

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**
 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.**

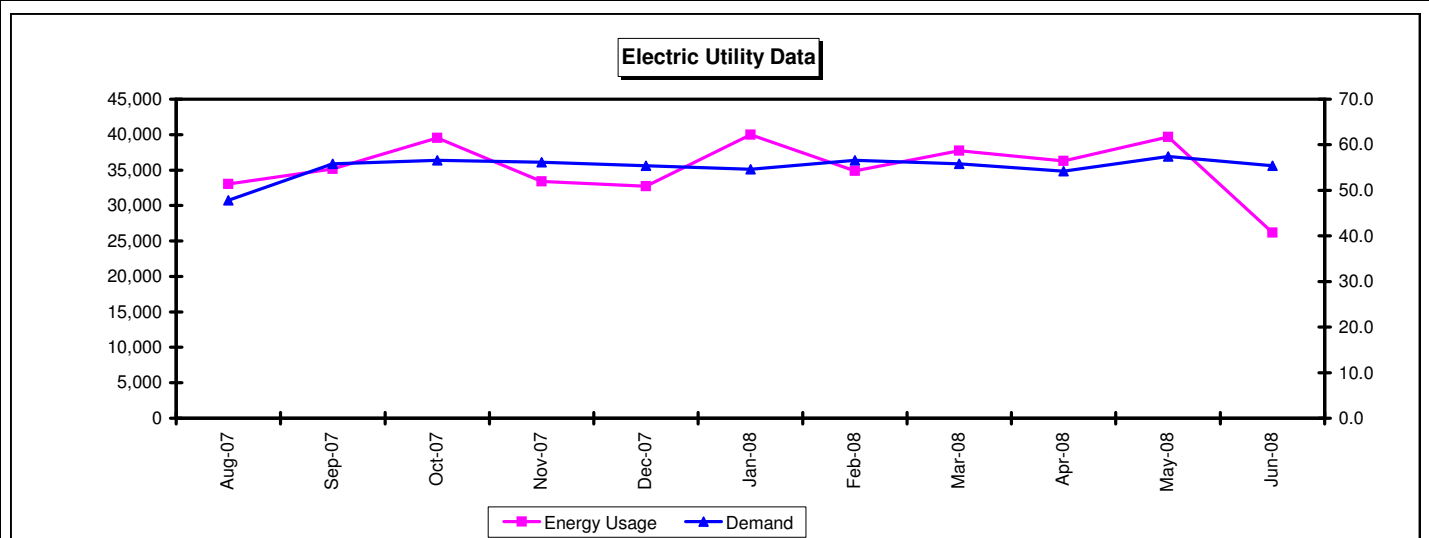
Utility Company: **PSNH**
 Old Acct. No.: **8000619-02-9-4**
 New Acct. No: **8000619-02-9-4**
 Rate: **G, Three Phase**
 Date: **2/7/2009**

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
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

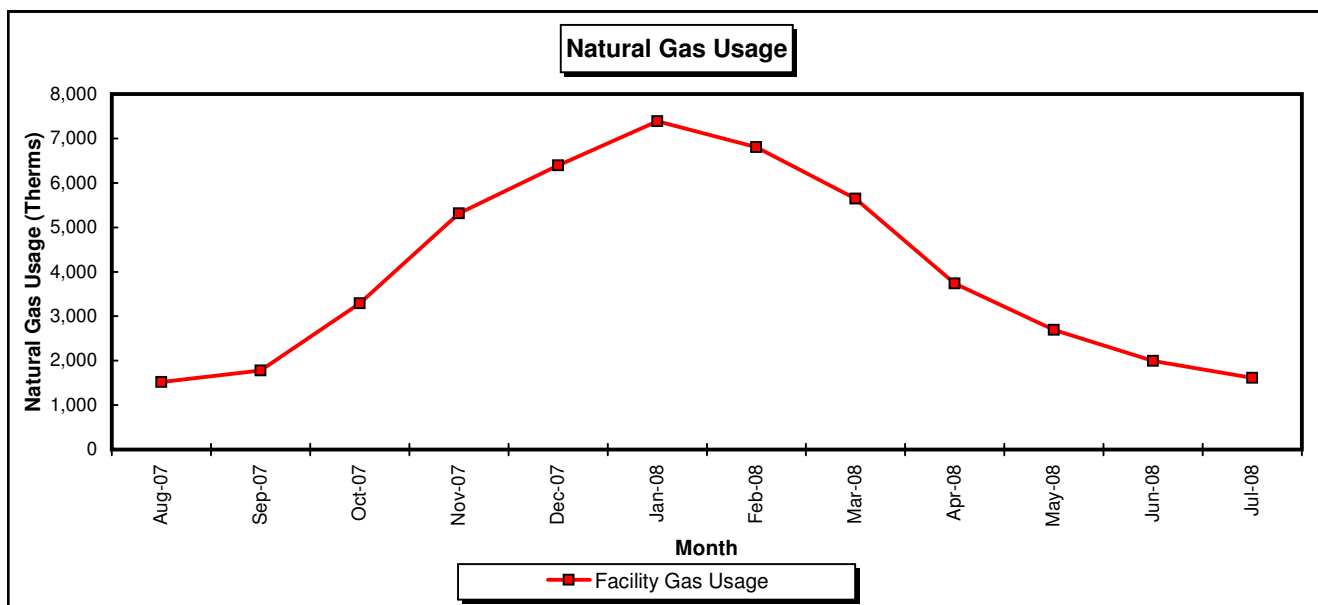
Load Factor = B/(A x E)



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.**

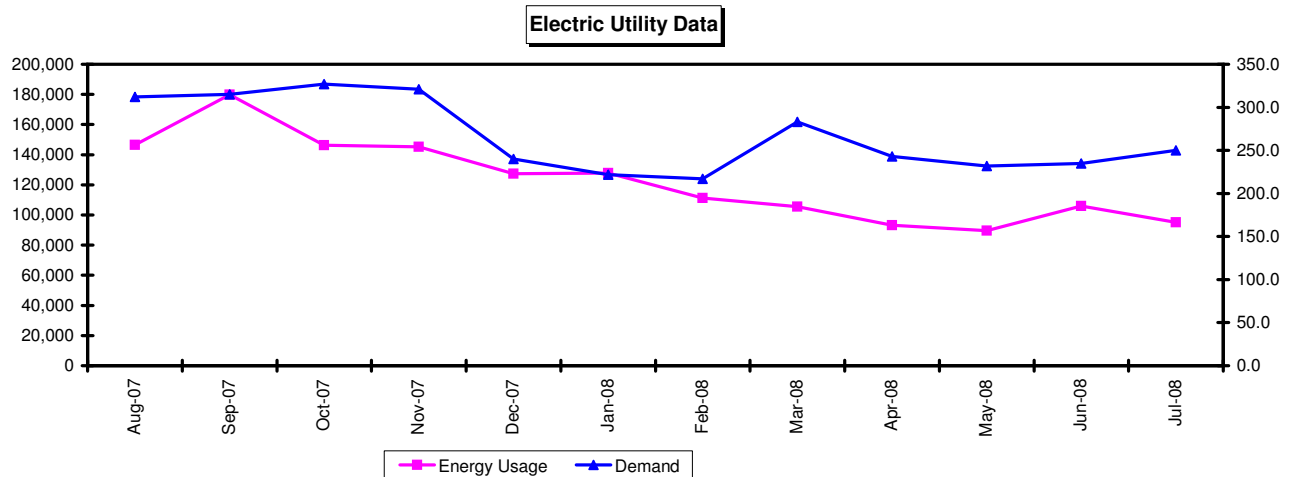
Utility Company: **PSNH**
 Old Acct. No.: **8000626-01-6-2**
 New Acct. N: **8000626-01-6-2**
 Rate: **GV**
 Date: **2/7/2009**

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

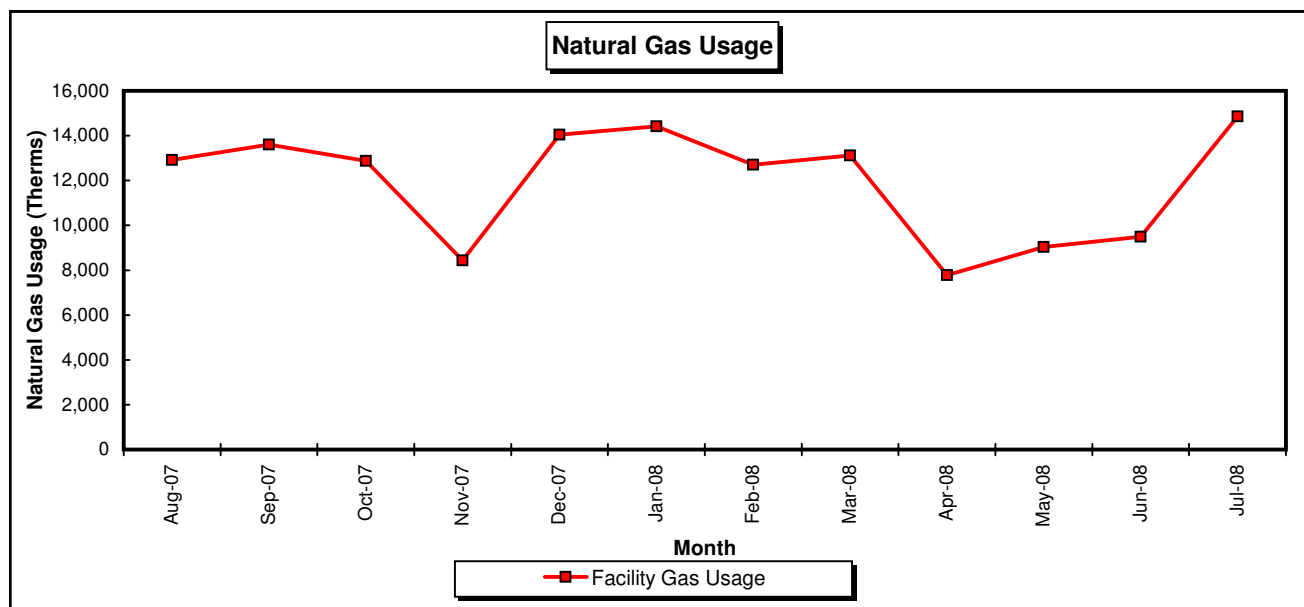
Load Factor = B/(A x E)



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

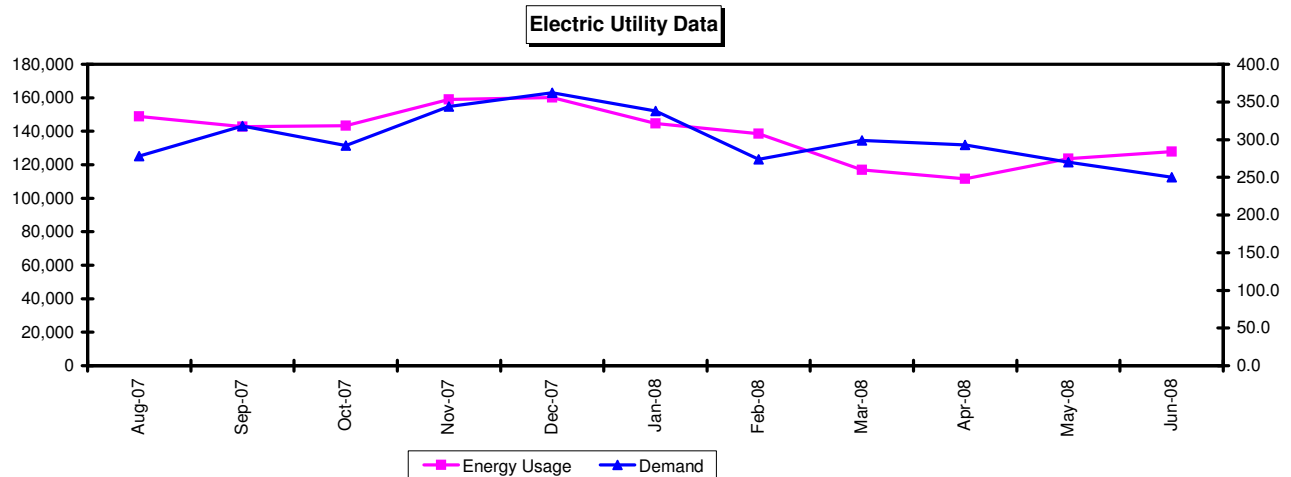
Utility Company: **PSNH**
 Old Acct. No.: **8000672-03-5-5**
 New Acct. N: **8000672-03-5-5**
 Rate: **GV**
 Date: **2/7/2009**

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
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

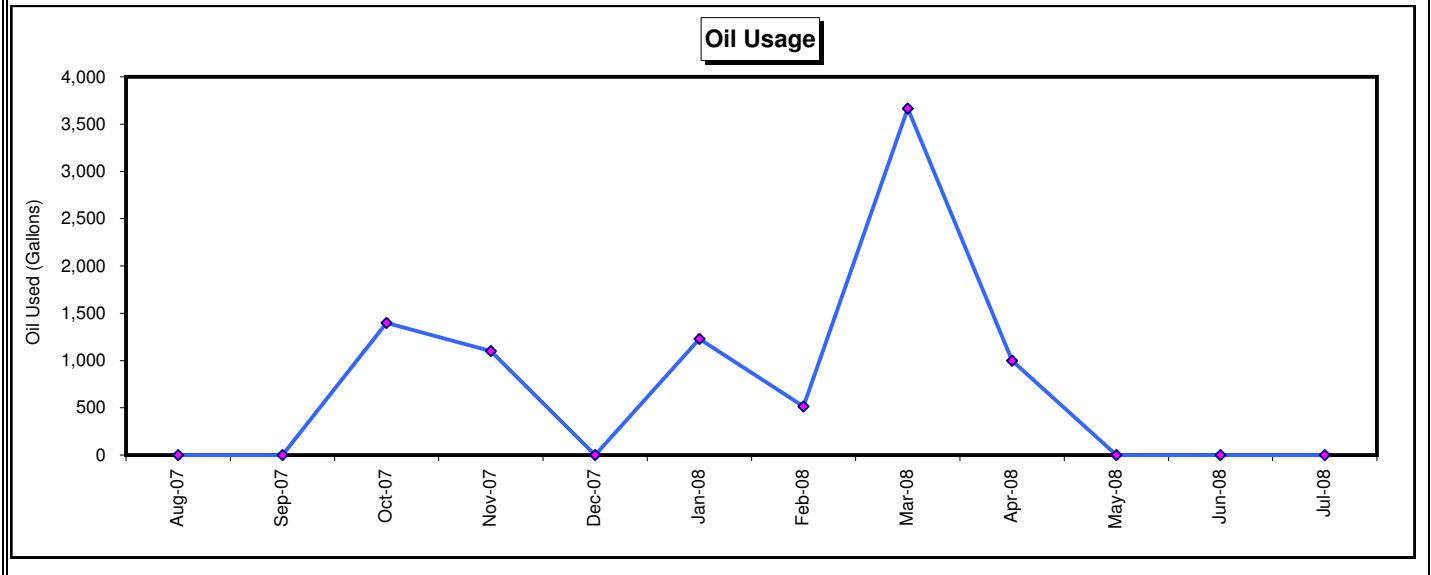
Load Factor = B/(A x E)



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

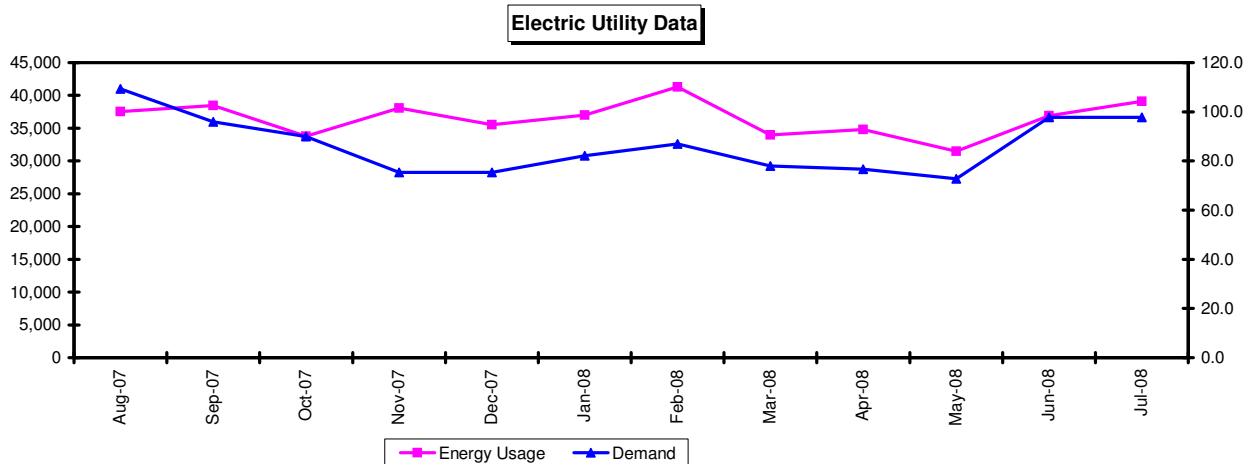
Includes only city Mgr bldg and police dept

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

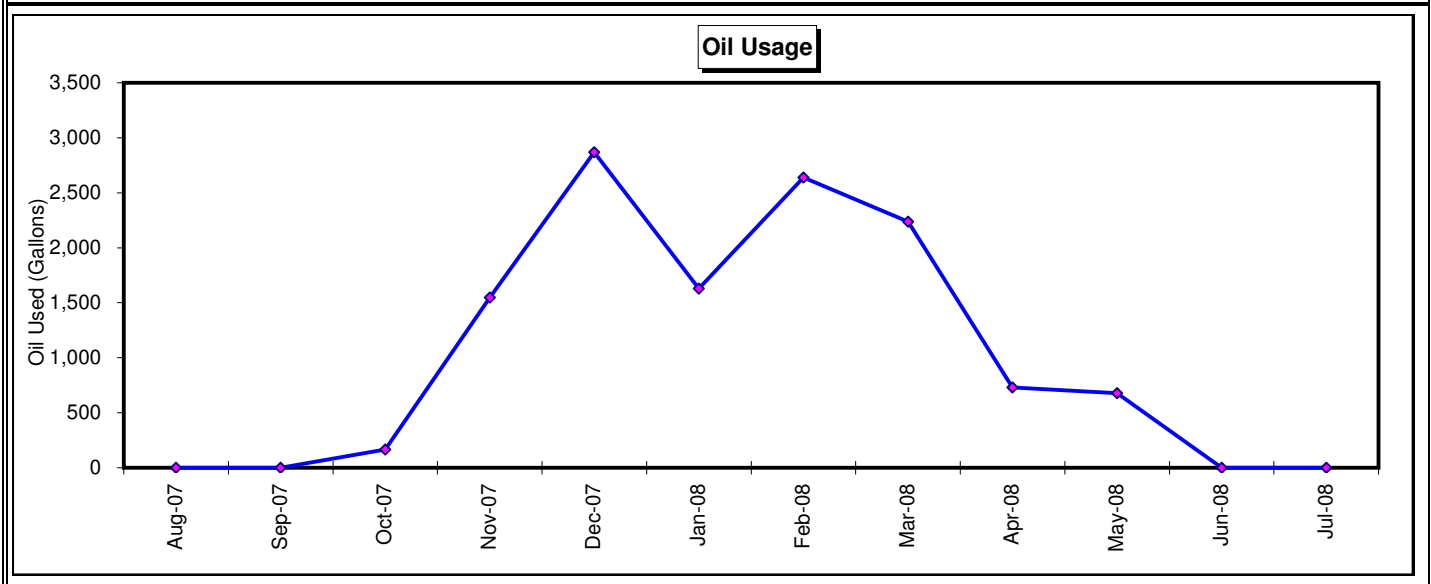
Load Factor = B/(A x E)



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.

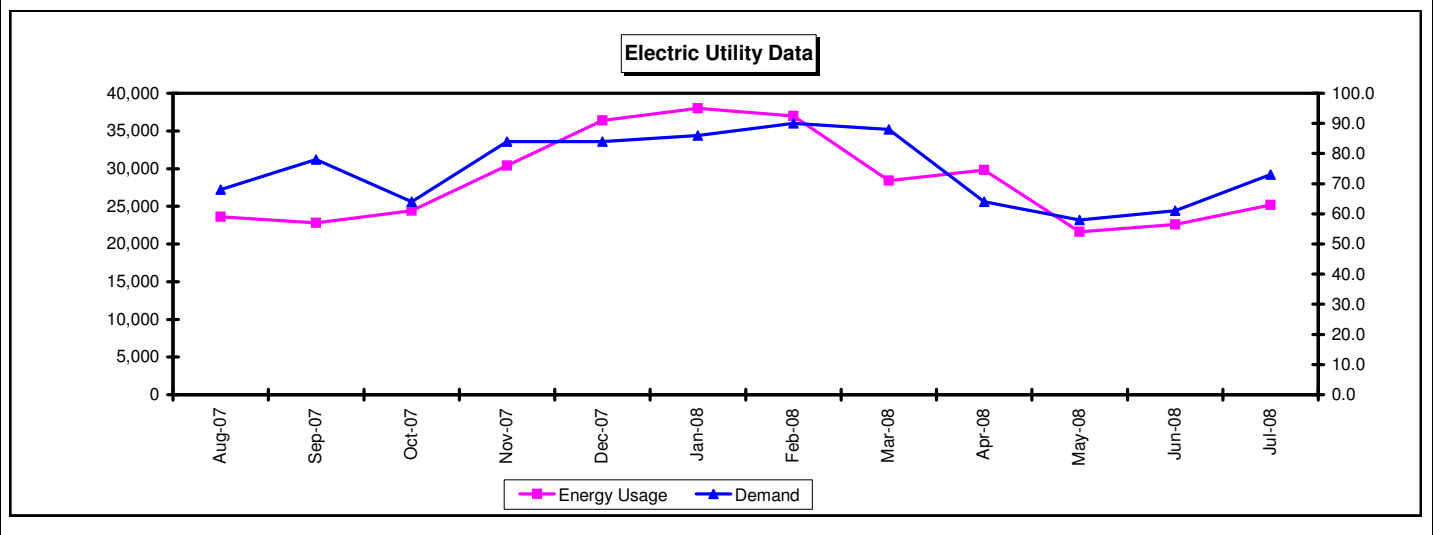
Utility Company: PSNH
 Old Acct. No.: 61-10-09245-1-5
 New Acct. N: 56632841078
 Rate: 0
 Date: 2/7/2009

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

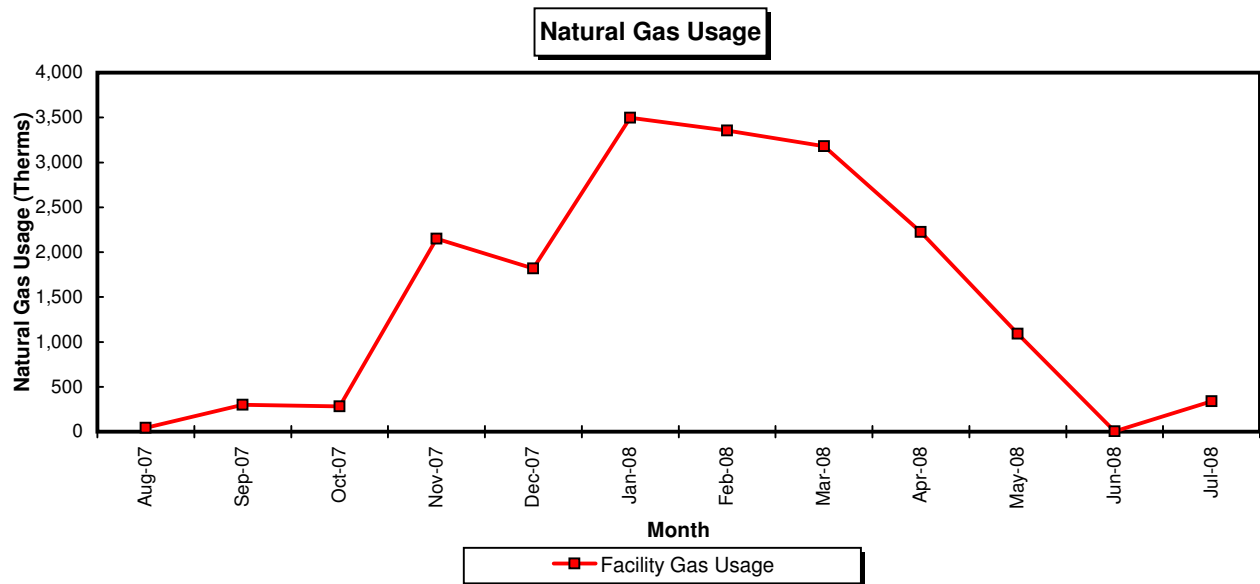
Load Factor = B/(A x E)



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.**

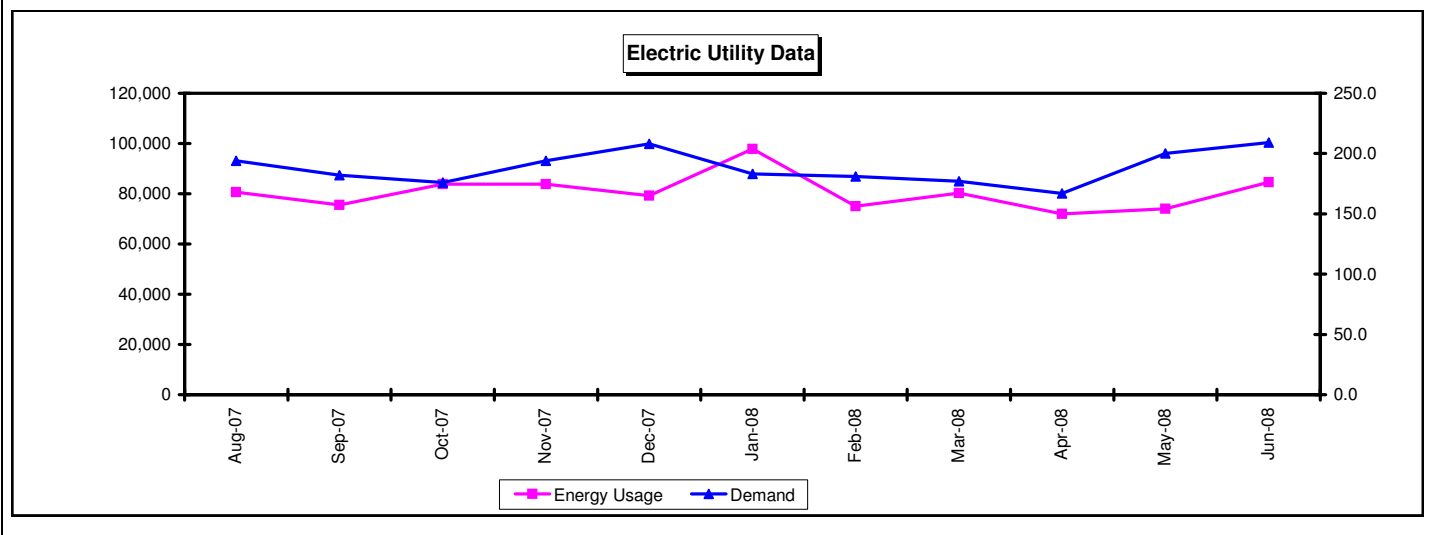
Utility Company: PSNH
 Old Acct. No.: 61-35-06856-1-8, □ 61-35-08894-0-0
 New Acct. N: 8001869-04-5-5
 Rate: GV
 Date: 2/7/2009

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

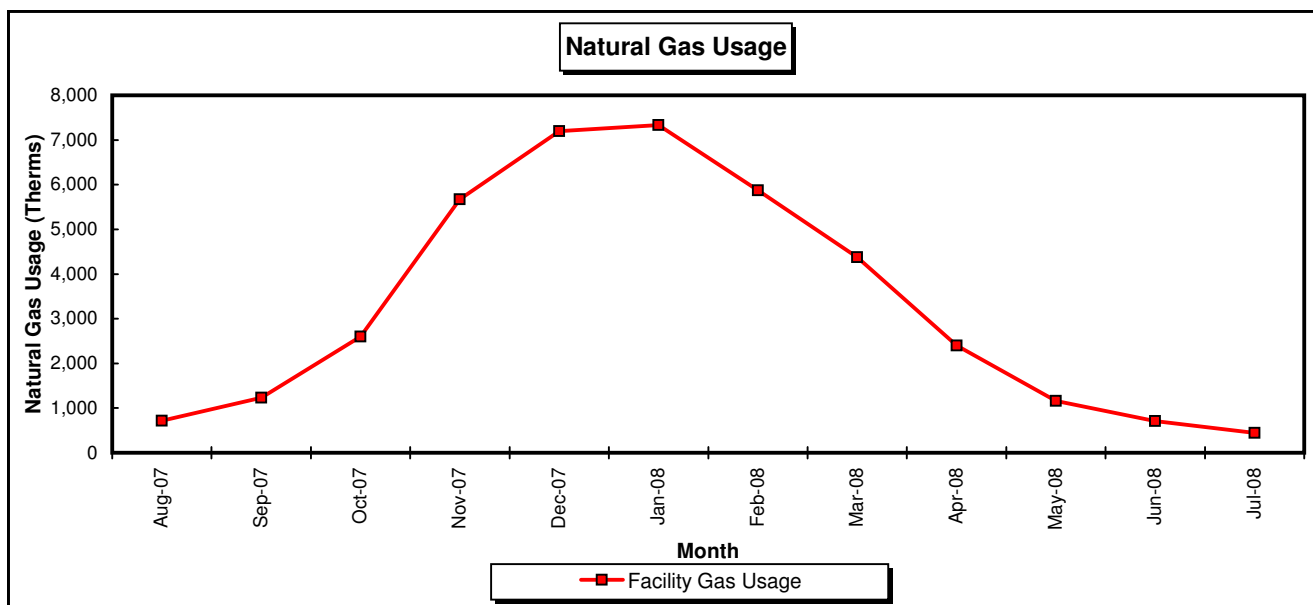
Load Factor = B/(A x E)



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**
 Year Built: **1905/1988**
 School Address: **73 Locust St**
Dover, NH
 Phone Number: **516-6050**
 Principal's Name: **Cathy Beaudoin**
 Facility Area: **20,000 sq. ft.**

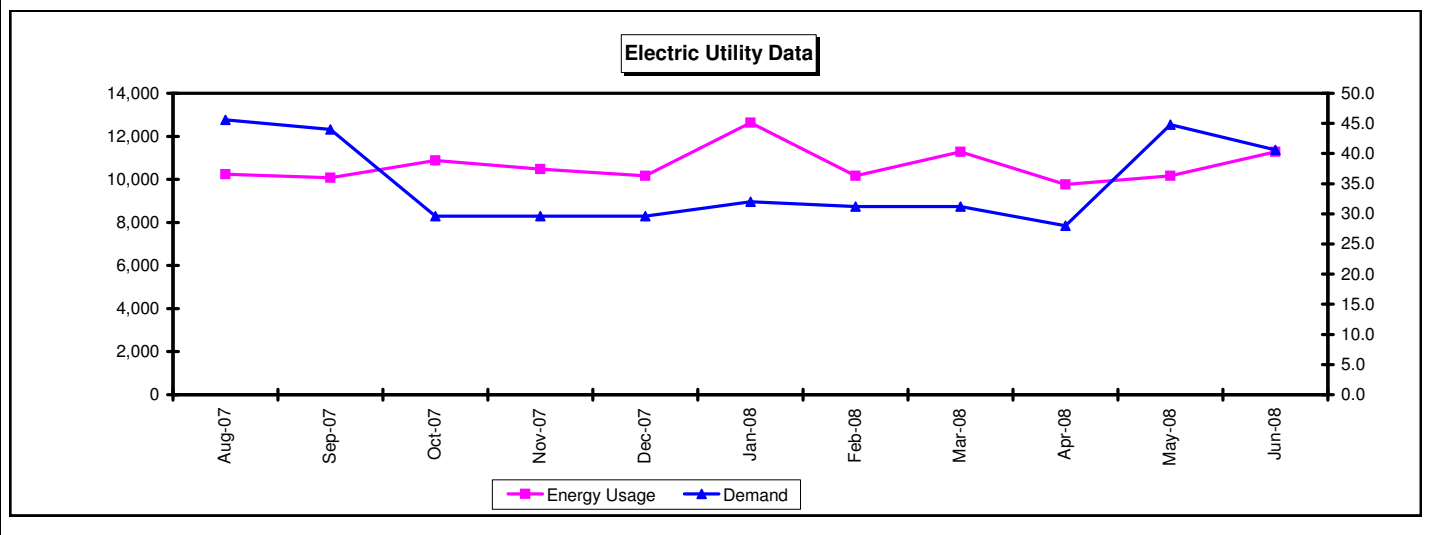
Utility Company: **PSNH**
 Old Acct. No.: **61-35-06833-0-8**
 New Acct. N: **56135401073**
 Rate: **0**
 Date: **2/7/2009**

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	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

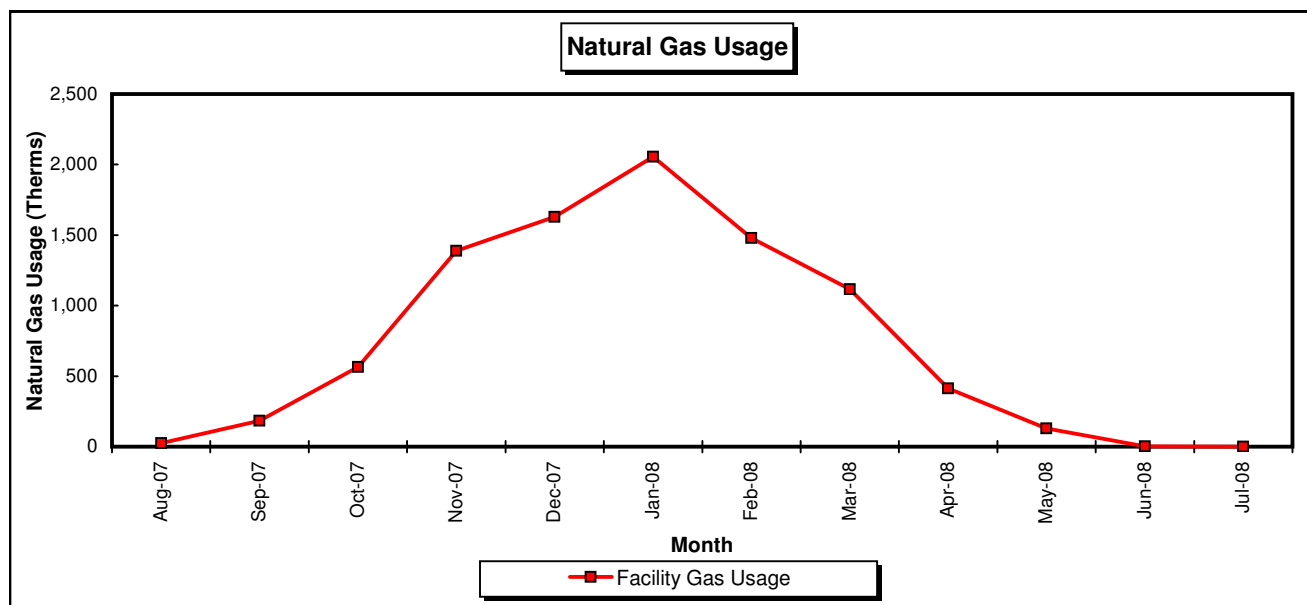
Load Factor = B/(A x E)



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**
 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.**

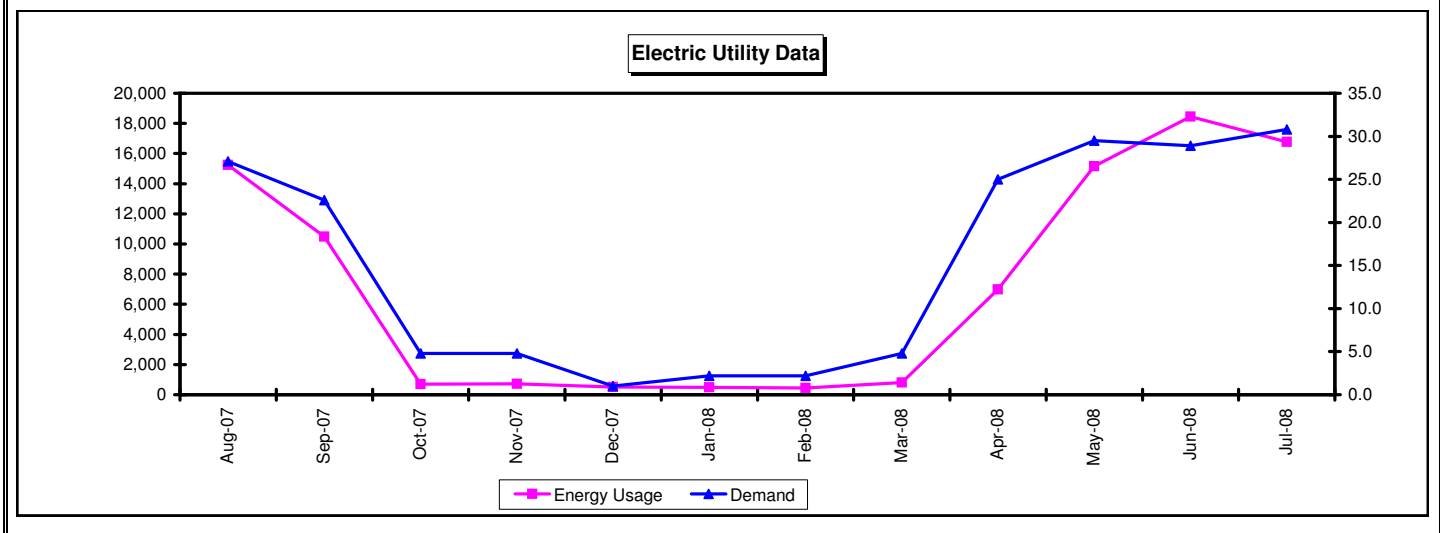
Utility Company: **PSNH**
 Old Acct. No.: **61-30-06136-0-3**
 New Acct. N: **56072321037**
 Rate: **0**
 Date: **2/7/2009**

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
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

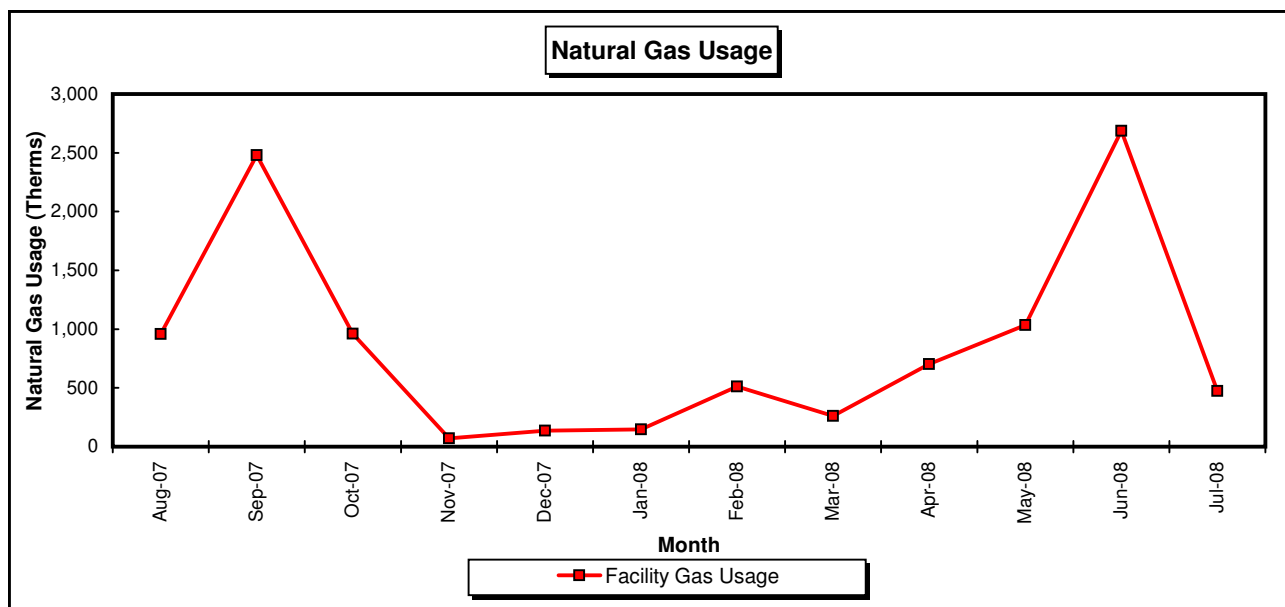
Load Factor = B/(A x E)



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.**

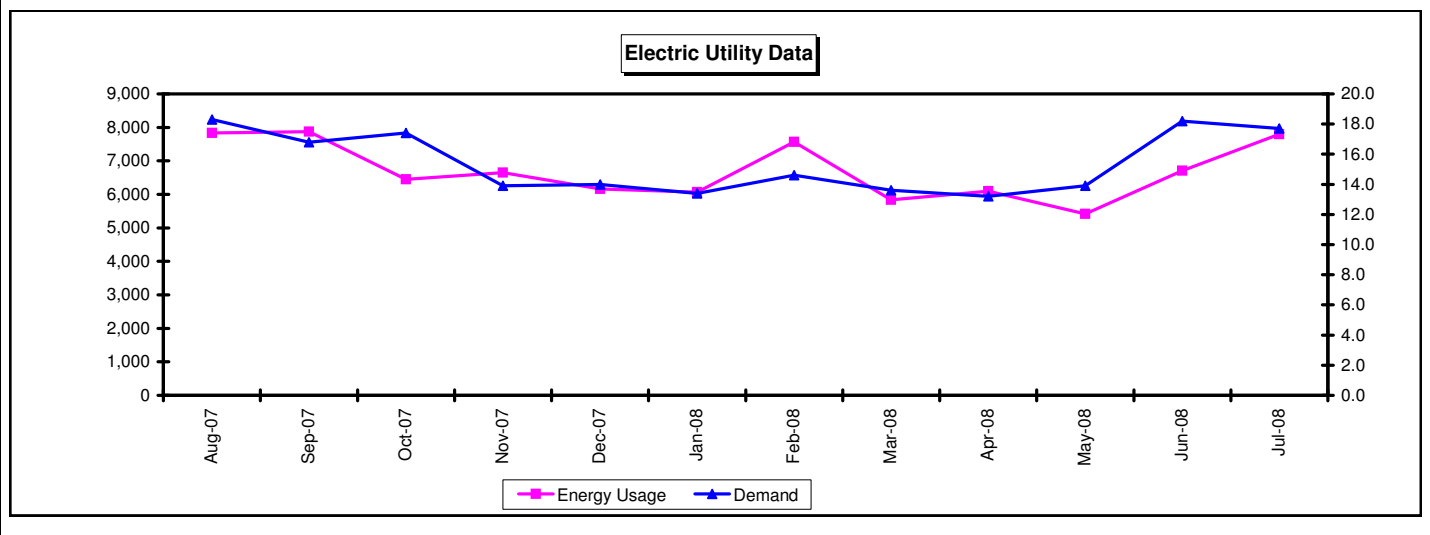
Utility Company: **PSNH**
 Old Acct. No.: **61-35-01167-0-5**
 New Acct. N: **56299411066**
 Rate: **0**
 Date: **2/7/2009**

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

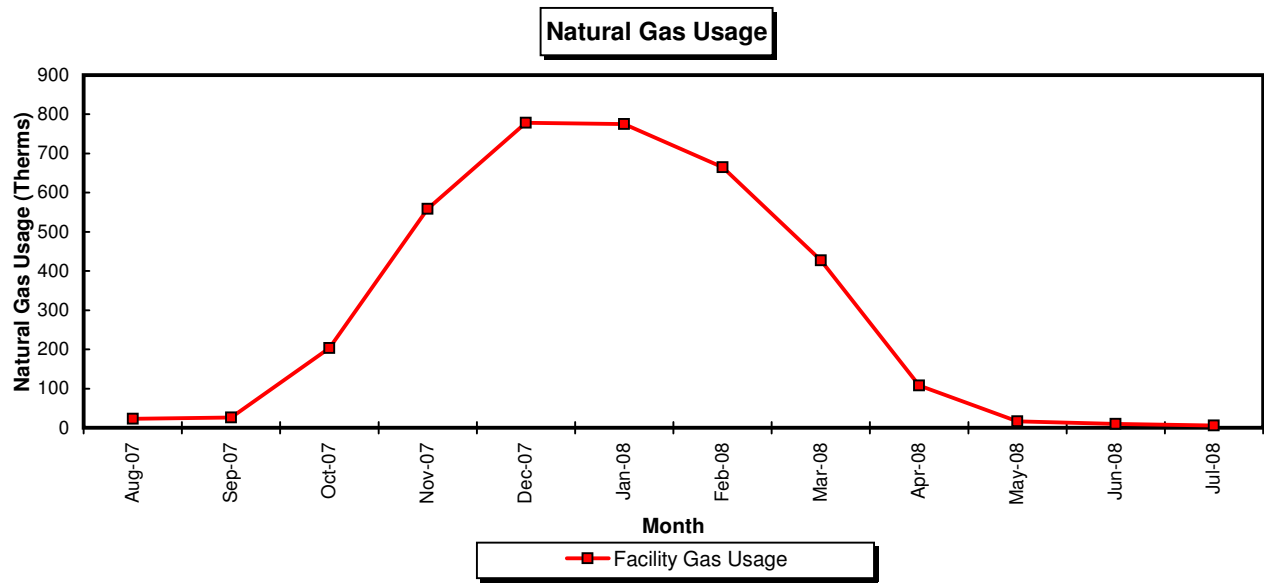
Load Factor = B/(A x E)



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
 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.

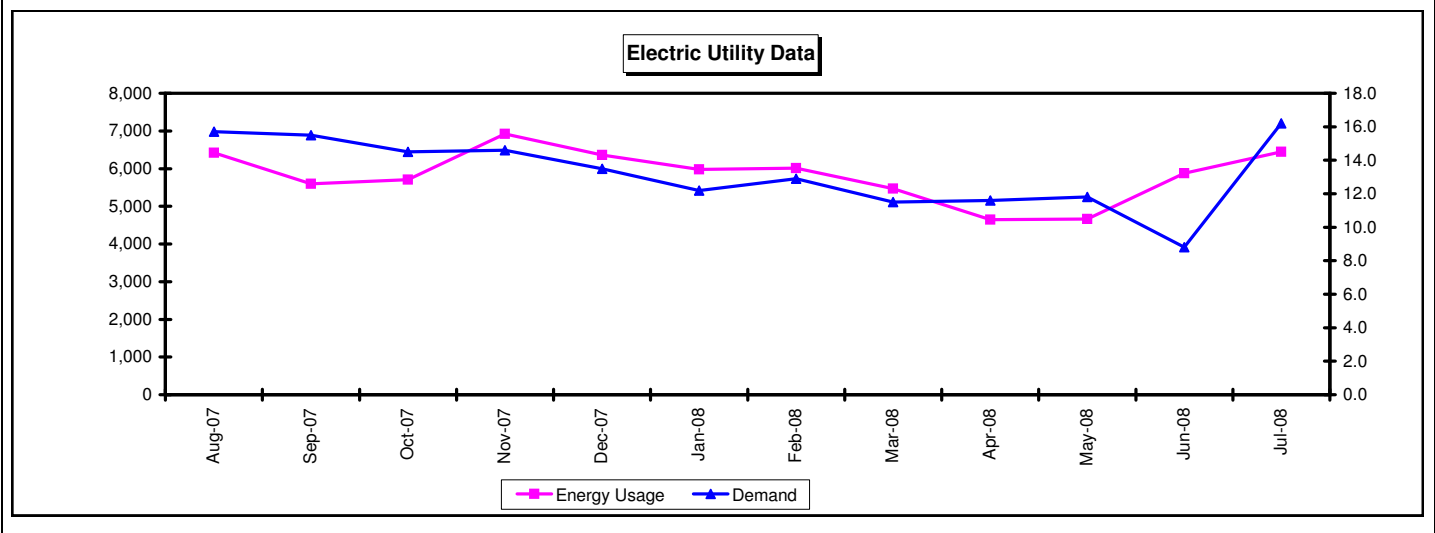
Utility Company: PSNH
 Old Acct. No.: 61-10-03228-0-1
 New Acct. N: 56847801073
 Rate: 0
 Date: 2/7/2009

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
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

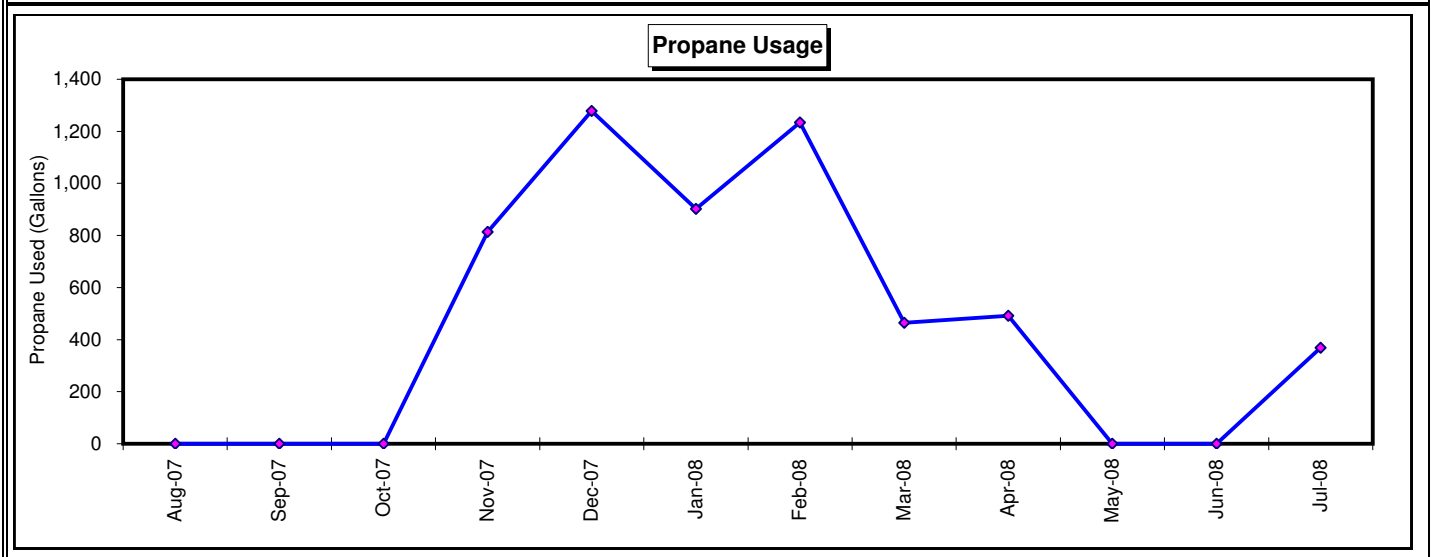
Load Factor = B/(A x E)



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.

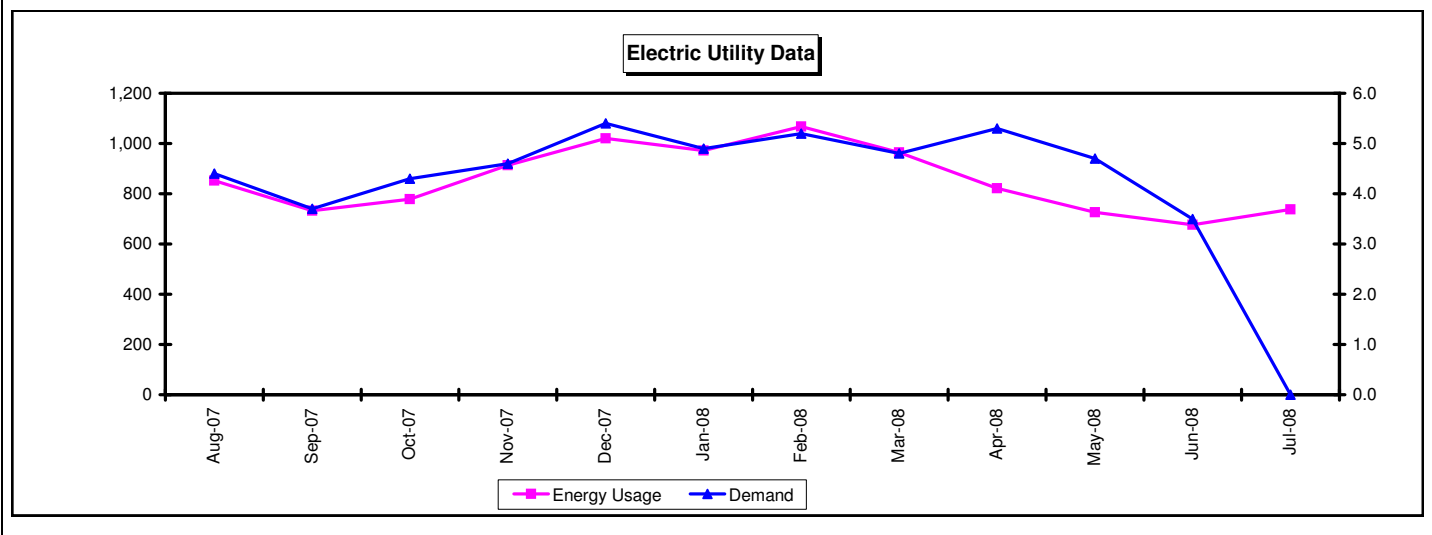
Utility Company: PSNH
 Old Acct. No.: 61-35-05696-0-6
 New Acct. N: 56143521011
 Rate: 0
 Date: 2/7/2009

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

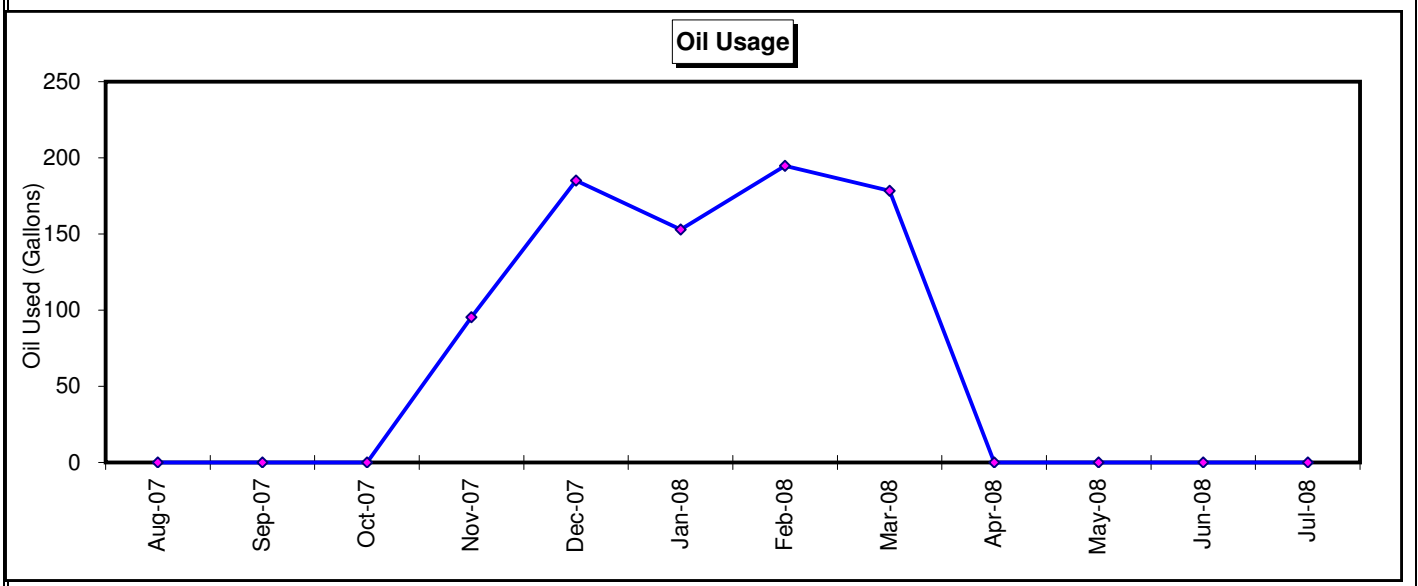
Load Factor = B/(A x E)



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.**

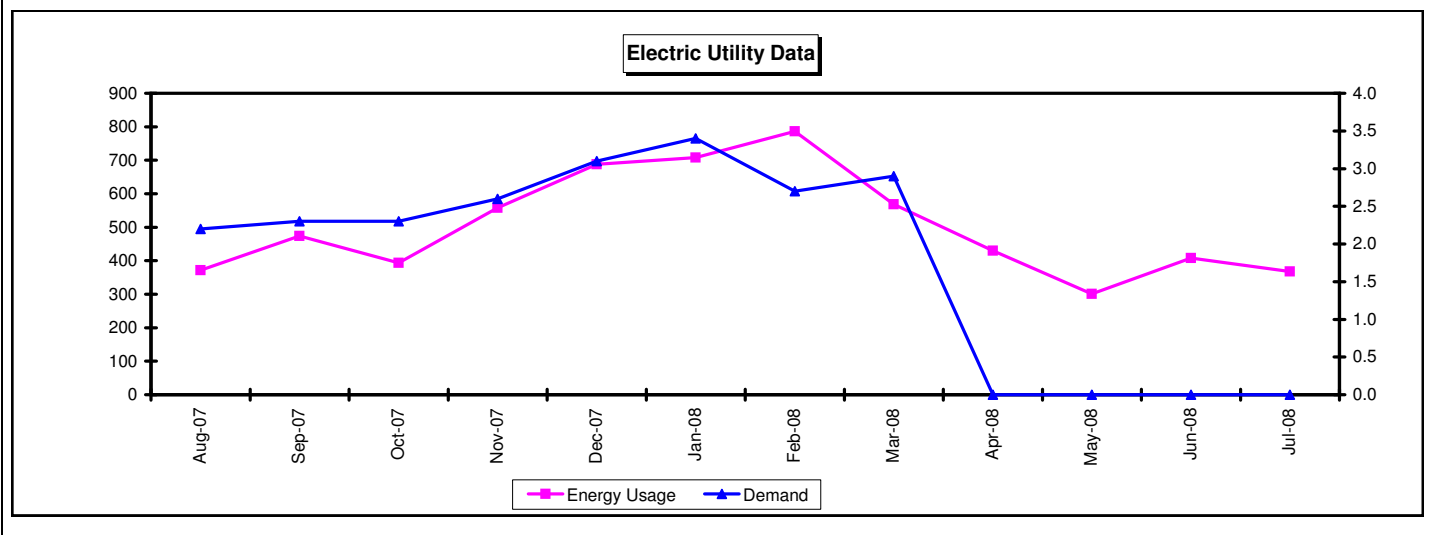
Utility Company: **PSNH**
 Old Acct. No.: **61-35-05566-0-3, 61-35-05567-0-2**
 New Acct. N: **56560290074, 56511290090**
 Rate: **0**
 Date: **2/7/2009**

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

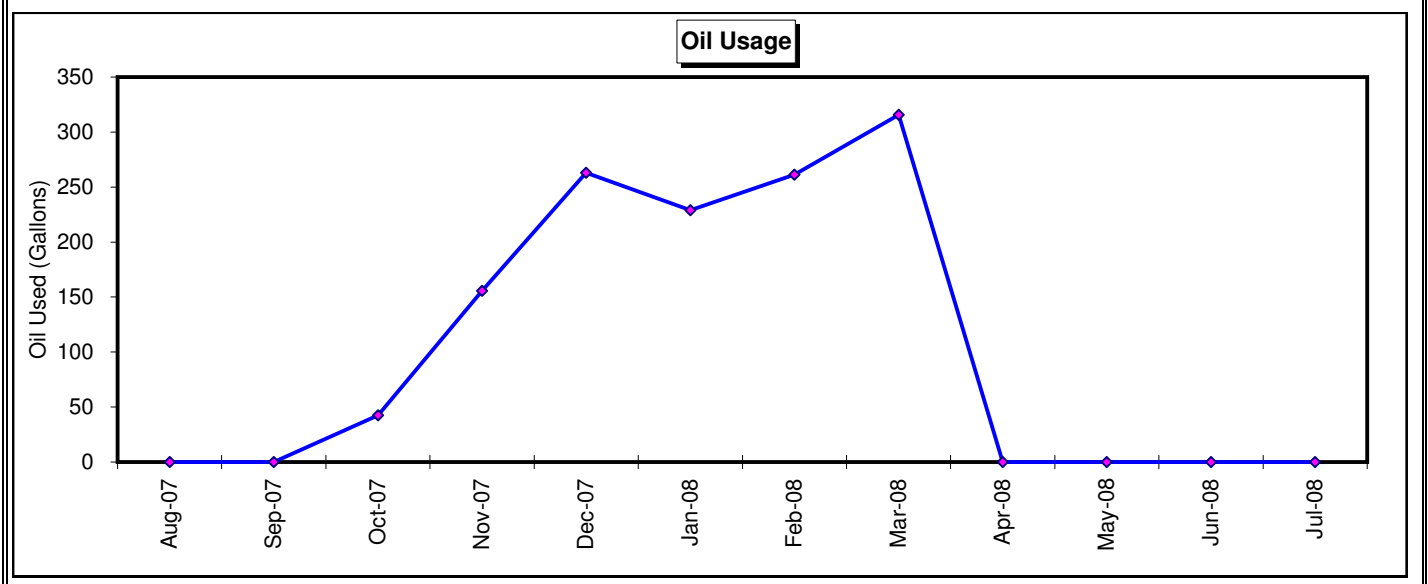
Load Factor = B/(A x E)



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.

