Benefits

Quality design and construction make the 30HXC (Water-Cooled) and 30HXA (Condenserless) units the preferred choice

Easy installation

The 30HX chiller has a compact design that fits through a standard door opening and requires minimal indoor space. The 30HX chiller is delivered as a complete package for easy installation. There are no extra controls, clocks, starters, or other items to install.

The 30HX unit also provides a single location electrical power entrance (using the accessory field-installed control power transformer) and quick, easy piping (using victaulic-type clamp-on couplings).

The 30HX 208/230-v, 230-v, 460-v and 575-v units are designed in accordance with UL (Underwriters' Laboratory, U.S.A.) and UL, Canada (Underwriters' Laboratory, Canada) standards to minimize electrical inspection time.

A quick start-up is assured once installation is complete, since each 30HX unit is manufactured at an ISO 9001:2000 listed manufacturing facility to guarantee quality. In addition, all 30HXC units are tested under load at the factory to provide reliable start-up.

NOTE: Units shipped with optional nitrogen charge are tested for proper operation of the electrical components but are not run-tested at the factory.

Easy operation

The 30HX units have a quiet, low-vibration design featuring screw compressors.

Efficiency levels of the 30HX units meet or exceed energy efficiency requirements of ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) 90.1-2001 and CSA (Canadian Standards Association) for both full-load and part-load operation, thus saving on operating costs through lower electrical costs. All 30HX units are also rated in accordance with ARI (Air Conditioning and Refrigeration Institute, U.S.A.) standards. The 60 Hz 30HXC units are ARI certified.

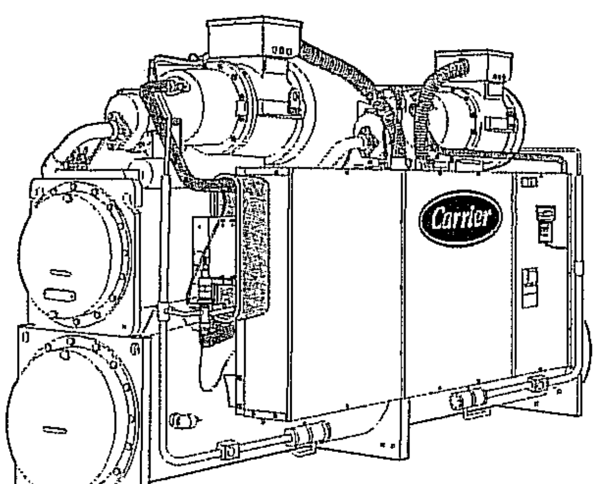
The 30HX controls are fully automatic. The leaving-fluid temperature is directly controlled to within .5° F (.3° C), and the entering-fluid temperature is continuously monitored to detect load and flow changes.

Dual, independent refrigerant circuits provide reliable, dependable cooling, and the 30HX units use medium-pressure HFC-134a refrigerant to minimize stress on the compressors and ensure a long life.

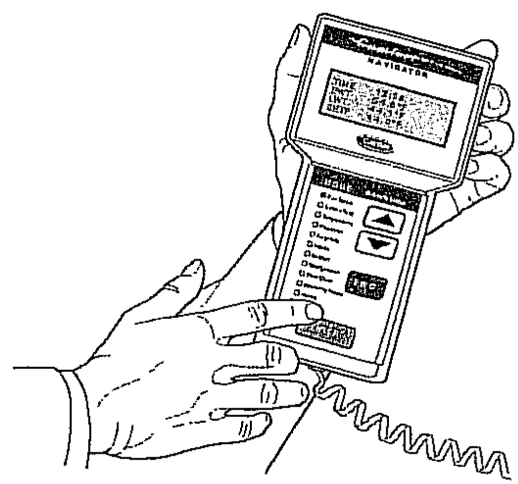
From a service standpoint, the 30HX units offer the following features:

- Use of HFC-134a refrigerant, which has no planned phase-out in its future
- Mechanically cleanable cooler and condenser (30HXC units)
- Twin-screw compressors, which require no routine service or maintenance
- Easily accessed service information includes suction and discharge pressure and temperature using standard Navigator™ display module
- All parts are available through Totaline parts stores.

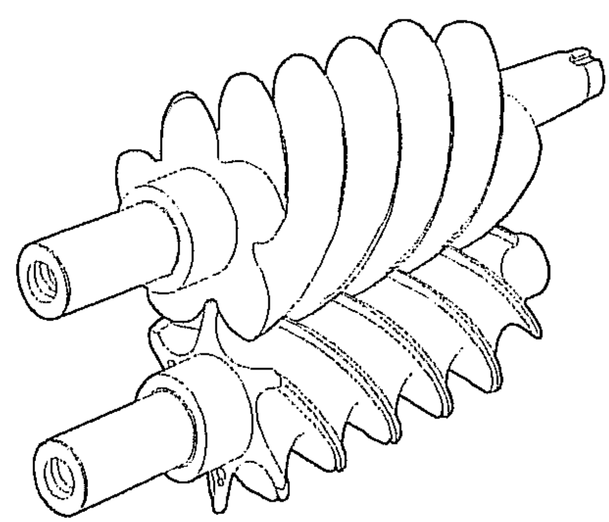
DUAL INDEPENDENT REFRIGERANT CIRCUITS



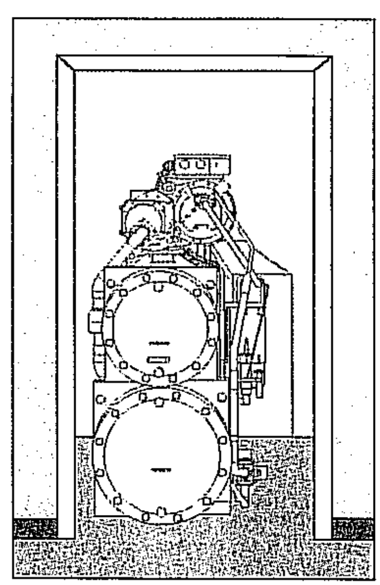
NAVIGATOR IN DISPLAY MODE



TWIN-SCREW COMPRESSOR DESIGN



FITS THROUGH STANDARD DOORWAY



ARI* capacity ratings

30HXC WATER-COOLED CHILLER ARI RATINGS (60 Hz ONLY)

UNIT SIZE 30HXC	CAPACITY		INPUT POWER (kW)	COOLER FLOW		COOLER PRESSURE DROP		CONDENSER FLOW		CONDENSER PRESSURE DROP		FULL-LOAD EFFICIENCY (kW/Ton)	IPLV† (kW/Ton)
	Tons	Output kW		GPM	L/s	Ft of Water	kPa	GPM	L/S	Ft of Water	kPa		
076	75.4	265.2	53.7	181.0	11.4	12.6	37.7	226.2	14.3	8.0	23.9	0.712	0.512
086	83.1	292.3	60.4	199.4	12.6	15.1	44.9	249.3	15.7	9.6	28.6	0.727	0.523
096	94.0	330.5	67.0	225.5	14.2	14.9	44.6	281.9	17.8	9.9	29.4	0.713	0.513
106	104.3	366.8	75.3	250.3	15.8	13.4	40.1	312.9	19.7	12.0	35.7	0.722	0.521
116	113.6	399.4	79.9	272.6	17.2	11.7	34.9	340.7	21.5	15.3	45.5	0.703	0.509
126	123.0	432.6	86.8	295.2	18.6	13.5	40.3	369.0	23.3	17.7	52.7	0.706	0.509
136	136.5	479.9	97.0	327.5	20.7	12.8	38.3	409.4	25.8	16.7	49.9	0.711	0.527
146	145.9	513.2	105.1	350.2	22.1	14.5	43.3	437.8	27.6	19.0	56.5	0.720	0.533
161	156.5	550.6	111.7	375.7	23.7	12.0	35.7	469.6	29.6	19.4	57.9	0.714	0.520
171	165.9	585.3	118.2	398.1	25.1	13.3	39.6	497.6	31.4	15.9	47.4	0.712	0.538
186	177.2	623.1	126.7	426.2	26.8	12.1	36.2	531.6	33.5	18.0	53.7	0.715	0.562
206	211.6	744.0	146.4	507.7	32.0	12.8	38.2	634.7	40.0	19.0	56.7	0.692	0.510
246	248.6	874.1	172.4	596.5	37.6	14.1	42.1	745.7	47.0	20.1	59.9	0.693	0.522
261	257.2	904.6	180.5	617.3	38.9	15.0	44.8	771.6	48.7	21.4	63.9	0.702	0.523
271	267.4	940.3	189.5	641.7	40.5	16.1	48.0	802.1	50.6	23.0	68.7	0.709	0.525

LEGEND

IPLV — Integrated Part-Load Value

*Air Conditioning and Refrigeration Institute (U.S.A.).
†IPLV shown is the lower of Sequence A or Sequence B unloading.

NOTES:

1. Rated (60 Hz only) in accordance with ARI Standard 550/590-98 at standard rating conditions.
2. Standard rating conditions are as follows:
   Cooler Conditions:
   Leaving Water Temperature: 44 F (6.7 C)
   Flow: 2.4 gpm per ton (0.043 L/s per kW)
   Condenser Conditions:
   Entering Water temperature: 85 F (29.4 C)
   Flow: 3.0 gpm per ton (0.054 L/s per kW)
   Fouling Factor (Cooler):
   0.00010 hr x sq ft x F per Btuh (0.000018 m^2 x K per W)
   Fouling Factor (Condenser):
   0.00025 hr x sq ft x F per Btuh (0.000044 m^2 x K per W)
3. IPLV is a single number part-load efficiency value calculated from the system full-load efficiency values and corrected for a typical building air-conditioning application.
4. All data in this table is rated (60 Hz only) in accordance with ARI Standard 550/590-98 as represented in the ECOLOGIC™ Chiller Selection Program (E-Cat) version 2.80.
5. Contact Carrier for custom ratings.

Rated in accordance with ARI Standard 550/590-98.

60 Hz only

ASHRAE 90.1 COMPLIANT

ENGLISH (cont)

UNIT SIZE 30HX	161	171	186	206	246	261	271
UNIT OPERATING WEIGHT (lb)							
Water-Cooled (HXC)	7452	7660	7854	10,581	10,969	10,992	11,029
Condenserless (HXA)	5752	5777	5946	7,485	7,621	7,621	7,621
COMPRESSORS	Semi-Hermetic, Twin Screw						
Quantity	2	2	2	3	3	3	3
Nominal Capacity per Compressor (tons)	80/56	66/80	80/80	66/39/80	80/56/80	80/66/80	80/80/80
Economizer	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Capacity Steps							
Standard	6	6	6	8	8	8	8
Optional (maximum)	8	8	8	11	11	11	11
Minimum Step Capacity (%)							
Standard	20	20	20	13	13	13	13
Optional	10	10	10	7	7	7	7
REFRIGERANT	R-134a						
Charge* (lb) Circuit A/Circuit B	157/110	119/140	135/135	220/135	220/135	220/135	220/135
COOLER TYPE	Shell and Tube with Enhanced Copper Tubes						
Part No. 10HX400-	601	611	621	631	632	632	632
Net Fluid Volume (gal)	28.5	28.5	33.4	43.1	47.2	47.2	47.2
Maximum Refrigerant Pressure (psig)	220	220	220	220	220	220	220
Maximum Water-Side Pressure (psig)	300	300	300	300	300	300	300
Water Connections							
Inlet and Outlet (in.) (Standard Pass)	5	5	5	6	6	6	6
Drain (NPT) (Standard Pass)	3/8	3/8	3/8	3/8	3/8	3/8	3/8
Relief Valve							
Connection (in. NPTF)	3/4	3/4	3/4	3/4	3/4	3/4	3/4
Flow Capacity (lb air/min)	31.7	31.7	31.7	31.7	31.7	31.7	31.7
Relief Setting (psig)	220	220	220	220	220	220	220
Standard Number of Passes	2	2	2	2	2	2	2
30HXA OIL SEPARATOR							
Part No. 09RX400-	215	214	214	213	213	213	213
Maximum Refrigerant Pressure (psig)	320	320	320	320	320	320	320
Refrigerant Connections (in.)							
Discharge Circuit A/B	2 1/8/2 1/8	2 1/8/2 1/8	2 1/8/2 1/8	2 1/8/2 1/8	2 1/8/2 1/8	2 1/8/2 1/8	2 1/8/2 1/8
Liquid Circuit A/B	1 3/8/1 3/8	1 3/8/1 3/8	1 3/8/1 3/8	1 5/8/1 3/8	1 5/8/1 3/8	1 5/8/1 3/8	1 5/8/1 3/8
Relief Valve							
Connection (in. SAE Flare)	5/8	5/8	5/8	5/8	5/8	5/8	5/8
Flow Capacity (lb air/min)	21.6	21.6	21.6	21.6	21.6	21.6	21.6
Relief Setting (psig)	320	320	320	320	320	320	320
CONDENSER (HXC)	Shell and Tube with Enhanced Copper Tubes						
Part No. 09RX400-	261	262	262	263	264	264	264
Net Fluid Volume (gal)	30.6	37.6	37.6	47.6	55.1	55.1	55.1
Maximum Refrigerant Pressure (psig)	220	220	220	220	220	220	220
Maximum Water-Side Pressure (psig)	300	300	300	300	300	300	300
Water Connections (in.)	Victaulic Type Connection						
Inlet and Outlet (Standard Pass)	6	6	6	8	8	8	8
Drain (NPT) (Standard Pass)	3/8	3/8	3/8	3/8	3/8	3/8	3/8
Relief Valve							
Connection (in. NPTF)	3/4	3/4	3/4	3/4	3/4	3/4	3/4
Flow Capacity (lb air/min)	31.7	31.7	31.7	31.7	31.7	31.7	31.7
Relief Setting (psig)	220	220	220	220	220	220	220
Standard Number of Passes	2	2	2	2	2	2	2
DISCHARGE LINE†							
Relief Valve							
Connection (in. SAE Flare)	3/8	3/8	3/8	3/8	3/8	3/8	3/8
Flow Capacity (lb air/min)	6.3	6.3	6.3	6.3	6.3	6.3	6.3
Setting (psig)	350	350	350	350	350	350	350

LEGEND

NPTF — National Pipe Thread Female
SAE — Society of Automotive Engineers

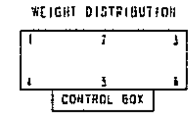
*Charges listed are for 30HXC units. The 30HXA units are shipped with a holding charge only. To determine the refrigerant charge requirements for 30HXA units see the System Refrigerant Charge for Start-Up table in the Application Data on page 28.
†Only on units with factory-installed suction service valves.

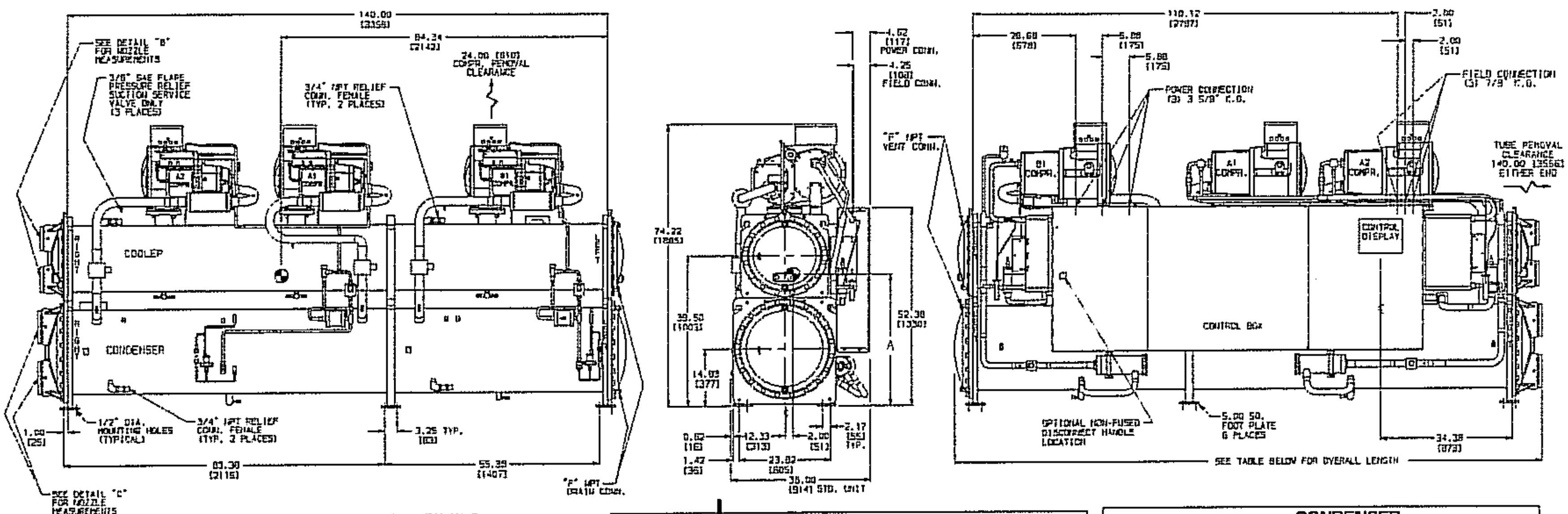
Dimensions (cont)

30HXC206-271

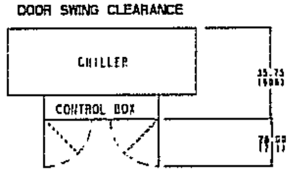
UNIT	OPERATING WEIGHT - lb (kg)	A	WGT DISTRIBUTION AT EACH MTG PLATE - lb (kg)					
			1	2	3	4	5	6
30HXC206	10581 (4799)	33.88 (860)	948 (430)	2406 (1091)	1243 (564)	1201 (545)	3133 (1421)	1650 (748)
30HXC246	10969 (4976)	34.38 (873)	985 (447)	2515 (1141)	1306 (592)	1154 (523)	3276 (1486)	1733 (786)
30HXC261	10992 (4986)	34.38 (873)	985 (447)	2520 (1143)	1311 (595)	1154 (523)	3283 (1489)	1739 (789)
30HXC271	11029 (5003)	34.38 (873)	985 (447)	2529 (1147)	1318 (598)	1154 (523)	3294 (1494)	1749 (793)

NOTES:
1. Operating weight includes weight of water and refrigerant.
2. ⊕ Denotes center of gravity.
3. Dimensions are in inches (mm).
4. Recommended service clearance around machine is 36 in. (914.4 mm).
5. Victaulic nozzles are standard on all models. Flow switch factory installed in cooler outlet victaulic nozzle.



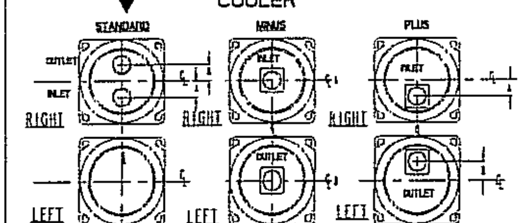


DOOR SWING CLEARANCE



OVERALL LENGTH TABLE		
COOLER	CONDENSER	OVERALL LENGTH
STANDARD COOLER	STANDARD CONDENSER	152.54 [3875]
STANDARD COOLER	MINUS ONE PASS CONDENSER	160.00 [4064]
PLUS ONE PASS COOLER	STANDARD CONDENSER	160.00 (4064]
PLUS ONE PASS COOLER	MINUS ONE PASS CONDENSER	160.00 [4064]
MINUS ONE PASS COOLER	STANDARD CONDENSER	160.00 (4064]
MINUS ONE PASS COOLER	MINUS ONE PASS CONDENSER	160.00 [4064]

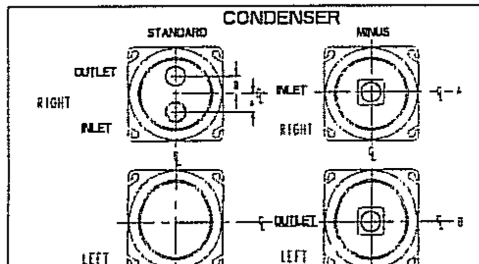
COOLER



UNIT		A	B	F	NUMBER OF PASSES	CONNECTION SIZE
30HXC206,246,261,271	STD	[illegible]	[illegible]	3/8"	2	6"
30HXC206,246,261,271	MINUS	0.00	0.00	3/4"	1	6"
30HXC206,246,261,271	PLUS	[illegible]	[illegible]	3/4"	3	6"

DETAIL "B"

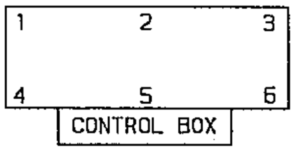
CONDENSER



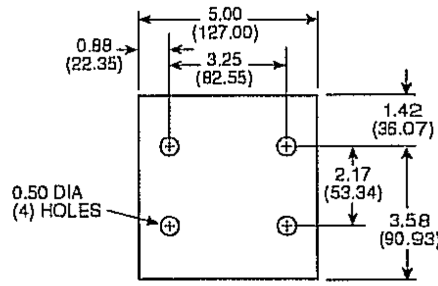
UNIT		A	B	NUMBER OF PASSES	CONNECTION SIZE
30HXC206,246,261,271	STD	[illegible]	[illegible]	2	6"
30HXC206,246,261,271	MINUS	9.00	0.00	1	6"

DETAIL "C"

WEIGHT DISTRIBUTION AT MOUNTING PLATES



WEIGHT DISTRIBUTION AT EACH MOUNTING PLATE



NOTE: Dimensions shown in Inches (mm).

30HX FOOT

30HXC UNITS — lb (kg)

UNIT 30HXC	MOUNTING PLATE NO.					
	1	2	3	4	5	6
076	738 (335)	943 (428)	595 (270)	1110 (503)	1418 (643)	896 (406)
086	738 (335)	947 (430)	597 (271)	1112 (504)	1427 (647)	902 (409)
096	686 (311)	968 (439)	693 (314)	1027 (466)	1447 (656)	1034 (469)
106	730 (331)	1028 (466)	744 (337)	1073 (487)	1510 (685)	1092 (495)
116	728 (330)	1114 (505)	777 (352)	1053 (478)	1615 (733)	1127 (511)
126	738 (335)	1127 (511)	780 (354)	1061 (481)	1628 (738)	1131 (513)
136	758 (344)	1176 (533)	811 (368)	1083 (491)	1689 (766)	1171 (531)
146	763 (346)	1182 (536)	815 (370)	1085 (492)	1697 (770)	1172 (532)
161	817 (371)	1272 (577)	908 (412)	1219 (553)	1890 (857)	1346 (610)
171	936 (425)	1318 (598)	840 (381)	1379 (626)	1946 (883)	1241 (563)
186	962 (436)	1361 (617)	860 (390)	1410 (640)	1996 (905)	1265 (574)
206	948 (430)	2406 (1091)	1243 (564)	1201 (545)	3133 (1421)	1650 (748)
246	985 (447)	2515 (1141)	1306 (592)	1154 (523)	3276 (1486)	1733 (786)
261	985 (447)	2520 (1143)	1311 (595)	1154 (523)	3283 (1489)	1739 (789)
271	985 (447)	2529 (1147)	1318 (598)	1154 (523)	3294 (1494)	1749 (793)

30HXA UNITS — lb (kg)

UNIT 30HXA	MOUNTING PLATE NO.					
	1	2	3	4	5	6
076	555 (252)	793 (360)	418 (190)	926 (420)	1326 (601)	699 (317)
086	555 (252)	798 (362)	418 (190)	928 (421)	1340 (608)	705 (320)
096	509 (231)	808 (367)	493 (224)	848 (385)	1350 (612)	827 (375)
106	555 (252)	869 (394)	541 (245)	896 (406)	1410 (640)	880 (399)
116	530 (240)	895 (406)	540 (245)	855 (388)	1456 (660)	887 (402)
126	540 (245)	905 (410)	541 (245)	864 (392)	1468 (666)	887 (402)
136	548 (249)	926 (420)	555 (252)	873 (396)	1498 (679)	908 (412)
146	551 (250)	930 (422)	555 (252)	883 (400)	1506 (683)	908 (412)
161	560 (254)	965 (438)	598 (271)	954 (433)	1650 (748)	1025 (465)
171	627 (284)	968 (439)	534 (242)	1072 (486)	1658 (752)	918 (416)
186	648 (294)	1004 (455)	552 (250)	1110 (504)	1703 (772)	939 (426)
206	671 (304)	1702 (772)	879 (399)	850 (385)	2216 (1005)	1167 (529)
246	681 (309)	1748 (793)	911 (413)	797 (362)	2276 (1032)	1209 (548)
261	681 (309)	1748 (793)	911 (413)	797 (362)	2276 (1032)	1209 (548)
271	681 (309)	1748 (793)	911 (413)	797 (362)	2276 (1032)	1209 (548)

NOTE: See pages 11-18 for center of gravity details.

Application data

Unit location

Unit should be level (particularly in its major lengthwise dimension) to assure proper oil return.

The unit should be located indoors in an area of temperature greater than 50 F (10 C).

Good acoustic design practice should be followed, i.e., unit should not be located adjacent to sound-sensitive areas unless appropriate consideration has been made.

Cooler fluid temperature

1. *Maximum* leaving water (fluid) temperature (LWT) is 60 F (21 C). Unit can start and pull down with up to 95 F (35 C) entering water (fluid) temperature due to MOP (maximum operating pressure) feature of the expansion valve. For sustained operation, it is recommended that entering fluid temperature not exceed 70 F (21.1 C).
2. *Minimum* LWT is 40 F (4.4 C) for standard units. The brine option is required for operation with leaving fluid temperatures in the range of 39 to 12 F (4 to –9 C). For ratings below 40 F (4.4 C) LWT, contact your local Carrier representative.
3. *Minimum* entering water (fluid) temperature (EWT) is 45 F (7.2 C). *Maximum* EWT is 70 F (21.1 C).

Leaving-fluid temperature reset

The accessory reset sensor can be applied to the chiller to provide reset of in LWT constant fluid flow systems. Reset reduces compressor power usage at part load when design LWT is not necessary. Humidity control should be considered, since higher coil temperatures resulting from reset will reduce latent heat capacity. Three reset applications are offered:

From return-fluid temperature — Increases LWT set point as return (or entering) fluid temperature decreases (indicating load decrease). Reset from return fluid may be used in any application where return fluid provides accurate load indication. Limitation of return-fluid reset is that the LWT may only be reset to value of design return-fluid temperature. No additional hardware is required.

From outdoor-air temperature — Increases LWT as outdoor ambient temperature decreases (indicating load decrease). This reset should be applied only where outdoor ambient temperature is an accurate indication of load. A field-supplied thermistor is required.

From occupied space temperature — Increases LWT as space temperature decreases (indicating load decrease). This reset should be applied only where space temperature is an accurate indication of load. A field-supplied thermistor is required.

Temperature can also be reset using a 4 to 20 mA signal from the control system. This type of reset requires the Energy Management Module Accessory.

Condenser fluid temperature

1. *Maximum* leaving condenser fluid temperature is 105 F (40.5 C) on all 30HXC units.
2. *Standard* 30HXC units will start at entering condenser fluid temperatures above 55 F (12.8 C). In general, however, continuous machine operation with entering condenser fluid temperatures below 70 F (21.1 C) is not recommended. When the entering condenser fluid temperature is expected to drop below 70 F (21.1 C), it is recommended that some form of condenser flow control be used to optimize performance. Tower pump, bypass valves, or flow regulating valves may be controlled by a 4 to 20 mA output from the 30HXC control (60-second open to close time recommended for actuator).

Cooler and water-cooled condenser temperature rise

Ratings and performance data in this publication are for a cooling temperature rise of 10° F (5.6° C). Units may be operated at a different temperature rise, provided flow limits are not exceeded and corrections to capacity, etc., are made. For minimum flow rates, see the Minimum Flow Rates table. High flow rate is limited by pressure drop that can be tolerated.

Minimum cooler flow — Flow (maximum cooler temperature rise) is shown in the Minimum Flow Rates table. Minimum flow rate must be maintained to prevent fouling. When gpm (L/s) required is lower (or rise is higher), follow recommendations below:

1. Multiple smaller chillers can be applied in series, each providing a portion of the design temperature rise.
2. Chilled fluid can be recirculated to raise flow rate. However, mixed temperature entering cooler must be maintained at a minimum of at least 5° F (2.8° C) above the leaving chilled fluid temperature.
3. Special plus one-pass cooler can be used. Contact your Carrier representative for further information.

Maximum cooler flow (> 5 gpm/ton or < 5° F rise [> 0.09 L/s · kW or < 2.7° C rise]) — Maximum flow results in practical maximum pressure drop through cooler. Special minus-one-pass cooler can be used to reduce pressure drop. Contact your Carrier representative.

Return fluid can bypass the cooler to keep pressure drop through cooler within acceptable limits. This permits a higher ΔT with lower fluid flow through cooler and mixing after the cooler. Contact your Carrier representative if pressure drop appears excessive.

Variable cooler flow rates — These variable rates may be applied to standard 30HX series chillers. However, the unit will attempt to maintain a constant leaving chilled-fluid temperature. In such cases, minimum fluid loop volume must be in excess of 3 gal per ton (3.2 L per kW) and flow rate must change in steps of less than 10% per minute. Apply 6 gal per ton (6.5 L per kW) fluid loop volume minimum if flow rate changes more rapidly.

Minimum water-cooled condenser flow — This value (maximum rise) is shown in Minimum Flow Rates table. Ensure leaving-fluid temperature does not exceed 105 F (40.5 C).

