



RESPONSE TO REQUEST FOR QUOTES

Volume II – ECM/Cost Submittal

GESA 2021-2 Guaranteed Energy Savings Project

Pennsylvania Department of Human Services
Wernersville State Hospital

October 12, 2021

SUBMITTED BY:

The Efficiency Network (TEN)
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Contents

Energy Conservation Measures/Cost Submission (2.6).....	1
Recommended Project	6
Optional ECMs	6
Project Monitoring and Maintenance Services	6
Energy Conservation Measure Descriptions.....	9
ECM 1 Interior & Exterior Light Conversion to LED.....	10
ECM 2 Lighting Controls	11
ECM 3 – Weatherization	12
ECM 4 – Boiler Fuel Switch.....	12
ECM 5 – Evaluate Condensate System and Piping Insulation	14
ECM 6 – Decentralized Heating System (Not Currently Recommended – Long Payback).....	15
ECM 7 – Install Building Sub-Meters on Steam Distribution	17
ECM 8 – Steam Trap Testing and Repairs	18
ECM 9 – Chilled Water System Retro-Commissioning	19
ECM 10 – AHU Modifications – BAS Upgrades.....	21
ECM 11 – Kitchen Exhaust Hood Controls.....	23
ECM 12 – Refrigeration Controls.....	24
ECM 12.1 – Kitchen RTU Economizer	25
ECM 13 – Window Replacements (Not Currently Recommended – Long Payback)	26
Measurement and Verification Approach (Method).....	28
 Appendix 0 – Potential ECMs to Consider During the IGA,	
– ECM ESCO A - Cogeneration	
– ECM ESCO B – Solar PV	
Appendix 1 – 13: Core ECM Savings Calculations and Material Cutsheets	
Appendix A – B: ESCO Voluntary ECM Savings Calculations and Material Cutsheets	



Energy Conservation Measures/Cost Submission (2.6)

TEN is pleased to submit the following Energy Conservation Measures (ECMs) for DHS/DGS consideration. This proposal was developed under the parameters identified in the RFQ inclusive of bulletins 1-4 received by TEN. We have identified a self-funding project excluding ECM 6 - Decentralization and ECM 13 – New Windows. Inclusion of those two ECMs will require Energy Related Cost Savings (ERCS). Several project options are summarized for your consideration.

Investment Grade Audit

TEN will continue its RFQ audit and design efforts during the investment grade audit which will require a focused effort by TEN and DHS to deliver a report within 60 days. We are capable and commit to meeting this timeline. Our team also offers the experience of expediting an interim feasibility during the gap between ESCO selection and IGA audit agreement approval. We suggest this approach to offer DHS additional incite and input on their preferred solution to fuel switch and/or decentration at the onset of the IGA. While we have a self-funding solution proposed, DHS may prefer to include additional operation and Maintenance (O&M) savings or Energy Related Cost Savings (ERCS) to pursue a different solution. The DHS's appetite for ERCS is best determined early in the IGA process. Our team successfully demonstrated this approach at SCI Houtzdale which laid the groundwork for an outstanding project. This work will be at TEN's risk, while DHS is processing the audit agreement. This interim step will be in coordination with all relevant stakeholders to facilitate decision making on the most expedient solutions to optimize the Fuel Switch and Decentralization ECMs within the GESA. We have also complemented this development and design experience with additional engineering and construction resources to ensure unique focus for an expedited project for Wernersville State Hospital. This includes key subcontractors that are local and experienced within DHS/DGS and/or your facilities (Conexus, Heim Company & West Side Hammer Electric). Each has a base of operation within 60 miles of your facility ensuring depth of resources close by.

Anticipated milestones are:

- | | |
|-------------------------------------|-------------------------|
| • Kick-off Meeting upon Selection: | January 2022 |
| • Investment Grade Audit: | February – March 2022 |
| • Interim IGA Review Meeting(s): | April – June 2022 |
| • Final IGA Acceptance & Financing: | July 2022 |
| • GESA Contract Execution: | August - September 2022 |

In essence, TEN's IGA effort has already begun, aided by our understanding of similar facilities and our internal staff time on site. We have organized the information already collected during the proposal phase and limited site visits. While this has certainly given us the ability to deliver this quote within the tolerance of accuracy required, it also provides us with an understanding of those areas, such as BAS, in which we will need to focus to hone an optimal project for DHS. Our team will meet in advance to outline an agenda and identify additional information needed before the audit kickoff meeting, so we can be well prepared from the start of the IGA period to use both DHS/DGS and the TEN team's time most efficiently.

TEN will perform the Investment Grade Audit with in-house engineers complemented by an equally experienced design consultant (Entech Engineering) as well as local design-build contractors. The IGA will include, but not be limited to, the following tasks:

- | | |
|---|---|
| • Analyze utility bills and establish utility baselines | • Develop list of ECMs to review with Agency |
| • Physically audit and inspect mechanical and electrical systems to determine, sizing, loads, efficiency, operating conditions and hours of operation | • Develop scopes of work |
| | • Perform energy calculations, methodology, assumptions |
| | • Estimate incentives and rebates |



- Analyze energy consumption for major equipment and systems
- Estimate environmental costs or benefits (emissions reduction)
- Develop commissioning and M&V plans

Upon the IGA kickoff, we will continue with the activities identified above for the ECMs identified in this quote as well as other opportunities discovered through this process and submit a scope of work for the project to the Commonwealth in the form of an IGA report that will reduce DHS's energy and operating expenses. This will include additional on-site surveys of the facilities and further interviews with key stakeholders to better understand the operating characteristics of the facility. The report will include an executive summary which lists all proposed ECMs with the total implementation cost of each ECM, energy savings, energy cost savings, and useful life of the equipment analyses.

The IGA report will present a thorough analysis of each facilities' main energy consuming systems and discuss the scope of proposed ECMs and solutions for DHS. This will summarize the findings and scope developed during bi-weekly meetings of joint DHS, DGS, PSFEI, Agency Consultant and TEN teams. The IGA report will also summarize existing conditions including calculation of baseline energy use and, descriptions of physical conditions, equipment counts, nameplate data, and control strategies prior to project implementation. This analysis will be based on generally accepted engineering practices and reconciled with historic usage. This will include defining under what conditions the baseline may be adjusted for legitimate changes in weather, occupancy, number of users, and equipment usage.

For each ECM proposed, the IGA will include: 1. Total implementation costs for each measure; 2. Equipment counts; 3. Performance characteristics and efficiency levels of the equipment comprising the proposed measure; 4. Installation and maintenance cost; 5. Useful life; and 6. Energy and cost savings.

Projected energy savings calculations will account for on- and off-peak savings, demand savings, and the interaction between recommended measures. All maintenance and monitoring costs will be clearly identified and modeled in the cashflow. The IGA report will also clearly list the contractors and subcontractors who will work on the project.

Project Team

The project team has been thoroughly discussed in the Technical Submission and will include key members from TEN:

- David Robb – VP, Major Accounts
- Jim Harven, PE, CEM, EBCP – Sr. Devel. Mgr.
- Greg Lok, PE, CEM, CMVP – VP, Engineering
- Rajas Hatwalne, CEM – Sr. Energy Engineer
- Mike Fendya, PE, CEM – Sr. Energy Engineer
- Wayne Chase, CMVP, Director, Post Construction
- Dave Clark – VP, Construction
- Bob Tobin – Sr Project Mgr.
- Tony Albright –Project / Site Manager
- Mike Schneider, CPM, CLEP, LC – Mgr. Design
- Daric Holmes – Auditor / Project Designer
- Key sub-contractors / Design Consultants

Energy Conservation Measures and Costs

The ECM summary on the following page confirms that TEN evaluated, prepared scopes of work, solicited pricing and calculated savings for all the core ECMs identified in Appendix R of the RFQ as well as identifying additional ECMs for DHS consideration. Some of these additional ECMs, such as Cogeneration, and Solar Photovoltaic (PV) have the ability to provide modest additional positive cashflow but aren't currently recommended due to their large first cost. These two ECMs and others can be included in the final project at the DHS discretion.



Project Options / O&M Savings / ERCS

We have provided two (2) project options for your consideration. Both options ensure that ECM 4 – Fuel switch can be accomplished in either an energy savings only approach as well as one with O&M savings.

- **Self-Funded Project** – Without O&M savings nor Energy Related Cost Savings (ERCS)
 - Unfortunately, ECM 6 and ECM 13 have too long a payback for this option
- **Recommended Project** – Includes enhancements to the Lighting and Fuel Switch ECMs 1 & 4 (O&M savings are included but ERCS is not required)

The self-funded project has excess cashflow sufficient to add \$40,996 of additional projects but not enough to offset the longer payback of ECMs 6 and 13. ECM summaries and cashflows follow.

Project Option Matrix					
ECM #	Energy Conservation Measure Description	Construction Cost	Annual Energy Savings	Self-Funding Project No O&M Savings	Recommended ECMs
1	LED Ltg. Int. & Ext. - Type A	\$ 405,675	\$ 59,280	✓	✓
1.1	LED Ltg. Add - Type C	\$ 291,921	\$ 13,056		✓
2	Lighting Controls	included above	\$ -	✓	✓
3	Weatherization	\$ 88,667	\$ 8,666	✓	✓
4	Boiler Fuel Switch - Addl. NG Stm Blrs.	\$ 1,513,770	\$ 124,090	✓	✓
4.1	Add for All New NG Blrs + Plant Upgrades	\$ 814,883	\$ 17,105		✓
5	Piping Insulation	\$ 41,742	\$ 3,319	✓	✓
6	Decentralized Heating System	\$ 5,727,500	\$ 160,035		
7	Steam Meters	\$ 334,304	\$ -	✓	✓
8	Steam Traps	\$ 397,806	\$ 31,897	✓	✓
9	Chiller Plant Modifications - RCx	\$ 59,974	\$ 8,811	✓	✓
10	AHU Modifications & BAS Upgrades	\$ 835,761	\$ 93,097	✓	✓
11	Kitchen Hood Controls	\$ 55,012	\$ 3,467	✓	✓
12	Kitchen Systems - Refr. Controls	\$ 28,394	\$ 1,757	✓	✓
12.1	Kitchen Systems - RTU Economizer	\$ 11,345	\$ 741	✓	✓
13	Replace Windows	\$ 4,807,330	\$ 4,553		
Total Construction Cost (before consultant fee & DHS contingency):				\$ 3,772,449	\$ 4,879,254
PLUS DHS Energy Consultant Fee:				\$ 270,161	\$ 349,424
Sub-Total (incl. Consultant Fee):				\$ 4,042,610	\$ 5,228,678
LESS Act 129 Rebates (Estimated):				\$ 13,746	\$ 28,338
Sub-Total (after Rebates):				\$ 4,028,864	\$ 5,200,339
Plus Project Contingency Fund:				\$ 75,449	\$ 97,585
Net Financed Amount:				\$ 4,104,313	\$ 5,297,925
1st Year Energy Savings:				\$ 282,397	\$ 285,182
Annual O&M Savings:				\$ -	\$ 80,104
Annual Energy and O&M Savings:				\$ 282,397	\$ 365,286
Project Simple Payback (w/o ERCS)				14.3	14.2
Required Annual Energy Related Cost Savings (ERCS):				\$ -	\$ -
Net Present Value (NPV) of Cashflow				\$ 40,996	\$ 20,627



Self Funded Project (18 year payback)								Annual Utility Savings					H
ECM #	Base Project (No ERCS Required) Energy Conservation Measure Description	A Construction Cost	B Utility Rebates	C Annual Energy Savings	D O&M Savings	E Total Energy and O&M Savings	F Simple Payback	Natural Gas (DTH)	Electric (kWh)	Steam (Mlbs)	Oil (gal)	Coal (tons)	Annual SPB Shortfall
1	LED Ltg. Int. & Ext. - Type A	\$ 405,675	\$ -	\$ 52,917	\$ -	\$ 52,917	7.7	-	693,126	-	-	-	-
2	Lighting Controls (included in ECM 1)	\$ -	\$ -	\$ -	\$ -	\$ -	n/a	-	-	-	-	-	-
3	Weatherization	\$ 88,667	\$ -	\$ 8,666	\$ -	\$ 8,666	10.2	-	-	1,120	-	-	-
4	Boiler Fuel Switch - Addl. NG Stm Blrs.	\$ 1,513,770	\$ -	\$ 105,700	\$ -	\$ 105,700	14.3	(56,295)	98,735	7,333	7,948	2,179	-
5	Piping Insulation	\$ 41,742	\$ -	\$ 3,319	\$ -	\$ 3,319	12.6	-	-	429	-	-	-
7	Steam Meters	\$ 334,304	\$ -	\$ -	\$ -	\$ -	n/a	-	-	-	-	-	-
8	Steam Traps	\$ 397,806	\$ -	\$ 31,897	\$ -	\$ 31,897	12.5	-	-	4,122	-	-	-
9	Chiller Plant Modifications - RCx	\$ 59,974	\$ 2,308	\$ 8,811	\$ -	\$ 8,811	6.8	-	115,405	-	-	-	-
10	AHU Modifications & BAS Upgrades	\$ 835,761	\$ 10,444	\$ 65,122	\$ -	\$ 65,122	12.8	-	522,187	3,264	-	-	-
11	Kitchen Hood Controls	\$ 55,012	\$ 534	\$ 3,467	\$ -	\$ 3,467	15.9	262	26,705	-	-	-	-
12	Kitchen Systems - Refr. Controls	\$ 28,394	\$ 460	\$ 1,757	\$ -	\$ 1,757	16.2	-	23,012	-	-	-	-
12.1	Kitchen Systems - RTU Economizer	\$ 11,345	\$ -	\$ 741	\$ -	\$ 741	15.3	-	9,712	-	-	-	-
	Consultant Fee	\$ 270,161	\$ -	\$ -	\$ -	\$ -	n/a	-	-	-	-	-	-

Totals	\$ 4,042,610	\$ 13,746	\$ 282,397	\$ -	\$ 282,397	14.3
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-56,033	1,488,882	16,268	7,948	2,179	0
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PLUS Contingency Fund (2%):	\$ 75,449
LESS Utility Rebates:	\$ 13,746
LESS Energy Related Cost Savings:	\$ -
Net Financed Amount:	\$ 4,104,313

Excess Cumulative Cashflow:	\$ 53,654
NPV of Cashflow:	\$ 40,996

Project Cost:	\$ 4,042,610
DHS Contingency:	\$ 75,449
Rebates/ Incentives:	\$ 13,746
Net Project Cost to be Financed:	\$ 4,104,313
First Year Energy Savings:	\$ 282,397

Interest Rate:	3.00%
Utility Escalation Rate:	1%
Construction Period (Months):	12
Payment Frequency:	Annual
Construction Period Interest:	\$ 119,955

Year	Annual Energy Costs (Before)	Annual Energy Costs (After)	Annual Energy Savings	O&M Savings	Total Annual Savings	Annual Financing Payments	Energy Related Cost Savings	Other Payments (M&V)	Net Annual Benefit	Excess Cumulative Cashflow
	A	B	C=A-B	D	E=C+D	F	G	H	I=E-F+G-H	J
0	\$ 1,451,667	\$ 1,345,868	\$ 105,800	\$ -	\$ 105,800	Sav. Paid Yr1	\$ -	\$ -		\$ -
1	\$ 1,466,184	\$ 1,183,787	\$ 282,397	\$ -	\$ 282,397	\$ 370,215	\$ -	\$ 15,000	\$ 2,981	\$ 2,981
2	\$ 1,480,846	\$ 1,195,625	\$ 285,220	\$ -	\$ 285,220	\$ 266,790	\$ -	\$ 15,450	\$ 2,981	\$ 5,962
3	\$ 1,495,654	\$ 1,207,581	\$ 288,073	\$ -	\$ 288,073	\$ 269,178	\$ -	\$ 15,914	\$ 2,981	\$ 8,942
4	\$ 1,510,611	\$ 1,219,657	\$ 290,953	\$ -	\$ 290,953	\$ 287,973	\$ -	\$ -	\$ 2,981	\$ 11,923
5	\$ 1,525,717	\$ 1,231,854	\$ 293,863	\$ -	\$ 293,863	\$ 290,882	\$ -	\$ -	\$ 2,981	\$ 14,904
6	\$ 1,540,974	\$ 1,244,172	\$ 296,802	\$ -	\$ 296,802	\$ 293,821	\$ -	\$ -	\$ 2,981	\$ 17,885
7	\$ 1,556,384	\$ 1,256,614	\$ 299,770	\$ -	\$ 299,770	\$ 296,789	\$ -	\$ -	\$ 2,981	\$ 20,865
8	\$ 1,571,948	\$ 1,269,180	\$ 302,767	\$ -	\$ 302,767	\$ 299,787	\$ -	\$ -	\$ 2,981	\$ 23,846
9	\$ 1,587,667	\$ 1,281,872	\$ 305,795	\$ -	\$ 305,795	\$ 302,814	\$ -	\$ -	\$ 2,981	\$ 26,827
10	\$ 1,603,544	\$ 1,294,691	\$ 308,853	\$ -	\$ 308,853	\$ 305,872	\$ -	\$ -	\$ 2,981	\$ 29,808
11	\$ 1,619,579	\$ 1,307,638	\$ 311,941	\$ -	\$ 311,941	\$ 308,961	\$ -	\$ -	\$ 2,981	\$ 32,788
12	\$ 1,635,775	\$ 1,320,714	\$ 315,061	\$ -	\$ 315,061	\$ 312,080	\$ -	\$ -	\$ 2,981	\$ 35,769
13	\$ 1,652,133	\$ 1,333,921	\$ 318,211	\$ -	\$ 318,211	\$ 315,231	\$ -	\$ -	\$ 2,981	\$ 38,750
14	\$ 1,668,654	\$ 1,347,260	\$ 321,394	\$ -	\$ 321,394	\$ 318,413	\$ -	\$ -	\$ 2,981	\$ 41,731
15	\$ 1,685,341	\$ 1,360,733	\$ 324,608	\$ -	\$ 324,608	\$ 321,627	\$ -	\$ -	\$ 2,981	\$ 44,712
16	\$ 1,702,194	\$ 1,374,340	\$ 327,854	\$ -	\$ 327,854	\$ 324,873	\$ -	\$ -	\$ 2,981	\$ 47,692
17	\$ 1,719,216	\$ 1,388,084	\$ 331,132	\$ -	\$ 331,132	\$ 328,151	\$ -	\$ -	\$ 2,981	\$ 50,673
18	\$ 1,736,408	\$ 1,401,965	\$ 334,443	\$ -	\$ 334,443	\$ 331,463	\$ -	\$ -	\$ 2,981	\$ 53,654

Note: Const. period savings applied to 1st yr payment per RFQ 2.6C1h(9).

NPV of Cashflow (column H): **\$40,996**



Recommended Project		A	B	C	D	E	F	Annual Utility Savings					H
ECM #	O&M Savings Included (No ERCS Required) Energy Conservation Measure Description	Construction Cost	Utility Rebates	Annual Energy Savings	O&M Savings	Total Energy and O&M Savings	Simple Payback	Natural Gas (DTH)	Electric (kWh)	Steam (Mlbs)	Oil (gal)	Coal (tons)	Annual \$PB Shortfall
1	LED Ltg. Int. & Ext. - Type A	\$ 405,675	\$ 13,863	\$ 52,917	\$ 6,363	\$ 59,280	6.8	-	693,126	-	-	-	-
1.1	LED Ltg. Add - Type C	\$ 291,921	\$ 730	\$ 2,785	\$ 10,271	\$ 13,056	22.4	-	36,480	-	-	-	-
2	Lighting Controls (included in ECM 1)	\$ -	\$ -	\$ -	\$ -	\$ -	n/a	-	-	-	-	-	-
3	Weatherization	\$ 88,667	\$ -	\$ 8,666	\$ -	\$ 8,666	10.2	-	-	1,120	-	-	-
4	Boiler Fuel Switch - Addl. NG Strm Blrs.	\$ 1,513,770	\$ -	\$ 105,700	\$ 18,390	\$ 124,090	12.2	(56,295)	98,735	7,333	7,948	2,179	-
4.1	Add for All New NG Blrs + Plant Upgrades	\$ 814,883	\$ -	\$ -	\$ 17,105	\$ 17,105	47.6	-	-	-	-	-	-
5	Piping Insulation	\$ 41,742	\$ -	\$ 3,319	\$ -	\$ 3,319	12.6	-	-	429	-	-	-
7	Steam Meters	\$ 334,304	\$ -	\$ -	\$ -	\$ -	n/a	-	-	-	-	-	-
8	Steam Traps	\$ 397,806	\$ -	\$ 31,897	\$ -	\$ 31,897	12.5	-	-	4,122	-	-	-
9	Chiller Plant Modifications - RCx	\$ 59,974	\$ 2,308	\$ 8,811	\$ -	\$ 8,811	6.8	-	115,405	-	-	-	-
10	AHU Modifications & BAS Upgrades	\$ 835,761	\$ 10,444	\$ 65,122	\$ 27,975	\$ 93,097	9.0	-	522,187	3,264	-	-	-
11	Kitchen Hood Controls	\$ 55,012	\$ 534	\$ 3,467	\$ -	\$ 3,467	15.9	262	26,705	-	-	-	-
12	Kitchen Systems - Refr. Controls	\$ 28,394	\$ 460	\$ 1,757	\$ -	\$ 1,757	16.2	-	23,012	-	-	-	-
12.1	Kitchen Systems - RTU Economizer	\$ 11,345	\$ -	\$ 741	\$ -	\$ 741	15.3	-	9,712	-	-	-	-
	Consultant Fee	\$ 349,424	\$ -	\$ -	\$ -	\$ -	n/a	-	-	-	-	-	-
		\$ -	\$ -	\$ -	\$ -	\$ -		-	-	-	-	-	-

Totals	\$ 5,228,678	\$ 28,338	\$ 285,182	\$ 80,104	\$ 365,286	14.2
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-56,033	1,525,362	16,268	7,948	2,179	0
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PLUS Contingency Fund (2%):	\$ 97,585
LESS Utility Rebates:	\$ 28,338
LESS Energy Related Cost Savings:	\$ -
Net Financed Amount:	\$ 5,297,925

Excess Cumulative Cashflow:	\$ 26,996
NPV of Cashflow:	\$ 20,627

Project Cost:	\$ 5,228,678
DHS Contingency:	\$ 97,585
Rebates/ Incentives:	\$ 28,338
Net Project Cost to be Financed:	\$ 5,297,925
First Year Energy Savings:	\$ 365,286

Interest Rate:	3.00%
Utility Escalation Rate:	1%
Construction Period (Months):	12
Payment Frequency:	Annual
Construction Period Interest	\$ 155,764

Year	Annual Energy Costs (Before)	Annual Energy Costs (After)	Annual Energy Savings	O&M Savings	Total Annual Savings	Annual Financing Payments	Energy Related Cost Savings	Other Payments (M&V)	Net Annual Benefit	Excess Cumulative Cashflow
	A	B	C=A-B	D	E=C+D	F	G	H	I=E-F+G-H	J
0	\$ 1,451,667	\$ 1,345,868	\$ 105,800	\$ -	\$ 105,800	Sav. Paid Yr1	\$ -	\$ -		\$ -
1	\$ 1,466,184	\$ 1,181,002	\$ 285,182	\$ 80,104	\$ 365,286	\$ 454,586	\$ -	\$ 15,000	\$ 1,500	\$ 1,500
2	\$ 1,480,846	\$ 1,192,812	\$ 288,033	\$ 80,271	\$ 368,304	\$ 351,354	\$ -	\$ 15,450	\$ 1,500	\$ 3,000
3	\$ 1,495,654	\$ 1,204,740	\$ 290,914	\$ 80,439	\$ 371,352	\$ 353,939	\$ -	\$ 15,914	\$ 1,500	\$ 4,499
4	\$ 1,510,611	\$ 1,216,788	\$ 293,823	\$ 80,608	\$ 374,431	\$ 372,931	\$ -	\$ -	\$ 1,500	\$ 5,999
5	\$ 1,525,717	\$ 1,228,956	\$ 296,761	\$ 80,780	\$ 377,541	\$ 376,041	\$ -	\$ -	\$ 1,500	\$ 7,499
6	\$ 1,540,974	\$ 1,241,245	\$ 299,729	\$ 80,953	\$ 380,681	\$ 379,182	\$ -	\$ -	\$ 1,500	\$ 8,999
7	\$ 1,556,384	\$ 1,253,658	\$ 302,726	\$ 81,127	\$ 383,854	\$ 382,354	\$ -	\$ -	\$ 1,500	\$ 10,498
8	\$ 1,571,948	\$ 1,266,194	\$ 305,753	\$ 81,304	\$ 387,057	\$ 385,558	\$ -	\$ -	\$ 1,500	\$ 11,998
9	\$ 1,587,667	\$ 1,278,856	\$ 308,811	\$ 81,482	\$ 390,293	\$ 388,793	\$ -	\$ -	\$ 1,500	\$ 13,498
10	\$ 1,603,544	\$ 1,291,645	\$ 311,899	\$ 81,663	\$ 393,561	\$ 392,062	\$ -	\$ -	\$ 1,500	\$ 14,998
11	\$ 1,619,579	\$ 1,304,561	\$ 315,018	\$ 81,844	\$ 396,862	\$ 395,363	\$ -	\$ -	\$ 1,500	\$ 16,497
12	\$ 1,635,775	\$ 1,317,607	\$ 318,168	\$ 82,028	\$ 400,196	\$ 398,697	\$ -	\$ -	\$ 1,500	\$ 17,997
13	\$ 1,652,133	\$ 1,330,783	\$ 321,350	\$ 82,214	\$ 403,564	\$ 402,064	\$ -	\$ -	\$ 1,500	\$ 19,497
14	\$ 1,668,654	\$ 1,344,091	\$ 324,563	\$ 82,401	\$ 406,964	\$ 405,465	\$ -	\$ -	\$ 1,500	\$ 20,997
15	\$ 1,685,341	\$ 1,357,532	\$ 327,809	\$ 82,591	\$ 410,399	\$ 408,900	\$ -	\$ -	\$ 1,500	\$ 22,496
16	\$ 1,702,194	\$ 1,371,107	\$ 331,087	\$ 82,782	\$ 413,869	\$ 412,369	\$ -	\$ -	\$ 1,500	\$ 23,996
17	\$ 1,719,216	\$ 1,384,818	\$ 334,398	\$ 82,975	\$ 417,373	\$ 415,873	\$ -	\$ -	\$ 1,500	\$ 25,496
18	\$ 1,736,408	\$ 1,398,666	\$ 337,742	\$ 83,170	\$ 420,912	\$ 419,412	\$ -	\$ -	\$ 1,500	\$ 26,996

Note: Const. period savings applied to 1st yr payment per RFQ 2.6C1h(9).

NPV of Cashflow (column H): **\$20,627**



Annual Financial Projections

The cash flows illustrate that the proposed project(s) will pay for themselves within 18 years (after construction) when modeled at a 3% interest rate. The net present value of the Self-Funding Project excess cash flow over 18 years is \$40,996 based on a 3% discount rate. The Self-Funding Project is cashflow positive without using O&M savings nor ERCS, per RFQ 2.6C1(c). The Recommended Project incorporates the additional O&M savings, per RFQ 5.3A(12). The columns in the cash flows represent the following. **Note:** The payments in column D of the cash flow include the repayment of capitalized interest cost based on a twelve (12) month construction period.

- | | |
|---|---------------------------------------|
| A. Annual energy costs without improvements | G. Energy Related Cost Savings (ERCS) |
| B. Annual energy costs with improvements | H. M&V payments |
| C. Annual energy cost savings (A-B) | I. Net annual benefit |
| D. Annual O&M savings | J. Cumulative cash flow |
| E. Total Annual savings | K. Net Present Value of cash flow |
| F. Payments for financing equipment | |

Recommended Project

The Recommended Project includes scope enhancements to the lighting and fuel switch ECMs, in particular, all new steam boilers at the central plant (rather than just redundant capacity) along with upgrades to the feed water and domestic hot water equipment. These enhancements are made possible through the inclusion of operation and maintenance (O&M) savings but do **not** require any Energy Related Cost Savings (ERCS). We have been conservative in the application of operation and maintenance (O&M) savings. More aggressive O&M savings or ERCS could be used to support longer payback ECMs like ECM 6-Decentralization and ECM 13-New Windows. These ECMs are not included due to their current long payback. TEN also developed two ESCO ECMs for your consideration. ESCO A – Cogeneration and ESCO B – Solar PV are both **just** self-funding and can be included in the project, however this warrants further discussion with DHS as they would double the size of the project.

Optional ECMs

Immediately below is a summary of additional ECMs investigated by TEN for potential inclusion by DHS.

ECMs Evaluated But Not Included		A	B	C	D	E	F	G Annual Utility Savings					H
ECM #	Evaluated Project Conservation Measure Description	Construction Cost	Utility Rebates	Annual Energy Savings	O&M Savings	Total Energy and O&M Savings	Simple Payback	Natural Gas (DTH)	Electric (kWh)	Steam (Mlbs)	Oil (gal)	Coal (tons)	Annual SPB Shortfall
6	Decentralized Heating System	\$ 5,727,500	\$ -	\$ 160,035	\$ -	\$ 160,035	36	(47,646)	(76,645)	7,333	7,948	2,179	\$ 158,159
9.1	Chiller Plant Modifications - New Chillers	\$ 954,100	\$ 5,139	\$ 19,617	\$ -	\$ 19,617	49		256,951				\$ 33,103
13	Replace Windows	\$ 4,807,330	\$ -	\$ 4,553	\$ -	\$ 4,553	1,056	780	3,865	-	-	-	\$ 262,520
ESCO A	Cogeneration	\$ 4,350,000	\$ 500,000	\$ 330,656	\$ (93,931)	\$ 236,725	16	(29,319)	5,262,111	-	-	-	-
ESCO B	Solar PV Array - Ground Mount	\$ 746,162	\$ -	\$ 46,781	\$ -	\$ 46,781	16	-	493,000	-	-	-	-

Project Monitoring and Maintenance Services

The measurement and verification of the proposed ECMs is anticipated to be conducted according to the M&V plan identified in the Technical Submission. Onsite measurements, field work and report generation will be prepared by Wayne Chase a Certified Measurement and Verification Professional (CMVP) and Certified Energy Manager (CEM) in conjunction with Greg Lok, his supervisor who is also a CMVP and PE. The proposed M&V plan includes IPMVP options A, B, C & D and is more specifically addressed later in this volume.



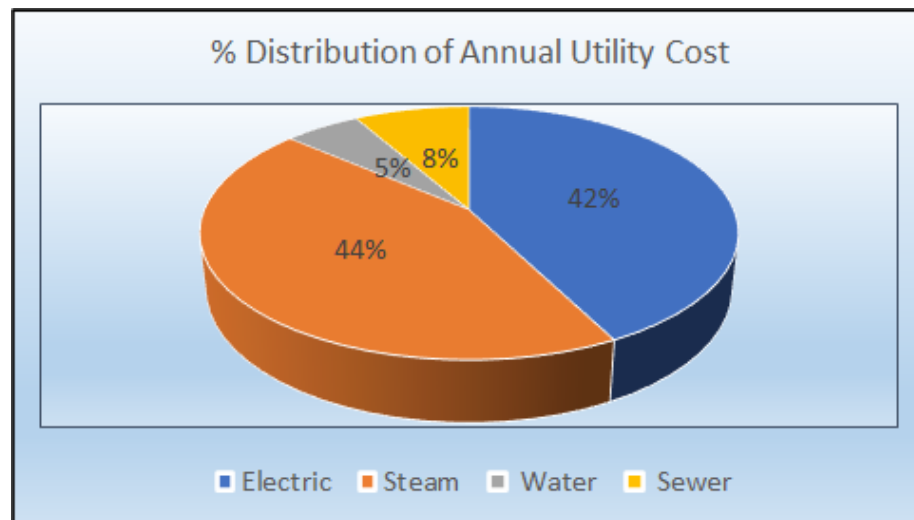
It is anticipated that DHS will incorporate the upgraded systems into their preventative maintenance routines or renegotiated service agreements which includes maintenance as a means of ensuring availability and maximizing revenues. TEN's project management team will be available to facilitate warranty claims or repair work as necessary. Project training is included in the installation cost of the project.

Baseline Utility Data

The following table summarize utilities as provided in the request for proposal and bulletins. This information was then analyzed to aid in identifying areas for energy savings and to ensure TEN did not over-potential project savings. The total area and costs were derived from the utility cost and usage summary reports provided. The resulting analysis also served as the starting point for bottom-up and top-down savings calculations and validations.

DHS Wernersville Baseline Energy Consumption and Cost								
Annual Electric Usage (kWH)	Annual Steam Usage (Milb)	Annual Water Usage (kGal)	Annual Sewer Usage (kGal)	Annual Electric Cost (\$)	Annual Steam Cost (\$)	Annual Water Cost (\$)	Annual Sewer Cost (\$)	Total Utility Cost per Yr
6,042,606	61,646	18,742	11,478	\$447,836	\$462,978	\$57,366	\$87,208	\$1,055,388

As shown above, electric and steam are the largest utility costs incurred by DHS Wernersville, accounting for approximately 85% of the utility spend. The facility primarily uses anthracite coal as the boiler fuel to generate high pressure steam. However during the summer months, they switch to natural gas as primary fuel and fuel oil as backup. The utility data provided shows coal, natural gas, and oil being consumed every year to generate steam. Since all three fuel types are used to generate steam, steam generated at the central plant is also metered and shows up on the utility data, TEN decided to utilize steam as the baseline heating fuel to simplify energy accounting and savings calculations.

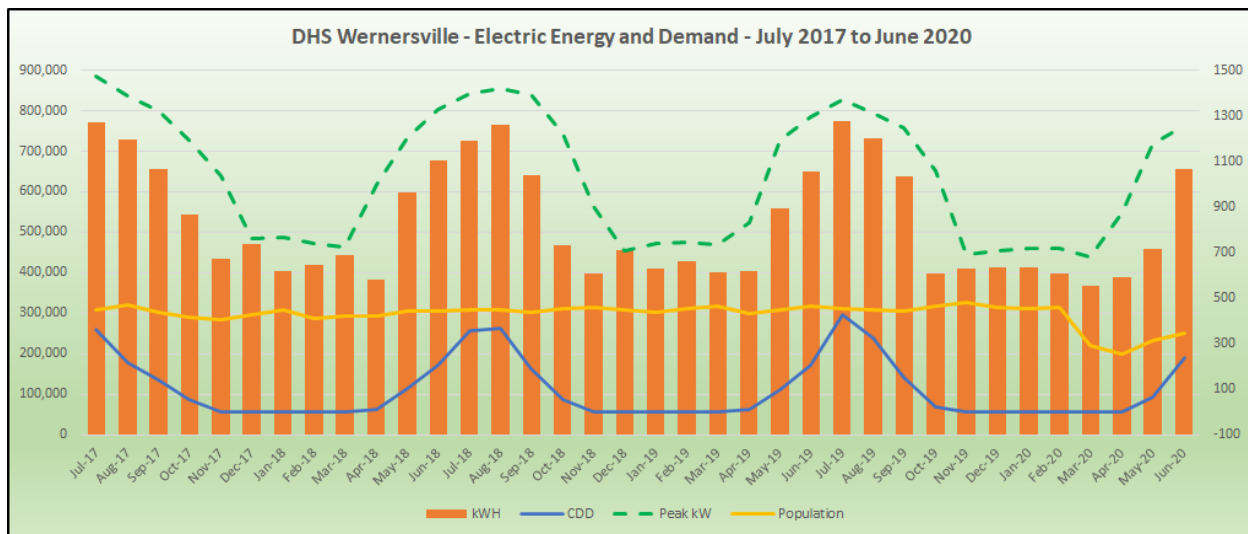


DHS Wernersville Baseline Energy Usage and Total Cost								
SqFt	Annual Electric Usage (kWH)	Annual Coal Usage (Tons)	Annual Fuel Oil Usage (Gallon)	Annual Nat. Gas Used (MCF)	Total Energy (MMBtu/Yr)	Site EUI (KBtu/SqFt)	Total Utility Cost per Yr	Cost Index (\$/SqFt)
770,000	6,042,606	2,304	6,693	20,440	99,594,372	143	\$1,055,388	\$1.51

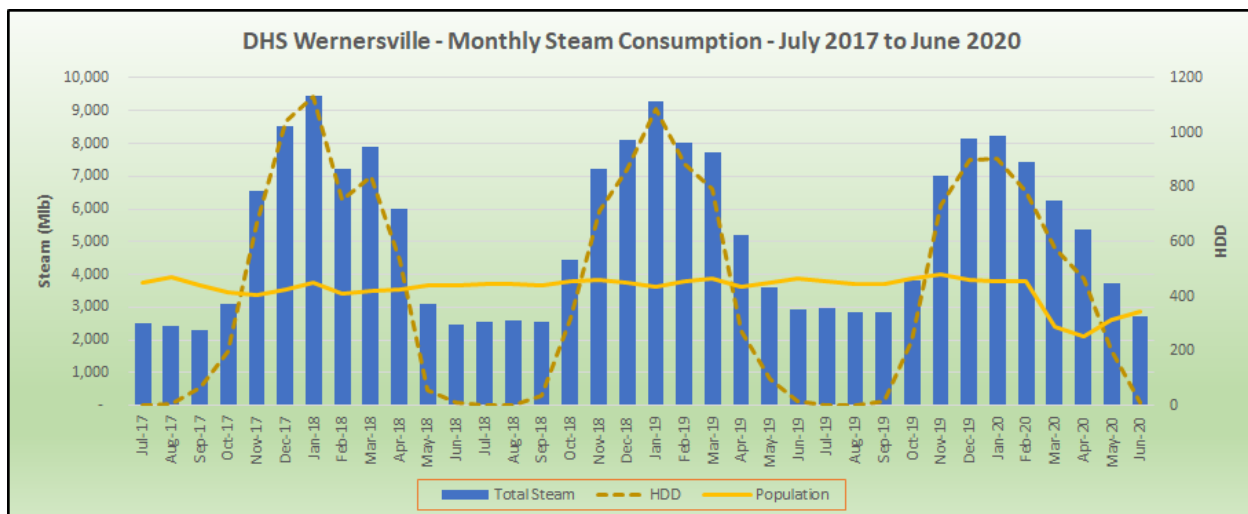


The tables above show the total energy and water/sewer use and the raw Energy Usage Index (EUI), in btu's per sq.ft. for all three fuels for steam generation and electricity, as well as annual gallons / sq.ft. for water and sewer. The calculated energy use index (site EUI) represents 79% of heating fuel usage and 21% electric. This type of benchmarking facilitates energy accounting and assists in identifying opportunities for improvement and to verify energy savings.

The monthly electric data from July 2017 to June 2020 was analyzed. Electric service is provided by PPL Electric Utilities. There are two electric meters, a common meter for all three chiller plants and the second meter for the entire campus. Major consumers of electricity at the facility include lighting and HVAC. The following plot shows monthly electric consumption (kWH) along with demand (kW), population and cooling degree-days (CDD).

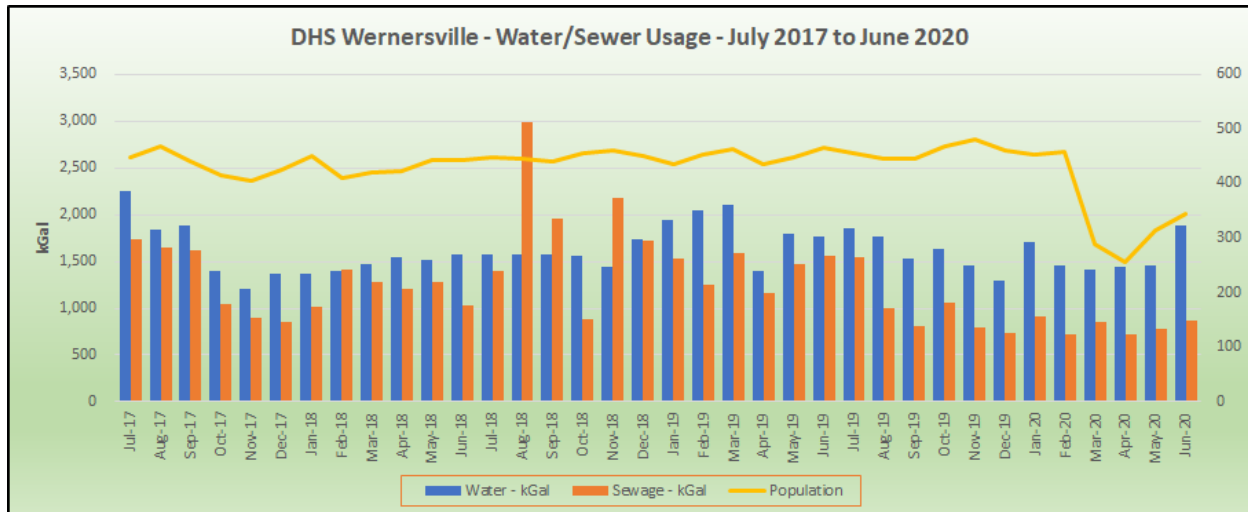


The steam data from July 2017 to June 2020 shows monthly steam generated from all three fuels. It also shows the steam demand during the summer months when steam is used for domestic hot water, kitchen, and a small reheat load. More often than not, steam production exceeds demand during the summer months, and the excess steam is blown off at the central plant.





The monthly water/sewer consumption data is shown below. The facility is also equipped with rainwater harvesting system at the three main buildings. The sewer system is believed to be equipped with a dedicated meter and the plot also shows the higher water consumption as a result of boiler and cooling tower makeup.



Utility rates were derived from the summary spreadsheets since actual copies were not available.

DHS Wernersville Baseline Energy Rates for Analysis				
Electric \$/kW	Electric \$/kWh (Blended)	Steam \$/Mlb	Water \$/kGal	Sewer \$/kGal
\$0.00	\$0.0741	\$7.51	\$3.06	\$7.60

Energy Conservation Measure Descriptions

The following pages describe the technical feasibility, suitability, reasonableness, comprehensiveness and acceptability of the proposed ECMs. Quality & DHS familiarity of the proposed equipment as well as local suppliers & installers was also a key consideration of ECM scoping.

We have identified some optional “ESCO ECMs” for your consideration that complement the required RFQ Core ECMs. We also commit to DHS that we will prepare/finalize a feasibility study of relevant Fuel Switch & Decentralize options for your consideration between ESCO selection and audit agreement approval. Like SCI Houtzdale, it will arm DHS stakeholders with sufficient information to select their preferred Fuel Switch and/or Decentralization approach at the onset of the IGA.

We greatly appreciate Wernersville staff supporting our four site visits and our desire to maximize our staff disciplines during each. We trust that it demonstrated TEN’s commitment to use DHS escort time effectively and develop the proposal with our internal staff rather than delegate to subcontractors. While all of our pricing is backed by contractor quotes, it has been at the direction of our staff who have prepared the scopes of work based on those site visits. We believe this is why you see a strong correlation between TEN’s RFQ and IGA pricing. Conversely minimal effort and abbreviated scopes of work may yield especially attractive RFQ cost and savings but not hold true during the IGA.



ECM 1 Interior & Exterior Light Conversion to LED

Overview

The Efficiency Network has conducted an audit and preliminary lighting design for the Wernersville State Hospital. The lighting design is focused on the potential energy savings through an LED lighting retrofit project and includes two different approaches to linear fluorescent lamp retrofit for DHS consideration:

- **ECM 1** – Type A TLED Lamp Retrofit (provides better payback to support ECM-4)
- **ECM 1.1** – Upgrade from Type A to Type C TLED Lamp & Driver Retrofit

Existing Conditions

Interior lighting - Most luminaires have generation II T8 technology with 25-watt fluorescent lamps and electronic ballasts utilizing low, medium, and high ballast factor along with compact fluorescent and HID technologies. Other technologies include 13W GX23 2-Pin lamps in drum fixtures, and T5HO linear fluorescent lamps. **Exterior lighting** includes the Tunnel System, Shoe Box style pole lighting, Wall Packs, Canopy lights, Dusk-to-Dawn, and Jelly Jar luminaires.

Proposed Upgrade

Recommended Lighting Efficiency Measures:

1. Retrofit existing T12, T8 & T5HO (2'3'/4') fluorescent lamps with UL Type A TLED lamps.
2. Relamp existing CFL and incandescent lamps with new LED A19 lamps.
3. Retrofit pin-base compact fluorescent lamps with new LED retrofit kit.
4. Retrofit CFL drum luminaires with new LED drum kits.
5. Relamp T8 Linear Fluorescent Bed Lights with UL Type A TLED plug-n-play lamps.
6. Retrofit HID lamps with new LED lamps that are omni-directional and bypass the ballast.
7. Retrofit HID lamps with new LED lamps that are hazardous location rated and are ballast compatible.
8. Replace Induction, compact fluorescent, and HID wall packs with new LED wall packs with photocell.
9. Existing LED exit signs will remain as is.
10. No occupancy sensors are included at this time due to sensors already present / installed on previous energy-saving project. TEN will look for additional areas that will benefit from sensors during the IGA.

Scope of Work

The lighting system improvement's will be designed to maximize savings while maintaining or improving existing light levels in each area. Post-retrofit light levels are typically increased due to design and installation of newer and more efficient equipment.



Retrofit Type	# of Luminaires
Retrofit existing luminaire with UL Type A	4,892
Retrofit drum and wall sconce with "Ready Fit" LED kit	285
New LED, wall pack, flood, jelly jar, shoe box, or dusk-to-dawn	255
Screw-in LED lamp	46
Plug-in LED lamp	6
No Retrofit LED exit sign	136
No Retrofit LED exterior luminaires	30
Replacement (new luminaire)	255
Retrofit	5,229
No Replacement / No Retrofit	166
Totals	5,650

Maintenance Impact

Wernersville will realize additional savings in the reduction of replacement materials, either through the extended warranties, reduced energy usage of proposed LED luminaires, lamps (and drivers), as well as increased operating life of new equipment. Utility incentives will be realized but not guaranteed based on the proposed LED lighting upgrade as per the utility rebate incentive program and current available funds.

Training

Training will be provided by Tony Albright and Daric Holmes and will address warranty procedures as well as maintenance that may be required by DHS. Due to the long life of the product being installed, it may be some time before significant maintenance is required. TEN will deliver to DHS comprehensive operations and maintenance manuals including an electronic video of the training provided.

Measurement and Verification (and Savings)

ECM	Electric (kWh)	Material Savings	M&V
1 - Lighting Base – Predominantly Type A TLED	693,126	\$6,363	IMPVP – Option A
Add 1.1 – Upgrade to Type C TLED & Driver	36,480	\$10,271	IMPVP – Option A
Total	729,606	\$16,634	

ECM 2 Lighting Controls

Existing Conditions

TEN observed existing lighting controls that were installed during the previous energy-saving project. The areas that would benefit from lighting controls were already addressed and as a result no additional short payback savings are available. **It should be noted that the cost and savings in ECM-1 includes replacing existing luminaire mounted controls with similar new integrated controls.** New LED exterior luminaires are a good example of a proposed one for one replacement. **As such, the cost of these integrated controls is borne within ECM-1 and not broken out within ECM-2.** During the IGA stage, TEN will continue to look for lighting control opportunities that may not have been included in the first GESA project.



ECM 3 – Weatherization

Existing Conditions

Existing buildings typically have numerous air-leak paths through the envelope in such locations as gaps at transitions between wall, floor and roof levels, structural penetrations through the wall system, and at transitions in wall system types.

Proposed Upgrade

TEN proposes to install sweeps, weather stripping and astragals on doors and to seal various building envelope penetrations with sealant to reduce the amount of infiltration into buildings.

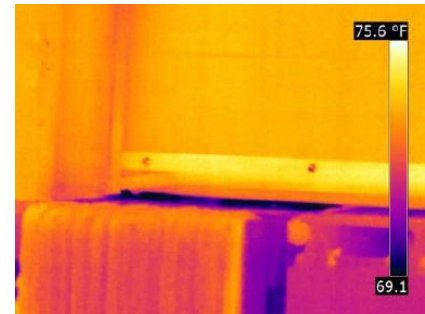


Figure 1. Building 35 - Thermal Image of Air Exfiltration Under Door

Scope of Work

Quantity	Envelope Improvement Type
1,986	Linear Feet - Wall cracks, window/door frames and vents sealed with polyurethane sealant
114	Sets of weather-strip DF
120	Door sweeps
36	Astragals (weather-strip for center of double door)
4	Sets of weather-strip DF (OH Door)
4	Door sweeps (OH Door)

Maintenance Impact

Installation of the proposed scope will not increase maintenance requirements.

Training

Tony Albright will train the maintenance staff regarding annual inspection and repair, if necessary.

Measurement and Verification (and Savings)

- 1,120 MIb Steam (IPMVP Option C)

ECM 4 – Boiler Fuel Switch

Existing Conditions

The existing boiler plant is circa 1955 and consists of three coal fired boilers as well as condensate, feed water, blowdown, coal handling, and ash handling systems. The plant also includes domestic water pumping, domestic water heating and domestic water conditioning systems.

The plant delivers 100 psig steam to the old boiler plant (Bldg 13) where the pressure is reduced to 50 psi and distributed to the campus. The boiler plant is metered and currently provides a peak load of 19,000 MIbs of steam to the campus according to owner supplied data. Existing loads on campus include comfort heating, domestic water heating and kitchen appliances (Bldg 34).



Although the existing plant is meticulously maintained, finding local operators capable of maintaining a coal-fired plant of this size is becoming problematic.



Proposed Upgrade

TEN will decommission the coal fired plant and install a new natural gas/oil fired boiler plant with the required redundancy. The new plant will deliver 50 psig steam to meet the space heating, water heating, and process steam requirements for the campus. The new plant will be automated and connected to the new building management system (provided under a separate ECM) for remote monitoring and control.

Scope of Work

TEN will decommission the three (3) coal fired boilers, coal handling and ash handling systems all of which will be abandoned in place.

Two (2) new 250 hp boilers will be installed in the existing boiler plant and, in conjunction with the existing 750 hp boiler, will offer 100% redundancy. The new boilers will be dual fuel and capable of operating on natural gas or fuel oil to maintain resiliency and capitalize on an interruptible gas rate.

New boiler feed water pumps will be provided to meet the needs of the new boiler plant.

Existing supporting systems will remain in place and be reused. These systems include condensate, feed water, blowdown, domestic water pumping, domestic water heating and domestic water conditioning systems.

ECM 4.1 – Add for All New Natural Gas Boilers and Plant Upgrades

While the base ECM 4 does accomplish the task of converting the plant to natural gas/oil, the scope is meant to produce the results with energy savings alone. As a consequence, the existing 750 hp boiler remains in service. With the inclusion of O&M savings into the cash flow, the scope can be enhanced, thus removing the 17-year-old 750 hp boiler and installing all new boilers.

Proposed Solution

As with ECM 4, TEN will downsize and convert the existing coal fired central plant to natural gas. We will decommission the three (3) coal fired boilers, coal handling and ash handling systems all of which will be abandoned in place. However, TEN will remove the existing 750 hp boiler and its supporting systems to the point of reconnection.

Three (3) new 250 hp boilers will be installed in the existing boiler plant and will offer 100% redundancy. The new boilers will be dual fuel and capable of operating on natural gas or fuel oil to maintain resiliency and capitalize on an interruptible gas rate.

New deaerator system including boiler feed water pumps will be provided to meet the needs of the new boiler plant.

Existing supporting systems will remain in place and be reused. These systems include condensate, blowdown, domestic water pumping, domestic water heating and domestic water conditioning systems.

Maintenance Impact (ECM 4 and 4.1)

There are inherent advantages to the new boiler plant due to its reduced complexity in comparison with the existing coal fired facility. The major benefits are outlined below:

- Eliminate coal handling and conveying systems
- Eliminate ash handling and conveying systems
- Eliminate environmental/emission control measures that may be required for coal
- Eliminate steam turbines for the combustion air blower system
- Eliminate the boiler coal bed conveyor system
- Only one boiler operator is required to operate the new plant
- ECM 4.1 will replace provide all new equally sized steam boilers improving plant longevity.



Training

Extensive training will be provided on the proper maintenance and operation for the new boilers, combustion controls, and ancillary equipment installed with this project. Videotaped training will be coordinated and overseen by Bob Tobin and Rajas Hatwalne.

Measurement and Verification (and Savings)

- | | | | |
|-----------|----------------------------------|------------|----------------------------|
| • -56,295 | DTH Natural Gas (IPMVP Option C) | • \$18,390 | ECM 4 Maintenance Savings |
| • 98,735 | kWh Electric (IPMVP Option B) | • \$17,105 | ECM 4.1 Overtime Reduction |
| • 7,333 | Mlb Steam (IPMVP Option C) | | |
| • 7,948 | Gal Oil (IPMVP Option C) | | |
| • 2,179 | Tons Coal (IPMVP Option C) | | |

ECM 5 – Evaluate Condensate System and Piping Insulation

Existing Conditions

TEN evaluated the condensate receivers as well as condition of the steam and condensate piping. The condensate receivers are a necessary part of any steam system. When steam is used in the end devices such as heating coils the steam transfers its heat to the coil and condenses. A steam trap will allow the condensed steam to pass through to the condensate return system and ultimately be pumped back to the steam plant. Properly working condensate receivers maintain the integrity of the entire system and are necessary to return the condensate back to the steam plant. In general, the existing condensate receiver system appear to be in good working condition. The overall higher rate of steam condensate returned to the boiler plant (more than 80%) also indicates proper system operation.



Figure 2. Building 34 - Kitchen Warehouse Walk-In Freezer

During the building survey, TEN evaluated the condensate receiver tanks and the steam/condensate piping for missing or inadequate insulation. It is a common occurrence for steam pipe insulation to become damaged or missing after steam system repair activities. Rigid insulation must be removed to gain access to the area to be repaired and in most instances cannot be reused. Since most repairs are unplanned and replacement insulation is not readily available, the piping remains bare and wastes energy.

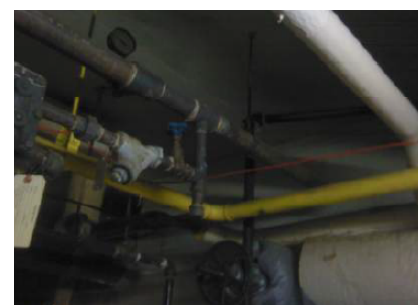
Proposed Upgrade

TEN evaluated the performance of six different systems consisting of piping, duct and equipment at the facility. Specifically identified and assessed where systems that were not insulated. TEN recommends the installation of removable insulation blankets on valves, fittings, PRVs, and strainers with missing insulation. Straight pipe runs will be insulated with new rigid insulation of the appropriate thickness for the application.

Thermal insulation improves energy efficiency by minimizing the heat loss (energy loss) in steam piping systems.



Energy loss from bare valve and flanges



Un-insulated valve and flanges



Blanket insulation is a custom designed, self-contained insulation system, which is used on in-line piping component, such as, valves, strainers and traps. This insulation system is constructed of high-density insulation filler with a fully encapsulated outer jacketing. It is designed to be removed easily and intact and is therefore re-usable. In addition to energy efficiency, this feature lowers maintenance costs, and serves as personnel protection from hot surfaces. This will significantly help reduce energy losses (by up to 90% in some cases) and will also help ensure proper steam pressure at the plant. Steam savings will result due to reduced losses in the steam distribution system.

Piping Heat Loss is based on the following factors:

Material of pipe, Surface area of Bare Piping, Steam Pressure, and Ambient Temperature

For the bare valves and fittings, the following equation calculates the total steam lost for each insulation application – Bare fitting = $25 \times (\text{Temp of bare fitting} - \text{Ambient air Temp}) / (0 + (25/3.2))$

Insulated Fitting = $0.26 \times (\text{Temp of bare fitting} - \text{Ambient air Temp}) / (1 + (0.26/3.2))$

Heat loss Savings = (Bare – Insulated) x Annual hours of use for the application

Maintenance Impact

The new removable insulation blankets recommended in this measure can be removed for service and reused. This results in a cost savings compared to rigid insulation which must be replaced if removed or damaged.

Training

Tony Albright will train the maintenance staff regarding annual inspection and repair, if necessary.

Measurement and Verification (and Savings)

- 429 Mlb Steam (IPMVP Option C)

ECM 6 – Decentralized Heating System (Not Currently Recommended – Long Payback)

Existing Conditions

The existing boiler plant is circa 1955 and consists of three coal fired boilers as well as condensate, feed water, blowdown, coal handling, and ash handling systems. The plant also includes domestic water pumping, domestic water heating and domestic water conditioning systems.

The plant delivers 100 psig steam to the old boiler plant (Bldg 13) where the pressure is reduced to 50 psi and distributed to the campus. The boiler plant is metered and currently provides a peak load of 19,000 Mlbs of steam to the campus according to owner supplied data. Existing loads on campus include comfort heating, domestic water heating and kitchen appliances (Bldg 34). Although the existing plant is meticulously maintained, finding local operators capable of maintaining a coal-fired plant of this size is becoming problematic.



Proposed Upgrade

Buildings 34, 35 & 37:

As these three buildings are by enlarge heated with hot water terminal equipment, TEN will install a new natural gas heating hot water plant in each building and convert the existing facilities to hot water in their entirety.



TEN will decommission the coal fired plant and install a new natural gas/oil fired boiler plant with the required redundancy. The new plant will deliver 50 psig steam to meet the space heating, water heating, and process steam requirements for the balance of the campus.

The new plant will be automated and connected to the new building management system (provided under a separate ECM) for remote monitoring and control.

Scope of Work

Buildings 34, 35 & 37

TEN will install a new natural gas/oil fired heating hot water plant in each building and convert the existing facilities to hot water in their entirety. This involves removing the remaining steam terminal equipment throughout and installing hydronic or electric counterparts such as unit heaters, domestic water heaters and kitchen appliances. Post implementation, these three buildings will be decoupled from the central plant entirely.

Central Plant

The rest of the campus is served by terminal steam equipment or, in the case of DOC, not eligible for conversion under the scope of this contract. TEN will downsize and convert the existing coal fired central plant to natural gas. We will decommission the three (3) coal fired boilers, coal handling and ash handling systems all of which will be abandoned in place. We will remove the existing 750 hp boiler and its supporting systems to the point of reconnection.

Two (2) new 250 hp boilers will be installed in the existing boiler plant and will offer 100% redundancy. The new boilers will be dual fuel and capable of operating on natural gas or fuel oil to maintain resiliency and capitalize on an interruptible gas rate. New boiler feed water pumps will be provided to meet the needs of the new boiler plant. Existing supporting systems will remain in place and be reused. These systems include condensate, feed water, blowdown, domestic water pumping, domestic water heating and domestic water conditioning systems.

Maintenance Impact

Although this decentralization measure includes maintaining the central plant, albeit much smaller, there are inherent advantages to decentralizing due to its reduced complexity in comparison with the existing coal fired facility. The major benefits are outlined below:

- Eliminate coal handling and conveying systems
- Eliminate ash handling and conveying systems
- Eliminate environmental/emission control measures that may be required for coal
- Eliminate steam turbines for the combustion air blower system
- Eliminate the boiler coal bed conveyer system
- Only one boiler operator is required to operate the new plant
- Eliminate steam pipe, flash steam and condensate losses associated with building 34, 35 & 37 distribution systems.
- Eliminate steam trap maintenance for building 34, 35 & 37 and associated distribution systems.
- Note that there will be *additional maintenance* associated with adding hot water boiler plants in building 34, 35 & 37.

Reason Not Recommended

While decentralizing is normally an attractive alternative to operating a high-pressure steam plant there are several challenges at Wernersville that, in our opinion, support maintaining a centralized system. Following are some of the broader points:



- Although building 34, 35 and 37 convert most of the steam to heating hot water at the point of entry, high pressure steam is utilized sporadically throughout the building for unit heaters, kitchen equipment, dishwasher boosters, etc. Converting this equipment to electric or providing a dedicated high pressure steam boiler adds substantial cost and maintenance to the conversion that erodes away the ECM's performance.
- Barring building 34, 35 and 37, many of the buildings on campus either utilize steam in terminal equipment or are occupied by the DOC and are not eligible for conversion under this contract. Conversion of these buildings to heating hot water would be expensive or in the case of DOC occupied buildings impractical.
- A new steam plant will need to be built to serve other buildings on campus. The incremental cost of increasing the plant size to accommodate the entire campus is cheaper than constructing additional boiler plants around campus.
- The existing steam distribution system appears to be in good shape and reportedly returns 80-90 percent of the condensate. This diminishes the returns for converting to heating hot water.
- The central plant will offer redundancy and dual fuel without additional oil storage around campus.
- The project cannot take credit for the boiler operator salaries and therefore does not contribute to the project's economics.

Training

Extensive training will be provided on the proper maintenance and operation for the new boilers, combustion controls, and ancillary equipment installed with this project. Videotaped training will be coordinated and overseen by Bob Tobin and Rajas Hatwalne.

Measurement and Verification (and Savings) – Note ECM 4 and ECM 6 savings replace each other

- | | | | |
|-----------|----------------------------------|-------------|------------------------|
| • -47,646 | DTH Natural Gas (IPMVP Option C) | | |
| • -76,645 | kWh Electric (IPMVP Option B) | • \$18,390 | Maintenance Savings |
| • 7,333 | Mlb Steam (IPMVP Option C) | • \$17,105 | Overtime Reduction |
| • 7,948 | Gal Oil (IPMVP Option C) | • -\$15,000 | Increased Blrs. Maint. |
| • 2,179 | Tons Coal (IPMVP Option C) | | |

ECM 7 – Install Building Sub-Meters on Steam Distribution

Existing Conditions

The central steam distribution system currently serves all buildings at Wernersville State Hospital. However, none of the buildings or group of buildings are currently equipped with steam meters. Only the central steam plant is equipped with a meter which measures the entire steam flow generated at the plant. Without the steam sub-meters, the facility cannot measure and monitor the steam usage at the building level. With many buildings now partially occupied, steam sub-meters will allow for better management of steam load based on actual demand.

Proposed Upgrade

Submeters are simply sensors that measure the flow of energy, fluid, or gas in more detail than a utility bill provides. There are following advantages of installing building submeters

- Identification of unnecessary equipment running at night, off shift, or during the weekend.
- Ability to get information back to steam operators the same day and to provide operators with feedback the next day about implemented changes.





- Comparison and benchmarking of usage across similar facilities (stores, warehouses, or buildings) and over time.
- Better management of steam usage.

Scope of Work

TEN will install vortex type steam flow meter in the following buildings:

#	Bldg No	Service	Steam Pipe Dia. (in)
1	1	Admin and Archives	1.5
2	3	South Mountain Workshop	1.5
3	5	Parkside West	8.0
5	12	Chapel and Cafeteria	8.0
6	13	Garage and Maint. Office	8.0
7	14	Cold Storage, Maint. Shops	6.0
11	26	East Hall	3.0
12	28	Old Kitchen, now Storeroom	3.0
13	31	Hill Hall	4.0
14	32	Laundry (Sorting & Dispensing only)	3.0
15	33	Boiler Plant	8.0
16	34	Schuylkill Ctr (Mens Building)	8.0
17	35	Lebanon Ctr (Womens Building)	4.0
18	37	Berks Ctr	8.0

TEN will install a new metering software for data acquisition and aggregation. These meters will be integrated with the building automation system. TEN will also install a new energy dashboard to view the building submeter data.

Maintenance Impact

The additional steam sub-meters will allow for better management of steam load based on actual demand.

Training

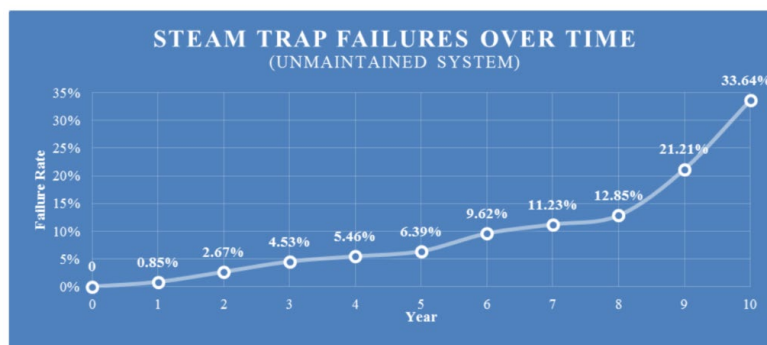
Tony Albright and Rajas Hatwalne will train the maintenance staff regarding annual inspection and repair.

Measurement and Verification (and Savings) – No savings (M&V: n/a)

ECM 8 – Steam Trap Testing and Repairs

Existing Conditions

Steam traps are important in the steam system to remove the condensate from the system. If the condensate is not removed from the steam system, the system loses efficiency. In some cases, a steam trap that is failed closed will cause an excessive buildup of condensate and could cause a blockage of steam flow. Steam trap losses depend on the steam pressure and temperature, the type of trap, orifice size, and the level of leakage through the failed trap. Steam losses are calculated based on the amount of steam lost through the trap. Failed closed or “plugged” traps are unique in that there is no steam lost through the trap itself.





Based on the steam trap data provided by the facility and a preliminary walk-through, there are approximately 900 traps on steam distribution system. There are numerous studies that indicate the average failure rate for steam traps in a properly maintained system ranges from 10% to 20% per year. The failure rate for steam trap in an unmaintained system gets worse over time. This is shown on the chart below.

Proposed Upgrade

TEN recommends performing a full steam trap survey of all the buildings where steam will remain. Ultrasonic testing and thermal imaging will be used to identify steam traps that are not functioning properly. Steam traps that are found to be failed open, failed closed, blocked, or leaking will be repaired or replaced.

Most steam traps are easily repairable with drop-in kits from the manufacturer. Repair kits will be recommended in most applications. When steam traps are not sized correctly or not of the correct type for the application, replacement will be performed.

Scope of Work

TEN will perform a full steam trap survey during IGA phase to verify counts, applications, run hours, and failure rates of steam traps. Steam traps will be tagged, and a complete inventory list created to track maintenance. Steam traps will also be evaluated for proper application. Failed traps will be rebuilt using drop in kits. When a improperly sized or type of steam trap is identified an new steam trap of the proper size and type will be installed.

Maintenance Impact

Steam traps should be inspected on an annual basis.

Training

Tony Albright and Rajas Hatwalne will review the new trap survey and corresponding tagging procedure with maintenance staff along with confirming the ongoing procedure for annual inspection and repair.

Measurement and Verification (and Savings)

- 4,122 Mlbs Steam (IPMVP – Option C)

ECM 9 – Chilled Water System Retro-Commissioning

Existing Conditions

Buildings 34, 35 and 37 each contain a chilled water (CHW) plant, each serving only their own building. All other cooling at the Facility is by window air conditioners or ductless mini-split systems.

The three CHW plants each contain one (1) constant-speed York MaxE screw chiller installed around 2012. The Building 34 and 35 chillers are each 185 nominal tons and the Building 37 chiller is 215 nominal tons. Each plant also contains two (2) CHW pumps, two (2) condenser water (CW) pumps and one (1) BAC cooling tower (CT). Buildings 34 and 35 each have a single VFD serving both CHW pumps, while the Building 37 CHW pumps each have their own VFD. The Building 37 CW pumps each have dedicated VFDs, and this plant also has a CT bypass pump which is used on system start-up during colder temperatures.



Figure 3. Building 34 – 185-ton York MaxE Screw Chiller



While investigating the Facilities and reviewing BAS data, TEN noted the following issues:

Buildings 34 and 35

- CHW pumps were operating in hand
- CHW bypass valves were not modulating and no CHW was being bypassed
- CHW loop DP was well above set point (Bldg. 34)
- CHW loop DP sensor appears to be out of calibration (Bldg. 35)
- CHW pumps were riding their curves

Buildings 37

- Two CHW pumps were operating at times, with at least one pump in hand
- With two CHW pumps operating, they appeared to be operating at different speeds
- CHW flow was well above design flow
- CHW bypass valve was bypassing water despite high system flow rates

Figure 4. Chilled Water System Observations

Proposed Upgrade

TEN proposes to perform retro-commissioning (RCx) on DHS Wernersville's three CHW plants. The RCx process will recalibrate sensors, remove manual overrides and return the systems to their original automated sequences, resulting in improved system efficiency and reduced wear on CHW system components.

Scope of Work

For each of the three (3) CHW systems:

- Perform point-to-point check-out of BAS points
- Verify sequences of operation
- Implement either CHWST or CHW DP reset sequence based on system CHW valve position
- Test and tune control loops
- Calibrate CHW flow and differential pressure sensors
- Reinstate variable CHW flow
- Replace CHW plant controller (Building 37 only)
- Perform limited repairs to deficient sensors/equipment
- Replace select AHU 2-way valves with 3-way valves to maintain CHWST at ends of branches (Buildings 34 and 35 only; (4) valves max)

ECM 9.1 (ALT) – Chiller Replacements (Not Currently Recommended – Long Payback)

Existing Conditions

Buildings 34, 35 and 37 each contain one York MaxE constant-speed screw chiller, all of which were installed around 2012. The Building 34 and 35 chillers are 185-tons and the Building 37 chiller is 215-tons. Site staff relayed to TEN that these chillers experience operating issues when the entering condenser water temperature (ECWT) approaches 75°F. To address this issue, the ECWT set point for all three CHW plants cooling towers is set to 80°F, with no reset, which does not allow the chiller compressors to operate more efficiently with lower ECWTs when outside air conditions would allow. TEN verified during site investigations that all three CHW plants had their ECWT set point at 80°F when outside air temperatures were around 72°F.

Proposed Upgrade

TEN proposes to replace the existing chillers with variable-speed chillers capable of receiving lower ECWTs and slowing their compressor speed at lower loads to save energy.



Scope of Work

For each of the three (3) CHW systems:

- Remove existing chiller
- Install new variable-speed York YV chiller (or similar), connecting to existing distribution
- Replace CHW plant controller (Bldgs. 34 and 35 only)
- Update CHW plant sequences based on new chiller capabilities
- Perform chiller start-up, commissioning and customer training

Maintenance Impact (ECMs 9 and 9.1)

By reinstating variable CHW flow at Buildings 34 and 35 and by returning Building 37's CHW flow to no more than its design flow rate, the wear and tear on each system's CHW pumps and CHW valves will be reduced, extending their useful life. Replacing the chillers under Alt ECM 9.1 will not result in any new maintenance requirements but will result in having newer equipment installed which should experience fewer component failures.

Training

Training will be coordinated and overseen by Bob Tobin and Mike Fendya. Representatives from the control system manufacturer will address interface procedures, general interrogation, temporary and permanent adjustments, etc. Training will also cover system components that differ from the configurations now in place. TEN will include an electronic video of the training to be referred to for new hires or a refresher. Training will also be provided to address warranty procedures and comprehensive operations and maintenance manuals.

Measurement and Verification (and Savings)

Savings – ECM 9

- 115,405 kWh Electric (IPMVP Option B)

Additional Savings – Alternate ECM 9.1

- 256,951 kWh Electricity (IPMVP Option B)

ECM 10 – AHU Modifications – BAS Upgrades

Existing Conditions

TEN evaluated the HVAC units (rooftop units, air handling units, etc) and associated building automation system (BAS) serving the existing buildings including the three hospital buildings 34, 35, and 37. There are eighteen (18) rooftop units (RTUs) currently serving the three hospital buildings, six RTUs per building. Additionally, buildings 34 and 35 are equipped with comparatively smaller air handling units (AHUs) which serve areas not covered by the RTUs. Similarly, building 37 is equipped with fan coil units (FCUs) to serve conditioned air to select spaces. Collectively, there are 56 HVAC units of varying capacities currently serving the three hospital buildings 34, 35, and 37. This equates to 191 HP of supply and return fans generating 201,075 CFM of conditioned air while bringing in 42,640 CFM of ventilation air, based on design data.

These HVAC units were replaced approximately 15 years ago and generally appear to be in good working condition. The RTUs are variable air volume (VAV) units, while the AHUs and FCUs are constant air volume (CAV) units. However, it was noted through the BAS front-end that most of the RTUs were

	AHU-1	AHU-2	AHU-3	AHU-4	AHU-5	AHU-6
Rtn Air Temp	73.2 deg F	72.9 deg F	73.6 deg F	73.9 deg F	70.9 deg F	71.8 deg F
Damper Output	10.0 %	10.0 %	10.0 %	10.0 %	10.0 %	10.0 %
Mixed Air Temp	74.8 deg F	75.6 deg F	75.4 deg F	72.6 deg F	71.8 deg F	73.4 deg F
Filter Status	Dirty	Clean	Clean	Clean	Clean	Clean
Heating Output	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
Lo Temp Alm	Normal	Normal	Normal	Normal	Normal	Normal
Cooling Output	74.3 %	100.0 %	41.5 %	100.0 %	100.0 %	100.0 %
SF Cmd	On	On	Off	Off	Off	Off
SF Status	On	On	On	On	On	On
SF Alarm	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %
Disch Air Temp	66.3 deg F	61.3 deg F	69.6 deg F	64.5 deg F	55.1 deg F	58.1 deg F
Duct Static Press	0.5 in wc	0.6 in wc	0.6 in wc	0.5 in wc	0.7 in wc	0.5 in wc
Zone-1 Temp	72.8 deg F	72.7 deg F	71.9 deg F	73.4 deg F	72.1 deg F	72.0 deg F
Zone-2 Temp	73.5 deg F	75.9 deg F	74.1 deg F	75.1 deg F	250.4777 deg F	49.8 deg F
Zone Humidity	71.3 %RH	71.1 %RH	9.4 %RH	68.4 %RH	74.4 %RH	65.3 %RH



operating at 100% speed and there was little or no modulation in VFD speed. All HVAC units appear to operate continuously, additionally it was noted that a few AHUs were operating even though the supply fans were commanded ‘off’.

A brief review of the existing Metasys BAS shows that all of the HVAC units along with ancillary systems in building 34, 35, and 37 can be controlled and monitored through the BAS. Additionally, the steam to heating hot water heat exchangers in buildings 3, 5, and 31 are also on BAS. The DDC controllers are equipment and building level are a mix of proprietary vs newer BACnet controllers and many controllers are at design input capacity which cannot take additional control points, for example, CO2 sensors for demand control ventilation.

Proposed Upgrade

The traditional building automation systems were great for controlling and monitoring operational components. However, the smart BAS that are available today solve more complex issues than just controlling and monitoring the buildings HVAC system. Today's smart BAS combined with IoT's (Internet of Things) array of sensors make it possible to monitor in real time just about anything inside a facility, from temperature to air quality to energy use to energy accounting and much more.

TEN will install a new building automation system and connect all existing HVAC equipment to the new BAS. The new BAS will use some of the existing equipment controllers, will be an open protocol BACnet / Niagara DDC building automation system.

Scope of Work

TEN will install a new BAS with Niagara N4 front-end with BACnet building controllers, remote access, data trending, and alarms.

- Includes campus wide user-friendly graphics with a web based HTML5 interface and a server workstation.
- Upgrade existing supervisory controllers in buildings 3, 5, 31, 34, 35, and 37 with Niagara N4 JACE.
- Upgrade existing field controllers for chilled water and heating hot water systems in buildings 34, 35, and 37.
- Implement demand control ventilation
 - Install new CO2 sensors in return air duct for RTUs serving buildings 34 and 35 using existing field controllers.
 - Install new field controllers for AHUs in buildings 34 and 35 along with new CO2 sensors mounted in RA duct. Install the following DDC control points:
 - Zone temperature
 - Zone humidity
 - Supply air temperature
 - Return air temperature
 - Mixed air temperature
 - Control of existing damper actuators
 - Fan command and status
 - Freezestat
 - Install new field controllers for RTUs in building 37 along with new CO2 sensors mounted in RA duct. Install the following DDC control points:
 - Zone temperature
 - Zone humidity
 - Supply air temperature
 - Return air temperature
 - Mixed air temperature
 - 2/3 Differential pressure sensor
 - Control of existing damper actuators
 - Fan command and status
 - Freezestat
- Perform retro-commissioning (RCx) and install analytics software.
 - TEN will install and program analytics software to implement fault detection and diagnosis (FDD) system.



- The analytics software will include approximately 5,000 control points. A daily/weekly report will be generated listing all faults and costs associated with those faults.
- The RCx plan will include performing functional tests and check-outs of the following systems,
 - The outside air dampers, any mixed or return air dampers and any relief dampers for proper operation according to their ranges.
 - Pre-heat and cooling coil valves and actuators for proper operation according to their ranges and to confirm that the valves are fully functional and under proper control of the BAS.
 - Check all the temperature sensors to ensure that the sensors are reading within reasonable boundaries.
 - Turn the unit off for a few minutes to ensure the OA damper closes fully and that the return and relief air damper open to their correct positions.
 - Ensure that the freeze stat is mounted at an appropriate location and is properly routed across the entire air flow.
 - Test the supply, return and exhaust fans motors and VFDs for proper operation to ensure that they respond properly to BAS commands.

Maintenance Impact

Implementation of the new BAS equipment will have a positive impact on facility operation by replacing obsolete and failing controllers resulting in less downtime of equipment.

Training

Training will be coordinated and overseen by Bob Tobin and Rajas Hatwalne. Representatives from the control system manufacturer will address interface procedures, general interrogation, temporary and permanent adjustments, etc. Training will also cover system components that differ from the configurations now in place throughout the facility. TEN will include an electronic video of the training to be referred to for new hires or a refresher. Training will also be provided to address warranty procedures and comprehensive operations and maintenance manuals.

Measurement and Verification (and Savings)

- 522,187 kWh Electric (IPMVP Option B)
- 3,364 Mlb Steam (IPMVP Option C)
- \$27,975 Maintenance Savings

ECM 11 – Kitchen Exhaust Hood Controls

Existing Conditions

The Building 34 kitchen contains one main exhaust hood covering the steam and natural gas-fired cooking equipment. The hood is served by a 10,000 CFM (nominal) exhaust fan (EF) and heating-only make-up air unit (MAU). A Green Energy Hood control system is installed on the hood which is supposed to monitor at least for steam, and potentially also for heat, and then reduce the speed of the EF and MAU fans during low cooking loads. The EF and MAU are scheduled through the BAS to operate from 4am to 6pm daily.

During site investigations TEN noticed that there were excessive amounts of condensation occurring on the underside of the hood, that there was significantly lower exhaust flow on the side of the hood above the steam convection ovens, and that there was a large amount of steam not being captured by the hood. Balancing reports located on-site show that the EF was designed for 10,000 CFM, but is only providing 7,684 CFM, while the MAU is providing 8,723 CFM. The EF should be exhausting more air than the MAU is providing in order to keep the kitchen space negative as compared to surrounding spaces.



Figure 5. Building 34 Kitchen Exhaust Hood



Kitchen staff said that they had not seen indication of the EF or MAU varying flow. TEN did not find any inspection or calibration reports on-site for the Green Energy Hood system to indicate that its sensors have been kept calibrated and functional. Neither the EF, MAU nor the Green Energy Hood controls are visible on the BAS to allow for verification of proper functioning.

Proposed Upgrade

TEN is operating under the assumption that the Green Energy Hood system is not functional and proposes to install a new Melink Intelli-Hood system to restore the variable flow functionality of the EF and MAU. TEN will also perform a Testing and Balance (TAB) of the EF and MAU to adjust air flow as close to the design conditions as possible.

Scope of Work

- Perform TAB on EF and MAU
- Install Melink Intelli-Hood System on main hood
 - Install temperature and optic sensors
 - Install hood controllers and air purge units
 - Install low-voltage cabling to all components
 - Install VFDs on existing 5 HP EF and MAU motors
 - Install CAT5 communication cables from Intelli-Hood controllers to the VFDs
 - Perform programming, commissioning and customer training

Maintenance Impact

Implementation of this scope will improve the humidity conditions in the kitchen which will slow corrosion rates of equipment in the kitchen, prolonging their useful life. The sensors will have to be cleaned periodically. During construction, as-built documents and operation & maintenance manuals for the new equipment will be provided.

Training

Training will be provided on the proper maintenance and operation for the new exhaust fan controls, VFDs. The training, coordinated by Bob Tobin will be electronically recorded for additional future reference.

Measurement and Verification (and Savings)

- 262 DTH Natural Gas (IPMVP Option C)
- 26,705 kWh Electricity (IPMVP Option B)

ECM 12 – Refrigeration Controls

Existing Conditions

The Building 34 Kitchen contains a total of nine walk-in refrigeration units. Of the five walk-ins located inside the kitchen area, four are refrigerators and one is a freezer. All of these five walk-ins have relatively new condensing units. There are also four larger walk-in units located in the warehouse/loading dock adjacent to the kitchen; two refrigerators and two freezers. The refrigerator units have box temperatures between 36°F and 38°F and utilize timed off-time defrosts. The freezer units have temperatures between -5°F and -10°F and utilize electric resistance defrosts. Of the three walk-in freezers, only one is utilizing demand-based defrosts, while the others are implementing timed defrosts. The use of timed electric resistance defrosts results in wasted energy, both by the defrost element and by the compressors which now have to remove that heat from the walk-in.



Figure 6. Building 34 - Kitchen Warehouse Walk-In Freezer



The five kitchen area walk-ins all have 2-speed EC motors, which are very efficient. The four warehouse walk-ins each appear to contain either shaded pole or permanent split capacitor fan motors with a single speed. TEN also noted during site investigations that the suction line on one of the warehouse freezer walk-ins was iced over. This is typically due to low refrigerant levels in the system. DHS Wernersville should have their refrigeration service company check this system and recharge the refrigerant if necessary to prevent any future issues.

Proposed Upgrade

TEN proposes to install NRM Cooltrol controllers on the four walk-in refrigeration units located in the warehouse, including control of the one (1) walk-in freezer which currently uses timed defrosts, and to replace the 14 existing evaporator fan motors in these four walk-ins with new EC motors. The Cooltrol controllers will automatically cycle the evaporator fans to more tightly control box temperatures and will only perform defrosts on the one freezer unit when frost build-up is detected on the evaporator coil.

Scope of Work

- Install (4) Cooltrol controllers
- Install (1) electric defrost kit
- Replace (14) evaporator fan motors with EC motors
- Integrate new controllers to existing evaporators
- Provide all required low-voltage wiring
- Provide programming, system commissioning and customer training

ECM 12.1 – Kitchen RTU Economizer

Existing Conditions

The Building 34 kitchen is served by a 6-ton cooling-only RTU with DX coil. This unit uses 100% return air and is not capable of economization. Due to the constant heat load in the kitchen, this unit provides cooling throughout the year.

Proposed Upgrade

TEN proposes to install an economizer section on this RTU to take advantage of free-cooling when the outside air temperature is less than the return air temperature.

Scope of Work

- Disconnect and remove a section of return ductwork at the RTU
- Furnish and install economizer section at the return air opening
- Reconnect the remaining ductwork to the economizer module
- Furnish and install a barometric relief grille & hood on the return duct prior to the economizer
- Integrate economizer module wiring harness into existing RTU controller

Maintenance Impact (ECMs 12 and 12.1)

The installation of the proposed refrigeration controls will require minimal maintenance attention. Use of an economizer will reduce the load on the DX compressor and prolong its useful life.



Figure 7. Building 34 - Kitchen



Training

Training will be provided on the proper maintenance and operation for the new economizer section and refrigeration control system and any other ancillary equipment installed with this project. The in-person training, coordinated by Bob Tobin, will be electronically recorded for future reference.

Measurement and Verification (and Savings)

Savings – ECM 12

- 23,012 kWh Electric (IPMVP Option B)

Savings – Add ECM 12.1

- 9,712 kWh Electric (IPMVP Option B)

ECM 13 – Window Replacements (Not Currently Recommended – Long Payback)

Existing Conditions

Buildings 34, 35 and 37 each have old aluminum frame, single-pane windows installed throughout. Most of these windows are combined with another layer of storm windows on the interior. Many of the window frames contain gaps between them and the building frame, allowing outside air infiltration. These windows are well beyond their expected useful life.

Proposed Upgrade

TEN proposes to replace windows in Buildings 34, 35 and 37 with new, energy efficient windows and thermal panels. Most of the windows are 6 feet tall, which will allow for the installation of thermal panels to cover half of the existing window openings while still allowing sufficient sunlight to enter the spaces.

Scope of Work

- Building 34 and 35 (each)
 - Install (288) new windows with ½ double-paned glazing and ½ thermal panel
 - Install (30) new windows with double-paned glazing
- Building 37
 - Install (392) new windows with ½ double-paned glazing and ½ thermal panel
- Caulk around the exterior of the new window frames to eliminate infiltration

Maintenance Impact

The new windows will require less maintenance than the existing windows, at least initially for tasks such as caulking. However, given the temporary nature of this, no dollar value is claimed.



Figure 8. Building 34 - Windows

Training

Training will be provided on the proper maintenance and operation of the new units. The training, coordinated by Bob Tobin, will be recorded for additional future reference.

Measurement and Verification (and Savings)

- 780 DTH Natural Gas (IPMVP – Option C) | 3,865 kWh Electric (IPMVP – Option B)



Monitoring and Maintenance

TEN's ongoing monitoring and coordination of maintenance services is led by Wayne Chase, Director of Post-Construction Services. Wayne is a certified Measurement and Verification Professional (CMVP) with regard to the industry standard International Performance Measurement & Verification Protocol (IPMVP). IPMVP was first established by the U.S. D.O.E., and has become the internationally recognized protocol for performance measurement and verification (M&V). The IPMVP guidelines provide a consistent, reliable approach to M&V around the world. Our M&V department is further supported by Greg Lok, TEN's VP, Engineering who also holds CMVP credentials and both regularly report project performance to our president and chief operating officer Rob Campbell.

Wayne has already been engaged on the Wernersville project and the initial plan for M&V of proposed ECMs. If selected, Wayne will be regularly engaging in developing a M&V plan for the project that will be reviewed with DHS to ensure it addresses its expectations. This includes a cost benefit analysis to determine where DHS would like to invest its M&V budget. For example, it makes the most sense to complete the most robust and potentially costlier M&V approach on the ECMs that generate the largest magnitude of savings. This is described in greater detail on the following pages. We focus on M&V early in the IGA process because the M&V approach taken will dictate the pre-installation data required. If this step is delayed, a client and ESCO may limit their M&V options.

Maintenance and Training

TEN does not require a maintenance agreement in conjunction with its guaranteed energy savings projects. More often, our clients prefer to incorporate the maintenance of their new equipment into their current maintenance routines or existing maintenance contracts with trusted vendors. We pay special attention to select equipment that has proven reliable with good access to parts and repair services in the region. TEN will provide training on all equipment installed under this GESA project. Certain ECMs such as the new central plant equipment (boilers and feed water system upgrades) as well as the BAS will be quite extensive & include new system operation. It will be coordinated by our project management team under the lead direction of Bob Tobin and include members of TEN, subcontractors and factory representatives. We have anticipated and recommend videotaping this training whenever possible so that it can be included and organized with the project closeout information and available for future reference. All warranty work will be coordinated by our project management team including attic stock which may be provided to expedite repair while any equipment deficiencies are addressed. In instances, where a maintenance agreement is warranted/desired, TEN can coordinate the provision and payment of those services through the GESA project, if desired by DHS. Additional detail regarding training scope & assigned personnel is found with each unique ECM writeup.

Operations and Maintenance Expense

We have carefully reviewed the operations and maintenance cost information provided in RFQ Appendix I, All Utilities Spreadsheet, and Bulletin 2 to determine areas for O&M savings. While we have identified meaningful savings due to replacement of existing maintenance intensive equipment, these upgrades in no way eliminate the entire scope of work contained within your existing service agreements and parts and material budgets. As such, we have been selective in the calculation of O&M savings which total no more than 34% of the annualized amount identified in these documents. We look forward to carefully analyzing these costs and fine tuning the reasonable application of O&M savings to the GESA project with the Wernersville team. An O&M summary table is located on the Appendix 1 – 13 cover sheet.



Measurement and Verification Approach (Method)

TEN has three (3) Certified Measurement and Verification Professionals (CMVP) on staff to provide a guaranteed savings program based upon sound and proven engineering design principles that 1) isolate the energy efficiency criteria for which TEN is responsible, and 2) specify those other parameters which are beyond the TEN's control.

TEN's M&V is guided by the recommended core concepts and principles of the International Performance Measurement & Verification Protocol (IPMVP), the industry standard for development and implementation of M&V plans in energy savings projects. IPMVP provides four Options for determining savings (A, B, C and D) as summarized in the following table:

IPMVP Option	How Savings Are Calculated	Typical Applications
A. Retrofit Isolation: Key Parameter Measurement Savings are determined by field measurement of the key performance parameter(s) which define the energy use of the ECMs affected system(s) and/or the success of the project.	Engineering calculation of baseline and reporting period energy from: <ul style="list-style-type: none">• Short-term or continuous measurements of key operating parameter(s); and• Estimated values.	A lighting retrofit where power draw is the key performance parameter that is measured periodically. Estimate operating hours of the lights based on building schedules and occupant behavior.
B. Retrofit Isolation: All Parameter Measurement Savings are determined by field measurement of the energy use of the ECM-affected system.	Short-term or continuous measurements of baseline and reporting period energy, and/or engineering computations using measurements of proxies of energy use.	Application of a variable speed drive and controls to a motor to adjust fan flow. In the baseline period the power logger is in place for a week to verify constant loading. The meter is in place throughout the reporting period to track variations in power use and count kWh.
C. Whole Facility Savings are determined by measuring energy use at the whole facility or sub-facility level.	Analysis of whole facility baseline and reporting period (utility) meter data. Routine adjustments as required, using techniques such as simple comparison or regression analysis.	Multifaceted energy management program affecting many systems in a facility. Measure energy use with the gas and electric utility meters for a twelve-month baseline period and throughout the reporting period.
D. Calibrated Simulation Savings are determined through simulation of the energy use of the whole facility, or of a sub-facility. Simulation routines are demonstrated to adequately model actual energy performance measured in the facility.	Energy use simulation, calibrated with hourly or monthly utility billing data. Energy end use metering may be used to help refine input data.	Multifaceted energy management program affecting many systems in a facility but where no meter existed in the baseline period. Energy use measurements, after installation of gas and electric meters, are used to calibrate a simulation.

The description below has been used to determine both pre-implementation (Baseline) and post-implementation (Reporting Period) energy use for the average weather year.

$$\text{Energy Savings} = \text{Baseline Energy Use TMY} - \text{Reporting Period Energy Use TMY} + \text{Adjustments}$$



The "Adjustments" term in this general equation brings energy use in the two-time periods to the same set of conditions. Adjustments can be put into two categories, Routine and Non-Routine. Routine Adjustments are factors that are expected to change such as weather, etc. Non-Routine Adjustments are factors that are not expected such as added equipment, occupancy schedules, large construction projects, change in space use, etc. Adjustments are derived from identifiable physical facts. Adjustments are commonly made to modify the Reporting Period conditions back to the Static Factors of the baseline; in most cases, these corrections are necessary to make a fair comparison. Such adjustment process yields savings, which are often described as "avoided energy use" of the post-retrofit period. The levels of such savings are dependent on post-retrofit period operating conditions. Adjustments may also be made to an agreed fixed set of conditions such as those of the baseline or some other period. The level of savings computed in this situation is unaffected by post-retrofit period conditions but reflects operation under a set of conditions which must be established in advance.

For Measurement and Verification purposes, consideration is given to predictability, measurability, and the likely impact of all plausible factors for the following categories –

- Weather variation
- Occupancy level and schedule of operation
- Installed equipment intensity and schedule
- Change in use of space through additions or remodeling
- Occupant or user demand for services (e.g., temperature, plant output)
- Appropriate use of the ECM consistent with manufacturer & training guidelines
- Appropriate use of non-ECM equipment impacting ECM performance
- Equipment deterioration, both ECM-related equipment and non-ECM related
- Equipment life, both ECM and non-ECM related

TEN provides a 100% savings guarantee on our projects. Any savings shortfall is corrected at TEN's expense or paid directly to the customer. If TEN is unable to reconcile missed savings during a reconciliation period then TEN will undertake, at its own expense, to bring that measure into compliance with the savings guarantee. If these efforts do not result in savings compliance, then TEN will pay the missed savings amount directly to the customer for each reconciliation period during the term of the contract providing a 100% savings guarantee.

Per the RFQ, TEN has included 3 years of measurement and verification in the cashflow, however we can provide these services for the full project term, if desired.

Proposed Measurement and Verification Plan

Explanation of Guaranteed Savings Measurement and Verification methodology

a. Explanation in terms of dollars, not percentage

TEN proposes to initially meet with your representatives to discuss the cost benefit analysis of each measurement and verification option for each measure and then determine the M&V plan. This discussion will include how the measurements will be taken and for how long or how the utility information will be obtained to determine the tasks required and the hours needed to perform the agreed upon plan. TEN then will review the plan, scope of work, the personnel that will be performing the work. TEN's team, including Wayne Chase, and Greg Lok have extensive expertise in developing and performing measurement and verification plans; however, we, in conjunction with you, determine what tasks TEN will perform and the scope. We believe that this approach will not only provide you some control in arriving at M&V cost, but also will reflect the actual cost to perform the work vs. just a percentage of hard costs, since the cost of the project does not always correlate to the complexity and cost to measure and verify the results. At this juncture, we have estimated the annual M&V cost as \$15,000 for the two proposed projects.



b. Methodology Compliance with the DGS Design Manual, General Conditions and the IPMVP

TEN follows the International Performance Measurement & Verification Protocol (IPMVP), the industry standard for development and implementation of M&V plans in energy savings projects. IPMVP provides four Options for determining savings (A, B, C and D). We will additionally review each ECM and M&V approach to ensure compliance with DGS's Design Manual and General Conditions prior to the final M&V selections and cost benefit analysis identified above.

c. Reasonableness and Transparency of the M&V Pricing Methodology

TEN will outline the tasks and time to complete tasks for the final selection of the M&V option for each ECM and apply our disclosed hourly rates, and then review with you and DGS. TEN will utilize client automation tools when possible, to minimize time and cost of M&V services, if approved by our customer. M&V for ECMs 2, and 7 was omitted due to no additional savings for those ECMs.

ECM Number	ECM Description	Electric kWh	Steam Mlbs	Coal Tons	Natural Gas DTH	Fuel Oil Gals
1	LED Lighting. Int. & Ext. - Type A or C	A	N/A	N/A	N/A	N/A
3	Weatherization	N/A	C	N/A	N/A	N/A
4	Boiler Fuel Switch – Addl. NG Steam Boilers.	B	C	C	C	C
5	Piping Insulation	N/A	C	N/A	C	N/A
6	Decentralized Heating System	B	C	N/A	C	N/A
8	Steam Traps	N/A	C	N/A	N/A	N/A
9	Chiller Plant Modifications - RCx	B	N/A	N/A	N/A	N/A
10	AHU Modifications & BAS Upgrades	B	C	N/A	N/A	N/A
11	Kitchen Hood Controls	B	N/A	N/A	C	N/A
12	Kitchen Systems - Refr. Controls	B	N/A	N/A	N/A	N/A
12.1	Kitchen Systems - RTU Economizer	B	N/A	N/A	N/A	N/A
13	Window Replacements	B	N/A	N/A	C	N/A

Our proposed M&V plan focuses on Options B and C which is most appropriate method to show true savings because of the interactions between the controls and equipment in the majority of the ECMs as well as the large magnitude of savings achieved by the heating fuel switch.

Appendices:

Savings calculations and equipment cutsheets are placed in the appendices and tabbed with their corresponding ECM number.



Appendix 0 – Optional ECMs to Consider During the IGA

ECM ESCO A – Cogeneration

Existing Conditions

The existing boiler plant is circa 1955 and consists of three coal fired boilers. The plant delivers 50 psig steam to the campus. The boiler plant is metered and currently provides a peak load of 19,000 Mlbs of steam to the campus according to owner supplied data.

There are a total of three (3) electrical feeds serving the campus to provide the required redundancy. Feeds A and B enter at the boiler plant, are 2400kV and serve the entire campus. A separate 13.2kV feed enters the campus and exclusively serves the chillers for building 34, 35 & 37.

An analysis of the existing thermal and electrical loads on campus reveals a good coincident load profile conducive to combined heat and power (CHP) application.

Proposed Upgrade

TEN will install a new 800kW microturbine generator to offset much of the onsite electrical consumption and demand. Waste heat from the microturbine will be used to produce steam and supplement the boiler plant.

In addition to reducing utility cost, Wernersville will capture ongoing incentives from PPL associated with capacity/transmission charges, as well as a one-time rebate to help offset capital costs.



The new CHP will not only provide economic benefits to Wernersville but can also offer resiliency to the entire campus in the event of a power outage.

Scope of Work

TEN will install a new 800kW microturbine generator at the existing boiler plant. The generator will be located outdoors on the northeast side of the building and interconnected with the utility at the existing 2400kV substation. Additional switchgear will be installed on the southeast side of the building to facilitate the interconnection.

We will install a waste heat boiler in the existing boiler plant. The boiler will utilize the waste heat from microturbine to produce steam for the campus. The new boiler will utilize the existing plant infrastructure to support its operation.

Maintenance Impact

- The waste heat boiler will be maintained by the existing plant operators and is typical of a high pressure boiler.
- Microturbines are typically very reliable but do required maintenance at certain intervals. These units will be maintained through a contract with the manufacturer's representative. Cost for this maintenance is normally based on \$/kWh generated and is built into the energy savings model.



ECM ESCO B – Install a Solar PV System

Existing Conditions

There has been an effort in the industry to emphasize the need for distributed energy due to electric grid reliability issues. Renewable energy is a means of providing on-site electric generation for reliability and provide an economic solution to reduce carbon and greenhouse gas emissions.

Currently, there isn't on-site electric generation from renewable resources at Wernersville State Hospital. However, because of available open areas and the ease of interconnection makes the facility suitable for the installation of a photovoltaic (PV) solar array.

Proposed Upgrade

TEN will design, supply, install, commission, and test the fully integrated and operational net-metered solar electric renewable energy system. The installation of a solar array will provide on-site generation of renewable electric energy to offset purchased electricity used at the facility.

TEN is proposing the installation of a fixed 480 volt, 400 kW (DC) ground mounted system close to the farm buildings (see picture). This location is south facing to allow for maximum electric generation. It is also located fairly close to the central plant building where it can be tied into the electric distribution system.

The chiller plant and the campus electric meters can be virtually net-metered.



Scope of Work

The PV array will be held in place with a galvanized steel rack mounted to either concrete piers or ballasted posts. Conduit and power cable will be direct buried and delivered to the electric switchgear in the central steam plant. Inverters will be provided to convert the direct current generated power to usable alternate current electricity. Tie-in's and disconnects will be installed in the existing main distribution panel.

Maintenance Impact

The new PV solar array will require periodic cleaning to maintain the maximum solar generating capacity at the design levels. Also, periodic inspection of the power connections and inverters is recommended to maintain operation and prevent failure.



Appendix 1 – 13: Core ECM Savings Calculations and Material Cutsheets

Each appendix tab number corresponds to the appropriate ECM number. The savings calculations and cutsheets are separated by a color flysheet.