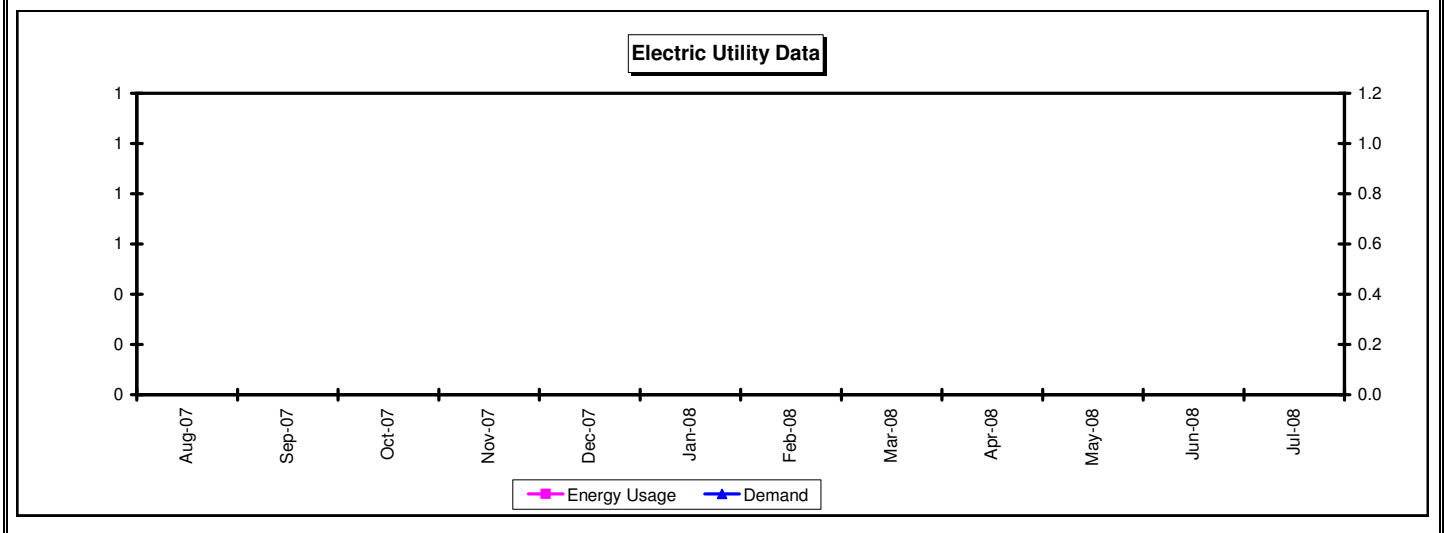
Utility Company: PSNH
 Old Acct. No.: 61-10-11423-0-7
 New Acct. N: 56599551058
 Rate: 0
 Date: 2/7/2009

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

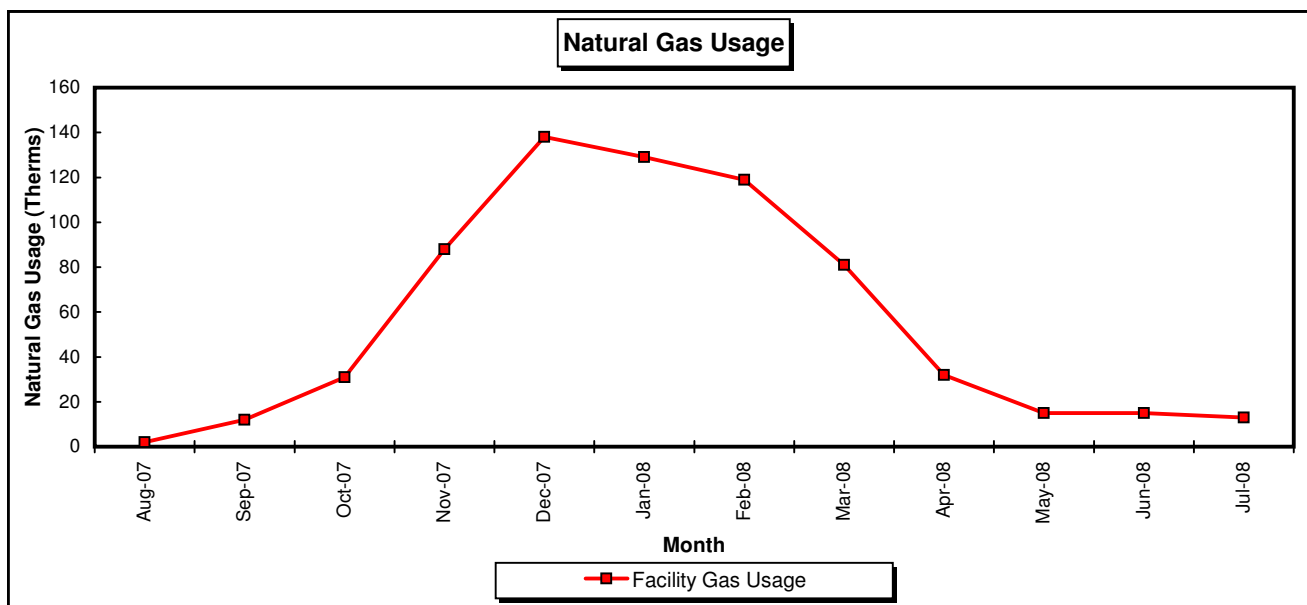
Load Factor = B/(A x E)



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.**

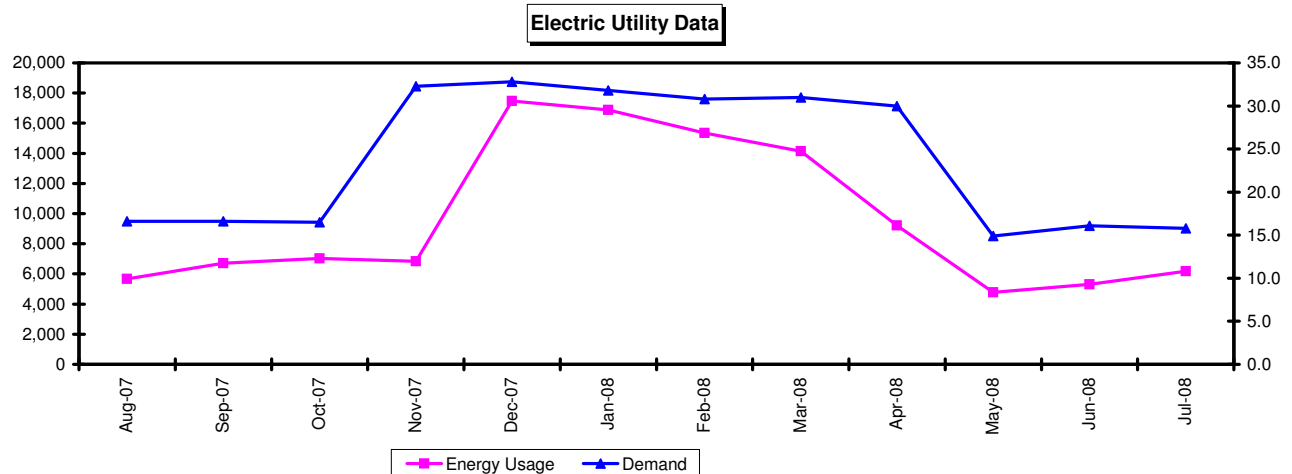
Utility Company: **PSNH**
 Old Acct. No.: **61-35-04075-1-8, 61-35-04442-0-6**
 New Acct. N: **56303841092, 56709941074**
 Rate: **0**
 Date: **2/7/2009**

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

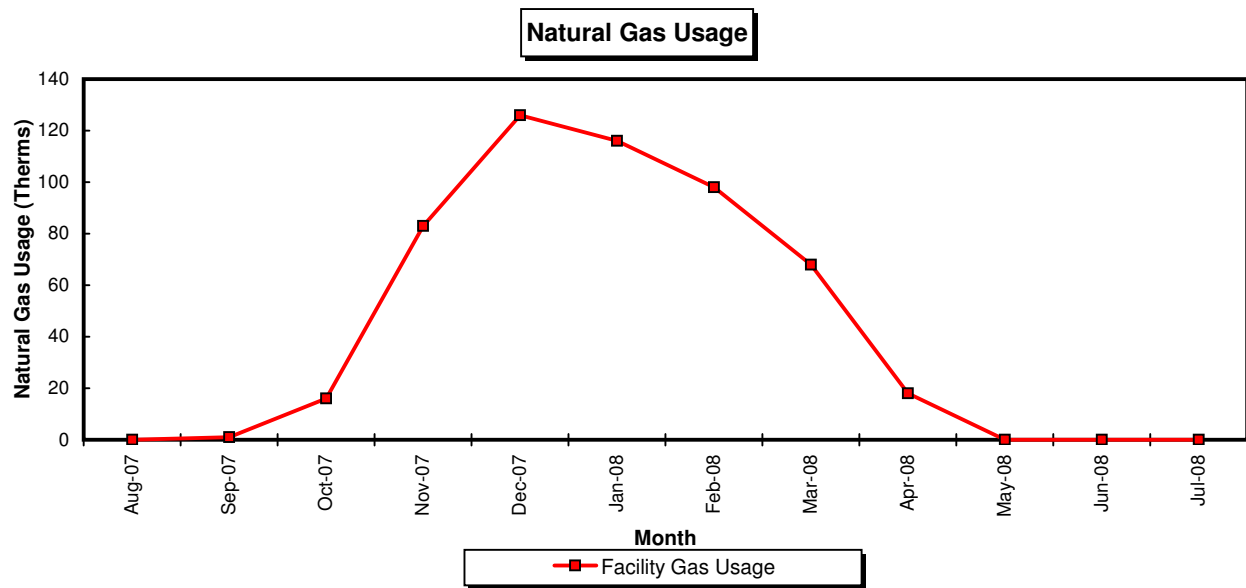
Load Factor = B/(A x E)



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.**

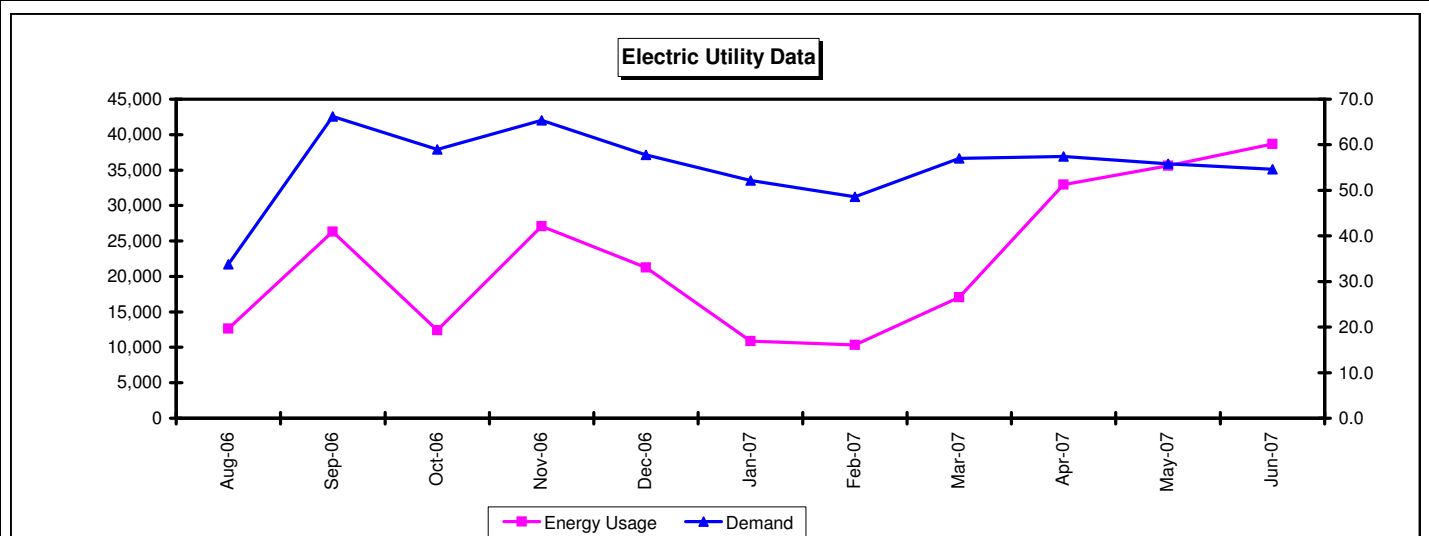
Utility Company: **PSNH**
 Old Acct. No.: **8000619-02-9-4**
 New Acct. No.: **8000619-02-9-4**
 Rate: **G, Three Phase**
 Date: **2/7/2009**

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

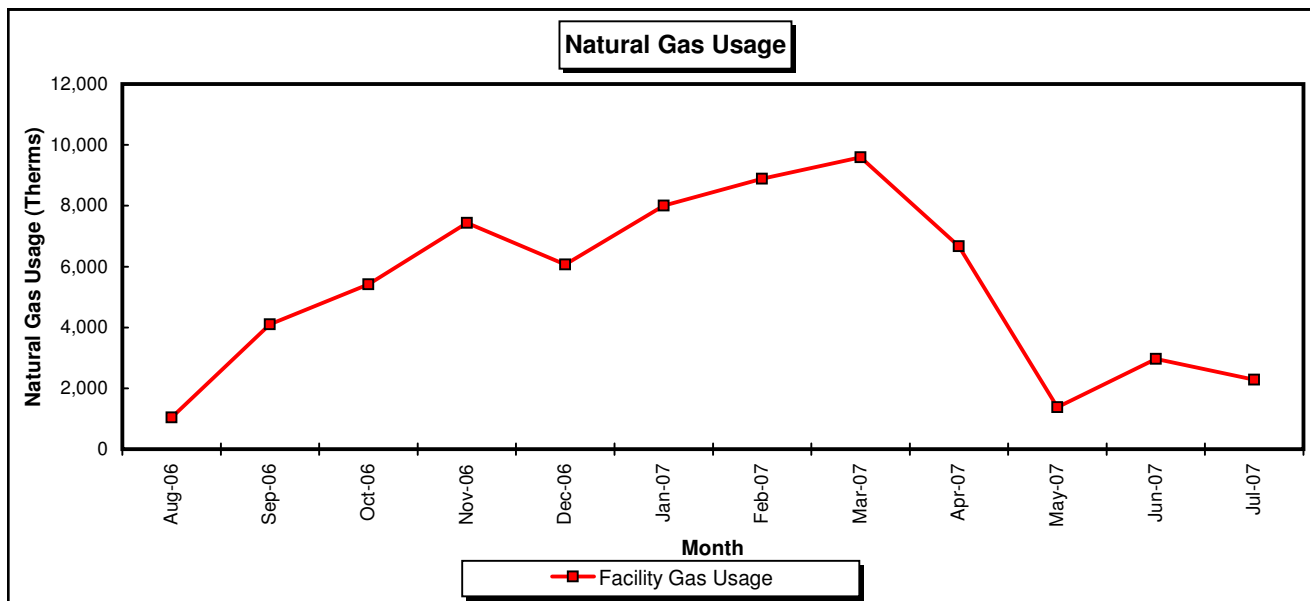
Load Factor = B/(A x E)



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.**

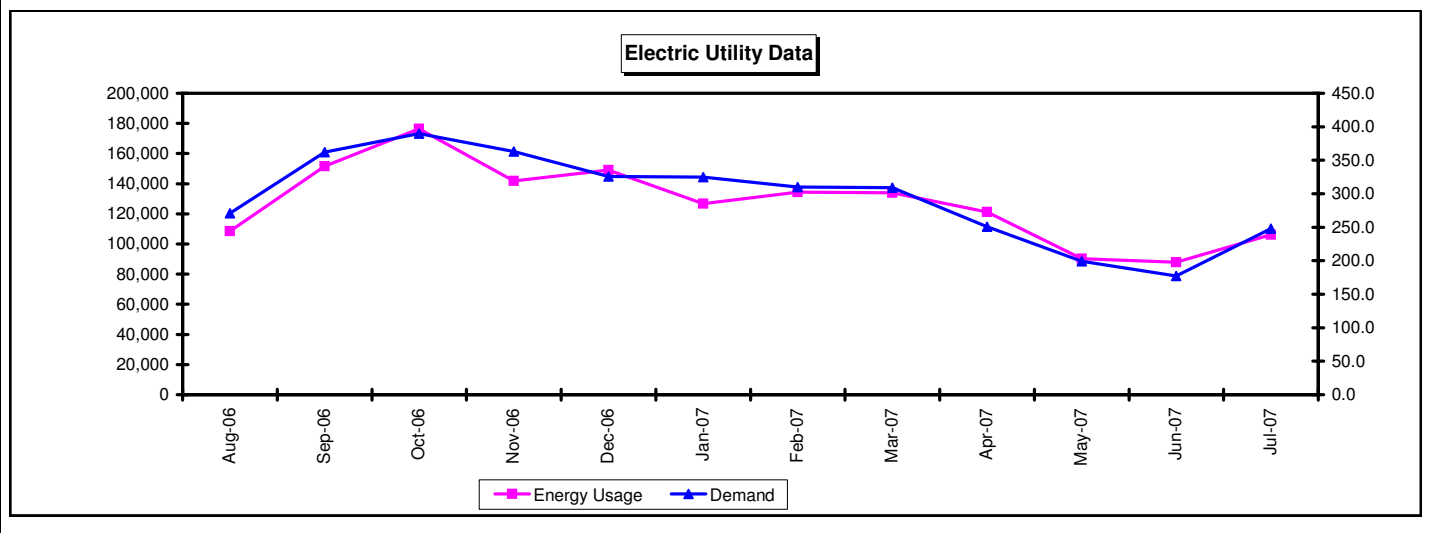
Utility Company: **PSNH**
 Old Acct. No.: **8000626-01-6-2**
 New Acct. No.: **8000626-01-6-2**
 Rate: **GV**
 Date: **2/7/2009**

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

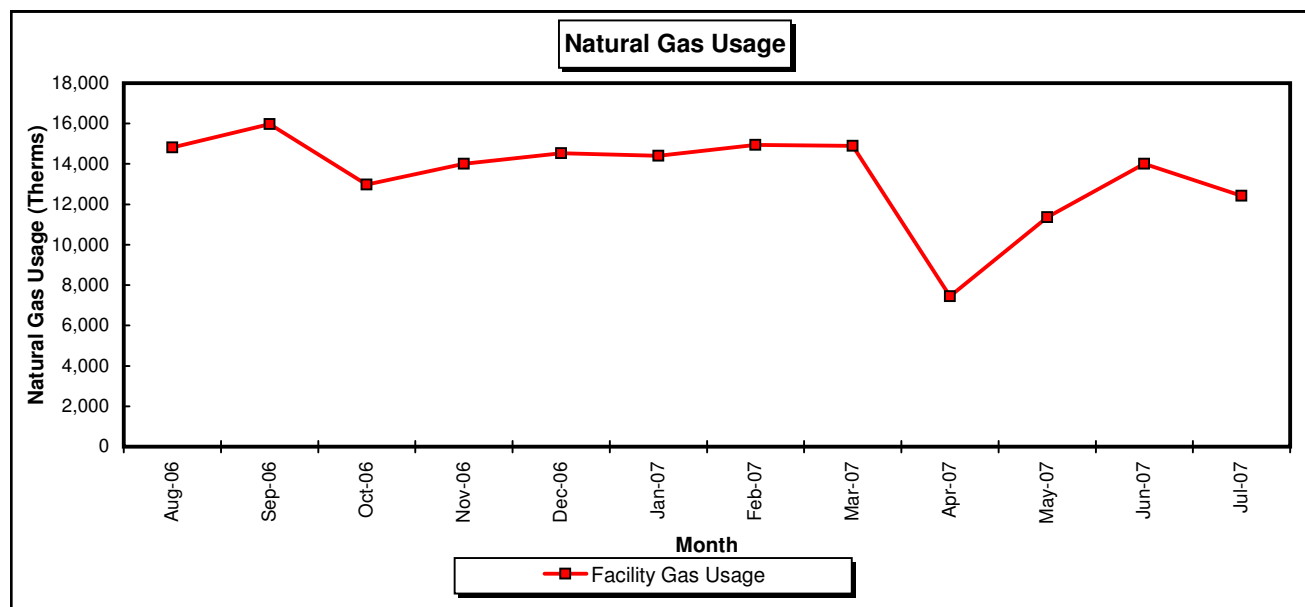
Load Factor = B/(A x E)



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.**

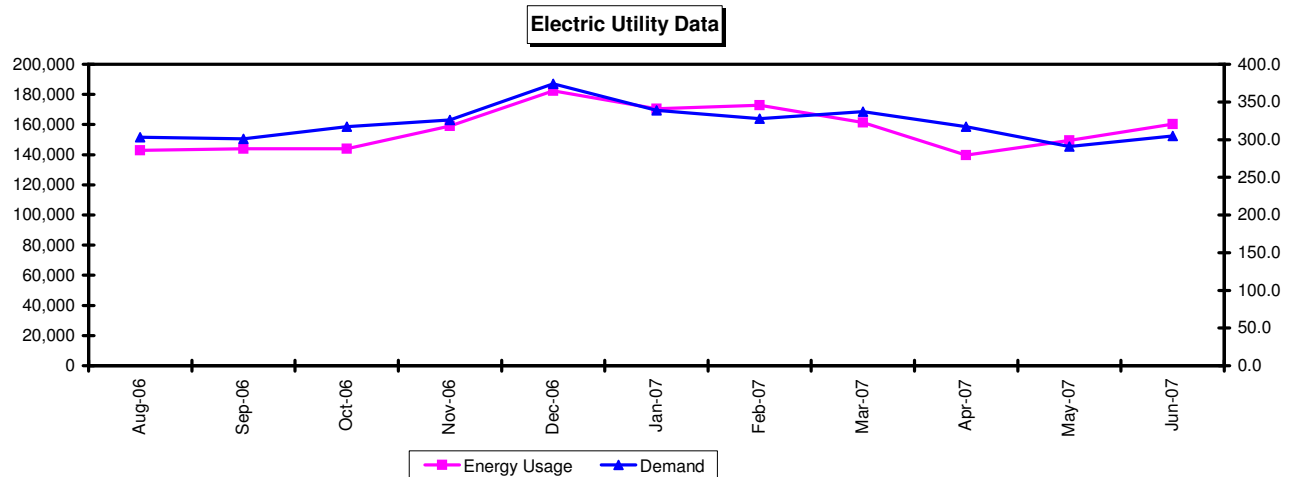
Utility Company: **PSNH**
 Old Acct. No.: **8000672-03-5-5**
 New Acct. No.: **8000672-03-5-5**
 Rate: **GV**
 Date: **2/7/2009**

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/kWh:		\$0.00			

Table Formulas: Hours per Month = D x 24

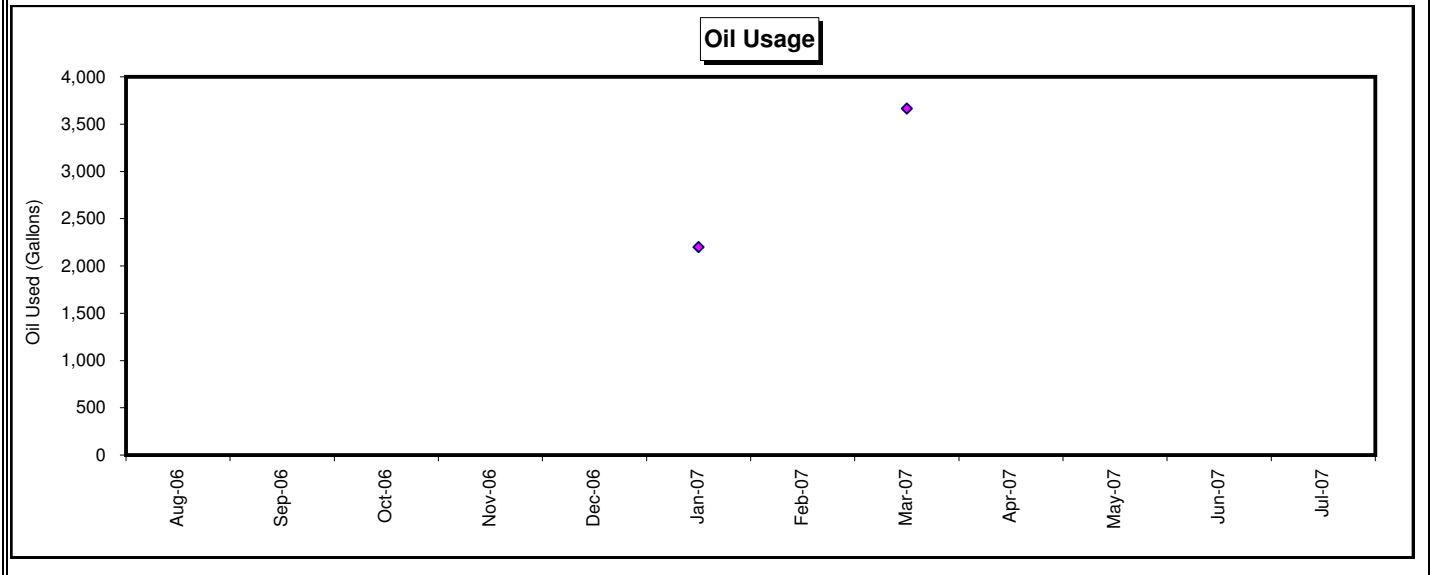
Load Factor = B/(A x E)



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**
 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. No.: 56906401021, 56395401037
 Rate: 0
 Date: 2/7/2009

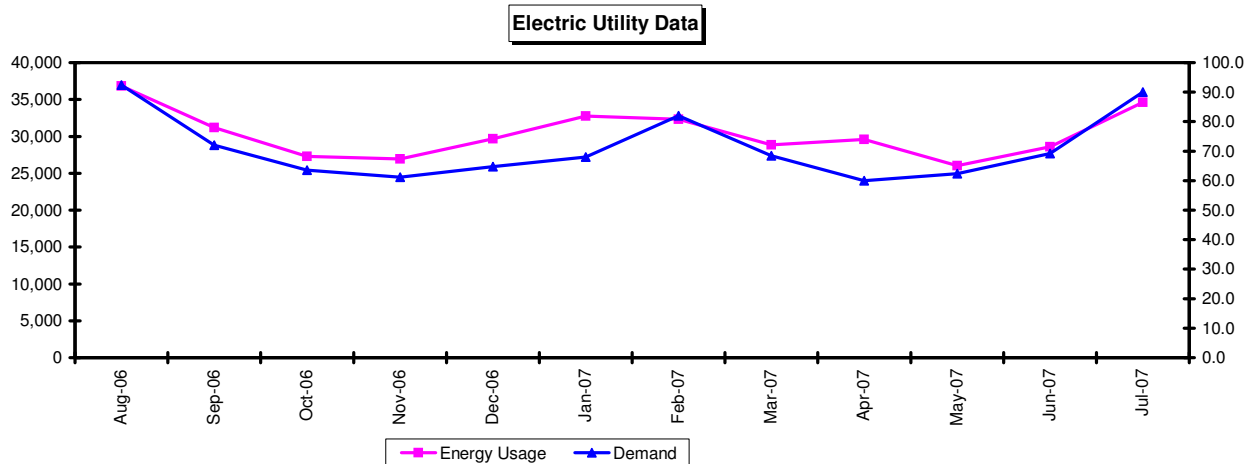
Includes only city Mgr bldg and police dept

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
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

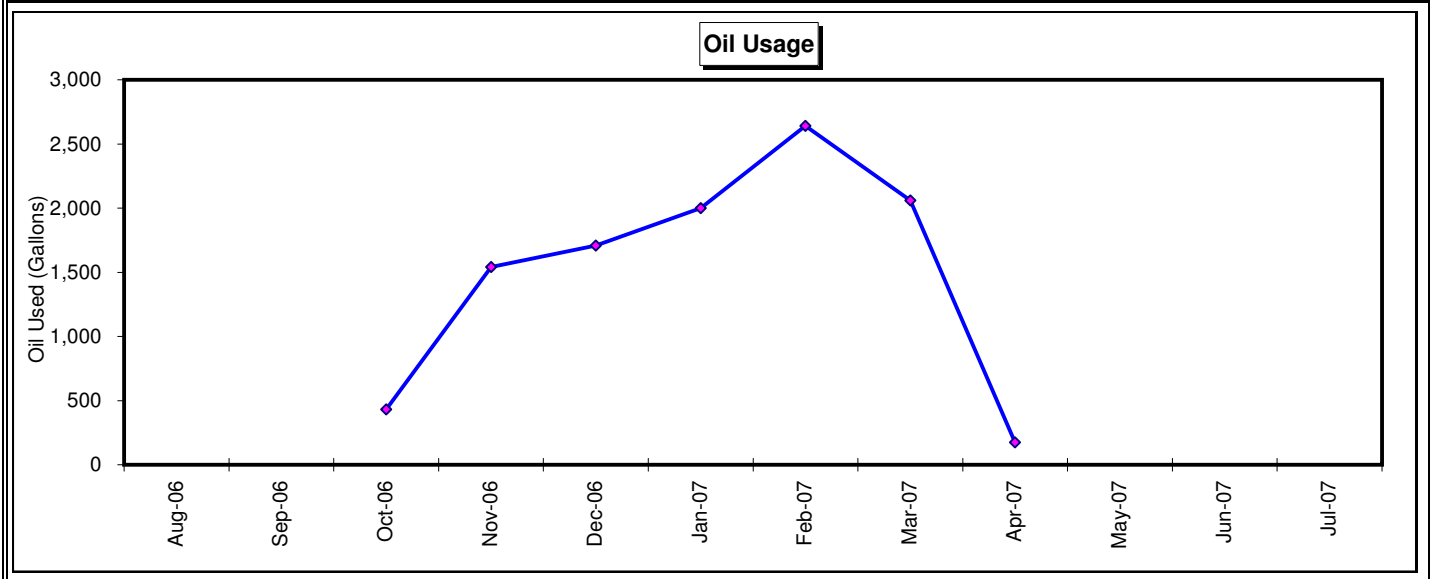
Load Factor = B/(A x E)



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.

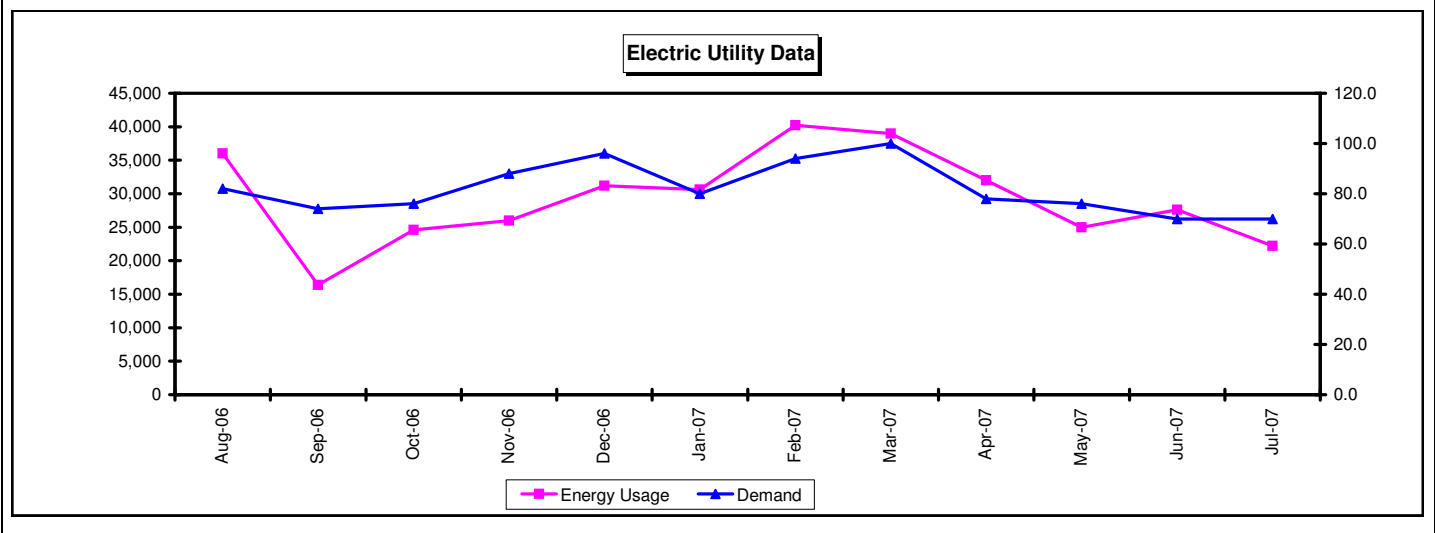
Utility Company: PSNH
 Old Acct. No.: 61-10-09245-1-5
 New Acct. No.: 56632841078
 Rate: 0
 Date: 2/7/2009

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

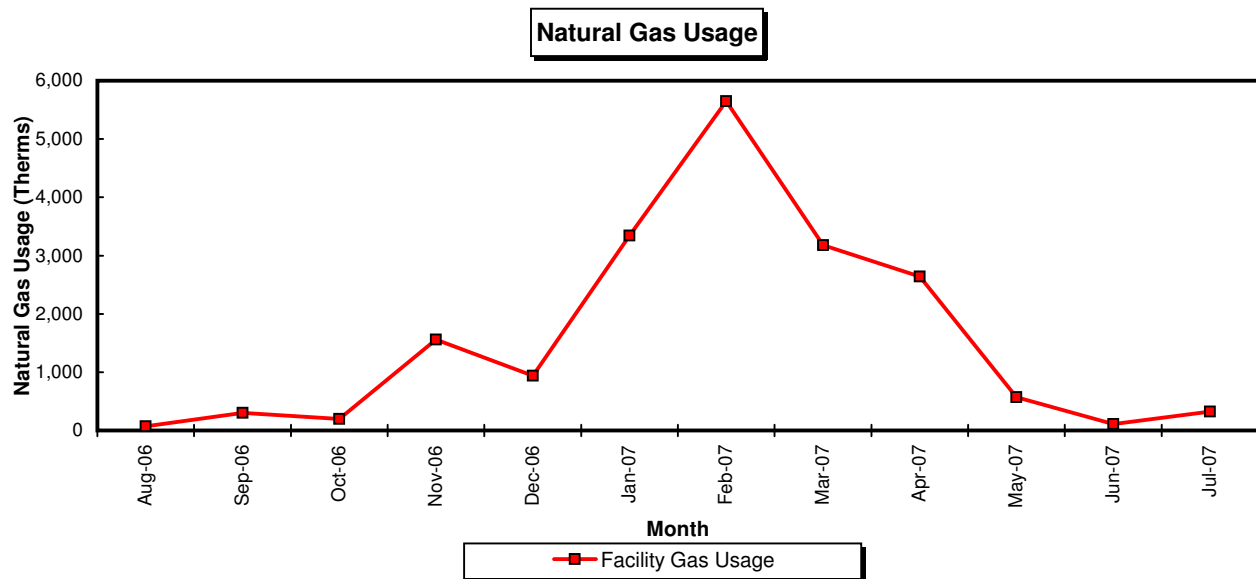
Load Factor = B/(A x E)



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.**

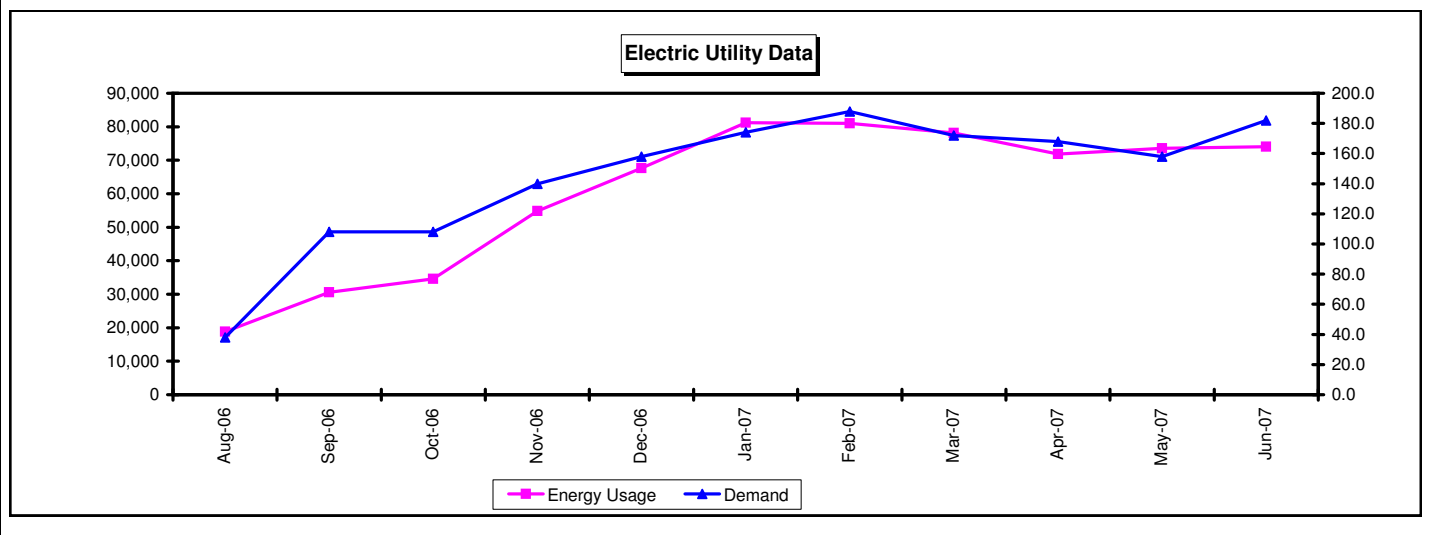
Utility Company: **PSNH**
 Old Acct. No.: **61-35-06856-1-8, 61-35-08894-0-0**
 New Acct. No.: **8001869-04-5-5**
 Rate: **GV**
 Date: **2/7/2009**

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

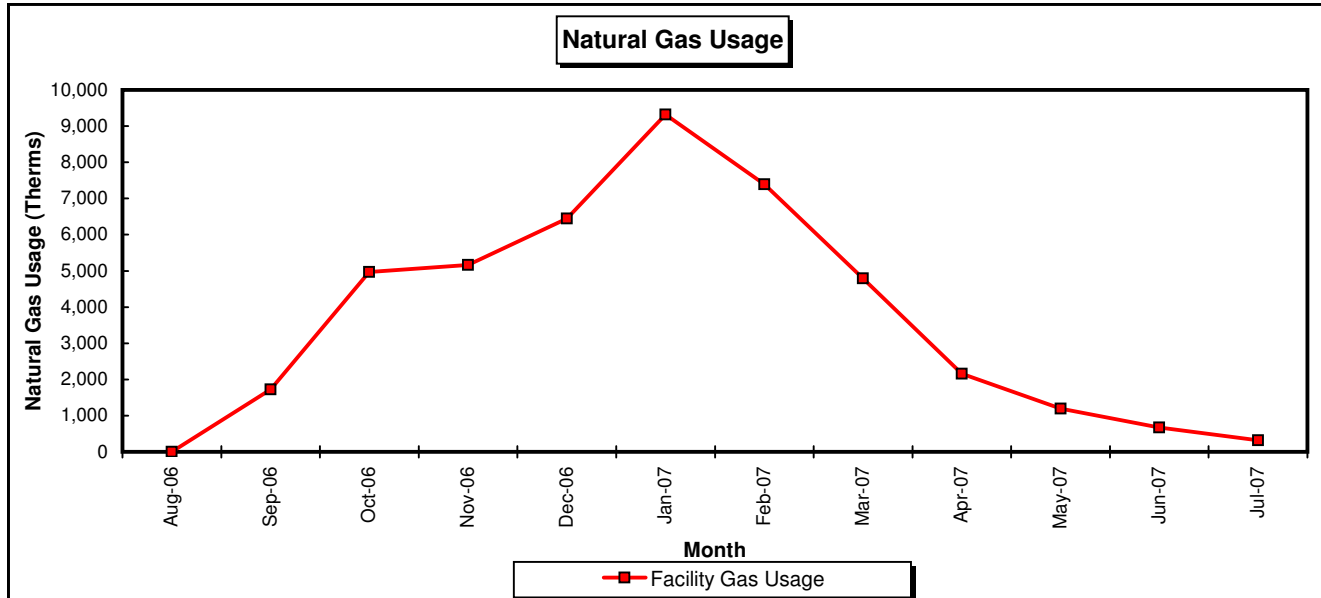
Load Factor = B/(A x E)



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**
 Year Built: **1905/1988**
 School Address: **73 Locust St**
Dover, NH
 Phone Number: **516-6050**
 Principal's Name: **Cathy Beaudoin**
 Facility Area: **20,000 sq. ft.**

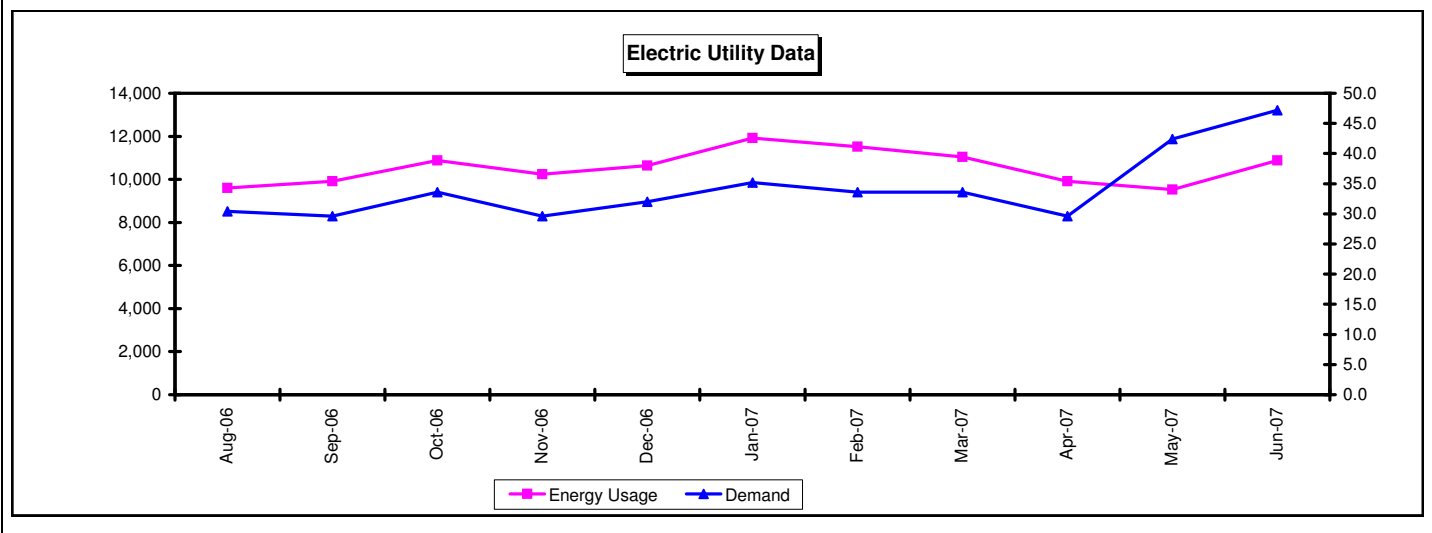
Utility Company: PSNH
 Old Acct. No.: 61-35-06833-0-8
 New Acct. No.: 56135401073
 Rate: 0
 Date: 2/7/2009

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	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

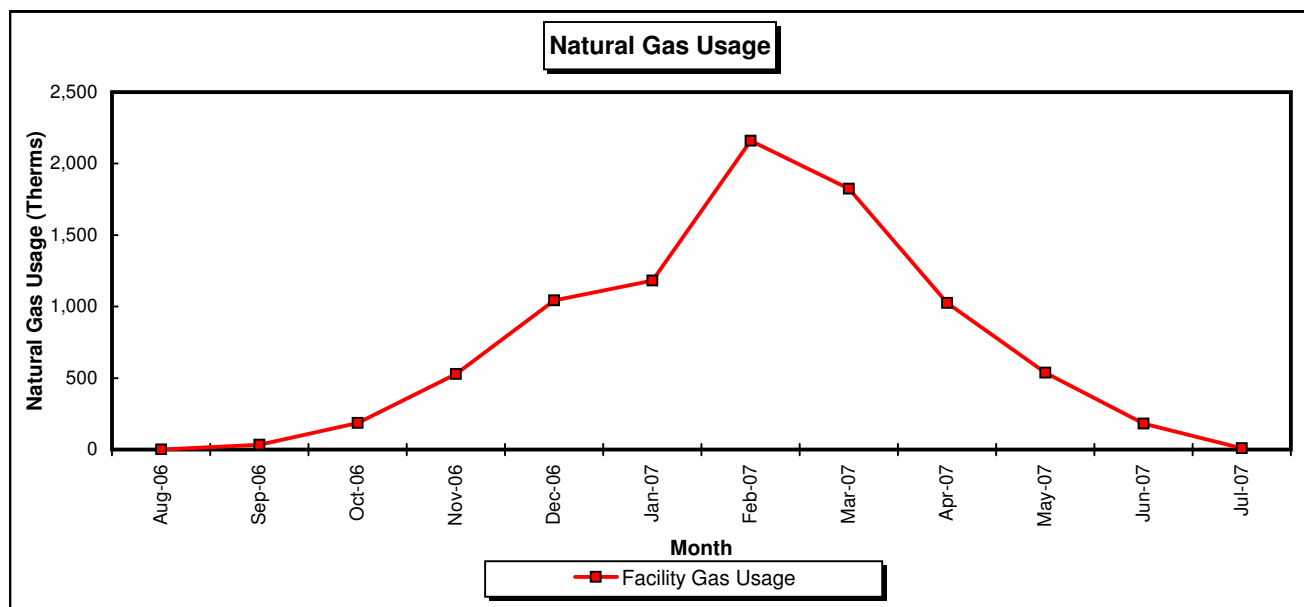
Load Factor = B/(A x E)



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.**

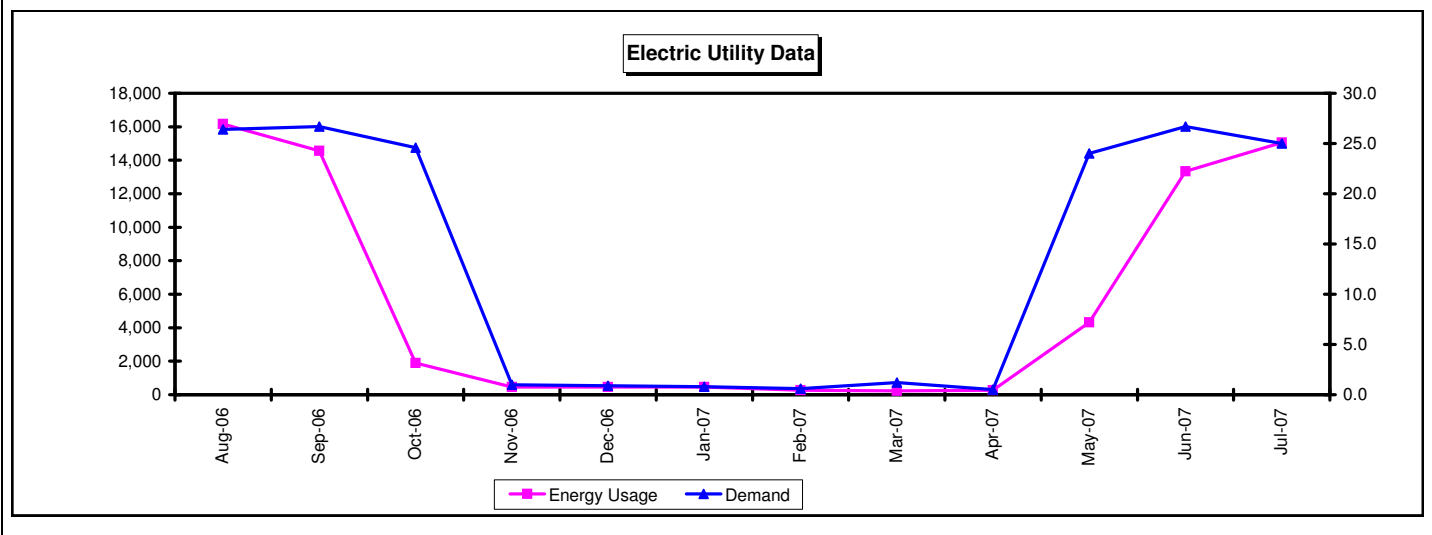
Utility Company: PSNH
 Old Acct. No.: 61-30-06136-0-3
 New Acct. No.: 56072321037
 Rate: 0
 Date: 2/7/2009

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

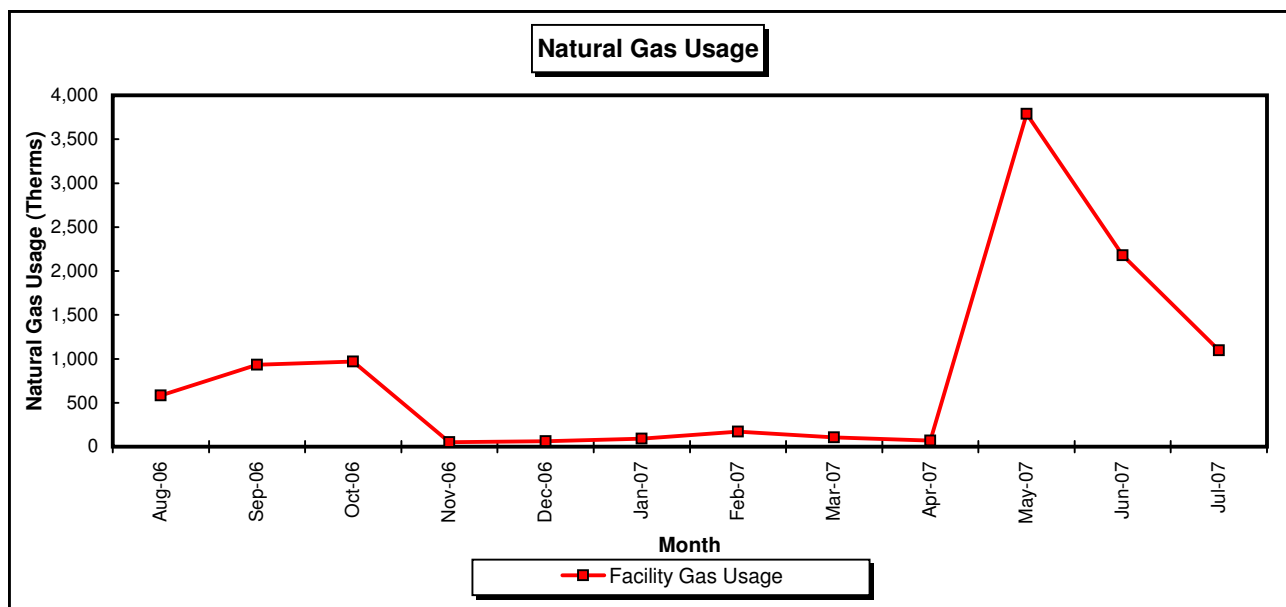
Load Factor = B/(A x E)



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

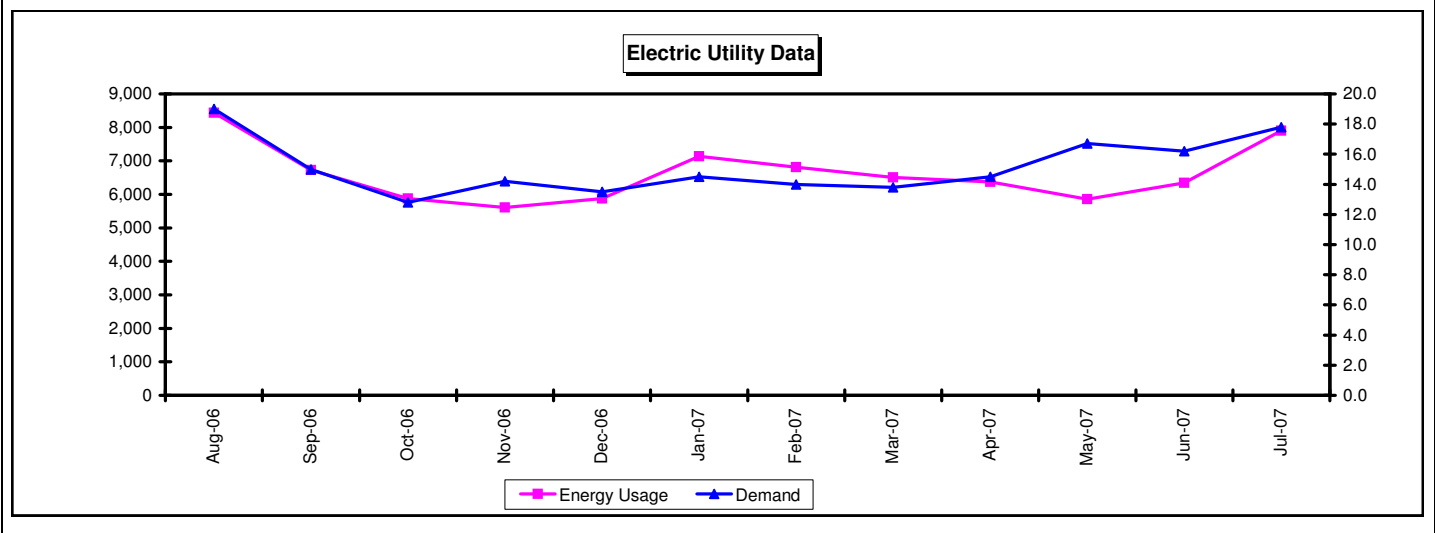
Utility Company: PSNH
 Old Acct. No.: 61-35-01167-0-5
 New Acct. No.: 56299411066
 Rate: 0
 Date: 2/7/2009

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
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

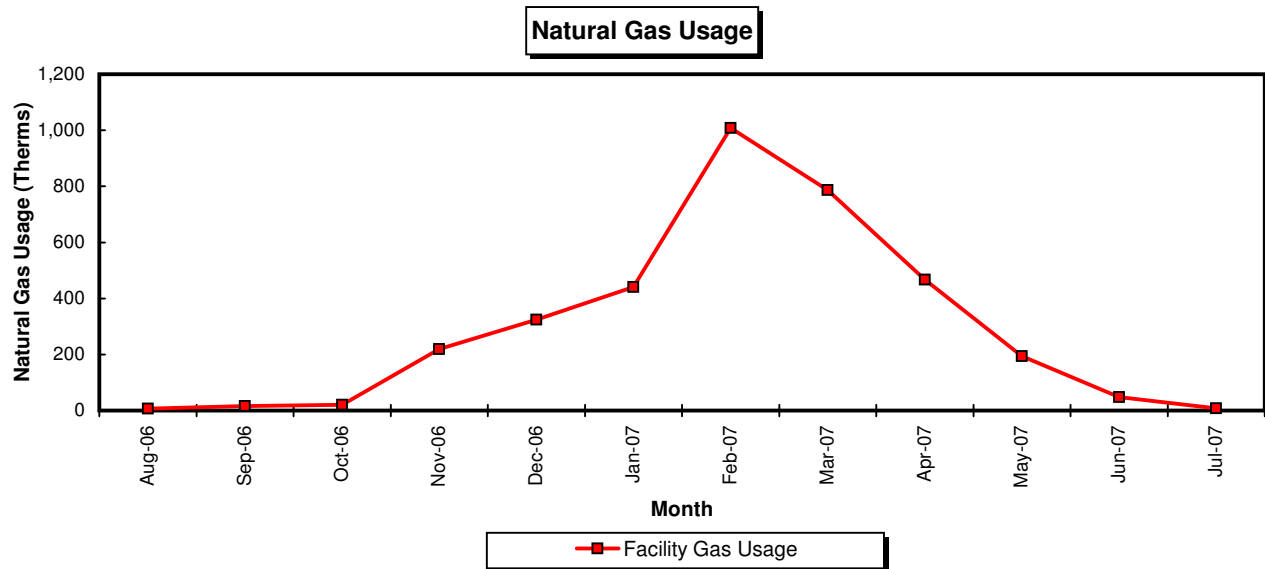
Load Factor = B/(A x E)



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
 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.