MINIMUM FLOW RATES

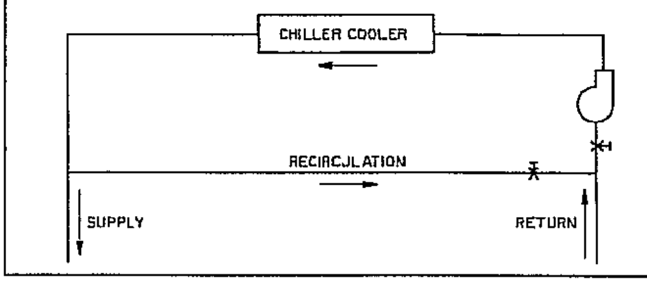
DEVICE	UNIT SIZE 30HX	COOLER No. of Passes	COOLER Type	MIN. FLOW RATE* GPM	MIN. FLOW RATE* L/s	COOLER TEMP DIFFERENCE F	COOLER TEMP DIFFERENCE C
COOLER	076	2	Minus 1	136.0	8.6	13	7.4
		3	Standard	90.0	5.7	20	11.1
		4	Plus 1	68.0	4.3	27	14.8
	086	2	Minus 1	149.0	9.4	13	7.4
		3	Standard	100.0	6.3	20	11.1
		4	Plus 1	75.0	4.7	27	14.8
	096	2	Minus 1	169.0	10.7	13	7.4
		3	Standard	113.0	7.1	20	11.1
		4	Plus 1	85.0	5.3	27	14.8
	106	2	Minus 1	188.0	11.8	13	7.4
		3	Standard	125.0	7.9	20	11.1
		4	Plus 1	94.0	5.9	27	14.8
	116	1	Minus 1	272.0	17.2	10	5.6
		2	Standard	136.0	8.6	20	11.1
		3	Plus 1	91.0	5.7	30	16.7
	126	1	Minus 1	295.0	18.6	10	5.6
		2	Standard	147.0	9.3	20	11.1
		3	Plus 1	98.0	6.2	30	16.7
	136	1	Minus 1	327.0	20.7	10	5.6
		2	Standard	164.0	10.3	20	11.1
		3	Plus 1	109.0	6.9	30	16.7
	146	1	Minus 1	350.0	22.1	10	5.6
		2	Standard	175.0	11.0	20	11.1
		3	Plus 1	117.0	7.4	30	16.7
	161	1	Minus 1	376.0	23.7	10	5.6
		2	Standard	188.0	11.9	20	11.1
		3	Plus 1	125.0	7.9	30	16.7
	171	1	Minus 1	399.0	25.2	10	5.6
		2	Standard	199.0	12.6	20	11.1
		3	Plus 1	133.0	8.4	30	16.7
	186	1	Minus 1	426.0	26.9	10	5.6
		2	Standard	213.0	13.4	20	11.1
		3	Plus 1	142.0	9.0	30	16.7
	206	1	Minus 1	508.0	32.1	10	5.6
		2	Standard	254.0	16.0	20	11.1
		3	Plus 1	169.0	10.7	30	16.7
	246	1	Minus 1	597.0	37.7	10	5.6
		2	Standard	309.0	18.8	20	11.1
		3	Plus 1	199.0	12.6	30	16.7
	261	1	Minus 1	618.0	39.0	10	5.6
		2	Standard	309.0	19.5	20	11.1
		3	Plus 1	206.0	13.0	30	16.7
	271	1	Minus 1	642.0	40.5	10	5.6
		2	Standard	321.0	20.3	20	11.1
		3	Plus 1	214.0	13.5	30	16.7
CONDENSER	076,086	2	—	105	6.6	—	—
	096,106	2	—	135	8.5	—	—
	116,126	2	—	170	10.7	—	—
	136,146	2	—	195	12.3	—	—
	161	2	—	235	14.8	—	—
	171,186	2	—	255	16.1	—	—
	206	2	—	273	17.2	—	—
	246	2	—	333	21.0	—	—
	261	2	—	333	21.0	—	—
	271	2	—	333	21.0	—	—

*Based on 20 F (11.1 C) temperature difference at ARI conditions.

NOTES:

1. The 30HX units will start with loop temperatures up to 95 F (35 C).
2. Minimum flow rate shown is based on ARI Ratings and is for reference only. **20 F (11.1 C) is the maximum cooler temperature differential that will determine actual minimum flow rate.**
3. To obtain proper temperature control, loop fluid volume must be at least 3 gal/ton (3.23 L/kW) of chiller nominal capacity for air conditioning and at least 6 gal/ton (6.5 L/kW) for process applications.

RECIRCULATION FLOW



Oversizing chillers

Oversizing chillers by more than 15% at design conditions must be avoided as the system operating efficiency will be adversely affected (resulting in greater and/or excessive electrical demand and cycling of compressors). When future expansion of equipment is anticipated, install a single chiller to meet present load requirements, and install a second chiller to meet the additional load demand.

It is also recommended that the installation of 2 smaller chillers be considered where operation at minimum load is critical. The operation of 2 small chillers at higher loading is preferred to operating a single chiller at or near its minimum recommended value.

The minimum load control accessory should not be used as a means to allow oversizing chillers. Minimum load control should be given consideration where substantial operating time is anticipated below the minimum unloading step.

Parallel chillers

Where chiller capacities greater than can be supplied by a single 30HX chiller are required, or where stand-by capability is desired, chillers may be installed in parallel. Units may be of the same or different sizes. However, cooler and condenser flow rates must be balanced to ensure proper flow to each chiller. The standard 30HX *Comfort*Link™ control can be configured to provide lead/lag control for two chillers. The accessory Chillervisor™ System Manager III control may be used for proper leaving chilled fluid temperature control and to ensure proper staging sequence of up to 8 chillers. Refer to the accessory Chillervisor System Manager III installation instructions for further details.

Series chillers

Chillers in series may be used for capacities greater than those supplied by a single 30HX chiller. Using the Minus-One-Pass Cooler Head option, fluid pressure drop across the cooler can be held to reasonable levels. The leaving fluid temperature sensors need not be relocated. However, the cooler minimum entering fluid temperature limitations should be considered for the chillers located downstream of other chillers. The standard 30HX control can control two 30HX chillers in series. Condensers should be piped in parallel to maximize capacity and efficiency. This should also minimize condenser pressure drop and saturated condensing temperatures. However, if condensers are piped in series, ensure that the leaving fluid temperature does not exceed 105 F (40.5 C).

Energy management

Demand limiting and load shedding are popular techniques used to reduce peak electric demands typically experienced during hot summer days when air conditioning loads are highest. When utility electricity demands exceed a certain level, electrical loads are turned off to keep the peak demands below a prescribed maximum limit. Compressor unloading reduces electrical demand while allowing the chiller to operate under part-load capacity and to maintain partial chilled fluid cooling.

Electrical demand can be limited through demand limit input to chiller control which unloads the chiller to a predetermined percentage of the load. One stage of unloading can be initiated by a remote signal to significantly reduce the chiller power consumption. This power reduction applies to the full load power at nominal conditions. The demand limit control should not be cycled less than 10 minutes on and 5 minutes off.

Duty cycling

Duty cycling will cycle an electrical load at regular intervals, regardless of electrical demand. This reduces the electrical demand by "fooling" demand measuring devices. Duty cycling of the entire compressor is **NOT** recommended since motor windings and bearings will be damaged by constant cycling.

Wye-delta start

Wye-delta start is standard on 30HX 208/230-v, 60-Hz units and 230-v, 50-Hz units and optional on all other 30HX units. This feature is not always required on 30HX units due to the use of multiple compressors that allow small electrical load increments, but is available if required. Maximum instantaneous current flow (see ICF in Electrical Data tables on pages 59-62) should be used in determining need.

Vibration isolation

External vibration isolators are available as field-installed accessories.

Strainers

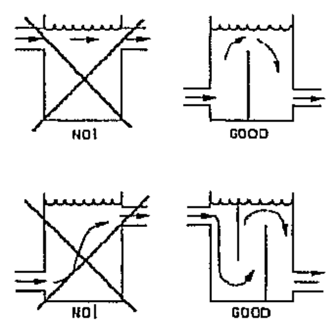
A strainer with a minimum screen size of 20 mesh must be installed in both the cooler and condenser fluid lines, within 10 ft (3 m) of the inlets to both the cooler and condenser. For 30HXA units, this requirement applies only to the cooler.

Chilled fluid loop volume

The chilled fluid loop volume in circulation must equal or exceed 3 gal per nominal ton of cooling (3.2 L per kW) for temperature stability and accuracy in normal air conditioning applications. For example, a 30HXC096 with a nominal capacity of 94.0 tons would require 282 gal (1067.4 L) in circulation in the system loop.

For process jobs where accuracy is vital, or for operation at ambient temperatures below 32 F (0° C) with low unit loading conditions, there should be from 6 to 10 gal per ton (6.5 to 10.8 L per kW). To achieve this volume, it is often necessary to install a tank in the loop. Tank should be baffled to ensure there is no stratification, and that water (or brine) entering the tank is adequately mixed with liquid in the tank. See Tank Installation drawing.

TANK INSTALLATION



Fouling factor

The factor used to calculate tabulated ratings for the cooler is 0.00010 $ft^2 \cdot hr \cdot F/Btu$ (0.000018 $m^2 \cdot K/W$), and for the condenser is 0.00025 $ft^2 \cdot hr \cdot F/Btu$ (0.00044 $m^2 \cdot K/W$). As fouling factor is increased, unit capacity decreases and compressor power increases. To determine selections at other fouling factors, use the chiller program in the electronic catalog.

Cooler and water-cooled condenser freeze protection

If chiller refrigerant or fluid lines are in an area where ambient conditions fall below 32 F (0° C), it is recommended that an antifreeze solution be added to protect the unit and fluid piping to a temperature 12° F (6.7° C) below the lowest anticipated temperature. For corrections to performance, refer to the chiller program in the electronic catalog.

Use only antifreeze solutions approved for heat exchanger duty. Use of automotive antifreezes is not recommended because of the fouling that can occur once their relatively short-lived inhibitors break down.

If the system will not be used during freezing weather conditions and the chiller and fluid piping are not protected with an antifreeze solution, it is recommended that the chiller and outdoor piping be drained.

Refer to Cooler Fluid Temperature section, page 21, for leaving fluid temperature for brine units. When leaving chilled fluid temperatures will be lower than 40 F (4.4 C), an appropriate antifreeze solution must be used in the cooler. In addition, the following special installation instructions will apply:

1. In addition to the factory-mounted chilled water flow switch, a field-supplied condenser water flow switch must be installed.
2. The chiller must control both the chilled water pump and the condenser pump. The cooler pump must operate for a minimum of 10 minutes after the chiller has shut down and the condenser pump must operate for a minimum of 30 minutes after the chiller has shut down. In the event of a loss of condenser water flow, the flow of chilled fluid to the evaporator must be stopped or the isolation valve must be closed. This is necessary to reduce the possibility of condenser freeze-up.

Application data (cont)

3. Condenser head pressure control valves must not reduce condenser flow below 0.75 gallons per ton (0.4 L/s per kW) or the lowest detectable flow level of the condenser water flow switch. For further information, refer to the 30HX Installation Instructions or contact your Carrier representative.

30HXA remote condenser requirements

1. Do not manifold independent refrigerant circuits into a single condenser circuit.
2. Ensure each refrigerant circuit has its own head pressure control.
3. Condensing pressure control must be provided on condensers used with 30HXA to maintain a minimum 75 F (24 C) saturated discharge temperature at light loads.
4. Condenser must provide 15° F (8.3° C) subcooling, a maximum of 40° F (22.2° C) difference between saturated condensing temperature and outdoor ambient temperature (to prevent overload at high ambient temperatures), and a minimum of 20° F (11.1° C) difference (to assure subcooling).
5. Minimum saturated discharge temperature (SDT) is 90 F (32.2 C). Maximum SDT is 135 F (57.2 C) at full load.
6. Condenser should not be located more than 15 ft (4.6 m) below chiller to maintain subcooling.
7. Design discharge and liquid piping according to Carrier System Design Manual. Piping must be sized for HFC-134a. Refer to the ASHRAE Refrigeration Handbook for R-134a sizing tables. Also see 30HX Installation instructions and the Typical 30HXA Refrigerant Piping to Remote Condenser diagrams on page 29.
8. Maximum interconnecting refrigerant line length is 200 ft (61 m) actual.
9. Liquid line solenoid valves are required.
10. If accessory sound enclosure is installed, run lines along the floor so the sound enclosure can be notched to clear lines.

Refrigerant pipe sizing for 30HXA with Carrier 09D condenser combinations — For refrigerant pipe sizing of the 30HXA follow these directions:

Discharge line:

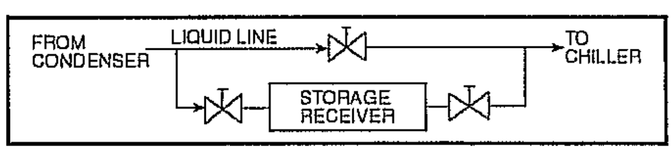
1. For applications at conditions of 40 F (4.4 C) or higher, use the Refrigerant Line Sizes for 30HXA Chiller/09DK Condenser Combinations tables on pages 25 and 26.

   For applications using brine, other condensers, or LWT below 40 F (4.4 C), size lines using the ASHRAE Refrigeration Handbook, or other suitable design guide.
2. Install horizontal lines level or pitched slightly toward the base of discharge riser and the condenser (in the direction of flow).
3. If chiller is below the condenser, loop the discharge line to at least one inch (25.4 mm) above the top of condenser.
4. A double discharge riser (as shown in Refrigerant Line Sizes, Double Discharge Riser Pipe Sizes table on page 26) is required if any of the following conditions exist:
   a. Unit is equipped with minimum load control.
   b. Chiller is located below condenser.
   c. Discharge line size is in shaded area in Refrigerant Line Sizes, Recommended Refrigerant Pipe Sizes table on page 25.
5. Minimize line length and restrictions to minimize pressure drop and refrigerant charge.
6. If accessory sound enclosure is applied, run lines along the floor so sound enclosure may be notched to clear lines.
7. Lines should not be buried underground.

Liquid line:

1. For applications at conditions of 40 F (4.4 C) or higher LWT, use the Refrigerant Line Sizes for 30HXA Chiller/09DK Condenser Combinations tables on pages 25 and 26.

   For applications using brine, other condensers, or LWT below 40 F (4.4 C), size lines using the ASHRAE Refrigeration Handbook, or other suitable design guide.
2. If chiller is above condenser, maximum vertical separation is 15 ft (4.6 m).
3. Minimize line length and restrictions to minimize pressure drop and refrigerant charge.
4. Field-supplied liquid line solenoid valves are required. The solenoid valves must be located close to the chiller.
5. If sound enclosure is applied, run lines along floor so sound enclosure may be notched to clear lines.
6. In-line receivers are NOT recommended due to their negative effect on system subcooling. Where the use of a receiver is desired for service purposes, the receiver should be piped in parallel with the main liquid line and equipped with shut-off valves to isolate it during unit operation. See sketch below.
7. Filter driers (field supplied) are required.



Relief valve vent lines

1. Vent per local code requirements.
2. Each chiller has a minimum of 4 refrigerant relief valves: 2 on the cooler, 2 on the condenser (30HXC) or oil separator (30HXA). Units with factory-installed suction service valves also have one relief valve on each compressor discharge line. See Dimensions section on pages 11-18 for specific locations.
3. If sound enclosure is applied, run lines along floor so sound enclosure may be notched to clear lines.

Electrical data (cont)

ELECTRICAL DATA, 30HXC UNITS (cont)

UNIT 30HXC	UNIT VOLTAGE V-Hz (3 Ph)	UNIT VOLTAGE Supplied Min	UNIT VOLTAGE Supplied Max	POWER SUPPLY QTY. REQD.	NO. POWER SUPPLY CONDUCTORS	UNIT VOLTAGE MCA	UNIT VOLTAGE MOCP	ICF XL	ICF WD	Rec Fuse Size XL	Rec Fuse Size WD	CONTROL CIRCUIT V-Hz (Single Ph)	CONTROL CIRCUIT Supplied Min	CONTROL CIRCUIT Supplied Max	CONTROL CIRCUIT MCA and MOCP
	230-60	207	253	1	6	428.4	600	—	604.5	—	500	115-60	104	127	15
	208/230-60	187	253	1	6	476.0	700	—	623.6	—	600	115-60	104	127	15
	460-60	414	506	1	3	215.0	300	771.1	302.1	250	250	115-60	104	127	15
171	575-60	518	633	1	3	171.8	250	616.8	241.8	200	200	115-60	104	127	15
	380-60	342	418	1	3	260.2	350	861.2	343.2	300	300	230-60	207	254	15
	380/415-50	342	440	1	3	266.6	350	961.8	375.8	300	300	230-50	198	254	15
	230-50	207	253	1	6	440.4	600	—	606.8	—	500	230-50	207	254	15
	230-60	207	253	1	6	462.3	600	—	638.5	—	600	115-60	104	127	15
	208/230-60	187	253	1	6	513.7	700	—	661.3	—	600	115-60	104	127	15
	460-60	414	506	1	3	232.0	300	788.1	319.1	300	300	115-60	104	127	15
186	575-60	518	633	1	3	185.4	250	630.4	255.4	225	225	115-60	104	127	15
	380-60	342	418	1	3	280.8	400	881.8	363.8	350	350	230-60	207	254	15
	380/415-50	342	440	1	3	289.4	400	984.6	398.6	350	350	230-50	198	254	15
	230-50	207	253	1	6	478.1	600	—	644.5	—	600	230-50	207	254	15
	230-60	207	253	1	6	524.5	700	—	700.7	—	600	115-60	104	127	15
	208/230-60	187	253	1	6	582.8	800	—	730.4	—	700	115-60	104	127	15
	460-60	414	506	1	3	263.2	350	819.3	350.3	300	300	115-60	104	127	15
206	575-60	518	633	1	3	210.4	250	655.4	280.4	250	250	115-60	104	127	15
	380-60	342	418	1	3	318.6	400	919.6	401.6	350	350	230-60	207	254	15
	380/415-50	342	440	1	3	326.8	450	1022.0	436.0	400	400	230-50	198	254	15
	230-50	207	253	1	6	539.8	700	—	706.2	—	600	230-50	207	254	15
	230-60	207	253	1	6	604.1	800	—	780.3	—	700	115-60	104	127	15
	208/230-60	187	253	1	6	671.3	800	—	818.9	—	800	115-60	104	127	15
	460-60	414	506	1	3	303.2	400	859.3	390.3	350	350	115-60	104	127	15
246	575-60	518	633	1	3	242.3	300	687.3	312.3	300	300	115-60	104	127	15
	380-60	342	418	1	3	367.0	450	968.0	450.0	400	400	230-60	207	254	15
	380/415-50	342	440	1	3	377.6	500	1072.8	486.8	450	450	230-50	198	254	15
	230-50	207	253	1	6	623.8	800	—	790.2	—	700	230-50	207	254	15
	230-60	207	253	1	6	633.8	800	—	810.0	—	700	115-60	104	127	15
	208/230-60	187	253	1	6	704.3	800	—	851.9	—	800	115-60	104	127	15
	460-60	414	506	1	3	318.1	400	874.2	405.2	350	350	115-60	104	127	15
261	575-60	518	633	1	3	254.2	300	699.2	324.2	300	300	115-60	104	127	15
	380-60	342	418	1	6	385.0	500	986.0	468.0	450	450	230-60	207	254	15
	380/415-50	342	440	1	6	395.2	500	1090.4	504.4	450	450	230-50	198	254	15
	230-50	207	253	1	6	652.9	800	—	819.3	—	800	230-50	207	254	15
	230-60	207	253	1	6	667.8	800	—	843.9	—	800	115-60	104	127	15
	208/230-60	187	253	1	6	742.0	800	—	889.6	—	800	115-60	104	127	15
	460-60	414	506	1	3	335.1	400	891.2	422.2	400	400	115-60	104	127	15
271	575-60	518	633	1	3	267.8	350	712.8	337.8	300	300	115-60	104	127	15
	380-60	342	418	1	6	405.6	500	1006.6	488.6	450	450	230-60	207	254	15
	380/415-50	342	440	1	6	418.0	500	1113.2	527.2	500	500	230-50	198	254	15
	230-50	207	253	1	6	690.6	800	—	857.0	—	800	230-50	207	254	15

LEGEND

- **ICF** — Maximum Instantaneous Current Flow during start-up (the point in the starting sequence where the sum of the LRA for the start-up compressor, plus the total RLA for all running compressors is at a maximum)
- **LRA** — Locked Rotor Amps
- **MCA** — Minimum Circuit Ampacity (for wire sizing)
- **MOCP** — Maximum Overcurrent Protection
- **RLA** — Rated Load Amps
- **WD** — Wye-Delta Start
- **XL** — Across-the-Line Start

NOTES:

1. Each main power source must be supplied from a field-supplied fused electrical service with a (factory-installed or field-installed) disconnect located in sight from the unit.
2. Control circuit power must be supplied from a separate source through a field-supplied disconnect (except for 380/415-50 units). An accessory control transformer may be used to provide control circuit power from the main unit power supply.
3. Maximum incoming wire size for each terminal block is 500 kcmil.
4. Maximum allowable phase imbalance is: voltage, 2%; amps, 5%.
5. Use copper conductors only.
6. The MOCP is calculated as follows:

   MOCP = (2.25) (largest RLA) + the sum of the other RLAs. Size the fuse one size down from the result. The RLAs are listed on the nameplate.

   The recommended fuse size in amps (RFA) is calculated as follows:

   RFA = (1.50) (largest RLA) + the sum of the other RLAs. Size the fuse one size up from the result. The RLAs are listed on the nameplate.

Controls

The standard microprocessor-based control in the 30HX units provides the following functions:

- leaving fluid temperature control (using both entering and leaving fluid sensors)
- 7-day time sequence of both pump and chiller
- temperature reset from return fluid (standard) or from outdoor ambient (accessory), occupied space temperature (accessory), 4 to 20 mA signal (accessory), or via the optional Carrier Comfort Network (CCN)
- automatic compressor lead-lag switching based on compressor accumulated run times and number of cycles
- automatic temperature range across the cooler adjustment
- fully automatic control of the chiller components

A 4-line, 20-character per line display is used to accomplish the following (see figure below):

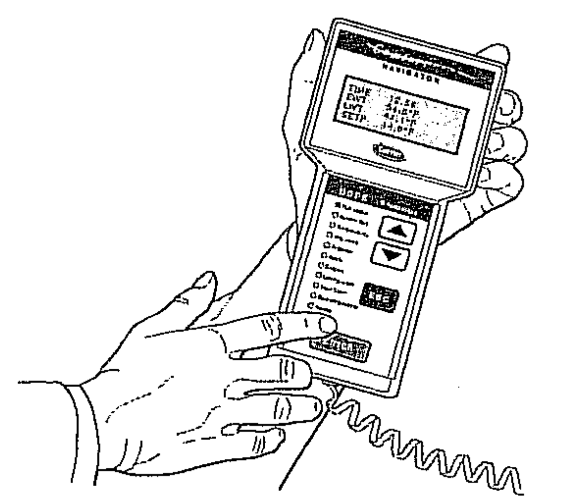
- set schedules and set points
- identify operating mode
- display current temperatures and pressures being used by the control for internal calculations
- identify abnormal (alarm or alert) conditions

Sequence of operation

The control has a 44 F (6.2 C) leaving fluid temperature (LWT) set point as shipped from the factory. If temperature reset or demand limiting is in effect, this set point may change.

Start-up — The chiller will start when the circulating pump is energized. (If the flow switch is applied, the chiller starts after the flow has been proven.) The compressor starts unloaded.

NAVIGATOR™ DISPLAY MODULE — STANDARD



NOTE: Which compressor starts first is determined by the automatic lead/lag feature.

If the entering fluid temperature is 85 F (29 C) or higher, the maximum operating pressure (MOP) feature limits the suction pressure to keep the chiller on line.

Normal operation — The entering fluid temperature sensor monitors changes in entering fluid temperature to anticipate changes in the cooling load. Based on leaving fluid temperature, the control adds or subtracts capacity to maintain a constant leaving fluid temperature.

Dual chiller control — The Dual Chiller Routine is available for the control of two units supplying chilled fluid on a common loop.

In parallel flow applications, an additional leaving fluid temperature thermistor must be installed and connected to the lead chiller.

Transition to off — The chiller unloads once the "time-to-stop" signal has been given. This signal can be either internal or external.

Safeties — The 30HX control as shipped from the factory automatically deenergizes any active compressor that experiences any of the following:

- electrical overload
- thermal overload protection
- high pressure
- low oil pressure
- loss of refrigerant charge
- loss of phase protection
- reverse rotation (control prevents compressor start)
- current imbalance
- ground current
- low chilled fluid temperature

Additional information

Detailed information on controls and operation is available in the Controls, Start-Up, Operation and Troubleshooting guide included with each unit. Packaged Service Training programs are also available. Contact your Carrier representative for more information.

Guide specifications

Water-Cooled and Condenserless HVAC Guide Specifications

Size Range: **75 to 265 Tons (264 to 931 kW)**

Carrier Model Number: **30HXA — Condenserless**
30HXC — Water-Cooled

Part 1 — General

1.01 SYSTEM DESCRIPTION

Microprocessor controlled water-cooled (30HXC) or condenserless (30HXA) liquid chiller utilizing screw compressors and electronic expansion valves.

1.02 QUALITY ASSURANCE

A. Unit shall be rated in accordance with ARI Standard 550/590-98 (U.S.A.). The 60 Hz 30HXC units shall be ARI certified for performance.

B. Unit construction shall comply with ASHRAE 15 Safety Code, NEC, and ASME applicable codes (U.S.A. codes).

C. Unit shall be manufactured at an ISO 9001:2000 registered facility.

D. 208/230 v, 230 v, 460 v, 575 v, 60 Hz units shall be constructed in accordance with UL or UL Canada standards and shall be tested and listed by ETL or ETL, Canada, as conforming to those standards. Units shall carry the ETL and ETL, Canada, labels.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unit controls shall be capable of withstanding 150 F (66 C) storage temperatures in the control compartment.

B. Unit shall be stored and handled per unit manufacturer's recommendations.

Part 2 — Products

2.01 EQUIPMENT

A. General:

Factory assembled, single-piece, water-cooled (30HXC) or condenserless (30HXA) liquid chiller with dual (2) independent refrigerant circuits. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge (HFC-134a) (30HXA units shipped with holding charge only), and special features required prior to field start-up.

B. Compressors:

1. Semi-hermetic twin-screw compressors with internal muffler and check valve.
2. Each compressor shall be equipped with a discharge shutoff valve.

C. Cooler (Evaporator):

1. Shall be tested and stamped in accordance with ASME Code (U.S.A.) for a refrigerant working-side pressure of 220 psig (1408 kPa). Waterside pressure rating shall be 300 psig (2068 kPa). In Canada, maximum waterside pressure shall be 250 psig (1725 kPa), per the Canadian National Registry.
2. Shall be mechanically cleanable shell-and-tube type with removable heads.
3. Tubes shall be internally enhanced, seamless-copper type, and shall be rolled into tube sheets.
4. Shall be equipped with Victaulic fluid connections.
5. Shell shall be insulated with $^3/_4$-in. (19-mm) closed-cell, polyvinyl chloride foam with a maximum K factor of 0.28. Heads may require field insulation.
6. Shall have a cooler drain and vent.
7. Design shall incorporate 2 independent refrigerant circuits.
8. Shall include isolation valves to allow isolation of the refrigerant charge in either the evaporator or the condenser.
9. Shall be equipped with factory-installed thermal dispersion chilled fluid flow switch.

D. Condenser (30HXC units):

1. Shall be tested and stamped in accordance with ASME code (U.S.A.) for a refrigerant working-side pressure of 220 psig (1408 kPa). Waterside pressure rating shall be 300 psig (2068 kPa). In Canada, maximum waterside pressure shall be 250 psig (1725 kPa), per the Canadian National Registry.
2. Shall be mechanically cleanable shell-and-tube type with removable heads.
3. Tubes shall be internally enhanced, seamless-copper type, and shall be rolled into tube sheets.
4. Shall be equipped with Victaulic water connections.
5. Design shall incorporate 2 independent refrigerant circuits.

E. Oil Separator (30HXA Units):

1. Shall be tested and stamped in accordance with ASME Code (U.S.A.) for a refrigerant working-side pressure of 320 psig (2206 kPa).
2. Design shall incorporate 2 independent refrigerant circuits.

F. Refrigeration Components:

Refrigerant circuit components shall include oil separator, high and low side pressure relief devices, discharge and liquid line shutoff valves, filter drier, moisture indicating sight glass, expansion valve, refrigerant economizer (unit sizes 161-271), and complete charge of compressor oil. The 30HXC units shall have a complete operating charge of refrigerant HFC-134a; 30HXA units shall have a holding charge only.

G. Controls, Safeties, and Diagnostics:

1. Controls:

   a. Unit controls shall include the following minimum components:

      1) Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
      2) Power and control circuit terminal blocks.
      3) ON/OFF control switch.
      4) Replaceable solid-state relay panels.
      5) Thermistor installed to measure saturated condensing temperature, cooler saturation temperature, compressor return gas temperature, and cooler entering and leaving fluid temperatures.
      6) Chilled fluid flow switch.

   b. Unit controls shall include the following functions as standard:

      1) Automatic circuit lead/lag.
      2) Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature setpoint accuracy to 0.1 ° F (0.06° C).
      3) Limiting the chilled fluid temperature pull-down rate at start-up to an adjustable range of 0.2° F to 2° F (0.11° C to 1.1° C) per minute to prevent excessive demand spikes at start-up.
      4) Seven-day time schedule.
      5) Leaving chilled fluid temperature reset from return fluid, outdoor-air temperature, space temperature, or 4 to 20 mA input.
      6) Demand limit control with 2-stage control (0 to 100% each) or through 4 to 20 mA input (0 to 100%).
      7) Chilled and condenser water pump start/stop control.
      8) Dual chiller control for series chiller applications without addition of hardware modules or additional thermistors.
      9) Dual chiller control for parallel flow applications use one additional sensor.
      10) Amperage readout per compressor with %MTA per compressor.

   c. The control panel shall include, as standard, a portable hand held display module with a minimum of 4 lines and 20 characters per line, of clear English, Spanish, Portuguese or French language. Display menus shall provide clear language descriptions of all menu items, operating modes, configuration points and alarm diagnostics. Reference to factory codes shall not be accepted. An industrial grade coiled extension cord shall allow the display module to be moved around the chiller. Magnets shall hold the display module to any sheet metal panel to allow hands-free operation. Display module shall have NEMA 4x housing suitable for use in outdoor environments. Display shall have back light and contrast adjustment for easy viewing in bright sunlight or night conditions. The display module shall have raised surface buttons with positive tactile response.

   d. The chiller controller shall include multiple connection ports for communicating with the local equipment network, the Carrier Comfort Network (CCN) and the ability to access all chiller control functions from any point on the chiller.

   e. The control system shall allow software upgrade without the need for new hardware modules.