Appendix A- B: ESCO Voluntary ECM Savings Calculations and Material Cutsheets

Each appendix tab letter corresponds to the appropriate ESCO voluntary ECM letter. The savings calculations and cutsheets are separated by a color flysheet.

Operations and Maintenance Savings – All ECMs

The following table summarizes the proposed operations and maintenance savings for the ECMs contained in Appendix 1 - 13 and A – B.

ECM	Description	O&M Savings Amount	Notes	Reference
1	LED Ltg. Int. & Ext. - Type A	\$ 6,363	Material Savings: Reduced amount since Option A utilizes existing ballasts	
1.1	LED Ltg. Add - Type C	\$ 10,271	Material Savings: Additional amount when utilizing new lamps and drivers	
2	Lighting Controls			
3	Weatherization	\$ -		
4	Boiler Fuel Switch - Addl. NG Stm Blrs.	\$ 18,390	Reduced matinenance costs from eliminating coal boilers; 25% in water treatment costs.	All Utilities Summary & Bulletin #2
4.1	Add for All New NG Blrs + Plant Upgrades	\$ 17,105	Reduced overtime labor costs (37%) when utilizing all new boilers, aeration & boiler feeds	RFQ Appendix I
5	Piping Insulation	\$ -		
6	Decentralized Heating System	\$ 20,495	Same savings as ECM 4 & 4.1 combined, but subtracts \$15,000 to maintain 3 new HW plants	All Utilities Summary, Bulletin #2, and Appendix I
7	Steam Meters	\$ -		
8	Steam Traps	\$ -		
9	Chiller Plant Modifications - RCx	\$ -		
9.1	Chiller Water Plant Modifications - New Chillers	\$ -		
10	AHU Modifications & BAS Upgrades	\$ 27,975	ECM essentially upgrades the entire BAS which better allows WSH to go from full maintenance to PM maintenance	Appendix I
11	Kitchen Hood Controls	\$ -		
12	Kitchen Systems - Refr. Controls	\$ -		
12.1	Kitchen Systems - RTU Economizer	\$ -		
13	Replace Windows	\$ -		
ESCO A	Cogeneration	\$ (93,931)	Cost to maintain system annually	
ESCO B	Solar PV Array - Ground Mount	\$ -		

ECM #1

Interior & exterior light conversion to LED

Savings Calculations

ECM 1 LED Lighting Upgrade Savings Calculations

Summary

A summary of savings for each of the two lighting options is contained in spreadsheets on the following pages. They are differentiated by their retrofit approach to existing linear fluorescent lamps that were most recently retrofit in the Johnson Controls GESA project. The Type A retrofit is less expensive with slightly less savings but a better payback. The non-linear lamp retrofits and new luminaries are consistent between both options.

- **Self-Funding Project** – Type A TLED Lamp Retrofit (provides better payback to support ECM-4)
- **Recommended Project** – Upgrade from Type A to Type C TLED Lamp & Driver Retrofit

Energy Savings Calculations and Methodology

TEN calculated the energy and demand cost savings for this ECM by multiplying the energy and demand savings for each applicable lamp/ballast combination (LBC) by the approved incremental energy costs. The results of these calculations are summed for total electric demand and energy savings.

TEN calculated the energy savings under this ECM using the following formulas:

Where:

ESLIGHTING = Energy savings, in kWh, for the lighting retrofits
Pbase = Electrical power, in kW, per fixture for appropriate baseline LBC group
Ppost = Electrical power, in kW, per fixture for appropriate post-installation LBC group
Hbase = Existing annual operating hours defined by fixture's pre hours group
Nbase = Number of fixtures in representative baseline LBC group
Npost = Number of fixtures in representative post-installation LBC group

Where:

DSLIGHTING = Monthly demand savings, in kW, for the lighting retrofits
Pbase = Electrical power, in kW, per fixture for appropriate baseline LBC group
Ppost = Electrical power, in kW, per fixture for appropriate post-installation LBC group
DFlighting = Hours group diversity factor
Nbase = Number of fixtures in representative baseline LBC group
Npost = Number of fixtures in representative post-installation LBC group

Operations & Maintenance Savings

Material Savings

Where:

ExAnlLpCost = Existing Burn Hours × Qty of Lamps × Lamp Unit \$/Hour
ExAnlBstCost = Existing Burn Hours × Qty of Ballasts × Ballast Unit \$/Hour
PropAnlLpCost = Existing Burn Hours × Qty of Lamps × Lamp Unit \$/Hour
PropAnlBstCost = Existing Burn Hours × Qty of Ballasts × Ballast Unit \$/Hour
PropAnlCost = Proposed Burn Hours × ((Qty of Lamps × Lamp Unit \$/ Hour) + (Qty of Ballasts × Ballast Unit \$/Hour))

Annual Material Savings = ((Project Term × (Existing Anl Lp Matl \$ + Existing Anl Ballast Matl \$)) - ((Project Term - Proposed Lp Warranty Period) × Proposed Anl Lp Matl \$) + ((Project Term - Proposed Ballast Warranty Period) × Proposed Anl Ballast Matl \$)) ÷ Project Term

Note: Labor savings not included due to in house labor.

Additional Detail on Existing Conditions

1 - Administration Building

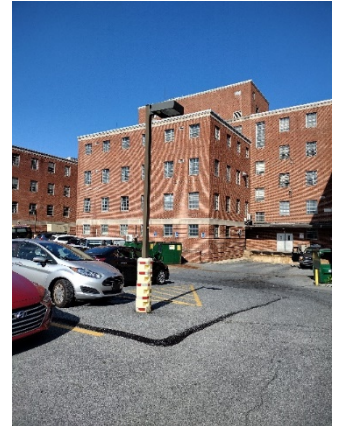
The Administration Building is a historical 28,752-square-foot building with 7,388-square-feet currently in use. The building houses the Pennsylvania State Hospital System Historical Archives and is a combination of offices, work rooms and representative rooms for the artifacts. Existing systems are predominantly 25W T8 linear fluorescent lamps retrofitted into older fixtures. Existing ceilings are hard and spline. The second floor with a T12 linear fluorescent lighting system is currently not in use and is excluded from the current scope.

3 – East Hall - South Mountain Workshop

The South Mountain Workshop Building is a 27,535-square-foot building which serves as a space for vocational training. The space has large open work rooms, offices, and storage spaces. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures a combination of good and poor condition; ceilings are drop with recessed fixtures and hard.

5 – Parkside House - Berks Co. Senior Citizens Building

The Berks Co. Senior Citizens Building is a 35,360-square-foot building of which 9,281-square-feet are currently in use. The building currently serves as a space for Senior Citizens in the local community to meet for activities and provides congregate meals at lunchtime. The space has large open meeting spaces, smaller meeting areas and offices. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are in fair condition; ceilings are hard.



11 - Stone Barn – No Lights

The Stone Barn Building is a 6,095-square-foot building which provides storage. There are no lights in the building.

12 - Storerooms

The Storerooms Building is a 44,532-square-foot building of which 30,112 is currently in use. The space provides storage for large bulk items used daily by the Wernersville State Hospital Community. This includes paper products, cleaning supplies, food products and other items. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are in good condition; ceilings are hard. The open areas have 20-foot ceilings.

13 - Garage and Maintenance Office

The Garage and Maintenance Office Building is a 12,722-square-foot building that serves as a space for offices, conference room, open garage area for maintenance and employee break room. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are in good condition; ceilings are a combination of drop with recessed fixtures and hard.

14 - Cold Storage and Maintenance Shops

The Cold Storage and Maintenance Shops Building is a 43,648-square-foot building of which 39,148 square-feet is in-use. The building serves as a space for shop areas for maintenance and storage for parts, lamps, paint, and new light fixtures. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are in fair to poor condition; ceilings are a combination of drop with surface mounted fixtures, hard and open truss.



16 - Fire House

The Fire House Building is a 5,361-square-foot building that serves as a space for shop areas for offices, educational training room and an open garage with an antique fire engine. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are in good condition; ceilings are a combination of drop with surface mounted fixtures, hard and open truss.

17 – 17A Warehouse, 17C Cider Mill, 17D Farm Office, 17E Scale House, 17F Garage (Piggery Area) – no lights and 17H Slaughterhouse – no lights

The 17 Buildings are 19,858-square-feet combined. The buildings are located on two sides of the campus and are part of the original farm buildings. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are a combination good, fair, and poor condition; ceilings are a combination of hard and open truss. These buildings, 17F Garage (Piggery Area) and 17F Slaughterhouse, do not have lights.

24 & 25 – 24O Sewage Screen Chamber Pit, 25A – Cottage #1, 25B, Cottage #2, 25C Cottage #3, 25E M Mill (Wels Shop & Storage) and 25F Wertz Cottage-Residence

The 24 & 25 Buildings are 17,436-square-feet combined. The 25 buildings provide housing and 24O supports the sewage for the housing. Existing systems are predominantly 13W GX23 2-Pin lamps in drum fixtures and 25W T8 linear fluorescent lamps. Existing fixtures are in fair condition; ceilings are hard. These buildings, 17F Garage (Piggery Area) and 17F Slaughterhouse, do not have lights.

26 – East Hall - Maintenance Shops

The Maintenance Shops is a 23,418-square-foot building that serves as a space for the wood working shop, break room area and storage. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are in fair condition; ceilings are hard and open truss.

28 - Old Main Kitchen

The Old Main Kitchen Building is a 12,715-square-foot building which serves as storage for large bulk items. This building is located next to the 12 – Storerooms Building. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are in good condition; ceilings are hard and in poor condition.

31 - Hill Hall

The Hill Hall Building is a 20,466-square-foot building that serves as a space for offices and conference rooms. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are in good and fair condition; ceilings are a combination of drop with recessed fixtures and hard.

32 - Laundry

The Laundry Building is a 20,938-square-foot building which serves as a space for laundry management and storage. Existing systems are predominantly 25W T8 & T5HO linear fluorescent lamps. Existing fixtures a combination of good and poor condition; ceilings are hard. The large open areas have 20-foot ceilings.



33 - Boiler Plant

The Boiler Plant Building is a 20,642-square-foot building which serves as a space for the coal-fired boiler plant. The space has large open room for the boiler plant, catwalk, offices, explosion proof storage spaces and an exterior coal garage. The building operates continuously. Existing systems are predominantly 25W T8 & T5HO linear fluorescent lamps. Existing fixtures a combination of good and poor condition; ceilings are hard and open truss.

34 - Schuylkill Center

The Schuylkill Building is a 122,577-square-foot building that serves patients, staff, nurses, and doctors. The building has offices, conference rooms, patient rooms, day rooms, patient services, restrooms, cafeterias, and kitchens. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are a combination of good, fair, and poor condition; ceilings are drop with recessed fixtures, hard, open truss, and spline.

35 - Lebanon Center (West Hall)

The Schuylkill Building is a 116,977-square-foot building that serves patients, staff, nurses, and doctors. The building has offices, conference rooms, patient rooms, day rooms, patient services, restrooms, cafeterias, and kitchens. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are a combination of good, fair, and poor condition; ceilings are drop with recessed fixtures, hard, open truss, and spline.

37 - Berks Center

The Schuylkill Building is a 116,211-square-foot building that serves patients, staff, nurses, and doctors. The building has offices, conference rooms, patient rooms, day rooms, patient services, restrooms, cafeterias, kitchens, and mechanical rooms. Existing systems are predominantly 25W T8 linear fluorescent lamps. Existing fixtures are a combination of good, fair, and poor condition; ceilings are drop with recessed fixtures, hard, open truss, and spline.

Exterior Lighting

The exterior lighting includes the Tunnel System, Shoe Box style pole lighting, Wall Packs, Canopy lights, Dusk-to-Dawn, and Jelly Jar luminaires.

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Building 1	1	80-watt CFL Canopy	85	4380	0.085	1	New LED Canopy 30w	30	0.03	0.055	240.9
Building 1	5	1x4 1L 25-watt wrap	23	2550	0.115	5	Type A LED	10	0.05	0.065	165.75
Building 1	26	1x4 2L 25-watt wrap	44	2550	1.144	26	Type A LED	20	0.52	0.624	1591.2
Building 1	12	1x8 2L Wrap HBF	59	2550	0.708	12	Type A LED	20	0.24	0.468	1193.4
Building 1	4	2/13 Drum	30	2550	0.12	4	Retro kit	15	0.06	0.06	153
Building 1	2	2L 52-watt CFL WP	58	2550	0.116	2	WP LED	25	0.05	0.066	168.3
Building 1	6	3/13-watt Drum	43	2550	0.258	6	Retro kit	15	0.09	0.168	428.4
Building 1	1	1L 17-watt LBF	15	2550	0.015	1	Type A LED	8	0.008	0.007	17.85
Building 1	1	2L 25-watt HBF	59	2550	0.059	1	Type A LED	20	0.02	0.039	99.45
Building 1	12	2L 25-watt LBF	38	2550	0.4572	12	Type A LED	20	0.24	0.2172	553.86
Building 1	2	4L 25-watt LBF	77	2550	0.154	2	Type A LED	48	0.096	0.058	147.9
Building 3	12	1x4 1L 25-watt wrap	23	2550	0.276	12	Type A LED	10	0.12	0.156	397.8
Building 3	2	2/13 Drum	30	2550	0.06	2	Retro kit	15	0.03	0.03	76.5
Building 3	37	Exit LED	2	8760	0.074	37	N/R	2	0.074	0	0
Building 3	21	1L 25-watt	23	2550	0.483	21	Type A LED	10	0.21	0.273	696.15
Building 3	5	2L 25-watt HBF	59	2550	0.295	5	Type A LED	20	0.1	0.195	497.25
Building 3	204	2L 25-watt LBF	38	2550	7.7724	204	Type A LED	20	4.08	3.6924	9415.62
Building 5	3	100 Watt Metal Halide Canopy	125	4380	0.375	3	New LED Canopy 30w	30	0.09	0.285	1248.3
Building 5	4	100 Watt Metal Halide Wall Pack	125	4380	0.5	4	New 30 Watt LED Wall Pack	30	0.12	0.38	1664.4
Building 5	10	120 watt Induction WP	130	4380	1.3	10	New WP	52	0.52	0.78	3416.4
Building 5	48	1x4 1L 25-watt wrap	23	2550	1.104	48	Type A LED	10	0.48	0.624	1591.2
Building 5	56	1x8 2L Wrap HBF	59	2550	3.304	56	Type A LED	20	1.12	2.184	5569.2
Building 5	12	Exit LED	2	8760	0.024	12	N/R	2	0.024	0	0
Building 5	1	1L 25-watt LBF	21	2550	0.021	1	Type A LED	10	0.01	0.011	28.05
Building 5	73	2L 25-watt LBF	38	2550	2.7813	73	Type A LED	20	1.46	1.3213	3369.315
Building 12	39	1x8 2L Wrap HBF	59	2550	2.301	39	Type A LED	20	0.78	1.521	3878.55
Building 12	1	2/13 Drum	29	2550	0.029	1	Retro kit	15	0.015	0.014	35.7
Building 12	2	3/13 Drum	42	2550	0.084	2	Retro kit	15	0.03	0.054	137.7
Building 12	17	4L T5 Hibay	236	2550	4.012	17	Type A LED	90	1.53	2.482	6329.1
Building 12	4	Exit LED	2	8760	0.008	4	N/R	2	0.008	0	0
Building 12	7	2L 25-watt HBF	59	2550	0.413	7	Type A LED	20	0.14	0.273	696.15
Building 12	25	2L 25-watt LBF	38	2550	0.9525	25	Type A LED	20	0.5	0.4525	1153.875
Building 13	3	1x4 1L 25-watt wrap	23	2550	0.069	3	Type A LED	10	0.03	0.039	99.45
Building 13	8	2/13 Sconce	30	2550	0.24	8	Retro kit	15	0.12	0.12	306
Building 13	1	3/13 Drum	42	2550	0.042	1	Retro kit	15	0.015	0.027	68.85
Building 13	28	2L 25-watt HBF	59	2550	1.652	28	Type A LED	20	0.56	1.092	2784.6
Building 13	28	2L 25-watt LBF	38	2550	1.0668	28	Type A LED	20	0.56	0.5068	1292.34
Building 13	15	4L 25-watt LBF	77	2550	1.155	15	Type A LED	48	0.72	0.435	1109.25
Building 14	35	1x4 1L 25-watt wrap	23	2550	0.805	35	Type A LED	10	0.35	0.455	1160.25
Building 14	12	1x4 2L 25-watt wrap	44	2550	0.528	12	Type A LED	20	0.24	0.288	734.4
Building 14	45	1x8 2L Wrap HBF	59	2550	2.655	45	Type A LED	20	0.9	1.755	4475.25
Building 14	3	2/13 Drum	30	2550	0.09	3	Retro kit	15	0.045	0.045	114.75
Building 14	6	Exit LED	2	8760	0.012	6	N/R	2	0.012	0	0
Building 14	10	2L 25-watt HBF	59	2550	0.59	10	Type A LED	20	0.2	0.39	994.5

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Building 14	64	2L 25-watt LBF	38	2550	2.4384	64	Type A LED	20	1.28	1.1584	2953.92
Building 14	14	2L 25-watt LBF	38	2550	0.5334	14	Type A LED	20	0.28	0.2534	646.17
Building 16	2	100 Watt Metal Halide Wall Pack	125	4380	0.25	2	New 30 Watt LED Wall Pack	30	0.06	0.19	832.2
Building 16	17	1x4 1L 25-watt wrap	23	2550	0.391	17	Type A LED	10	0.17	0.221	563.55
Building 16	1	1x8 2L Wrap HBF	59	2550	0.059	1	Type A LED	20	0.02	0.039	99.45
Building 16	6	2L 25-watt HBF	59	2550	0.354	6	Type A LED	20	0.12	0.234	596.7
Building 16	8	4L 25-watt LBF	77	2550	0.616	8	Type A LED	48	0.384	0.232	591.6
Building 26	2	1x4 1L 25-watt wrap	23	2550	0.046	2	Type A LED	10	0.02	0.026	66.3
Building 26	12	1x4 2L 25-watt wrap	44	2550	0.528	12	Type A LED	20	0.24	0.288	734.4
Building 26	32	1x8 2L Wrap HBF	59	2550	1.888	32	Type A LED	20	0.64	1.248	3182.4
Building 26	8	1x8 2L Wrap HBF	59	2550	0.472	8	Type A LED	20	0.16	0.312	795.6
Building 26	17	2/13 Drum	30	2550	0.51	17	Retro kit	15	0.255	0.255	650.25
Building 26	4	3/13 Drum	42	2550	0.168	4	Retro kit	15	0.06	0.108	275.4
Building 26	17	Exit LED	2	8760	0.034	17	N/R	2	0.034	0	0
Building 26	13	2L 25-watt	44	2550	0.572	13	Type A LED	20	0.26	0.312	795.6
Building 26	69	2L 25-watt LBF	38	2550	2.6289	69	Type A LED	20	1.38	1.2489	3184.695
Building 26	6	3L 25-watt LBF	62	2550	0.372	6	Type A LED	36	0.216	0.156	397.8
Building 28	25	1x4 1L 25-watt wrap	23	2550	0.575	25	Type A LED	10	0.25	0.325	828.75
Building 28	64	1x8 2L Wrap HBF	59	2550	3.776	64	Type A LED	20	1.28	2.496	6364.8
Building 28	15	2/13 Drum	30	2550	0.45	15	Retro kit	15	0.225	0.225	573.75
Building 28	2	Exit LED	2	8760	0.004	2	N/R	2	0.004	0	0
Building 28	24	1L 25-watt LBF	21	2550	0.504	24	Type A LED	10	0.24	0.264	673.2
Building 28	1	2L 17-watt LBF	33	2550	0.033	1	Type A LED	16	0.016	0.017	43.35
Building 28	4	2L 25-watt HBF	59	2550	0.236	4	Type A LED	20	0.08	0.156	397.8
Building 28	17	2L 25-watt LBF	38	2550	0.6477	17	Type A LED	20	0.34	0.3077	784.635
Building 31	8	25 CFL	25	2500	0.2	8	Screw-In	11	0.088	0.112	280
Building 31	69	1x4 1L 25-watt wrap	23	2500	1.587	69	Type A LED	10	0.69	0.897	2242.5
Building 31	2	2/13 Drum	30	2500	0.06	2	Retro kit	15	0.03	0.03	75
Building 31	8	3/13 Drum	42	2500	0.336	8	Retro kit	15	0.12	0.216	540
Building 31	24	Exit LED	2	8760	0.048	24	N/R	2	0.048	0	0
Building 31	3	1L 25-watt LBF	21	2500	0.063	3	Type A LED	10	0.03	0.033	82.5
Building 31	25	2L 17-watt LBF	31	2500	0.775	25	Type A LED	16	0.4	0.375	937.5
Building 31	21	2L 25-watt HBF	59	2500	1.239	21	Type A LED	20	0.42	0.819	2047.5
Building 32	6	26 CFL WP	28	4380	0.168	6	New WP	10	0.06	0.108	473.04
Building 32	2	80-watt CFL Canopy	85	4380	0.17	2	New LED Canopy 30w	30	0.06	0.11	481.8
Building 32	8	1x4 1L 25-watt Wrap	23	2500	0.184	8	Type A LED	10	0.08	0.104	260
Building 32	4	2/13 Drum	30	2500	0.12	4	Retro kit	15	0.06	0.06	150
Building 32	33	4L T5 Hibay	236	2500	7.788	33	Type A LED	90	2.97	4.818	12045
Building 32	9	2L 25-watt LBF	38	2500	0.3429	9	Type A LED	20	0.18	0.1629	407.25
Building 32	12	2L 25-watt	44	2500	0.528	12	Type A LED	20	0.24	0.288	720
Building 32	4	4L 25-watt LBF	77	2500	0.308	4	Type A LED	48	0.192	0.116	290
Building 33	3	120 watt Induction WP	130	4380	0.39	3	New WP	52	0.156	0.234	1024.92
Building 33	22	200 Induction WP	215	4380	4.73	22	New WP	85	1.87	2.86	12526.8
Building 33	4	26 CFL WP	28	4380	0.112	4	New WP	12	0.048	0.064	280.32

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Building 33	30	1x4 1L 25-watt wrap	23	5400	0.69	30	Type A LED	10	0.3	0.39	2106
Building 33	40	1x4 2L 25-watt wrap	44	5400	1.76	40	Type A LED	20	0.8	0.96	5184
Building 33	43	2/13 Drum	30	5400	1.29	43	Retro kit	15	0.645	0.645	3483
Building 33	35	4L T5 Hibay	236	5400	8.26	35	Type A LED	95	3.325	4.935	26649
Building 33	1	2L 17-watt LBF	31	5400	0.031	1	Type A LED	16	0.016	0.015	81
Building 33	61	2L 25-watt LBF	38	5400	2.3241	61	Type A LED	20	1.22	1.1041	5962.14
Building 34	7	120 watt Induction WP	130	4380	0.91	7	New WP	52	0.364	0.546	2391.48
Building 34	2	26 CFL WP	28	4380	0.056	2	New WP	12	0.024	0.032	140.16
Building 34	20	1x4 1L 25-watt wrap	23	5400	0.46	20	Type A LED	10	0.2	0.26	1404
Building 34	2	1x4 2L 25-watt wrap	44	5400	0.088	2	Type A LED	20	0.04	0.048	259.2
Building 34	27	2/13 Drum	30	5400	0.81	27	Retro kit	15	0.405	0.405	2187
Building 34	11	2/13 Can	30	5400	0.33	11	Retro kit	15	0.165	0.165	891
Building 34	11	2/13 Sconce	30	5400	0.33	11	Retro kit	15	0.165	0.165	891
Building 34	30	3/13 Drum	42	5400	1.26	30	Retro kit	15	0.45	0.81	4374
Building 34	25	3l T5 Hibay	177	5400	4.425	25	Type A LED	70	1.75	2.675	14445
Building 34	32	4L T5 Hibay	236	5400	7.552	32	Type A LED	95	3.04	4.512	24364.8
Building 34	17	Exit LED	2	8760	0.034	17	N/R	2	0.034	0	0
Building 34	93	1L 25-watt LBF	21	5400	1.953	93	Type A LED	10	0.93	1.023	5524.2
Building 34	37	2L 17-watt LBF	31	5400	1.147	37	Type A LED	16	0.592	0.555	2997
Building 34	29	2L 17-watt	33	5400	0.957	29	Type A LED	16	0.464	0.493	2662.2
Building 34	105	2L 25-watt HBF	59	5400	6.195	105	Type A LED	20	2.1	4.095	22113
Building 34	626	2L 25-watt LBF	38	5400	23.8506	626	Type A LED	20	12.52	11.3306	61185.24
Building 34	10	3L 25-watt LBF	58	5400	0.58	10	Type A LED	36	0.36	0.22	1188
Building 34	30	4L 25-watt LBF	77	5400	2.31	30	Type A LED	48	1.44	0.87	4698
Building 35	7	120 watt Induction WP	130	4380	0.91	7	New WP	52	0.364	0.546	2391.48
Building 35	2	26 CFL WP	28	4380	0.056	2	New WP	12	0.024	0.032	140.16
Building 35	20	1x4 1L 25-watt wrap	23	5400	0.46	20	Type A LED	10	0.2	0.26	1404
Building 35	2	1x4 2L 25-watt wrap	44	5400	0.088	2	Type A LED	20	0.04	0.048	259.2
Building 35	27	2/13 Drum	30	5400	0.81	27	Retro kit	15	0.405	0.405	2187
Building 35	11	2/13 Can	30	5400	0.33	11	Retro kit	15	0.165	0.165	891
Building 35	11	2/13 Sconce	30	5400	0.33	11	Retro kit	15	0.165	0.165	891
Building 35	30	3/13 Drum	42	5400	1.26	30	Retro kit	15	0.45	0.81	4374
Building 35	25	3l T5 Hibay	177	5400	4.425	25	Type A LED	70	1.75	2.675	14445
Building 35	32	4L T5 Hibay	236	5400	7.552	32	Type A LED	95	3.04	4.512	24364.8
Building 35	17	Exit LED	2	8760	0.034	17	N/R	2	0.034	0	0
Building 35	93	1L 25-watt LBF	21	5400	1.953	93	Type A LED	10	0.93	1.023	5524.2
Building 35	37	2L 17-watt LBF	31	5400	1.147	37	Type A LED	16	0.592	0.555	2997
Building 35	29	2L 17-watt	33	5400	0.957	29	Type A LED	16	0.464	0.493	2662.2
Building 35	105	2L 25-watt HBF	59	5400	6.195	105	Type A LED	20	2.1	4.095	22113
Building 35	626	2L 25-watt LBF	38	5400	23.8506	626	Type A LED	20	12.52	11.3306	61185.24
Building 35	10	3l 25-watt LBF	58	5400	0.58	10	Type A LED	36	0.36	0.22	1188
Building 35	30	4L 25-watt LBF	77	5400	2.31	30	Type A LED	48	1.44	0.87	4698
Building 37	78	1x4 1L 25-watt Wrap	23	5400	1.794	78	Type A LED	10	0.78	1.014	5475.6
Building 37	5	1x4 2L 25-watt wrap	44	5400	0.22	5	Type A LED	20	0.1	0.12	648

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Building 37	23	1x4 4L 25-watt Wrap	85	5400	1.955	23	Type A LED	48	1.104	0.851	4595.4
Building 37	3	2/13 Drum	30	5400	0.09	3	Retro kit	15	0.045	0.045	243
Building 37	4	3/13 Drum	30	5400	0.12	4	Retro kit	15	0.06	0.06	324
Building 37	15	2L 25-watt	44	5400	0.66	15	Type A LED	20	0.3	0.36	1944
Building 37	2	1L 17-watt LBF	15	5400	0.03	2	Type A LED	8	0.016	0.014	75.6
Building 37	11	1L 25-watt LBF	21	5400	0.231	11	Type A LED	10	0.11	0.121	653.4
Building 37	2	2L 17-watt LBF	31	5400	0.062	2	Type A LED	16	0.032	0.03	162
Building 37	33	2L 17-watt	33	5400	1.089	33	Type A LED	16	0.528	0.561	3029.4
Building 37	417	2L 25-watt HBF	59	5400	24.603	417	Type A LED	20	8.34	16.263	87820.2
Building 37	450	2L 25-watt LBF	38	5400	17.145	450	Type A LED	20	9	8.145	43983
Building 37	26	2L 25-watt	44	5400	1.144	26	Type A LED	20	0.52	0.624	3369.6
Building 37	48	2L 25-watt	44	5400	2.112	48	Type A LED	20	0.96	1.152	6220.8
Building 37	18	4L 25-watt LBF	77	5400	1.386	18	Type A LED	48	0.864	0.522	2818.8
Tunnel	30	25 CFL	25	2500	0.75	30	Screw-In	11	0.33	0.42	1050
Tunnel	101	1x8 2L Wrap HBF	59	2500	5.959	101	Type A LED	20	2.02	3.939	9847.5
Tunnel	22	1x8 2L Wrap LBF	38	2500	0.836	22	Type A LED	20	0.44	0.396	990
Tunnel	114	2L 25-watt	44	2500	5.016	114	Type A LED	20	2.28	2.736	6840
Tunnel	27	1L 25-watt LBF	21	2500	0.567	27	Type A LED	10	0.27	0.297	742.5
Tunnel	1	3L 25-watt LBF	58	2500	0.058	1	Type A LED	36	0.036	0.022	55
Exterior #34	13	100 Watt HPS Shoe box	125	4380	1.625	13	New 40 Watt LED Shoe box	40	0.52	1.105	4839.9
Exterior #34	10	100 Watt Metal Halide Wall Pack w/Photocell	125	4380	1.25	10	New 30 Watt LED Wall Pack w/ Photocell	30	0.3	0.95	4161
Exterior #34	12	100 Watt Metal Halide Canopy	125	4380	1.5	12	New 27 Watt LED Canopy	27	0.324	1.176	5150.88
Exterior #34	5	20 Watt LED Canopy	20	4380	0.1	5	N/R	20	0.1	0	0
Exterior #35	6	32 Watt Plug-In CFL	36	4380	0.216	6	Retrofit with (1) 15.5 Watt LED Plug-In Lamp	15.5	0.093	0.123	538.74
Exterior #35	9	100 Watt HPS Shoe box	125	4380	1.125	9	New 40 Watt LED Shoe box	40	0.36	0.765	3350.7
Exterior #35	4	100 Watt Metal Halide Wall Pack w/Photocell	125	4380	0.5	4	New 30 Watt LED Wall Pack w/ Photocell	30	0.12	0.38	1664.4
Exterior #35	1	400 Watt HPS Flood	464	4380	0.464	1	New 135 Watt LED Flood	135	0.135	0.329	1441.02
Exterior #35	4	LED Cobra	75	4380	0.3	4	N/R	75	0.3	0	0
Exterior #35	3	100 Watt Metal Halide Canopy	125	4380	0.375	3	New 27 Watt LED Canopy	27	0.081	0.294	1287.72
Exterior #37	26	100 Watt HPS Shoe box	125	4380	3.25	26	New 40 Watt LED Shoe box	40	1.04	2.21	9679.8
Exterior #37	1	23 Watt CF Screw-In 12x12 Canopy	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
Exterior #37	7	100 Watt Metal Halide Wall Pack w/Photocell	125	4380	0.875	7	New 30 Watt LED Wall Pack w/ Photocell	30	0.21	0.665	2912.7
Exterior #37	2	32 Watt Plug-In CFL Wall Pack	36	4380	0.072	2	New 30 Watt LED Wall Pack	30	0.06	0.012	52.56
Exterior #37	4	100 Watt Metal Halide Canopy	125	4380	0.5	4	New 27 Watt LED Canopy	27	0.108	0.392	1716.96
Exterior #37	1	LED Flood	25	4380	0.025	1	N/R	25	0.025	0	0
Exterior #37	2	23 Watt CF Screw-In Coach	23	4380	0.046	2	Re-Lamp with (1) 15 Watt LED A19	15	0.03	0.016	70.08
Exterior HOSPITAL PLANT	3	50 Watt HPS Wall Pack	70	4380	0.21	3	New 30 Watt LED Wall Pack	30	0.09	0.12	525.6
Exterior HOSPITAL PLANT	1	175 Watt Mercury Vapor Dusk to Dawn	210	4380	0.21	1	New 40 Watt LED Dusk to Dawn	40	0.04	0.17	744.6
Exterior HOSPITAL PLANT	1	70 Watt HPS Shoe box	90	4380	0.09	1	New 40 Watt LED Shoe box	40	0.04	0.05	219
MAIN STREET LIGHTING	15	250 Watt HPS Shoe box	300	4380	4.5	15	New 70 Watt LED Shoe box	70	1.05	3.45	15111
SPORTSMAN RD	9	250 Watt HPS Shoe box	300	4380	2.7	9	New 70 Watt LED Shoe box	70	0.63	2.07	9066.6
PARKING LOT A	4	100 Watt HPS Shoe box	125	4380	0.5	4	New 40 Watt LED Shoe box	40	0.16	0.34	1489.2
PARKING ADJ. TO 34	4	100 Watt HPS Shoe box	125	4380	0.5	4	New 40 Watt LED Shoe box	40	0.16	0.34	1489.2
BY COTTAGES	3	100 Watt HPS Shoe box	125	4380	0.375	3	New 40 Watt LED Shoe box	40	0.12	0.255	1116.9

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Exterior #34	2	50 Watt Metal Halide RLM	72	4380	0.144	2	New 26 Watt LED Post Top; Gray	26	0.052	0.092	402.96
Exterior #34	6	23 Watt CFI Wall pack	23	4380	0.138	6	New 23 Watt LED Wall Pack	23	0.138	0	0
Exterior #34	1	80 Watt HID Induction Wall Pack	83	4380	0.083	1	New 27 Watt LED Flood; Difficult Access	27	0.027	0.056	245.28
Exterior #34	1	150 Watt HPS Wall Pack	185	4380	0.185	1	New 40 Watt LED Wall Pack	40	0.04	0.145	635.1
Exterior #35	2	23 Watt CF Canopy	23	4380	0.046	2	New 10 Watt LED Canopy	12	0.024	0.022	96.36
Exterior #35	4	LED Wallpack	15	4380	0.06	4	N/R	15	0.06	0	0
Exterior #35	8	150 Watt Metal Halide Wall Pack	185	4380	1.48	8	New 40 Watt LED Wall Pack	40	0.32	1.16	5080.8
Exterior #35	1	175 Watt Mercury Vapor Dusk to Dawn	210	4380	0.21	1	New 40 Watt LED Dusk to Dawn	40	0.04	0.17	744.6
Exterior #35	1	80 Watt HID Induction Wall Pack	83	4380	0.083	1	New 27 Watt LED Flood; Difficult Access	27	0.027	0.056	245.28
Exterior #35	1	150 Watt Metal Halide Canopy	185	4380	0.185	1	New 40 Watt LED Canopy	40	0.04	0.145	635.1
Exterior #37	5	LED Wallpack	15	4380	0.075	5	N/R	15	0.075	0	0
Exterior #37	1	100 Watt Metal Halide Wall Pack	125	4380	0.125	1	New 30 Watt LED Wall Pack	30	0.03	0.095	416.1
Exterior #37	4	LED Wallpack	15	4380	0.06	4	N/R	15	0.06	0	0
Exterior #37	1	23 Watt CF Jelly Jar; Photocell	23	4380	0.023	1	New 20 Watt LED Jelly Jar	20	0.02	0.003	13.14
Exterior #37	1	70 Watt Metal Halide Wall Pack	94	4380	0.094	1	New 30 Watt LED Wall Pack	30	0.03	0.064	280.32
Exterior #37	1	150 Watt Metal Halide Canopy	185	4380	0.185	1	New 40 Watt LED Canopy	40	0.04	0.145	635.1
Exterior #37	1	23 Watt CF Jelly Jar	23	4380	0.023	1	New 20 Watt LED Jelly Jar	20	0.02	0.003	13.14
HOSPITAL PLANT	2	26 Watt CFL Plug-In Wall pack	26	4380	0.052	2	New 23 Watt LED Wall Pack	23	0.046	0.006	26.28
HOSPITAL PLANT	3	26 Watt CF Wall Pack	26	4380	0.078	3	New 23 Watt LED Wall Pack	23	0.069	0.009	39.42
HOSPITAL PLANT	1	23 Watt CF RLM Fixture	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
MAIN STREET LIGHTING	1	LED Wallpack	15	4380	0.015	1	N/R	15	0.015	0	0
SPORTSMAN RD	3	150 Watt Metal Halide Wall Pack	185	4380	0.555	3	New 40 Watt LED Wall Pack	40	0.12	0.435	1905.3
PARKING LOT A	1	150 Watt Metal Halide Canopy	185	4380	0.185	1	New 40 Watt LED Canopy	40	0.04	0.145	635.1
PARKING ADJ. TO 34	1	150 Watt Metal Halide Wall Pack; Difficult Access	185	4380	0.185	1	New 40 Watt LED Wall Pack; Difficult Access	40	0.04	0.145	635.1
BY COTTAGES	2	LED Canopy	20	4380	0.04	2	N/R	20	0.04	0	0
Exterior #05	1	23 Watt CF Coach Pole	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
Exterior #05	2	100 Watt Metal Halide Wall Pack	125	4380	0.25	2	New 30 Watt LED Wall Pack	30	0.06	0.19	832.2
Exterior #05	1	LED Canopy	20	4380	0.02	1	N/R	20	0.02	0	0
Exterior#05	1	23 Watt CF Coach Pole	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
Exterior #01	2	100 Watt Metal Halide Wall Pack	125	4380	0.25	2	New 30 Watt LED Wall Pack	30	0.06	0.19	832.2
Exterior #16	1	LED Canopy	20	4380	0.02	1	N/R	20	0.02	0	0
Exterior #26/3	1	23 Watt CF Coach Pole	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
Exterior #26/3	2	100 Watt Metal Halide Wall Pack	125	4380	0.25	2	New 30 Watt LED Wall Pack	30	0.06	0.19	832.2
Exterior #26/3	1	23 Watt CF Jelly Jar	23	4380	0.023	1	New 20 Watt LED Jelly Jar	20	0.02	0.003	13.14
Exterior #28/12	1	175 Watt Mercury Vapor Dusk to Dawn	210	4380	0.21	1	New 40 Watt LED Dusk to Dawn	40	0.04	0.17	744.6
Exterior #28/12	1	23 Watt Compact Fluorescent ;Difficult Access	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19; Very Difficult Access	15	0.015	0.008	35.04
Exterior #28/12	1	26 Watt CFL Plug-In Flood	26	4380	0.026	1	New 15 Watt LED Flood Light	15	0.015	0.011	48.18
Exterior #14	2	LED Canopy	20	4380	0.04	2	N/R	20	0.04	0	0
5,650					289.06	5,650	124.8			164.2	729,607
Derate for existing ballasts											5%
693,126											

ECM 1.1 TYPE C RETROFIT

Wernersville State Hospital
GESA 2021-2

in addition to other luminaire retrofits / replacements

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Building 1	1	80-watt CFL Canopy	85	4380	0.085	1	New LED Canopy 30w	30	0.03	0.055	240.9
Building 1	5	1x4 1L 25-watt wrap	23	2550	0.115	5	Type C LED	10	0.05	0.065	165.75
Building 1	26	1x4 2L 25-watt wrap	44	2550	1.144	26	Type C LED	20	0.52	0.624	1591.2
Building 1	12	1x8 2L Wrap HBF	59	2550	0.708	12	Type C LED	20	0.24	0.468	1193.4
Building 1	4	2/13 Drum	30	2550	0.12	4	Retro kit	15	0.06	0.06	153
Building 1	2	2L 52-watt CFL WP	58	2550	0.116	2	WP LED	25	0.05	0.066	168.3
Building 1	6	3/13-watt Drum	43	2550	0.258	6	Retro kit	15	0.09	0.168	428.4
Building 1	1	1L 17-watt LBF	15	2550	0.015	1	Type C LED	8	0.008	0.007	17.85
Building 1	1	2L 25-watt HBF	59	2550	0.059	1	Type C LED	20	0.02	0.039	99.45
Building 1	12	2L 25-watt LBF	38	2550	0.4572	12	Type C LED	20	0.24	0.2172	553.86
Building 1	2	4L 25-watt LBF	77	2550	0.154	2	Type C LED	48	0.096	0.058	147.9
Building 3	12	1x4 1L 25-watt wrap	23	2550	0.276	12	Type C LED	10	0.12	0.156	397.8
Building 3	2	2/13 Drum	30	2550	0.06	2	Retro kit	15	0.03	0.03	76.5
Building 3	37	Exit LED	2	8760	0.074	37	N/R	2	0.074	0	0
Building 3	21	1L 25-watt	23	2550	0.483	21	Type C LED	10	0.21	0.273	696.15
Building 3	5	2L 25-watt HBF	59	2550	0.295	5	Type C LED	20	0.1	0.195	497.25
Building 3	204	2L 25-watt LBF	38	2550	7.7724	204	Type C LED	20	4.08	3.6924	9415.62
Building 5	3	100 Watt Metal Halide Canopy	125	4380	0.375	3	New LED Canopy 30w	30	0.09	0.285	1248.3
Building 5	4	100 Watt Metal Halide Wall Pack	125	4380	0.5	4	New 30 Watt LED Wall Pack	30	0.12	0.38	1664.4
Building 5	10	120 watt Induction WP	130	4380	1.3	10	New WP	52	0.52	0.78	3416.4
Building 5	48	1x4 1L 25-watt wrap	23	2550	1.104	48	Type C LED	10	0.48	0.624	1591.2
Building 5	56	1x8 2L Wrap HBF	59	2550	3.304	56	Type C LED	20	1.12	2.184	5569.2
Building 5	12	Exit LED	2	8760	0.024	12	N/R	2	0.024	0	0
Building 5	1	1L 25-watt LBF	21	2550	0.021	1	Type C LED	10	0.01	0.011	28.05
Building 5	73	2L 25-watt LBF	38	2550	2.7813	73	Type C LED	20	1.46	1.3213	3369.315
Building 12	39	1x8 2L Wrap HBF	59	2550	2.301	39	Type C LED	20	0.78	1.521	3878.55
Building 12	1	2/13 Drum	29	2550	0.029	1	Retro kit	15	0.015	0.014	35.7
Building 12	2	3/13 Drum	42	2550	0.084	2	Retro kit	15	0.03	0.054	137.7
Building 12	17	4L 54-watt Hi-Bay	236	2550	4.012	17	Type C LED	90	1.53	2.482	6329.1
Building 12	4	Exit LED	2	8760	0.008	4	N/R	2	0.008	0	0
Building 12	7	2L 25-watt HBF	59	2550	0.413	7	Type C LED	20	0.14	0.273	696.15
Building 12	25	2L 25-watt LBF	38	2550	0.9525	25	Type C LED	20	0.5	0.4525	1153.875
Building 13	3	1x4 1L 25-watt wrap	23	2550	0.069	3	Type C LED	10	0.03	0.039	99.45
Building 13	8	2/13 Sconce	30	2550	0.24	8	Retro kit	15	0.12	0.12	306
Building 13	1	3/13 Drum	42	2550	0.042	1	Retro kit	15	0.015	0.027	68.85
Building 13	28	2L 25-watt HBF	59	2550	1.652	28	Type C LED	20	0.56	1.092	2784.6
Building 13	28	2L 25-watt LBF	38	2550	1.0668	28	Type C LED	20	0.56	0.5068	1292.34
Building 13	15	4L 25-watt LBF	77	2550	1.155	15	Type C LED	48	0.72	0.435	1109.25
Building 14	35	1x4 1L 25-watt wrap	23	2550	0.805	35	Type C LED	10	0.35	0.455	1160.25
Building 14	12	1x4 2L 25-watt wrap	44	2550	0.528	12	Type C LED	20	0.24	0.288	734.4
Building 14	45	1x8 2L Wrap HBF	59	2550	2.655	45	Type C LED	20	0.9	1.755	4475.25
Building 14	3	2/13 Drum	30	2550	0.09	3	Retro kit	15	0.045	0.045	114.75
Building 14	6	Exit LED	2	8760	0.012	6	N/R	2	0.012	0	0
Building 14	10	2L 25-watt HBF	59	2550	0.59	10	Type C LED	20	0.2	0.39	994.5

ECM 1.1 TYPE C RETROFIT

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Building 14	64	2L 25-watt LBF	38	2550	2.4384	64	Type C LED	20	1.28	1.1584	2953.92
Building 14	14	2L 25-watt LBF	38	2550	0.5334	14	Type C LED	20	0.28	0.2534	646.17
Building 16	2	100 Watt Metal Halide Wall Pack	125	4380	0.25	2	New 30 Watt LED Wall Pack	30	0.06	0.19	832.2
Building 16	17	1x4 1L 25-watt wrap	23	2550	0.391	17	Type C LED	10	0.17	0.221	563.55
Building 16	1	1x8 2L Wrap HBF	59	2550	0.059	1	Type C LED	20	0.02	0.039	99.45
Building 16	6	2L 25-watt HBF	59	2550	0.354	6	Type C LED	20	0.12	0.234	596.7
Building 16	8	4L 25-watt LBF	77	2550	0.616	8	Type C LED	48	0.384	0.232	591.6
Building 26	2	1x4 1L 25-watt wrap	23	2550	0.046	2	Type C LED	10	0.02	0.026	66.3
Building 26	12	1x4 2L 25-watt wrap	44	2550	0.528	12	Type C LED	20	0.24	0.288	734.4
Building 26	32	1x8 2L Wrap HBF	59	2550	1.888	32	Type C LED	20	0.64	1.248	3182.4
Building 26	8	1x8 2L Wrap HBF	59	2550	0.472	8	Type C LED	20	0.16	0.312	795.6
Building 26	17	2/13 Drum	30	2550	0.51	17	Retro kit	15	0.255	0.255	650.25
Building 26	4	3/13 Drum	42	2550	0.168	4	Retro kit	15	0.06	0.108	275.4
Building 26	17	Exit LED	2	8760	0.034	17	N/R	2	0.034	0	0
Building 26	13	2L 25-watt	44	2550	0.572	13	Type C LED	20	0.26	0.312	795.6
Building 26	69	2L 25-watt LBF	38	2550	2.6289	69	Type C LED	20	1.38	1.2489	3184.695
Building 26	6	3L 25-watt LBF	62	2550	0.372	6	Type C LED	36	0.216	0.156	397.8
Building 28	25	1x4 1L 25-watt wrap	23	2550	0.575	25	Type C LED	10	0.25	0.325	828.75
Building 28	64	1x8 2L Wrap HBF	59	2550	3.776	64	Type C LED	20	1.28	2.496	6364.8
Building 28	15	2/13 Drum	30	2550	0.45	15	Retro kit	15	0.225	0.225	573.75
Building 28	2	Exit LED	2	8760	0.004	2	N/R	2	0.004	0	0
Building 28	24	1L 25-watt LBF	21	2550	0.504	24	Type C LED	10	0.24	0.264	673.2
Building 28	1	2L 17-watt LBF	33	2550	0.033	1	Type C LED	16	0.016	0.017	43.35
Building 28	4	2L 25-watt HBF	59	2550	0.236	4	Type C LED	20	0.08	0.156	397.8
Building 28	17	2L 25-watt LBF	38	2550	0.6477	17	Type C LED	20	0.34	0.3077	784.635
Building 31	8	25 CFL	25	2500	0.2	8	Screw-In	11	0.088	0.112	280
Building 31	69	1x4 1L 25-watt wrap	23	2500	1.587	69	Type C LED	10	0.69	0.897	2242.5
Building 31	2	2/13 Drum	30	2500	0.06	2	Retro kit	15	0.03	0.03	75
Building 31	8	3/13 Drum	42	2500	0.336	8	Retro kit	15	0.12	0.216	540
Building 31	24	Exit LED	2	8760	0.048	24	N/R	2	0.048	0	0
Building 31	3	1L 25-watt LBF	21	2500	0.063	3	Type C LED	10	0.03	0.033	82.5
Building 31	25	2L 17-watt LBF	31	2500	0.775	25	Type C LED	16	0.4	0.375	937.5
Building 31	21	2L 25-watt HBF	59	2500	1.239	21	Type C LED	20	0.42	0.819	2047.5
Building 32	6	26 CFL WP	28	4380	0.168	6	New WP	10	0.06	0.108	473.04
Building 32	2	80-watt CFL Canopy	85	4380	0.17	2	New LED Canopy 30w	30	0.06	0.11	481.8
Building 32	8	1x4 1L 25-watt Wrap	23	2500	0.184	8	Type C LED	10	0.08	0.104	260
Building 32	4	2/13 Drum	30	2500	0.12	4	Retro kit	15	0.06	0.06	150
Building 32	33	4L T5 Hibay	236	2500	7.788	33	Type C LED	90	2.97	4.818	12045
Building 32	9	2L 25-watt LBF	38	2500	0.3429	9	Type C LED	20	0.18	0.1629	407.25
Building 32	12	2L 25-watt	44	2500	0.528	12	Type C LED	20	0.24	0.288	720
Building 32	4	4L 25-watt LBF	77	2500	0.308	4	Type C LED	48	0.192	0.116	290
Building 33	3	120 watt Induction WP	130	4380	0.39	3	New WP	52	0.156	0.234	1024.92
Building 33	22	200 Induction WP	215	4380	4.73	22	New WP	85	1.87	2.86	12526.8
Building 33	4	26 CFL WP	28	4380	0.112	4	New WP	12	0.048	0.064	280.32

ECM 1.1 TYPE C RETROFIT

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Building 33	30	1x4 1L 25-watt wrap	23	5400	0.69	30	Type C LED	10	0.3	0.39	2106
Building 33	40	1x4 2L 25-watt wrap	44	5400	1.76	40	Type C LED	20	0.8	0.96	5184
Building 33	43	2/13 Drum	30	5400	1.29	43	Retro kit	15	0.645	0.645	3483
Building 33	35	4L T5 Hibay	236	5400	8.26	35	Type C LED	95	3.325	4.935	26649
Building 33	1	2L 17-watt LBF	31	5400	0.031	1	Type C LED	16	0.016	0.015	81
Building 33	61	2L 25-watt LBF	38	5400	2.3241	61	Type C LED	20	1.22	1.1041	5962.14
Building 34	7	120 watt Induction WP	130	4380	0.91	7	New WP	52	0.364	0.546	2391.48
Building 34	2	26 CFL WP	28	4380	0.056	2	New WP	12	0.024	0.032	140.16
Building 34	20	1x4 1L 25-watt wrap	23	5400	0.46	20	Type C LED	10	0.2	0.26	1404
Building 34	2	1x4 2L 25-watt wrap	44	5400	0.088	2	Type C LED	20	0.04	0.048	259.2
Building 34	27	2/13 Drum	30	5400	0.81	27	Retro kit	15	0.405	0.405	2187
Building 34	11	2/13 Can	30	5400	0.33	11	Retro kit	15	0.165	0.165	891
Building 34	11	2/13 Sconce	30	5400	0.33	11	Retro kit	15	0.165	0.165	891
Building 34	30	3/13 Drum	42	5400	1.26	30	Retro kit	15	0.45	0.81	4374
Building 34	25	3l T5 Hibay	177	5400	4.425	25	Type C LED	70	1.75	2.675	14445
Building 34	32	4L T5 Hibay	236	5400	7.552	32	Type C LED	95	3.04	4.512	24364.8
Building 34	17	Exit LED	2	8760	0.034	17	N/R	2	0.034	0	0
Building 34	93	1L 25-watt LBF	21	5400	1.953	93	Type C LED	10	0.93	1.023	5524.2
Building 34	37	2L 17-watt LBF	31	5400	1.147	37	Type C LED	16	0.592	0.555	2997
Building 34	29	2L 17-watt	33	5400	0.957	29	Type C LED	16	0.464	0.493	2662.2
Building 34	105	2L 25-watt HBF	59	5400	6.195	105	Type C LED	20	2.1	4.095	22113
Building 34	626	2L 25-watt LBF	38	5400	23.8506	626	Type C LED	20	12.52	11.3306	61185.24
Building 34	10	3L 25-watt LBF	58	5400	0.58	10	Type C LED	36	0.36	0.22	1188
Building 34	30	4L 25-watt LBF	77	5400	2.31	30	Type C LED	48	1.44	0.87	4698
Building 35	7	120 watt Induction WP	130	4380	0.91	7	New WP	52	0.364	0.546	2391.48
Building 35	2	26 CFL WP	28	4380	0.056	2	New WP	12	0.024	0.032	140.16
Building 35	20	1x4 1L 25-watt wrap	23	5400	0.46	20	Type C LED	10	0.2	0.26	1404
Building 35	2	1x4 2L 25-watt wrap	44	5400	0.088	2	Type C LED	20	0.04	0.048	259.2
Building 35	27	2/13 Drum	30	5400	0.81	27	Retro kit	15	0.405	0.405	2187
Building 35	11	2/13 Can	30	5400	0.33	11	Retro kit	15	0.165	0.165	891
Building 35	11	2/13 Sconce	30	5400	0.33	11	Retro kit	15	0.165	0.165	891
Building 35	30	3/13 Drum	42	5400	1.26	30	Retro kit	15	0.45	0.81	4374
Building 35	25	3l T5 Hibay	177	5400	4.425	25	Type C LED	70	1.75	2.675	14445
Building 35	32	4L T5 Hibay	236	5400	7.552	32	Type C LED	95	3.04	4.512	24364.8
Building 35	17	Exit LED	2	8760	0.034	17	N/R	2	0.034	0	0
Building 35	93	1L 25-watt LBF	21	5400	1.953	93	Type C LED	10	0.93	1.023	5524.2
Building 35	37	2L 17-watt LBF	31	5400	1.147	37	Type C LED	16	0.592	0.555	2997
Building 35	29	2L 17-watt	33	5400	0.957	29	Type C LED	16	0.464	0.493	2662.2
Building 35	105	2L 25-watt HBF	59	5400	6.195	105	Type C LED	20	2.1	4.095	22113
Building 35	626	2L 25-watt LBF	38	5400	23.8506	626	Type C LED	20	12.52	11.3306	61185.24
Building 35	10	3l 25-watt LBF	58	5400	0.58	10	Type C LED	36	0.36	0.22	1188
Building 35	30	4L 25-watt LBF	77	5400	2.31	30	Type C LED	48	1.44	0.87	4698
Building 37	78	1x4 1L 25-watt Wrap	23	5400	1.794	78	Type C LED	10	0.78	1.014	5475.6
Building 37	5	1x4 2L 25-watt wrap	44	5400	0.22	5	Type C LED	20	0.1	0.12	648

ECM 1.1 TYPE C RETROFIT

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Building 37	23	1x4 4L 25-watt Wrap	85	5400	1.955	23	Type C LED	48	1.104	0.851	4595.4
Building 37	3	2/13 Drum	30	5400	0.09	3	Retro kit	15	0.045	0.045	243
Building 37	4	3/13 Drum	30	5400	0.12	4	Retro kit	15	0.06	0.06	324
Building 37	15	2L 25-watt	44	5400	0.66	15	Type C LED	20	0.3	0.36	1944
Building 37	2	1L 17-watt LBF	15	5400	0.03	2	Type C LED	8	0.016	0.014	75.6
Building 37	11	1L 25-watt LBF	21	5400	0.231	11	Type C LED	10	0.11	0.121	653.4
Building 37	2	2L 17-watt LBF	31	5400	0.062	2	Type C LED	16	0.032	0.03	162
Building 37	33	2L 17-watt	33	5400	1.089	33	Type C LED	16	0.528	0.561	3029.4
Building 37	417	2L 25-watt HBF	59	5400	24.603	417	Type C LED	20	8.34	16.263	87820.2
Building 37	450	2L 25-watt LBF	38	5400	17.145	450	Type C LED	20	9	8.145	43983
Building 37	26	2L 25-watt	44	5400	1.144	26	Type C LED	20	0.52	0.624	3369.6
Building 37	48	2L 25-watt	44	5400	2.112	48	Type C LED	20	0.96	1.152	6220.8
Building 37	18	4L 25-watt LBF	77	5400	1.386	18	Type C LED	48	0.864	0.522	2818.8
Tunnel	30	25 CFL	25	2500	0.75	30	Screw-In	11	0.33	0.42	1050
Tunnel	101	1x8 2L Wrap HBF	59	2500	5.959	101	Type C LED	20	2.02	3.939	9847.5
Tunnel	22	1x8 2L Wrap LBF	38	2500	0.836	22	Type C LED	20	0.44	0.396	990
Tunnel	114	2L 25-watt	44	2500	5.016	114	Type C LED	20	2.28	2.736	6840
Tunnel	27	1L 25-watt LBF	21	2500	0.567	27	Type C LED	10	0.27	0.297	742.5
Tunnel	1	3L 25-watt LBF	58	2500	0.058	1	Type C LED	36	0.036	0.022	55
Exterior #34	13	100 Watt HPS Shoe box	125	4380	1.625	13	New 40 Watt LED Shoe box	40	0.52	1.105	4839.9
Exterior #35	10	100 Watt Metal Halide Wall Pack w/Photocell	125	4380	1.25	10	New 30 Watt LED Wall Pack w/ Photocell	30	0.3	0.95	4161
Exterior #36	12	100 Watt Metal Halide Canopy	125	4380	1.5	12	New 27 Watt LED Canopy	27	0.324	1.176	5150.88
Exterior #37	5	20 Watt LED Canopy	20	4380	0.1	5	No Retrofit	20	0.1	0	0
Exterior #35	6	32 Watt Plug-In CFL	36	4380	0.216	6	Retrofit with (1) 15.5 Watt LED Plug-In Lamp	15.5	0.093	0.123	538.74
Exterior #35	9	100 Watt HPS Shoe box	125	4380	1.125	9	New 40 Watt LED Shoe box	40	0.36	0.765	3350.7
Exterior #35	4	100 Watt Metal Halide Wall Pack w/Photocell	125	4380	0.5	4	New 30 Watt LED Wall Pack w/ Photocell	30	0.12	0.38	1664.4
Exterior #35	1	400 Watt HPS Flood	464	4380	0.464	1	New 135 Watt LED Flood	135	0.135	0.329	1441.02
Exterior #35	4	LED Cobra	75	4380	0.3	4	No Retrofit	75	0.3	0	0
Exterior #35	3	100 Watt Metal Halide Canopy	125	4380	0.375	3	New 27 Watt LED Canopy	27	0.081	0.294	1287.72
Exterior #37	26	100 Watt HPS Shoe box	125	4380	3.25	26	New 40 Watt LED Shoe box	40	1.04	2.21	9679.8
Exterior #37	1	23 Watt CF Screw-In 12x12 Canopy	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
Exterior #37	7	100 Watt Metal Halide Wall Pack w/Photocell	125	4380	0.875	7	New 30 Watt LED Wall Pack w/ Photocell	30	0.21	0.665	2912.7
Exterior #37	2	32 Watt Plug-In CFL Wall Pack	36	4380	0.072	2	New 30 Watt LED Wall Pack	30	0.06	0.012	52.56
Exterior #37	4	100 Watt Metal Halide Canopy	125	4380	0.5	4	New 27 Watt LED Canopy	27	0.108	0.392	1716.96
Exterior #37	1	LED Flood	25	4380	0.025	1	No Retrofit	25	0.025	0	0
Exterior #37	2	23 Watt CF Screw-In Coach	23	4380	0.046	2	Re-Lamp with (1) 15 Watt LED A19	15	0.03	0.016	70.08
Exterior PLANT	3	50 Watt HPS Wall Pack	70	4380	0.21	3	New 30 Watt LED Wall Pack	30	0.09	0.12	525.6
Exterior PLANT	1	175 Watt Mercury Vapor Dusk to Dawn	210	4380	0.21	1	New 40 Watt LED Dusk to Dawn	40	0.04	0.17	744.6
Exterior PLANT	1	70 Watt HPS Shoe box	90	4380	0.09	1	New 40 Watt LED Shoe box	40	0.04	0.05	219
MAIN STREET LIGHTING	15	250 Watt HPS Shoe box	300	4380	4.5	15	New 70 Watt LED Shoe box	70	1.05	3.45	15111
SPORTSMAN RD	9	250 Watt HPS Shoe box	300	4380	2.7	9	New 70 Watt LED Shoebox	70	0.63	2.07	9066.6
PARKING LOT A	4	100 Watt HPS Shoe box	125	4380	0.5	4	New 40 Watt LED Shoe box	40	0.16	0.34	1489.2
PARKING ADJ. TO 34	4	100 Watt HPS Shoe box	125	4380	0.5	4	New 40 Watt LED Shoe box	40	0.16	0.34	1489.2
Exterior BY COTTAGES	3	100 Watt HPS Shoe box	125	4380	0.375	3	New 40 Watt LED Shoe box	40	0.12	0.255	1116.9

ECM 1.1 TYPE C RETROFIT

Job: Wernersville State Hospital

Location	Number of Fixtures Pre	Pre Description	Pre Watts	Hours of Operation	Total kW Pre	Number of Fixtures Post	Post Description	Post Watts	Total kW Post	kW Saved	kWH Saved
Exterior #34	2	50 Watt Metal Halide RLM	72	4380	0.144	2	New 26 Watt LED Post Top; Gray	26	0.052	0.092	402.96
Exterior #34	6	23 Watt CFI Wall pack	23	4380	0.138	6	New 23 Watt LED Wall Pack	23	0.138	0	0
Exterior #34	1	80 Watt HID Induction Wall Pack	83	4380	0.083	1	New 27 Watt LED Flood; Difficult Access	27	0.027	0.056	245.28
Exterior #34	1	150 Watt HPS Wall Pack	185	4380	0.185	1	New 40 Watt LED Wall Pack	40	0.04	0.145	635.1
Exterior #35	2	23 Watt CF Canopy	23	4380	0.046	2	New 10 Watt LED Canopy	12	0.024	0.022	96.36
Exterior #35	4	LED Wallpack	15	4380	0.06	4	No Retrofit	15	0.06	0	0
Exterior #35	8	150 Watt Metal Halide Wall Pack	185	4380	1.48	8	New 40 Watt LED Wall Pack	40	0.32	1.16	5080.8
Exterior #35	1	175 Watt Mercury Vapor Dusk to Dawn	210	4380	0.21	1	New 40 Watt LED Dusk to Dawn	40	0.04	0.17	744.6
Exterior #35	1	80 Watt HID Induction Wall Pack	83	4380	0.083	1	New 27 Watt LED Flood; Difficult Access	27	0.027	0.056	245.28
Exterior #35	1	150 Watt Metal Halide Canopy	185	4380	0.185	1	New 40 Watt LED Canopy	40	0.04	0.145	635.1
Exterior #37	5	LED Wallpack	15	4380	0.075	5	No Retrofit	15	0.075	0	0
Exterior #37	1	100 Watt Metal Halide Wall Pack	125	4380	0.125	1	New 30 Watt LED Wall Pack	30	0.03	0.095	416.1
Exterior #37	4	LED Wallpack	15	4380	0.06	4	No Retrofit	15	0.06	0	0
Exterior #37	1	23 Watt CF Jelly Jar; Photocell	23	4380	0.023	1	New 20 Watt LED Jelly Jar	20	0.02	0.003	13.14
Exterior #37	1	70 Watt Metal Halide Wall Pack	94	4380	0.094	1	New 30 Watt LED Wall Pack	30	0.03	0.064	280.32
Exterior #37	1	150 Watt Metal Halide Canopy	185	4380	0.185	1	New 40 Watt LED Canopy	40	0.04	0.145	635.1
Exterior #37	1	23 Watt CF Jelly Jar	23	4380	0.023	1	New 20 Watt LED Jelly Jar	20	0.02	0.003	13.14
Exterior PLANT	2	26 Watt CFL Plug-In Wall pack	26	4380	0.052	2	New 23 Watt LED Wall Pack	23	0.046	0.006	26.28
Exterior PLANT	3	26 Watt CF Wall Pack	26	4380	0.078	3	New 23 Watt LED Wall Pack	23	0.069	0.009	39.42
Exterior PLANT	1	23 Watt CF RLM Fixture	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
MAIN STREET LIGHTING	1	LED Wallpack	15	4380	0.015	1	No Retrofit	15	0.015	0	0
SPORTSMAN RD	3	150 Watt Metal Halide Wall Pack	185	4380	0.555	3	New 40 Watt LED Wall Pack	40	0.12	0.435	1905.3
PARKING LOT A	1	150 Watt Metal Halide Canopy	185	4380	0.185	1	New 40 Watt LED Canopy	40	0.04	0.145	635.1
PARKING ADJ. TO 34	1	150 Watt Metal Halide Wall Pack; Difficult Access	185	4380	0.185	1	New 40 Watt LED Wall Pack; Difficult Access	40	0.04	0.145	635.1
BY COTTAGES	2	LED Canopy	20	4380	0.04	2	No Retrofit	20	0.04	0	0
Exterior #05	1	23 Watt CF Coach Pole	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
Exterior #06	2	100 Watt Metal Halide Wall Pack	125	4380	0.25	2	New 30 Watt LED Wall Pack	30	0.06	0.19	832.2
Exterior #07	1	LED Canopy	20	4380	0.02	1	No Retrofit	20	0.02	0	0
Exterior #08	1	23 Watt CF Coach Pole	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
Exterior #01	2	100 Watt Metal Halide Wall Pack	125	4380	0.25	2	New 30 Watt LED Wall Pack	30	0.06	0.19	832.2
Exterior #16	1	LED Canopy	20	4380	0.02	1	No Retrofit	20	0.02	0	0
Exterior #26/3	1	23 Watt CF Coach Pole	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19	15	0.015	0.008	35.04
Exterior #26/3	2	100 Watt Metal Halide Wall Pack	125	4380	0.25	2	New 30 Watt LED Wall Pack	30	0.06	0.19	832.2
Exterior #26/3	1	23 Watt CF Jelly Jar	23	4380	0.023	1	New 20 Watt LED Jelly Jar	20	0.02	0.003	13.14
Exterior #28/12	1	175 Watt Mercury Vapor Dusk to Dawn	210	4380	0.21	1	New 40 Watt LED Dusk to Dawn	40	0.04	0.17	744.6
Exterior #28/12	1	23 Watt Compact Fluorescent ;Difficult Access	23	4380	0.023	1	Re-Lamp with (1) 15 Watt LED A19; Very Difficult Access	15	0.015	0.008	35.04
Exterior #28/12	1	26 Watt CFL Plug-In Flood	26	4380	0.026	1	New 15 Watt LED Flood Light	15	0.015	0.011	48.18
Exterior #14	2	LED Canopy	20	4380	0.04	2	No Retrofit	20	0.04	0	0
5,650			289.06			5,650	124.8			164.2	729,607

ECM #1
Interior & exterior light conversion to LED

Equipment Information Sheets

C-CP-B-SQ-3L/4L/7L Series

LED Square Canopy Light

Replaces 100W-150W PSMH /175W MH

C-LITE
LED LIGHTING

EXTREMELY DURABLE DESIGN WITH AN EFFICACY UP TO 136 LUMENS PER WATT!



PRODUCT SPECIFICATIONS

OVERVIEW

- Initial Delivered Lumens: 3,600 (3L); 4,900 (4L); 7,200 (7L)
- CRI: ≥ 70
- CCT: Neutral White 4000K, Cool White 5000K
- Input Power: 27 W (3L); 36W (4L); 53W (7L)
- Dimmable: No
- Operating Temperature Range: -30°C (-22°F) to 40°C (104°F)
- Estimated L_{70} Lifetime @ 25°C: > 100,000 hours
- Power Factor: > 0.9
- Total Harmonic Distortion: < 20%
- Limited Warranty: 5 Years*
- Replaces 100W -150W PSMH/175W MH
- BUG Rating per TM-15-11: B1-U3-G1 (3L); B2-U3-G2 (4L & 7L)
- For use under covered ceilings only

PERFORMANCE	DURABLE	RECOMMENDED USE	INPUT VOLTAGE
<ul style="list-style-type: none">• Uses up to 80% less energy than comparable PSMH fixtures• Type VS distribution pattern	<ul style="list-style-type: none">• Polyester powder-coat finish provides corrosion protection for long-lasting color• UV-stabilized lens designed to last• Die-cast aluminum housing	<ul style="list-style-type: none">• Security• Entryways• Perimeter Lighting• Exterior canopies	<ul style="list-style-type: none">• Universal (120V through 277V Operation)

ORDERING INFORMATION

Example: C-CP-B-SQ-3L-40K-WH

C-CP-B	SQ			
PRODUCT	STYLE	LUMEN PACKAGE	CCT	COLOR
C-CP-B	SQ Square Canopy	3L 3,600 Lumens 27W 4L 4,900 Lumens 36W 7L 7,200 Lumens 53W	40K Neutral White (4000K) 50K Cool White (5000K)	DB Dark Bronze WH White

CERTIFICATIONS:

US: c-lite.com T (800) 236-6800 F (262) 504-5415

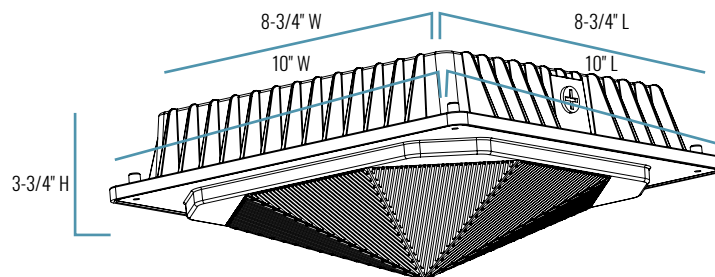
Canada: creelighting-canada.com T (800) 473-1234 F (800) 890-7507

Rev. Date: 06/05/2020

For informational purposes only. Content is subject to change. *See creelighting.com/warranty for details



C-CP-B-SQ-3L/4L/7L Series



SERIES OVERVIEW

DIMENSIONS	PRODUCT WEIGHT	MOUNTING HEIGHT	SPACING
8-3/4" L x 8-3/4" W x 3-3/4" H 10" L x 10" W (Outer Edge)	4.03 lbs. (3L) 4.14 lbs. (4L) 4.44 lbs. (7L)	8 to 15 feet	3 to 4 times the mounting height

FIXTURE SPECIFICATIONS

HOUSING	Low-copper, die-cast aluminum housing Dark bronze or white polyester powder-coat finish
LENS ASSEMBLY	UV-stabilized acrylic prismatic refractor with self-retaining screws
MOUNTING	3/4" conduit entry on top for pendant mounting (pendant by others) 1/2" conduit entries on two sides

ELECTRICAL PERFORMANCE

OPERATING TEMPERATURE RANGE	ESTIMATED L_{70} LIFETIME @ 25°C (77°F)	POWER FACTOR	TOTAL HARMONIC DISTORTION	DIMMABLE
-30°C (-22°F) to 40°C (104°F)	> 100,000 hours	> 0.9	< 20%	No

LUMEN PACKAGE	SYSTEM WATTS (120-277V)	INPUT VOLTAGE	120V	208V	240V	277V
3L	27	CURRENT DRAW (Amps)	0.23A	0.13A	0.11A	0.10A
4L	36		0.30A	0.17A	0.15A	0.13A
7L	53		0.44A	0.25A	0.22A	0.19A

WARRANTY AND CERTIFICATIONS

WARRANTY	cULus LISTED	DLC
5 Year Limited*	Wet Locations - Not intended for use with direct exposure to high-pressure water	DLC Premium Qualified. Please refer to www.designlights.org/QPL for most current information

CA RESIDENTS WARNING: Cancer and Reproductive Harm –
www.p65warnings.ca.gov

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Canada: creelighting-canada.com T (800) 473-1234 F (800) 890-7507

Rev. Date: 06/05/2020

For informational purposes only. Content is subject to change. *See creelighting.com/warranty for details

C-LITE
LED LIGHTING

FUTURE FIT >
LED KITS



FUTURE FIT >

LED KITS



Why retrofit when you can Future Fit?

Keystone's innovative Future Fit LED kits are the ideal solution to convert legacy fixtures into energy-efficient LED systems. Keystone pre-packages the appropriate Keystone drivers, modules, and mounting accessories, so that the LED retrofit can be installed quickly and easily either in the field or at the point of fixture manufacture. We did all the safety testing and performance verification, so upgrading to LED is as easy as zip-screwing in these clever Future Fit LED kits, only from Keystone.

TABLE OF CONTENTS

LIGHT ENGINE KITS

2 CIRCULAR KITS: 8" 1600, 2200, AND 2750 LUMENS; 13" SWITCHABLE LUMENS

5 RECTANGULAR KITS: 3" x 6" 800 AND 1600 LUMENS; 5.5" x 11" SWITCHABLE LUMENS

7 SCENCE KITS: 8", 1100 AND 700 LUMENS

8 FUTURE FIT AC LED LIGHT ENGINES: 90 CRI 7", 4", AND 3"; 80 CRI 7", 5.5", 4", AND 3"

LINEAR KITS WITH ALUMAGROOVE

11 2' AND 4' KITS

FREE PRODUCT SAMPLES AVAILABLE UPON REQUEST.

Call 800.464.2680 or email us at samples@keystonetech.com



**2016
AWARD
WINNER**

NAILED

Best Overall
Product

LIGHT ENGINE KITS

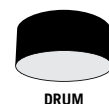
SYSTEM FEATURES FOR ALL CIRCULAR, RECTANGULAR, AND SCONCE LIGHT ENGINE KITS:

Module Features: LM80 tested LEDs by Samsung • 120° beam angle • Calculated life expectancy: L70 = 93,000 hours at tc <85°C
• Highly reflective white soldermask

Driver Features: UL 8750 Recognized Component • Meets FCC Part 15 Class B (consumer) limit for EMI • Over current, short circuit, and open circuit protection • Class 2 output • Type 1 outdoor, suitable for dry and damp locations • THD: <20%

8" CIRCULAR LED KITS

1600, 2200, AND 2750 LUMEN OPTIONS



Each pre-assembled UL Classified 1598C kit includes (1) dimmable LED driver, (1) LED module, (1) metal pan, mounting hardware, and accessories

8", 1600 LUMEN CIRCULAR

KIT SPECIFICATIONS:

Dimming Type: Phase Control

Driver: KTLD-20-1-560-FDIM-AQ7

Module: (1) KTLN-960-C2-8xx-64B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number*	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120V	KT-RKIT-CP-8-1600-830-FDIM	1	560mA	560mA	1700	12.5W	136 lm/W	80%	15.6W	109 lm/W
4000K	120V	KT-RKIT-CP-8-1600-840-FDIM	1	560mA	560mA	1750	12.5W	140 lm/W	80%	15.6W	112 lm/W
5000K	120V	KT-RKIT-CP-8-1600-850-FDIM	1	560mA	560mA	1800	12.5W	144 lm/W	80%	15.6W	115 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: KTLD-20-UV-560-VDIM-AQ7

Module: (1) KTLN-960-C2-8xx-64B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number*	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	KT-RKIT-CP-8-1600-830-VDIM	1	560mA	560mA	1700	12.5W	136 lm/W	80%	15.6W	109 lm/W
4000K	120-277V	KT-RKIT-CP-8-1600-840-VDIM	1	560mA	560mA	1750	12.5W	140 lm/W	80%	15.6W	112 lm/W
5000K	120-277V	KT-RKIT-CP-8-1600-850-VDIM	1	560mA	560mA	1800	12.5W	144 lm/W	80%	15.6W	115 lm/W

TYPICAL INSTALLATION APPLICATION



8" CIRCULAR LED KITS

1600, 2200, AND 2750 LUMEN OPTIONS

8", 2200 LUMEN CIRCULAR

KIT SPECIFICATIONS:

Dimming Type: Phase Control

Driver: KTLD-20-1-560-FDIM-AQ7

Module: (1) KTLM-960-C2-8xx-80B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number*	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120V	KT-RKIT-CP-8-2200-830-FDIM	1	560mA	560mA	2110	15.5W	136 lm/W	80%	19.3W	109 lm/W
4000K	120V	KT-RKIT-CP-8-2200-840-FDIM	1	560mA	560mA	2180	15.5W	141 lm/W	80%	19.3W	113 lm/W
5000K	120V	KT-RKIT-CP-8-2200-850-FDIM	1	560mA	560mA	2240	15.5W	145 lm/W	80%	19.3W	116 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: KTLD-20-UV-560-VDIM-AQ7

Module: (1) KTLM-960-C2-8xx-80B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number*	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	KT-RKIT-CP-8-2200-830-VDIM	1	560mA	560mA	2110	15.5W	136 lm/W	80%	19.3W	109 lm/W
4000K	120-277V	KT-RKIT-CP-8-2200-840-VDIM	1	560mA	560mA	2180	15.5W	141 lm/W	80%	19.3W	113 lm/W
5000K	120-277V	KT-RKIT-CP-8-2200-850-VDIM	1	560mA	560mA	2240	15.5W	145 lm/W	80%	19.3W	116 lm/W

8", 2750 LUMEN CIRCULAR

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: KTLD-25-UV-700-VDIM-AQ7

Module: (1) KTLM-960-C2-8xx-80B

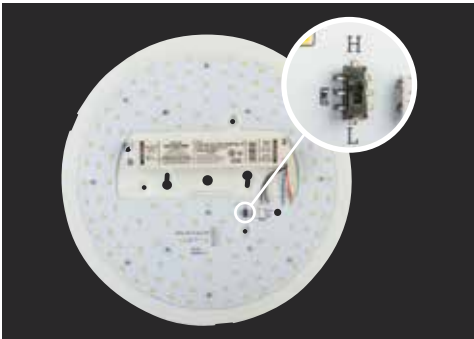
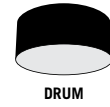
Color Temp	Input Voltage	LED Retrofit Kit Catalog Number*	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
2700K	120-277V	KT-RKIT-CP-8-2750-827-VDIM	1	700mA	700mA	2590	20W	130 lm/W	80%	25W	104 lm/W
3000K	120-277V	KT-RKIT-CP-8-2750-830-VDIM	1	700mA	700mA	2640	20W	132 lm/W	80%	25W	106 lm/W
3500K	120-277V	KT-RKIT-CP-8-2750-835-VDIM	1	700mA	700mA	2690	20W	135 lm/W	80%	25W	108 lm/W
4000K	120-277V	KT-RKIT-CP-8-2750-840-VDIM	1	700mA	700mA	2750	20W	138 lm/W	80%	25W	110 lm/W
5000K	120-277V	KT-RKIT-CP-8-2750-850-VDIM	1	700mA	700mA	2845	20W	142 lm/W	80%	25W	114 lm/W

GENERATION 2 UPGRADES: All 8" circular items in this catalog will be upgraded to Generation 2 (/G2) starting Q1 2018. G2 models feature upgraded LED chip sets. Part numbers will be updated with a /G2 suffix to reflect this change.

13" SWITCHABLE LUMEN CIRCULAR LED KITS

3000 OR 4000 LUMEN OPTIONS

RoHS Compliant **10YEAR** WARRANTY



Each pre-assembled UL Classified 1598C kit includes (1) dimmable LED driver, (1) LED module, (1) metal pan, mounting hardware, and accessories

13", Set at 3000 Lumens

KIT SPECIFICATIONS:
Dimming Type: 0-10V
Driver: (1) KTLD-36-UV-1000-VDIM-AF6
Module: (1) KTLM-1440-C3-8xx-120B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number	No. of Modules	Total System Drive Current	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	KT-RKIT-CP-13-4000-830-VDIM	1	760mA	2920	24W	122 lm/W	85%	27W	108 lm/W
3500K	120-277V	KT-RKIT-CP-13-4000-835-VDIM	1	760mA	3000	24W	125 lm/W	85%	27W	111 lm/W
4000K	120-277V	KT-RKIT-CP-13-4000-840-VDIM	1	760mA	3100	24W	129 lm/W	85%	27W	115 lm/W
5000K	120-277V	KT-RKIT-CP-13-4000-850-VDIM	1	760mA	3220	24W	133 lm/W	85%	27W	119 lm/W

13", Set at 4000 Lumens

KIT SPECIFICATIONS:
Dimming Type: 0-10V
Driver: (1) KTLD-36-UV-1000-VDIM-AF6
Module: (1) KTLM-1440-C3-8xx-120B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number	No. of Modules	Total System Drive Current	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	KT-RKIT-CP-13-4000-830-VDIM	1	1000mA	3800	31W	123 lm/W	85%	36W	106 lm/W
3500K	120-277V	KT-RKIT-CP-13-4000-835-VDIM	1	1000mA	3850	31W	124 lm/W	85%	36W	108 lm/W
4000K	120-277V	KT-RKIT-CP-13-4000-840-VDIM	1	1000mA	4000	31W	129 lm/W	85%	36W	112 lm/W
5000K	120-277V	KT-RKIT-CP-13-4000-850-VDIM	1	1000mA	4150	31W	134 lm/W	85%	36W	116 lm/W



RECTANGULAR LED KITS

800 AND 1600 LUMEN OPTIONS



Each pre-assembled UL Classified 1598C kit includes (1) LED driver, (2) LED modules, (1) metal pan, mounting hardware, and accessories

3"x6", 800 LUMEN RECTANGULAR

KIT SPECIFICATIONS:

Wiring: Series

Driver: (1) KTLD-14-UV-560-AF5

Module: (2) KTLM-1080-R1-8xx-18B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total Lumens per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	KT-RKIT-RP-6-800-830-UV	2	560mA	560mA	415	830	6.5W	128 lm/W	82%	8W	104 lm/W
4000K	120-277V	KT-RKIT-RP-6-800-840-UV	2	560mA	560mA	425	850	6.5W	131 lm/W	82%	8W	106 lm/W
5000K	120-277V	KT-RKIT-RP-6-800-850-UV	2	560mA	560mA	435	870	6.5W	134 lm/W	82%	8W	109 lm/W

3"x6", 1600 LUMEN RECTANGULAR

KIT SPECIFICATIONS:

Wiring: Series

Driver: (1) KTLD-14-UV-560-AF5

Module: (2) KTLM-1080-R1-8xx-36B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total Lumens per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	KT-RKIT-RP-6-1600-830-UV	2	560mA	560mA	775	1550	12.5W	124 lm/W	82%	15W	103 lm/W
4000K	120-277V	KT-RKIT-RP-6-1600-840-UV	2	560mA	560mA	800	1600	12.5W	128 lm/W	82%	15W	107 lm/W
5000K	120-277V	KT-RKIT-RP-6-1600-850-UV	2	560mA	560mA	825	1650	12.5W	132 lm/W	82%	15W	110 lm/W

Note: Catalog numbers ending in -UV replace the previous dedicated 120V version of the rectangular LED kits (catalog numbers KT-RKIT-RP-6-800-8xx and KT-RKIT-RP-6-1600-8xx)

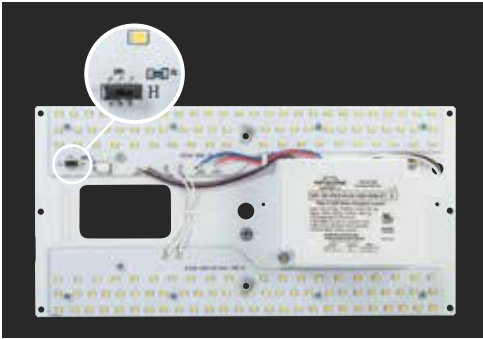
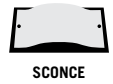
TYPICAL INSTALLATION APPLICATION



SWITCHABLE LUMEN RECTANGULAR LED KITS

3000 AND 4000 LUMEN OPTIONS

RoHS Compliant **10YEAR** WARRANTY



Each pre-assembled UL Classified 1598C kit includes (1) LED driver, (2) LED modules, (1) metal pan, mounting hardware, and accessories

5.5"x 11", SET AT 3000 LUMENS

KIT SPECIFICATIONS:

Wiring: Series

Driver: (1) KTLD-40-UV-1000-VDIM-AT1 /K

Module: (2) KTLM-1680-R2-8xx-70B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number	No. of Modules	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	KT-RKIT-RP-11-4000-830-VDIM	2	3030	23.5W	129 lm/W	85%	26W	117 lm/W
3500K	120-277V	KT-RKIT-RP-11-4000-835-VDIM	2	3100	23.5W	132 lm/W	85%	26W	119 lm/W
4000K	120-277V	KT-RKIT-RP-11-4000-840-VDIM	2	3200	23.5W	136 lm/W	85%	26W	123 lm/W
5000K	120-277V	KT-RKIT-RP-11-4000-850-VDIM	2	3300	23.5W	140 lm/W	85%	26W	127 lm/W

5.5"x 11", SET AT 4000 LUMENS

KIT SPECIFICATIONS:

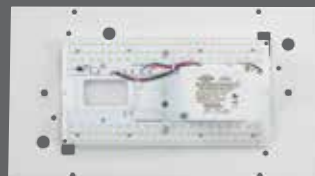
Wiring: Series

Driver: (1) KTLD-40-UV-1000-VDIM-AT1 /K

Module: (2) KTLM-1680-R2-8xx-70B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number	No. of Modules	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	KT-RKIT-RP-11-4000-830-VDIM	2	3850	31W	124 lm/W	85%	34.5W	112 lm/W
3500K	120-277V	KT-RKIT-RP-11-4000-835-VDIM	2	3960	31W	128 lm/W	85%	34.5W	115 lm/W
4000K	120-277V	KT-RKIT-RP-11-4000-840-VDIM	2	4100	31W	132 lm/W	85%	34.5W	119 lm/W
5000K	120-277V	KT-RKIT-RP-11-4000-850-VDIM	2	4200	31W	136 lm/W	85%	34.5W	122 lm/W

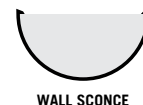
TYPICAL INSTALLATION APPLICATION



SCNCE LED KITS

8", 1100 AND 700 LUMEN OPTIONS

RoHS Compliant **10YEAR** WARRANTY



Each pre-assembled UL 1598C Classified kit includes (1) phase control dimmable LED driver, (1) LED module, (1) metal pan, mounting hardware, and accessories

8", 700 LUMEN WALL SCONCE

KIT SPECIFICATIONS:

Dimming Type: Phase Control

Driver: (1) KTLD-10-1-350-FDIM-AF5

Module: (1) KTLM-480-R3-8xx-20B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total Sytem Efficacy
3000K	120V	KT-RKIT-HCP-8-650-830-FDIM	1	350mA	350mA	680	5W	136 lm/W	80%	6W	113 lm/W
4000K	120V	KT-RKIT-HCP-8-650-840-FDIM	1	350mA	350mA	700	5W	140 lm/W	80%	6W	117 lm/W
5000K	120V	KT-RKIT-HCP-8-650-850-FDIM	1	350mA	350mA	720	5W	144 lm/W	80%	6W	120 lm/W

8", 1100 LUMEN WALL SCONCE

KIT SPECIFICATIONS:

Dimming Type: Phase Control

Driver: (1) KTLD-10-1-350-FDIM-AF5

Module: (1) KTLM-480-R3-8xx-32B

Color Temp	Input Voltage	LED Retrofit Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total Sytem Efficacy
3000K	120V	KT-RKIT-HCP-8-1150-830-FDIM	1	350mA	350mA	1115	8W	139 lm/W	80%	10W	112 lm/W
4000K	120V	KT-RKIT-HCP-8-1150-840-FDIM	1	350mA	350mA	1150	8W	144 lm/W	80%	10W	115 lm/W
5000K	120V	KT-RKIT-HCP-8-1150-850-FDIM	1	350mA	350mA	1180	8W	148 lm/W	80%	10W	118 lm/W

GENERATION 2 UPGRADES: All sconce items in this catalog will be upgraded to Generation 2 (/G2) starting Q1 2018. G2 models feature upgraded LED chip sets. Part numbers will be updated with a /G2 suffix to reflect this change.

TYPICAL INSTALLATION APPLICATION





PRODUCT FEATURES

- L70 > 50,000 hours
- Operating temperature: 0°F-104°F, -18°C-40°C
- High power factor >.90
- T24 JA8 Compliant (90CRI 2700K and 3000K only)
- Suitable for fully enclosed fixtures
- THD <20%
- 5% minimum dimming, low flicker
- Comes with mounting accessories
- Pre-assembled with metal heatsink 5VA cover

COMPATIBLE DIMMERS

Manufacturer	Model Number
Lutron	S-600PR-WH
Lutron	TGCL-153PH-WH
Lutron	MACL-153MH-LA
Leviton	WA-RXX-06674-12A

90 CRI AC LED Light Engines

3" ROUND

Catalog Number	Color Temp	CRI	Wattage	Lumens	Efficacy	Input Voltage	Dimming Method
10W							
KT-RKIT10AC-3C-927-FDIM	2700K	>90	10W	700	70 lm/W	120V	Phase Control
KT-RKIT10AC-3C-930-FDIM	3000K	>90	10W	750	75 lm/W	120V	Phase Control
KT-RKIT10AC-3C-940-FDIM	4000K	>90	10W	800	80 lm/W	120V	Phase Control
KT-RKIT10AC-3C-950-FDIM	5000K	>90	10W	820	82 lm/W	120V	Phase Control

EQUIVALENTS

- 1 x 60W Incandescent
- 1 x 18W CFL

4" ROUND

Catalog Number	Color Temp	CRI	Wattage	Lumens	Efficacy	Input Voltage	Dimming Method
17W							
KT-RKIT17AC-4C-927-FDIM	2700K	>90	17W	1100	65 lm/W	120V	Phase Control
KT-RKIT17AC-4C-930-FDIM	3000K	>90	17W	1200	71 lm/W	120V	Phase Control
KT-RKIT17AC-4C-940-FDIM	4000K	>90	17W	1300	72 lm/W	120V	Phase Control
KT-RKIT17AC-4C-950-FDIM	5000K	>90	17W	1340	74 lm/W	120V	Phase Control

EQUIVALENTS

- 2 x 40W Incandescent
- 2 x 11W CFL
- 20W T9 Circline

7" ROUND

Catalog Number	Color Temp	CRI	Wattage	Lumens	Efficacy	Input Voltage	Dimming Method
28W							
KT-RKIT28AC-7C-927-FDIM	2700K	>90	28W	2046	74 lm/W	120V	Phase Control
KT-RKIT28AC-7C-930-FDIM	3000K	>90	28W	2160	80 lm/W	120V	Phase Control
KT-RKIT28AC-7C-940-FDIM	4000K	>90	28W	2220	82 lm/W	120V	Phase Control
KT-RKIT28AC-7C-950-FDIM	5000K	>90	28W	2280	83 lm/W	120V	Phase Control

EQUIVALENTS

- 2 x 75W Incandescent
- 2 x 18W CFL
- 32W T9 Circline

80 CRI AC LED Light Engines

3" ROUND

Catalog Number	Color Temp	CRI	Wattage	Lumens	Efficacy	Input Voltage	Dimming Method
8W							
KT-RKIT8AC-3C-830-FDIM	3000K	>80	8W	730	90 lm/W	120V	Phase Control
KT-RKIT8AC-3C-840-FDIM	4000K	>80	8W	750	92 lm/W	120V	Phase Control
KT-RKIT8AC-3C-850-FDIM	5000K	>80	8W	750	92 lm/W	120V	Phase Control

EQUIVALENTS

- 1 x 60W Incandescent
- 1 x 18W CFL

4" ROUND

Catalog Number	Color Temp	CRI	Wattage	Lumens	Efficacy	Input Voltage	Dimming Method
12W							
KT-RKIT12AC-4C-830-FDIM	3000K	>80	12W	1050	90 lm/W	120V	Phase Control
KT-RKIT12AC-4C-840-FDIM	4000K	>80	12W	1100	92 lm/W	120V	Phase Control
KT-RKIT12AC-4C-850-FDIM	5000K	>80	12W	1100	92 lm/W	120V	Phase Control

EQUIVALENTS

- 2 x 40W Incandescent
- 2 x 11W CFL
- 20W T9 Circline

5.5" ROUND

Catalog Number	Color Temp	CRI	Wattage	Lumens	Efficacy	Input Voltage	Dimming Method
16W							
KT-RKIT16AC-5C-830-FDIM	3000K	>80	16W	1600	100 lm/W	120V	Phase Control
KT-RKIT16AC-5C-840-FDIM	4000K	>80	16W	1650	103 lm/W	120V	Phase Control
KT-RKIT16AC-5C-850-FDIM	5000K	>80	16W	1650	103 lm/W	120V	Phase Control

EQUIVALENTS

- 2 x 60W Incandescent
- 2 x 13W CFL
- 20W T9 Circline

7" ROUND

Catalog Number	Color Temp	CRI	Wattage	Lumens	Efficacy	Input Voltage	Dimming Method
19W							
KT-RKIT19AC-7C-830-FDIM	3000K	>80	19W	1900	100 lm/W	120V	Phase Control
KT-RKIT19AC-7C-840-FDIM	4000K	>80	19W	1950	103 lm/W	120V	Phase Control
KT-RKIT19AC-7C-850-FDIM	5000K	>80	19W	1950	103 lm/W	120V	Phase Control
25W							
KT-RKIT25AC-7C-830-FDIM	3000K	>80	25W	2400	95 lm/W	120V	Phase Control
KT-RKIT25AC-7C-840-FDIM	4000K	>80	25W	2450	98 lm/W	120V	Phase Control
KT-RKIT25AC-7C-850-FDIM	5000K	>80	25W	2450	98 lm/W	120V	Phase Control

EQUIVALENTS

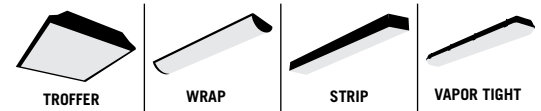
- 2 x 75W Incandescent
- 2 x 18W CFL
- 32W T9 Circline

A photograph of a modern glass-walled building with multiple floors and balconies. A large, semi-transparent red geometric shape, resembling a stylized arrow or a folded piece of paper, is overlaid diagonally across the center of the image. The building's interior is visible through the glass, showing balconies, railings, and some indoor plants.