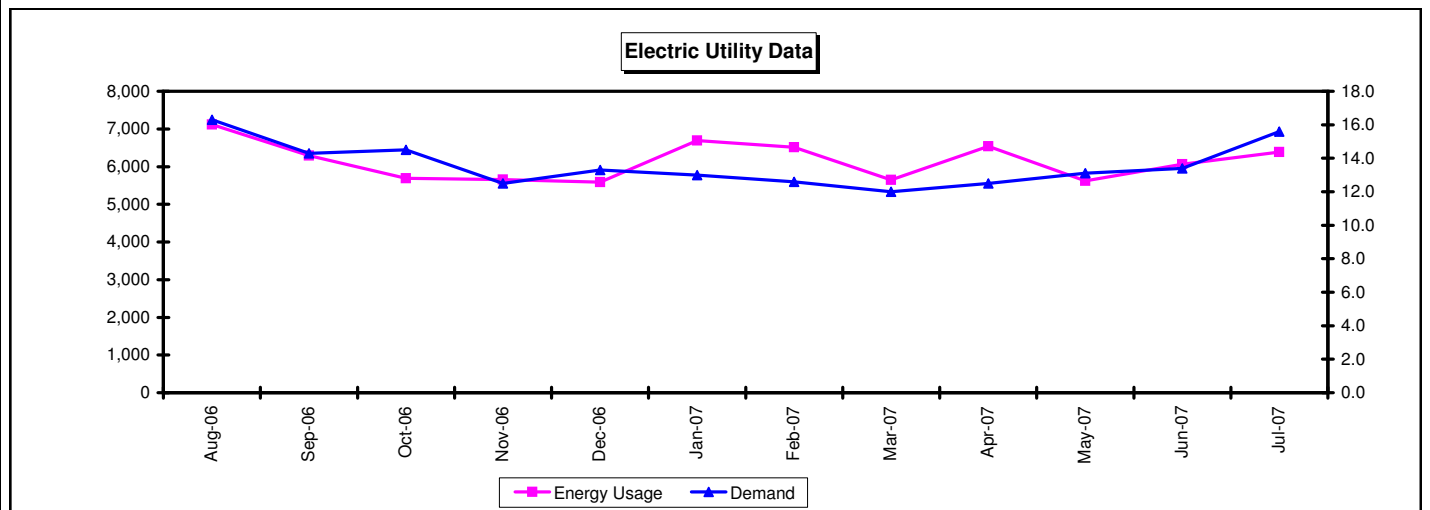
Utility Company: PSNH
 Old Acct. No.: 61-10-03228-0-1
 New Acct. No.: 56847801073
 Rate: 0
 Date: 2/7/2009

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
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

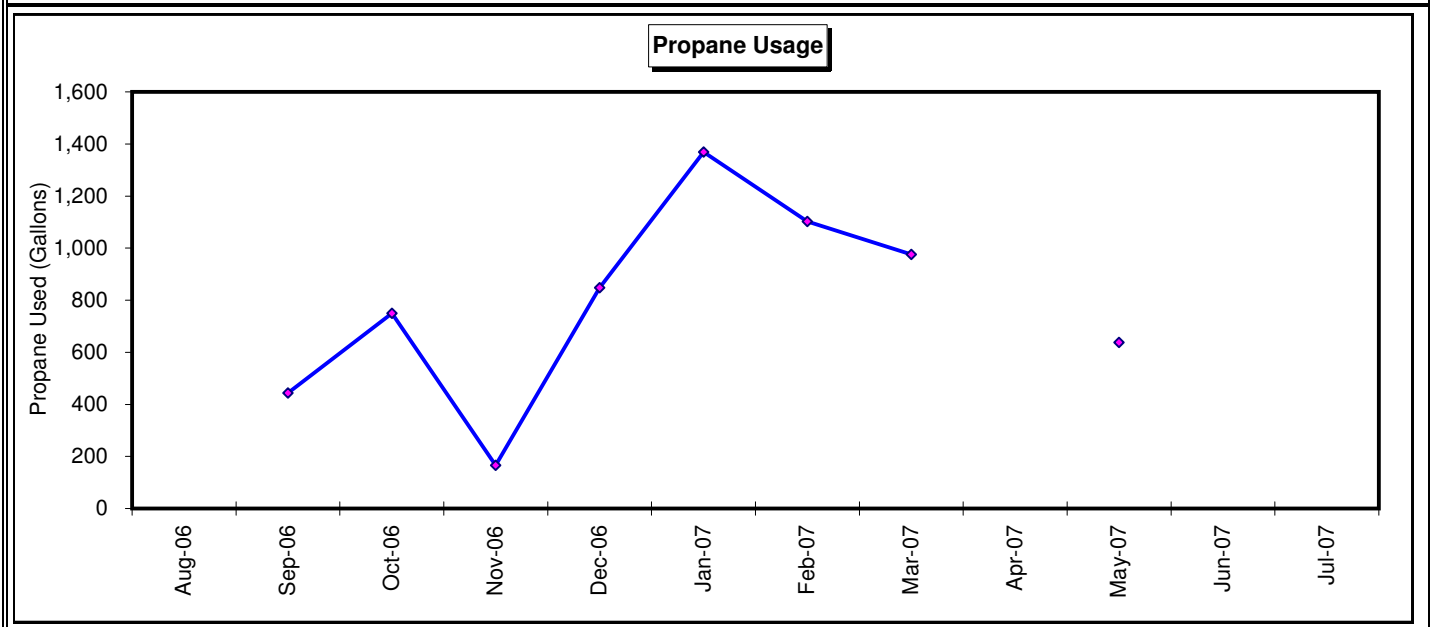
Load Factor = B/(A x E)



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.

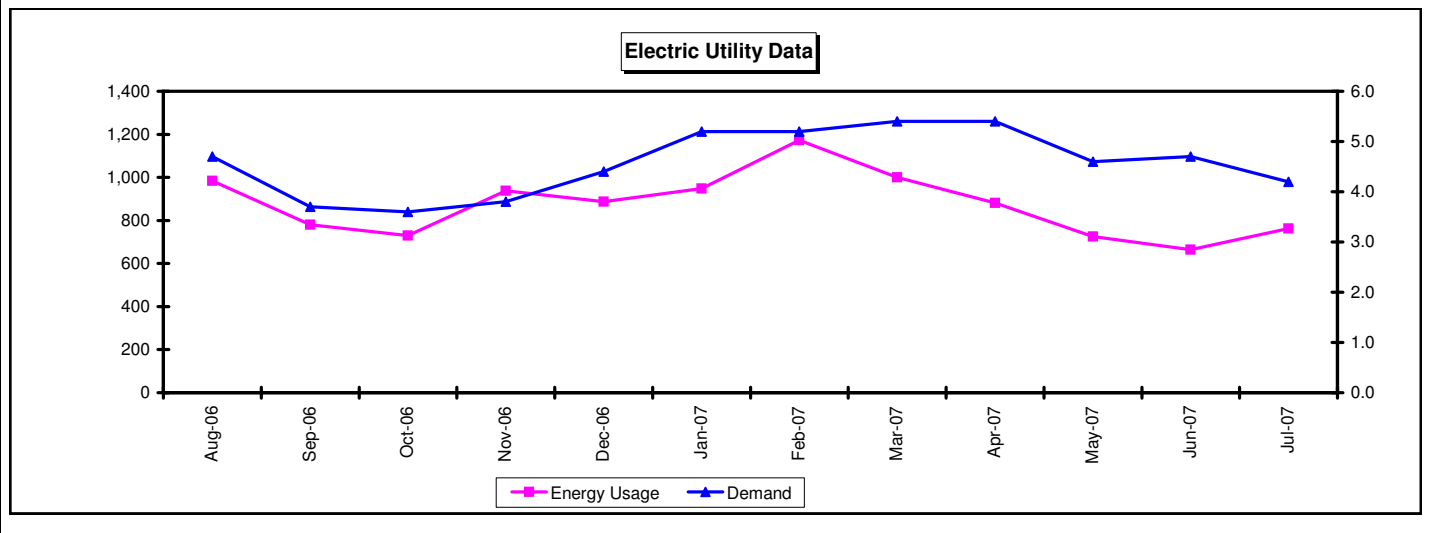
Utility Company: PSNH
 Old Acct. No.: 61-35-05696-0-6
 New Acct. No.: 56143521011
 Rate: 0
 Date: 2/7/2009

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

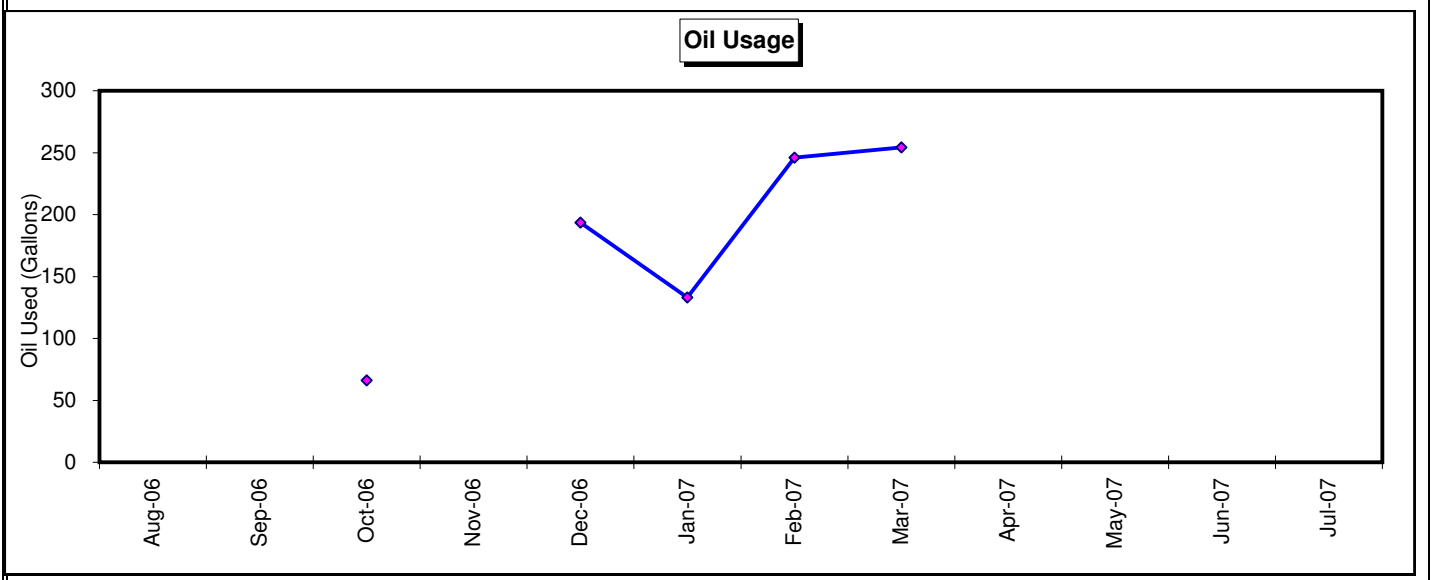
Load Factor = B/(A x E)



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

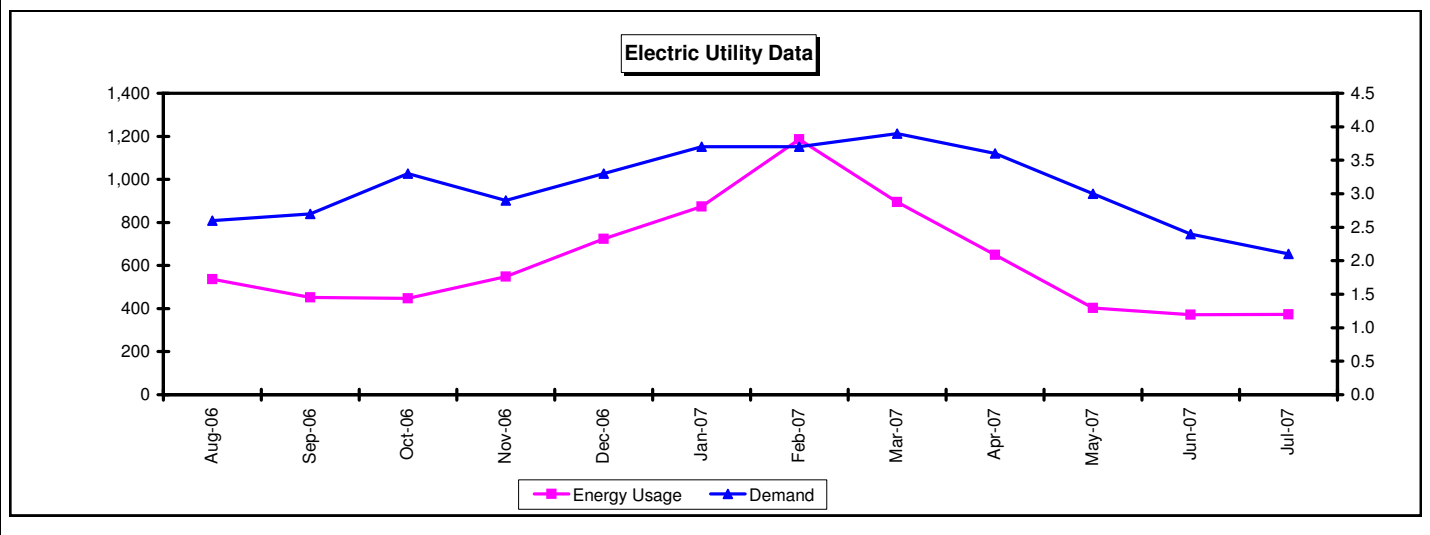
Utility Company: PSNH
 Old Acct. No.: 61-35-05566-0-3, □ 61-35-05567-0-2
 New Acct. No.: 56560290074, □ 56511290090
 Rate: 0
 Date: 2/7/2009

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
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

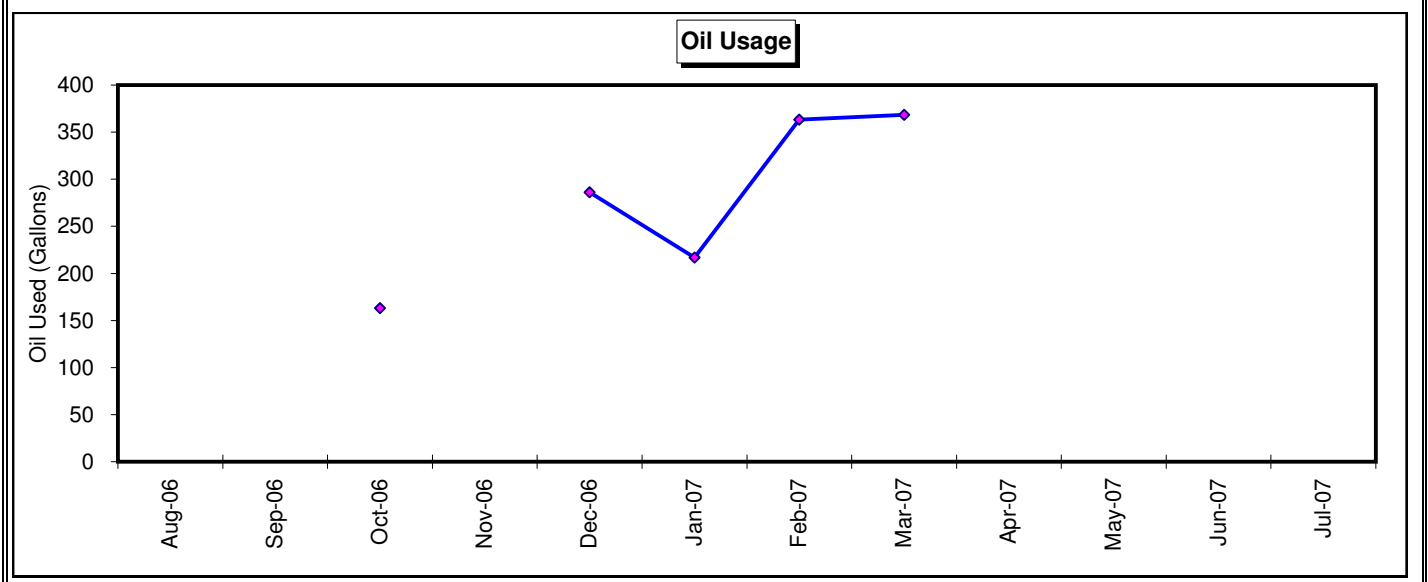
Load Factor = B/(A x E)



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.

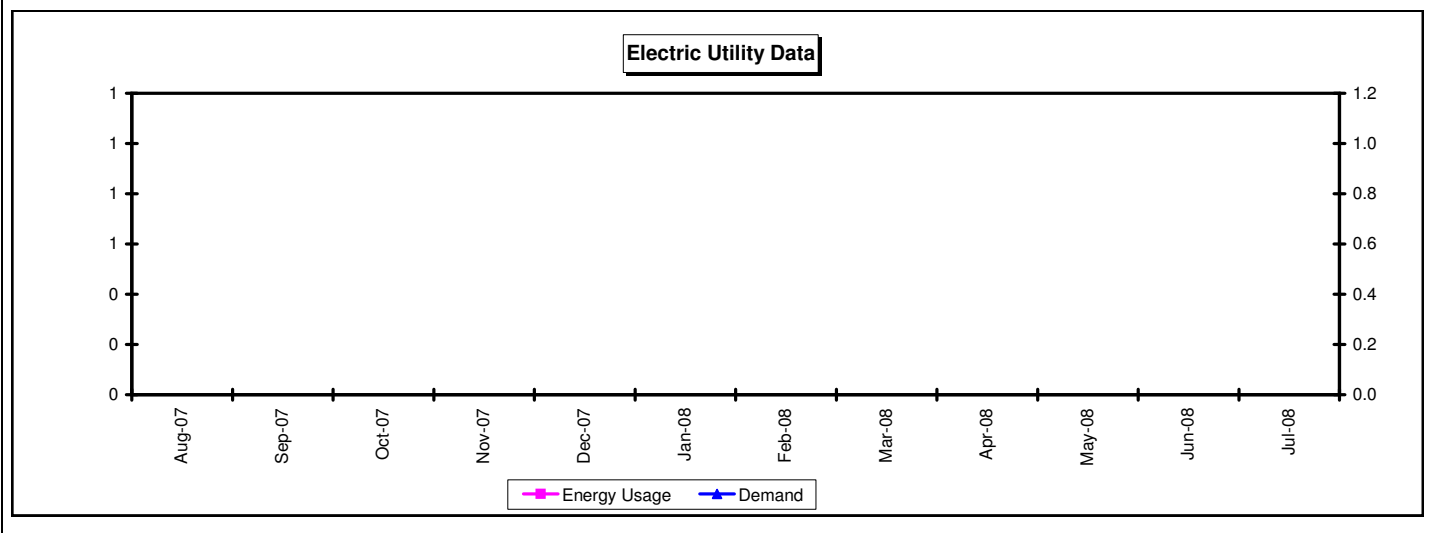
Utility Company: PSNH
 Old Acct. No.: 61-10-11423-0-7
 New Acct. No.: 56599551058
 Rate: 0
 Date: 2/7/2009

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

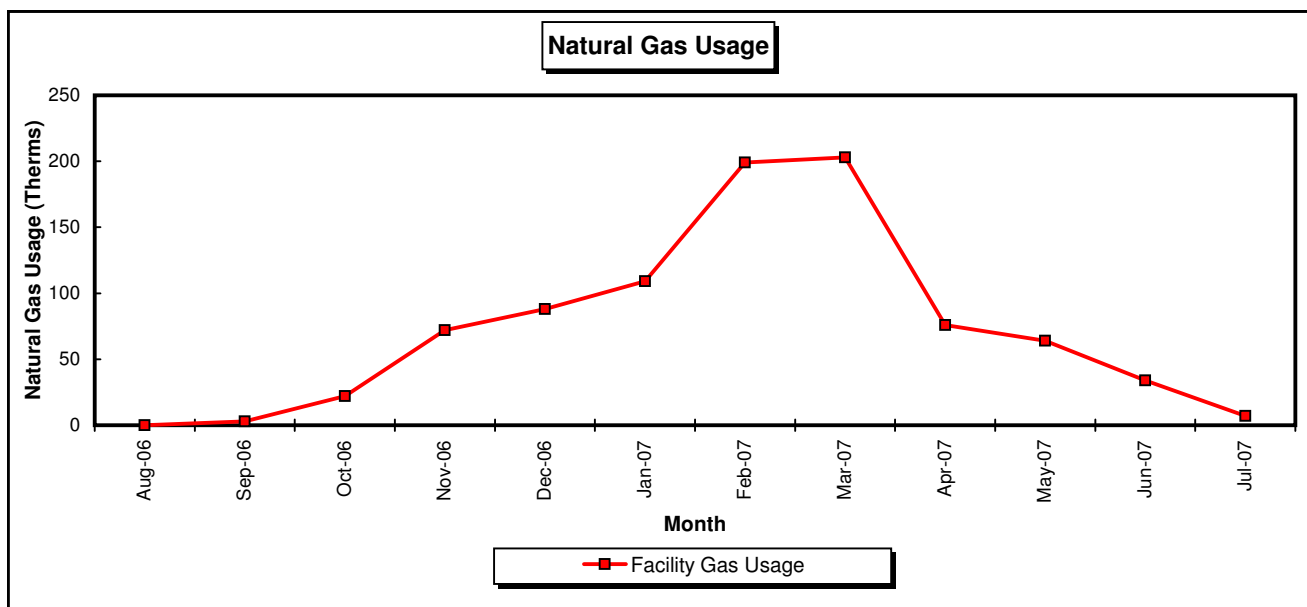
Load Factor = B/(A x E)



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.**

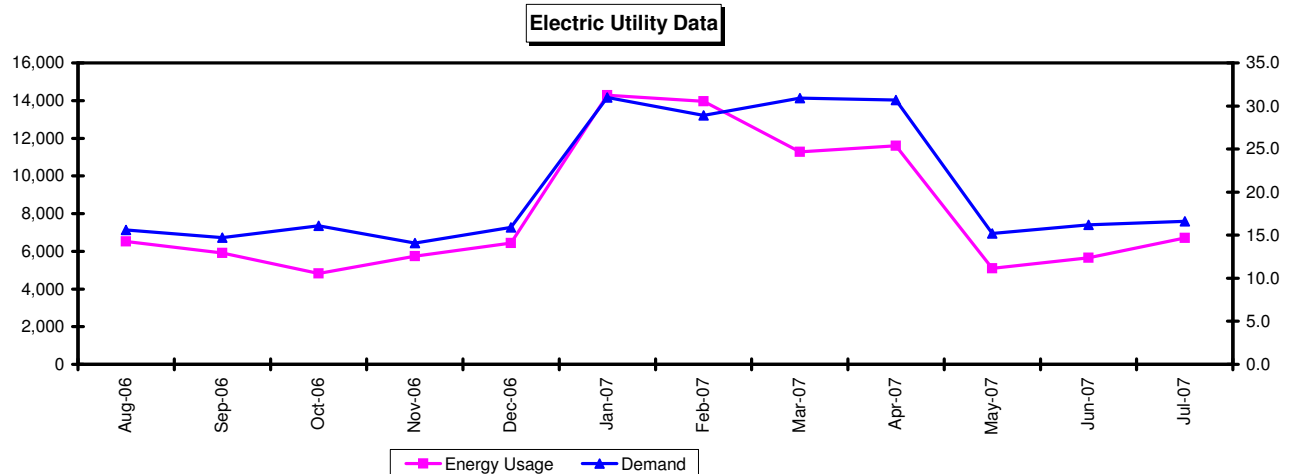
Utility Company: **PSNH**
 Old Acct. No.: **61-35-04075-1-8, 61-35-04442-0-6**
 New Acct. No.: **56303841092, 56709941074**
 Rate: **0**
 Date: **2/7/2009**

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

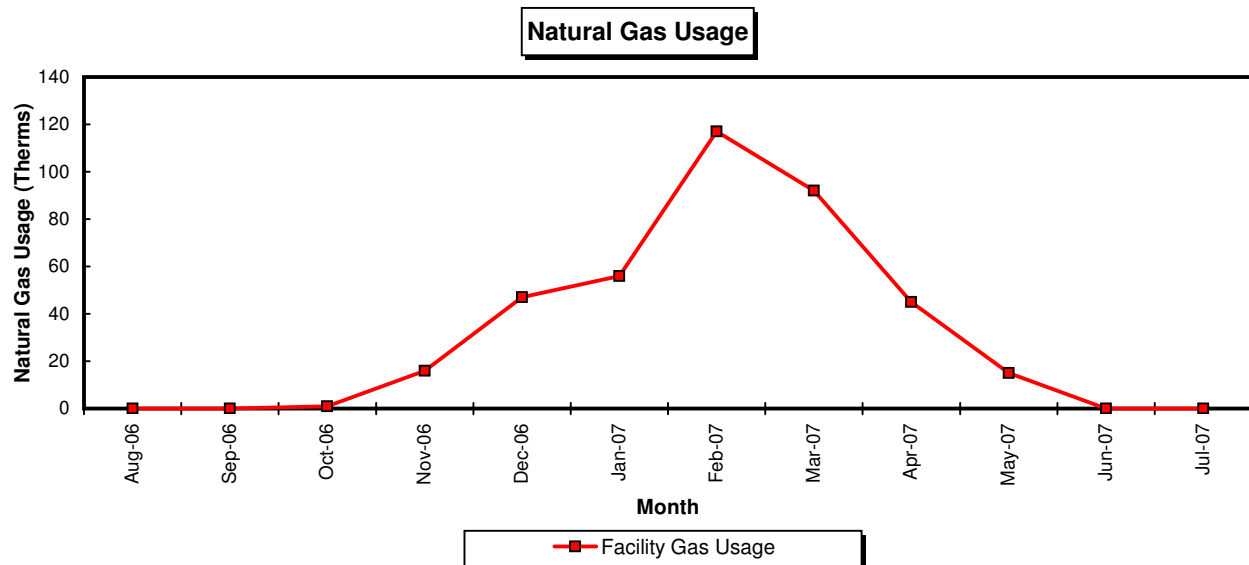
Load Factor = B/(A x E)



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**
 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.**

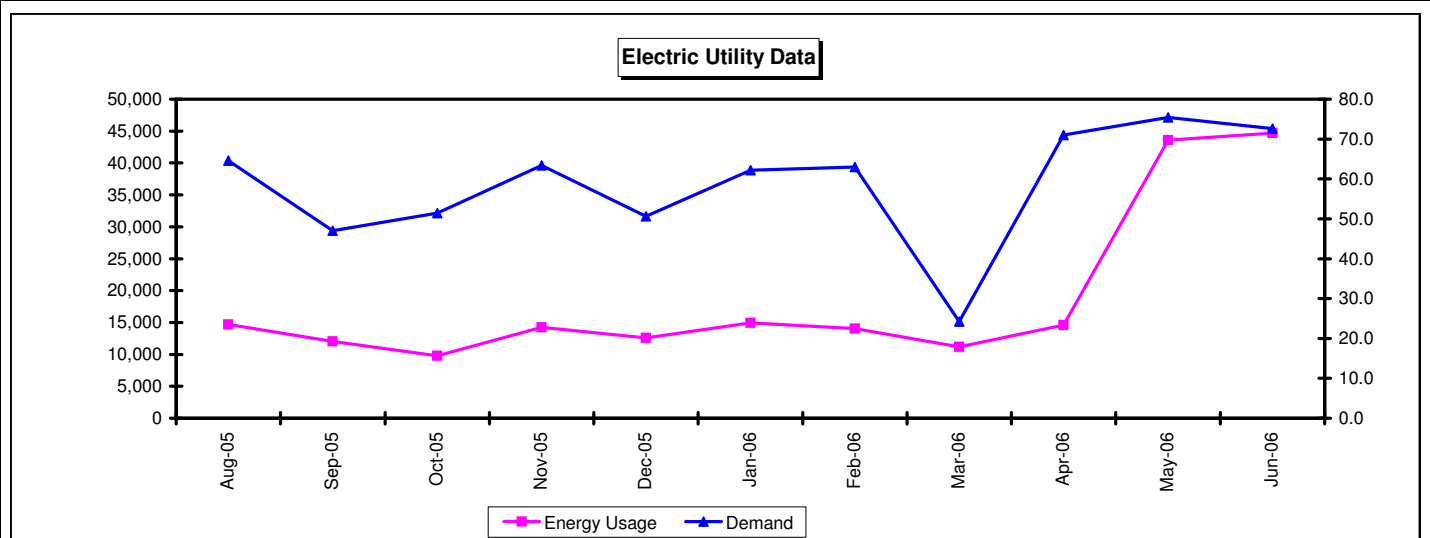
Utility Company: **PSNH**
 Old Acct. No.: **8000619-02-9-4**
 New Acct. No.: **8000619-02-9-4**
 Rate: **G, Three Phase**
 Date: **2/7/2009**

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
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

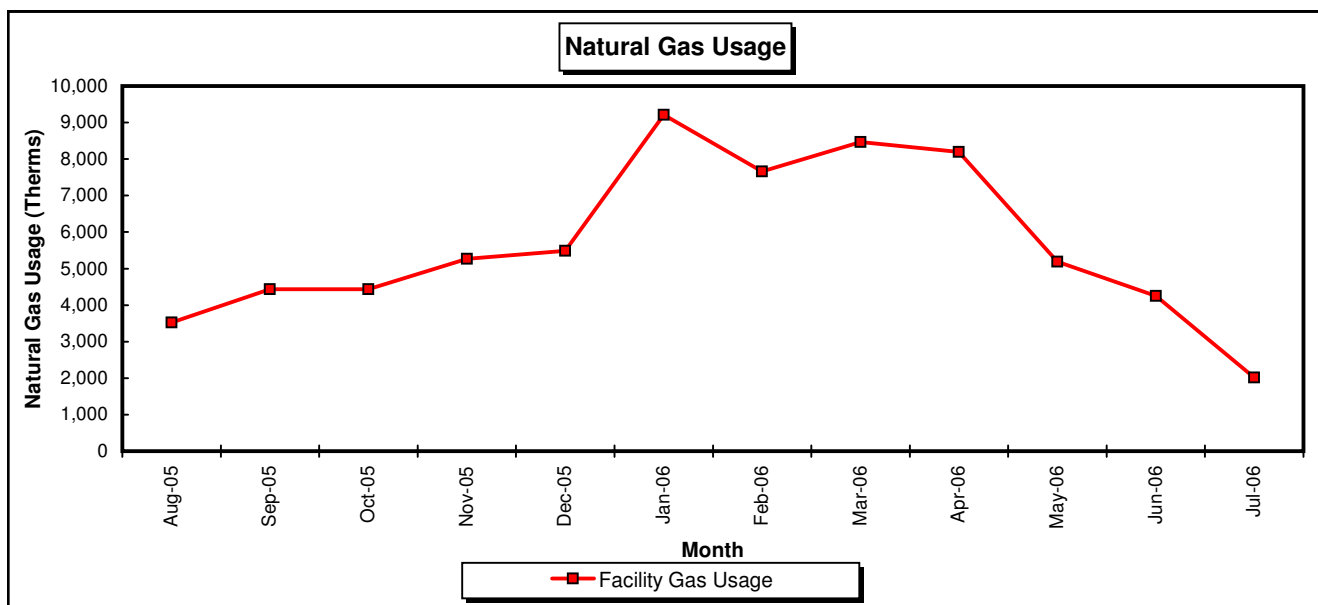
Load Factor = B/(A x E)



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.**

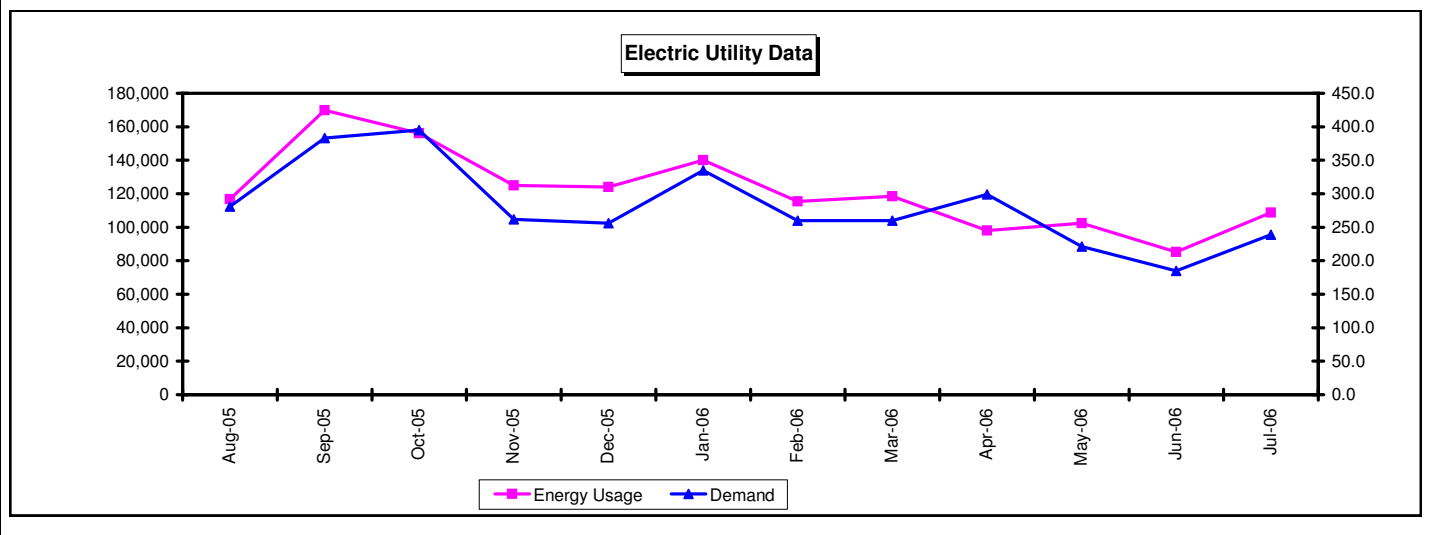
Utility Company: **PSNH**
 Old Acct. No.: **8000626-01-6-2**
 New Acct. No.: **8000626-01-6-2**
 Rate: **GV**
 Date: **2/7/2009**

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

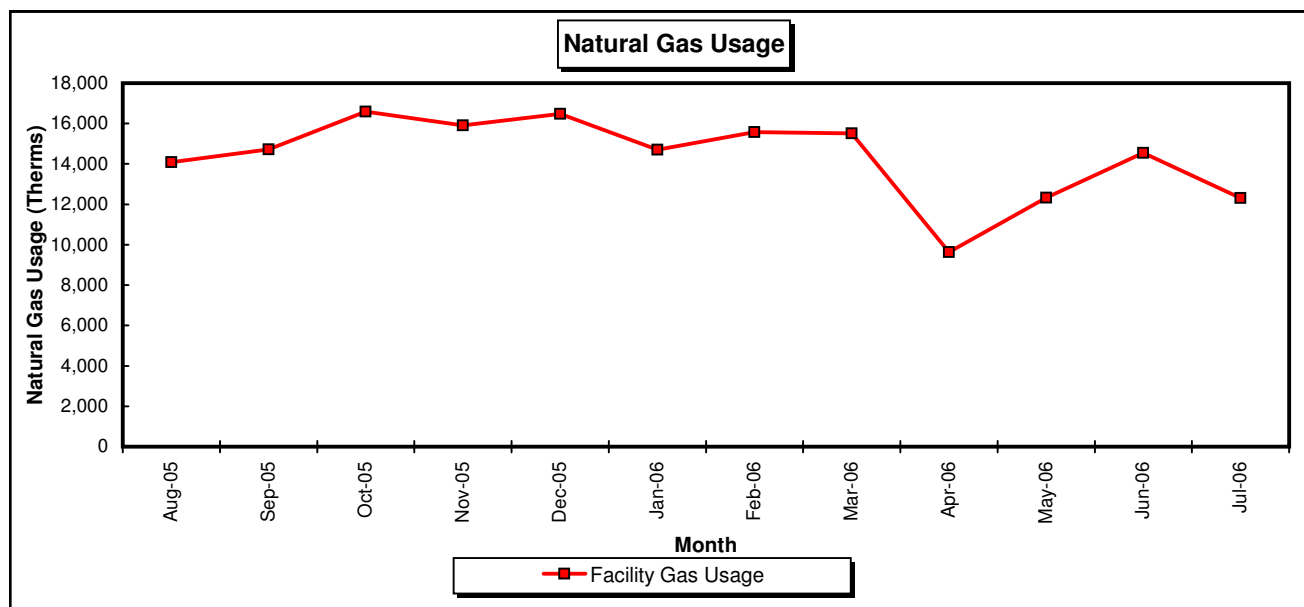
Load Factor = B/(A x E)



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.**

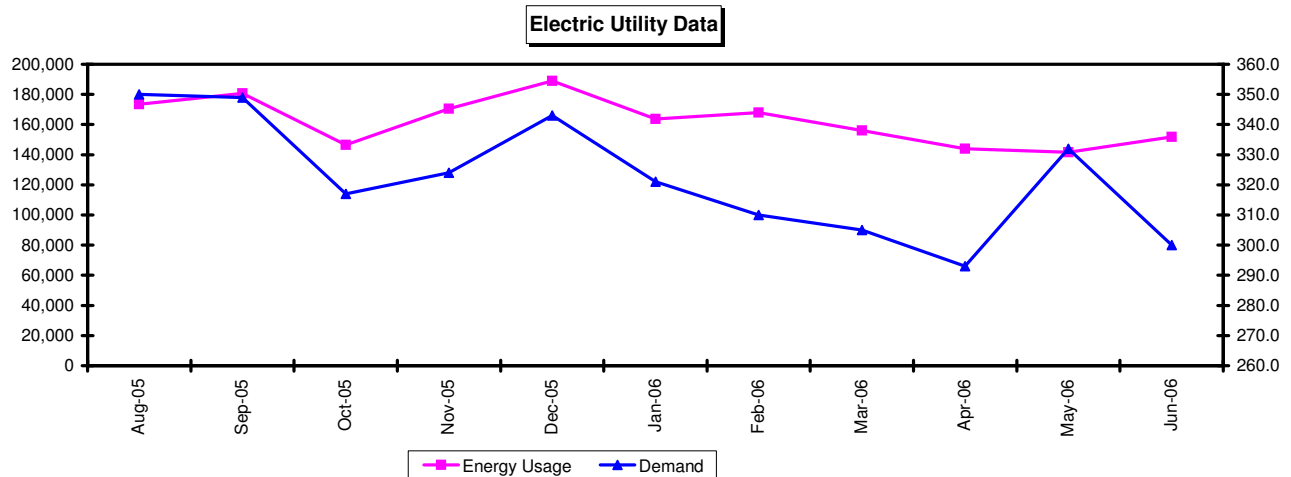
Utility Company: PSNH
 Old Acct. No.: 8000672-03-5-5
 New Acct. No.: 8000672-03-5-5
 Rate: GV
 Date: 2/7/2009

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

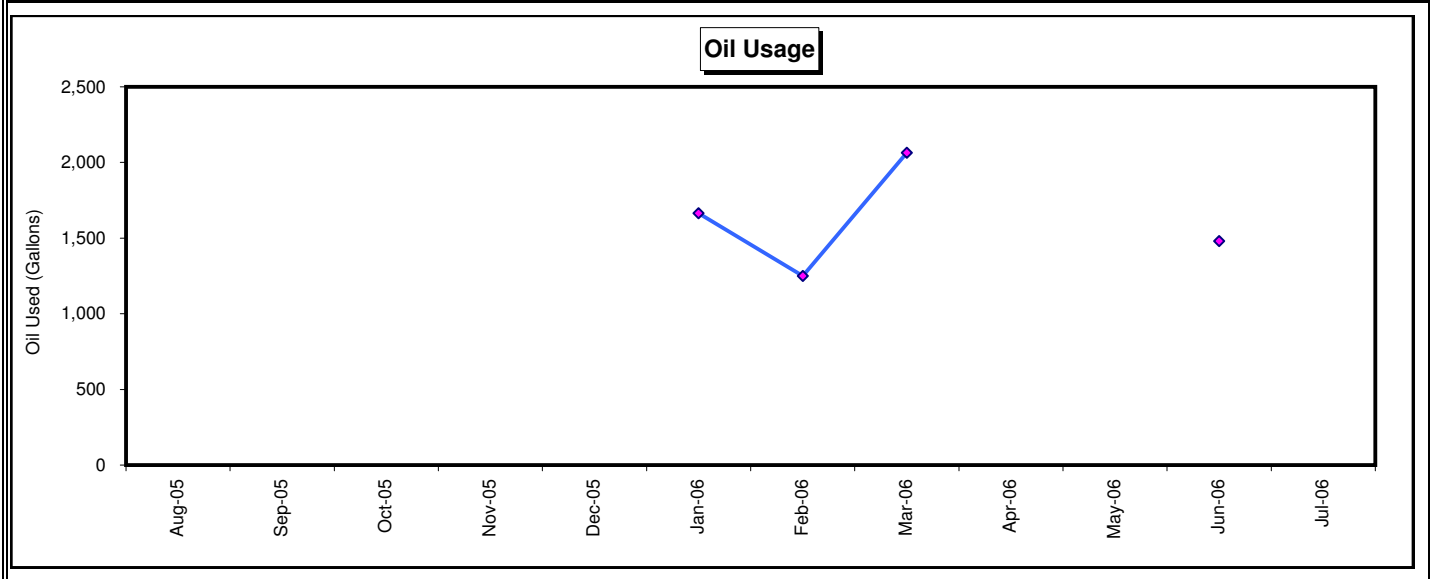
Load Factor = B/(A x E)



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**
 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. No.: **56906401021, 56395401037**
 Rate: **0**
 Date: **2/7/2009**

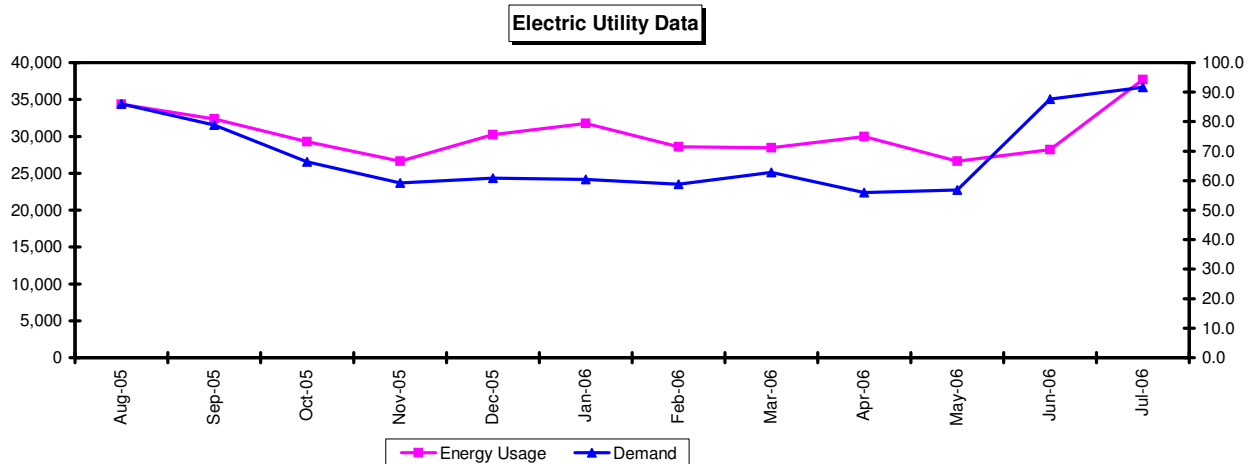
Includes only city Mgr bldg and police dept

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
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

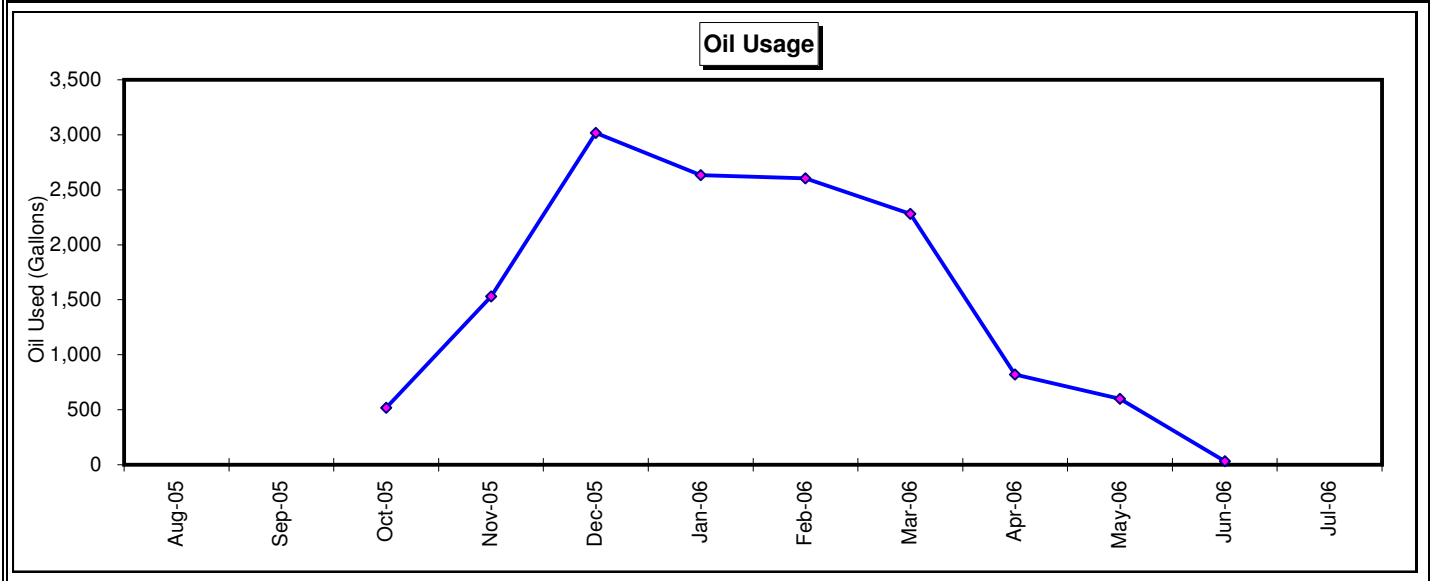
Load Factor = B/(A x E)



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.

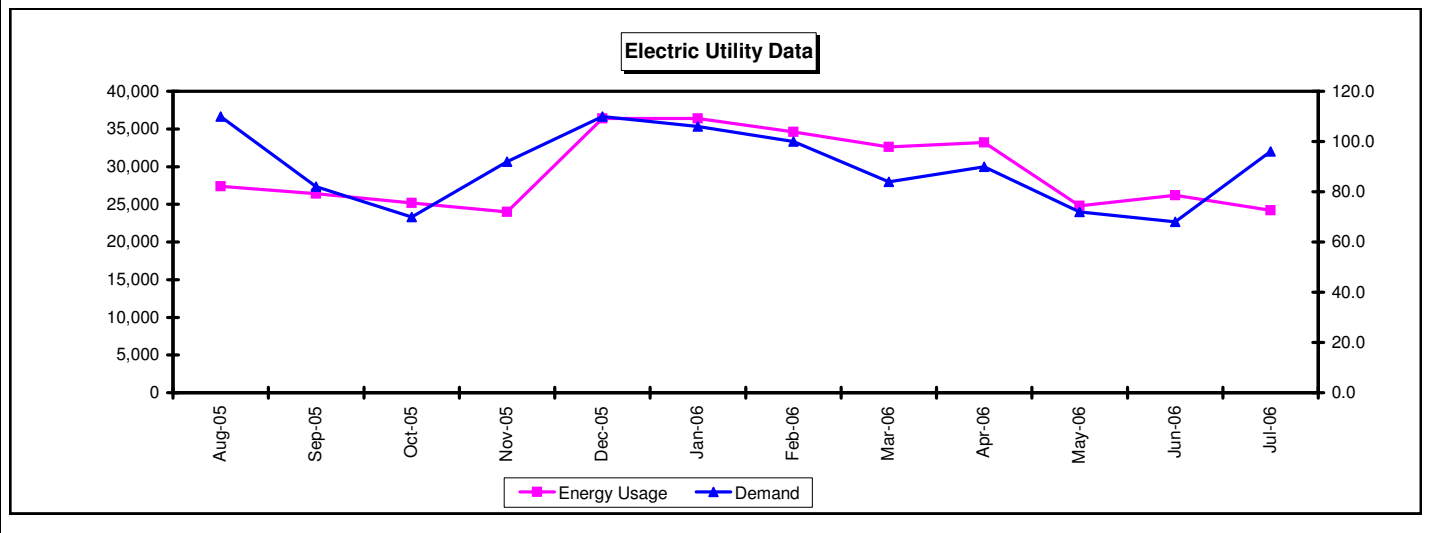
Utility Company: PSNH
 Old Acct. No.: 61-10-09245-1-5
 New Acct. No.: 56632841078
 Rate: 0
 Date: 2/7/2009

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

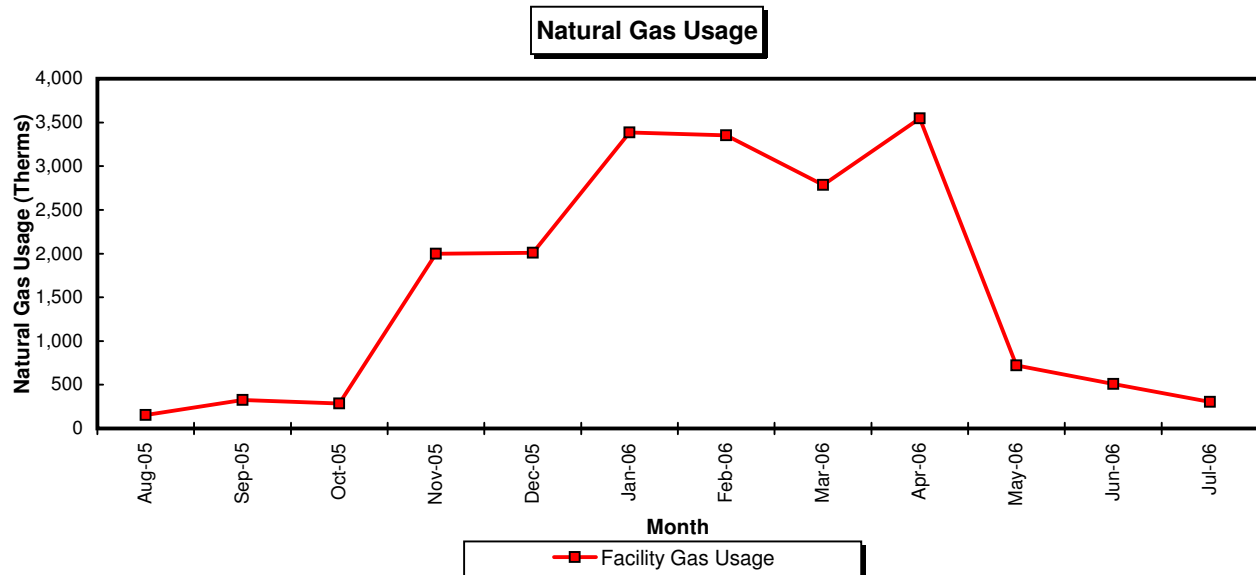
Load Factor = B/(A x E)



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**
 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.**

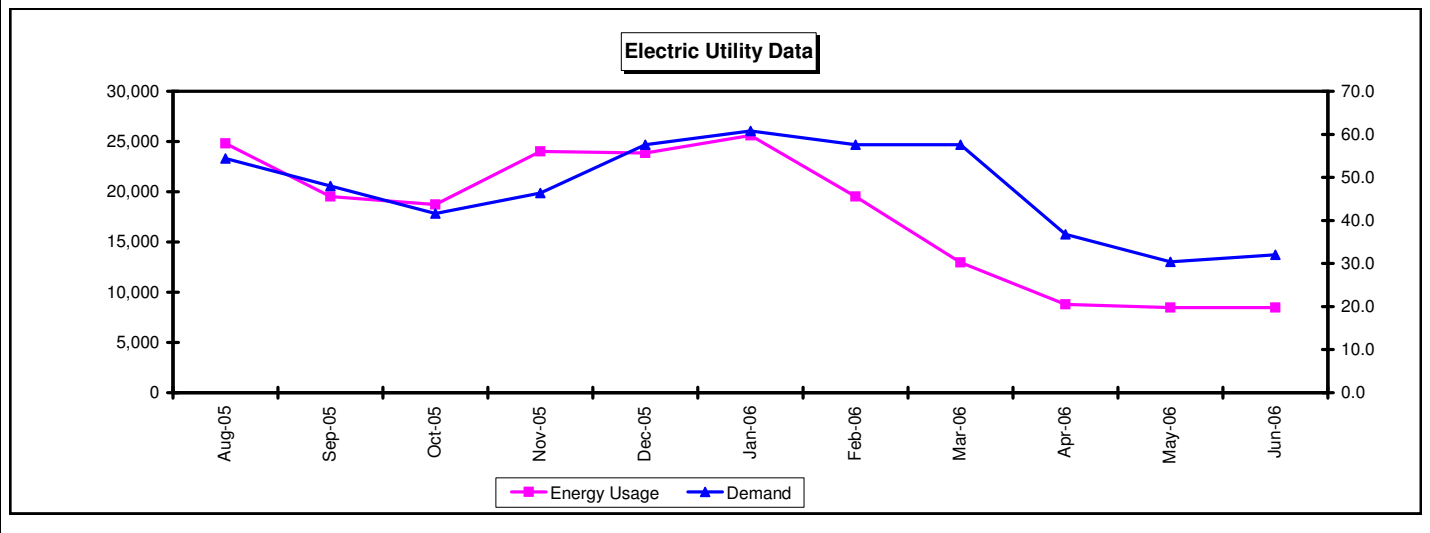
Utility Company: PSNH
 Old Acct. No.: 61-35-06856-1-8, □ 61-35-08894-0-0
 New Acct. No.: 8001869-04-5-5
 Rate: GV
 Date: 2/7/2009

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
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

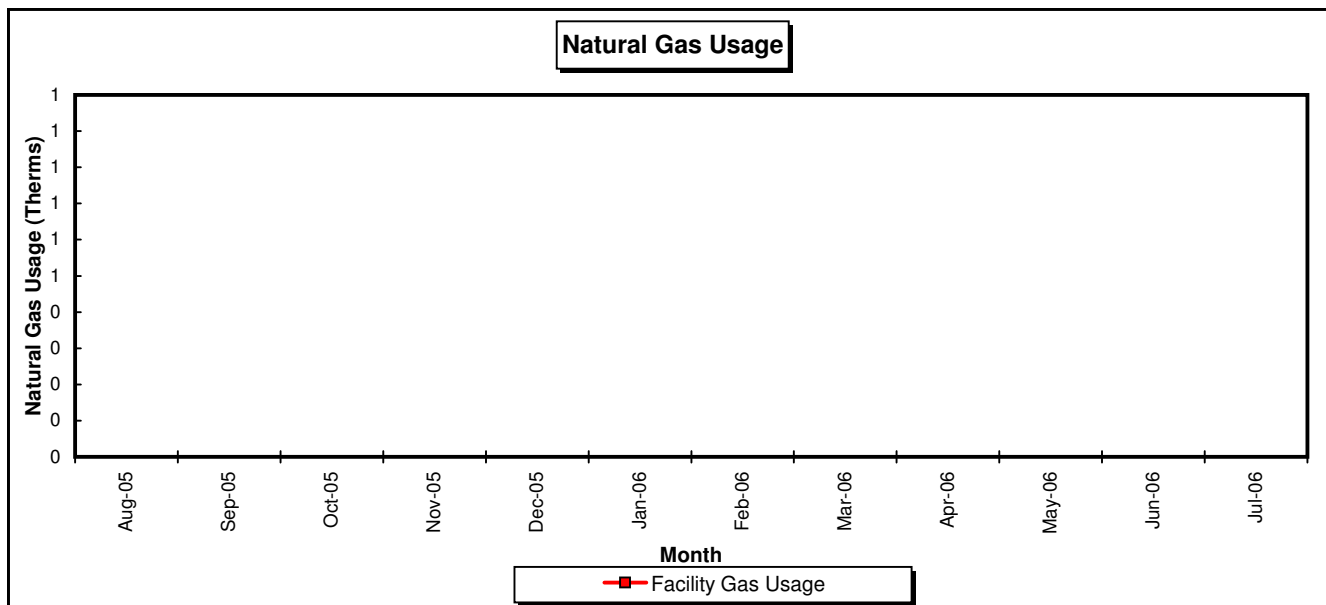
Load Factor = B/(A x E)



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**
 Year Built: **1905/1988**
 School Address: **73 Locust St**
Dover, NH
 Phone Number: **516-6050**
 Principal's Name: **Cathy Beaudoin**
 Facility Area: **20,000 sq. ft.**

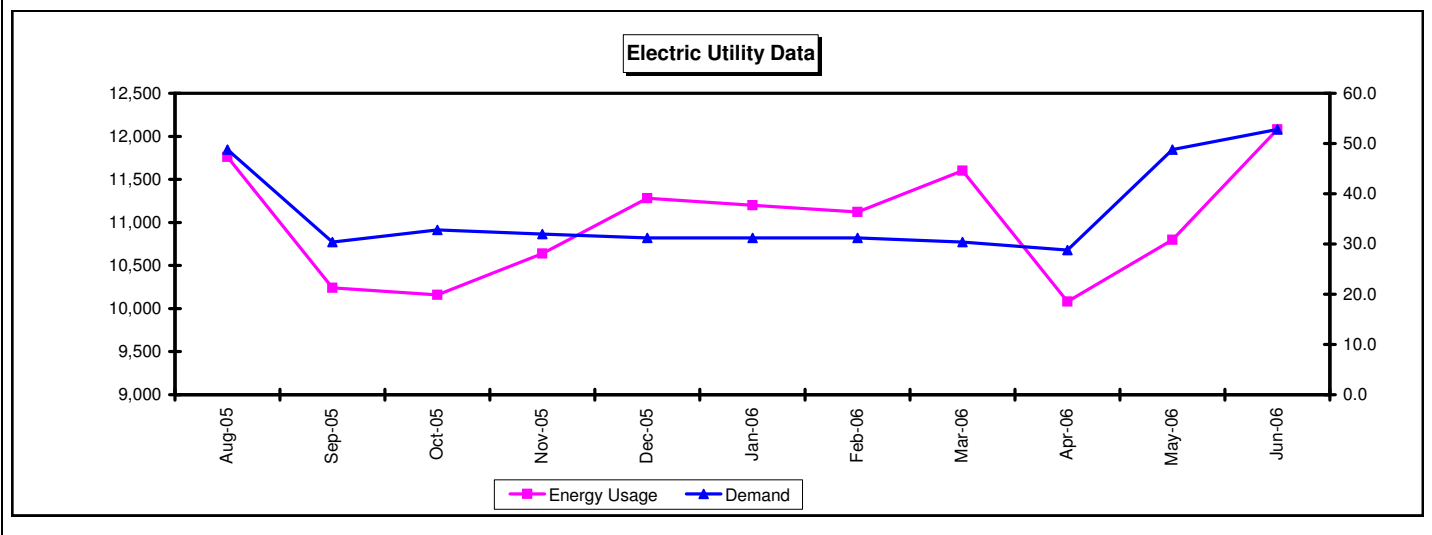
Utility Company: **PSNH**
 Old Acct. No.: **61-35-06833-0-8**
 New Acct. No.: **56135401073**
 Rate: **0**
 Date: **2/7/2009**

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	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