2. Safeties:

   Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:

   a. Loss of refrigerant charge.
   b. Reverse rotation.
   c. Low chilled fluid temperature.
   d. Low oil pressure (each compressor circuit).
   e. Voltage imbalance.
   f. Ground current fault.
   g. Thermal overload.
   h. High pressure.
   i. Electrical overload.
   j. Loss of phase.
   k. Current imbalance.
   l. Loss of flow.

3. Diagnostics:

   a. The display module shall be capable of indicating the safety lockout condition by displaying the information in clear language at the display. Information included for display shall be:

      1) Compressor lockout.
      2) Loss of charge.
      3) Low fluid flow.
      4) Low oil pressure.
      5) Cooler freeze protection.
      6) High or low suction superheat.
      7) Thermistor malfunction.
      8) Entering and leaving-fluid temperature.
      9) Evaporator and condenser pressure.
      10) Electronic expansion valve positions.
      11) All set points.
      12) Time of day.

b. Display module, in conjunction with the microprocessor, must also be capable of displaying the output results of a service test. Service test shall verify operation of every switch, thermistor, and compressor before chiller is started. User shall be able to force each output device.

c. Diagnostics shall include the ability to review a list of the 20 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.

d. An alarm history buffer shall allow the user to store no less than 20 alarm events with clear language descriptions, time and date stamp event entry.

H. Operating Characteristics:

Unit shall be capable of starting up with 95 F (35 C) entering fluid temperature to the cooler.

I. Electrical Requirements:

1. Unit primary electrical power supply shall enter the unit at a single location (some units have multiple power poles).
2. Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.
3. Control voltage shall be 115-v (60 Hz) or 230-v (50 Hz), single-phase, separate power supply.
4. Unit shall be shipped with factory control and power wiring installed.

J. Special Features:

Certain standard features are not applicable when the features designated by * are specified. For assistance in amending the specifications, contact your local Carrier Sales office.

* 1. Wye-Delta Starter:

Unit shall have a factory-installed, Wye-Delta starter to minimize electrical inrush current.

2. Sound Reduction Enclosure:

Unit shall have field-installed sound reduction enclosure which covers the entire unit to muffle compressor noise.

3. Vibration Isolation:

Unit shall be supplied with rubber-in-shear vibration isolators for field installation.

4. Control Power Transformer:

Unit shall be supplied with a field-installed transformer that will supply control circuit power from the main unit power supply.

5. Temperature Reset Sensor:

Unit shall reset leaving chilled fluid temperature based on outdoor ambient temperature or space temperature when this sensor is installed.

* 6. Brine Option:

Unit shall be factory modified to start and operate at leaving chilled fluid temperatures of between 15 F (–9 C) and 40 F (4.4 C).

* 7. Minimum Load Control:

Unit shall be equipped with factory (or field) installed, microprocessor-controlled, minimum load control that shall permit unit operation down to 10% of full capacity.

8. Multi-Chiller Control:

Control shall enable management of multiple parallel chillers (up to 8) or two (2) chillers in series in a single system.

9. Minus-One-Pass Cooler:

Factory-installed option shall reduce pressure drop for high flow applications. Shall also provide same end inlet and outlet for 076-106 sizes and opposite end inlet for 116-271 sizes.

10. Plus-One-Pass Cooler:

Factory-installed option shall enhance low temperature brine performance.

11. Suction Service Valves:

Unit shall be supplied with factory-installed suction service valves.

12. Cooler Head Insulation:

Unit shall be supplied with field-installed cooler insulation that shall cover the cooler heads.

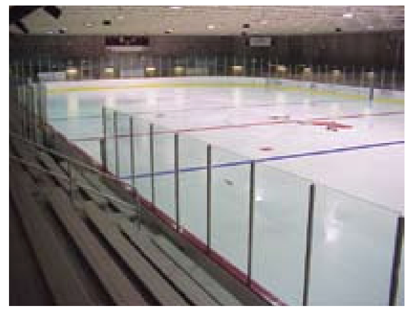
13. Energy Management Module:

A factory or field installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point reset or demand limit control; 2-point demand limit control (from 0 to 100%) activated by a remote contact closure; and discrete input for "Ice Done" indication for ice storage system interface.

ICEMAX

Creating superior, cost-effective ice surfaces

Johnson Controls



What is Icemax?

Icemax is a protein that is derived from a biotech fermentation process much like making beer, wine, yogurt or cheese. The active protein in Icemax has been in use globally for 20 years and has been used in a wide array of applications, including snowmaking, cloud seeding, wastewater concentration, ice harvesting and thermal storage process cooling plants.

How does Icemax work?

Icemax changes the molecular adhesion properties of water and will influence ice crystal size by producing finer and more tightly packed crystalline lattices. Icemax increases the bond cohesion between ice crystals at higher temperatures. Icemax reduces the amount of heat required to be removed to reach the nucleation or freezing point of water. Must be kept frozen for maximum efficacy.

What can Icemax do for my rink?

As a parts per million additive to ice rink water, Icemax provides a cost-effective way to generate a superior ice surface, reduce energy costs, and improve customer satisfaction.

Superior Ice Surface

- Icemax will produce a tighter grained ice crystal that will behave much like de-ionized ice rink water, without the capital and maintenance costs of a DI plant.
- Icemax will help to remove impurities from the rink's source water, giving the ice a cleaner, smoother surface.
- Icemax will increase the bond cohesion between ice layers to give a better, stronger and more durable ice surface without the risk of ice layer delamination.

Energy Cost-Savings

- Icemax can produce a stronger ice layer bond even when cold water is used in the resurfacing equipment, allowing substantial energy cost-savings of 10%-20%.
- With Icemax, rink operators can run their base ice temperature 2 to 4 degrees higher to save energy, while still maintaining a quality ice surface.

Customer Satisfaction

- In addition to providing a superior quality ice surface, Icemax gets customers back on the ice sooner by speeding up the freezing process during resurfacing.

7257 S. Revere Parkway, Centennial, CO 80112 Tel: 888-275-0242
Printed in USA PUBL-5083
www.johnsoncontrols.com/snow

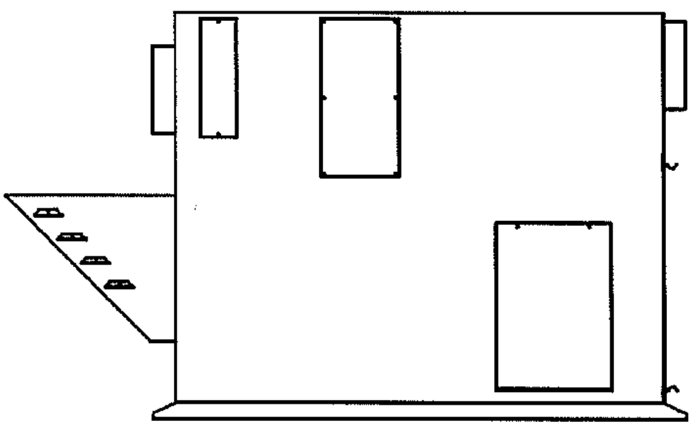
CDIMS ARID-Ice™

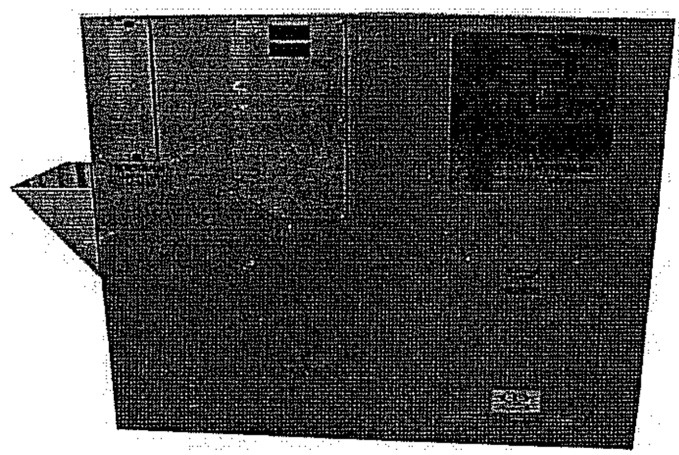
Advanced Reactive Drying

MS-2600-ARID-Ice Desiccant Dehumidifier

ARID Ice introduces the new **MS 2600** Desiccant Dehumidifier. The **MS 2600** is designed for the smaller recreational, practice and curling rinks. This system is designed to mimic the physical and power consumption profiles of typical mechanical refrigeration dehumidifiers, making it an excellent replacement system. The **MS 2600** provides considerably more drying capacity with minimal retrofit cost. The **MS 2600** is designed to deliver 2600 scfm of dry air and runs on less than 20 amps of electricity at 480 volts. It's deep grain depression makes it the best choice for moisture control in Ice surface venues.

Model	CFM	Fuel Type	"L" Dim.	"W" Dim.	"H" Dim.	Weight
MS-2600	2600	Electric	61 ¼"	40 ⅛"	36 ½"	350 lbs





Entering Air Dry Bulb (dF)	Nominal Lb. Moisture Removal per Hour Entering Air Relative Humidity (%)							
	100%	90%	80%	70%	60%	50%	40%	30%
80	31.4	28.3	27.2	25.9	24.5	22.6	20.3	17.9
75	31.6	27.4	26.4	25.3	24	22.2	20.2	17.6
70	29.1	26.8	26.2	25.2	23.6	21.8	19.9	17.2
65	27.8	26.4	25.6	24.5	22.9	21.4	19.4	16.7
60	27.5	25.8	25.1	24	22.5	20.9	18.9	15.9
55	27	25.3	24.3	23.1	21.8	20.2	18	14.8
50	25.9	24.7	23.6	22.4	21.1	19.4	16.9	13.5
45	25.1	23.8	22.7	21.5	20.2	18.2	15.5	12
40	24.5	22.8	21.7	20.5	18.8	16.6	13.7	10.4
*Typical Design Conditions for Ice Arena Humidity Control								

Standard Features:

- **8" Round Connections Reactivation**
- **30% Pleated Efficiency Filters**
- **304 Stainless Construction**

Available Options:

- **Remote Humidistat Connection**
- **Reactivation Duct Installation Kit**
- **575/3/60 Model**

prestige

Fully Condensing Water Boiler

TriangleTube

Hot Water Specialists

Engineering Submittal Solo 399

Engineering Submittal Data

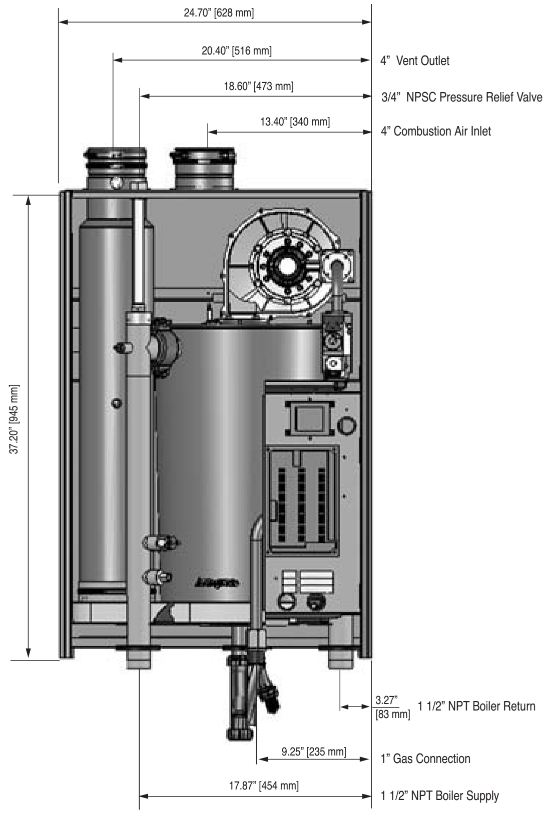
- ASME Boiler Certification - ASME "H" Stamp
- Unit complies with ANSI Z21.13 and CSA 4.9
- Fully condensing – 95.1% thermal efficiency
- Full modulation capability from 28% to rated input
- Modulation allows fewer and longer cycles leading to lower off cycle losses and operating cost
- Low pressure drop heat exchanger
- Capable of providing an indirect water heater with variable and/or continuous production for hot water
- Control interface and logic for indirect hot water storage tank with priority
- Approved for zero clearance to combustibles (excluding vent and boiler piping)
- Garage installation IAW special precautions NFPA 54/ANSI Z223.1
- Automatic boiler freeze protection
- Secondary Fluids and Anti-Freeze allowed when used per manufacturer's specifications.
- Superior grade stainless steel heat exchanger construction - 439 Grade
- Self cleaning flue ways in heat exchanger
- Low NOx Operation
- Digital display control panel
- Venting and exhaust through 4" (up to 100 feet) plastic PVC or CPVC piping (total of rise and run and fittings – 1 90 degree elbow equals 5 feet of run) through outside wall or roof
- Boost feature for set back thermostats and low temperature startup
- No banding material in the header configuration
- Wall mounted or optional floor stand
- Standard equipment:
  - ASME 30 psi pressure relief valve
  - pressure and temperature gauge
  - high limit temperature safety control
  - outdoor temperature reset control
  - air purging valves
  - 24 volt terminal strip with removable
  - jumpers for manual reset or automatic reset
  - pressure low water cutoff feature
- Microprocessor electronic gas and air controller
- Stainless steel premix burner
- Reliable spark ignition
- Unique geometry – 3 consecutive baffles guide water flow through the heat exchanger and around the combustion chamber
- High water content – stable temperature control and less sensitive to water flow and quality
- Electronic controls with easy to read menus, performance and trouble shooting codes
- Swing out control panel for easy service access
- Attractive appliance design for installation in high visibility areas.
- Boiler water supply temperature can be maintained by the Prestige, eliminating the need for a mix system to achieve the desired temperature with high limit protection
- Limited 10 year warranty

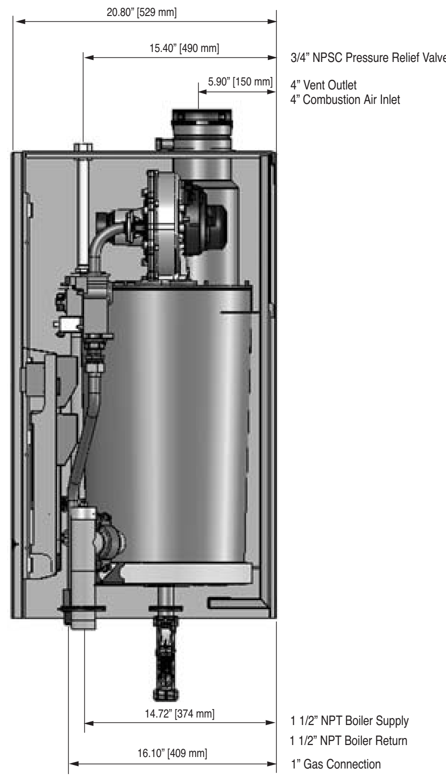
Project / Location: ______________________ Date: __________

Consulting Engineer / Architect: ______________________

Mechanical Contractor: ______________________

Notes: ______________________

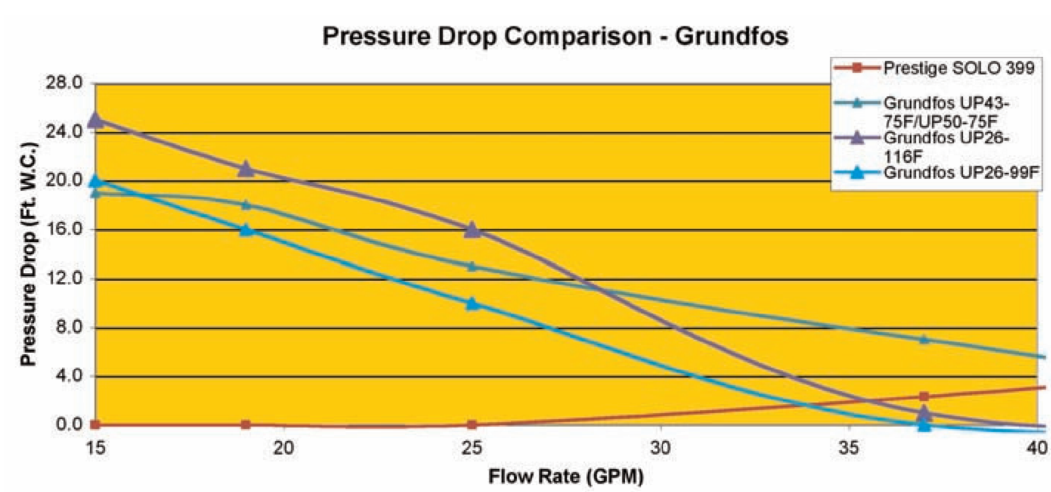




Side View

Model	Btu/HR Input Modulation	Max. Btu/Hr Output	Net I=B=R	Water Content (gal.)	Supply/Return Connections	Gas Connection	Air Inlet	Vent	Weight (Lbs)
Solo 399	112,000 - 399,000	379,000	330,000	7	1 1/2"	1"	4"	4"	200

Pressure Drop Curve
Solo 399 with Grundfos



Delta T	GPM	Available System Head in Feet		
		UP26-99F	UP26-116F	UP43/50-75F
20	37.9	---	---	4.0
30	25.3	10.0	16.0	13.0
40	19.0	16.0	21.0	18.0

Appendix 4-12 Power Factor Correction

Appendix 4-13 Transformers – Retrofit

E-Saver-C3 The Green Transformer

APPLICATIONS

The E-Saver-C3 transformer is the ideal transformer for institutional and commercial environments where energy efficiency is a priority. Optimized for lowest life cycle cost, the E-Saver-C3 reduces waste by as much as 74%. The E-Saver-C3 is a practical and affordable solution for K-12, colleges and universities, healthcare, governments and commercial buildings where lowest life cycle cost and energy savings are a priority.

DESCRIPTION AND CHARACTERISTICS

The E-Saver-C3 sets new benchmarks for environmental protection, energy efficiency and reliability. Designed to provide the lowest life cycle cost, the E-Saver-C3 meets US DOE Candidate Level 3 efficiency ensuring lower operating losses than standard off-the shelf transformers. To provide superior performance and reduce environmental impact the E-Saver-C3 comes with a superior Nomex based insulation system impregnated with an organic epoxy adhesive.

QUIET OPERATION

Workplace productivity can be compromised when noisy transformers are located close to people. To meet this challenge, the E-Saver-C3 has embedded structural and acoustic treatments that combine to ensure quiet-operation. To ensure quiet operation noise tests are part of our ISO 9001 procedures for every transformer.

OPTIONAL INTEGRATED METERING

To facilitate on-site commissioning and monitoring, Powersmiths' SMART meter can be integrated into the transformer. SMART is an energy and power meter that serves as a data acquisition system, providing on-going energy and power quality data for the building's energy management systems and education for sustainability software such as Powersmiths Interactive Learning System. An optional port is available to provide safe external access to live transformer primary and secondary voltages and currents; operating temperature and TVSS status, without opening the transformer enclosure.

ENVIRONMENTAL BENEFIT

The E-Saver-C3 is built in an ISO 9001 (quality management) and ISO 14001 (environmental management) certified facility. Throughout the manufacturing process Powersmiths takes steps to ensure that waste is eliminated and hazardous materials are avoided. Because Powersmiths transformers generate lower losses, they reduce power drawn from generating stations resulting in less smog and lower greenhouse gas emissions.

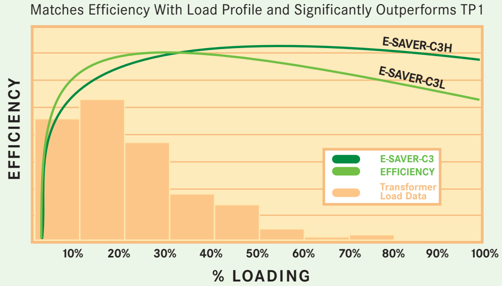
TESTING AND WARRANTY

During manufacturing and assembly the E-Saver-C3 is subjected to rigorous testing to ensure: efficiency under various load profiles and loading conditions; quiet operation; and insulation integrity. Powersmiths is the only manufacturer to production-test transformers with actual computer-power loading in an ISO 9001 environment. Data is provided for individual units by selecting the NLT option.

The E-Saver-C3's long life and dependable performance is backed up by Powersmiths' industry leading 25 year pro-rated warranty. The warranty is automatically extended to 40 years when Powersmiths Cyberhawk MPC monitor, protection and control system is installed at the building entrance.

MAXIMIZE YOUR ENERGY SAVINGS

Matches Efficiency With Load Profile and Significantly Outperforms TP1



KEY FEATURES

- Reduces electricity waste to help you meet your sustainability goals
- Optimized to provide quiet, efficient electrical power for improved productivity
- Significantly exceeds NEMA TP-1 efficiency for low operating cost over life of transformer
- Provides the lowest life cycle cost of any transformer on the market
- Produced in an ISO 9001 and ISO 14001 certified facility to ensure high quality and low environmental impact

STANDARD CONFIGURATION

Powersmiths E-Saver-C3 is a copper wound, 3-phase common-core, ventilated, dry type isolation transformer, built in an ISO 9001 and ISO14001 environment to NEMA ST-20 and other applicable ANSI and IEEE standards. Primary and secondary terminals and voltage taps are readily accessible by removing the front cover plate; 10kV BIL.

The E-Saver-C3 has a 220˚C class insulation, is rated for 60Hz, and comes in a NEMA 2 ventilated indoor enclosure. It meets the efficiency requirements of DOE candidate Standard Level 3 (CSL 3).

The E-Saver-C3 comes in two models. The E-Saver-C3L is optimized for light loading, has a UL listed k-7 rating and a 130˚C temperature rise. The E-Saver-C3H is optimized for heavy loading, has a UL listed k-13 rating and a 105˚C temperature rise. The C3H model has an 80˚C option with k-20 rating.

SELECT

kVA: Rating of unit (15-1000 kVA, up to 5000 kVA)
DEG: 0 or 30 degrees phase shift
PV: Primary voltage, (600, 480, 415, 400, 380, 208, up to 15kV)
SV: Secondary voltage (208/120V, 480/277V, 600/347V, others available)

SAMPLE PART NUMBER

E-SAVER-C3L-75-480-208

* FEDERAL REGISTER – US Department of Energy, Office of Energy Efficiency and Renewable Energy. 10 CFR Part 430, July 29, 2004. Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Distribution Transformers; Proposed Rule

TECHNICAL DATA

kVA	Impedance (%Z)	C3L Weight (lbs)	C3H Weight (lbs)	Case Size (Inches)
15	3.0 - 6.0%	200 - 250	210 - 260	A (18W x 17D x 27H)
30	3.0 - 6.0%	320 - 400	350 - 430	B (26W x 18D x 30H)
45	3.0 - 6.0%	400 - 500	420 - 520	B (26W x 18D x 30H)
75	3.0 - 6.0%	570 - 670	610 - 710	C (32W x 22D x 40H)
112.5	3.0 - 6.0%	850 - 950	880 - 1000	C (32W x 22D x 40H)
150	3.0 - 6.0%	1100 - 1300	1150 - 1350	D (38W x 27D x 48H)
225	3.0 - 6.0%	1550 - 1750	1700 - 1900	D+ (38W x 32D x 52H)
300	3.0 - 6.0%	1850 - 2050	1950 - 2150	D+ (38W x 32D x 52H)
500	3.0 - 6.0%	2500 - 2700	2900 - 3100	E+ (52W x 38D x 61H)
750	3.0 - 6.0%	3700 - 4300	4000 - 4400	F (64W x 47D x 67H)

The above data applies to configurations up to 600V, with NEMA 2 enclosure and standard temperature rise. Selection of some options may change enclosure size and weight. Consult factory for detailed product data sheet for these and other configurations. *Specific case used determined by factory unless specified. Up to 5000kVA, 15kV class available.

AVAILABLE OPTIONS

SMART1: Integrated metering port

SMART2: Integrated Power & Energy Meter

SMART3: Integrated Meter with Web access

CYBERHAWK-TX: Efficiency & Power Meter

N3R: NEMA 3R, ventilated enclosure

T80: 80 deg. C operating Temp. rise (C3H model only)

F50: 50Hz design

1S: Single electrostatic shields

2S: Dual electrostatic shields

3S: Triple electrostatic shields

ECO: ECOLOGO certified

SPD: (120/208V OR 277/480V)
- **PRO80:** 80kA, 7 mode, Filter
- **PRO120:**120kA, 7 mode, Filter
- **PRO160:** 160kA, 7 mode, Filter
- **PRO200:** 200kA, 7 mode, Filter
- **PRO240:** 240kA, 7 mode, Filter

PROXX: Where xx is custom ID

LK: Lug kit, screw-type

COL: Color other than the factory standard

TSB: Terminal Safety Barrier

TS: Thermal Sensors at 170˚C and 200˚C

NLT: Nonlinear load test

SE: Sensitive Environment, extra low noise

C2AL: DOE class 2 efficiency, with aluminum windings

Warranty: Our Commitment to lasting performance is spelled out in the longest transformer warranty in the business – 25 years pro-rated. 40 year pro-rated warranty with the installation of the Cyberhawk MPC at the building entrance. E-Saver is a trademark of Powersmiths International Corp.

Technical specification subject to change without notice.

POWERSMITHS

POWERSMITHS INTERNATIONAL CORP. 10 Devon Road, Brampton, Ontario L6T 5B5 Canada
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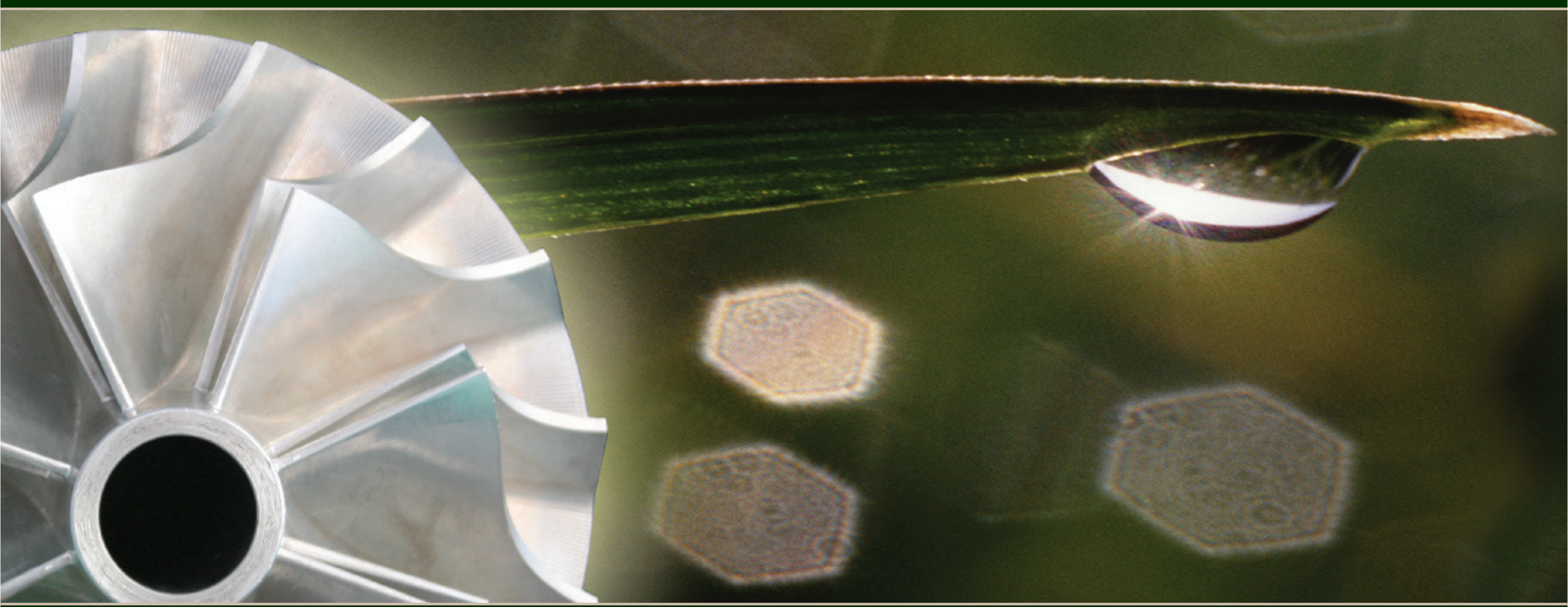
Appendix 4-14 WWTP Aeration Blower – Retrofit

HIGH SPEED TURBO BLOWERS



Innovation

Service

Experience

HSi HIGH SPEED TURBO

Introducing HSI High Speed Turbo Blowers and Exhausters

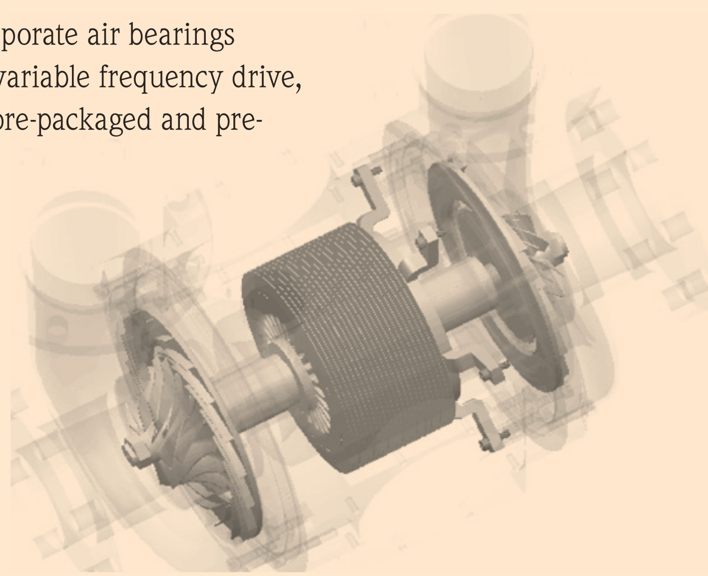
What if a blower could…

- Operate 20-40% more energy efficient than conventional machines?
- Require NO lubrication?
- Require NO maintenance besides inlet filter changes?
- Achieve sound levels below 85 dBA and operate with virtually no vibration?
- Have a simple, yet rugged design?
- Be environmentally friendly?