LINEAR LED KITS WITH ALUMAGROOVE

LINEAR LED KITS WITH ALUMAGROOVE

2' AND 4' KITS



NEW! High efficacy linear LED modules pre-mounted into aluminum extrusion via a patented manufacturing method
Each kit includes (1) LED driver, (2) LED modules, mounting hardware, optional diffused lens, and accessories

PRODUCT FEATURES

- UL Classified 1598C
- Dimmable with 0-10V dimmers
- High lumen density design; approximately 1,500 lumens/foot
- Completely heat sunked, no additional heat sinking needed to extend lifetime
- Low profile, push-in connectors
- Made with UL Recognized Components
- L70 calculated lifetime > 50,000 hours at 105°C/221°F LED temperature
- Optional diffused lenses are available for all lengths and are included with the kits listed below

RoHS Compliant **5 YEAR** WARRANTY

4' LINEAR KITS, 80 CRI

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-30-UV-900-VDIM-LA1

Module: (2) KTAG-44L-1400-30-8xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3500K	120-277V	>80	KT-RKIT-2AG44-4000-835-VDIM	2	900mA	450mA	4109	25W	166 lm/W	84%	29W	139 lm/W
4000K	120-277V	>80	KT-RKIT-2AG44-4000-840-VDIM	2	900mA	450mA	4158	25W	168 lm/W	84%	29W	141 lm/W
5000K	120-277V	>80	KT-RKIT-2AG44-4000-850-VDIM	2	900mA	450mA	4232	25W	171 lm/W	84%	29W	144 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-36-UV-1100-VDIM-LA3

Module: (2) KTAG-44L-1400-30-8xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3500K	120-277V	>80	KT-RKIT-2AG44-5000-835-VDIM	2	1100mA	550mA	5015	31W	164 lm/W	84%	36W	138 lm/W
4000K	120-277V	>80	KT-RKIT-2AG44-5000-840-VDIM	2	1100mA	550mA	5067	31W	166 lm/W	84%	36W	139 lm/W
5000K	120-277V	>80	KT-RKIT-2AG44-5000-850-VDIM	2	1100mA	550mA	5171	31W	169 lm/W	84%	36W	142 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-40-UV-1350-VDIM-LA3

Module: (2) KTAG-44L-1400-30-8xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3500K	120-277V	>80	KT-RKIT-2AG44-6000-835-VDIM	2	1350mA	675mA	6032	38W	159 lm/W	84%	45W	134 lm/W
4000K	120-277V	>80	KT-RKIT-2AG44-6000-840-VDIM	2	1350mA	675mA	6108	38W	161 lm/W	84%	45W	135 lm/W
5000K	120-277V	>80	KT-RKIT-2AG44-6000-850-VDIM	2	1350mA	675mA	6221	38W	164 lm/W	84%	45W	138 lm/W

LINEAR LED KITS WITH ALUMAGROOVE

2' AND 4' KITS

2' LINEAR KITS, 80 CRI

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-20-UV-650-VDIM-LA1

Module: (2) KTAG-22L-700-30-8xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3500K	120-277V	>80	KT-RKIT-2AG22-3000-835-VDIM	2	650mA	325mA	2907	18W	159 lm/W	84%	22W	133 lm/W
4000K	120-277V	>80	KT-RKIT-2AG22-3000-840-VDIM	2	650mA	325mA	2936	18W	160 lm/W	84%	22W	135 lm/W
5000K	120-277V	>80	KT-RKIT-2AG22-3000-850-VDIM	2	650mA	325mA	2997	18W	163 lm/W	84%	22W	137 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-30-UV-900-VDIM-LA1

Module: (2) KTAG-22L-700-30-8xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3500K	120-277V	>80	KT-RKIT-2AG22-4000-835-VDIM	2	900mA	450mA	3868	26W	151 lm/W	84%	31W	126 lm/W
4000K	120-277V	>80	KT-RKIT-2AG22-4000-840-VDIM	2	900mA	450mA	3909	26W	152 lm/W	84%	31W	128 lm/W
5000K	120-277V	>80	KT-RKIT-2AG22-4000-850-VDIM	2	900mA	450mA	3989	26W	155 lm/W	84%	31W	130 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-36-UV-1200-VDIM-LA3

Module: (2) KTAG-22L-700-30-8xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3500K	120-277V	>80	KT-RKIT-2AG22-5000-835-VDIM	2	1200mA	600mA	4964	35W	141 lm/W	84%	42W	118 lm/W
4000K	120-277V	>80	KT-RKIT-2AG22-5000-840-VDIM	2	1200mA	600mA	5014	35W	142 lm/W	84%	42W	119 lm/W
5000K	120-277V	>80	KT-RKIT-2AG22-5000-850-VDIM	2	1200mA	600mA	5116	35W	145 lm/W	84%	42W	122 lm/W

4' LINEAR KITS, 90 CRI

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-30-UV-900-VDIM-LA1

Module: (2) KTAG-44L-1400-30-9xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	>90	KT-RKIT-2AG44-3500-930-VDIM	2	900mA	450mA	3438	25W	139 lm/W	84%	29W	117 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-36-UV-1100-VDIM-LA3

Module: (2) KTAG-44L-1400-30-9xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	>90	KT-RKIT-2AG44-4200-930-VDIM	2	1100mA	550mA	4202	31W	137 lm/W	84%	36W	115 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-40-UV-1350-VDIM-LA3

Module: (2) KTAG-44L-1400-30-9xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	>90	KT-RKIT-2AG44-5000-930-VDIM	2	1350mA	675mA	5038	38W	133 lm/W	84%	45W	112 lm/W

LINEAR LED KITS WITH ALUMAGROOVE

2' AND 4' KITS

2' LINEAR KITS, 90 CRI

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-20-UV-650-VDIM-LA1

Module: (2) KTAG-22L-700-30-9xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	>90	KT-RKIT-2AG22-2500-930-VDIM	2	650mA	325mA	2462	18W	134 lm/W	84%	22W	113 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-30-UV-900-VDIM-LA1

Module: (2) KTAG-22L-700-30-9xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	>90	KT-RKIT-2AG22-3200-930-VDIM	2	900mA	450mA	3239	26W	126 lm/W	84%	31W	106 lm/W

KIT SPECIFICATIONS:

Dimming Type: 0-10V

Driver: (1) KTLD-36-UV-1200-VDIM-LA3

Module: (2) KTAG-22L-700-30-9xx-RJ

Color Temp	Input Voltage	CRI	AlumaGroove Kit Catalog Number	No. of Modules	Total System Drive Current	Drive Current per Module	Total System Lumens	Total Module Power	Module Efficacy	Driver Efficiency	Total System Power	Total System Efficacy
3000K	120-277V	>90	KT-RKIT-2AG22-4200-930-VDIM	2	1200mA	600mA	4157	35W	118 lm/W	84%	42W	99 lm/W



Keystone Technologies • 1390 Welsh Road, North Wales, PA 19454 • Phone (800) 464-2680
Fax (888) 966-0556 • www.keystonetech.com



ESSENTIAL SERIES

GENERAL PURPOSE LED BULBS

KT-LED11A19-O-8XX

REPLACEMENT LAMP

DESCRIPTION

11W A19 Lamp | 2700–5000K | >80 CRI | Omni-Directional



LAMP TYPE: A19
BASE TYPE: E26 (Medium)
WATTAGE: 11W
COLOR TEMPERATURE: 2700–5000K
COLOR RENDERING INDEX (CRI): >80
WARRANTY: 2 Years
RATED LIFE: L70 (15,000 Hours)



TYPICAL APPLICATIONS

- Table, Desk, and Floor Lamps
- Wall Sconces
- Surface Mount Ceiling Fixtures
- General Lighting
- Pendant Lights

PRODUCT FEATURES

- Energy Efficient, 80%+ Energy Savings over Legacy Equivalents
- Lower Heat Generation than Legacy Equivalents
- PF >0.70
- Complies with Part 15 of FCC
- Durable Plastic housing lowers the risk for breakage
- ANSI complaint construction ensures fitment for intended applications
- Operating temperature range –4°F/–20°C to 95°F/35°C
- Long Life minimizes replacement and maintenance costs
- Meets Energy Star requirements
- UL Listed
- Smooth diffused lens for comfortable glare free performance
- UL enclosed rated, suitable for use in totally enclosed luminaires
- Smooth, uniform dimming

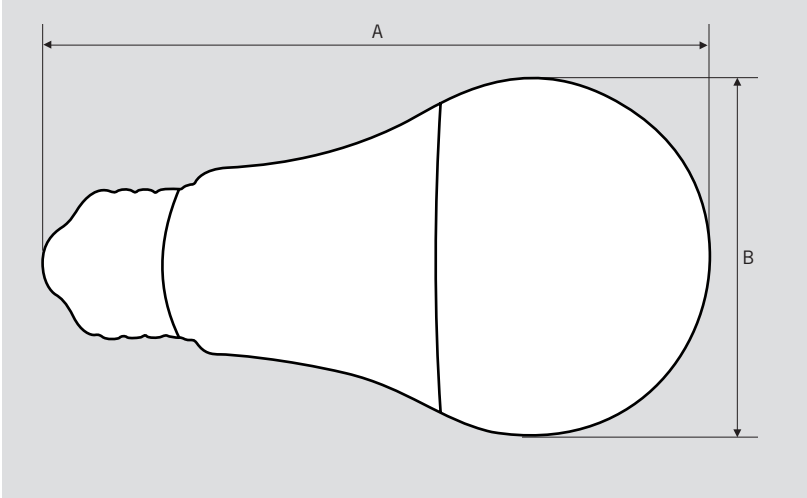
ELECTRICAL AND PERFORMANCE SPECIFICATIONS

Keystone Catalog Number	Description	Color Temp	Input Voltage	Rated Lamp Wattage	Legacy Equivalent Wattage	Base Type	Lumens	CRI	Light Distribution	Dimmable	Efficacy
KT-LED11A19-O-827	A19 bulb. Omni-Directional, dimmable	2700K	120V	11W	75W halogen	E26	1100	>80	230°	Yes	100 lm/W
KT-LED11A19-O-830	A19 bulb. Omni-Directional, dimmable	3000K	120V	11W	75W halogen	E26	1100	>80	230°	Yes	100 lm/W
KT-LED11A19-O-840	A19 bulb. Omni-Directional, dimmable	4000K	120V	11W	75W halogen	E26	1100	>80	230°	Yes	100 lm/W
KT-LED11A19-O-850	A19 bulb. Omni-Directional, dimmable	5000K	120V	11W	75W halogen	E26	1100	>80	230°	Yes	100 lm/W

KT-LED11A19-O-8XX

REPLACEMENT LAMP

PHYSICAL CHARACTERISTICS



PACKAGING

Carton Quantity	60 pcs
Carton Dimensions	15.55" × 13.07" × 10"
Carton Weight	10.6 lbs

LAMP DIMENSIONS

A (Length)	4.43"
B (Diameter)	2.36"

BASE TYPE: E26 (Medium)

ORDERING INFORMATION

ORDER CODE	CARTON QUANTITY	ITEM STATUS
KT-LED11A19-O-8XX	60 pcs	Active

CATALOG NUMBER BREAKDOWN

KT-LED11A19-O-8XX

1 2 3 4 5 6 7

- 1 Keystone Technologies
- 2 LED Lamp
- 3 Wattage
- 4 Lamp Shape
- 5 Omni-Directional
- 6 800 Series
- 7 Color Temperature



KT-LED18HID-E26-840-D

HID REPLACEMENT LED LAMP

DESCRIPTION

18W HID Replacement LED Lamp | 4000K | >80 CRI | IP64 Rated



LAMP TYPE: HID Replacement LED

BASE TYPE: E26 (Medium)

WATTAGE: 18W

COLOR TEMPERATURE: 4000K

METAL HALIDE EQUIVALENT: 70W

COLOR RENDERING INDEX (CRI): >80

WARRANTY: 5 Years

PRODUCT FEATURES

- Replacement for conventional metal halide lamp
- Non-dimmable; do not dim
- 50,000+ hour lifetime
- Environmentally friendly: No mercury used
- Instant startup
- UL listed
- Operating temperature: -29°C/-20°F to 60°C/140°F
- Integral driver, eliminates the need for external driver or ballast; includes 4kV surge protection
- IP64 rated; integrated heat sink quickly dissipates heat and guides water intrusion out of the lamp
- Suitable for use in fully enclosed fixture

Lamp does not meet CEC T20 requirements. Not to be sold or offered for sale in California, except when sold wholesale in California for final retail sale outside the state.

OPERATING SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

Input Voltage	Power Consumption	Power Factor	Input Current
120-277Vac	18W	>0.9	0.15A @ 120V 0.07A @ 277V

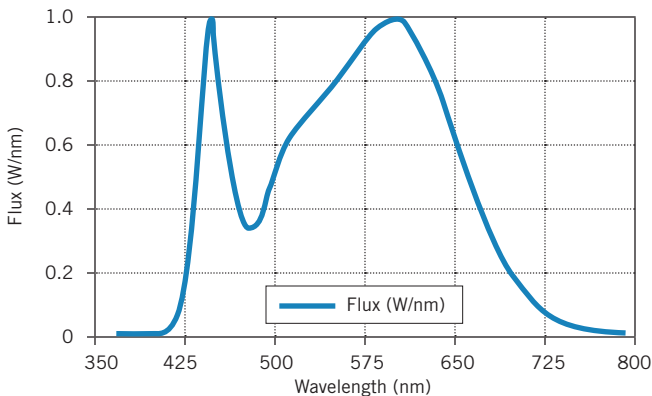
PHOTOMETRIC CHARACTERISTICS

Color Temperature (CCT)	4000K
Luminous Flux	2520 lm
Color Rendering Index (CRI)	>80
Efficacy	140 lm/W
Visible Light Area	360°

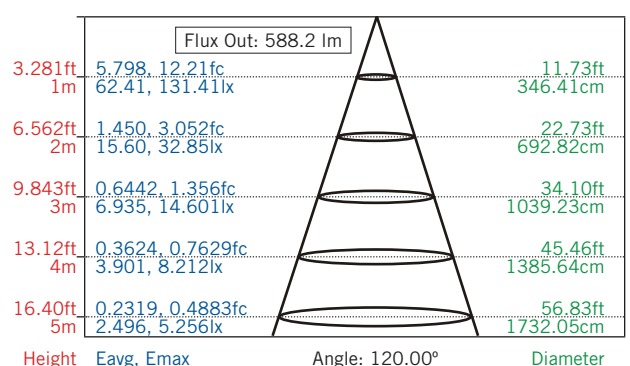
RATED LIFE

L70 (Hours)	50,000
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SPECTRAL DISTRIBUTION



LUX DISTANCE CURVE



Note: The curves indicate the illuminated area and the average illumination when the luminaire is at a different distance.



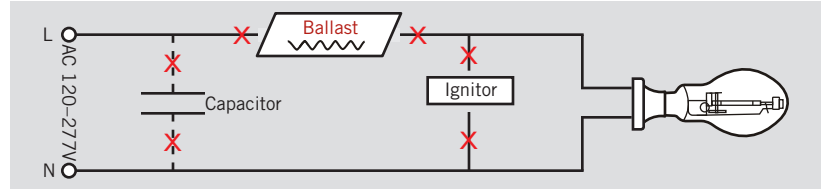
KT-LED18HID-E26-840-D

HID REPLACEMENT LED LAMP

WIRING DIAGRAM

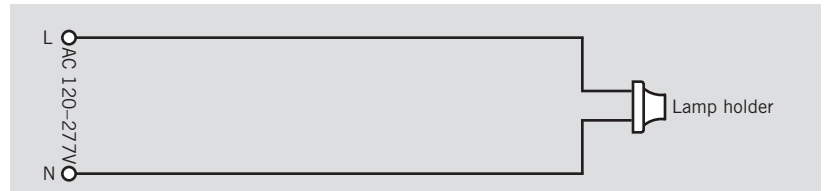
STEP 1

Disconnect power. Disconnect and remove existing ballast, capacitor, and/or ignitor (where applicable) from fixture.



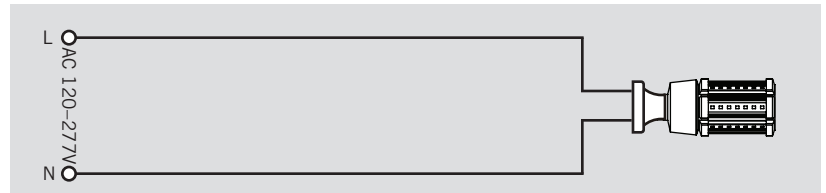
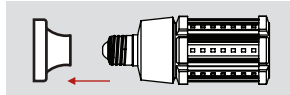
STEP 2

Rewire for line voltage to the lamp socket.

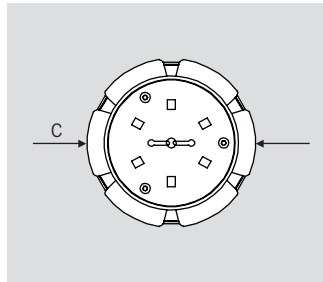
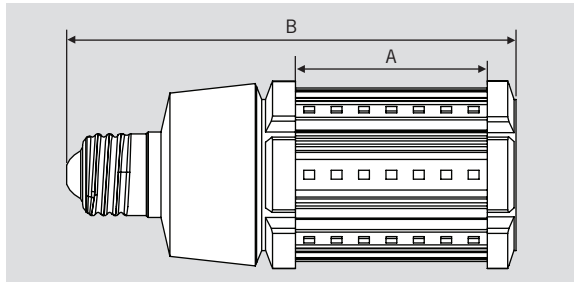


STEP 3

Install new LED replacement lamp. Ensure lamp is operating properly when power is turned on.



PHYSICAL CHARACTERISTICS



LAMP DIMENSIONS

A (Illuminated Length)	2.44"
B (Body Length)	5.70"
C (Diameter)	2.36"

BASE TYPE: E26 (Medium)

ORDERING INFORMATION

ORDER CODE	PACKAGING STYLE	PACK QTY.	ITEM STATUS
KT-LED18HID-E26-840-D-DP	Distributor Pack (Individual Cartons)	12	Quick Ship

CATALOG NUMBER BREAKDOWN

KT-LED18HID-E26-840-D-DP

1	2	3	4	5	6	7	8	9
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- 1 Keystone Technologies
- 2 LED Lamp
- 3 Wattage
- 4 Lamp Type
- 5 Base Type
- 6 800 Series
- 7 Color Temperature
- 8 Direct-Drive Series
- 9 Packaging Style



KT-LED80HID-EX39-840-D /G2

HID REPLACEMENT LED LAMP

DESCRIPTION

80W HID Replacement LED Lamp | 4000K | >80 CRI | IP64 Rated



LAMP TYPE: HID Replacement LED

BASE TYPE: EX39 (Mogul)

WATTAGE: 80W

COLOR TEMPERATURE: 4000K

METAL HALIDE EQUIVALENT: 320W

COLOR RENDERING INDEX (CRI): >80

WARRANTY: 5 Years

PRODUCT FEATURES

- Replacement for conventional metal halide lamp
- 50,000+ hour lifetime
- Environmentally friendly: no mercury used
- Instant startup
- UL Listed, DLC Listed
- Operating temperature range: -30°C to 60°C / -22°F to 140°F.
- Exceeding 30°C / 86°F in fully enclosed fixtures will engage active cooling and power de-rating to ensure full product lifetime
- Integral driver, eliminates the need for external driver or ballast; includes 6kV surge protection
- IP64 Rated; integrated heat sink quickly dissipates heat and guides water intrusion out of the lamp
- Active cooling technology: When internal thermal sensor is engaged, lamp power reduces to 80% of max; when sensor cools, lamp powers back up to 100% rated power
- Lamp includes safety tether for additional security when installing lamp in luminaire
- Suitable for use in fully enclosed fixture
- Do not use with standard dimmers. Not compatible with phase dimmers. Dimming functions with sensors only

OPERATING SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

Input Voltage	Power Consumption	Power Factor	Input Current
120-277Vac	80W	>0.9	0.73A @ 120V 0.32A @ 277V

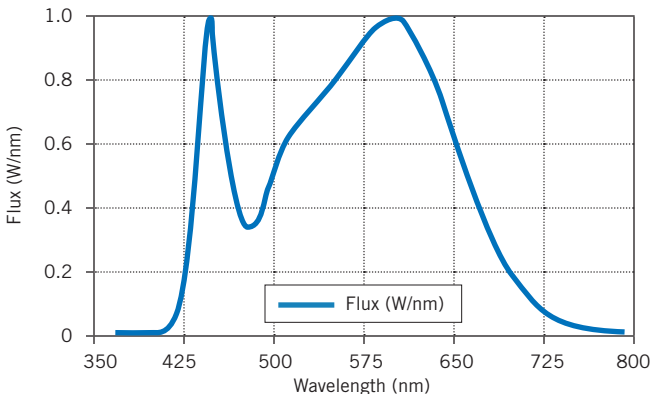
PHOTOMETRIC CHARACTERISTICS

Color Temperature (CCT)	4000K
Luminous Flux	11,850 lm
Color Rendering Index (CRI)	>80
Efficacy	148 lm/W
Visible Light Area	360°

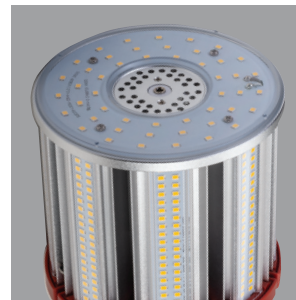
RATED LIFE

L70 (Hours)	50,000
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SPECTRAL DISTRIBUTION



SMART PORT



On the top of the lamp is a low-voltage AUX port for lamp level sensor controls which are coming soon, Q2+ 2019.



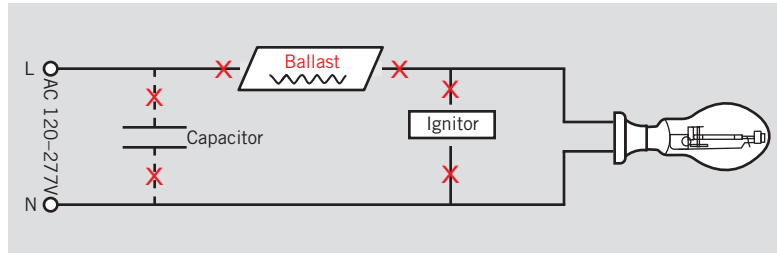
KT-LED80HID-EX39-840-D /G2

HID REPLACEMENT LED LAMP

WIRING INSTRUCTIONS

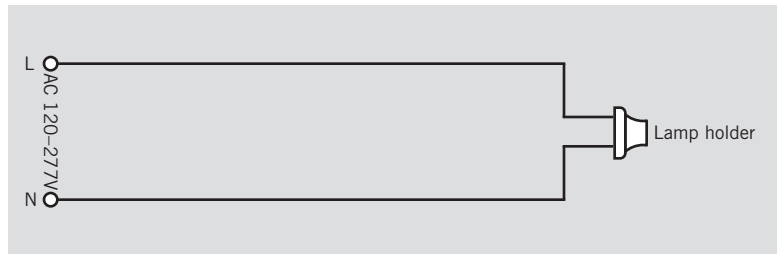
STEP 1

Disconnect power. Disconnect and remove existing ballast, capacitor, and/or ignitor (where applicable) from fixture.



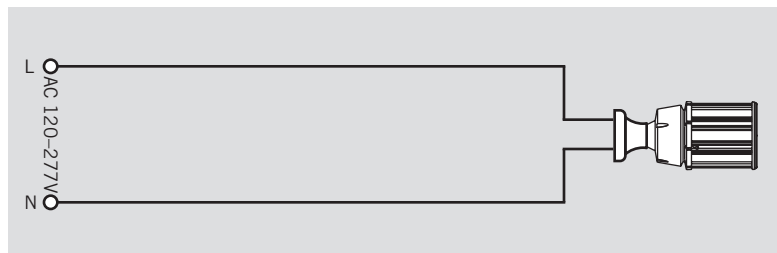
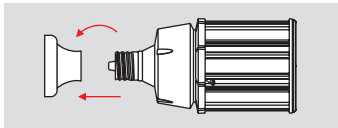
STEP 2

Rewire for line voltage to the lamp socket.

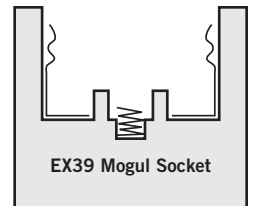
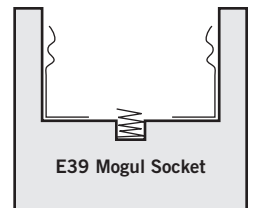


STEP 3

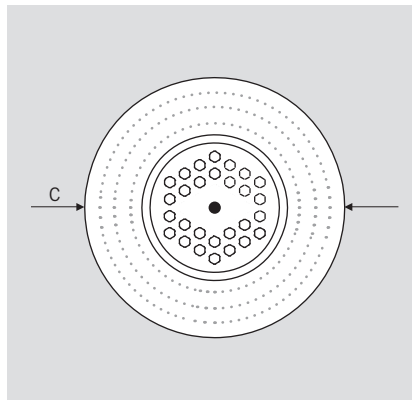
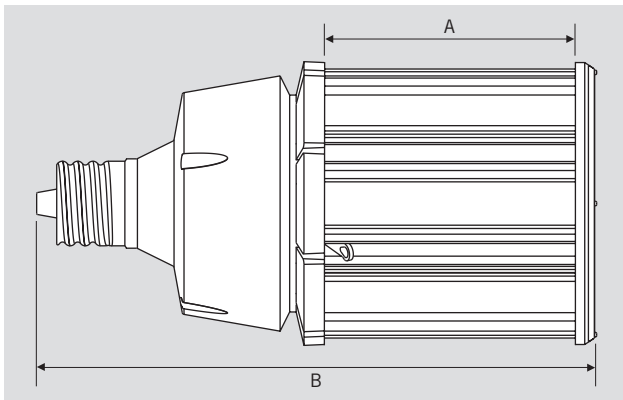
Install new LED replacement lamp. Ensure lamp is operating properly when power is turned on.



EX39-based lamps will work in *both* **E39** and **EX39** sockets.



PHYSICAL CHARACTERISTICS



LAMP DIMENSIONS

A (Illuminated Length)	4.00"
B (Body Length)	9.72"
C (Diameter)	5.12"

BASE TYPE: EX39 (Mogul)



KT-LED80HID-EX39-840-D /G2

HID REPLACEMENT LED LAMP

ORDERING INFORMATION

ORDER CODE	PACK QTY.	EASY CODE	UPC
KT-LED80HID-EX39-840-D /G2-DP	16	VKX-89	843654121192

CATALOG NUMBER BREAKDOWN

KT-LED80HID-EX39-840-D /G2-DP

1 2 3 4 5 6 7 8 9 10

- 1 Keystone Technologies
- 2 LED Lamp
- 3 Wattage
- 4 Lamp Type
- 5 Base Type
- 6 800 Series
- 7 Color Temperature
- 8 Direct-Drive Series
- 9 Second Generation
- 10 Packaging Style



KT-WPLED40-M2-8XX-VDIM

ARCHITECTURAL 40W FULL-CUTOFF LED WALL PACK

DESCRIPTION

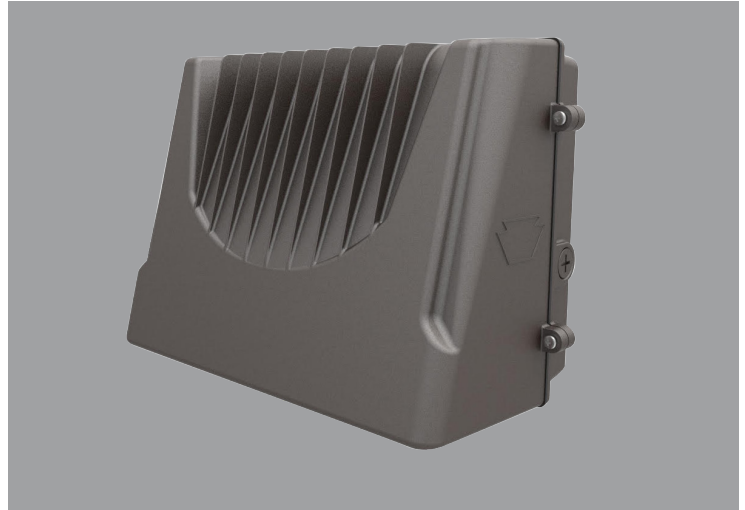
Architectural 40W Full-Cutoff LED Wall Pack | 120–277V Input | 4000–5000K | Medium-Size Bronze Housing | Wide Optic Lens

APPLICATION

Building Mount for exterior illumination (perimeters, pathways, loading docks, and other general security lighting requirements)



5 YEAR
WARRANTY



PRODUCT FEATURES

- Architectural full-cutoff design improves the appearance of building exteriors and optimizes functional light distribution
- Heavy-duty, die-cast aluminum housing features modern aesthetics while retaining (5) available 1/2" threaded conduit hubs: (1) on back and (1) on all four sides
- Powered by Keystone 0–10V dimming LED drivers
- Dark Sky friendly performance, eliminates undesirable sky glow and glare
- Features one translucent 3/4" threaded plug with anti-yellowing agent for use with photocell accessory KT-WPLED-PS-UV-KO
- Precision-crafted optical lens provides wide distribution pattern ideal for increased fixture spacing and uniformity
- Covers footprint of mid-size HID wallpacks
- Ambient operating temperature: –20°C/–4°F to 45°C/113°F
- UL listed for wet locations, IP65
- 0–10V dimming, 10% min
- Power Factor: >0.95
- THD: <20%
- LED chip lifetime: L70 >100,000 hrs @ 25°C/77°F ambient fixture temp
- Meets FCC Part 15, Part B, Class A standards for conducted and radiated emissions

ELECTRICAL SPECIFICATIONS

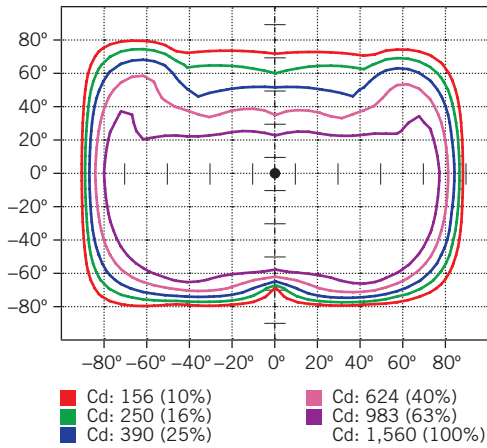
Catalog Number	Wattage	Lumens	Lumens Below 90°	Dimming	CCT	Efficacy	CRI	Housing Color	Input Voltage	Rated Life	Legacy Equivalent
KT-WPLED40-M2-840-VDIM	40W	5000 lm	4965 lm	0–10V	4000K	125 lm/W	>80	Bronze	120–277V	50,000 hrs	175W MH
KT-WPLED40-M2-850-VDIM		5200 lm	5160 lm		5000K	130 lm/W					

KT-WPLED40-M2-8XX-VDIM

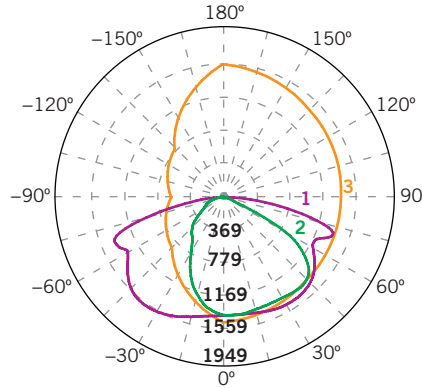
ARCHITECTURAL 40W FULL-CUTOFF LED WALL PACK

PHOTOMETRIC SPECIFICATIONS

ISOCANDELA PLOT



LUMINOUS INTENSITY DISTRIBUTION



Average diffuse angle (50%): **125.1°**

1 Violet C0-C180

2 Green C90-C270

3 Orange G36

Unit: cd

FLUX DISTRIBUTION

Zone	Lumens	% Luminaire
Forward Light	3,171 lm	62.0%
0°-30°	596 lm	11.6%
30°-60°	1,594 lm	31.2%
60°-80°	912 lm	17.8%
80°-90°	70 lm	1.4%
Back Light	1,905 lm	37.2%
0°-30°	514 lm	10.1%
30°-60°	876 lm	17.1%
60°-80°	460 lm	9.0%
80°-90°	54 lm	1.1%
Up Light	39 lm	0.8%
90°-100°	3 lm	0.1%
100°-180°	36 lm	0.7%

BUG* Rating

Asymmetrical Luminaire Types

Type I, II, III, IV B2 U2 G1

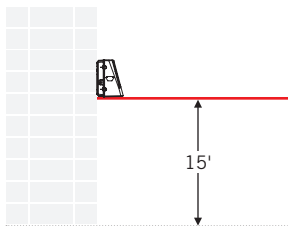
Quadrilateral Symmetrical Luminaire Types

Type V, Area Light B2 U2 G1

* Backlight, Uplight, Glare

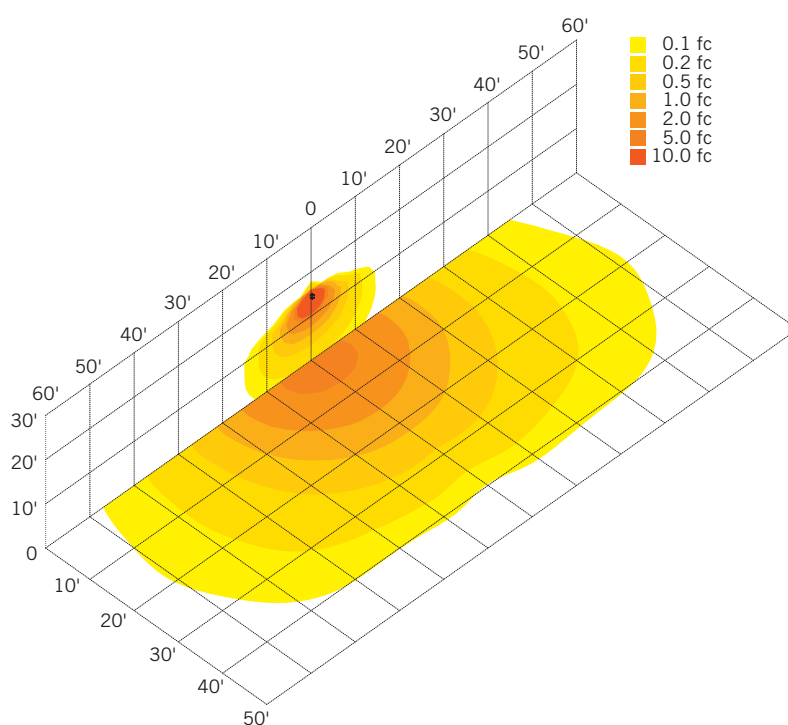
MOUNTING

Side view



LIGHT DISTRIBUTION PATTERN

Isometric view from above; Luminaire mounted at 15'

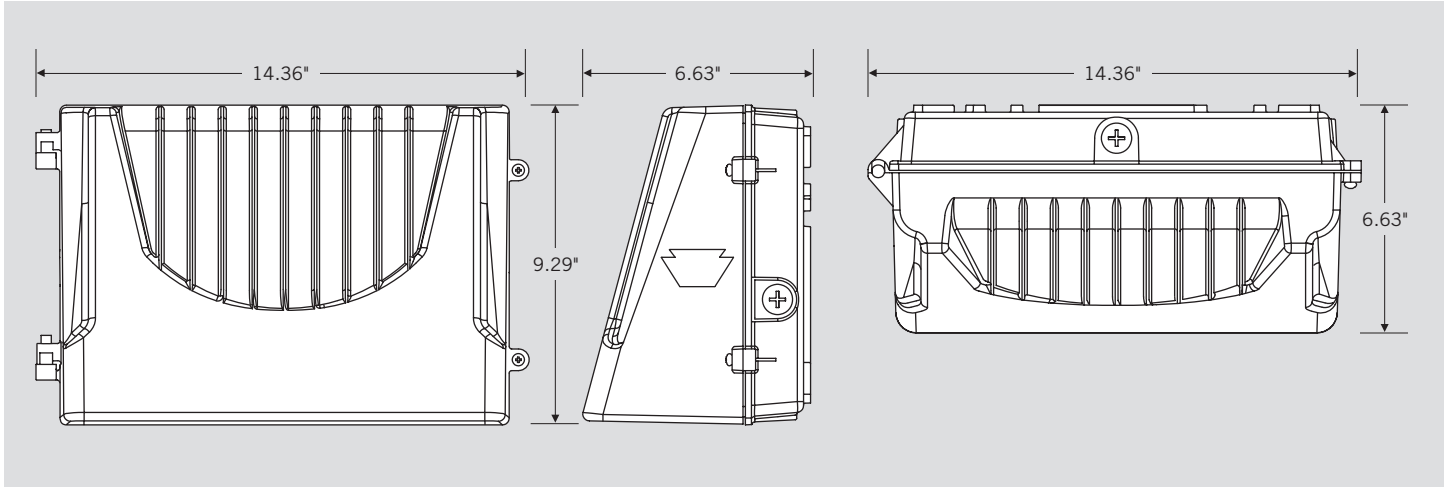




KT-WPLED40-M2-8XX-VDIM

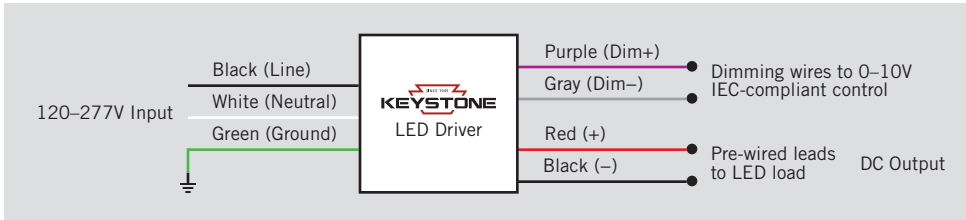
ARCHITECTURAL 40W FULL-CUTOFF LED WALL PACK

PHYSICAL SPECIFICATIONS



GENERAL SETUP INSTRUCTIONS

GENERAL WIRING DIAGRAM



Caution: Before installing, make certain that AC power to the fixture is off.

Caution: The electrical rating of this product is 120–277V. Installer must confirm that there is 120–277V at the fixture before installation.

ACCESSORIES (SOLD SEPARATELY)

Catalog Number	Description
KTSP-10KV-C	Wallpack 10kV Surge Protector, Compact Design
KT-WPLED-PS-UV-KO	Keystone Wall Pack Button Photocell



KT-WPLED40-M2-8XX-VDIM

ARCHITECTURAL 40W FULL-CUTOFF LED WALL PACK

ORDERING INFORMATION

ORDER CODE	PACK QTY.	ITEM STATUS
KT-WPLED40-M2-840-VDIM	1	Quick Ship
KT-WPLED40-M2-850-VDIM	1	Quick Ship

CATALOG NUMBER BREAKDOWN

KT-WPLED40-M2-8XX-VDIM

1	2	3	4	5	6	7	8	9
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1 Keystone Technologies

2 Fixture Type

3 LED Lamp

4 Max Wattage

5 Size

6 Style

7 CRI

8 Color

9 Dimming

2 Fixture Type

F	Flood
WP	Wallpack

5 Size

S	Small
M	Medium
L	Large

6 Style

1	Non-Cutoff
2	Full-Cutoff

7 CRI

8	>80
9	>90

8 Color

40	4000K
50	5000K

9 Dimming

VDIM	0-10V
------	-------

XFIT

OUTDOOR FIXTURES

XFit Outdoor Fixtures

Keystone's line of highly efficient LED outdoor lighting solutions.

Keystone has a solution for your entire building, inside and out. We're expanding our popular line of XFit fixtures and heading outdoors to meet your lighting needs for building exteriors, parking lots, pathways and general outdoor areas. Look for our Color Select and Power Select technology on many of these new fixtures, allowing you to field select from multiple color temperatures or lumen outputs with a simple switch.

Count on Keystone to bring you well-designed, versatile products that allow for dramatic SKU/stocking reductions and help contractors save time with easy installation, while providing customers with dramatic energy savings.

- 4 Floodlights
- 8 Traditional Wall Packs
- 12 Full Cutoff Wall Packs
- 16 Small Wall Packs
- 20 Area Lights
- 28 Dusk-to-Dawn Fixtures
- 34 Part Numbers and Product Specs



XFIT | FLOODLIGHT FIXTURES

Powerful, efficient LED lighting with
incredible versatility



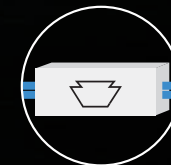
COLOR SELECT TECHNOLOGY

ADJUSTABLE: 3000K - 4000K - 5000K



BUILT-IN DUSK-TO-DAWN PHOTOCELL

AUTOMATICALLY TURNS ON/OFF WHEN DAYLIGHT
IS AVAILABLE FOR INCREASED ENERGY SAVINGS
(ACTIVATE WITH ON/OFF SWITCH)



BUILT-IN 120-277V KEYSTONE LED DRIVER

PROVIDES 0-10V DIMMING & AMPLE SURGE PROTECTION
FOR INCREASED VERSATILITY AND RELIABILITY



CONSOLIDATE SKUS WITH INTERCHANGEABLE MOUNTING OPTIONS INCLUDED

YOKE & KNUCKLE MOUNT INCLUDED FOR 15W, 35W, & 60W;
SLIPFITTER & TRUNNION MOUNT INCLUDED FOR 75W & 100W
ENSURES UNIVERSAL FIT

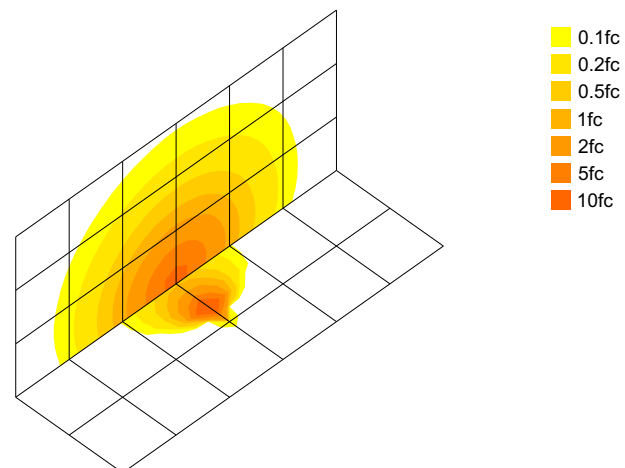
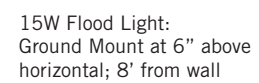
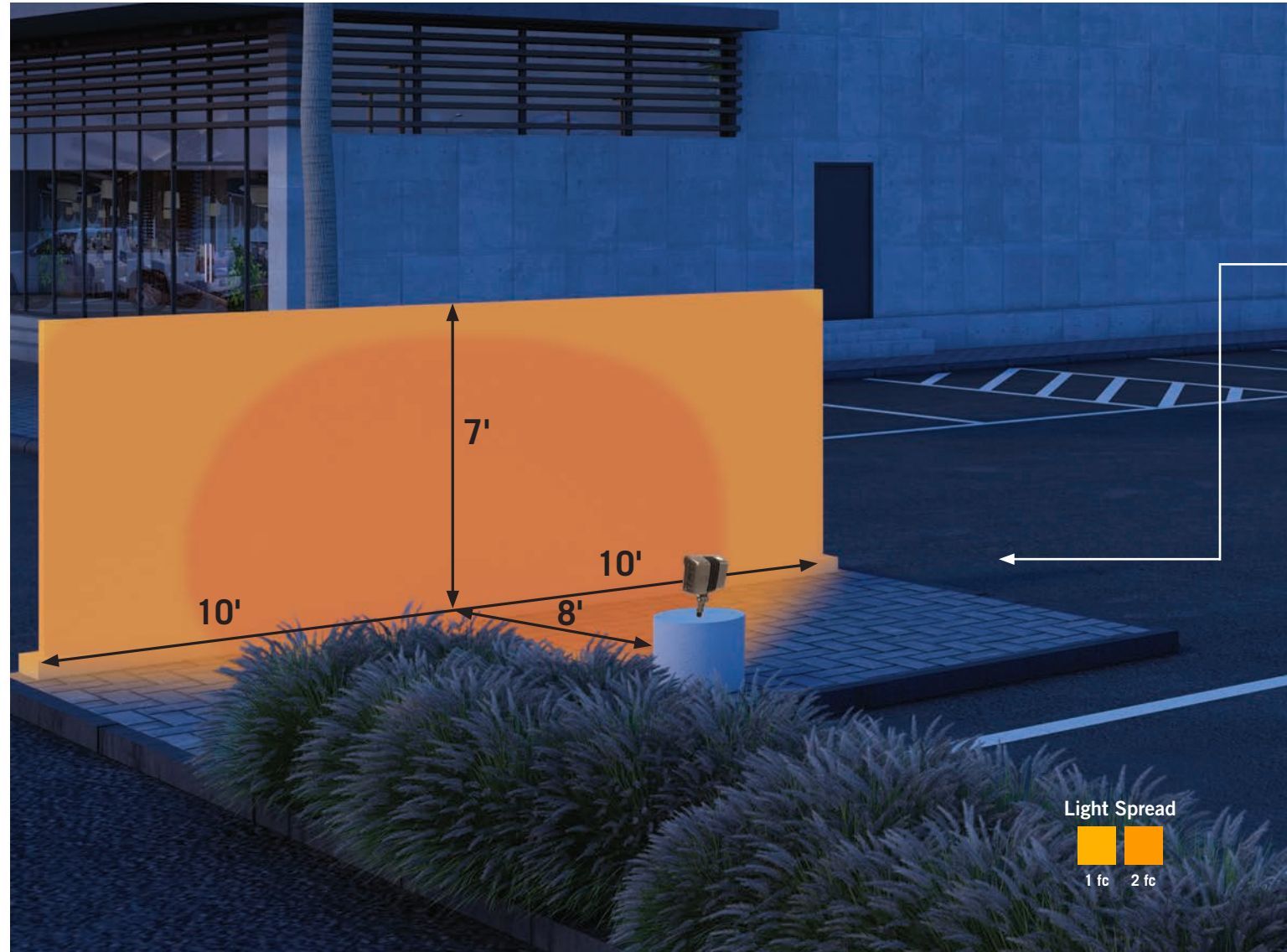


100,000 HOUR
LED LIFETIME

IP65
RATED

5 YEAR
WARRANTY

XFIT FLOODLIGHT FIXTURES



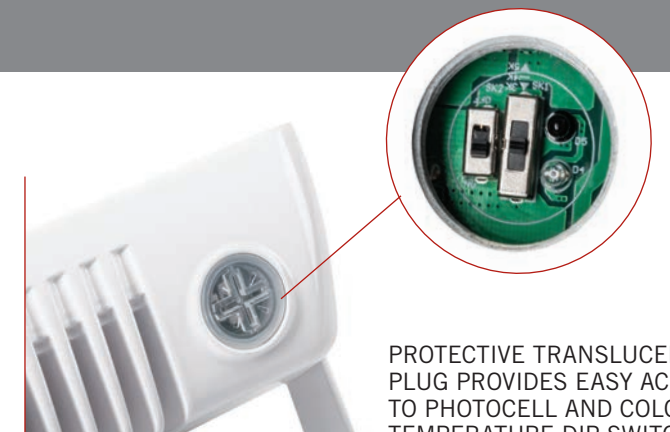
FEATURES AND BENEFITS



SHOWN IN BRONZE
WITH YOKE MOUNT



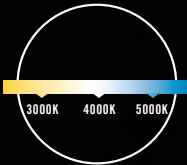
SHOWN IN WHITE
WITH KNUCKLE MOUNT



PROTECTIVE TRANSLUCENT
PLUG PROVIDES EASY ACCESS
TO PHOTOCELL AND COLOR
TEMPERATURE DIP SWITCHES

XFIT | TRADITIONAL WALL PACK FIXTURES

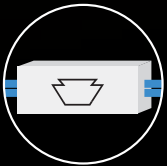
Match the appearance of legacy HID fixtures while covering the same footprint



COLOR SELECT TECHNOLOGY
ADJUSTABLE: 3000K - 4000K - 5000K



BUILT-IN DUSK-TO-DAWN PHOTOCELL
AUTOMATICALLY TURNS ON/OFF WHEN DAYLIGHT IS AVAILABLE FOR INCREASED ENERGY SAVINGS (ACTIVATE WITH ON/OFF SWITCH)



BUILT-IN 120-277V KEYSTONE LED DRIVER
PROVIDES 0-10V DIMMING & AMPLE SURGE PROTECTION FOR INCREASED VERSATILITY AND RELIABILITY



EASY INSTALLATION
5 KO ACCESS POINTS (4 SIDES AND 1 BACK) AND CAPTIVE SCREWS INCLUDED



100,000 HOUR
LED LIFETIME

IP65
RATED

5 YEAR
WARRANTY

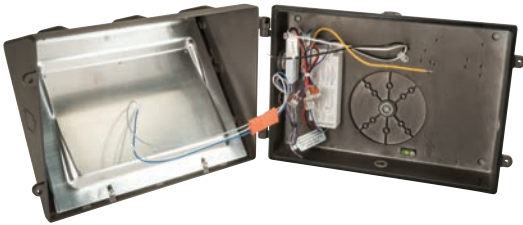
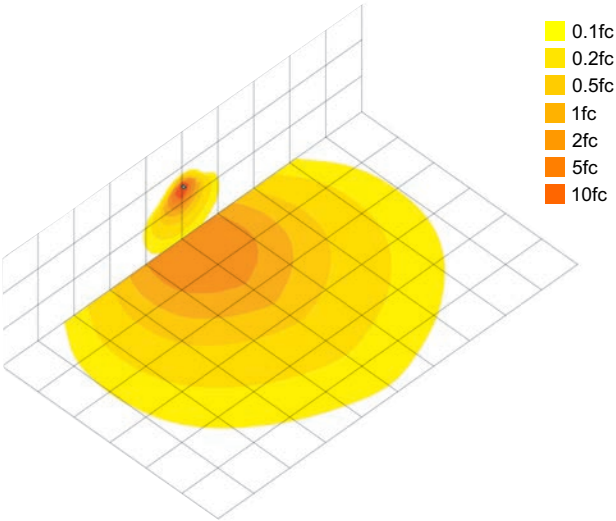
XFIT TRADITIONAL WALL PACKS



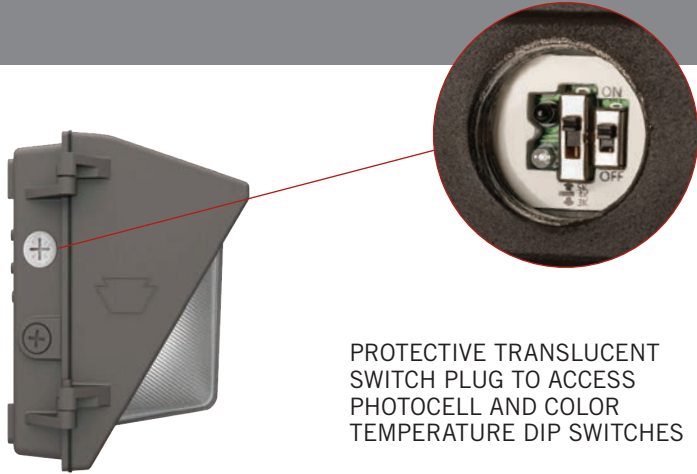
FEATURES AND BENEFITS

- Adds energy savings with 0-10V dimming
- Provides uniform light distribution with advanced optical lens technology
- Fits existing legacy product footprint (14" & 17")
- Designed with two dip switches (for photocell and color temperature adjustment) protected by a translucent plug
- Borosilicate Glass lens is high impact resistant and prevents discoloration over time

35W Traditional WP: Building exterior mounted at 15'



SIDE OPENING FOR EASY ACCESS

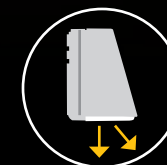


XFIT | FULL CUTOFF WALL PACK FIXTURES

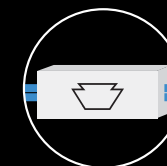
Optimize light distribution and improve the appearance of building exteriors



IMPROVED APPEARANCE WITH ARCHITECTURAL
FULL CUTOFF DESIGN



OPTIMIZE LIGHT DISTRIBUTION
LIGHT THE SAME AREA WITH FEWER FIXTURES



BUILT-IN 120-277V KEYSTONE LED DRIVER
PROVIDES 0-10V DIMMING & AMPLE SURGE PROTECTION
FOR INCREASED VERSATILITY AND RELIABILITY



100,000 HOUR
LED LIFETIME

IP65
RATED

5 YEAR
WARRANTY



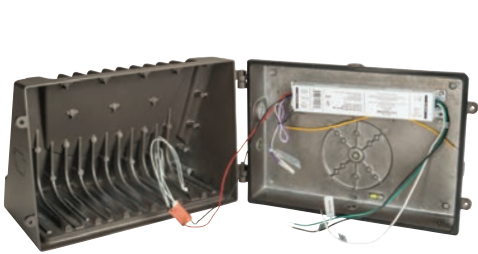
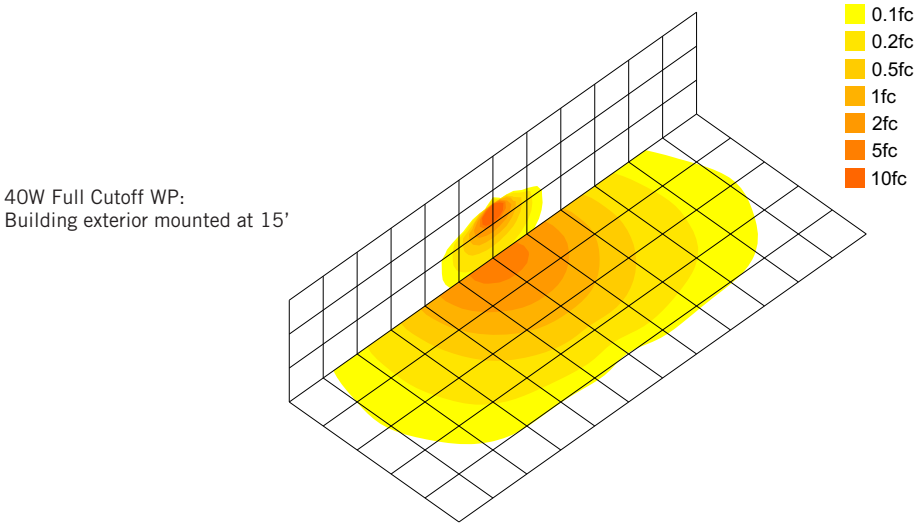
XFIT FULL CUTOFF WALL PACKS



60W FULL CUTOFF

FEATURES AND BENEFITS

- Eliminates undesirable sky glow and glare with dark sky friendly performance
- Covers the existing footprint of mid-size legacy HID fixtures with an updated design, while hiding any unsightly marks and fading
- Increases control and energy efficiency with photocell accessory (available separately)
- Provides wide light distribution with advanced optical lens technology, ideal for increased fixture spacing and uniformity

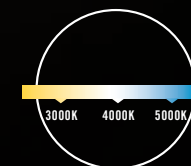


SIDE OPENING FOR EASY ACCESS



XFit | SMALL LOW PROFILE WALL PACK FIXTURES

Flexible mounting virtually
anywhere with a compact design



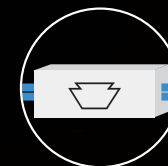
COLOR SELECT TECHNOLOGY (on select models)

ADJUSTABLE: 3000K - 4000K - 5000K



BUILT-IN DUSK-TO-DAWN PHOTOCELL

AUTOMATICALLY TURNS ON/OFF WHEN DAYLIGHT
IS AVAILABLE FOR INCREASED ENERGY SAVINGS
(ACTIVATE WITH ON/OFF SWITCH)



BUILT-IN 120-277V KEYSTONE LED DRIVER

PROVIDES 0-10V DIMMING & AMPLE SURGE PROTECTION
FOR INCREASED VERSATILITY AND RELIABILITY

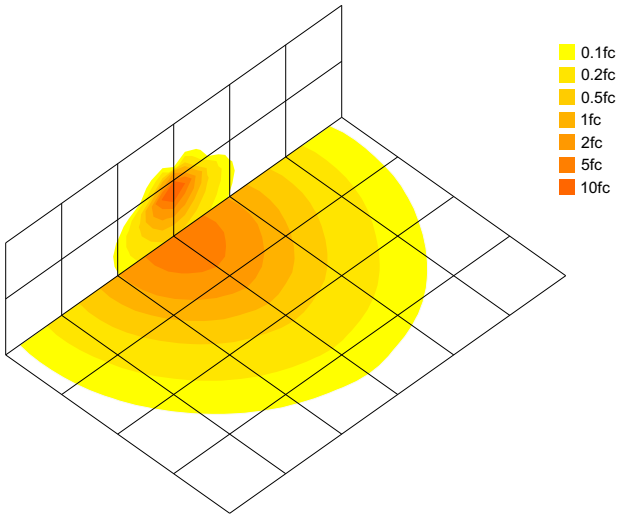
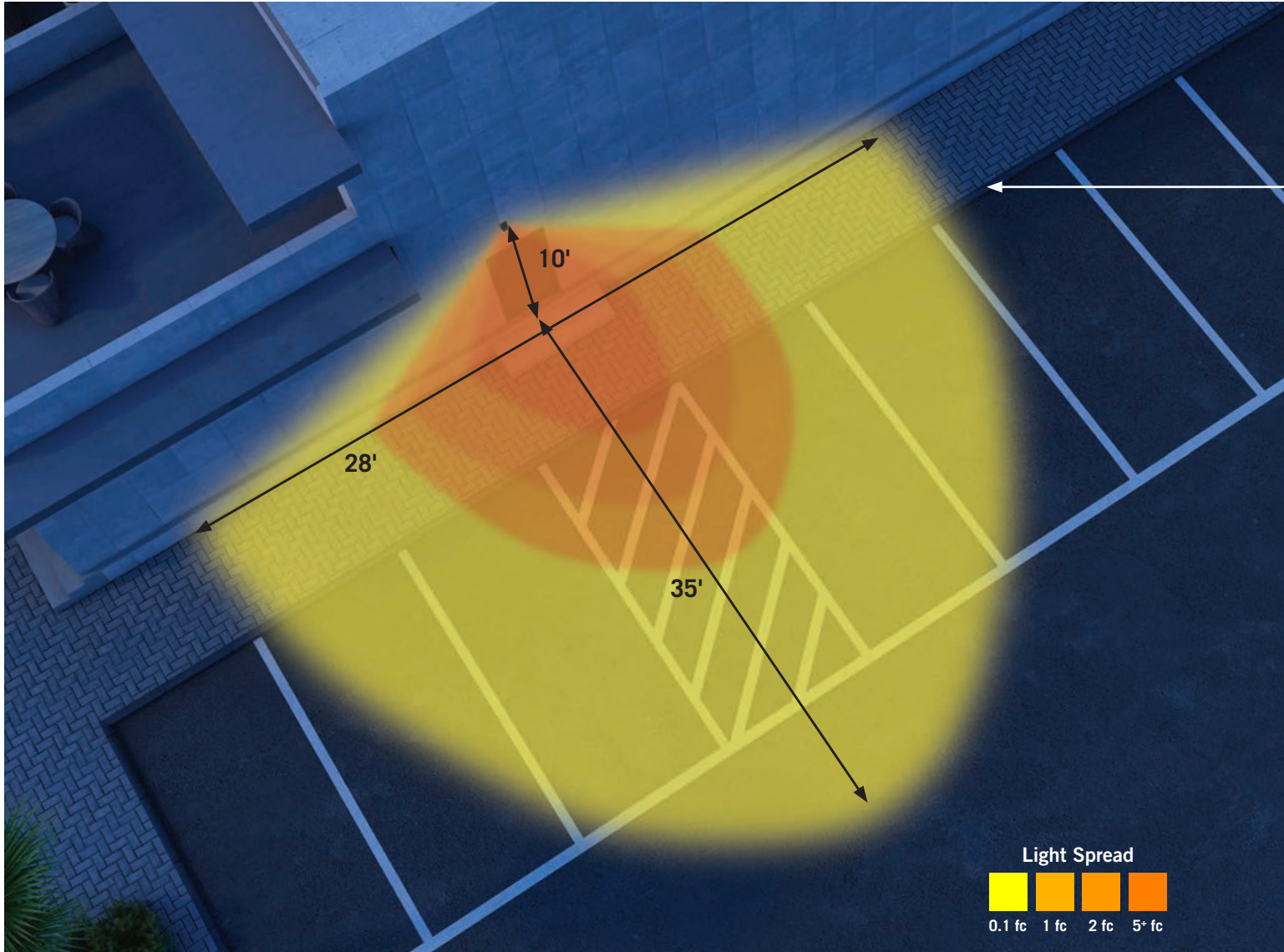


100,000 HOUR
LED LIFETIME

IP65
RATED

5 YEAR
WARRANTY

XFIT SMALL LOW PROFILE WALL PACKS



20W Small Wall Pack: Building exterior mounted at 10'



20W SMALL LOW PROFILE

FEATURES AND BENEFITS

- Meets general safety and security illumination needs with a uniform vertical and horizontal light distribution pattern
- Ensures reliable operation with a Keystone LED dimming driver
- Provides ADA compliance with low profile housing (less than 4" deep)
- Reduces glare at low mounting height applications with advanced poly carb lens technology
- Designed with two dip switches (protected by a translucent plug) to disable the photocell and adjust color temperature as needed.



SHOWN IN BRONZE



SHOWN IN WHITE



SHOWN IN BLACK



PROTECTIVE TRANSLUCENT SWITCH PLUG TO ACCESS PHOTOCELL AND COLOR TEMPERATURE DIP SWITCHES



XFiT | AREA LIGHTS

Low profile, energy efficient,
flexible solutions

A full portfolio of area lights for any job.

Select units feature Keystone's Power Select options, creating simplified stocking and a reduction of SKU inventory by up to 90%.



100,000 HOUR
LED LIFETIME

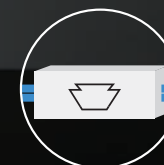
IP65
RATED

5 YEAR
WARRANTY



POWER SELECT TECHNOLOGY (on select models)

REDUCE SKUS AND INCREASE BOTH FLEXIBILITY AND CONVENIENCE WITH FIELD ADJUSTABLE POWER OUTPUTS (3 OPTIONS)



BUILT-IN 120-277V KEYSTONE LED DRIVER

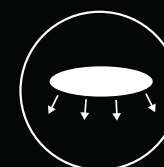
PROVIDES 0-10V DIMMING & AMPLE SURGE PROTECTION FOR INCREASED VERSATILITY AND RELIABILITY



INTEGRAL LATCH DESIGN FOR HASSLE FREE HINGED ACCESS TO DRIVER COMPARTMENT

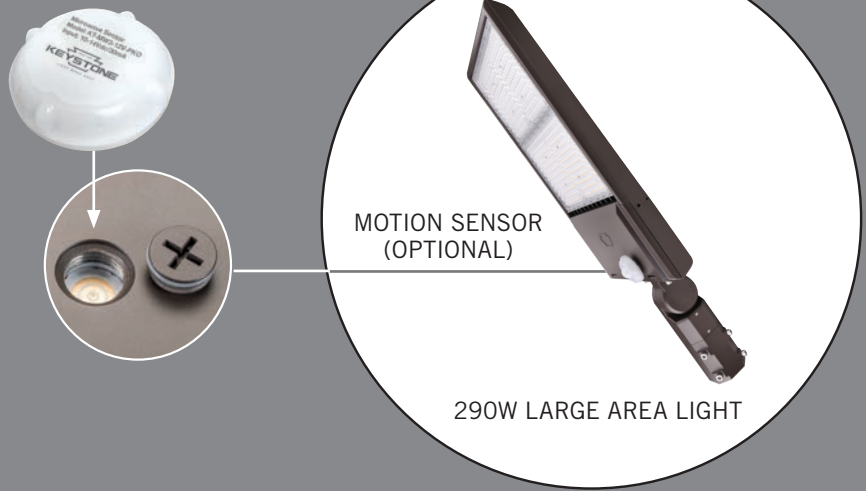


4 CONTRACTOR FRIENDLY MOUNTING OPTIONS SHARED BETWEEN ALL SIZES



FOUR OPTICS TYPES AVAILABLE (III & V STOCK, II & IV 7-10 DAYS LT)

XFIT AREA LIGHTS

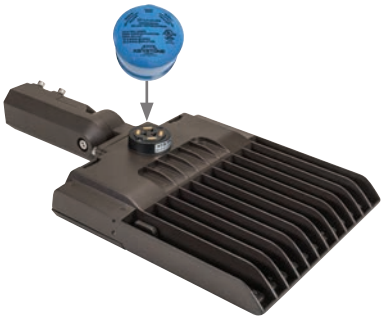


FEATURES AND BENEFITS:

- Field installable, screw-in motion sensor (optional)
- Compact, low profile design delivers high performance illumination and improves application site aesthetics
- Integrated NEMA/ANSI C136.10 3-pin twist-lock receptacle with shorting cap, standard on all fixtures, simplifies ordering requirements
- Trusted Keystone 0-10V driver for smooth dimming and energy savings
- Available in 120-277V and 480V
- Heavy-duty, die-cast aluminum housing with ample heat sinking for enhanced thermal performance
- Superior surge protection with 6kV built-in plus 10kV external protection



SHOWN OPEN WITH
KEYSTONE DRIVER



3-PIN NEMA TWIST-LOCK
RECEPTACLE

XFIT

SPECIAL STOCKING OPTIONS

Unique stocking options — all components in one simple package



TYPE III

OPTIC PACKAGE

- Power Select - field adjustable wattage options: 140W / 100W / 70W medium fixture
- Includes adjustable pole mount kit and photocell with Type III fixture optics
- 12V AUX tap
- Available in 4000K or 5000K
- 6kV built-in plus 10kV external surge protection
- Ideal for multi-headed pole applications



PACKAGE INCLUDES:

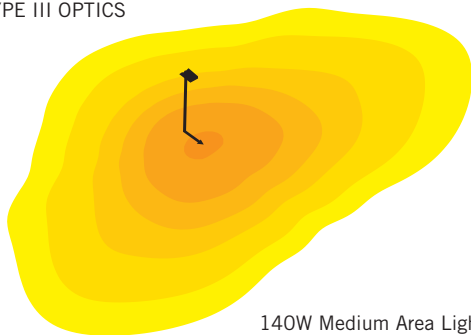


DAYLIGHT SENSOR
AND SHORTING CAP



ADJUSTABLE POLE
MOUNT KIT

TYPE III OPTICS



0.1fc
0.2fc
0.5fc
1fc
2fc
5fc
10fc

TYPE V

OPTIC PACKAGE

- Power Select - field adjustable wattage options: 140W / 100W / 70W medium fixture
- Includes pre-installed slipfitter mount kit and photocell with Type V fixture optics
- 12V AUX tap
- Available in 4000K or 5000K
- 6kV built-in plus 10kV external surge protection
- Ideal for single-headed and general flood applications



PACKAGE INCLUDES:

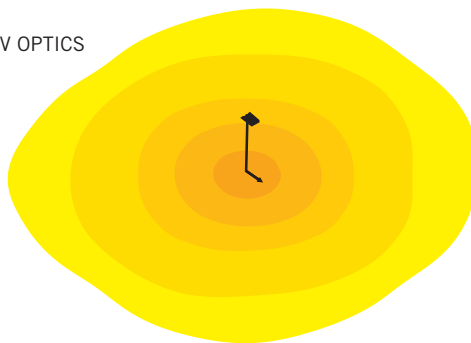


DAYLIGHT SENSOR
AND SHORTING CAP



SLIPFITTER
MOUNT KIT
(PRE-INSTALLED)

TYPE V OPTICS



0.1fc
0.2fc
0.5fc
1fc
2fc
5fc
10fc

XFIT AREA LIGHTS PROJECT OPTIONS

Customize your fixture package in 4 easy steps



1. Select Fixture

SMALL:
70W / 9800 LUMENS
110W / 14000 LUMENS



MEDIUM:
140W / 19600 LUMENS

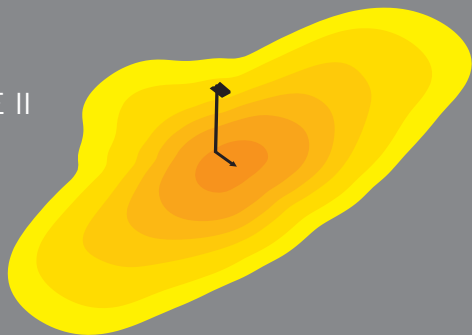


LARGE:
210W / 29400 LUMENS
290W / 40600 LUMENS

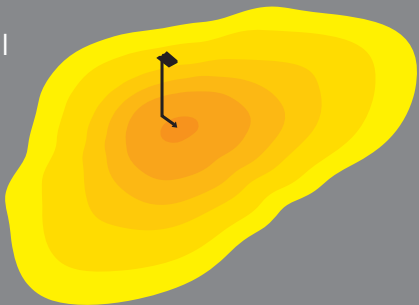


2. Select Optic

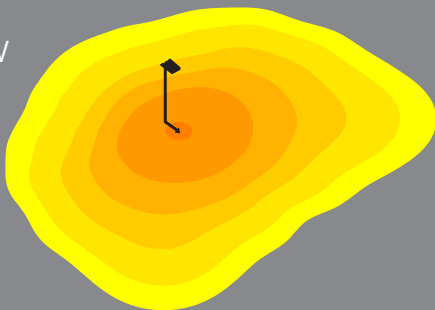
TYPE II



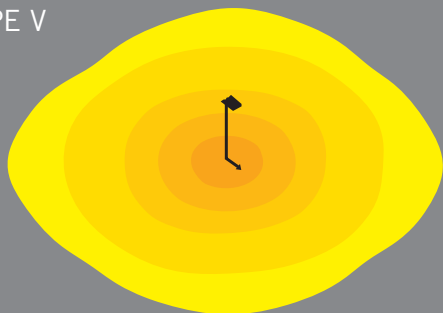
TYPE III



TYPE IV



TYPE V



3. Select Mount

ADJUSTABLE
POLE MOUNT



FIXED POLE
MOUNT



SLIPFITTER
MOUNT



TRUNNION
MOUNT



4. Select Sensor

MOTION
SENSOR



DAYLIGHT
SENSOR



Select Additional Accessories:

- GLARE SHIELDS - Page 41
- POLE ACCESSORIES - Page 42



XFIT | DUSK-TO-DAWN FIXTURES

Functional style to
withstand the rigors of
commercial applications

This dusk-to-dawn fixture offers multi-purpose general area lighting options in a common aesthetic. To maximize energy savings, it also features daylight sensing capability through a standard NEMA twist-lock receptacle, allowing the units to dim down in stages and has an optional motion sensor available.



100,000 HOUR
LED LIFETIME

IP65
RATED

5 YEAR
WARRANTY



COLOR SELECT TECHNOLOGY (on select models)

ADJUSTABLE: 3000K - 4000K - 5000K



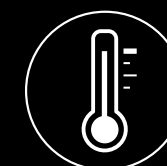
POWER SELECT TECHNOLOGY (on select models)

REDUCE SKUS AND INCREASE BOTH FLEXIBILITY AND CONVENIENCE WITH FIELD ADJUSTABLE POWER OUTPUTS (3 OPTIONS)



BUILT-IN DUSK-TO-DAWN PHOTOCELL

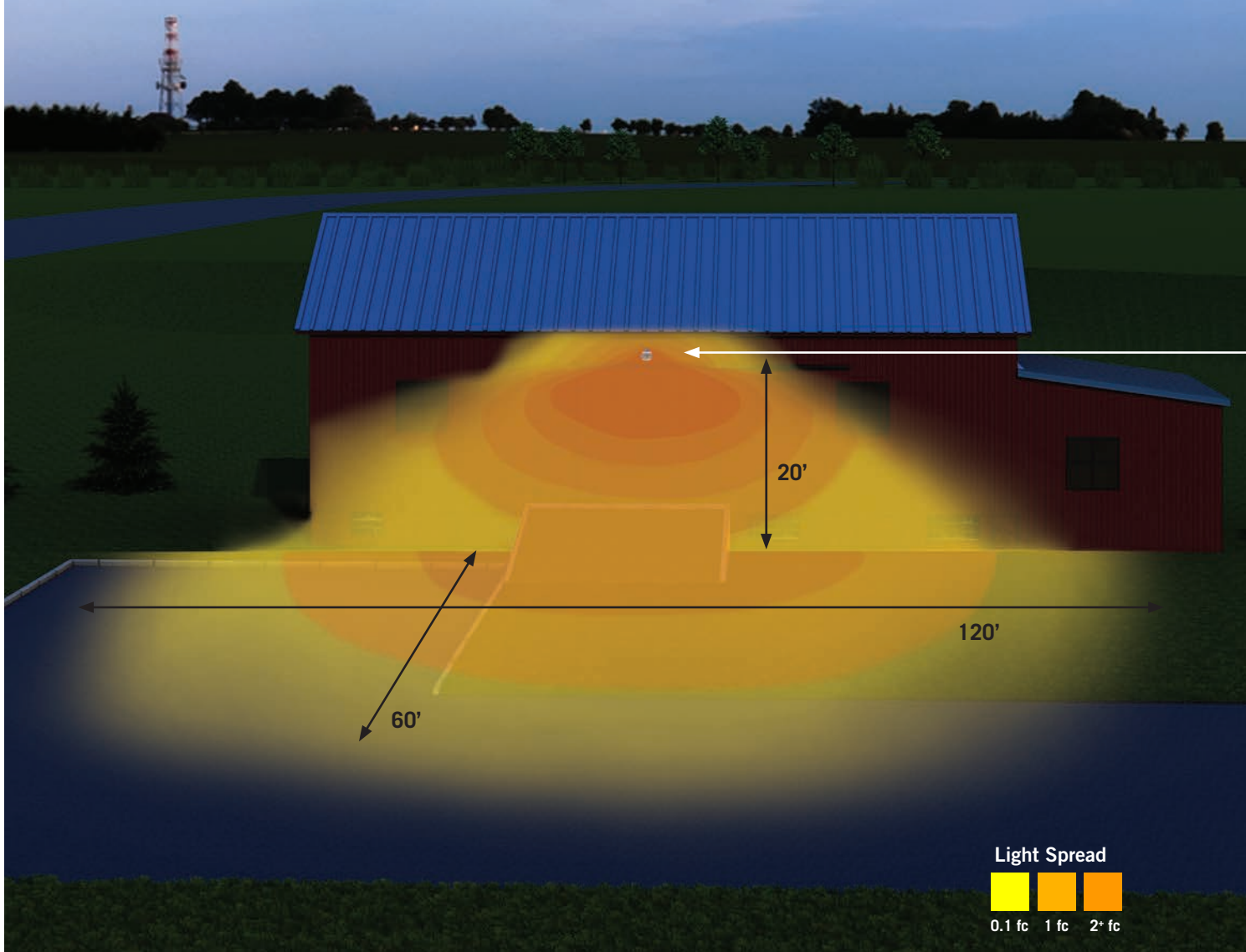
AUTOMATICALLY TURNS ON/OFF WHEN DAYLIGHT IS AVAILABLE FOR INCREASED ENERGY SAVINGS (ACTIVATE WITH ON/OFF SWITCH)



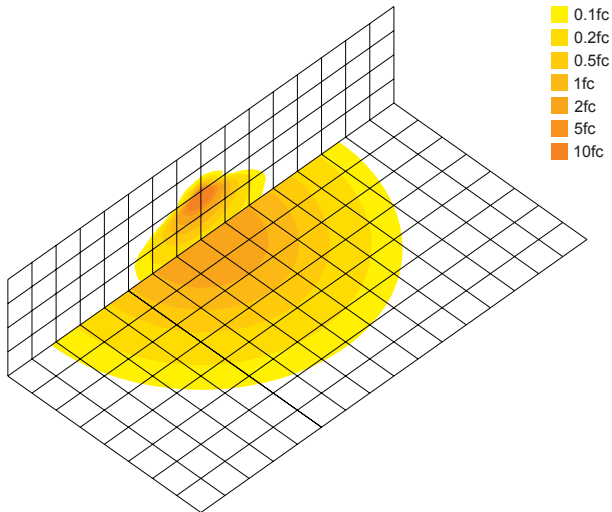
50°C MAX AMBIENT TEMPERATURE

DESIGNED TO HANDLE HARSH CONDITIONS WITH AMPLE HEAT SINKING

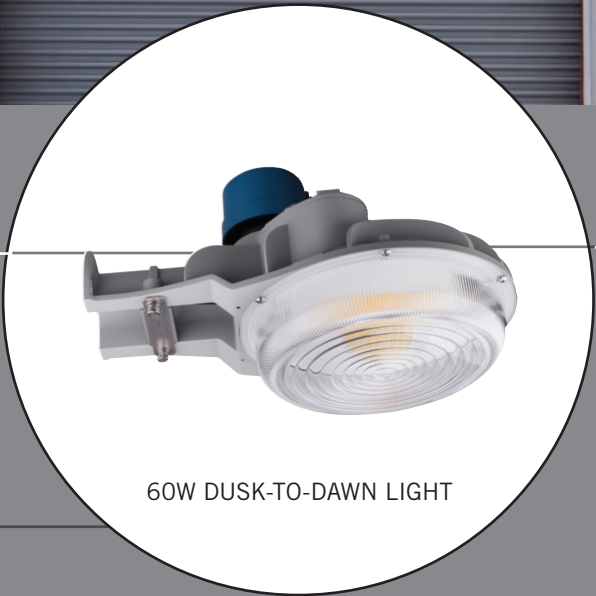
XFIT DUSK-TO-DAWN FIXTURES



60W Dusk-to-Dawn Light:
Barn exterior mounted at 20'



COLOR
SELECT
SWITCH



60W DUSK-TO-DAWN LIGHT

POWER
SELECT
SWITCH



FEATURES AND BENEFITS

- Compact design matches appearance and light distribution of legacy HID, optimized for one to one replacements
- Impact resistant and highly diffused poly carb lens with anti-yellowing agent offers reduced glare for low mounting height applications
- NEMA 3-Pin photocell included
- Ensures reliable operation with a Keystone LED dimming driver
- Heavy-duty, die-cast aluminum housing with ample heat sinking for enhanced thermal performance



DUSK-TO-DAWN FIXTURE
WITH PHOTOCELL INCLUDED

Ordering a sample is always
easy.



keystonetech.com/samples



samples@keystonetech.com



800.464.2680

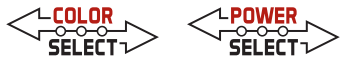


Lighting Layouts

Keystone offers complimentary lighting layout services for our products, to help take the next step in bringing your project to life. We can provide answers to your lighting questions to determine how many fixtures you need, what types of lamps are best for your applications, and how to save the maximum amount of energy, all within budget. By utilizing industry leading lighting layout design software, we provide accurate and dependable application renderings. For new construction or retrofit, simply provide Keystone with a few key project details, and our lighting designers will get to work on your request.

Visit: keystonetech.com/lighting-layout

Floodlights



CATALOG NUMBER	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	SELECTABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	HOUSING COLOR	PHOTOCELL INCLUDED	MOUNTING INCLUDED
KT-FLED15-R1A-UNV-8CSB-VDIM	15W	70W	2100	140 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	Universal 1/2" Knuckle or Yoke
			2175	145 lm/W						
			1920	128 lm/W						
KT-FLED15-R1A-UNV-8CSB-VDIM-W	15W	70W	2100	140 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	White	Yes	Universal 1/2" Knuckle or Yoke
			2175	145 lm/W						
			1920	128 lm/W						
KT-FLED35-R1A-UNV-8CSB-VDIM	35W	150-175W	4900	140 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	Universal 1/2" Knuckle or Yoke
			5075	145 lm/W						
			4480	128 lm/W						
KT-FLED35-R1A-UNV-8CSB-VDIM-W	35W	150-175W	4900	140 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	White	Yes	Universal 1/2" Knuckle or Yoke
			5075	145 lm/W						
			4480	128 lm/W						
KT-FLED60-R1A-UNV-8CSB-VDIM	60W	250W	8040	134 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	Universal 1/2" Knuckle or Yoke
			8580	143 lm/W						
			7320	122 lm/W						
KT-FLED60-R1A-UNV-8CSB-VDIM-W	60W	250W	8040	134 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	White	Yes	Universal 1/2" Knuckle or Yoke
			8580	143 lm/W						
			7320	122 lm/W						
KT-FLED75-R1A-UNV-8CSB-VDIM	75W	250-320W	10050	134 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	Universal 2 3/8" Slipfitter or Trunnion
			10725	143 lm/W						
KT-FLED100-R1A-UNV-8CSB-VDIM	100W	400W	13400	134 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	Universal 2 3/8" Slipfitter or Trunnion
			14300	143 lm/W						
			12200	122 lm/W						

FIXTURE ACCESSORIES FOR FLOOD LIGHTS

FLOOD LIGHT SURFACE MOUNT KIT KT-FLED-SM-1-KIT	>		>	
4" ROUND FLOOD LIGHT JUNCTION BOX COVER KT-FLED-RC-4	>		>	
4" ROUND FLOOD LIGHT JUNCTION BOX COVER KT-FLED-RC-4-W	>		>	

The products on this page have Color Select technology and can be switched between these color temperatures:

30

3000K
Soft White

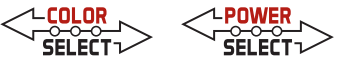
40

4000K
Cool White

50

5000K
Daylight White

Traditional Wall Packs



CATALOG NUMBER	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	SELECTABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	HOUSING COLOR	PHOTOCELL INCLUDED	NOMINAL WIDTH
KT-WPLED35-M1-8CSB-VDIM	35W	150W	4690	134 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	14"
			5040	144 lm/W						
			4865	139 lm/W						
KT-WPLED55-M1-8CSB-VDIM	55W	175-250W	7370	134 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	14"
			7920	144 lm/W						
			7645	139 lm/W						
KT-WPLED80-M1-8CSB-VDIM	80W	250-320W	10800	135 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	14"
			11600	145 lm/W						
			11200	140 lm/W						
KT-WPLED120-L1-8CSB-VDIM	120W	400W	15600	130 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes	17"
			16800	140 lm/W						
			16200	135 lm/W						

FIXTURE ACCESSORIES FOR TRADITIONAL WALL PACKS

KTSP-10KV-C	>		10KV SURGE PROTECTOR, COMPACT DESIGN
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The products on this page have Color Select technology and can be switched between these color temperatures:

30

3000K
Soft White

40

4000K
Cool White

50

5000K
Daylight White

Full Cutoff Wall Packs



CATALOG NUMBER	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	AVAILABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	HOUSING COLOR	PHOTOCELL INCLUDED	NOMINAL WIDTH
KT-WPLED40-M2-8xx-VDIM	40W	175W	5200	130 lm/W	<div><div></div><div></div></div>	120-277V	0-10V	Bronze	No	14"
KT-WPLED60-M2-8xx-VDIM	60W	250W	7800	130 lm/W	<div><div></div><div></div></div>	120-277V	0-10V	Bronze	No	14"
KT-WPLED100-M2-8xx-VDIM	100W	400W	13000	130 lm/W	<div><div></div><div></div></div>	120-277V	0-10V	Bronze	No	14"

FIXTURE ACCESSORIES FOR FULL CUTOFF WALL PACKS

KTSP-10KV-C		10KV SURGE PROTECTOR, COMPACT DESIGN
KTSP-WPLED-PS-UV-KO		WALL PACK BUTTON PHOTOCELL

If xx is used in a product catalog number, select an available color temperature and replace xx with the first two digits of that temperature when ordering.

40

4000K
Cool White

50

5000K
Daylight White

Small Low Profile Wall Packs



COLOR SELECT

CATALOG NUMBER	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	SELECTABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	HOUSING COLOR	PHOTOCELL INCLUDED
KT-WPLED20-S1-8CSB-VDIM	20W	50-70W MH	2500	125 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Bronze	Yes
			2700	135 lm/W					
			2600	130 lm/W					
KT-WPLED20-S1-8CSB-VDIM-B	20W	50-70W MH	2500	125 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	Black	Yes
			2700	135 lm/W					
			2600	130 lm/W					
KT-WPLED20-S1-8CSB-VDIM-W	20W	50-70W MH	2500	125 lm/W	<div><div></div><div></div><div></div></div>	120-277V	0-10V	White	Yes
			2700	135 lm/W					
			2600	130 lm/W					

DEDICATED COLOR

CATALOG NUMBER	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	AVAILABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	HOUSING COLOR	PHOTOCELL INCLUDED
KT-WPLED20-S1-840-VDIM	20W	50-70W	2500	125 lm/W	4000K	120-277V	0-10V	Bronze	Yes
KT-WPLED20-S1-850-VDIM	20W	50-70W	2500	125 lm/W	5000K	120-277V	0-10V	Bronze	Yes

FIXTURE ACCESSORIES FOR SMALL LOW PROFILE WALL PACKS

KTSP-10KV-C		10KV SURGE PROTECTOR, COMPACT DESIGN
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The products on this page with Color Select technology can be switched between these color temperatures:

30

3000K
Soft White

40

4000K
Cool White

50

5000K
Daylight White

Special Stocking Area Lights



Premium package includes a medium size 70W / 100W / 140W Power Select fixture body, mounting kit, and a 3-pin twist-lock photocell (with 7-pin receptacle and shorting cap) in a full color box. An additional mounting kit is not required with these packages.

TYPE III OPTIC PACKAGE



PACKAGE INCLUDES:



DAYLIGHT SENSOR
AND SHORTING CAP



ADJUSTABLE POLE
MOUNT KIT

CATALOG NUMBER	OPTICS TYPE	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	AVAILABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	CRI	HOUSING COLOR
KT-ALED140PS-M1-3-PMA-8xx-VDIM-P	III	140W	175W-400W	19600	140 lm/W	<div><div></div><div></div></div>	120-277V	0-10V	>80	Bronze
		100W		14300						
		70W		10200						

TYPE V OPTIC PACKAGE



PACKAGE INCLUDES:



DAYLIGHT SENSOR
AND SHORTING CAP



SLIPFITTER
MOUNT KIT

CATALOG NUMBER	OPTICS TYPE	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	AVAILABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	CRI	HOUSING COLOR
KT-ALED140PS-M1-5-SF-8xx-VDIM-P	V	140W	175W-400W	19600	140 lm/W	<div><div></div><div></div></div>	120-277V	0-10V	>80	Bronze
		100W		14300						
		70W		10200						

If xx is used in a product catalog number, select an available color temperature and replace xx with the first two digits of that temperature when ordering.

40

4000K
Cool White

50

5000K
Daylight White

Area Lights



SMALL AREA LIGHTS



FIXTURE DIMENSIONS

LENGTH	WIDTH	HEIGHT
14.06"	9.13"	2.60"

CATALOG NUMBER	OPTICS TYPE *	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	AVAILABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	CRI	HOUSING COLOR **
KT-ALED70-S1-3-NM-8xx-VDIM	III	70W	175-250W	9800	140 lm/W	<div><div></div><div></div></div>	120-277V	0-10V	>80	Bronze
KT-ALED70-S1-5-NM-8xx-VDIM	V									
KT-ALED100-S1-3-NM-8xx-VDIM	III	100W	250-320W	14000	140 lm/W	<div><div></div><div></div></div>	120-277V	0-10V	>80	Bronze
KT-ALED100-S1-5-NM-8xx-VDIM	V									

MEDIUM AREA LIGHTS





FIXTURE DIMENSIONS

LENGTH	WIDTH	HEIGHT
14.21"	13.11"	2.76"

CATALOG NUMBER	OPTICS TYPE *	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	AVAILABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	CRI	HOUSING COLOR **
KT-ALED140-M1-3-NM-8xx-VDIM	III	140W	400W	19600	140 lm/W	<div><div></div><div></div></div>	120-277V	0-10V	>80	Bronze
KT-ALED140-M1-5-NM-8xx-VDIM	V									
KT-ALED140HV-M1-3-NM-8xx-VDIM	III	140W	400W	19600	140 lm/W	<div><div></div><div></div></div>	277-480V	0-10V	>80	Bronze
KT-ALED140HV-M1-5-NM-8xx-VDIM	V									

LARGE AREA LIGHTS



FIXTURE DIMENSIONS

LENGTH	WIDTH	HEIGHT
21.93"	13.11"	2.76"

CATALOG NUMBER	OPTICS TYPE *	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	AVAILABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	CRI	HOUSING COLOR **
KT-ALED210-L1-3-NM-8xx-VDIM	III	210W	400-750W	29400	140 lm/W	<div><div></div><div></div></div>	120-277	0-10V	>80	Bronze
KT-ALED210-L1-5-NM-8xx-VDIM	V									
KT-ALED290-L1-3-NM-8xx-VDIM	III	290W	1000W	40600	140 lm/W	<div><div></div><div></div></div>	120-277	0-10V	>80	Bronze
KT-ALED290-L1-5-NM-8xx-VDIM	V									
KT-ALED290HV-L1-3-NM-8xx-VDIM	III	290W	1000W	40600	140 lm/W	<div><div></div><div></div></div>	277-480V	0-10V	>80	Bronze
KT-ALED290HV-L1-5-NM-8xx-VDIM	V									

Type II and Type IV optics available with short lead time.

- * Fixtures with Type 2 (II) and Type 4 (IV) optics are available and assembled to order. Lead times may apply. See spec sheets for full ordering code details.
- ** Fixtures/Mounts with alternate housing colors are available and made to order. Extended lead times apply. See spec sheets for full ordering code details.

If xx is used in a product catalog number, select an available color temperature and replace xx with the first two digits of that temperature when ordering.

40

4000K
Cool White

50

5000K
Daylight White

Area Lights



MOUNTING KITS (One Required Per Fixture)

CATALOG NUMBER	DESCRIPTION	HOUSING COLOR	FEATURES
KT-ALED-PM-1-KIT	Fixed pole mount kit; suitable for round or square poles	Bronze	Easy access plate design
KT-ALED-PMA-1-KIT	Adjustable pole mount kit; suitable for round or square poles	Bronze	Adjustable angle design with easy access plate
KT-ALED-SF-1-KIT	Slipfitter mount kit; fits 2 3/8" tenon	Bronze	Easy access plate design
KT-ALED-TM-1-KIT	Trunnion mount kit	Bronze	N/A

FIXED POLE MOUNT

ADJUSTABLE POLE MOUNT

SLIPFITTER MOUNT

TRUNNION MOUNT

OPTIC TYPES

TYPE II

Provides a lateral distribution of light; ideal for walkways, on-ramps, and other pathways

TYPE III

Projects light outward; ideal for roadways, general parking areas, and any large application where general lighting is required

TYPE IV

Semi-circular shape provides a forward throw light; ideal for perimeter applications such as parking areas and sides of buildings

TYPE V

Produces a circular distribution that has the same intensity at all angles; ideal for intersections, commercial parking lot lighting, and any areas where sufficient, evenly distributed light is necessary

Area Lights



FIXTURE ACCESSORIES

CATALOG NUMBER	DESCRIPTION
Performance Accessories	
KT-ALED-GS-S1-KIT	Reversible glare shield kit for small area light fixtures; bronze housing
KT-ALED-GS-M1-KIT	Reversible glare shield kit for medium area light fixtures; bronze housing
KT-ALED-GS-L1-KIT	Reversible glare shield kit for large area light fixtures; bronze housing
KTSP-10KV-C	10kV surge protector; compact design
Control Accessories	
KT-TLP-UV-3PN	NEMA 3-pin photocell 120-277V; 1800VA max; blue housing
KT-TLP-HV-3PN	NEMA 3-pin photocell 200-480V; 1800VA max; yellow housing
KT-RSC-7PN	NEMA 7-pin receptacle and shorting cap; black housing
KTS-MW3-12V-PKO /X	Microwave sensor for up to 30' mounting height with pre-set standby level of 50% after a 10 minute hold time

REVERSIBLE GLARE SHIELD

SURGE PROTECTOR

MICROWAVE MOTION SENSOR

7-PIN RECEPTACLE

3-PIN PHOTOCELL (YELLOW)
200-480V

3-PIN PHOTOCELL (BLUE)
120-277V

Area Lights



POLE ACCESSORIES

CATALOG NUMBER	DESCRIPTION
Wall Mount Tenon Adaptors	
KT-WMT-S	Wall mount single 2 3/8" tenon; bronze housing
KT-WMT-S90	Wall mount single 2 3/8" tenon; 90°; bronze housing
Pole Mount Side Tenon Adaptors	
KT-PMST-SQ-S	Pole mount single 2 3/8" tenon; side mount for square pole; bronze housing
KT-PMST-R-S	Pole mount single 2 3/8" tenon; side mount for round pole; bronze housing
Pole Mount Top Tenon Adaptors	
KT-PMTT-4R-SV	Pole mount single 2 3/8" tenon; top mount vertical for 4" round pole; bronze housing
KT-PMTT-4SQ-SV	Pole mount single 2 3/8" tenon; top mount vertical for 4" square pole; bronze housing
KT-PMTT-5SQ-SV	Pole mount single 2 3/8" tenon; top mount vertical for 5" square pole; bronze housing
KT-PMTT-4SQ-S90	Pole mount single 2 3/8" tenon; top mount horizontal 90° for 4" square pole; bronze housing
KT-PMTT-4SQ-D180	Pole mount dual 2 3/8" tenon; top mount horizontal 180° for 4" square pole; bronze housing
KT-PMTT-4SQ-D90	Pole mount dual 2 3/8" tenon; top mount horizontal 90° for 4" square pole; bronze housing
KT-PMTT-4SQ-T90	Pole mount triple 2 3/8" tenon; top mount horizontal 90° for 4" square pole; bronze housing
KT-PMTT-4SQ-Q90	Pole mount quad 2 3/8" tenon; top mount horizontal 90° for 4" square pole; bronze housing

Bullhorn Adaptors

KT-BH-SF-D180	Dual bull horn; in-line 180°; slips over 2 3/8" tenon
KT-BH-SF-T180	Triple bull horn; in-line 180°; slips over 2 3/8" tenon
KT-BH-SF-T120	Triple bull horn, 120°, slips over 2 3/8" tenon
KT-BH-SF-Q180	Quad bull horn; in-line 180°; slips over 2 3/8" tenon
KT-BH-SF-Q90	Quad bull horn, 90°; slips over 2 3/8" tenon

 WALL MOUNT TENON ADAPTOR (KT-WMT-S)	 90° WALL MOUNT TENON ADAPTOR (KT-WMT-S90)	 POLE MOUNT SIDE TENON ADAPTORS (KT-PMST-SQ-S AND KT-PMST-R-S)	 ROUND TOP MOUNT VERTICAL TENON ADAPTOR (KT-PMTT-4R-SV)	 SQUARE TOP MOUNT VERTICAL TENON ADAPTOR (KT-PMTT-4SQ-SV AND KT-PMTT-5SQ-SV)
 90° DUAL TOP MOUNT HORIZONTAL TENON ADAPTOR (KT-PMTT-4SQ-D90)	 180° DUAL TOP MOUNT HORIZONTAL TENON ADAPTOR (KT-PMTT-4SQ-D180)	 TRIPLE TOP MOUNT HORIZONTAL TENON ADAPTOR (KT-PMTT-4SQ-T90)	 QUAD TOP MOUNT HORIZONTAL TENON ADAPTOR (KT-PMTT-4SQ-Q90)	 DUAL BULL HORN ADAPTOR (KT-BH-SF-D180)
 180° TRIPLE BULL HORN ADAPTOR (KT-BH-SF-T180)	 120° TRIPLE BULL HORN ADAPTOR (KT-BH-SF-T120)	 180° QUAD BULL HORN ADAPTOR (KT-BH-SF-Q180)	 90° QUAD BULL HORN ADAPTOR (KT-BH-SF-Q90)	

Dusk-to-Dawn Fixtures



COLOR AND POWER SELECT

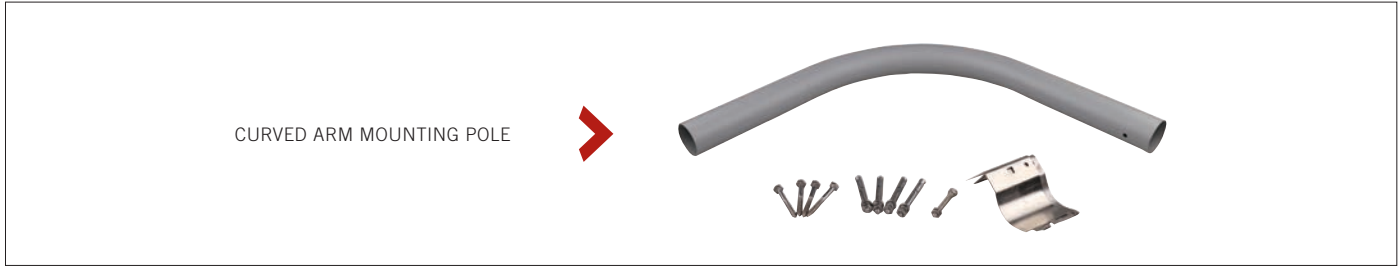
CATALOG NUMBER	OPTICS TYPE	SELECTABLE WATTAGES	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	SELECTABLE COLOR TEMPS	INPUT VOLTAGE	DIM-MING	CRI	HOUSING COLOR
KT-ALED60PS-D2D-WM-8CSB-VDIM	V	30W	150-250W	5200	155-170 lm/W		120-277V	0-10V	>80	Gray
		40W		6850						
		60W		9250						

DEDICATED COLOR

CATALOG NUMBER	OPTICS TYPE	WATTAGE	METAL HALIDE EQUIVALENT WATTAGE	LUMENS	EFFICACY	AVAILABLE COLOR TEMPS	INPUT VOLTAGE	DIMMING	CRI	HOUSING COLOR
KT-ALED40-D2D-WM-850-VDIM	V	40W	175W	6100	150 lm/W	5000K	120-277V	0-10V	>80	Gray

FIXTURE MOUNT ACCESSORIES FOR DUSK TO DAWN LIGHTS

CATALOG NUMBER	DESCRIPTION	COLOR
KT-ALED-CA-D2D-KIT	24" curved arm mounting pole for dawn to dusk area light	Gray



The products on this page with Color Select technology can be switched between these color temperatures:

30	3000K Soft White	40	4000K Cool White	50	5000K Daylight White
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The Keystone Difference

Our mission at Keystone is to change the way you think about lighting. We believe that lighting should be simple, hassle-free, and enjoyable. Keystone is Light Made Easy®.



**Fast
Quotes**



**Quick
Delivery**



**75 Year
Legacy**



**Complimentary
Lighting Layouts**



**No Questions
Asked
Return Policy**



**Free
Samples**



LIGHT MADE EASY®

KEYSTONE TECHNOLOGIES

Philadelphia, PA • Phone 800.464.2680 • Fax 888.966.0556 • keystonetech.com



SMARTDRIVE LED
PLUG & PLAY WITH BALLAST

KT-LED8T8-24GC-840-S

T8 LED LAMP

DESCRIPTION

8W T8 LED | 4000K | >80 CRI | High Efficiency | Ballast Compatible



LAMP TYPE: Linear
BULB TYPE: T8 LED
BASE TYPE: G13 (Medium Bi-Pin)
WATTAGE: 8W
COLOR TEMPERATURE: 4000K
COLOR RENDERING INDEX (CRI): >80
WARRANTY: 5 Years



PRODUCT FEATURES

- Compatible with Most Instant and Program Start Electronic T8 Ballasts, Contact Keystone for Ballast Compatibility List
- Direct Replacement for F17T8 Fluorescent Lamps
- UL Listed; Listed on DLC QPL
- 50,000+ Hour Lifetime
- Environmentally Friendly: No Mercury Used
- Instant Startup
- Frosted Lens Eliminates Pixelation
- Operating Temperature: -20°C/-4°F to 45°C/113°F
- 100+ Lumens per Watt (Bare Lamp Efficacy)
- Suitable for Dry and Damp Locations
- Improved Lamp Durability with Shatterproof Coated Glass, designed to pass drop tests of 6' on hard surface
- NSF Listed: NSF/ANSI Standard 2 - Food Equipment, Splash Zone (Not for Direct Food Zone without additional fixture considerations)

OPERATING SPECIFICATIONS

ELECTRICAL AND PERFORMANCE CHARACTERISTICS

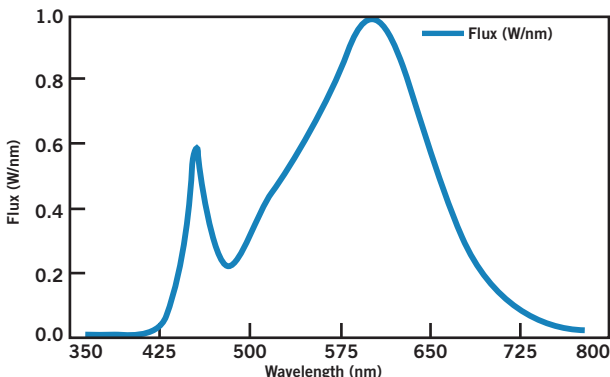
Input Voltage	CRI	Bare Lamp Wattage	Nominal Lamp Lumens	System Wattage*			Initial Lumens*			Beam Angle	Nominal Bare Lamp Efficacy	Power Factor	Max. THD
				0.78BF	0.88BF	1.18BF	0.78BF	0.88BF	1.18BF				
Ballast Dependent	>80	8W	1150 lm	9.3W	10.4W	14.3W	1110 lm	1235 lm	1610 lm	220°	127.0	>0.9	20%

* Nominal values. Actual values may vary depending on electronic ballast used.

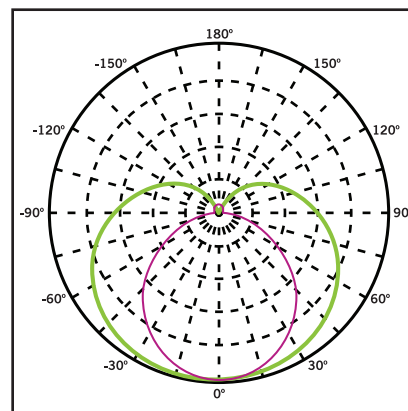
RATED LIFE

L70 (Hours)	50,000
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SPECTRAL DISTRIBUTION



POLAR CANDELA DISTRIBUTION



Maximum Candela = 1248.55
Located at Horizontal Angle = 0,
Vertical Angle 0

1. Violet Vertical Plane through Horizontal Angles (90-270)
2. Green Vertical Plane through Horizontal Angles (0-180)

Beam Angle: 220°

Visible Light Area: 325°



KT-LED8T8-24GC-840-S

T8 LED LAMP

WIRING

Plug and Play: Simply replace the existing fluorescent lamp with Keystone Smart Drive LED lamp. No changes to the existing fluorescent ballast wiring needed. For ballast compability questions, please contact Keystone.