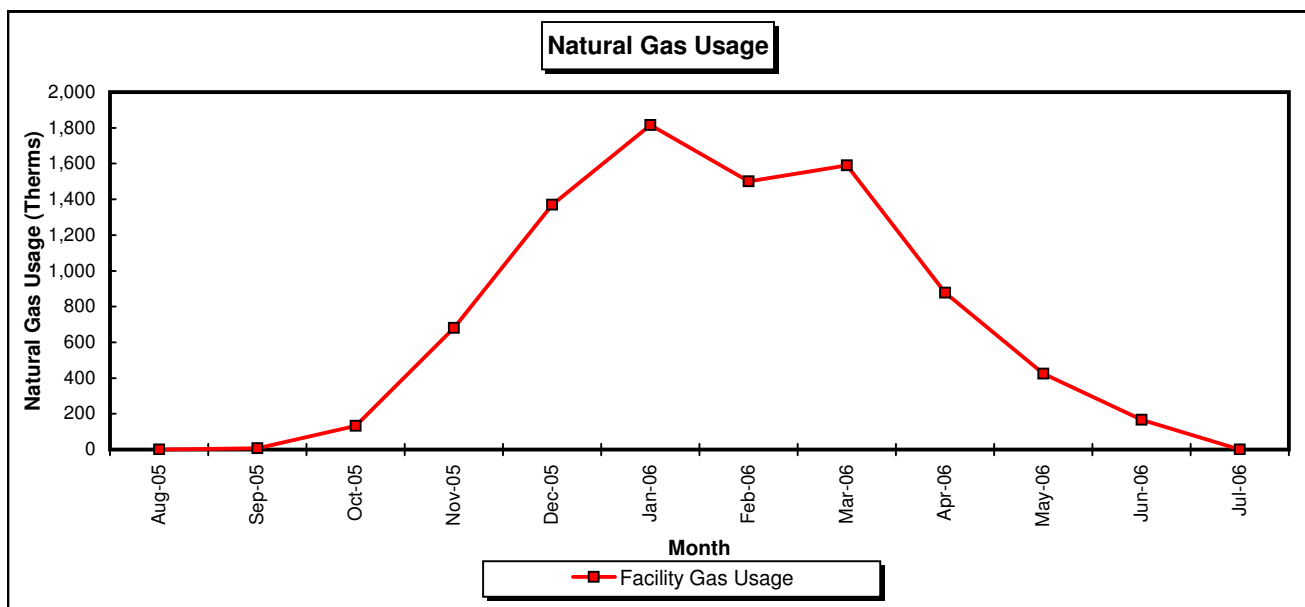
Load Factor = B/(A x E)



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.**

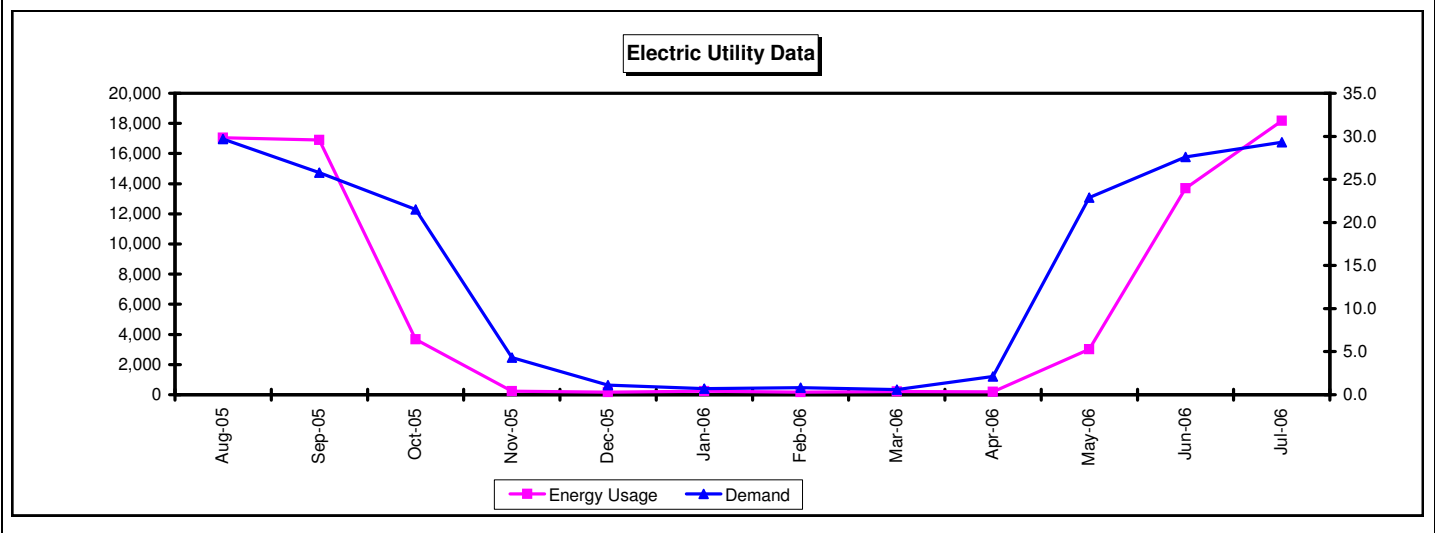
Utility Company: **PSNH**
 Old Acct. No.: **61-30-06136-0-3**
 New Acct. No.: **56072321037**
 Rate: **0**
 Date: **2/7/2009**

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

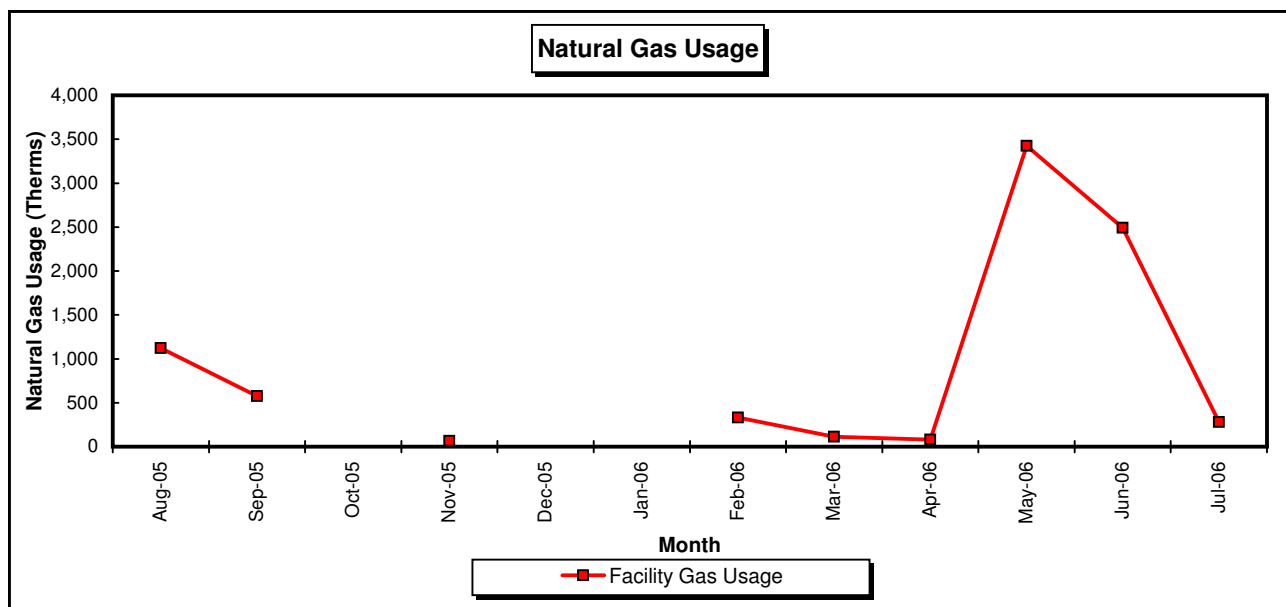
Load Factor = B/(A x E)



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.**

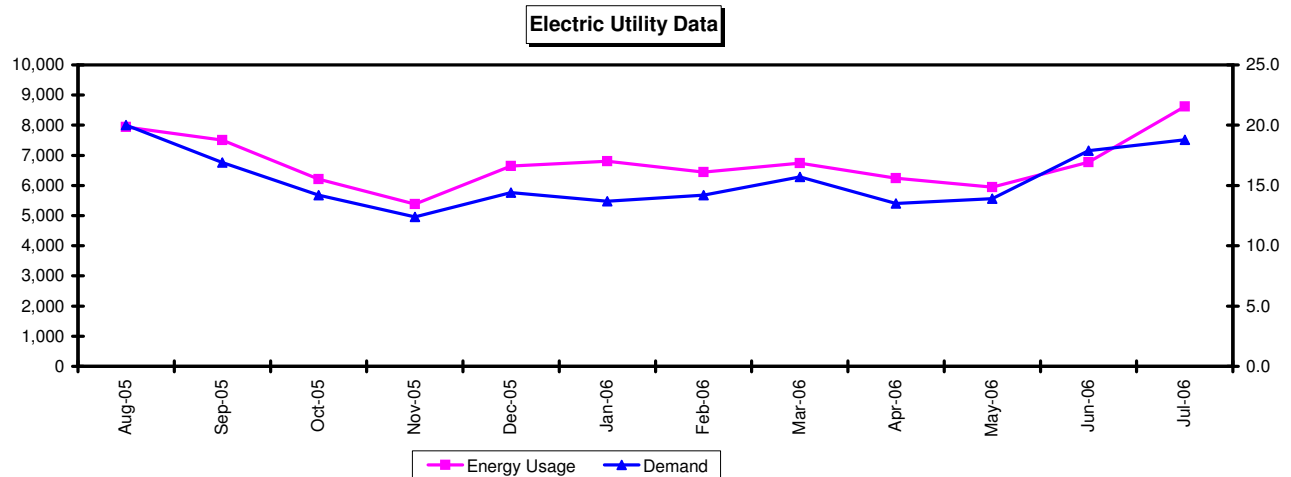
Utility Company: **PSNH**
 Old Acct. No.: **61-35-01167-0-5**
 New Acct. No.: **56299411066**
 Rate: **0**
 Date: **2/7/2009**

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

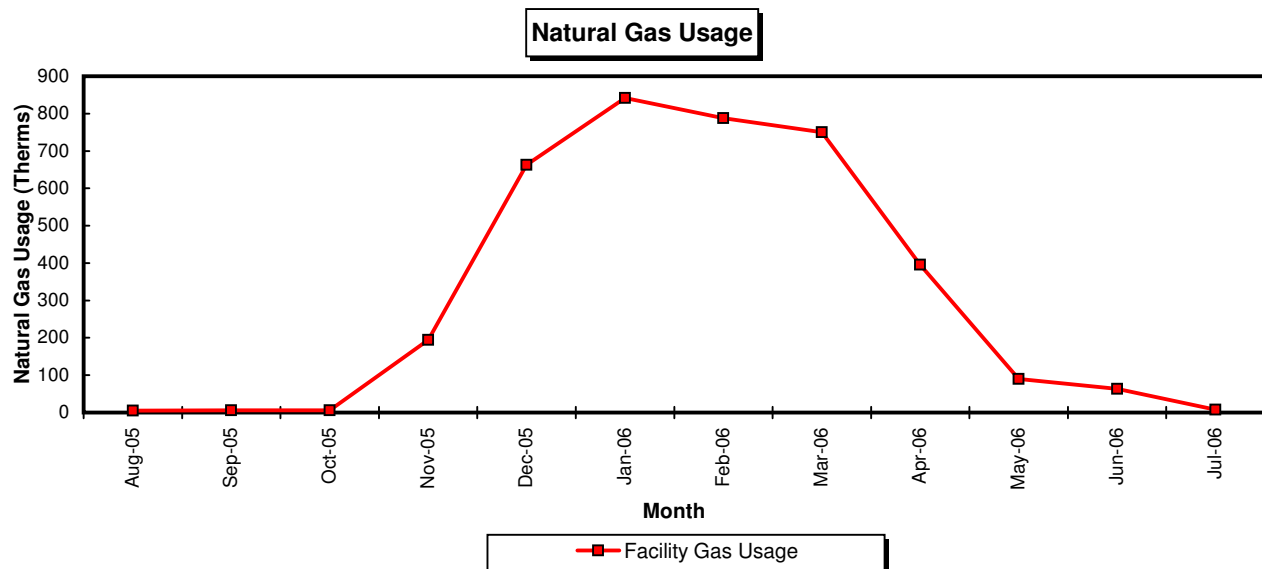
Load Factor = B/(A x E)



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.

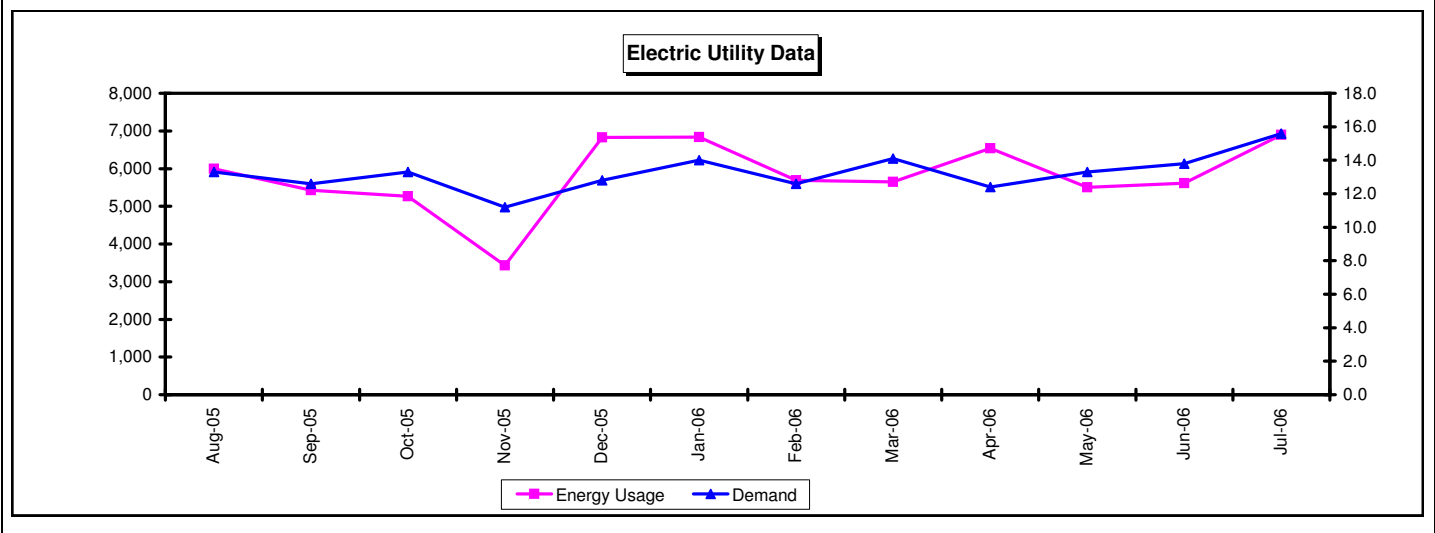
Utility Company: PSNH
 Old Acct. No.: 61-10-03228-0-1
 New Acct. No.: 56847801073
 Rate: 0
 Date: 2/7/2009

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

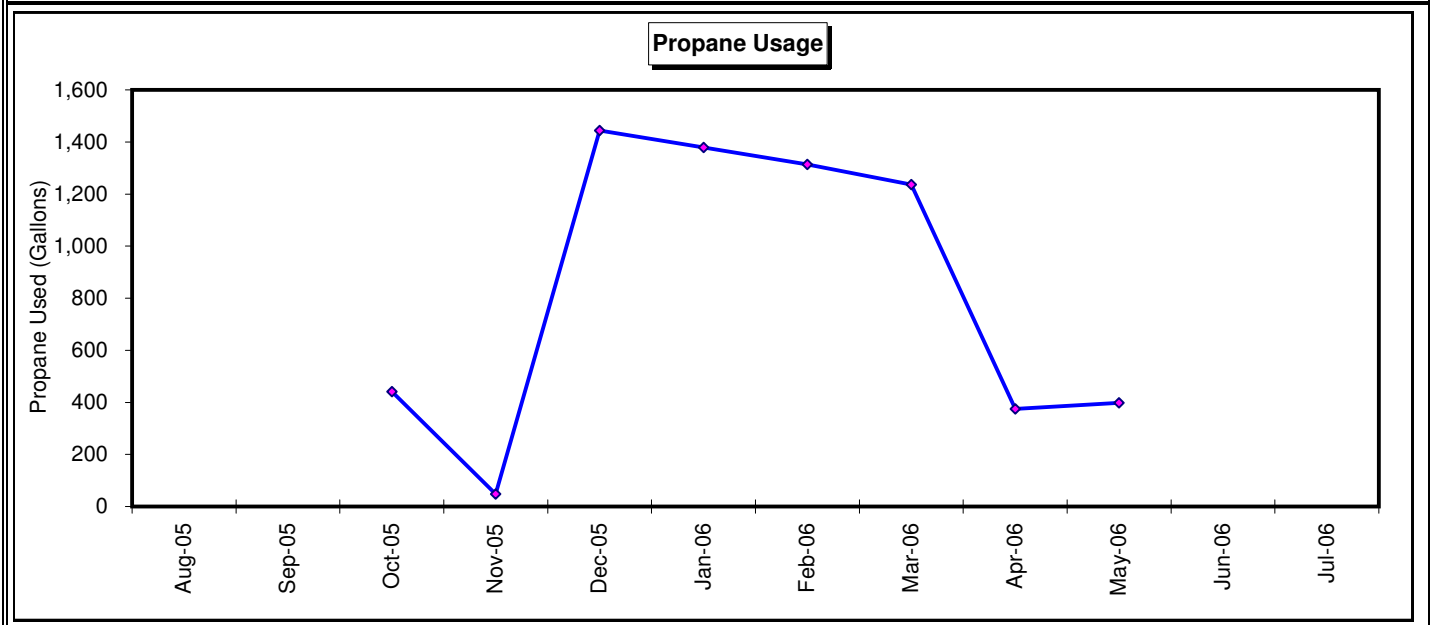
Load Factor = B/(A x E)



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

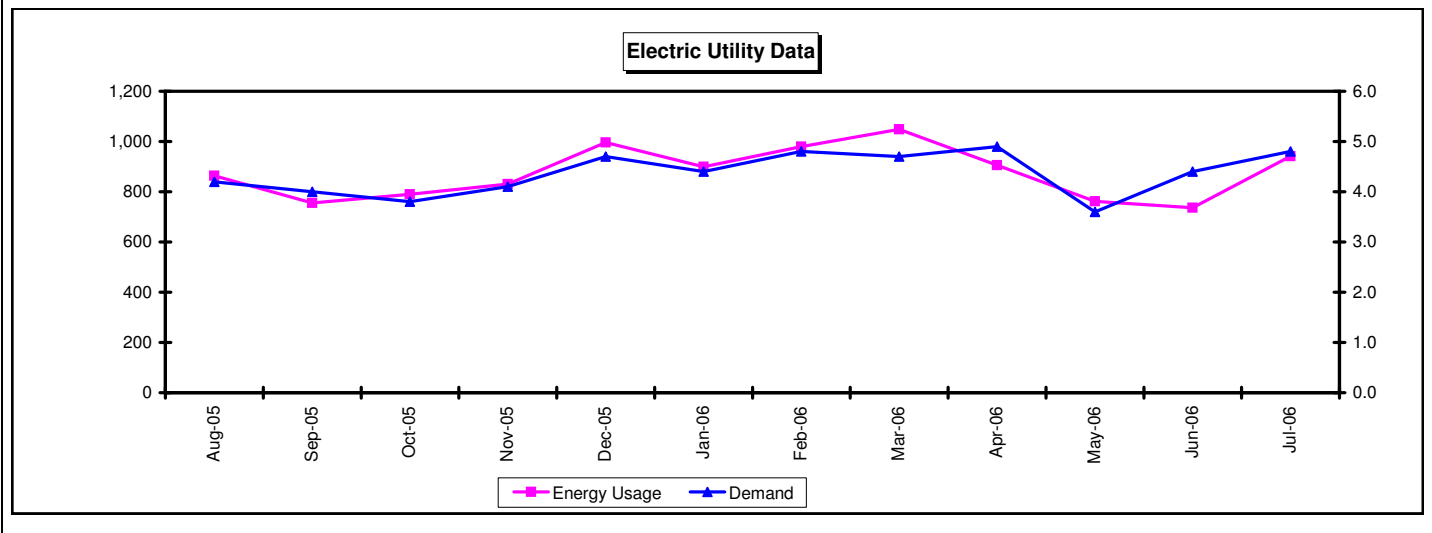
Utility Company: PSNH
 Old Acct. No.: 61-35-05696-0-6
 New Acct. No.: 56143521011
 Rate: 0
 Date: 2/7/2009

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
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

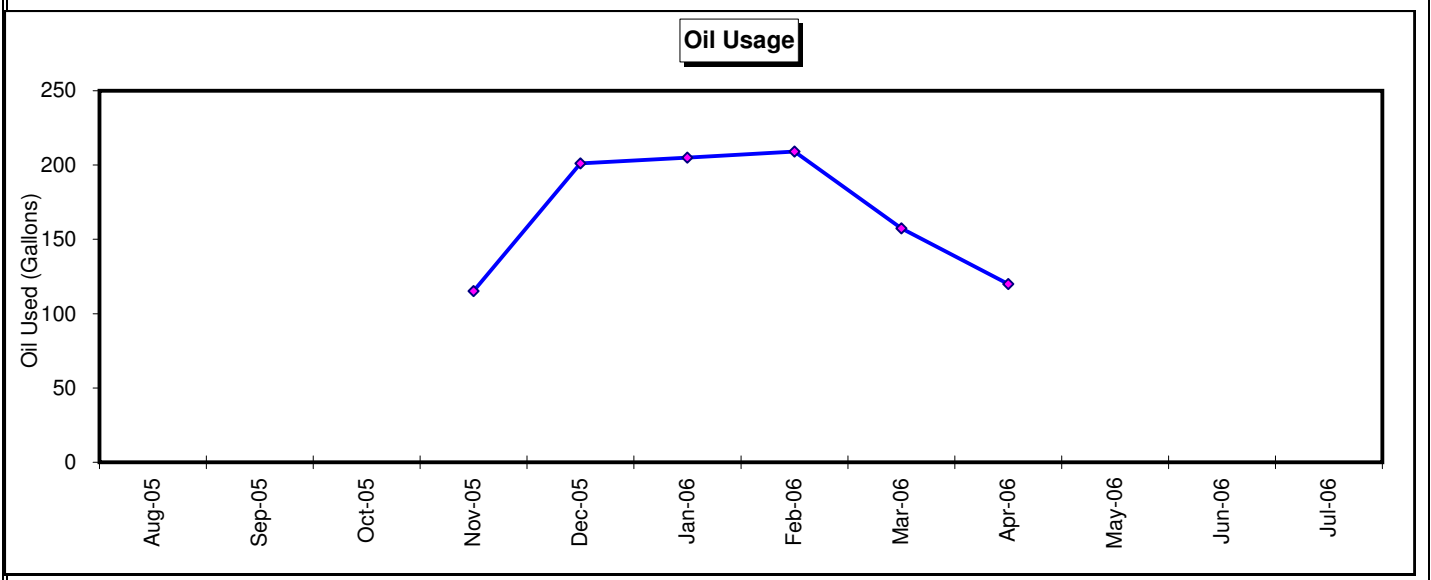
Load Factor = B/(A x E)



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.**

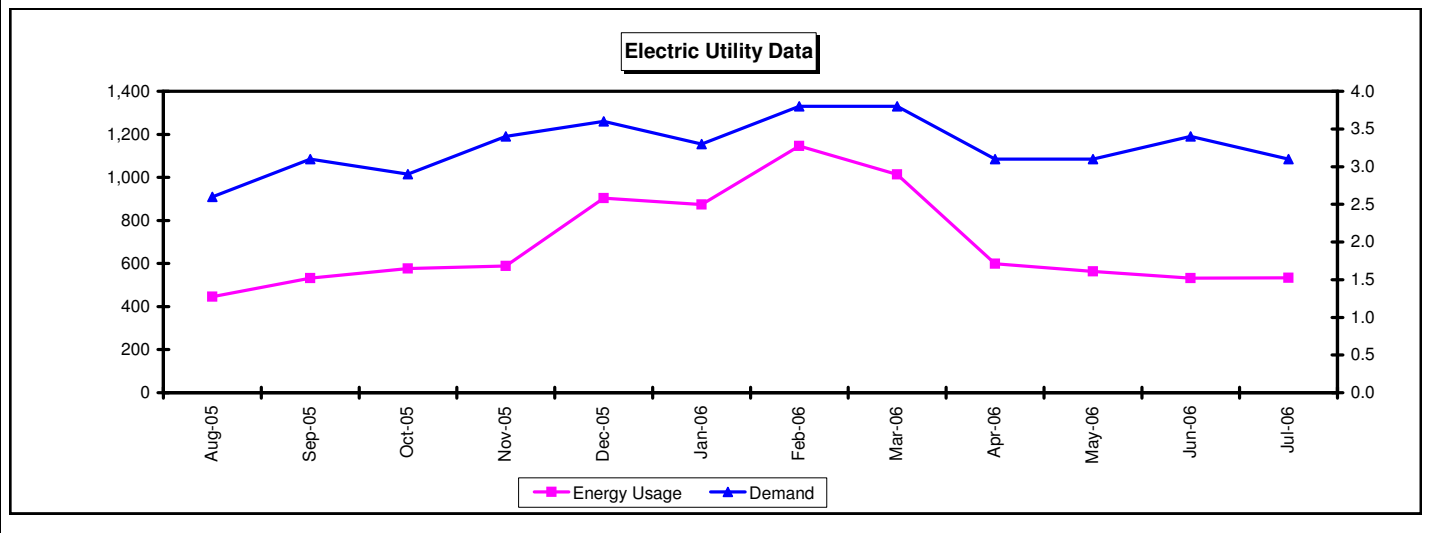
Utility Company: PSNH
 Old Acct. No.: 61-35-05566-0-3, □ 61-35-05567-0-2
 New Acct. No.: 56560290074, □ 56511290090
 Rate: 0
 Date: 2/7/2009

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

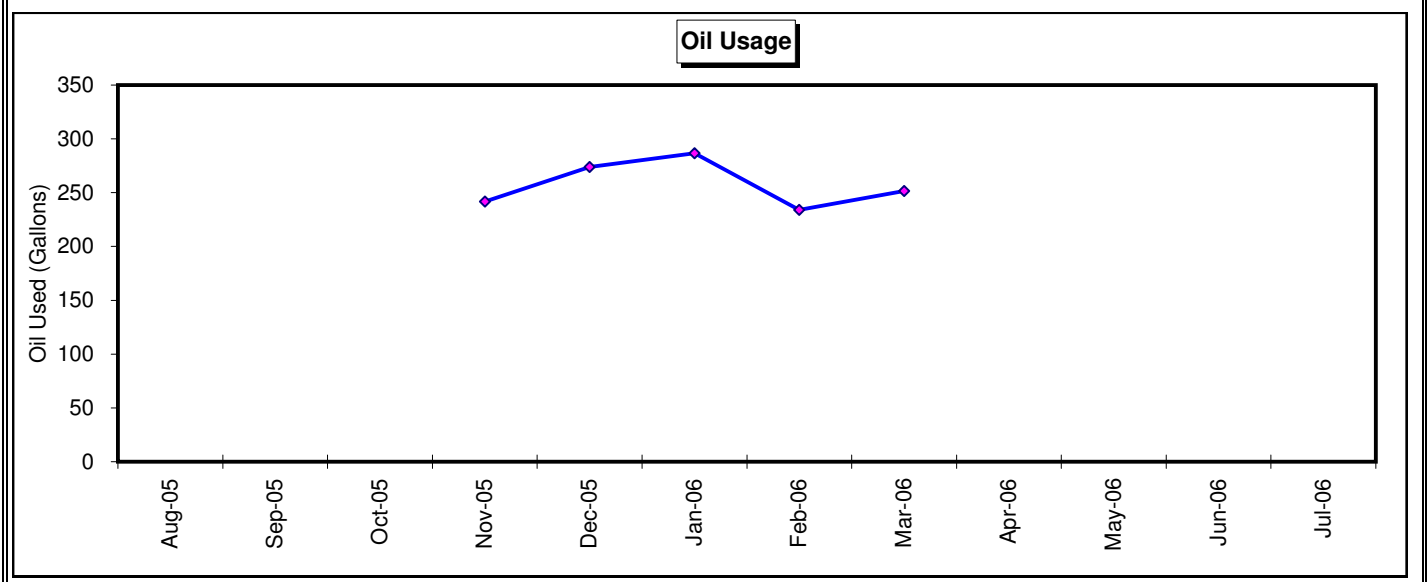
Load Factor = B/(A x E)



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.

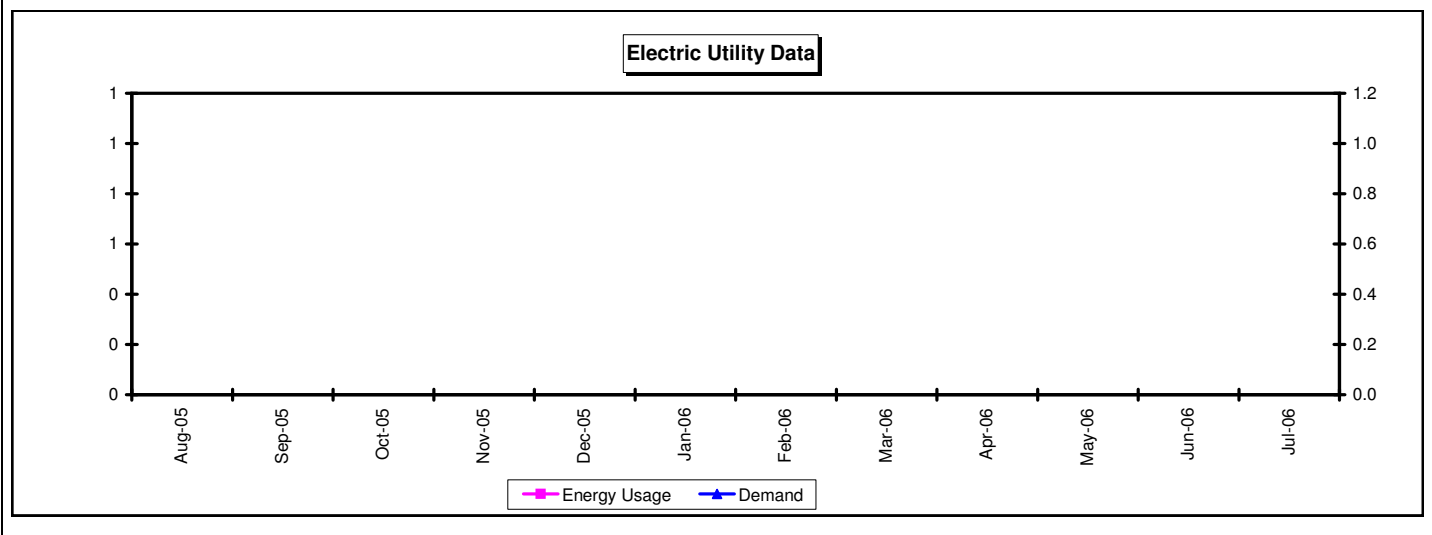
Utility Company: PSNH
 Old Acct. No.: 61-10-11423-0-7
 New Acct. No.: 56599551058
 Rate: 0
 Date: 2/7/2009

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

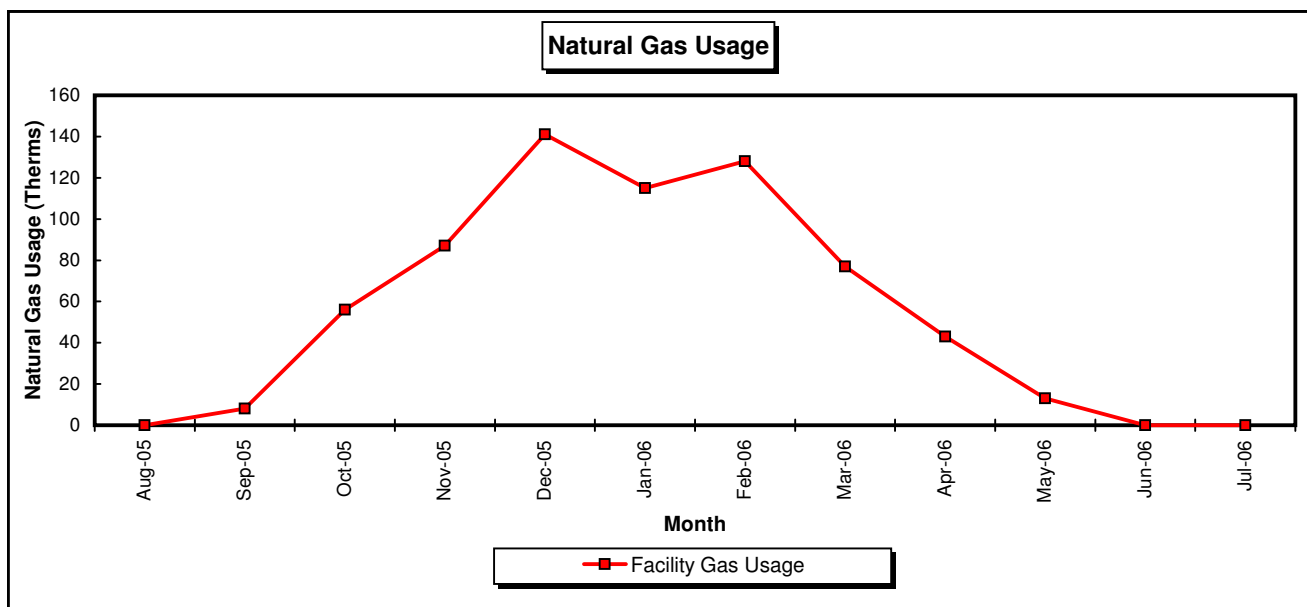
Load Factor = B/(A x E)



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.**

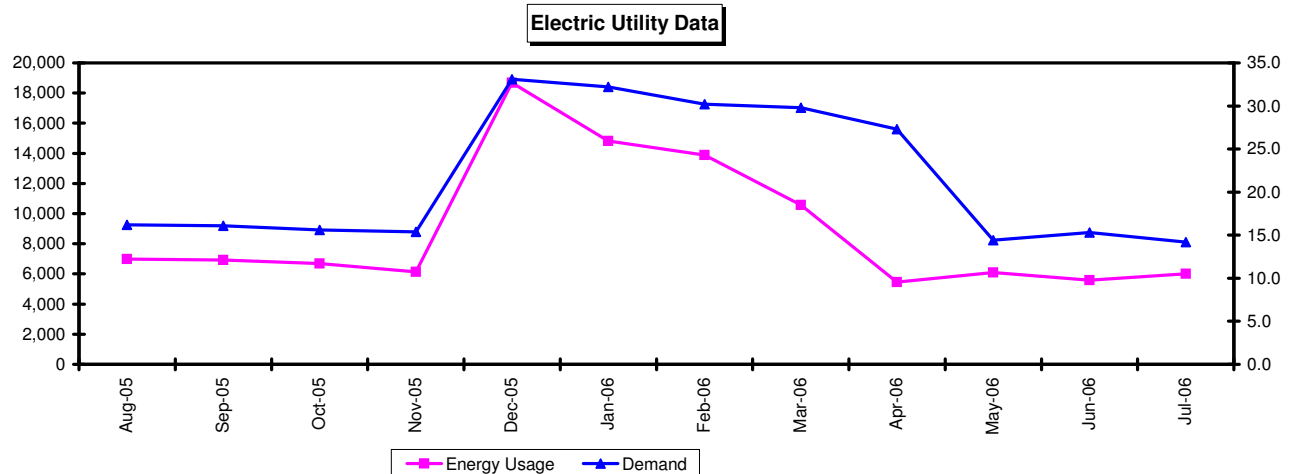
Utility Company: **PSNH**
 Old Acct. No.: **61-35-04075-1-8, 61-35-04442-0-6**
 New Acct. No.: **56303841092, 56709941074**
 Rate: **0**
 Date: **2/7/2009**

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

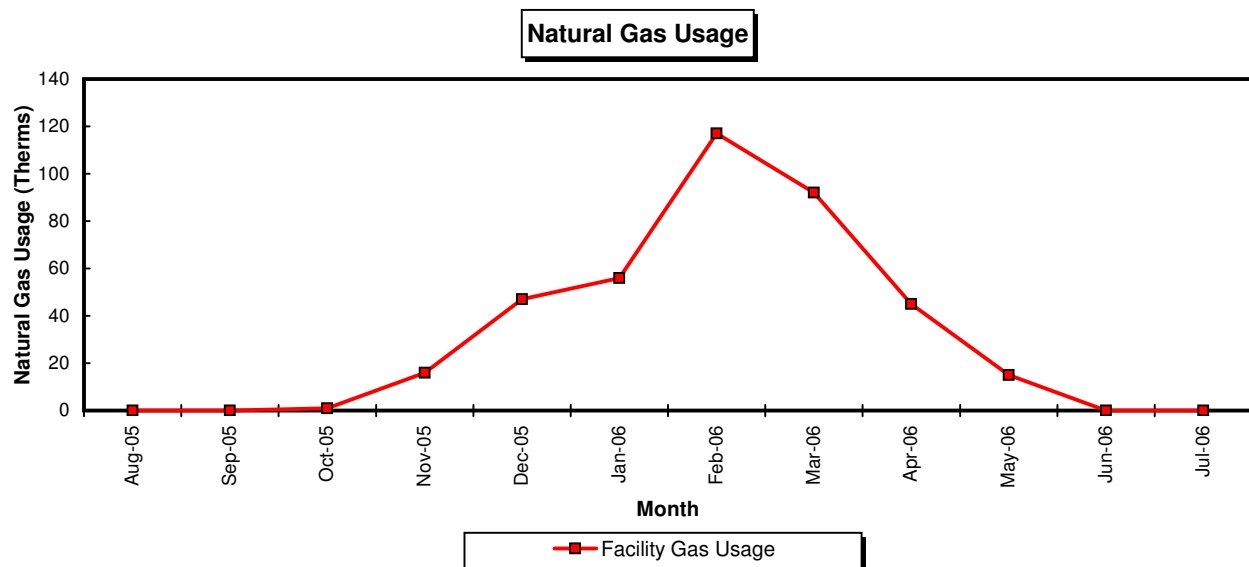
Load Factor = B/(A x E)



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



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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		#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	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

OUTPUT

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

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 MEASURES	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	Thermal 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 (LITEHRS)

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)

883 ...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)

50 ...WEEKS/YEAR OF BUILDING OPERATION (WPY)

10% ...PERCENT OF AREA AIR CONDITIONED (%COOLED)

= KWHRED/KWRED / WPY

= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

(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) = $\sum$ (Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)

Estimated Energy Usage (kWh/yr) = $\sum$ (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			Output Ton- Hours or MMBtu	kWh Saved	Input MMBtuSaved
					Existing Occupied	Existing Unoccupied	Cooling/Heati ng Btu saved			
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 5660 / 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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency 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
Building 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

Bin Temp				Existing Case				Proposed Case			
	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 (Σ(OAT-Occupied Setpoint) x Occupied Hours + Σ(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10⁶Infiltration Load MMBtu = (1.08 x Infiltration CFM x (Σ(OAT-Occupied Setpoint) x Occupied Hours + Σ(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10⁶

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 10⁶/12000 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	\$8.62
\$kWh	\$0.10
\$MMBtu	\$14.37

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

Building: Building	Existing	Proposed	
Unit #: Pool HVAC	Y	Y	Y = Yes, N = No
Area Served: Pool Enclosure	Y	Y	Y = Included, N = Not Included
System Type: SZCV	P	P	S = Standard, H = High, P = Premium
Annual Time Period: All	N	Y	Y = Included, N = Not Included
	C	V	C = Cycling, V = VFD
	C	V	C = Cycling, V = VFD
	N	Y	Y = Included, N = Not Included

Summary Of Estimated Annual Energy Usage	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
Existing HVAC Systems And Controls	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	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
Existing HVAC Systems With Existing Pool Cover And New VFD's And Controls	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	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
With Existing Pool Cover And New VFD's And Controls	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				Percent Evaporation With Pool Cover In Place
86 °F 60% RH	1	General	4,500	84 °F	Lbs/Hr Still Water	Lbs/Hr With Activity	Lbs/Hr With Pool Covered	Maximum Activity Factor	
					128	128	13	1	10%
			Totals	4,500		128	128	13	

Estimated Pool Water Evaporation Rates By Daily Time Period				Pool Water Heating Parameters:			
	Estimated Activity Level	Evaporation Rate Lbs/Hr		Estimated Average City Water Temperature: 55 °F			
				Weighted Average Pool Makeup Water Temperature: 84 °F			
12 M To 8 AM	1.25	160		Pool Water Heating Efficiency: 83%			
8 AM To 4 PM	1.5	192		(Existing Boiler)			
4 PM To 12 M	1.25	160					
(For Occupied Hours Only)							

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		Exhaust Fans		System Total MMBtu	Fans Total kWh
							% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	Total kWh
95 / 99	0	160	11,913	95 °F	0	0	100%	7.5	0	100%	7.5	0
90 / 94	0	160	12,132	91 °F	0	0	100%	7.5	0	100%	7.5	0
85 / 89	0	160	9,094	87 °F	0	0	100%	7.5	0	100%	7.5	0
80 / 84	2	160	7,223	84 °F	0	0	100%	7.5	15	100%	7.5	15
75 / 79	9	160	6,183	82 °F	1	0	100%	7.5	67	100%	7.5	67
70 / 74	49	160	5,855	81 °F	4	0	100%	7.5	366	100%	7.5	366
65 / 69	161	160	5,486	79 °F	18	0	100%	7.5	1,201	100%	7.5	1,201
60 / 64	300	160	4,719	78 °F	37	0	100%	7.5	2,238	100%	7.5	2,238
55 / 59	286	160	3,988	78 °F	36	16	100%	7.5	2,134	100%	7.5	2,134
50 / 54	228	160	3,469	78 °F	29	15	100%	7.5	1,701	100%	7.5	1,701
45 / 49	201	160	3,125	78 °F	26	15	100%	7.5	1,499	100%	7.5	1,499
40 / 44	172	160	2,889	78 °F	24	15	100%	7.5	1,283	100%	7.5	1,283
35 / 39	253	160	2,731	77 °F	42	28	100%	7.5	2,166	100%	7.5	2,166
30 / 34	295	160	2,685	76 °F	46	31	100%	7.5	2,201	100%	7.5	2,201
25 / 29	237	160	2,685	75 °F	41	28	100%	7.5	1,768	100%	7.5	1,768
20 / 24	202	160	2,685	75 °F	37	25	100%	7.5	1,507	100%	7.5	1,507
15 / 19	178	160	2,685	74 °F	36	24	100%	7.5	1,328	100%	7.5	1,328
10 / 14	91	160	2,685	73 °F	20	13	100%	7.5	679	100%	7.5	679
5 / 9	55	160	2,685	72 °F	13	9	100%	7.5	410	100%	7.5	410
0 / 4	61	160	2,685	71 °F	15	10	100%	7.5	455	100%	7.5	455
-5 / -1	40	160	2,685	70 °F	10	7	100%	7.5	298	100%	7.5	298
-10 / -6	40	160	2,685	69 °F	11	7	100%	7.5	298	100%	7.5	298
-15 / -11	11	160	2,685	68 °F	3	2	100%	7.5	82	100%	7.5	82
-20 / -16	9	160	2,685	67 °F	3	2	100%	7.5	67	100%	7.5	67
		2,920	466,470			451			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		Exhaust Fans		System Total MMBtu	Fans Total kWh
							% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	Total kWh
95 / 99	0	192	14,296	96 °F	0	0	100%	7.5	0	100%	7.5	0
90 / 94	18	192	14,558	92 °F	0	0	100%	7.5	134	100%	7.5	134
85 / 89	62	192	10,912	87 °F	0	0	100%	7.5	463	100%	7.5	463
80 / 84	207	192	8,667	84 °F	8	0	100%	7.5	1,544	100%	7.5	1,544
75 / 79	224	192	7,419	82 °F	16	0	100%	7.5	1,671	100%	7.5	1,671
70 / 74	253	192	7,026	79 °F	27	0	100%	7.5	1,887	100%	7.5	1,887
65 / 69	216	192	6,583	78 °F	29	0	100%	7.5	1,611	100%	7.5	1,611
60 / 64	264	192	5,662	77 °F	39	0	100%	7.5	1,969	100%	7.5	1,969
55 / 59	171	192	4,785	77 °F	26	10	100%	7.5	1,276	100%	7.5	1,276
50 / 54	183	192	4,162	77 °F	28	12	100%	7.5	1,365	100%	7.5	1,365
45 / 49	168	192	3,750	76 °F	27	13	100%	7.5	1,253	100%	7.5	1,253
40 / 44	168	192	3,467	76 °F	26	14	100%	7.5	1,194	100%	7.5	1,194
35 / 39	227	192	3,278	75 °F	41	23	100%	7.5	1,768	100%	7.5	1,768
30 / 34	251	192	3,142	75 °F	46	27	100%	7.5	1,872	100%	7.5	1,872
25 / 29	189	192	3,008	74 °F	36	22	100%	7.5	1,410	100%	7.5	1,410
20 / 24	116	192	2,919	74 °F	23	15	100%	7.5	865	100%	7.5	865
15 / 19	111	192	2,858	73 °F	24	15	100%	7.5	828	100%	7.5	828
10 / 14	41	192	2,809	72 °F	9	6	100%	7.5	306	100%	7.5	306
5 / 9	21	192	2,765	71 °F	5	3	100%	7.5	157	100%	7.5	157
0 / 4	15	192	2,737	71 °F	4	2	100%	7.5	112	100%	7.5	112
-5 / -1	6	192	2,737	70 °F	2	1	100%	7.5	45	100%	7.5	45
-10 / -6	5	192	2,741	69 °F	1	1	100%	7.5	37	100%	7.5	37
-15 / -11	2	192	2,730	68 °F	1	0	100%	7.5	15	100%	7.5	15
-20 / -16	0	192	2,728	67 °F	0	0	100%	7.5	0	100%	7.5	0
		2,920	559,764			417			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:					Daily/Weekly Occupancy Schedule:						
OA Conditions	DB	MCWB	Enthalpy	Moisture	Percent Occupied						
90 °F	71 °F		34.7 Btu/Lb	83.3 Gr/Lb	Times By Daily Time Period						
Space Conditions	DB	RH	Enthalpy	Moisture							
86 °F	60% RH		38.6 Btu/Lb	114 Gr/Lb							
					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%		
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				
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						Pool Enclosure Exhaust Fans					
	Supply Fan #1					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						Total Full Load Input kw: 7.5					
Total Minimum Input kw (With VFD Control): 1.5						Total Minimum Input kw (With VFD Control): 1.5					
Unoccupied Operation - Minimum Space Airflow Setpoints:						Estimated Pool Enclosure Heat Loss Parameters:					
	Minimum % Of Design Ventilation Air	Minimum Percent Supply Air Volume	Minimum Percent Exhaust Air Volume	Occupied Percent Supply Air Volume		Existing H&V Unit - Total Space Heating Capacity: 82					
						Existing Radiant Heat - Total Space Heating Capacity: 147					
						Existing Systems - Total Space Heating Capacity: 229					
	0%	20%	20%	75%		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			Exhaust Fans			System Total MMBtu	Fans Total kWh
							% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	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			405	202		21,783			21,776	607	43,559	
		Total Pounds												

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	Pool Water Evaporation Rate Lbs/Hour	Total Fresh Air CFM	Reheat MMBtu	Space Heating MMBtu	Supply And Return Fans			Exhaust Fans			System Total MMBtu	Fans Total kWh
						% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	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	403
-10 / -6	27	13	183	1	5	100%	7.5	201	100%	7.5	201	5	403
-15 / -11	7	13	183	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	2	84
	2,555	32,653		29	206			19,060			19,060	235	38,121
		Total Pounds											

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

Building: Building		Proposed	
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	Y	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	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
Existing HVAC Systems With Proposed Pool Cover And VFD's And Controls	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

V. Pool Data And Calculated Evaporation Rates

Pool Data And Calculated Evaporation Rates:									
Pool Enclosure Air Conditions 86 °F 60% RH	Pool # 1	Pool Usage General	Pool Area - SF 4,500	Pool Water Temp. 84 °F	Total Evaporation Rates			Maximum Activity Factor 1	Percent Evaporation With Pool Cover In Place 10%
					Lbs/Hr Still Water	Lbs/Hr With Activity	Lbs/Hr With Pool Covered		
					128	128	13		
Totals			4,500		128	128	13		
Estimated Pool Water Evaporation Rates By Daily Time Period					Pool Water Heating Parameters:				
	Estimated Rate Level	Evaporation Lbs/Hr	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)						
	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)									
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 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			Exhaust Fans			System Total MMBtu	Fans Total kWh	
							% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	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			451	160			9,474			22,457	610	31,931
		Total Pounds													

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			Exhaust Fans			System Total MMBtu	Fans Total kWh	
							% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	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	3,276	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			417	105			9,542			22,457	522	31,999
		Total Pounds													

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:						Daily/Weekly Occupancy Schedule:					
OA Conditions	90 °F	DB 71 °F	MCWB 34.7 Btu/Lb	Enthalpy 83.3 Gr/Lb	Moisture	Percent Occupied Times By Daily Time Period					
Space Conditions	DB 86 °F	RH 60% RH	Enthalpy 38.6 Btu/Lb	Moisture 114 Gr/Lb		Weekday	Start	End	12 AM To 8 AM	8 AM To 4 PM	4 PM To 12 AM
Existing Heating & Ventilating Units - Design Airflow And Heating Data:						Monday	5:30 AM	9:00 PM	31%	100%	63%
Quantity: 1						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	2,888	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

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			Pool Enclosure Exhaust Fans						
	Supply Fan #1				Exhaust Fan #1				
	10				10				
Motor Nameplate HP	1800				1800				
Motor Design RPM (1800/3600)	ODP				ODP				
Motor Type (ODP/TEFC)	P				P				
Efficiency Level (S/H/P)	90%				90%				
Estimated Load Factor	9.0				9.0				
Fan Motor Full Load BHP	90.0%				90.0%				
Motor Efficiency	Yes				Yes				
VFD (Yes/No)	3%				3%				
VFD Losses	7.7				7.7				
Fan Motor Full Load Input kw	1.5				1.5				
Fan Motor Minimum Input kw	Total Full Load Input kw: 7.7				Total Full Load Input kw: 7.7				
	Total Minimum Input kw (With VFD Control): 1.5				Total Minimum Input kw (With VFD Control): 1.5				
<u>Unoccupied Operation - Minimum Space Airflow Setpoints:</u>					<u>Estimated Pool Enclosure Heat Loss Parameters:</u>				
					Existing H&V Units - Total Space Heating Capacity: 147				
Minimum % Of Design Ventilation	Minimum Percent Supply Air Volume	Minimum Percent Exhaust Air Volume	Estimated Peak Load Factor: 80%						
Air			Estimated Peak Space Heating Load MBH: 117						
0%	20%	20%	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						
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

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 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			Exhaust Fans			System Total CFM
							% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	Total kWh	
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		405		130	9,477			22,449			534
		Total Pounds											

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													
Outside Air Temp. Bangor Deg. F	Daily Time Period All System Hours	Pool Water Evaporation Rate Lbs/Hour	Total Fresh Air CFM	Reheat MMBtu	Space Heating MMBtu	Supply And Return Fans			Exhaust Fans			System Total MMBtu	Fans Total kWh
						% Of Design System Airflow CFM	Average Total Input kW	Total kWh	% Of Design System Airflow CFM	Average Total Input kW	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	21		104	3,930			3,930			125	7,860
Total Pounds													

Title	Water Conservation
Date	February 1, 2009
District	Dover, NH
School	Dover Indoor Pool

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%

Summary	Existing	Proposed	Savings	\$ Savings
kWh/yr				\$0
kW				
MMBtu/yr			37	\$528
kGal/yr	487	272	215	\$2,379
Total				\$2,907

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, (°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	Fixture Type	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		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																	
Site:	\$ / kWh	Room	Type	Qty.	Volts	Amps	Lighting * Watts/ unit	Lighting Found	Existing Operation Hrs/Day	Days/Yr.	Compressor Existing Normal	Duty Cycle Proposed Nite	Machine Location is Occupied Hrs/Day	Days/Yr.	Number of Controllers Required 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	
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	Vending Machine	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
<u>Proposed Annual Electricity Use:</u>	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)	Un-Occupied Dehumidification on Load (tons)	Un-Occupied Dehumidification Energy Consumption (kWh)	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 Dehumidification on Load (tons)	Un-Occupied Dehumidification Energy Consumption (kWh)	Un-Occupied Dehumidification 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	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					124111

Post Retro
kwh

* Total savings includes water savings of 64.3 kgals that is worth \$710

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%	
Reduction 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

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

OUTPUT

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

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](#)
[Show 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 MEASURES	kW	Electricity Savings 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		\$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 ceiling (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	Thermal 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 (LITEHRS)

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)

1,029 ...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)

52 ...WEEKS/YEAR OF BUILDING OPERATION (WPY)

90% ...PERCENT OF AREA AIR CONDITIONED (%COOLED)

= KWHRED/KWRED / WPY

= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

(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) = $\sum(\text{Existing Fixture Watts} \times \text{Operating Hours/yr} \times 1 \text{ kW}/1000 \text{ Watts})$

Estimated Energy Usage (kWh/yr) = $\sum(\text{Proposed Fixture Watts} \times \text{Op. Hours/yr} \times 1 \text{ kW}/1000 \text{ Watts})$

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			Output Ton- Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
					Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu 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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency Ratio (EER)
 MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	Water Conservation
Date	February 2, 2009
District	Dover, NH
Building	Dover Ice Arena

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%

Savings Summary	Existing	Proposed	Savings	\$ Savings
kWh/yr				\$0
kW				\$0
MMBtu/yr			52.7	\$655
kGal/yr	558	320	239	\$2,636
Total				\$3,291

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, (°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	Fixture Type	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	Flushes/Day, Min/Day	(gpf, gpm)	(gpf, gpm)	(gal/yr)	(gal/yr)	(gal/yr)	(MMBtu/yr)	(\$/yr)	(\$/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	Days/Yr.	Compressor Existing Normal	Duty Cycle Proposed Nite	Machine Location is Occupied Hrs/Day	Days/Yr.	Number of Controllers Required Beverage	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	
Dover Ice Arena	\$ 0.11														0	0	
Dover Ice Arena	\$ 0.11														0	0	
Totals:															0	0	

* Lighting watts is included in the volt / amp data and Total kW

Calculations & Output Data:																	
Lighting Savings																	
Site		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		
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)

<u>Constants or Assumptions Pre-Retrofit</u>					<u>Constants or Assumptions Post-Retrofit</u>				
Ceiling Emissivity		0.90			Ceiling Emissivity		0.90		
Ice Emissivity		0.95			Ice Emissivity		0.95		
Proposed Emissivity		0.10			Proposed Emissivity		0.10		
Existing Ceiling Area over Ice (minus s	16593	sq ft			Existing Ceiling Area over Ice (minus s	16593	sq ft		
Proposed Low-E Coverage	16593	sq ft			Proposed Low-E Coverage	16593	sq ft		
Temp Ice Rankine	483	23	degrees F		Temp Ice Rankine	483			
Temp Ceiling Rank	500	40	degrees F	yr round avg	Temp Ceiling Rankine	500			
<u>Q Before= A * Fci * Sigma (Tc cubed - Ti Cubed)</u>					<u>Q After= A * Fci * Sigma (Tc cubed - Ti Cubed)</u>				
$Fci = (1/Fci + (1/emiss of Ceiling - 1) + Ac/Ai (1/emiss of Ice - 1))^{-1}$					$Fci = (1/Fci + (1/emiss of Ceiling - 1) + Ac/Ai (1/emiss of Ice - 1))^{-1}$				
Stefan Boltzman Constant	0.0000000017				Stefan Boltzman Constant	0.0000000017			
Fci	0.6800				Fci	0.6800			
1/Fci	1.4706				1/Fci	1.4706			
1/emiss of Ceiling - 1	0.1111				1/emiss of Ceiling - 1	9.0000			
Ac/Ai	1.0000				Ac/Ai	1.0000			
1/emiss of Ice - 1	0.0526				1/emiss of Ice - 1	0.0526			
Fci without Low E Ceiling	0.6119				Fci of Low E Ceiling	0.0950			
Q	140,542				Q	21,827			
Tons per Hour	11.7				Tons per Hour	1.82			
Tons per Hour Saved	9.89								
Hours	5,200								
Ton Hours	51,443								
kw/ton	0.77								
kwh Saved with Low E	39,611								

Rink 2 (New)

<u>Constants or Assumptions Pre-Retrofit</u>					<u>Constants or Assumptions Post-Retrofit</u>				
Ceiling Emissivity	0.90				Ceiling Emissivity	0.90			
Ice Emissivity	0.95				Ice Emissivity	0.95			
Proposed Emissivity	0.10				Proposed Emissivity	0.10			
Existing Ceiling Area over Ice (minus s	16593	sq ft			Existing Ceiling Area over Ice (minus s	16593	sq ft		
Proposed Low-E Coverage	16593	sq ft			Proposed Low-E Coverage	16593	sq ft		
Temp Ice Rankine	484	24	degrees F		Temp Ice Rankine	484			
Temp Ceiling Rank	500	40	degrees F	yr round avg	Temp Ceiling Rankine	500			
<u>Q Before= A * Fci * Sigma (Tc cubed - Ti Cubed)</u>					<u>Q After= A * Fci * Sigma (Tc cubed - Ti Cubed)</u>				
$Fci = (1/Fci + (1/emiss of Ceiling - 1) + Ac/Ai (1/emiss of Ice - 1))^{-1}$					$Fci = (1/Fci + (1/emiss of Ceiling - 1) + Ac/Ai (1/emiss of Ice - 1))^{-1}$				
Stefan Boltzman Constant	0.0000000017				Stefan Boltzman Constant	0.0000000017			
Fci	0.6800				Fci	0.6800			
1/Fci	1.4706				1/Fci	1.4706			
1/emiss of Ceiling - 1	0.1111				1/emiss of Ceiling - 1	9.0000			
Ac/Ai	1.0000				Ac/Ai	1.0000			
1/emiss of Ice - 1	0.0526				1/emiss of Ice - 1	0.0526			
Fci without Low E Ceiling	0.6119				Fci of Low E Ceiling	0.0950			
Q	132,674				Q	20605.26225			
Tons per Hour	11.1				Tons per Hour	1.717105188			
Tons per Hour Saved	9.34								
Hours	8,016								
Ton Hours	74,862								
kw/ton	0.77								
kwh Saved with Low E	57,644								

Estimated Load Profile And Pump Speed Required			
Daily		Existing	Proposed
Time	OA	Cooling	Cooling
Period	Temp.	Load	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 Bin Deg. F		OAT Deg. F	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		
			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
85	/	89	87 °F	0	-	-	62	4,691	3,281	14	940
80	/	84	82 °F	2	92	50	207	15,662	10,954	72	4,836
75	/	79	77 °F	9	413	226	224	16,948	11,854	97	6,515
70	/	74	72 °F	49	2,250	1,233	253	19,142	13,389	191	12,828
65	/	69	67 °F	161	7,392	4,051	216	16,343	11,431	211	14,171
60	/	64	62 °F	300	13,773	7,549	264	19,974	13,971	298	20,014
55	/	59	57 °F	286	10,700	7,476	171	11,485	9,308	249	14,607
50	/	54	52 °F	228	8,530	5,960	183	12,290	9,961	172	10,090
45	/	49	47 °F	201	7,520	5,254	168	11,283	9,145	211	12,377
40	/	44	42 °F	172	6,435	4,496	160	10,746	8,709	167	9,796
35	/	39	37 °F	293	13,698	7,659	237	18,131	12,901	272	18,496
30	/	34	32 °F	295	13,791	7,711	251	19,202	13,663	271	18,428
25	/	29	27 °F	237	11,080	6,195	189	14,459	10,288	230	15,640
20	/	24	22 °F	202	9,444	5,280	116	8,874	6,314	151	10,268
15	/	19	17 °F	178	8,322	4,653	111	8,492	6,042	142	9,656
10	/	14	12 °F	91	4,254	2,379	41	3,137	2,232	89	6,052
5	/	9	7 °F	55	2,571	1,438	21	1,607	1,143	43	2,924
0	/	4	2 °F	61	2,852	1,595	15	1,148	816	17	1,156
-5	/	-1	-3 °F	40	1,870	1,046	6	459	327	10	680
-10	/	-6	-8 °F	40	1,870	1,046	5	383	272	8	544
-15	/	-11	-13 °F	11	514	288	2	153	109	1	68
-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