What if you found this blower with the local service and support that you know and trust?

HSI offers tomorrow's technology today with our high speed turbo product line with over 10 models ranging from 5hp to 300hp (1 to 250kW) manufactured at our state-of-the-art facility in Houston, Texas USA.

These revolutionary blower designs incorporate air bearings supported a single shaft with integrated variable frequency drive, control system and motor. These are all pre-packaged and pre-wired in a single enclosure for simple installation and application. Flow ranges from 10 to 10,000 SCFM (15 to 15,000 nm^3/hr) and pressures to 25 psi (1.7 bar) through the range of operation.

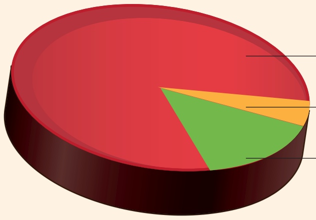


HIGH SPEED TURBO

What is Your TRUE Cost of Ownership?

What does efficiency and payback really mean? "Wire to Air Efficiency" is the total cost of power to produce the performance you require. At HSI, we believe efficiency is only what a manufacturer can guarantee and further what a manufacturer can verify with actual results. Whether it be on our own ASME PTC-10 Compliant Performance Testing Facility or at your location, HSI is ready to show you real results.

Total cost of ownership includes power consumption, maintenance as well as initial capital costs.



Let us offer a 20 year life cycle analysis on your next project.

POWER SAVING

The HSI Turbo Blower is 20–40% more efficient than traditional type blowers offering payback of investments in 2 to 3 years from energy savings alone.

LOW MAINTENANCE

NO lubrication, NO alignment and NO scheduled maintenance outside of routine inlet filter changes. This can save you time and money compared to lubricated type blowers.

NOISE

Each standard package is fully enclosed and does not exceed 85 dBA per OSHA standards.

INSTALLATION

A compact blower design allows considerable space savings. No special foundation support required and the lightweight design offers easy access without the requirement of large overhead cranes.

CONTROL

Completely integrated controls are pre-engineered as a working system and can be upgraded to communicate with any known protocol for remote operation and monitoring.

INTEGRATION

With three different control modes as standard, this blower can seamlessly operate in parallel with other types of blowers.

COMPLETE PACKAGE

Compressor, motor, variable speed motor starter, pressure relief valve, expansion joint, and control cabinet built in one complete pre-engineered system. Just add electricity and piping.

SERVICE

Simple modular design offers complete replacement parts to be accessed without special tools or training. All in stock and readily available from our factory in Houston, Texas USA.

Impeller

Highly Advanced Computation Fluid Dynamic programming allows for performance design to truly offer an advancement in efficiency.

Our unique lost gypsum method for cast aluminum can create smoother, deeper and more intricate vane designs than other existing technologies. In addition to performance, this design provides a better strength to weight ratio which offers superior stability.

Double suction symmetric structure

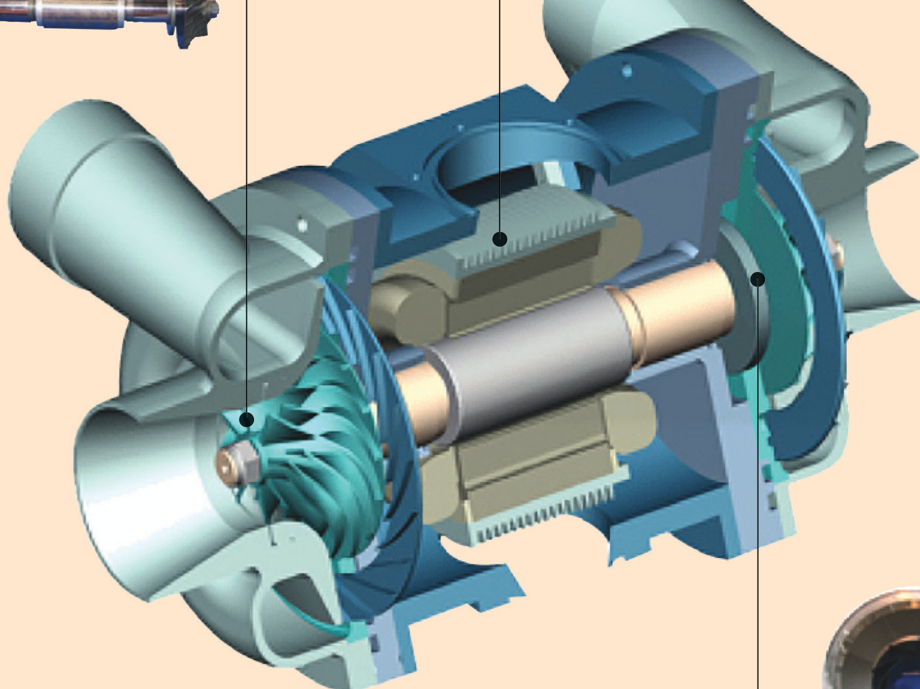
- Impellers at both ends of a common shaft counterbalance thrust load in the axial direction (axial load≈0)
- Superior stability and durability
- Improved efficiency over single impeller design
- Reduction of local stress or twisting

Motor

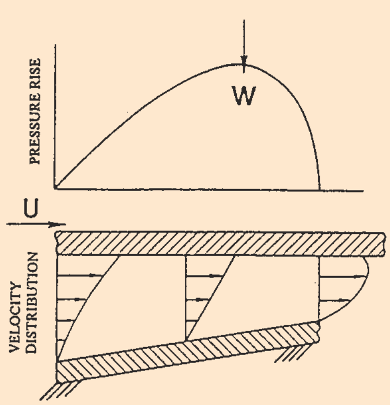
- Highly efficient and reliable motor design
- Specifically designed for high speed service
- Designed for high heat environments

Inlet air is channeled over the motor to provide cooling prior to compression and discharge.

- Cooling fins are made of aluminum, which has superior heat conductivity
  - Additional cooling instruments (cooling fan, ventilation, or water channel) not required



Principle of Air Bearing Technology



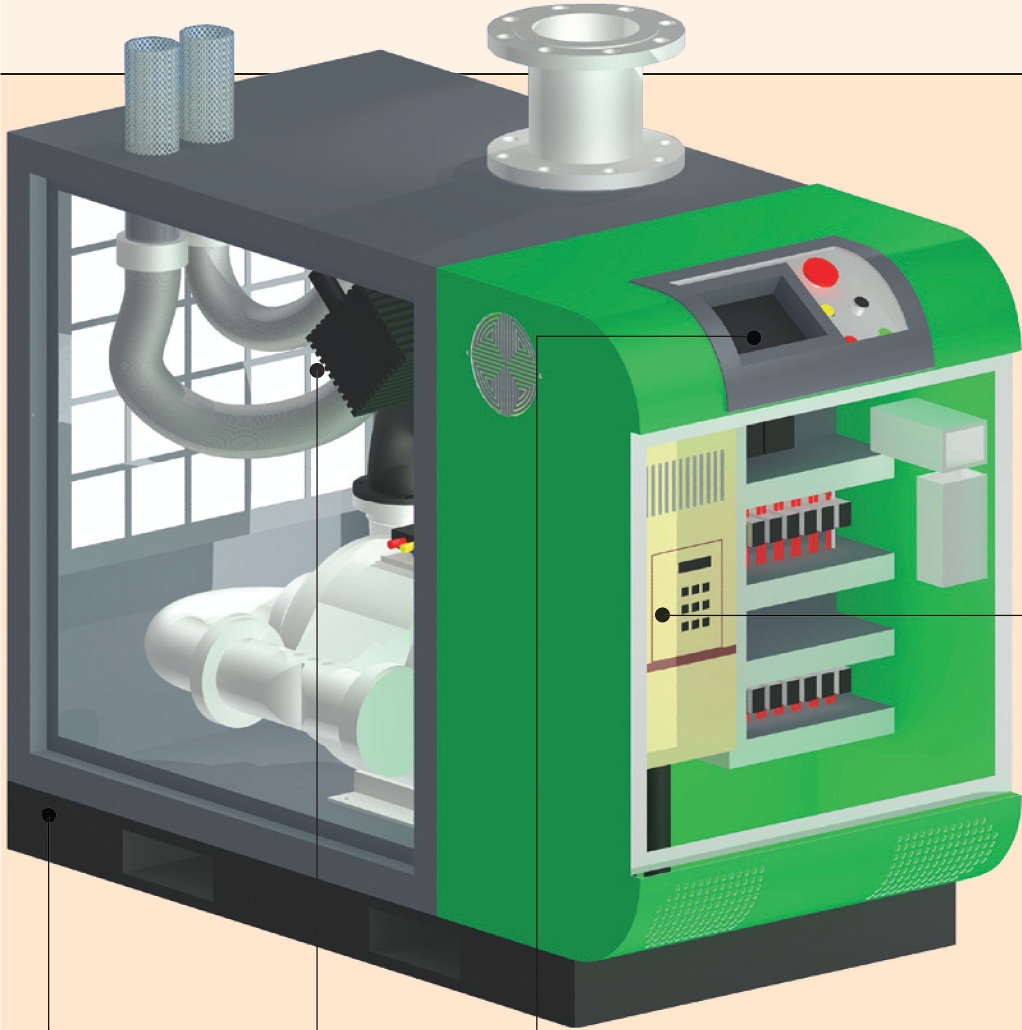
Bearings

Air Bearings

- Individually layered bearings are assembled in the housing to support the shaft
- As the shaft rotates at high speed, an air film is formed between the shaft and the bearings which achieves friction free floating without the use of lubricants
- No additional cooling required
- Suitable for high speed; bearing load capability increases with higher RPM.

Superior durability

- Little or no wear after 35,000 continuous on/off cycles
- Possible to operate under extreme environment (max. 250°C)
- Little or no vibration and noise



Enclosure and Control

Variable Frequency Drive

- Highly efficient design with minimal heat loss
- Specifically tuned to match high speed motor and provide the best efficiency over the entire speed range.
- Stable performance throughout the range of operation
- Lowest inrush current of any motor starter
- Unlimited starts and stops

Programmable Logic Controller (PLC)

- Integrated with VFD starter
- Complete system monitoring
- Simple touch screen HMI interface
- Protective cover
- Control modes include constant pressure mode, quantitative mode, and proportional mode

Enclosure

- UL/ULC certified electrical enclosure
- Self ventilating design
- Easy change inlet air filter
- Instant access to every component
- Compact low footprint

Relief Valve

- Built in automated pressure relief valve for surge protection with integral vented discharge silencers

Constant Pressure Mode

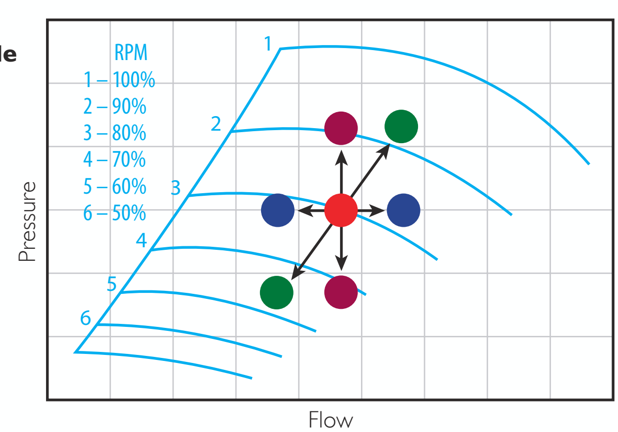
- Pressure: fixed
- Flow: variable

Quantitative Mode

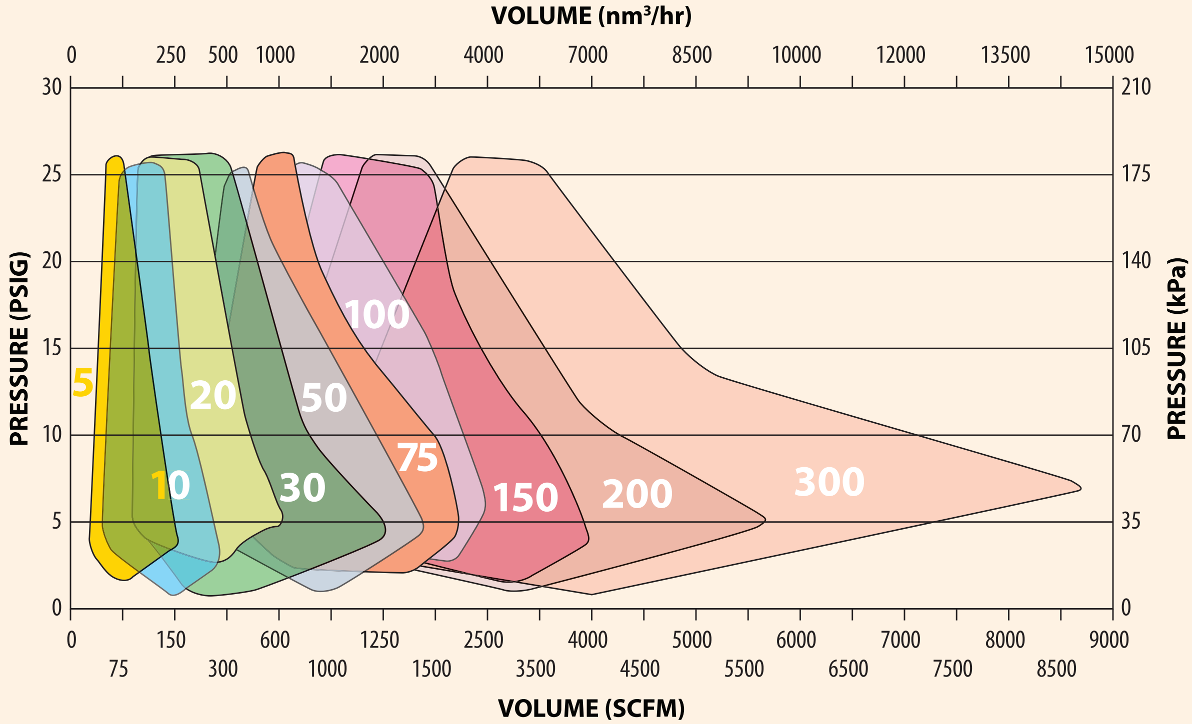
- Pressure: variable
- Flow: fixed

Proportional Mode

- Pressure: variable
- Flow: variable



Performance Envelope 10 standard models from 5 hp to 300 hp (5 to 250 kw) shown.



Blower Model	Impeller Configuration	Outlet Flange (in)	Cabinet Enclosure Dimensions Size L x W x H (mm)	Cabinet Enclosure Dimensions Size L x W x H (in)	Weight Kg	Weight Lbs
HT-5	single	3	600 x 600 x 850	23.6 x 23.6 x 33.5	296	651
HT-5	twin	3	600 x 600 x 850	23.6 x 23.6 x 33.5	300	661
HT-10	single	3	600 x 600 x 850	23.6 x 23.6 x 33.5	296	651
HT-10	twin	3	600 x 600 x 850	23.6 x 23.6 x 33.5	300	661
HT-20	single	4	1100 x 700 x 1050	43.3 x 27.6 x 41.3	376	827
HT-20	twin	4	1100 x 700 x 1050	43.3 x 27.6 x 41.3	380	839
HT-30	single	4	1100 x 700 x 1050	43.3 x 27.6 x 41.3	397	873
HT-30	twin	4	1100 x 700 x 1050	43.3 x 27.6 x 41.3	402	888
HT-50	single	6	1400 x 700 x 1050	55.1 x 27.6 x 41.3	434	955
HT-50	twin	6	1400 x 700x x1050	55.1 x 27.6 x 41.3	440	970
HT-75	single	6	1350 x 850 x 1500	53.1 x 33.5 x 59.1	612	1346
HT-75	twin	6	1700 x 850 x 1500	66.9 x 33.5 x 59.1	632	1390
HT-100	single	6	1350 x 850 x 1500	53.1 x 33.5 x 59.1	667	1467
HT-100	twin	6	1700 x 850 x 1500	66.9 x 33.5 x 59.1	687	1511
HT-150	single	8	1800 x 950 x 1600	70.9 x 37.4 x 63.0	828	1822
HT-150	twin	8	1800 x 950 x 1600	70.9 x 37.4 x 63.0	848	1866
HT-200	single	12	2000 x 1050 x 1700	78.7 x 41.3 x 66.9	1040	2288
HT-200	twin	12	2000 x 1050 x 1700	78.7 x 41.3 x 66.9	1043	2298
HT-300	single	12	2100 x 1050 x 1750	82.7 x 41.3 x 68.9	1210	2662
HT-300	twin	12	2100 x 1050 x 1750	82.7 x 41.3 x 68.9	1212	2672

Custom enclosures available including: Separate blower and control cabinets. Outdoor enclosure modifications. Enclosure dimensions subject to change without notice.

HIGH SPEED TURBO

Common Applications

Water and Waste Water

Basin aeration
Air scouring
Filter backwash systems
Grit chamber aeration
Lagoon aeration
Wastewater treatment
SBR
MBR

General Industrial

Pneumatic conveying
Blow off systems
Fermentation
Galvanization process
Printing systems
Pulp and paper industry
Carbon black
Steel plating
Black liquor recovery
Air knife drying

Power Industry

Flue gas
Desulphurization
Oxidation air
Coal gasification
Fluidized bed

Petroleum & Chemical

Sulphur recovery
Thermal oxidation

Specifications

TECHNICAL DATA

Configuration

Number of impellers	1 or 2 impellers (single, in series or in parallel)
Pressure range	2 To 25 PSIG (.13 to 1.7 bar)
Flow range	10 to 10,000 SCFM (1 to 300 m2m).
Outlet connection	Flanged ASA 125# / ANSI 150# drilling
Inlet filter	10 micron felted synthetic material, powder coated steel frame, washable with compressed air or soap
Pressure relief valve	Pneumatic actuated pressure relief valve and integral silencers included in standard package. No external compressed air utility required
Operating speed	8000 RPM to 45,000RPM (sub critical operation)
Casing pressure	50 PSIG maximum
Seals (air)	Self contained
Bearings	Air foil – non contact, non wearing, dynamic fluid film – utilizing air
Lubrication	None required
Drive type	Self contained motor and shaft with integrally attached overhung impeller(s)
Vibration tolerence	Maximum allowable .07 in/sec (2mm/sec)
Rotor balance	Military standard 167-1. Individual impellers and rotating assembly dynamically balanced
Enclosure/electrical	NEMA 12 (standard), upgrades available
Electrical cabinet	UL, ULC Listed
Motor voltage	240, 380, 440, 480, 575 volt, 50 or 60Hz, 3 phase input power. Internal control voltage transformer.
Motor HP/KW rating	5 to 300 hp (1 to 250kW)
Motor	IP 45, 54 protection, highly efficient permanent magnet or induction type motor.
Motor starter	Inverter type – variable frequency drive
VFD type	Highly efficient 6 pulse drive standard with operating range to 1000 hz operation (optional harmonic filters available)
Noise level	Under 85 dBA per OSHA standards
Control	Programmable logic controller with touch screen human machine interface (standard)
UV protective cover	Included to protect touch screen interface
Network connections	Ethernet, RS232, or DH485 as standard. Optional connections to communicate with any protocol available.
Cooling system	Internally self cooled by inlet air or external cooling options available to capture heat to supplement HVAC or water heating.

MATERIALS OF CONSTRUCTION

Blower housing	Cast aluminum
Impellers	Cast aluminum
Air bearings	Teflon® coated Inconel®
Blower enclosure	16 gauge sheet metal with synthetic wool sound dampening material
Blower enclosure skid	Heavy duty steel I-beam construction with fork lift access ports
Enclosure finish	Powder coated with 2 coat epoxy paint standard

HIGH SPEED TURBO

HIGH SPEED TURBO BLOWERS

HSi

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sales@hsiblowers.com

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CERTIFIED QUALITY MANAGEMENT SYSTEM ISO 9001:2000
DNV

E-SL-025, Rev. 01
8-12-08 photo

Appendix 4-15 Heating System Upgrade – Boiler Replacement

Appendix 5
Lighting Schedules

Summary of Recommended Lighting Retrofit

City of Dover - Butterfield Gym-Indoor Pool - S1

ESCO Code	Qty	Description
ADFW/N-T8-QXPS-UNV	2	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS AND (1) 4' T8 XPS SUPER SAVER LAMP
BDF-T8-QLXPS-UNV	1	IN 4 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XPS SUPER SAVER LAMPS
BDF-T8-QXPS-UNV	34	IN 4 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XPS SUPER SAVER LAMPS
CADFWW/N-T8-QXPS-UNV	5	REPLACE 4' 3 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' 1 LAMP FLUORESCENT WIDE WRAP FIXTURE CONTAINING QHEN NORMAL POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (1) 4' T8 XPS SUPER SAVER LAMP
CDFWW/N-T8-QLXPS-UNV	11	REPLACE 4' 3-LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' WIDE WIDE WRAP FIXTURE CONTAINING QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, LENS AND (2) 4' T8 XPS SUPER SAVER LAMPS
NOUPGRADE-13WPL	3	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 13 WATT PL COMPACT FLUORESCENT FIXTURE
NOUPGRADE-26WPL	18	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 26 WATT PL COMPACT FLUORESCENT FIXTURE
NOUPGRADE-2X13WPL	8	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 2 x 13 WATT PL COMPACT FLUORESCENT FIXTURE
NOUPGRADE-4'3L32WT8NP	1	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 4' 3 LAMP T8 32 WATT ELECTRONIC NORMAL POWER BALLAST FIXTURES
NOUPGRADE-MH400	12	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 400 WATT METAL HALIDE FIXTURE
NOUPGRADE-VENDINGMACHIN	1	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON THE VENDING MACHINE

Summary of Recommended Lighting Retrofit

City of Dover - Butterfield Gym-Indoor Pool - S1

ESCO Code	Qty	Description
SLS15-I60-120	1	REPLACE EXISTING 60 WATT INCANDESCENT LAMP WITH SLS15 COMPACT FLUORESCENT LAMP
UDF-T8-QXPS-UNV	6	IN FLUORESCENT 2X2 T8 FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 2' T8 XPS SUPER SAVER LAMPS
VSS-120	1	INSTALL VENDING MACHINE SENSOR VM 150 SYSTEM
WSS-DT-120	1	REPLACE STANDARD ON / OFF SWITCH WITH WALL MOUNTED DUAL TECHNOLOGY OCCUPANCY SENSOR
	105	

Fixture Locations

City of Dover - Butterfield Gym-Indoor Pool - S1

Dover, NH

Map	Location	Hours	Qty	Code	Notes
1	2nd Floor - Indoor Pool Conference Area	100	10	NOUPGRADE-26WPL	Existing 1 x 26W CF Recessed Can
1	2nd Floor - Indoor Pool Conference Area	100	8	NOUPGRADE-2X13WPL	Exisitng 2 x 13W CF Wall Sconce
2	2nd Floor Office	100	8	NOUPGRADE-26WPL	Existing 1 x 26W CF Recessed Can
2	2nd Floor Office - Storage Area	100	1	NOUPGRADE-4'3L32WT8NP	Existing 1 x 4 3L T8 Wide Wrap
3	Stairwell	1,600	5	CDFWW/N-T8-QLXPS-UNV	
4	Women's Locker Room	3,000	16	BDF-T8-QXPS-UNV	Sensor in Place
5	Men's Locker Room	3,000	16	BDF-T8-QXPS-UNV	Sensor in Place
5	Men's Locker Room	3,000	2	UDF-T8-QXPS-UNV	Sensor in Place
6	Men's Room	5,100	1	WSS-DT-120	
6	Men's Room	5,100	1	BDF-T8-QXPS-UNV	
6	Men's Room	5,100	1	UDF-T8-QXPS-UNV	
7	Hallway to Pool Area	5,100	5	CADFWW/N-T8-QXPS-UNV	Replacing 3L T8 Wide Wrap: (4) Wall-Mounted; (1) Ceiling Mounted; 8' AFF
8	Family Changing Room	1,600	1	BDF-T8-QXPS-UNV	
8	Family Changing Room	1,600	2	UDF-T8-QXPS-UNV	
9	Changing Room	1,000	1	UDF-T8-QXPS-UNV	
10	Registration Area	5,100	6	CDFWW/N-T8-QLXPS-UNV	
10	Registration Area	5,100	1	BDF-T8-QLXPS-UNV	
10	Registration Area	100	3	NOUPGRADE-13WPL	Existing 13W CF Recessed Can
10.1	Registration Area	8,760	1	NOUPGRADE-VENDINGMACHINE	Dasani Machine
10.1	Registration Area	8,760	1	VSS-120	
11	Pool Office	5,100	2	ADFW/N-T8-QXPS-UNV	
11	Pool Office - Storage Room	1,000	1	SLS15-I60-120	Replacing 60W Incandescent
12	Pool Area	100	12	NOUPGRADE-MH400	Existing 400W Metal Halide Fixtures
	Total		**105**		

Summary of Recommended Lighting Retrofit

City of Dover - Ice Arena - S3

ESCO Code	Qty	Description
ADD-ADFW/N-QLXP5K-UNV	2	WHERE THERE IS NO EXISTING FIXTURE INSTALL NEW 4' WRAP FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (1) 4' T8 XP 5000K SUPER SAVER LAMP
ADD-VRX32W-120	1	WHERE THERE IS NO EXISTING FIXTURE, INSTALL NEW LOWBAY FIXTURE CONTAINING (1) HARD WIRED ELECTRONIC COMPACT FLUORESCENT BALLAST AND (1) CF 32 WATT COMPACT FLUORESCENT LAMP
ADF-T8-QLXP5K-UNV	4	IN 2 LAMP 4' T8 FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (1) 4' T8 XP 5000K SUPER SAVER LAMP
ADFTW/N-T8-QLXP5K-UNV	6	INSTALL NEW 4' FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, WRAP LENS AND (1) 4' T8 XP 5000K SUPER SAVER LAMP
ADFTW/N-T8-VT-QLXP5K-UNV	1	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' VAPOR TIGHT FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, WRAP LENS AND (1) 4' T8 XP 5000K SUPER SAVER LAMP
ADFTWW/N-T8-QLXP5K-UNV	2	REPLACE EXISTING 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' WIDE WRAP FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, WRAP LENS AND (1) 4' T8 XP 5000K SUPER SAVER LAMP
ADFW/NS-T8-QLXP5K-UNV	1	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS, FIXTURE MOUNTED OCCUPANCY SENSOR AND (1) 4' T8 XP 5000K SUPER SAVER LAMP
ADFW/N-T8-QLXP5K-UNV	4	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS AND (1) 4' T8 5000K XP SUPER SAVER LAMP
ADFW/N-T8-QXP-UNV	1	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS AND (1) 4' T8 XP SUPER SAVER LAMP
ADFWW/N-T8-QLXP5K-UNV	2	REPLACE EXISTING 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' 1 LAMP WIDE WRAP FIXTURE CONTAINING QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS & (1) 4' T8 XP 5000K SUPER SAVER LAMP
A-T8-QLXP5K-UNV	114	IN 2 LAMP 4' T8 FLUORESCENT FIXTURE INSTALL QHEL SUPER SAVER ELECTRONIC BALLAST AND (2) 4' T8 5000K XP SUPER SAVER LAMPS

Summary of Recommended Lighting Retrofit

City of Dover - Ice Arena - S3

ESCO Code	Qty	Description
BDF-T8-QLXP5K-UNV	1	IN 4 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
BDFWW/N-T8-QLXP5K-UNV	2	REPLACE EXISTING 4' 4 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' WIDE WRAP FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, (2) 4' T8 XP 5000K SUPER SAVER LAMPS
CDFS/N-T8-QLXP5K-UNV	1	REPLACE EXISTING 4' 3 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' 2 LAMP SURFACE WRAP FLUORESCENT FIXTURE CONTAINING QHEL LOW POWER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
CDF-T8-QLXP5K-UNV	81	IN 3 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
CDFT-T8-QLXP5K-UNV	2	IN 3 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL TANDEM WIRED QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
CSS-277	12	INSTALL CEILING MOUNTED OCCUPANCY SENSOR SYSTEM
E1/E-T8-QLXP5K-UNV	4	IN 2 LAMP 8' T8 FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS.
EDF-T8-QLXP5K-UNV	2	IN 2 LAMP 8' ELECTRONIC BALLAST T8 LAMP FLUORESCENT FIXTURE INSTALL QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 5000K XP SUPER SAVER LAMPS
EDFW/NS-T8-QLXP5K-UNV	2	REPLACE 8' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 8' FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, FIXTURE MOUNTED OCCUPANCY SENSOR AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
EDFW/NS-T8-VT-QLXP5K-UNV	1	REPLACE 8' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 8' VAPOR TIGHT FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, FIXTURE MOUNTED OCCUPANCY SENSOR AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
EDFW/N-T8-VT-QLXP5K-UNV	1	REPLACE 8' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 8' VAPOR TIGHT FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS

Summary of Recommended Lighting Retrofit

City of Dover - Ice Arena - S3

ESCO Code	Qty	Description
FMS-277	5	INSTALL OCCUPANCY SENSOR SYSTEM DIRECTLY TO EACH INDIVIDUAL FIXTURE
FSS-277	3	INSTALL OCCUPANCY SENSOR SYSTEM DIRECTLY TO EACH INDIVIDUAL FIXTURE OR ROW OF FIXTURES
HDF/E-T8-QLXP5K-UNV	2	IN 2 LAMP T8 8' FLUORESCENT FIXTURE INSTALL QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (4) 4' T8 XP 5000K SUPER SAVER LAMPS
HDF-QLXP5K-UNV	13	IN 2 LAMP 8' HIGH OUTPUT FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (4) 4' T8 XP 5000K SUPER SAVER LAMPS
HSS-277	3	INSTALL HALLWAY OCCUPANCY SENSOR SYSTEM
NO UPGRADE	384	SEE FIXTURE LOCATION KEY FOR NOTES ON CASES WHERE NO UPGRADE OR RETROFIT IS BEING PERFORMED
NOUPGRADE-4'1L32WT8NP	4	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 4' 1 LAMP T8 32 WATT ELECTRONIC NORMAL POWER BALLAST FIXTURES
NOUPGRADE-LEDEXIT	3	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING LED EXIT SIGN
NOUPGRADE-MH100	1	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 100 WATT METAL HALIDE FIXTURE
NOUPGRADE-MH400	33	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 400 WATT METAL HALIDE FIXTURE
NOUPGRADE-VENDINGMACHIN	2	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON THE VENDING MACHINE