PHYSICAL CHARACTERISTICS

LAMP DIMENSIONS

	A (Illuminated Length)	20.68"
	B (Body Length)	23.19"
	C (Diameter)	1.00"

NOMINAL LENGTH: 24" **BASE TYPE:** G13 (Medium Bi-Pin)

ORDERING INFORMATION

ORDER CODE	PACKAGING STYLE	PACK QTY.	ITEM STATUS
KT-LED8T8-24GC-840-S-CP	Carton Pack (Egg Crate Packaging)	25	Quick Ship
KT-LED8T8-24GC-840-S-DP	Distributor Pack (Individual Cartons)	20	Quick Ship

CATALOG NUMBER BREAKDOWN

KT-LED8T8-24GC-840-S-CP

Keystone Technologies	LED Lamp	Wattage	Lamp Type	Nominal Length (Inches)	Shatterproof Coated Glass	800 Series	Color Temp.	Smart Drive Series	Packaging Style
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KT-LED10T8-36GC-840-S

T8 LED LAMP

DESCRIPTION

10W T8 LED | 4000K | >80 CRI | High Efficiency | Ballast Compatible



LAMP TYPE: Linear
BULB TYPE: T8 LED
BASE TYPE: G13 (Medium Bi-Pin)
WATTAGE: 10W
COLOR TEMPERATURE: 4000K
COLOR RENDERING INDEX (CRI): >80
WARRANTY: 5 Years



PRODUCT FEATURES

- **Compatible with Most Instant and Program Start Electronic T8 Ballasts, Contact Keystone for Ballast Compatibility List**
- Direct Replacement for F25T8 Fluorescent Lamps
- DLC & UL Listed
- 50,000+ Hour Lifetime
- Environmentally Friendly: No Mercury Used
- Instant Startup
- Frosted Lens Eliminates Pixelation
- Operating Temperature: -20°C/-4°F to 45°C/113°F
- 100+ Lumens per Watt (Bare Lamp Efficacy)
- Suitable for Dry and Damp Locations
- Improved Lamp Durability with Shatterproof Coated Glass, designed to pass drop tests of 6' on hard surface
- NSF Listed: NSF/ANSI Standard 2 - Food Equipment, Splash Zone (Not for Direct Food Zone without additional fixture considerations)

OPERATING SPECIFICATIONS

ELECTRICAL AND PERFORMANCE CHARACTERISTICS

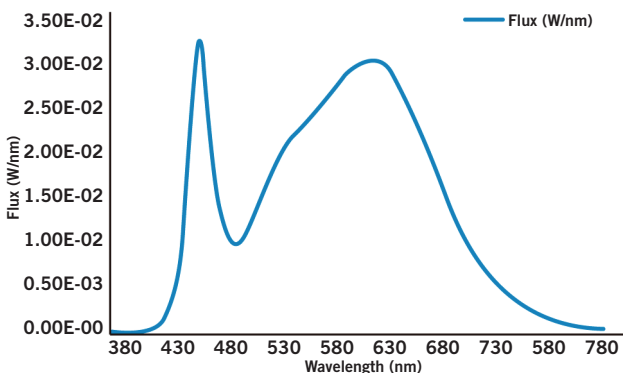
Input Voltage	CRI	Bare Lamp Wattage	Nominal Lamp Lumens	System Wattage*			Initial Lumens*			Beam Angle	Nominal Bare Lamp Efficacy	Power Factor	Max. THD
				0.78BF	0.88BF	1.18BF	0.78BF	0.88BF	1.18BF				
Ballast Dependent	>80	10W	1450	10.86	13.3	18.6	1300	1450	1880	220°	145	>0.9	20%

* Nominal values. Actual values may vary depending on electronic ballast used.

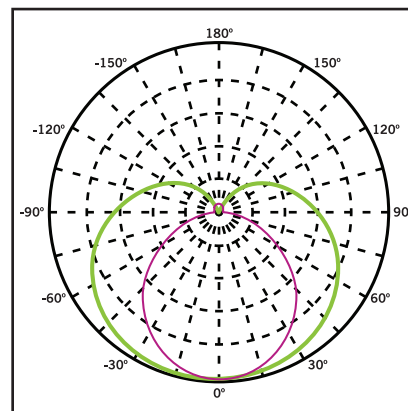
RATED LIFE

L70 (Hours)	50,000
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SPECTRAL DISTRIBUTION



POLAR CANDELA DISTRIBUTION



Maximum Candela = 1248.55
Located at Horizontal Angle = 0,
Vertical Angle 0

1. **Violet** Vertical Plane through Horizontal Angles (90-270)
2. **Green** Vertical Plane through Horizontal Angles (0-180)

Beam Angle: 220°

Visible Light Area: 325°



SMARTDRIVE LED

PLUG & PLAY WITH T8 BALLASTS

KT-LED10T8-36GC-840-S

T8 LED LAMP

WIRING

Plug and Play: Simply replace the existing fluorescent lamp with Keystone Smart Drive LED lamp. No changes to the existing fluorescent ballast wiring needed. For ballast compability questions, please contact Keystone.

PHYSICAL CHARACTERISTICS

LAMP DIMENSIONS

	A (Illuminated Length)	32.60"
	B (Body Length)	35.10"
	C (Diameter)	1.00"

NOMINAL LENGTH: 36" **BASE TYPE:** G13 (Medium Bi-Pin)

ORDERING INFORMATION

ORDER CODE	PACKAGING STYLE	PACK QTY.	ITEM STATUS
KT-LED10T8-36GC-840-S-CP	Carton Pack (Egg Crate Packaging)	25	Quick Ship
KT-LED10T8-36GC-840-S-DP	Distributor Pack (Individual Cartons)	20	Quick Ship

CATALOG NUMBER BREAKDOWN

KT-LED10T8-36GC-840-S-CP

Keystone Technologies	LED Lamp	Wattage	Lamp Type	Nominal Length (Inches)	Shatterproof Coated Glass	800 Series	Color Temp.	Smart Drive Series	Packaging Style
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SMARTDRIVE LED
PLUG & PLAY WITH BALLAST

KT-LED12T8-48G-840-S /G2

T8 LED LAMP

DESCRIPTION

12W T8 LED | 4000K | >80 CRI | High Efficiency | Ballast Compatible



RoHS
Compliant

5 YEAR
WARRANTY

LAMP TYPE: Linear
BULB TYPE: T8 LED
BASE TYPE: G13 (Medium Bi-Pin)
WATTAGE: 12W
COLOR TEMPERATURE: 4000K
COLOR RENDERING INDEX (CRI): >80
WARRANTY: 5 Years



PRODUCT FEATURES

- Compatible with Most Instant Start Electronic T8 Ballasts, Contact Keystone for Ballast Compatibility List
- Direct Replacement for the Following Fluorescent Lamps: F32T8/32W, F32T8/30W, F32T8/28W, F32T8/25W
- UL Listed
- 50,000+ Hour Lifetime
- Environmentally Friendly: No Mercury Used
- Instant Startup
- Frosted Lens Eliminates Pixelation
- Operating Temperature: -20°C/-4°F to 45°C/113°F
- 100+ Lumens per Watt (Bare Lamp Efficacy)
- Suitable for Dry and Damp Locations

OPERATING SPECIFICATIONS

ELECTRICAL AND PERFORMANCE CHARACTERISTICS

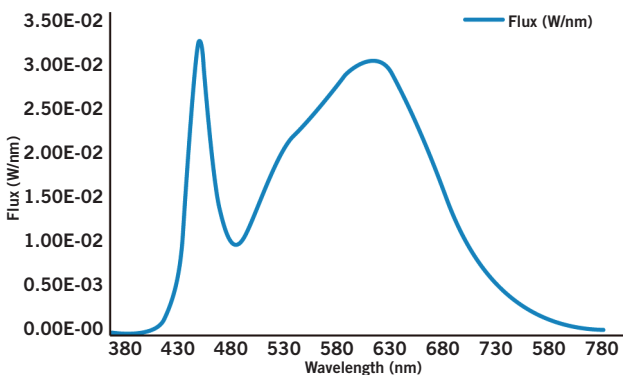
Input Voltage	CRI	Bare Lamp Wattage	Nominal Lamp Lumens	System Wattage*			Initial Lumens*			Nominal Bare Lamp Efficacy	Power Factor	Max. THD
				0.78BF	0.88BF	1.18BF	0.78BF	0.88BF	1.18BF			
Ballast Dependent	>80	12W	1800 lm	13.29W	15W	20.1W	1584 lm	1800 lm	2382 lm	150	>0.9	20%

* Nominal values. Actual values may vary depending on electronic ballast used.

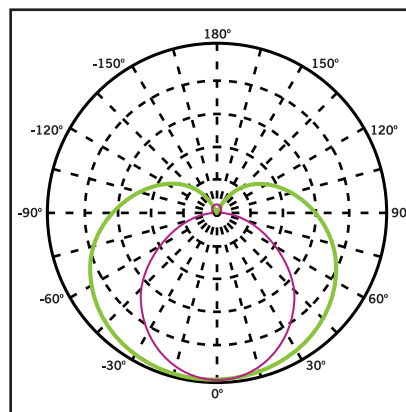
RATED LIFE

L70 (Hours)	50,000
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SPECTRAL DISTRIBUTION



POLAR CANDELA DISTRIBUTION



Maximum Candela = 1248.55
Located at Horizontal Angle = 0,
Vertical Angle 0

1. Violet Vertical Plane through Horizontal Angles (90-270)
2. Green Vertical Plane through Horizontal Angles (0-180)

Beam Angle: 220°

Visible Light Area: 325°



KT-LED12T8-48G-840-S /G2

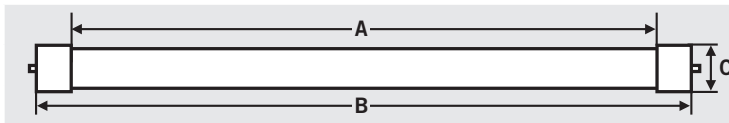
T8 LED LAMP

WIRING

Plug and Play: Simply replace the existing fluorescent lamp with Keystone Smart Drive LED lamp. No changes to the existing fluorescent ballast wiring needed. For ballast compability questions, please contact Keystone.

PHYSICAL CHARACTERISTICS

LAMP DIMENSIONS



A (Illuminated Length)	44.70"
B (Body Length)	47.15"
C (Diameter)	1.00"

NOMINAL LENGTH: 48" **BASE TYPE:** G13 (Medium Bi-Pin)

ORDERING INFORMATION

ORDER CODE	PACKAGING STYLE	PACK QTY.	ITEM STATUS
KT-LED12T8-48G-840-S /G2-CP	Carton Pack (Egg Crate Packaging)	25	Quick Ship
KT-LED12T8-48G-840-S /G2-DP	Distributor Pack (Individual Cartons)	20	Quick Ship

CATALOG NUMBER BREAKDOWN

KT-LED12T8-48G-840-S /G2-CP

Keystone Technologies	LED Lamp	Wattage	Lamp Type	Nominal Length (Inches)	Glass Case	800 Series	Color Temp.	Smart Drive Series	2nd Generation	Packaging Style
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PERFORMANCE **SERIES**

COMMERCIAL GRADE SCREW-IN LED BULBS



SEPTEMBER 2019

PERFORMANCE SERIES

COMMERCIAL GRADE SCREW-IN LED BULBS

Keystone's Performance Series LED A and PAR lamps are the ideal, energy-efficient solution for both commercial retrofit and new construction applications. Performance Series LED lamps provide high lumen outputs at a fraction of the power consumption compared to legacy equivalents. The long, useful, lifetime of these LED lamps also reduces maintenance and replacement costs.

A STYLE LAMPS



FEATURES AND BENEFITS

- **Universal input voltage (120-277V)**
- **Dimmable 20W option**
- Omni-directional light output
- Up to 75% energy savings compared to legacy equivalent lamps
- Can be used in base-up or base-down position
- Rated for both open and enclosed fixtures
- Large metal heat sink for optimal heat dissipation
- THD: <20%; power factor: >0.90
- Operating temperature range -4°F/-20°C to 113°F/45°C; 95°F/35°C max for fully enclosed fixture
- Ideal for post top, bollard, and outdoor corridor lighting
- Suitable for dry and damp locations
- Meets Energy Star requirements
- UL 1993 and 1598C Rated



RoHS
Compliant

5YEAR
WARRANTY

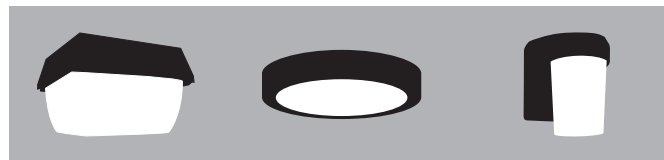
TYPICAL APPLICATIONS



POST TOP



BOLLARD



OUTDOOR CORRIDOR OPTIONS



SWAN



COMMERCIAL A21 LAMPS

OPTIONS: Universal Input Voltage, Non-Dimmable • 120V Input, Dimmable

Catalog Number	Color Temperature	Input Voltage	Rated Lamp Wattage	Legacy Equivalent Wattage	Base Type	Dimmable	Lumens	CRI	Light Distribution	Efficacy
KT-LED14A21-O-E26-827	2700K	120-277V	14W	100W Incandescent	E26	No	1,760	>80	340°	126 lm/W
KT-LED14A21-O-E26-830	3000K	120-277V	14W	100W Incandescent	E26	No	1,790	>80	340°	128 lm/W
KT-LED14A21-O-E26-840	4000K	120-277V	14W	100W Incandescent	E26	No	1,900	>80	340°	136 lm/W
KT-LED14A21-O-E26-850	5000K	120-277V	14W	100W Incandescent	E26	No	1,960	>80	340°	140 lm/W
KT-LED20A21-O-E26-827	2700K	120-277V	20W	150W Incandescent	E26	No	2,500	>80	340°	125 lm/W
KT-LED20A21-O-E26-830	3000K	120-277V	20W	150W Incandescent	E26	No	2,540	>80	340°	127 lm/W
KT-LED20A21-O-E26-840	4000K	120-277V	20W	150W Incandescent	E26	No	2,720	>80	340°	136 lm/W
KT-LED20A21-O-E26-850	5000K	120-277V	20W	150W Incandescent	E26	No	2,760	>80	340°	138 lm/W
DIMMABLE										
KT-LED20A21-O-E26-827-DIM	2700K	120V	20W	150W Incandescent	E26	Yes	2,460	>80	340°	123 lm/W
KT-LED20A21-O-E26-830-DIM	3000K	120V	20W	150W Incandescent	E26	Yes	2,500	>80	340°	125 lm/W
KT-LED20A21-O-E26-840-DIM	4000K	120V	20W	150W Incandescent	E26	Yes	2,680	>80	340°	125 lm/W
KT-LED20A21-O-E26-850-DIM	5000K	120V	20W	150W Incandescent	E26	Yes	2,710	>80	340°	125 lm/W



COMMERCIAL A23 LAMPS

Universal Input Voltage, Non-Dimmable

Catalog Number	Color Temperature	Input Voltage	Rated Lamp Wattage	Legacy Equivalent Wattage	Base Type	Lumens	CRI	Light Distribution	Efficacy
KT-LED25A23-O-E26-830	3000K	120-277V	25W	200W Incandescent/ 100W HID	E26	3,380	>80	330°	135 lm/W
KT-LED25A23-O-E26-840	4000K	120-277V	25W	200W Incandescent/ 100W HID	E26	3,530	>80	330°	141 lm/W
KT-LED25A23-O-E26-850	5000K	120-277V	25W	200W Incandescent/ 100W HID	E26	3,600	>80	330°	144 lm/W
KT-LED25A23-O-EX39-830	3000K	120-277V	25W	200W Incandescent/ 100W HID	EX39	3,380	>80	330°	135 lm/W
KT-LED25A23-O-EX39-840	4000K	120-277V	25W	200W Incandescent/ 100W HID	EX39	3,530	>80	330°	141 lm/W
KT-LED25A23-O-EX39-850	5000K	120-277V	25W	200W Incandescent/ 100W HID	EX39	3,590	>80	330°	143 lm/W



COMMERCIAL A25 LAMPS

Universal Input Voltage, Non-Dimmable

Catalog Number	Color Temperature	Input Voltage	Rated Lamp Wattage	Legacy Equivalent Wattage	Base Type	Lumens	CRI	Light Distribution	Efficacy
KT-LED35A25-O-E26-830	3000K	120-277V	35W	300W Incandescent/ 150W HID	E26	4,550	>80	330°	130 lm/W
KT-LED35A25-O-E26-840	4000K	120-277V	35W	300W Incandescent/ 150W HID	E26	4,780	>80	330°	137 lm/W
KT-LED35A25-O-E26-850	5000K	120-277V	35W	300W Incandescent/ 150W HID	E26	4,850	>80	330°	139 lm/W
KT-LED35A25-O-EX39-830	3000K	120-277V	35W	300W Incandescent/ 150W HID	EX39	4,550	>80	330°	130 lm/W
KT-LED35A25-O-EX39-840	4000K	120-277V	35W	300W Incandescent/ 150W HID	EX39	4,780	>80	330°	137 lm/W
KT-LED35A25-O-EX39-850	5000K	120-277V	35W	300W Incandescent/ 150W HID	EX39	4,850	>80	330°	139 lm/W

PAR LAMPS



FEATURES AND BENEFITS

- **Universal input voltage (120-277V)**
- Up to 75% energy savings compared to legacy equivalent lamps
- Can be used in base-up or base-down position
- Rated for open and recessed fixtures
- Large metal heat sink for optimal heat dissipation
- THD: <20%; power factor: >0.90
- Operating temperature range -4°F/-20°C to 113°F/45°C
- Ideal for recessed corridor and high-power flood lighting
- Suitable for dry and damp locations
- UL 1993 Rated



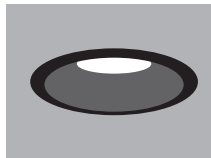
RoHS
Compliant

5YEAR
WARRANTY



50,000 HOUR
LIFETIME

TYPICAL APPLICATIONS



RECESSED CORRIDOR



FLOOD



SWAN

COMMERCIAL PAR38 LAMPS

Universal Input Voltage, Non-Dimmable

Catalog Number	Description	Color Temperature	Input Voltage	Rated Lamp Wattage	Legacy Equivalent Wattage	Base Type	Lumens	CRI	Light Distribution	Efficacy
KT-LED18PAR38-NF-830	Narrow Flood	3000K	120-277V	18W	250W Halogen	E26	1,950	>80	25°	108 lm/W
KT-LED18PAR38-NF-840	Narrow Flood	4000K	120-277V	18W	250W Halogen	E26	2,060	>80	25°	114 lm/W
KT-LED18PAR38-NF-850	Narrow Flood	5000K	120-277V	18W	250W Halogen	E26	2,100	>80	25°	114 lm/W
KT-LED18PAR38-F-830	Standard Flood	3000K	120-277V	18W	250W Halogen	E26	1,950	>80	40°	108 lm/W
KT-LED18PAR38-F-840	Standard Flood	4000K	120-277V	18W	250W Halogen	E26	2,060	>80	40°	114 lm/W
KT-LED18PAR38-F-850	Standard Flood	5000K	120-277V	18W	250W Halogen	E26	2,100	>80	40°	114 lm/W

We'd love to send you a FREE SAMPLE!

Call: 800-464-2680 | Email: samples@keystonetech.com | Web: keystonetech.com/samples

Some restrictions apply.





KT-LED62P-H-8xx-D

2-PIN LED LAMP

DESCRIPTION

6W 2-Pin LED Lamp | 2700K, 3000K, 3500K, 4000K, 5000K | ≥ 83 CRI
Line Voltage Compatible



LAMP TYPE: Compact

BULB TYPE: 2-Pin LED

BASE TYPE: Gx23

WATTAGE: 6W

COLOR TEMPERATURE: 2700K, 3000K, 3500K, 4000K, 5000K

COLOR RENDERING INDEX (CRI): ≥ 83

WARRANTY: 5 Years



PRODUCT FEATURES

- Replaces 13W Gx23 CFL Lamps
- 50,000+ Hour Lifetime
- Approximately 50% More Energy Efficient than Traditional CFL Lamps
- Environmentally Friendly: No Mercury Used
- Instant Startup
- Frosted Lens Eliminates Pixelation
- UL Classified
- Operating Temperature: -20°C/-4°F to 45°C/113°F
- Up to 5x Longer Life than Traditional CFL Lamps
- Non-Dimmable
- Rotatable 270°

OPERATING SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

Input Voltage	Lamp Wattage	Power Factor
120-277V	6W	>0.9

PHOTOMETRIC CHARACTERISTICS

Color Temperature (CCT)	2700K	3000K	3500K	4000K	5000K
Luminous Flux	500 lm	500 lm	500 lm	550 lm	550 lm
Color Rendering Index (CRI)	≥ 83	≥ 83	≥ 83	≥ 83	≥ 83
Bare Lamp Efficacy	83 lm/W	83 lm/W	83 lm/W	92 lm/W	92 lm/W
Beam Angle	>120°	>120°	>120°	>120°	>120°
LED Quantity	21	21	21	21	21

RATED LIFE

L70 (Hours)	50,000
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KT-LED62P-H-8xx-D

2-PIN LED LAMP

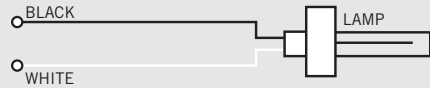
WIRING

BYPASS MAGNETIC BALLAST WITH 1 LAMP (Gx23 SOCKET)

BEFORE

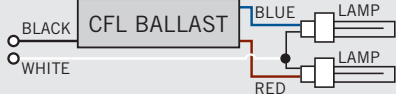


AFTER



BYPASS MAGNETIC BALLAST WITH 2 LAMPS (Gx23 SOCKET)

BEFORE

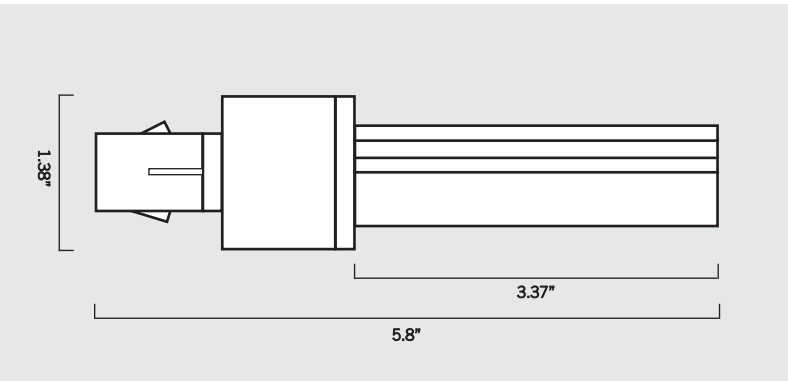


AFTER



PHYSICAL CHARACTERISTICS

LAMP DIMENSIONS

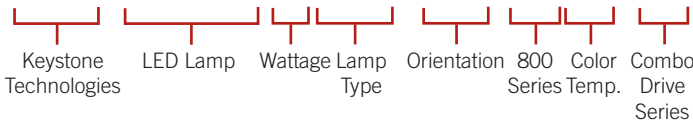


ORDERING INFORMATION

ORDER CODE	PACKAGING STYLE	PACK QTY.	ITEM STATUS
KT-LED62P-H-8xx-D-DP	Distributor Pack	10	Quick Ship

CATALOG NUMBER BREAKDOWN

KT-LED62P-H-8xx-D



ECM 2

Lighting Controls

This ECM does not have standalone savings or cutsheets. Associated savings and cutsheets are contained within ECM 1.

ECM #3

Weatherization of windows & doors

Savings Calculations



I-Star Energy Solutions
104 Fite Way, Suite C
Quarryville, PA 17566
Contact: Andrew Martin
Phone #: (717) 989-6909
Email: andymartin@irexcorp.com



Project Name:
Date of Report:
Type of Report:
Weather Data City/State:

Wernersville State Hospital
10/4/2021
Building Envelope Calculation
Harrisburg Intl AP, PA

Information provided by customer

Information provided by our company

Definitions:

ASHRAE Fundamentals 16.23-48 Applies $Q = A_L \cdot \sqrt{C_s \cdot \Delta t + C_w \cdot U^2}$

$Q_T = Q \cdot I$ = Infiltrated/Exfiltrated Air Flow Rate, Cfm

Q = Air Flow Rate, Cfm

A_L = Effective air leakage area, in²

C_s = Stack coefficient, cfm²/(in⁴*°F)

C_w = Wind Coefficient, cfm²/(in⁴* mph²)

Δt = Indoor - Outdoor temperature differential

U = Wind speed, mph

I = Infiltration/Exfiltration Factor

Inputs and Assumptions:

Main Building/Admin (1)		Wernersville State Hospital
Temperature Which Heating Begins	70 °F	Used to Establish Maximum Outdoor Temperature for Heating System Operation
Temperature Which Cooling Begins	75 °F	Used to Establish Minimum Outdoor Temperature for Cooling System Operation
Day Operation Begins (Sunday is Day 1)	1 Sunday	These Values Used to Establish Occupied Hours vs Unoccupied Hours
Day Operation Ends (Sunday is Day 1)	7 Saturday	
Hour Operation Begins (Hour 1 is Midnight to 1 AM)	6 Hour	
Hour Operation Ends (Hour 1 is Midnight to 1 AM)	15 Hour	
Directional Wind Infiltration/Exfiltration	70% per cent	
Occupied Cooling Temperature Setpoint	75 °F	Used for Occupied Cooling Enthalpy Calculations
Occupied Heating Temperature Setpoint	70 °F	Used for Occupied Heating ΔT Calculations
Unoccupied Cooling Indoor Temperature Setpoint	75 °F	Used for Unoccupied Cooling Enthalpy Calculations
Unoccupied Heating Indoor Temperature Setpoint	70 °F	Used for Unoccupied Heating ΔT Calculations
Cooling Plant Efficiency	0.992 kW/ton	
Heating Plant Efficiency	75% per cent	
Energy Cost \$/kWh	\$ 0.07410 per kWh	Electric
Fuel Energy Cost \$/MMBtu	\$ 7.51000 per MMBtu	Natural Gas
# of Floors in Building	3	
Local Shelter Class (see Table 5 below)	2 Typical shelter for an isolated rural house	
A_L = Effective Air Leakage Area from Survey, ft ²	1.22 ft ²	
Existing Insulation Area from Survey, ft ²		
Existing U-Value		
Proposed U-Value		



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Project Name: **Wernersville State Hospital**

Calculations:

Main Building/Admin (1)	Wernersville State Hospital
Air Leakage from Survey, in ² = (144 * 1 ft ²):	175.5 in ²
Selected Basic Model Stack Coefficient C _s	0.04490 cfm ² /(in ⁴ x °F)
Selected Basic Model Wind Coefficient C _w	0.0143 cfm ² /(in ⁴ *mph ²)
Cooling Season Energy from Weather Table-Occupied Cooling ton-hours (2,416,158 Btu / 12,000 Btu/ton):	201 ton-hours
Cooling Season Energy from Weather Table-Unoccupied Cooling ton-hours (2,177,496 Btu / 12,000 Btu/ton):	181 ton-hours
Heating Season Energy from Weather Table-Occupied (17,338,595 Btu / 1,000,000 Btu):	17 MMBtu
Heating Season Energy from Weather Table-Unoccupied (24,621,357 Btu / 1,000,000 Btu):	25 MMBtu
ECM Energy and Cost Savings:	
Cooling Season kWh Energy Savings-Occupied (201 ton-hours * .99 kW/ton):	200 kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (181 ton-hours * .99 kW/ton):	180 kWh/yr
Controls Occupied Hours Per Year	3,650 Hrs/year
Controls Unoccupied Hours Per Year	5,110 Hrs/year
Fuel Energy Savings-Heating Season-Occupied (17 MMBtu / 75 %):	23 MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (25 MMBtu / 75 %):	33 MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (200 kWh/Yr x \$0.07410 per kWh):	\$ 15 per year
Cooling Season kWh Energy Cost Savings-Unoccupied (180 kWh/Yr x \$0.07410 per kWh):	\$ 13 per year
Fuel Energy Cost Savings-Heating Season-Occupied (23 MMBtu x \$7.51 per MMBtu):	\$ 174 per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (33 MMBtu x \$7.51 per MMBtu):	\$ 247 per year
Total Savings Cost (\$15 kWh/yr + \$13 kWh/yr + \$174 Btu + \$247 Btu):	\$ 448 per year
Building Insulation	
Cooling Season kWh Energy Savings-Occupied (ft ² x (U-Value - . U-Value) * 24 * 603 CDD / 12,000 Btu/ton) * (.99 kW/ton):	0 kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 631 CDD / 12,000 Btu/ton) * (.99 kW/ton):	0 kWh/yr
Fuel Energy Savings-Heating Season-Occupied (ft ² x (U-Value - . U-Value) * 24 * 2452 HDD / 1,000,000 Btu) / (75 %):	0 MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 3719 HDD / 1,000,000 Btu) / (75 %):	0 MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (kWh/Yr x \$0.07410 per kWh):	\$ - per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$ - per year
Fuel Energy Cost Savings-Heating Season-Occupied (MMBtu x \$7.51 per MMBtu):	\$ - per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$ - per year
Total Savings Cost (\$0 kWh/yr + \$0 kWh/yr + \$0 Btu + \$0 Btu):	\$ - per year

Crack area Calculation		
Width	LE	ft ²
1/16	182	0.948
1/8	26	0.271
1/4		0.000
1/2		0.000
3/4		0.000
1		0.000
1 1/2		0.000
2		0.000
Penetrations		1.219
		1.219

Constants and calculated values used in calculations:

Occupied Indoor Enthalpy at 75° F and 60% RH	30.220 Btu/lb (air)
Unoccupied Indoor Enthalpy at 75° F and 60% RH	30.220 Btu/lb (air)
ASHRAE Sensible Heat Coefficient	1.08

These calculations are based on ASHRAE Fundamentals 2009, chapter 16, page 16.23, formula number 48 as shown below.



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Project Name: **Wernersville State Hospital**

ASHRAE Enthalpy Coefficient	4.5
Btu/ton	12,000 Btu/ton
Btu	1000000 Btu

ASHRAE TABLE 16.23, Table 4 Basic Model Stack Coefficient C_s

Story	Stack Coefficient C_s
1	0.01500
2	0.02990
3	0.04490
4	0.06283
5	0.07858
6	0.09433
7	0.11008
8	0.12583
9	0.14158
10	0.15733

ASHRAE TABLE 16.23, Table 5 Local Shelter Class:

- 1 No Obstructions or local shielding
- 2 Typical shelter for an isolated rural house
- 3 Typical shelter used by other buildings across the street from building under study
- 4 Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away
- 5 Typical shelter produced by building or other structures immediately adjacent

ASHRAE TABLE 16.23, Table 6 Basic Model Wind Coefficient C_w

# of Stories	Shelter Class 1	Shelter Class 2	Shelter Class 3	Shelter Class 4	Shelter Class 5	Values Used
1	0.0119	0.0092	0.0065	0.0039	0.0012	0.0092
2	0.0157	0.0121	0.0086	0.0051	0.0016	0.0121
3	0.0184	0.0143	0.0101	0.0060	0.0018	0.0143
4	0.0218	0.0170	0.0120	0.0071	0.0021	0.0170
5	0.0251	0.0195	0.0138	0.0082	0.0024	0.0195
6	0.0283	0.0221	0.0156	0.0092	0.0027	0.0221
7	0.0316	0.0246	0.0174	0.0103	0.0030	0.0246
8	0.0348	0.0272	0.0192	0.0113	0.0033	0.0272
9	0.0381	0.0297	0.0210	0.0124	0.0036	0.0297
10	0.0413	0.0323	0.0228	0.0134	0.0039	0.0323

Basic Model. The following calculations are based on the Sherman and Grimsrud (1980) model, which uses the effective air leakage area at 0.016 in. of water. This leakage area can be obtained from a whole-building pressurization test. Using effective air leakage area, the airflow rate from infiltration is calculated according to

$$Q = A_L \sqrt{C_s \Delta t + C_w U^2} \quad (48)$$

where

Q = airflow rate, cfm

A_L = effective air leakage area, in²

C_s = stack coefficient, cfm²/(in⁴·°F)

Δt = average indoor-outdoor temperature difference for time interval of calculation, °F

C_w = wind coefficient, cfm²/(in⁴·mph²)

U = average wind speed measured at local weather station for time interval of calculation, mph

Table 4 presents values of C_s for one-, two-, and three-story houses. The value of wind coefficient C_w depends on the local shelter class of the building (described in Table 5) and the building height. Table 6 presents values of C_w for one-, two-, and three-story houses in shelter classes 1 through 5. In calculating values in Tables 4 and 6, the following assumptions were made regarding input to the basic model:

Indoor Cooling Occupied Setpoint Calculations



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Project Name:

Wernersville State Hospital

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F

75.0000

Indoor Cooling Unoccupied Setpoint Calculations

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F



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Project Name:
Date of Report:
Type of Report:
Weather Data City/State:

Wernersville State Hospital
10/4/2021
Building Envelope Calculation
Harrisburg Intl AP, PA

Information provided by customer

Information provided by our company

Definitions:

ASHRAE Fundamentals 16.23-48 Applies $Q = A_L \cdot \sqrt{C_s \cdot \Delta t + C_w \cdot U^2}$

$Q_T = Q \cdot I$ = Infiltrated/Exfiltrated Air Flow Rate, Cfm

Q = Air Flow Rate, Cfm

A_L = Effective air leakage area, in²

C_s = Stack coefficient, cfm²/(in⁴*°F)

C_w = Wind Coefficient, cfm²/(in⁴* mph²)

Δt = Indoor - Outdoor temperature differential

U = Wind speed, mph

I = Infiltration/Exfiltration Factor

Inputs and Assumptions:

South Mountain Workshop (3)		Wernersville State Hospital
Temperature Which Heating Begins	70 °F	Used to Establish Maximum Outdoor Temperature for Heating System Operation
Temperature Which Cooling Begins	75 °F	Used to Establish Minimum Outdoor Temperature for Cooling System Operation
Day Operation Begins (Sunday is Day 1)	1 Sunday	These Values Used to Establish Occupied Hours vs Unoccupied Hours
Day Operation Ends (Sunday is Day 1)	7 Saturday	
Hour Operation Begins (Hour 1 is Midnight to 1 AM)	6 Hour	
Hour Operation Ends (Hour 1 is Midnight to 1 AM)	15 Hour	
Directional Wind Infiltration/Exfiltration	70% per cent	
Occupied Cooling Temperature Setpoint	75 °F	Used for Occupied Cooling Enthalpy Calculations
Occupied Heating Temperature Setpoint	70 °F	Used for Occupied Heating ΔT Calculations
Unoccupied Cooling Indoor Temperature Setpoint	75 °F	Used for Unoccupied Cooling Enthalpy Calculations
Unoccupied Heating Indoor Temperature Setpoint	70 °F	Used for Unoccupied Heating ΔT Calculations
Cooling Plant Efficiency	0.992 kW/ton	
Heating Plant Efficiency	75% per cent	
Energy Cost \$/kWh	\$ 0.07410 per kWh	Electric
Fuel Energy Cost \$/MMBtu	\$ 7.51000 per MMBtu	Natural Gas
# of Floors in Building	3	
Local Shelter Class (see Table 5 below)	4 Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away	
A_L = Effective Air Leakage Area from Survey, ft ²	0.91 ft ²	
Existing Insulation Area from Survey, ft ²		
Existing U-Value		
Proposed U-Value		



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Project Name: **Wernersville State Hospital**

Calculations:

South Mountain Workshop (3)		Wernersville State Hospital	
Air Leakage from Survey, in ² = (144 * 1 ft ²):		130.5	in ²
Selected Basic Model Stack Coefficient C _s		0.04490	cfm ² /(in ⁴ x °F)
Selected Basic Model Wind Coefficient C _w		0.0060	cfm ² /(in ⁴ *mph ²)
Cooling Season Energy from Weather Table-Occupied Cooling ton-hours (1,361,350 Btu / 12,000 Btu/ton):		113	ton-hours
Cooling Season Energy from Weather Table-Unoccupied Cooling ton-hours (1,204,157 Btu / 12,000 Btu/ton):		100	ton-hours
Heating Season Energy from Weather Table-Occupied (10,867,111 Btu / 1,000,000 Btu):		11	MMBtu
Heating Season Energy from Weather Table-Unoccupied (15,831,961 Btu / 1,000,000 Btu):		16	MMBtu
ECM Energy and Cost Savings:			
Cooling Season kWh Energy Savings-Occupied (113 ton-hours * .99 kW/ton):		113	kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (100 ton-hours * .99 kW/ton):		100	kWh/yr
Controls Occupied Hours Per Year		3,650	Hrs/year
Controls Unoccupied Hours Per Year		5,110	Hrs/year
Fuel Energy Savings-Heating Season-Occupied (11 MMBtu / 75 %):		14	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (16 MMBtu / 75 %):		21	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (113 kWh/Yr x \$0.07410 per kWh):	\$	8	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (100 kWh/Yr x \$0.07410 per kWh):	\$	7	per year
Fuel Energy Cost Savings-Heating Season-Occupied (14 MMBtu x \$7.51 per MMBtu):	\$	109	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (21 MMBtu x \$7.51 per MMBtu):	\$	159	per year
Total Savings Cost (\$8 kWh/yr + \$7 kWh/yr + \$109 Btu + \$159 Btu):	\$	283	per year
Building Insulation			
Cooling Season kWh Energy Savings-Occupied (ft ² x (U-Value - . U-Value) * 24 * 603 CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 631 CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Fuel Energy Savings-Heating Season-Occupied (ft ² x (U-Value - . U-Value) * 24 * 2452 HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 3719 HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Occupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Total Savings Cost (\$0 kWh/yr + \$0 kWh/yr + \$0 Btu + \$0 Btu):	\$	-	per year

Crack area Calculation		
Width	LE	ft ²
1/16	120	0.625
1/8	27	0.281
1/4		0.000
1/2		0.000
3/4		0.000
1		0.000
1 1/2		0.000
2		0.000
		0.906
Penetrations		0.906

Constants and calculated values used in calculations:

Occupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
Unoccupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
ASHRAE Sensible Heat Coefficient	1.08	

These calculations are based on ASHRAE Fundamentals 2009, chapter 16, page 16.23, formula number 48 as shown below.



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Project Name: **Wernersville State Hospital**

ASHRAE Enthalpy Coefficient	4.5
Btu/ton	12,000 Btu/ton
Btu	1000000 Btu

ASHRAE TABLE 16.23, Table 4 Basic Model Stack Coefficient C_s

Story	Stack Coefficient C_s
1	0.01500
2	0.02990
3	0.04490
4	0.06283
5	0.07858
6	0.09433
7	0.11008
8	0.12583
9	0.14158
10	0.15733

ASHRAE TABLE 16.23, Table 5 Local Shelter Class:

- 1 No Obstructions or local shielding
- 2 Typical shelter for an isolated rural house
- 3 Typical shelter used by other buildings across the street from building under study
- 4 Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away
- 5 Typical shelter produced by building or other structures immediately adjacent

ASHRAE TABLE 16.23, Table 6 Basic Model Wind Coefficient C_w

# of Stories	Shelter Class 1	Shelter Class 2	Shelter Class 3	Shelter Class 4	Shelter Class 5	Values Used
1	0.0119	0.0092	0.0065	0.0039	0.0012	0.0039
2	0.0157	0.0121	0.0086	0.0051	0.0016	0.0051
3	0.0184	0.0143	0.0101	0.0060	0.0018	0.0060
4	0.0218	0.0170	0.0120	0.0071	0.0021	0.0071
5	0.0251	0.0195	0.0138	0.0082	0.0024	0.0082
6	0.0283	0.0221	0.0156	0.0092	0.0027	0.0092
7	0.0316	0.0246	0.0174	0.0103	0.0030	0.0103
8	0.0348	0.0272	0.0192	0.0113	0.0033	0.0113
9	0.0381	0.0297	0.0210	0.0124	0.0036	0.0124
10	0.0413	0.0323	0.0228	0.0134	0.0039	0.0134

Basic Model. The following calculations are based on the Sherman and Grimsrud (1980) model, which uses the effective air leakage area at 0.016 in. of water. This leakage area can be obtained from a whole-building pressurization test. Using effective air leakage area, the airflow rate from infiltration is calculated according to

$$Q = A_L \sqrt{C_s \Delta t + C_w U^2} \quad (48)$$

where

Q = airflow rate, cfm

A_L = effective air leakage area, in²

C_s = stack coefficient, cfm²/(in⁴·°F)

Δt = average indoor-outdoor temperature difference for time interval of calculation, °F

C_w = wind coefficient, cfm²/(in⁴·mph²)

U = average wind speed measured at local weather station for time interval of calculation, mph

Table 4 presents values of C_s for one-, two-, and three-story houses. The value of wind coefficient C_w depends on the local shelter class of the building (described in Table 5) and the building height. Table 6 presents values of C_w for one-, two-, and three-story houses in shelter classes 1 through 5. In calculating values in Tables 4 and 6, the following assumptions were made regarding input to the basic model:

Indoor Cooling Occupied Setpoint Calculations



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Project Name:

Wernersville State Hospital

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F

75.0000

Indoor Cooling Unoccupied Setpoint Calculations

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F



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Project Name:
Date of Report:
Type of Report:
Weather Data City/State:

Wernersville State Hospital
10/4/2021
Building Envelope Calculation
Harrisburg Intl AP, PA

Information provided by customer

Information provided by our company

Definitions:

ASHRAE Fundamentals 16.23-48 Applies $Q = A_L \cdot \sqrt{C_s \cdot \Delta t + C_w \cdot U^2}$

$Q_T = Q \cdot I$ = Infiltrated/Exfiltrated Air Flow Rate, Cfm

Q = Air Flow Rate, Cfm

A_L = Effective air leakage area, in²

C_s = Stack coefficient, cfm²/(in⁴*°F)

C_w = Wind Coefficient, cfm²/(in⁴* mph²)

Δt = Indoor - Outdoor temperature differential

U = Wind speed, mph

I = Infiltration/Exfiltration Factor

Inputs and Assumptions:

Parkside House West (5)		Wernersville State Hospital
Temperature Which Heating Begins	70 °F	Used to Establish Maximum Outdoor Temperature for Heating System Operation
Temperature Which Cooling Begins	75 °F	Used to Establish Minimum Outdoor Temperature for Cooling System Operation
Day Operation Begins (Sunday is Day 1)	1 Sunday	These Values Used to Establish Occupied Hours vs Unoccupied Hours
Day Operation Ends (Sunday is Day 1)	7 Saturday	
Hour Operation Begins (Hour 1 is Midnight to 1 AM)	6 Hour	
Hour Operation Ends (Hour 1 is Midnight to 1 AM)	15 Hour	
Directional Wind Infiltration/Exfiltration	70% per cent	
Occupied Cooling Temperature Setpoint	75 °F	Used for Occupied Cooling Enthalpy Calculations
Occupied Heating Temperature Setpoint	70 °F	Used for Occupied Heating ΔT Calculations
Unoccupied Cooling Indoor Temperature Setpoint	75 °F	Used for Unoccupied Cooling Enthalpy Calculations
Unoccupied Heating Indoor Temperature Setpoint	70 °F	Used for Unoccupied Heating ΔT Calculations
Cooling Plant Efficiency	0.992 kW/ton	
Heating Plant Efficiency	75% per cent	
Energy Cost \$/kWh	\$ 0.07410 per kWh	Electric
Fuel Energy Cost \$/MMBtu	\$ 7.51000 per MMBtu	Natural Gas
# of Floors in Building	3	
Local Shelter Class (see Table 5 below)	2 Typical shelter for an isolated rural house	
A_L = Effective Air Leakage Area from Survey, ft ²	5.19 ft ²	
Existing Insulation Area from Survey, ft ²		
Existing U-Value		
Proposed U-Value		



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Project Name: **Wernersville State Hospital**

Calculations:

Parkside House West (5)		Wernersville State Hospital	
Air Leakage from Survey, in ² = (144 * 5 ft ²):		747	in ²
Selected Basic Model Stack Coefficient C _s		0.04490	cfm ² /(in ⁴ x °F)
Selected Basic Model Wind Coefficient C _w		0.0143	cfm ² /(in ⁴ *mph ²)
Cooling Season Energy from Weather Table-Occupied Cooling ton-hours (10,284,161 Btu / 12,000 Btu/ton):		857	ton-hours
Cooling Season Energy from Weather Table-Unoccupied Cooling ton-hours (9,268,315 Btu / 12,000 Btu/ton):		772	ton-hours
Heating Season Energy from Weather Table-Occupied (73,800,172 Btu / 1,000,000 Btu):		74	MMBtu
Heating Season Energy from Weather Table-Unoccupied (104,798,595 Btu / 1,000,000 Btu):		105	MMBtu
ECM Energy and Cost Savings:			
Cooling Season kWh Energy Savings-Occupied (857 ton-hours * .99 kW/ton):		850	kWh/yr
Cooling Seasons kWh Energy Savings-Unoccupied (772 ton-hours * .99 kW/ton):		766	kWh/yr
Controls Occupied Hours Per Year		3,650	Hrs/year
Controls Unoccupied Hours Per Year		5,110	Hrs/year
Fuel Energy Savings-Heating Season-Occupied (74 MMBtu / 75 %):		98	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (105 MMBtu / 75 %):		140	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (850 kWh/Yr x \$0.07410 per kWh):	\$	63	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (766 kWh/Yr x \$0.07410 per kWh):	\$	57	per year
Fuel Energy Cost Savings-Heating Season-Occupied (98 MMBtu x \$7.51 per MMBtu):	\$	739	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (140 MMBtu x \$7.51 per MMBtu):	\$	1,049	per year
Total Savings Cost (\$63 kWh/yr + \$57 kWh/yr + \$739 Btu + \$1049 Btu):	\$	1,908	per year
Building Insulation			
Cooling Season kWh Energy Savings-Occupied (ft ² x (U-Value - . U-Value) * 24 * 603 CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 631 CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Fuel Energy Savings-Heating Season-Occupied (ft ² x (U-Value - . U-Value) * 24 * 2452 HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 3719 HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Occupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Total Savings Cost (\$0 kWh/yr + \$0 kWh/yr + \$0 Btu + \$0 Btu):	\$	-	per year

Crack area Calculation		
Width	LF	ft ²
1/16	932	4.854
1/8	32	0.333
1/4		0.000
1/2		0.000
3/4		0.000
1		0.000
1 1/2		0.000
2		0.000
Penetrations		5.188
		5.188

Constants and calculated values used in calculations:

Occupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
Unoccupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
ASHRAE Sensible Heat Coefficient	1.08	

These calculations are based on ASHRAE Fundamentals 2009, chapter 16, page 16.23, formula number 48 as shown below.



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Project Name: **Wernersville State Hospital**

ASHRAE Enthalpy Coefficient	4.5
Btu/ton	12,000 Btu/ton
Btu	1000000 Btu

ASHRAE TABLE 16.23, Table 4 Basic Model Stack Coefficient C_s

Story	Stack Coefficient C_s
1	0.01500
2	0.02990
3	0.04490
4	0.06283
5	0.07858
6	0.09433
7	0.11008
8	0.12583
9	0.14158
10	0.15733

ASHRAE TABLE 16.23, Table 5 Local Shelter Class:

- 1 No Obstructions or local shielding
- 2 Typical shelter for an isolated rural house
- 3 Typical shelter used by other buildings across the street from building under study
- 4 Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away
- 5 Typical shelter produced by building or other structures immediately adjacent

ASHRAE TABLE 16.23, Table 6 Basic Model Wind Coefficient C_w

# of Stories	Shelter Class 1	Shelter Class 2	Shelter Class 3	Shelter Class 4	Shelter Class 5	Values Used
1	0.0119	0.0092	0.0065	0.0039	0.0012	0.0092
2	0.0157	0.0121	0.0086	0.0051	0.0016	0.0121
3	0.0184	0.0143	0.0101	0.0060	0.0018	0.0143
4	0.0218	0.0170	0.0120	0.0071	0.0021	0.0170
5	0.0251	0.0195	0.0138	0.0082	0.0024	0.0195
6	0.0283	0.0221	0.0156	0.0092	0.0027	0.0221
7	0.0316	0.0246	0.0174	0.0103	0.0030	0.0246
8	0.0348	0.0272	0.0192	0.0113	0.0033	0.0272
9	0.0381	0.0297	0.0210	0.0124	0.0036	0.0297
10	0.0413	0.0323	0.0228	0.0134	0.0039	0.0323

Basic Model. The following calculations are based on the Sherman and Grimsrud (1980) model, which uses the effective air leakage area at 0.016 in. of water. This leakage area can be obtained from a whole-building pressurization test. Using effective air leakage area, the airflow rate from infiltration is calculated according to

$$Q = A_L \sqrt{C_s \Delta t + C_w U^2} \quad (48)$$

where

Q = airflow rate, cfm

A_L = effective air leakage area, in²

C_s = stack coefficient, cfm²/(in⁴·°F)

Δt = average indoor-outdoor temperature difference for time interval of calculation, °F

C_w = wind coefficient, cfm²/(in⁴·mph²)

U = average wind speed measured at local weather station for time interval of calculation, mph

Table 4 presents values of C_s for one-, two-, and three-story houses. The value of wind coefficient C_w depends on the local shelter class of the building (described in Table 5) and the building height. Table 6 presents values of C_w for one-, two-, and three-story houses in shelter classes 1 through 5. In calculating values in Tables 4 and 6, the following assumptions were made regarding input to the basic model:



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Project Name:

Wernersville State Hospital

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F

75.0000

Indoor Cooling Unoccupied Setpoint Calculations

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F



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Project Name:
Date of Report:
Type of Report:
Weather Data City/State:

Wernersville State Hospital
10/4/2021
Building Envelope Calculation
Harrisburg Intl AP, PA

Information provided by customer

Information provided by our company

Definitions:

ASHRAE Fundamentals 16.23-48 Applies $Q = A_L \cdot \sqrt{C_s \cdot \Delta t + C_w \cdot U^2}$

$Q_T = Q \cdot I$ = Infiltrated/Exfiltrated Air Flow Rate, Cfm

Q = Air Flow Rate, Cfm

A_L = Effective air leakage area, in²

C_s = Stack coefficient, cfm²/(in⁴*°F)

C_w = Wind Coefficient, cfm²/(in⁴* mph²)

Δt = Indoor - Outdoor temperature differential

U = Wind speed, mph

I = Infiltration/Exfiltration Factor

Inputs and Assumptions:

Garage and Maintenance (13)			Wernersville State Hospital
Temperature Which Heating Begins	70	°F	Used to Establish Maximum Outdoor Temperature for Heating System Operation
Temperature Which Cooling Begins	75	°F	Used to Establish Minimum Outdoor Temperature for Cooling System Operation
Day Operation Begins (Sunday is Day 1)	1	Sunday	These Values Used to Establish Occupied Hours vs Unoccupied Hours
Day Operation Ends (Sunday is Day 1)	7	Saturday	
Hour Operation Begins (Hour 1 is Midnight to 1 AM)	6	Hour	
Hour Operation Ends (Hour 1 is Midnight to 1 AM)	15	Hour	
Directional Wind Infiltration/Exfiltration	70%	per cent	
Occupied Cooling Temperature Setpoint	75	°F	Used for Occupied Cooling Enthalpy Calculations
Occupied Heating Temperature Setpoint	70	°F	Used for Occupied Heating ΔT Calculations
Unoccupied Cooling Indoor Temperature Setpoint	75	°F	Used for Unoccupied Cooling Enthalpy Calculations
Unoccupied Heating Indoor Temperature Setpoint	70	°F	Used for Unoccupied Heating ΔT Calculations
Cooling Plant Efficiency	0.992	kW/ton	
Heating Plant Efficiency	75%	per cent	
Energy Cost \$/kWh	\$ 0.07410	per kWh	Electric
Fuel Energy Cost \$/MMBtu	\$ 7.51000	per MMBtu	Natural Gas
# of Floors in Building	2		
Local Shelter Class (see Table 5 below)	4	Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away	
A_L = Effective Air Leakage Area from Survey, ft ²	0.78	ft ²	
Existing Insulation Area from Survey, ft ²		ft ²	
Existing U-Value			
Proposed U-Value			



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Project Name: **Wernersville State Hospital**

Calculations:

Garage and Maintenance (13)			Wernersville State Hospital		
Air Leakage from Survey, in ² = (144 * 1 ft ²):			111.75	in ²	
Selected Basic Model Stack Coefficient C _s			0.02990	cfm ² /(in ⁴ x °F)	
Selected Basic Model Wind Coefficient C _w			0.0051	cfm ² /(in ⁴ *mph ²)	
Cooling Season Energy from Weather Table-Occupied Cooling ton-hours (1,020,723 Btu / 12,000 Btu/ton):			85	ton-hours	
Cooling Season Energy from Weather Table-Unoccupied Cooling ton-hours (908,251 Btu / 12,000 Btu/ton):			76	ton-hours	
Heating Season Energy from Weather Table-Occupied (7,907,601 Btu / 1,000,000 Btu):			8	MMBtu	
Heating Season Energy from Weather Table-Unoccupied (11,444,587 Btu / 1,000,000 Btu):			11	MMBtu	
ECM Energy and Cost Savings:					
Cooling Season kWh Energy Savings-Occupied (85 ton-hours * .99 kW/ton):			84	kWh/yr	
Cooling Season kWh Energy Savings-Unoccupied (76 ton-hours * .99 kW/ton):			75	kWh/yr	
Controls Occupied Hours Per Year			3,650	Hrs/year	
Controls Unoccupied Hours Per Year			5,110	Hrs/year	
Fuel Energy Savings-Heating Season-Occupied (8 MMBtu / 75 %):			11	MMBtu	
Fuel Energy Savings-Heating Season-Unoccupied (11 MMBtu / 75 %):			15	MMBtu	
Cooling Season kWh Energy Cost Savings-Occupied (84 kWh/Yr x \$0.07410 per kWh):			\$ 6	per year	
Cooling Season kWh Energy Cost Savings-Unoccupied (75 kWh/Yr x \$0.07410 per kWh):			\$ 6	per year	
Fuel Energy Cost Savings-Heating Season-Occupied (11 MMBtu x \$7.51 per MMBtu):			\$ 79	per year	
Fuel Energy Cost Savings-Heating Season-Unoccupied (15 MMBtu x \$7.51 per MMBtu):			\$ 115	per year	
Total Savings Cost (\$6 kWh/yr + \$6 kWh/yr + \$79 Btu + \$115 Btu):			\$ 206	per year	
Building Insulation					
Cooling Season kWh Energy Savings-Occupied (ft ² x (U-Value - . U-Value) * 24 * 603 CDD / 12,000 Btu/ton) * (.99 kW/ton):			0	kWh/yr	
Cooling Season kWh Energy Savings-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 631 CDD / 12,000 Btu/ton) * (.99 kW/ton):			0	kWh/yr	
Fuel Energy Savings-Heating Season-Occupied (ft ² x (U-Value - . U-Value) * 24 * 2452 HDD / 1,000,000 Btu) / (75 %):			0	MMBtu	
Fuel Energy Savings-Heating Season-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 3719 HDD / 1,000,000 Btu) / (75 %):			0	MMBtu	
Cooling Season kWh Energy Cost Savings-Occupied (kWh/Yr x \$0.07410 per kWh):			\$ -	per year	
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):			\$ -	per year	
Fuel Energy Cost Savings-Heating Season-Occupied (MMBtu x \$7.51 per MMBtu):			\$ -	per year	
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):			\$ -	per year	
Total Savings Cost (\$0 kWh/yr + \$0 kWh/yr + \$0 Btu + \$0 Btu):			\$ -	per year	

Crack area Calculation		
Width	LE	ft ²
1/16	121	0.630
1/8	14	0.146
1/4		0.000
1/2		0.000
3/4		0.000
1		0.000
1 1/2		0.000
2		0.000
Penetrations		0.776

Constants and calculated values used in calculations:

Occupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
Unoccupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
ASHRAE Sensible Heat Coefficient	1.08	

These calculations are based on ASHRAE Fundamentals 2009, chapter 16, page 16.23, formula number 48 as shown below.



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Project Name: **Wernersville State Hospital**

ASHRAE Enthalpy Coefficient	4.5
Btu/ton	12,000 Btu/ton
Btu	1000000 Btu

ASHRAE TABLE 16.23, Table 4 Basic Model Stack Coefficient C_s

Story	Stack Coefficient C_s
1	0.01500
2	0.02990
3	0.04490
4	0.06283
5	0.07858
6	0.09433
7	0.11008
8	0.12583
9	0.14158
10	0.15733

ASHRAE TABLE 16.23, Table 5 Local Shelter Class:

- 1 No Obstructions or local shielding
- 2 Typical shelter for an isolated rural house
- 3 Typical shelter used by other buildings across the street from building under study
- 4 Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away
- 5 Typical shelter produced by building or other structures immediately adjacent

ASHRAE TABLE 16.23, Table 6 Basic Model Wind Coefficient C_w

# of Stories	Shelter Class 1	Shelter Class 2	Shelter Class 3	Shelter Class 4	Shelter Class 5	Values Used
1	0.0119	0.0092	0.0065	0.0039	0.0012	0.0039
2	0.0157	0.0121	0.0086	0.0051	0.0016	0.0051
3	0.0184	0.0143	0.0101	0.0060	0.0018	0.0060
4	0.0218	0.0170	0.0120	0.0071	0.0021	0.0071
5	0.0251	0.0195	0.0138	0.0082	0.0024	0.0082
6	0.0283	0.0221	0.0156	0.0092	0.0027	0.0092
7	0.0316	0.0246	0.0174	0.0103	0.0030	0.0103
8	0.0348	0.0272	0.0192	0.0113	0.0033	0.0113
9	0.0381	0.0297	0.0210	0.0124	0.0036	0.0124
10	0.0413	0.0323	0.0228	0.0134	0.0039	0.0134

Basic Model. The following calculations are based on the Sherman and Grimsrud (1980) model, which uses the effective air leakage area at 0.016 in. of water. This leakage area can be obtained from a whole-building pressurization test. Using effective air leakage area, the airflow rate from infiltration is calculated according to

$$Q = A_L \sqrt{C_s \Delta t + C_w U^2} \quad (48)$$

where

Q = airflow rate, cfm

A_L = effective air leakage area, in²

C_s = stack coefficient, cfm²/(in⁴·°F)

Δt = average indoor-outdoor temperature difference for time interval of calculation, °F

C_w = wind coefficient, cfm²/(in⁴·mph²)

U = average wind speed measured at local weather station for time interval of calculation, mph

Table 4 presents values of C_s for one-, two-, and three-story houses. The value of wind coefficient C_w depends on the local shelter class of the building (described in Table 5) and the building height. Table 6 presents values of C_w for one-, two-, and three-story houses in shelter classes 1 through 5. In calculating values in Tables 4 and 6, the following assumptions were made regarding input to the basic model:



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Project Name:

Wernersville State Hospital

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F

75.0000

Indoor Cooling Unoccupied Setpoint Calculations

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F



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Project Name:
Date of Report:
Type of Report:
Weather Data City/State:

Wernersville State Hospital
10/4/2021
Building Envelope Calculation
Harrisburg Intl AP, PA

Information provided by customer

Information provided by our company

Definitions:

ASHRAE Fundamentals 16.23-48 Applies $Q = A_L \cdot \sqrt{C_s \cdot \Delta t + C_w \cdot U^2}$

$Q_I = Q \cdot I$ = Infiltrated/Exfiltrated Air Flow Rate, Cfm

Q = Air Flow Rate, Cfm

A_L = Effective air leakage area, in²

C_s = Stack coefficient, cfm²/(in⁴*°F)

C_w = Wind Coefficient, cfm²/(in⁴* mph²)

Δt = Indoor - Outdoor temperature differential

U = Wind speed, mph

I = Infiltration/Exfiltration Factor

Inputs and Assumptions:

Hill Hall (31)		Wernersville State Hospital
Temperature Which Heating Begins	70 °F	Used to Establish Maximum Outdoor Temperature for Heating System Operation
Temperature Which Cooling Begins	75 °F	Used to Establish Minimum Outdoor Temperature for Cooling System Operation
Day Operation Begins (Sunday is Day 1)	1 Sunday	These Values Used to Establish Occupied Hours vs Unoccupied Hours
Day Operation Ends (Sunday is Day 1)	7 Saturday	
Hour Operation Begins (Hour 1 is Midnight to 1 AM)	6 Hour	
Hour Operation Ends (Hour 1 is Midnight to 1 AM)	15 Hour	
Directional Wind Infiltration/Exfiltration	70% per cent	
Occupied Cooling Temperature Setpoint	75 °F	Used for Occupied Cooling Enthalpy Calculations
Occupied Heating Temperature Setpoint	70 °F	Used for Occupied Heating ΔT Calculations
Unoccupied Cooling Indoor Temperature Setpoint	75 °F	Used for Unoccupied Cooling Enthalpy Calculations
Unoccupied Heating Indoor Temperature Setpoint	70 °F	Used for Unoccupied Heating ΔT Calculations
Cooling Plant Efficiency	0.992 kW/ton	
Heating Plant Efficiency	75% per cent	
Energy Cost \$/kWh	\$ 0.07410 per kWh	Electric
Fuel Energy Cost \$/MMBtu	\$ 7.51000 per MMBtu	Natural Gas
# of Floors in Building	2	
Local Shelter Class (see Table 5 below)	2 Typical shelter for an isolated rural house	
A_L = Effective Air Leakage Area from Survey, ft ²	5.18 ft ²	
Existing Insulation Area from Survey, ft ²		
Existing U-Value		
Proposed U-Value		



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Project Name: **Wernersville State Hospital**

Calculations:

Hill Hall (31)	Wernersville State Hospital	
Air Leakage from Survey, in ² = (144 * 5 ft ²):	746.25	in ²
Selected Basic Model Stack Coefficient C _s	0.02990	cfm ² /(in ⁴ x °F)
Selected Basic Model Wind Coefficient C _w	0.0121	cfm ² /(in ⁴ *mph ²)
Cooling Season Energy from Weather Table-Occupied Cooling ton-hours (9,160,121 Btu / 12,000 Btu/ton):	763	ton-hours
Cooling Season Energy from Weather Table-Unoccupied Cooling ton-hours (8,287,636 Btu / 12,000 Btu/ton):	691	ton-hours
Heating Season Energy from Weather Table-Occupied (63,927,885 Btu / 1,000,000 Btu):	64	MMBtu
Heating Season Energy from Weather Table-Unoccupied (90,072,361 Btu / 1,000,000 Btu):	90	MMBtu
ECM Energy and Cost Savings:		
Cooling Season kWh Energy Savings-Occupied (763 ton-hours * .99 kW/ton):	757	kWh/yr
Cooling Seasons kWh Energy Savings-Unoccupied (691 ton-hours * .99 kW/ton):	685	kWh/yr
Controls Occupied Hours Per Year	3,650	Hrs/year
Controls Unoccupied Hours Per Year	5,110	Hrs/year
Fuel Energy Savings-Heating Season-Occupied (64 MMBtu / 75 %):	85	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (90 MMBtu / 75 %):	120	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (757 kWh/Yr x \$0.07410 per kWh):	\$ 56	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (685 kWh/Yr x \$0.07410 per kWh):	\$ 51	per year
Fuel Energy Cost Savings-Heating Season-Occupied (85 MMBtu x \$7.51 per MMBtu):	\$ 640	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (120 MMBtu x \$7.51 per MMBtu):	\$ 902	per year
Total Savings Cost (\$56 kWh/yr + \$51 kWh/yr + \$640 Btu + \$902 Btu):	\$ 1,649	per year
Building Insulation		
Cooling Season kWh Energy Savings-Occupied (ft ² x (U-Value - . U-Value) * 24 * 603 CDD / 12,000 Btu/ton) * (.99 kW/ton):	0	kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 631 CDD / 12,000 Btu/ton) * (.99 kW/ton):	0	kWh/yr
Fuel Energy Savings-Heating Season-Occupied (ft ² x (U-Value - . U-Value) * 24 * 2452 HDD / 1,000,000 Btu) / (75 %):	0	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (ft ² x (U-Value - . U-Value) * 24 * 3719 HDD / 1,000,000 Btu) / (75 %):	0	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (kWh/Yr x \$0.07410 per kWh):	\$ -	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$ -	per year
Fuel Energy Cost Savings-Heating Season-Occupied (MMBtu x \$7.51 per MMBtu):	\$ -	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$ -	per year
Total Savings Cost (\$0 kWh/yr + \$0 kWh/yr + \$0 Btu + \$0 Btu):	\$ -	per year

Crack area Calculation		
Width	LE	ft ²
1/16	939	4.891
1/8	28	0.292
1/4		0.000
1/2		0.000
3/4		0.000
1		0.000
1 1/2		0.000
2		0.000
Penetrations		5.182
		5.182

Constants and calculated values used in calculations:

Occupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
Unoccupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
ASHRAE Sensible Heat Coefficient	1.08	

These calculations are based on ASHRAE Fundamentals 2009, chapter 16, page 16.23, formula number 48 as shown below.



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Project Name: **Wernersville State Hospital**

ASHRAE Enthalpy Coefficient	4.5
Btu/ton	12,000 Btu/ton
Btu	1000000 Btu

ASHRAE TABLE 16.23, Table 4 Basic Model Stack Coefficient C_s

Story	Stack Coefficient C_s
1	0.01500
2	0.02990
3	0.04490
4	0.06283
5	0.07858
6	0.09433
7	0.11008
8	0.12583
9	0.14158
10	0.15733

ASHRAE TABLE 16.23, Table 5 Local Shelter Class:

- 1 No Obstructions or local shielding
- 2 Typical shelter for an isolated rural house
- 3 Typical shelter used by other buildings across the street from building under study
- 4 Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away
- 5 Typical shelter produced by building or other structures immediately adjacent

ASHRAE TABLE 16.23, Table 6 Basic Model Wind Coefficient C_w

# of Stories	Shelter Class 1	Shelter Class 2	Shelter Class 3	Shelter Class 4	Shelter Class 5	Values Used
1	0.0119	0.0092	0.0065	0.0039	0.0012	0.0092
2	0.0157	0.0121	0.0086	0.0051	0.0016	0.0121
3	0.0184	0.0143	0.0101	0.0060	0.0018	0.0143
4	0.0218	0.0170	0.0120	0.0071	0.0021	0.0170
5	0.0251	0.0195	0.0138	0.0082	0.0024	0.0195
6	0.0283	0.0221	0.0156	0.0092	0.0027	0.0221
7	0.0316	0.0246	0.0174	0.0103	0.0030	0.0246
8	0.0348	0.0272	0.0192	0.0113	0.0033	0.0272
9	0.0381	0.0297	0.0210	0.0124	0.0036	0.0297
10	0.0413	0.0323	0.0228	0.0134	0.0039	0.0323

Basic Model. The following calculations are based on the Sherman and Grimsrud (1980) model, which uses the effective air leakage area at 0.016 in. of water. This leakage area can be obtained from a whole-building pressurization test. Using effective air leakage area, the airflow rate from infiltration is calculated according to

$$Q = A_L \sqrt{C_s \Delta t + C_w U^2} \quad (48)$$

where

Q = airflow rate, cfm

A_L = effective air leakage area, in²

C_s = stack coefficient, cfm²/(in⁴·°F)

Δt = average indoor-outdoor temperature difference for time interval of calculation, °F

C_w = wind coefficient, cfm²/(in⁴·mph²)

U = average wind speed measured at local weather station for time interval of calculation, mph

Table 4 presents values of C_s for one-, two-, and three-story houses. The value of wind coefficient C_w depends on the local shelter class of the building (described in Table 5) and the building height. Table 6 presents values of C_w for one-, two-, and three-story houses in shelter classes 1 through 5. In calculating values in Tables 4 and 6, the following assumptions were made regarding input to the basic model:

Indoor Cooling Occupied Setpoint Calculations



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Project Name:

Wernersville State Hospital

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F

75.0000

Indoor Cooling Unoccupied Setpoint Calculations

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
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Project Name:
Date of Report:
Type of Report:
Weather Data City/State:

Wernersville State Hospital
10/4/2021
Building Envelope Calculation
Harrisburg Intl AP, PA

Information provided by customer

Information provided by our company

Definitions:

ASHRAE Fundamentals 16.23-48 Applies $Q = A_L \cdot \sqrt{C_s \cdot \Delta t + C_w \cdot U^2}$

$Q_I = Q \cdot I$ = Infiltrated/Exfiltrated Air Flow Rate, Cfm

Q = Air Flow Rate, Cfm

A_L = Effective air leakage area, in²

C_s = Stack coefficient, cfm²/(in⁴*°F)

C_w = Wind Coefficient, cfm²/(in⁴* mph²)

Δt = Indoor - Outdoor temperature differential

U = Wind speed, mph

I = Infiltration/Exfiltration Factor

Inputs and Assumptions:

Building 34		Wernersville State Hospital
Temperature Which Heating Begins	70 °F	Used to Establish Maximum Outdoor Temperature for Heating System Operation
Temperature Which Cooling Begins	75 °F	Used to Establish Minimum Outdoor Temperature for Cooling System Operation
Day Operation Begins (Sunday is Day 1)	1 Sunday	These Values Used to Establish Occupied Hours vs Unoccupied Hours
Day Operation Ends (Sunday is Day 1)	7 Saturday	
Hour Operation Begins (Hour 1 is Midnight to 1 AM)	1 Hour	
Hour Operation Ends (Hour 1 is Midnight to 1 AM)	24 Hour	
Directional Wind Infiltration/Exfiltration	70% per cent	
Occupied Cooling Temperature Setpoint	75 °F	Used for Occupied Cooling Enthalpy Calculations
Occupied Heating Temperature Setpoint	70 °F	Used for Occupied Heating ΔT Calculations
Unoccupied Cooling Indoor Temperature Setpoint	75 °F	Used for Unoccupied Cooling Enthalpy Calculations
Unoccupied Heating Indoor Temperature Setpoint	70 °F	Used for Unoccupied Heating ΔT Calculations
Cooling Plant Efficiency	0.992 kW/ton	
Heating Plant Efficiency	75% per cent	
Energy Cost \$/kWh	\$ 0.07410 per kWh	Electric
Fuel Energy Cost \$/MMBtu	\$ 7.51000 per MMBtu	Natural Gas
# of Floors in Building	3	
Local Shelter Class (see Table 5 below)	2 Typical shelter for an isolated rural house	
A_L = Effective Air Leakage Area from Survey, ft ²	4.30 ft ²	
Existing Insulation Area from Survey, ft ²		
Existing U-Value		
Proposed U-Value		



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Project Name: **Wernersville State Hospital**

Calculations:

Building 34		Wernersville State Hospital	
Air Leakage from Survey, in ² = (144 * 4 ft ²):		618.75	in ²
Selected Basic Model Stack Coefficient C _s		0.04490	cfm ² /(in ⁴ x °F)
Selected Basic Model Wind Coefficient C _w		0.0143	cfm ² /(in ⁴ *mph ²)
Cooling Season Energy from Weather Table-Occupied Cooling ton-hours (16,195,575 Btu / 12,000 Btu/ton):		1,350	ton-hours
Cooling Season Energy from Weather Table-Unoccupied Cooling ton-hours (Btu / 12,000 Btu/ton):		-	ton-hours
Heating Season Energy from Weather Table-Occupied (147,935,726 Btu / 1,000,000 Btu):		148	MMBtu
Heating Season Energy from Weather Table-Unoccupied (Btu / 1,000,000 Btu):		-	MMBtu
ECM Energy and Cost Savings:			
Cooling Season kWh Energy Savings-Occupied (1,350 ton-hours * .99 kW/ton):		1,339	kWh/yr
Cooling Seasons kWh Energy Savings-Unoccupied (ton-hours * .99 kW/ton):		-	kWh/yr
Controls Occupied Hours Per Year		8,760	Hrs/year
Controls Unoccupied Hours Per Year		-	Hrs/year
Fuel Energy Savings-Heating Season-Occupied (148 MMBtu / 75 %):		197	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (MMBtu / 75 %):		-	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (1,339 kWh/Yr x \$0.07410 per kWh):	\$	99	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Occupied (197 MMBtu x \$7.51 per MMBtu):	\$	1,481	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Total Savings Cost (\$99 kWh/yr + \$0 kWh/yr + \$1481 Btu + \$0 Btu):	\$	1,581	per year
Building Insulation			
Cooling Season kWh Energy Savings-Occupied (ft ² x (U-Value - U-Value) * 24 * 1234 CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (ft ² x (U-Value - U-Value) * 24 * CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Fuel Energy Savings-Heating Season-Occupied (ft ² x (U-Value - U-Value) * 24 * 6171 HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (ft ² x (U-Value - U-Value) * 24 * HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Occupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Total Savings Cost (\$0 kWh/yr + \$0 kWh/yr + \$0 Btu + \$0 Btu):	\$	-	per year

Crack area Calculation		
Width	LF	ft ²
1/16	641	3.339
1/8	92	0.958
1/4		0.000
1/2		0.000
3/4		0.000
1		0.000
1 1/2		0.000
2		0.000
Penetrations		4.297
		4.297

Constants and calculated values used in calculations:

Occupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
Unoccupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
ASHRAE Sensible Heat Coefficient	1.08	

These calculations are based on ASHRAE Fundamentals 2009, chapter 16, page 16.23, formula number 48 as shown below.



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Project Name: **Wernersville State Hospital**

ASHRAE Enthalpy Coefficient	4.5
Btu/ton	12,000 Btu/ton
Btu	1000000 Btu

ASHRAE TABLE 16.23, Table 4 Basic Model Stack Coefficient C_s

Story	Stack Coefficient C_s
1	0.01500
2	0.02990
3	0.04490
4	0.06283
5	0.07858
6	0.09433
7	0.11008
8	0.12583
9	0.14158
10	0.15733

ASHRAE TABLE 16.23, Table 5 Local Shelter Class:

- 1 No Obstructions or local shielding
- 2 Typical shelter for an isolated rural house
- 3 Typical shelter used by other buildings across the street from building under study
- 4 Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away
- 5 Typical shelter produced by building or other structures immediately adjacent

ASHRAE TABLE 16.23, Table 6 Basic Model Wind Coefficient C_w

# of Stories	Shelter Class 1	Shelter Class 2	Shelter Class 3	Shelter Class 4	Shelter Class 5	Values Used
1	0.0119	0.0092	0.0065	0.0039	0.0012	0.0092
2	0.0157	0.0121	0.0086	0.0051	0.0016	0.0121
3	0.0184	0.0143	0.0101	0.0060	0.0018	0.0143
4	0.0218	0.0170	0.0120	0.0071	0.0021	0.0170
5	0.0251	0.0195	0.0138	0.0082	0.0024	0.0195
6	0.0283	0.0221	0.0156	0.0092	0.0027	0.0221
7	0.0316	0.0246	0.0174	0.0103	0.0030	0.0246
8	0.0348	0.0272	0.0192	0.0113	0.0033	0.0272
9	0.0381	0.0297	0.0210	0.0124	0.0036	0.0297
10	0.0413	0.0323	0.0228	0.0134	0.0039	0.0323

Basic Model. The following calculations are based on the Sherman and Grimsrud (1980) model, which uses the effective air leakage area at 0.016 in. of water. This leakage area can be obtained from a whole-building pressurization test. Using effective air leakage area, the airflow rate from infiltration is calculated according to

$$Q = A_L \sqrt{C_s \Delta t + C_w U^2} \quad (48)$$

where

Q = airflow rate, cfm

A_L = effective air leakage area, in²

C_s = stack coefficient, cfm²/(in⁴·°F)

Δt = average indoor-outdoor temperature difference for time interval of calculation, °F

C_w = wind coefficient, cfm²/(in⁴·mph²)

U = average wind speed measured at local weather station for time interval of calculation, mph

Table 4 presents values of C_s for one-, two-, and three-story houses. The value of wind coefficient C_w depends on the local shelter class of the building (described in Table 5) and the building height. Table 6 presents values of C_w for one-, two-, and three-story houses in shelter classes 1 through 5. In calculating values in Tables 4 and 6, the following assumptions were made regarding input to the basic model:



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Project Name:

Wernersville State Hospital

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F

75.0000

Indoor Cooling Unoccupied Setpoint Calculations

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F



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Project Name:
Date of Report:
Type of Report:
Weather Data City/State:

Wernersville State Hospital
10/4/2021
Building Envelope Calculation
Harrisburg Intl AP, PA

Information provided by customer

Information provided by our company

Definitions:

ASHRAE Fundamentals 16.23-48 Applies $Q = A_L \cdot \sqrt{C_s \cdot \Delta t + C_w \cdot U^2}$

$Q_I = Q \cdot I$ = Infiltrated/Exfiltrated Air Flow Rate, Cfm

Q = Air Flow Rate, Cfm

A_L = Effective air leakage area, in²

C_s = Stack coefficient, cfm²/(in⁴*°F)

C_w = Wind Coefficient, cfm²/(in⁴* mph²)

Δt = Indoor - Outdoor temperature differential

U = Wind speed, mph

I = Infiltration/Exfiltration Factor

Inputs and Assumptions:

Building 35		Wernersville State Hospital
Temperature Which Heating Begins	70 °F	Used to Establish Maximum Outdoor Temperature for Heating System Operation
Temperature Which Cooling Begins	75 °F	Used to Establish Minimum Outdoor Temperature for Cooling System Operation
Day Operation Begins (Sunday is Day 1)	1 Sunday	These Values Used to Establish Occupied Hours vs Unoccupied Hours
Day Operation Ends (Sunday is Day 1)	7 Saturday	
Hour Operation Begins (Hour 1 is Midnight to 1 AM)	1 Hour	
Hour Operation Ends (Hour 1 is Midnight to 1 AM)	24 Hour	
Directional Wind Infiltration/Exfiltration	70% per cent	
Occupied Cooling Temperature Setpoint	75 °F	Used for Occupied Cooling Enthalpy Calculations
Occupied Heating Temperature Setpoint	70 °F	Used for Occupied Heating ΔT Calculations
Unoccupied Cooling Indoor Temperature Setpoint	75 °F	Used for Unoccupied Cooling Enthalpy Calculations
Unoccupied Heating Indoor Temperature Setpoint	70 °F	Used for Unoccupied Heating ΔT Calculations
Cooling Plant Efficiency	0.992 kW/ton	
Heating Plant Efficiency	75% per cent	
Energy Cost \$/kWh	\$ 0.07410 per kWh	Electric
Fuel Energy Cost \$/MMBtu	\$ 7.51000 per MMBtu	Natural Gas
# of Floors in Building	3	
Local Shelter Class (see Table 5 below)	2 Typical shelter for an isolated rural house	
A_L = Effective Air Leakage Area from Survey, ft ²	4.30 ft ²	
Existing Insulation Area from Survey, ft ²		
Existing U-Value		
Proposed U-Value		



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Project Name: **Wernersville State Hospital**

Calculations:

Building 35		Wernersville State Hospital	
Air Leakage from Survey, in ² = (144 * 4 ft ²):		618.75	in ²
Selected Basic Model Stack Coefficient C _s		0.04490	cfm ² /(in ⁴ x °F)
Selected Basic Model Wind Coefficient C _w		0.0143	cfm ² /(in ⁴ *mph ²)
Cooling Season Energy from Weather Table-Occupied Cooling ton-hours (16,195,575 Btu / 12,000 Btu/ton):		1,350	ton-hours
Cooling Season Energy from Weather Table-Unoccupied Cooling ton-hours (Btu / 12,000 Btu/ton):		-	ton-hours
Heating Season Energy from Weather Table-Occupied (147,935,726 Btu / 1,000,000 Btu):		148	MMBtu
Heating Season Energy from Weather Table-Unoccupied (Btu / 1,000,000 Btu):		-	MMBtu
ECM Energy and Cost Savings:			
Cooling Season kWh Energy Savings-Occupied (1,350 ton-hours * .99 kW/ton):		1,339	kWh/yr
Cooling Seasons kWh Energy Savings-Unoccupied (ton-hours * .99 kW/ton):		-	kWh/yr
Controls Occupied Hours Per Year		8,760	Hrs/year
Controls Unoccupied Hours Per Year		-	Hrs/year
Fuel Energy Savings-Heating Season-Occupied (148 MMBtu / 75 %):		197	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (MMBtu / 75 %):		-	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (1,339 kWh/Yr x \$0.07410 per kWh):	\$	99	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Occupied (197 MMBtu x \$7.51 per MMBtu):	\$	1,481	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Total Savings Cost (\$99 kWh/yr + \$0 kWh/yr + \$1481 Btu + \$0 Btu):	\$	1,581	per year
Building Insulation			
Cooling Season kWh Energy Savings-Occupied (ft ² x (U-Value - U-Value) * 24 * 1234 CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (ft ² x (U-Value - U-Value) * 24 * CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Fuel Energy Savings-Heating Season-Occupied (ft ² x (U-Value - U-Value) * 24 * 6171 HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (ft ² x (U-Value - U-Value) * 24 * HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Occupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Total Savings Cost (\$0 kWh/yr + \$0 kWh/yr + \$0 Btu + \$0 Btu):	\$	-	per year

Crack area Calculation		
Width	LF	ft ²
1/16	641	3.339
1/8	92	0.958
1/4		0.000
1/2		0.000
3/4		0.000
1		0.000
1 1/2		0.000
2		0.000
Penetrations		4.297
		4.297

Constants and calculated values used in calculations:

Occupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
Unoccupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
ASHRAE Sensible Heat Coefficient	1.08	

These calculations are based on ASHRAE Fundamentals 2009, chapter 16, page 16.23, formula number 48 as shown below.



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ASHRAE Enthalpy Coefficient	4.5
Btu/ton	12,000 Btu/ton
Btu	1000000 Btu

ASHRAE TABLE 16.23, Table 4 Basic Model Stack Coefficient C_s

Story	Stack Coefficient C_s
1	0.01500
2	0.02990
3	0.04490
4	0.06283
5	0.07858
6	0.09433
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8	0.12583
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ASHRAE TABLE 16.23, Table 5 Local Shelter Class:

- 1 No Obstructions or local shielding
- 2 Typical shelter for an isolated rural house
- 3 Typical shelter used by other buildings across the street from building under study
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ASHRAE TABLE 16.23, Table 6 Basic Model Wind Coefficient C_w

# of Stories	Shelter Class 1	Shelter Class 2	Shelter Class 3	Shelter Class 4	Shelter Class 5	Values Used
1	0.0119	0.0092	0.0065	0.0039	0.0012	0.0092
2	0.0157	0.0121	0.0086	0.0051	0.0016	0.0121
3	0.0184	0.0143	0.0101	0.0060	0.0018	0.0143
4	0.0218	0.0170	0.0120	0.0071	0.0021	0.0170
5	0.0251	0.0195	0.0138	0.0082	0.0024	0.0195
6	0.0283	0.0221	0.0156	0.0092	0.0027	0.0221
7	0.0316	0.0246	0.0174	0.0103	0.0030	0.0246
8	0.0348	0.0272	0.0192	0.0113	0.0033	0.0272
9	0.0381	0.0297	0.0210	0.0124	0.0036	0.0297
10	0.0413	0.0323	0.0228	0.0134	0.0039	0.0323

Basic Model. The following calculations are based on the Sherman and Grimsrud (1980) model, which uses the effective air leakage area at 0.016 in. of water. This leakage area can be obtained from a whole-building pressurization test. Using effective air leakage area, the airflow rate from infiltration is calculated according to

$$Q = A_L \sqrt{C_s \Delta t + C_w U^2} \quad (48)$$

where

Q = airflow rate, cfm

A_L = effective air leakage area, in²

C_s = stack coefficient, cfm²/(in⁴·°F)

Δt = average indoor-outdoor temperature difference for time interval of calculation, °F

C_w = wind coefficient, cfm²/(in⁴·mph²)

U = average wind speed measured at local weather station for time interval of calculation, mph

Table 4 presents values of C_s for one-, two-, and three-story houses. The value of wind coefficient C_w depends on the local shelter class of the building (described in Table 5) and the building height. Table 6 presents values of C_w for one-, two-, and three-story houses in shelter classes 1 through 5. In calculating values in Tables 4 and 6, the following assumptions were made regarding input to the basic model:

Indoor Cooling Occupied Setpoint Calculations



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Project Name:		Wernersville State Hospital	
Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin
* All calculations assume TDB and TWB above 32 Deg F			

75.0000

Indoor Cooling Unoccupied Setpoint Calculations			
Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin
* All calculations assume TDB and TWB above 32 Deg F			



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Project Name:
Date of Report:
Type of Report:
Weather Data City/State:

Wernersville State Hospital
10/4/2021
Building Envelope Calculation
Harrisburg Intl AP, PA

Information provided by customer

Information provided by our company

Definitions:

ASHRAE Fundamentals 16.23-48 Applies $Q = A_L \cdot \sqrt{C_s \cdot \Delta t + C_w \cdot U^2}$

$Q_i = Q \cdot I$ = Infiltrated/Exfiltrated Air Flow Rate, Cfm

Q = Air Flow Rate, Cfm

A_L = Effective air leakage area, in²

C_s = Stack coefficient, cfm²/(in⁴*°F)

C_w = Wind Coefficient, cfm²/(in⁴* mph²)

Δt = Indoor - Outdoor temperature differential

U = Wind speed, mph

I = Infiltration/Exfiltration Factor

Inputs and Assumptions:

Building 37		Wernersville State Hospital
Temperature Which Heating Begins	70 °F	Used to Establish Maximum Outdoor Temperature for Heating System Operation
Temperature Which Cooling Begins	75 °F	Used to Establish Minimum Outdoor Temperature for Cooling System Operation
Day Operation Begins (Sunday is Day 1)	1 Sunday	These Values Used to Establish Occupied Hours vs Unoccupied Hours
Day Operation Ends (Sunday is Day 1)	7 Saturday	
Hour Operation Begins (Hour 1 is Midnight to 1 AM)	1 Hour	
Hour Operation Ends (Hour 1 is Midnight to 1 AM)	24 Hour	
Directional Wind Infiltration/Exfiltration	70% per cent	
Occupied Cooling Temperature Setpoint	75 °F	Used for Occupied Cooling Enthalpy Calculations
Occupied Heating Temperature Setpoint	70 °F	Used for Occupied Heating ΔT Calculations
Unoccupied Cooling Indoor Temperature Setpoint	75 °F	Used for Unoccupied Cooling Enthalpy Calculations
Unoccupied Heating Indoor Temperature Setpoint	70 °F	Used for Unoccupied Heating ΔT Calculations
Cooling Plant Efficiency	0.992 kW/ton	
Heating Plant Efficiency	75% per cent	
Energy Cost \$/kWh	\$ 0.07410 per kWh	Electric
Fuel Energy Cost \$/MMBtu	\$ 7.51000 per MMBtu	Natural Gas
# of Floors in Building	5	
Local Shelter Class (see Table 5 below)	3	Typical shelter used by other buildings across the street from building under study
A_L = Effective Air Leakage Area from Survey, ft ²	3.04 ft ²	
Existing Insulation Area from Survey, ft ²		
Existing U-Value		
Proposed U-Value		



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Project Name: **Wernersville State Hospital**

Calculations:

Building 37		Wernersville State Hospital	
Air Leakage from Survey, in ² = (144 * 3 ft ²):		437.25	in ²
Selected Basic Model Stack Coefficient C _s		0.07858	cfm ² /(in ⁴ x °F)
Selected Basic Model Wind Coefficient C _w		0.0138	cfm ² /(in ⁴ *mph ²)
Cooling Season Energy from Weather Table-Occupied Cooling ton-hours (12,348,263 Btu / 12,000 Btu/ton):		1,029	ton-hours
Cooling Season Energy from Weather Table-Unoccupied Cooling ton-hours (Btu / 12,000 Btu/ton):		-	ton-hours
Heating Season Energy from Weather Table-Occupied (123,337,198 Btu / 1,000,000 Btu):		123	MMBtu
Heating Season Energy from Weather Table-Unoccupied (Btu / 1,000,000 Btu):		-	MMBtu
ECM Energy and Cost Savings:			
Cooling Season kWh Energy Savings-Occupied (1,029 ton-hours * .99 kW/ton):		1,021	kWh/yr
Cooling Seasons kWh Energy Savings-Unoccupied (ton-hours * .99 kW/ton):		-	kWh/yr
Controls Occupied Hours Per Year		8,760	Hrs/year
Controls Unoccupied Hours Per Year		-	Hrs/year
Fuel Energy Savings-Heating Season-Occupied (123 MMBtu / 75 %):		164	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (MMBtu / 75 %):		-	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (1,021 kWh/Yr x \$0.07410 per kWh):	\$	76	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Occupied (164 MMBtu x \$7.51 per MMBtu):	\$	1,235	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Total Savings Cost (\$76 kWh/yr + \$0 kWh/yr + \$1235 Btu + \$0 Btu):	\$	1,311	per year
Building Insulation			
Cooling Season kWh Energy Savings-Occupied (ft ² x (U-Value - U-Value) * 24 * 1234 CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Cooling Season kWh Energy Savings-Unoccupied (ft ² x (U-Value - U-Value) * 24 * CDD / 12,000 Btu/ton) * (.99 kW/ton):		0	kWh/yr
Fuel Energy Savings-Heating Season-Occupied (ft ² x (U-Value - U-Value) * 24 * 6171 HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Fuel Energy Savings-Heating Season-Unoccupied (ft ² x (U-Value - U-Value) * 24 * HDD / 1,000,000 Btu) / (75 %):		0	MMBtu
Cooling Season kWh Energy Cost Savings-Occupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Cooling Season kWh Energy Cost Savings-Unoccupied (kWh/Yr x \$0.07410 per kWh):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Occupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Fuel Energy Cost Savings-Heating Season-Unoccupied (MMBtu x \$7.51 per MMBtu):	\$	-	per year
Total Savings Cost (\$0 kWh/yr + \$0 kWh/yr + \$0 Btu + \$0 Btu):	\$	-	per year

Crack area Calculation		
Width	LE	ft ²
1/16	437	2.276
1/8	73	0.760
1/4		0.000
1/2		0.000
3/4		0.000
1		0.000
1 1/2		0.000
2		0.000
Penetrations		3.036

Constants and calculated values used in calculations:

Occupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
Unoccupied Indoor Enthalpy at 75° F and 60% RH	30.220	Btu/lb (air)
ASHRAE Sensible Heat Coefficient	1.08	

These calculations are based on ASHRAE Fundamentals 2009, chapter 16, page 16.23, formula number 48 as shown below.



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Quarryville, PA 17566
Contact: Andrew Martin
Phone #: (717) 989-6909
Email: andymartin@irexcorp.com



Project Name: **Wernersville State Hospital**

ASHRAE Enthalpy Coefficient	4.5
Btu/ton	12,000 Btu/ton
Btu	1000000 Btu

ASHRAE TABLE 16.23, Table 4 Basic Model Stack Coefficient C_s

Story	Stack Coefficient C_s
1	0.01500
2	0.02990
3	0.04490
4	0.06283
5	0.07858
6	0.09433
7	0.11008
8	0.12583
9	0.14158
10	0.15733

ASHRAE TABLE 16.23, Table 5 Local Shelter Class:

- 1 No Obstructions or local shielding
- 2 Typical shelter for an isolated rural house
- 3 Typical shelter used by other buildings across the street from building under study
- 4 Typical shelter for urban buildings on larger lots where sheltering obstacles are more than one building height away
- 5 Typical shelter produced by building or other structures immediately adjacent

ASHRAE TABLE 16.23, Table 6 Basic Model Wind Coefficient C_w

# of Stories	Shelter Class 1	Shelter Class 2	Shelter Class 3	Shelter Class 4	Shelter Class 5	Values Used
1	0.0119	0.0092	0.0065	0.0039	0.0012	0.0065
2	0.0157	0.0121	0.0086	0.0051	0.0016	0.0086
3	0.0184	0.0143	0.0101	0.0060	0.0018	0.0101
4	0.0218	0.0170	0.0120	0.0071	0.0021	0.0120
5	0.0251	0.0195	0.0138	0.0082	0.0024	0.0138
6	0.0283	0.0221	0.0156	0.0092	0.0027	0.0156
7	0.0316	0.0246	0.0174	0.0103	0.0030	0.0174
8	0.0348	0.0272	0.0192	0.0113	0.0033	0.0192
9	0.0381	0.0297	0.0210	0.0124	0.0036	0.0210
10	0.0413	0.0323	0.0228	0.0134	0.0039	0.0228

Basic Model. The following calculations are based on the Sherman and Grimsrud (1980) model, which uses the effective air leakage area at 0.016 in. of water. This leakage area can be obtained from a whole-building pressurization test. Using effective air leakage area, the airflow rate from infiltration is calculated according to

$$Q = A_L \sqrt{C_s \Delta t + C_w U^2} \quad (48)$$

where

Q = airflow rate, cfm

A_L = effective air leakage area, in²

C_s = stack coefficient, cfm²/(in⁴·°F)

Δt = average indoor-outdoor temperature difference for time interval of calculation, °F

C_w = wind coefficient, cfm²/(in⁴·mph²)

U = average wind speed measured at local weather station for time interval of calculation, mph

Table 4 presents values of C_s for one-, two-, and three-story houses. The value of wind coefficient C_w depends on the local shelter class of the building (described in Table 5) and the building height. Table 6 presents values of C_w for one-, two-, and three-story houses in shelter classes 1 through 5. In calculating values in Tables 4 and 6, the following assumptions were made regarding input to the basic model:



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Project Name:

Wernersville State Hospital

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F

75.0000

Indoor Cooling Unoccupied Setpoint Calculations

Dry Bulb Temp	DB	75	Deg F
Relative Humidity	RH	60	%
Humidity Ratio	W	0.0112	lb v/lb dry air
Enthalpy	h	78.16	grains/lb dry air
Dew Point Temp	DP	30.220	BTH/lb dry air
Saturation Pressure	PW	60.24	Deg F
Saturation Pressure	PWS	0.2580	
	TDBR	0.4301	
		534.67	Rankin

* All calculations assume TDB and TWB above 32 Deg F

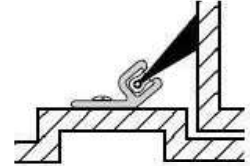
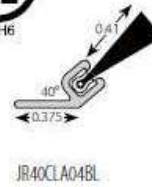
ECM #3

Weatherization of windows & doors

Equipment Information Sheets

Jamb Seals

Product Code	Brush Length (inches)	Holder Length (inches)	Holder Angle	Finish Color	Stock (feet)
JR40CLA04BL	0.41	0.375	40°	Clear Anodized	7, 8, 9, 10
J135CLA04BL	0.41	0.450	35°	Clear Anodized	7, 10
J135DUR04BL	0.41	0.450	35°	Duranodic	7, 10
J135GLD04BL	0.41	0.450	35°	Gold Anodized	7
J140CLA04BL	0.41	0.750	40°	Clear Anodized	7, 8, 10
J140DUR04BL	0.41	0.750	40°	Duranodic	7, 10



Astragals

Astragals are the weather-stripping material used to cover the gap between two doors.

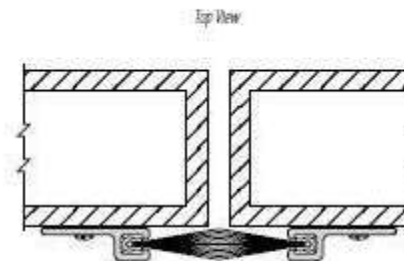
Sealeze Astra-Sweep Nylon Therm-L- Brush Astragal Seal

1,500,000 cycle testing ANSI 156.4, 1980

www.sealeze.com

Astragal Seal Kits

Kit Product Code	Brush Length (inches)	Door Height (feet)
A180CLA04BL14	0.41	7
A180DUR04BL14	0.41	7
A180GLD04BL14	0.41	7
C380CLA06BL14	0.59	7
C380DUR06BL14	0.59	7
C380GLD06BL14	0.59	7
A180CLA04BL16	0.41	8
A180DUR04BL16	0.41	8
A180GLD04BL16	0.41	8
C380CLA06BL16	0.59	8
C380DUR06BL16	0.59	8
C380GLD06BL16	0.59	8



Door Sweeps

The reference to DS is for the door sweep material, which is also a Commercial/ Industrial product. All weather-stripping materials shall have a mill finish, unless otherwise specified.

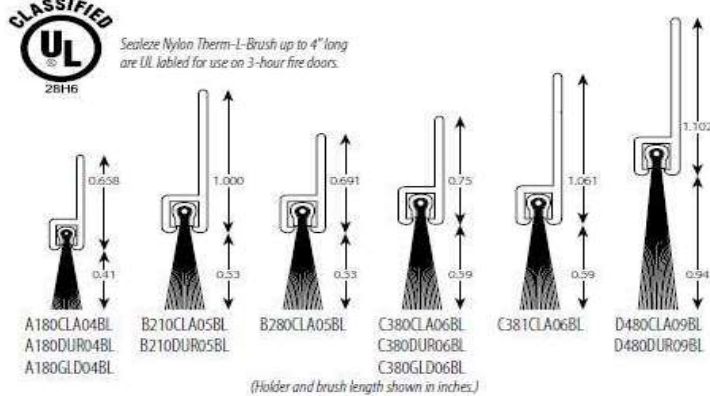
Sealeze Nylon Therm-L- Brush Door Sweep

1,500,000 cycle testing ANSI 156.4, 1980

www.sealeze.com

Door Sweeps

Brush weatherseals are ideal for sealing the irregular surfaces of thresholds at door bottoms, conforming to the surface while not impairing the door's movements. Select the right brush and holder, based on the size of the gap to be sealed and the desired appearance of the holder.



Product Code (inches)	Brush Length (inches)	Holder Length (inches)	Stock Length (feet)
A180CLA04BL	0.41	0.658	7, 8, 10
A180DUR04BL	0.41	0.658	7, 10
A180GLD04BL	0.41	0.658	12
B210CLA05BL	0.53	1.000	3, 7, 10
B210DUR05BL	0.53	1.000	10
B280CLA05BL	0.53	0.691	10
C380CLA06BL	0.59	0.750	3, 7, 10
C380DUR06BL	0.59	0.750	7, 10
C380GLD06BL	0.59	0.750	3, 8
C381CLA06BL	0.59	1.061	3, 7, 10
D480CLA09BL	0.94	1.102	3, 7, 8, 9, 10, 12
D480DUR09BL	0.94	1.102	8, 10

SEALANTS

Polyurethane Sealants:

We will be installing polyurethane sealant in all wall cracks, concrete cracks, mortar cracks, control joints, and exterior applications unless otherwise specified.

Polyurethanes are usually considered better than silicones for most common exterior building applications. We will be installing a polyurethane sealant that adheres to most common construction materials without primers, offers long service life under severe climate conditions, excellent shear resistance, exceptional elasticity, resists sagging and is non-toxic when cured. Polyurethane sealant becomes tack-free within eight hours and cures fully in about a week. It can be painted, but the paint will not expand or contract with the sealant and may crack or peel.

Type: One-component, ultra-low moisture curing, fast skinning, commercial grade sealant;

Compliance: Sealant shall meet or exceed requirements of these standards:

1. ASTM C920, Type S, Grade NS, Class 35, Use NT, M, A, and O.

DAP Premium Polyurethane Concrete & Masonry Sealant #18814

White Lightning Storm Blaster

<http://www.sherwin-williams.com>

Loxon SI

<http://www.sherwin-williams.com>



Silicone Sealants:

We will be installing silicone sealant for all silicone weather-strip application, for capping the exterior edges of any EPDM glazing gaskets, and for sealing joints between non-porous surfaces such as metal and glass unless otherwise specified.

Although silicones are often considered extremely durable, the bonding characteristics of most silicones are not as good as polyurethanes. We will install silicone sealant for adhering weather-strip when specified, for capping the exterior edges of any EPDM glazing gaskets, and for sealing joints between non-porous surfaces such as metal and glass.