<u>Conductive Loads:</u>	
Ice Resurfacing:	
<u>Calc @ 21 deg F ice surface:</u>	
$Q = 8.33 V_f [1.0(t_i - 32) + 144 + 0.49(32 - t_i)]$	
V_f = flood water volume	150 gal
t_i = flood water temp	150 deg F
t_i = ice temp	21 deg F
$Q =$	334,104
<u>Calc @ 24 deg F ice surface:</u>	
$Q = 8.33 V_f [1.0(t_i - 32) + 144 + 0.49(32 - t_i)]$	
V_f = flood water volume	150 gal
t_i = 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	

<u>Convective Loads:</u>	
<u>Calc @ 21 deg F ice surface:</u>	
$Q = h(t_a - t_i) + [K(X_a - X_i)(1226 \text{ Btu/lb})(10 \text{ lb/mol})]$	
$h = 0.6 + 0.00318V$	0.918
V = air velocity	100 ft/min
t_a = 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
<u>Calc @ 24 deg F ice surface:</u>	
$Q = h(t_a - t_i) + [K(X_a - X_i)(1226 \text{ Btu/lb})(10 \text{ lb/mol})]$	
$h = 0.6 + 0.00318V$	0.918
V = air velocity	100 ft/min
t_a = 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:

$$Q = A_c * f_{ci} * \text{sig} * (T_c^{**4} - T_i^{**4})$$

$$f_{ci} = [1/F_{ci} + (1/e_c - 1) + A_c/A_i * (1/e_i - 1)]^{** -1}$$

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
ti = ice temp	479 deg R
tc = ceiling temp	520 deg R
Q =	385,747

Calc @ 24 deg F ice surface:

$$Q = A_c * f_{ci} * \text{sig} * (T_c^{**4} - T_i^{**4})$$

$$f_{ci} = [1/F_{ci} + (1/e_c - 1) + A_c/A_i * (1/e_i - 1)]^{** -1}$$

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
ti = 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			
Weighted Average	3%	0.00%	
		4.79%	

Notes: Ground Heat Load Reduction Assumed at 2%

Lighting Radiation Load Savings Assumed equal to Ceiling Radiation

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

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

Existing kWh 803,412

Thermal Savings from the ability to use cold flood water

Existing					500*gpm*dt	Heater eff 80%	Annual 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

Summary	Existing	Proposed	Savings	Savings
kWh/yr			72,307	\$ 7,665
kW				
MMBtu/yr	520	200	320	\$ 3,975
Total				\$ 11,639

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**

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							Material	Specific Heat Btu/lb-F	Temperature		Density or Weight
Width	Length	Area	Qty of Ice						Initial (F)	Final (F)	
	ft	ft	ft ²	ft ³	gal of water	lbs water	6" Concrete	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 Glyc	0.83	40	15	32,000 lb
Average Ice Thickness (inches)			1.5 in								
Concrete Thickness			6 in								
Estimated System Losses			15%	Latent heat of freezing water							
Time period to make 1.5" ice			48 hr	Building and Pumping Load							
Zamboni Usage per hr			1.5	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

$Q_i = 8.33 \times V_i (1.0 \times (t_i - 32 \text{ F}) + 144 + 0.49 \times (32 - t_i))$

Assumption: 140 gallons of the 180 gallons of hot water is actually used for resurfacing

where;

Q_i	= heat load per flood	32.2 tons
V_i	= flood water volume	140.0 gal
t_i	= 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 coefficienty (Btu/hr-ft ² -F)	0.6159
V	= air velocity over the ice, (ft/min)	5
$Q_{cv} = h \times (t_a - t_i) + ((K)(X_a - X_i)(1226 \text{ Btu/lb})(18 \text{ lb/mol}))$		
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

Radiant Loads		
$Q = A_c \times f_{ci} \times \sigma \times (T_c^4 - T_i^4)$		
$f_{ci} = [1/F_{ci} + (1/\epsilon_c - 1) + A_c/A_i \times (1/\epsilon_i - 1)]^{-1}$		
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	= ice temp, deg R	479 R
t _c	= ceiling temp, deg R	520 R

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

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: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3">Schedule And Percent Occupied</th> <th>12 AM</th> <th>8 AM</th> <th>4 PM</th> </tr> <tr> <th colspan="3">Times By Daily Time Period</th> <th>To</th> <th>To</th> <th>To</th> </tr> <tr> <th>Weekday</th> <th>Start</th> <th>End</th> <th>8 AM</th> <th>4 PM</th> <th>12 AM</th> </tr> </thead> <tbody> <tr> <td>Monday:</td> <td>5:00 AM</td> <td>11:00 PM</td> <td>20%</td> <td>80%</td> <td>80%</td> </tr> <tr> <td>Tuesday:</td> <td>5:00 AM</td> <td>11:00 PM</td> <td>20%</td> <td>80%</td> <td>80%</td> </tr> <tr> <td>Wednesday:</td> <td>5:00 AM</td> <td>11:00 PM</td> <td>20%</td> <td>80%</td> <td>80%</td> </tr> <tr> <td>Thursday:</td> <td>5:00 AM</td> <td>11:00 PM</td> <td>20%</td> <td>80%</td> <td>80%</td> </tr> <tr> <td>Friday:</td> <td>5:00 AM</td> <td>11:00 PM</td> <td>20%</td> <td>80%</td> <td>80%</td> </tr> <tr> <td>Saturday:</td> <td>5:00 AM</td> <td>11:00 PM</td> <td>20%</td> <td>100%</td> <td>100%</td> </tr> <tr> <td>Sunday:</td> <td>5:00 AM</td> <td>11:00 PM</td> <td>20%</td> <td>100%</td> <td>100%</td> </tr> <tr> <td colspan="3">Operating Percentage - Annual Total</td> <td>20%</td> <td>86%</td> <td>86%</td> </tr> </tbody> </table>	Schedule And Percent Occupied			12 AM	8 AM	4 PM	Times By Daily Time Period			To	To	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%
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Estimated Load Profile And Pump Speed Required <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Daily Time Period</th> <th>OA Temp.</th> <th>Existing Cooling Load</th> <th>Proposed Cooling Load</th> </tr> </thead> <tbody> <tr> <td>12 AM To 8 AM</td> <td>60 °F</td> <td>65%</td> <td>62%</td> </tr> <tr> <td>8 AM To 4 PM</td> <td>30 °F</td> <td>100%</td> <td>95%</td> </tr> <tr> <td>4 PM To 12 AM</td> <td>30 °F</td> <td>90%</td> <td>86%</td> </tr> <tr> <td>12 AM To 8 AM</td> <td>30 °F</td> <td>80%</td> <td>76%</td> </tr> </tbody> </table>	Daily Time Period	OA Temp.	Existing Cooling Load	Proposed Cooling Load	12 AM To 8 AM	60 °F	65%	62%	8 AM To 4 PM	30 °F	100%	95%	4 PM To 12 AM	30 °F	90%	86%	12 AM To 8 AM	30 °F	80%	76%	Annual Months Of Operation At Above Weekly Schedule: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Month</th> <th>System</th> <th>Rink 1 (old)</th> <th>Rink 2 (new)</th> </tr> </thead> <tbody> <tr><td>January</td><td>100%</td><td>100%</td><td>100%</td></tr> <tr><td>February</td><td>100%</td><td>100%</td><td>100%</td></tr> <tr><td>March</td><td>89%</td><td>89%</td><td>89%</td></tr> <tr><td>April</td><td>89%</td><td>89%</td><td>89%</td></tr> <tr><td>May</td><td>44%</td><td>0%</td><td>89%</td></tr> <tr><td>June</td><td>44%</td><td>0%</td><td>89%</td></tr> <tr><td>July</td><td>44%</td><td>0%</td><td>89%</td></tr> <tr><td>August</td><td>44%</td><td>0%</td><td>89%</td></tr> <tr><td>September</td><td>89%</td><td>89%</td><td>89%</td></tr> <tr><td>October</td><td>89%</td><td>89%</td><td>89%</td></tr> <tr><td>November</td><td>100%</td><td>100%</td><td>100%</td></tr> <tr><td>December</td><td>100%</td><td>100%</td><td>100%</td></tr> </tbody> </table>	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%
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Outside Air Temperature Setpoints For Pump Operation:			
Pump Outside Air "Lockout" Temperature	70 °F		
Pump Outside Air "Lockon" Temperature	30 °F		

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

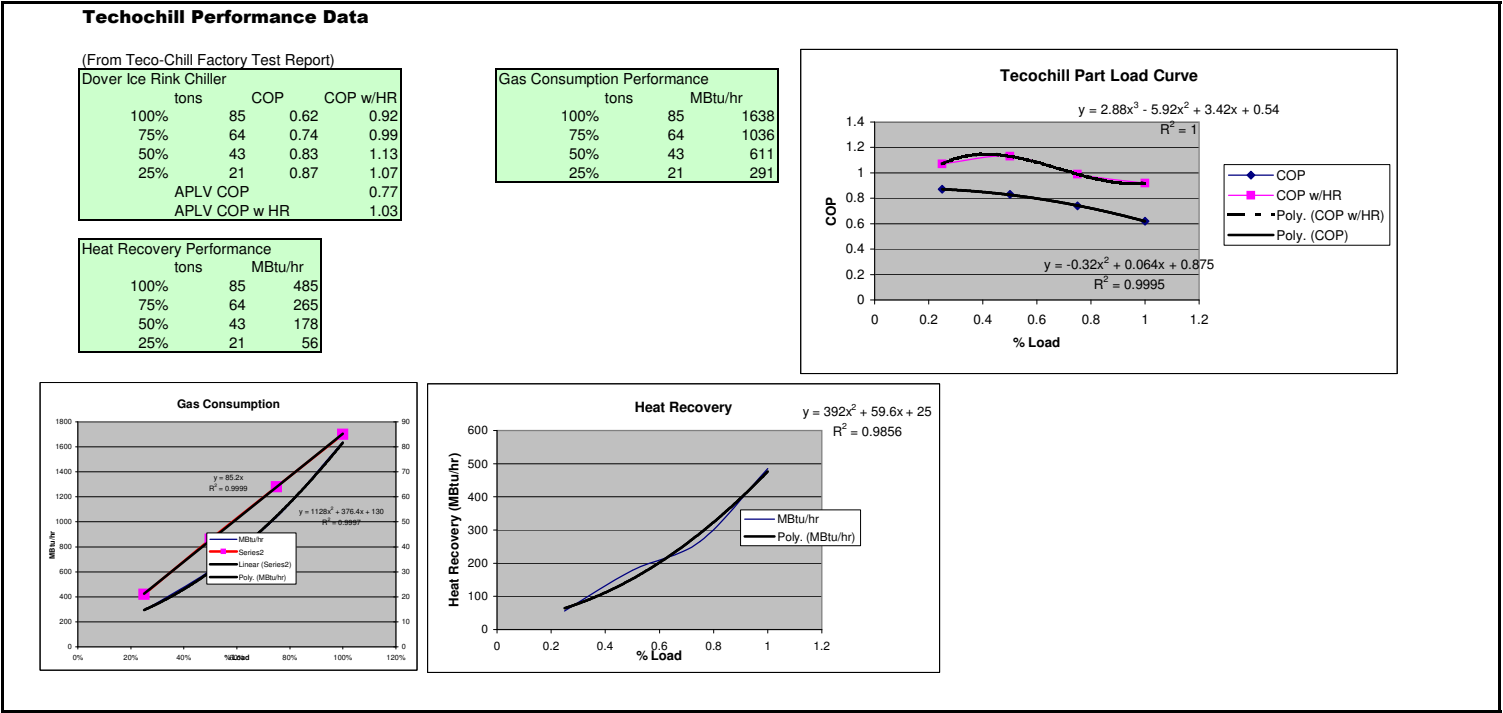
Chiller 1	Compressor 1				
	Compressor 2				
Chiller 2	Compressor 1				
	Compressor 2				

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				Daily Time Period 8 AM To 4 PM				Daily Time Period 4 PM To 12 AM				Total		
		System Hours	Tecochill Ton-Hrs	Heat Recovery MMBtu	Gas Cons MMBtu	System Hours	Tecochill Ton-Hrs	Heat Recovery MMBtu	Gas Cons MMBtu	System Hours	Tecochill Ton-Hrs	Heat Recovery MMBtu	Gas Cons MMBtu	Tecochill Ton-Hrs	Heat Recovery MMBtu	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

Chiller Performance Curve

2,908,192



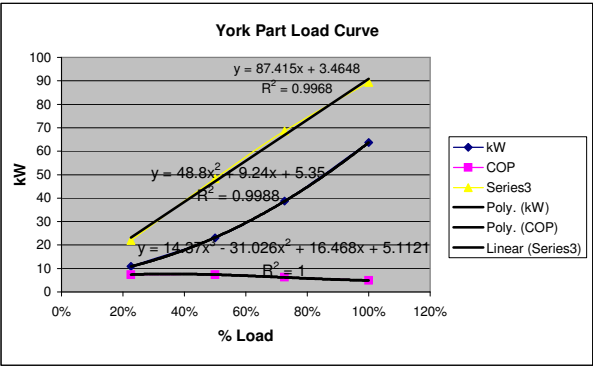
Proposed Electric Chiller Tons 89.4

Outside Air Temp. Bin Deg. F		OAT	Daily Time Period 12 AM To 12 AM				Daily Time Period 8 AM To 4 PM				Daily Time Period 4 PM To 12 AM				Total for 24 hrs		
			System Hours	Electric Ton-Hrs	Thermal Heat MMBtu	Electric kWh	System Hours	Electric Ton-Hrs	Thermal Heat MMBtu	Electric kWh	System Hours	Electric Ton-Hrs	Thermal Heat MMBtu	Electric kWh	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	-	207	17,595	-	13,106	72	5,508	-	3,834	23,214	-	17,005
75	/	79	77 °F	9	497	-	224	19,040	-	14,183	97	7,421	-	5,165	26,958	-	19,638
70	/	74	72 °F	49	2,707	-	253	21,505	-	16,019	191	14,612	-	10,171	38,824	-	27,771
65	/	69	67 °F	161	8,895	-	216	18,360	-	13,676	211	16,142	-	11,236	43,397	-	30,109
60	/	64	62 °F	300	16,575	-	264	22,440	-	16,715	298	22,797	-	15,868	61,812	-	42,268
55	/	59	57 °F	286	13,371	-	171	13,082	-	10,827	249	16,932	-	13,259	43,384	-	33,318
50	/	54	52 °F	228	10,659	-	183	14,000	82	11,587	172	11,696	-	9,159	36,355	82	28,106
45	/	49	47 °F	201	9,397	-	168	12,852	75	10,637	211	14,348	-	11,236	36,597	75	28,361
40	/	44	42 °F	172	8,041	-	160	12,240	72	10,130	167	11,356	-	8,893	31,637	72	24,575
35	/	39	37 °F	293	13,698	-	237	18,131	106	15,006	272	18,496	-	14,484	50,324	106	38,948
30	/	34	32 °F	295	13,791	-	251	19,202	112	15,892	271	18,428	-	14,431	51,421	112	39,846
25	/	29	27 °F	237	11,080	-	189	14,459	84	11,967	230	15,640	-	12,247	41,178	84	31,865
20	/	24	22 °F	202	9,444	-	116	8,874	52	7,345	151	10,268	-	8,041	28,586	52	21,906
15	/	19	17 °F	178	8,322	-	111	8,492	50	7,028	142	9,656	-	7,561	26,469	50	20,335
10	/	14	12 °F	91	4,254	-	41	3,137	18	2,596	89	6,052	-	4,739	13,443	18	10,273
5	/	9	7 °F	55	2,571	-	21	1,607	9	1,330	43	2,924	-	2,290	7,102	9	5,395
0	/	4	2 °F	61	2,852	-	15	1,148	7	950	17	1,156	-	905	5,155	7	3,824
-5	/	-1	-3 °F	40	1,870	-	6	459	3	380	10	680	-	532	3,009	3	2,204
-10	/	-6	-8 °F	40	1,870	-	5	383	2	317	8	544	-	426	2,797	2	2,034
-15	/	-11	-13 °F	11	514	-	2	153	1	127	1	68	-	53	735	1	535
-20	/	-16	-18 °F	9	421	-	0	-	-	-	0	-	-	-	421	-	291
															580,992	673	434,630

Chiller Performance Curve

York Performance Data (YCW0094HE)

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

Estimated Load Profile And Pump Speed Required

Daily		Percent	Pump
Time	OA	Cooling	Percent
Period	Temp.	Load	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

Daily/Weekly Occupancy Schedule:

Schedule And Percent Occupied			12 AM	8 AM	4 PM
Times By Daily Time Period			To	To	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%
Annual Operating Hours Per Period			1,170	2,013	2,013
Total Annual Pump Operating Hours			5,196	59%	

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	Pump Energy Savings 12 AM To 8 AM			Daily Time Period	Pump Energy Savings 8 AM To 4 PM			Daily Time Period	Pump Energy Savings 4 PM To 12 AM		
	12 AM To 8 AM	Pump Percent Speed With VFD	CW Pump kW Saved	CW Pump Total kWh Saved	8 AM To 4 PM	Pump Percent Speed With VFD	CW Pump kW Saved	CW Pump Total kWh Saved	4 PM To 12 AM	Pump Percent Speed With VFD	CW Pump kW Saved	CW Pump Total kWh Saved
	System Hours				System Hours				System Hours			
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 KWH:	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 Losses	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 Losses	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

OUTPUT

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

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 MEASURES	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	Thermal 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
RTVs	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	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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency 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 Losses	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 Losses	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

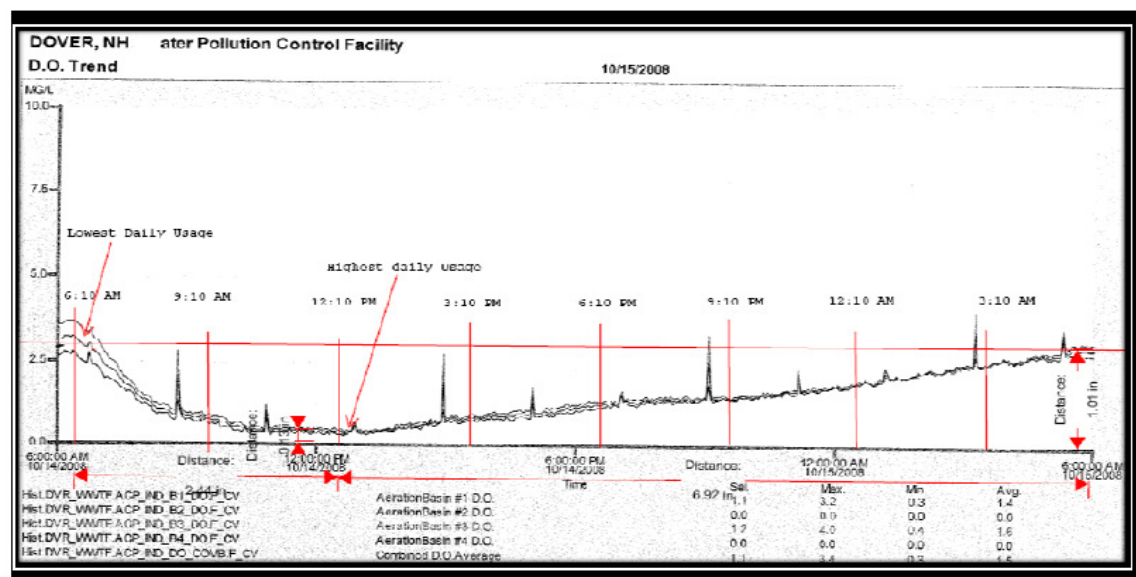
POWER CONSUMPTION COMPARISON BETWEEN EXISTING AND PROPOSED BLOWERS

						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 Differential	Y Axis Interval Differential	X Axis Interval Differential	Y Axis Differential @ 3 Hours	Y Axis Differential @ 6 Hours	Y Axis Differential @ 9 Hours	Y Axis Differential @ 12 Hours	Y Axis Differential @ 15 Hours	Y Axis Differential @ 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 Differential	Y Axis Interval Differential	X Axis Interval Differential	Y Axis Differential @ 3 Hours	Y Axis Differential @ 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

OUTPUT

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

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 MEASURES	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	Thermal 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 (LITEHRS)

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)

356 ...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)

50 ...WEEKS/YEAR OF BUILDING OPERATION (WPY)

60% ...PERCENT OF AREA AIR CONDITIONED (%COOLED)

= KWHRED/KWRED / WPY

= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

(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) = $\sum$ (Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)

Estimated Energy Usage (kWh/yr) = $\sum$ (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			Output Ton- Hours or Oil Gallons	kWh Saved	Input Gallons Saved
					Existing Occupied	Existing Unoccupied	Cooling/Heati ng Btu 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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency 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
Building 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 = $1.08 \times \text{CFM} \times \% \text{ Speed at Warm-up} \times (\text{Occupied Temperature Setpoint} - \text{Room Air Temperature}) \times \text{Warm-Up Hours}$

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 = $(\text{UA} \times (\Sigma(\text{OAT} - \text{Occupied Setpoint})))$

Infiltration Load Btu/Hr = $(1.08 \times \text{Infiltration CFM} \times (\Sigma(\text{OAT} - \text{Occupied Setpoint})))$

Total Actual Heating Energy (MMBtu) Required Durng Watm-Up Cycle = $(\text{Envelope Load} + \text{Infiltration Load}) / (10^6 \times \text{Warm-Up Hours})$

Where

$\text{UA} = 1/\text{R-Value of Wall} \times \text{Wall Area} + 1/\text{R-Value of Roof} \times \text{Roof Area}$

$\text{Infiltration CFM} = \text{Building Area} \times 10 \text{ Feet Average Height} \times \text{Building Air Changes Per Hour} / 60$

$\text{Warm-Up Hours} = \text{Hours Before Occupancy Unit Ventilators Turned to Occupied Mode}$

$\text{Heating MMBtu Savings} = (\text{Baseline MMBtu} - \text{Proposed MMBtu}) / \text{Heating System Efficiency}$

Title	Water Conservation
Date	February 1, 2009
District	Dover, NH
Building	Dover City Hall

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%

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

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	Fixture Type	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		Flushes/Day	Min/Day	(gpf, gpm)		(gal/yr)	(gal/yr)	(gal/yr)	(MMBtu/yr)	(\$/yr)	(\$/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	Days/Yr.	Compressor Existing Normal	Duty Cycle Proposed Nite	Machine Location is Occupied Hrs/Day	Days/Yr.	Number of Controllers Required Beverage	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	
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:																	
Lighting 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 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
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

OUTPUT

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

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			Thermal		Water		Total Savings
		kW	kWh/yr	\$/yr	MMBtu/yr	\$/yr	kgal/yr	\$/yr	\$/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	Thermal 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 (LITEHRS)

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)

224 ...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)

50 ...WEEKS/YEAR OF BUILDING OPERATION (WPY)

25% ...PERCENT OF AREA AIR CONDITIONED (%COOLED)

= KWHRED/KWRED / WPY

= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

(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) = $\sum$ (Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)

Estimated Energy Usage (kWh/yr) = $\sum$ (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
RTVs	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	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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency 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
Building 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 (Σ(OAT-Occupied Setpoint) x Occupied Hours + Σ(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10⁶Infiltration Load MMBtu = (1.08 x Infiltration CFM x (Σ(OAT-Occupied Setpoint) x Occupied Hours + Σ(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10⁶

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 10⁶/12000 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				VFD
Fan Controls				load factor
	Motor hp	kW	Metered?	
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)/10⁶)/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		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
						OA CFM	RA CFM										
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	2,467	8,664					-	702,000	342,040	4,212,000	11,316	527		18,555

BASELINE CASE - UNOCCUPIED

Bin Temp	MCWB	Humidity Ratio	Hours	Total Hours		Airflow		MARH	Preheat	Sensible Cooling	Latent Cooling	Reheat	Cooling kWh	Heating MMBtu	% Fan Speed	Fan kWh	
		(Grains/lb)	Unoccupied	Occupied	OA CFM	RA CFM	MAT			(grains/lb)	Btu/Hr						Btu/Hr
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	Hours	Total Hours	Airflow		MARH	Preheat	Sensible Cooling	Latent Cooling	Reheat	Cooling kWh	Heating MMBtu	% Fan Speed	Fan kWh		
		Ratio (Grains/lb)			Unoccupied	Occupied										OA CFM	RA CFM
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	Hours Unoccupied	Occupied	Total Hours	Airflow		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	
		Ratio (Grains/lb)				OA CFM	RA CFM										
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

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%

Summary	Existing	Proposed	Savings	\$ Savings
kWh/yr				
kW				
MMBtu/yr			12.4	\$140
kGal/yr	118	62	56.3	\$622
Total				\$762

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	Fixture Type	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 Flushes/Day	Estimated Min/Day	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	Days/Yr.	Compressor Duty Cycle Existing Normal	Proposed Nite	Machine Location is Occupied Hrs/Day	Days/Yr.	Number of Controllers Required Beverage	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:															0	0

* Lighting watts is included in the volt / amp data and Total kW

Calculations & Output Data:																
Lighting Savings																
Site		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	0.000	0	0	0	0	0	0	\$ 0	
Public Works Building		0	0	0	0	0	0	0.000	0	0	0	0	0	0	\$ 0	
Public Works Building		0	0	0	0	0	0	0.000	0	0	0	0	0	0	\$ 0	
Public Works Building		0	0	0	0	0	0	0.000	0	0	0	0	0	0	\$ 0	
Public Works Building		0	0	0	0	0	0	0.000	0	0	0	0	0	0	\$ 0	
Public Works Building		0	0	0	0	0	0	0.000	0	0	0	0	0	0	\$ 0	
Public Works Building		0	0	0	0	0	0	0.000	0	0	0	0	0	0	\$ 0	
Public Works Building		0	0	0	0	0	0	0.000	0	0	0	0	0	0	\$ 0	
Public Works Building		0	0	0	0	0	0	0.000	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 Losses	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 Losses	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 (°F)	55 °F

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 MEASURES	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		Thermal Energy		Total \$/yr	COST PER FT PER YR	
			kWh/yr	\$/yr	MMBtu/yr	\$/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!

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
RTVs	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

ASSUMPTION

Average Wind Speed (MPH)	8.70
Correction Factor	30%
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	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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency Ratio (EER)
 MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	EMS-Temperature Setback
Date	February 10, 2009
District	Dover, NH
Building	McConnell Center

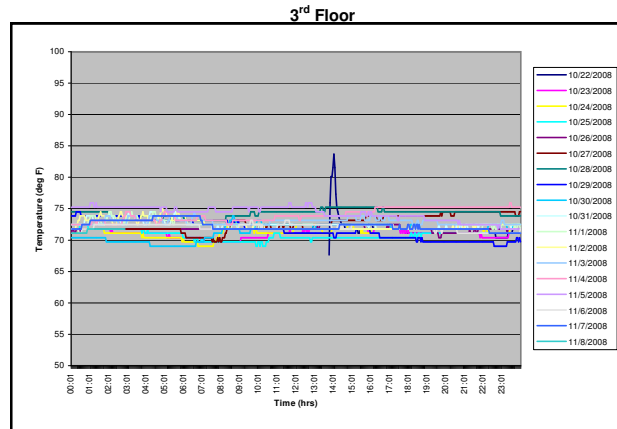
Summary	Baseline	Proposed	Savings	\$ Savings
kWh/yr	5,301	4,170	1,132	\$121
kW				
MMBtu/yr	2,692	2,231	461	\$6,503
Total				\$6,625

Input Variables

	Existing	Proposed
Summer Occupied Setpoint	72	74
Summer Unoccupied Setpoint	78	78
Winter Occupied Setpoint	72	72
Winter Unoccupied Setpoint	72	60
Building 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



				Existing Case				Proposed Case			
Bin Temp	Hours Unoccupied	Hours 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	184	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 (Σ(OAT-Occupied Setpoint) x Occupied Hours + Σ(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10⁶Infiltration Load MMBtu = (1.08 x Infiltration CFM x (Σ(OAT-Occupied Setpoint) x Occupied Hours + Σ(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10⁶

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 10⁶/12000 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 Losses	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 Losses	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

OUTPUT

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

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
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	Thermal 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 (LITEHRS)

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)

376 ...SUMMER COOLING COINCIDENT HRS (CLGCOHRS)

50 ...WEEKS/YEAR OF BUILDING OPERATION (WPY)

40% ...PERCENT OF AREA AIR CONDITIONED (%COOLED)

= KWHRED/KWRED / WPY

= MAX((HHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

= MAX((CHPY / 168 - (52 WKS - WPY)),0) * LITEHRS

(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) = $\sum$ (Existing Fixture Watts x Operating Hours/yr x 1 kW/1000 Watts)

Estimated Energy Usage (kWh/yr) = $\sum$ (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			Output Ton- Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
					Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu 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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency 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
Building 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	8,684	90	278	648	463	76	235	648	390

Formulas:

For both Existing and Proposed Case:

Envelope Load MMBtu = (UA x (Σ(OAT-Occupied Setpoint) x Occupied Hours + Σ(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10⁶Infiltration Load MMBtu = (1.08 x Infiltration CFM x (Σ(OAT-Occupied Setpoint) x Occupied Hours + Σ(OAT-Unoccupied Setpoint) x Unoccupied Hours))/10⁶

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 10⁶/12000 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

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%

Summary	Existing	Proposed	Savings	\$ Savings
kWh/yr				\$0
kW				
MMBtu/yr			10	\$148
kGal/yr	210	83	127	\$1,405
Total				\$1,553

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 (°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	Fixture Type	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	Flushes/Day, Min/Day	(gpf, gpm)		(gal/yr)	(gal/yr)	(gal/yr)	(MMBtu/yr)	(\$/yr)	(\$/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 Applicable Fuel Usage - (Net Applicable Fuel Usage x (Current Fuel-to-Heat Efficiency/Proposed Fuel-to-Heat Efficiency))



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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 MEASURES	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	Thermal Energy		Total \$/yr	COST PER FT PER YR	
					MMBtu/yr	\$/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

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%	

Summary	Existing	Proposed	Savings	\$ Savings
kWh/yr				\$0
kW				
MMBtu/yr			25.2	\$319
kGal/yr	333	192	141	\$1,554
Total				\$1,873

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 (°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	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	Estimated Min/Day	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



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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

OUTPUT

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

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 MEASURES	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	Thermal Energy		Total \$/yr	COST PER FT PER YR	
					MMBtu/yr	\$/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			Output Ton- Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
					Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/ Heating Btu 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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency Ratio (EER)
 MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	Water Conservation
Date	February 1, 2009
District	Dover, NH
Building	Central Fire Station

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%

Summary	Existing	Proposed	Savings	\$ Savings
kWh/yr				\$0
kW				\$0
MMBtu/yr			3	\$51
kGal/yr	42	22	21	\$229
Total				\$280

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, (°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	Fixture Type	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 Flushes/Day	Estimated Min/Day	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

OUTPUT

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

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 MEASURES	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	Thermal 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			Output Ton- Hours or Oil Gallons	kWh Saved	Input Gallons Saved
					Existing Occupied	Existing Unoccupied	Cooling/Heati ng Btu 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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency Ratio (EER)
 MMBtu Saved = Output MMBtu / Boiler Efficiency

Title	Water Conservation
Date	February 10, 2009
District	Dover, NH
Building	South End Fire Station

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%

Summary	Existing	Proposed	Savings	\$ Savings
kWh/yr				\$0
kW				
MMBtu/yr			2	\$36
kGal/yr	19	10	9	\$99
Total				\$134

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, (°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	Fixture Type	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
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

OUTPUT

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

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 MEASURES	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	Thermal 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
RTVs	-	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			Output Ton- Hours or Oil Gallons	kWh Saved	Input Gallons Saved
					Existing Occupied	Existing Unoccupied	Cooling/ Heating Btu 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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency 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

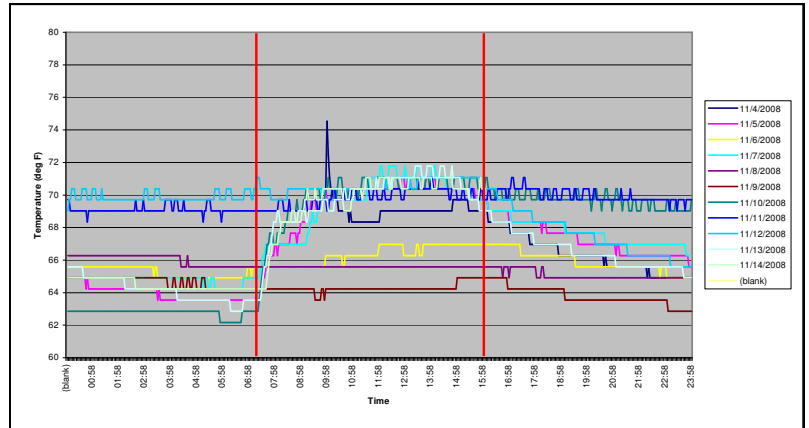
Input Variables

	Existing	Proposed
Summer Occupied Setpoint	74	74
Summer Unoccupied Setpoint	78	78
Winter Occupied Setpoint	70	70
Winter Unoccupied Setpoint	65	60
Building 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



Bin Temp				Existing Case				Proposed Case			
	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 = $(UA \times (\sum(OAT - \text{Occupied Setpoint}) \times \text{Occupied Hours} + \sum(OAT - \text{Unoccupied Setpoint}) \times \text{Unoccupied Hours})) / 10^6$ Infiltration Load MMBtu = $(1.08 \times \text{Infiltration CFM} \times (\sum(OAT - \text{Occupied Setpoint}) \times \text{Occupied Hours} + \sum(OAT - \text{Unoccupied Setpoint}) \times \text{Unoccupied Hours})) / 10^6$

Where

 $UA = 1/R\text{-Value of Wall} \times \text{Wall Area} + 1/R\text{-Value of Roof} \times \text{Roof Area}$

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

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%

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

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 (%)	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	Fixture Type	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		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	-	-	-	-	-	-



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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

OUTPUT

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

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

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 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 MEASURES	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	Thermal Energy		Total \$/yr	COST PER FT PER YR	
					MMBtu/yr	\$/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

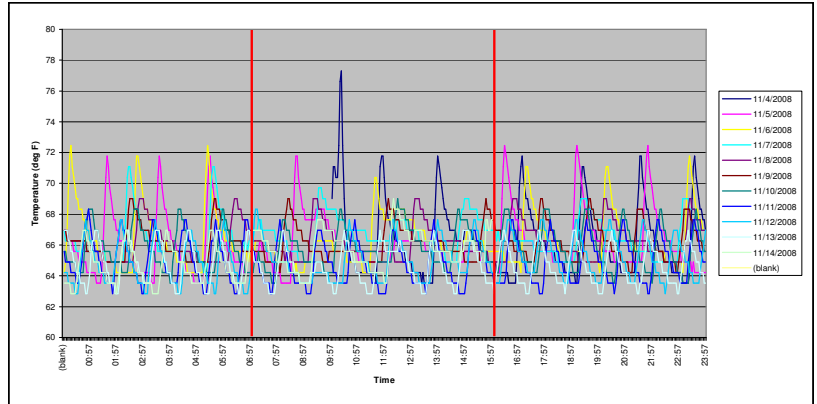
Input Variables

	Existing	Proposed
Summer Occupied Setpoint	74	74
Summer Unoccupied Setpoint	78	78
Winter Occupied Setpoint	66	66
Winter Unoccupied Setpoint	66	60
Building 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



Bin Temp				Existing Case				Proposed Case			
	Hours		Total Hours	Envelope	Infiltration	Cooling kWh	Heating MMBtu	Envelope	Infiltration	Cooling kWh	Heating MMBtu
	Unoccupied	Occupied		Loss/Gain MMBtu	Loss/Gain MMBtu			Loss/Gain MMBtu	Loss/Gain 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 = $(UA \times (\sum(OAT - \text{Occupied Setpoint}) \times \text{Occupied Hours} + \sum(OAT - \text{Unoccupied Setpoint}) \times \text{Unoccupied Hours})) / 10^6$ Infiltration Load MMBtu = $(1.08 \times \text{Infiltration CFM} \times (\sum(OAT - \text{Occupied Setpoint}) \times \text{Occupied Hours} + \sum(OAT - \text{Unoccupied Setpoint}) \times \text{Unoccupied Hours})) / 10^6$

Where

UA = $1/R\text{-Value of Wall} \times \text{Wall Area} + 1/R\text{-Value of Roof} \times \text{Roof Area}$ Infiltration CFM = $\text{Building Area} \times 10 \text{ Feet Average Height} \times \text{Building Air Changes Per Hour} / 60$ Cooling kWh = $(\text{Envelope} + \text{Infiltration Load}) \times 10^6 / 12000 \times \text{kW/Ton Cooling Efficiency (Loads for Hours above Balance Point only)}$ Heating MMBtu = $(\text{Envelope} + \text{Infiltration Load}) / \text{Heating Efficiency (Loads for Hours below Balance Point only)}$



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

OUTPUT

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

Monday

Unoccupied

Tuesday

Occupied

Wednesday

Unoccupied

Thursday

Occupied

Friday

Unoccupied

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

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 MEASURES	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	Thermal Energy		Total \$/yr	COST PER FT PER YR	
					MMBtu/yr	\$/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
RTVs	-	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			Output Ton-Hours or Gas MMBtu	kWh Saved	Input MMBtu Saved
Cooling					Existing Occupied Btu saved	Existing Unoccupied Btu saved	Cooling/Heating Btu saved			
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 Infiltration (CFM) Summer/Winter x delta T x Bin Occupied Hours x Correction Factor
 Existing Unoccupied Btu Saved = 1.08 x Infiltration (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 Efficiency 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

OUTPUT

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

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 MEASURES	Electricity Savings			Thermal		Water		Total Savings
		kW	kWh/yr	\$/yr	MMBtu/yr	\$/yr	kgal/yr	\$/yr	\$/yr
FIM 4	Energy Management System -Upgrades								
FIM 4.5	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	Thermal 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

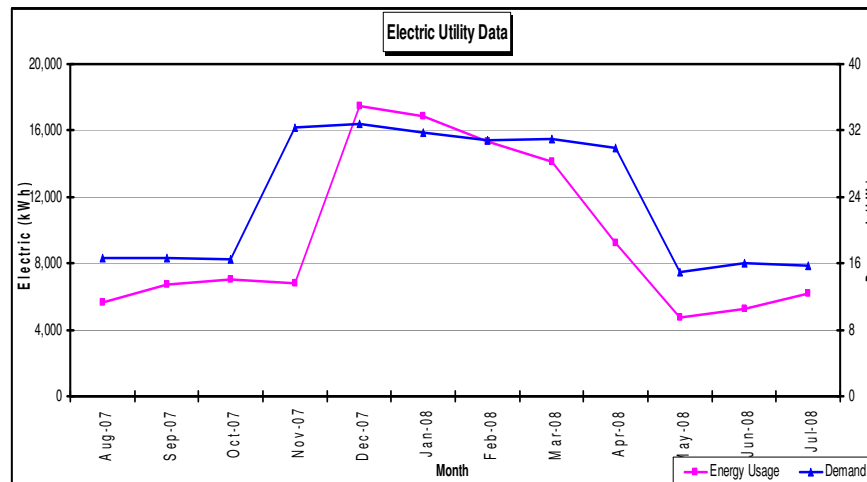
Summary	Existing	Proposed	Savings	\$ Savings
kWh/yr			19,905	\$ 2,430
kW				
MMBtu/yr				

\$/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.

**Proposed System:**

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
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

assumed



Appendix 4

Outline Specifications for All Equipment





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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 life¹. The longest lasting Marathon® Compact Fluorescent
- The 14W Universal has 12,000 hours rated average life¹

► Energy Savings

Saves up to 75% in electricity costs compared to standard incandescent lamps

► Featuring ALTO® Lamp Technology

Low mercury and TCLP²-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.



PHILIPS

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
13077-3	Universal SLS 20 ALTO	120	20	75A19	Med	2700	82	1200	5.6	15,000	285	.50-.60	-22F/-30C	60F/140F
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
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
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.

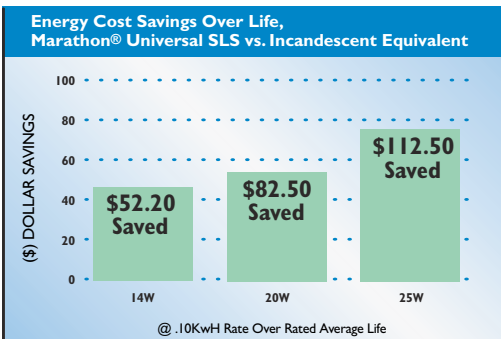
2) Average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Use in recessed cans or totally enclosed indoor fixtures could result in reduced lamp life.

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 wattage(s).

• This product utilizes ALTO® Lamp Technology.



Lamp Dimensions

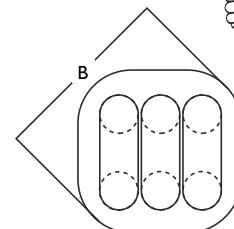
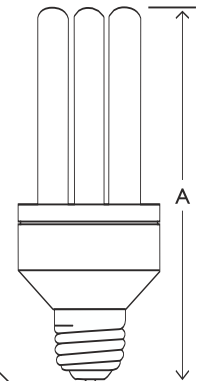
	SLS 14	SLS 20	SLS 25
MOL A	4.9"	5.6"	6.2"
Max. Diameter B	2.3"	2.3"	2.3"
Weight	3.6 oz.	3.9 oz.	4.2 oz.
Lamp Harp Fit	7"	8"	9"

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.





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

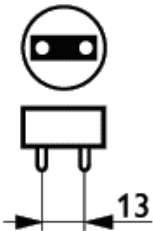
- Rated average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Lamp life is appreciably longer if lamps are started less frequently. (202)
- Average life under engineering data with lamps turned off and restarted once every 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

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



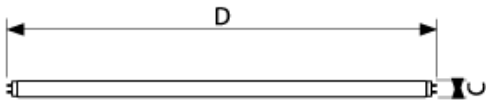
F-T8-Adv Med Bipin/GB



Base Medium Bi-Pin

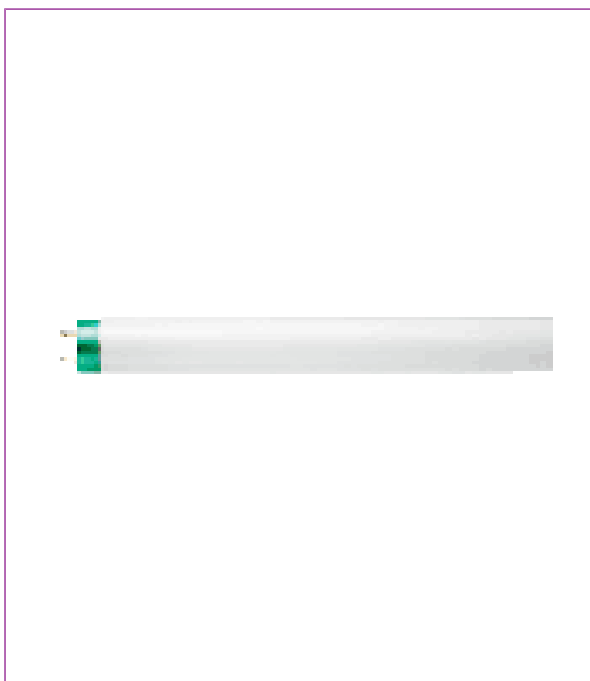


Energy Saving Energy Saving



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 maintenance; 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.

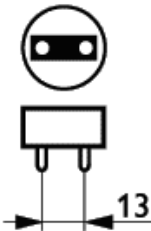
Notes

- 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)

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



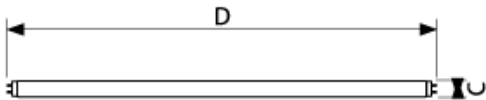
F-T8-ISA Med Bipin/GB



Base Medium Bi-Pin

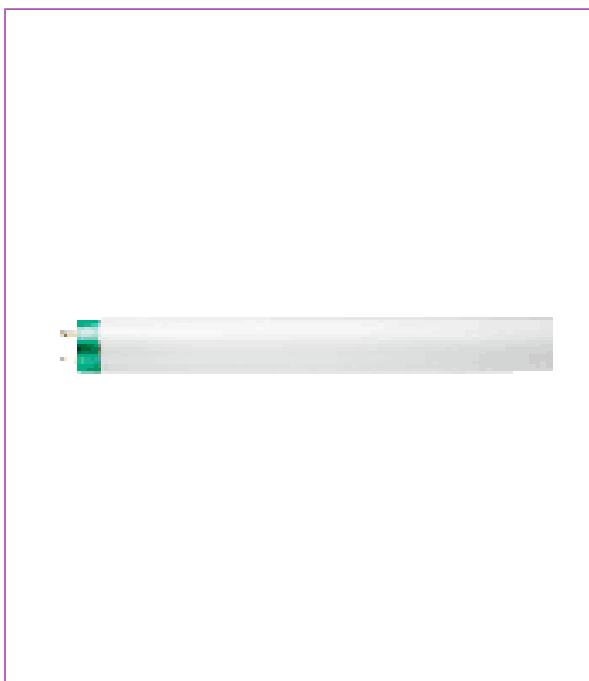


Energy Saving Product Energy Saving



F-T8-ISA Med Bipin





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 without burn-in.

Applications

- Ideal for T8 applications requiring maximum light output and long life. Ideal for light harvesting.

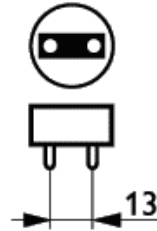
Notes

- 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)
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- 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	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



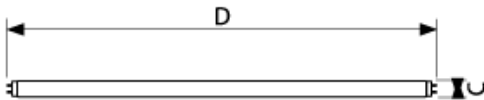
F-T8-Adv Med Bipin/GB



Base Medium Bi-Pin



Energy Saving Product Energy Saving



F-T8-Adv Med Bipin



MarathonTM

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



PHILIPS

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. Q ty.	Color Temp (Kelvin)	CRI	Approx. Initial Lumens	MO L (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 Q ty.	Case Weight (lbs.)	Case Cube (cu. ft.)	Pallet Q ty.	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		15 = 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 wattage(s).

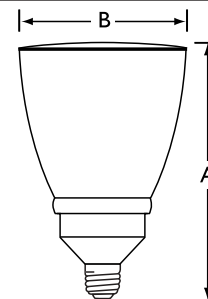
CAUTION: Risk of electric shock—do not use where directly exposed to water, rain or snow. Do not use with dimmers.
For dimming circuits use Marathon R30 or R40 Dimmable Flood.

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.

Lamp Dimensions

SLS/R30	SLS/R30 15	SLS/R30 20
MO L 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
MO L 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





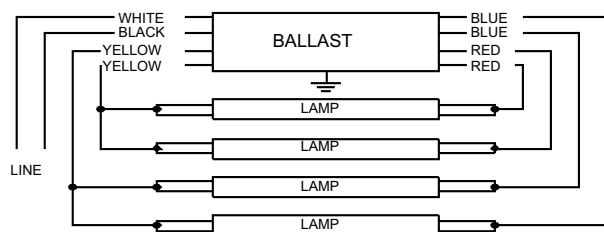
IOP4P32LWSC@120V

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

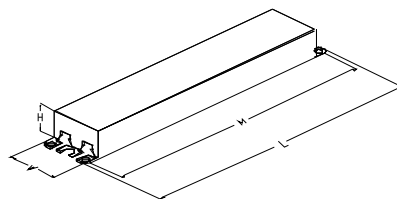


Diag. 66

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



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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

Revised 08/03/2005



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O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD

ROSEMONT, ILLINOIS 60018

TELEPHONE: (847) 390-5000 FAX: (847) 390-5109

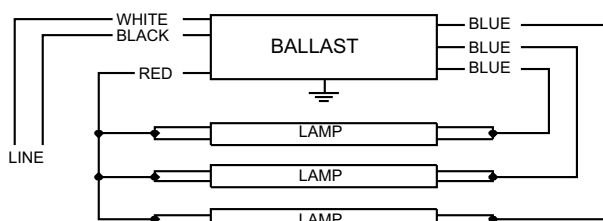


Electrical Specifications

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

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

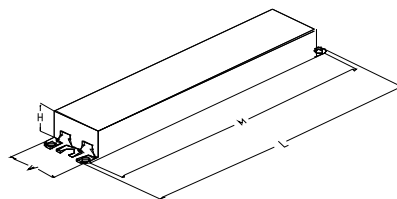


Diag. 65

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

Revised 08/03/2005



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Corporate Offices: Phone: 800-322-2086



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.
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 - 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).

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

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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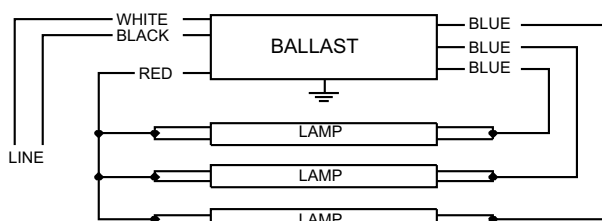
Electrical Specifications

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

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

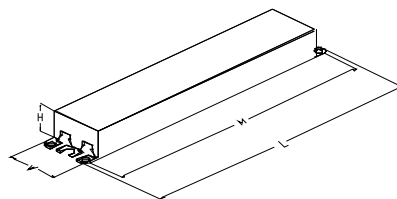


Diag. 65

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

Revised 08/03/2005



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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.
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 - 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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ADVANCE TRANSFORMER CO.
O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD
ROSEMONT, ILLINOIS 60018
TELEPHONE: (847) 390-5000 FAX: (847) 390-5109



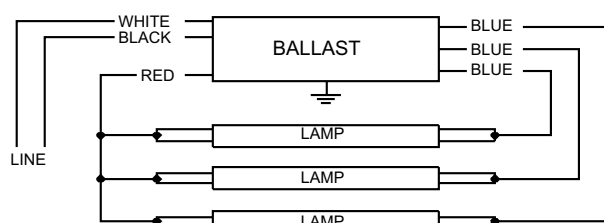
IOP3P32HL90CSC@120

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



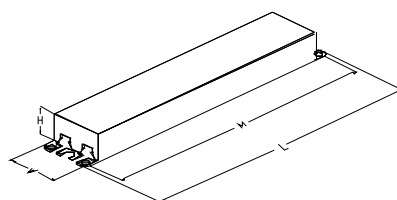
Diag. 65

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.		in.	cm.
Black	25	63.5	Yellow/Blue		0
White	25	63.5	Blue/White		0
Blue	31	78.7	Brown		0
Red	37	94	Orange		0
Yellow		0	Orange/Black		0
Gray		0	Black/White		0
Violet		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

Revised 08/23/2006



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Corporate Offices: Phone: 800-322-2086



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

Revised 08/23/2006



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O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD

ROSEMONT, ILLINOIS 60018

TELEPHONE: (847) 390-5000 FAX: (847) 390-5109

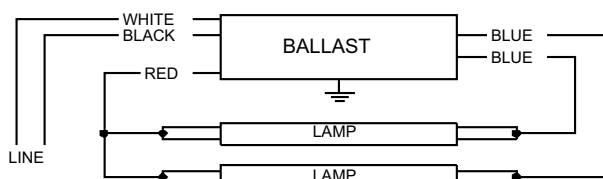


Electrical Specifications

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

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

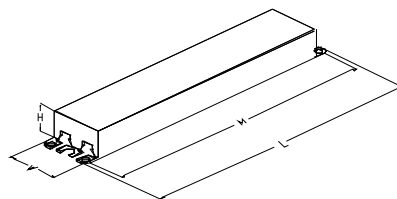


Diag. 64

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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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



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).

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

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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ADVANCE TRANSFORMER CO.
O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD
ROSEMONT, ILLINOIS 60018
TELEPHONE: (847) 390-5000 FAX: (847) 390-5109



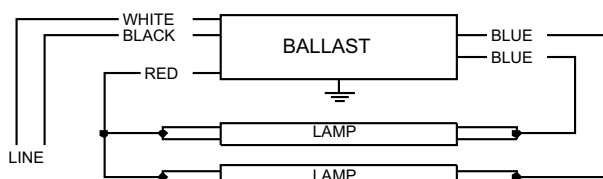
Electrical Specifications

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

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

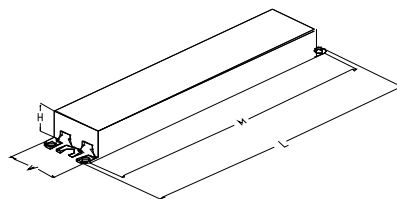


Diag. 64

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



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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



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

Revised 08/03/2005



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ADVANCE TRANSFORMER CO.

O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD

ROSEMONT, ILLINOIS 60018

TELEPHONE: (847) 390-5000 FAX: (847) 390-5109

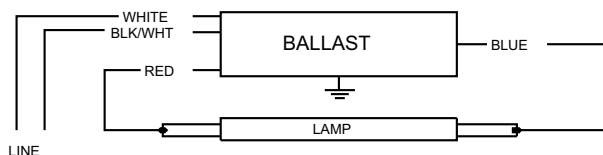


Electrical Specifications

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

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

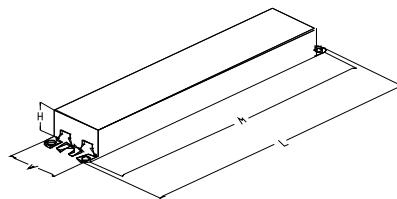


Diag. 63

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

Revised 08/02/2005



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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



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

Revised 08/02/2005



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ADVANCE TRANSFORMER CO.

O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD

ROSEMONT, ILLINOIS 60018

TELEPHONE: (847) 390-5000 FAX: (847) 390-5109



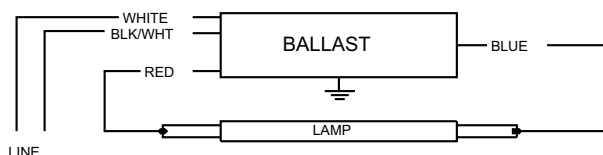
Electrical Specifications

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

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

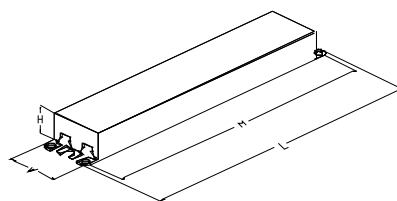


Diag. 63

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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ADVANCE

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Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071

Corporate Offices: Phone: 800-322-2086



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

Revised 08/23/2006



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ADVANCE TRANSFORMER CO.

O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD

ROSEMONT, ILLINOIS 60018

TELEPHONE: (847) 390-5000 FAX: (847) 390-5109

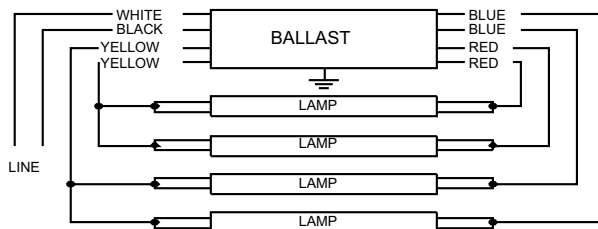


Electrical Specifications

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

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

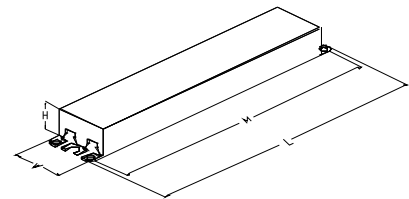
Wiring Diagram



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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Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071

Corporate Offices: Phone: 800-322-2086



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).

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

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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O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD

ROSEMONT, ILLINOIS 60018

TELEPHONE: (847) 390-5000 FAX: (847) 390-5109

TECHNICAL DATA

TYPICAL APPLICATIONS

- Classrooms
- Large Storage Rooms
- Large Conference Rooms
- Hallways

SENSOR HIGHLIGHTS

- Corner Mount Dual Technology
- 120° 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: 14° to 85° 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 -4° 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)

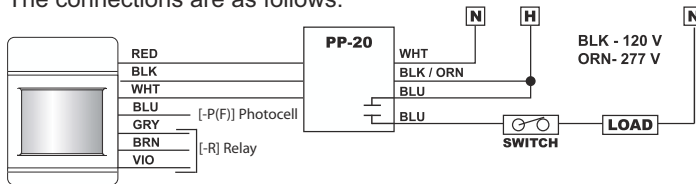
The *WV-PDT* offers two Photocell options for spaces with abundant natural light. It is ideal for public spaces with windows like vestibules, corridors, or bathrooms; however it is not recommended for work spaces where occupants set light levels manually. Each photocell option utilizes a set-point value 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:



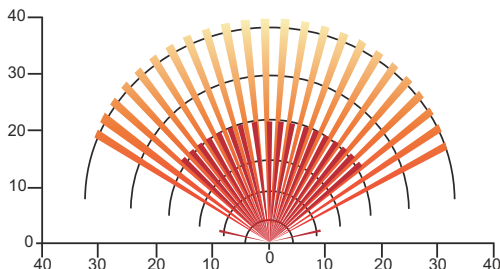
Do Not Wire Hot

INSTALLATION CONSIDERATION

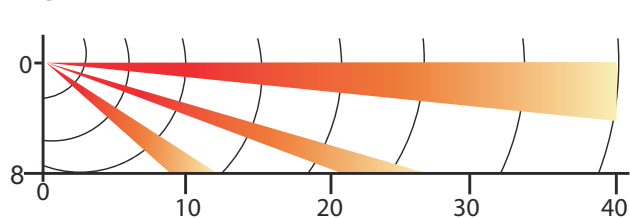
The WV-PDT's rear enclosure is beveled so as to be corner mounted at 8 to 10 feet (see tilt settings). Ideally, the sensor should mount, as shown below, in the corner above the entrance door or in the corner along the same wall as the entrance. If the room is large and multiple sensors are needed, mount 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 30° 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.



TOP VIEW



SIDE VIEW



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.



TILT ADJUSTMENT

Mt. Ht.	Position
7' - 8'	Vertical
8' - 9'	Center
9' - 10'	Forward
Above 10'	Use WV-BR



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.

sensorswitch

SENSOR SWITCH, INC.

900 Northrop Rd., Wallingford, CT 06492
(203) 265-2842 info@sensorswitch.com
www.sensorswitch.com

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TECHNICAL DATA

TYPICAL APPLICATIONS

- Classrooms w/o Obstructions
- Large Conference Rooms
- Large Open Spaces
- Hallways

SENSOR HIGHLIGHTS

- Corner Mount PIR Sensor
- 120° 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: 14° to 85° 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

WV-16 SERIES

WV-BR (Bracket)



Programmable Edition!