Summary of Recommended Lighting Retrofit

City of Dover - Ice Arena - S3

ESCO Code	Qty	Description
PLATES	2	INSTALL COVER PLATE TO CEILING
PULL CHAINS	4	INSTALL PULL CHAIN TO EXISTING OR NEW FIXTURE BEING INSTALLED
SLSR3020-I65-120	4	REPLACE EXISTING 65 WATT INCANDESCENT LAMP WITH SLS20 COMPACT FLUORESCENT FLOOD (REFLECTORIZED) LAMP
SWITCH	2	INSTALL SINGLE LIGHT SWITCH IN CORRESPONDING MAP LOCATION
UDF-T8-QLXP5K-UNV	1	IN FLUORESCENT 2X2 T8 FIXTURE INSTALL QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 2' T8 XP 5000K SUPER SAVER LAMPS
VSS(2)-120	1	INSTALL VENDING MACHINE SENSOR VM 151 SYSTEM
VSS-120	1	INSTALL VENDING MACHINE SENSOR VM 150 SYSTEM
WSS-120	2	REPLACE STANDARD ON / OFF SWITCH WITH WALL MOUNTED OCCUPANCY SENSOR
WSS-277	10	REPLACE STANDARD ON/OFF SWITCH WITH WALL MOUNTED OCCUPANCY SENSOR SYSTEM
X-REMOVE	2	REMOVE FIXTURES
	729	

Fixture Locations

City of Dover - Ice Arena - S3

Dover, NH

Map	Location	Hours	Qty	Code	Notes
1	Locker Room #8	1,000	8	A-T8-QLXP5K-UNV	Sensor in Place
2	Locker Room #9	2,000	6	A-T8-QLXP5K-UNV	Sensor in Place
3	Common Restroom Area	2,000	4	A-T8-QLXP5K-UNV	Sensor in Place
4	Locker Room #10	2,000	6	A-T8-QLXP5K-UNV	Sensor in Place
5	Hallway	8,760	2	A-T8-QLXP5K-UNV	Tamper Proof Vapor Tight Fixtures
6	Locker Room #11	2,000	6	A-T8-QLXP5K-UNV	Sensor in Place; (5) Missing Lenses
7	Common Restroom	2,000	4	A-T8-QLXP5K-UNV	
8	Locker Room #12	2,000	6	A-T8-QLXP5K-UNV	Sensor in Place; (5) Missing Lenses
9	Coach's Office	500	1	A-T8-QLXP5K-UNV	
10	Dover High School Locker Room	1,600	6	A-T8-QLXP5K-UNV	Sensor in Place; (6) Missing Lenses
10.1	Dover High School Locker Room - Restroom Area	1,000	2	A-T8-QLXP5K-UNV	Lenses in Place
10.2	Dover High School Locker Room - Small Hallway	1,600	1	A-T8-QLXP5K-UNV	
11	Holt Boiler Room	500	1	HDF-QLXP5K-UNV	
12	Holt Zamboni Room	5,950	7	HDF-QLXP5K-UNV	
13	Holt Net Storage Area	8,760	2	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
13	Holt Net Storage Area	2,000	5	HDF-QLXP5K-UNV	
13.1	Holt Net Storage Area - Small Hallway	8,760	2	ADFWW/N-T8-QLXP5K-UNV	
14	Maintenance Storage Area	5,950	2	EDF-T8-QLXP5K-UNV	Size 4 1/4 x 96
14	Maintenance Storage Area	5,950	2	FSS-277	
15	Locker Room #5	1,000	2	NOUPGRADE-4'1L32WT8NP	Sensor in Place; Existing 8' 2L T8 Strip - Open Lamp
15	Locker Room #5	1,000	1	FMS-277	
16	Locker Room #4	8,760	1	WSS-120	
16	Locker Room #4	8,760	1	A-T8-QLXP5K-UNV	No Switch/No Sensor
16	Locker Room #4	8,760	1	A-T8-QLXP5K-UNV	No Switch/No Sensor
17	Common Bathroom	2,000	2	A-T8-QLXP5K-UNV	Sensor in Place; Vapor-Tight Fixture; Lenses Missing
17.1	Hallway in Front of Restroom	8,760	1	ADFW/N-T8-QXP-UNV	Requires Square Base Fixture Piped Into Side of Fixture
17.2	Long Hallway	8,760	1	EDFW/NS-T8-QLXP5K-UNV	Replacing 8' 2L T8 Strip Fixture
17.2	Long Hallway	8,760	1	FMS-277	
17.3	Hallway Outside Referee's Room	8,760	1	EDFW/NS-T8-QLXP5K-UNV	
17.3	Hallway Outside Referee's Room	8,760	1	FMS-277	
18	Referee's Room	1,000	1	FMS-277	

Fixture Locations
City of Dover - Ice Arena - S3
Dover, NH

Map	Location	Hours	Qty	Code	Notes
18	Referee's Room	1,000	1	EDFW/NS-T8-VT-QLXP5K-UNV	
19	St. Thomas Locker Room	1,600	1	WSS-277	
19	St. Thomas Locker Room	1,600	2	ADFW/N-T8-QLXP5K-UNV	
19	St. Thomas Locker Room	1,600	2	BDFWW/N-T8-QLXP5K-UNV	
19.1	St. Thomas Locker Room - Coach's Office	1,000	1	A-T8-QLXP5K-UNV	
19.2	St. Thomas Locker Room - Coach's Office	8,760	1	E1/E-T8-QLXP5K-UNV	
19.2	St. Thomas Locker Room - Coach's Office	8,760	1	FSS-277	
20	Storage/Boiler Room	8,760	1	ADF-T8-QLXP5K-UNV	Sensor in Place - Not Functioning
20	Storage/Boiler Room	8,760	1	WSS-277	
20.1	Boiler Room	8,760	1	E1/E-T8-QLXP5K-UNV	Size 4 1/4 x 96; Sensor in Place - Not Functioning
20.1	Boiler Room	8,760	1	WSS-277	
21	Restroom For Locker Rooms 1, 2 & 3	1,000	1	ADFTW/N-T8-VT-QLXP5K-UNV	Sensor in Place
22	Locker Room 3	8,760	1	NOUPGRADE-4'1L32WT8NP	Sensor in Place - Not Functioning
22	Locker Room 3	8,760	1	WSS-277	
23	Locker Room 2	8,760	1	NOUPGRADE-4'1L32WT8NP	Sensor in Place - Not Functioning
23	Locker Room 2	8,760	1	WSS-277	
24	Locker Room 1	8,760	1	WSS-277	
24	Locker Room 1	8,760	1	EDFW/N-T8-VT-QLXP5K-UNV	Sensor in Place - Not Functioning
25	Foster Ice Arena	3,000	7	A-T8-QLXP5K-UNV	
25	Foster Ice Arena	-	192	NO UPGRADE	Existing 2' 2L 55W Biax Fixture
26	Arcade Room	5,950	6	ADFTW/N-T8-QLXP5K-UNV	
26	Arcade Room	-	3	PULL CHAINS	
26	Arcade Room	5,950	1	ADFW/N-T8-QLXP5K-UNV	
26	Arcade Room	-	1	PULL CHAINS	
27	Party Room	1,000	2	ADFTWW/N-T8-QLXP5K-UNV	Sensor in Place
28	Dover Youth Hockey Area - 2nd Floor	2,600	2	CDF-T8-QLXP5K-UNV	In Upper Conference Area
28	Dover Youth Hockey Area - 2nd Floor	2,600	1	WSS-277	
28.1	Dover Youth Hockey Area - 2nd Floor	2,600	1	ADFW/N-T8-QLXP5K-UNV	Replacing 2L T8 Industrial Fixture Near Copier
28.1	Dover Youth Hockey Area - 2nd Floor	2,600	1	CDFS/N-T8-QLXP5K-UNV	Replacing 2 x 4 Surface Mount Box
28.1	Dover Youth Hockey Area - 2nd Floor	2,600	1	BDF-T8-QLXP5K-UNV	In 36-Cell Parabolic Recessed Troffer
28.1	Dover Youth Hockey Area - 2nd Floor	2,600	1	UDF-T8-QLXP5K-UNV	In Small Vestibule Area

Fixture Locations

City of Dover - Ice Arena - S3

Dover, NH

Map	Location	Hours	Qty	Code	Notes
28.1	Dover Youth Hockey Area - 2nd Floor	8,760	1	A-T8-QLXP5K-UNV	2nd Floor Landing
28.1	Dover Youth Hockey Area - 2nd Floor	2,600	1	A-T8-QLXP5K-UNV	Existing 2 x 4 Fixture Over Small Stairwell
28.2	Dover Youth Hockey Area - 2nd Floor	2,000	1	WSS-120	
28.2	Dover Youth Hockey Area - 2nd Floor	2,000	4	SLSR3020-I65-120	Replacing 65W Incandescent - In Small Office
28.3	Dover Youth Hockey Area - 2nd Floor	8,760	1	ADFW/NS-T8-QLXP5K-UNV	
28.3	Dover Youth Hockey Area - 2nd Floor	8,760	1	FMS-277	
29	Electric Compressor Room	3,000	2	HDF/E-T8-QLXP5K-UNV	
29	Electric Compressor Room	8,760	1	X-REMOVE	Remove 2 x 4 2L T8
29	Electric Compressor Room	8,760	1	ADD-VRX32W-120	Wall-Mounted Flood Fixture For Gage Readings
30	Foster Zamboni Room	3,000	2	E1/E-T8-QLXP5K-UNV	
31	Gas Compressor Room	2,000	6	A-T8-QLXP5K-UNV	Existing 1 x 4 2L T8 Vapor Tight
32	Foster Score Booth Area	1,000	1	A-T8-QLXP5K-UNV	
33	Snack Bar Area	2,600	8	CDF-T8-QLXP5K-UNV	
33	Snack Bar Area	2,600	1	CSS-277	W2000A
33.1	Snack Bar Area	8,760	1	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
34	Electrical Room/Paper Storage	500	3	ADF-T8-QLXP5K-UNV	
35	Sprinkler Room/Interface Room	-	1	SWITCH	Re-Install Switch in Interface Room For 3-Way Switching
35	Sprinkler Room/Interface Room	-	1	SWITCH	Install New Switch in Sprinkler Area
35	Sprinkler Room/Interface Room	8,760	2	ADD-ADFW/N-QLXP5K-UNV	(1) in Sprinkler Room; (1) in Interface Room
35	Sprinkler Room/Interface Room	8,760	1	X-REMOVE	Remove 8' 2L T8 Slimline Fixture
36	Hallway Outside of Holt	5,950	3	HSS-277	
36	Hallway Outside of Holt	5,950	19	CDF-T8-QLXP5K-UNV	(9) Fixtures Are Ballast Load Only
36.1	Hallway Outside of Holt	8,760	1	VSS-120	
36.1	Hallway Outside of Holt	8,760	1	NOUPGRADE-VENDINGMACHINE	Coke Machine
36.2	Hallway Outside of Holt	8,760	1	NOUPGRADE-VENDINGMACHINE	Single Coke Machine
36.2	Hallway Outside of Holt	8,760	1	VSS(2)-120	
37	Main Entry Vestibule Area	5,950	2	CSS-277	CMPDT
37	Main Entry Vestibule Area	5,950	15	CDF-T8-QLXP5K-UNV	
38	Vestibule Outside of Foster Rink	5,950	8	CDF-T8-QLXP5K-UNV	
38	Vestibule Outside of Foster Rink	5,950	1	CSS-277	CMPDT
39	Men's Room	5,950	2	CDF-T8-QLXP5K-UNV	

Fixture Locations

City of Dover - Ice Arena - S3

Dover, NH

Map	Location	Hours	Qty	Code	Notes
39	Men's Room	5,950	1	CSS-277	CMPDT
40	Women's Room	5,950	1	CSS-277	CMPDT
40	Women's Room	5,950	2	CDF-T8-QLXP5K-UNV	
41	Registration Area	5,950	1	CDF-T8-QLXP5K-UNV	
42	File Area	5,950	2	CDF-T8-QLXP5K-UNV	
42	File Area	5,950	1	CSS-277	CX105 - Corner Mount
43	Office	5,950	2	CDF-T8-QLXP5K-UNV	
43	Office	5,950	1	CSS-277	CMPDT
44	Conference Room	1,000	6	CDF-T8-QLXP5K-UNV	Sensor in Place
45	Great Bay Figure Skating Club Office Area	1,000	1	CDF-T8-QLXP5K-UNV	
46	Rink Manager's Office	-	1	PLATES	4 x 4 Raised Device Box Cover Plate
46	Rink Manager's Office	2,600	1	CDF-T8-QLXP5K-UNV	
46	Rink Manager's Office	2,600	1	WSS-277	
47	Locker Room 6	2,000	5	A-T8-QLXP5K-UNV	Sensor in Place; (3) of (5) Lenses Not Installed
48	Common Bathroom	8,760	1	CSS-277	W500A/CMPDT
48	Common Bathroom	8,760	3	A-T8-QLXP5K-UNV	(1) of (3) Lenses Not Installed
49	Locker Room 7	2,000	3	A-T8-QLXP5K-UNV	Sensor in Place; (1) Lens Not Installed
49	Locker Room 7	8,760	1	A-T8-QLXP5K-UNV	Night Light in Rear of Room
50	Berwick Academy Locker Room	1,600	8	A-T8-QLXP5K-UNV	Sensor in Place; (1) Lens Missing
50.1	Berwick Academy Locker Room	1,000	1	WSS-277	
50.1	Berwick Academy Locker Room	1,000	5	A-T8-QLXP5K-UNV	In Rear Storage/Work Area
51	Berwick Academy Girl's Locker Room	1,600	7	A-T8-QLXP5K-UNV	Sensor in Place; (4) Lenses Not Installed
52	Berwick Academy Coach's Office	1,000	1	WSS-277	
52	Berwick Academy Coach's Office	-	1	PLATES	4 x 4 Raised Device Box Plate
52	Berwick Academy Coach's Office	1,000	2	A-T8-QLXP5K-UNV	
53	Pro Shop	5,950	6	CDF-T8-QLXP5K-UNV	
53	Pro Shop	5,950	1	CSS-277	W500A
54	Men's Room	5,950	1	CSS-277	W500A
54	Men's Room	5,950	2	CDF-T8-QLXP5K-UNV	
55	Women's Room	5,950	1	CSS-277	W1000A
55	Women's Room	5,950	4	CDF-T8-QLXP5K-UNV	

Fixture Locations

City of Dover - Ice Arena - S3

Dover, NH

Map	Location	Hours	Qty	Code	Notes
55	Women's Room	5,950	2	CDFT-T8-QLXP5K-UNV	
56	Holt Arena	-	192	NO UPGRADE	Existing 2' 2L 55W Biax Fixture
56	Holt Arena	3,000	7	A-T8-QLXP5K-UNV	
57	Exterior - Outside of Compressor Room	3,650	1	NOUPGRADE-MH100	Replacing MH100; Wall Pack; 8' AFF
57	Exterior	3,650	11	NOUPGRADE-MH400	Replacing MH400; Wall Pack Required; (2) @ 20' AFF & (9) @ 13' AFF
57	Exterior	3,650	6	NOUPGRADE-MH400	Replacing MH400; Bldg Mtd Wall Pack; (4) @ 10' AFF & (2) @ 7' AFF
57	Exterior	3,000	16	NOUPGRADE-MH400	Replacing MH400; 24' Pole Lights; Square Tenon Box Fixture; 24' AFF
	Total		**729**		

Summary of Recommended Lighting Retrofit

City of Dover - Dover City Hall - S2

ESCO Code	Qty	Description
ADF-T8-QXPS-UNV	2	IN 2 LAMP 4' T8 FLUORESCENT FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (1) 4' T8 XPS SUPER SAVER LAMP
ADFW/N-QXPS-UNV	1	REPLACE 4' 2 LAMP FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (1) 4' T8 XPS SUPER SAVER LAMP
AFW/N-(2)I150-QXPS-UNV	1	REPLACE (2) 150 WATT INCANDESCENT FIXTURES WITH NEW 4' FLUORESCENT WRAP FIXTURE WITH QHEN NORMAL POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS AND (2) 4' T8 XPS SUPER SAVER LAMPS
A-RL-XPS	2	IN 2 LAMP 4' T8 FLUORESCENT FIXTURE INSTALL (2) 4' T8 XPS SUPER SAVER LAMPS
BDF-T8-QLXPS-UNV	5	IN 4 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XPS SUPER SAVER LAMPS
BDF-T8-QXPS-UNV	30	IN 4 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XPS SUPER SAVER LAMPS
BDFT-T8-QXPS-UNV	2	IN 4 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, AND (2) 4' T8 XPS SUPER SAVER LAMPS
BDFTWW/N-T8-QLXPS-UNV	4	REPLACE EXISTING 4' 4 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' SURFACE MOUNTED WIDE WRAP FIXTURE WITH TANDEM WIRED QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 XPS SUPER SAVER LAMPS
BDFWW/N-T8-QLXPS-UNV	4	REPLACE EXISTING T8 4 LAMP 4' FLUORESCENT FIXTURE WITH NEW 4' WIDE WRAP FIXTURE WITH QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, (2) 4' T8 XPS SUPER SAVER LAMPS AND WRAP LENS.
BDFWW/N-T8-QXPS-UNV	14	REPLACE EXISTING T8 4 LAMP 4' FLUORESCENT FIXTURE WITH NEW 4' WIDE WRAP FIXTURE WITH QHEN REGULAR POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, (2) 4' T8 XPS SUPER SAVER LAMPS AND WRAP LENS.
CDF-T8-QXPS-UNV	10	IN 3 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XPS SUPER SAVER LAMPS

Summary of Recommended Lighting Retrofit

City of Dover - Dover City Hall - S2

ESCO Code	Qty	Description
CSS-120	13	INSTALL CEILING MOUNTED OCCUPANCY SENSOR SYSTEM
EDFW/N-T8-QXPS-UNV	1	REPLACE 8' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 8' FLUORESCENT FIXTURE WITH QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 XPS SUPER SAVER LAMPS
HDF/E-T8-QXPS-UNV	1	IN 2 LAMP T8 8' FLUORESCENT FIXTURE INSTALL QHEN NORMAL POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (4) 4' T8 XPS SUPER SAVER LAMPS
K1/R-CF13-UNV	5	IN STANDARD SINGLE FACE EXIT SIGN WITH 13 WATT COMPACT FLUORESCENT BULB INSTALL L.E.D. RETROFIT KIT
MH70-MF1/2-Q500-UNV	1	REPLACE 500 WATT QUARTZ FIXTURES WITH NEW 70 WATT METAL HALIDE MINI FLOOD FIXTURE WITH 1/2" NIPPLE MOUNT
NO UPGRADE	181	SEE FIXTURE LOCATION KEY FOR NOTES ON CASES WHERE NO UPGRADE OR RETROFIT IS BEING PERFORMED
NOUPGRADE-18WPL	1	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 18 WATT PL COMPACT FLUORESCENT FIXTURE
NOUPGRADE-2'2LT8NP	2	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 2' 2 LAMP T8 F17 LAMPS WITH T8 NORMAL POWER ELECTRONIC BALLASTS FIXTURES
NOUPGRADE-4'2L32WT8NP	31	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 4' 2 LAMP T8 32 WATT ELECTRONIC NORMAL POWER BALLAST FIXTURES
NOUPGRADE-4'4L32WT8NP	15	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 4' 4 LAMP T8 32 WATT ELECTRONIC NORMAL POWER BALLAST FIXTURES
NOUPGRADE-VENDINGMACHIN	2	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON THE VENDING MACHINE

Summary of Recommended Lighting Retrofit

City of Dover - Dover City Hall - S2

ESCO Code	Qty	Description
SLS20-I60-120	56	REPLACE EXISTING 60 WATT INCANDESCENT LAMP WITH SLS20 COMPACT FLUORESCENT LAMP
SLS9G-I25-120	12	REPLACE EXISTING 25 WATT INCANDESCENT LAMP WITH 9 WATT GLOBE CANDLEABRA COMPACT FLUORESCENT LAMP
SLSR3020/D-I75-120	4	REPLACE EXISTING 75 WATT INCANDESCENT LAMP WITH SLS20 COMPACT FLUORESCENT DIMMABLE FLOOD (REFLECTORIZED) LAMP
SLSR3020-I65-120	5	REPLACE EXISTING 65 WATT INCANDESCENT LAMP WITH SLS20 COMPACT FLUORESCENT FLOOD (REFLECTORIZED) LAMP
SP-120/277	2	INSTALL SLAVE PACK WITH CEILING MOUNTED OCCUPANCY SENSOR SYSTEM
VSS-120	2	INSTALL VENDING MACHINE SENSOR VM 150 SYSTEM
WIRE MOLD EXTENSION BOX	3	INSTALL WIRE MOLD EXTENSION BOX IN CORRESPONDING MAP LOCATION
WSS-120	15	REPLACE STANDARD ON / OFF SWITCH WITH WALL MOUNTED OCCUPANCY SENSOR
WSS-DT-120	2	REPLACE STANDARD ON / OFF SWITCH WITH WALL MOUNTED DUAL TECHNOLOGY OCCUPANCY SENSOR
	429	

Fixture Locations

City of Dover - Dover City Hall - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
1	City Clerk's Open Office	-	6	NO UPGRADE	Existing 4' 2L T8 Surface Mount Wrap
2	Hallway	-	2	NO UPGRADE	Existing CF in Hanging Decorative Fixture
2	Hallway	-	12	NO UPGRADE	Existing 1 x 4 2L T8 Wrap
2	Hallway	4,000	1	EDFW/N-T8-QXPS-UNV	Behind Stairwell
2	Hallway	8,760	1	NOUPGRADE-VENDINGMACHINE	Dasani Machine in Elevator Alcove
2	Hallway	8,760	1	VSS-120	
3	City Manager's Reception Area	3,250	2	BDFWW/N-T8-QLXPS-UNV	
3	City Manager's Reception Area	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
4	City Manager's Office	-	6	NO UPGRADE	Existing 2L Incandescent Wall Mounted Decorative Fixture
4	City Manager's Office	-	1	NO UPGRADE	Existing 8L Incandescent Hanging Chandelier
4	City Manager's Office	-	1	NO UPGRADE	Existing 1 x 4 2L T8 Surface Mount Box
4	City Manager's Office	-	1	NO UPGRADE	Existing 2 x 4 2L Decorative Surface Mount Fixture
5	Human Resources	2,000	1	WSS-120	
5	Human Resources	2,000	1	BDFWW/N-T8-QLXPS-UNV	
6	Conference Room/Break Area	3,250	1	NOUPGRADE-4'4L32WT8NP	Existing 8' 4L T8 Surface Mount Wrap
6	Conference Room/Break Area	3,250	1	WSS-120	
6	Conference Room/Break Area	-	1	WIRE MOLD EXTENSION BOX	
6	Conference Room/Break Area	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
7	Copy Room	-	1	NO UPGRADE	Existing 4' 2L T8 Chain Hung Wrap Fixture on Sensor
8	Tax Collector/Water & Sewer Dept. Open Office	-	7	NO UPGRADE	Existing 8' 4L T8 Surface Mount Wrap
8	Tax Collector/Water & Sewer Dept. Open Office	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap in Vault
9	Welfare Department	2,000	2	BDFWW/N-T8-QXPS-UNV	
10	Planning Open Office	2,600	1	BDFWW/N-T8-QXPS-UNV	
10	Planning Open Office	-	1	NO UPGRADE	Existingf 1 x 2 2L T8 Surface Mount Wrap
10	Planning Open Office	2,000	1	BDFWW/N-T8-QXPS-UNV	In Rear Office
10	Planning Open Office	2,000	1	WSS-120	
10	Planning Open Office	-	1	WIRE MOLD EXTENSION BOX	
11	Room #10	-	2	NO UPGRADE	Existing 4' 2L T8 Surface Mount Wrap
12	Men's Room	-	1	NO UPGRADE	Existing 1 x 4 2L T8 Surface Mount Wrap on Sensor

Fixture Locations

City of Dover - Dover City Hall - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
12	Men's Room	-	2	NO UPGRADE	Existing 2 x 4 2L T8 Surface Mount Box Fixture on Sensor
13	Planning Open Office Area	-	8	NO UPGRADE	Existing 1 x 4 2L T8 Surface Mount Wrap
13	Planning Open Office Area	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
14	Planning Office	2,600	3	NOUPGRADE-4'2L32WT8NP	Existing 1 x 4 2L T8 Surface Mount Wrap
14	Planning Office	2,600	1	WSS-120	
15	Tax Assessor's Open Office	2,600	3	BDFWW/N-T8-QXPS-UNV	
15	Tax Assessor's Open Office	-	1	NO UPGRADE	Existing 1 x 4 2L T8 Surface Mount Wrap
16	Assessor's Office	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
16	Assessor's Office	2,600	1	BDFWW/N-T8-QXPS-UNV	
16	Assessor's Office	2,600	1	WSS-120	
17	Women's Room	3,250	1	WSS-120	
17	Women's Room	3,250	1	NOUPGRADE-18WPL	Existing 18W CF Recessed Can
17	Women's Room	3,250	2	NOUPGRADE-2'2LT8NP	Existing 1 x 2 2L T8 Surface Mount Wrap
18	Finance Open Office	2,600	2	BDFTWW/N-T8-QLXPS-UNV	
18	Finance Open Office	2,600	1	BDFWW/N-T8-QLXPS-UNV	Over File Cabinets
19	Office	2,600	2	NOUPGRADE-4'2L32WT8NP	Existing 1 x 4 2L Decorative Drop Lens Surface Mount Fixture
19	Office	2,600	1	WSS-120	
21	Office	2,600	1	WSS-120	
21	Office	2,600	1	NOUPGRADE-4'4L32WT8NP	Existing 8' 4L T8 Surface Mount Wrap
21	Office	2,600	1	NOUPGRADE-4'2L32WT8NP	Existing 4' 2L T8 Surface Mount Wrap
22	Accounting Office	2,600	2	BDFWW/N-T8-QXPS-UNV	
22	Accounting Office	-	2	NO UPGRADE	Existing 4' 2L T8 Surface Mount Wrap
23	Office	-	2	NO UPGRADE	Existing 8' 4L T8 Surface Mount Wrap
23	Office	-	1	NO UPGRADE	Existing CF Schoolhouse Globe
23	Office	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap in Vault
24	Custodial Closet	-	2	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap on Sensor
25	3rd Floor - Rear Stairwell	-	3	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
26	Function Room	-	16	NO UPGRADE	Existing 2 x 4 4L T8 Surface Mount Box
26	Function Room	8,760	5	K1/R-CF13-UNV	In Decorative Exit Signs

Fixture Locations

City of Dover - Dover City Hall - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
27	Building Inspector's Office	2,600	2	BDFTWW/N-T8-QLXPS-UNV	
28	Inspection Open Office	2,600	4	BDFWW/N-T8-QXPS-UNV	
29	Women's Room	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
29	Women's Room	-	1	NO UPGRADE	Existing 1 x 4 2L T8 Surface Mount Wrap
30	Conference Room	2,000	4	NOUPGRADE-4'4L32WT8NP	Existing 8' 4L T8 Surface Mount Wrap
30	Conference Room	2,000	1	CSS-120	W1000A
30	Conference Room	1,000	12	SLS9G-I25-120	Wall Mounted Decorative Fixture
31	Open Office Area	2,600	5	NOUPGRADE-4'4L32WT8NP	Existing 8' 4L T8 Surface Mount Wrap
31	Open Office Area	2,600	4	NOUPGRADE-4'2L32WT8NP	Existing 4' 2L T8 Surface Mount Wrap
31	Open Office Area	2,600	2	CSS-120	W500A
32	Corner Office	2,600	2	NOUPGRADE-4'4L32WT8NP	Existing 8' 4L T8 Surface Mount Wrap
32	Corner Office	2,600	1	CSS-120	CX105
33	File Area	-	2	NO UPGRADE	Existing 8' 4L T8 Surface Mount Wrap; Sensor in Place
34	Office	2,600	2	NOUPGRADE-4'2L32WT8NP	Existing 4' 2L T8 Surface Mount Wrap
34	Office	2,600	1	WSS-120	
34	Office	-	1	WIRE MOLD EXTENSION BOX	
35	Men's Room	2,600	1	NOUPGRADE-4'2L32WT8NP	Existing 4' 2L T8 Surface Mount Wrap
35	Men's Room	2,600	1	WSS-DT-120	
35	Men's Room	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap in Small Entry Vestibule
36	Large Open Office Area	2,600	2	CSS-120	W500A
36	Large Open Office Area	2,600	13	NOUPGRADE-4'2L32WT8NP	Existing 4' 2L T8 Surface Mount Wrap
37	Corridor	-	2	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
37	Corridor	-	11	NO UPGRADE	Existing 1 x 4 2L T8 Surface Mount Wrap
38	Conference Room	2,000	4	BDF-T8-QXPS-UNV	
38	Conference Room	2,000	1	CSS-120	DT200
38	Conference Room	-	1	SP-120/277	
39	Council Chambers	-	8	NO UPGRADE	Existing 8' 4L T8 Pendant Mount Wrap
39	Council Chambers	-	2	NO UPGRADE	Existing 4' 2L T8 Pendant Mount Wrap
40	Legal Office	-	4	NO UPGRADE	Existing 2 x 4 2L T8 Recessed Troffer