Type: One-component, ultra-low modulus, neutral-cure silicone rubber sealant;

Compliance: Sealant shall meet or exceed requirements of these standards:

2. ASTM C920, Type S, Grade NS, Class 100/50, Use T, NT, G, M, A, and O.
3. GSA CID A-A-272A.
4. GSA CID A-A-1556.

Dow Corning 790 Silicone Building Sealant

<http://www.dowcorning.com>

GE SCS200 SilPruf Silicone Sealant and Adhesive

<http://www.siliconeforbuilding.com>

950ASiliconized Acrylic Latex Caulk

<http://www.sherwin-williams.com>

Polyurethane Spray Foam Sealant:

Dow FROTH-PAK™ Foam Sealant

<http://building.dow.com>

ECM #4

Boiler house fuel switch – coal to natural gas with oil backup

Savings Calculations

NORMALIZED DATA

MONTH	Sum of STEAM MLB	Sum of ELECT KWH	Sum of COGEN OPERATION (MLB)	Sum of COGEN OPERATION (KWH)	Sum of COGEN NG MCF	Sum of SUPPLIMENTAL HEAT MLB	Sum of BOILER NG MCF	Sum of PURCHASED KWH
01	9,437	424,938	-	-	-	9,437	12,583	424,938
02	7,939	396,609	-	-	-	7,939	10,585	396,609
03	6,414	427,226	-	-	-	6,414	8,552	427,226
04	4,683	448,718	-	-	-	4,683	6,244	448,718
05	3,323	524,683	-	-	-	3,323	4,431	524,683
06	2,720	650,624	-	-	-	2,720	3,627	650,624
07	2,619	815,800	-	-	-	2,619	3,492	815,800
08	2,685	744,285	-	-	-	2,685	3,580	744,285
09	2,903	605,441	-	-	-	2,903	3,871	605,441
10	4,767	443,151	-	-	-	4,767	6,356	443,151
11	6,238	427,832	-	-	-	6,238	8,317	427,832
12	7,702	425,350	-	-	-	7,702	10,269	425,350
Grand Total	61,430	6,334,657	-	-	-	61,430	81,907	6,334,657
EXISTING NON-NORMAL	61,646	6,042,606	REFRESH THE PIVOT TABLE AFTER MAKING INPUT CHANGES					
% OF EXISTING	100%	105%						

COMMODITY DATA

COMMODITY	STEAM MLB	% OF TOTAL	COST/MLB	COST/UNIT
COAL	42,851	70%	7.978	148.374
NAT GAS	17,991	29%	6.018	5.297
OIL	804	1%	15.984	1.920
TOTAL/WEIGHTED AVG	61,646	100%	7.510	
ELECT				0.074

	NG	COAL	OIL	ELECT
	MCF	TON	GAL	KWH
EXISTING	25,611	2,179	7,948	6,334,657
PROPOSED	81,907			6,334,657
SAVINGS	(56,295)	2,179	7,948	-
SAVINGS \$	\$ (298,203)	\$ 323,250	\$ 15,261	\$ -

UTILITY SAVINGS	40,309
COGEN MAINT	NA
SAVINGS TOTAL	40,309

GENERATOR

PERFORMANCE DATA

RATED POWER	1,000.00 KW
PARASITIC LOADS	50.00 KW
NET POWER	- KW
FUEL INPUT	11.43 MMBTU
USEFUL THERMAL	4.18 MMBTU
POWER TO HEAT RATIO	0.77 KW
ELECTRIC EFF	28% KW
THERMAL EFF	37% KW
OVERALL EFF	65% MMBTU

CAPITAL AND O&M COSTS

INSTALLED COST	2,500.00 \$/KWH
MAINT COST	0.015 \$/KWH

MODEL OUTPUTS

PEAK USAGE	- KW
AVERAGE USAGE	- KW
MIN USAGE	- KW
% OF TOTAL KWH	0%
% OF TOTAL MBH	0%

NEW PLANT EFF

75%

OLD PLANT EFF

70%

EXISTING NG BOILER

750.00 BHP

25,050.00 LB/HR

EXISTING PEAK

18,000.00 LB/HR

521.74 BHP

ECM #4

Boiler house fuel switch – coal to natural gas with oil backup

Equipment Information Sheets



CUSTOMIZED SOLUTIONS

Grundfos innovations Custom-Built for your needs

be
think
innovate

GRUNDFOS 

Custom solutions for industrial applications

Combining features to customize pumps

With expert assistance from our engineers, customers can choose among an unmatched range of designs, features, options, materials, and much more, combining them to create a tailor-made solution. Custom CR solutions add up to over a million possible configurations.

A solution for every need

Grundfos CR has the most extensive range on the market, but standard pump ranges can't match all conceivable applications. Grundfos customers needing a non-standard solution are able to pick and choose pump elements or "modules" to cover nearly any situation.

Our custom solutions engineering department works exclusively to custom design pumps for industry. Every day Grundfos customers order pumps that will handle:

- extreme temperatures
- extreme pressures
- aggressive/hazardous liquids
- vaporous liquids
- low NPSH level
- belt drive
- paints
- varnishes
- high viscosity liquids
- explosive liquids
- horizontal mounting

Cost-efficient custom solutions

Grundfos customized pumps are constructed specifically to your exact requirements. Working in close cooperation with you, our skilled specialists carefully analyze the situation to make sure the solution fully meets your expectations.

This does not mean every customized pump is designed from scratch at prohibitive cost. Grundfos customers can go right to the assembly stages. Custom designed pumps from Grundfos are the result of judicious selection from a range of high-quality elements, combined with great ease and speed to create ideal solutions at low costs.

If you do not find a suggestion to suit your particular problem in our brochure, simply contact Grundfos with your requirements. We will do everything we can to provide a solution.



We've got SOLUTIONS...

Motors for special applications

The motor is a crucial element of the final pump solution. Grundfos offers choices to ensure maximum performance for all customers.

Your many motor choices

The standard range of Grundfos motors will cover most application demands – and customized solutions are available for highly specific requirements such as:

- Special supply voltages
- Extreme operating conditions (temperature, humidity, atmosphere)
- Special motor protection
- Specific approvals
- Special motor design
- High motor efficiency

Full range of variants available

The table at right shows an overview of some of the most popular alternative motor variants and designs that Grundfos can supply. The table is by no means complete. A range of special designs and motor features is available — just contact Grundfos.

Table A

Motor Size HP	PH	Material Number
1	1	85700004X
	3	85600004X
1-1/2	1	85700005X
	3	85600005X
2	1	85700006X
	3	85600006X
3	1	84Z03251
	3	85600008X
5	1	85700012X
	3	85600012X
7-1/2	3	85600017X
10	3	85600022X
15	3	856000244
20	3	85600025X
25	3	85600026X
30	3	84Z03216



VARIANT

Different motor brand

Different position of motor

Explosion-proof motor

Different enclosure class

Anti-condensation heating (space heaters)

Integrated variable speed drive

Special supply voltage

Motor insulation class

Efficiency class

Oversized motor

Tropicalized windings

Wye/Delta starting

Test sheets

MIURA'S EX SERIES DUAL-FUEL ON-DEMAND STEAM BOILERS



*The new, BL Micro Controller
Boiler Control System*



*Miura Gas/Oil-Fired
EX Series
High Pressure Steam Boiler*



On-Demand Steam Solutions

MIURA'S GAS/OIL SERIES ON-DEMAND STEAM BOILERS SAVE 20% FUEL COSTS CONSERVE RESOURCES.

EX SERIES

Miura is known world-wide for our commitment to protecting the environment and our innovative and efficient boiler designs. Our EX Gas/Oil Series High Pressure Steam Boiler is the most versatile industrial steam boiler in the world. The EX design minimizes carryover and produces dry 99+% saturated steam in 5 minutes or less from a cold start. Faster start-up means less fuel used, greater savings, and more responsible use of precious natural resources.



- Dual fuel fired Natural Gas, Propane or #2 Fuel Oil
- High pressure options available (300 MAWP, 250 MAWP or 170 MAWP)
- Hot water boilers are available depending on models (refer to a Miura hot water boiler catalog for details)
- NOx rating is available as low as 30ppm depending on model

ADDITIONAL BENEFITS



Water to Steam in 5 minutes

Miura Boilers produce steam in 5 minutes using their exclusive “floating header” design, a revolutionary advance that results in our customers using substantially less gas and oil. On average our customers save 20% on fuel costs and equivalent CO₂ reductions. Given ever-increasing concern with energy costs & CO₂ emissions, forward-thinking organizations recognize the value that Miura’s technology can bring to their “triple bottom line”.

PROFITS

**Energy &
Emissions
Savings
20%**

Modular “MI System” offers enhanced design flexibility & energy management

Facilities with larger loads can employ Miura’s innovative “MI” (Multiple Installation) system to build an **On-Demand** steam plant customized to meet site-specific demand requirements. The MI System provides both the flexibility to build-to-

suit current steam loads within very tight tolerances while allowing ease of future expansion of system capacity. In addition, the multiple modular units enhance a facility’s energy management capability by providing higher efficiency during part-load / stand-by conditions via the MI System’s ability to **stage multiple units on/off in response to demand fluctuations.**



BL MICRO CONTROLLER BOILER CONTROL SYSTEM



The new BL Micro Controller Boiler Control System (left), the “brain” behind Miura’s enhanced energy management system, offers significant advancements including many new individual monitoring points – an increase of over 60% compared to our popular XJ1 Controller.

The BL Controller provides robust 24/7 boiler Monitoring, Measuring & Verification (MM&V) capabilities and enhances troubleshooting by identifying problems and suggesting solutions via an easy-to-read display that interfaces with Miura Online Maintenance® software. Information is accessible both on site and on-line. The BL Controller features simple, intuitive programming that is easy to set up, program and operate. When combined with our O&M training program, the easy-to-use interface provides your facility with an intelligent boiler system to optimize energy and personnel management for increased productivity, efficiency and a reduced environmental impact.

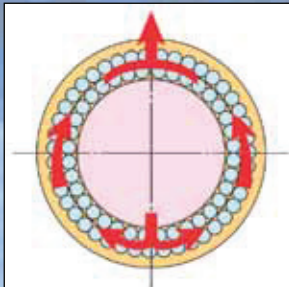
High Performance via Enhanced Control Capability

The BL Micro Controller Boiler Control System measures the performance of your boiler in an easy-to-read, user-friendly format:

- Greater control over steam pressure settings for steadier steam pressure.
- Allows for compensated adjustment of high and low fire scale thermocouple settings.
- Allows for compensated adjustment of automatic blowdown based upon Total Dissolved Solids (TDS) and/or blowdown rates.
- Easily interfaces with the Miura “Colormetry” unit to minimize scale formation due to water softener failure.

- Steam Pressure
- Flue Gas Temperature
- Feed Water Temperature
- Scale Monitor Temperature
- Overheat Monitor Temperature
- Flame Current
- Remaining Time to Blowdown
- Automatic Surface Blowdown Valve (On/Off)
- Water Conductivity
- 11-Point Boiler Management Data
- ... Plus many more

Omega Flow



Flow of combustion gas

Dual Fuel (Gas/Oil)

Miura’s EX Series boilers offer a unique advantage for users of both gas and oil. Now you can enjoy the flexibility of switching fuel, without the need for a separate burner, typically required by other manufacturers. Miura technology means outstanding innovation and ease of use.

Built-in Online Monitoring Miura’s MOM / ER “Dashboard” Systems

Efficiency is also measured in consistent, reliable performance and Miura offers a robust suite of “dashboard” monitoring systems integrated with its BL boiler controller to provide real-time, 24/7 monitoring capability. Miura’s On-line Maintenance®

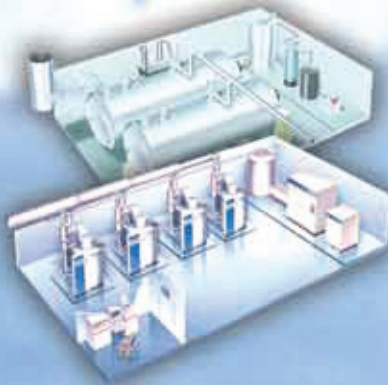


(“MOM”) system provides a unique “sliding window” feature that records cautions / alarms in real time + 4 seconds preceding them to provide enhanced troubleshooting capability. The “MOM” system is standard with every unit and Miura offers monitoring to subscribing customers with a free 12-month trial of the service. Miura offers its ER monitoring system to those facilities that wish to integrate boiler monitoring into their on-site control system rather than subscribe to an off-site monitoring service.

See Miura’s MOM / ER brochure for more information.

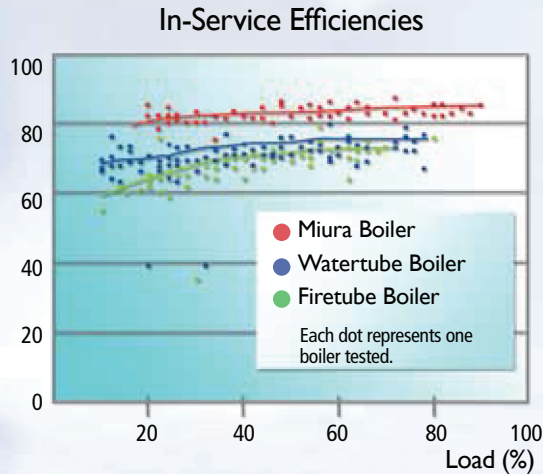
Reduced Boiler Footprint

Miura’s unique compact modular design utilizes a low volume pressure vessel offering output capacities comparable to much larger conventional boilers. The resulting reduced boiler footprint provides design flexibility, reduced construction costs and enhanced utilization of existing space.



SUPERIOR FUEL SAVINGS & CO₂ REDUCTIONS

Highest In-Service Efficiencies in the commercial / industrial boiler industry



Miura's innovative design promises to move boiler technology into the 21st century, providing energy savings averaging 20% over other boiler designs. At 10% to 40% fuel savings, Miura can save about \$200,000 per year in fuel for a typical 600 BHP steam system (assuming fuel cost of \$0.90 / them) with reduced CO₂ emissions of over 1,100 metric tons per year.

The chart (left) compares in-service efficiencies of Miura boilers with both conventional firetube and watertube boilers. Miura's low volume design results in optimal heat transfer with fuel-to-steam efficiencies of 85% at all load conditions. Although typical firetube designs can deliver up to 83% fuel-to-steam, studies comparing actual operating **In-Service Efficiencies** have shown Miura averages 10% to 40% in fuel savings over standard firetube designs.

Whereas conventional boiler efficiency is significantly reduced during part-load conditions, Miura offers consistently high operating efficiency at all load conditions.

HIGH IN-SERVICE EFFICIENCY

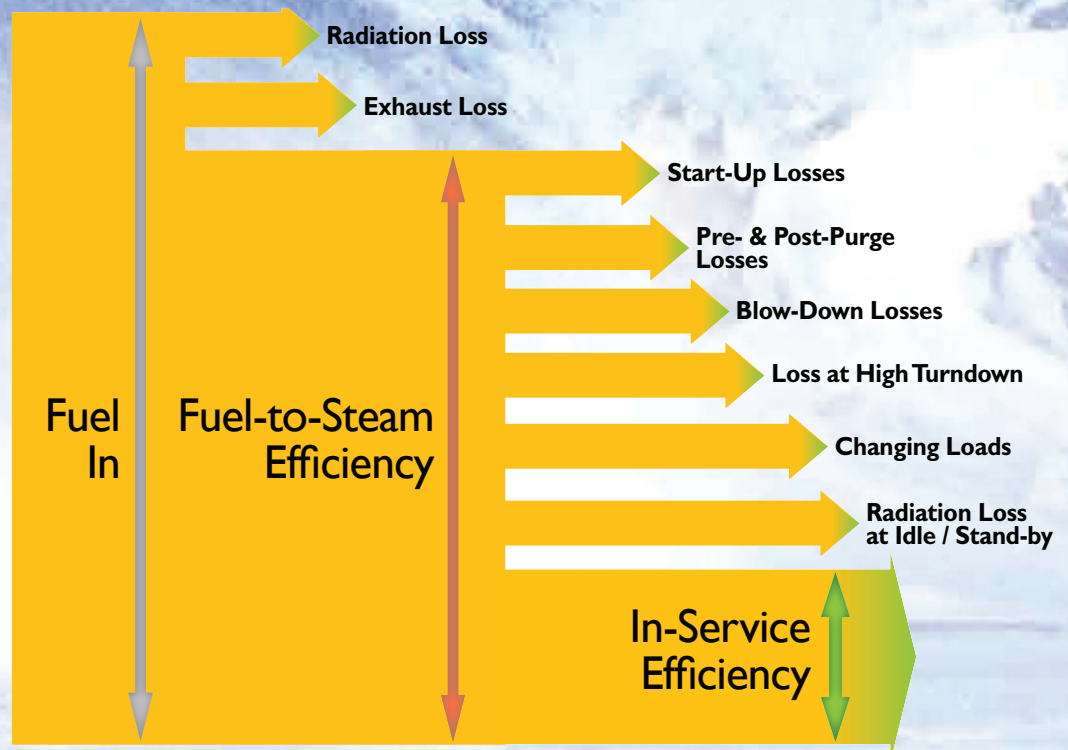
A Standard of Performance that sets Miura apart from other Steam Boiler manufacturers

In-Service Efficiency is a measure of overall boiler system performance, no matter your load profile. High In-Service Efficiency is the level of performance every Miura customer can expect. This standard of excellence has been established based on taking all factors of the boilers operation into account (see chart).

For a further explanation, let's review the common Definitions of Efficiency as related to the Boiler:

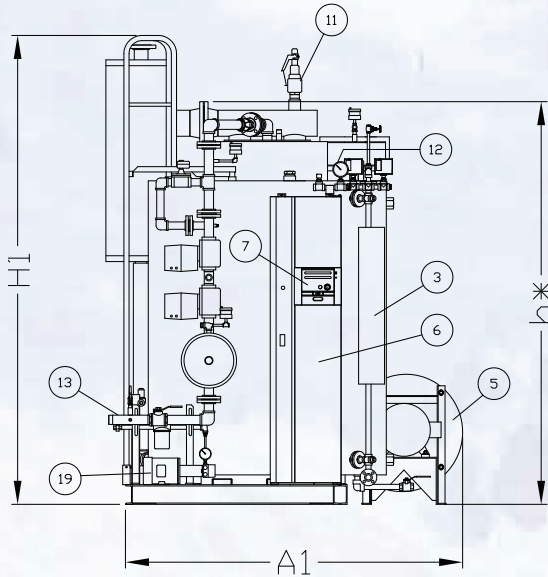
Miura has developed the term "In-Service Efficiency" to include Combustion Efficiency, Thermal Efficiency and all of the other energy losses from a boiler's operational cycle that contribute to operating efficiency including: radiation losses, blow-down losses, pre- and post-purge losses, and other losses that occur during changing loads, high turn-down, part-load and stand-by operation.

In-Service Efficiency is a more comprehensive measure of boiler efficiency. It better reflects a boiler's contribution to a facility's annual energy costs and is a more effective way to compare boiler performance. As a "bottom line" boiler performance indicator, In-Service Efficiency is the best measure of the true cost of steam.

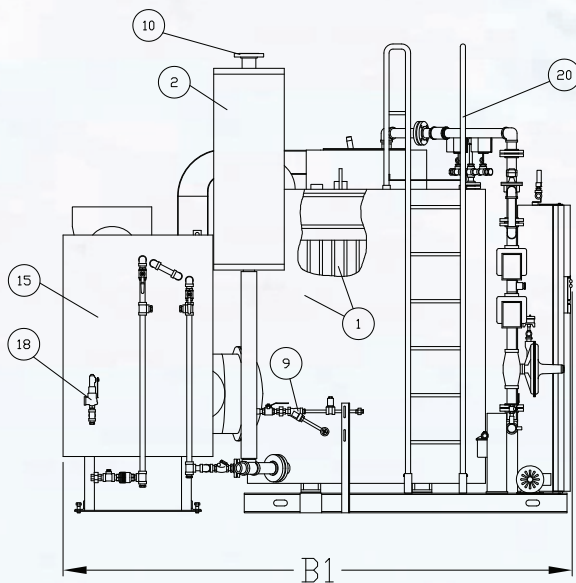


EX SERIES SPECIFICATIONS

FRONT VIEW



SIDE VIEW



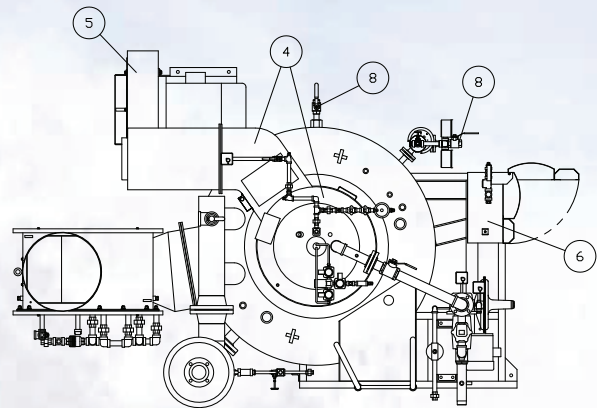
(Inches)

	A1	B1	H1	h*
EX-100 SGO	81	109	99	88
EX-150 SGO	91	130	120	103
EX-200 SGO	91	130	120	103
EX-250 SGO	94	136	146	120
EX-300 SGO**	106	142	157	131
EX-300 SGOF	114	140 ½	156 ½	130 ½

* Minimum height for Boiler Knock Down

** Drawing not applicable for EX-300 SGO-12 (see new EX-300 insert)

TOP VIEW



NO.	NAME OF PART
1	BOILER VESSEL
2	STEAM SEPARATOR
3	LIQUID VOLUME CONTROLLER
4	WIND BOX
5	FAN (AIR INLET)
6	ELECTRICAL CABINET
7	BL CONTROLLER
8	MANUAL BLOW DOWN
9	SURFACE BLOW DOWN
10	STEAM OUTLET
11	MAIN SAFETY VALVE
12	STEAM PRESSURE GAUGE
13	MAIN GAS INLET
14	FEED WATER INLET
15	ECONOMIZER
16	INVERTER BOX (OPTION)
17	LIFTING LUGS
18	ECON. RELIEF VALVE (OPTION)
19	OIL PUMP
20	LADDER

EX SERIES SPECIFICATIONS

NEW

ITEM	EX-100 SGO	EX-150 SGO	EX-200 SGO	EX-250 SGO	EXN-300 SGO (F) (*6,*7)	EX-300 SGO
Utilization Horsepower	100HP	150HP	200HP	250HP	300HP	300BHP
Maximum Pressure (*1)	170 PSIG MAWP, 150 PSIG Maximum Operating					
Equivalent Output (*2)	3,450 LB/HR	5,175 LB/HR	6,900 LB/HR	8,625 LB/HR	10,350 LB/HR	10,350 LB/HR
Heat Output	3,348,000 BTU/HR	5,022,000 BTU/HR	6,695,000 BTU/HR	8,369,000 BTU/HR	10,050,000 BTU/HR	10,040,000 BTU/HR
Efficiency (fuel to steam) (*3)	85% (80% without Economizer)					
Heating Surface Area	196 FT ²	323 FT ²	323 FT ²	389 FT ²	499 FT ²	515 FT ²
Operational Weight	7,250 LBS	11,500 LBS	11,500 LBS	17,850 LBS	18,000 LBS	18,000 LBS
Shipping Weight	7,500 LBS	7,700 LBS	8,340 LBS	8,990 LBS	11,010 LBS	11,010 LBS
Dimensions Given are Approximate						
Width	81 in.	91 in.	91 in.	94 in.	99 in.	99 in.
Length	109 in.	130 in.	130 in.	136 in.	142 in.	142 in.
Height	99 in.	120 in.	120 in.	146 in.	157 in.	166 in.
Combustion System	Proprietary Forced Draft, Step Fired Modulation Hi-Low-Off					
Ignition System	Electric Spark Ignited, Interrupted Gas Pilot					
Power Supply	208, 230, 460, or 575 V, 3 PHASE, 60 HZ					
Max. Electrical Consumption	13.35 KVA (14.2 for oil)	24.5 KVA (25.4 for oil)	27.5 KVA (28.5 for oil)	32.3 KVA (34.3 for oil)	35.4 KVA (37.3 for oil)	35.4 KVA (37.3 for oil)
Fuel Type (*4)	Natural Gas or Propane (3-5 PSIG), No. 2 oil					
Gas Consumption (*5)	3,920 SCFH	5,880 SCFH	7,850 SCFH	9,810 SCFH	11,780 SCFH	11,670 SCFH
No. 2 oil	28.1 GAL/Hr	42.2 GAL/Hr	56.3 GAL/Hr	68.7 GAL/Hr	84.5 GAL/Hr	82.3 GAL/Hr
Gas Supply Pressure	3-5 PSIG Natural (Gas or Propane)					
Main Steam Outlet	2 in.	3 in.	3 in.	4 in.	4 in.	4 in.
Safety Valve Outlet (*8)	One 2 in.	One 2 ½ in.			Two 2 ½ in.	Two 2 ½ in.
Main Water Inlet	1 in.	1 in.	1 in.	1 ¼ in.	1 ¼ in.	1 ½ in.
Fuel Gas Inlet	2 in.	2 in.	2 in.	2 ½ in.	2 ½ in.	2 ½ in.
Fuel Oil Inlet	¾ in.					
Automatic Surface Blowdown	One ¾ in.			Two ¾ in.		
Manual Blowdown	Two 1 in.				One 1 in. and One 1 ¼ in.	
Chimney Diameter (ID)	14 in.	20 in.	20 in.	20 in.	26 in.	20 in.
Flame Detector	Ultraviolet Flame Eye Sensor					
Pressure Control	Adjustable Pressure Transducer and Switch					
Liquid Volume Control	Electric Conductivity Type					
Overheat Protection	Low Water Cut Off & Thermocouple					

- Note: *1 Optional EXH-SGO Series at 250 PSIG MAWP, 225 PSIG maximum operating.
 *2 Equivalent output calculated from and at 212°F (100°C) feed water at 212°F (100°C) steam.
 *3 Thermal Efficiencies are based on high heating values of fuels at 68°F (20°C) feed water.
 *4 UL and c-UL approved for natural gas, propane, and No. 2 oil.
 *5 Gas consumption based on natural gas with high heating 1004 BTU/SCF.
 *6 Low water content option available to meet provincial water volume regulations in Canada.
 *7 Low NOx model (EXN300SGOF) available to meet 30ppm NOx.
 *8 Safety valve outlet size may change depending on the pressure setting.

Additional Notes:

- 1 All Miura steam boilers are fully packaged and test fired at factory.
- 2 Built to meet and exceed UL & ASME standards in U.S.A; c-UL & B-51 standards in Canada.
- 3 Flue gas recirculation is optional only with the Economizer

"S" - Economizer
 "G" - Natural Gas or Propane Fired
 "O" - #2 Oil Fired
 "F" - Flue Gas Recirculation
 "N" - Low NOx



View Miura's
Virtual Start-Up Video

USA: 1-888-309-5574 • Canada: 1-800-666-2182 • www.miuraboiler.com
 Worldwide Headquarters • Japan: +81-89-979-7123 • www.miuraz.co.jp
 Facilities located in: USA • Canada • Japan • China • Korea • Taiwan



Miura

Miura Steam is Engineered for Greater Efficiency,
Lower Costs, and Reduced Environmental Impact.

ECM #5
Evaluate condensate system

Savings Calculations



SUMMARY OF ESTIMATE

Effective Lineal Footage (sq)	INSULATED			NON-INSULATED		
	Total Insulated Cost per Year	Total Insulated KBtu Heat Loss per Year	Total Insulated KBtu Heat Savings per Year	Total Bare Fuel Cost per Year	Total Bare KBtu Heat Loss per Year	Total Bare KBtu Heat Savings per Year
5.6 High Pressure Steam	16.58	1,697E+03 \$	402.70	4,126E+04 \$	419.27	4,296E+04
7.8 Heating Hot Water	5.69	5,772E+02 \$	51.87	5,320E+03 \$	57.56	5,897E+03
7.0 Domestic Hot Water	4.62	4,760E+02 \$	34.65	3,549E+03 \$	39.27	4,025E+03
20.4 TOTAL Garage and Maintenance (13)	26.89	2,750E+03 \$	489.22	5,013E+04 \$	516.11	5,388E+04

ENVIRONMENTAL EMISSIONS									
Annual CO2 Emissions LBS Insulated	Annual CO2 Emissions LBS Bare	Annual CO2 Emission Reduction	Annual NOx Emissions LBS Insulated	Annual NOx Emissions LBS Bare	Annual NOx Emission Reduction	Annual CE Emissions LBS Insulated	Annual CE Emissions LBS Bare	Annual CE Emission Reduction	Annual CE Emission Reduction
264	6,674	6,411	1	13	13	-	-	-	-
90	916	827	0	2	2	-	-	-	-
74	625	551	0	1	1	-	-	-	-
427	8,216	7,789	1	16	16	-	-	-	-



SUMMARY OF ESTIMATE

Effective Lineal Footage (sq)	INSULATED			NON-INSULATED		
	Total Insulated Cost per Year	Total Insulated KBtu Heat Loss per Year	Total Insulated Cost Savings per Year	Total Bare Fuel Cost per Year	Total Bare KBtu Heat Loss per Year	
23.5	57.34	5.875E+03 \$	1,401.78	1,436E+05 \$	1,459.12	1,495E+05
2.0	2.30	2.360E+02 \$	23.58	2,416E+03 \$	25.88	2,652E+03
25.5	59.64	6.111E+03 \$	1,425.36	1,460E+05 \$	1,485.00	1,522E+05
TOTAL Building 33						

ENVIRONMENTAL EMISSIONS									
Annual CO2 Emissions LBS Insulated	Annual CO2 Emissions LBS Bare	Annual CO2 Emission Reduction	Annual NOx Emissions LBS Insulated	Annual NOx Emissions LBS Bare	Annual NOx Emission Reduction	Annual CE Emissions LBS Insulated	Annual CE Emissions LBS Bare	Annual CE Emission Reduction	
913	23,229	22,317	2	47	45	-	-	-	-
37	412	375	0	1	1	-	-	-	-
949	23,641	22,692	2	47	46	-	-	-	-



SUMMARY OF ESTIMATE

Effective Lineal Footage (sq)	INSULATED			NON-INSULATED		
	Total Insulated Cost per Year	Total Insulated KBtu Heat Loss per Year	Total Insulated Cost Savings per Year	Total Bare Fuel Cost per Year	Total Bare KBtu Heat Loss per Year	Total Bare Cost per Year
6.4	10.68	1.097E+03 \$	145.82	1.494E+04 \$	156.49	1.603E+04
39.5	52.70	5.413E+03 \$	648.07	6.639E+04 \$	700.77	7.180E+04
18.5	18.95	1.948E+03 \$	111.59	1.143E+04 \$	130.53	1.338E+04
31.1	28.76	2.942E+03 \$	268.52	2.752E+04 \$	297.28	3.046E+04
95.4	111.08	1.140E+04 \$	1,173.99	1.203E+05 \$	1,285.07	1.317E+05
TOTAL Building 34						

ENVIRONMENTAL EMISSIONS									
Annual CO2 Emissions LBS Insulated	Annual CO2 Emissions LBS Bare	Annual CO2 Emission Reduction	Annual NOx Emissions LBS Insulated	Annual NOx Emissions LBS Bare	Annual NOx Emission Reduction	Annual CE Emissions LBS Insulated	Annual CE Emissions LBS Bare	Annual CE Emission Reduction	
170	2,491	2,321	0	5	5	-	-	-	-
841	11,157	10,316	2	22	21	-	-	-	-
303	2,079	1,776	1	4	4	-	-	-	-
457	4,733	4,275	1	9	9	-	-	-	-
1,771	20,459	18,688	4	41	37	-	-	-	-



SUMMARY OF ESTIMATE

Effective Lineal Footage (sq)	INSULATED			NON-INSULATED		
	Total Insulated Cost per Year	Total Insulated KBtu Heat Loss per Year	Total Insulated KBtu Heat Savings per Year	Total Bare Fuel Cost per Year	Total Bare KBtu Heat Loss per Year	Total Bare KBtu Heat Savings per Year
21.9	\$ 25.84	2,650E+03 \$	396.39	4,062E+04 \$	422.23	4,327E+04
10.6	\$ 21.41	2,194E+03 \$	283.44	2,904E+04 \$	304.86	3,124E+04
45.9	\$ 44.04	4,522E+03 \$	394.93	4,046E+04 \$	438.97	4,498E+04
7.2	\$ 3.43	3,504E+02 \$	22.78	2,337E+03 \$	26.21	2,687E+03
85.6	\$ 94.73	9,716E+03 \$	1,097.54	1,125E+05 \$	1,192.27	1,222E+05
TOTAL Building 35						

ENVIRONMENTAL EMISSIONS									
Annual CO2 Emissions LBS Insulated	Annual CO2 Emissions LBS Bare	Annual CO2 Emission Reduction	Annual NOx Emissions LBS Insulated	Annual NOx Emissions LBS Bare	Annual NOx Emission Reduction	Annual CE Emissions LBS Insulated	Annual CE Emissions LBS Bare	Annual CE Emission Reduction	Annual CE Emission Reduction
412	6,724	6,312	1	13	13	-	-	-	-
341	4,854	4,513	1	10	9	-	-	-	-
703	6,989	6,286	1	14	13	-	-	-	-
54	418	363	0	1	1	-	-	-	-
1,510	18,984	17,474	3	38	35	-	-	-	-

ECM #5

Evaluate condensate system

Equipment Information Sheets

DATA SHEET

Earthwool® 1000° Pipe Insulation

with ECOSE® Technology



DESCRIPTION

Earthwool 1000° Pipe Insulation is a molded, one-piece insulation made from highly resilient, inorganic glass fibers bonded with ECOSE Technology.

APPLICATION

- Iron, copper, stainless steel, PVC, and CPVC piping
- Hot, cold, concealed and exposed piping systems operating at temperatures 0° F-1000° F (-18° C to 538° C)
- Additional weather protection is needed for outdoors use

SPECIFICATION COMPLIANCE

U.S.

- ASTM C547; Type I, Type IV
- ASTM C585
- ASTM C1136 (jacket); Type I, II, III, IV, VII, VIII, X
- NFPA 90A and 90B
- Conformity for fit Marine Equipment IMO 1408
- MIL-DTL-32585; Type 1, Form 4, Facing A and D
- USCG 164.109/4/1
- UL/ULC Classified

- ASTM C795, MIL-I-24244, NRC Reg. Guide 1.36 (Certification needs to be specified at time of order)

Canada

- CAN/ULC S102
- CGSB 51-GP-9M
- CGSB 51-GP-52M (jacket)
- CAN/CGSB-51.9 (obsolete, replaced by ASTM C547)

CONTRACTOR: _____

JOB: _____

DATE: _____

DOING MORE FOR THE WORLD WE LIVE IN.

Knauf Insulation products with ECOSE® Technology are made using our patented, bio-based binder - a smarter alternative to the phenol/formaldehyde (PF) binder traditionally used in fiberglass products. The bio-based binder holds our product together and gives the product its unique appearance.

All of our products are formaldehyde-free and made from sustainable resources, such as recycled glass and sand. And we're proud to be putting glass bottles back to work rather than into landfills. Our products are made with a minimum of 50% recycled glass—totaling an average of 26 million bottles each month.



TECHNICAL DATA

Property (Unit)	Test	Performance
Corrosiveness	ASTM C665	Does not accelerate corrosion of steel
Corrosion	ASTM C1617	Pass
Maximum Service Temperature	ASTM C411 + ASTM C447	1000° F (538° C)
Water Vapor Permeance	ASTM E96, Procedure A	0.01 perms or less
Water Vapor Sorption (by weight)	ASTM C1104	Less than 5%
Shrinkage	ASTM C356	Negligible
Mold Growth	ASTM C1338	Pass
Surface Burning Characteristics (flame spread/smoke developed)	ASTM E84, UL 723, CAN/ULC S102	UL/ULC Classified FHC 25/50

INDOOR AIR QUALITY

- UL Environment
 - GREENGUARD Certified
 - GREENGUARD Gold Certified
 - Validated to be Formaldehyde-Free
- Does not contain polybrominated diphenyl ethers (PBDE) such as: Penta-BDE, Octa-BDE or Deca-BDE
- EUCEB Certified
- IgCC Section 806.6 compliant

PRODUCT FORMS AND SIZES

- Produced in 3' (914 mm) sections
- For iron pipe ½" – 24" (15 mm – 610 mm) nominal pipe size
- For copper tube ⅝" – 6⅞" (16 mm – 156 mm)
- All insulation inner and outer diameters comply with ASTM C585.

- Wall thicknesses from ½" to 6" (13 mm to 152 mm) in single layer for most sizes
- With or without a white, factory-applied jacket, ASJ+ (all-service jacket) is composed of aluminum foil, reinforced with a glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.
- A matching ASJ+ butt strip is supplied for each section
- The longitudinal lap of the jacket has the SSL+ self-sealing lap that creates a strong and lasting bond

Packaging

- Four carton sizes for easy ordering, inventory tracking and storage
- Reinforced carton handles for strength and easy lifting
- Bar-coded cartons for accurate shipments and tracking
- Full product range stocked at distributors for fast availability

THERMAL CONDUCTIVITY | ASTM C335

Mean Temperature	k	k (SI)
75° F (24° C)	0.23	0.033
100° F (38° C)	0.24	0.035
200° F (93° C)	0.28	0.040
300° F (149° C)	0.34	0.049
400° F (204° C)	0.42	0.061
500° F (260° C)	0.51	0.074
600° F (316° C)	0.62	0.089

ASHRAE 90.1-2016 REQUIREMENTS

MINIMUM PIPE INSULATION THICKNESS								
Fluid Operating Temperature Range and Usage	Insulation Conductivity		Nominal Pipe or Tube Size					
	Conductivity Range BTU-in./(hr · ft² · °F)	Mean Temperature Rating	<1"	1"-<1½"	1½"-<4"	4"-<8"	≥8"	
Heating and Hot Water Systems (Steam, Steam Condensate, Hot-Water Heating and Domestic Water Systems) a, b, c, d								
Above 350° F	0.32–0.34	250° F	4½"	5"	5"	5"	5"	
251–350° F	0.29–0.31	200° F	3"	4"	4½"	4½"	4½"	
201–250° F	0.27–0.30	150° F	2½"	2½"	2½"	3"	3"	
141–200° F	0.25–0.29	125° F	1½"	1½"	2"	2"	2"	
105–140° F	0.22–0.28	100° F	1"	1"	1½"	1½"	1½"	
Cooling Systems (Chilled Water, Brine, Refrigerant) a, b, c, d								
40–60° F	0.21–0.27	75° F	½"	½"	1"	1"	1"	
Below 40° F	0.20–0.26	50° F	½"	1"	1"	1"	1½"	

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r \{ (1 + t/r)^{K/k} - 1 \}$, where T=minimum insulation thickness (in.), r=actual outside radius of pipe (in.), t=insulation thickness listed in this table for applicable fluid temperature and pipe size, K=conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu · in.(h · ft² · °F)); and k=the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. These thicknesses are based on energy efficiency considerations only.

c. For piping smaller than 1½" and located in partitions within conditioned spaces, reduction of these thicknesses by 1" shall be permitted (before thickness adjustment required in footnote a) but not to thicknesses below 1". These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

PRECAUTIONS

Hot Pipe

- May be installed while the system is in operation, at all temperatures up to 1000° F (538° C).
- Knauf Insulation recommends, for insulation thicknesses greater than 6" (152 mm), the temperature must be increased from 500° F (260° C) to maximum temperature at a rate not exceeding 100° F (37.8° C) per hour.
- During initial heat-up to operating temperatures above 350° F (177° C), a slight odor and some smoke may be given off as a portion of the bonding material used in the insulation begins to undergo a controlled decomposition.
- If natural convection is not adequate in confined areas, forced ventilation should be provided in order to protect against any harmful fumes and vapors that might be generated.
- Care must also be taken when using sealants, solvents or flammable adhesive during installation.
- A maximum of 6" (152 mm) wall thickness is recommended.

Cold Pipe

- Use a continuous vapor retarder on piping operating below ambient temperatures.
- Seal all joints, surfaces, seams and fittings to prevent condensation.
- On below freezing applications, and in high-abuse areas, the ASJ+ jacket shall be protected with a PVC vapor retarding outer jacket. In addition, exposed ends of insulation shall be sealed with vapor barrier mastic installed per the mastic manufacturer's instructions. Vapor seals at butt joints shall be applied at 12' to 21' intervals; at the Engineer's discretion and at each fitting to isolate any water incursion.
- On chilled water systems operating in high humidity conditions, it is recommended that the same guidelines be followed as listed above for below freezing applications.
- Exterior hanger supports are recommended.

Outside Application

- Do not expose pipe insulation to weather. It must be covered with appropriate jacketing, mastic or vapor retardant coatings.
- All exposed surfaces must be protected. Proto® Indoor/Outdoor PVC Jacketing is recommended. See Knauf Insulation Guide Specifications for recommended PVC jacketing application guidelines.
- Apply jacketing, mastics or vapor retardant adhesives per manufacturer's instructions.
- For metallic jackets, factory-applied moisture retarders are recommended.

ASJ+ SSL+

- Keep adhesive and contact surfaces free from dirt and water. Seal immediately once adhesive is exposed.

- Apply when ambient and insulation temperatures are between 20° F and 130° F (-6.7° C and 54° C).
- If stored below 20° F or above 130° F, allow insulation cartons to stand within recommended temperature range for 24 hours prior to application.
- Do not store product below -20° F (-29° C) or above 150° F (66° C).
- When using Knauf Insulation's SSL+ Advanced Closure System, make sure the longitudinal and circumferential joints are properly sealed by rubbing the closure firmly with a squeegee. Use of staples is not recommended.
- When using Earthwool® 1000° pipe insulation, the surface temperature of the ASJ+ facing should not exceed 150° F (66° C).

Fittings and Hangers

- Use Proto 25/50 Rated (ASTM E84) PVC Fitting Covers, applying PVC fittings per Proto's Data Sheet.
- Fittings should be insulated to same thickness as the adjoining insulation.
- Apply fittings per manufacturer's instructions.
- When required by specification, a hard insert of sufficient length should be used to avoid compression of the insulation.

APPLICATION GUIDELINES

Storage

- Protect insulation from water damage or other abuse, welding sparks and open flame.
- Cartons are not designed for outside storage.

Preparation

- Apply only on clean, dry surfaces
- Pipe or vessel should be tested and released before insulation is applied.

General Guidelines

- All sections should be firmly butted.
- Seal circumferential joint with a minimum 3" (76 mm) wide butt strip.
- Jackets, coating and adhesives should have a comparable F.H.C. rating.
- ASJ+ may be painted. As with traditional ASJ, Knauf Insulation does not encourage the painting of ASJ+ because the application of any paint may change the surface burning characteristics and will void the UL Classification and Knauf Insulation Limited Warranty.

Insulation Limited Warranty

- Where painting is necessary, use common water, oil, or solvent-based paints. All paints should be tested for compatibility and adhesion before use.
- All piping should have continuous insulation.
- Position longitudinal lap downward to avoid dirt and moisture infiltration.
- Do not expose pipe insulation to excessive vibration or physical abuse.
- Faced insulation should not have a facing temperature above 150° F (66° C).

SSL+ Installation Instructions:

- To install SSL+, first remove the kraft release liner to expose adhesive.
- Carefully align the jacketing. Starting in the center of the insulation section, begin initial SSL+ tack using pressure in the direction of the overlap. Again, starting in the center of the insulation section, with a plastic squeegee begin to apply firm pressure to the bonded lap area swiping from the center of the insulation section toward each end.
- **Note:** After initial SSL+ adhesive tack, it is critical that the closure is not re-opened and repositioned on the facing. Doing so will delaminate the jacket and adhesive, diminishing the bond strength.

Butt Strip Installation Instructions:

- To install Butt Strips, remove the kraft release liner by

separating the butt strip from the kraft using the convenient, easy release kiss cut.

- Simply wrap the butt strip, centered around the joint, and apply firm pressure with a squeegee.
- **Note:** After initial Butt Strip adhesive tack, it is critical that the closure is not re-opened and repositioned on the facing. Doing so will weaken the adhesive and diminish bond strength.

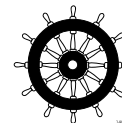
Recommended Thicknesses (ASHRAE 90.1-2016)

The minimum thicknesses are based on ASHRAE 90.1-2016 standards and do not necessarily represent the Economic Thickness of Insulation or the thickness required for proper condensation control. Rather, they serve as minimum recommendations for commercial applications. For recommended Economic Thickness, install according to Knauf Insulation or NAIMA 3E Plus programs or as specified.

FIBERGLASS AND MOLD

Fiberglass insulation will not sustain mold growth. However, mold can grow on almost any material when it becomes wet and contaminated. Carefully inspect any insulation that has been exposed to water. If it shows any sign of mold it must be discarded. If the material is wet but shows no evidence of mold, it should be dried rapidly and thoroughly. If it shows signs of facing degradation from wetting, it should be replaced.

CERTIFICATIONS



Check with your Knauf Insulation Territory Manager to ensure information is current.

The chemical and physical properties of this product represent average values determined in accordance with accepted test methods. The data is subject to normal manufacturing variations. The data is supplied as a technical service and is subject to change without notice. References to numerical flame spread ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions.

This product is covered by one or more U.S. and/or other patents.
See patent www.knaufnorthamerica.com/patents

Visit knaufnorthamerica.com to learn more.

KNAUF INSULATION, INC.

One Knauf Drive
Shelbyville, IN 46176

Technical Support

(317) 398-4434 ext. 8727
info.us@knaufinsulation.com

ECM #6

Evaluate smaller or select buildings to be disconnected and decentralized from the central heating plant

Savings Calculations

**ECM-6 - Decentralized Option
NORMALIZED DATA**

MONTH	Sum of STEAM MLB	Sum of ELECT KWH	Sum of COGEN OPERATION (MLB)	Sum of COGEN OPERATION (KWH)	Sum of COGEN NG MCF	Sum of SUPPLIMENTAL HEAT MLB	Sum of BOILER NG MCF	Sum of PURCHASED KWH
01	4,907	424,938	-	-	-	4,907	6,543	424,938
02	4,128	396,609	-	-	-	4,128	5,504	396,609
03	3,335	427,226	-	-	-	3,335	4,447	427,226
04	2,435	448,718	-	-	-	2,435	3,247	448,718
05	1,728	524,683	-	-	-	1,728	2,304	524,683
06	1,414	650,624	-	-	-	1,414	1,886	650,624
07	1,362	815,800	-	-	-	1,362	1,816	815,800
08	1,396	744,285	-	-	-	1,396	1,861	744,285
09	1,510	605,441	-	-	-	1,510	2,013	605,441
10	2,479	443,151	-	-	-	2,479	3,305	443,151
11	3,244	427,832	-	-	-	3,244	4,325	427,832
12	4,005	425,350	-	-	-	4,005	5,340	425,350
Grand Total	31,943	6,334,657	-	-	-	31,943	42,591	6,334,657
EXISTING NON-NORMAL	61,646	6,042,606	REFRESH THE PIVOT TABLE AFTER MAKING INPUT CHANGES					
% OF EXISTING	52%	105%	New central Plant After Decentralization					

COMMODITY DATA

COMMODITY	STEAM MLB	% OF TOTAL	COST/MLB	COST/UNIT
COAL	42,851	70%	7.978	148.374
NAT GAS	17,991	29%	6.018	5.297
OIL	804	1%	15.984	1.920
TOTAL/WEIGHTED AVG	61,646	100%	7.510	
ELECT				0.074

Annual HDD	4,847	hours
Current design steam load for 3 buildings	8,603	Lbs/hr
Estimated annual steam usage, for 3 buildings	33,359	MLb/yr
Future design hot water load, al 3 buildings	5,694	MBH
Estimated annual gas usage, for 3 buildings	30,666	MCF/yr
Estimated electric usage, including kitchen	175,200	kWH/yr

	NG	COAL	OIL	ELECT
	MCF	TON	GAL	KWH
EXISTING	25,611	2,179	7,948	6,334,657
PROPOSED	81,907			6,334,657
SAVINGS	(56,295)	2,179	7,948	-

	Decentralization Option			
	NG	COAL	OIL	ELECT
	MCF	TON	GAL	KWH
EXISTING	25,611	2,179	7,948	6,334,657
PROPOSED	73,257			6,411,122
SAVINGS	(47,646)	2,179	7,948	(76,465)

ECM #6

Evaluate smaller or select buildings to be disconnected and decentralized from the central heating plant

Equipment Information Sheets

CREST[®]

CONDENSING BOILER

HIGH EFFICIENCY
COMMERCIAL BOILERS

12 MODELS FROM 750,000 TO
6.0 MILLION BTU/HR

UP TO 96.2% THERMAL EFFICIENCY

UP TO 25:1 TURNDOWN RATIO

 **SMART TOUCH**[™]
OPERATING CONTROL

 **CONXUS**[®]
REMOTE CONNECT

NOW AVAILABLE WITH
REALTIME O₂ FEEDBACK[™]



RIDE THE LOCHINVAR WAVE[™]

Registered under U.S. Patent #9,746,176

DESIGNED ★ ENGINEERED ★ ASSEMBLED

USA

 **Lochinvar**[®]

NO ONE BRINGS IT ALL TOGETHER LIKE LOCHINVAR

Lochinvar is the industry leader that other leading companies call upon for the most advanced and efficient water heating products in the world. For that reason, Lochinvar is trusted to go beyond the call of duty to find a solution for every project, no matter the size. You will not find a water heating company that works harder or cares more.

That's why no one brings it all together quite like Lochinvar.

A HISTORY OF INNOVATION

For nearly 80 years, Lochinvar, an American company, has been a leader of innovation and high-efficiency water heating. Through Lochinvar's pride in leadership and commitment to excellence, the company has continually improved year after year.

Today, Lochinvar touts the broadest line of high-efficiency water heating solutions, a world-class research & development department, comprehensive service with every sale and industry-leading training through Lochinvar University.

ALWAYS LEADING THE CHARGE

Introduced in 2011, the CREST® was a breakthrough product for Lochinvar. With five sizes ranging from 1.5 to 3.5 million BTU/hr and boasting a 92% thermal efficiency the CREST led the way for Lochinvar in the commercial condensing boiler industry.

A unique combustion system featuring 2 fans, 2 gas valves, and a dual chamber burner allowed the CREST to maximize turndown unlike any other product. The Wave fire tube, designed and engineered at Lochinvar, delivered robust heat transfer and set itself apart from the competition.

In 2015, the product line was enhanced by expanding the product offering down to 750,000 BTU/hr and up to 5 million BTU/hr. Along with that a new combustion system was introduced that allowed greater flexibility and more robust operation. In 2016, the 6 million BTU/hr input model was introduced making this product line broader in its capability.

Now the entire model line features a more streamline combustion system along with a greater thermal efficiency of up to 96.2%. Combined with the standard offering of CON-X-US® the CREST brings the best tools together in one product. Complete control from anywhere, installation flexibility, high turndown, and excellent serviceability are what set the CREST above the rest.

2011-2012

» 1.5 MILLION -
5 MILLION RELEASED

2015

» ENHANCED EFFICIENCY
» NEW MODELS
» NEW COMBUSTION
TECHNOLOGY
» 96.2% EFFICIENCY
ON MODELS FROM
750,000-2 MILLION BTU

2016

» 6 MILLION RELEASED

2018

» OUTDOOR MODEL
RELEASED
» NEW COMBUSTION
TECHNOLOGY
» 96% EFFICIENCY
ON MODELS FROM
2.5-6.0 MILLION BTU

CREST[®]

CONDENSING BOILER

RIDE THE LOCHINVAR WAVE[™]

UP TO 6.0 MILLION BTU & 96.2% EFFICIENCY

With the exclusive wave fire-tube design, advancements in Lochinvar combustion technology and the SMART TOUCH[™] control with CON-X-US, CREST changed how the industry thinks about fire-tube boilers. Now you have the opportunity to use all of these features in sizes ranging from 750,000 to 6.0 million BTU/hr and delivering up to 96.2% thermal efficiency.

HEAT ENERGY AND COMBUSTION
PRODUCTS FLOW DOWNWARD INTO
FIRE TUBES FROM THE BURNER

ENGINEERED HEAT
EXCHANGER FOR OPTIMUM
HEAT TRANSFER

HEATED WATER FLOWS UP AND OUT
WITH MINIMAL PRESSURE DROP

*NON-METALLIC PVC
VENTING FLEXIBILITY

FLUE OUTLET AND CONDENSATE
DRAIN AT THE BOTTOM

* 5.0 - 6.0 Stainless Steel Vent Only



THE CREST COMBUSTION SYSTEM

CREST boilers are equipped with a top-mounted micro-metal fiber burner, engineered specifically for fire-tube technology. The system is designed to ensure smooth, quiet modulating combustion with up to 25:1 turndown. A FBN-2001 fires at its maximum 1,999,999 Btu/hr rate when the heat load is highest, and then gradually turns down to as low as 4% (80,000 Btu/hr) as load decreases. A modulating system runs smoothly and efficiently, without frequent on/off cycling. When the system is zoned, CREST's high turndown works to match the actual system demand. In return, CREST reduces the customer's fuel bill and provides better comfort by load-matching the heat loss of the system.

REDUCE INSTALLATION COST WITH VARIABLE FLOW TECHNOLOGY

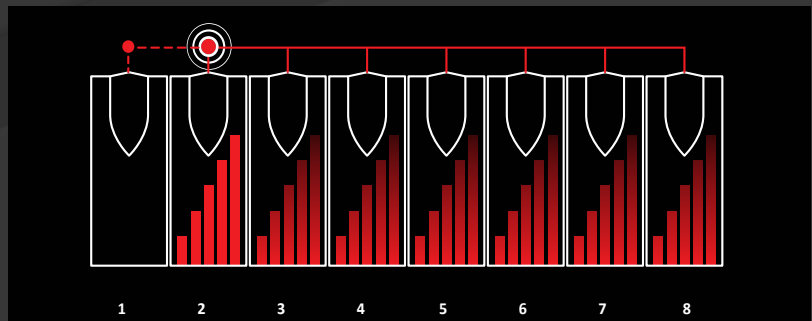
CREST can operate over a wide range of flow rates with very low pressure drop. This permits installation of a full flow (variable primary) system. Installation is streamlined, without the time and materials cost of primary/secondary piping, and pumps needed to maintain flow in a water-tube boiler. Variable flow also makes CREST more flexible at handling frequent fluctuations in the system flow rate.

HIGH EFFICIENCY WITH MINIMUM SUPPLY PRESSURE

CREST operates reliably with supply gas pressure as low as 4 inches water column. Negative Regulation technology draws gas into a pre-mix combustion system, instead of relying on utility pressure through the gas valve. Operation is steady in low gas pressure systems or when peak gas supply demand occurs. Plus, Neg/Reg fan control fine-tunes the fuel/air ratio entering the burner, providing an even, cleaner-burning flame, achieving high combustion efficiency.

PEACE OF MIND, WHEN IT MATTERS MOST

Cascade redundancy provides peace of mind because it helps ensure that a CREST boiler system will always deliver reliable performance with no downtime. If the lead boiler is turned off for maintenance, cascade redundancy automatically shifts the lead role to the second sequenced boiler. Up to eight CREST boilers can be sequenced using a 2-wire daisy-chain connection. Cascade sequencing can be programmed for lead-lag or efficiency optimized operation.



With lead-lag operation, one lead boiler modulates to capacity on demand. As load increases, the system then cascades to additional lag boilers in sequence. The first-on role shifts daily, distributing equal runtimes to each unit.

In an efficiency optimized system (see illustration above), all boilers fire and modulate simultaneously at the same Btu/hr input rates, maximizing thermal efficiency.



CREST features the next generation of Lochinvar's all-in-one SMART TOUCH™ operating control with the integration of the CON-X-US advanced technology. SMART TOUCH with CON-X-US provides outstanding functionality, and can

be integrated directly into a Building Automation System via Modbus and BACnet MSTP as standard equipment.

A 8" touch screen along with an updated user interface allows users to quickly see what their unit is doing. On screen graphs can help diagnose issues in the field. A new screen saver mode identifies the status of

the boiler. Dark green indicates running mode, olive green is blocking mode and red is lockout mode. This is another way Lochinvar is leading the charge with boiler controls.



INTRODUCING BOILER PLANT CONTROL, **FROM ANYWHERE.**

And now, the CON-X-US mobile communication platform allows the SMART TOUCH to go where no other boiler has gone before. CON-X-US provides the ability to monitor and manage multiple CREST boiler plants without ever stepping into the mechanical rooms. CON-X-US will send alerts via text or email notifying of changes in system status, and anytime, from anywhere, a user can check system status and re-program boiler functions. Once downloaded, the free CON-X-US mobile application allows for remote access to all SMART TOUCH functions using any internet-capable device.

- DO REGULAR CON-X-US CHECKS FOR ALL YOUR CREST CUSTOMERS, AND LET THEM KNOW YOU'RE MONITORING THEIR BOILER'S PERFORMANCE.

- ADJUST SETPOINTS, DOMESTIC HOT WATER, RESET CURVES, PUMP DELAYS AND MORE, USING THE CON-X-US INTERACTIVE DISPLAY.

- STATUS ALERTS VIA TEXT OR E-MAIL LET YOU KNOW WHEN A CREST BOILER NEEDS ATTENTION.

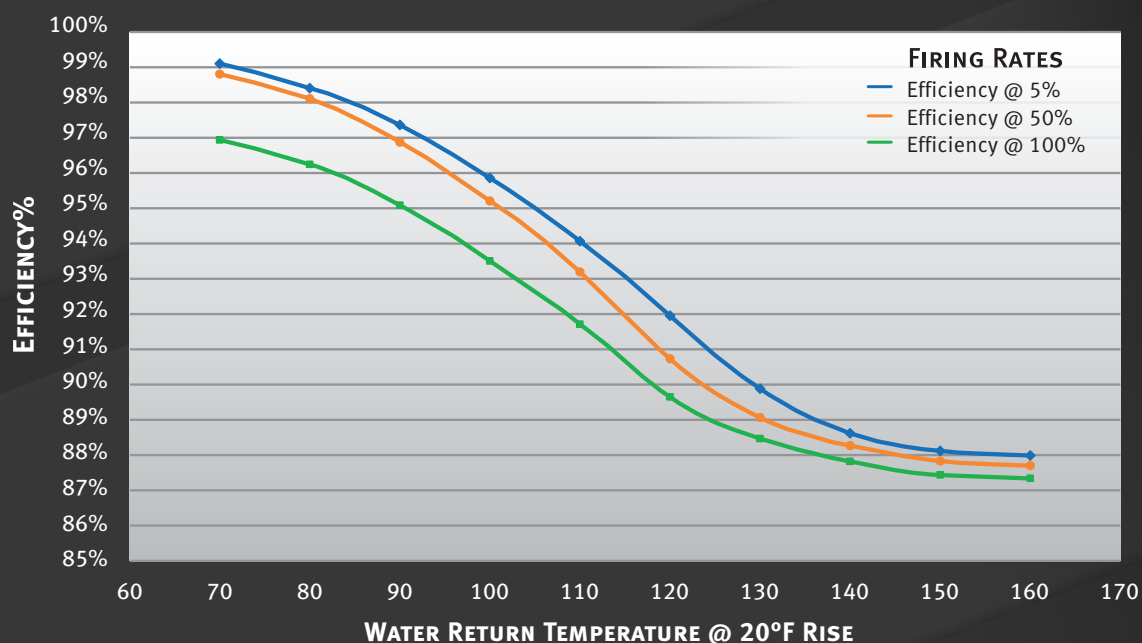


SUPERIOR FIRE-TUBE HEAT EXCHANGER DESIGN BOOSTS THERMAL EFFICIENCY

The CREST boiler takes fire-tube technology to a new level. The patented Wave configuration creates turbulence as flue gas products flow down the tube, scrubbing the energy from the flue products. The Wave design also enhances the life of the heat exchanger by allowing the tubes to flex, so they operate stress free with none of the adverse effects suffered by traditional fire-tube boilers.

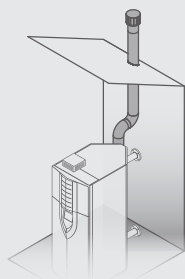
Each fire tube is welded into the heat exchanger and surrounded by water, and the heat transfer process is enhanced by the water's counterflow. As water flows up inside the vessel, superheated flue products flow down the fire tube. With one pass, heat is effectively captured, reaching condensing temperatures. At the top of the vessel, the combustion chamber is also water-backed for additional heat transfer.

CREST BOILER EFFICIENCY

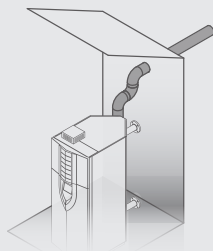


FLEXIBLE VENTING OPTIONS

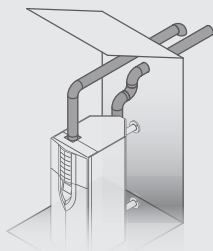
CREST offers 6 venting options, and permits direct-vent air intake and exhaust runs up to 100 equivalent feet, using PVC, CPVC, polypropylene or stainless steel pipe.** Plus, multiple units can be common-vented to reduce time and materials cost.



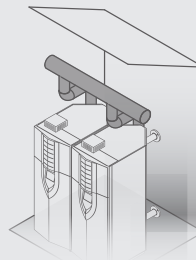
Room Air Vertical



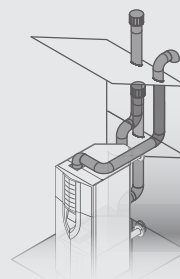
Room Air Sidewall



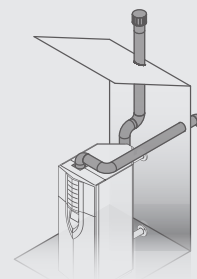
Direct-Vent



Common-Vent*



Direct-Vent Vertical



Vertical w/Sidewall Air

*Contact Lochinvar for information on common venting of CREST boilers.

** Available for models FB 0751-4001. Stainless steel pipe only for models FB 5001-6001.

SMART TOUCH FUNCTIONS AND FEATURES

SMART TOUCH FEATURES

- ›CON-X-US Remote Connect
- ›SMART TOUCH Touchscreen Operating Control
- ›Full-Color 8" Touchscreen LCD Display
- ›Built-in Cascading Sequencer for up to 8 Boilers
 - Built-in Redundancy
 - Cascade Multiple Sized Boilers
 - Lead/Lag Cascade
 - Efficiency Optimized Cascade
- ›Front-End Loading Capability with Copper-Fin II® and Power-Fin® Boilers
- ›Building Management System Integration with 0-10 VDC Input
- ›BACnet MSTP Communications
- ›Outdoor Reset Control with Outdoor Air Sensor
- ›Password Security
- ›Domestic Hot Water Prioritization
 - DHW tank piped with priority in the boiler loop
 - DHW tank piped as a zone in the system with the pumps controlled by the Smart System
 - DHW Modulation Limiting
 - Separately Adjustable SH/DHW Switching Times
- ›Low Water Flow Safety Control & Indication
- ›Inlet & Outlet Temperature Readout
- ›Freeze Protection
- ›Service Reminder
- ›Time Clock
- ›Data Logging
 - Hours Running, Space Heating
 - Hours Running, Domestic Hot Water
 - Hours Running, Modulation Rate
 - Ignition Attempts
 - Last 10 Lockouts
- ›Programmable System Efficiency Optimizers
 - Night Setback
 - Anti-Cycling
 - Outdoor Air Reset Curve
 - Ramp Delay
 - Boost Temperature & Time
 - Modulation Factor Control
- ›Three Pump Control
 - System Pump
 - Boiler Pump
 - Domestic Hot Water Pump

›High-Voltage Terminal Strip

- > 120V/1PH/60Hz (FB 0751-2001)
- > 208V/3PH/60Hz (FB 2501-3501)
- > 480V/3PH/60Hz (FB 4001-6001)

›Low-Voltage Terminal Strip

- 24 VAC Auxiliary Device Relay
- Auxiliary Proving Switch Contacts
- Alarm on Any Failure Contacts
- Runtime Contacts
- DHW Thermostat Contacts
- Unit Enable/Disable Contacts
- System Sensor Contacts
- DHW Tank Sensor Contacts
- Outdoor Air Sensor Contacts
- Cascade Contacts
- 0-10 VDC BMS External Control Contact
- 0-10 VDC Variable Speed Boiler Pump Control Contact

OPTIONAL EQUIPMENT

- Alarm Bell
- BMS Gateway - BACnet IP or LonWorks
- Wireless Outdoor Temperature Sensor
- Condensate Neutralization Kit
- Common Vent Damper Kits
- Motorized Isolation Valve
- Variable Speed Boiler Pump
- Electrical Transformer Options (Shipped Loose):
 - FB 0751-2001
 - > 208V/3PH/60Hz → 120V/1PH/60Hz
 - > 480V/3PH/60Hz → 120V/1PH/60Hz
 - > 600V/3PH/60Hz → 120V/1PH/60Hz
 - FB 2501-3501
 - > 480V/3PH/60Hz → 208V/3PH/60Hz
 - > 600V/3PH/60Hz → 208V/3PH/60Hz
 - FB 4001-6001
 - > 208V/3PH/60Hz → 480V/3PH/60Hz
 - > 600V/3PH/60Hz → 480V/3PH/60Hz
- RealTime O₂ Feedback
- Modbus Communication

*Lochinvar should be consulted before selecting a boiler for installations having unusual piping and pickup requirements, such as intermittent system operation, extensive piping systems, etc. *The ratings have been determined under the provisions governing forced draft burners.

CODES & REGISTRATIONS

ANSI Z21.13/CSA Certified
 ASME Certified, "H" Stamp / National Board
 California Code Compliant
 CSD1 / Factory Mutual / GE Gap Compliant
 Canadian Registration Number (CRN)
 South Coast Air Quality Management District
 Qualified (FB 0751-2001)
 AHRI Certified

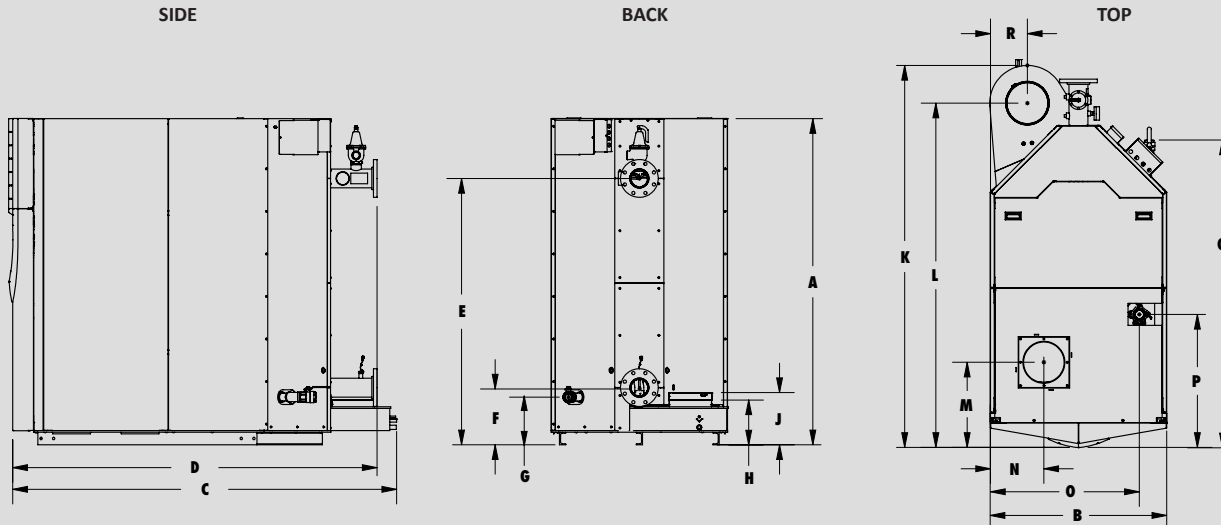
STANDARD FEATURES

Proof of Closure Valve (6001)
 Modulating Burner with up to 25:1 Turndown
 Direct-Spark Ignition
 Low NOx Operation
 Sealed Combustion
 Air Inlet Filter
 Low Gas Pressure Operation
 Vertical and Horizontal Direct Venting

- > Direct Vent up to 100 Feet
- > PVC, CPVC, Polypropylene or AL29-4C (FB 0751-4001)
- > AL29-4C (FB 0751-6001)

ASME "H" Stamped Heat Exchanger
 316L Stainless Steel Fire Tubes
 160 psi Working Pressure
 On/Off Switch
 Adjustable High Limit with Manual Reset
 Low Water Cutoff with Manual Reset & Test
 High & Low Gas Pressure Switches w/Manual Reset
 Low Air Pressure Switches
 Condensate Trap w/Blocked Drain Switch
 Drain Valve
 System Sensor
 Outdoor Air Sensor
 Inlet & Outlet Temperature Sensors
 High-Voltage Terminal Strip
 Low-Voltage Terminal Strip
 Downstream Gas Test Cocks
 50 psi ASME Relief Valve
 Temperature & Pressure Gauge
 Zero Clearances to Combustible Materials
 High Altitude Models Available
 10-Year Limited Warranty (See Warranty for Details)
 1-Year Warranty on Parts (See Warranty for Details)

CREST BOILER DIMENSIONS AND SPECIFICATIONS



For technical information call 800-722-2101. Lochinvar LLC reserves the right to make product changes or improvements without prior notice. Dimensions are approximate and should not be used for construction purposes.

CREST HEATING BOILER



DIMENSIONS AND SPECIFICATIONS

Model Number	Input MBH		Thermal %	Gross Output MBH	Net AHRI Rating MBH	Turndown	A	B	C	D	E	F	G	H
FB*0751	50	750	96.2%	722	628	15:1	78"	30"	55-1/2"	57-5/8"	66-1/8"	11-7/8"	11-3/8"	11-1/4"
FB*1001	50	999	96.2%	961	836	20:1	78"	30"	56-1/2"	57-5/8"	66-1/8"	11-7/8"	11-3/8"	11-1/4"
FB*1251	62.5	1,250	96.2%	1,203	1,046	20:1	78"	30"	56-1/2"	57-3/4"	66-1/8"	11-7/8"	11-3/8"	11-1/4"
FB*1501	60	1,500	96.2%	1,443	1,255	25:1	78"	30"	67-3/4"	68"	65-3/8"	12-3/8"	11-3/8"	11-1/4"
FB*1751	70	1,750	96.2%	1,684	1,464	25:1	78"	30"	66-1/4"	68"	65-3/8"	12-3/8"	11-3/8"	11-1/4"
FB*2001	80	1,999	96.2%	1,923	1,672	25:1	78"	30"	66-1/2"	68"	65-3/8"	12-3/8"	11-3/8"	11-1/4"
FB*2501	125	2,500	96%	2,400	2,087	20:1	77-3/4"	35"	83-3/4"	83-3/4"	63-3/4"	13-1/2"	11-1/4"	10-1/2"
FB*3001	150	3,000	96%	2,883	2,507	20:1	77-3/4"	35"	83-3/4"	83-3/4"	63-3/4"	13-1/2"	11-1/4"	10-1/2"
FB*3501	175	3,500	96%	3,364	2,925	20:1	77-3/4"	42"	91-1/2"	86-3/4"	63-1/2"	13-1/4"	11-1/2"	10-3/4"
FB*4001	333.3	3,999	96%	3,843	3,342	12:1	77-3/4"	45-1/2"	103-1/2"	99"	63-1/2"	13-3/4"	11-1/2"	10-3/4"
FB*5001	499.9	4,999	96%	4,804	4,177	10:1	77-3/4"	46-1/2"	102-1/4"	99-1/2"	63-1/2"	15"	11-1/2"	10-3/4"
FB*6001	600	6,000	96%	5,766	5,014	10:1	77-3/4"	50"	102-3/4"	99-3/4"	63-1/4"	14-3/4"	11-1/2"	10-3/4"

Model Number	J	K	L	M	N	O	P	Q	R	Gas Conn.	Water Inlet/Outlet	Air Inlet	Vent Size	Oper. Weight (lbs.)	Ship. Weight (lbs.)
FB*0751	12-1/2"	55"	51"	13"	8-3/4"	26-3/4"	23-3/4"	49-1/2"	7-3/8"	1-1/4"	3"	6"	6"	1,768	1,560
FB*1001	12-1/2"	56"	51"	13"	8-3/4"	26-3/4"	23-1/8"	49-1/2"	6-1/2"	1-1/4"	3"	6"	6"	1,838	1,596
FB*1251	12-1/2"	56"	51-3/8"	13"	8-3/4"	26-3/4"	21-5/8"	49-1/2"	6-1/2"	1-1/2"	3"	6"	8"	1,975	1,648
FB*1501	12-1/2"	67-1/4"	62-3/8"	15-7/8"	9"	26-7/8"	27-7/8"	59-1/4"	5-1/8"	1-1/2"	4"	8"	8"	2,307	1,961
FB*1751	12-1/2"	65-3/4"	61-1/2"	15-7/8"	9"	27"	27-1/8"	58-3/4"	5-1/8"	1-1/2"	4"	8"	8"	2,458	2,017
FB*2001	12-1/2"	66"	61-1/2"	15-7/8"	9"	27"	26-3/4"	58-3/4"	5-1/8"	1-1/2"	4"	8"	8"	2,570	2,087
FB*2501	12-1/4"	83-1/4"	76-1/4"	19-3/4"	9-1/4"	28-3/4"	32"	71"	7-1/4"	2"	4"	8"	9"	3,600	2,577
FB*3001	12-1/4"	83-1/4"	76-1/4"	19-3/4"	9-1/4"	28-3/4"	32"	71"	7-1/4"	2"	4"	10"	10"	3,900	2,881
FB*3501	12-1/2"	91"	82"	20-1/4"	12-3/4"	35-1/2"	31-3/4"	73-1/4"	8-3/4"	2"	4"	10"	10"	4,600	3,218
FB*4001	12-1/2"	103"	94"	24-3/4"	13-1/2"	39-1/2"	42-1/4"	85-1/4"	10-1/2"	2-1/2"	4"	12"	12"	5,200	3,805
FB*5001	12-1/2"	101-3/4"	92-1/2"	22"	14"	39-3/4"	39-1/2"	84"	9"	2-1/2"	6"	14"	14"	5,900	4,101
FB*6001	12-1/2"	102-1/2"	93-1/4"	20"	15-3/4"	43-1/2"	36-1/2"	83-3/4"	9-1/4"	3"	6"	14"	14"	6,900	4,711

Notes: *Insert "N" for natural gas, "L" for LP gas models and "D" for dual fuel. Indoor installation only. Lochinvar should be consulted before selecting a boiler for installations having unusual piping and pickup requirements, such as intermittent system operation, extensive piping systems, etc. The ratings have been determined under the provisions governing forced draft burners. The Net AHRI water ratings shown are based on a piping and pickup allowance of 1.15.



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The *Comfort* Experts


Taco[®]
Comfort  *Solutions*[™]
A Taco Group Company

KS Series Pumps

Vertical In-Line Split Coupled

GPM: 40 - 12,000
Head (ft): 10 - 380
HP: 3/4 - 600
SIZES: 1-1/2" — 14"



Designed for optimum performance and ease of installation and maintenance. Ideal for HVAC and industrial applications.

The split coupler design permits changing of the seal without disturbing the motor or the piping.

The axial load is hydraulically balanced to increase bearing life, better

pump efficiencies, and lower NPSH requirements.

The recirculating line flushes seal faces and extends seal life.

Optimum pump efficiency is achieved by close running impeller to casing clearances.

KV Series Pumps

Vertical In-Line Close Coupled

GPM: 40 - 2,400
Head (ft): 10 - 380
HP: 3/4 - 100
SIZES: 1-1/2" — 8"



Designed for optimum performance and ease of installation and maintenance.

Ideal for HVAC and industrial applications.

Space saving design that doesn't require isolation pads.

Closed coupled design provides improved alignment and increased seal life.

The axial load is hydraulically balanced to increase bearing life, better pump efficiencies, and lower NPSH requirements.

The recirculating line flushes seal faces and extends seal life.

Optimum pump efficiency is achieved by close running impeller to casing clearances.

NOTE: All pumps are also available with 50Hz or 60Hz motors

ECM #7

Steam sub meter & data collection through BAS

Savings Calculations

ECM 7
Steam sub meter and data collection through BAS

This ECM does not have standalone savings.

ECM #7

Steam sub meter & data collection through BAS

Equipment Information Sheets

Rosemount Orifice Series

Differential Pressure Flow



Innovative Offering for Better Measurement

ROSEMOUNT®


EMERSON™
Process Management

Revolutionizing the Industry Workhorse – Orifice Plate Technology

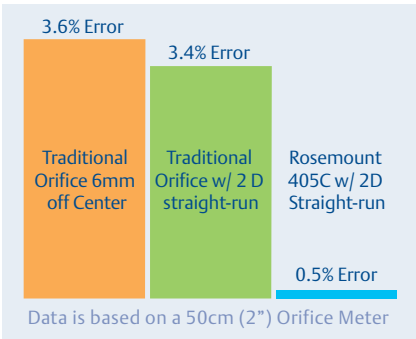
It’s no coincidence that orifice plates are still the most popular flow technology. They provide reliable and accurate flow measurement for gas, liquid and steam applications. Orifice flowmeter installations are straightforward and affordable.



Best Primary Element Offering

Rosemount orifice primary elements offer best-in-class capabilities.

- Best practices for better measurement
- Wide variety of innovative solutions



Minimized Installation Errors

Rosemount orifice flowmeters facilitate proper installation to maximize performance.

- Alignment mechanisms ensure centering
- Reduced straight run requirements



Engineered To Your Specifications

Rosemount orifice flowmeters are designed and built to meet your requirements.

- Arrives tested, calibrated and ready-to-install
- Custom designs through Engineered Assemblies

Reduced Total Cost of Ownership

Rosemount orifice flowmeters reduce capital and operating expenditures and are more reliable.

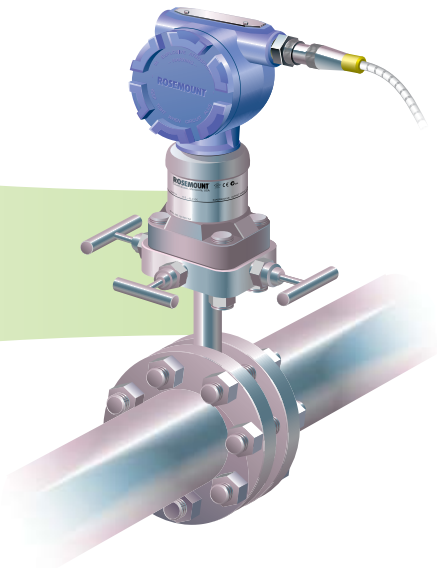
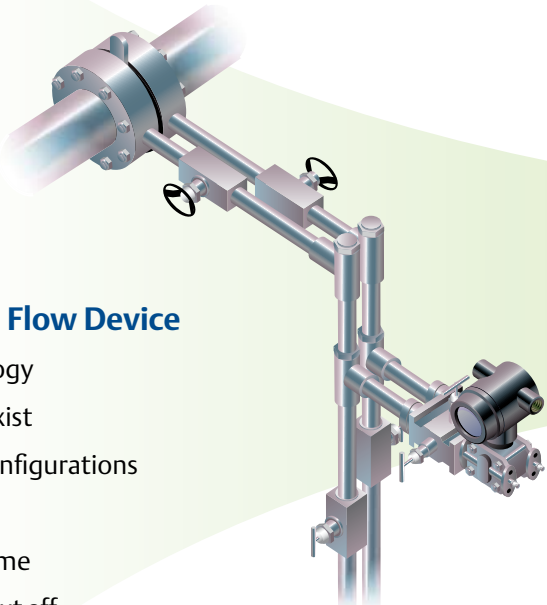
- Integrated components lower installed costs
- Direct mounting eliminates maintenance-intensive impulse lines

Proven Technology

Orifice technology is time-tested with established standards for manufacture and use. Performance under varied installation and process conditions is well documented.

The Most Specified Flow Device

- Well-known technology
- Industry standards exist
- Flexible mounting configurations
- Highly repeatable
- Excellent response time
- No inherent low-flow cut off
- Field calibrated
- Two-wire



Reliable and

proven technology

•

Reduced cost

and maximized

performance

•

A complete line of

ready-to-install

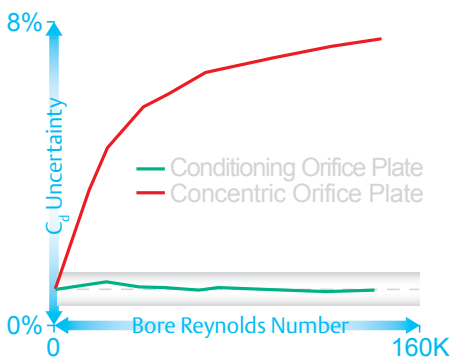
flowmeters

Unconditionally Better Measurement – Conditioning Orifice Plate Technology

While orifice plate technology has been the overwhelming choice for flow measurement, it has traditionally required significant straight-run for accurate results. Rosemount conditioning orifice plate technology provides unprecedented performance with minimal straight-run. Orifice metering is now more flexible and better than ever before.

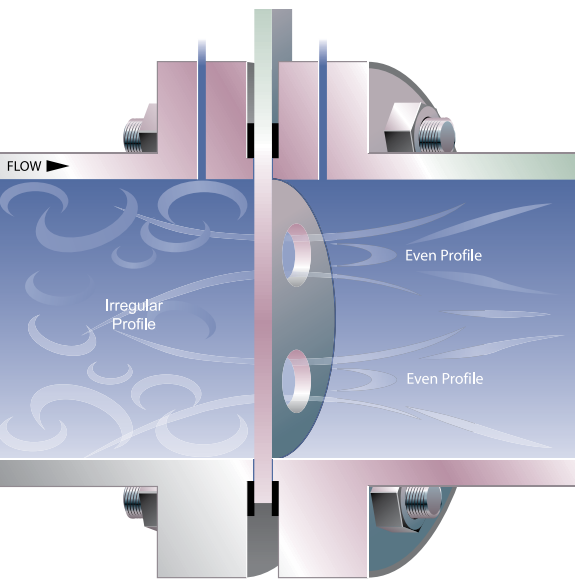
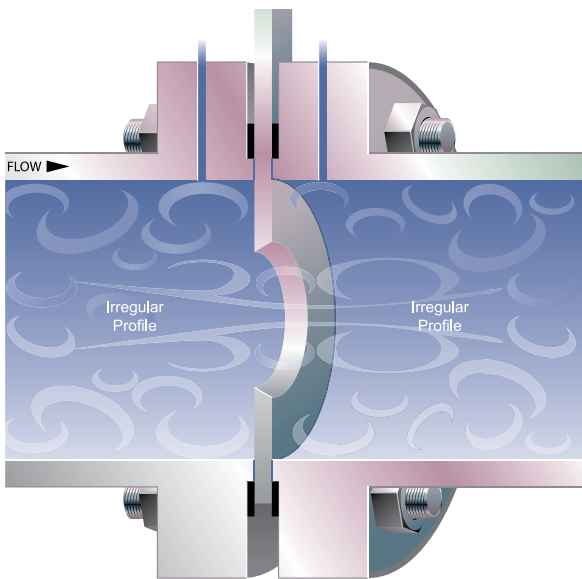
Improved Performance

Rosemount conditioning orifice plate technology eliminates errors caused by upstream disturbances. This unique design achieves 0.5% accuracy, making it the best performing primary element available.



The Impact of Swirl

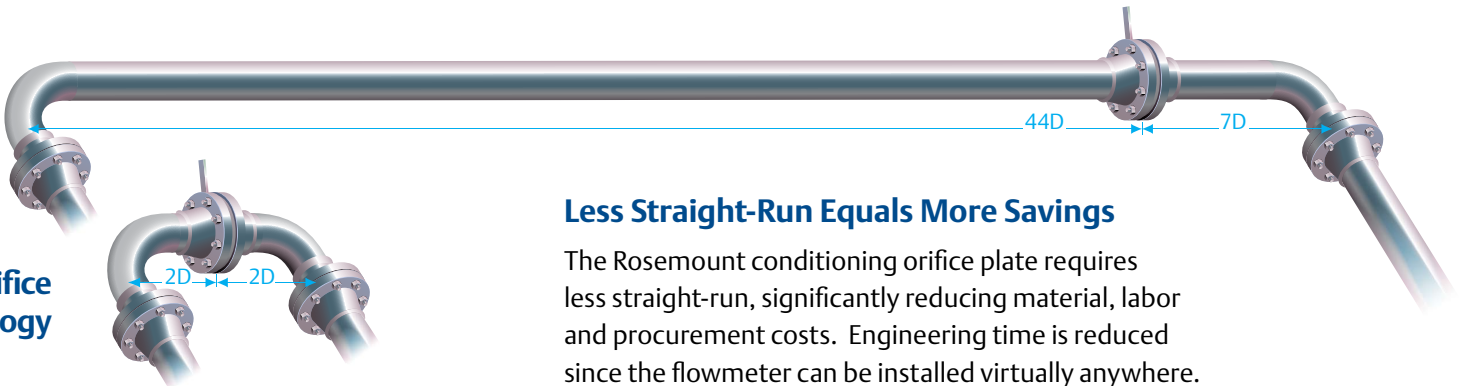
Upstream disturbances cause swirl in a pipe and create an irregular flow profile. These effects are amplified across a concentric orifice plate, allowing the disturbance to impact measurement.



Controlling Swirl with an Innovative Design

The four equally spaced holes of the Rosemount conditioning orifice plate eliminate swirl and irregular flow profiles. This results in a more stable and accurate measurement.

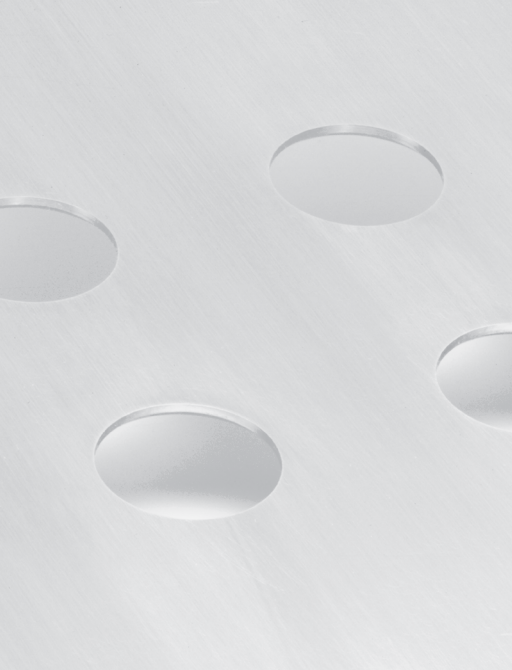
Traditional Orifice Plate Technology



Conditioning Orifice Plate Technology

Less Straight-Run Equals More Savings

The Rosemount conditioning orifice plate requires less straight-run, significantly reducing material, labor and procurement costs. Engineering time is reduced since the flowmeter can be installed virtually anywhere.



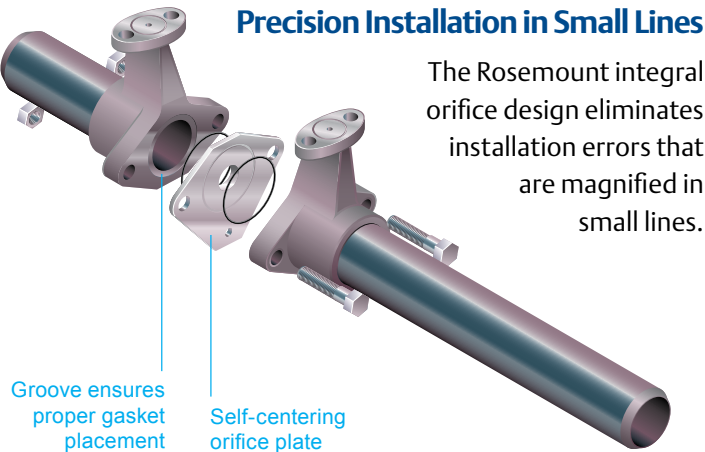
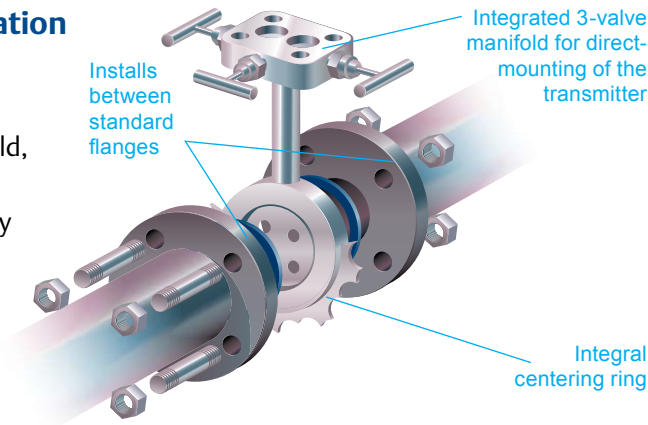
- Reduce pipe straight-run and increase savings
- Improve flow accuracy with the innovative design
- Two pipe diameters from an upstream flow disturbance

Best Practices for Better Measurement – Improved Orifice Installation

Rosemount orifice products are designed for ease of installation and maximum performance by eliminating the need for impulse lines, special flanges or piping modifications. Self-centering mechanisms ensure optimal accuracy while improving the overall installation process. Fully leak-tested, calibrated and ready-to-install assemblies are provided to ensure a better measurement experience.

Simplified Installation

Rosemount compact orifice technology combines the manifold, connection hardware and the orifice primary element in a single, reliable package.

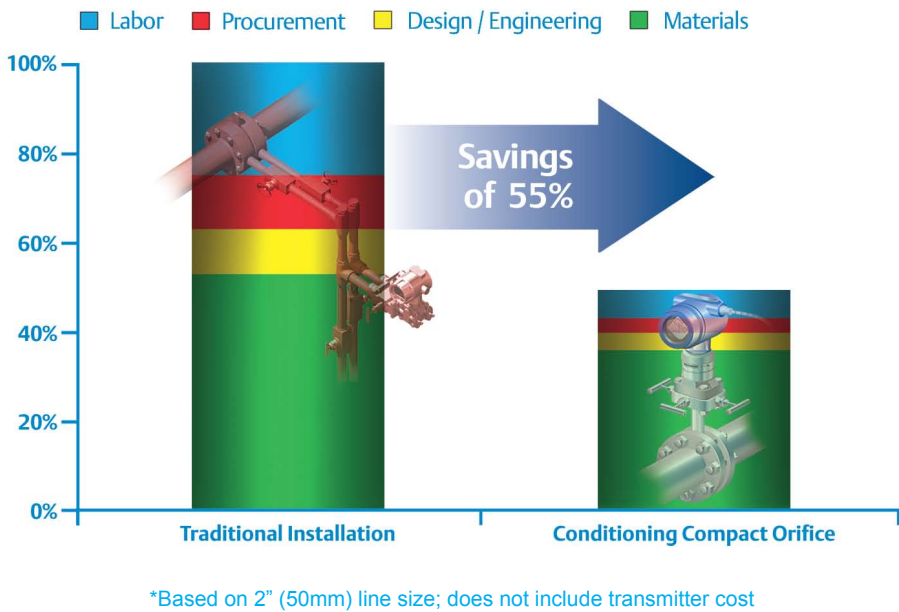


Precision Installation in Small Lines

The Rosemount integral orifice design eliminates installation errors that are magnified in small lines.

Low Installed Cost

Unique Rosemount orifice flowmeters offer significant installation savings. Specification, ordering, and installation occur as one seamless process. This reduces risk and ensures faster delivery for an efficient start-up.



Reduced Fugitive Emissions

The direct-mount capabilities of the Rosemount offering results in a reliable, worry-free installation. Impulse lines and extra connection hardware are eliminated, reducing potential leak points by up to 70%.



Economical

and simple installation

•

Direct-mount

flowmeters reduce

total installed costs

•

Enhanced

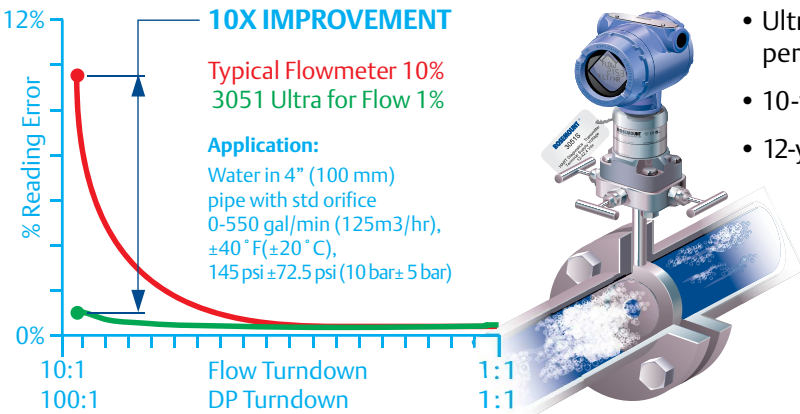
environmental

compliance

The Complete Solution for Better Measurement – Rosemount DP Flowmeters

Rosemount 3051S flowmeters combine the industry leading 3051S transmitter with innovative orifice technologies. These customized flowmeter assemblies offer all of the scalable benefits of the 3051S in a direct-mount DP flow platform. The unprecedented performance and reliability of Rosemount 3051S Flowmeters is complimented by simplified ordering and installation.

Enhanced Flow Measurement Over a Wide Turndown



- Ultra for Flow performance
- 10-yr stability
- 12-yr warranty

Smart Wireless DP Flow Solutions

Rosemount 3051S DP Flowmeters are part of Emerson's Smart Wireless solutions. Smart Wireless extends the benefits of the PlantWeb® architecture to assets that were previously physically inaccessible or too costly to reach.



Advanced DP Flow Capabilities

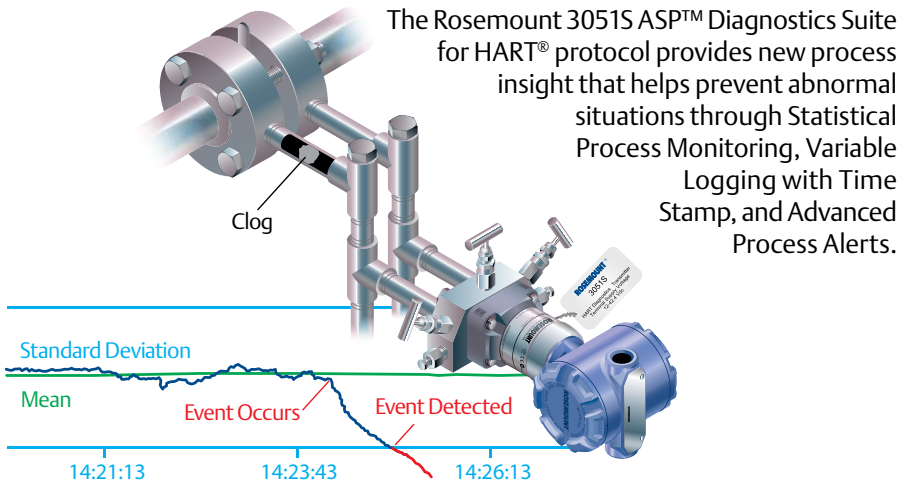
The ability to optimize your DP flow application requirements

- Remote display & interface
- User-configurable flow units
- Process alerts
- Low flow cut-off



Display and interface can be mounted remotely at-grade level for safe and easy access

Advanced Diagnostic Functionality



Increase reliability and performance with unprecedented flow measurement capabilities

-
- Improve your bottom line by replacing individual components with a single flowmeter
-
- Increase process efficiency with PlantWeb digital architecture

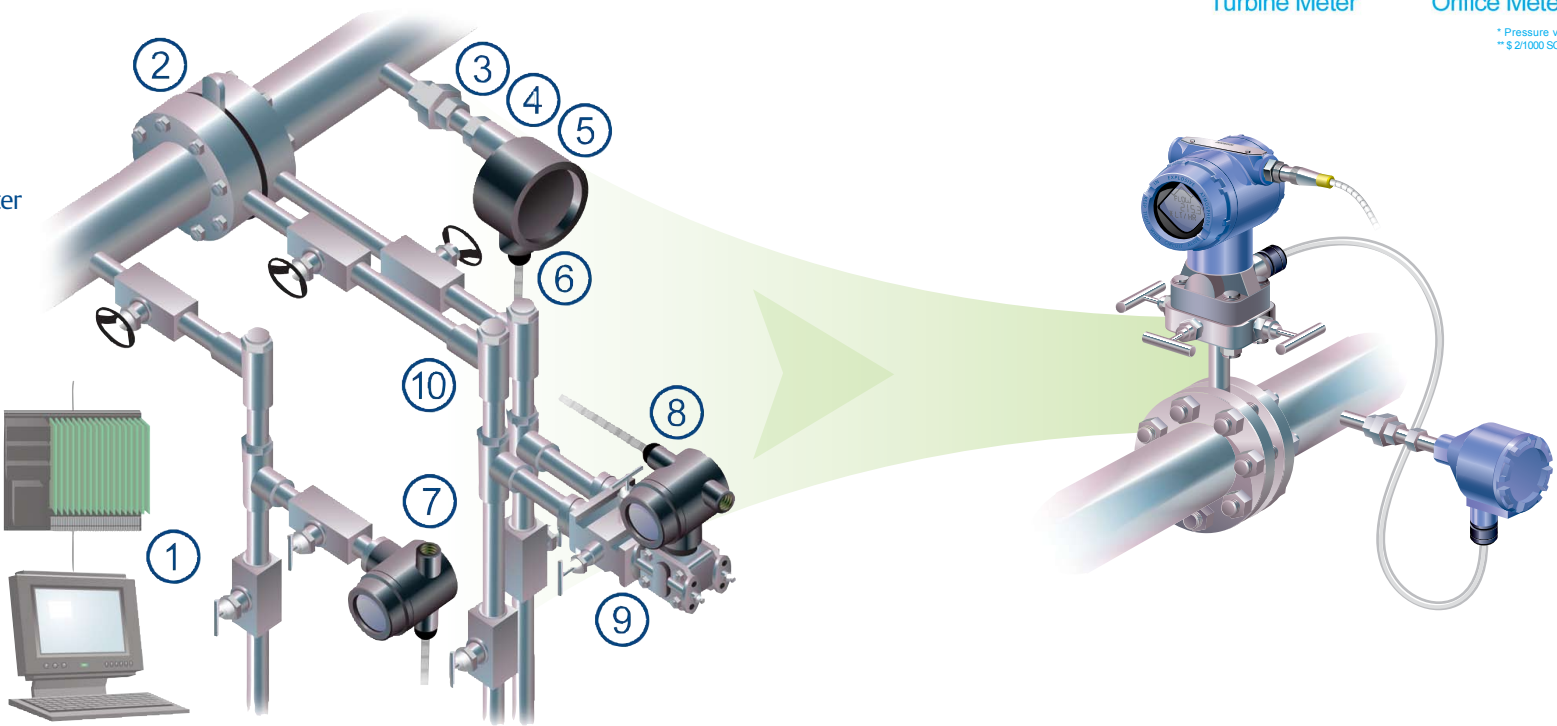
Rosemount MultiVariable Flowmeter Capabilities

Rosemount MultiVariable Flowmeters are the most advanced DP Flowmeters available. Rosemount Mass Flowmeters deliver real-time mass flow in a single integrated package, making mass flow measurement accurate and easy while reducing process variability. Our integrated flowmeters provide the functionality of ten devices in the convenience of one advanced mass flowmeter package.