Able to fit in the palm of your hand, the *WV-16* Wide View Sensor unobtrusively amounts 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)

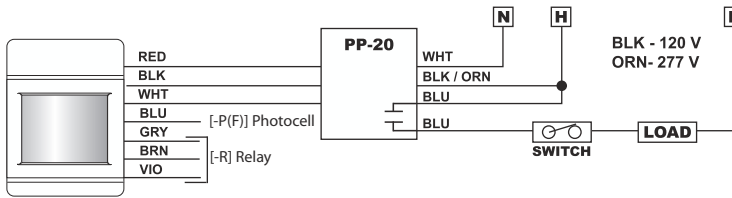
The *WV-16* offers two Photocell options for spaces with abundant natural light. It is ideal for public spaces with windows like vestibules, corridors, or bathrooms; however it is not recommended for work spaces where occupants set light levels manually. Each photocell option utilizes a set-point value 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

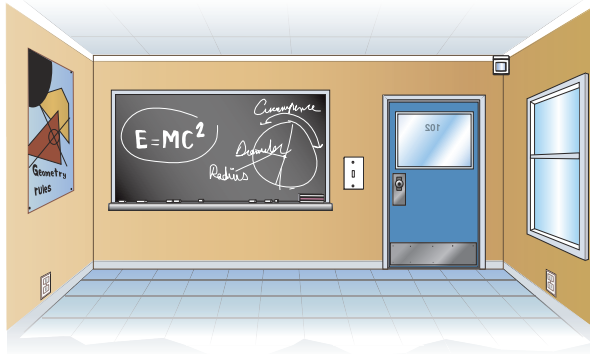
Wire lead connections are Class II, 18 to 22 AWG. The WV-16 uses 3 leads (Red, Black, and White); the Photocell options add a Blue lead, and the Relay Option adds 3 leads (Brown, Gray, and Violet). The connections are as follows:



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.



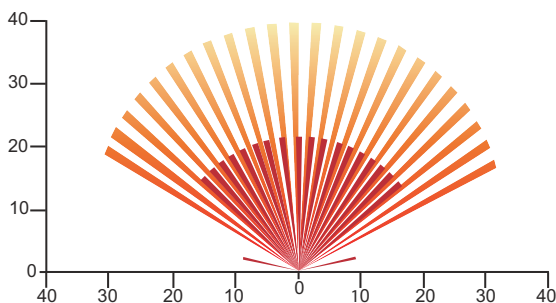
WV-BR

TILT ADJUSTMENT

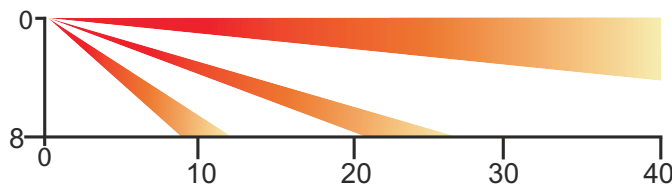
Mt. Ht.	Position
7' - 8'	Vertical
8' - 9'	Center
9' - 10'	Forward
Above 10'	Use WV-BR



TOP VIEW



SIDE VIEW



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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SENSOR SWITCH, INC.

900 Northrop Rd., Wallingford, CT 06492
(203) 265-2842 info@sensorswitch.com
www.sensorswitch.com

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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)

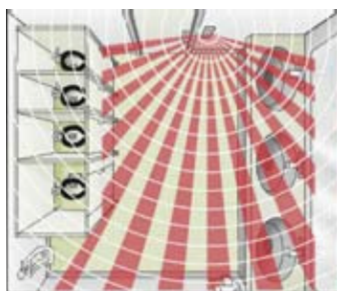
WSD-PDT Series Programmable Edition!

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.

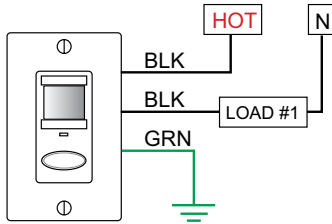
Model Numbering System: WSD-PDT-[LENS]-[PHOTOCELL]-[VOLTAGE]-[COLOR*]-[TEMP/HUMIDITY]

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

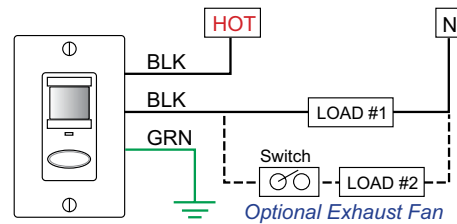
**347 VAC: Plate not provided

*Must specify color

T065-003-P

TYPICAL WIRING DIAGRAM (DO NOT WIRE HOT)


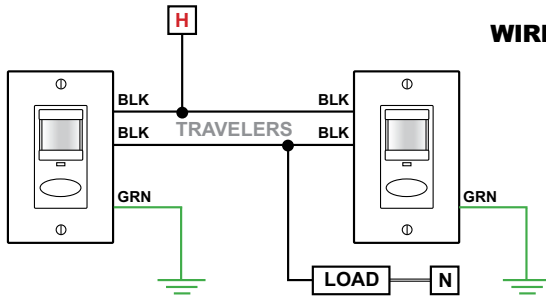
Note: Connection to Ground required for sensor to function!



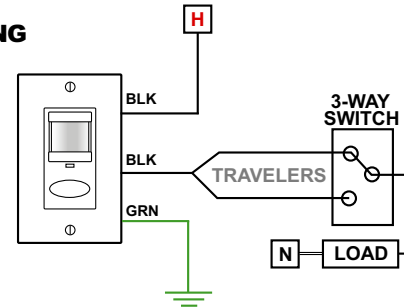
Note: Black wires are replaced with Red wires for 347 VAC.

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

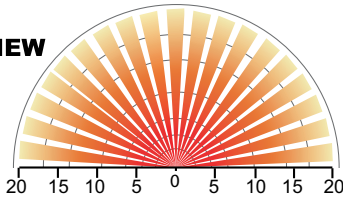
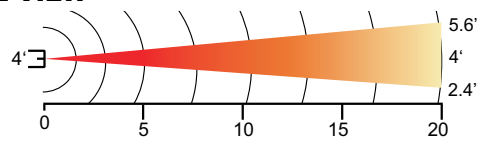
Travelers are used to wire sensors in parallel. If only one sensor is needed to view space, 3-way switch is non-functional.


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 Resistant* 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 : Puissance Maximales Des Lampes 1500 Watts, Type 347 VAC.

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

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.

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SENSOR SWITCH, INC.

900 Northrop Rd., Wallingford, CT 06492
(203) 265-2842 info@sensorswitch.com
www.sensorswitch.com

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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

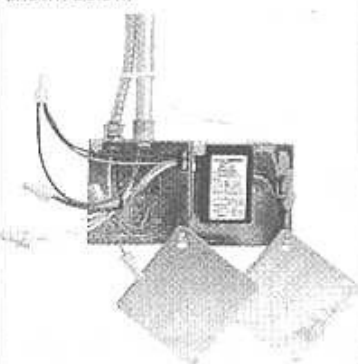
- Size: (1/2" inch chase nipple not inc.) MP-20 & MSP-20: 4 1/8" x 3" x 1 7/8"
- Mounting: 1/2" inch chase nipple
- Operating Voltage: 120, 240, or 277 VAC
- Each Relay: 20 Amps
- 1 HP Motor Load
- Output Voltage: 15 VDC, 150 mA
- Class II: 18 AWG, up to 2,000 ft.
- Plenum Rated
- Relative Humidity: 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)

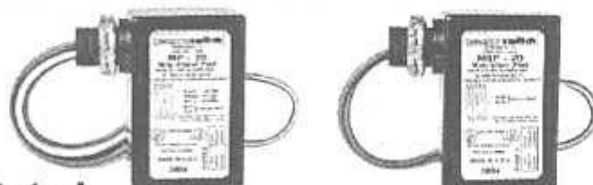
- Conformally Coated PCB
- Operates down to -40° F
- Corrosion resistant from moisture

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 transformer 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

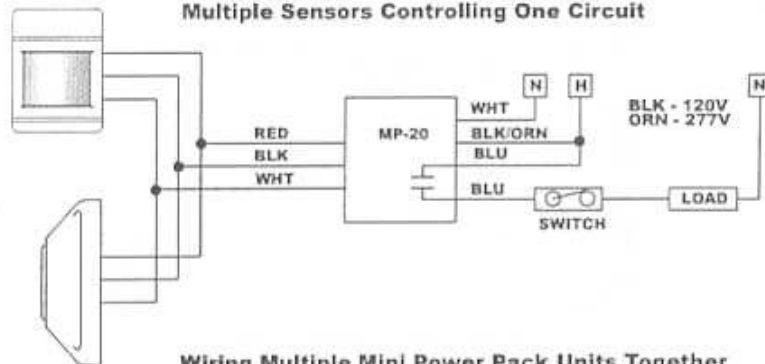
MODEL#	DESCRIPTION	OUTPUT VOLTAGE	OUTPUT CURRENT
MP-20	Power Pack with 20 Amp Relays	15 to 24 VDC	70 to 110 mA
MSP-20	Slave Pack with 20 Amp Relays	N/A	40 mA(consumption)

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

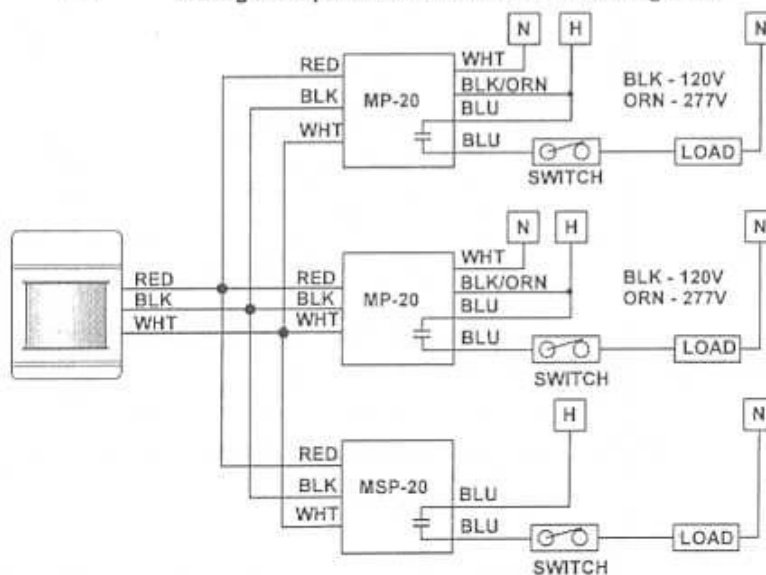
TYPICAL WIRING DIAGRAMS - DO NOT WIRE HOT

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.

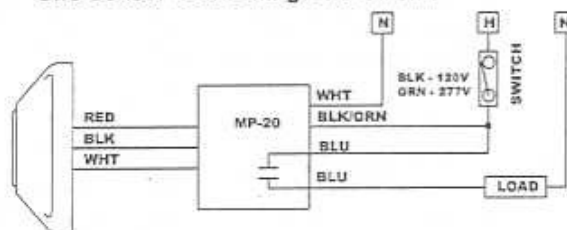
Multiple Sensors Controlling One Circuit



Wiring Multiple Mini Power Pack Units Together



One Sensor Controlling One Circuit



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SENSOR SWITCH, INC.
900 Northrop Rd., Wallingford, CT 06492
(203) 265-2842 info@sensorswitch.com
www.sensorswitch.com

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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: 14° to 160° F (-10° to 29° C)
- Storage Temp: -14° to 160° 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 -40° F (-40° C)

HW-13 SERIES

Programmable Edition!



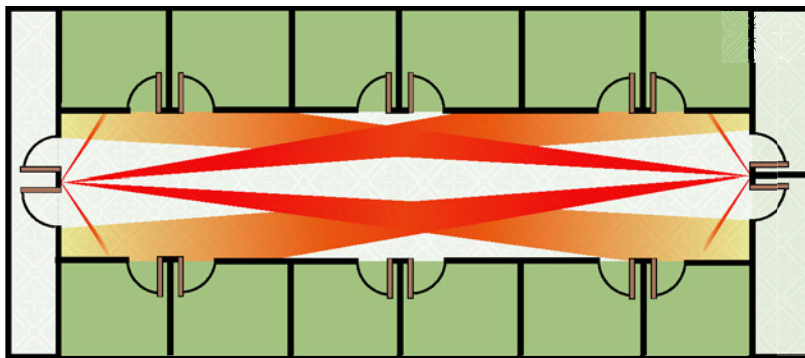
Long narrow Passive Infrared (PIR) detection is provided by the *HW-13* for control of Hallway lighting. Typically mounted at either end of a long corridor, the *HW-13* detects occupants entering the hallway up to 130 feet away. Detection at these distances is for entrances at right angles to the beam 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.

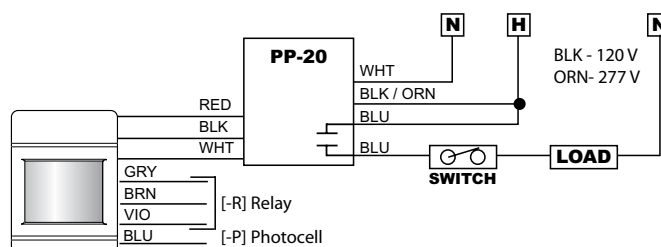
STANDARD HW-13

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)

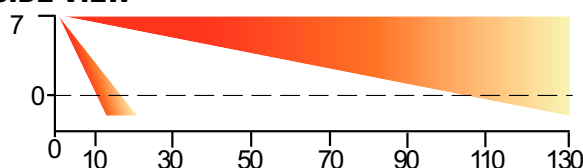
The WV-BR Ceiling Mount Bracket allows the HW-13 to be ceiling mounted for conditions where mounting to the wall is not possible. **Note:** View shown is when the sensor is installed fully vertically. Tilting will aim view pattern down.



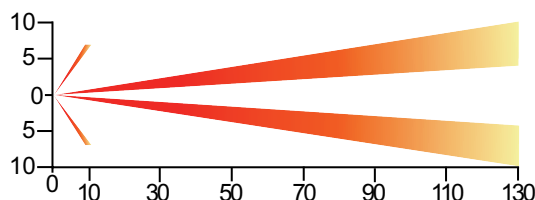
FIELD OF VIEW vs. TILT ADJUSTMENT

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 forward.

SIDE VIEW



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.

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SENSOR SWITCH, INC.

900 Northrop Rd., Wallingford, CT 06492
(203) 265-2842 info@sensorswitch.com
www.sensorswitch.com

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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)

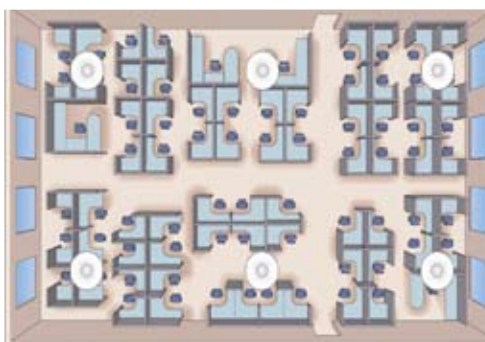
- Conformally coated Circuit Board is corrosion resistant from moisture
- Operates down to -4° F (-20° C)

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

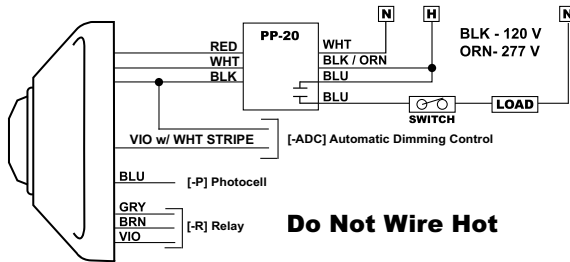
Wire lead connections are Class II, 18 to 22 AWG.

STANDARD CM-9

RED - 12 to 24 VAC/VDC

BLACK - Common

WHITE - Output (HI DC for Occupancy)



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.

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

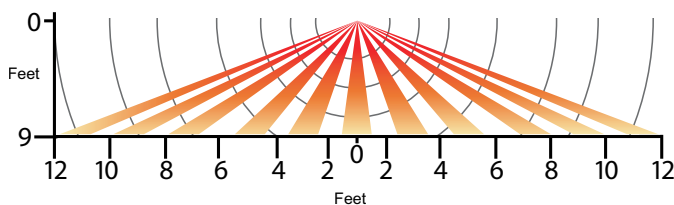
The CM-PDT is provided with 2 self tapping mounting screws. The sensor typically mounts directly to the ceiling tile, or to the metallic grid. However, if desired, the mounting holes are slotted to line up with a standard round or rectangular box (screws not provided).

Note: The ceiling tile provides insulation from stray plenum noises. Only penetrate tile to allow for mounting screws and wires (3 small holes).

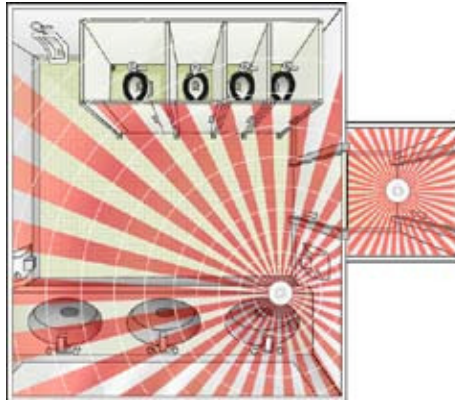
FIELD OF VIEW

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



Multi-Stall Restroom w/Vestibule

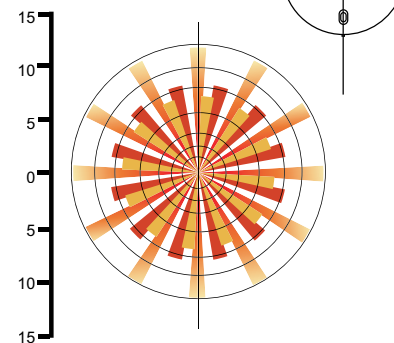


PIR used with PDT

- 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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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: 14° to 160° F (-10° to 71° C)
- Storage Temp: -14° to 160° 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 -40° F(-40° 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

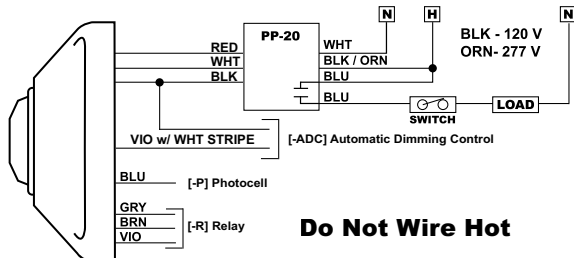
Wire lead connections are Class II, 18 to 22 AWG.

STANDARD CM-9

RED - 12 to 24 VAC/VDC

BLACK - Common

WHITE - Output (HI DC for Occupancy)



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)

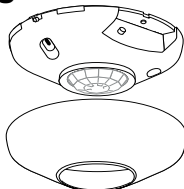
Use Blue wire from sensor in place of White wire. For multi-level control, use 2 Power Packs and connect White to primary load and Blue to daylight load.

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.)

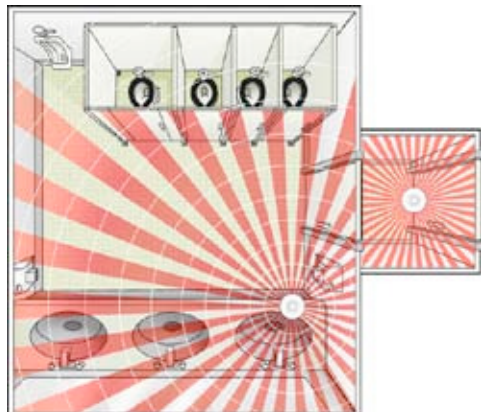
MOUNTING CONSIDERATIONS

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).



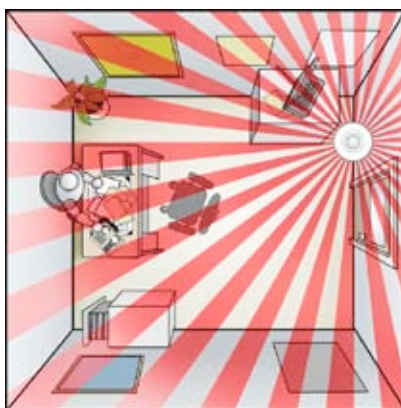
INSTALLATION CONSIDERATION

In smaller spaces like 12' x 12' (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 initial 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

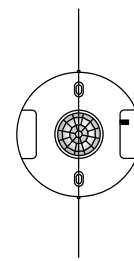


Small Office

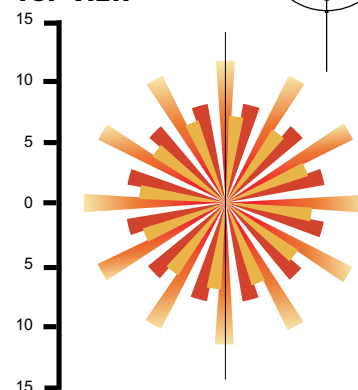
- Mount sensor near entrance wall viewing entire room without seeing out doorway
- Low Voltage sensors provide easiest installation in drop Ceilings.

Note: For maximum distance place the sensor so that the screw axis is aligned with the entrance axis.

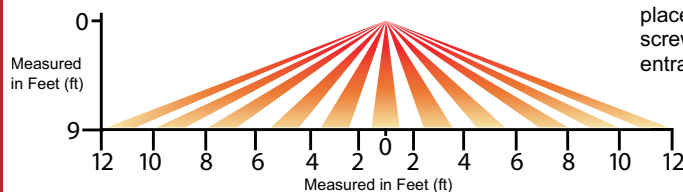
Note: Heat producing sources controlled by the sensor must not be in the view pattern of the sensor. Symptom: Sensor cycles or appears to continually stay "On". Solution: Move sensor or mask lens segments that view the source.



TOP VIEW



SIDE VIEW



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TECHNICAL DATA

TYPICAL APPLICATIONS

- High Mounting (15-45ft)
- Warehouse
- Gymnasiums
- Racquetball Courts

SENSOR HIGHLIGHTS

- Ceiling Mount PIR Sensor
- 360° 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: 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

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

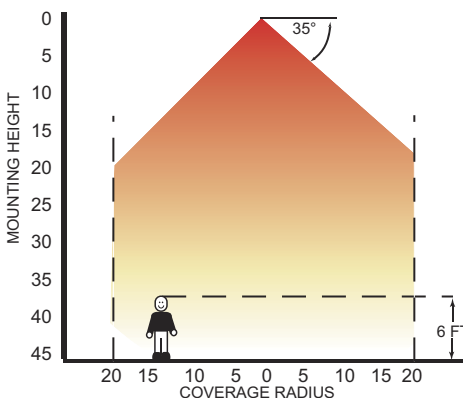
The CM-6 typically operates with a PP-20 or MP-20 Power Pack. However, this unique sensor accepts 12 to 24 volts AC or DC (Red & Black wires), and outputs the DC component (White wire). When occupancy is detected, the output goes high and can drive up to a 200 mA of connected load. When used with the 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

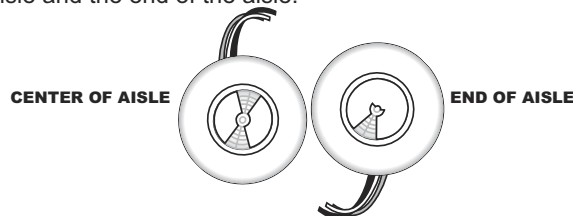
VIOLET-During Occupancy Contacts Open

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

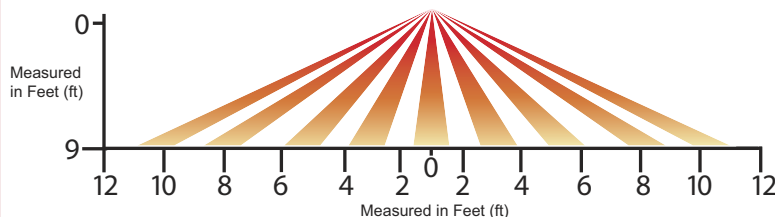
The sensor views a 360° circular pattern. The kit provided may be used to mask off half of the viewing for end of aisle, or trim the side viewing to create a rectangular pattern for center of aisle. Shown below is the masking for the center of aisle and the end of the aisle.



FIELD OF VIEW

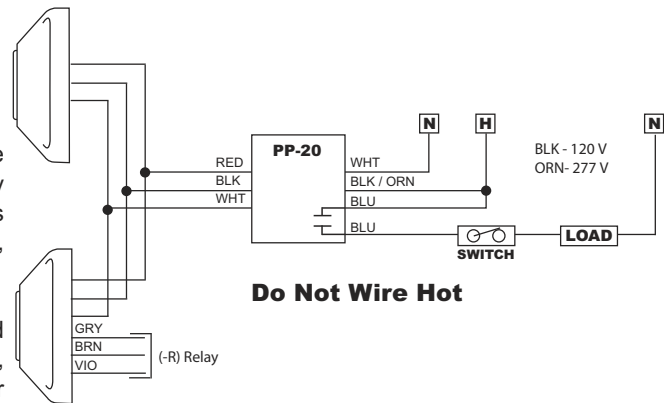
The CM-6 lens views in 5 separate 360° cones shaped patterns. The outermost (fifth) cone viewing at a 54° angle is only effective up to a 12-15 foot mounting height and is therefore not typically considered in High Bay applications. The fourth cone views at a 45° angle and is effective up to 20 feet. 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



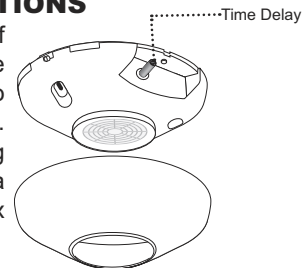
INPUT/OUTPUT

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:

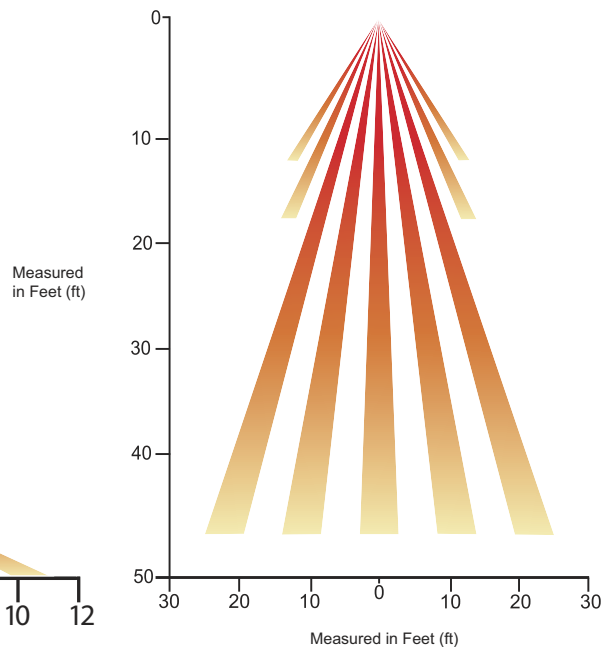


MOUNTING CONSIDERATIONS

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



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Appendix 4-3 Building Envelope Improvements



Q-LON® QDS 650 DOOR SEAL



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	97" (2.46m) 125 pcs./carton
82" (2.08m) 125 pcs./carton	120" (3.05m) 125 pcs./carton
86" (2.18m) 100 pcs./carton	144" (3.66m) 125 pcs./carton

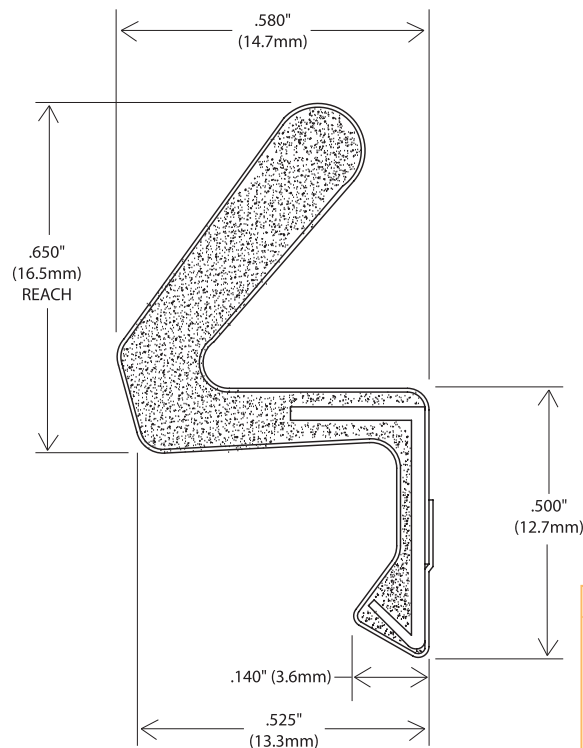
COLORS

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)



UP TO 90 MINUTES



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. stabilized, paint-resistant liner for kerf applications.

Schlegel®

QDS 650

LINEAL SHRINKAGE			COMPRESSION SET		
	%	Q-LON PERFORMANCE		%	Q-LON PERFORMANCE
Q-LON door seals	0.10	—	Q-LON door seals	5	—
Knock-off door seals	1.10	11.0 times better	Knock-off door seals	17	3.4 times better
TPE magnetic seals	0.40	4.0 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.

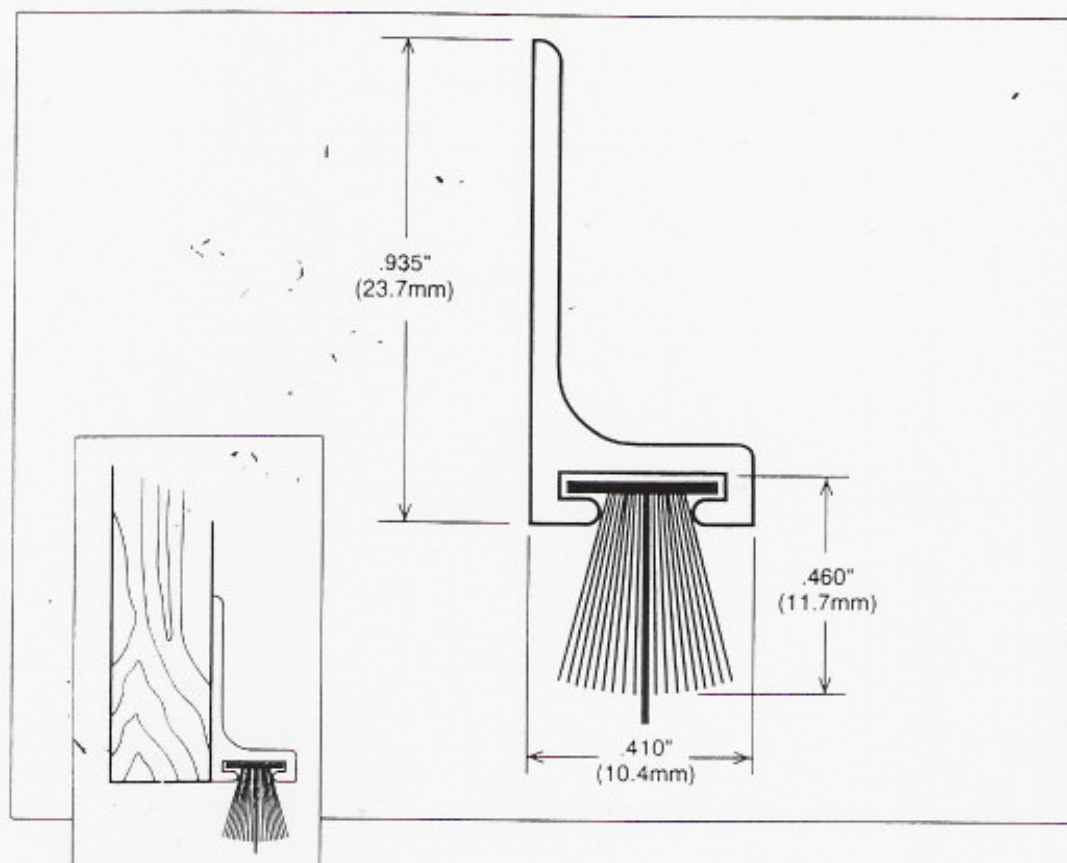
WATER ABSORPTION No visible effects in degradation; water absorption negligible after being submerged in water for 24 hours and then exposed to -30° F (-34° C) for one week. Compressed 50% upon removal from the freezer. (Tested at Schlegel Testing Laboratories.)



Schlegel 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

Applications: 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.



1-800-586-0354

Rapid Response Fax 1-716-427-9993

bpssproducts@schlegel.com

Q-LON® QFS 375 DOOR SEAL (ADHESIVE BACKED)



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, GVI, file #R14384.

STANDARD PACK

39" (.99m) 300 pcs./carton,
all others 150 pcs./carton.

COLORS

Black, white, bronze

COLOR/LENGTH

Black 39" (.99m)

Black 86" (2.18m)

White 39" (.99m)

White 86" (2.18m)

Bronze 39" (.99m)

Bronze 86" (2.18m)

PART NO.

U9862T03900

U9862T08600

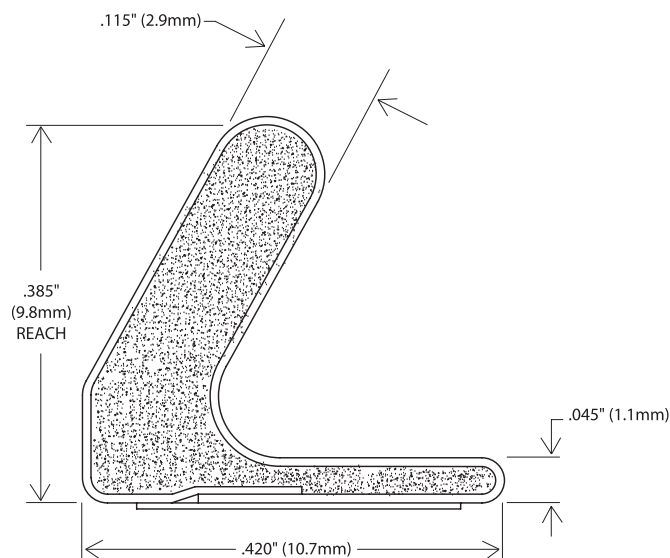
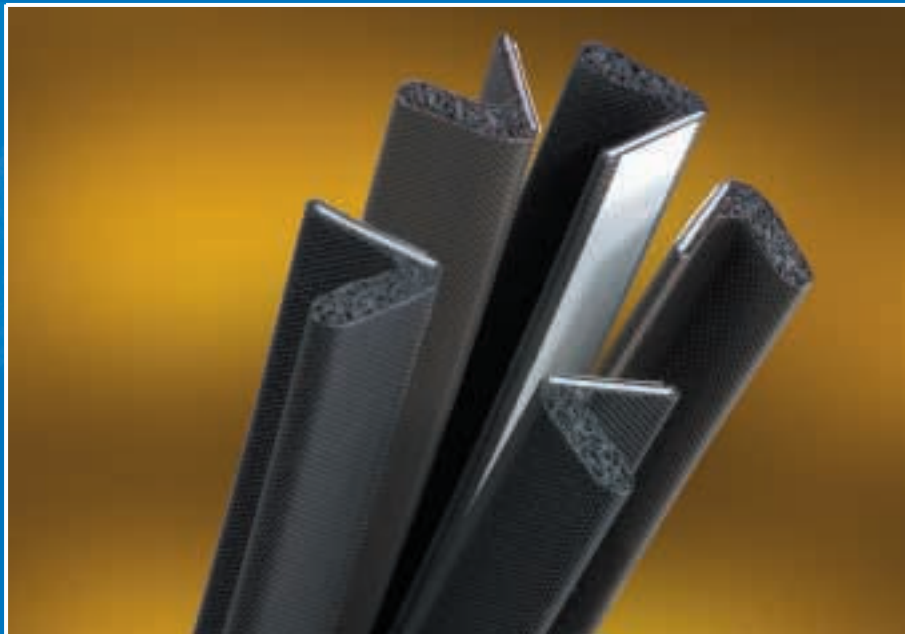
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U9864T03900

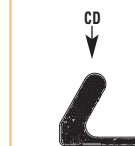
U9864T08600

NOTE: Other lengths available upon request.
Tolerance +/- 1" (25.4mm)



UP TO 3 HOURS

CD=COMPRESSION DIRECTION



ACTUAL SIZE

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. stabilized, paint-resistant liner for kerfless applications.

Schlegel®

QFS 375

	LINEAL SHRINKAGE			COMPRESSION SET	
	%	Q-LON PERFORMANCE		%	Q-LON PERFORMANCE
Q-LON door seals	0.10	—	Q-LON door seals	5	—
Knock-off door seals	1.10	11.0 times better	Knock-off door seals	17	3.4 times better
TPE magnetic seals	0.40	4.0 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.)



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Appendix 4-4 Energy Management System – Upgrades





FIELD-SELECTABLE
4-20mA/0-10VDC OUTPUT

3 Year
Warranty

CDE



Compact duct unit

CWE



CO₂ with optional resistive
temperature output in a compact wall unit

Economy Wall and Duct CO₂ Sensors

The CDE/CWE are non-dispersive infrared (NDIR) analyzers designed for measuring environmental CO₂ 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 $\pm 1\%$ 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 $\pm 5\%$ of measured value
Repeatability	± 20 ppm $\pm 1\%$ 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).

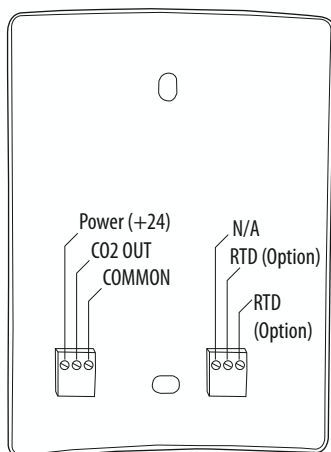
NEW! All Products Meet CE Requirements



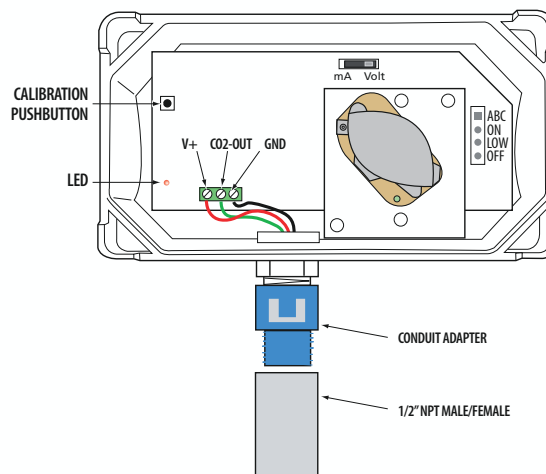


APPLICATION/WIRING DIAGRAMS

CWE Wall Mount

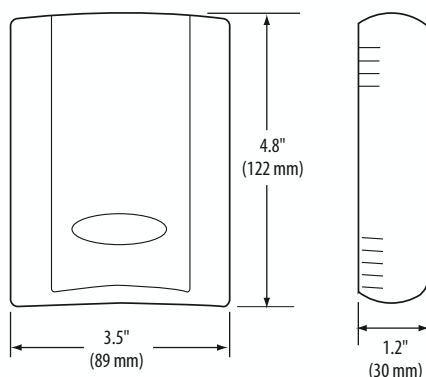


CDE Duct Mount

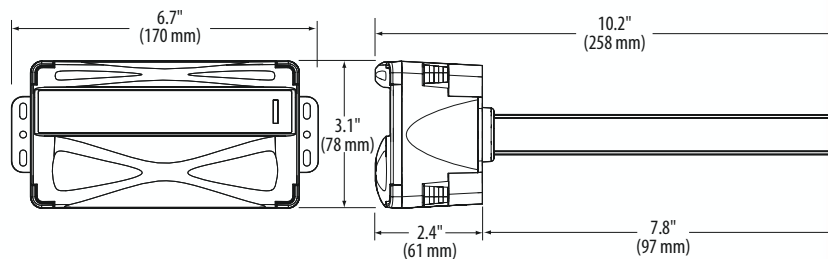


DIMENSIONAL DRAWINGS

CWE Wall Mount



CDE Duct Mount



ORDERING INFORMATION



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:
CWE 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

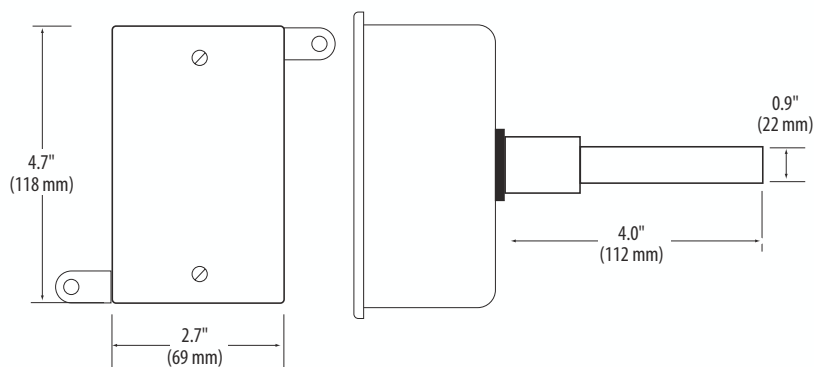
Wiring	22AWG; 2-wire:RTD/Thermistor, 4-20mA; 3-wire: Voltage output models
Junction Box	Weatherproof
<i>Transmitter:</i>	
Input Power	4-20mA version - Loop powered 12-30VDC only, 30mA max; 0-5/0-10V versions - 12-30VDC/24VAC, 15mA max
Temp Output	2-wire, loop powered 4-20mA; 3-wire, 0-5V/0-10VDC
Sensor Type	Solid-state, integrated circuit (Transmitter)
Accuracy	$\pm 0.5^{\circ}\text{C}$ ($\pm 1^{\circ}\text{F}$) typical
Ranges	0° to 50°C (32° to 122°F), -40° to 50°C (-40° to 122°F)
<i>Linitemp:</i>	
Input Power	5 to 30VDC
Output	$1\mu\text{A}/^{\circ}\text{C}$ or $10\text{mV}/^{\circ}\text{C}$
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	
Temp. Response*	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	
	PTC	PTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	NTC	

*PTC: Positive Temperature Coefficient

*NTC: Negative Temperature Coefficient

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

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

ORDERING INFORMATION

RTD/Thermistor Models

Sensor Type	Output	Cal Certificate
TO ☐	☐ R0	☐
B = 100R Platinum, RTD	= Resistive Output	0 = None
C = 1k Platinum, RTD		1 = 1 point Cal validation
D = 10k T2, Thermistor		2 = 2 point Cal validation
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		

Example:

TO C R0 2

Temperature Transmitter Models



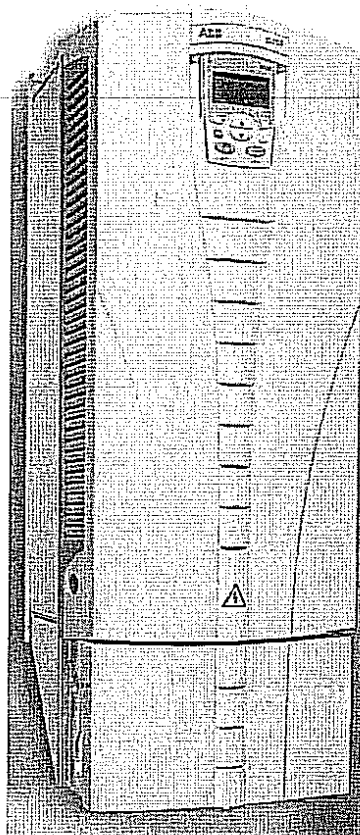
Output	Range	Cal Certificate
TOA ☐	☐	☐
M = 4-20mA	1 = -40 to 50°C	0 = None
V = 0-5/0-10VDC	(-40° to 122°F)	1 = 1 point Cal validation
	2 = 0° to 50°C	2 = 2 point Cal validation
	(32° to 122°F)	

Example:

TOA M 1 0

NOTE: For 4-20mA transmitter output, order any TO with the 100Ω platinum RTD and accessory AA10xx. See page 209.





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.





ACH550 HVAC AC DRIVES

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_rT)
- 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 (OHD1-01)
- 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



ACH550 HVAC AC DRIVES

SPECIFICATIONS

Input Connection

Input Voltage (U _i)	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 _i , V _i , W _i (U _i , V _i , 1-phase)

Output (Motor) Connection

Output Voltage:	0 to U _i , 3-phase symmetrical, U ₂ 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



ACH550 HVAC AC DRIVES

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 (I _{2t}):	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

U₁ = Input Voltage
U₂ = 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



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

INVERTER-DRIVEN COMPRESSOR TECHNOLOGY

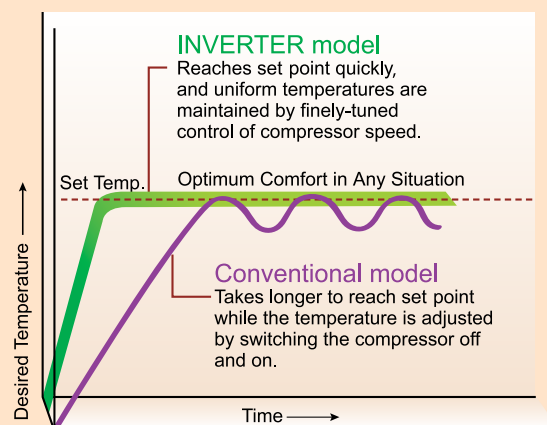
INVERTER Technology for Superior Year-round Comfort and Performance

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.

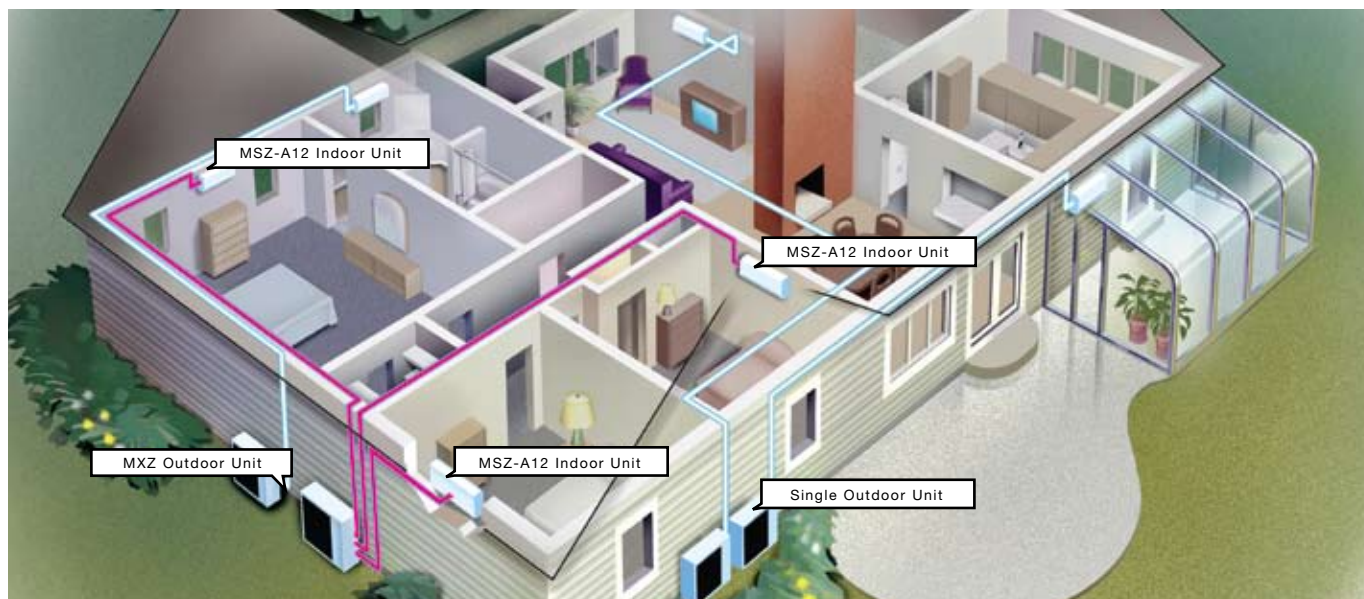
High-speed Performance When You Need It

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.



M-SERIES

RESIDENTIAL AND SELECT COMMERCIAL

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

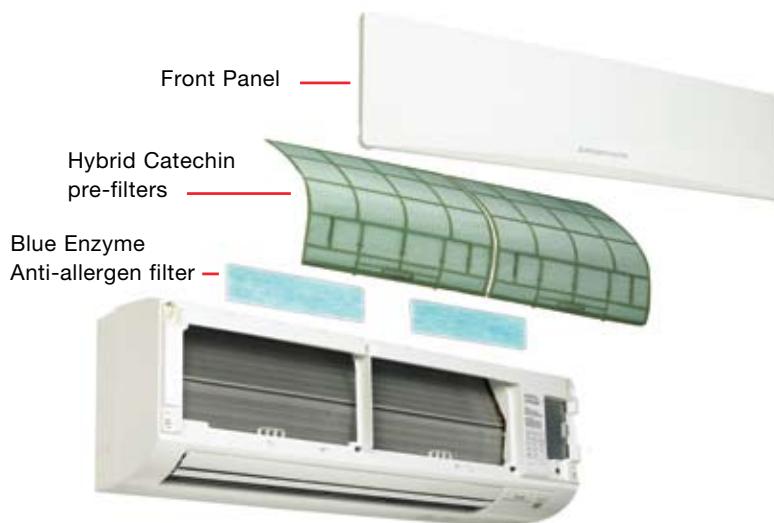
MSZ-FD09/12NA systems produce the highest ductless system ratings in the industry at **23 SEER** while being extremely quiet at a low 22dB(A) for the indoor unit.

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**.

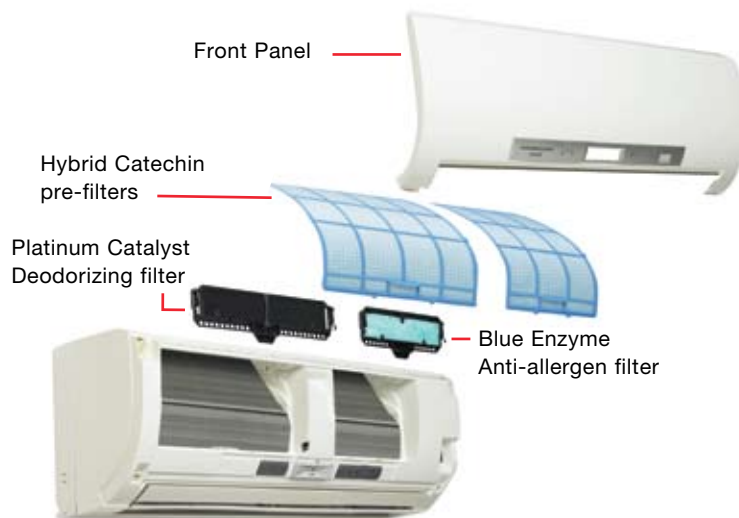
High Heat from Low Energy

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

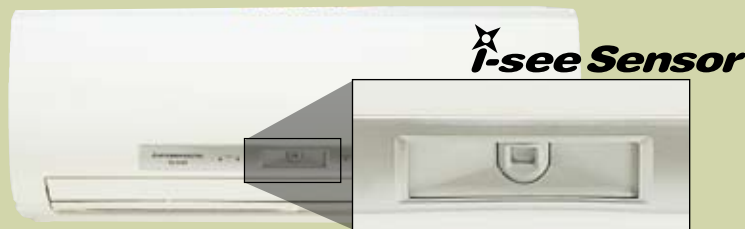
Do you hear that? No? You barely hear our systems because Mr. Slim indoor units operate with nearly a whisper of sound. A police siren, for example, has a sound level of 118 decibels; a circular saw produces 107 decibels of sound. A vacuum cleaner in your home creates 74 decibels of noise. Even a library environment is at 33 decibels while a whisper-tone voice produces 35 decibels. Certain Mr. Slim units operate 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 mitsubishiiv.com for details.



(MS-A12WA MODEL SHOWN)

MS/MSY COOLING-ONLY

M-SERIES Specifications



INVERTER



NON-INVERTER

Model Name	Indoor Unit		MS-A09WA	MS-A12WA
	Outdoor Unit		MU-A09WA	MU-A12WA
Cooling *1	Rated Capacity	Btu/h	9,500	12,000
	Capacity Range	Btu/h	-	-
	Total Input	W	870	1,070
	Energy Efficiency	SEER	13	
	Moisture Removal	Pints/h	2.7	3.2
Sensible Heat Factor			0.68	0.70
Power Supply	Phase, Cycle, Voltage		1 Phase, 60Hz, 115V *2	
Voltage	Indoor - Outdoor L1 N / S1-S2		AC 115V	
	Indoor - Outdoor L2 / S2-S3		AC 115V	
	Indoor - Remote Controller		Wireless Type	
Indoor Unit	MCA	A	1.2	
	Fan Motor	F.L.A.	0.95	
	Airflow (Lo-Med-Hi)	DRY (CFM)	183-261-335	222-286-406
		WET (CFM)	162-233-300	198-254-363
	Sound Pressure Level (Lo-Med-Hi)	dB(A)	26-32-40	33-38-45
	External Finish Color		Munsell No. 1.0Y 9.2/0.2	
	Dimension Unit	W: In.	30-11/16	
		D: In.	8-1/4	
		H: In.	11-3/4	
	Weight Unit	Lbs.	23	
	Field Drainpipe Size O.D.	In.	5/8	
Outdoor Unit	MCA	A	14	16
	Max. Fuse Size	(Time Delay) A	15	20
	Fan Motor	F.L.A.	0.63	0.93
	Compressor	Model (Type)	Single Rotary	
		R.L.A.	9.3	10.82
		L.R.A.	47	56
	Airflow	CFM	1,083	1,327
	Refrigerant Control		Capillary Tube	
	Sound Pressure Level (Cooling) *1	dB(A)	47	52
	External Finish Color		Munsell No. 3Y 7.8/1.1	
	Dimensions	W: In.	31-1/2	33-7/16
		D: In.	11-1/4	11-7/16
		H: In.	21-5/8	23-13/16
	Weight	Lbs.	78	96
Remote Controller	Type		Wireless Remote	
Refrigerant	Type		R410A	
	Charge	Lbs., Oz.	2, 5	3, 1
	Oil	Type (Fl. Oz.)	NE022 (10.8)	
Refrigerant Pipe	Gas Side O.D.	In.	3/8	1/2
	Liquid Side O.D.		1/4	
	Height Difference (Max.)	Ft.	35	
	Length (Max.)		65	
Connection Method	Indoor/Outdoor		Flared/Flared	

MSY-A15NA	MSY-A17NA
MUY-A15NA	MUY-A17NA
15,000	16,200
3,100-15,000	3,100-16,200
1,690 (210-1,690)	2,070 (210-2,070)
16	
4.7	5.1
0.65	
1 Phase, 60Hz, 208/230V *2	
AC 208-230V	
DC12-24V	
Wireless Type (Optional Wired Controller: DC12V)	
1.0	
0.76	
268-328-381	
240-293-342	
34-40-45	34-40-46
Munsell No. 1.0Y 9.2/0.2	
30-11/16	
8-1/4	
11-3/4	
23	
5/8	
14	
15	
0.52	
DC INVERTER-driven Twin Rotary	
10.1	
12	
1,249	
Linear Expansion Valve	
50	52
Munsell No. 3Y 7.8/1.1	
31-1/2	
11-1/4	
21-5/8	
88	
Wireless Remote (Optional Wired Controller)	
R410A	
2, 7	
NE022 (15.2)	
1/2	
1/4	
40	
65	
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)

INVERTER



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.)	NEO22 (15.2)	NEO22 (29)	
Refrigerant Pipe	Gas Side O.D.	In.	5/8		
	Liquid Side O.D.		1/4	3/8	
	Height Difference (Max.)	Ft.	50		
	Length (Max.)		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. 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.



(MSZ-FD12NA MODEL SHOWN)

INVERTER



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 47° 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 17° 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) WET (CFM)	152-229-307 134-205-275	162-226-339 144-202-307	152-240-353 134-215-318	162-226-381 144-202-350
	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.		1/4			
	Height Difference (Max.)	Ft.	40			
	Length (Max.)		65			
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. 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 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)

INVERTER



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)	DRY (CFM)	268-328-381		296-431-568	389-639-848	
	(Lo-Med-Hi) *1	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		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.		1/4		3/8		
	Height Difference (Max.)	Ft.	40		50		
	Length (Max.)		65		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. 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 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



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.	In.	1/4			
	Height Difference (Max.)		49/33 *9			
	Length (Max.)	Ft.	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)				Power Usage (W)	Energy Efficiency		Current (A)		Port Adapter Requirements	
	Heating Capacity (Btu/h)									Size	Quantity and Port Adapter Part No.
	Unit A	Unit B	Unit C	Total		SEER	HSPF	208V	230V		
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.

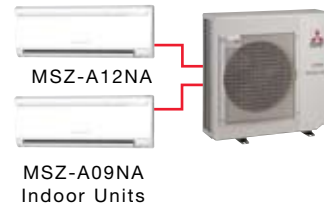
MXZ-2A20NA Combinations

Indoor Unit (Unit A + Unit B) Combinations	Cooling Capacity (Btu/h)			Power Usage (W)	Energy Efficiency		Current (A)	
	Heating Capacity (Btu/h)				SEER	HSPF	208V	230V
	Unit A	Unit B	Total					
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

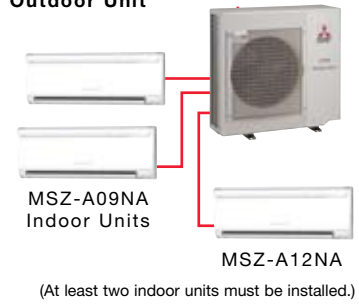
*Port Adapter size = 3/8" x 1/2", Qty = 1, Part No. = MAC-A454JP-E

Specifications are subject to change without notice.

MXZ-2A20NA (2:1) Outdoor Unit



MXZ-3A30NA (3:1, 2:1) Outdoor Unit



- Refer to combination chart for port adaptor references -

MXZ-4A36NA (4:1, 3:1) Outdoor Unit



MXZ-4A36NA Combinations

Indoor Unit Combinations (Unit A + Unit B + Unit C + Unit D)	Cooling Capacity (Btu/h)					Power Usage (W)	Energy Efficiency		Current (A)		Port Adapter Requirements	
	Heating Capacity (Btu/h)						SEER	HSPF	208V	230V	Size	Quantity and Port Adapter Part No.
	Unit A	Unit B	Unit C	Unit D	Total							
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.

Mr. SLIM®

Split-ductless A/C and Heat Pumps

Provides personalized comfort control for every room.



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.



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HVAC Advanced Products Division

Mitsubishi Electric Advanced Products Division
3400 Lawrenceville Suwanee Road
Suwanee, GA 30024

Phone: 888-467-7546 Fax: 800-658-1458

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See complete warranty for terms, conditions and limitations. A copy is available from Mitsubishi Electric.

Form No. MSBROM-09-08-20M SP

For more information visit www.mrslim.com



Appendix 4-6 Water Conservation





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:

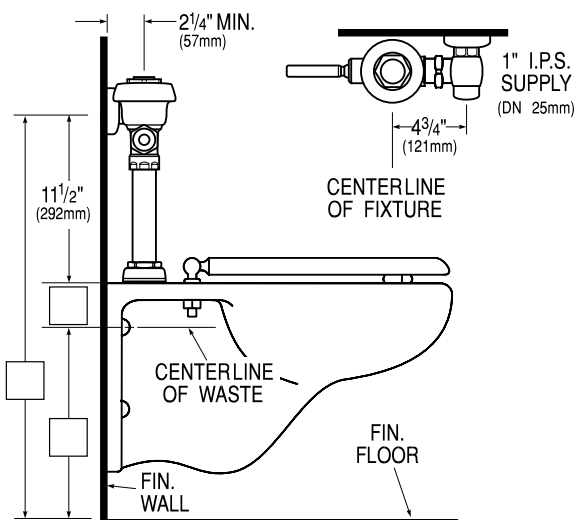
- PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass
- ADA Compliant Metal Oscillating Non-Hold-Open Handle with Triple Seal Handle Packing
- 1" I.P.S. Screwdriver Bak-Chek™ Angle Stop
- Free Spinning Vandal Resistant Stop Cap
- Adjustable Tailpiece
- High Back Pressure Vacuum Breaker 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

The information contained in this document is subject to change without notice.