Fixture Locations

City of Dover - Dover City Hall - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
41	Office	1,600	2	NOUPGRADE-4'4L32WT8NP	Existing 2 x 4 4L T8 Prismatic Recessed Troffer
41	Office	1,600	1	WSS-120	WI200 w/ Photo
42	Basement - Boiler Room	-	7	NO UPGRADE	Existing 4' 2L T8 Industrial Fixture
43	Chief of Police Office	1,400	3	BDF-T8-QXPS-UNV	Sensor in Place
44	Chief's Conference Room	2,600	3	BDF-T8-QXPS-UNV	
44	Chief's Conference Room	2,600	1	CSS-120	DT200
45	Captain's Office	3,000	3	BDF-T8-QXPS-UNV	
45	Captain's Office	3,000	1	CSS-120	DT200
46	Police Reception Area	3,000	3	BDF-T8-QLXPS-UNV	
47	Communication Supervisor's Office	3,000	1	CDF-T8-QXPS-UNV	
47	Communication Supervisor's Office	3,000	1	WSS-120	
48	Dispatch Area	-	4	NO UPGRADE	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer
48	Dispatch Area	-	3	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
48	Dispatch Area	1,600	4	SLSR3020/D-I75-120	Dimmable; Replacing 75W Incandescent Recessed Can
48	Dispatch Area	-	3	NO UPGRADE	Existing 4' 1L T8 Indirect Fixture
49	Interview Area	3,000	3	BDF-T8-QXPS-UNV	
50	Room	-	2	NO UPGRADE	Existing 2 x 4 2L T8 Prismatic Troffer Recessed
50	Room	1,600	5	SLSR3020-I65-120	Replacing 65W Incandescent
51	Hallway	-	4	NO UPGRADE	Existing 2 x 4 2L T8 Prismatic Troffer
52	Records Room	-	8	NO UPGRADE	Existing 2 x 4 2L T8 Prismatic Troffer
53	I T Room	-	2	NO UPGRADE	Existing 2 x 4 2L T8 Prismatic Troffer; On Sensor
54	Detective's Area	3,000	4	CDF-T8-QXPS-UNV	
55	Lieutenant's Office	2,600	2	CDF-T8-QXPS-UNV	
55	Lieutenant's Office	2,600	1	CSS-120	CX105
56	File Storage	1,000	1	CDF-T8-QXPS-UNV	
56	File Storage	1,000	1	WSS-120	
57	Interview Room	500	1	CDF-T8-QXPS-UNV	
58	Interview Room	500	1	CDF-T8-QXPS-UNV	
59	Vestibule	8,760	2	BDF-T8-QLXPS-UNV	

Fixture Locations

City of Dover - Dover City Hall - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
60	Booking Room	-	3	NO UPGRADE	Existing 2 x 4 3L T8 Prismatic Troffer
60	Booking Room	-	1	NO UPGRADE	Existing 1 x 2 2L T8 Surface Mount Wrap
61	Hold Cell Area	-	4	NO UPGRADE	Existing 1 x 4 2L Vandal Proof Prismatic T8 Troffer
61	Hold Cell Area	-	5	NO UPGRADE	Existing 1L T8 Corner Mount Vandal Proof Fixture
62	Sallyport Area	8,760	1	HDF/E-T8-QXPS-UNV	
62	Sallyport Area - Small Storage Side	3,000	2	ADF-T8-QXPS-UNV	
63	Training Office	1,600	2	BDF-T8-QXPS-UNV	
63	Training Office	1,600	1	WSS-120	
64	Traffic Bureau Office	2,600	1	BDF-T8-QXPS-UNV	
64	Traffic Bureau Office	2,600	1	WSS-120	
65	Spent Shell Storage Area	1,000	1	ADFW/N-QXPS-UNV	Existing 1 x 4 2L T12 Wrap Fixture
65	Spent Shell Storage Area	-	1	NO UPGRADE	Existing 1 x 4 2L T8 Surface Mount Wrap in Vault
66	Mail Room	8,760	2	BDFT-T8-QXPS-UNV	
66	Mail Room	-	1	SP-120/277	
66	Mail Room	8,760	2	BDF-T8-QXPS-UNV	
66	Mail Room	8,760	1	CSS-120	DT200
67	Shift Commander's Area	8,760	3	BDF-T8-QXPS-UNV	
68	Animal Control Hallway	8,760	1	BDF-T8-QXPS-UNV	
68	Animal Control Hallway	8,760	2	A-RL-XPS	Existing 2x4 2L T8 PRismatic Troffer
68	Animal Control Hallway	8,760	1	CSS-120	
69	Men's Locker	6,000	3	NOUPGRADE-4'2L32WT8NP	Existing 1 x 4 2L T8 Surface Mount Wrap
69	Men's Locker	6,000	1	WSS-DT-120	
71	Shower Area	-	2	NO UPGRADE	Existing CF Wall Mounted Vanity Fixture; On Sensor
71	Shower Area	-	4	NO UPGRADE	Existing 2 x 4 2L T8 Prismatic Troffer; On Sensor
72	Exercise Room	2,000	4	NO UPGRADE	Existing 2 x 4 2L T8 Prismatic Recessed Troffer; Sensor in Place
73	Women's Locker	6,000	1	NOUPGRADE-4'2L32WT8NP	Existing 1 x 4 2L T8 Surface Mount Wrap; Lens Missing
73	Women's Locker	6,000	1	WSS-120	
74	Prosecutor's Office	2,600	4	BDF-T8-QXPS-UNV	Sensor in Place
75	Copy Area	8,760	1	BDF-T8-QXPS-UNV	

Fixture Locations

City of Dover - Dover City Hall - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
75	Copy Area	-	1	NO UPGRADE	Existing 4' 1L T8 Strip Fixture in Display Cabinet
76	Vending Area	8,760	1	VSS-120	
76	Vending Area	-	1	NO UPGRADE	Exiting 1 x 2 2L T8 Surface Mount Wrap
76	Vending Area	8,760	1	NOUPGRADE-VENDINGMACHINE	Coke Machine
77	Bathroom	8,760	1	NOUPGRADE-4'2L32WT8NP	Existing 2 x 4 2L T8 Recessed Troffer; Lens and Door Missing
77	Bathroom	8,760	1	CSS-120	W500A
78	Evidence Storage Room	-	4	NO UPGRADE	Existing 2 x 4 2L T8 Prismatic Troffer; No Access
79	Storage	-	2	NO UPGRADE	Existing 1 x 4 2L T8 Wrap Fixture
80	Attic Area to Clock Tower	3,650	1	MH70-MF1/2-Q500-UNV	Replacing 500W Roof Mounted Quartz Fixture; 1/2" Nipple Mount
80	Attic Area to Clock Tower	500	3	SLS20-I60-120	Replacing 60W Incandescent
80	Attic Area to Clock Tower	500	1	AFW/N-(2)I150-QXPS-UNV	Replacing (2) 150W Incandescent
80	Attic Area to Clock Tower	500	2	SLS20-I60-120	Replacing 60W Incandescent; On Landing Below Clock Tower
80	Attic Area to Clock Tower	4,368	48	SLS20-I60-120	Replacing 60W Incandescent Around Clock Face
80	Attic Area to Clock Tower	500	3	SLS20-I60-120	Replacing 60W Incandescent; Landing Lighting
	Total		**429**		

Summary of Recommended Lighting Retrofit

City of Dover - DPW - S2

ESCO Code	Qty	Description
ADFT-T8-QXP5K-UNV	60	IN 2 LAMP 4' T8 FLUORESCENT FIXTURE INSTALL QHEN NORMAL POWER SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, AND (1) 4' T8 XP 5000K SUPER SAVER LAMP
ADFW/N-T8-QLXP5K-UNV	2	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS AND (1) 4' T8 5000K XP SUPER SAVER LAMP
ADFW/N-T8-VF-QLXP5K-UNV	4	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT VANITY FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS AND (1) 4' T8 XP 5000K SUPER SAVER LAMP
A-T8-QLXP5K-UNV	10	IN 2 LAMP 4' T8 FLUORESCENT FIXTURE INSTALL QHEL SUPER SAVER ELECTRONIC BALLAST AND (2) 4' T8 5000K XP SUPER SAVER LAMPS
BODINE REWIRE	4	INSTALL AFTER RETROFIT EXISTING 1 LAMP T8 EMERGENCY BALLAST IN EXISTING FIXTURE
CDF-T8-QL255K-UNV	2	IN 3 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 25 WATT 5000K SUPER SAVER LAMPS
CDF-T8-QLXP5K-UNV	110	IN 3 LAMP 2X4 T8 FLUORESCENT FIXTURE INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
CSS-277	14	INSTALL CEILING MOUNTED OCCUPANCY SENSOR SYSTEM
EDF-QXP5K-UNV	1	IN 2 LAMP 8' FLUORESCENT FIXTURE INSTALL QHEN NORMAL POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
EDF-T8-QXP5K-UNV	4	IN 2 LAMP 8' T8 FLUORESCENT FIXTURE INSTALL QHEN NORMAL POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 XP 5000K SUPER SAVER LAMPS
FMS-277	44	INSTALL OCCUPANCY SENSOR SYSTEM DIRECTLY TO EACH INDIVIDUAL FIXTURE

Summary of Recommended Lighting Retrofit

City of Dover - DPW - S2

ESCO Code	Qty	Description
FSS-277	21	INSTALL OCCUPANCY SENSOR SYSTEM DIRECTLY TO EACH INDIVIDUAL FIXTURE OR ROW OF FIXTURES
HDF/E-T8-QLXP5K-UNV	17	IN 2 LAMP T8 8' FLUORESCENT FIXTURE INSTALL QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (4) 4' T8 XP 5000K SUPER SAVER LAMPS
HDF-QXP5K-UNV	12	IN 8' 2 LAMP HIGH OUTPUT FLUORESCENT FIXTURE INSTALL QHEN ELECTRONIC BALLAST, REFLECTOR AND (4) 4' T8 XP 5000K SUPER SAVER LAMPS
HDFW/N-T8-VT-QLXP5K-UNV	8	REPLACE 8' 2 LAMP T8 HIGH OUTPUT FLUORESCENT FIXTURE WITH NEW 8' 4 LAMP VAPOR TIGHT FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (4) 4' T8 XP 5000K SUPER SAVER LAMPS
MH320/R/PS-MH400-277	21	RETROFIT 400 WATT METAL HALIDE FIXTURES WITH 320 WATT PULSE START METAL HALIDE SYSTEM
NOUPGRADE-2X18WPL	17	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 2x18 WATT PL COMPACT FLUORESCENT FIXTURE
NOUPGRADE-LEDEXIT	17	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING LED EXIT SIGN
NOUPGRADE-MH100	26	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 100 WATT METAL HALIDE FIXTURE
NOUPGRADE-VENDINGMACHIN	1	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON THE VENDING MACHINE
PLATES	1	INSTALL COVER PLATE TO CEILING
SP-120/277	1	INSTALL SLAVE PACK WITH CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

Summary of Recommended Lighting Retrofit

City of Dover - DPW - S2

ESCO Code	Qty	Description
VDF4'/NS-MH400-QHXP5K-UN	44	REPLACE 400 WATT METAL HALIDE FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH (2) QHEH HIGH OUTPUT SUPER SAVER ELECTRONIC BALLASTS, FIXTURE MOUNTED OCCUPANCY SENSOR, REFLECTOR AND (6) 4' T8 XP 5000K SHATTERSHIELD SUPER SAVER LAMPS
VRX42W-I150-120	4	REPLACE 150 WATT INCANDESCENT FIXTURE WITH NEW LOWBAY FIXTURE CONTAINING (1) HARD WIRED ELECTRONIC COMPACT FLUORESCENT BALLAST AND (1) CF 42 WATT COMPACT FLUORESCENT LAMP
VSS-120	1	INSTALL VENDING MACHINE SENSOR VM 150 SYSTEM
WSS-277	12	REPLACE STANDARD ON/OFF SWITCH WITH WALL MOUNTED OCCUPANCY SENSOR SYSTEM
WSS-DT-277	1	REPLACE STANDARD ON / OFF SWITCH WITH WALL MOUNTED DUAL TECHNOLOGY OCCUPANCY SENSOR
X-REMOVE	1	REMOVE FIXTURES
	460	

Fixture Locations
City of Dover - DPW - S2
Dover, NH

Map	Location	Hours	Qty	Code	Notes
1	Open Office Area	8,760	4	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer; Night Light
1	Open Office Area	2,250	1	A-T8-QLXP5K-UNV	Existing 2 x 4`2L T8 Prismatic Toffer
1	Open Office Area	8,760	4	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
1	Open Office Area	2,250	12	NOUPGRADE-2X18WPL	Existing 2 x 18W CF Recessed Can; 60 FC Average
1	Open Office Area	2,250	23	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer
2	Conference Room	1,600	8	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer; A/B Switched
2	Conference Room	1,600	1	CSS-277	DT200
2	Conference Room	-	1	SP-120/277	
2.1	Conference Room	1,600	3	NOUPGRADE-2X18WPL	Existing 2 x 18W CF Recessed Can; 85 FC Average
3	Community Services Director's Office	1,600	2	CDF-T8-QLXP5K-UNV	
3	Community Services Director's Office	1,600	1	WSS-277	
4	Assistant City Engineer's Office	1,600	1	WSS-277	
4	Assistant City Engineer's Office	1,600	2	CDF-T8-QLXP5K-UNV	
5	City Engineer's Office	1,600	2	CDF-T8-QLXP5K-UNV	
5	City Engineer's Office	1,600	1	WSS-277	
6	Environmental Projects Manager's Office	1,600	2	CDF-T8-QLXP5K-UNV	
6	Environmental Projects Manager's Office	1,600	1	WSS-277	
7	File Storage Room	1,000	2	CDF-T8-QLXP5K-UNV	
7	File Storage Room	1,000	1	WSS-277	
8	Archive Room	1,000	1	WSS-277	
8	Archive Room	1,000	2	CDF-T8-QL255K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic
9	Blueprint Room	1,000	4	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic
9	Blueprint Room	1,000	1	CSS-277	CX105
10	Storage	500	1	A-T8-QLXP5K-UNV	
11	Housekeeping	1,600	2	ADFW/N-T8-QLXP5K-UNV	
11	Housekeeping	1,600	1	WSS-277	
12	Unisex Bathroom	1,000	1	A-T8-QLXP5K-UNV	
12	Unisex Bathroom	1,000	1	WSS-277	
13	Corridor	8,760	4	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer

Fixture Locations
City of Dover - DPW - S2
Dover, NH

Map	Location	Hours	Qty	Code	Notes
13	Corridor	1,000	9	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer
13	Corridor	8,760	4	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
13	Corridor	-	1	NOUPGRADE-2X18WPL	Exotomg 2 x 18W CF Recessed Can
14	Storage	1,000	2	A-T8-QLXP5K-UNV	
14	Storage	1,000	1	WSS-277	
15	Men's Locker Room	1,600	4	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer
15	Men's Locker Room	2,000	3	ADFW/N-T8-VF-QLXP5K-UNV	Existing 1 x 4 2L T8 Vanity Fixture
15	Men's Locker Room	2,000	2	CSS-277	W500A or CMPDT
15.1	Men's Locker Room	8,760	2	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer; Night Lights
15.1	Men's Locker Room	-	2	BODINE REWIRE	Rewire Existing Bodine Ballast After Retrofit
15.1	Men's Locker Room	1,600	1	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer
15.1	Men's Locker Room	200	2	A-T8-QLXP5K-UNV	Exiting 1 x 4 2L T8 Vapor Tight Fixture
16	Women's Locker Room	2,000	2	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer
16	Women's Locker Room	2,000	1	NOUPGRADE-2X18WPL	Existing 2 x 18W CF Recessed Can
16	Women's Locker Room	2,000	1	WSS-DT-277	Dual Technology Required
16	Women's Locker Room	2,000	1	ADFW/N-T8-VF-QLXP5K-UNV	Existing 1 x 4 2L T8 Vanity Fixture
16.1	Women's Locker Room	8,760	1	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer
16.1	Women's Locker Room	100	1	A-T8-QLXP5K-UNV	Vapor Tight Fixture in Shower Area
16.1	Women's Locker Room	-	1	BODINE REWIRE	Rewire Existing Bodine Ballast After Retrofit
17	Break Area	2,000	4	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer; A/B Switched
17	Break Area	2,000	1	CSS-277	CMPDT
17.1	Break Area	8,760	1	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer; Night Light
17.2	Break Area	8,760	1	NOUPGRADE-VENDINGMACHINE	Coke Vending Machine
17.2	Break Area	8,760	1	VSS-120	
18	Training Room	1,000	5	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer
18	Training Room	1,000	1	CSS-277	CMPDT
18.1	Training Room	8,760	1	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer; Night Light
19	Utility Supervisor's Office	2,250	1	WSS-277	WI200 w/ Photocell
19	Utility Supervisor's Office	2,250	2	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer

Fixture Locations

City of Dover - DPW - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
20	Office	2,250	1	CSS-277	CX105
20	Office	2,250	4	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer
21	Command Center	1,600	2	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer
21	Command Center	8,760	1	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer; Night Light
22	Recycling Office	1,600	1	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 18-Cell Parabolic Recessed Troffer; Night Light
23	Inventory Coordinator's Office	2,250	2	CDF-T8-QLXP5K-UNV	
23	Inventory Coordinator's Office	2,250	1	WSS-277	
23.1	Inventory Coordinator's Office	-	1	X-REMOVE	Remove 2nd Switch Close to Utility Stockroom & Plate
23.1	Inventory Coordinator's Office	-	1	PLATES	Blank Cover Plate on X-Remove Switch
24	Stockroom	2,250	4	CSS-277	CMPDT
24	Stockroom	2,250	12	ADFT-T8-QXP5K-UNV	Size 4 1/4 x 96
24	Stockroom	2,250	7	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer
24.1	Stockroom	8,760	1	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
24.1	Stockroom	8,760	1	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L T8 Prismatic Troffer; Night Light
24.1	Stockroom	8,760	2	ADFT-T8-QXP5K-UNV	Night Light
25	Electrical Room	200	2	ADFT-T8-QXP5K-UNV	
26	Warm Storage Area	8,760	6	HDF-QXP5K-UNV	20' AFF; Require Rapid Start Ballast; Existing 250W HO's
26	Warm Storage Area	8,760	6	FSS-277	
26	Warm Storage Area	2,250	27	VDF4'/NS-MH400-QHXP5K-UN	Replacing MH400; 20' - 26' AFF; Hook, Cord & Plug; Lower Fixtures 6'
26	Warm Storage Area	2,250	27	FMS-277	
26.1	Warm Storage Area	8,760	2	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
27	Mezzanine Storage	-	1	BODINE REWIRE	
27	Mezzanine Storage	500	14	ADFT-T8-QXP5K-UNV	
27	Mezzanine Storage	8,760	1	A-T8-QLXP5K-UNV	Night Light in Stairwell
28	HVAC Mezzanine	1,000	10	ADFT-T8-QXP5K-UNV	
28	HVAC Mezzanine	1,000	5	FSS-277	
29	Wash Bay	1,600	8	HDFW/N-T8-VT-QLXP5K-UNV	16' AFF
29	Wash Bay	8,760	1	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
30	Storage Area	1,600	6	HDF-QXP5K-UNV	16' AFF

Fixture Locations

City of Dover - DPW - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
31	Storage	500	2	EDF-T8-QXP5K-UNV	
31	Storage	8,760	1	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
32	Carpenter Shop	1,600	7	HDF/E-T8-QLXP5K-UNV	10' AFF
32	Carpenter Shop	8,760	1	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
33	Area Behind Paint Booth	4,500	1	VDF4'/NS-MH400-QHXP5K-UN	Replacing MH400; 26' AFF
33	Area Behind Paint Booth	4,500	1	FMS-277	
33.1	Area Behind Paint Booth	8,760	1	EDF-T8-QXP5K-UNV	Night Light; 16' AFF
34	Maintenance Bay	4,500	6	VDF4'/NS-MH400-QHXP5K-UN	Replacing MH400; Lower to 2' Above Rolling Crane; 26' - 30' AFF
34	Maintenance Bay	4,500	6	FMS-277	
34.1	Maintenance Bay	8,760	1	EDF-QXP5K-UNV	Wall Mounted Near Exit Door; Night Light
34.1	Maintenance Bay	8,760	1	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
35	Fleet Shop Area	4,500	10	FMS-277	
35	Fleet Shop Area	4,500	10	VDF4'/NS-MH400-QHXP5K-UN	Replacing MH400; 26' - 28' AFF; Lower to 2' Above Rolling Crane
35.1	Fleet Shop Area	8,760	1	NOUPGRADE-LEDEXIT	Existing Battery Back-Up LED Exit
35.1	Fleet Shop Area	8,760	1	EDF-T8-QXP5K-UNV	Night Light; 22' AFF
36	Maintenace Mezzanine	4,500	20	ADFT-T8-QXP5K-UNV	
36	Maintenace Mezzanine	4,500	10	FSS-277	
37	Oil Storage	2,600	4	VRX42W-I150-120	Replacing 150W Incandescent; Pendant Mount RAB Fixture
38	Fleet Office	3,000	4	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L 18-Cell Parabolic
38	Fleet Office	3,000	1	CSS-277	CMPDT
39	Break Room	2,000	3	CDF-T8-QLXP5K-UNV	Existing 2 x 4 3L 18-Cell Parabolic
39	Break Room	2,000	1	WSS-277	
40	Fleet Parts Room	3,000	10	HDF/E-T8-QLXP5K-UNV	10' AFF
40	Fleet Parts Room	3,000	2	CSS-277	W1000A or CMPDT
40	Fleet Parts Room	8,760	1	NOUPGRADE-LEDEXIT	Existing Battery Back-Uip LED Exit
41	Stairway to Mezzaine	8,760	1	A-T8-QLXP5K-UNV	Night Light Near Entry Door; Tamper-Proof/Vapor Tight
42	Exterior & Recycling Area Pole Lights	3,650	21	MH320/R/PS-MH400-277	Replacing MH400; Approx. (5) @ 30' AFF & (16) @ 24' AFF
42	Exterior & Recycling Area Pole Lights	3,650	23	NOUPGRADE-MH100	Existing MH100 Building Mounted Wall Pack
42	Exterior & Recycling Area Pole Lights	3,650	3	NOUPGRADE-MH100	Existing MH100 Recessed Can In Front Entry

Fixture Locations

City of Dover - DPW - S2

Dover, NH

Map	Location	Hours	Qty	Code	Notes
	Total		**460**		

Summary of Recommended Lighting Retrofit

City of Dover - Dover Library - S3

ESCO Code	Qty	Description
ADD-CF3X32-120	1	WHERE THERE IS NO EXISTING FIXTURE, INSTALL NEW SCHOOL HOUSE GLOBE FIXTURE CONTAINING (3) HARD WIRED COMPACT FLUORESCENT BALLASTS AND (3) PL 32 WATT COMPACT FLUORESCENT LAMPS
ADF-T8-QXPS-UNV	5	IN 2 LAMP 4' T8 FLUORESCENT FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (1) 4' T8 XPS SUPER SAVER LAMP
ADFT-T8-QXPS-UNV	24	IN 2 LAMP 4' T8 FLUORESCENT FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, AND (1) 4' T8 XPS SUPER SAVER LAMP
ADFTW/NCF9-T8-SEN-QLXPS-	8	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' 1 LAMP WRAP FLUORESCENT FIXTURE WITH TANDEM WIRED QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, SENSOR AND (1) 4' T8 XPS SUPER SAVER LAMP
ADFTW/N-T8-QXPS-UNV	8	INSTALL NEW 4' FLUORESCENT FIXTURE WITH QHEN SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, WRAP LENS AND (1) 4' T8 XPS SUPER SAVER LAMP
ADFTW/N-T8-VF-QLXPS-UNV	10	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' 1 LAMP FLUORESCENT VANITY FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, WRAP LENS AND (1) 4' T8 XPS SUPER SAVER LAMP
ADFW/NCF9-T8-SEN-QLXP-UN	5	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' 1 LAMP WRAP FLUORESCENT FIXTURE WITH QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, SENSOR AND (1) 4' T8 XP SUPER SAVER LAMP
ADFW/N-T8-QLXPS-UNV	3	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS AND (1) 4' T8 XPS SUPER SAVER LAMP
ADFW/N-T8-QXPS-UNV	3	REPLACE 4' 2 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' FLUORESCENT FIXTURE WITH QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, WRAP LENS AND (1) 4' T8 XPS SUPER SAVER LAMP
BDFTW/N-T8-VF-QLXPS-UNV	4	REPLACE EXISTING 4' 4 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' VANITY FIXTURE WITH TANDEM WIRED QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 XPS SUPER SAVER LAMPS
BDFTWW/N-T8-QLXPS-UNV	2	REPLACE EXISTING 4' 4 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' SURFACE MOUNTED WIDE WRAP FIXTURE WITH TANDEM WIRED QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (2) 4' T8 XPS SUPER SAVER LAMPS

Summary of Recommended Lighting Retrofit

City of Dover - Dover Library - S3

ESCO Code	Qty	Description
BDFWW/N-T8-QLXPS-UNV	5	REPLACE EXISTING T8 4 LAMP 4' FLUORESCENT FIXTURE WITH NEW 4' WIDE WRAP FIXTURE WITH QHEL SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, (2) 4' T8 XPS SUPER SAVER LAMPS AND WRAP LENS.
CADFTW/N-T8-VF-QLXPS-UNV	2	REPLACE 4' 3 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' 1 LAMP FLUORESCENT VANITY WRAP FIXTURE CONTAINING QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, AND (1) 4' T8 XPS SUPER SAVER LAMP
CADFTW/N-T8-VF-QXPS-UNV	2	REPLACE 4' 3 LAMP T8 FLUORESCENT FIXTURE WITH NEW 4' 1 LAMP FLUORESCENT VANITY WRAP FIXTURE CONTAINING QHEN NORMAL POWER SUPER SAVER ELECTRONIC BALLAST TANDEM WIRED, REFLECTOR, AND (1) 4' T8 XPS SUPER SAVER LAMP
CSS-120	7	INSTALL CEILING MOUNTED OCCUPANCY SENSOR SYSTEM
FSS-120	17	INSTALL OCCUPANCY SENSOR SYSTEM DIRECTLY TO EACH INDIVIDUAL FIXTURE OR ROW OF FIXTURES
NO UPGRADE	102	SEE FIXTURE LOCATION KEY FOR NOTES ON CASES WHERE NO UPGRADE OR RETROFIT IS BEING PERFORMED
NOUPGRADE-4'1L32WT8NP	4	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 4' 1 LAMP T8 32 WATT ELECTRONIC NORMAL POWER BALLAST FIXTURES
NOUPGRADE-4'2L32WT8LP	83	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 4' 2 LAMP T8 32 WATT ELECTRONIC LOW POWER BALLAST FIXTURES
NOUPGRADE-4'2L32WT8NP	30	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 4' 2 LAMP T8 32 WATT ELECTRONIC NORMAL POWER BALLAST FIXTURES
NOUPGRADE-4'4L32WT8NP	6	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 4' 4 LAMP T8 32 WATT ELECTRONIC NORMAL POWER BALLAST FIXTURES
NOUPGRADE-I300W	12	NO UPGRADE OR RETROFIT IS BEING PERFORMED ON EXISTING 300 WATT INCANDESCENT LAMP

Summary of Recommended Lighting Retrofit

City of Dover - Dover Library - S3

ESCO Code	Qty	Description
PHOTO	1	INSTALL PHOTOCELL INTO EXISTING FIXTURE
PLATES	1	INSTALL COVER PLATE TO CEILING
SLS20-I75-120	1	REPLACE EXISTING 75 WATT INCANDESCENT LAMP WITH SLS20 COMPACT FLUORESCENT LAMP
SLS23-I100-120	1	REPLACE EXISTING 100 WATT INCANDESCENT LAMP WITH SLS23 COMPACT FLUORESCENT LAMP
SLSR3020/D-I65-120	14	REPLACE EXISTING 65 WATT INCANDESCENT LAMP WITH SLS20 COMPACT FLUORESCENT DIMMABLE FLOOD (REFLECTORIZED) LAMP
SLSR3020/D-I75-120	4	REPLACE EXISTING 75 WATT INCANDESCENT LAMP WITH SLS20 COMPACT FLUORESCENT DIMMABLE FLOOD (REFLECTORIZED) LAMP
SLSR4020/D-I65-120	15	REPLACE EXISTING 65 WATT INCANDESCENT LAMP WITH SLS20 DIMMABLE COMPACT FLUORESCENT FLOOD (REFLECTORIZED) LAMP
SSS-120	13	INSTALL OCCUPANCY SENSOR SYSTEM
STAIRWELL-CF9-120	13	AS A PART OF THE STAIRWELL FIXTURE AND LISTED SEPARATELY FOR SAVINGS IS A COMPACT FLUORESCENT 9 WATT COMPACT FLUORESCENT LAMP ON 24 HOURS A DAY
UDF3-2'2LUTUBET8-QLXPS-U	27	IN 2X2 FLUORESCENT FIXTURE WITH (2) T8 U-TUBE LAMPS INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (3) 2' T8 XPS SUPER SAVER LAMPS
UDF3-T8-QLXPS-UNV	28	IN 2X2 FLUORESCENT FIXTURE WITH (3) T8 U-TUBE LAMPS INSTALL QHEL LOW POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (3) 2' T8 XPS SUPER SAVER LAMPS

Summary of Recommended Lighting Retrofit

City of Dover - Dover Library - S3

ESCO Code	Qty	Description
UDF3-T8-QXPS-UNV	9	IN 2X2 FLUORESCENT FIXTURE WITH (3) T8 U-TUBE LAMPS INSTALL QHEN NORMAL POWER SUPER SAVER ELECTRONIC BALLAST, REFLECTOR AND (3) 2' T8 XPS SUPER SAVER LAMPS
UDF-QXPS-UNV	1	IN FLUORESCENT 2X2 FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 2' T8 XPS SUPER SAVER LAMPS
UDF-T8-QXPS-UNV	17	IN FLUORESCENT 2X2 T8 FIXTURE INSTALL QHEN SUPER SAVER ELECTRONIC BALLAST, REFLECTOR, AND (2) 2' T8 XPS SUPER SAVER LAMPS
WSS-120	6	REPLACE STANDARD ON / OFF SWITCH WITH WALL MOUNTED OCCUPANCY SENSOR
WSS-DT-120	2	REPLACE STANDARD ON / OFF SWITCH WITH WALL MOUNTED DUAL TECHNOLOGY OCCUPANCY SENSOR
X-REMOVE-8'2LT12	5	REMOVE 2 LAMP 8' FLUORESCENT FIXTURE
X-REMOVE-8'2LT8	4	REMOVE 2 LAMP 8' T8 FLUORESCENT FIXTURE
	505	