Ten Devices. One Flowmeter.

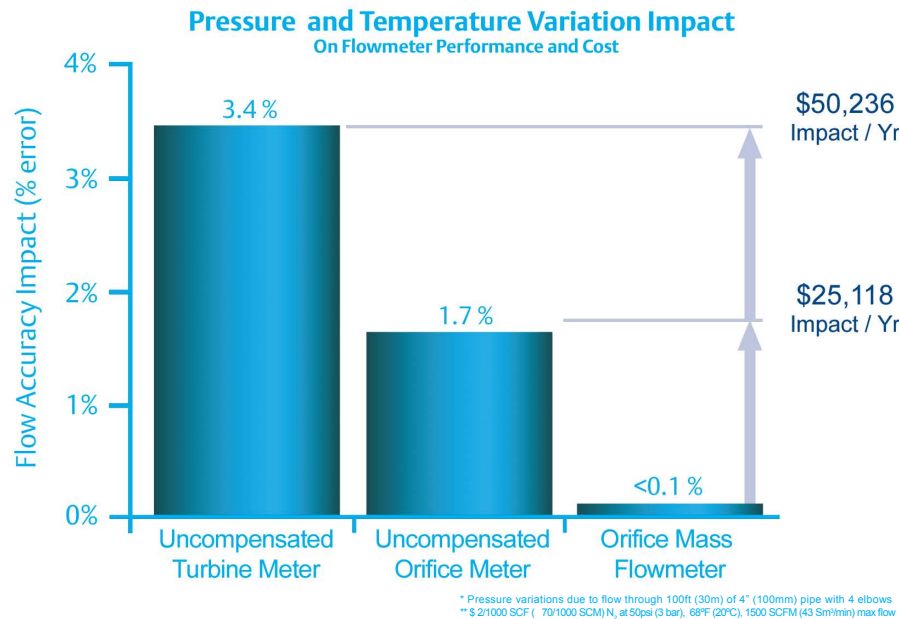
Advanced electronics integrated with orifice technology create a mass flowmeter with unprecedented capabilities. Rosemount mass flowmeters integrate the ten individual components required for traditional mass flow measurement. No longer is a separate flow computer or DCS calculation required for measuring mass flow.

- 1. Flow Computer
- 2. Primary Element
- 3. Thermowell
- 4. Temperature Sensor
- 5. Temperature Transmitter
- 6. Sensor Wiring
- 7. Pressure Transmitter
- 8. DP Transmitter
- 9. Manifold
- 10. Connection Hardware



Proven Mass Flow Measurement

All gas and steam flows have pressure and temperature variations that significantly reduce flow accuracy. Rosemount Multivariable Orifice Flowmeters with real-time compensation virtually eliminate this impact.



- Real-time fully compensated mass flow in a single, integrated flowmeter package
- Improves accuracy and performance by up to 90% compared to an uncompensated flowmeter
- Arrives fully assembled, leak-tested, and ready-to-install

Multiple variables in one device reduce process penetrations, inventory, and installation costs

•

Reduce process variability and increase profitability in a single flowmeter

•

Accurate measurement with unmatched operating performance including dynamically compensated mass flow

Innovative Elements in a Comprehensive Offering

The Rosemount orifice offering includes everything you need to engineer and install your flow point. This comprehensive offering has been developed for easy specification and ordering. Each product is manufactured in strict accordance with industry standards, ensuring the highest level of quality and performance.

Orifice Plates

Rosemount orifice plates are manufactured to meet AGA, ASME, ISO and DIN standards. A revolutionary conditioning orifice plate eliminates the need for long straight-runs while providing unprecedented performance.



Flange Unions & Meter

Rosemount flange unions and meter runs meet the most stringent requirements with careful attention given to tap location, pipe wall smoothness and flange facings. Each assembly comes complete with all required installation hardware.



Compact Orifice Plates

The Rosemount 405 compact orifice primary element is a fully integrated solution that eliminates the need for fittings, tubing, valves, adapters, manifolds and mounting brackets. The unique wafer body allows installation in any flange location. A conditioning orifice plate option delivers unprecedented performance in limited straight-run applications.



Integral Orifice Assemblies

The Rosemount 1195 integral orifice provides high accuracy in small line size applications. A self-centering plate, precision honed pipe section and tight machining tolerances ensure higher installed performance. Numerous process connections are available for flexible installation.



Engineered Assemblies

Rosemount Engineered Assemblies deliver complete measurement solutions. Each assembly is factory configured, leak-tested and ready-to-install. Engineered Assemblies are easily customized to meet the needs of virtually any application.



Easy procurement

with a wide range

of styles and ratings

•

Faster start – ups

through easy

installations

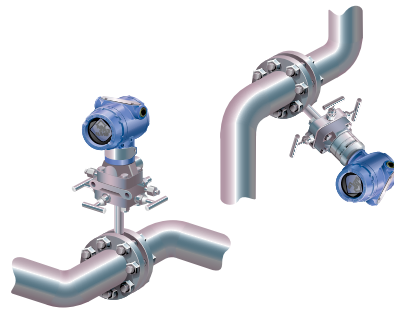
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Increase process

efficiency with best-

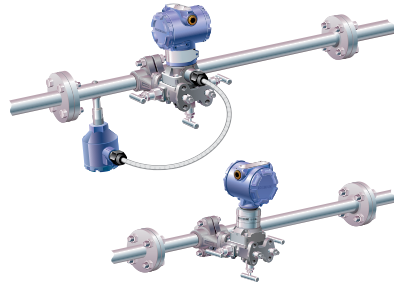
in-class products

To see just how Emerson can provide multiple savings in flow measurement applications with best-in-class Rosemount orifice solutions, visit us online at www.rosemount.com/DPflow



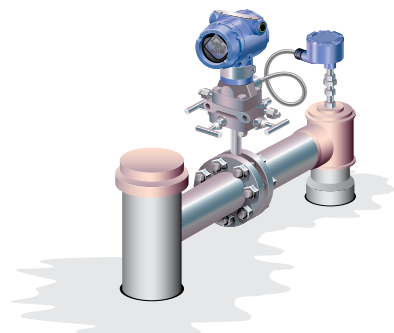
Install in Short Straight Pipe Run

- The conditioning orifice requires less straight pipe run, significantly reducing engineering, procurement and installation costs
- Delivers superior performance with only two pipe diameters from an upstream flow disturbance



Improve Utility Measurements in Small Lines

- The 1195 self-centering plate design and precision honed pipe sections maximize installed performance
- Numerous process connections available for installation flexibility



Improve Oil and Gas Wellhead Measurement

- The conditioning orifice provides superior flow measurement directly after the wellhead
- Reduced short straight pipe results in substantial installation savings
- Proven accurate and reliable in wet gas applications

Complete Capabilities. Better Measurement.



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ECM #8

Replace, repair or recondition steam traps

Savings Calculations

APPENDIX

H2O Applied Technologies LLC
 Project: Wernersville State Hospital
 CM: Steam Trap Retrofit
 Survey Type: Preliminary
 Eng: JSC

CM SAVINGS SUMMARY			
Utility	Baseline	Post-Retrofit	\$ Savings

TRAP SURVEY:		TOTAL TRAP SUMMARY		TESTED TRAP SUMMARY	
Condition	Code	Quantity	Percent	Quantity	Percent
Abandoned in place	A	45	7%		
Vacuum Breaker	VB	0	0%		
Not Tested	NT	603	93%		
Plugged (Failed)	P	0	0%	0	5%
Blowing (Failed)	B	0	0%	0	5%
Leaking	L	0	0%	0	10%
Working Properly	OK	0	0%	0	80%
Totals:		648	100%	0	100%
			percent tested:	0%	

Totals: 648

Line Item	Qty.	Tag #	Building	Floor	Room Description	Location	Application
1	1	10001	Bldg 34		Basement Mec 01 left corner heat E		Heat Exchanger
2	1	10002	Bldg 34		Basement Mec 01 left corner heat E		Heat Exchanger
3	1	10003	Bldg 34		Basement Mec 01 above Cond Pur		Drip Leg
4	1	10004	Bldg 34		Basement Mec 01 above Cond Pur		Drip Leg
5	1	10005	Bldg 34		Basement Mec 01 Dom. Hot water		Heat Exchanger
6	1	10006	Bldg 34		Basement Mec 01 Dom. Hot water		Drip Leg
7	1	10007	Bldg 34		Basement Mec 01 Dom. Hot water		Heat Exchanger
8	1	10008	Bldg 34		Basement Mec 01 Dom. Hot water		Drip Leg
9	1	10009	Bldg 34		Kitchen Tray washer		Heat Exchanger
10	1	10010	Bldg 34		Kitchen Steam Kettle		Steam Kettle
11	1	10011	Bldg 34		Kitchen Steam Kettle		Steam Kettle
12	1	10012	Bldg 34		Kitchen Steam Kettle		Steam Kettle
13	1	10013	Bldg 34		Freezer # 2		Unit Heater
14	1	10014	Bldg 34		Kitchen Dock Area Fat Freezer #2		Unit Heater
15	1	10015	Tunnel #34 to #10		Midway Of Tunnel		Drip Leg
16	1	10016	Tunnel #34 to #10		Midway Of Tunnel		Drip Leg
17	1	10017	Tunnel #34 to #35		Midway @ cond. Pumps		Drip Leg

Reviewed by:

Date:

Design Data & Assumptions		
Modified Napier Formula		
q = 24.24 * D² * (P+14.7) * Orifice Factor * App Factor * Loss Factor		
q = Heat Loss (lb/hr)		
D = Orifice Diameter (inches)		
P = Gauge Pressure (psig)		
Orifice Factor = 0.66 Orifice diameter reduction due to presence of condensate.		
Application Factor = (See note) 1.0 for Drip Legs, 0.92 for Coils or other Valved Applications.		
Loss Factor = (See table below)		
Condition	Code	Loss Factor
Abandoned	A	0
Vacuum breaker/Vent	VB	0
Not Tested	NT	0.08
Plugged (Failed Closed)	P	0
Blowing (Failed Open)	B	1
Leaking	L	0.3
Working Properly	OK	0

										1,300	1,858	5,889	-	5,889		
Line Pressure (psig)	Test Result	Manufacturer	Model	Type	Pipe Size	Orifice Size	Hours Active	Loss Factor	Boile eff.	Baseline Losses			Post Retrofit Losses	Annual Savings		
										(lb/hr)	(Mbtu/hr)	(MMbtu/yr)	(MMbtu/yr)	(MMBtu/yr)		
17	NT		77HL	FT	2	0.500	4279	0.08	70%	9	13.33	57	-	57		
17	NT		1E	TS	1/2	0.200	4279	0.08	70%	1	2.13	9	-	9		
50	NT		152	TD	3/4	0.340	8760	0.08	70%	10	13.68	120	-	120		
50	NT		B1H-75	IB	1/2	0.157	8760	0.08	70%	2	2.92	26	-	26		
17	NT		77HL	FT	1 1/2	0.500	8760	0.08	70%	9	13.33	117	-	117		
17	NT		55AL	FT	3/4	0.218	8760	0.08	70%	2	2.75	24	-	24		
17	A		151	TD	3/4	0.340	0	-	70%	-	-	-	-	-	trap is not in use/ tank#2 is storage tank	
17	NT		Unknown BP 125	FT	1/2	0.200	8760	0.08	70%	2	2.32	20	-	20		
17	NT		1031-20	TS	3/4	0.188	8760	0.08	70%	1	1.88	17	-	17		
50	NT		B1	TS	1/2	0.200	1460	0.08	70%	3	4.35	6	-	6		
50	NT		B1	TS	1/2	0.200	1460	0.08	70%	3	4.35	6	-	6		
50	NT		30	TS	1/2	0.200	1460	0.08	70%	3	4.35	6	-	6		
17	NT		FT-15	FT	3/4	0.218	1279	0.08	70%	2	2.53	3	-	3		
17	NT		FT-15	FT	3/4	0.218	1279	0.08	70%	2	2.53	3	-	3		
50	NT		60	TS	1/2	0.130	8760	0.08	70%	1	2.00	18	-	18		
50	NT		60	TS	1/2	0.130	8760	0.08	70%	1	2.00	18	-	18		
50	NT		151	TD	1/2	0.340	8760	0.08	70%	10	13.68	120	-	120		

ECM #8

Replace, repair or recondition steam traps

Equipment Information Sheets



Float & Thermostatic Steam Traps

Series 2000 (VAC-125 PSIG)

Product Features

- High quality premium grade components
- Variety of piping combinations “H-Pattern” design
- Responds quickly to changes in condensate load
- Condensate discharge temperature closely follows the saturated steam curve
- Function not impaired by high back pressure
- Energy efficient
- Simple on-line repair
- Meets MIL Spec WWT-696



Sizes 3/4" to 2" NPT

Description

Barnes & Jones Series 2000 Float & Thermostatic steam traps are designed for all types of applications including steam heating, steam process equipment and industrial steam distribution. Typical applications include unit heaters, steam coils water heaters, low-pressure steam mains and risers, steam kettles and high-pressure steam mains and risers.

Float & Thermostatic steam traps are specially well suited for chillers, steam coils, air handling equipment, humidification, high pressure drip traps and more. Please consult the factory for assistance with steam trap selection.

Operation

The opening and closing of the water valve is caused by changes in the condensate level within the body of the steam trap. When the water level drops, the weight of the float closes the water valve. As condensate enters the steam trap body, the float rises and opens the valve, allowing condensate to be discharged. The float is designed to provide sufficient buoyancy to overcome the differential pressure across the valve. The internal float and valve configuration is such that the condensate level is always above the valve, creating a continuous water seal at the seat.

Construction

Barnes & Jones float and thermostatic steam traps are compact, rugged design with easy access to all interior parts. The body is cast with two inlet and two outlet pipe connections (H-pattern) that permit multiple piping options for all types of applications. All working parts are made of stainless steel and are attached to the cover casting. The repair kit consists of a complete, factory assembled head which simply bolts on for ease of repair. No pipe connections need to be broken except for 2" models which are piped through the head.

Part	Material Description
Head/Body	Cast Iron, ASTM-A278 Class 30
Bolting	Steel, Grade 5
Gaskets	Non-Asbestos Fiber
Float	Stainless Steel
Valve Plug	Stainless Steel
Valve Seat	Stainless Steel
Air Vent	Phosphor Bronze, Calibrated Thermostatic Element
Air Vent	Stainless Steel Ball, Seat & Housing

Ease of Steam Trap Repair

Factory preassembled repair kits are available for most B&J models and other manufactures F&T traps. Consult the Factory for selections.



RK2015-3 Repair Kit Head Assembly

Engineering Specifications

CAPACITIES (SHEMA) lbs. hot condensate per hour.

Model	Size (NPT)	Orifice	Pressure Differential (PSIG)						
			1/4	1/2	1	2	5	10	15
FT2015-3	3/4"	.203"	70	100	140	200	210	220	230
FT2015-4	1"	.203"	175	250	350	500	525	550	575
FT2015-5	1-1/4"	.312"	425	600	850	1200	1260	1320	1380
FT2015-6	1-1/2"	.500"	850	1200	1700	2400	2520	2640	2760
FT2015-8	2"	.625"	1775	2500	3550	5000	5250	5500	5750

Note: Low pressure F&T trap capacities are in accordance with standards adopted by the Steam Heating Manufacturer's Association (SHEMA) providing for continuous elimination of air when the trap is operating at its maximum rating. No safety factor need be applied. Actual capacities significantly greater than SHEMA ratings indicate.

CAPACITIES (Gross) lbs. hot condensate per hour.

Model	Size (NPT)	Orifice	Pressure Differential (PSIG)														
			1/4	1/2	1	2	5	10	15	20	25	30	40	50	75	100	125
FT2015-3	3/4"	.203"	293	387	513	683	824	1050	1129	-	-	-	-	-	-	-	-
FT2015-4	1"	.203"	293	387	513	683	824	1050	1129	-	-	-	-	-	-	-	-
FT2015-5	1-1/4"	.312"	630	808	1029	1302	1722	2100	2457	-	-	-	-	-	-	-	-
FT2015-6	1-1/2"	.500"	1155	1785	2520	3465	5250	6930	7980	-	-	-	-	-	-	-	-
FT2015-8	2"	.625"	2415	2940	3780	4883	7245	9450	11445	-	-	-	-	-	-	-	-
FT2030-3	3/4"	.203"	293	387	513	683	824	1050	1129	1271	1365	1439	-	-	-	-	-
FT2030-4	1"	.203"	293	387	513	683	824	1050	1129	1271	1365	1439	-	-	-	-	-
FT2030-5	1-1/4"	.312"	394	525	725	956	1260	1575	1764	1890	1995	2100	-	-	-	-	-
FT2030-6	1-1/2"	.437"	1050	1365	1785	2415	3570	4830	5775	6300	6930	7350	-	-	-	-	-
FT2030-8	2"	.500"	1365	1890	2625	3570	5460	7140	8190	9030	9765	10500	-	-	-	-	-
FT2075-3	3/4"	.203"	168	224	294	383	546	735	835	919	977	1019	1176	1292	1523	-	-
FT2075-4	1"	.203"	168	224	294	383	546	735	835	919	977	1019	1176	1292	1523	-	-
FT2075-5	1-1/4"	.339"	410	578	667	956	1397	1943	2258	2520	2730	2940	3203	3465	3990	-	-
FT2075-6	1-1/2"	.339"	557	761	1008	1365	1995	2783	3203	3570	3885	4200	4620	4988	5670	-	-
FT2075-8	2"	.437"	893	1155	1575	2100	3255	4358	4987	5460	5775	6090	6720	7140	8085	-	-
FT2125-3	3/4"	.125"	105	142	184	242	347	436	525	593	651	698	788	872	1019	1199	1249
FT2125-4	1"	.125"	105	142	184	242	347	436	525	593	651	698	788	872	1019	1199	1249
FT2125-5	1-1/4"	.250"	294	389	504	662	956	1260	1523	1733	1864	1995	2179	2363	2783	3098	3308
FT2125-6	1-1/2"	.250"	420	546	714	935	1365	1785	2153	2415	2625	2835	3150	3360	3990	4410	4725
FT2125-8	2"	.338"	578	709	924	1286	2048	2730	3150	3413	3675	3990	4410	4850	5775	6405	6930

Note: Capacities based on continuous discharge at steam temperature. Results in accordance with ANSI/ASME PTC 39.1 Condensate Removal Devices for Steam Systems. Significantly greater capacities are realized when condensate temperature is below saturated steam temperature. Appropriate safety factors should be applied to these ratings. Consult the factory for assistance with trap sizing.

DIMENSIONS (in.)

Size	A	B	C	D	WT
3/4" & 1"	5 ¹¹ / ₁₆	5	3 ⁵ / ₁₆	5 ⁵ / ₈	11 lbs.
1-1/4"	6 ¹ / ₈	5 ¹ / ₂	3	5 ³ / ₈	12 lbs.
1-1/2"	8 ¹ / ₄	6	3	8 ¹ / ₄	24 lbs.
2"	10	4 ⁷ / ₈	4 ⁷ / ₈	9 ¹ / ₄	22 lbs.



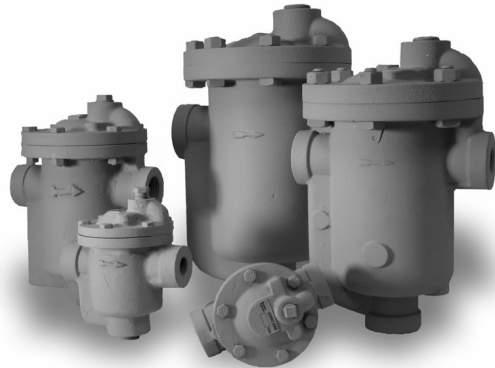


Series 8000 Inverted Bucket Traps

Low to High Pressure Steam Service
PMO: VAC-250 PSIG, Sizes 1/2" to 2.5" NPT

FEATURES

- Series 8000 available in sizes from 1/2" to 2.5" NPT.
- High strength cast iron construction.
- Low maintenance, maximum service & reliability.
- Immediate Condensate discharge at Saturated Steam Temp.
- Meets MIL Spec WW T696.
- Pressure Change Kits available for all sizes and pressure



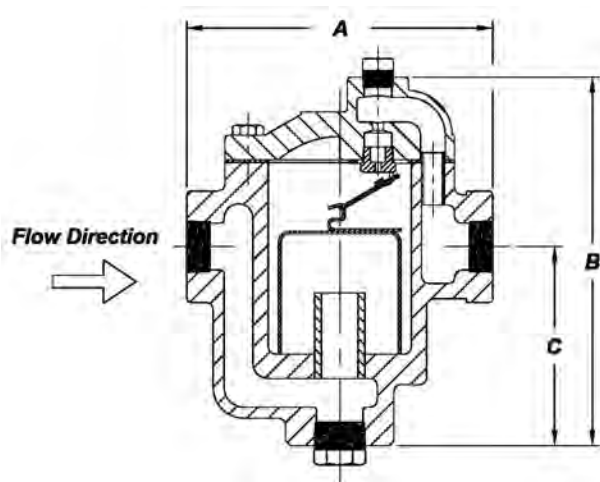
Series 8000 Inverted Bucket Trap

Product Dimensions

Model #	8000	8011	8012	8013	8014	8015	8016
Pipe Size (in.)	1/2, 3/4	1/2, 3/4, 1	1/2, 3/4	1/2, 3/4, 1	1/2, 3/4, 1, 1-1/4	1-1/4, 1-1/2, 2	2, 2-1/2
Prime Plug	1/4"	1/4"	1/2"	3/4"	1"	1-1/2"	2"
"A" Dimension	5"	5"	6-1/2"	7-3/4"	9"	10-1/4"	13"
"B" Dimension	5-7/16"	6-7/8"	9-1/16"	11-3/4"	13-5/8"	16-1/4"	21-5/16"
"C" Dimension	2-3/4"	4-3/4"	5-3/8"	7-1/32"	7-13/16"	8-1/16"	11"
Weight #	5	6	15	27.5	44	71	131
Max Op. Pressure	150	250	250	250	250	250	250

Product Materials

Part	Materials
Cap & Body	ASTM A48 CI 30
Gasket	Compressed Non Asbestos
Bolt/Nut	Grade 5 or 7
Valve & Seat	Stainless Steel
Retainer, Lever, Bucket	Stainless Steel



SERIES 8000 Bucket Traps: Gross Capacity - Lbs. of Condensate Per Hour																			
Model			Pressure Differential (PSIG)																
Type	PMO	Orifice	1/4	1	5	10	15	20	30	60	70	80	100	125	150	180	200	225	250
8000	20	3/16	140	272	460	560	646	698	-	-	-	-	-	-	-	-	-	-	-
	80	1/8	48	112	200	310	370	420	510	640	662	690	-	-	-	-	-	-	-
	125	7/64	24	56	92	150	200	262	350	490	530	570	642	685	-	-	-	-	-
	150	#38	20	54	75	112	153	205	275	385	415	442	482	545	572	-	-	-	-
8011	15	1/4	192	452	835	952	1062	-	-	-	-	-	-	-	-	-	-	-	-
	30	3/16	125	310	545	672	775	882	1000	-	-	-	-	-	-	-	-	-	-
	70	5/32	72	170	185	440	500	590	715	905	952	-	-	-	-	-	-	-	-
	125	1/8	56	135	225	342	396	465	568	715	762	805	862	955	-	-	-	-	-
	200	7/64	32	70	155	232	277	338	410	550	582	615	665	740	812	855	865	-	-
	250	#38	46	82	100	155	192	243	295	426	455	475	525	576	621	675	702	732	765
8012	15	5/16	350	825	1610	1920	2110	-	-	-	-	-	-	-	-	-	-	-	-
	30	1/4	285	510	950	1385	1640	1800	2060	-	-	-	-	-	-	-	-	-	-
	70	3/16	198	425	790	950	1125	1270	1510	2010	2210	-	-	-	-	-	-	-	-
	125	5/32	110	310	585	690	820	910	1075	1450	1555	1660	1810	2020	-	-	-	-	-
	200	1/8	70	180	330	470	510	585	712	990	1060	1111	1240	1375	1525	1580	1605	-	-
	250	7/64	40	130	250	350	375	425	525	725	790	820	915	1020	1111	1180	1230	1285	1320
8013	15	1/2	955	1880	2910	3525	3900	-	-	-	-	-	-	-	-	-	-	-	-
	30	3/8	500	1420	2310	2700	3320	3510	4000	-	-	-	-	-	-	-	-	-	-
	60	5/16	350	950	1745	2050	2525	2630	3140	4440	-	-	-	-	-	-	-	-	-
	80	9/32	310	740	1355	1600	1960	2220	2450	3500	3825	4025	-	-	-	-	-	-	-
	125	1/4	270	620	1110	1320	1620	1820	2020	2850	3120	3320	3610	3925	-	-	-	-	-
	180	7/32	185	500	880	1170	1350	1600	2100	2510	2700	2830	3070	3200	3520	3725	-	-	-
	250	3/16	140	410	715	960	1125	1310	1710	2060	2220	2320	2510	2610	2715	3030	3225	3410	3500
8014	15	5/8	1410	2920	4825	5810	6500	-	-	-	-	-	-	-	-	-	-	-	-
	30	1/2	955	2255	3710	4750	5220	6010	6810	-	-	-	-	-	-	-	-	-	-
	60	3/8	510	1775	2960	3560	4000	4725	5420	6810	-	-	-	-	-	-	-	-	-
	80	11/32	390	1570	2525	2925	3225	3525	4440	5775	6000	6420	-	-	-	-	-	-	-
	125	5/16	320	1210	2000	2500	2750	3125	3510	4820	5275	5625	6220	6710	-	-	-	-	-
	180	9/32	275	960	1510	1925	2220	2360	2910	3800	4260	4510	4820	5520	5710	6010	-	-	-
	250	1/4	190	590	1010	1260	1465	1610	2220	3160	3360	3520	3810	4310	4460	4710	5330	5525	5725
8015	15	3/4	2060	4170	7625	9020	10000	-	-	-	-	-	-	-	-	-	-	-	-
	30	9/16	925	2020	5220	6430	7725	8525	9525	-	-	-	-	-	-	-	-	-	-
	60	7/16	600	2220	3810	5025	6025	6625	7625	9525	-	-	-	-	-	-	-	-	-
	100	3/8	510	1720	3030	3620	4525	5220	6110	8525	9225	9725	10240	-	-	-	-	-	-
	125	11/32	390	1510	2625	3200	3910	4525	5440	7505	8060	8525	9610	10910	-	-	-	-	-
	180	5/16	340	1210	2110	2620	3220	3710	4525	6600	7025	7260	8120	8980	9500	10000	-	-	-
	225	9/32	310	980	1710	2125	2600	2960	3620	5420	5710	5925	6610	7320	7360	7900	9225	9810	-
	250	1/4	260	710	1220	1510	1920	2110	2610	3800	4010	4170	4600	5110	5500	6000	6375	6800	7000
8016	15	1-1/16	4060	8420	14525	17350	19200	-	-	-	-	-	-	-	-	-	-	-	-
	25	7/8	2090	5500	10000	12650	15620	18525	-	-	-	-	-	-	-	-	-	-	-
	40	3/4	1905	4510	8220	10625	12810	15000	18000	-	-	-	-	-	-	-	-	-	-
	60	5/8	1460	3520	6910	8720	10620	12110	14270	19825	-	-	-	-	-	-	-	-	-
	80	9/16	1270	3100	6000	7620	9330	10620	12500	17325	18320	19000	-	-	-	-	-	-	-
	125	1/2	1065	2620	5000	6410	7820	8900	10500	14525	15420	16330	18100	20000	-	-	-	-	-
	180	7/16	915	2220	4190	5550	6660	7525	9520	12420	13330	14200	15800	17500	18500	20000	-	-	-
	250	3/8	590	1820	3410	4525	5410	6110	7500	10125	10825	11510	12830	14300	15610	16900	17500	18500	19000



Thermodynamic Steam Trap

Series TK, 600 PSI (42 Bar)

Product Features

- Stainless Steel Construction ASTM A743
- Stainless Steel Disc AISI 420
- Compact, Lightweight and resistant to water-hammer.
- Condensate discharge close to saturated steam temperature.
- Applications: Hi-Pressure Drip, Tracing, Press Machines, Steam Dryers.
- Available in 3/8", 1/2", 3/4" & 1" NPT



Sizes: 3/8", 1/2", 3/4" & 1" NPT

PMO 600 PSIG @ 850° F

Product Description

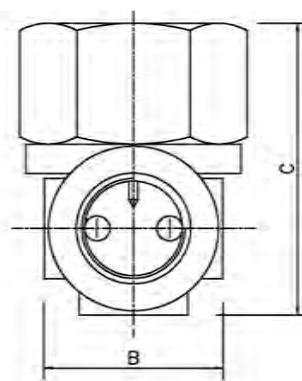
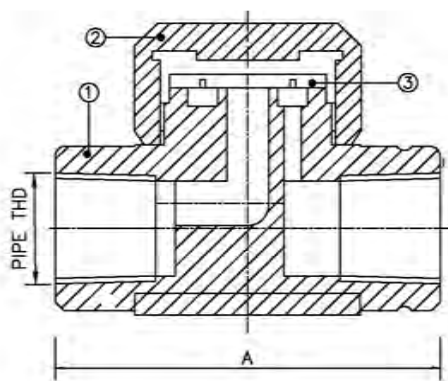
TK Series Thermodynamic steam traps combine reliability, simplicity and efficiency of operation. Designed with just one moving part (stainless steel disc) TD traps discharge with a positive shut-off. Able to withstand superheat, water-hammer, corrosive condensate, freezing and vibration the TK series traps are the first choice for efficient and reliable removal of condensate.

CAPACITIES - Condensate (lbs./hr.)

		Pressure (PSIG)																			
Model	Size	5	10	15	20	25	30	40	50	75	100	150	200	250	300	350	400	450	500	550	600
TK-11	3/8"	186	192	197	202	217	222	233	253	314	379	504	624	715	805	830	905	1075	1125	1190	1295
TK-22	1/2"	316	351	381	416	441	471	516	581	712	827	1022	1167	1302	1443	1568	1673	1778	1883	1964	2064
TK-33	3/4"	431	476	521	566	611	651	722	827	1022	1187	1482	1712	1952	2114	2269	2494	2629	2785	2990	3145
TK-44	1"	681	741	816	886	941	1002	1082	1227	1502	1802	2217	2628	2938	3303	3603	3873	4123	4354	4564	4844

NOTE: Maximum back pressure not to exceed 80% of inlet pressure (measured in absolute pressure) or trap may not properly close.

TK Series Thermodynamic Steam Traps



Specifications

- Sizes: 3/8", 1/2", 3/4" & 1" NPT
- PMO 600 PSIG @ 850° F
- Min Operating Pressure: 4 PSI
- Max Back Pressure: 80% of Inlet Pressure.

DIMENSIONS IN INCHES (MM) & WEIGHT LBS (KGS)

SIZE	A	B	C	WT.
3/8	2 (51)	1 (26)	1 3/4 (44)	0.9 (0.4)
1/2	2 11/16 (68)	1 1/4 (32)	2 (51)	1.3 (0.6)
3/4	2 13/16 (71)	1 9/16 (40)	2 3/8 (60)	2.2 (1.0)
1	3 5/16 (84)	1 7/8 (48)	2 7/8 (73)	3.3 (1.5)

MATERIALS

3	DISC	ST STEEL 420	1	
2	CAP	ASTM A743 Gr. CA40	1	
1	BODY	ASTM A743 Gr. CA40	1	

Thermostatic Steam Trap Repair Elements (Cage Units) for All Makes & Models VAC - 300 PSIG

Features

- Single Source for ALL your thermostatic trap elements
- Available for over 1000 makes and models
- One-piece repair reduces maintenance time and aggravation*
- No special tools needed for installation
- The only repair element available today that is calibrated to ensure maximum sensitivity in the field
- Every element is factory tested, under live steam, before shipment to you
- Improves original trap's performance with a payback in fuel savings within weeks
- Over 100 years repairing millions of steam traps.

Description

The Cage Unit comprises all working parts of a thermostatic steam trap including the seat. All parts are calibrated together under actual steam conditions at our factory and are locked into the precisely correct working relationship within a stainless steel housing. This is a one piece, stand alone, fully removable and testable "trap within a trap." There are no loose parts to contend with; gone is the potential of overtightening, undertightening, crossthreading or misaligning assorted pieces of a "repair kit."

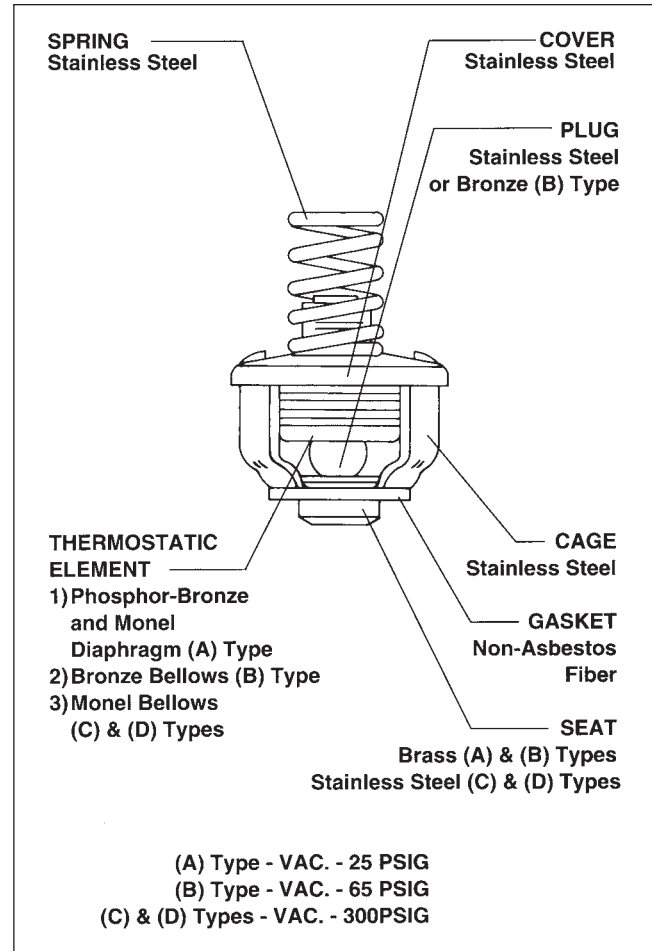
To the user, calibrated construction of the Barnes & Jones Cage Unit offers the assurance that every element will operate with the same performance in the field as it did when tested in our factory. This guarantees a greater sensitivity than could ever be promised with a bag of uncalibrated parts or any uncalibrated element.

Along with the fuel savings that accrues with the use of a more sensitive element, the Cage Unit offers increased efficiency with maintenance as well. The one piece construction allows for removal and testing of the element outside of the original trap body. See the reverse side for testing and maintenance information.

Adaptations of the Cage Unit are available for more than 1000 makes, styles and sizes of thermostatic steam traps for low, medium and high pressure service. Even if your system consists of traps from Dunham-Bush, Hoffman, Nicholson, Sarco, Warren-Webster and any other brands, Barnes & Jones Cage Units can repair them all! Ask for the "Steam Trap Repair Guide" to find the Cage Unit specifically designed to upgrade the working parts in your particular steam trap.

DO NOT be fooled by others offering a quick fix with nuggets, capsules, discs or other control devices for steam traps. Barnes & Jones has been repairing thermostatic and float & thermostatic steam traps for over 100 years and is the acknowledged leader in product performance and design.

*In some instances a new cover is needed on the first installation only. Consult the B & J Steam Trap Repair Guide.



Steam Trap Maintenance & Repair

A faulty steam trap can ...

- waste valuable heating \$\$\$
- destroy condensate pumps
- create hot and cold spots within a heating zone
- cause production inefficiency of process equipment
- produce destructive water hammer
- lead to undue wear on, and premature failure of, other traps

COMMON METHODS OF CHECKING TRAPS

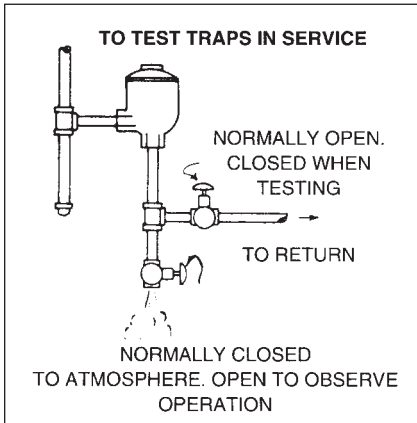


Fig. 1

Some people feel that a hot return line from the trap indicates a leak. Others listen to the trap for a tell tale whistle. Neither method is practical! A trap which is cycling properly will discharge condensate near saturated steam temperature. Obviously the return line will be hot also. In a closed system, piping will carry noises for long distances. With several traps in the vicinity, listening will not always pin point the specific trap that is bad.

Observing the discharge from the traps is the only positive way of checking the operation of a steam trap! Only then can you determine whether the trap is cycling properly and if it closes tightly. To do this in a closed system it is necessary to valve the discharge at each trap, so that the discharge from that trap is isolated from the rest of the system and the condensate can be dumped to atmosphere from the trap body as in Figure 1. It is of course a more

costly installation but worth the added cost in the long run. Traps installed outdoors generally discharge to atmosphere and their operation can be observed readily.

If it is deemed too costly, or is physically impossible, to valve the discharge of every trap, the only possible way to check the trap operation (unless you use Barnes & Jones traps or Cage Units) is to remove each trap, mount it on a test rack and observe the operation. This can be time consuming and costly, perhaps as costly as to forget preventive maintenance and simply wait for each trap to fail badly before repairing it.

B & J MAKES TRAP CHECKING EASY

The Barnes & Jones thermostatic trap or any make of thermostatic trap with a B & J Cage Unit interior can, however, be easily and accurately tested by periodically replacing the Cage Unit, as in Figure 2. Then the Cage Units that have been removed can be tested in a representative trap body that has been attached to a steam line such as in Fig. 1. This can be done with complete accuracy as each Cage Unit operates independently and the trap body acts solely as a housing. This is not possible to do with other manufacturers' elements whose performance is dependent upon the relationship of a screwed in seat, element, lock washer and cover with the original trap body. The Cage Unit combines all these parts in an unalterable working relationship.



Fig. 2

ECM #9

Evaluate chiller and cooling tower systems across the complex

Savings Calculations

Chiller Replacement - Building 34

EXISTING CONDITIONS

Inputs

		Chiller Data				Load %		kW/ton		CHW Design Data			CWP Design Data			CT Fan Design Data		
		Capacity	185	tons		100%		0.516		Flow	284.0	GPM	Flow	640.0	GPM	Motor HP	20.0	HP
		IPLV	0.686	kW/ton		75%		0.592		Head	97	ft. wc.	Head	80	ft. wc.	Motor Eff.	90.0%	
						50%		0.667		Pump Eff.	62.0%		Pump Eff.	78.0%		Motor LF	75.0%	
		kW/ton Calc Method: Actual				25%		0.743		Min. Spd.	80%		Motor Eff.	88.5%				
OAT (F)	Hrs	MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)
97.5	1	76.6	100%	185.0	80	46	0.516	95.5	95	100%	9.0	9	100%	14.0	14	100%	12.4	12
92.5	13	73.1	90%	166.5	80	46	0.546	90.9	1,182	95%	7.8	101	100%	14.0	182	85%	7.9	103
87.5	154	73.1	80%	148.0	80	46	0.576	85.3	13,137	90%	6.7	1,032	100%	14.0	2,152	70%	4.6	705
82.5	429	71.2	70%	129.5	80	46	0.607	78.6	33,700	85%	5.7	2,450	100%	14.0	5,994	55%	2.3	1,000
77.5	552	68.5	60%	111.0	80	46	0.637	70.7	39,018	80%	4.8	2,660	100%	14.0	7,713	40%	1.0	528
72.5	751	66.8	50%	92.5	80	46	0.667	61.7	46,335	80%	4.8	3,619	100%	14.0	10,493	35%	0.7	494
67.5	815	62.9	40%	74.0	80	46	0.697	51.6	42,048	80%	4.8	3,927	100%	14.0	11,388	35%	0.7	536
62.5	858	57.3	30%	55.5	80	46	0.727	40.4	34,638	80%	4.818	4,134	100%	14.0	11,988	35%	0.7	564
57.5	744	53.3	20%	37.0	80	46	0.743	27.5	20,440	80%	4.818	3,585	100%	14.0	10,396	35%	0.7	489
52.5	530	47.6	10%	18.5	80	46	0.743	13.7	7,280	80%	4.818	2,554	100%	14.0	7,405	35%	0.7	349
47.5	379	42.8								0%	0.000	0						
42.5	464	38.5								0%	0.000	0						
37.5	316	33.6								0%	0.000	0						
32.5	153	28.9								0%	0.000	0						
27.5	44	24.4								0%	0.000	0						
22.5	20	20.1								0%	0.000	0						
17.5	8	15.4								0%	0.000	0						
12.5	0	10.5								0%	0.000	0						
7.5	0	5.5								0%	0.000	0						
2.5	0	1.1								0%	0.000	0						
Total		6,231							237,874			24,070			67,725			4,780

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	61.7	4.8	14.0	0.7	81.1
Apr	87.5	85.3	6.7	14.0	4.6	110.6
May	87.5	85.3	6.7	14.0	4.6	110.6
Jun	92.5	90.9	7.8	14.0	7.9	120.6
Jul	92.5	90.9	7.8	14.0	7.9	120.6
Aug	87.5	85.3	6.7	14.0	4.6	110.6
Sep	92.5	90.9	7.8	14.0	7.9	120.6
Oct	97.5	95.5	9.0	14.0	12.4	130.9
Nov	67.5	51.6	4.8	14.0	0.7	71.0
Dec		0.0	0.0	0.0	0.0	0.0
Total		737.5	62.1	125.8	51.2	976.5

Chiller Replacement - Building 34

PROPOSED CONDITIONS

Inputs

Inputs Changed

Chiller Data		Load %	kW/ton
Capacity	185 tons	100%	0.6863
IPLV	0.402 kW/ton	75%	0.4984
		50%	0.3497
		25%	0.3502
kW/ton Calc Method:		Actual	

CHW Design Data			CWP Design Data			CT Fan Design Data		
Flow	284.0 GPM		Flow	640.0 GPM		Motor HP	20.0 HP	
Head	97 ft. wc.		Head	80 ft. wc.		Motor Eff.	90.0%	
Pump Eff.	62.0%		Pump Eff.	78.0%		Motor LF	75.0%	
Motor Eff.	93.0%		Motor Eff.	88.5%				
Min. Spd.	80%							

OAT (F)	Hrs	MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)
97.5	1	76.6	100%	185.0	80	46	0.686	127.0	127	100%	9.0	9	100%	14.0	14	100%	12.4	12
92.5	13	73.1	90%	166.5	80	46	0.611	101.8	1,323	95%	7.8	101	100%	14.0	182	95%	10.8	140
87.5	154	73.1	80%	148.0	80	46	0.536	79.3	12,216	90%	6.7	1,032	100%	14.0	2,152	90%	9.3	1,426
82.5	429	71.2	70%	129.5	80	46	0.469	60.7	26,037	85%	5.7	2,450	100%	14.0	5,994	85%	7.9	3,384
77.5	552	68.5	60%	111.0	80	46	0.409	45.4	25,071	80%	4.8	2,660	100%	14.0	7,713	80%	6.7	3,674
72.5	751	66.8	50%	92.5	80	46	0.350	32.3	24,293	80%	4.8	3,619	100%	14.0	10,493	75%	5.6	4,173
67.5	815	62.9	40%	74.0	80	46	0.350	25.9	21,102	80%	4.8	3,927	100%	14.0	11,388	65%	3.7	3,033
62.5	858	57.3	30%	55.5	80	46	0.350	19.4	16,671	80%	4.8	4,134	100%	14.0	11,988	55%	2.3	2,000
57.5	744	53.3	20%	37.0	80	46	0.350	13.0	9,640	80%	4.8	3,585	100%	14.0	10,396	45%	1.3	989
52.5	530	47.6	10%	18.5	80	46	0.350	6.5	3,434	80%	4.8	2,554	100%	14.0	7,405	35%	0.7	349
47.5	379	42.8																
42.5	464	38.5																
37.5	316	33.6																
32.5	153	28.9																
27.5	44	24.4																
22.5	20	20.1																
17.5	8	15.4																
12.5	0	10.5																
7.5	0	5.5																
2.5	0	1.1																

Total	6,231								139,914		24,070		67,725		19,180			
								Saved kWh	97,959		0		0		-14,400			
								% Savings	41%		0%		0%		-301%			

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	32.3	4.8	14.0	5.6	56.7
Apr	87.5	79.3	6.7	14.0	9.3	109.3
May	87.5	79.3	6.7	14.0	9.3	109.3
Jun	92.5	101.8	7.8	14.0	10.8	134.3
Jul	92.5	101.8	7.8	14.0	10.8	134.3
Aug	87.5	79.3	6.7	14.0	9.3	109.3
Sep	92.5	101.8	7.8	14.0	10.8	134.3
Oct	97.5	127.0	9.0	14.0	12.4	162.4
Nov	67.5	25.9	4.8	14.0	3.7	48.4
Dec		0.0	0.0	0.0	0.0	0.0
Total		728.4	62.1	125.8	81.8	998.1

Utility Savings Summary		% Saved
Existing kW	976.5	
Proposed kW	998.1	
Saved kW	-21.6	-2%
Existing kWh	334,449	
Proposed kWh	250,890	
Saved kWh	83,560	25%

Chiller Replacement - Building 35

EXISTING CONDITIONS

Inputs

Chiller Data				Load %		kW/ton		CHW Design Data				CWP Design Data			CT Fan Design Data				
Capacity		185 tons		100%		0.516		Flow		284.0 GPM		Flow		640.0 GPM		Motor HP		20.0 HP	
IPLV		0.686 kW/ton		75%		0.592		Head		97 ft. wc.		Head		80 ft. wc.		Motor Eff.		90.0%	
kW/ton Calc Method: Actual				50%		0.667		Pump Eff.		62.0%		Pump Eff.		78.0%		Motor LF		75.0%	
				25%		0.743		Min. Spd.		80%		Motor Eff.		88.5%					
MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)			
76.6	100%	185.0	80	46	0.516	95.5	95	100%	9.0	101	100%	14.0	14	100%	12.4	12			
73.1	90%	166.5	80	46	0.546	90.9	1,182	95%	7.8	1032	100%	14.0	182	85%	7.9	103			
73.1	80%	148.0	80	46	0.576	85.3	13,137	90%	6.7	1,032	100%	14.0	2,152	70%	4.6	705			
71.2	70%	129.5	80	46	0.607	78.6	33,700	85%	5.7	2,450	100%	14.0	5,994	55%	2.3	1,000			
68.5	60%	111.0	80	46	0.637	70.7	39,018	80%	4.8	2,660	100%	14.0	7,713	40%	1.0	528			
66.8	50%	92.5	80	46	0.667	61.7	46,335	80%	4.8	3,619	100%	14.0	10,493	35%	0.7	494			
62.9	40%	74.0	80	46	0.697	51.6	42,048	80%	4.8	3,927	100%	14.0	11,388	35%	0.7	536			
57.3	30%	55.5	80	46	0.727	40.4	34,638	80%	4.818	4,134	100%	14.0	11,988	35%	0.7	564			
53.3	20%	37.0	80	46	0.743	27.5	20,440	80%	4.818	3,585	100%	14.0	10,396	35%	0.7	489			
47.6	10%	18.5	80	46	0.743	13.7	7,280	80%	4.818	2,554	100%	14.0	7,405	35%	0.7	349			
42.8								0%	0.000	0									
38.5								0%	0.000	0									
33.6								0%	0.000	0									
28.9								0%	0.000	0									
24.4								0%	0.000	0									
20.1								0%	0.000	0									
15.4								0%	0.000	0									
10.5								0%	0.000	0									
5.5								0%	0.000	0									
1.1								0%	0.000	0									
237,874								24,070			67,725			4,780					

Chiller Replacement - Building 35

PROPOSED CONDITIONS

Inputs

Inputs Changed

kW/ton Calc Method: Actual

Chiller Data		Load %	kW/ton
Capacity	185 tons	100%	0.6863
IPLV	0.402 kW/ton	75%	0.4984
		50%	0.3497
		25%	0.3502

CHW Design Data			CWP Design Data			CT Fan Design Data		
Flow	284.0 GPM		Flow	640.0 GPM		Motor HP	20.0 HP	
Head	97 ft. wc.		Head	80 ft. wc.		Motor Eff.	90.0%	
Pump Eff.	62.0%		Pump Eff.	78.0%		Motor LF	75.0%	
Motor Eff.	93.0%		Motor Eff.	88.5%				
Min. Spd.	80%							

OAT (F)	Hrs	MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)
97.5	1	76.6	100%	185.0	80	46	0.686	127.0	127	100%	9.0	9	100%	14.0	14	100%	12.4	12
92.5	13	73.1	90%	166.5	80	46	0.611	101.8	1,323	95%	7.8	101	100%	14.0	182	95%	10.8	140
87.5	154	73.1	80%	148.0	80	46	0.536	79.3	12,216	90%	6.7	1,032	100%	14.0	2,152	90%	9.3	1,426
82.5	429	71.2	70%	129.5	80	46	0.469	60.7	26,037	85%	5.7	2,450	100%	14.0	5,994	85%	7.9	3,384
77.5	552	68.5	60%	111.0	80	46	0.409	45.4	25,071	80%	4.8	2,660	100%	14.0	7,713	80%	6.7	3,674
72.5	751	66.8	50%	92.5	80	46	0.350	32.3	24,293	80%	4.8	3,619	100%	14.0	10,493	75%	5.6	4,173
67.5	815	62.9	40%	74.0	80	46	0.350	25.9	21,102	80%	4.8	3,927	100%	14.0	11,388	65%	3.7	3,033
62.5	858	57.3	30%	55.5	80	46	0.350	19.4	16,671	80%	4.8	4,134	100%	14.0	11,988	55%	2.3	2,000
57.5	744	53.3	20%	37.0	80	46	0.350	13.0	9,640	80%	4.8	3,585	100%	14.0	10,396	45%	1.3	989
52.5	530	47.6	10%	18.5	80	46	0.350	6.5	3,434	80%	4.8	2,554	100%	14.0	7,405	35%	0.7	349
47.5	379	42.8																
42.5	464	38.5																
37.5	316	33.6																
32.5	153	28.9																
27.5	44	24.4																
22.5	20	20.1																
17.5	8	15.4																
12.5	0	10.5																
7.5	0	5.5																
2.5	0	1.1																

Total	6,231								139,914			24,070			67,725			19,180
								Saved kWh	97,959			0			0			-14,400
								% Savings	41%			0%			0%			-301%

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	32.3	4.8	14.0	5.6	56.7
Apr	87.5	79.3	6.7	14.0	9.3	109.3
May	87.5	79.3	6.7	14.0	9.3	109.3
Jun	92.5	101.8	7.8	14.0	10.8	134.3
Jul	92.5	101.8	7.8	14.0	10.8	134.3
Aug	87.5	79.3	6.7	14.0	9.3	109.3
Sep	92.5	101.8	7.8	14.0	10.8	134.3
Oct	97.5	127.0	9.0	14.0	12.4	162.4
Nov	67.5	25.9	4.8	14.0	3.7	48.4
Dec		0.0	0.0	0.0	0.0	0.0
Total		728.4	62.1	125.8	81.8	998.1

Utility Savings Summary		% Saved
Existing kW	976.5	
Proposed kW	998.1	
Saved kW	-21.6	-2%
Existing kWh	334,449	
Proposed kWh	250,890	
Saved kWh	83,560	25%

Chiller Replacement - Building 37

EXISTING CONDITIONS

Inputs

KW/ton Calc Method:		Chiller Data		Load %		kW/ton		CHW Design Data				CWP Design Data			CT Fan Design Data		
		Capacity	215 tons	100%	0.516	Flow	320.0 GPM	Flow	788.0 GPM	Motor HP	25.0 HP						
		IPLV	0.407 kW/ton	75%	0.592	Head	102 ft. wc.	Head	48 ft. wc.	Motor Eff.	90.0%						
				50%	0.667	Pump Eff.	70.0%	Pump Eff.	78.0%	Motor LF	75.0%						
				25%	0.743	Motor Eff.	93.0%	Motor Eff.	88.5%								
MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)	
76.6	100%	215.0	80	46	0.516	110.9	111	100%	9.4	9	100%	10.3	10	100%	15.5	16	
73.1	90%	193.5	80	46	0.546	105.7	1,374	95%	8.2	106	100%	10.3	134	85%	9.9	128	
73.1	80%	172.0	80	46	0.576	99.1	15,268	90%	7.0	1,083	100%	10.3	1,590	70%	5.7	882	
71.2	70%	150.5	80	46	0.607	91.3	39,165	85%	6.0	2,571	100%	10.3	4,428	55%	2.9	1,250	
68.5	60%	129.0	80	46	0.637	82.1	45,345	80%	5.1	2,791	100%	10.3	5,698	40%	1.2	659	
66.8	50%	107.5	80	46	0.667	71.7	53,849	80%	5.1	3,798	100%	10.3	7,752	35%	0.8	617	
62.9	40%	86.0	80	46	0.697	60.0	48,867	80%	5.1	4,121	100%	10.3	8,413	35%	0.8	670	
57.3	30%	64.5	80	46	0.727	46.9	40,255	80%	5.1	4,339	100%	10.3	8,856	35%	0.8	705	
53.3	20%	43.0	80	46	0.743	31.9	23,754	80%	5.1	3,762	100%	10.3	7,680	35%	0.8	612	
47.6	0%	0.0	80	46	0.743	0.0	0	0%	0.0	0		0.0	0		0.0	0	
42.8								0%	0.0	0							
38.5								0%	0.0	0							
33.6								0%	0.0	0							
28.9								0%	0.0	0							
24.4								0%	0.0	0							
20.1								0%	0.0	0							
15.4								0%	0.0	0							
10.5								0%	0.0	0							
5.5								0%	0.0	0							
1.1								0%	0.0	0							
267,987								22,580			44,561			5,539			

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	71.7	5.1	10.3	0.8	87.9
Apr	87.5	99.1	7.0	10.3	5.7	122.2
May	87.5	99.1	7.0	10.3	5.7	122.2
Jun	92.5	105.7	8.2	10.3	9.9	134.1
Jul	92.5	105.7	8.2	10.3	9.9	134.1
Aug	87.5	99.1	7.0	10.3	5.7	122.2
Sep	92.5	105.7	8.2	10.3	9.9	134.1
Oct	97.5	110.9	9.4	10.3	15.5	146.2
Nov	67.5	60.0	5.1	10.3	0.8	76.2
Dec		0.0	0.0	0.0	0.0	0.0
Total		857.1	65.2	92.9	63.9	1,079.1

Chiller Replacement - Building 37

PROPOSED CONDITIONS

Inputs

Inputs Changed

Chiller Data				Load %		kW/ton		CHW Design Data				CWP Design Data				CT Fan Design Data		
Capacity	215	tons		100%		0.6471		Flow	320.0	GPM		Flow	788.0	GPM		Motor HP	25.0	HP
IPLV	0.407	kW/ton		75%		0.4913		Head	102	ft. wc.		Head	48	ft. wc.		Motor Eff.	90.0%	
				50%		0.3601		Pump Eff.	70.0%			Pump Eff.	78.0%			Motor LF	75.0%	
				25%		0.3557		Min. Spd.	80%			Motor Eff.	88.5%					
kW/ton Calc Method:				Actual														

OAT (F)	Hrs	MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)
97.5	1	76.6	100%	215.0	80	46	0.647	139.1	139	100%	9.4	9	100%	10.3	10	100%	15.5	16
92.5	13	73.1	90%	193.5	80	46	0.585	113.2	1,471	95%	8.2	106	100%	10.3	134	95%	13.5	175
87.5	154	73.1	80%	172.0	80	46	0.522	89.9	13,839	90%	7.0	1,083	100%	10.3	1,590	90%	11.6	1,782
82.5	429	71.2	70%	150.5	80	46	0.465	70.0	30,026	85%	6.0	2,571	100%	10.3	4,428	85%	9.9	4,230
77.5	552	68.5	60%	129.0	80	46	0.413	53.2	29,379	80%	5.1	2,791	100%	10.3	5,698	80%	8.3	4,593
72.5	751	66.8	50%	107.5	80	46	0.360	38.7	29,072	80%	5.1	3,798	100%	10.3	7,752	75%	6.9	5,216
67.5	815	62.9	40%	86.0	80	46	0.358	30.8	25,116	80%	5.1	4,121	100%	10.3	8,413	65%	4.7	3,792
62.5	858	57.3	30%	64.5	80	46	0.357	23.0	19,733	80%	5.1	4,339	100%	10.3	8,856	55%	2.9	2,500
57.5	744	53.3	20%	43.0	80	46	0.356	15.3	11,380	80%	5.1	3,762	100%	10.3	7,680	45%	1.7	1,236
52.5	530	47.6	0%	0.0	80	46	0.356	0.0	0		0.0	0		0.0	0		0.0	0
47.5	379	42.8																
42.5	464	38.5																
37.5	316	33.6																
32.5	153	28.9																
27.5	44	24.4																
22.5	20	20.1																
17.5	8	15.4																
12.5	0	10.5																
7.5	0	5.5																
2.5	0	1.1																

Total	6,231		160,155		22,580		44,561		23,539
		Saved kWh	107,832		0		0		-18,000
		% Savings	40%		0%		0%		-325%

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	38.7	5.1	10.3	6.9	61.0
Apr	87.5	89.9	7.0	10.3	11.6	118.8
May	87.5	89.9	7.0	10.3	11.6	118.8
Jun	92.5	113.2	8.2	10.3	13.5	145.1
Jul	92.5	113.2	8.2	10.3	13.5	145.1
Aug	87.5	89.9	7.0	10.3	11.6	118.8
Sep	92.5	113.2	8.2	10.3	13.5	145.1
Oct	97.5	139.1	9.4	10.3	15.5	174.4
Nov	67.5	30.8	5.1	10.3	4.7	50.8
Dec		0.0	0.0	0.0	0.0	0.0
Total		817.7	65.2	92.9	102.2	1,078.0

Utility Savings Summary		% Saved
Existing kW	1,079.1	
Proposed kW	1,078.0	
Saved kW	1.1	0%
Existing kWh	340,668	
Proposed kWh	250,836	
Saved kWh	89,832	26%

CHW System RCx - Building 34

EXISTING CONDITIONS

Inputs

		Chiller Data				Load %		kW/ton		CHW Design Data			CWP Design Data			CT Fan Design Data		
		Capacity	185	tons		100%		0.516		Flow	185.0	GPM	Flow	640.0	GPM	Motor HP	20.0	HP
		IPLV	0.686	kW/ton		75%		0.619		Head	104	ft. wc.	Head	80	ft. wc.	Motor Eff.	90.0%	
						50%		0.722		Pump Eff.	62.0%		Pump Eff.	78.0%		Motor LF	75.0%	
		kW/ton Calc Method:	Actual			25%		0.825		Min. Spd.	100.0%							
OAT (F)	Hrs	MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)
97.5	1	76.6	100%	185.0	80	46	0.516	95.5	95	100%	6.3	6	100%	14.0	14	100%	12.4	12
92.5	13	73.1	90%	166.5	80	46	0.557	92.8	1,206	100%	6.3	82	100%	14.0	182	85%	7.9	103
87.5	154	73.1	80%	148.0	80	46	0.598	88.6	13,639	100%	6.3	968	100%	14.0	2,152	70%	4.6	705
82.5	429	71.2	70%	129.5	80	46	0.640	82.8	35,533	100%	6.3	2,697	100%	14.0	5,994	55%	2.3	1,000
77.5	552	68.5	60%	111.0	80	46	0.681	75.6	41,714	100%	6.3	3,470	100%	14.0	7,713	40%	1.0	528
72.5	751	66.8	50%	92.5	80	46	0.722	66.8	50,156	100%	6.3	4,721	100%	14.0	10,493	35%	0.7	494
67.5	815	62.9	40%	74.0	80	46	0.763	56.5	46,029	100%	6.3	5,123	100%	14.0	11,388	35%	0.7	536
62.5	858	57.3	30%	55.5	80	46	0.804	44.6	38,305	100%	6.3	5,393	100%	14.0	11,988	35%	0.7	564
57.5	744	53.3	20%	37.0	80	46	0.825	30.5	22,711	100%	6.3	4,677	100%	14.0	10,396	35%	0.7	489
52.5	530	47.6	10%	18.5	80	46	0.825	15.3	8,089	100%	6.3	3,332	100%	14.0	7,405	35%	0.7	349
47.5	379	42.8								100%	6.3	2,382						
42.5	464	38.5								100%	6.3	2,917						
37.5	316	33.6								100%	6.3	1,986						
32.5	153	28.9								100%	6.3	962						
27.5	44	24.4								100%	6.3	277						
22.5	20	20.1								100%	6.3	126						
17.5	8	15.4								100%	6.3	50						
12.5	0	10.5								100%	6.3	0						
7.5	0	5.5								100%	6.3	0						
2.5	0	1.1								100%	6.3	0						
Total	6,231								257,476			39,168			67,725			4,780

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	66.8	6.3	14.0	0.7	87.7
Apr	87.5	88.6	6.3	14.0	4.6	113.4
May	87.5	88.6	6.3	14.0	4.6	113.4
Jun	92.5	92.8	6.3	14.0	7.9	120.9
Jul	92.5	92.8	6.3	14.0	7.9	120.9
Aug	87.5	88.6	6.3	14.0	4.6	113.4
Sep	92.5	92.8	6.3	14.0	7.9	120.9
Oct	97.5	95.5	6.3	14.0	12.4	128.2
Nov	67.5	56.5	6.3	14.0	0.7	77.4
Dec		0.0	0.0	0.0	0.0	0.0
Total		762.7	56.6	125.8	51.2	996.2

CHW System RCx - Building 34

PROPOSED CONDITIONS

Inputs

Inputs Changed

kW/ton Calc Method: Actual

Chiller Data		Load % kW/ton	
Capacity	185 tons	100%	0.516
IPLV	kW/ton	75%	0.592
		50%	0.667
		25%	0.743

90%

CHW Design Data			CWP Design Data			CT Fan Design Data		
Flow	284.0 GPM		Flow	640.0 GPM		Motor HP	20.0 HP	
Head	97 ft. wc.		Head	80 ft. wc.		Motor Eff.	90.0%	
Pump Eff.	62.0%		Pump Eff.	78.0%		Motor LF	75.0%	
Motor Eff.	93.0%		Motor Eff.	88.5%				
Min. Spd.	80%							

OAT (F)	Hrs	MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)
97.5	1	76.6	100%	185.0	80	46	0.516	95.5	95	100%	9.0	9	100%	14.0	14	100%	12.4	12
92.5	13	73.1	90%	166.5	80	46	0.546	90.9	1,182	95%	7.8	101	100%	14.0	182	85%	7.9	103
87.5	154	73.1	80%	148.0	80	46	0.576	85.3	13,137	90%	6.7	1,032	100%	14.0	2,152	70%	4.6	705
82.5	429	71.2	70%	129.5	80	46	0.607	78.6	33,700	85%	5.7	2,450	100%	14.0	5,994	55%	2.3	1,000
77.5	552	68.5	60%	111.0	80	46	0.637	70.7	39,018	80%	4.8	2,660	100%	14.0	7,713	40%	1.0	528
72.5	751	66.8	50%	92.5	80	46	0.667	61.7	46,335	80%	4.8	3,619	100%	14.0	10,493	35%	0.7	494
67.5	815	62.9	40%	74.0	80	46	0.697	51.6	42,048	80%	4.8	3,927	100%	14.0	11,388	35%	0.7	536
62.5	858	57.3	30%	55.5	80	46	0.727	40.4	34,638	80%	4.8	4,134	100%	14.0	11,988	35%	0.7	564
57.5	744	53.3	20%	37.0	80	46	0.743	27.5	20,440	80%	4.8	3,585	100%	14.0	10,396	35%	0.7	489
52.5	530	47.6	10%	18.5	80	46	0.743	13.7	7,280	80%	4.8	2,554	100%	14.0	7,405	35%	0.7	349
47.5	379	42.8								0%	0.0	0						
42.5	464	38.5								0%	0.0	0						
37.5	316	33.6								0%	0.0	0						
32.5	153	28.9								0%	0.0	0						
27.5	44	24.4								0%	0.0	0						
22.5	20	20.1								0%	0.0	0						
17.5	8	15.4								0%	0.0	0						
12.5	0	10.5								0%	0.0	0						
7.5	0	5.5								0%	0.0	0						
2.5	0	1.1								0%	0.0	0						

Total	6,231								237,874			24,070			67,725			4,780
								Saved kWh	19,602			15,098	\$ 3,170		0			0
								% Savings	8%			39%			0%			0%

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	61.7	4.8	14.0	0.7	81.1
Apr	87.5	85.3	6.7	14.0	4.6	110.6
May	87.5	85.3	6.7	14.0	4.6	110.6
Jun	92.5	90.9	7.8	14.0	7.9	120.6
Jul	92.5	90.9	7.8	14.0	7.9	120.6
Aug	87.5	85.3	6.7	14.0	4.6	110.6
Sep	92.5	90.9	7.8	14.0	7.9	120.6
Oct	97.5	95.5	9.0	14.0	12.4	130.9
Nov	67.5	51.6	4.8	14.0	0.7	71.0
Dec		0.0	0.0	0.0	0.0	0.0
Total		737.5	62.1	125.8	51.2	976.5

Utility Savings Summary		% Saved
Existing kW	996.2	
Proposed kW	976.5	
Saved kW	19.7	2%
Existing kWh	369,149	
Proposed kWh	334,449	
Saved kWh	34,700	9%

CHW System RCx - Building 35

EXISTING CONDITIONS

Inputs

Chiller Data				Load %		kW/ton		CHW Design Data				CWP Design Data			CT Fan Design Data				
Capacity		185 tons		100%		0.516		Flow		185.0 GPM		Flow		640.0 GPM		Motor HP		20.0 HP	
IPLV		0.686 kW/ton		75%		0.619		Head		104 ft. wc.		Head		80 ft. wc.		Motor Eff.		90.0%	
kW/ton Calc Method: Actual				50%		0.722		Pump Eff.		62.0%		Pump Eff.		78.0%		Motor LF		75.0%	
				25%		0.825		Motor Eff.		93.0%		Motor Eff.		88.5%					
MCWB	CHW Load	CHW Load	CWST	CHWST	Chiller Eff.	Chiller Power	Chiller Energy	CHWP Speed	CHWP Power	CHWP Energy	CWP Speed	CWP Power	CWP Energy	CT Fan Speed	CT Fan Power	CT Fan Energy			
(F)	(%)	(tons)	(F)	(F)	(kW/ton)	(kW)	(kWh)	(%)	(kW)	(kWh)	(%)	(kW)	(kWh)	(%)	(kW)	(kWh)			
76.6	100%	185.0	80	46	0.516	95.5	95	100%	6.3	6	100%	14.0	14	100%	12.4	12			
73.1	90%	166.5	80	46	0.557	92.8	1,206	100%	6.3	82	100%	14.0	182	85%	7.9	103			
73.1	80%	148.0	80	46	0.598	88.6	13,639	100%	6.3	968	100%	14.0	2,152	70%	4.6	705			
71.2	70%	129.5	80	46	0.640	82.8	35,533	100%	6.3	2,697	100%	14.0	5,994	55%	2.3	1,000			
68.5	60%	111.0	80	46	0.681	75.6	41,714	100%	6.3	3,470	100%	14.0	7,713	40%	1.0	528			
66.8	50%	92.5	80	46	0.722	66.8	50,156	100%	6.3	4,721	100%	14.0	10,493	35%	0.7	494			
62.9	40%	74.0	80	46	0.763	56.5	46,029	100%	6.3	5,123	100%	14.0	11,388	35%	0.7	536			
57.3	30%	55.5	80	46	0.804	44.6	38,305	100%	6.3	5,393	100%	14.0	11,988	35%	0.7	564			
53.3	20%	37.0	80	46	0.825	30.5	22,711	100%	6.3	4,677	100%	14.0	10,396	35%	0.7	489			
47.6	10%	18.5	80	46	0.825	15.3	8,089	100%	6.3	3,332	100%	14.0	7,405	35%	0.7	349			
42.8								100%	6.3	2,382									
38.5								100%	6.3	2,917									
33.6								100%	6.3	1,986									
28.9								100%	6.3	962									
24.4								100%	6.3	277									
20.1								100%	6.3	126									
15.4								100%	6.3	50									
10.5								100%	6.3	0									
5.5								100%	6.3	0									
1.1								100%	6.3	0									
257,476								39,168			67,725			4,780					

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	66.8	6.3	14.0	0.7	87.7
Apr	87.5	88.6	6.3	14.0	4.6	113.4
May	87.5	88.6	6.3	14.0	4.6	113.4
Jun	92.5	92.8	6.3	14.0	7.9	120.9
Jul	92.5	92.8	6.3	14.0	7.9	120.9
Aug	87.5	88.6	6.3	14.0	4.6	113.4
Sep	92.5	92.8	6.3	14.0	7.9	120.9
Oct	97.5	95.5	6.3	14.0	12.4	128.2
Nov	67.5	56.5	6.3	14.0	0.7	77.4
Dec		0.0	0.0	0.0	0.0	0.0
Total		762.7	56.6	125.8	51.2	996.2

CHW System RCx - Building 35

PROPOSED CONDITIONS

Inputs

Inputs Changed

kW/ton Calc Method: Actual

Chiller Data		Load % kW/ton	
Capacity	185 tons	100%	0.516
IPLV	kW/ton	75%	0.592
		50%	0.667
		25%	0.743

90%

CHW Design Data			CWP Design Data			CT Fan Design Data		
Flow	284.0 GPM		Flow	640.0 GPM		Motor HP	20.0 HP	
Head	97 ft. wc.		Head	80 ft. wc.		Motor Eff.	90.0%	
Pump Eff.	62.0%		Pump Eff.	78.0%		Motor LF	75.0%	
Motor Eff.	93.0%		Motor Eff.	88.5%				
Min. Spd.	80%							

OAT (F)	Hrs	MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)
97.5	1	76.6	100%	185.0	80	46	0.516	95.5	95	100%	9.0	9	100%	14.0	14	100%	12.4	12
92.5	13	73.1	90%	166.5	80	46	0.546	90.9	1,182	95%	7.8	101	100%	14.0	182	85%	7.9	103
87.5	154	73.1	80%	148.0	80	46	0.576	85.3	13,137	90%	6.7	1,032	100%	14.0	2,152	70%	4.6	705
82.5	429	71.2	70%	129.5	80	46	0.607	78.6	33,700	85%	5.7	2,450	100%	14.0	5,994	55%	2.3	1,000
77.5	552	68.5	60%	111.0	80	46	0.637	70.7	39,018	80%	4.8	2,660	100%	14.0	7,713	40%	1.0	528
72.5	751	66.8	50%	92.5	80	46	0.667	61.7	46,335	80%	4.8	3,619	100%	14.0	10,493	35%	0.7	494
67.5	815	62.9	40%	74.0	80	46	0.697	51.6	42,048	80%	4.8	3,927	100%	14.0	11,388	35%	0.7	536
62.5	858	57.3	30%	55.5	80	46	0.727	40.4	34,638	80%	4.8	4,134	100%	14.0	11,988	35%	0.7	564
57.5	744	53.3	20%	37.0	80	46	0.743	27.5	20,440	80%	4.8	3,585	100%	14.0	10,396	35%	0.7	489
52.5	530	47.6	10%	18.5	80	46	0.743	13.7	7,280	80%	4.8	2,554	100%	14.0	7,405	35%	0.7	349
47.5	379	42.8								0%	0.0	0						
42.5	464	38.5								0%	0.0	0						
37.5	316	33.6								0%	0.0	0						
32.5	153	28.9								0%	0.0	0						
27.5	44	24.4								0%	0.0	0						
22.5	20	20.1								0%	0.0	0						
17.5	8	15.4								0%	0.0	0						
12.5	0	10.5								0%	0.0	0						
7.5	0	5.5								0%	0.0	0						
2.5	0	1.1								0%	0.0	0						
Total	6,231								237,874			24,070			67,725			4,780

Saved kWh	19,602	15,098	\$ 3,170	0	0
% Savings	8%	39%		0%	0%

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	61.7	4.8	14.0	0.7	81.1
Apr	87.5	85.3	6.7	14.0	4.6	110.6
May	87.5	85.3	6.7	14.0	4.6	110.6
Jun	92.5	90.9	7.8	14.0	7.9	120.6
Jul	92.5	90.9	7.8	14.0	7.9	120.6
Aug	87.5	85.3	6.7	14.0	4.6	110.6
Sep	92.5	90.9	7.8	14.0	7.9	120.6
Oct	97.5	95.5	9.0	14.0	12.4	130.9
Nov	67.5	51.6	4.8	14.0	0.7	71.0
Dec		0.0	0.0	0.0	0.0	0.0
Total		737.5	62.1	125.8	51.2	976.5

Utility Savings Summary		% Saved
Existing kW	996.2	2%
Proposed kW	976.5	
Saved kW	19.7	
Existing kWh	369,149	9%
Proposed kWh	334,449	
Saved kWh	34,700	

CHW System RCx - Building 37

EXISTING CONDITIONS

Inputs

kW/ton Calc Method:		Chiller Data		Load %		kW/ton		CHW Design Data				CWP Design Data			CT Fan Design Data		
		Capacity	215 tons	100%	0.516	Flow	320.0 GPM	Flow	788.0 GPM	Motor HP	25.0 HP						
		IPLV	0.686 kW/ton	75%	0.619	Head	102 ft. wc.	Head	48 ft. wc.	Motor Eff.	90.0%						
				50%	0.722	Pump Eff.	70.0%	Pump Eff.	78.0%	Motor LF	75.0%						
				25%	0.825	Motor Eff.	93.0%	Motor Eff.	88.5%								
Min. Spd.	100.0%																
MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)	
76.6	100%	215.0	80	46	0.516	110.9	111	105%	10.8	11	100%	10.3	10	100%	15.5	16	
73.1	90%	193.5	80	46	0.557	107.8	1,402	105%	10.8	141	100%	10.3	134	85%	9.9	128	
73.1	80%	172.0	80	46	0.598	102.9	15,850	105%	10.8	1,667	100%	10.3	1,590	70%	5.7	882	
71.2	70%	150.5	80	46	0.640	96.3	41,295	105%	10.8	4,645	100%	10.3	4,428	55%	2.9	1,250	
68.5	60%	129.0	80	46	0.681	87.8	48,478	105%	10.8	5,977	100%	10.3	5,698	40%	1.2	659	
66.8	50%	107.5	80	46	0.722	77.6	58,289	105%	10.8	8,132	100%	10.3	7,752	35%	0.8	617	
62.9	40%	86.0	80	46	0.763	65.6	53,493	105%	10.8	8,825	100%	10.3	8,413	35%	0.8	670	
57.3	30%	64.5	80	46	0.804	51.9	44,516	105%	10.8	9,290	100%	10.3	8,856	35%	0.8	705	
53.3	20%	43.0	80	46	0.825	35.5	26,393	105%	10.8	8,056	100%	10.3	7,680	35%	0.8	612	
47.6	0%	0.0	80	46	0.825	0.0	0		0.0	0		0.0	0		0.0	0	
42.8																	
38.5																	
33.6																	
28.9																	
24.4																	
20.1																	
15.4																	
10.5																	
5.5																	
1.1																	
289,828								46,744			44,561			5,539			

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	77.6	10.8	10.3	0.8	99.6
Apr	87.5	102.9	10.8	10.3	5.7	129.8
May	87.5	102.9	10.8	10.3	5.7	129.8
Jun	92.5	107.8	10.8	10.3	9.9	138.8
Jul	92.5	107.8	10.8	10.3	9.9	138.8
Aug	87.5	102.9	10.8	10.3	5.7	129.8
Sep	92.5	107.8	10.8	10.3	9.9	138.8
Oct	97.5	110.9	10.8	10.3	15.5	147.6
Nov	67.5	65.6	10.8	10.3	0.8	87.6
Dec		0.0	0.0	0.0	0.0	0.0
Total		886.4	97.5	92.9	63.9	1,140.7

CHW System RCx - Building 37

PROPOSED CONDITIONS

Inputs

Values Changed

kW/ton Calc Method: Actual

Chiller Data		Load %	kW/ton
Capacity	215 tons	100%	0.516
IPLV	0.407 kW/ton	75%	0.592
		50%	0.667
		25%	0.743

90%

CHW Design Data			CWP Design Data			CT Fan Design Data		
Flow	320.0 GPM		Flow	788.0 GPM		Motor HP	25.0 HP	
Head	102 ft. wc.		Head	48 ft. wc.		Motor Eff.	90.0%	
Pump Eff.	70.0%		Pump Eff.	78.0%		Motor LF	75.0%	
Motor Eff.	93.0%		Motor Eff.	88.5%				
Min. Spd.	80%							

OAT (F)	Hrs	MCWB (F)	CHW Load (%)	CHW Load (tons)	CWST (F)	CHWST (F)	Chiller Eff. (kW/ton)	Chiller Power (kW)	Chiller Energy (kWh)	CHWP Speed (%)	CHWP Power (kW)	CHWP Energy (kWh)	CWP Speed (%)	CWP Power (kW)	CWP Energy (kWh)	CT Fan Speed (%)	CT Fan Power (kW)	CT Fan Energy (kWh)
97.5	1	76.6	100%	215.0	80	46	0.516	110.9	111	100%	9.4	9	100%	10.3	10	100%	15.5	16
92.5	13	73.1	90%	193.5	80	46	0.546	105.7	1,374	95%	8.2	106	100%	10.3	134	85%	9.9	128
87.5	154	73.1	80%	172.0	80	46	0.576	99.1	15,268	90%	7.0	1,083	100%	10.3	1,590	70%	5.7	882
82.5	429	71.2	70%	150.5	80	46	0.607	91.3	39,165	85%	6.0	2,571	100%	10.3	4,428	55%	2.9	1,250
77.5	552	68.5	60%	129.0	80	46	0.637	82.1	45,345	80%	5.1	2,791	100%	10.3	5,698	40%	1.2	659
72.5	751	66.8	50%	107.5	80	46	0.667	71.7	53,849	80%	5.1	3,798	100%	10.3	7,752	35%	0.8	617
67.5	815	62.9	40%	86.0	80	46	0.697	60.0	48,867	80%	5.1	4,121	100%	10.3	8,413	35%	0.8	670
62.5	858	57.3	30%	64.5	80	46	0.727	46.9	40,255	80%	5.1	4,339	100%	10.3	8,856	35%	0.8	705
57.5	744	53.3	20%	43.0	80	46	0.743	31.9	23,754	80%	5.1	3,762	100%	10.3	7,680	35%	0.8	612
52.5	530	47.6	0%	0.0	80	46	0.743	0.0	0	0%	0.0	0		0.0	0	0%	0.0	0
47.5	379	42.8																
42.5	464	38.5																
37.5	316	33.6																
32.5	153	28.9																
27.5	44	24.4																
22.5	20	20.1																
17.5	8	15.4																
12.5	0	10.5																
7.5	0	5.5																
2.5	0	1.1																

Total	6,231								267,987		22,580		44,561		5,539
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Saved kWh	21,841	24,164	0	0
% Savings	8%	52%	0%	0%

Month	Peak OAT	Chiller Demand (kW)	CHWP Demand (kW)	CWP Demand (kW)	CT Fan Demand (kW)	Total Demand (kW)
Jan		0.0	0.0	0.0	0.0	0.0
Feb		0.0	0.0	0.0	0.0	0.0
Mar	72.5	71.7	5.1	10.3	0.8	87.9
Apr	87.5	99.1	7.0	10.3	5.7	122.2
May	87.5	99.1	7.0	10.3	5.7	122.2
Jun	92.5	105.7	8.2	10.3	9.9	134.1
Jul	92.5	105.7	8.2	10.3	9.9	134.1
Aug	87.5	99.1	7.0	10.3	5.7	122.2
Sep	92.5	105.7	8.2	10.3	9.9	134.1
Oct	97.5	110.9	9.4	10.3	15.5	146.2
Nov	67.5	60.0	5.1	10.3	0.8	76.2
Dec		0.0	0.0	0.0	0.0	0.0
Total		857.1	65.2	92.9	63.9	1,079.1

Utility Savings Summary		% Saved
Existing kW	1,140.7	
Proposed kW	1,079.1	
Saved kW	61.6	5%
Existing kWh	386,672	
Proposed kWh	340,668	
Saved kWh	46,005	12%

ECM #9

Evaluate chiller and cooling tower systems across the complex

Equipment Information Sheets

ECY-S1000 Series

Control, Automation and
Connectivity Servers

ECY PSE™



Overview

The ECY-CSC is sized to cost-effectively meet the requirements of any HVAC application from small to medium to large systems. The most capable Connected System Controller model can be expanded to support up to 20 input/output (I/O) modules (up to 320 I/Os) while being able to adapt to new requirements as the need arises.

A connecting cable is used to connect successive rows of modules within a controls' cabinet to provide power and communication.

Features & Benefits

- Support for a range of communication protocols such as BACnet MS/TP, Modbus RTU, Modbus TCP, and M-Bus
- With the RESTful API, data can be accessed from different applications, such as energy dashboards, analytics tools, and mobile applications
- Expandable as needs increase to support up to 20 input/output (I/O) modules (up to 320 I/Os)
- Integrates up to three RS-485 ports
- Lighting and shade/sunblind expansion modules to control lights and shades/sunblinds
- Compatible with Distech Controls line of *Bluetooth*® low energy technology enabled devices and mobile application providing state-of-the-art occupant management
- Multi-sensor compatibility combines motion and luminosity (Lux) sensors
- Available remote access to program, configure, or maintain the installation, reducing costs associated with on-site visits
- Terminal blocks are uniquely identified and color-coded for clarity and to prevent wiring mistakes
- Embedded alarms, trend log and schedule support allows for fully distributed data and logic
- Automatic email notifications for system status and alarms to ensure faster system servicing and response time

Model Selection

Example: ECY-S1000**E-28-MS**

Series ¹	WebServer	License Points Limit	BACnet MS/TP Routing
ECY-S1000	[blank] : No Embedded Graphics E : With Embedded Graphics	-28 : 28 Points HW (3 Modbus) -48 : 48 Points HW (10 Modbus) [blank] : No Limits (320 typ., 96 Modbus)	[blank] : No BACnet MS/TP Routing Option -MS : With BACnet MS/TP Routing ²

1. SEP models (single Ethernet port) have secondary Ethernet port factory disabled

2. Option already included in no limits license, please specify [blank]

Accessories

ECLYPSE Wi-Fi Adapter	Wi-Fi Adapter for ECLYPSE Connected Controllers.
ECLYPSE Open-To-Wireless™ Adapter	EnOcean communication protocol adapter for ECLYPSE Connected Controllers.

Product Specifications

Power Supply Input

Voltage	18VDC
Power Consumption	8.9W; external loads excluded

Communications

Ethernet Connection Speed	10/100 Mbps
Cable Type	Cat 5e, 8 conductor twisted pair (unshielded)
Addressing	IPv4 or Hostname
BACnet Profile	BACnet Building Controller (B-BC)), AMEV AS-A and AS-B
BACnet Listing	BTL, WSP B-BC
BACnet Interconnectivity	BBMD forwarding capabilities BACnet MS/TP to BACnet/IP routing
BACnet Transport Layer	IP & MS/TP (optional)
Web Server Protocol	HTML5
Web Server Application Interface	REST API
BACnet MS/TP or Modbus RTU	1 × RS-485 serial communications ports
RS-485 Wiring	1-pair + Common/shield
RS-485 EOL Resistor	Built-in
RS-485 Baud Rates	9600, 19 200, 38 400, or 76 800 bps
RS-485 Addressing	Controller's Web Configuration Interface
Modbus TCP	Devices must be on the same subnet
Wireless Adapter	Optional, USB Port Connection
Wi-Fi Communication Protocol	IEEE 802.11b/g/n
Wi-Fi Network Types	Client, Access Point, Hotspot

Subnetwork

Communication	RS-485
Cable Type	Cat 5e, 8 conductor twisted pair
Connector	RJ-45
Connection Topology	Daisy-chain
Maximum number of standard room devices supported per controller combined ¹	12
Allure EC-Smart-Vue Series ²	12
Allure EC-Smart-Comfort Series	6
Allure EC-Smart-Air Series ²	6
EC-Multi Sensor	4
ECx-Light-4 / ECx-Light-4D / ECx-Light-DALI	4
ECx-Blind-4 / ECx-Blind-4LV	4
Maximum number of Bluetooth low energy room devices per controller combined ³	6
Allure UNITOUCH™	2
EC-Multi-Sensor-BLE	4

- For more details about supported quantities, see the ECLYPSE Selection Tool.xlsm spreadsheet file available for download on the Documentation and Resources Portal.
- A controller can support a maximum of 2 Allure sensor models equipped with a CO₂ sensor. Any remaining connected sensors must be without a CO₂ sensor.
- A mixed architecture with standard room devices and Bluetooth low energy enabled devices is not recommended.

Hardware

Processor	Sitara ARM processor
CPU Speed	1GHz
Memory	4GB Non-volatile Flash (applications & storage) 512MB RAM
Real Time Clock (RTC)	Real Time Clock with rechargeable battery Supports SNTP network time synchronization
RTC Battery	20 hours charge time, 20 days discharge time Up to 500 charge / discharge cycles
Cryptographic Module	FIPS 140-2 Level 1 Compliant
Ethernet	2 switched RJ-45 Ethernet ports (Supported Protocols: BACnet/IP, Modbus TCP, NTP, and REST)

USB Connections	2 × USB 2.0 Ports 1 × Micro-USB 2.0 Ports
RS-485 Serial Communications	Screw terminals (Supported Protocols: BACnet MS/TP or Modbus RTU)
Subnet	RJ-45
Green LED	Power status, Subnet TX, RS-485 TX, and Ethernet Traffic
Orange LED	Controller status, Subnet RX, RS-485 RX, and Ethernet Speed

Open-to-Wireless Adapter

Communication Protocol	EnOcean wireless standard ¹
Connector Type	USB
Number of Wireless Inputs	Unlimited ²



1. Available when an optional external ECLYPSE Open-to-Wireless Adapter is connected to the controller. Refer to the Open-to-Wireless Application Guide for a list of supported EnOcean wireless modules.
2. Wireless inputs will only be limited by physical distance between the EnOcean devices and the ECLYPSE Open-to-Wireless Adapter.

Mechanical

Dimensions (H × W × D)	4.74 × 3.57 × 2.31" (120.31 × 90.67 × 58.56mm)
Shipping weight	0.85lbs (0.39kg)
Mounting	DIN rail or screw mounting
Enclosure Material	FR/ABS
Enclosure Rating ¹	Plastic housing, UL94-V0 flammability rating

1. All materials and manufacturing processes comply with the RoHS directive and are marked according to the Waste Electrical and Electronic Equipment (WEEE) directive

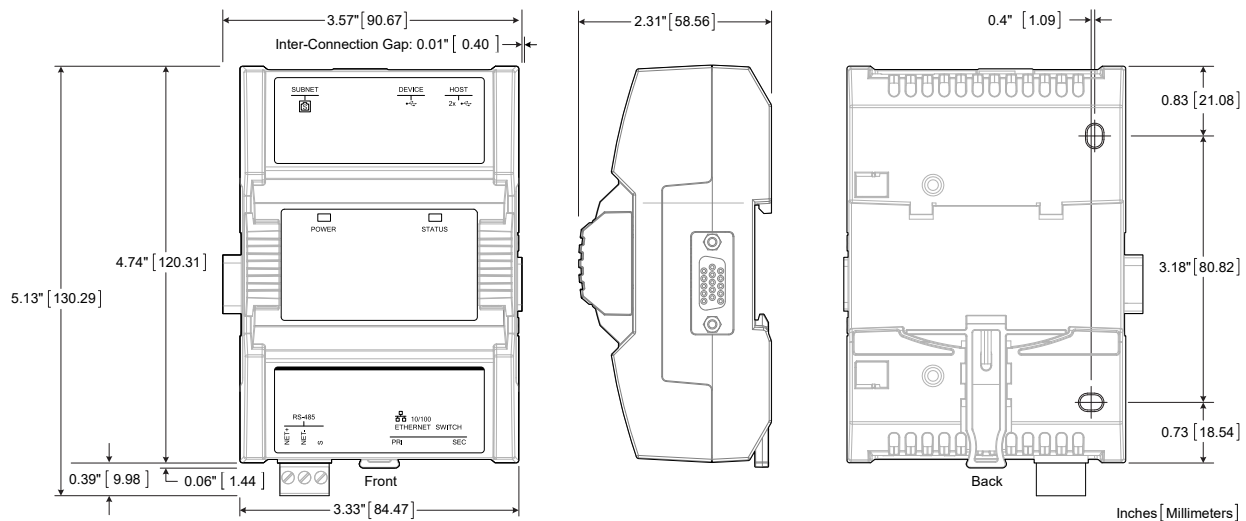
Environmental

Operating Temperature	32 to 122°F (0 to 50°C)
Storage Temperature	-22 to 158°F (-30 to 70°C),
Relative Humidity	0 to 90% non-condensing
Ingress Protection Rating	IP20
Nema Rating	1

Standards and Regulations

CE Emission	EN61000-6-3: 2007+A1:2011
CE Immunity	EN61000-6-1: 2007
FCC	Compliance with FCC rules part 15, subpart B, class B

UL Listed (CDN & US) UL916 Energy management equipment



Specifications subject to change without notice.

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Global Head Office - 4205 place de Java, Brossard, QC, Canada, J4Y 0C4 - EU Head Office - ZAC de Sacuny, 558 avenue Marcel Mérieux, 69530 Brignais, France

Unit Tag	Qty	Model No	Net Cooling Capacity (ton.R)	Nominal Voltage	Refrigerant Type
CH-185	1	YVWACBCDGXJE0185SA	185.0	460-3-60.0	R134a

PIN:								
YVWACBCDGX	JE0185SAX4	6BXXSSXSXA	LXXSXREXXX	AC201EXTSA	X42621CXX1	CGWX94492C	XXSCGWLBS	XXX1XXXXF1
....5...10	....5...20	....5...30	....5...40	....5...50	....5...60	....5...70	....5...80	....5...90

Evaporator Data			Condenser Data			Performance Data	
EWT (°F)	58.00		EWT (°F)	85.00		Full Load Efficiency (kW/ton.R)	0.6863
LWT (°F)	42.00		LWT (°F)	94.30		IPLV.IP (kW/ton.R)	0.3835
Flow (USGPM)	276.9		Flow (USGPM)	573.3		NPLV.IP (kW/ton.R)	0.4019
Pressure Drop (ft H2O)	8.44		Pressure Drop (ft H2O)	16.2		Heat Rejection (MBH)	2653
Fluid	Water		Fluid	Water		Physical Data	
Fouling Factor (h.ft².F/Btu)	0.000100		Fouling Factor (h.ft².F/Btu)	0.000250		Rigging Wt. (lb)	8550
Fluid Volume (USGAL)	48.00		Fluid Volume (USGAL)	50.00		Operating Wt. (lb)	9264
Min Fluid Flow Rate (USGPM)	240.0		Min Fluid Flow Rate (USGPM)	240.0		Refrigerant Charge (lb)	359
Max Fluid Flow Rate (USGPM)	750.0		Max Fluid Flow Rate (USGPM)	910.0		Length (in)	140.6
Evap Type	Hybrid Falling Film		Cond Type	Water Cooled Condenser		Width (in)	55.6
Chiller Type	Water Cooled VSD Screw		Compressor Type	VSD Screw - Semi Hermetic		Height (in)	72.7
Number Passes	2		Number Passes	2			

Electrical Data				
Circuit	1	2	3	4
Compressor RLA	176	0	0	0
Compressor Overload Setting	214	0	0	0

Single Point				
Min. Circuit Ampacity	214			
Max. Fuse / CB Rating (A)	350			
Unit Short Circuit Withstand (STD)	65 [kA]			
Wires Per Phase	1			
Wire Range (Lug Size)	2/0~500 kcmil			
Starter Type	VSD		Operating Condition Electrical Data	
			Compressor kW	127.0
			Total kW	127.0
			Chiller FLA	180

Notes:

Sound Data in accordance with AHRI Standard 575

Nominal Current based on design conditions

Subject to change without prior notice

Min flow rate is for chillers using water. For glycol chillers please contact the application engineering team.

Certified in accordance with the AHRI Water-Cooled Water-Chilling and Heat Pump Water-Heating Packages Using Vapor Compression Cycle Certification Program, which is based on AHRI Standard 550/590 (I-P) and AHRI Standard 551/591 (SI). Certified units may be found in the AHRI Directory at www.ahridirectory.org. Auxiliary components included in total KW - Oil heaters, Chiller controls. Auxiliary power is already included in the compressor power



ASHRAE Standard 90.1-2010 and ASHRAE Standard 90.1-2013 & 2016 Compliant.

Part Load Rating Data					
Load %	Capacity (ton.R)	COND EWT (°F)	COND LWT (°F)	Total kW	Unit Efficiency (kW/ton.R)
100	185.0	85.00	94.30	127.0	0.6863
75	138.7	75.00	81.65	69.16	0.4984
50	92.50	65.00	69.26	32.35	0.3497
25	46.25	65.00	67.13	16.20	0.3502

Sound Pressure Levels (In Accordance with AHRI 575)									
Load %	63 Hz (dB)	125 Hz (dB)	250 Hz (dB)	500 Hz (dB)	1 kHz (dB)	2 kHz (dB)	4 kHz (dB)	8 kHz (dB)	LpA
100	58	71	56	82	84	74	71	67	86
75	63	64	57	70	79	69	63	63	80
50	57	58	84	79	70	60	52	51	79
25	57	71	71	71	68	51	44	45	72

Note: Unit is equipped with Low Sound Kit (Level 1 Reduction).

THE OCTAVE AND A-WEIGHTED SOUND PRESSURE LEVELS ARE THE LEVELS EXPECTED TO BE OBTAINED IF MEASUREMENTS ARE PERFORMED IN ACCORDANCE WITH AHRI STANDARD 575-08, METHOD OF MEASURING MACHINERY SOUND WITHIN EQUIPMENT ROOMS.

THESE LEVELS ARE EXPECTED TO OCCUR ONLY IN AN ACOUSTIC FREE-FIELD ENVIRONMENT, SUCH AS A LARGE MACHINERY ROOM WITH ACOUSTIC ABSORPTION ON PERIMETER WALLS. PROPER ISOLATION IS REQUIRED AT THE CHILLER MOUNTING FEET, WATER PIPING AND OTHER CHILLER TO BUILDING INTERFACES.

TOLERANCES: THE SOUND LEVEL OF IDENTICAL UNIT SELECTIONS CAN VARY DUE TO MANUFACTURING TOLERANCE AND TEST REPEATABILITY. VARIATIONS OF +/-3 dBA ON THE A-WEIGHTED LEVELS AND +/-5 DB ON THE OCTAVE BAND LEVELS ARE POSSIBLE.

Performance at AHRI Conditions					
Evaporator Data		Condenser Data		Performance Data	
EWT (°F)	54.00	EWT (°F)	85.00	Full Load Efficiency (kW/ton.R)	0.6586
LWT (°F)	44.00	LWT (°F)	94.30	IPLV.IP (kW/ton.R)	0.3835
Flow Rate (USGPM)	442.8	Flow Rate (USGPM)	569.5	Heat Rejection (MBH)	2636
Pressure Drop (ft H2O)	19.5	Pressure Drop (ft H2O)	16.0	Cooling Capacity (ton.R)	185.0
Fluid	Water	Fluid	Water		
Fouling Factor (h.ft².F/Btu)	0.000100	Fouling Factor (h.ft².F/Btu)	0.000250		
Fluid Volume (USGAL)	48.00	Fluid Volume (USGAL)	50.00		

Note: Unit rated at design condition capacity.

Part Load Rating Data at AHRI Conditions					
Load %	Capacity (ton.R)	COND EWT (°F)	COND LWT (°F)	Total kW	Unit Efficiency (Btu/W·h)
100	185.0	85.00	94.30	121.9	18.22
75	138.8	75.00	81.66	66.60	25.00
50	92.50	65.00	69.27	30.91	35.91
25	46.25	65.00	67.13	14.95	37.12

Unit Tag	Qty	Model No	Net Cooling Capacity (ton.R)	Nominal Voltage	Refrigerant Type
CH-215	1	YVWAMBCEAE0215SA	215.0	460-3-60.0	R134a

PIN:								
YVWAMBCEE	AE0215SAX4	6DXSSSSXSA	LXXSXREXXX	AC183EXTSA	X42621CXX1	CGWX94492C	XXSCGWHBES	XXX1XXXXF1
....5...10	....5...20	....5...30	....5...40	....5...50	....5...60	....5...70	....5...80	....5...90

Evaporator Data			Condenser Data			Performance Data	
EWT (°F)	58.00		EWT (°F)	85.00		Full Load Efficiency (kW/ton.R)	0.6471
LWT (°F)	42.00		LWT (°F)	94.30		IPLV.IP (kW/ton.R)	0.3856
Flow (USGPM)	321.8		Flow (USGPM)	660.0		NPLV.IP (kW/ton.R)	0.4071
Pressure Drop (ft H2O)	7.72		Pressure Drop (ft H2O)	19.4		Heat Rejection (MBH)	3055
Fluid	Water		Fluid	Water		Physical Data	
Fouling Factor (h.ft².F/Btu)	0.000100		Fouling Factor (h.ft².F/Btu)	0.000250		Rigging Wt. (lb)	12280
Fluid Volume (USGAL)	59.70		Fluid Volume (USGAL)	62.34		Operating Wt. (lb)	13298
Min Fluid Flow Rate (USGPM)	230.0		Min Fluid Flow Rate (USGPM)	280.0		Refrigerant Charge (lb)	276/276
Max Fluid Flow Rate (USGPM)	910.0		Max Fluid Flow Rate (USGPM)	1090		Length (in)	164.4
Evap Type	Hybrid Falling Film		Cond Type	Water Cooled Condenser		Width (in)	55.3
Chiller Type	Water Cooled VSD Screw		Compressor Type	VSD Screw - Semi Hermetic		Height (in)	71.8
Number Passes	2		Number Passes	2			

Electrical Data				
Circuit	1	2	3	4
Compressor RLA	96	97	0	0
Compressor Overload Setting	140	141	0	0

Single Point				
Min. Circuit Ampacity	211			
Max. Fuse / CB Rating (A)	300			
Unit Short Circuit Withstand (STD)	50 [kA]			
Wires Per Phase	1			
Wire Range (Lug Size)	#2 AWG - 600 kcmil			
Starter Type	VSD		Operating Condition Electrical Data	
			Compressor kW	139.1
			Total kW	139.1
			Chiller FLA	197

Notes:

Sound Data in accordance with AHRI Standard 575

Nominal Current based on design conditions

Subject to change without prior notice

Min flow rate is for chillers using water. For glycol chillers please contact the application engineering team.