SLOAN®

Made in the U.S.A.
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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>

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:

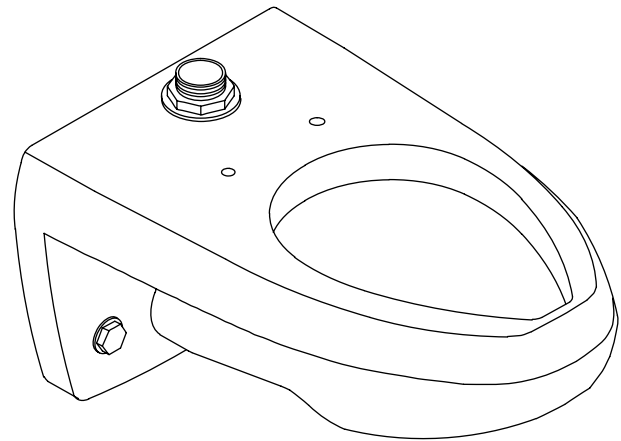
- ADA
- ASME A112.19.2
- ASME A112.19.6
- ICC/ANSI A117.2
- Energy Policy Act of 1992 (EPACT)
- IAPMO/UPC
- CSA B125

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	

BOWL
K-4330

ADA



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

Product Specification:

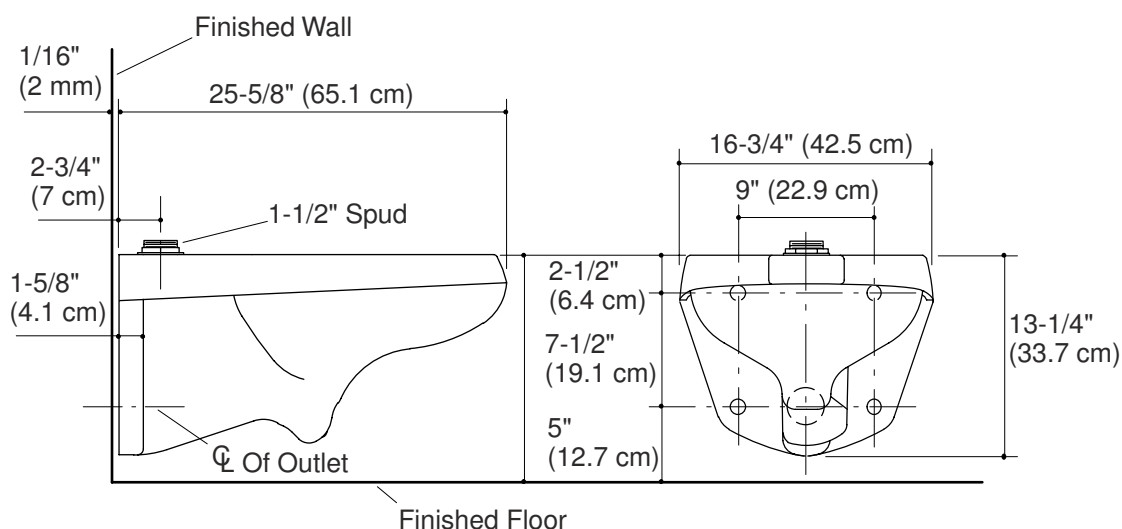
The elongated bowl shall be wall-mount with a 1-1/2" top spud. Bowl shall be made of vitreous china. Bowl shall have 12-3/8" (31.4 cm) x 11-3/8" (28.9 cm) water area. Bowl shall be 1.6 gpf (6 lpf). Bowl shall be ADA compliant when installed at required height of 17" (43.2 cm) - 19" (48.3 cm) from the 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-_____

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.

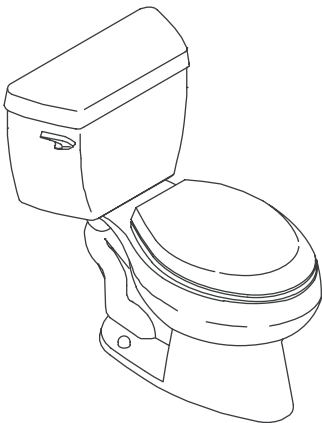


Product Diagram

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

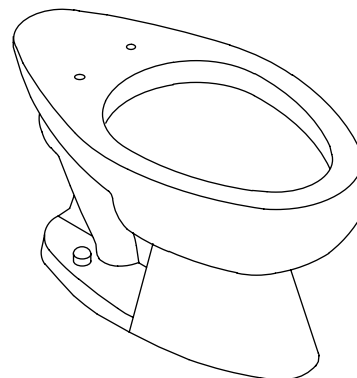
Product Specification:

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-_____ -_____.

BOWL K-4349

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)



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	Lustra™ 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-_____-_____.

WELLCOMME™

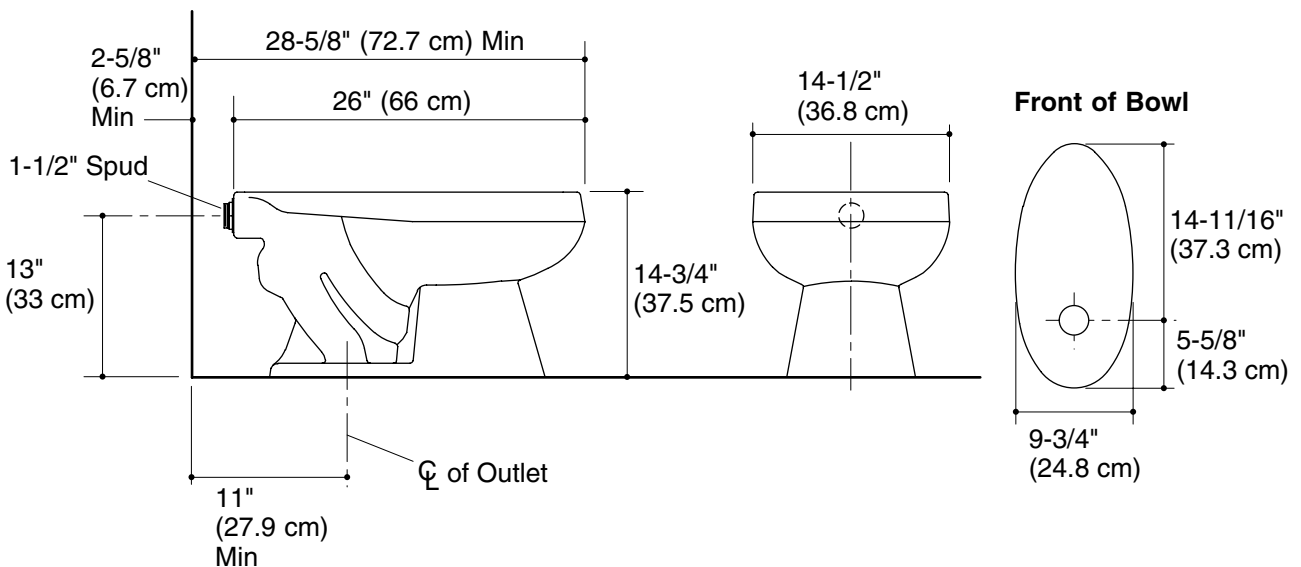
Technical Information

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 3/4" 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:

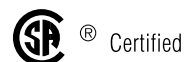
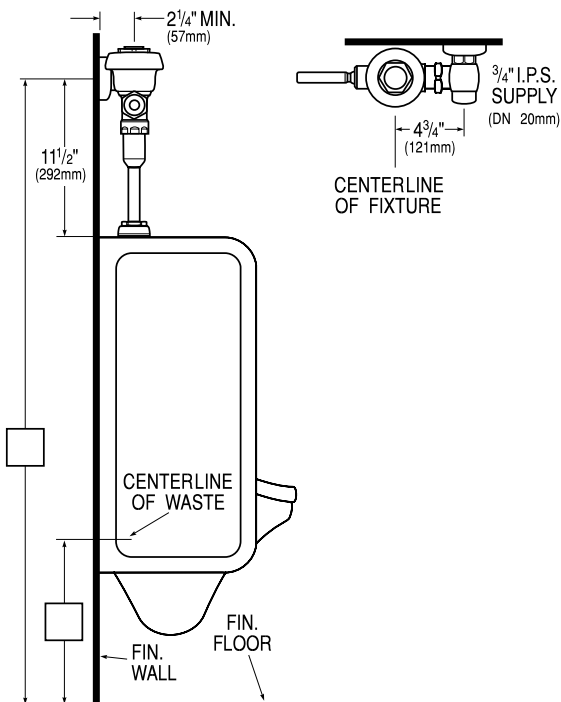
- PERMEX™ Synthetic Rubber Diaphragm with Dual Filtered Fixed Bypass
- ADA Compliant Metal Oscillating Non-Hold-Open Handle with Triple Seal Handle Packing
- 3/4" I.P.S. Screwdriver Bak-Chek™ Angle Stop
- Free Spinning Vandal Resistant Stop Cap
- Adjustable Tailpiece
- High Back Pressure Vacuum Breaker Flush Connection with One-piece Bottom Hex Coupling Nut
- Spud Coupling and Flange for 3/4" 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.



This space for Architect/Engineer approval

The information contained in this document is subject to change without notice.

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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.

* Based on electric rate and occupancy.



VENDINGMISERS® BENEFIT THE ENVIRONMENT AND REDUCE ENERGY COSTS

One VendingMiser® reduces greenhouse gas emissions by 2200 lbs. of CO₂ and 3600 grams of NO_x 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 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

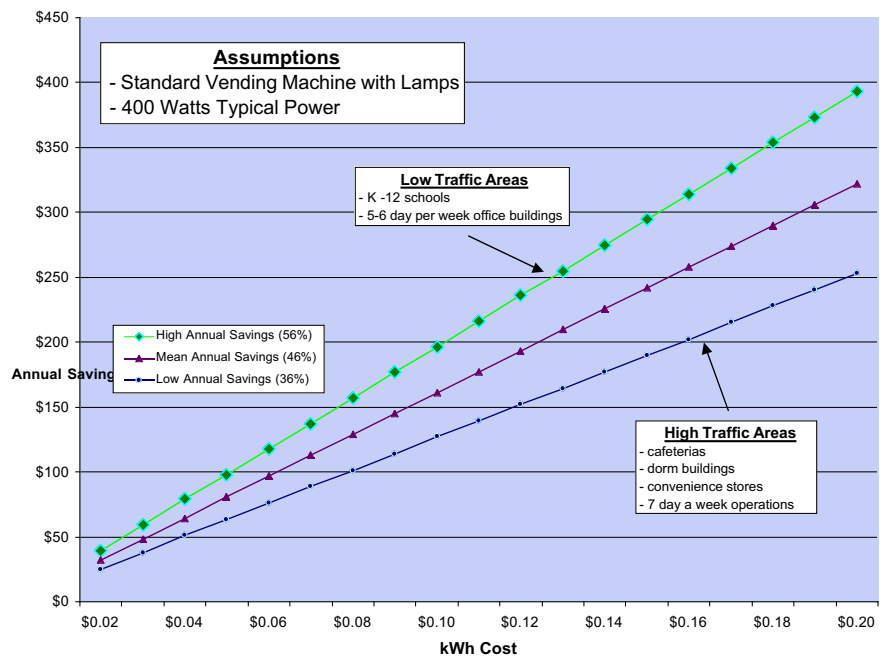
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety: UL/C-UL Listed
Information Technology Equipment (ITE) 9T79



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

1. Introduction
2. Typical semi-automatic installation
3. Typical semi-automatic with deployer installation
4. Typical fully automatic installation
5. Typical storage reel installation
6. Typical deployer installation
7. Operation - semi-automatic
8. Operation - semi-automatic with deployer
fully automatic
9. Energy savings guidelines
10. Blanket to core connection
11. Auto reel schematic and parts list
12. Wall mount brackets
13. Wall mount brackets and core (isometric)
14. Wall mount bracket with power box
15. Deployer
16. Automatic reel system - questions and answers
17. continued
18. Wall mounting the reel systems - questions
19. Automatic reel specifications
20. Deployer specifications
21. Control system specifications
22. Pool blanket specifications
23. Warranty
24. Care and maintenance - Safety (MUST READ)
25. Troubleshooting
26. To replace power box

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!

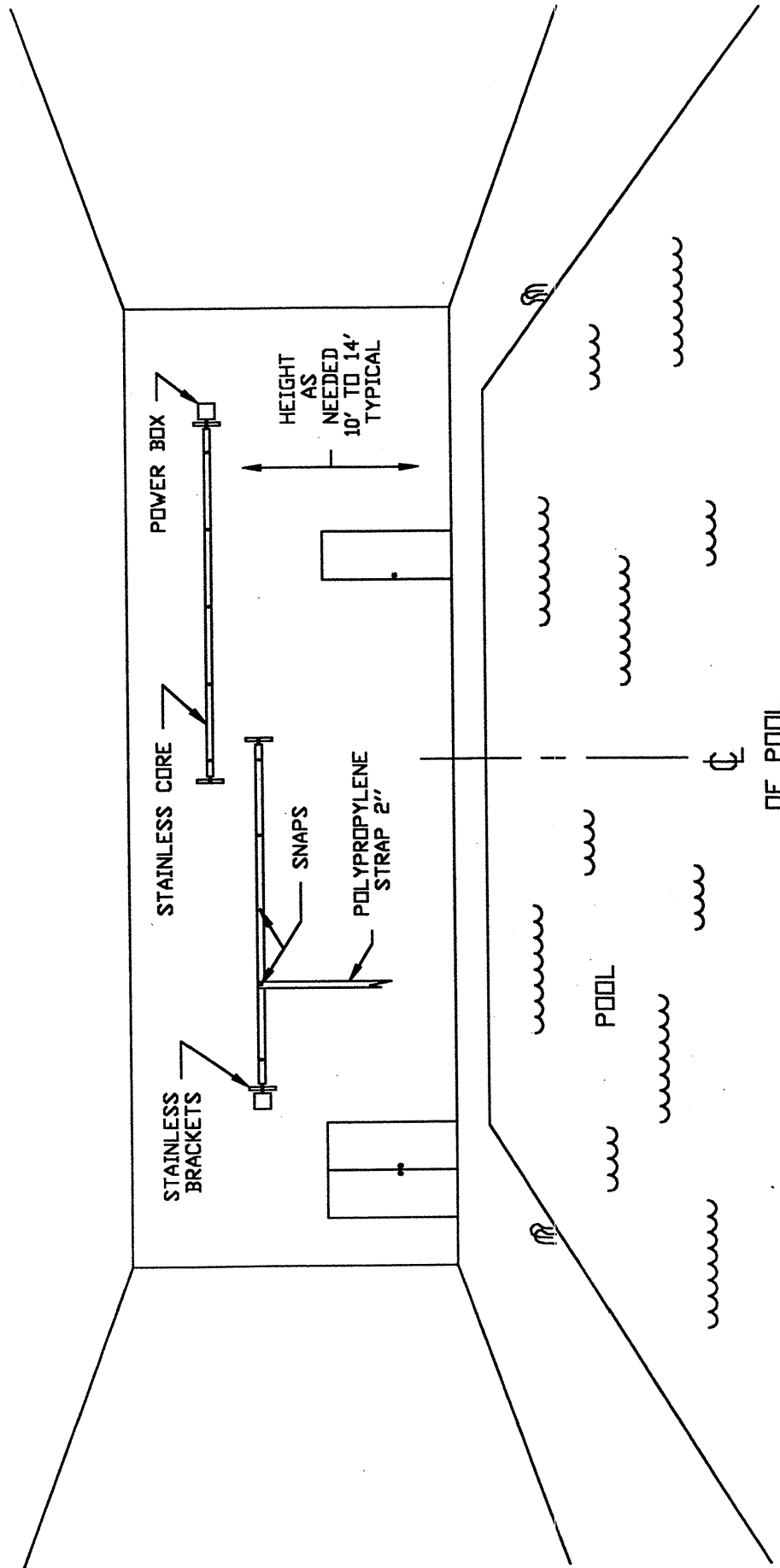
LEVELS of AUTOMATION

There are three levels of reel system automation:

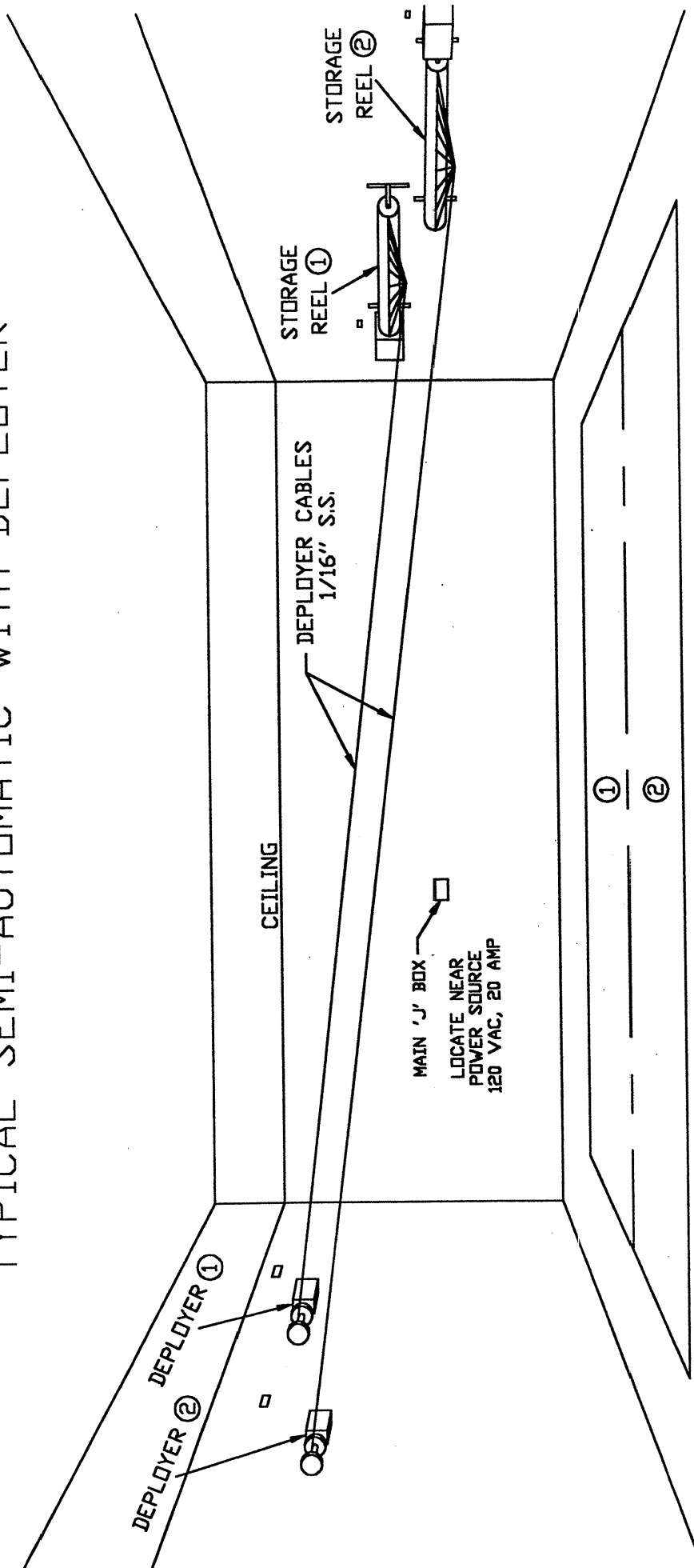
1. Semi-Automatic
2. Semi-Automatic with Deployer
3. Fully Automatic

Drawings and operating details of each follow.

TYPICAL SEMI-AUTOMATIC INSTALLATION

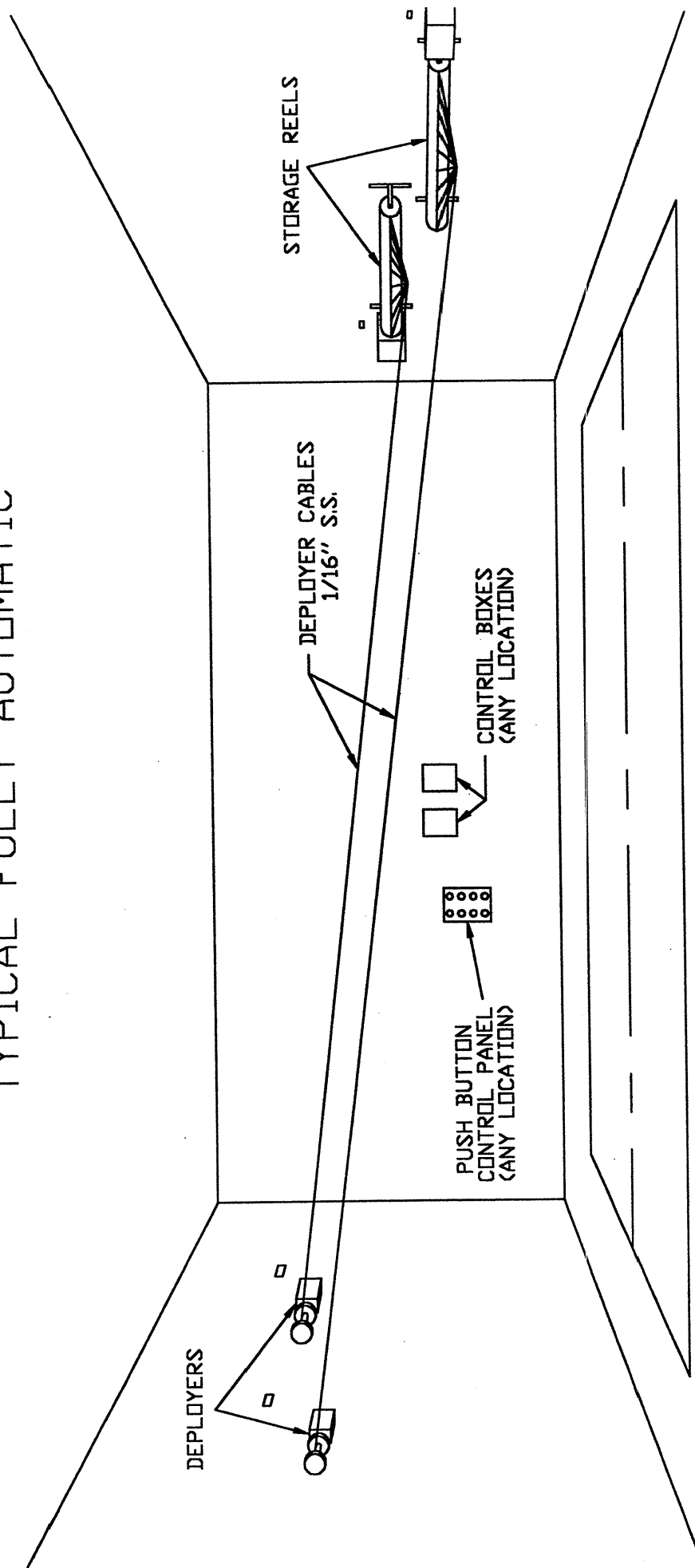


TYPICAL SEMI-AUTOMATIC WITH DEPLOYER

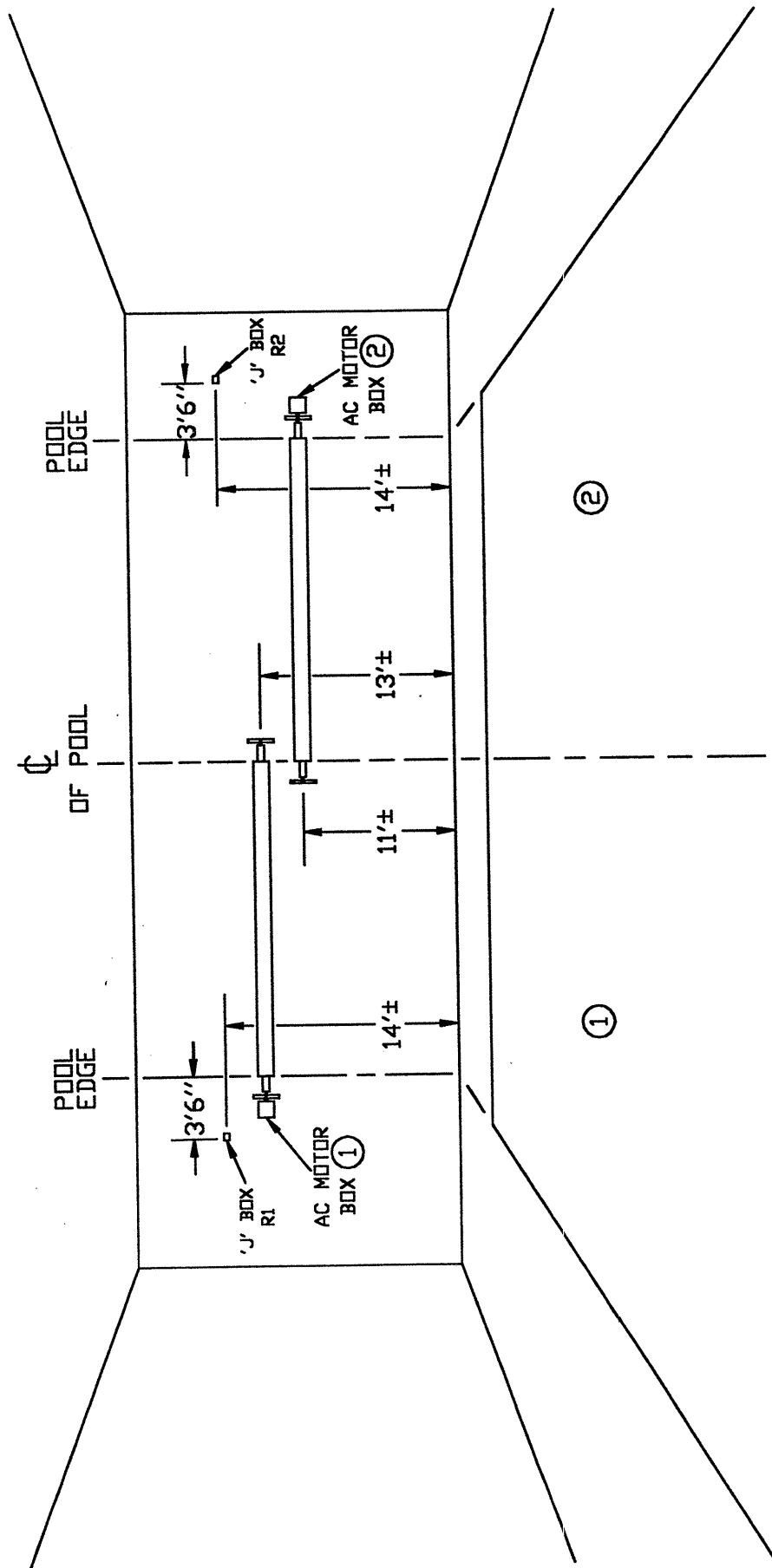


NOTE: 'MAIN 'J' BOX' MUST BE AT LEAST 20'
FROM STORAGE REEL MOTORS.

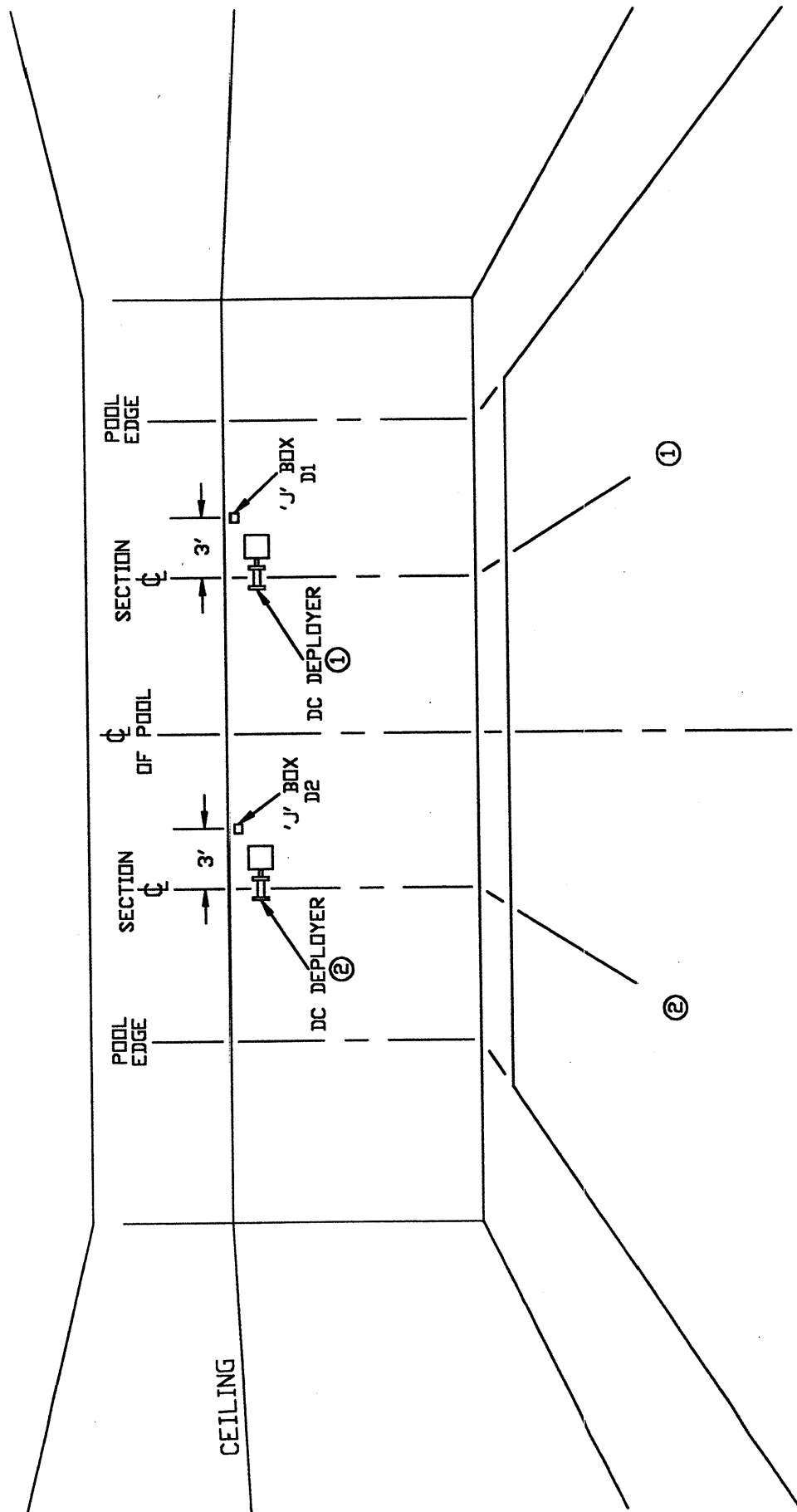
TYPICAL FULLY AUTOMATIC



TYPICAL STORAGE REELS



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.

NEVER ALLOW ANY ONE IN WATER WHEN
ANY PORTION OF BLANKET IS ON THE POOL

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

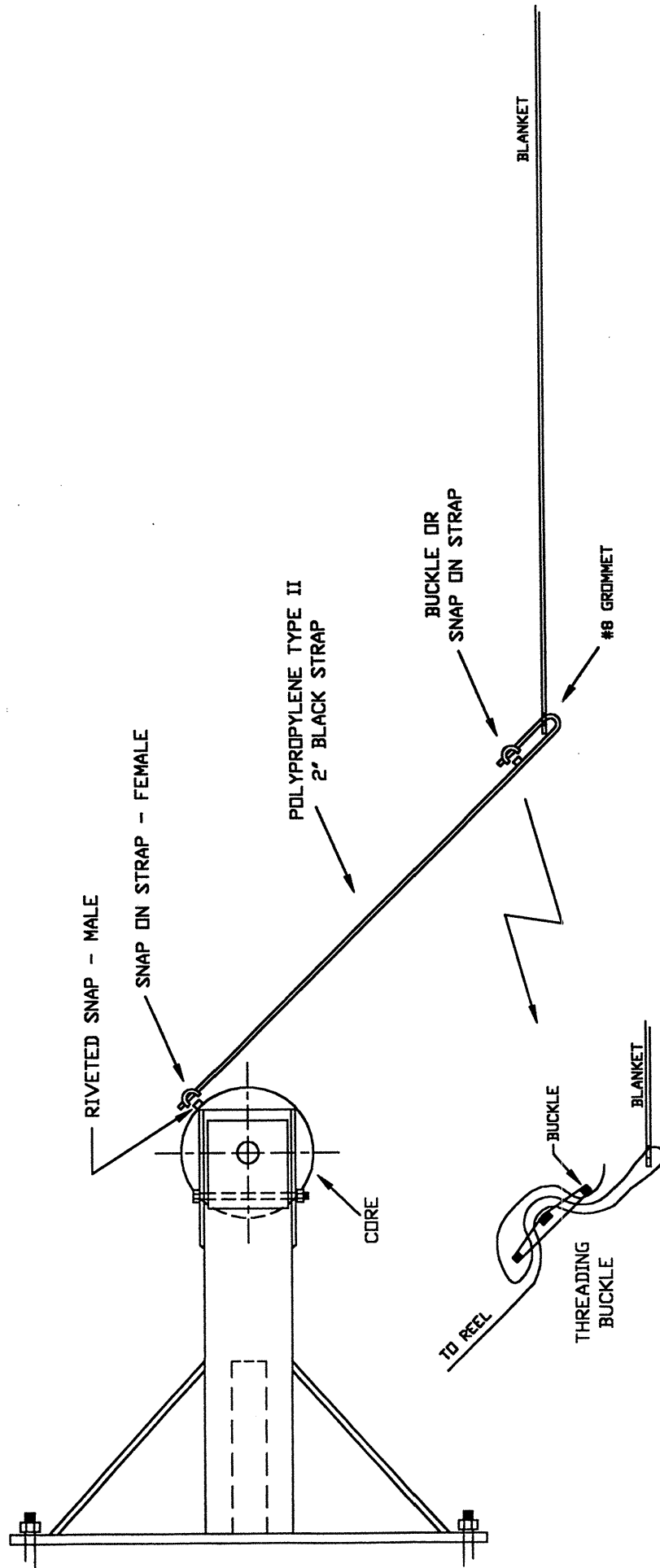
1. Push “retract” buttons and hold down until blanket stops retracting.

SWIMMING UNDER THE BLANKET WILL CAUSE DROWNING

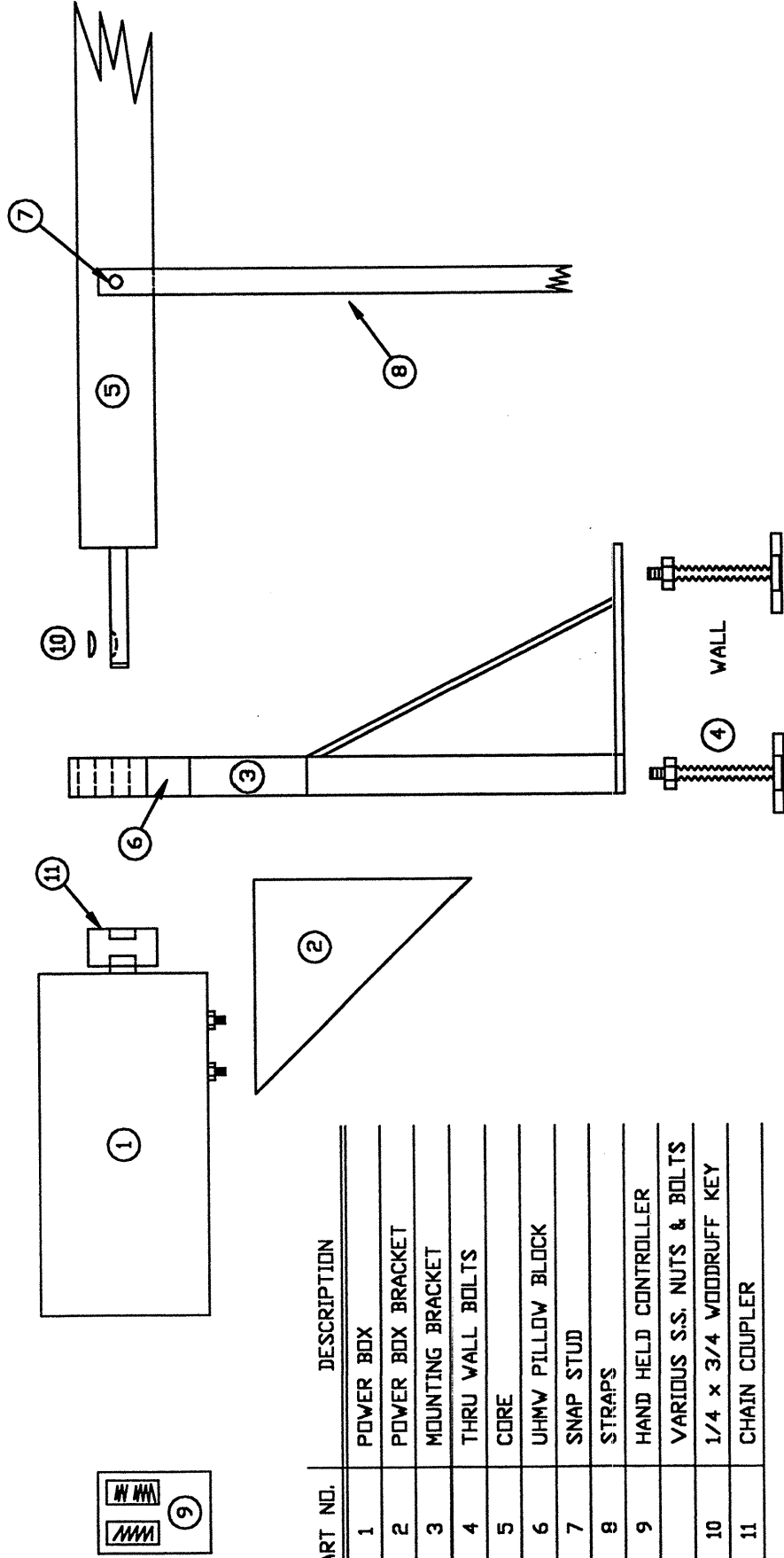
ENERGY SAVINGS GUIDELINES

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 is on the pool.

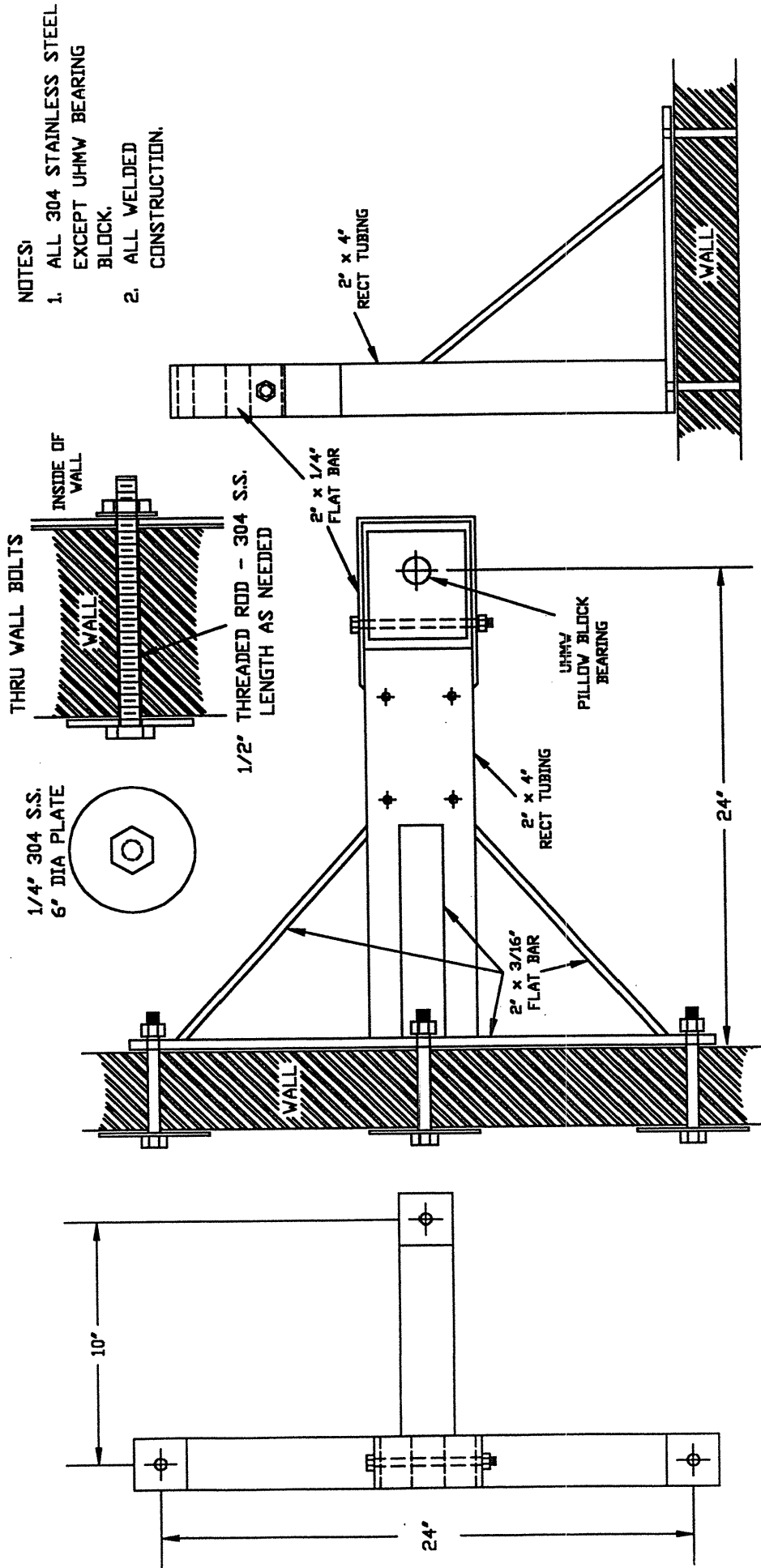


TYPICAL BLANKET TO CORE CONNECTION

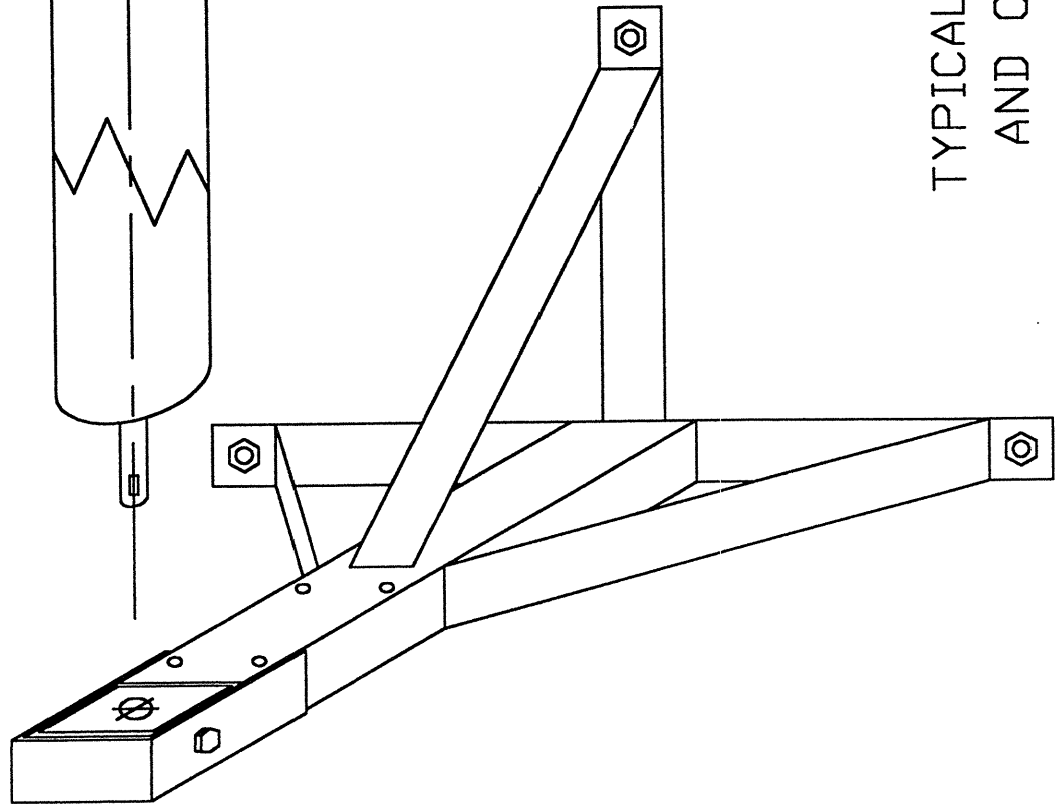
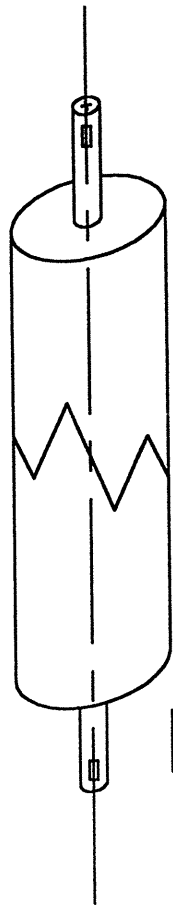
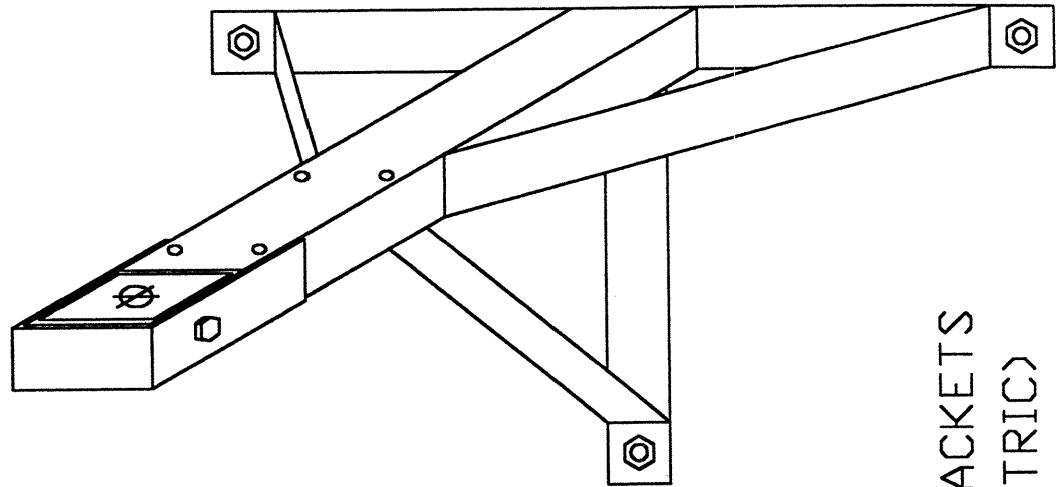


PART NO.	DESCRIPTION
1	POWER BOX
2	POWER BOX BRACKET
3	MOUNTING BRACKET
4	THRU WALL BOLTS
5	CORE
6	UHMW PILLOW BLOCK
7	SNAP STUD
8	STRAPS
9	HAND HELD CONTROLLER
	VARIOUS S.S. NUTS & BOLTS
10	1/4 x 3/4 WOODRUFF KEY
11	CHAIN COUPLER

AUTO REEL SCHEMATIC AND PARTS LIST

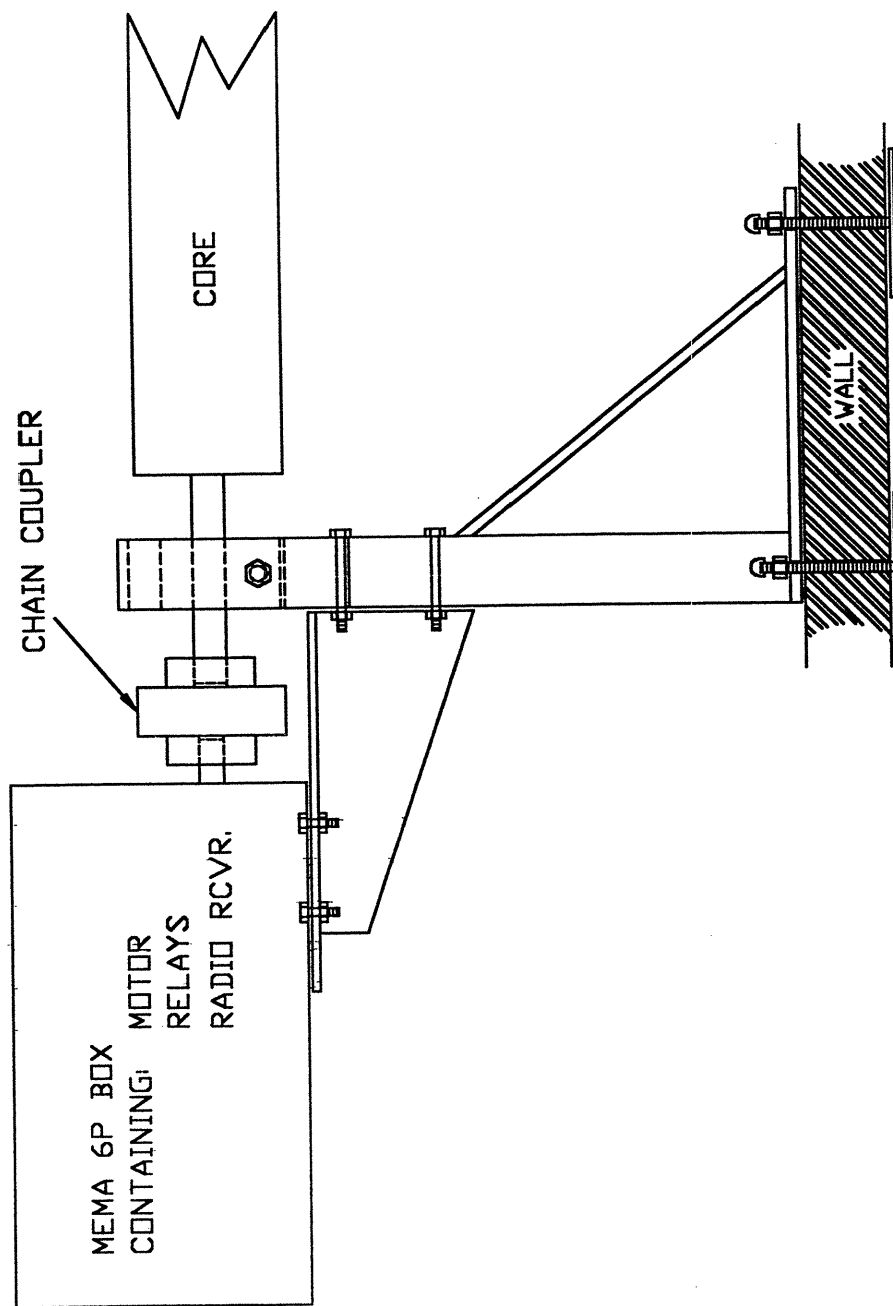


TYPICAL WALL MOUNT BRACKET W/ THRU BOLT

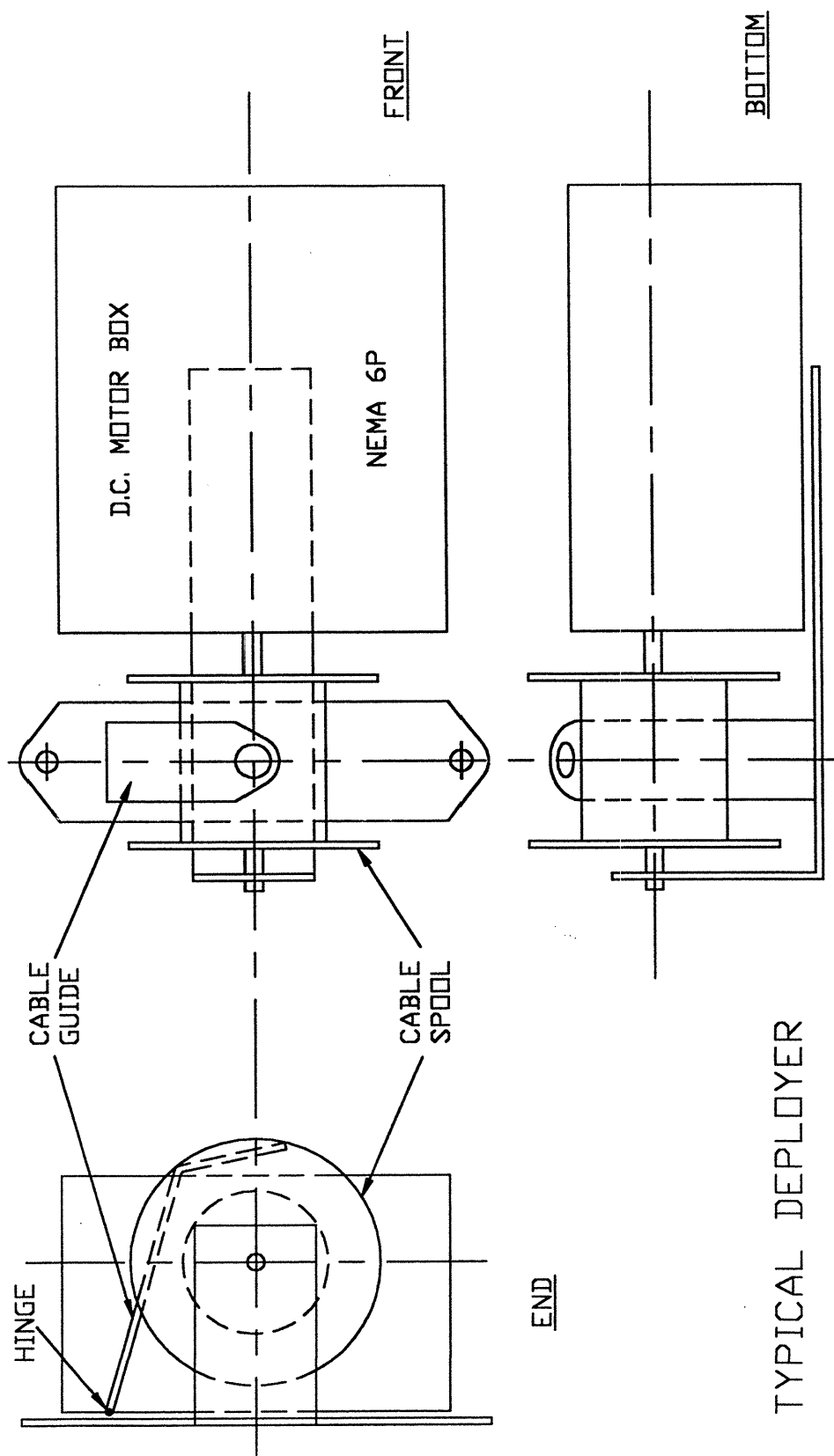


TYPICAL MOUNT BRACKETS
AND CORE (ISOMETRIC)

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) 1/2" stainless steel through-wall bolts.* The reel core shall be all stainless steel with a 4 1/2" 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) 1/2" stainless steel through-wall bolts.* The reel core shall be all stainless steel with a 4 1/2" 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.

MINIMUM 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 at all--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 1/100th 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.



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Appendix 4-11 Ice Arena - Upgrades



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	4 / inch (MD)	16 / 100 mm (MD)
	Fiberglass	4 / inch (XD)	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		 APPROVED 
		Film Side	Foil Side	Film Side	Foil Side	
Flame Spread		10	5	10	5	
Smoke Developed		20	10	20	10	

Physical Properties based upon statistical averages, Weight / Thickness +/- 10%

“LAMTEC” AND “WMP” ARE REGISTERED TRADEMARKS OF LAMTEC CORPORATION

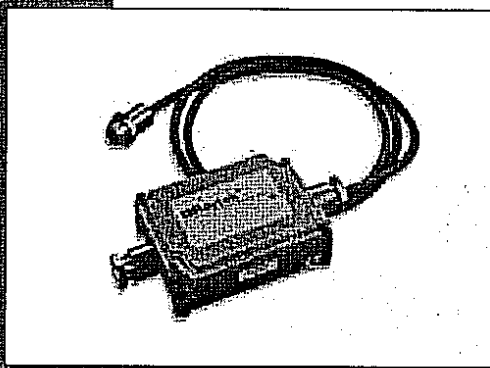
Lamtec Corporation 700 Bartley-Chester Road P.O. Box 37 Flanders, New Jersey 07836-0037 USA

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

Technical Data

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!

Technical Data

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	$\pm 1\%$ or $\pm 1^\circ\text{C}$ ($\pm 2^\circ\text{F}$) whichever is greater
LT	$\pm 2^\circ\text{C}$ ($\pm 4^\circ\text{F}$) for target temp. $< -20^\circ\text{C}$ (4°F)
TC outputs	$\pm 1\%$ or $\pm 2.5^\circ\text{C}$ ($\pm 5^\circ\text{F}$) whichever is greater
<i>At ambient temperature $23^\circ\text{C} \pm 5^\circ\text{C}$ ($73^\circ\text{F} \pm 9^\circ\text{F}$)</i>	

Repeatability

All models	$\pm 0.5\%$ or $\pm 0.5^\circ\text{C}$ ($\pm 1^\circ\text{F}$) whichever is greater

Technical Data

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.)

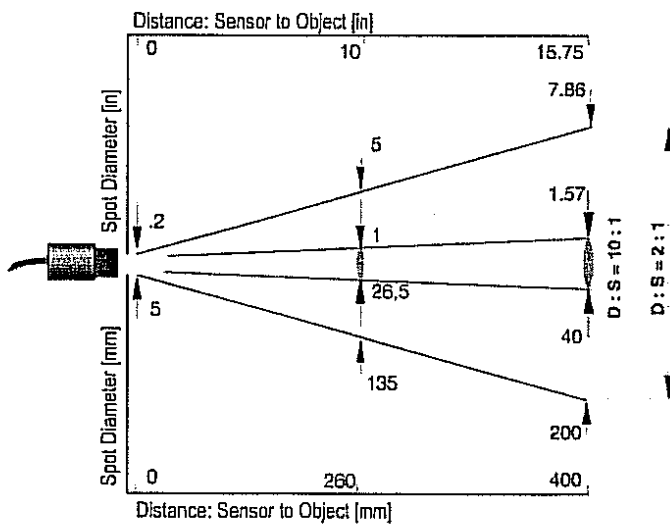


Figure 1: Spot Size Chart

Technical Data

Temperature Resolution

LT	$\pm 0.1 \text{ K } (\pm 0.2^\circ\text{F})^*$
	$\pm 0.25 \text{ K } (\pm 0.5^\circ\text{F})^{**}$

At ambient temperature $23^\circ\text{C} \pm 5^\circ\text{C}$ ($73^\circ\text{F} \pm 9^\circ\text{F}$)

* For a zoomed temperature span of 300°C (600°F)

** For the full temperature range of the unit

Temperature Coefficient

MIC	$\pm 0.05 \text{ K per K or } \pm 0.05\% / \text{K}$ whichever is greater, at ambient: 23 to 125°C (73 to 185°F)
MIH	$\pm 0.05 \text{ K per K or } \pm 0.05\% / \text{K}$ whichever is greater, at ambient: 23 to 180°C (73 to 356°F)
MIC, MIH	$\pm 0.1 \text{ K per K or } \pm 0.1\% \text{ per K}$ whichever is greater, at ambient: 0 to 23°C (32 to 73°F)
MID	$\pm 0.15 \text{ K per K or } \pm 0.15\% \text{ per K}$ whichever is greater, at ambient: 0 to 85°C (32 to 185°F)
Box	$\pm 0.1 \text{ K per K or } \pm 0.1\% \text{ per K}$ whichever is greater

Thermal Shock (within 20 min.)