Fixture Locations

City of Dover - Dover Library - S3

Dover, NH

Map	Location	Hours	Qty	Code	Notes
1	2nd Floor - Historical Room	3,175	3	NOUPGRADE-4'2L32WT8LP	Existing 4' 2L Low Power Ballast Indirect Box Fixture
1	2nd Floor - Historical Room	3,175	1	CSS-120	DT200 - Corner Mount
1	2nd Floor - Historical Room	3,175	12	NOUPGRADE-4'2L32WT8LP	Existing 4' 4L Low Power Ballast Indirect Box Fixture
2	Trustees Room	2,000	6	NOUPGRADE-4'2L32WT8LP	Existing 4L Low Power Ballast
2	Trustees Room	2,000	1	CSS-120	DT200 - Corner Mount
3	2nd Floor Open Area Hallway	3,175	1	ADD-CF3X32-120	Replacing (5) 8' 2L T12 Slimline & (4) 8' 2L T8 Slimline Fixtures
3	2nd Floor Open Area Hallway	3,175	2	NOUPGRADE-4'2L32WT8LP	Replacing 1 x 4 2L T8 Direct/Indirect Box
3	2nd Floor Open Area Hallway - Over Elevator	3,175	2	NOUPGRADE-4'2L32WT8LP	Existing 8' 4L Low Power Ballast
3	2nd Floor Open Area Hallway	3,175	5	X-REMOVE-8'2LT12	Replacing (5) 8' 2L T12 Slimline & (4) 8' 2L T8 Slimline Fixtures
3	2nd Floor Open Area Hallway	3,175	4	X-REMOVE-8'2LT8	Replacing (5) 8' 2L T12 Slimline & (4) 8' 2L T8 Slimline Fixtures
4	Clerical Area	3,175	1	WSS-120	
4	Clerical Area	3,175	2	BDFTWW/N-T8-QLXPS-UNV	
4	Clerical Area	3,175	1	NOUPGRADE-4'2L32WT8NP	10' AFF; Replacing Existing Wide Wrap
5	Restroom	500	1	NOUPGRADE-4'2L32WT8NP	
6	Storage	-	1	NO UPGRADE	Existing 4' 2L T8 Vanity; No Access
7	Learning Center	2,000	2	BDFWW/N-T8-QLXPS-UNV	
7	Learning Center	2,000	1	WSS-120	
8	Library Director's Office	3,175	1	WSS-120	
8	Library Director's Office	3,175	2	BDFWW/N-T8-QLXPS-UNV	
9	Kitchenette Area	1,000	1	BDFWW/N-T8-QLXPS-UNV	
9	Kitchenette Area	1,000	1	WSS-120	Requires Combination GFI/Switch Device Cover Plate
9	Kitchenette Area	-	1	PLATES	
10	Lecture Hall	2,000	24	ADFT-T8-QXPS-UNV	14' AFF; Soffit Lighting; Requires Narrow Reflector
10	Lecture Hall	2,000	15	SLSR4020/D-I65-120	Dimmable; Replacing 65W Incandescent; 14' AFF
10	Lecture Hall	2,000	4	NO UPGRADE	Existing Incandescent Reflectorized Recessed Can
10	Lecture Hall	1,000	6	NOUPGRADE-I300W	Dimmable Wall Sconce; Replacing 300W Incandescent
11	1st Floor - Useful Arts Area	3,175	6	NOUPGRADE-4'2L32WT8LP	Existing 4L Ballast
11	1st Floor - Useful Arts Area	3,175	3	NOUPGRADE-4'2L32WT8LP	12' AFF; 22 FC; Indirect Fixture
12	Staff Room	3,175	1	NO UPGRADE	Existing 5X13W CF Chandelier Fixture

Fixture Locations

City of Dover - Dover Library - S3

Dover, NH

Map	Location	Hours	Qty	Code	Notes
12	Staff Room - Leaded Glass Fixture Over Table	2,000	1	SLS23-I100-120	Replacing 100W Incandescent
13	Browsing Area	3,175	12	NOUPGRADE-4'2L32WT8LP	4L Low Power Ballast Existing; Indirect Box Fixture
13	Browsing Area	3,175	3	NOUPGRADE-4'2L32WT8LP	Indirect Box Fixture
14	Circulation Desk Area	3,175	10	NOUPGRADE-4'2L32WT8LP	12' AFF; Pendant Mounted; Indirect Box Fixture
14	Circulation Desk Area - Over Elevator	3,175	2	NOUPGRADE-4'2L32WT8LP	Square Vanity Required
15	Reference Room	3,175	16	NOUPGRADE-4'2L32WT8LP	12' AFF; Indirect Box Fixture
15	Reference Room	3,175	6	NOUPGRADE-4'2L32WT8LP	12' AFF; Indirect Box Fixture
16	Reading Area	3,175	27	UDF3-2'2LUTUBET8-QLXPS-U	22 FC Average
16	Reading Area	3,175	4	BDFTW/N-T8-VF-QLXPS-UNV	Replacing 8' 8L T8 Up/Down Light
16	Reading Area	3,175	3	NO UPGRADE	Existing 13W CF Wall Sconce
16.1	Reading Area - Near Sitting Area	3,175	8	ADFTW/N-T8-VF-QLXPS-UNV	9' AFF; Replacing 8' 4L T8 Box Fixture
16.2	Reading Area - Atrium Area	3,175	14	SLSR3020/D-I65-120	Dimmable; Track Lighting; Replacing 65W Incandescent; 10' AFF
16.2	Reading Area - Atrium Area	3,175	1	PHOTO	
16.3	Reading Area - Atrium Area	3,175	1	UDF-QXPS-UNV	Existing 2 x 2 T8 U-Tube Prismatic
17	Stack Area	-	13	NO UPGRADE	Existing 4' 1L T8 Strip Fixture
17	Stack Area	-	2	NO UPGRADE	Existing 2' 1L T8 Strip Fixture
18	Stack Area Below Mezzanine	-	36	NO UPGRADE	Existing 4' 1L T8 Strip Fixture
19	Assistant Director's Area	3,175	1	ADFW/N-T8-QXPS-UNV	
20	2nd Floor Stack Area	3,175	8	UDF3-T8-QXPS-UNV	
20	2nd Floor Stack Area	3,175	6	NOUPGRADE-4'4L32WT8NP	Existing 8' 4L T8 Wrap Fixture
20	2nd Floor Stack Area	3,175	6	NOUPGRADE-4'2L32WT8NP	
21	Ground Floor - Staff Only Stack Area	3,175	1	NO UPGRADE	Existing 2' 2L T8 Wrap Fixture
21	Ground Floor - Staff Only Stack Area	3,175	17	NOUPGRADE-4'2L32WT8NP	Existing 8' 2L T8 Wrap Fixture
21	Ground Floor - Staff Only Stack Area	3,175	17	FSS-120	
21	Ground Floor - Staff Only Stack Area	3,175	1	NOUPGRADE-4'1L32WT8NP	Existing 4' 1L T8 Wrap Fixture
22	Women's Room	-	4	NO UPGRADE	Existing 13W CF Vanity Style Fixture
22	Women's Room	-	1	NO UPGRADE	Existing CF on Pullchain
23	Custodial Area	3,175	5	ADF-T8-QXPS-UNV	
24	Tech Room	3,175	2	ADFW/N-T8-QXPS-UNV	

Fixture Locations

City of Dover - Dover Library - S3

Dover, NH

Map	Location	Hours	Qty	Code	Notes
24	Tech Room	3,175	2	CADFTW/N-T8-VF-QXPS-UNV	Replacing 8' 6L Fixture; (4) Lamps Down; (2) Lamps Up
25	Processing Area	3,175	8	ADFTW/N-T8-QXPS-UNV	Pendant Mount; 8' AFF
26	Hallway/Elevator Alcove	-	3	NO UPGRADE	Existing CF Recessed Can
26	Hallway/Elevator Alcove	3,175	7	UDF-T8-QXPS-UNV	
26	Hallway/Elevator Alcove	-	4	NO UPGRADE	Existing 18W CF Wall Sconce
27	Elevator Machine Room	-	1	NO UPGRADE	Existing 4' 2L T8 Strip Fixture; No Access
28	Hallway to Restroom	3,175	1	NOUPGRADE-4'2L32WT8NP	Wall Mounted; 6' AFF
29	Restroom	500	1	SLS20-I75-120	Replacing 75W Incandescent
30	Stairwell	3,175	1	NOUPGRADE-4'2L32WT8NP	
31	Craft Room	2,000	1	CSS-120	DT200
31	Craft Room	2,000	4	SLSR3020/D-I75-120	Dimmable; Replacing 75W Incandescent Recessed Can
31	Craft Room	2,000	4	UDF-T8-QXPS-UNV	
32	Craft Storage	1,000	2	UDF-T8-QXPS-UNV	
32	Craft Storage	1,000	1	WSS-120	
33	Men's Room	3,175	2	UDF-T8-QXPS-UNV	
33	Men's Room	3,175	1	WSS-DT-120	
34	Women's Room	3,175	2	UDF-T8-QXPS-UNV	
34	Women's Room	3,175	1	WSS-DT-120	
35	Children's Library - Small Stage Area	3,175	1	NOUPGRADE-4'1L32WT8NP	Existing 4' 1L T8 Vanity Style Fixture
35	Children's Library - Upper Level	3,175	2	CSS-120	W500A
35	Children's Library - Upper Level	3,175	8	UDF3-T8-QLXPS-UNV	
36	Children's Library	3,175	2	CADFTW/N-T8-VF-QLXPS-UNV	Replacing 8' 6L Fixture in Corner
36	Children's Library - Above Cork Board	3,175	1	NOUPGRADE-4'2L32WT8NP	
36	Children's Library	3,175	8	NO UPGRADE	Existing 4' 1L T8 Strip Fixture in Soffit
36	Children's Library	3,175	4	NO UPGRADE	Existing CF R30 in Track Lighting
36	Children's Library	3,175	3	NO UPGRADE	Existing 18W CF Wall Sconce
36.1	Children's Library	3,175	11	UDF3-T8-QLXPS-UNV	Existing 2L U6 T8
36.1	Children's Library	3,175	1	CSS-120	W1000A
36.2	Children's Library	3,175	9	UDF3-T8-QLXPS-UNV	Existing 2L U6 T8

Fixture Locations

City of Dover - Dover Library - S3

Dover, NH

Map	Location	Hours	Qty	Code	Notes
36.2	Children's Library	3,175	1	CSS-120	W1000A
37	Librarian's Area	3,175	1	UDF3-T8-QXPS-UNV	
37	Librarian's Area	3,175	1	WSS-120	
37	Librarian's Area	3,175	2	NOUPGRADE-4'1L32WT8NP	Existing 4' 1L T8 Under Counter Light
38	Stairwell From 1st to 2nd Floor	3,175	2	ADFTW/N-T8-VF-QLXPS-UNV	Square Vanity Fixture
38	Stairwell From 1st to 2nd Floor	500	4	NOUPGRADE-I300W	Remainder of Stairwell Fixtures on Dimmer
38	Stairwell From 1st to 2nd Floor	3,175	2	NOUPGRADE-I300W	Replacing 300W Quartz Wall Sconce
38.1	Entry Vestibule	3,175	2	NOUPGRADE-4'2L32WT8NP	Square Vanity Fixture
39	Emergency Stairwell	8,760	5	STAIRWELL-CF9-120	
39	Emergency Stairwell	8,760	5	ADFW/NCF9-T8-SEN-QLXP-UN	
39	Emergency Stairwell	8,760	5	SSS-120	
39.1	Emergency Stairwell	8,760	3	ADFW/N-T8-QLXPS-UNV	Ceiling Mounted Hallway Light
39.2	Emergency Stairwell	8,760	8	ADFTW/NCF9-T8-SEN-QLXPS-	8' AFF Wall Mounted
39.2	Emergency Stairwell	8,760	8	SSS-120	8' AFF Wall Mounted
39.2	Emergency Stairwell	8,760	8	STAIRWELL-CF9-120	8' AFF Wall Mounted
40	Exterior	3,650	4	NO UPGRADE	Existing HPS50; (1) Globe; (2) Canopy Style
40	Exterior - Main Entry	3,650	7	NO UPGRADE	Existing HPS250 Cobra Head
40	Exterior - Main Entry	3,650	2	NO UPGRADE	Existing HPS150 Globe Fixtures
	Total		**505**		

Appendix 6
Commissioning Plan

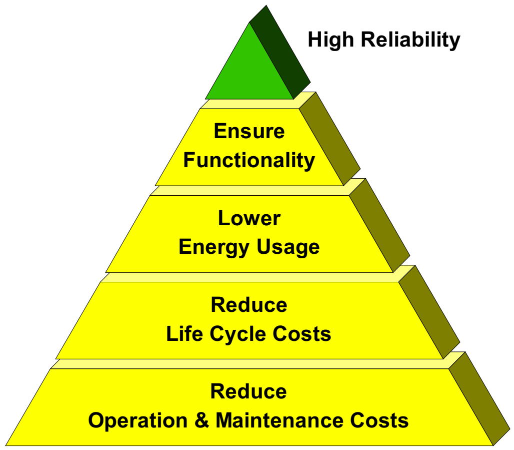
City of Dover New Hampshire

Performance Contract Commissioning Plan

December 20, 2008

Table of Contents

Section 1: Introduction



Building Commissioning Plan: Benefits

Abstract

This documentation describes the Johnson Controls standard building commissioning plan.

The purpose of the commissioning plan is to guide the installation contractor and commissioning team through an effective process. It describes the reasoning behind the commissioning plan, and how it should be implemented.

The commissioning plan is intended to cover the entire project process, from conception to acceptance. It provides procedural information and a confirmation methodology to ensure that the system is operating per established requirements to meet business needs.

The commissioning plan also applies to projects involving the re-commissioning of existing systems. Existing facilities that suffer from poor temperature controls, excessive use of energy, high maintenance costs, or evidence of problems related to design and/or operation not meeting current conditions, are candidates for re-commissioning.

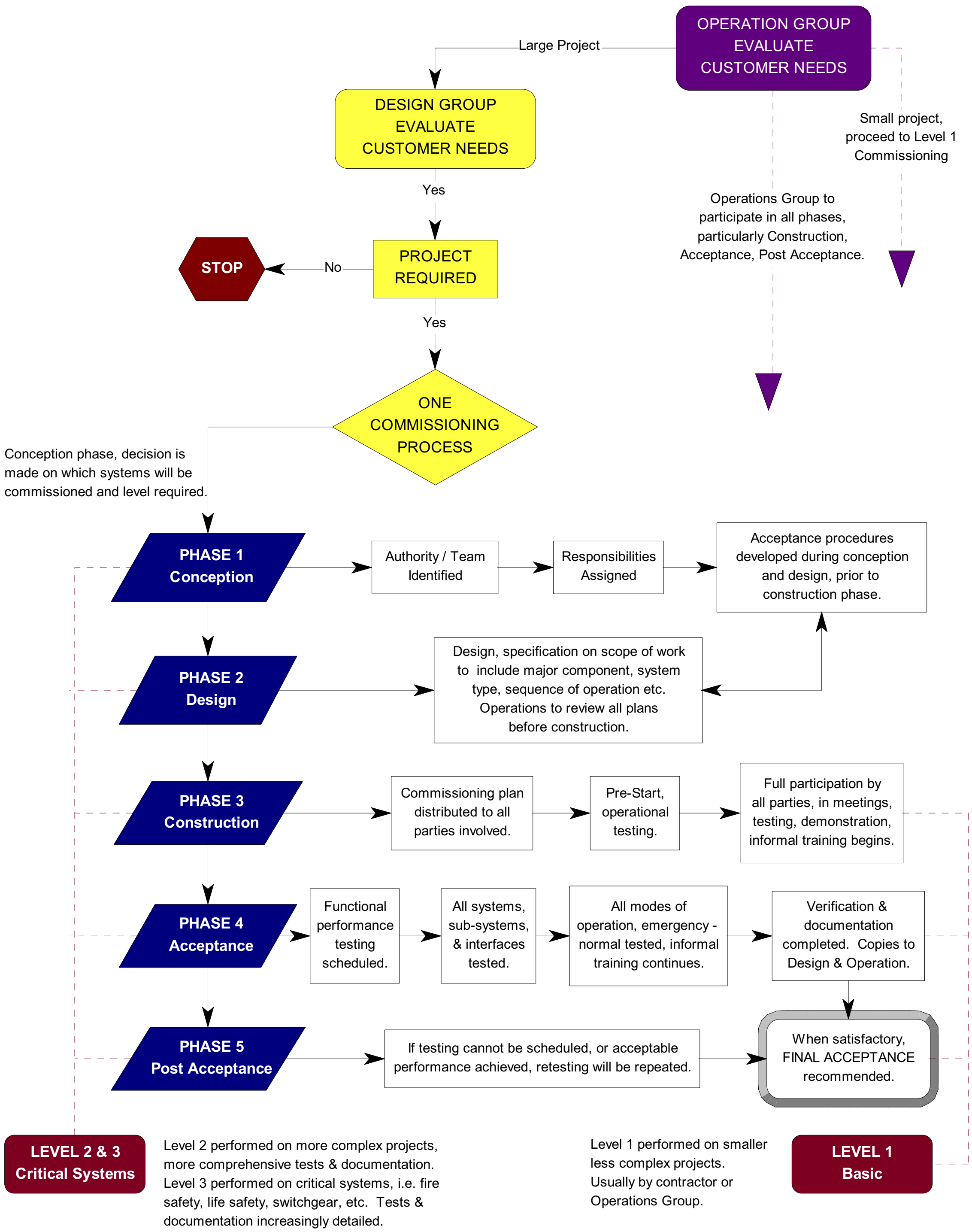
Commissioning Process Objectives

The major objectives for implementing a commissioning process are to:

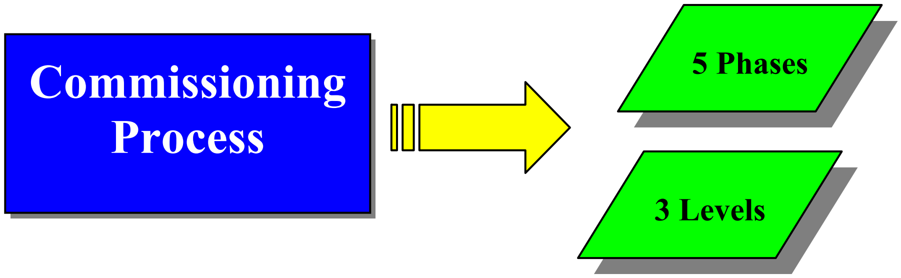
- Ensure total system functionality and reliability
- Optimize energy usage
- Lower operation and maintenance costs
- Extend life of assets
- Reduce building life-cycle costs
- Improve occupant comfort
- Ensure human safety

Process Strategy/Flow

The diagram below illustrates the flow of activity during the commissioning process.



Section 2: Commissioning Process



Stringent building codes, energy conservation and data and telecommunications equipment requirements, and occupant demands for comfort and indoor air quality mandate a high level of sophistication in building environmental controls. As a result, building equipment and systems have become complex in their control strategies.

In order to achieve a consistent level of building environment quality, a commissioning process should be implemented as an integral part of an installation project.

The intent of a commissioning process is to transform the building (project) system from a state of static completion to a state of dynamic operation, in accordance with design intent and contract specifications.

Phases and Levels

The commissioning process takes place in five phases. In addition, three different levels of commissioning intensity are used, depending upon variations in project size, scope, complexity, critical or highly specialized systems.

Five Phases

1. Conception
2. Design
3. Construction
4. Acceptance
5. Post Acceptance

Levels of Intensity

Level 1 - System Readiness and Start-Up

Level 2 - Initial Operation

Level 3 - Functional System Test

Note: *The subject of phases is discussed in greater detail in* ***Section 4: Phases of Commissioning****. The subject of levels is explained further in* ***Section 5: Levels of Commissioning****.*

Documentation and Training

To support and ensure the long term integrity of the building system, documentation and training are an integral part of the commissioning process. Documentation consists of four categories; the first three should be provided by the installation contractor, the fourth should be maintained and updated by the operations personnel.

Documentation

1. System Documentation
2. Application Documentation
3. Test & Verification
4. Maintenance Records

Training

1. Formal Training
2. Performance Oriented Training (P.O.T.)
3. Recurrent P.O.T.

Before final acceptance of a project:

- System functionality should be demonstrated.
- All documentation proposed in the commissioning plan should be submitted.
- P.O.T. training and/or formal training is scheduled and completed.

Plan Development

The commissioning plan is developed early in a project's lifecycle, during the conception and design phases of the project. At this time, a commissioning team or authority is appointed as well. The team is responsible for planning, organizing, implementing, and overseeing the commissioning process. The team should also verify and accept results.

The commissioning process planning encompass the following elements:

- Preparation, submission, and approval of the system commissioning plan. On Levels 2 and 3 (Initial Operation; Functional System Test), plan development is the responsibility of the Design Engineer and the Project Manager, with the aid of input from the Operations Manager and/or Operations Staff. On Level 1 (System Readiness and Start Up), the contractor, Project Manager or Operation Manager should be responsible for the plan.
- Participation of the commissioning team in preconstruction, planning and construction meetings. The team should maintain meeting minutes.
- Coordination of meetings with other trades to assure compatibility/integration of equipment, systems, and construction.
- Development of a workplan or schedule to assure identification of milestones for the implementation of the system commissioning process.
- Review of the system equipment and systems submittal data for effect on system commissioning.
- Review of changes and alterations to plans and specifications for effect on system commissioning.
- Review of records pertaining to system flushing, cleaning, in conjunction with air/water test and balance reports to determine the effect on system commissioning.

- Review of system construction documentation, including:
    1. Drawings
    2. Submittals
    3. Reports
    4. Inspections data
    5. Pre-start check data
    6. Start-up and initial operation data
    7. Functional performance and verification of all systems
    8. Manuals and warranties
- Direct training of systems operation/maintenance personnel. This may include Operation Engineers, Management Personnel, and Design Engineers.

Before final acceptance of a project, documentation proposed in the commissioning plan will be supplied to the Design Engineer and Operation Manager. Upon final demonstration of the proper operation and functionality of the system(s) to the appointed commissioning authorities, final acceptance can be granted.

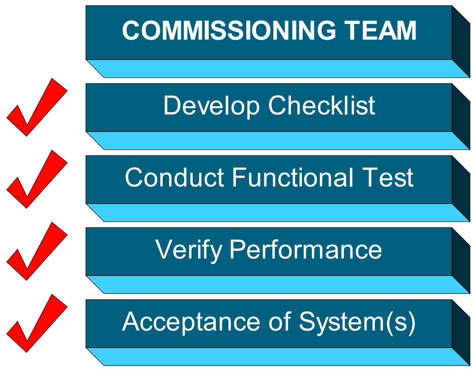
Commissioning Process and Project Costs Not sure if this section belongs

A single standard commissioning process should be applied to the possible range of projects and systems. As such, commissioning can be organized to accomplish a desirable result at a cost consistent with the value and risk of a particular project.

The determination of appropriate hours and cost to be committed to a project should depend on:

- The size of the project
- Complexity of the systems
- The degree of interface between systems
- All test procedures mandated by code or regulation
- Johnson Controls commissioning requirements
- Service effecting potential of the systems

Section 3: Commissioning Team



In the initial stages of the project (usually during the Conception and Design phases), a Commissioning Team is selected. For projects that involve strategic partners, it is recommended that staff from JCI and the strategic partners participate in the commissioning process to facilitate team development.

Throughout the commissioning and construction process, the team should maintain the common goal of providing the client with a fully functional facility, within budget and in accordance with completion deadline(s).

Team Development

When the size of the project does not require intense commissioning (as in Level 1, System Readiness & Start-up), a team may not be required. In these situations, the contractor may be able to fulfill all commissioning obligations with oversight by construction management.

- During Level 1 commissioning, a suitable Construction Project Manager should be selected from either the Design and Construction, or Operations Group.
- The contractor should be responsible for submitting a plan with proper documentation for approval. This document has to be approved by the group initiating the work/project.

Team Members

Depending upon the size and type of construction in the project, the commissioning team should include one or more of the following individuals:

1. Commissioning Authority (Construction Project Manager - leader)
2. Client's Representative
3. Operating Personnel
   a. Operation Manager
   b. Field / Lead Engineer
4. Design Engineer
5. Building Security Personnel
6. Contractor(s) and sub-contractors
   a. facility/property
   b. civil
   c. plumbing
   d. mechanical
   e. traffic
   f. special construction
   g. conveying
   h. fire protection
   i. special purpose equipment
   j. site utilities

Team Responsibilities

The team oversees the commissioning process through tasks listed in the table below. These tasks are also discussed in *Section 4: Phases of Commissioning*.

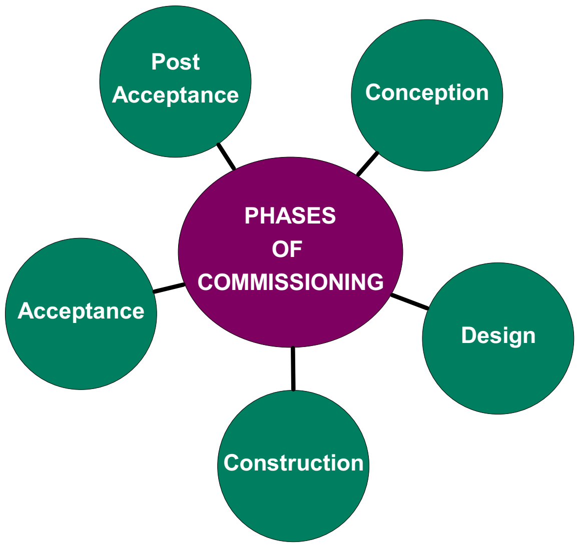
	Design Engineer	C. A. - Project Manager	Operations Manager	Operations Engineer	Contractor/Vendor
Define occupancy needs	A	X	A	A	
Develop design intent	X	R	R	R	
Design drawings / specifications	X	R	R	R	
Develop acceptance checklist. assign levels of commissioning	X	R	R	R	
Create commissioning plan, acceptance procedures, benchmarks, test protocols, code requirements, and training needs	X	X	A	R	
Identify timelines, milestones, develop & maintain schedule throughout process		X	A	A	
Coordinate meetings with trades		X	A	A	X
Maintain meeting minutes, distribute to "Team "		X			A
Attend all pre-construction, planning, and construction meetings		X	X	X	X
Coordinate changes, alterations to plans and specifications	A	X	R	R	A
Coordinate any corrective actions necessary		X	A	A	A
Observe installation		X	X	X	
Verify System Readiness & Start-up, i.e. flushing, cleaning		X	A	A	X
Verify Initial Operation i.e. balance report		X	A	A	X
Verify Functional Performance i.e. proper operation		X	A	A	X
Obtain, and review documentation		X	R	R	X
Direct P.O.T. training		X	A		
Acceptance of system		X	X	A	
Issue completion certificate		X			

Legend: Responsible - X

Assist - A

Review - R

Section 4: Phases of Commissioning



There are **five major phases** in the commissioning process:

1. Conception
2. Design
3. Construction
4. Acceptance
5. Post Acceptance

Phase 1: Conception

During this phase, occupancy needs must be defined, and planning for specific equipment to meet these needs takes place. It is essential that all of the following parties be involved in this process:

- Design and Construction
- Commissioning Authority
- Operations
- Installation/Supplier (if identified at this stage)

Preconstruction and Construction Meetings

During these meetings, documents containing commissioning criteria should be prepared and should include data regarding:

1. Systems to be commissioned
2. Level of commissioning to be undertaken
3. Assignments for project responsibilities
4. Composition of the commissioning team
5. Workplan with project timeline and milestones
6. Verification and acceptance procedures including benchmarks, test protocols, and code requirements
7. Operator training requirements
8. Documentation requirements, including:
    - Commissioning plan content and submission procedures
    - Procedures for on-site commissioning checks and tests
    - Training and operation documentation
    - Final commissioning report

Phase 2: Design

This phase focuses on the creation of design documentation. This documentation includes content from mechanical, electrical, HVAC and other related disciplines. It also includes drawings, specifications, requirements data, and design intent abstracts.

The following elements are analyzed in design documentation:

1. Commissioning issues
2. Maintenance issues
3. Alarm standards, relating to the building automation system
4. Interfacing when required with the Computerized Maintenance Management System (CMMS)
5. Control logic standards (control programming)

Scope of Work documentation

The Design and Construction Engineer should develop specifications for Scope of Work documentation with descriptions of the various systems required. The document should be reviewed by the Operations Group prior to construction. This document should cover system type(s), major components, intended operation under both full and partial loads, sequence of operation, including start-up, occupied, unoccupied, fire emergency, etc., as applicable.

Commissioning Plan documentation

Prior to construction the Design Engineer, and Project Manager should prepare a detailed commissioning plan in accordance with the specifications. The entire commissioning team should review, and revise the document as necessary.

The final commissioning plan should contain items developed during the conception phase, as listed below:

1. Scope - A brief description of the overall process with outlines of the proper communication channels.
2. Reference Documents – Technical drawings and specifications relevant to commissioning.
3. Commissioning Level - Systems being installed should be described along with the level of commissioning to be undertaken.
4. Pre-Start and Functional Performance Tests - A description of checks and tests to be carried out for each system to be commissioned. These tests are used to verify the correct operation of equipment under all specified sequences and modes of control.
5. Demonstration - A brief description of the demonstration and instruction program for the operators.
6. Schedule - Dates for complete installation, operational/functional testing, and time allowed for operator instruction and demonstration.

Phase 3: Construction

In this phase, the system is installed, tested, and put into operation. Pre-start checks are made to insure the installation is complete and everything is ready for a safe start-up.

Once equipment and systems pass the pre-start check, start-up and initial operation can occur. When these procedures are completed, the system is ready for functional performance testing.

Project Review Meetings

During the construction phase, the commissioning team will schedule and attend regular on-site project review meetings. The commissioning plan is reviewed along with status of project and timelines, and corrective actions taken to address outstanding issues. These meetings continue until the project is completed and acceptance is final.

On-Site Training

One of the most important parts of the commissioning process is the training of operations and maintenance personnel. These people should be on site during construction to observe the installation of the system and to learn about its operation. The Commissioning Authority should direct the operator training.