Certified in accordance with the AHRI Water-Cooled Water-Chilling and Heat Pump Water-Heating Packages Using Vapor Compression Cycle Certification Program, which is based on AHRI Standard 550/590 (I-P) and AHRI Standard 551/591 (SI). Certified units may be found in the AHRI Directory at www.ahridirectory.org. Auxiliary components included in total KW - Oil heaters, Chiller controls. Auxiliary power is already included in the compressor power



ASHRAE Standard 90.1-2010 and ASHRAE Standard 90.1-2013 & 2016 Compliant.

Part Load Rating Data					
Load %	Capacity (ton.R)	COND EWT (°F)	COND LWT (°F)	Total kW	Unit Efficiency (kW/ton.R)
100	215.0	85.00	94.30	139.1	0.6471
75	161.2	75.00	81.70	79.23	0.4913
50	107.5	65.00	69.31	38.71	0.3601
25	53.75	65.00	67.15	19.12	0.3557

Sound Pressure Levels (In Accordance with AHRI 575)									
Load %	63 Hz (dB)	125 Hz (dB)	250 Hz (dB)	500 Hz (dB)	1 kHz (dB)	2 kHz (dB)	4 kHz (dB)	8 kHz (dB)	LpA
100	61	64	59	71	77	71	68	61	79
75	58	70	75	88	77	70	62	63	86
50	58	63	74	75	69	63	61	61	75
25	55	60	71	72	66	60	58	58	72

Note: Unit is equipped with Low Sound Kit (Level 1 Reduction).

THE OCTAVE AND A-WEIGHTED SOUND PRESSURE LEVELS ARE THE LEVELS EXPECTED TO BE OBTAINED IF MEASUREMENTS ARE PERFORMED IN ACCORDANCE WITH AHRI STANDARD 575-08, METHOD OF MEASURING MACHINERY SOUND WITHIN EQUIPMENT ROOMS.

THESE LEVELS ARE EXPECTED TO OCCUR ONLY IN AN ACOUSTIC FREE-FIELD ENVIRONMENT, SUCH AS A LARGE MACHINERY ROOM WITH ACOUSTIC ABSORPTION ON PERIMETER WALLS. PROPER ISOLATION IS REQUIRED AT THE CHILLER MOUNTING FEET, WATER PIPING AND OTHER CHILLER TO BUILDING INTERFACES.

TOLERANCES: THE SOUND LEVEL OF IDENTICAL UNIT SELECTIONS CAN VARY DUE TO MANUFACTURING TOLERANCE AND TEST REPEATABILITY. VARIATIONS OF +/-3 dBA ON THE A-WEIGHTED LEVELS AND +/-5 DB ON THE OCTAVE BAND LEVELS ARE POSSIBLE.

Performance at AHRI Conditions					
Evaporator Data		Condenser Data		Performance Data	
EWT (°F)	54.00	EWT (°F)	85.00	Full Load Efficiency (kW/ton.R)	0.6222
LWT (°F)	44.00	LWT (°F)	94.30	IPLV.IP (kW/ton.R)	0.3856
Flow Rate (USGPM)	514.6	Flow Rate (USGPM)	656.1	Heat Rejection (MBH)	3036
Pressure Drop (ft H2O)	17.7	Pressure Drop (ft H2O)	19.2	Cooling Capacity (ton.R)	215.0
Fluid	Water	Fluid	Water		
Fouling Factor (h.ft².F/Btu)	0.000100	Fouling Factor (h.ft².F/Btu)	0.000250		
Fluid Volume (USGAL)	59.70	Fluid Volume (USGAL)	62.34		

Note: Unit rated at design condition capacity.

Part Load Rating Data at AHRI Conditions					
Load %	Capacity (ton.R)	COND EWT (°F)	COND LWT (°F)	Total kW	Unit Efficiency (Btu/W·h)
100	215.0	85.00	94.30	133.8	19.28
75	161.3	75.00	81.71	75.95	25.48
50	107.5	65.00	69.31	36.46	35.38
25	53.75	65.00	67.15	17.93	35.98

ECM #10

Evaluate rooftop air handling systems, including ventilation air (Co2 sensors), economizers, controls, heating source, setback schedules

Savings Calculations

Equipment Scheduling - Current Schedules

Current Daily Operating Hours				
	12am-8am	8am-4pm	4pm-12am	Total Hrs/Day
Monday	8.0	8.0	8.0	24.0
Tuesday	8.0	8.0	8.0	24.0
Wednesday	8.0	8.0	8.0	24.0
Thursday	8.0	8.0	8.0	24.0
Friday	8.0	8.0	8.0	24.0
Saturday	8.0	8.0	8.0	24.0
Sunday	8.0	8.0	8.0	24.0
Total				168.0
Possible Weekly Hours Are:				168.0
Percentage On Time				100%

Current Monthly Operating Hours								
	Week 1	Week 2	Week 3	Week 4	Week 5	Total Weeks	Possible Weeks	Duty
January	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
February	1.0	1.0	1.0	1.0	0.0	4.0	4.0	100.0%
March	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
April	1.0	1.0	1.0	1.0	0.3	4.3	4.3	100.0%
May	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
June	1.0	1.0	1.0	1.0	0.3	4.3	4.3	100.0%
July	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
August	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
September	1.0	1.0	1.0	1.0	0.3	4.3	4.3	100.0%
October	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
November	1.0	1.0	1.0	1.0	0.3	4.3	4.3	100.0%
December	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
Total						52.1	52.1	100%

Equipment Scheduling - Future (Proposed) Schedules

Future Daily Operating Hours				
	12am-8am	8am-4pm	4pm-12am	Total Hrs/Day
Monday	3.0	8.0	4.0	15.0
Tuesday	3.0	8.0	4.0	15.0
Wednesday	3.0	8.0	4.0	15.0
Thursday	3.0	8.0	4.0	15.0
Friday	3.0	8.0	4.0	15.0
Saturday	3.0	8.0	4.0	15.0
Sunday	3.0	8.0	4.0	15.0
Total				105.0
Possible Weekly Hours Are:				168.0
Percentage On Time				63%

Future Monthly Operating Hours								
	Week 1	Week 2	Week 3	Week 4	Week 5	Total Weeks	Possible Weeks	Duty
January	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
February	1.0	1.0	1.0	1.0	0.0	4.0	4.0	100.0%
March	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
April	1.0	1.0	1.0	1.0	0.3	4.3	4.3	100.0%
May	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
June	1.0	1.0	1.0	1.0	0.3	4.3	4.3	100.0%
July	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
August	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
September	1.0	1.0	1.0	1.0	0.3	4.3	4.3	100.0%
October	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
November	1.0	1.0	1.0	1.0	0.3	4.3	4.3	100.0%
December	1.0	1.0	1.0	1.0	0.4	4.4	4.4	100.0%
Total						52.1	52.1	100%

Interior AHU Optimum Start/Stop - Fan Energy Savings

VFD Exponent

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TMY3 Weather Bin Data - Reading PA					Current Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %	Fan Power %	Current Fan Energy kWh/bin	Proposed Operating Hours	Proposed Fan Energy kWh/bin	Total Savings kWh/bin
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)									
95 / 99	97	1	77	40	1	100%	0%	100%	100%	25	1	15	9
90 / 94	92	13	73	37	13	93%	0%	100%	100%	321	8	201	120
85 / 89	87	154	73	37	154	80%	0%	100%	100%	3,803	96	2,377	1,426
80 / 84	82	429	71	35	429	68%	0%	100%	100%	10,595	268	6,622	3,973
75 / 79	77	552	69	33	552	55%	0%	100%	100%	13,633	345	8,521	5,112
70 / 74	72	752	67	32	752	43%	0%	100%	100%	18,573	470	11,608	6,965
65 / 69	67	820	63	29	820	30%	0%	100%	100%	20,252	513	12,658	7,595
60 / 64	62	901	57	25	901	18%	0%	100%	100%	22,253	563	13,908	8,345
55 / 59	57	827	53	22	827	5%	0%	100%	100%	20,425	517	12,766	7,659
50 / 54	52	742	48	19	742	0%	6%	100%	100%	18,326	464	11,454	6,872
45 / 49	47	564	43	17	564	0%	16%	100%	100%	13,930	353	8,706	5,224
40 / 44	42	812	39	15	812	0%	26%	100%	100%	20,055	508	12,534	7,520
35 / 39	37	706	34	13	706	0%	36%	100%	100%	17,437	441	10,898	6,539
30 / 34	32	488	29	11	488	0%	46%	100%	100%	12,052	305	7,533	4,520
25 / 29	27	364	24	9	364	0%	56%	100%	100%	8,990	228	5,619	3,371
20 / 24	22	305	20	7	305	0%	66%	100%	100%	7,533	191	4,708	2,825
15 / 19	17	156	15	6	156	0%	76%	100%	100%	3,853	98	2,408	1,445
10 / 14	12	108	11	4	108	0%	86%	100%	100%	2,667	68	1,667	1,000
5 / 9	7	66	6	3	66	0%	96%	100%	100%	1,630	41	1,019	611
Total		8,760			8,760					216,352	5,475	135,220	81,132

Table of Assumptions

Minimum Air Flow, VAV	100%
Heating 'On' Point (deg. F)	55.00
Heating Design Temp (deg. F)	5.00
Cooling 'On' Point (deg. F)	55.00
Cooling Design Temp (deg. F)	95.00

Equipment Performance Data

Supply Fan, total capacity (HP)	40 hp
Supply Fan Motor, total (kW)	25 kW
Return Fan Motor, total capacity (HP)	hp
Return Fan Motor, total (kW)	kW
Total Fan kW	25 kW
Total CFM	69,300
OA CFM	11,230
% OA - average value	16%

Interior AHU Optimum Start/Stop - Cooling Energy Savings

TMY3 Weather Bin Data - Reading PA					Current		Proposed		Current Vent Cooling kW	Cooling Energy kWh/bin	Proposed Operating Hours	Cooling Energy kWh/bin	Total Savings kWh/bin
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)	Current Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %					
95 / 99	97	1	77	40	1	100%	0%	100%	71.12	71	1	44	27
90 / 94	92	13	73	37	13	93%	0%	100%	57.23	744	8	465	279
85 / 89	87	154	73	37	154	80%	0%	100%	57.65	8,878	96	5,549	3,329
80 / 84	82	429	71	35	429	68%	0%	100%	50.07	21,479	268	13,424	8,055
75 / 79	77	552	69	33	552	55%	0%	100%	40.80	22,523	345	14,077	8,446
70 / 74	72	752	67	32	752	43%	0%	100%	35.33	26,567	470	16,604	9,963
65 / 69	67	820	63	29	820	30%	0%	100%	22.69	18,609	513	11,631	6,979
60 / 64	62	901	57	25	901	18%	0%	100%	6.69	6,029	563	3,768	2,261
55 / 59	57	827	53	22	827	5%	0%	100%	3.84	3,173	517	1,983	1,190
50 / 54	52	742	48	19	742	0%	6%	100%	0.00	-	464	-	-
45 / 49	47	564	43	17	564	0%	16%	100%	0.00	-	353	-	-
40 / 44	42	812	39	15	812	0%	26%	100%	0.00	-	508	-	-
35 / 39	37	706	34	13	706	0%	36%	100%	0.00	-	441	-	-
30 / 34	32	488	29	11	488	0%	46%	100%	0.00	-	305	-	-
25 / 29	27	364	24	9	364	0%	56%	100%	0.00	-	228	-	-
20 / 24	22	305	20	7	305	0%	66%	100%	0.00	-	191	-	-
15 / 19	17	156	15	6	156	0%	76%	100%	0.00	-	98	-	-
10 / 14	12	108	11	4	108	0%	86%	100%	0.00	-	68	-	-
5 / 9	7	66	6	3	66	0%	96%	100%	0.00	-	41	-	-
Total		8,760			8,760					108,073	5,475	67,546	40,528

Table of Assumptions	
Minimum Air Flow, CAV	100%
Heating 'On' Point (deg. F)	55.00
Heating Design Temp (deg. F)	5.00
Cooling 'On' Point (deg. F)	55.00
Cooling Design Temp (deg. F)	95.00
Discharge Air Enthalpy (Btu/lb):	23.21
Cooling System Efficiency	1.00 kW/ton

Equipment Performance Data	
Supply Fan, total capacity (HP)	40 hp
Supply Fan Motor, total (kW)	25 kW
Return Fan Motor, total capacity (HP)	hp
Return Fan Motor, total (kW)	kW
Total Fan kW	25 kW
Total CFM	69,300
OA CFM	11,230
% OA - average value	16%

Interior AHU Optimum Start/Stop - Heating Energy Savings

TMY3 Weather Bin Data - Reading PA					Current Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %	Current Vent heating MMBtu	Heating Energy MMBtu	Proposed		
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)							Proposed Operating Hours	Heating Energy MMBtu	Total Savings Steam Mlb
95 / 99	97	1	77	40	1	100%	0%	100%	0.00	-	1	-	-
90 / 94	92	13	73	37	13	93%	0%	100%	0.00	-	8	-	-
85 / 89	87	154	73	37	154	80%	0%	100%	0.00	-	96	-	-
80 / 84	82	429	71	35	429	68%	0%	100%	0.00	-	268	-	-
75 / 79	77	552	69	33	552	55%	0%	100%	0.00	-	345	-	-
70 / 74	72	752	67	32	752	43%	0%	100%	0.00	-	470	-	-
65 / 69	67	820	63	29	820	30%	0%	100%	0.00	-	513	-	-
60 / 64	62	901	57	25	901	18%	0%	100%	0.00	-	563	-	-
55 / 59	57	827	53	22	827	5%	0%	100%	0.00	-	517	-	-
50 / 54	52	742	48	19	742	0%	6%	100%	0.00	2	464	1	1
45 / 49	47	564	43	17	564	0%	16%	100%	0.02	13	353	8	7
40 / 44	42	812	39	15	812	0%	26%	100%	0.06	48	508	30	27
35 / 39	37	706	34	13	706	0%	36%	100%	0.11	79	441	50	45
30 / 34	32	488	29	11	488	0%	46%	100%	0.18	89	305	56	50
25 / 29	27	364	24	9	364	0%	56%	100%	0.27	99	228	62	56
20 / 24	22	305	20	7	305	0%	66%	100%	0.38	115	191	72	65
15 / 19	17	156	15	6	156	0%	76%	100%	0.50	78	98	49	44
10 / 14	12	108	11	4	108	0%	86%	100%	0.64	69	68	43	39
5 / 9	7	66	6	3	66	0%	96%	100%	0.80	53	41	33	30
Total		8,760			8,760					645	5,475	403	364

Table of Assumptions	
Minimum Air Flow, CAV	100%
Heating 'On' Point (deg. F)	55.00
Heating Design Temp (deg. F)	5.00
Cooling 'On' Point (deg. F)	55.00
Cooling Design Temp (deg. F)	95.00
Discharge Air Enthalpy (Btu/lb):	23.21
Steam Conversion Efficiency	70%
Latent Heat of Saturated Steam (10 #)	950 Btu/Lb

Equipment Performance Data	
Supply Fan, total capacity (HP)	40 hp
Supply Fan Motor, total (kW)	25 kW
Return Fan Motor, total capacity (HP)	hp
Return Fan Motor, total (kW)	kW
Total Fan kW	25 kW
Total CFM	69,300
OA CFM	11,230
% OA - average value	16%

Interior AHU Demand Control Ventilation - Cooling Energy Savings

TMY3 Weather Bin Data - Reading PA					Current		Proposed						Total Savings kWh/bin
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)	Proposed Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %	Vent Cooling kW	Cooling Energy kWh/bin	Vent Cooling kW	Cooling Energy kWh/bin	
95 / 99	97	1	77	40	1	100%	0%	100%	71.12	44	44	27	17
90 / 94	92	13	73	37	8	93%	0%	100%	57.23	465	35	287	178
85 / 89	87	154	73	37	96	80%	0%	100%	57.65	5,549	36	3,424	2,125
80 / 84	82	429	71	35	268	68%	0%	100%	50.07	13,424	31	8,284	5,140
75 / 79	77	552	69	33	345	55%	0%	100%	40.80	14,077	25	8,687	5,390
70 / 74	72	752	67	32	470	43%	0%	100%	35.33	16,604	22	10,246	6,358
65 / 69	67	820	63	29	513	30%	0%	100%	22.69	11,631	14	7,177	4,454
60 / 64	62	901	57	25	563	18%	0%	100%	6.69	3,768	4	2,325	1,443
55 / 59	57	827	53	22	517	5%	0%	100%	3.84	1,983	2	1,224	759
50 / 54	52	742	48	19	464	0%	6%	100%	0.00	-	-	-	-
45 / 49	47	564	43	17	353	0%	16%	100%	0.00	-	-	-	-
40 / 44	42	812	39	15	508	0%	26%	100%	0.00	-	-	-	-
35 / 39	37	706	34	13	441	0%	36%	100%	0.00	-	-	-	-
30 / 34	32	488	29	11	305	0%	46%	100%	0.00	-	-	-	-
25 / 29	27	364	24	9	228	0%	56%	100%	0.00	-	-	-	-
20 / 24	22	305	20	7	191	0%	66%	100%	0.00	-	-	-	-
15 / 19	17	156	15	6	98	0%	76%	100%	0.00	-	-	-	-
10 / 14	12	108	11	4	68	0%	86%	100%	0.00	-	-	-	-
5 / 9	7	66	6	3	41	0%	96%	100%	0.00	-	-	-	-
Total		8,760			5,475					67,546	213	41,682	25,864

Table of Assumptions		
Minimum Air Flow, CAV	100%	
Heating 'On' Point (deg. F)	55.00	
Heating Design Temp (deg. F)	5.00	
Cooling 'On' Point (deg. F)	55.00	
Cooling Design Temp (deg. F)	95.00	
Discharge Air Enthalpy (Btu/lb):	23.21	
Cooling System Efficiency	1.00	kW/ton

Equipment Performance Data		
Supply Fan, total capacity (HP)	40	hp
Supply Fan Motor, total (kW)	25	kW
Return Fan Motor, total capacity (HP)		hp
Return Fan Motor, total (kW)		kW
Total Fan kW	25	kW
Total CFM	69,300	
OA CFM	11,230	6,930
% OA - average value - Current	16%	
% OA - average value - Proposed	10%	

Interior AHU Demand Control Ventilation - Heating Energy Savings

TMY3 Weather Bin Data - Reading PA					Proposed								
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)	Proposed Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %	Current Vent heating MMBtu	Heating Energy MMBtu	Vent Heating MMBtu	Heating Energy MMBtu	Total Savings Steam Mlb
95 / 99	97	1	77	40	1	100%	0%	100%	0.00	-	-	-	-
90 / 94	92	13	73	37	8	93%	0%	100%	0.00	-	-	-	-
85 / 89	87	154	73	37	96	80%	0%	100%	0.00	-	-	-	-
80 / 84	82	429	71	35	268	68%	0%	100%	0.00	-	-	-	-
75 / 79	77	552	69	33	345	55%	0%	100%	0.00	-	-	-	-
70 / 74	72	752	67	32	470	43%	0%	100%	0.00	-	-	-	-
65 / 69	67	820	63	29	513	30%	0%	100%	0.00	-	-	-	-
60 / 64	62	901	57	25	563	18%	0%	100%	0.00	-	-	-	-
55 / 59	57	827	53	22	517	5%	0%	100%	0.00	-	-	-	-
50 / 54	52	742	48	19	464	0%	6%	100%	0.00	1	0	1	1
45 / 49	47	564	43	17	353	0%	16%	100%	0.02	8	0	5	5
40 / 44	42	812	39	15	508	0%	26%	100%	0.06	30	0	18	17
35 / 39	37	706	34	13	441	0%	36%	100%	0.11	50	0	31	29
30 / 34	32	488	29	11	305	0%	46%	100%	0.18	56	0	35	32
25 / 29	27	364	24	9	228	0%	56%	100%	0.27	62	0	38	36
20 / 24	22	305	20	7	191	0%	66%	100%	0.38	72	0	44	41
15 / 19	17	156	15	6	98	0%	76%	100%	0.50	49	0	30	28
10 / 14	12	108	11	4	68	0%	86%	100%	0.64	43	0	27	25
5 / 9	7	66	6	3	41	0%	96%	100%	0.80	33	0	20	19
Total		8,760			5,475					403	2	249	232

Table of Assumptions	
Minimum Air Flow, CAV	100%
Heating 'On' Point (deg. F)	55.00
Heating Design Temp (deg. F)	5.00
Cooling 'On' Point (deg. F)	55.00
Cooling Design Temp (deg. F)	95.00
Discharge Air Enthalpy (Btu/lb):	23.21
Steam Conversion Efficiency	70%
Latent Heat of Saturated Steam (10 #)	950 Btu/Lb

Equipment Performance Data	
Supply Fan, total capacity (HP)	40 hp
Supply Fan Motor, total (kW)	25 kW
Return Fan Motor, total capacity (HP)	hp
Return Fan Motor, total (kW)	kW
Total Fan kW	25 kW
Total CFM	69,300
OA CFM	11,230 6,930
% OA - average value	16%
% OA - average value - Proposed	10%

RTU Demand Control Ventilation - Cooling Energy Savings

TMY3 Weather Bin Data - Reading PA					Current		Proposed						Total Savings kWh/bin
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)	Current Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %	Vent Cooling kW	Cooling Energy kWh/bin	Vent Cooling kW	Cooling Energy kWh/bin	
95 / 99	97	1	77	40	1	100%	0%	100%	198.93	199	125	125	74
90 / 94	92	13	73	37	13	93%	0%	100%	160.06	2,081	101	1,309	771
85 / 89	87	154	73	37	154	80%	0%	100%	161.24	24,831	101	15,626	9,205
80 / 84	82	429	71	35	429	68%	0%	100%	140.04	60,076	88	37,806	22,270
75 / 79	77	552	69	33	552	55%	0%	100%	114.12	62,997	72	39,644	23,353
70 / 74	72	752	67	32	752	43%	0%	100%	98.81	74,307	62	46,761	27,546
65 / 69	67	820	63	29	820	30%	0%	100%	63.48	52,050	40	32,755	19,295
60 / 64	62	901	57	25	901	18%	0%	100%	18.72	16,864	12	10,612	6,251
55 / 59	57	827	53	22	827	5%	0%	100%	10.73	8,874	7	5,584	3,290
50 / 54	52	742	48	19	742	0%	6%	100%	0.00	-	-	-	-
45 / 49	47	564	43	17	564	0%	16%	100%	0.00	-	-	-	-
40 / 44	42	812	39	15	812	0%	26%	100%	0.00	-	-	-	-
35 / 39	37	706	34	13	706	0%	36%	100%	0.00	-	-	-	-
30 / 34	32	488	29	11	488	0%	46%	100%	0.00	-	-	-	-
25 / 29	27	364	24	9	364	0%	56%	100%	0.00	-	-	-	-
20 / 24	22	305	20	7	305	0%	66%	100%	0.00	-	-	-	-
15 / 19	17	156	15	6	156	0%	76%	100%	0.00	-	-	-	-
10 / 14	12	108	11	4	108	0%	86%	100%	0.00	-	-	-	-
5 / 9	7	66	6	3	66	0%	96%	100%	0.00	-	-	-	-
Total		8,760			8,760					302,278	608	190,223	112,055

Table of Assumptions		
Minimum Air Flow, CAV	100%	
Heating 'On' Point (deg. F)	55.00	
Heating Design Temp (deg. F)	5.00	
Cooling 'On' Point (deg. F)	55.00	
Cooling Design Temp (deg. F)	95.00	
Discharge Air Enthalpy (Btu/lb):	23.21	
Cooling System Efficiency	1.00	kW/ton

Equipment Performance Data		
Supply Fan, total capacity (HP)	121	hp
Supply Fan Motor, total (kW)	25	kW
Return Fan Motor, total capacity (H	31	hp
Return Fan Motor, total (kW)	18	kW
Total Fan kW	43	kW
Total CFM	131,775	
OA CFM	31,410	19,766
% OA - average value - Current	24%	
% OA - average value - Proposed	15%	

RTU Demand Control Ventilation - Heating Energy Savings

TMY3 Weather Bin Data - Reading PA					Proposed								
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)	Current Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %	Current Vent heating MMBtu	Heating Energy MMBtu	Vent Heating MMBtu	Heating Energy MMBtu	Total Savings Steam Mlb
95 / 99	97	1	77	40	1	100%	0%	100%	0.00	-	-	-	-
90 / 94	92	13	73	37	13	93%	0%	100%	0.00	-	-	-	-
85 / 89	87	154	73	37	154	80%	0%	100%	0.00	-	-	-	-
80 / 84	82	429	71	35	429	68%	0%	100%	0.00	-	-	-	-
75 / 79	77	552	69	33	552	55%	0%	100%	0.00	-	-	-	-
70 / 74	72	752	67	32	752	43%	0%	100%	0.00	-	-	-	-
65 / 69	67	820	63	29	820	30%	0%	100%	0.00	-	-	-	-
60 / 64	62	901	57	25	901	18%	0%	100%	0.00	-	-	-	-
55 / 59	57	827	53	22	827	5%	0%	100%	0.00	-	-	-	-
50 / 54	52	742	48	19	742	0%	6%	100%	0.01	6	0	4	4
45 / 49	47	564	43	17	564	0%	16%	100%	0.06	35	0	22	20
40 / 44	42	812	39	15	812	0%	26%	100%	0.16	133	0	84	74
35 / 39	37	706	34	13	706	0%	36%	100%	0.31	222	0	140	124
30 / 34	32	488	29	11	488	0%	46%	100%	0.51	250	0	157	139
25 / 29	27	364	24	9	364	0%	56%	100%	0.76	277	0	174	154
20 / 24	22	305	20	7	305	0%	66%	100%	1.06	322	1	203	179
15 / 19	17	156	15	6	156	0%	76%	100%	1.40	218	1	137	122
10 / 14	12	108	11	4	108	0%	86%	100%	1.79	194	1	122	108
5 / 9	7	66	6	3	66	0%	96%	100%	2.23	147	1	93	82
Total		8,760			8,760					1,804	5	1,135	1,006

Table of Assumptions	
Minimum Air Flow, CAV	100%
Heating 'On' Point (deg. F)	55.00
Heating Design Temp (deg. F)	5.00
Cooling 'On' Point (deg. F)	55.00
Cooling Design Temp (deg. F)	95.00
Discharge Air Enthalpy (Btu/lb):	23.21
Steam Conversion Efficiency	70%
Latent Heat of Saturated Steam (10 #)	950 Btu/Lb

Equipment Performance Data	
Supply Fan, total capacity (HP)	121 hp
Supply Fan Motor, total (kW)	25 kW
Return Fan Motor, total capacity (hp)	31 hp
Return Fan Motor, total (kW)	18 kW
Total Fan kW	43 kW
Total CFM	131,775
OA CFM	31,410 19,766
% OA - average value	24%
% OA - average value - Proposed	15%

RCx Improve VAV Operation - Fan Energy Savings

TMY3 Weather Bin Data - Reading PA					VFD Exponent 2.2									
					Current					Proposed				
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)	Current Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %	Fan Power %	Current Fan Energy kWh/bin	Percent Air Flow %	Fan Power %	Proposed Fan Energy kWh/bin	Total Savings kWh/bin
95 / 99	97	1	77	40	1	100%	0%	100%	100%	43	100%	100%	43	-
90 / 94	92	13	73	37	13	93%	0%	93%	84%	469	93%	84%	469	-
85 / 89	87	154	73	37	154	80%	0%	90%	79%	5,228	80%	61%	4,035	1,194
80 / 84	82	429	71	35	429	68%	0%	90%	79%	14,565	75%	53%	9,752	4,813
75 / 79	77	552	69	33	552	55%	0%	90%	79%	18,741	75%	53%	12,548	6,192
70 / 74	72	752	67	32	752	43%	0%	90%	79%	25,531	75%	53%	17,095	8,436
65 / 69	67	820	63	29	820	30%	0%	90%	79%	27,840	75%	53%	18,641	9,199
60 / 64	62	901	57	25	901	18%	0%	90%	79%	30,590	75%	53%	20,482	10,108
55 / 59	57	827	53	22	827	5%	0%	90%	79%	28,077	75%	53%	18,800	9,277
50 / 54	52	742	48	19	742	0%	6%	90%	79%	25,192	75%	53%	16,868	8,324
45 / 49	47	564	43	17	564	0%	16%	90%	79%	19,148	75%	53%	12,821	6,327
40 / 44	42	812	39	15	812	0%	26%	90%	79%	27,568	75%	53%	18,459	9,109
35 / 39	37	706	34	13	706	0%	36%	90%	79%	23,969	75%	53%	16,049	7,920
30 / 34	32	488	29	11	488	0%	46%	90%	79%	16,568	75%	53%	11,094	5,474
25 / 29	27	364	24	9	364	0%	56%	90%	79%	12,358	75%	53%	8,275	4,083
20 / 24	22	305	20	7	305	0%	66%	90%	79%	10,355	75%	53%	6,934	3,422
15 / 19	17	156	15	6	156	0%	76%	90%	79%	5,296	76%	55%	3,651	1,645
10 / 14	12	108	11	4	108	0%	86%	90%	79%	3,667	86%	72%	3,318	349
5 / 9	7	66	6	3	66	0%	96%	96%	91%	2,583	96%	91%	2,583	-
Total		8,760			8,760					297,788			201,916	95,872

Table of Assumptions	
Minimum Air Flow, VAV	90%
Heating 'On' Point (deg. F)	55.00
Heating Design Temp (deg. F)	5.00
Cooling 'On' Point (deg. F)	55.00
Cooling Design Temp (deg. F)	95.00
Proposed VAV Fan Flow	75%

Equipment Performance Data	
Supply Fan, total capacity (HP)	121 hp
Supply Fan Motor, total (kW)	25 kW
Return Fan Motor, total capacity (	31 hp
Return Fan Motor, total (kW)	18 kW
Total Fan kW	43 kW
Total CFM	131,775
OA CFM	31,410
% OA - average value	24%

RCx Improve VAV Operation - Cooling Energy Savings

TMY3 Weather Bin Data - Reading PA					Current	Cooling	Heating	Percent	Current	Cooling	Percent	Vent	Cooling	Total
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)	Operating Bin Hours	Load %	Load %	Air Flow %	Vent Cooling kW	Energy kWh/bin	Air Flow %	Cooling kW	Energy kWh/bin	Savings kWh/bin
95 / 99	97	1	77	40	1	100%	0%	100%	71.12	71	100%	71.12	71	-
90 / 94	92	13	73	37	13	93%	0%	93%	52.93	688	93%	52.93	688	-
85 / 89	87	154	73	37	154	80%	0%	90%	51.88	7,990	80%	46.12	7,102	888
80 / 84	82	429	71	35	429	68%	0%	90%	45.06	19,331	75%	37.55	16,109	3,222
75 / 79	77	552	69	33	552	55%	0%	90%	36.72	20,271	75%	30.60	16,892	3,378
70 / 74	72	752	67	32	752	43%	0%	90%	31.80	23,910	75%	26.50	19,925	3,985
65 / 69	67	820	63	29	820	30%	0%	90%	20.43	16,749	75%	17.02	13,957	2,791
60 / 64	62	901	57	25	901	18%	0%	90%	6.02	5,426	75%	5.02	4,522	904
55 / 59	57	827	53	22	827	5%	0%	90%	3.45	2,855	75%	2.88	2,380	476
50 / 54	52	742	48	19	742	0%	6%	90%	0.00	-	75%	0.00	-	-
45 / 49	47	564	43	17	564	0%	16%	90%	0.00	-	75%	0.00	-	-
40 / 44	42	812	39	15	812	0%	26%	90%	0.00	-	75%	0.00	-	-
35 / 39	37	706	34	13	706	0%	36%	90%	0.00	-	75%	0.00	-	-
30 / 34	32	488	29	11	488	0%	46%	90%	0.00	-	75%	0.00	-	-
25 / 29	27	364	24	9	364	0%	56%	90%	0.00	-	75%	0.00	-	-
20 / 24	22	305	20	7	305	0%	66%	90%	0.00	-	75%	0.00	-	-
15 / 19	17	156	15	6	156	0%	76%	90%	0.00	-	76%	0.00	-	-
10 / 14	12	108	11	4	108	0%	86%	90%	0.00	-	86%	0.00	-	-
5 / 9	7	66	6	3	66	0%	96%	96%	0.00	-	96%	0.00	-	-
Total		8,760			8,760					97,292			81,647	15,645

Table of Assumptions	
Minimum Air Flow, CAV	90%
Heating 'On' Point (deg. F)	55.00
Heating Design Temp (deg. F)	5.00
Cooling 'On' Point (deg. F)	55.00
Cooling Design Temp (deg. F)	95.00
Discharge Air Enthalpy (Btu/lb):	23.21
Cooling System Efficiency	1.00 kW/ton

Equipment Performance Data	
Supply Fan, total capacity (HP)	40 hp
Supply Fan Motor, total (kW)	25 kW
Return Fan Motor, total capacity (HP)	hp
Return Fan Motor, total (kW)	kW
Total Fan kW	25 kW
Total CFM	69,300
OA CFM	11,230
% OA - average value	16%

RCx Improve VAV Operation - Heating Energy Savings

Proposed

TMY3 Weather Bin Data - Reading PA					Current Operating Bin Hours	Cooling Load %	Heating Load %	Percent Air Flow %	Current Vent heating MMBtu	Heating Energy MMBtu	Percent Air Flow %	Vent heating MMBtu	Heating Energy MMBtu	Total Savings Steam Mlb
Temp Range	Avg. Temp in Bin	Hours In Bin	MCWB DegF	Enthalpy (Btu/Lb)										
95 / 99	97	1	77	40	1	100%	0%	100%	0.00	-	100%	0.00	-	-
90 / 94	92	13	73	37	13	93%	0%	93%	0.00	-	93%	0.00	-	-
85 / 89	87	154	73	37	154	80%	0%	90%	0.00	-	80%	0.00	-	-
80 / 84	82	429	71	35	429	68%	0%	90%	0.00	-	75%	0.00	-	-
75 / 79	77	552	69	33	552	55%	0%	90%	0.00	-	75%	0.00	-	-
70 / 74	72	752	67	32	752	43%	0%	90%	0.00	-	75%	0.00	-	-
65 / 69	67	820	63	29	820	30%	0%	90%	0.00	-	75%	0.00	-	-
60 / 64	62	901	57	25	901	18%	0%	90%	0.00	-	75%	0.00	-	-
55 / 59	57	827	53	22	827	5%	0%	90%	0.00	-	75%	0.00	-	-
50 / 54	52	742	48	19	742	0%	6%	90%	0.00	2	75%	0.00	2	1
45 / 49	47	564	43	17	564	0%	16%	90%	0.02	11	75%	0.02	9	3
40 / 44	42	812	39	15	812	0%	26%	90%	0.05	43	75%	0.04	36	11
35 / 39	37	706	34	13	706	0%	36%	90%	0.10	71	75%	0.08	59	18
30 / 34	32	488	29	11	488	0%	46%	90%	0.16	81	75%	0.14	67	20
25 / 29	27	364	24	9	364	0%	56%	90%	0.24	89	75%	0.20	74	22
20 / 24	22	305	20	7	305	0%	66%	90%	0.34	104	75%	0.28	86	26
15 / 19	17	156	15	6	156	0%	76%	90%	0.45	70	76%	0.38	59	16
10 / 14	12	108	11	4	108	0%	86%	90%	0.58	62	86%	0.55	60	4
5 / 9	7	66	6	3	66	0%	96%	96%	0.77	51	96%	0.77	51	-
Total		8,760			8,760					584			503	121

Table of Assumptions

Minimum Air Flow, CAV	90%
Heating 'On' Point (deg. F)	55.00
Heating Design Temp (deg. F)	5.00
Cooling 'On' Point (deg. F)	55.00
Cooling Design Temp (deg. F)	95.00
Discharge Air Enthalpy (Btu/lb):	23.21
Steam Conversion Efficiency	70%
Latent Heat of Saturated Steam (10 #)	950 Btu/Lb

Equipment Performance Data

Supply Fan, total capacity (HP)	40 hp
Supply Fan Motor, total (kW)	25 kW
Return Fan Motor, total capacity (HP)	hp
Return Fan Motor, total (kW)	kW
Total Fan kW	25 kW
Total CFM	69,300
OA CFM	11,230
% OA - average value	16%

Retro-Commissioning of HVAC Systems

Facility Name	DHS Wernersville		
Square Footage	354,000		
Annual kWh	6,042,606		
Annual Electric Cost	\$	447,836	
Annual Steam, Mlb		61,646	
Heating Cost	\$	462,978	
Total Energy Cost \$	\$	910,814	
Total Million Btu		82,269	
EUI, Btu/SF	232,399		
EUI, \$/SF	\$	2.57	\$ 1.27 \$ 1.31
			49.2% 50.8%
RCx Energy Savings Factor, \$/SF	\$0.05		
RCx Non-Energy Savings Factor, \$/SF	\$0.00		
Potential Energy Savings \$	\$	22,770	
Potential Non-Energy Savings \$	\$	-	
Total Savings	\$	22,770	\$ 11,196 \$ 11,574
RCx Install Cost Factor, \$/SF	\$0.25		
Est. Installed Cost \$	\$	227,704	151,092 1,541
Simple Payback		10.0	kWH Saved MMBtu Saved
Post ECM EUI, \$/SF	\$	2.52	

Numbers are only estimates and may interact with other measures based upon the scopes of work

ECM #10

Evaluate rooftop air handling systems, including ventilation air (Co2 sensors), economizers, controls, heating source, setback schedules

Equipment Information Sheets

niagara analytics 2.1

PRODUCT DEFINITION

Niagara Analytics version 2.1 is a data analytics extension to the Niagara Framework® available on Niagara 4 Supervisors and JACE® 8000 controllers. It gives Niagara 4 and JACE 8000 users the ability to apply a variety of analytic algorithms and diagnostics to both historical and real-time data available in Niagara. Users have the ability to discover and mitigate previously unknown operational issues, which helps to maximize their investment in Niagara Framework-based products. Niagara Analytics 2.1 is compatible with Niagara 4 version 4.4 and 4.6.

JACE 8000 SERIES AND EDGE CONTROLLER ORDERING INFORMATION

Part number*	Description
NA-EC-N4-100	Niagara Analytics Framework (on Niagara 4) license for 100 analytic points for an Embedded Controller (JACE 8000)
NA-EC-N4-250	Niagara Analytics Framework (on Niagara 4) license for 250 analytic points for an Embedded Controller (JACE 8000)
NA-EC-N4-500	Niagara Analytics Framework (on Niagara 4) license for 500 analytic points for an Embedded Controller (JACE 8000)
NA-EC-N4-1000	Niagara Analytics Framework (on Niagara 4) license for 1,000 analytic points for an Embedded Controller (JACE 8000)
EDGE-10	Niagara Edge 10 field controller with 10 points of onboard IO, 1 RS-485 serial port, and 2 10/100 Ethernet ports. Supports 1 IO-R-34. Includes Niagara N4 and drivers for BACnet, Modbus and SNMP. Supports up to 3 devices or 50 points. Includes all software updates released for commercial use by Tridium for the life of N4, but not for any later versions.

NIAGARA 4 SUPERVISOR ORDERING INFORMATION

Part number*	Description
NA-S-N4-250	Niagara Analytics Framework (on Niagara 4) license for 250 analytic points for a Supervisor
NA-S-N4-1000	Niagara Analytics Framework (on Niagara 4) license for 1,000 analytic points for a Supervisor
NA-S-N4-2500	Niagara Analytics Framework (on Niagara 4) license for 2,500 analytic points for a Supervisor
NA-S-N4-10000	Niagara Analytics Framework (on Niagara 4) license for 10,000 analytic points for a Supervisor
NA-S-N4-50000	Niagara Analytics Framework (on Niagara 4) license for 50,000 analytic points for a Supervisor
NA-S-N4-100000	Niagara Analytics Framework (on Niagara 4) license for 100,000 analytic points for a Supervisor
NA-S-N4-UNL	Niagara Analytics Framework (on Niagara 4) license for Unlimited analytic points for a Supervisor
TRN-CRS-N4-ANALYT	Training Classroom Session Niagara 4 Analytics Instructor-Led Certification Training. Student must be Niagara 4 certified to attend.

*Niagara Analytics 2.1 licenses are conveniently and cost-effectively based on the number of analytical points and do not expire.

KEY ADVANTAGES

- One data model common to Niagara 4
- Ability to leverage Niagara 4 tagging and hierarchies
- Algorithm library with examples for BAS and energy
- Real-time data analysis and control on the onsite JACE controller
- Wiresheet programming using Niagara Workbench
- Extensive HTML5 user visualization
- Ad-Hoc energy reporting
- Uses Niagara histories instead of an external database
- Analytic alerts that provide actionable information

INCLUSION OF ANALYTIC POINTS AS A BASE

25 analytic points are included with every Supervisor and JACE 8000 license

10 analytical points are included with every Edge controller license

Niagara 4 includes a Software Maintenance Agreement (SMA) that covers all Niagara Analytics enhancements, adding to the value of the SMA when you invest in Niagara 4.

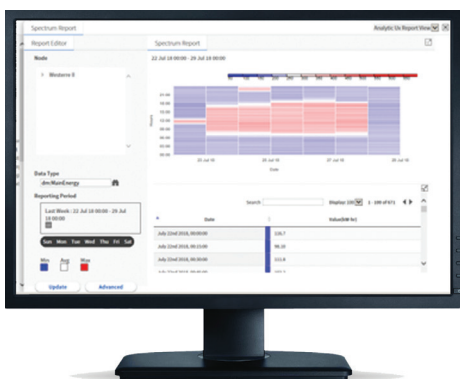
powered by

niagara
framework®

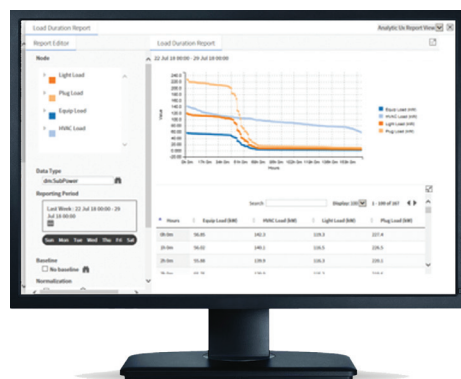
FEATURES

Component	Benefit
Wire sheet configuration	Use Niagara wire sheet programming to configure algorithms. Includes an extensive library of math, logic and filter components.
Algorithm library	Includes algorithms for diagnosing system performance and making energy calculations. Modify the included algorithms to build your own library.
Energy charts and reports	Includes 7 configurable energy reports and charts that allow the user to visualize how energy is being used and make informed decisions
Tag library	Uses Niagara tag libraries including Haystack tags
Alerts	Create actionable alerts that provide meaningful insights
Missing data strategy	Interpolate data that is missing due to equipment or communication issues
Dashboard widgets <ul style="list-style-type: none"> • Web chart • Web table 	Widgets to create HTML5 analytic dashboards and graphic pages that can be accessed via PC browser or mobile device
Public APIs	Create custom function blocks and integrate with third-party visualization packages

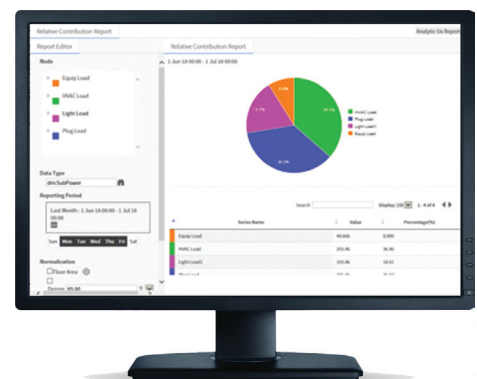
Spectrum Report



Load Duration Report



Relative Contribution Report



Discover and mitigate operational issues using Niagara Analytics 2.1 algorithms

Niagara Analytics 2.1 is available through a wide variety of original equipment manufacturers. Our open distribution business model and open protocol support allow a vendor-neutral application compatible with devices and systems throughout the world.

Contact your Tridium representative or Niagara partner today to get started.



tridium.com

Locations and customer support, worldwide

Headquarters
North America
1 804 747 4771

Support
North America & Latin America
1 877 305 1745

Europe, Middle East & Africa
44 1403 740290

Asia Pacific
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CO2 DUCT

Sensor with Conduit Option

The ACI Carbon Dioxide Duct Series (A/CO2-D) monitors the carbon dioxide (CO2) levels in industrial, commercial, school, and office-type environments. The concentration of CO2 is a strong indication of the overall indoor air quality. The A/CO2 Series is based on a single beam, non-dispersive infrared technology and is a cost-efficient solution for measuring carbon dioxide levels for building climate control. In addition, ABC software eliminates the need for manual calibration. Carbon Dioxide concentration is measured up to 2,000 ppm and is converted into proportional analog outputs. The factory default output is 4-20 mA, whereas 0-5

VDC and 0-10 VDC outputs are field selectable via integral dip switches. The A/CO2-D provides data which can be used in conjunction with a Building Automation System or Demand Control Ventilation to decrease energy consumption while creating a healthier indoor climate.

Applications: Schools, Office Buildings, Auditoriums, Gymnasiums, Shopping Malls, Theatres, Demand Control Ventilation & Economizers

The CO2 Duct Series are covered by ACI's Five (5) Year Limited Warranty. The warranty can be found in the front of ACI's Sensors & Transmitters catalog, as well as on ACI's website, www.workaci.com.

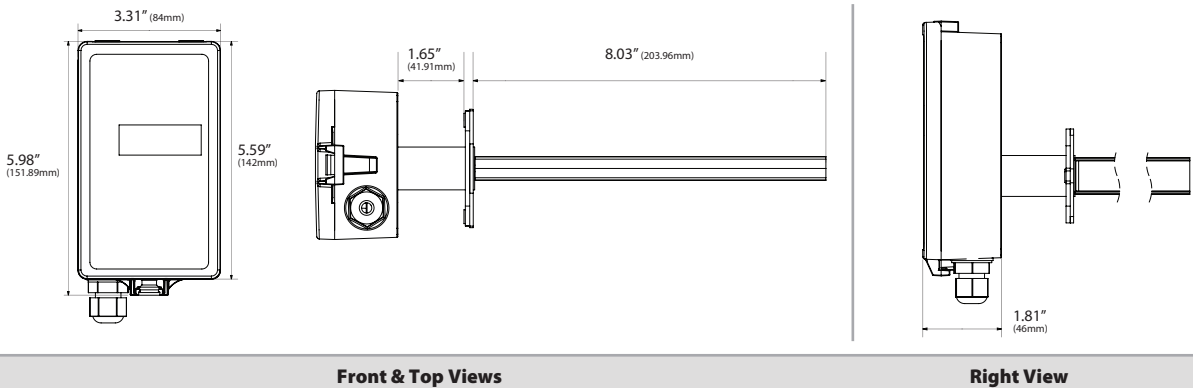
PRODUCT SPECIFICATIONS

Supply Voltage:	24 VAC +/-20%, 50/60 Hz (half-wave rectifier) | 16.5-40 VDC maximum
Power Consumption:	3 VA for 24 VAC, 3W for 24 VDC (peak); <0.9W (average)
Sensing Technology:	Single beam infrared sensing technology (NDIR)
Sensing Method:	Diffusion
Measurement Range Default:	0 to 2,000 ppm
Extended CO2 Ranges:	Up to 10,000 ppm (factory set)
CO2 Accuracy ¹:	+/- 40 ppm and +/- 3% of reading (@ 15-35°C; 20-70% RH and 101.3 kPa)
Extended Range Accuracy > 2000 ppm:	+/- 30 ppm and +/- 5% of reading
CO2 Output Signal:	Output 1: 0-5 VDC or 0-10 VDC (Default) | Output 2: 4-20 mA (500 Ohm load maximum)
Fail Safe:	Polarity protected
Pressure Dependence:	+ 1.6% reading per kPa (deviation from standard pressure 101.3 kPa)
Response Time:	≤ 2 minutes, diffusion
Warm-Up Time:	< 1 minute (@ full specs < 15 minutes)
Operating Temperature Range:	32 to 122°F (0 to 50°C)
Operating Humidity Range:	0 to 95%, non-condensing
Enclosure:	Duct Box: PC & ABS blend, Flammability Rating UL94V-0 Cover: Makrolon® 6555 plastic, Flammability Rating UL94V-0 Pipe: PC & ABS blend, Flammability Rating UL94V-0
Sensor Life ²:	> 15 years (typical)
Calibration ³:	ABC algorithm (Automatic Baseline Correction)
Product Dimensions:	(H) 5.59" (142 mm) x (W) 3.31" (84 mm) x (D) 1.81" (46 mm)
Product Weight:	0.79 lbs (0.36 kg)
Agency Approvals:	EMC Directive 2014/30/EC | RoHS Directive 2011/65/EU

Note ¹: Accuracy is defined after minimum three (3) ABC periods (1 period = 8 days) of continuous operations | **Note ²:** In normal indoor air quality (IAQ) applications | Corrosive environments are excluded | **Note ³:** Building CO2 levels must drop to 400 ppm same time during the week for ABC to work properly | If the building is occupied 24 hours / day, ABC must be turned off



DIMENSIONAL DRAWING



STANDARD ORDERING

Model # Example: A/CO2-DUCT -OR- 137295

Model #	Item #	Description
A/CO2-DUCT	137295	CO2 Duct (0-5 VDC, 0-10 VDC, 4-20 mA)
A/CO2-DUCT-C	137562	CO2 Duct with 1/2" Conduit Adapter (0-5 VDC, 0-10 VDC, 4-20 mA)

ACCESSORIES ORDERING

Model # Example: A/CUSTOM CAL GAS -OR- 140970

Model #	Item #	Description
A/CUSTOM CAL GAS*	140970	Custom Calibration

Note: Contact ACI's Technical Support for custom calibration ranges





EC-BOS-8

Multi-Protocol Web Building Controller



Overview

The EC-BOS-8 is a compact, embedded controller and server platform for connecting multiple and diverse devices and sub-systems. With Internet connectivity and Webserving capability, the EC-BOS-8 provides integrated control, supervision, data logging, alarming, scheduling and network management. It streams data and graphical displays to a standard Web browser via an Ethernet or wireless LAN, or remotely over the Internet.

The EC-BOS-8 operates with EC-Net™ 4 web-based building management platform powered by the Niagara Framework®. The EC-BOS-8 can also run EC-Net Access for managing access control systems.

Features & Benefits

- Scalable licensing model and modular hardware make the EC-BOS-8 suitable for installation in small buildings, as well as large multi-unit campuses when combined with EC-Net Supervisor
- Integrates many communication protocols and automation systems including HVAC, lighting, energy, fire & smoke, physical access, video and industrial/processing
- Two on-board isolated RS-485 ports for connecting to various common networks, e.g. BACnet MS/TP, Modbus RTU, Wiegand access control devices
- Option modules for additional physical network connections, e.g. LonWorks® FTT-10A, RS-232, RS-485, and Wiegand access readers
- USB type A port for station backup and restore functions
- Backward compatibility allows the EC-BOS-8 to run an EC-Net^{AX} station (minimum requirement is 3.8.111)

Model Selection

To order a fully functional EC-BOS-8, the following three components are required: EC-BOS-8, Core Software, Software Maintenance Agreement (SMA). If ordering a demo core, an SMA is not required. Refer to the [EC-Net Selection Tool](#) to calculate the required components.

EC-BOS-8 Series

Example: EC-BOS-8 with Worldwide WiFi

Series	WiFi Setting ¹
EC-BOS-8: EC-BOS-8 includes two isolated RS485 ports, two 10/100MB Ethernet ports and USB Backup & Restore.	With US WiFi: US WiFi setting for enabling WiFi on EC-BOS-8 units installed in the US. With Worldwide WiFi: Worldwide WiFi setting for enabling WiFi on EC-BOS-8 units installed anywhere in the world except the US. With Permanently Disabled WiFi: WiFi setting for permanently disabling WiFi on EC-BOS-8 units.

1. Refer to the [EC-BOS-8 Global Shipping Guide](#) for more information.

EC-BOS-8 Core Software

Example: EC-BOS-8 Core - 100 Devices/5000 Points

Series	Devices/Points ¹
EC-BOS-8 Core: EC-BOS-8 core software. Includes standard open drivers. Requires EC-Net 4.1 or higher. Software Maintenance Agreement (SMA) must be purchased in conjunction with core software.	5 Devices/250 Points: Supports up to 5 devices and 250 points. 10 Devices/500 Points: Supports up to 10 devices and 500 points. 25 Devices/1250 Points: Supports up to 25 devices and 1250 points. 100 Devices/5000 Points: Supports up to 100 devices and 5000 points. 200 Devices/10000 Points: Supports up to 200 devices and 10000 points.
EC-BOS-8 Core – Demo: EC-BOS-8 core software. Includes all available drivers. Supports up to 500 devices and 25000 points. Runs on EC-Net 4.1 or higher and EC-Net ^{AX} (minimum v3.8.111). Note: This license expires annually, and its renewal is covered by the EC-Net Support Fee.	N/A

1. Devices/Points cannot be added to the Demo version (EC-BOS-8 Core – Demo) of the EC-BOS-8 core software.

For more information regarding the EC-Net drivers currently offered by Distech Controls, refer to the [EC-Net Drivers Reference Guide](#).

EC-BOS-8 Software Maintenance Agreement

Software maintenance is required when purchasing an EC-BOS-8. The minimum initial software maintenance plan is 18 months. Optional 3- or 5-year maintenance may be substituted.

If Maintenance coverage is not purchased for any period, the price of Maintenance for the next period for which it is purchased will be (a) the Maintenance fee for the period(s) for which Maintenance was not purchased, up to a maximum of 5 years; and (b) the Maintenance fee for the next year.

These software maintenance plans are ordered separately according to the EC-BOS-8 model chosen. See the price list for more details. Take advantage of the Asset Manager online tool to receive notifications about SMA expirations and Enterprise SMA to align all SMA expiration dates to a single one for the entire system.

Example: EC-BOS-8 (100 Device Core) 3 year SMA

Series	Software Maintenance Agreement
EC-BOS-8 (5 Device Core)	18 month SMA: Initial 18-month software maintenance agreement. Must be purchased in conjunction with initial core software. Optional 3 or 5 year maintenance may be substituted.
EC-BOS-8 (10 Device Core)	1 year SMA: 1-year software maintenance agreement (includes new and interim releases).
EC-BOS-8 (25 Device Core)	3 year SMA: 3-year software maintenance agreement (includes new and interim releases).
EC-BOS-8 (100 Device Core)	5 year SMA: 5-year software maintenance agreement (includes new and interim releases).
EC-BOS-8 (200 Device Core)	

EC-BOS-8 Device Integration Pack

Example: EC-BOS-8 Device Integration Pack - 25

Series	Devices/Points
EC-BOS-8 Device Integration Pack: EC-BOS-8 device integration pack purchased in conjunction with initial core software.	10: Adds support for additional 10 devices and 500 points to core software. 25: Adds support for additional 25 devices and 1250 points to core software. 50: Adds support for additional 50 devices and 2500 points to core software.

EC-BOS-8 Device Upgrade Pack

Example: EC-BOS-8 Device Upgrade Pack - 25

Series	Devices/Points
EC-BOS-8 Device Upgrade Pack: EC-BOS-8 device upgrade pack purchased any time <u>after</u> initial core software purchase.	10: Adds support for additional 10 devices and 500 points to core software. 25: Adds support for additional 25 devices and 1250 points to core software. 50: Adds support for additional 50 devices and 2500 points to core software.

EC-BOS-8 Software Option

Example: EC-BOS-8 AX *Station Pack*

Option	Description
EC-BOS-8 AX Station Pack	Enables EC-BOS-8 to run EC-Net ^{AX} (minimum 3.8.111)
EC-BOS-8 EC-Net Access Pack	Enables EC-BOS-8 to run EC-Net Access (minimum 2.3.118). Includes licensing for 32 readers and EC-BOS-8 AX Station Pack.

EC-BOS-8 Hardware Accessory

Example: EC-BOS-8 *Wall Plug Module*

Accessory	Description
EC-BOS-8 Wall Plug Module	100-240VAC, 50/60 Hz. Wall Adapter – Connects to the 2.5mm barrel plug 24V input on the EC-BOS-8 and includes US, EU, UK, and AU style plugs.
EC-BOS-8 WLAN Antenna Cable Extension	Extension cable and bracket for EC-BOS-8 WLAN antenna.

EC-BOS-8 Add-on Modules

Example: *IO-R-16*

Add-on Module	Description
EC-NPB8-LON	EC-BOS-8 - Add-on single port LON FTT10A module.
EC-NPB8-2X-485	EC-BOS-8 - Add-on dual port RS-485 module.
EC-NPB8-232	EC-BOS-8 - Add-on single port RS-232 module.
IO-R-16	16 Point IO Module. Powered by IO-R-34. Connected to the EC-BOS-8 remotely over RS485.
IO-R-34	34 Point IO Module. Powered by 24VAC/DC. Capable of powering (4) IO-R-16 modules. Connected to the EC-BOS-8 remotely over RS485.
EC-Net Access Remote Reader	Remote reader module - 2 card reader inputs, 4 supervised inputs, 2 digital inputs, 2 form C (SPDT) relay outputs.
EC-Net Access Remote IO	Remote I/O module - 8 supervised inputs, 2 digital inputs, 8 form C (SPDT) relay outputs.

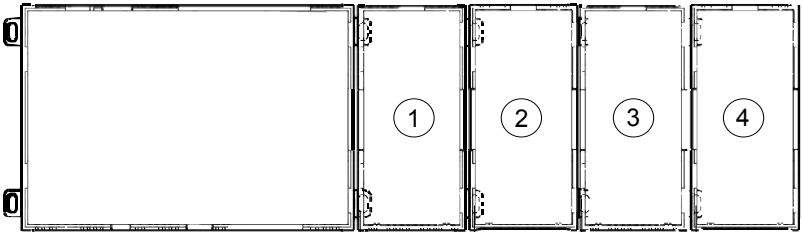
Expansion Modules

Modules	Description	Maximum Expansion Modules Supported
EC-NPB8-LON	EC-BOS-8 - Add-on single port LON FTT10A module.	4
EC-NPB8-2X-485	EC-BOS-8 - Add-on dual port RS-485 module.	2
EC-NPB8-232	EC-BOS-8 - Add-on single port RS-232 module.	4
IO-R-16	16 Point IO Module	16 ¹
IO-R-34	34 Point IO Module	8 ¹
EC-Net Access Remote Reader	Remote reader module	16 (each or combined)
EC-Net Access Remote IO	Remote I/O module	

1. For detailed information about maximum number of modules supported and maximum combinations, refer to the EC-BOS-8 I/O Modules datasheet.

Maximum Combinations (see figure below):

Expansion 1	Expansion 2	Expansion 3	Expansion 4
EC-NPB8-232 OR EC-NPB8-LON	EC-NPB8-232 OR EC-NPB8-LON	EC-NPB8-232 OR EC-NPB8-LON	EC-NPB8-232 OR EC-NPB8-LON
EC-NPB8-2X-485	EC-NPB8-232 OR EC-NPB8-LON	EC-NPB8-232 OR EC-NPB8-LON	EC-NPB8-232 OR EC-NPB8-LON
EC-NPB8-2X-485	EC-NPB8-2X-485	EC-NPB8-232 OR EC-NPB8-LON	



Product Specifications

Platform

Processor	TI AM3352 1000MHz ARM® Cortex™-A8
Memory	1GB DDR3 SDRAM
	- Removable micro-SD card with 4GB flash total storage/2GB user storage
	- Real-time clock
	- Batteryless
	- Secure boot

Communications

Wi-Fi	Client or WAP
Wi-Fi Communication Protocol	IEEE802.11a/b/g/n
	IEEE802.11n HT20 @ 2.4GHz
	IEEE802.11n HT20/HT40 @ 5GHz
Configurable radio	Off, WAP, or Client
Client Authentication Method	WPAPSK/WPA2PSK supported
USB type A connector	Back-up and restore support
RS-485	2 isolated RS-485 with selectable bias and termination
Ethernet	2 10/100MB Ethernet ports
BACnet Listing	BTL, B-BC listed with version 4.4.93 or later

Power Supply

Voltage	24VAC/DC power supply
Consumption	24VA (24VAC); 24W (24VDC)

Environmental

Operating Temperature	-20 to 60°C (-4 to 140 °F)
Storage Temperature	-40 to 85°C (-40 to 185 °F)
Relative Humidity	5% to 95% - Non condensing
Shipping and Vibration	ASTM D4169, Assurance Level II
MTTF	10 years+

Operating Systems

EC-Net 4	4.1 or later
EC-Net ^{AX}	3.8.111 or later
EC-Net Access	2.3.118 or later

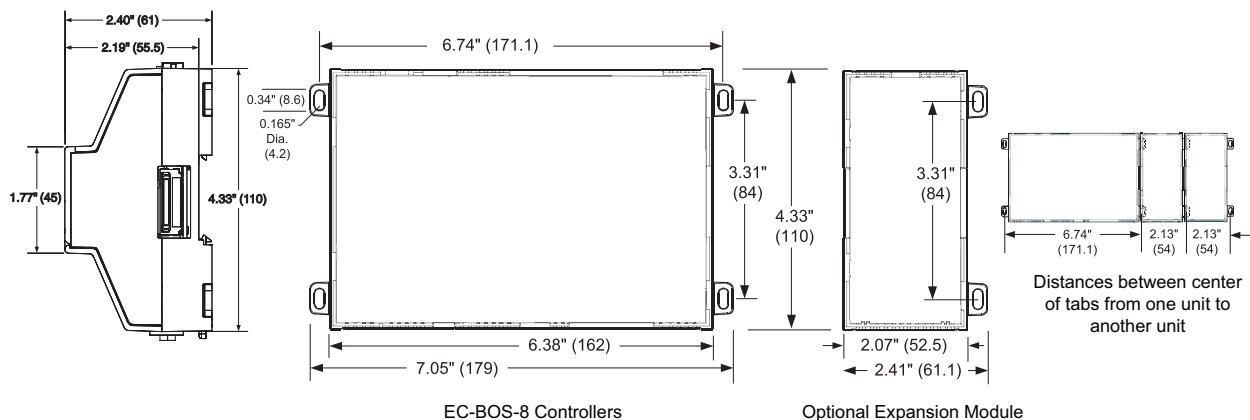
EC-Net Access Licensing Quantities

Card Readers	32
Access Rights	250
Schedules	100
Access Zones	50
Simultaneous Users	10
Personnel	20,000
Area Controllers	N/A

Standards and Regulations

UL	UL 916
	C-UL listed to Canadian Standards Associations (CSA)
	C22.2 No. 205-M1983 "Signal Equipment"
	UL 864, 10 th Edition, UUKL Listed Smoke Control Equipment ¹ (UUKL model only)
CE	EN 61326-1
FCC	Part 15 Subpart B, Class B, Part 15 Subpart C
R&TTE Compliance	1999/5/EC R&TTE Directive
Other compliances	CCC, SRRC, RSS, RoHS

1. For detailed specifications regarding the EC-BOS-8 UUKL model, refer to the Distech Controls UUKL Smoke Control Design Guide (UUKL Design Guide_UG_10_EN) and Distech Controls UUKL Smoke Control Application Guide (UUKL Application Guide_UG_10_EN).



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EC-Net Supervisor



Overview

The EC-Net™ Supervisor is a software platform used in server-class applications. It makes managing all buildings at an enterprise level possible, giving facilities managers the ability to quickly respond to problems and insights to optimize their system.

The EC-Net Supervisor allows multiple Niagara-based EC-BOS series controllers, as well as other IP-based devices such as the ECLYPSE™ Connected IP and Wi-Fi products series, to be networked together. It serves real-time graphical information to standard Web-browser clients and provides server-level functions. These functions include centralized data logging/trending, archiving to external databases, alarming, system navigation, master scheduling, database management, and integration with other enterprise software applications. Also, it provides a comprehensive graphical engineering toolset for application development.

The EC-Net Supervisor operates with EC-Net™ web-based building management platform powered by the Niagara Framework®.

The EC-Net Supervisor can also run EC-Net Access for managing access control systems.

Features & Benefits

- Scalable licensing model for medium-sized sites with few integrations and EC-BOS-8 or IP-based controllers, up to large multi-site and remote campuses
- Integrates many automation systems including those for HVAC, lighting, energy, fire and smoke, physical access, video, and industrial/processing control
- Integrates enterprise-level applications including databases, user management, and hotel guest management
- Protects your system and data with best practice security features including role-based user and permissions management, password management (strength settings, expiration, history), encryption (TLS), certificates and electronic signatures
- Tagging and templating functions provides the foundation for organizing data, advanced searching capability and deploying systems more quickly and consistently
- Adaptive end user views are displayed using HTML5, for a consistent user experience across all web browsers and devices, including desktop, tablet and mobile
- EC-Net Access offers easy configuration of physical access control system via a web browser connection, along with advanced functions for occupancy counting, anti-passback, threat level management, elevator control, and more, as well as integrations to photo ID badging/printing software and visitor management

Model Selection

To order a fully functional EC-Net Supervisor, the following two components are required as a minimum: EC-Net Supervisor model (based on number of Niagara network connections), and Software Maintenance Agreement (SMA). If ordering a demo version, an SMA is not required. Refer to the [EC-Net Selection Tool](#) to calculate the required components.

EC-Net Supervisor Models

Example: EC-Net Supervisor 10

Series	Niagara Network connections
EC-Net Supervisor: Includes standard drivers and is also licensed to run EC-Net ^{AX} 3.8.	0: 0 Niagara network connections 1: 1 Niagara network connection 2: 2 Niagara network connections 3: 3 Niagara network connections 10: 10 Niagara network connections 100: 100 Niagara network connections UNL: Unlimited Niagara network connections
EC-Net Supervisor Demo: Includes all drivers and EC-Net Pro. Can also run EC-Net ^{AX} 3.8. Purchase this version for internal use, e.g. technician's laptops. Note: This license expires annually, and its renewal is covered by the EC-Net Support Fee.	N/A

For more information regarding the EC-Net drivers currently offered by Distech Controls, refer to the [EC-Net Drivers Reference Guide](#).

EC-Net Supervisor Software Maintenance Agreement

Software maintenance is required when purchasing an EC-Net Supervisor. The minimum initial software maintenance plan is 18 months. Optional 3- or 5-year maintenance may be substituted.

If Maintenance coverage is not purchased for any period, the price of Maintenance for the next period for which it is purchased will be (a) the Maintenance fee for the period(s) for which Maintenance was not purchased, up to a maximum of 5 years; and (b) the Maintenance fee for the next year.

These software maintenance plans are ordered separately according to the EC-Net Supervisor model chosen. See the price list for more details. Take advantage of the Asset Manager online tool to receive notifications about SMA expirations and Enterprise SMA to align all SMA expiration dates to a single one for the entire system.

Example: EC-Net Supervisor 10 – 5-year SMA

Series	Software Maintenance Agreement
EC-Net Supervisor 0	18-month SMA: Initial 18-month maintenance must be purchased in conjunction with initial Supervisor software 1-year SMA: 1-year maintenance (Includes new and interim releases) 3-year SMA: 3-year maintenance (Includes new and interim releases) 5-year SMA: 5-year maintenance (Includes new and interim releases)
EC-Net Supervisor 1	
EC-Net Supervisor 2	
EC-Net Supervisor 3	
EC-Net Supervisor 10	
EC-Net Supervisor 100	
EC-Net Supervisor UNL	

Core Capacity Upgrades

Core upgrades add extra Niagara connection capacity to the EC-Net Supervisor license. The following options are available:

Series	Upgrades
Niagara Connection Adder	Adds one additional Niagara connection to EC-Net Supervisor.
EC-Net Supervisor 100 Upgrade	Upgrades "small" EC-Net Supervisor (EC-Net Supervisor 0 through EC-Net Supervisor 10) to 100 Niagara connections. Will maintain any Niagara Connection Adder that were added to original license.
EC-Net Supervisor UNL	Upgrades EC-Net Supervisor 100 to unlimited Niagara connections.

Integration Packs

Integration packs add device/point connection capacity from IP-based devices to the EC-Net Supervisor software. The following options are available:

Example: EC-Net Supervisor 100 Device Pack

Series	Connection Capacity
EC-Net Supervisor	10 Device Pack: Supports up to 10 devices or 500 points (Standard drivers included).
	25 Device Pack: Supports up to 25 devices or 1,250 points (Standard drivers included).
	50 Device Pack: Supports up to 50 devices or 2,500 points (Standard drivers included).
	100 Device Pack: Supports up to 100 devices or 5,000 points (Standard drivers included).
	200 Device Pack: Supports up to 200 devices or 10,000 points (Standard drivers included).
	500 Device Pack: Supports up to 500 devices or 25,000 points (Standard drivers included).
	1000 Device Pack: Supports up to 1000 devices or 50,000 points (Standard drivers included).

EC-Net Supervisor Software Option

Option	Upgrades
EC-Net Supervisor EC-Net Access Option	Enables EC-Net Supervisor to run EC-Net Access (minimum 2.4.45). Includes licensing for 32 readers, MySQL and MSSQL database drivers.

Access Reader Packs

Packs	Description
16-Reader Pack	Expands EC-Net Access license by 16 readers.
64-Reader Pack	Expands EC-Net Access license by 64 readers.
256-Reader Pack	Expands EC-Net Access license by 256 readers.
1024-Reader Pack	Expands EC-Net Access license by 1024 readers.

Complementary Software

Software	Description
Asure ID 7	<p>Asure ID 7 photo ID software for photo capture, printing and badge template design. Each instance of this option allows connection of one Asure ID workstation to the EC-Net Supervisor.</p> <p>Note:</p> <ul style="list-style-type: none">● This software product requires the EC-Net Supervisor Asure ID Driver to provide a single photo ID workstation.● The software license key for this product is delivered by email. An email address is required when placing the order.

Compatibility

In any given EC-Net 4 system, the EC-Net Supervisor must be running the highest version of any Niagara instance in the architecture.

When connecting to EC-BOS series controllers that are running older versions of EC-Net 4, these compatibility guidelines apply:

- EC-Net^{AX}: EC-Net Supervisors can connect to EC-BOS series controllers running EC-Net^{AX} versions 3.6.406, 3.7.108, 3.8.38 or higher.
- EC-Net R2: EC-Net^{AX} and EC-Net Supervisors can connect to an EC-BOS running R2 through the oBIX XML interface only. oBIX is included in all EC-Net^{AX} and EC-Net Supervisors as a means of integrating EC-Net-based Release 2 (R2) EC-BOS controllers. With Release 2.3.522 or higher, the oBIX driver can be added to expose all data points, schedules, trends and alarms to an EC-Net^{AX} or EC-Net 4 system. This oBIX driver is both a client and a server.

Product Specifications

The EC-Net Supervisor may run acceptably on lower-rated platforms, or may require more powerful platforms, depending on the application, number of data points integrated, data poll rate, number of concurrent users, performance expectations, etc. The following are the minimum platform requirements:

Platform Requirements

Processor	Intel® Xeon® CPU E5-2640 x64 (or better), compatible with dual and quad-core processors
Memory	4GB or more recommended
Hard drive	500 GB or more recommended
Display	Video card and monitor capable of displaying 1024 x 768 pixel resolution or greater
Network support	Ethernet adapter (10/100 Mb with RJ-45 connector)
Connectivity	Full-time high-speed ISP connection recommended for remote site access (i.e. T1, ADSL, cable modem)

EC-Net Access Licensing Quantities

Card Readers	10,000
Access Rights	25,000
Schedules	1,500
Access Zones	25,000
Personnel	1,000,000
Simultaneous Users	25
Area Controllers	250

Specifications subject to change without notice.

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ECLYPSE™ Connected Equipment Controller

ECLYPSE™



Overview

The ECLYPSE Connected Equipment Controller (ECY-303) is designed to satisfy the needs of a wide range of HVAC applications such as small and medium terminal applications. It integrates a control, automation and connectivity server, power supply, and I/O in one convenient package. It supports BACnet/IP communications and is a listed BACnet Building Controller (B-BC). In addition, the ECY-303-M3 model supports Modbus to connect to meters, Variable Frequency Drives, etc.

This programmable controller comes with an embedded web server that enables web-based application configuration and a visualization interface. It also features embedded scheduling, alarming, and logging. Control logic and graphic user interface can be customized as required for the application.

Features & Benefits

- Utilizes BACnet/IP and IT standards, delivering empowered IP connectivity and open integration with building management systems
- Uses cryptographic modules making it FIPS 140-2 "Inside"
- Via its RESTful API, data can be accessed from different applications, such as energy dashboards, analytics tools, and mobile applications
- Comes with ENVYISION™ Viewer and the associated preloaded rooftop unit applications and graphics pre-installed
- xpressENVYISION offers a simplified and streamlined experience in a workflow oriented, drag & drop GUI environment
- Supports EC-gfxProgram, which makes Building Automation System (BAS) programming effortless
- Supports both Modbus TCP & Modbus RTU devices
- Supports Smart Room Control for an end-to-end system for the control of HVAC equipment, lighting, and shades/sunblinds
- The status LEDs allow the user to confirm the status of the inputs/outputs and facilitate commissioning and troubleshooting
- Embedded alarms, trend log and schedule support allows for fully distributed data and logic providing a more robust system. Embedded trend logs simplify system troubleshooting when compared to a centralized system
- Automatic email notifications for system status and alarms to ensure faster system servicing and response time

Model Selection

Example: ECY-303-**M3** (**SI**)

Series ¹	Modbus TCP & RTU Devices	Units
ECY-303	[blank] : No Modbus TCP & RTU device support -M3 : Supports up to 3 Modbus TCP & RTU devices	(SI) : Preloaded Apps in SI (Metric) units (IMP) : Preloaded Apps in Imperial (US) units
16-points, 8 UI, 2 UO, 4 DO, 2 DUO, 18 Vdc power supply, ENVYISION Viewer		

1. SEP models (single Ethernet port) have secondary Ethernet port factory disabled

Accessories

ECLYPSE Wi-Fi Adapter	Wi-Fi Adapter for ECLYPSE Connected Controllers.
ECLYPSE Open-To-Wireless™ Adapter	EnOcean communication protocol adapter for ECLYPSE Connected Controllers.

Product Specifications

Power Supply Input

Voltage Range ¹	24VAC/DC; ±15%; Class 2
Nominal Power Consumption	18VA; all external loads excluded, no USB peripherals
Full Load Power Consumption	36VA; external 24VAC loads excluded
Frequency Range	50 to 60Hz
Overcurrent Protection	Field replaceable fuse
Fuse Type	2A, fast-acting, 5 × 20mm (GMA-2A)

1. 24VDC does not support DO (triac outputs).

Communications

Ethernet Connection Speed	10/100 Mbps
Cable Type	Cat 5e, 8 conductor twisted pair (unshielded)
Addressing	IPv4 or Hostname
BACnet Profile	BACnet Building Controller (B-BC)), AMEV AS-A and AS-B
BACnet Listing	BTL, WSP B-BC
BACnet Interconnectivity	BBMD forwarding capabilities
BACnet Transport Layer	IP
Web Server Protocol	HTML5
Web Server Application Interface	REST API
Modbus RTU	1 × RS-485 serial communications port
RS-485 Wiring	1-pair + Common/shield
Modbus TCP	Devices must be on the same subnet
Wireless Adapter	Optional, USB Port Connection
Wi-Fi Communication Protocol	IEEE 802.11b/g/n
Wi-Fi Network Types	Client, Access Point, Hotspot

Subnetwork

Communication	RS-485
Cable Type	Cat 5e, 8 conductor twisted pair
Connector	RJ-45
Connection Topology	Daisy-chain

- For more details about supported quantities, see the ECLYPSE Selection Tool.xlsm spreadsheet file available for download on the Documentation and Resources Portal.
- A controller can support a maximum of 2 Allure sensor models equipped with a CO₂ sensor. Any remaining connected sensors must be without a CO₂ sensor.
- A mixed architecture with standard room devices and Bluetooth low energy enabled devices is not recommended.

Maximum number of standard room devices supported per controller combined ¹	4
Allure EC-Smart-View Series ²	4
Allure EC-Smart-Comfort Series	4
Allure EC-Smart-Air Series ²	4
EC-Multi Sensor	4
ECx-Light-4 / ECx-Light-4D / ECx-Light-DALI	4
ECx-Blind-4 / ECx-Blind-4LV	4
Maximum number of Bluetooth low energy room devices per controller combined ³	4
Allure UNITOUCH™	2
EC-Multi-Sensor-BLE	4

- For more details about supported quantities, see the ECLYPSE Selection Tool.xlsm spreadsheet file available for download on the Documentation and Resources Portal.
- A controller can support a maximum of 2 Allure sensor models equipped with a CO₂ sensor. Any remaining connected sensors must be without a CO₂ sensor.
- A mixed architecture with standard room devices and Bluetooth low energy enabled devices is not recommended.

Hardware

Processor	Sitara ARM processor
CPU Speed	600MHz
Memory	4GB Non-volatile Flash (applications & storage) 512MB RAM
Real Time Clock (RTC)	Real Time Clock with rechargeable battery Supports SNTP network time synchronization
RTC Battery	20 hours charge time, 20 days discharge time Up to 500 charge / discharge cycles
Cryptographic Module	FIPS 140-2 Level 1 Compliant
Ethernet	2 switched RJ-45 Ethernet ports (Supported Protocols: BACnet/IP, Modbus TCP, NTP, and REST)
Integrated fail-safe for daisy-chaining	In case of power failure to one of the controllers, communication data is still relayed to the following controller on the daisy-chain
USB Connections	2 × USB 2.0 Ports 1 × Micro-USB 2.0 Ports

RS-485 Serial Communications	Screw terminals (Supported Protocols: Modbus RTU)
Subnet	RJ-45
Green LED	Power status, Subnet TX, and Ethernet Traffic
Orange LED	Controller status, Subnet RX, and Ethernet Speed

Open-to-Wireless Adapter

Communication Protocol	EnOcean wireless standard ¹
Connector Type	USB
Number of Wireless Inputs	Unlimited ²



1. Available when an optional external ECLYPSE Open-to-Wireless Adapter is connected to the controller. Refer to the Open-to-Wireless Application Guide for a list of supported EnOcean wireless modules.
2. Wireless inputs will only be limited by physical distance between the EnOcean devices and the ECLYPSE Open-to-Wireless Adapter.

Mechanical

Dimensions (H × W × D)	4.74 × 6.78 × 2.31" (120.31 × 172.10 × 58.56 mm)
Shipping weight	1.20lbs (0.55 kg)
Mounting	DIN rail or screw mounting
Enclosure Material ¹	FR/ABS
Enclosure Rating	Plastic housing, UL94-V0 flammability rating

1. All materials and manufacturing processes comply with the RoHS directive and are marked according to the Waste Electrical and Electronic Equipment (WEEE) directive

Environmental

Operating Temperature	-40 to 122°F (-40 to 50°C)
Storage Temperature	-40 to 158°F (-40 to 70°C)
Relative Humidity	0 to 90% non-condensing
Ingress Protection Rating	IP20 (IEC 60549)
Nema Rating	1

Standards and Regulations

CE Emission	EN61000-6-3: 2007+A1:2011
CE Immunity	EN61000-6-1: 2007
FCC	Compliance with FCC rules part 15, subpart B, class B
UL Listed (CDN & US)	UL916 Energy management equipment



Universal Inputs (UI)

General

Input Type	Universal; software configurable
Input Resolution	16-bit analog to digital converter
Power Supply Output	18VDC; 80mA maximum
Protection	Auto-reset fuse for 24VAC protection

Contact

Type	Dry contact
------	-------------

Counter

Type	Dry contact
Maximum Frequency	1Hz maximum
Minimum Duty Cycle	500 ms On / 500 ms Off

0 to 10VDC

Range	0 to 10VDC (40kΩ input impedance)
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0 to 5VDC

Range	0 to 5VDC (high input impedance)
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0 to 20mA

Range	0 to 20mA, 249Ω external resistor wired in parallel
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Resistance/Thermistor

Range	0 to 350 KΩ
-------	-------------

Supported Thermistor Types Any that operate in this range

Pre-configured Temperature Sensor Types:

Thermistor	10KΩ Type 2, 3 (10KΩ @ 77°F; 25°C)
Platinum	Pt1000 (1KΩ @ 32°F; 0°C)
Nickel	RTD Ni1000 (1KΩ @ 32°F; 0°C) RTD Ni1000 (1KΩ @ 69.8°F; 21°C)

Universal Outputs (UO)

General

Output Type	Universal; software configurable
Output Resolution Converter	10-bit digital to analog Converter
Output Protection,	Built-in snubbing diode to protect against back-EMF, for example when used with a 12VDC relay
	Output is internally protected against short circuits
Auto-reset Fuse	Provides protection from accidental 24VAC connection

0 or 12VDC (On/Off)

Range	0 or 12VDC
Source Current	Maximum 20 mA at 12VDC (minimum resistance 600Ω)

PWM

Range	Adjustable period from 2 to 65 seconds
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Thermal Actuator Management	Adjustable warm up and cool down time
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Floating

Minimum Pulse On/Off Time	500 milliseconds
Drive Time Period	Adjustable

0 to 10VDC

Source:

Voltage Range	0 to 10VDC linear
Source Current	Maximum 20 mA at 10VDC (minimum resistance 600Ω)

Sink:

Voltage Range	0 to 10VDC linear
Sink Current	Maximum 2.5 mA at 1VDC (minimum resistance 4kΩ)

Digital Output (DOT)

General

Output Type	24VAC Triac; software configurable
Maximum Current	0.5A continuous 1A @ 15% duty cycle for a 10 minute period
Power Source,	External power supply

0 or 24VAC (On/Off)

Range 0 or 24VAC

PWM

Range Adjustable period from 2 to 65 seconds

Floating

Minimum Pulse On/Off Time 500 milliseconds

Drive Time Period Adjustable

Digital-Universal Output (DUO)

General

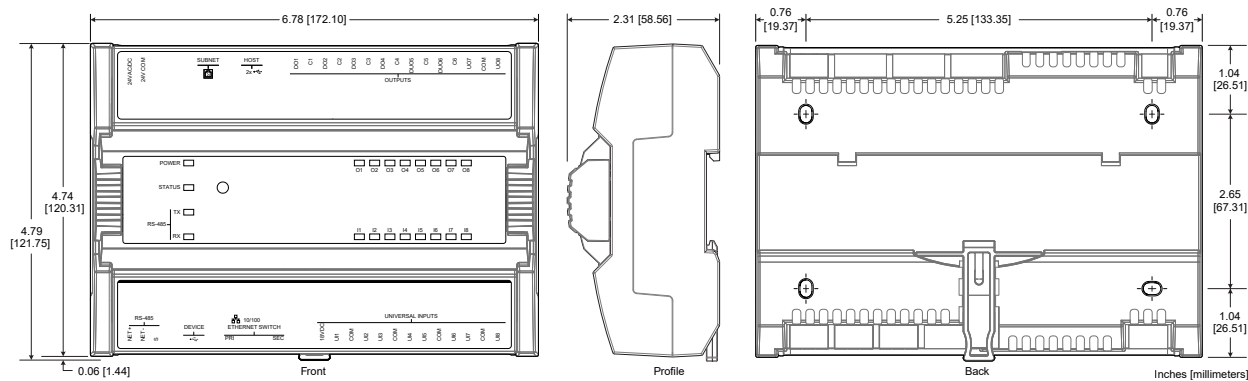
Output Type Universal or digital triac;
Software configurable

Specifications

Universal Output Mode See Universal Output (UO)

Digital Output Mode See Digital Output (DOT)

Dimensions



Specifications subject to change without notice.

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ECY-S1000 Series

Control, Automation and
Connectivity Servers

ECY PSE™



Overview

The ECY-CSC is sized to cost-effectively meet the requirements of any HVAC application from small to medium to large systems. The most capable Connected System Controller model can be expanded to support up to 20 input/output (I/O) modules (up to 320 I/Os) while being able to adapt to new requirements as the need arises.

A connecting cable is used to connect successive rows of modules within a controls' cabinet to provide power and communication.

Features & Benefits

- Support for a range of communication protocols such as BACnet MS/TP, Modbus RTU, Modbus TCP, and M-Bus
- With the RESTful API, data can be accessed from different applications, such as energy dashboards, analytics tools, and mobile applications
- Expandable as needs increase to support up to 20 input/output (I/O) modules (up to 320 I/Os)
- Integrates up to three RS-485 ports
- Lighting and shade/sunblind expansion modules to control lights and shades/sunblinds
- Compatible with Distech Controls line of *Bluetooth*® low energy technology enabled devices and mobile application providing state-of-the-art occupant management
- Multi-sensor compatibility combines motion and luminosity (Lux) sensors
- Available remote access to program, configure, or maintain the installation, reducing costs associated with on-site visits
- Terminal blocks are uniquely identified and color-coded for clarity and to prevent wiring mistakes
- Embedded alarms, trend log and schedule support allows for fully distributed data and logic
- Automatic email notifications for system status and alarms to ensure faster system servicing and response time

Model Selection

Example: ECY-S1000**E-28-MS**

Series ¹	WebServer	License Points Limit	BACnet MS/TP Routing
ECY-S1000	[blank] : No Embedded Graphics E : With Embedded Graphics	-28 : 28 Points HW (3 Modbus) -48 : 48 Points HW (10 Modbus) [blank] : No Limits (320 typ., 96 Modbus)	[blank] : No BACnet MS/TP Routing Option -MS : With BACnet MS/TP Routing ²

1. SEP models (single Ethernet port) have secondary Ethernet port factory disabled

2. Option already included in no limits license, please specify [blank]

Accessories

ECLYPSE Wi-Fi Adapter	Wi-Fi Adapter for ECLYPSE Connected Controllers.
ECLYPSE Open-To-Wireless™ Adapter	EnOcean communication protocol adapter for ECLYPSE Connected Controllers.

Product Specifications

Power Supply Input

Voltage	18VDC
Power Consumption	8.9W; external loads excluded

Communications

Ethernet Connection Speed	10/100 Mbps
Cable Type	Cat 5e, 8 conductor twisted pair (unshielded)
Addressing	IPv4 or Hostname
BACnet Profile	BACnet Building Controller (B-BC)), AMEV AS-A and AS-B
BACnet Listing	BTL, WSP B-BC
BACnet Interconnectivity	BBMD forwarding capabilities BACnet MS/TP to BACnet/IP routing
BACnet Transport Layer	IP & MS/TP (optional)
Web Server Protocol	HTML5
Web Server Application Interface	REST API
BACnet MS/TP or Modbus RTU	1 × RS-485 serial communications ports
RS-485 Wiring	1-pair + Common/shield
RS-485 EOL Resistor	Built-in
RS-485 Baud Rates	9600, 19 200, 38 400, or 76 800 bps
RS-485 Addressing	Controller's Web Configuration Interface
Modbus TCP	Devices must be on the same subnet
Wireless Adapter	Optional, USB Port Connection
Wi-Fi Communication Protocol	IEEE 802.11b/g/n
Wi-Fi Network Types	Client, Access Point, Hotspot

Subnetwork

Communication	RS-485
Cable Type	Cat 5e, 8 conductor twisted pair
Connector	RJ-45
Connection Topology	Daisy-chain
Maximum number of standard room devices supported per controller combined ¹	12
Allure EC-Smart-Vue Series ²	12
Allure EC-Smart-Comfort Series	6
Allure EC-Smart-Air Series ²	6
EC-Multi Sensor	4
ECx-Light-4 / ECx-Light-4D / ECx-Light-DALI	4
ECx-Blind-4 / ECx-Blind-4LV	4
Maximum number of Bluetooth low energy room devices per controller combined ³	6
Allure UNITOUCH™	2
EC-Multi-Sensor-BLE	4

1. For more details about supported quantities, see the ECLYPSE Selection Tool.xlsm spreadsheet file available for download on the Documentation and Resources Portal.
2. A controller can support a maximum of 2 Allure sensor models equipped with a CO₂ sensor. Any remaining connected sensors must be without a CO₂ sensor.
3. A mixed architecture with standard room devices and Bluetooth low energy enabled devices is not recommended.

Hardware

Processor	Sitara ARM processor
CPU Speed	1GHz
Memory	4GB Non-volatile Flash (applications & storage) 512MB RAM
Real Time Clock (RTC)	Real Time Clock with rechargeable battery Supports SNTP network time synchronization
RTC Battery	20 hours charge time, 20 days discharge time Up to 500 charge / discharge cycles
Cryptographic Module	FIPS 140-2 Level 1 Compliant
Ethernet	2 switched RJ-45 Ethernet ports (Supported Protocols: BACnet/IP, Modbus TCP, NTP, and REST)

USB Connections	2 × USB 2.0 Ports 1 × Micro-USB 2.0 Ports
RS-485 Serial Communications	Screw terminals (Supported Protocols: BACnet MS/TP or Modbus RTU)
Subnet	RJ-45
Green LED	Power status, Subnet TX, RS-485 TX, and Ethernet Traffic
Orange LED	Controller status, Subnet RX, RS-485 RX, and Ethernet Speed

Open-to-Wireless Adapter

Communication Protocol	EnOcean wireless standard ¹
Connector Type	USB
Number of Wireless Inputs	Unlimited ²



1. Available when an optional external ECLYPSE Open-to-Wireless Adapter is connected to the controller. Refer to the Open-to-Wireless Application Guide for a list of supported EnOcean wireless modules.
2. Wireless inputs will only be limited by physical distance between the EnOcean devices and the ECLYPSE Open-to-Wireless Adapter.

Mechanical

Dimensions (H × W × D)	4.74 × 3.57 × 2.31" (120.31 × 90.67 × 58.56mm)
Shipping weight	0.85lbs (0.39kg)
Mounting	DIN rail or screw mounting
Enclosure Material	FR/ABS
Enclosure Rating ¹	Plastic housing, UL94-V0 flammability rating

1. All materials and manufacturing processes comply with the RoHS directive and are marked according to the Waste Electrical and Electronic Equipment (WEEE) directive

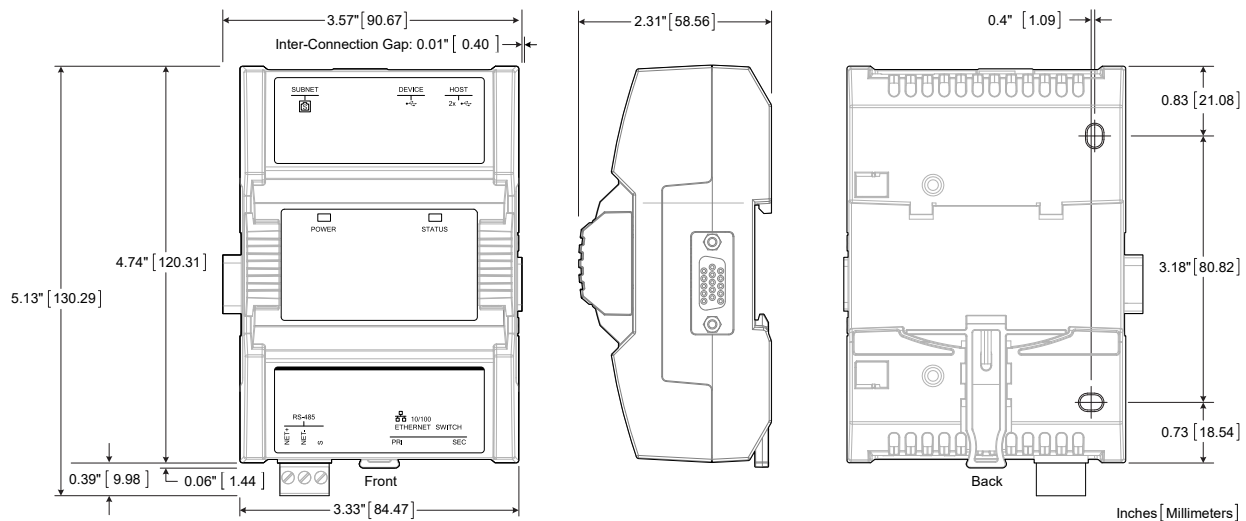
Environmental

Operating Temperature	32 to 122°F (0 to 50°C)
Storage Temperature	-22 to 158°F (-30 to 70°C),
Relative Humidity	0 to 90% non-condensing
Ingress Protection Rating	IP20
Nema Rating	1

Standards and Regulations

CE Emission	EN61000-6-3: 2007+A1:2011
CE Immunity	EN61000-6-1: 2007
FCC	Compliance with FCC rules part 15, subpart B, class B

UL Listed (CDN & US) UL916 Energy management equipment



Specifications subject to change without notice.

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ECM #11
Kitchen hood controls / flow requirements

Savings Calculations

FAN ENERGY SAVINGS

PROJECT: The Efficiency Network - Wernersville State Hospital - Bldg 34

SITE: Wernersville , PA

DATE: 10/4/2021

INPUT DATA:

A Operating Hours Per Day	14 HRS/DAY
B Operating Days Per Week	7 DAYS/WK
C Operating Weeks Per Year	52 WKS/YR
D Horsepower of Fan Motor(s)	10 HP
E Load Factor of Fan Motor(s)	0.90
F Cost Per Kilowatt Hour	\$0.07 \$/kWh

CONSTANT EXHAUST VOLUME ANALYSIS:

G Total Time (A x B x C)	5,096 HRS/YR
H Total kWh/HP/YR (0.746/System Effic. x G)	4,345 kWh/HP/YR

VARIABLE EXHAUST VOLUME ANALYSIS:

% Rated RPM I	% Run Time J	Time HRS/YR K=GxJ	Output kW/HP L	System Effic. M	Input kW/HP N=L/M	kWh/ HP/YR O=KxN
100%	20%	1019.2	0.746	0.875	0.853	868.9
90%	10%	509.6	0.544	0.875	0.622	316.7
80%	10%	509.6	0.382	0.875	0.437	222.4
70%	10%	509.6	0.256	0.875	0.292	149.0
60%	10%	509.6	0.161	0.875	0.184	93.8
50%	10%	509.6	0.093	0.875	0.107	54.3
40%	10%	509.6	0.048	0.875	0.055	27.8
30%	20%	1019.2	0.020	0.875	0.023	23.5
20%	0%	0	0.006	0.875	0.007	0.0
10%	0%	0	0.001	0.875	0.001	0.0
0%	0%	0	0.000	0.875	0.000	0.0

P Total kWh/HP/YR (Total of Column O)	1756.6
---------------------------------------	--------

CALCULATION:

(H - P) x D x E x F

UNCONTROLLED COST =

\$2,737 /YEAR

SAVINGS =

23,293 kWh/YEAR

\$1,631 /YEAR

HEATING SAVINGS

PROJECT: The Efficiency Network - Wernersville State Hospital - Bldg 34

SITE: Wernersville , PA

DATE: 10/4/2021

INPUT DATA:

A Previous Net Exhaust Volume	7,684 CFM
B New Net Exhaust Volume (1)	4995 CFM
C Winter Building Temperature	68.0 (°F)
D Previous Net Heat Load (2)	747,466 kBTU
E New Net Heat Load (2)	485,853 kBTU
F Operating Hours Per Day	14 HRS/DAY
G Operating Days Per Week	7 DAYS/WK
H Cost Per Fuel Unit (3)	\$5.50 \$/UNIT
I Heating Fuel Type	Natural Gas
J BTU Per Fuel Unit (4)	1,000 kBTU/UNIT
K System Efficiency (4)	0.8
L Supply Air Heating Multiplier (5)	0.80

UNCONTROLLED COST = \$4,111 /YEAR 65%

CALCULATION: (D-E) x L x H / (J x K)

SAVINGS = 261,613 kBTU/YEAR
\$1,439 /YEAR 35%

CALCULATION: D x L x H / (J x K)

NOTES:

(1) Determine the New Exhaust Volume by completing TABLE 1. The New Exhaust Volume equals the AVG % RPM x the Previous Exhaust Volume.

(2) Using design weather data via the Outdoor Airload Calculator and multiplied by days/year ratio.

(3) Using local energy costs.

(4) Using typical system efficiency.

(5) Estimation Factor

TABLE 1		
% Rated RPM (F)	% Run Time (I)	F x I
100%	20%	20%
90%	10%	9%
80%	10%	8%
70%	10%	7%
60%	10%	6%
50%	10%	5%
40%	10%	4%
30%	20%	6%
20%	0%	0%
10%	0%	0%

AVG % RPM = 65%

COOLING SAVINGS

PROJECT: The Efficiency Network - Wernersville State Hospital - Bldg 34

SITE: Wernersville , PA

DATE: 10/4/2021

INPUT DATA:

A Previous Net Exhaust Volume	7,684 CFM
B New Net Exhaust Volume (1)	4,995 CFM
C Previous Net Cooling Load (2)	232,879 kBTU
D New Net Cooling Load (2)	151,371 kBTU
E Cost Per Fuel Unit (5)	\$0.07 \$/kWh
F COP (6)	3.5
G Supply Air Cooling Multiplier (7)	0.50
H Building Cooling Set Point	72.0 (°F)
I Energy Content Per Fuel Unit	3.41 kBTU/Unit

UNCONTROLLED COST = \$682 /YEAR 65%

CALCULATION: $(C - D) \times G \times E / (I \times F)$

SAVINGS = 3,412 kWh/YEAR
\$239 /YEAR 35%

CALCULATION: $C \times G \times E / (I \times F)$

NOTES:

- (1) Using New Exhaust Volume from HEATING SAVINGS on page 3. See Note 1.
- (2) Obtained from Outdoor Airload Calculator
- (3) Using design weather data.
- (4) The multiplier corrects for actual % outside air.
- (5) Using local energy costs.
- (6) Using typical system efficiency.
- (7) Using cooling supply air factor.

DEFINITIONS

PROJECT: The Efficiency Network - Wernersville State Hospital - Bldg 34

SITE: Wernersville , PA

DATE: 10/4/2021

Definitions:

Load Factor: Used to discount motor nameplate HP. Instead of using the full nameplate HP of the motor, the rating is typically discounting it by 10% to account for the motor(s) likely not running at 100% full load.

Motor Efficiency: A value that can be edited, but unless we know better typically leave motor efficiency at 90% (sticking with the conservative route as this is obviously higher than most motors).