LT	$\pm 3.5 \text{ K at } \Delta T_{\text{ambient}} = 25 \text{ K } (45^\circ\text{F})$ 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		30FEXC	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
Company Name: Carrier Northeast

1/4/2008
3:18:04 PM

Location Untitled
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

50° Ambient

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

- Chiller

Condenser Data
Fluid Type Propylene glycol
Fluid concentration, % 40.0
Fluid Entering Temperature, °F 75.0
Fluid Leaving Temperature, °F 64.3
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

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.

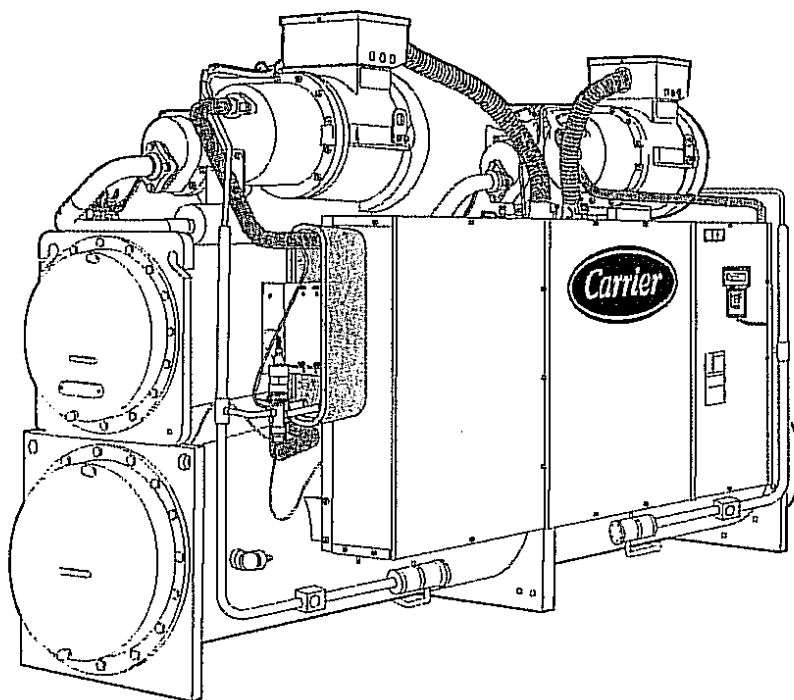


Product Data

30HXA, HXC076-271 Condenserless and Water-Cooled Liquid Chillers 50/60 Hz

75 to 265 Tons (264 to 931 kW)

Comfort **Link**TM



**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.

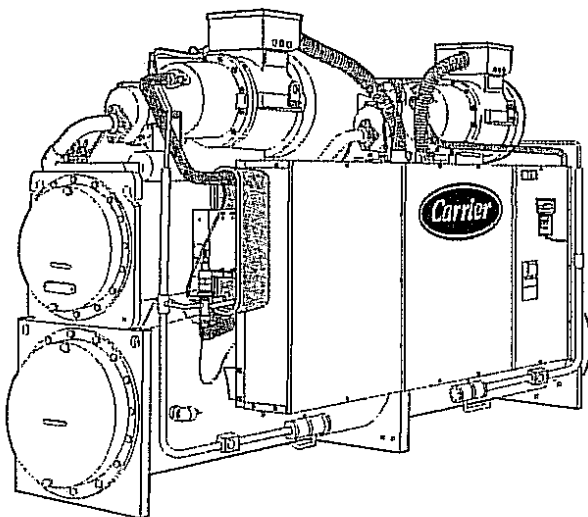
Dual, independent refrigerant circuits provide reliable, dependable cooling, and the 30HX units use medium-pressure HFC-134a refrigerant to

minimize stress on the compressors and ensure a long life.

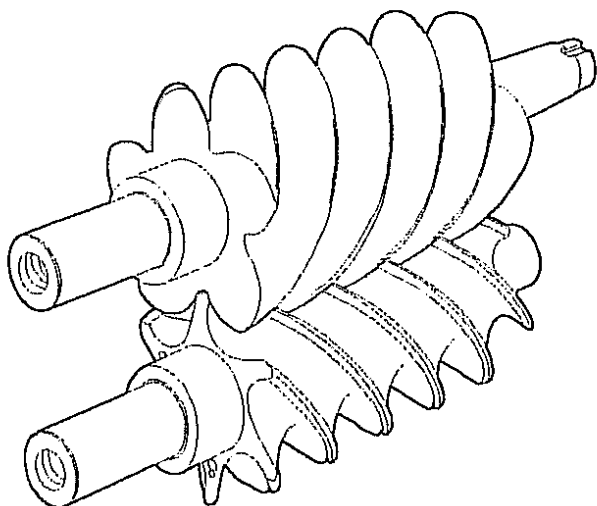
From a service standpoint, the 30HX units offer the following features:

- 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.

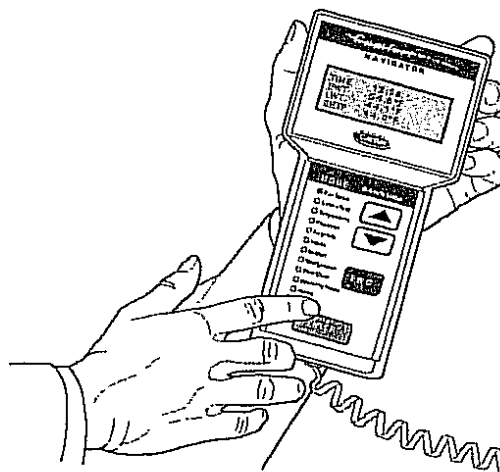
DUAL INDEPENDENT REFRIGERANT CIRCUITS



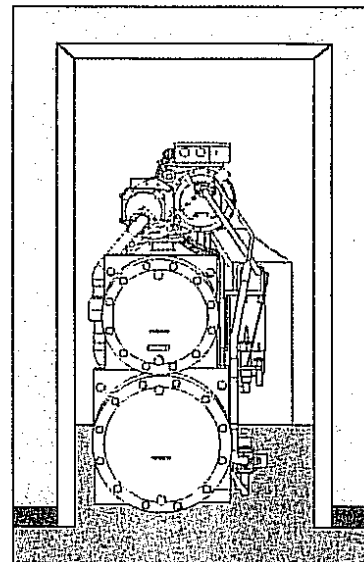
TWIN-SCREW COMPRESSOR DESIGN



NAVIGATOR IN DISPLAY MODE



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	904.8	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 m² x K per W)
Fouling Factor (Condenser):
0.00025 hr x sq ft x F per Btuh (0.000044 m² 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.



60 Hz only



Rated in accordance with
ARI Standard 550/590-98.



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							
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							
Charge* (lb) Circuit A/Circuit B	157/110	119/140	135/135	R-134a 220/135	220/135	220/135	220/135
COOLER TYPE							
Part No. 10HX400-							
Net Fluid Volume (gal)	601	611	621	631	632	632	632
Maximum Refrigerant Pressure (psig)	28.5	28.5	33.4	43.1	47.2	47.2	47.2
Maximum Water-Side 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-							
Maximum Refrigerant Pressure (psig)	215	214	214	213	213	213	213
Refrigerant Connections (in.)	320	320	320	320	320	320	320
Discharge Circuit A/B							
Liquid 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
Relief Valve	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
Connection (in. SAE Flare)							
Flow Capacity (lb air/min)	5/8	5/8	5/8	5/8	5/8	5/8	5/8
Relief Setting (psig)	21.6	21.6	21.6	21.6	21.6	21.6	21.6
Standard Number of Passes	320	320	320	320	320	320	320
CONDENSER (HXC)							
Part No. 09RX400-							
Net Fluid Volume (gal)	261	262	262	263	264	264	264
Maximum Refrigerant Pressure (psig)	30.6	37.6	37.6	47.6	55.1	55.1	55.1
Maximum Water-Side Pressure (psig)	220	220	220	220	220	220	220
Maximum Water-Side Pressure (psig)	300	300	300	300	300	300	300
Water Connections (in.)							
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

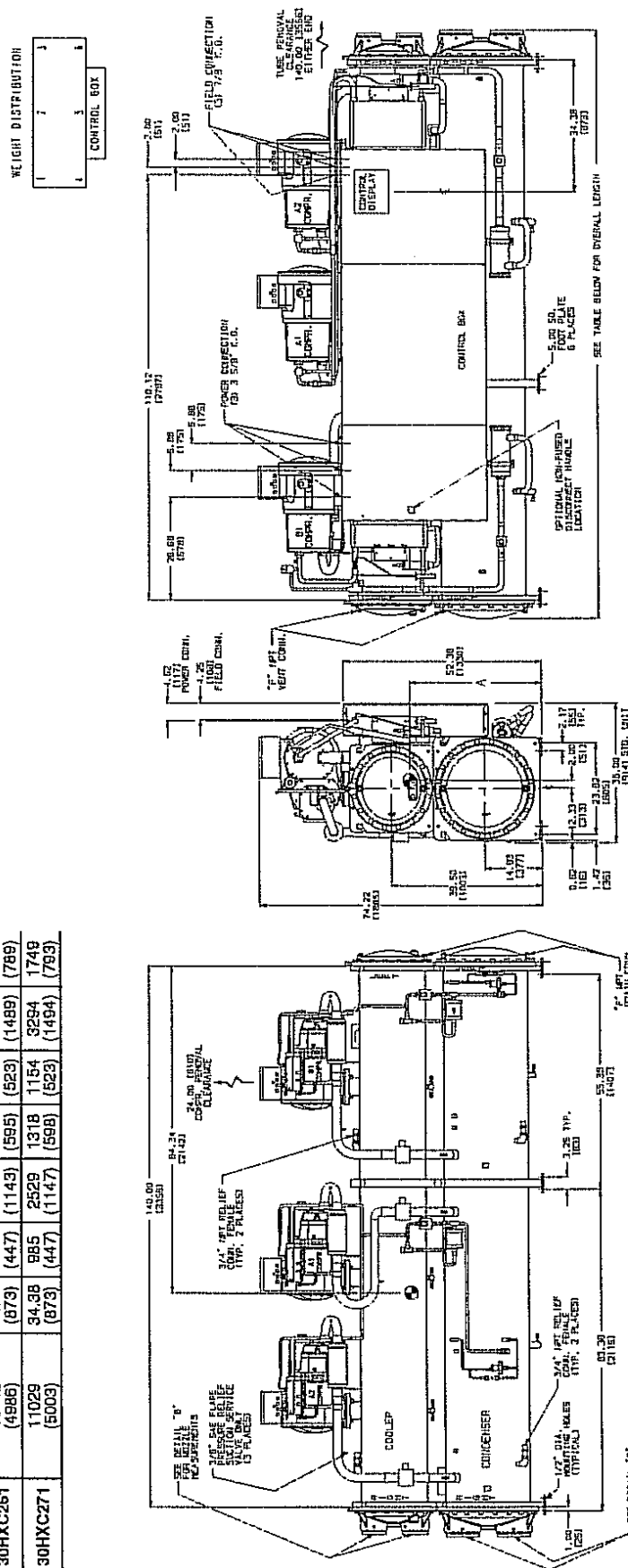
*Charges listed are for 30HXC units. The 30HXA units are shipped with a holding charge only. To determine the refrigerant charge requirements for 30HXA units see the System Refrigerant Charge for Start-Up table in the Application Data on page 28.

†Only on units with factory-installed suction service valves.

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. Vitec nozzles are standard on all models. Flow switch factory installed in cooler outlet vitec nozzle.

UNIT	OPERATING WEIGHT - lb (kg)	A	WGT DISTRIBUTION AT EACH MGT PLATE - lb (kg)					
			1	2	3	4	5	6
30HXC206	10581 (4799)	33.88 (860)	948 (430)	2406 (1091)	1243 (564)	1201 (545)	9133 (1421)	1850 (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)	3284 (1494)	1749 (793)



CONDENSER

STANDARD

RIGHT

STANDARD

LEFT

DETAIL "C"

COOLER

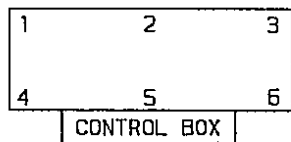
UNIT	A	B	F	F _{MIN}	F _{MAX}	W	H
30HC206	246.1	271	310	124	316*	7	8*
30HC200	246.1	271	MINUS	0.00	314*	1	8*
30HC206	246.1	271	PLUS	124	314*	3	8*

OVERALL LENGTH TABLE		
CONCRETE	CONCRETE	OVERALL LENGTH
STANDARD CONCRETE	STANDARD CONCRETE	157.44
STANDARD CONCRETE	WINDS ONE PASS CONCRETE	160.00
STANDARD CONCRETE	STANDARD CONCRETE	160.00
PLUS ONE PASS CONCRETE	PLUS ONE PASS CONCRETE	160.00
PLUS ONE PASS CONCRETE	WINDS ONE PASS CONCRETE	160.00
WINDS ONE PASS CONCRETE	STANDARD CONCRETE	160.00
WINDS ONE PASS CONCRETE	WINDS ONE PASS CONCRETE	160.00

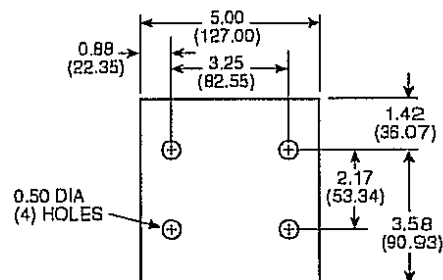
Dimensions (cont)



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)	1081 (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 [$> 0.09 \text{ L/s} \cdot \text{kW}$ or $< 2.7^\circ \text{C}$ 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).

Application data (cont)



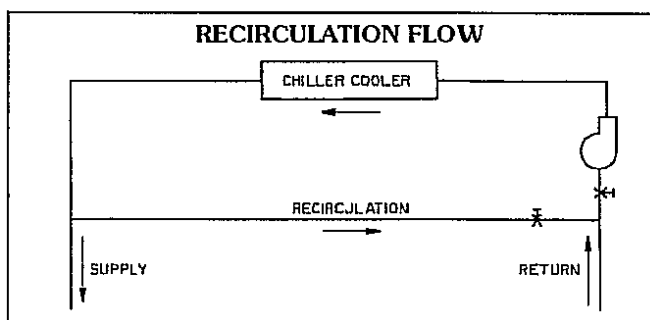
MINIMUM FLOW RATES

DEVICE	UNIT SIZE 30HX	COOLER		MIN. FLOW RATE*		COOLER TEMP DIFFERENCE	
		No. of Passes	Type	GPM	L/s	F	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	18.8	10	5.6
		2	Standard	147.0	9.9	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	10.9	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.



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 ComfortLink™ 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.

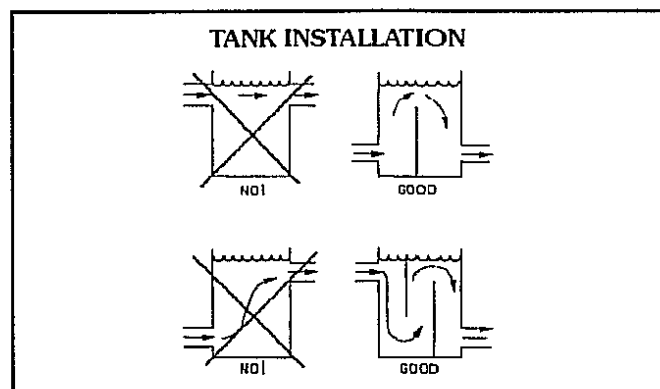
Strainers

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.



Fouling factor

The factor used to calculate tabulated ratings for the cooler is 0.00010 ft² · hr · F/Btu (0.000018 m² · K/W), and for the condenser is 0.00025 ft² · hr · F/Btu (0.00044 m² · 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:

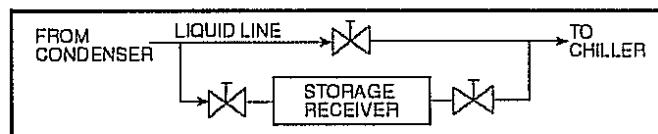
Discharge line:

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			POWER SUPPLY QTY. REQD.	NO. POWER SUPPLY CONDUCTORS	UNIT VOLTAGE						CONTROL CIRCUIT			
	V-Hz (3 Ph)	Supplied				MCA	MOCP	ICF		Rec Fuse Size		V-Hz (Single Ph)	Supplied		MCA and MOCP
		Min	Max					XL	WD	XL	WD		Min	Max	
171	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
	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
186	230-60	207	253	1	6	482.3	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
	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
206	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
	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
246	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
	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
261	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
	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
271	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
	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:

- 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.
- 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.

- Maximum incoming wire size for each terminal block is 500 kcmil.
- Maximum allowable phase imbalance is: voltage, 2%; amps, 5%.
- Use copper conductors only.
- 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 30-HX 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):

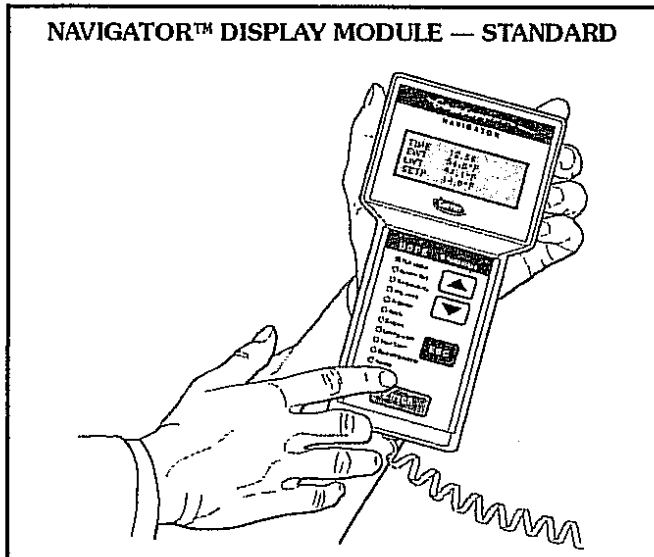
- set schedules and set points
- identify operating mode
- display current temperatures and pressures being used by the control for internal calculations
- identify abnormal (alarm or alert) conditions

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 30-HX 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 $\frac{3}{4}$ -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.

Guide specifications (cont)



- 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



ICEMAX

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.



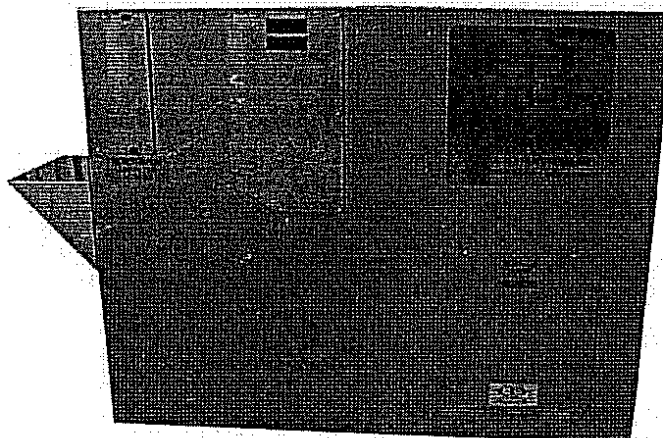
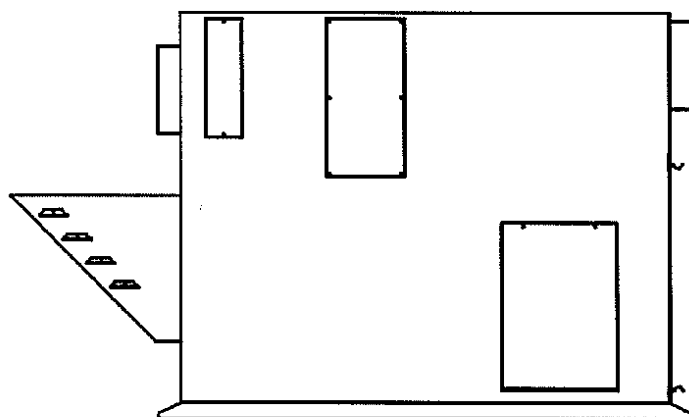
ARID-Ice™

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.

<u>Model</u>	<u>CFM</u>	<u>Fuel Type</u>	<u>"L" Dim.</u>	<u>"W" Dim.</u>	<u>"H" Dim.</u>	<u>Weight</u>
MS-2600	2600	Electric	61 1/4"	40 1/8"	36 1/2"	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								

*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



Engineering Submittal Solo 399



Engineering Submittal Data

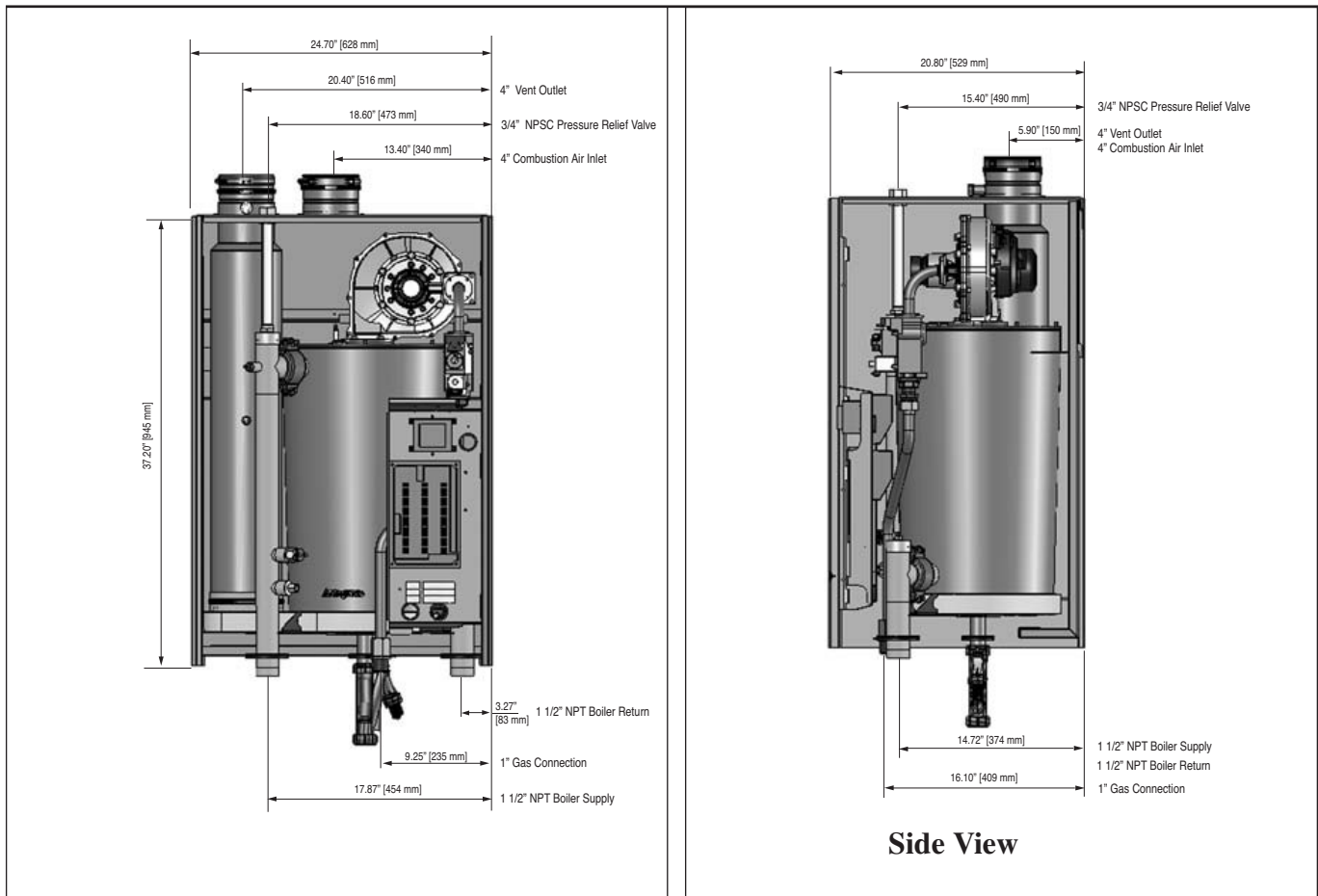
- ASME Boiler Certification - ASME "H" Stamp
- Unit complies with ANSI Z21.13 and CSA 4.9
- Fully condensing – 95.1% thermal efficiency
- Full modulation capability from 28% to rated input
- Modulation allows fewer and longer cycles leading to lower off cycle losses and operating cost
- Low pressure 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: _____

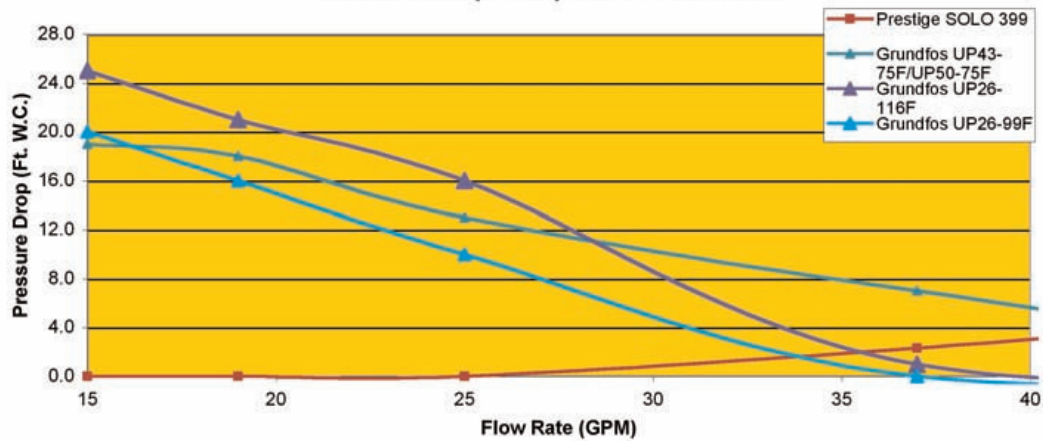
Notes: _____



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

Pressure Drop Comparison - 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





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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.

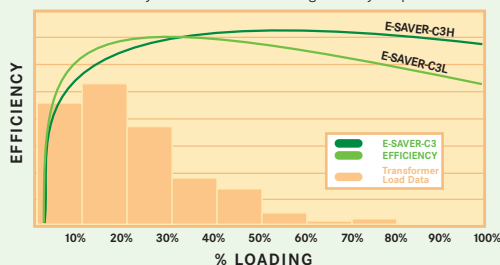
TESTING AND WARRANTY

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.

Phone: (905) 791-1493

Toll-free: (800) 747-9627

10 Devon Road, Brampton, Ontario L6T 5B5 Canada

Fax: (905) 791-8870

Email: info@powersmiths.com

www.powersmiths.com

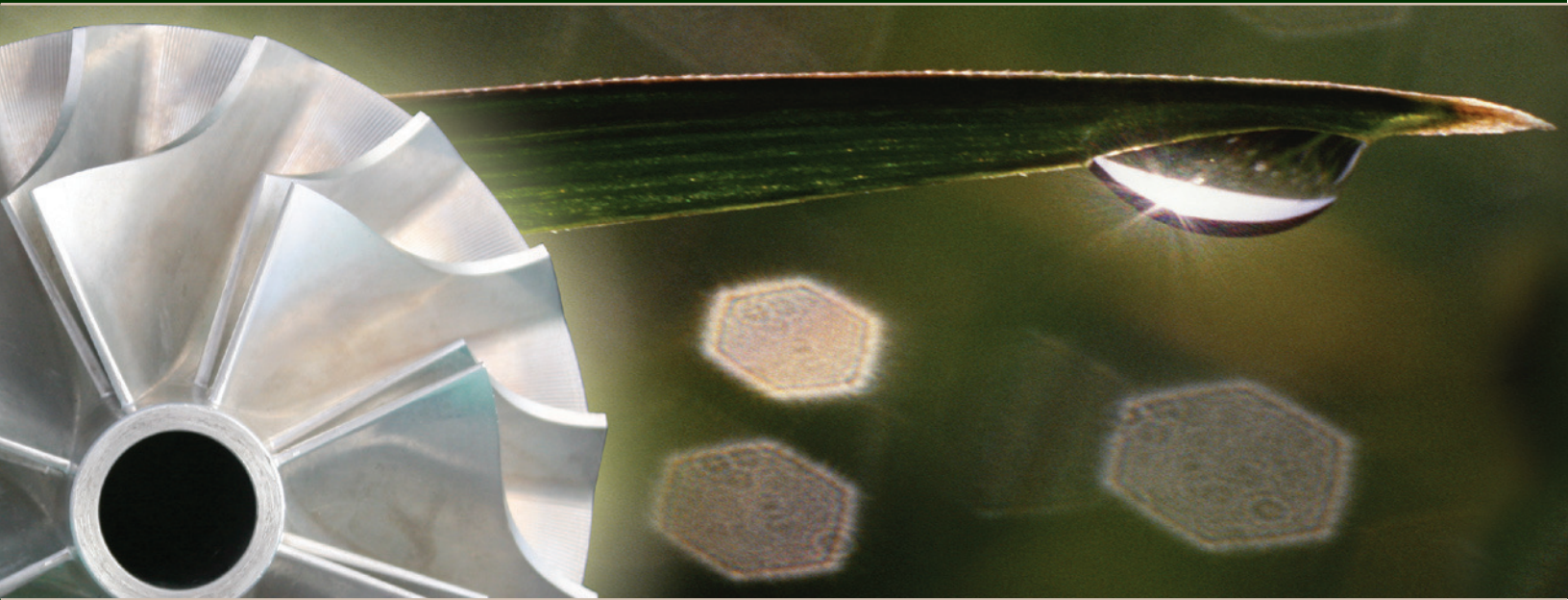


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Appendix 4-14 WWTP Aeration Blower – Retrofit



H I G H S P E E D T U R B O B L O W E R S



Innovation

Service

Experience





Introducing HSI High Speed Turbo Blowers and Exhausters

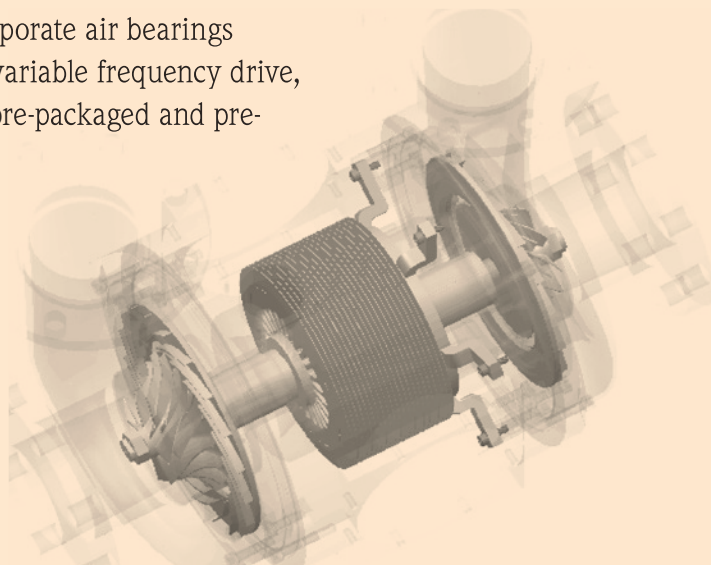
What if a blower could...

- 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 nm³/hr) and pressures to 25 psi (1.7 bar) through the range of operation.

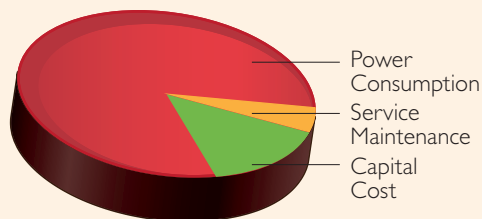




What is Your **TRUE** Cost of Ownership?

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

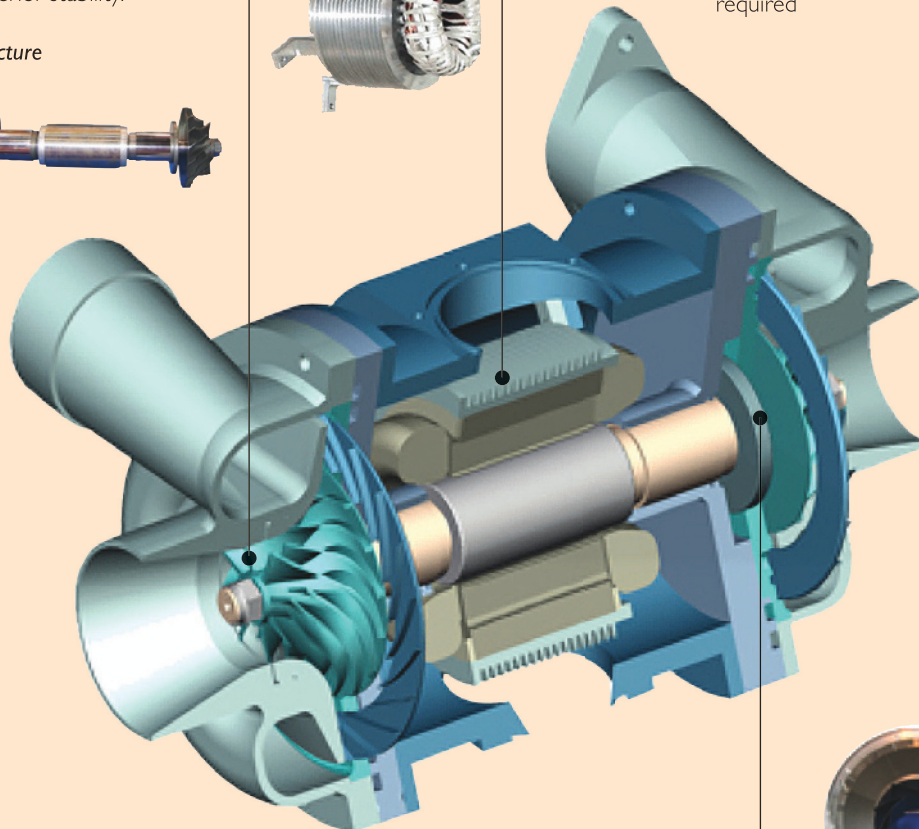


Motor

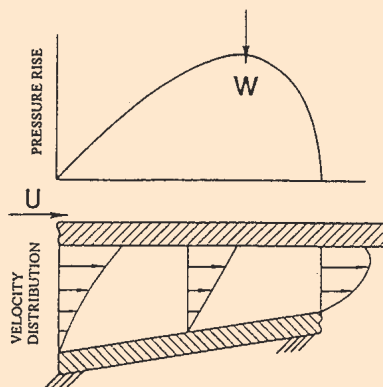
- Highly efficient and reliable motor design
- Specifically designed for high speed service
- Designed for high heat environments

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



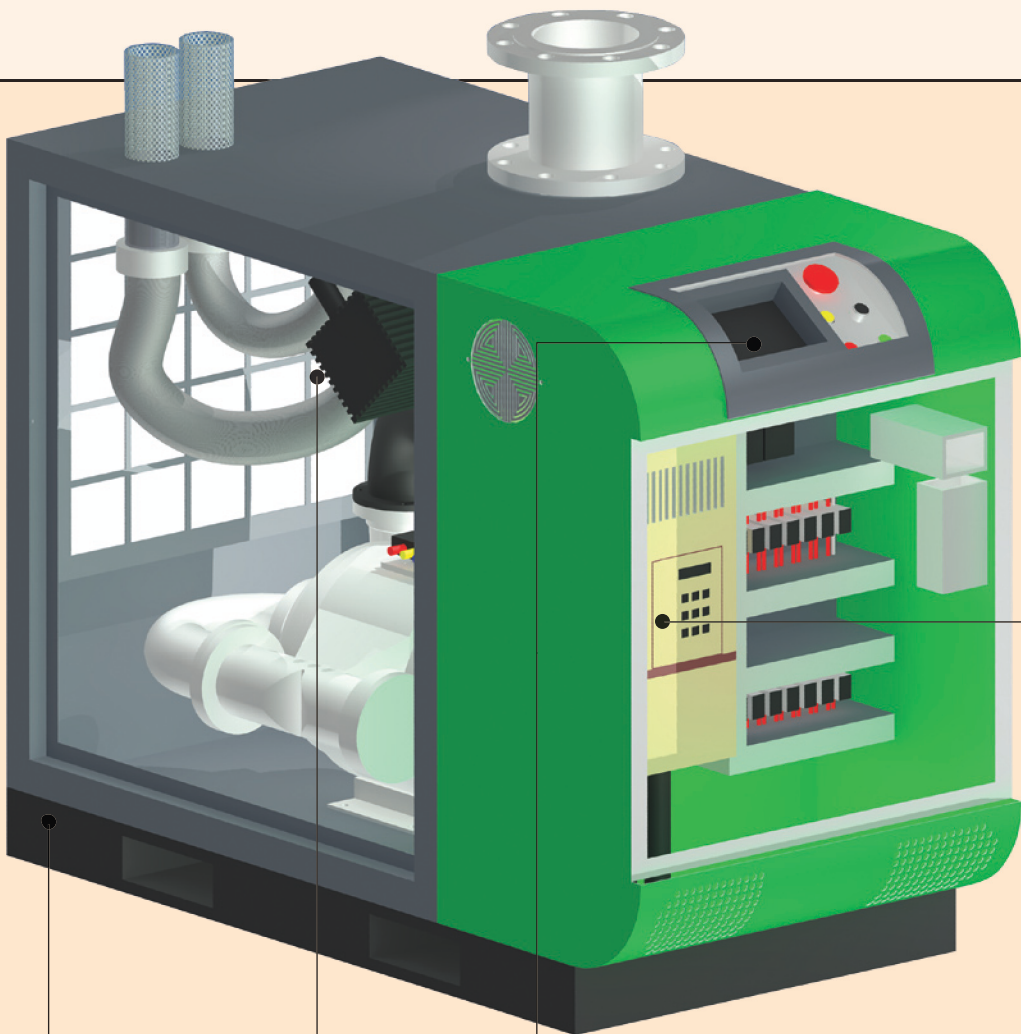
Bearings

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



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



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



Constant Pressure Mode

- Pressure: fixed
- Flow: variable



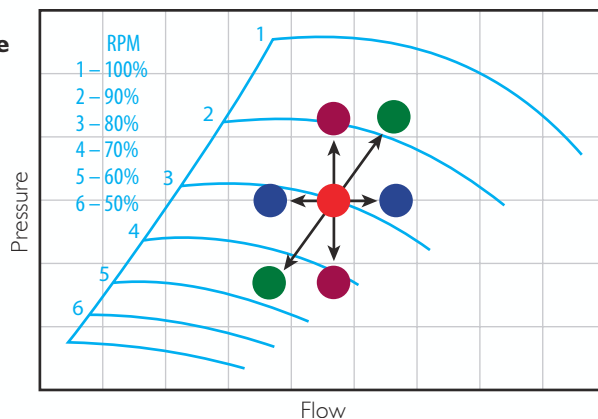
Quantitative Mode

- Pressure: variable
- Flow: fixed

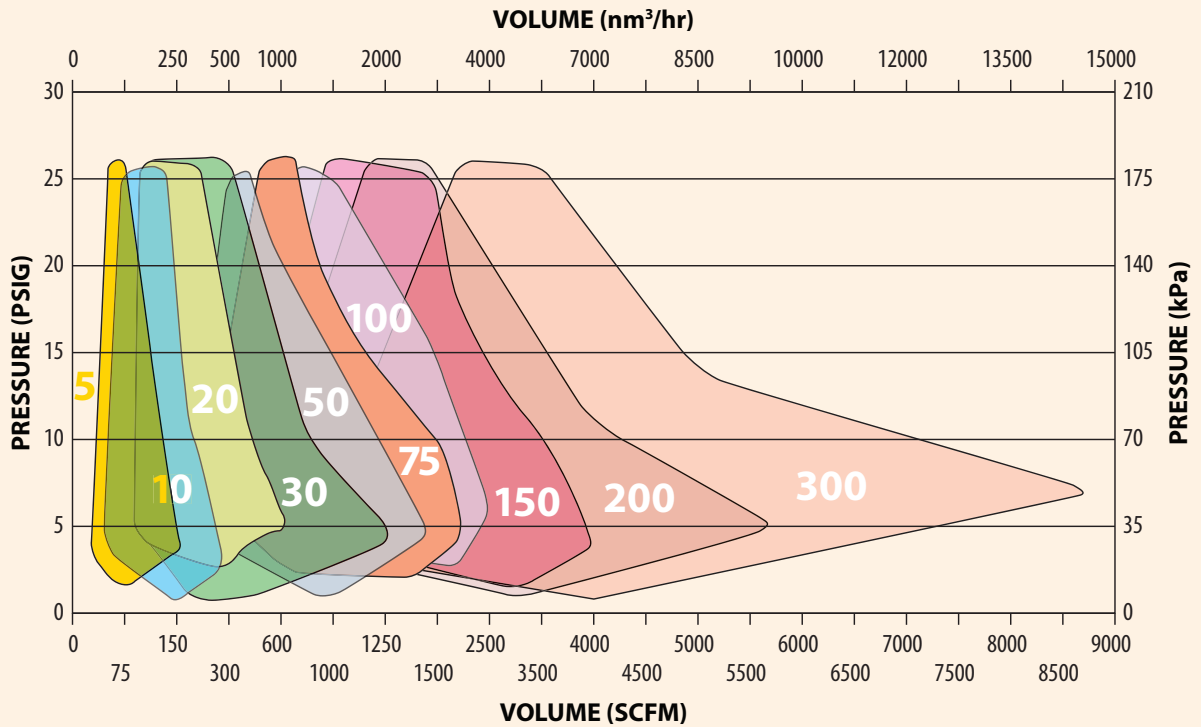


Proportional Mode

- 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 700x1050	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.

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

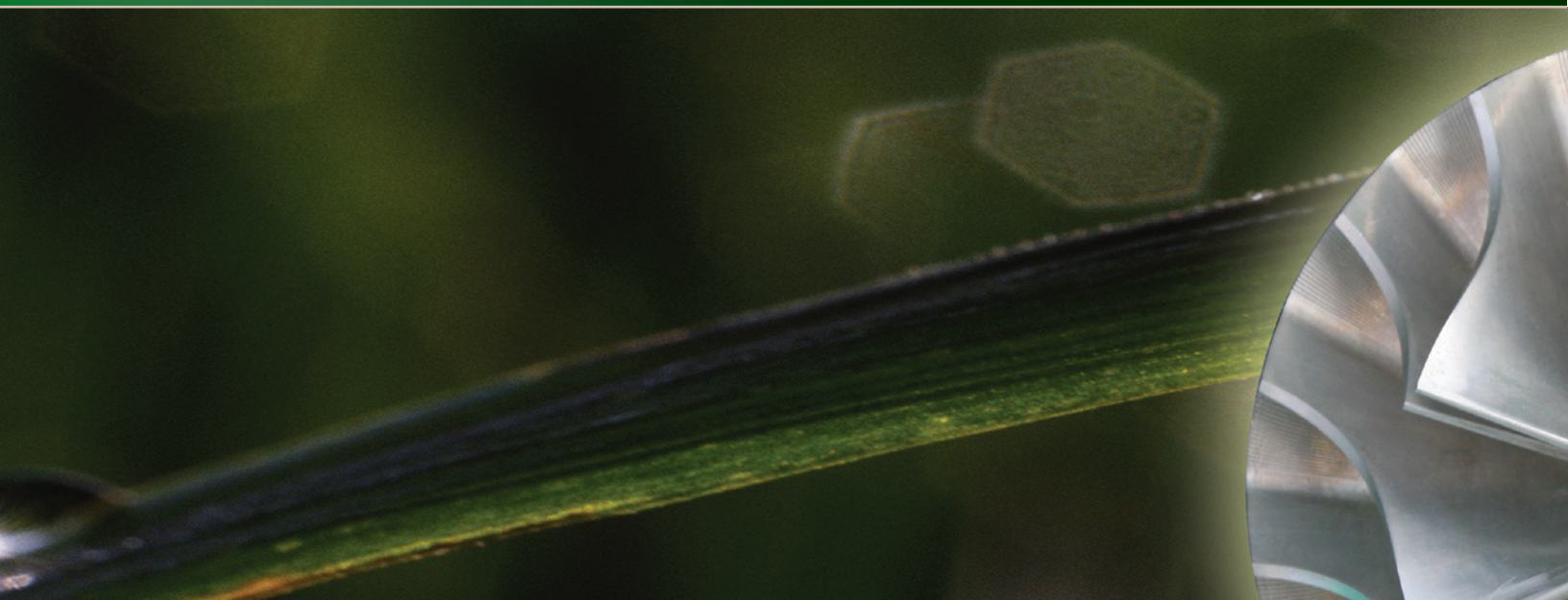
Number of impellers	1 or 2 impellers (single, in series or in parallel)
Pressure range	2 To 25 PSIG (.13 to 1.7 bar)
Flow range	10 to 10,000 SCFM (1 to 300 m2m).
Outlet connection	Flanged ASA 125# / ANSI 150# drilling
Inlet filter	10 micron felted synthetic material, powder coated steel frame, washable 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 tolerance	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 BLOWERS



7901 Hansen
Houston, Texas
77061
713-947-1623
1-800-725-2291
713-947-6409 Fax
www.hsiblowers.com
sales@hsiblowers.com

Additional Products

Multistage Centrifugal Blowers

Blower Control Systems

Aftermarket Services



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	Existing 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
ADFTWW/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

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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	Existing 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	Existing 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-LEEXIT	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-Up LED Exit
41	Stairway to Mezzanine	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	Total	Location	Hours	Qty	Code	Notes
				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

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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	BDFWW/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 - Leded 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

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Appendix 6

Commissioning Plan



City of Dover New Hampshire

Performance Contract Commissioning Plan

December 20, 2008

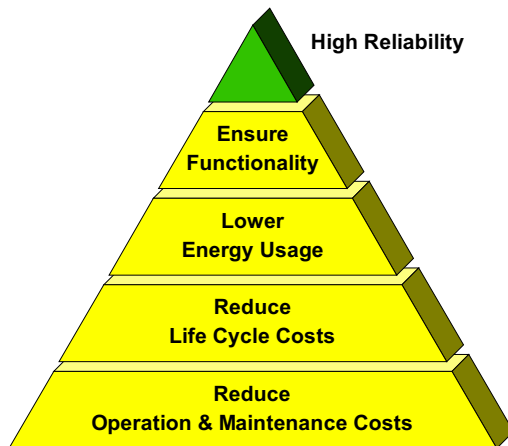


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Section 1: Introduction



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.

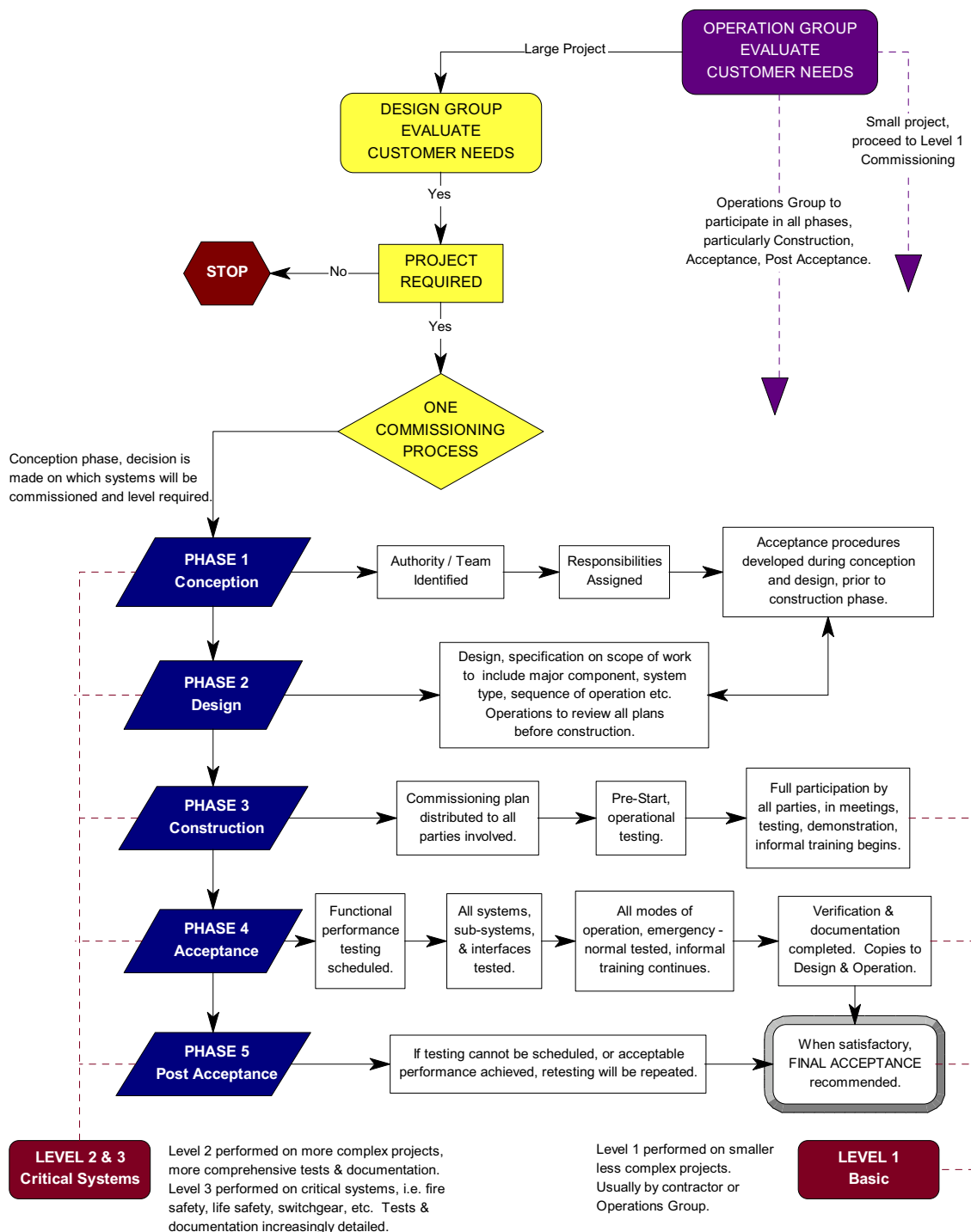
Commissioning Process Objectives

The major objectives for implementing a commissioning process are to:

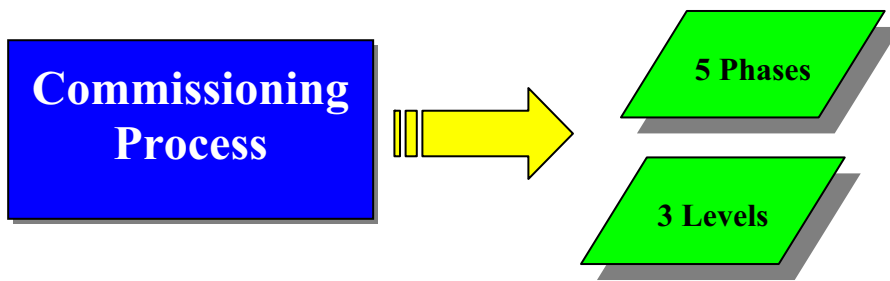
- Ensure total system functionality and reliability
- Optimize energy usage
- Lower operation and maintenance costs
- Extend life of assets
- Reduce building life-cycle costs
- Improve occupant comfort
- Ensure human safety

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.

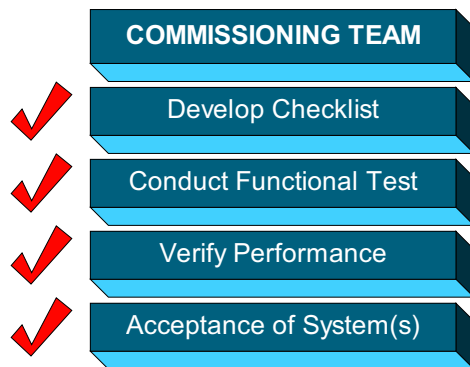
Commissioning Process and Project Costs Not sure if this section belongs

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

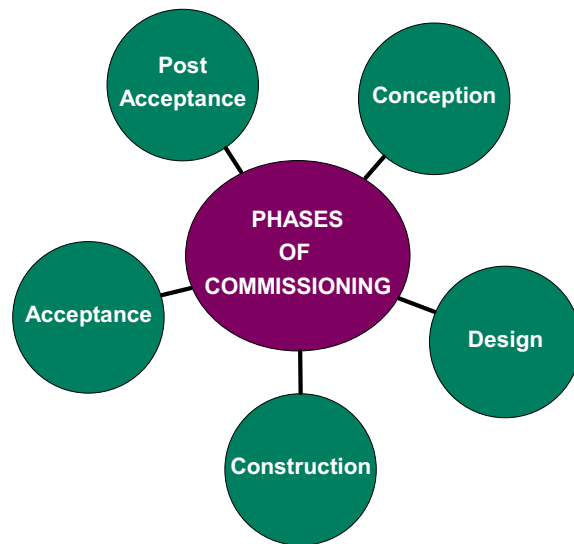
The team oversees the commissioning process through tasks listed in the table below. These tasks are also discussed in *Section 4: Phases of Commissioning*.

	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.

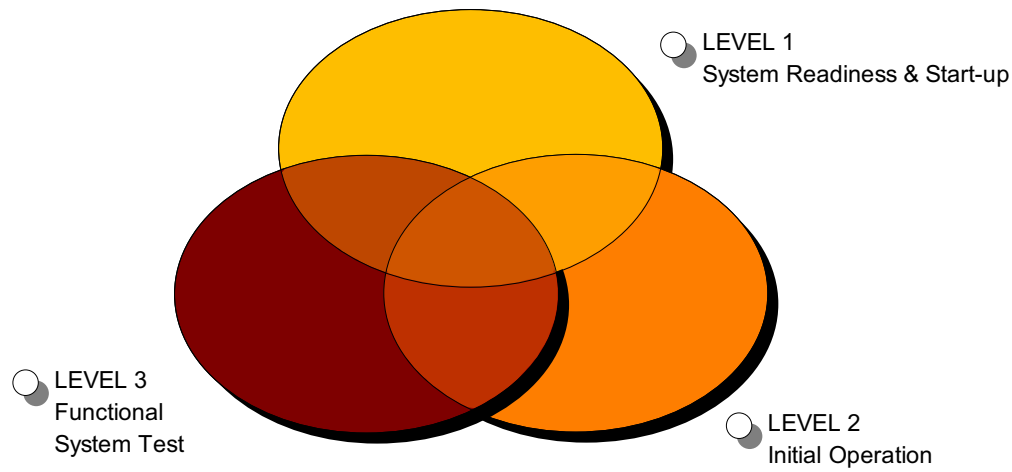
If any check or test cannot be accomplished due to building structure or other building system deficiencies outside the scope of the systems work, these deficiencies will be resolved and corrected by the appropriate parties before completion of the system commissioning process.

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.

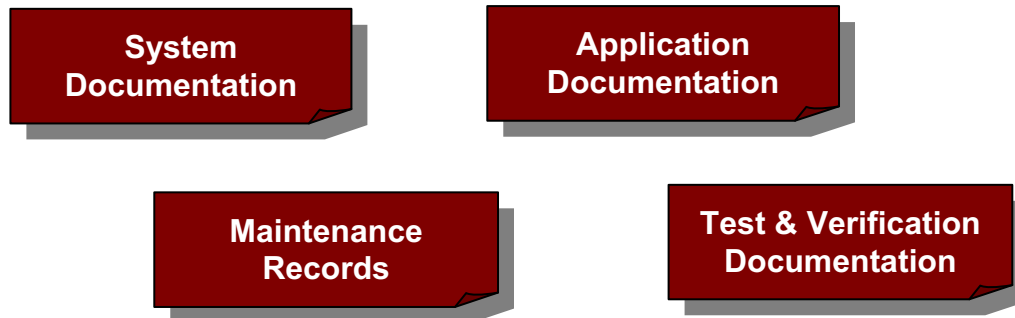
Phases and Levels of Commissioning

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

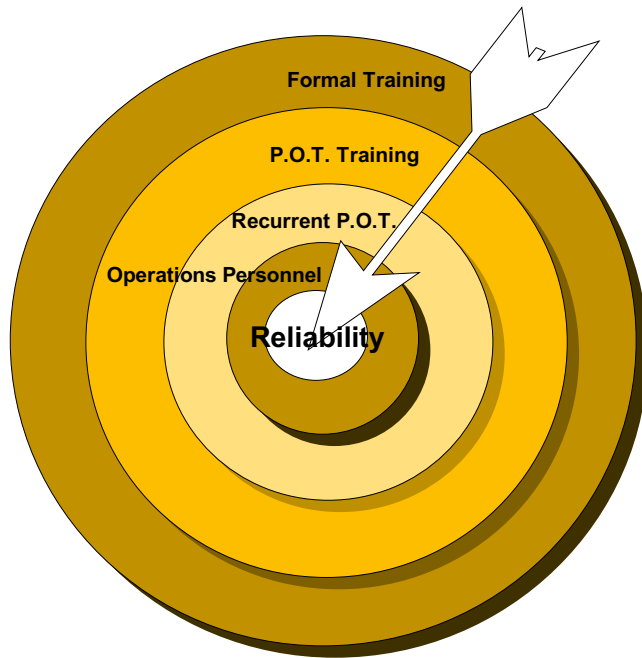
System Format

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:

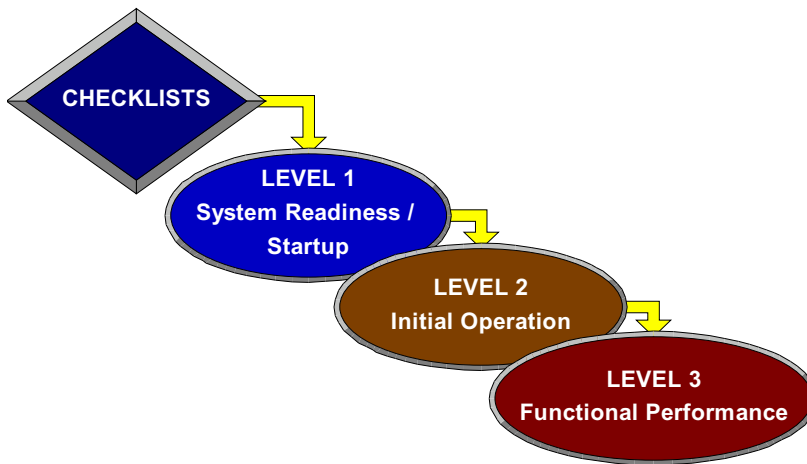
Recurrent P.O.T. is the responsibility of the Operations group, and is usually negotiated by the Operations Manager.

- 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		
Manufacturers 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 Inhibitor 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: _____

CONTROL SYSTEM VERIFICATION CHECKLIST**FPC 302 - HYDRONIC HEATING SYSTEM****SAMPLE**

PROJECT: _____ LOCATION: _____	SYSTEM: _____ 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 Setpoint 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: _____	

**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



Page ____ of ____

Building:

Project Name: _____

[illegible]

Notes and Comments on FIM Punch List Completion:

JCI Project Manager _____ Date _____