Design Change Updates

All system operation descriptions will be updated regularly to incorporate design changes that occur prior to or during the construction phase. This information should be combined with the equipment maintenance data and equipment submittals, including performance data, to form one complete operations and maintenance manual for training and subsequent use by the operations and maintenance staff.

During the pre-start check, if faulty equipment, incomplete or incorrect work is discovered, it is documented, discussed with responsible parties, and corrective action agreed to. Once corrected, this work needs to be rechecked; when found satisfactory start-up can be scheduled, progressing to functional testing and acceptance.

Phase 4: Acceptance

During this phase, activity focuses on the completion of the project, culminating in delivery of a fully operational facility.

Prior to any functional performance testing of systems, the commissioning team will verify that components and systems to be tested have been installed in accordance with the contract specifications.

Functional Performance Testing

Functional performance test checklists should be included in the approved commissioning plan, and should be used to document the results of the functional performance testing process.

The functional performance testing process will be performed on all equipment, subsystems, systems, and system interfaces. All must be tested for acceptance, and there should be a separate checklist for each to ensure that documentation specific to each is complete.

If there are numerous identical systems (i.e. mixing boxes), the Project Manager will witness enough repeated functional tests to assure that all are in accordance with the design requirement.

Testing Progression

Functional performance testing should progress from equipment or components through subsystems to complete systems. Functional performance testing should include consideration of the sequence of testing, starting of components, and should progress towards complete system testing. Functional problems should be easier to isolate and correct as a result of this approach.

Specific tests, and the most efficient order of testing may vary, depending on the following:

- The type of construction
- The number of systems
- The sequence of construction

- The relationship between building systems and tenant work
- The degree of interaction between systems
- The complexity of the control sequence
- The impact of system failures on health or safety, and other factors

Test Verification

The installation vendor should record, and the Commissioning Authority should verify the results of each individual check or test on the pre-approved test and report form from the commissioning plan.

In the event that some aspect of the system performance is not realized, then re-testing and related documentation demonstrating acceptable performance must be scheduled and completed before final acceptance.

Training Sessions

Training to the operating personnel on the proper operation of the equipment is crucial for maintaining reliability and long term integrity of the systems. This is carried out during the Performance Oriented Training (P.O.T.).

The operations manuals must be available at this time and referred to during the instructional sessions.

The training should include:

1. Start-up and shut-down procedures, operation under all modes of operation, and correct procedures under emergency or abnormal conditions.
2. A description of the system capabilities and limitations.
3. Procedures necessary for effective operational monitoring and alarming.
4. Analysis of useful information that can come from monitored data, and why the information is important in analyzing the system operation.
5. Inspection, service, and maintenance requirements for each system.

At the end of the process, every mode of systems operation, all systems equipment, components and zones, all backup systems, and every item in the control sequence description should have been proved operational under all normal operational modes, including part and full load, and under abnormal or emergency conditions.

Phase 5: Post Acceptance

Test Non-Completion

If any check or test cannot be accomplished for any reason, its non-completion should be noted along with an indication of when the test should be rescheduled.

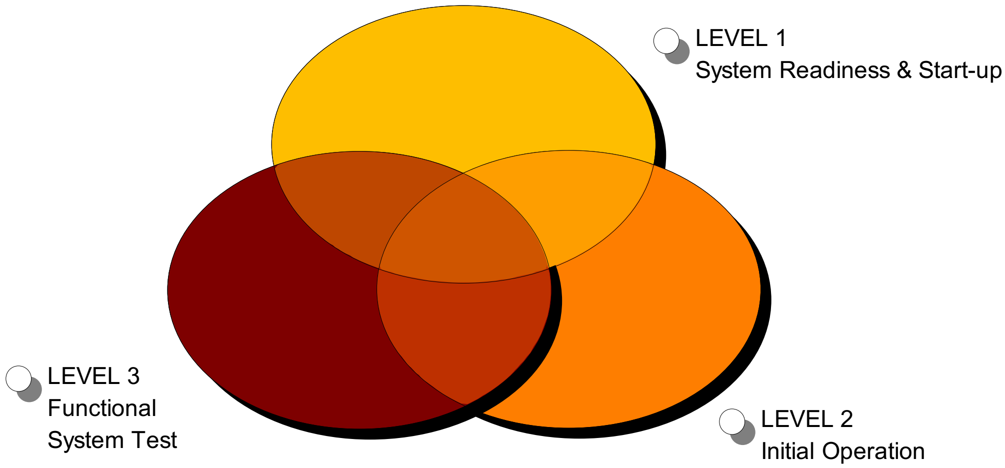
If any check or test cannot be accomplished due to building structure or other building system deficiencies outside the scope of the systems work, these deficiencies will be resolved and corrected by the appropriate parties before completion of the system commissioning process.

Performance Issues

Every check or test for which acceptable performance was not achieved should be repeated after the necessary corrective measures have been completed. This re-testing process should be repeated until acceptable performance is achieved.

If acceptable performance cannot be achieved, then the necessary corrective measures should be carried out. The Design Engineer should issue appropriate directions in this regard.

Section 5: Levels of Intensity



Projects can vary greatly in size, scope and complexity. Systems can be of a critical or highly specialized nature. Because of this potential for variance, Johnson Controls standards and guidelines employ **three different levels** of commissioning intensity:

1. System Readiness & Start-up
2. Initial Operation
3. Functional System Test

Level 1: System Readiness and Startup

Level 1 commissioning should be performed by the Project Manager during the construction and acceptance phases of the project. This level basically involves a visual inspection of the installation.

The contractor performs all required tasks. The Project Manager documents the installation.

Level 1 commissioning is intended to:

1. Ensure that the contractor meets basic contractual requirements to produce a complete installation, in accordance with the contract documents.
2. Help the contractor plan, organize, and coordinate that part of his/her work related to completing the installation and getting equipment and systems ready to start properly, safely, and on schedule.
3. Identify problems that may arise and provide a mechanism for problem resolution by the responsible parties, with necessary follow-up.
4. Provide documentation showing that system installation is in accordance with requirements.

Level 2: Initial Operation

Level 2 commissioning requires the pre-start up testing of the various system. The contractor or a testing agency conducts systems tests to insure system condition and capacities.

The contractor is responsible for this portion of the testing with oversight by the Project Manager and Property Management.

Level 2 commissioning is intended to include comprehensive pre-start up checks and tests, and to:

1. Ensure that the contractor meets basic contractual requirements to produce a fully functioning installation in accordance with the contract documents.
2. Ensure that system operations are checked and that specified performance is achieved in all respects. This is where the PAS adds value
3. Provide documentation showing that system operation is in accordance with requirements.
4. Ensure that the contractor is able to operate the equipment and systems, and can demonstrate system performance according to contract requirements.
5. Provide a framework for giving training demonstrations in proper systems operation to the Client(s), and for providing maintenance instructions and recommendations for the completed system.

Level 3: Functional System Test

Level 3 commissioning is the most detailed and exhaustive application of the commissioning process. It is carried out on systems which have a control sequence.

The contractor demonstrates that the systems function properly under all scenarios. The Project Manager observes systems in operation. In some cases, Level 3 commissioning involves acceptance of test procedures that are witnessed.

Level 3 commissioning is intended to:

1. Ensure that systems operation, including all control sequences, is adequately checked and that functional performance, as specified by the requirements, is achieved in all respects.
2. Provide documentation that reflects system operation in accordance with requirements.
3. Ensure that the contractor is able to operate the equipment and systems, and demonstrate system performance and functionality (according to contract requirements), to the client(s).
4. Provide a framework for giving training in proper systems operation to the clients(s), and for providing maintenance instructions and recommendations for the completed system.

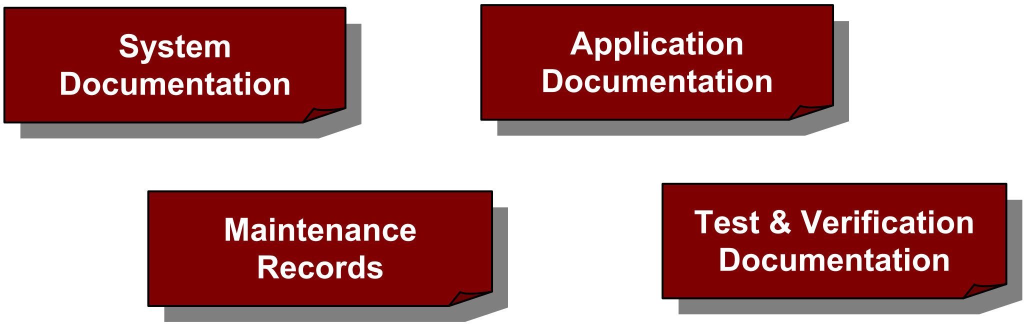
Phases and Levels of Commissioning

The scope and complexity each phase of the commissioning process will dictate the **level** of commissioning chosen.

In projects involving Level 1: System Readiness and Start-Up**,** planned commissioning activities occur mainly during the construction, acceptance, and post-acceptance phases of a project. In most instances, the operations staff should have the ability to review these projects before their implementation, during construction, and at final acceptance.

In projects involving Level 2: Initial Operation and Level 3: Functional System Test, activities are extensive during all five phases of a project.

Section 6: Documentation



There are **four categories of documentation** used in the commissioning process for maintenance and operation of building system(s). The first three–**System Documentation**, **Application Documentation**, and **Test & Verification Documentation**–are required throughout different phases of the project. It is important to have this documentation completed and delivered to both the Design Group and Operations Manager prior to any Performance Oriented training (P.O.T.).

The fourth category, **Maintenance Records**, should be ongoing throughout the life of the system, and kept current by the operations staff. During the life of the system, all maintenance and service records should be included whether completed by service contractors, operations staff, or a combination of the two.

It is essential for the contractor to provide the proper types of documentation in order to ensure long term integrity of the system. This documentation content should be specific enough so that Field Engineers and Operators can clearly understand system(s) capabilities, installation layout, and will be able to perform any system functions when required without difficulty.

System Documentation

System documentation may consist of one or more manuals, depending upon the installed system(s). Documentation that explains the operation of the system or equipment should be provided by the manufacturer.

The manuals should be edited to limit the data to those equipment models specifically used for the building project. All manuals should be delivered to the Commissioning Authority prior to the start of training.

Operators and Maintenance Manuals fall into the category of System Documentation. If the manufacturer's documentation does not adequately describe the operation and maintenance of the system(s) or equipment, supplemental documentation should be provided by the contractor/installer.

Operators and Maintenance Manuals should meet the following criteria:

Operators Manual

This should include information required for the proper operation of installed equipment. This information should be oriented in tone and language for users and operators. It should address:

- Equipment adjustment and regulation
- Inspection during operation
- Detection of malfunction
- Safety warnings

If the system is computer hardware- or software-based (i.e. DDC system), it should include instructions for the following:

- System log-on and log-off
- Interfacing with portable computers or terminals
- Viewing program and system variables
- Database backup on appropriate media
- Accessing and triggering trend logs
- Displaying alarms, history, schedules, equipment status, etc.

Maintenance Manual

This should include information required for the proper maintenance of installed equipment. It should address:

- Inspection schedules and checklists
- Lubrication, adjustment, calibration, etc., requirements along with time intervals

Application Documentation

This documentation should consist of design specifications, as-built drawings, specification catalogs, schematics, and databases when appropriate. Specific requirements include the following:

1. Design Intent
2. Specification Catalog - The specification catalog should include all the equipment data, including the following:
   A. Catalog cut sheets and brochures on manufacturer / model information
      I. Design criteria
      II. Operating procedures
      III. Principal components
      IV. Classification
      V. All appropriate adjustments and calibrations
      VI. Performance measurements
3. Sequence of Operation - when not a DDC control system
   A. Starting and stopping procedures
   B. Seasonal start-up, shutdown
   C. Alarming performance
   D. Part load performance
   E. Logs and records
4. DDC Databases - When required, as in HVAC equipment, with DDC controls. This section should include these five (5) categories of information:
   A. Sequence of operation - it should include a step by step sequence of events for all starting, stopping, modulating, seasonal control, including schedules, and all routines employed by the equipment. This sequence should be written in paragraph form.
   B. Control Logic - a printout of the actual program as written in the controller.
   C. Flow diagram - for all digital on/off devices i.e. dampers, fans, pumps, boilers, and chiller sequences. All appropriate set-points, delays, etc., which cause a change of state should be included.
   D. Points - A printout of all points in the program, i.e. analog, digital.
   E. Listing of all alarms – it should include alarm/alert set-points, return to normal set-points, and all messages attached to the alarm.
5. Schematics
   A. Drawings showing how all controls, safeties, interlocks, main power, etc., are wired for a given system
   B. Schematic of the duct system layout
6. Record Drawings

A. Record drawings consist of one or more drawings showing the location by floor and room where building systems equipment is installed, including interconnection of systems wiring.

B. Changes as a result of subsequent system commissioning procedures should be incorporated and delivered at the conclusion during the final system commissioning

7. Design Specifications - The specifications should include requirements and specifications supplied by the design team for work within a given project, including equipment required, installation practices, and design intent.

8. Spare Parts

   A. Essential inventory

   B. Distributor directory

9. Service Contracts.

   A. Warranty information

   B. Service and dealer directory

Test and Verification Documentation

Test and verification documentation should consist of all system start-up and checkout procedures. The results of each individual check or test should be recorded on the pre-approved test and report form from the commissioning plan.

It is essential that both installer and user groups provide individuals to observe, verify and document all tests. Test and verification documentation include (but not be limited to) the following items as applicable:

Level 1: System Readiness and Startup

1. Piping systems flushed and cleaned
2. Equipment lubricated
3. Filters installed and clean
4. Equipment drives aligned
5. Equipment vibration isolation restraints installed to specification
6. Motor rotation
7. Sensor, actuators, location and wiring

Level 2: Initial Operation

1. Piping systems hydrostatic tested
2. Hydronic balancing
3. Air system balancing
4. Controls calibrated
5. Programming sequence of controls
6. Adjusting sensitivity
7. Testing of safeties
8. Capacity test
9. Performance measurements and adjustments
10. All electrical service installed and checked
11. System(s) leak tested
12. Proper operation of fire dampers

Level 3: Functional Systems Test

1. Operation of control devices
2. Proper response to sequence of operation and set-point changes
3. Operation of equipment under normal, abnormal, and emergency conditions
4. Proper operation of staging and capacity modulation (HVAC)

Documentation Layout

For the purposes of commissioning projects, documentation layouts normally fall into **two** categories:

- Equipment format
- Systems format

Equipment Documentation Format

This manual layout is a compilation of manufacturers' and installer data on equipment and materials. It should be organized into divisions following the Construction Specification Institute (CSI) format.

Each section should include the information listed below (as appropriate):

1. System Documentation
   A. Operators Information (Operators Manual)
   B. Maintenance Instructions (Maintenance Manual)

2. Application Documentation

A. Design Intent
B. Specification catalog
C. Sequence of operation
D. Schematics
E. As-built drawings
F. Design Specifications
G. Spare Parts
H. Service contract
I. MSDS Sheets

3. Test - Verification Documentation

System Format

Due to the complexity of full systems (i.e. DDC and Fire Detection systems, etc.), documentation may involve multiple manuals. A **sample** layout for a critical DDC system documentation format is shown below:

1. System Documentation
   A. Operators Manual
   B. Maintenance Manual
2. Application Documentation
   A. Design Intent
   B. Specification Catalog
   C. DDC Database - sequence of operation
      I. English paragraph form
      II. Control Logic - (program printout)
      III. Flow Diagram - (sequence/program flow)
      IV. Points - Listing of all input/output devices
      V. Listing of all alarms - (include alarm/alert setpoints, return to normal setpoints, all messages)
   D. Schematics
   E. As-Built Drawings
   F. Design Specifications
   G. Spare Parts
      I. Essential Inventory

II. Distributor Directory

H. Service Contract

I. Warranty Information

II. Service and Dealer Directory

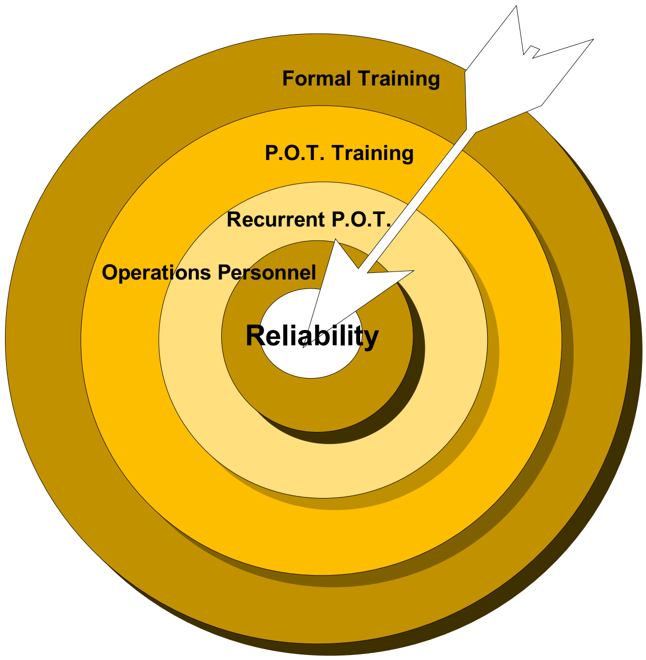
III. Test Documentation

a) System Readiness and Start-Up

b) Initial Operation

c) Functional System Test

Section 7: Training



Properly trained personnel can effectively support and ensure high reliability of the building system(s). Thus, training is a critical component of the project and project planning. The planning for training needs takes place during the conception phase of a project.

In order to effectively strategize the training function, the Operations Manager must be informed of the equipment and/or systems being installed in his/her facility. The Operations Manager should then conduct a skill set inventory of his/her staff as it relates to equipment and systems.

If, after conducting a skill set inventory, it is determined that a skill deficiency exists, **one or more of the following steps** should be taken:

1. Formal Training
2. Performance Oriented Training (P.O.T.)
3. Recurrent (post-commissioning) P.O.T.

Formal Training

Formal training may be provided by the manufacturer on-site or at the manufacturer's training facility.

Points to remember:

- When a determination is made that training is required, it should be scheduled as soon as possible. The training should be completed *before* the project is finalized and accepted.
- This kind of training may take several days to complete, depending on the complexity of equipment and systems.
- When a new system is being installed within a sub-area of the project (and particularly if the Operation Engineers have no experience or limited knowledge with the system), then manufacturer formal training should be provided as part of the installation.
- The head count for this training should be agreed upon during the early stages of commissioning by the Project Manager and Operations groups, and should generally include one or more operations personnel.
- A course agenda should be provided by the manufacturer/installer to the Operations Manager and Project Manager prior to the enrollment of any personnel in classes. If the course outline is deemed unsatisfactory, the manufacturer/installer should modify and customize the agenda/outline to meet operational requirements.

Performance Oriented Training (P.O.T.)

Performance Oriented Training (P.O.T.) should be provided on-site by the contractor/installer.

Points to remember:

- This training should be scheduled and completed before the project's final acceptance.
- The Operations Manager should provide a head count of individuals needing this training.
- This kind of training may take several days to complete. The length of the training should be agreed upon by all parties.

(It is important to remember that P.O.T. training is not intended to become a troubleshooting session of the system. If system troubleshooting discussion becomes prevalent, then the P.O.T. training should be rescheduled).

Listed below are items that should be included in the P.O.T. training process. This list is not inclusive of all possible components:

1. Instruction in the use of all documentation included. This includes an awareness and understanding of documentation contents; how to find what is needed, how to use it, and how to keep it up-to-date.
2. Depending upon the type of system, its operation procedures for all modes of operation, including warm-up, cool-down, occupied, unoccupied, alarm, trouble, etc.
3. Acceptance baseline tolerances for system adjustments in all operating modes.

4. Procedures for dealing with abnormal conditions and emergency situations.

Recurrent P.O.T.

After the final acceptance of a project, it may be necessary to provide Operations personnel with a limited amount of recurrent P.O.T. This training should focus on those systems which are critical to the reliability of the facility, and which are most used by the Operations force.

Points to remember:

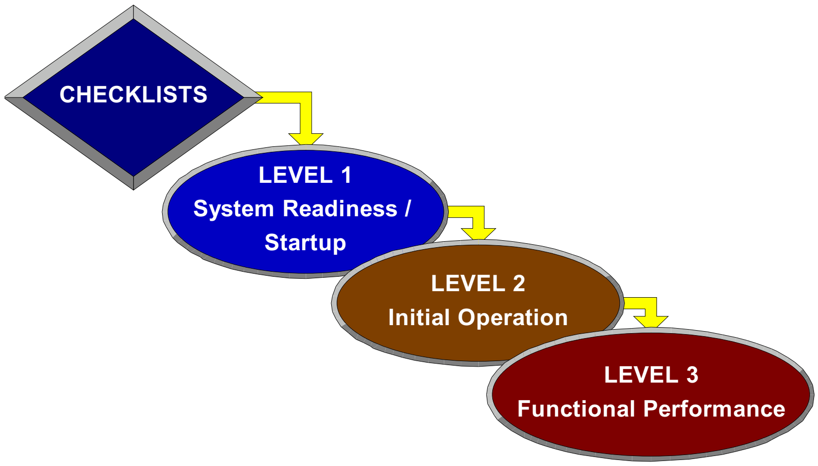
Recurrent P.O.T. is the responsibility of the Operations group, and is usually negotiated by the Operations Manager.

- Training may take several days to complete, and should be scheduled every second month for up to 12 months or six sessions. The length of the training should be agreed upon by all parties.
- Even though this training is site- and system-specific, it may be provided off-site, provided all parties agree to this. This kind of training is intended to provide in-depth instruction on the skill sets required in the operation and maintenance of the system.
- A course outline that describes all sessions should be provided by the contractor/installer to the Operations Manager. The Operations Manager may customize the course agenda for his/her site through the covered time period.

Other

It should be required that the building operator(s) be on-site periodically during the construction phase to observe the installation. This is particularly important during start-up of equipment, testing, adjusting, balancing, and during the entire functional performance testing/acceptance process.

Section 8: Checklists



The commissioning plan includes checklists to verify the commissioning process as it progresses from pre-start to start-up and initial operation, and finally to functional performance verification of all systems. The checklists should state the steps to be taken for carrying out Levels 1, 2, and 3 of the commissioning process.

The checklists provided in this section are **samples** used in the commissioning of HVAC systems. It is important that operational sequences (control logic) from the installation specification be present during the acceptance process.

The checklists cover the three levels of commissioning:

- Level 1 - System Readiness and Start-Up
- Level 2 - Initial Operation
- Level 3 - Functional System Test

Level 1 Checklist

During this phase equipment installation is verified. At its completion the system is ready for the initial operation checkout. All equipment is lubricated, air systems cleaned and final filters installed. Electrical services are installed and checked, equipment drives aligned, control point checkouts completed and safety controls installed.

Level 2 Checklist

In this phase of the commissioning process, the contractor, with the Project Manager, completes the testing, balancing, and calibration of all components and systems. Items such as piping systems are pressure tested, flushed, cleaned, and then filled or charged as applicable. The operation of safety controls is checked.

Level 3 Checklist

All equipment and systems is operated through the entire specified sequence of operation, as directed by the contract. The Project Manager and Property Management should witness and verify acceptable operation.

Section 9: Acceptance

The commissioning plan includes acceptance documentation to certify that the Facility Improvement Measure (FIM) is Substantially Complete and available for customer use. The commissioning process also provides for customer verification through onsite inspection (Walkthroughs).
As a result of these inspections Punch Lists may be generated and documented for resolution for Final Acceptance.

Appendix A Level 1 Checklist

OPC 110 - HOT WATER BOILER SYSTEM – OIL **SAMPLE**

PROJECT: ______________________ UNIT NO: ______________________

LOCATION: ______________________ SERVICE: ______________________

MANUFACTURER: ______________________ MODEL: ______________________

ITEM	OK	COMMENT
PHYSICAL INSTALLATION COMPLETE		
- Mounting, Isolators, Components		
- Burner & Oil System		
- Breeching & Combustion Air		
- Boiler Inspection & Chemical Treatment		
MECHANICAL SERVICE CONNECTIONS		
- Water Piping & Valves Installed & Tested		
- Oil Piping & Valves Installed & Tested		
- Valves Positioned for Start-up		
ELECTRICAL SERVICE CONNECTIONS		
- Electrical Connections Completed		
- Disconnect Switch Installed		
- Overload Heaters in Place (Sized Correctly)		
CONTROL SYSTEMS COMPLETE		
- Control System Operational (or DDC Program)		
- Integral Controls Operational		
- Ready to Start & Run under Control		
START-UP INSPECTION		
Start-up by Manufacturers Representative		
Mech., Elect. & Controls Contractors Present		
Firing Sequences Verified		
Pump & Flow Interlocks Verified		
Safety Controls & Flame Safeguards Verified		
Pressure & Temperature Gauges Checked		
Water Temperature Maintained		
Low Water Cutout Verified		
Safety Relief Valve Tested		
Water Temperature Maintained		
Combustion Efficiency & Capacity Test		
Vibration & Noise Level Acceptable		

GENERAL COMMENTS: ____

PRE-START BY: ______________________ DATE: ______________________

START-UP BY: ______________________ DATE: ______________________

Appendix A Level 2 Checklist

OPC 214 - HYDRONIC HEATING SYSTEM – GENERAL **SAMPLE**

PROJECT: ______________________________ UNIT NO: ______________________________

LOCATION: ______________________________ SERVICE: ______________________________

MANUFACTURER: ______________________________ MODEL: ______________________________

PRE-START-UP INSPECTION	OK	COMMENT
System Pressure Tested (Hrs)		
Water Make-up Station Installed		
Fill Pressure Set (PSI)		
Safety Relief Valve Setting (PSI)		
Safety Relief Valve Capacity (BTU)		
Backflow Preventer Installed		
Expansion Tank On Line		
Sight Glass Installed		
Air Vents Installed (High Points in System)		
Pressure & Temperature Gauges Installed		
Chemical Pot Feeder Installed		
Pumps Ready to Start - Checklists Completed		
Boilers Ready to Start - Checklists Completed		
Manufactuers Rep. On Site For Start-up		
Control System Completed (End to End Checks)		

CHEMICAL CLEANING & TREATMENT	OK	COMMENT
Cleaning Carried Out By Qualified Personnel		
Valves Positioned For Full Circulation		
City Water Circulated (HRS)		
System Drained - Strainers Cleaned		
Cleaning Solution - Circulated (HRS)		
Cleaning Solution - Drained - Strainers Cleaned		
2nd City Water Circulation (Stable PH & TDH)		
Corrosion Inhibiter Added Per Manuf. Instruc.		
System Valves Cycled During Flushing		
All Low Points Blown Down During Flushing		
Chemical Cleaning Report Attached		
Final PH =		
Final TDH =		
Chemical Concentration = PPM		

COMMENTS: ____

____

PRE-START BY: ______________________________ DATE: ______________________________

START-UP BY: ______________________________ DATE: ______________________________

Appendix A Level 3 Checklist

CONTROL SYSTEM VERIFICATION CHECKLIST

FPC 302 - HYDRONIC HEATING SYSTEM **SAMPLE**

PROJECT: ______________________ **SYSTEM:** ______________________

LOCATION: ______________________ **SERVICE:** ______________________

SYSTEM	TEST	COMMENT	OK
SYSTEM OFF			
Sensor Locations & Supports Checked			
Installation Complete			
Control Valves Checked & Stroked			
BOILER CONTROL			
Lead/Lag Boiler Sequences Verified			
Firing Sequences - Modulation Maintains Setpnt			
Supply Water Temperature Reset Verified			
Integral Control Functions Verified			
Circulation Pump Sequences Verified			
PRIMARY PUMP CONTROL			
Lead/Lag Pump Sequences Verified			
Pump On/Off Control Sequences Verified			
SECONDARY CIRCUIT CONTROL			
Lead/Lag Pump Sequences Verified			
Pump On/Off Control Sequences Verified			
Loop Water Temperature Reset Verified			
Control Valve Modulates To Maintain Setpoint			
Pressure Differential Sequence Verified			
SAFETY & MISC. CONTROLS			
Boiler High & Low Limits Verified			
Boiler Low Flow Limit Verified			
Integral Boiler Safety Controls Verified			

GENERAL COMMENTS: ______________________

TEST 1 BY: ______________________ **DATE:** ______________________

TEST 2 BY: ______________________ **DATE:** ______________________

VERIFIED BY: ______________________ **DATE:** ______________________

Appendix B Completion Documents

CERTIFICATE OF SUBSTANTIAL COMPLETION

Project Name: ______________________ PC Contract No: ___________________

FIM: # ____________ Building(s): _______________________

I, __________________________________, as an authorized representative for the Owner of the above named project, acknowledge:

- ☐ Furnished Owner's Manuals;
- ☐ Furnished As Built Drawings;
- ☐ Furnished Instruction and Training;
- ☐ Furnished Other: ____________________
- ☐ Completion of Inspection and Walk Through;
  - ☐ No Punch list Items Identified ☐ Punch list Attached
- ☐ Satisfactory Demonstration of Energy Conservation Measures;
  - ☐ No Punch list Items Identified ☐ Punch list Attached
- ☐ The Energy Conservation Measures are substantially complete and may be used by the owner for their intended purpose. The date of Substantial Completion for the portion of work listed above is: ___/___/______.
- ☐ The Energy Conservation Measures are accepted, subject to the completion of all outstanding punch list work.
- ☐ The Warranty start date for this portion of the work is: ____/____/______. The Warranty period is for: ___ year(s).

NOTES AND COMMENTS

Johnson Controls, Inc. will complete the work on the attached punch list within _____ days from the date listed below.

Johnson Controls	Date	Customer's Representative	Date

Appendix B Completion Documents

Johnson Controls

PERFORMANCE CONTRACTING

FIM Close-out Report
Punch List

Date: Page ____ of ____

FIM: Building:

JCI Contract No: Project Name:

Punch List Items	Completed	Date

Notes and Comments on FIM Punch List Completion:

All Punch List Items completed or resolved:
Subcontractor ______________________________ Date____________
Punch List completion approved:
JCI Project Manager ___________________________ Date ____________