Average Fan Speed Profile: Used to "bin" average fan speeds into 10% increments. For sites where log data is available, this is the result of taking hisogram data from the log files. For new sites, the average fan speed profile is estimated based on market segment along with hisorical knowledge/experience from Melink.

Previous Net Exhaust Volume: The summed exhaust volume for all of the hoods being run in the ESR. When known, the actual value is used.

Previous Net Heating/Cooling Load: Based on the Previous Net Exhaust Volume, this is calculated via the FishNick Outdoor Airload Calculator (OAC) with added parameters of daily run hours (time X to time Y) and dehumidification (if applicable).

New Net Heating/Cooling Load: Based off the Previous Net Cooling Load and calculated by multiplying total average run speed from the Average Fan Speed Profile.

System Efficiency (Heating): A measure of how efficient the heating system is. For direct-fired heaters, efficiency is approximated as 100%. For indirect heaters, efficiency is approximated at 80%

COP: Coefficient of Performance. A measure of how efficient an HVAC system is. For reference, a COP of 3 approximates to a SEER of 12 or EER of 10.5. A COP of 4 approximates to a SEER of 18 or EER of 13.7. A COP of 3 is typical.

Supply Air Heating/Cooling Multiplier: Factors that are utilized to discount the savings calculations for heating and cooling. Typically set to 0.8 if directly controlling a supply air unit that supplies either heating or cooling; if not directly controlling a supply air unit that is providing heating/cooling then the multiplier is typically 0.5.

ASHRAE 90.1-2010/13 Table 6.5.7.1.3: Maximum Net Exhaust Flow Rate, CFM per Linear Foot of Hood Length

Type of Hood	Light Duty Equipment	Medium Duty Equipment	Heavy Duty Equipment	Extra Heavy Duty Equipment
Wall-Mounted Canopy	140	210	280	385
Single Island	280	350	420	490
Double Island (Per Side)	175	210	280	385
Eyebrow	175	175	Not Allowed	Not Allowed
Backshelf / Pass-Over	210	210	280	Not Allowed

ECM #11

Kitchen hood controls / flow requirements

Equipment Information Sheets

Submittal Schedule

This schedule includes the products supplied as part of this submittal.

Schedule			Motor Data ¹			Drive Data			
Item	Qty	Tag	HP	FLA	Volts	Product ID	HP	Amps	Volts
1	1	5 HP	5	16.7	208 VAC	ACH580-01-017A-2	5	16.7	208 VAC
Notes: <ol style="list-style-type: none"> AC motor data is per National Electrical Code Table 430.250 for typical motors used in most applications. It is provided as typical data only. DC motor data is per typical industry standards. Actual motor data may vary 									

Submittal Schedule Details for 5 HP

Item	Tag / Equipment ID	Product ID
1	5 HP	ACH580-01-017A-2

Item Description

Input Voltage: 208 VAC Three Phase
Rated Output Current: 16.7A
Enclosure: UL (NEMA) Type 1
Nominal Horsepower: 5 HP
Frame Size: R1
Input Disconnecting Means: None
Bypass: None
Input Impedance: 5% equivalent impedance
Short Circuit Current Rating: 100 kA with fusing
Communication Protocols: Johnson Controls N2, Modbus RTU, BACnet (MS/TP)
Other Options:

Drive Input Fuse Ratings

Fuse Class	Amps (600 V)
Class CC or T	30

Wire Size Capacities of Power Terminals

Input Wiring	Output Wiring	Ground Wiring
#24 ... #10 1 lbf-ft	#24 ... #10 1 lbf-ft	#18 ... #6 1.1 lbf-ft

Dimensions and Weights

Height <i>in</i> (<i>mm</i>)	Width <i>in</i> (<i>mm</i>)	Depth <i>in</i> (<i>mm</i>)	Weight <i>lbs</i> (<i>kg</i>)
14.7 (373)	4.9 (125)	8.8 (223)	10 (4.6)

Heat Dissipation & Airflow Requirements

Power Losses		Airflow	
BTU/Hr	Watts	CFM	CM/Hr
454	133	25	42.5

ACH580-01/-31

The ACH580 drive sets new standards in both simplicity and reliability, and ensures smooth, energy-efficient operation of your HVAC systems in normal and mission-critical situations.

ACH580-01, wall-mounted base drives

The ACH580-01 wall-mounted drives are available from 1 to 100 HP at 208/240 V. The ACH580-01 drives are available in UL (NEMA) Type 1 configuration. In standard installations, the drive is mounted directly onto a wall and uses the provided conduit box. Conduit openings are provided for bottom conduit entry & exit. For mounting in a customer-supplied cabinet, the conduit box may be removed. The drive has a 100 kA SCCR rating when paired with appropriately sized upstream fuses.

Features for HVAC

The ACH580 comes standard with an intuitive control panel used to configure, control, and monitor the drive. An optional Bluetooth control panel allows the drive to be configured via the control panel or the DriveTune app.

A robust HVAC firmware package provides drive, motor, and application protection features. Examples of drive protection features include undervoltage, overvoltage, overcurrent, and ground fault protection. The ACH580 also has a variety of motor protection features including overload and stall protections.

Application specific features, such as accepting four separate start interlocks (safeties), along with broken belt detection, are also included. The drive includes BACnet MS/TP, Modbus RTU, and Johnson N2 as standard.

Technical specifications

Product compliance (complete list on following page)

ACH580-01/-31 CE, UL, cUL, and EAC

Supply connection

Input voltage (U_i)	
ACH580-xx-xxxA-2	208/240V
ACH580-xx-xxxA-4	480V
ACH580-xx-xxxA-6	600V
Input voltage tolerance	+10% / -15%
Phase	3-phase (1-phase, 240 V)
Frequency	48 to 63 Hz
Line Limitations	Max $\pm 3\%$ of nominal phase to phase input voltage
Power Factor ($\cos \phi$) at nominal load	
ACH580-01	0.98
ACH580-31	1.0
Efficiency at rated power	
ACH580-01	98.0%
ACH580-31	96.5%
Power Loss	Approximately 2% of rated power

Motor connection

Supported motor control	Scalar and vector
Supported motor types	Asynchronous motor, permanent magnet motor (vector), SynRM (vector)
Voltage	3-phase, from 0 to supply voltage
Frequency	0 to 500 Hz
Short Term Overload Capacity Variable Torque	110% for 1 min/10min
Peak Overload Capacity	1.35 for 2 second
Variable Torque	(2 sec / 10 min)
Switching Frequency	2, 4, 8 or 12 kHz Automatic fold back in case of overload
Acceleration/Deceleration Time	0 to 1800 s
Short Circuit Current Rating (SCCR)	100 ka with fusing

Inputs and outputs (drive)

2 analog inputs	Selection of Current/Voltage input mode is user programmable.
Voltage reference	0 (2) to 10 V, $R_{in} > 200 \text{ k}\Omega$
Current reference	0 (4) to 20 mA, $R_{in} = 100 \Omega$
Potentiometer reference value	10 V $\pm 1\%$ max. 20 mA
2 analog outputs	AO1 is user programmable for current or voltage. AO2 current
Voltage reference	0 to 10 V, $R_{load} > 100 \text{ k}\Omega$
Current reference	0 to 20 mA, $R_{load} < 500 \Omega$
Applicable potentiometer	1 k Ω to 10 k Ω
Internal auxiliary voltage	24 V DC $\pm 10\%$, max. 250 mA
Accuracy	+/- 1% full scale range at 25°C (77°F)
Output updating time	2 ms
6 digital inputs	12 to 24 V DC, 10 to 24 V AC, Connectivity of PTC sensors supported by a single digital input. PNP or NPN connection (5 DIs with NPN connection).

	Programmable
Input Updating Time	2 ms
3 relay outputs	Maximum switching voltage 250 V AC/30 V DC. Maximum continuous current 2 A rms. Programmable, Form C
Adjustable filters on analog inputs and outputs	
All control inputs isolated from ground and power	
Operation	
Air temperature	0 to -15 °C (32 to 5 °F). -15 to +50 °C (5 to 122 °F): No frost allowed. Output derated above +40 °C (104 °F)
Installation site altitude	0 to 4000 m (13123 ft) above sea level Output derated above 1000 m (3281 ft)
Relative humidity	5 to 95% No condensation allowed Maximum relative humidity is 60% in the presence of corrosive gasses
Atmospheric pressure	70 to 106 kPa (10.2 to 15.4 PSI) 0.7 to 1.05 atmospheres
Vibration	Risk category IV Certified (IBC 2018)
Environmental protections	
Chemical Gasses	Class 3C2
Solid Particles	Class 3S2 No conductive dust allowed
Pollution degree (IEC/EN 61800-5-1)	Pollution degree 2
Product compliance	
Standards and directives	Low Voltage Directive 2006/95/EC EMC Directive 2004/108/EC 60721-3-3: 2002 60721-3-1:1997 Quality assurance system ISO 9001 and Environmental system ISO 14001 CE, UL, cUL, and EAC approvals Galvanic isolation according to PELV RoHS2 (Restriction of Hazardous Substances) EN 61800-5-1: 2007; IEC/EN 61000-3-12; EN61800-3: 2017 + A1: 2012 Category C2 (1st environment restricted distribution); Safe torque off (EN 61800-5-2) BACnet Testing Laboratory (BTL) Seismic (IBC, OSHPD) Plenum (ACH580-01 only)
EMC (according to EN61800-3)	ACH580-01 and ACH580-31 class C2 (1st environment restricted distribution)

Storage (in Protective Shipping Package)	
Air Temperature	-40 to +70 °C (-40 to +158 °F)
Relative Humidity	Less than 95% No condensation allowed Maximum relative humidity is 60% in the presence of corrosive gasses
Chemical Gasses	Class 1C2
Solid Particles	Class 1S2 Contact ABB regarding Class 1S3
Atmospheric pressure	70 to 106 kPa 0.7 to 1.05 atmospheres
Vibration (ISTA)	
R1...R4	In accordance with ISTA 1A
R5...R9	In accordance with ISTA 3E
Transportation (in Protective Shipping Package)	
Air Temperature	-40° to 70°C (-40° to 158°F)
Relative Humidity	Less than 95% No condensation allowed Maximum relative humidity is 60% in the presence of corrosive gasses
Atmospheric Pressure	60 to 106 kPa (8.7 to 15.4 PSI) 0.6 to 1.05 atmospheres
Free Fall	R1: 76 cm (30 in) R2: 61 cm (24 in) R3: 46 cm (18 in) R4: 31 cm (12 in) R5: 25 cm (10 in)
Chemical Gasses	Class 2C2
Solid Particles	Class 2S2
Shock/ Drop (ISTA)	
R1...R4	In accordance with ISTA 1A
R5...R9	In accordance with ISTA 3E
Vibration (ISTA)	
R1...R4	In accordance with ISTA 1A
R5...R9	In accordance with ISTA 3E

Feature overview

Communication

Protocols as standard (EIA-485): BACnet MS/TP, Modbus RTU, Johnson Controls N2
Available as plug-in options: BACnet/IP, Modbus TCP, PROFIBUS-DP, DeviceNet, EtherNet/IP, LonWorks (coming 2019)

Application functions

Start interlock
Delayed start
Run permissive (damper monitoring)
Override operation mode
Real-time clock (scheduling)
PID controllers for motor and process
Motor flying start
Motor preheating
Energy optimizer and calculators
Timer
2 or 3 wire start/stop
Ramp to stop
2 independent adjustable accel/decel ramp

Protection functions

Overvoltage controller
Undervoltage controller
Motor earth-leakage monitoring
Motor short-circuit protection
Motor overtemperature protection
Output and input switch supervision
Motor overload protection (UL508C)
Phase-loss detection (both motor and supply)
Under load supervision (belt loss detection)
Overload supervision
Stall protection
Loss of reference
Panel loss
Ground fault
External events
Overcurrent
Current limit regulator
Transient/Surge protection (MOV and choke)

Panel functions

First start assistant
Primary settings for HVAC applications
Hand-Off-Auto operation mode
HVAC quick set-up
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 (resettable)
- Input / Output Terminal Monitor
- PID Actual Value (Feedback) & Error Fault Text

- Warning Text
- Three (3) Scalable Process Variable Displays
- User-Definable Engineering Units

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

PID control

One (1) Process PID

Four (4) Integral Independent Programmable PID

Setpoint Controllers (Process and External)

External Selection between Two (2) Sets of Process

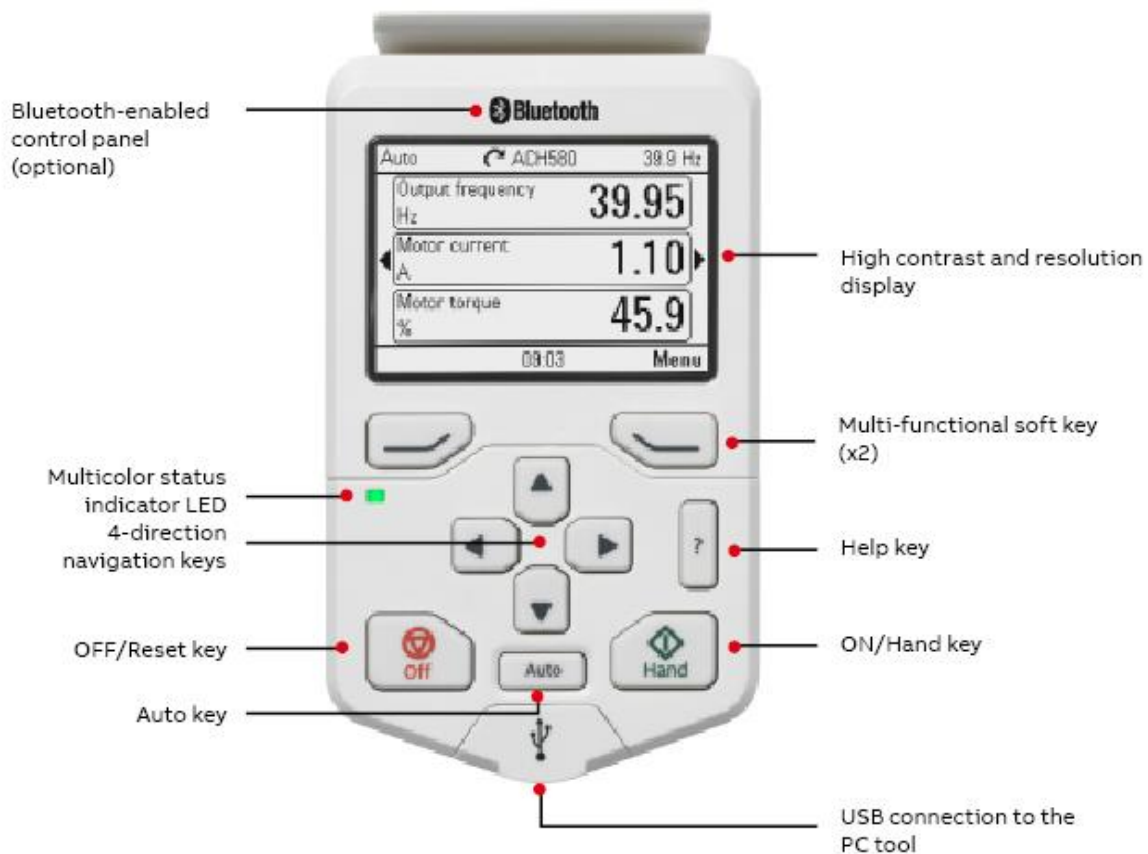
PID Controller Parameters

PID Sleep/Wake-Up

Control panel features

The ACH580 Assistant Control Panel features:

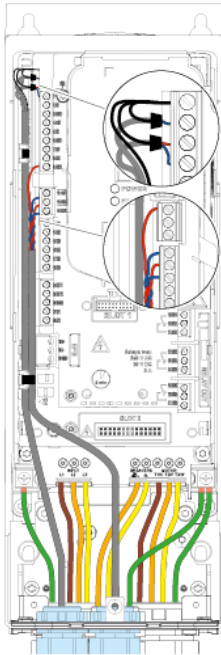
- Intuitive to operate
- Primary Setting menu to ease drive commissioning
- Real-time clock
- Diagnostic and maintenance functions
- Full-graphic display, including chart, graph, and meter options
- 21 editable home views
- USB interface for PC and tool connection as standard
- Parameters are alpha-numeric
- North American version supports 14 languages as standard
- Dedicated "Help" key
- 4 user sets
- Parameters are stored in control panel memory for later transfer to other drives or for backup of a particular system
- Back-up and restore parameters and/or motor data
- Automatic back-up 2 hours after parameter change
- Modified parameter display
- Creates unique short menu
- Shows parameters that differ from the default
- Bluetooth connectivity for use with mobile device (requires +J429 option)



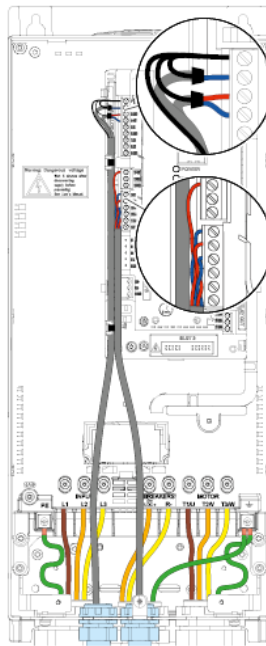
Cable connections

The following illustrations show the ACH580-01 and ACH580-31 cable connection points for the base drive. The illustrations indicate the location of input and output power connections as well as equipment and motor grounding connection points.

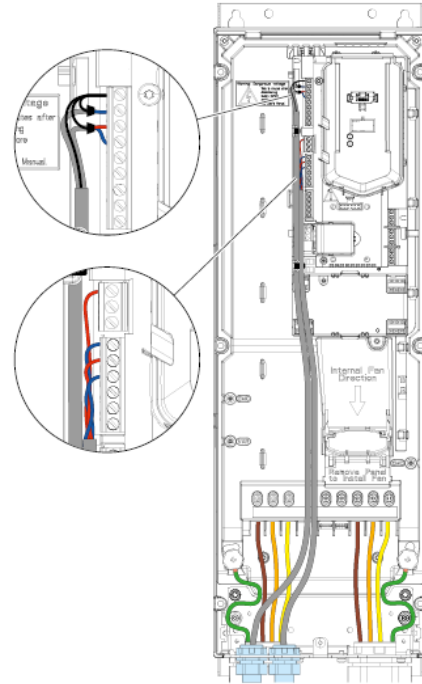
ACH580 drives are configured for wiring access from the bottom only. At least three separate metallic conduits are required, one for input power, one for output power to the motor and one for control signals.



ACH580-01, R1-R2, UL (NEMA) Type 1 and 12



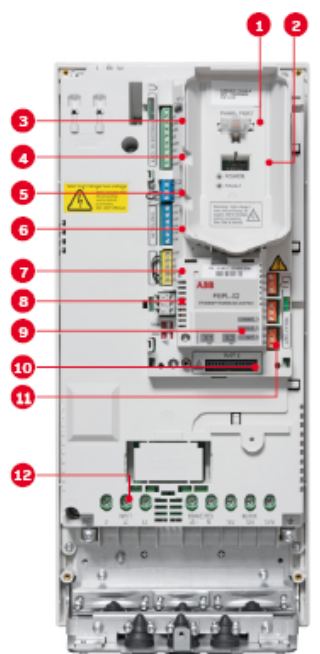
ACH580-01, R3, UL (NEMA) Type 1 and 12



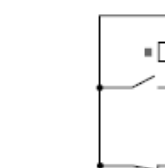
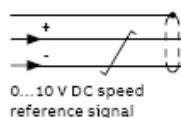
ACH580-01, R4, UL (NEMA) Type 1 and 12

Control connections

Default control connections







1. Panel port (PC tools, control panel)
2. ABB drive customizer port for programming the drive without mains
3. Analog inputs (2 × AI)
4. Analog outputs (2 × AO)
5. 24 V DC output
6. Digital inputs (6 × DI)
7. Safe torque off (STO)
8. Embedded fieldbus
9. Communication options (fieldbuses)
10. Analog and digital I/O extensions
11. Relay outputs (3 × RO)
12. Mains connection



Run status

Fault status

Terminal	Meaning	Default macro connections	
X1 Reference voltage and analog inputs and outputs			
1	SCR	Signal cable shield (screen)	
2	AI1	Output frequency/speed reference: 0 to 10 V	
3	AGND	Analog input circuit common	
4	+10 V	Reference voltage 10 V DC	
5	AI2	Actual feedback: 0 to 20 mA	
6	AGND	Analog input circuit common	
7	AO1	Output frequency: 0 to 10 V	
8	AO2	Motor current: 0 to 20 mA	
9	AGND	Analog output circuit common	
X2 & X3 Aux. voltage output and programmable digital inputs			
10	+24 V	Aux. voltage output +24 V DC, max. 250 mA	
11	DGND	Aux. voltage output common	
12	DCOM	Digital input common for all	
13	DI1	Stop (0)/Start (1)	
14	DI2	Not configured	
15	DI3	Constant frequency/speed selection	
16	DI4	Start interlock 1 (1 = allow start)	
17	DI5	Not configured	
18	DI6	Not configured	
X6, X7, X8 Relay outputs			
19	RO1C	 Damper control 250 V AC/30 V DC 2 A	Energize damper 19 connected to 21
20	RO1A		
21	RO1B	 Running 250 V AC/30 V DC 2 A	Running 22 connected to 24
22	RO2C		
23	RO2A	 Fault (-1) 250 V AC/30 V DC 2 A	Fault condition 25 connected to 26
24	RO2B		
25	RO3C		
26	RO3A		
27	RO3B		
X5 Embedded fieldbus			
29	B+	Embedded fieldbus, EFB (EIA-485)	
30	A-		
31	DGND	Termination switch	
34	TERM		
35	BIAS	Bias resistors switch	
X4 Safe torque off			
34	OUT1	Safe torque off. Factory connection. Both circuits must be closed for the drive to start. See chapter <i>The Safe torque off function</i> in the <i>hardware manual</i> of the drive.	
35	OUT2		
36	SGND		
37	IN1		
38	IN2		
X10 24 V AC/DC			
40	24 V AC/DC+ in	R6-R11 only: Ext. 24 V AC/DC input to power up the control unit when the main supply is disconnected.	
41	24 V AC/DC- in		

Notes:

- Connected with jumpers at the factory.
- Only frames R6-R11 have terminals 40 and 41 for external 24 V AC/DC input.

Engineering Data Summary

Fuses

Drive input fuses are recommended to disconnect the drive from power in the event that a component fails in the drive's power circuitry. Recommended drive input fuse specifications are listed in the *Submittal Schedule Details* and in the *Fuse Ratings Table*. Fuse rating information is provided for customer reference.

Item	Catalog Number	Drive Input Fuse Ratings	
		Amps (600V)	Bussmann Type
1	ACH580-01-017A-2	30	Class CC or T

Terminal Sizes / Cable Connection Requirements

Power and motor cable terminal sizes and connection requirements are shown in the *Submittal Schedule Details* and in the *Terminal Sizes / Cable Connection Requirements Table*. The information provided below is for connections to input power and motor cables. These connections may be made to an input circuit breaker or disconnect switch, a motor terminal block, overload relay, and/or directly to bus bars and ground lugs. The table also lists torque that should be applied when tightening terminals and spacing requirements where multiple mounting holes are provided in the bus bar.

Item	Catalog Number	Input Wiring	Output Wiring	Ground Wiring
1	ACH580-01-017A-2	#24 ... #10 1 lbf-ft	#24 ... #10 1 lbf-ft	#18 ... #6 1.1 lbf-ft

Heat Dissipation Requirements

The cooling air entering the drive must be clean and free from corrosive materials. The *Submittal Schedule Details* and the *Heat Dissipation Requirements table* below give the heat dissipated into the hot air exhausted from the drives. If the drives are installed in a confined space, the heat must be removed from the area by ventilation or air conditioning equipment.

Item	Catalog Number	Watts	BTU/Hr
1	ACH580-01-017A-2	133	454

Dimensions and Weights

Dimensions and weights of the drives provided are given in the *Submittal Schedule Details* and in the *Dimensions and Weights Table*. The table also lists the applicable dimension drawings that include additional detail. Dimension drawings may be provided in the back of this submittal.

Item	Catalog Number	Height mm (in)	Width mm (in)	Depth mm (in)	Weight kg (lbs)
1	ACH580-01-017A-2	373 (14.7)	125 (4.9)	223 (8.8)	4.6 (10)

Product short Circuit Current Rating

Short circuit ratings shown below are as show on the device rating label.

Item	Catalog Number	Short Circuit Current Rating
1	ACH580-01-017A-2	100 kA with fusing

Submittal Schedule

This schedule includes the products supplied as part of this submittal.

Schedule			Motor Data ¹			Drive Data			
Item	Qty	Tag	HP	FLA	Volts	Product ID	HP	Amps	Volts
1	1	5 HP	5	16.7	208 VAC	ACH580-VCR-017A-2	5	16.7	208 VAC
Notes: <ol style="list-style-type: none"> AC motor data is per National Electrical Code Table 430.250 for typical motors used in most applications. It is provided as typical data only. DC motor data is per typical industry standards. Actual motor data may vary 									

Submittal Schedule Details for 5 HP

Item	Tag / Equipment ID	Product ID
1	5 HP	ACH580-VCR-017A-2

Item Description
Input Voltage: 208 VAC Three Phase Rated Output Current: 16.7A Enclosure: UL (NEMA) Type 1 Nominal Horsepower: 5 HP Frame Size: R1 Input Disconnecting Means: Circuit Breaker Bypass: E-Clipse Bypass (Vertical) Input Impedance: 5% equivalent impedance Short Circuit Current Rating: 100 kA Communication Protocols: Johnson Controls N2, Modbus RTU, BACnet (MS/TP) Other Options:

Drive Input Fuse Ratings	
Fuse Class	Amps (600 V)
Class T	30

Wire Size Capacities of Power Terminals		
Input Wiring	Output Wiring	Ground Wiring
#14...#1/0 5.2 lbf-ft	#20...#6 1.2 lbf-ft	#14...#4 3 lbf-ft

Dimensions and Weights			
Height <i>in</i> (mm)	Width <i>in</i> (mm)	Depth <i>in</i> (mm)	Weight <i>lbs</i> (kg)
40.2 (1021)	5.4 (137)	10.6 (268)	30 (13.6)

Heat Dissipation & Airflow Requirements			
Power Losses		Airflow	
BTU/Hr	Watts	CFM	CM/Hr
556	163	25	42.5

ACH580-01/-31

The ACH580 drive sets new standards in both simplicity and reliability, and ensures smooth, energy-efficient operation of your HVAC systems in normal and mission-critical situations.

ACH580-01, wall-mounted base drives

The ACH580-01 wall-mounted drives are available from 1 to 100 HP at 208/240 V. The ACH580-01 drives are available in UL (NEMA) Type 1 configuration. In standard installations, the drive is mounted directly onto a wall and uses the provided conduit box. Conduit openings are provided for bottom conduit entry & exit. For mounting in a customer-supplied cabinet, the conduit box may be removed. The drive has a 100 kA SCCR rating when paired with appropriately sized upstream fuses.

Features for HVAC

The ACH580 comes standard with an intuitive control panel used to configure, control, and monitor the drive. An optional Bluetooth control panel allows the drive to be configured via the control panel or the DriveTune app.

A robust HVAC firmware package provides drive, motor, and application protection features. Examples of drive protection features include undervoltage, overvoltage, overcurrent, and ground fault protection. The ACH580 also has a variety of motor protection features including overload and stall protections.

Application specific features, such as accepting four separate start interlocks (safeties), along with broken belt detection, are also included. The drive includes BACnet MS/TP, Modbus RTU, and Johnson N2 as standard.

Technical specifications

Product compliance (complete list on following page)

ACH580-01/-31 CE, UL, cUL, and EAC

Supply connection

Input voltage (U_i)	
ACH580-xx-xxxA-2	208/240V
ACH580-xx-xxxA-4	480V
ACH580-xx-xxxA-6	600V
Input voltage tolerance	+10% / -15%
Phase	3-phase (1-phase, 240 V)
Frequency	48 to 63 Hz
Line Limitations	Max $\pm 3\%$ of nominal phase to phase input voltage
Power Factor ($\cos \phi$) at nominal load	
ACH580-01	0.98
ACH580-31	1.0
Efficiency at rated power	
ACH580-01	98.0%
ACH580-31	96.5%
Power Loss	Approximately 2% of rated power

Motor connection

Supported motor control	Scalar and vector
Supported motor types	Asynchronous motor, permanent magnet motor (vector), SynRM (vector)
Voltage	3-phase, from 0 to supply voltage
Frequency	0 to 500 Hz
Short Term Overload Capacity Variable Torque	110% for 1 min/10min
Peak Overload Capacity	1.35 for 2 second
Variable Torque	(2 sec / 10 min)
Switching Frequency	2, 4, 8 or 12 kHz Automatic fold back in case of overload
Acceleration/Deceleration Time	0 to 1800 s
Short Circuit Current Rating (SCCR)	100 ka with fusing

Inputs and outputs (drive)

2 analog inputs	Selection of Current/Voltage input mode is user programmable.
Voltage reference	0 (2) to 10 V, $R_{in} > 200 \text{ k}\Omega$
Current reference	0 (4) to 20 mA, $R_{in} = 100 \Omega$
Potentiometer reference value	10 V $\pm 1\%$ max. 20 mA
2 analog outputs	AO1 is user programmable for current or voltage. AO2 current
Voltage reference	0 to 10 V, $R_{load} > 100 \text{ k}\Omega$
Current reference	0 to 20 mA, $R_{load} < 500 \Omega$
Applicable potentiometer	1 k Ω to 10 k Ω
Internal auxiliary voltage	24 V DC $\pm 10\%$, max. 250 mA
Accuracy	+/- 1% full scale range at 25°C (77°F)
Output updating time	2 ms
6 digital inputs	12 to 24 V DC, 10 to 24 V AC, Connectivity of PTC sensors supported by a single digital input. PNP or NPN connection (5 DIs with NPN connection).

	Programmable
Input Updating Time	2 ms
3 relay outputs	Maximum switching voltage 250 V AC/30 V DC. Maximum continuous current 2 A rms. Programmable, Form C
Adjustable filters on analog inputs and outputs	
All control inputs isolated from ground and power	
Operation	
Air temperature	0 to -15 °C (32 to 5 °F). -15 to +50 °C (5 to 122 °F): No frost allowed. Output derated above +40 °C (104 °F)
Installation site altitude	0 to 4000 m (13123 ft) above sea level Output derated above 1000 m (3281 ft)
Relative humidity	5 to 95% No condensation allowed Maximum relative humidity is 60% in the presence of corrosive gasses
Atmospheric pressure	70 to 106 kPa (10.2 to 15.4 PSI) 0.7 to 1.05 atmospheres
Vibration	Risk category IV Certified (IBC 2018)
Environmental protections	
Chemical Gasses	Class 3C2
Solid Particles	Class 3S2 No conductive dust allowed
Pollution degree (IEC/EN 61800-5-1)	Pollution degree 2
Product compliance	
Standards and directives	Low Voltage Directive 2006/95/EC EMC Directive 2004/108/EC 60721-3-3: 2002 60721-3-1:1997 Quality assurance system ISO 9001 and Environmental system ISO 14001 CE, UL, cUL, and EAC approvals Galvanic isolation according to PELV RoHS2 (Restriction of Hazardous Substances) EN 61800-5-1: 2007; IEC/EN 61000-3-12; EN61800-3: 2017 + A1: 2012 Category C2 (1st environment restricted distribution); Safe torque off (EN 61800-5-2) BACnet Testing Laboratory (BTL) Seismic (IBC, OSHPD) Plenum (ACH580-01 only)
EMC (according to EN61800-3)	ACH580-01 and ACH580-31 class C2 (1st environment restricted distribution)

Storage (in Protective Shipping Package)	
Air Temperature	-40 to +70 °C (-40 to +158 °F)
Relative Humidity	Less than 95% No condensation allowed Maximum relative humidity is 60% in the presence of corrosive gasses
Chemical Gasses	Class 1C2
Solid Particles	Class 1S2 Contact ABB regarding Class 1S3
Atmospheric pressure	70 to 106 kPa 0.7 to 1.05 atmospheres
Vibration (ISTA)	
R1...R4	In accordance with ISTA 1A
R5...R9	In accordance with ISTA 3E
Transportation (in Protective Shipping Package)	
Air Temperature	-40° to 70°C (-40° to 158°F)
Relative Humidity	Less than 95% No condensation allowed Maximum relative humidity is 60% in the presence of corrosive gasses
Atmospheric Pressure	60 to 106 kPa (8.7 to 15.4 PSI) 0.6 to 1.05 atmospheres
Free Fall	R1: 76 cm (30 in) R2: 61 cm (24 in) R3: 46 cm (18 in) R4: 31 cm (12 in) R5: 25 cm (10 in)
Chemical Gasses	Class 2C2
Solid Particles	Class 2S2
Shock/ Drop (ISTA)	
R1...R4	In accordance with ISTA 1A
R5...R9	In accordance with ISTA 3E
Vibration (ISTA)	
R1...R4	In accordance with ISTA 1A
R5...R9	In accordance with ISTA 3E

Feature overview

Communication

Protocols as standard (EIA-485): BACnet MS/TP, Modbus RTU, Johnson Controls N2
Available as plug-in options: BACnet/IP, Modbus TCP, PROFIBUS-DP, DeviceNet, EtherNet/IP, LonWorks (coming 2019)

Application functions

Start interlock
Delayed start
Run permissive (damper monitoring)
Override operation mode
Real-time clock (scheduling)
PID controllers for motor and process
Motor flying start
Motor preheating
Energy optimizer and calculators
Timer
2 or 3 wire start/stop
Ramp to stop
2 independent adjustable accel/decel ramp

Protection functions

Overvoltage controller
Undervoltage controller
Motor earth-leakage monitoring
Motor short-circuit protection
Motor overtemperature protection
Output and input switch supervision
Motor overload protection (UL508C)
Phase-loss detection (both motor and supply)
Under load supervision (belt loss detection)
Overload supervision
Stall protection
Loss of reference
Panel loss
Ground fault
External events
Overcurrent
Current limit regulator
Transient/Surge protection (MOV and choke)

Panel functions

First start assistant
Primary settings for HVAC applications
Hand-Off-Auto operation mode
HVAC quick set-up
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 (resettable)
- Input / Output Terminal Monitor
- PID Actual Value (Feedback) & Error Fault Text

- Warning Text
- Three (3) Scalable Process Variable Displays
- User-Definable Engineering Units

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

PID control

One (1) Process PID

Four (4) Integral Independent Programmable PID

Setpoint Controllers (Process and External)

External Selection between Two (2) Sets of Process

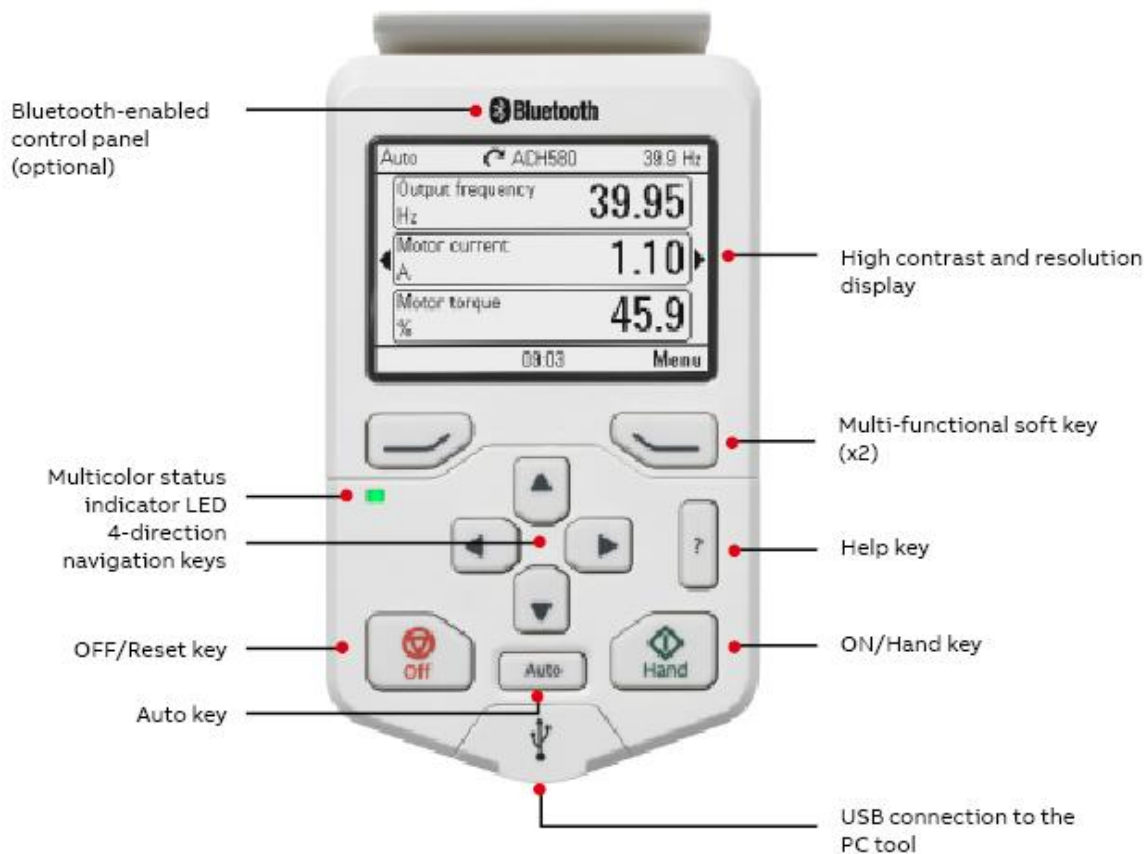
PID Controller Parameters

PID Sleep/Wake-Up

Control panel features

The ACH580 Assistant Control Panel features:

- Intuitive to operate
- Primary Setting menu to ease drive commissioning
- Real-time clock
- Diagnostic and maintenance functions
- Full-graphic display, including chart, graph, and meter options
- 21 editable home views
- USB interface for PC and tool connection as standard
- Parameters are alpha-numeric
- North American version supports 14 languages as standard
- Dedicated "Help" key
- 4 user sets
- Parameters are stored in control panel memory for later transfer to other drives or for backup of a particular system
- Back-up and restore parameters and/or motor data
- Automatic back-up 2 hours after parameter change
- Modified parameter display
- Creates unique short menu
- Shows parameters that differ from the default
- Bluetooth connectivity for use with mobile device (requires +J429 option)



ACH580 E-Clipse Bypass

The ACH580 drive sets new standards in both simplicity and reliability, and ensures smooth, energy-efficient operation of your HVAC systems in normal and mission-critical situations.

The ACH580 with ABB E-Clipse bypass is an ACH580 HVAC Drive in an integrated UL (NEMA) Type 1 enclosure with a bypass motor starter. The ACH580 with ABB E-Clipse bypass provides an input circuit breaker with door mounted and interlocked operator (padlockable in the OFF position), a bypass starter, electronic motor overload protection, a door mounted control panel with graphical display for local control, provisions for external control connections, and serial communications capability

The ACH580 with ABB E-Clipse bypass includes two contactors. One contactor is the bypass contactor, used to connect the motor directly to the incoming power line in the event that the ACH580 is out of service. The other contactor is the ACH580 output contactor that disconnects the ACH580 from the motor when the motor is operating in the Bypass mode. The drive output contactor and the bypass contactor are electrically interlocked to prevent “back feeding”.

The ACH580 with ABB E-Clipse bypass is a microprocessor-controlled “intelligent” system which features programmable Class 10, 20, or 30 overload curves, programmable underload (broken belt) and overload trip or indication. Also included as standard features are single-phase protection in bypass mode, programmable manual or automatic transfer to bypass, fireman’s override, smoke control, damper control, no contactor chatter on brown-out power conditions and serial communications. Should a drive problem occur, fast acting fuses exclusive to the ACH580 drive path disconnect the drive from the line prior to clearing upstream branch circuit protection, maintaining bypass capability.

Technical specifications

Product compliance (complete list on following page)

ACH580-VxR/BxR

UL508A

Supply connection

Input voltage (U ₁)	
ACH580-xx-xxxA-2	208/240V
ACH580-xx-xxxA-4	480V
ACH580-xx-xxxA-6	600V
Input voltage tolerance	+10% / -15%
Phase	3-phase
Frequency	48 to 63 Hz
Line Limitations	Max ±3% of nominal phase to phase input voltage
Power Factor (cos φ) at nominal load	
ACH580-VxR	0.98
ACH580-BxR	0.98
Efficiency at rated power	
ACH580-VxR	98.0%
ACH580-BxR	98.0%
Power Loss	Approximately 2% of rated power

Motor connection

Supported motor control	Scalar and vector
Supported motor types	Asynchronous motor
Voltage	3-phase, from 0 to supply voltage
Frequency	0 to 500 Hz
Short Term Overload Capacity Variable Torque	110% for 1 min/10min
Peak Overload Capacity	1.35 for 2 second
Variable Torque	(2 sec / 10 min)
Switching Frequency	2, 4, 8 or 12 kHz
	Automatic fold back in case of overload
Acceleration/Deceleration Time	0 to 1800 s
Short Circuit Current Rating (SCCR)	

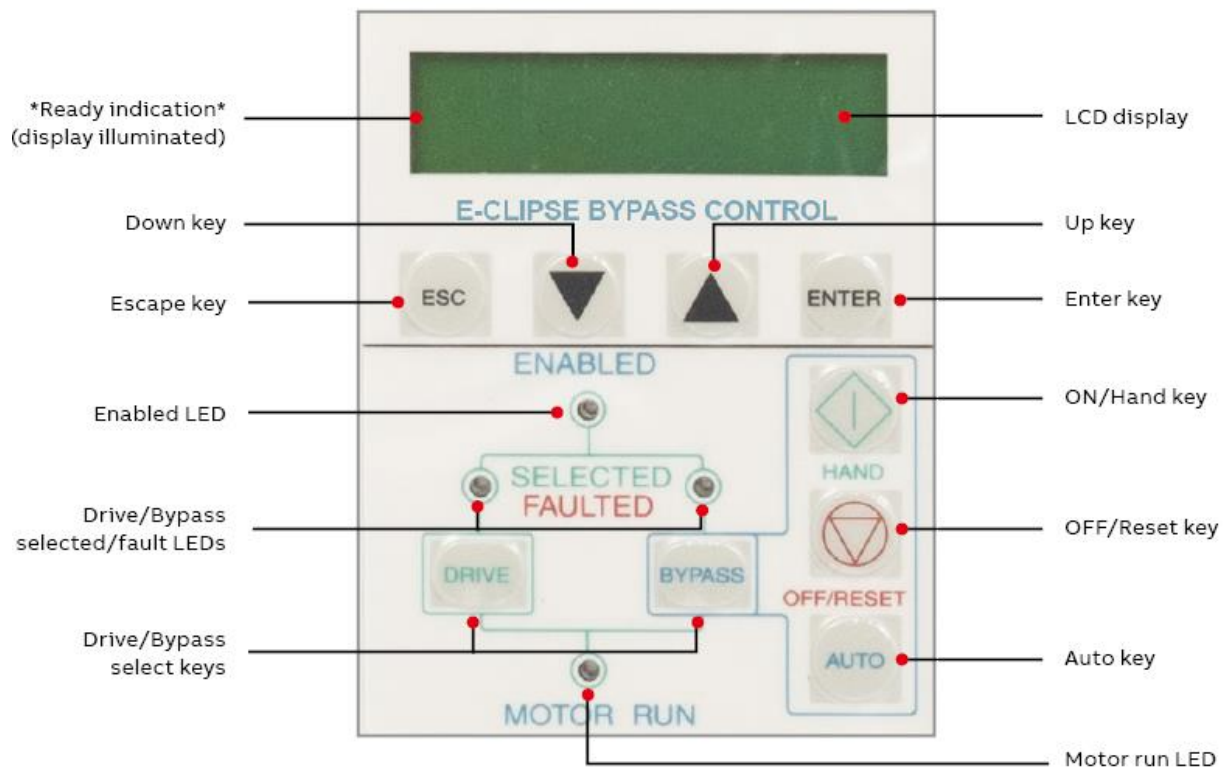
	240V	480V	600V
-VCR	100kA	100kA	10 kA
-VDR*	100kA	100kA	100 kA
-BCR	100kA	100kA	10 kA
-BDR*	100kA	100kA	100 kA

* External fuses are required for 100 kA rating as specified in the "Technical Data" section of User Manual [3AXD50000289554](#).

E-Cclipse control panel features

The ACH580 E-Cclipse Control Panel features:

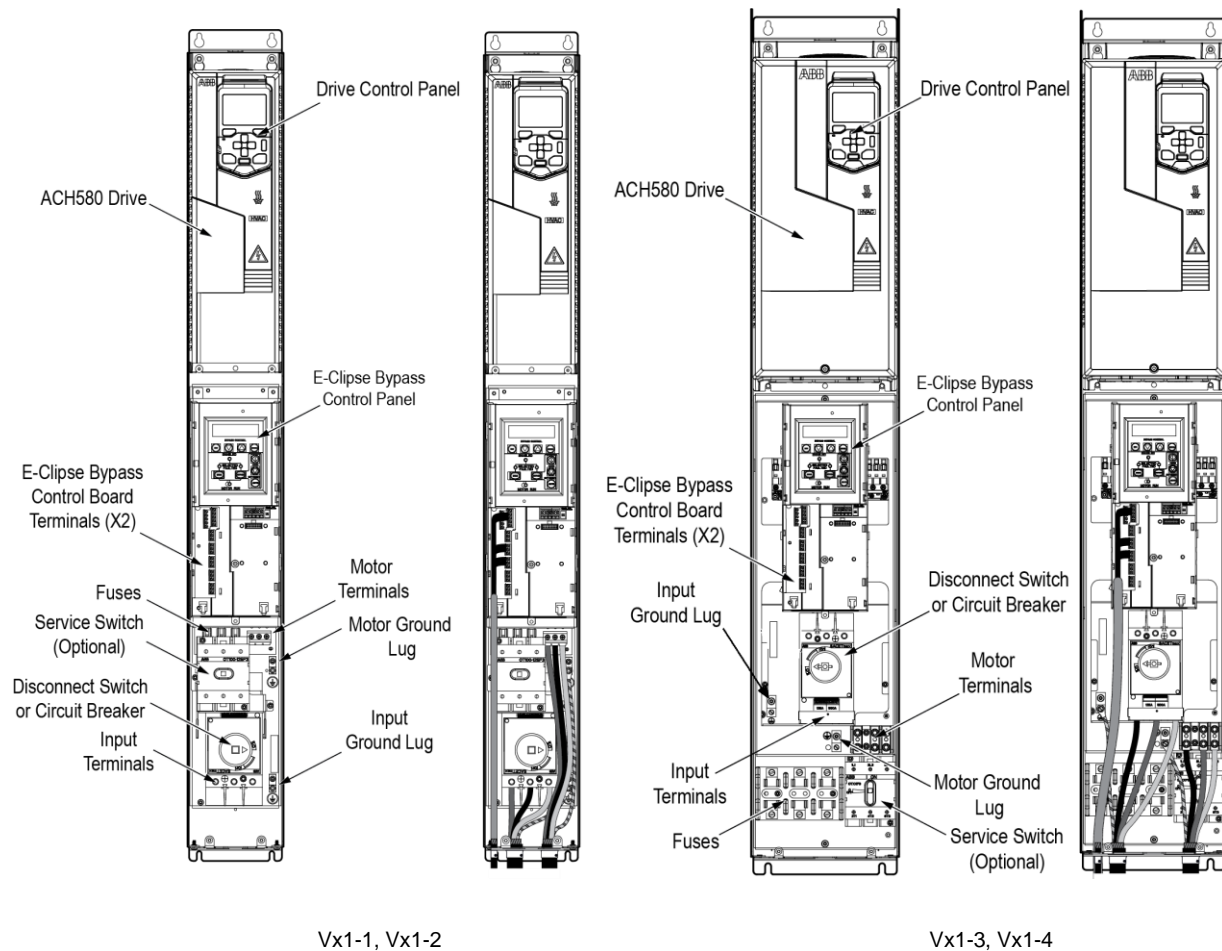
- Dedicated programming and operating controls (keys) are logically grouped on the keypad by their function.
 - o H-O-A, Drive/Bypass Selection keys (Control)
 - o UP/DOWN arrows, ESC, ENTER keys (Programming)
- LCD display provide:
 - o Operating Control Status
 - o Bypass Status
 - o Fault/Warning annunciation
 - o Parameter Lists and Values
 - o Power On indication
- Individual LEDs arranged to provide a logical control path visual:
 - o System Enabled
 - o Separate multi colored Drive and Bypass "SELECTED/FAULTED LEDs in separate paths
 - o Motor Run Indicator
 - o LEDs that illuminate, change color, and flash to provide visible indication of system status
- Provides System control from one location



Cable connections

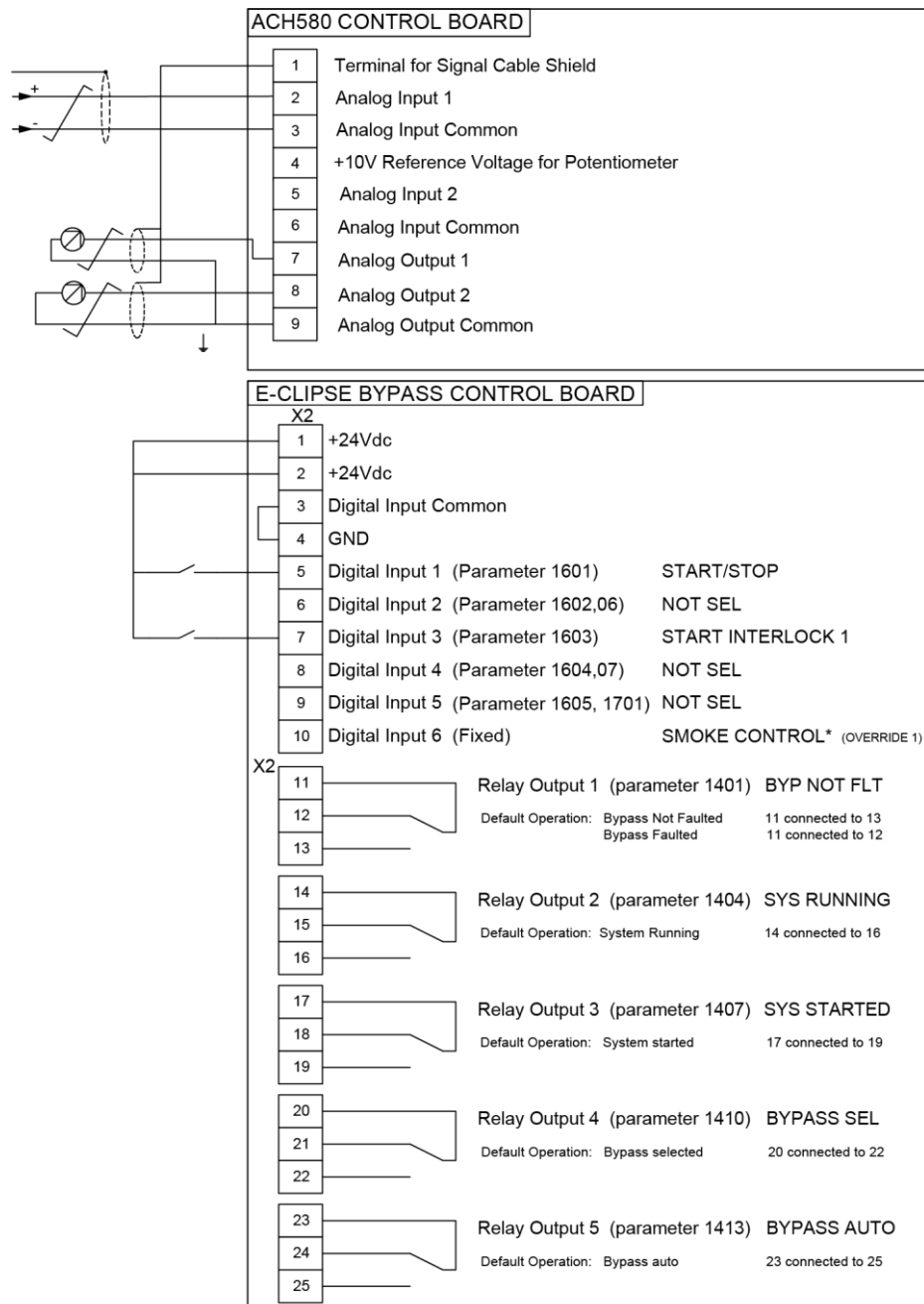
The following illustrations show the ACH580 with ABB E-Clipse bypass cable connection points for the various enclosure styles. The illustrations indicate the location of input and output power connections as well as equipment and motor grounding connection points.

ACH580 drives are configured for wiring access from the bottom only on Vertical ABB E-Clipse bypass units and from the top only on Standard ABB E-Clipse bypass units. At least three separate metallic conduits are required, one for input power, one for output power to the motor and one for control signals.



Control connections

The control wiring includes connections to an analog speed command signal and a start/stop relay contact for controlling the motor in the AUTO mode. There may also be connections to external run permissive interlock contacts and a connection from the Motor Run contact to an external status indication circuit. For a detailed description of the control circuit functions and alternate Control Connection diagrams, refer to the ACH580 E-Clipse bypass and packaged drive manual.



Engineering Data Summary

Fuses

Drive input fuses are recommended to disconnect the drive from power in the event that a component fails in the drive's power circuitry. Recommended drive input fuse specifications are listed in the *Submittal Schedule Details* and in the *Fuse Ratings Table*. Fuse rating information is provided for customer reference.

Item	Catalog Number	Drive Input Fuse Ratings	
		Amps (600V)	Bussmann Type
1	ACH580-VCR-017A-2	30	Class T

Terminal Sizes / Cable Connection Requirements

Power and motor cable terminal sizes and connection requirements are shown in the *Submittal Schedule Details* and in the *Terminal Sizes / Cable Connection Requirements Table*. The information provided below is for connections to input power and motor cables. These connections may be made to an input circuit breaker or disconnect switch, a motor terminal block, overload relay, and/or directly to bus bars and ground lugs. The table also lists torque that should be applied when tightening terminals and spacing requirements where multiple mounting holes are provided in the bus bar.

Item	Catalog Number	Input Wiring	Output Wiring	Ground Wiring
1	ACH580-VCR-017A-2	#14...#1/0 5.2 lbf-ft	#20...#6 1.2 lbf-ft	#14...#4 3 lbf-ft

Heat Dissipation Requirements

The cooling air entering the drive must be clean and free from corrosive materials. The *Submittal Schedule Details* and the *Heat Dissipation Requirements table* below give the heat dissipated into the hot air exhausted from the drives. If the drives are installed in a confined space, the heat must be removed from the area by ventilation or air conditioning equipment.

Item	Catalog Number	Watts	BTU/Hr
1	ACH580-VCR-017A-2	163	556

Dimensions and Weights

Dimensions and weights of the drives provided are given in the *Submittal Schedule Details* and in the *Dimensions and Weights Table*. The table also lists the applicable dimension drawings that include additional detail. Dimension drawings may be provided in the back of this submittal.

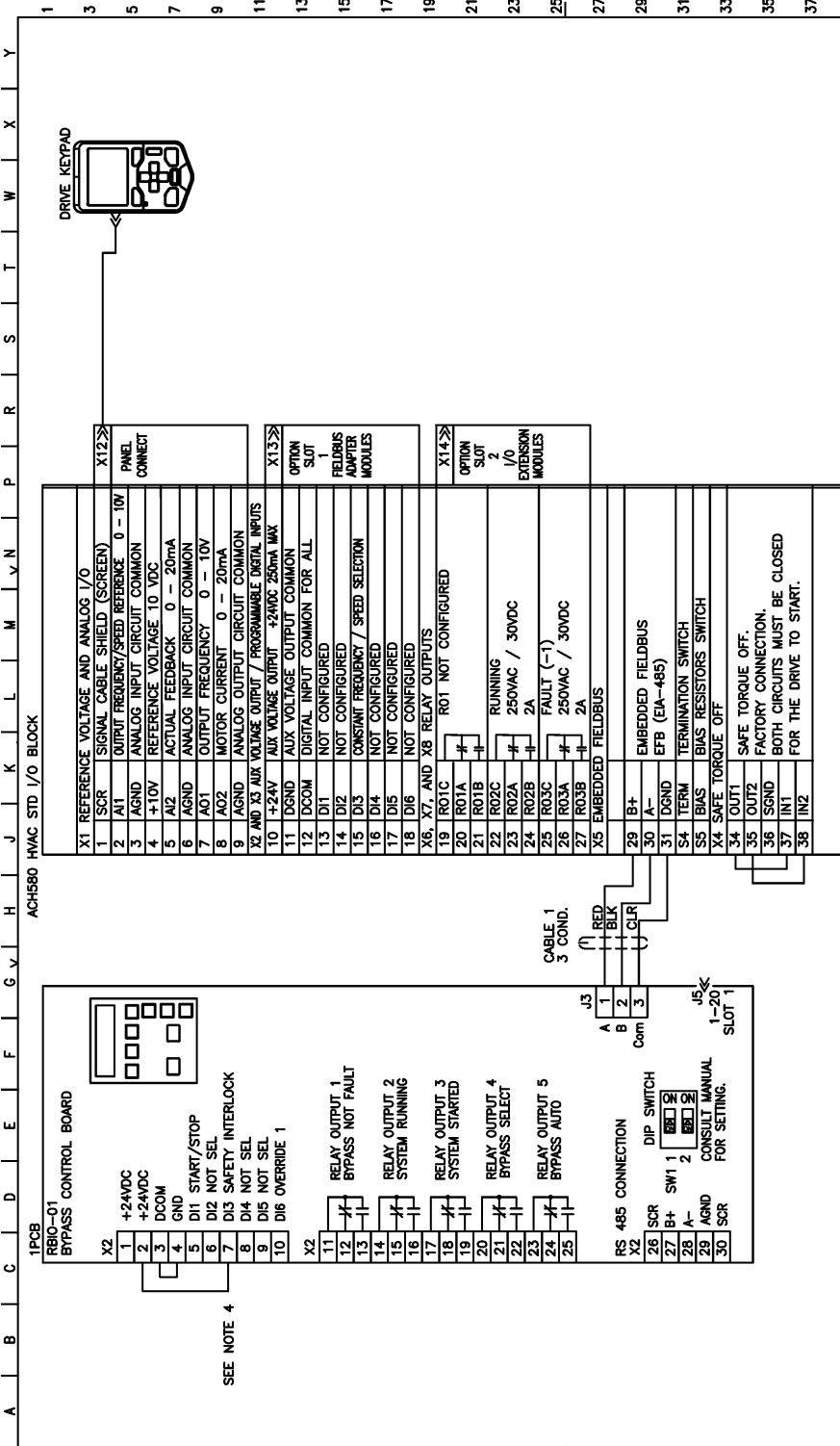
Item	Catalog Number	Height mm (in)	Width mm (in)	Depth mm (in)	Weight kg (lbs)
1	ACH580-VCR-017A-2	1021 (40.2)	137 (5.4)	268 (10.6)	13.6 (30)

Product short Circuit Current Rating

Short circuit ratings shown below are as show on the device rating label.

Item	Catalog Number	Short Circuit Current Rating
1	ACH580-VCR-017A-2	100 kA

Item	Part Number	Customer Designation
1	ACH580-VCR-017A-2	5 HP



- NOTES:
1. PROGRAMMING: PARAMETER 95.21, HW OPTIONS WORD 2, BIT 5 = 1 (BYPASS PRESENT)
 2. REFER TO USER MANUAL FOR OPERATION, CONNECTIONS AND WIRING
 3. THIS WIRING DIAGRAM IS FOR THE CUSTOMER INSTALLED DEVICES AND WIRING. THE CUSTOMER MUST VERIFY THE WIRING IS CORRECT BEFORE THE DRIVE IS POWERED UP.
 4. REPLACE JUMPER WITH NORMALLY CLOSED SAFETY INTERLOCK CONTACT AS NEEDED
 5. CONSULT USER'S MANUAL FOR I/O RATINGS
 6. BYPASS CONFIGURATION DOES NOT SUPPORT SAFE TORQUE OFF FUNCTIONALITY

Rev	Description	Date	App'd	Checked	Control Wiring Diagram	Project Name	Project Number	Customer Name	Customer Number	Revision Number	Rev
1						ACH580-VxR (R1-4)	ACH580-BxR (R5-8)	ABB Inc.	3AXD50000312146	7/25/2018	1



Intelli-Hood[®]

Melink Corporation

Product Specification



•Specifications are subject to change as updates are completed•

Intelli-Hood System Overview

1 SYSTEM CONTROLLER

Receives input from the Touchpad(s) and Hood Controller(s) to control the outputs for the VFDs.



2 HOOD CONTROLLER

Oversees Temperature and Optic Sensors on each hood and sends sensor data to the System Controller via RS-485 communication.



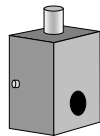
3 Touchpad

Provides switches for operation of hood lights and fans, bypass, monitoring LEDs and programming.



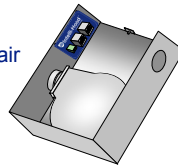
4 OPTIC SENSORS

Monitor the presence of smoke and vapors inside the hood. Send a signal to the Hood Controller to increase fan speed during cooking.



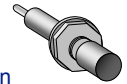
5 AIR PURGE UNITS

Miniature blowers send air into Optic Sensor housings to prevent smoke and grease from collecting on lenses.



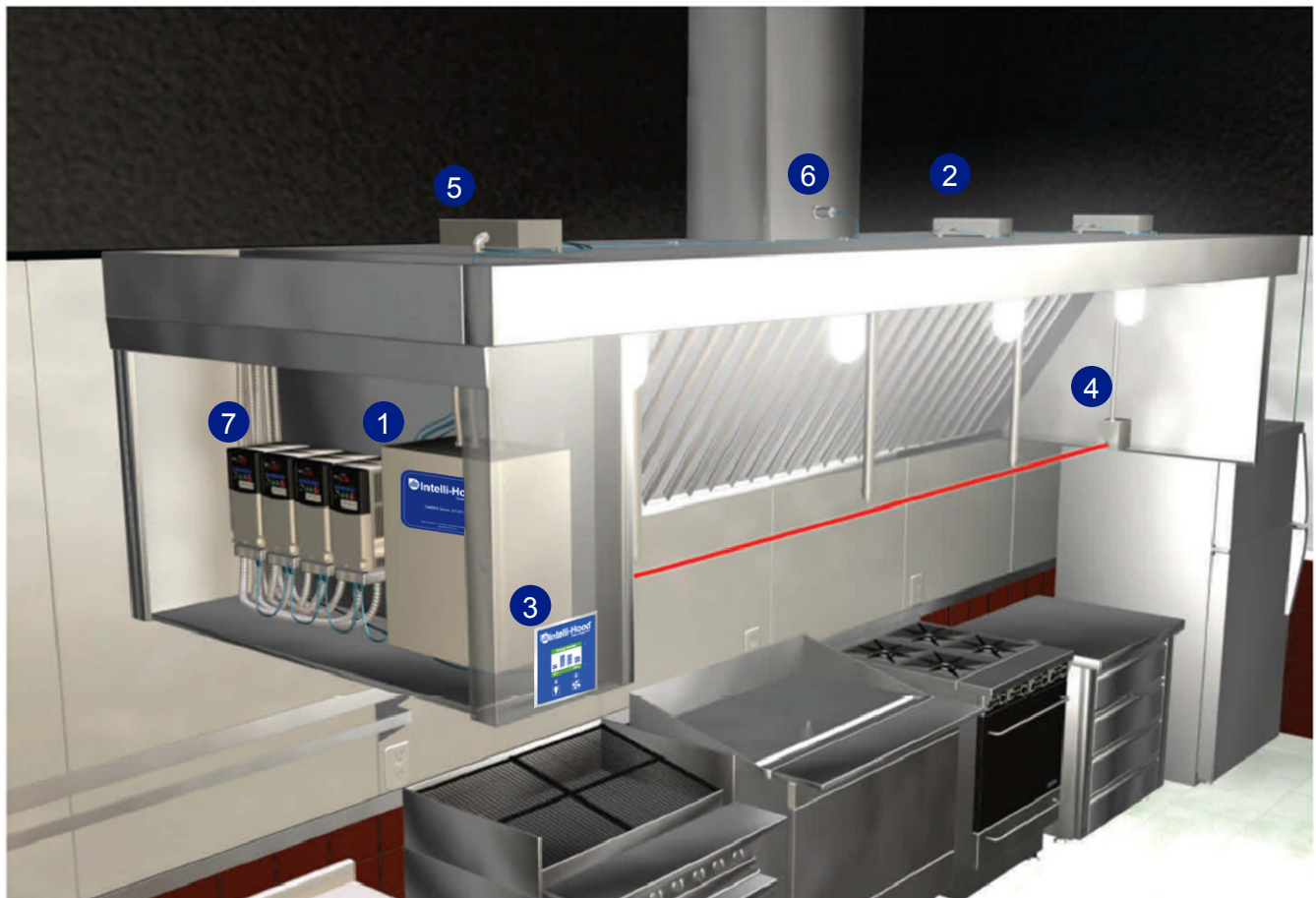
6 TEMPERATURE SENSOR

Monitors the exhaust air temperature in the duct and sends a signal to the Hood Controller to vary fan speed in proportion to heat load.



7 VFDs

Variable Frequency Drives receive signals from the Hood Controller to control the speed of the fans based on heat and smoke load.



•Specifications are subject to change as updates are completed•



Functional Description

The System Controller controls the lights and fans for up to 39 Hood Controllers. It is typically mounted above the ceiling and communicates between the hood sensors and VFDs via low-voltage Hood Network Cables. It is also connected to a Touchpad mounted on the front face of one of the hoods for easy user interface.

Control Specifications

Painted enclosure for durable construction and smooth finish

Communicates to Hood Controller(s), Touchpad(s), Temp Sensor(s), and Optic Sensor(s) via proprietary RS-485 Protocol

- May communicate with up to (39) Hood Controllers, (10) Touchpads, (10) Aux Touchpads, (10) Aux Power Supplies, and (10) Aux Light Controllers. Some limitations apply.

Communicates to Variable Frequency Drives via Modbus Protocol

- Refer to VFD submittal sheet for more information
- Supports up to 64 VFDs

Programmable I/O: (3) Digital Inputs, (4) Digital Outputs, (1) Analog Output, (1) Analog Input

Adjustable Temperature vs. Fan Speed Curve

Automatic On/Off based on Hood Temperature or Clock Schedule

Versatile programming parameters for setting up exhaust and supply airflow control

Removable Memory stores setup files and operational history data

BACnet over TCP/IP Interface

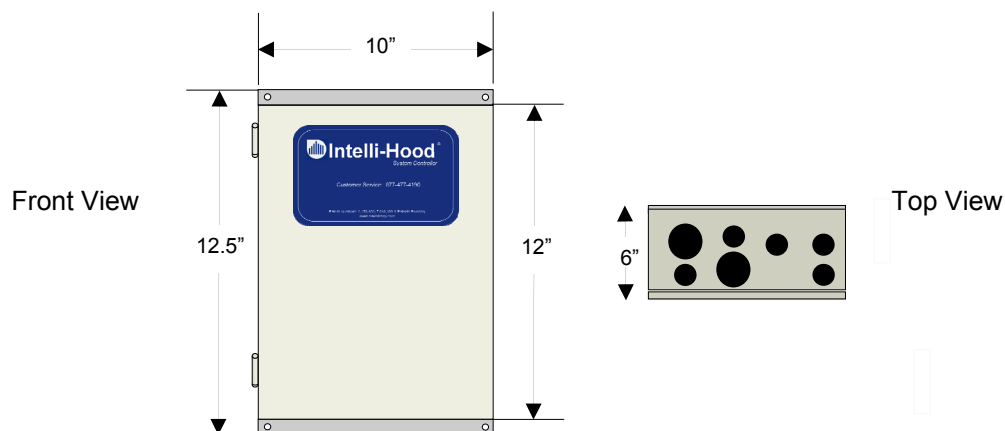
Internet-based Service Application for programming and monitoring

Automatic notification of faults/alarms via BACnet and email

•Specifications are subject to change as updates are completed•

Electrical Specifications

Input Voltage :	120 VAC to 220 VAC
Frequency :	50 Hz to 60 Hz +/- 3%
Power Consumption :	170 W
Ambient Temperature :	5 to 40°C, 32 to 120°F
Line Voltage Output Power Capacity:	15A General Purpose Load, Fused 6A Tungsten Load
Low Voltage plenum-rated, shielded cables to VFD(s), Optic Sensors, APU(s) and Temperature Sensors	



•Specifications are subject to change as updates are completed•

Functional Description

The Hood Controller oversees Temperature and Optic Sensors on each kitchen hood and sends the sensor data to the System Controller via RS-485 communication.

Mechanical Specifications

Galvanized Steel Enclosure, 7"x7", 2.1" tall

Temperature Rating: 0 to 49°C, 32 to 120°F

Steel Beam Clamps for installation on hoods or other mechanical structures above hood.

(4) 3/4" conduit holes for connections of Intelli-Hood Hood Network cables

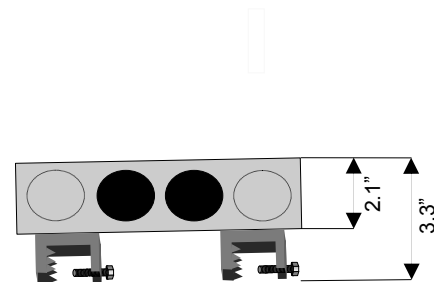
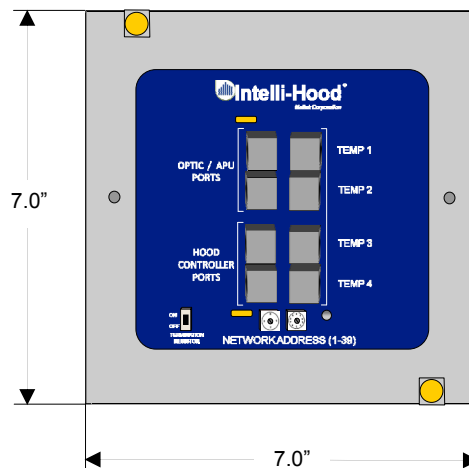
(4) 3/4" conduit knockouts for connections of Intelli-Hood Hood Network cables

Electrical Specifications

Low Voltage: 24VDC from the Hood Network, via Hood Network Cables

Power Consumption: A fully loaded Hood Controller with four temperature sensors, two air purge units, and one set of optic sensors consumes approximately 15W.

Front View



Side View

•Specifications are subject to change as updates are completed•

Functional Description

The Touchpad is the human interface point of the Intelli-Hood system. FANS and LIGHTS switches provide interface points of kitchen staff to control the hoods. A full-color screen displays the status of the fans and sensors. Setup switches provide a means of programming the system.

A System Controller may have up to ten (10) Touchpads connected to it. Programmable parameters allow the Setup Technician to dictate Touchpad and Hood relationships. Every System Controller is required to have at least one (1) Touchpad device connected to it to allow for human interface to diagnostics and programming parameters.

General Specifications

Full Color Screen: 2.5" diagonal, QVGA resolution, displays operating status and programming menus

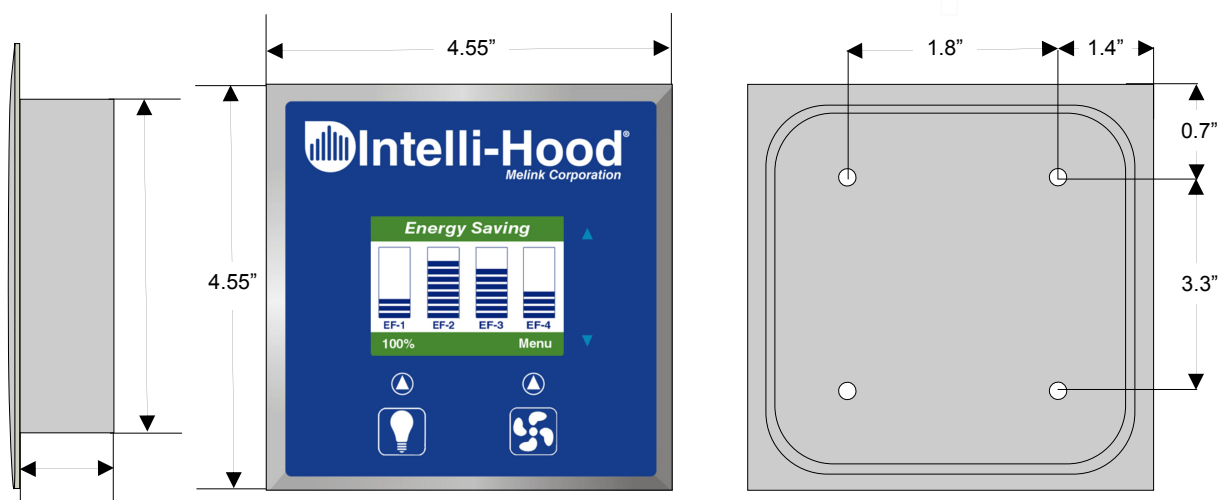
Switches: FANS: Changes system from Energy Saving Mode (fans running) to Standby Mode (fans off)
 LIGHTS: Changes state of line voltage relays which may be used to control Hood Lights circuits.
 Soft Keys: Allow user to boost fan speeds to full speed, access programming menus, access diagnostic and help screens

Stainless steel cover plate (304L) for durable construction and smooth finish

Synthetic membrane keypad for water protection

Temperature Rating: 5 to 40°C, 41 to 104°F

Low voltage: 24VDC from the Hood Network, via Hood Network Cable



•Specifications are subject to change as updates are completed•



Functional Description

A three-wire platinum resistive temperature device (RTD) sensor encased in a stainless steel tube. Threaded housing is designed to be assembled into UL-listed "Quick-Seal" exhaust duct fittings. Temperature Sensors are wired to the Hood Controllers via Hood Network Cables.

Standard sensors are installed in exhaust ducts, while Canopy sensors are installed in the hood canopy to provide enhanced automatic on/off functionality.

General Specifications

Stainless Steel Probe: 0.25" outside diameter, 2 lengths available (Standard and Canopy)

Three-Wire Configuration

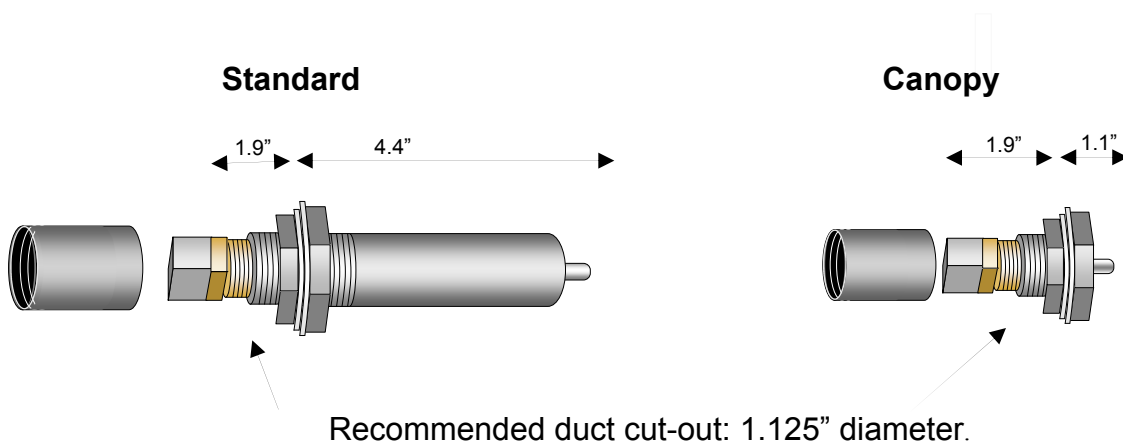
Brass Body, 1/2" external pipe thread

8 pin, RJ-45 connector

Temperature Rating: 0 to 535°C, 32 to 1000°F

RTD Rating: 100 Ohms with 0.385 platinum coefficient

Electrical Connection: Hood Network Cable



•Specifications are subject to change as updates are completed•



Functional Description

The Optic Sensors consist of an Emitter and a Receiver which are installed on opposite ends of the kitchen hood. An infrared beam spans the length of the hood to detect any smoke or other vapors generated by the cooking appliances. Upon detection, a signal is sent to the System Controller which automatically ramps the associated fan(s) to 100% speed until the effluent is evacuated. Optic Sensors are wired to the Hood Controllers via Hood Network Cables.

General Specifications

Stainless Steel Housing for durable construction and smooth finish

Optic Span: 3 to 40 feet (automatic gain adjustment for distance)

Auto-calibration: Every day at start-up or 24 hours

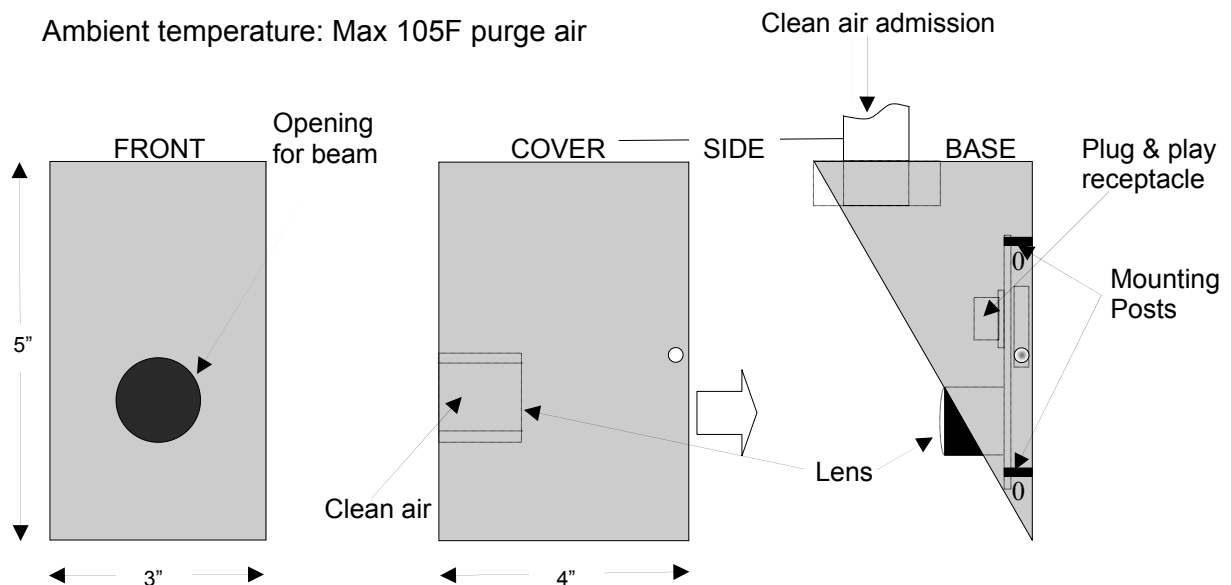
Conformal-coated circuit boards and water-tight cable connectors at sensor PCB connections

Temperature Rating: 0 to 85°C, 32 to 185°F

Response Time: 0.2 seconds

Low Voltage: 12VDC from the Hood Controller, via Hood Network Cable

Ambient temperature: Max 105F purge air



•Specifications are subject to change as updates are completed•



Air Purge Unit

Functional Description

The Air Purge Unit (APU) consists of a miniature blower in a steel box, mounted on each end of the hood above the optic sensors. The purpose of the APU is to pressurize the optic sensors housings with clean air to prevent grease vapors from fouling the lens. The blowing air also cools the optic circuit boards.

The stainless steel conduit pipe that connects the APU and Optic Sensor provides a path for the air flow and optic sensor control cable.

General Specifications

Enclosure constructed of 18 gauge galvanized steel

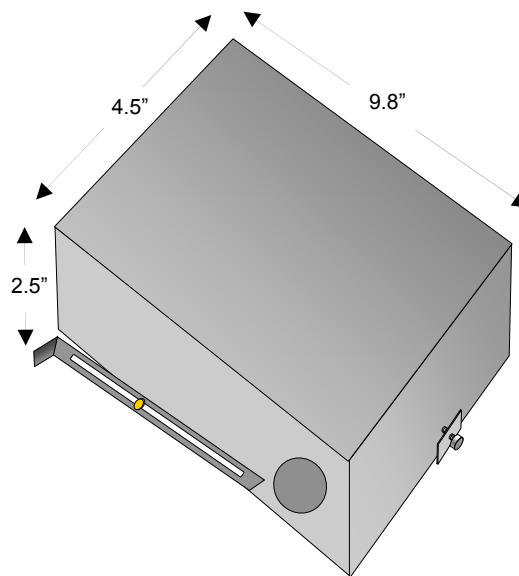
Adjustable support leg

Blower fan bearings permanently lubricated

Temperature Rating: 0 to 51°C, 0 to 125°F

Low Voltage: 12 VDC from the Hood Controller, via Hood Network Cable

Power Consumption: Approximately 7W



•Specifications are subject to change as updates are completed•

Functional Description

The electronic motor starter is a variable frequency drive (VFD) which is used to control the exhaust and supply fan motors. The VFD modulates the speed of the fan motors by varying the output voltage and frequency based on a serial RS-485 signal received from the System Controller. The VFD also sends a feedback signal to the System Controller in order for the Touchpad to display the actual speed of the motor.

Mechanical Specifications

NEMA 1 Enclosure.

Soft-start capability.

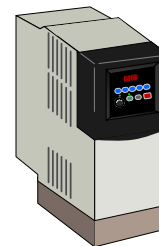
Digital keypad displays output frequency, current, voltage, and allows programming for field modifications.

Protective Functions: motor overload, overheating, overcurrent, overvoltage, output shorts, etc.

High and low frequency limiters.

Adjustable torque boost.

Daisy-chained via Hood Network Cables



Electrical Specifications

Input Voltage :	200-240 V/1 ϕ AC, 200-230 V/3 ϕ AC, 380-480 V/3 ϕ AC, or 460-600 V/3 ϕ AC
Input Frequency :	50 Hz to 60 Hz +/- 3%
Output Voltage :	80-240 V/ 3 ϕ AC or 160-480 V/ 3 ϕ AC
Ambient Temperature :	-10 to 50°C, 14 to 122°F
Humidity :	20%-95% relative humidity (non-condensing)

●Specifications are subject to change as updates are completed●



Functional Description

Custom 8-conductor cables connect the various components of Intelli-Hood. The cable is shielded, plenum rated, UL Type CMP OR CL3P FT-6. Per NFPA 70, the cable is allowed to be run in horizontal plenums and vertical chases without conduit when carrying current-limited low-voltage power and signals as it does with the Intelli-Hood.

Construction Specifications

UL TYPE OR STYLE:	CMP OR CL3P FT-6
PRIMARY INSULATION TYPE:	SGPVC
JACKET THICKNESS:	.015"
JACKET COLOR:	SPECIAL BLUE
JACKET MATERIAL:	CMP
NOMINAL O.D.:	0.190"
TEMP. RATING:	60C
CONDUCTOR/PAIR COUNT:	4 PAIRS
INSULATION THICKNESS:	0.007"
GAUGE & STRANDING:	24 AWG, 7/32 BC
VOLTAGE RATING:	300V
SHIELD:	FFE ALUMINUM POLYESTER
DRAIN WIRE:	24 AWG, 7/32 TC

Stock Pre-Terminated Lengths

2CB3-001: 1' (0.3m)	2CB3-050: 50' (15.2m)
2CB3-005: 5' (1.5m)	2CB3-075: 75' (22.8m)
2CB3-015: 15 (4.5m)	2CB3-100: 100' (30.5m)
2CB3-030: 30' (9.1m)	2CB3-200: 200' (61m)

•Specifications are subject to change as updates are completed•

Functional Description

The Aux Touchpad is an additional human interface point of the Intelli-Hood system. FANS, LIGHTS, and 100% switches provide interface points of kitchen staff to control the hoods. Indicator LEDs provide status for the FANS, LIGHTS, 100%, and Faults.

A System Controller may have up to ten (10) Aux Touchpads connected to it. Programmable parameters allow the Setup Technician to dictate Aux Touchpad and Hood relationships.

General Specifications

FANS Switch: Changes associated Hoods between Active Mode (fans running) to Standby Mode (fans off)

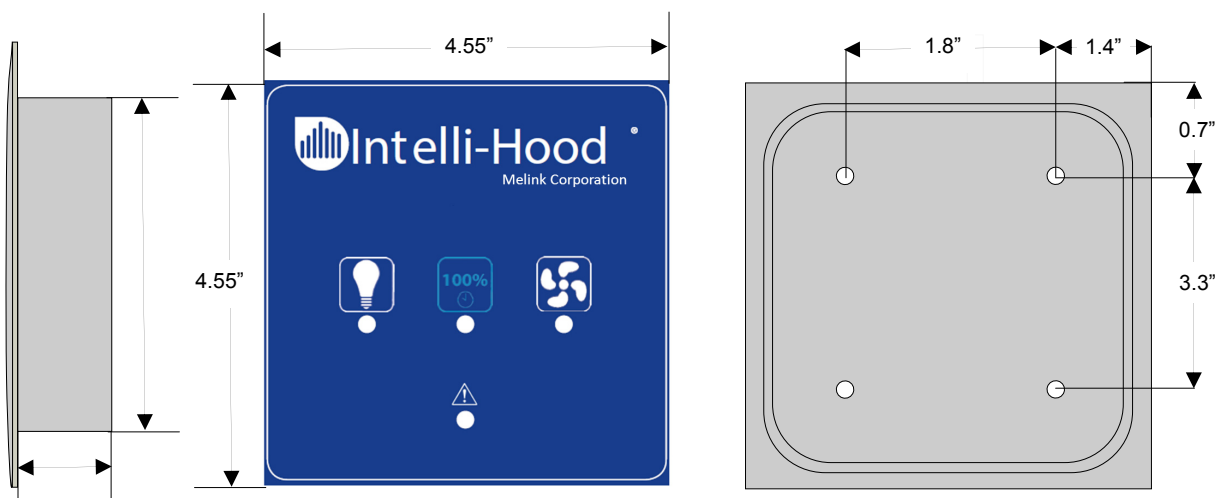
LIGHTS Switch: Changes state of associated line voltage relays which may be used to control Hood Lights circuits.

100% Switch: Allows user to temporarily boost fan speeds to full speed on associated Hoods.

Stainless steel cover plate (304L) for durable construction and smooth finish

Synthetic overlay for water protection

Low Voltage: 24VDC from the Hood Network, via Hood Network Cable



•Specifications are subject to change as updates are completed•



Functional Description

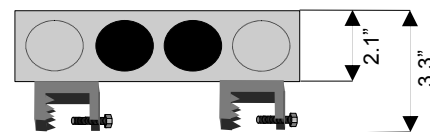
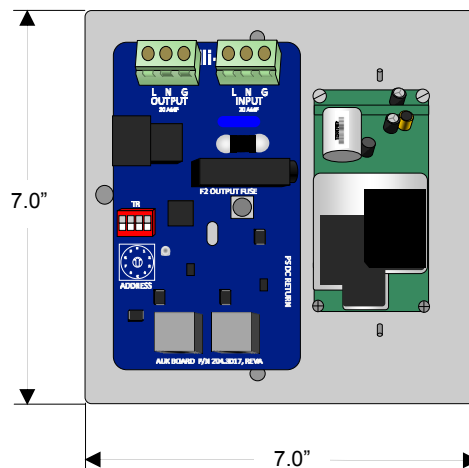
The Aux Power Supply (APS) may be used for large installations additional power is needed to operate Hood Controllers, Optic Sensors, and Touchpads. Since each Hood Network Port is power-limited, depending on the quantity of devices in a series line and the length of cable between devices, Aux Power Supply Device(s) may be needed to provide power to the Hood Network.

A System Controller may have up to 10 Aux Power Supplies connected to it.

Electrical Specifications

Input Voltage :	120 VAC to 220 VAC
Frequency :	50 Hz to 60 Hz +/- 3%
Output Voltage:	24VDC
Frequency :	50 Hz to 60 Hz +/- 3%
Power Consumption :	60W (max)
Ambient Temperature :	5 to 40°C, 41 to 104°F
Hood Network Connection:	24VDC from the Hood Network, via Hood Network Cable

Front View



Side View

•Specifications are subject to change as updates are completed•

Functional Description

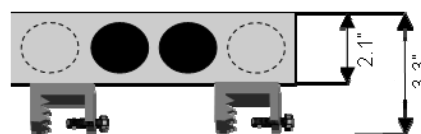
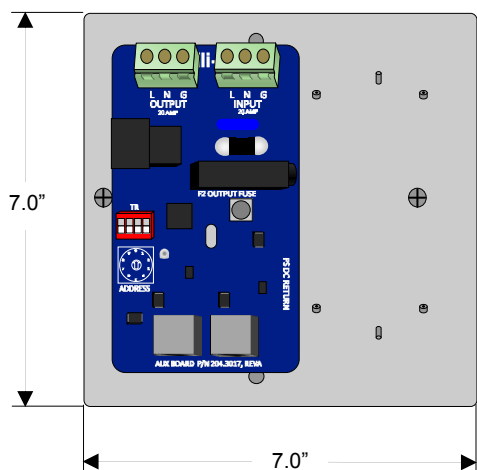
The Aux Light Controller (ALC) may be used for large installations where there is a need to control multiple light circuits. A System Controller may have up to 10 Aux Light Controllers connected to it. Relationships among the ALC and Touchpads are programmable via field editable parameters.

A System Controller may have up to 10 Aux Lighting Controllers connected to it.

Electrical Specifications

Input Voltage :	120 VAC to 220 VAC
Frequency :	50 Hz to 60 Hz +/- 3%
Power Consumption :	5W (not including lights)
Ambient Temperature :	5 to 40°C, 41 to 104°F
Hood Lights (voltage matches input):	120 VAC to 220 VAC (15A max)
Line Voltage Output Power Capacity:	15A General Purpose Load, Fused 6A Tungsten Load

Front View



Side View

•Specifications are subject to change as updates are completed•

ECM #12

Evaluate all kitchen and freezer building equipment, controls, and variable speed systems

Savings Calculations

Kitchen RTU Economizer - Building 34

EXISTING CONDITIONS

Inputs

RTU Data			
Capacity	6 tons	SAT	55 F
IEER	0.774 kW/ton	Zone Temp	68 F
Evap Fan Power	1.36 kW		

OAT (F)	Hrs	MCWB (F)	Clg. Load (%)	Clg. Load (tons)	SAT	RAT	Economizer	Fan Power (kW)	Fan Energy (kWh)	Cooling Power (kW)	Cooling Energy (kWh)	Total Energy (kWh)
97.5	1	76.6	100%	6.0	55	68 Off		1.36	1	4.6	5	6
92.5	13	73.1	94%	5.6	55	68 Off		1.36	18	4.4	57	74
87.5	154	73.1	88%	5.3	55	68 Off		1.36	209	4.1	630	838
82.5	429	71.2	82%	4.9	55	68 Off		1.36	582	3.8	1634	2216
77.5	552	68.5	76%	4.6	55	68 Off		1.36	749	3.5	1949	2697
72.5	751	66.8	70%	4.2	55	68 Off		1.36	1019	3.3	2442	3461
67.5	815	62.9	64%	3.8	55	68 Off		1.36	1105	3.0	2423	3528
62.5	858	57.3	58%	3.5	55	68 Off		0.68	582	2.7	2312	2893
57.5	744	53.3	52%	3.1	55	68 Off		0.68	505	2.4	1797	2302
52.5	530	47.6	46%	2.8	55	68 Off		0.68	359	2.1	1132	1492
47.5	379	42.8	40%	2.4	55	68 Off		0.68	257	1.9	704	961
42.5	464	38.5	34%	2.0	55	68 Off		0.68	315	1.6	733	1047
37.5	316	33.6	28%	1.7	55	68 Off		0.68	214	1.3	411	625
32.5	153	28.9	22%	1.3	55	68 Off		0.68	104	1.0	156	260
27.5	44	24.4	16%	1.0	55	68 Off		0.68	30	0.7	33	63
22.5	20	20.1	10%	0.6	55	68 Off		0.68	14	0.5	9	23
17.5	8	15.4	4%	0.2	55	68 Off		0.68	5	0.2	1	7
12.5	0	10.5	0%	0.0	55	68 Off		0.68	0	0.0	0	0
7.5	0	5.5	0%	0.0	55	68 Off		0.68	0	0.0	0	0
2.5	0	1.1	0%	0.0	55	68 Off		0.68	0	0.0	0	0
Total		6,231							6067		16428	22495

Month	Peak OAT	Evap Fan Demand (kW)	Cooling Demand (kW)	Column1	Column2	Total Demand (kW)
Jan	62.5	0.7	2.7	0.0	0.0	3.4
Feb	62.5	0.7	2.7	0.0	0.0	3.4
Mar	72.5	1.4	3.3	0.0	0.0	4.6
Apr	87.5	1.4	4.1	0.0	0.0	5.4
May	87.5	1.4	4.1	0.0	0.0	5.4
Jun	92.5	1.4	4.4	0.0	0.0	5.7
Jul	92.5	1.4	4.4	0.0	0.0	5.7
Aug	87.5	1.4	4.1	0.0	0.0	5.4
Sep	92.5	1.4	4.4	0.0	0.0	5.7
Oct	97.5	1.4	4.6	0.0	0.0	6.0
Nov	67.5	1.4	3.0	0.0	0.0	4.3
Dec	62.5	0.7	2.7	0.0	0.0	3.4
Total		14.2	44.3	0.0	0.0	58.6

Kitchen RTU Economizer - Building 34

PROPOSED CONDITIONS

Inputs	RTU Data			
	Capacity	6 tons	SAT	55 F
	IEER	0.774 kW/ton	Zone Temp	68 F
	Evap Fan Power	1.36 kW		

OAT (F)	Hrs	MCWB (F)	Clg. Load (%)	Clg. Load (tons)	SAT	RAT	Economizer	Fan Power (kW)	Fan Energy (kWh)	Cooling Power (kW)	Cooling Energy (kWh)	Total Energy (kWh)
97.5	1	76.6	100%	6.0	55	68	Off	1.36	1	4.6	5	6
92.5	13	73.1	94%	5.6	55	68	Off	1.36	18	4.4	57	74
87.5	154	73.1	88%	5.3	55	68	Off	1.36	209	4.1	630	838
82.5	429	71.2	82%	4.9	55	68	Off	1.36	582	3.8	1634	2216
77.5	552	68.5	76%	4.6	55	68	Off	1.36	749	3.5	1949	2697
72.5	751	66.8	70%	4.2	55	68	Off	1.36	1019	3.3	2442	3461
67.5	815	62.9	64%	3.8	55	68	On	1.36	1105	0.0	0	1105
62.5	858	57.3	58%	3.5	55	68	On	0.68	582	0.0	0	582
57.5	744	53.3	52%	3.1	55	68	On	0.68	505	0.0	0	505
52.5	530	47.6	46%	2.8	55	68	On	0.68	359	0.0	0	359
47.5	379	42.8	40%	2.4	55	68	On	0.68	257	0.0	0	257
42.5	464	38.5	34%	2.0	55	68	On	0.68	315	0.0	0	315
37.5	316	33.6	28%	1.7	55	68	On	0.68	214	0.0	0	214
32.5	153	28.9	22%	1.3	55	68	On	0.68	104	0.0	0	104
27.5	44	24.4	16%	1.0	55	68	On	0.68	30	0.0	0	30
22.5	20	20.1	10%	0.6	55	68	On	0.68	14	0.0	0	14
17.5	8	15.4	4%	0.2	55	68	On	0.68	5	0.0	0	5
12.5	0	10.5	0%	0.0	55	68	On	0.68	0	0.0	0	0
7.5	0	5.5	0%	0.0	55	68	On	0.68	0	0.0	0	0
2.5	0	1.1	0%	0.0	55	68	On	0.68	0	0.0	0	0
Total		6,231							6067		6716	12783

Month	Peak OAT	Evap Fan Demand (kW)	Cooling Demand (kW)	Column1	Column2	Total Demand (kW)
Jan	62.5	0.7	0.0	0.0	0.0	0.7
Feb	62.5	0.7	0.0	0.0	0.0	0.7
Mar	72.5	1.4	3.3	0.0	0.0	4.6
Apr	87.5	1.4	4.1	0.0	0.0	5.4
May	87.5	1.4	4.1	0.0	0.0	5.4
Jun	92.5	1.4	4.4	0.0	0.0	5.7
Jul	92.5	1.4	4.4	0.0	0.0	5.7
Aug	87.5	1.4	4.1	0.0	0.0	5.4
Sep	92.5	1.4	4.4	0.0	0.0	5.7
Oct	97.5	1.4	4.6	0.0	0.0	6.0
Nov	67.5	1.4	0.0	0.0	0.0	1.4
Dec	62.5	0.7	0.0	0.0	0.0	0.7
Total		14.2	33.3	0.0	0.0	47.5

Utility Savings Summary		% Saved
Existing kW	58.6	19%
Proposed kW	47.5	
Saved kW	11.1	
Existing kWh	22,495	43%
Proposed kWh	12,783	
Saved kWh	9,712	

WALK-IN COOLER ENERGY CONSERVATION BENEFIT ANALYSIS

1) *Customer:* **Wernersville State Hospital** **#36610-2-JR**
 2) *Address:* **160 Main St, Wernersville, PA 19565**
 3) *Telephone:* **610-678-3411**
Contact: **Mike Fendya, PE**
 4) *Utility Company:*
 5) *Account Number:* **0000-000-0000** Install Code: **4TC14ECM1EDF**

5) Cooler ID:	Cooler temperature set point: Degrees F	ft. length X	ft. width X	ft. height =	Walk-in Volume affected by Economizer	Total Walk-in Volume in Cu Ft
Warehouse East - Outer Freezer	-9.0	0.00	0.00	0.00	0	0
Warehouse East - Inner Freezer	-10.0	0.00	0.00	0.00	0	0
Warehouse West - Outer Cooler	38.0	0.00	0.00	0.00	0	0
Warehouse West - inner Cooler	36.0	0.00	0.00	0.00	0	0
N/A	38.0	0.00	0.00	0.00	0	0
N/A	38.0	0.00	0.00	0.00	0	0

Average Weighted Temp - Economizer Application: 38.0

Total Volume:

0	0
---	---

PART I**REFRIGERATION COMPRESSOR(S) AND CONDENSER FAN(S):**

6) [Compr motor (amps FLA) X (voltage) X (.85 PF) X sqrt(of ph)+Cond fan (amps FLA) X (voltage) X (.85 PF) X sqrt(of ph)]/1,000

	Comp V:	Comp A:	Comp Ph:	Fan V:	Fan A:	Phase	KW Load:
Warehouse East - Outer Freezer	208	12.0	3	230	2.5	1	4.16
Warehouse East - Inner Freezer	208	14.4	3	230	2.7	1	4.94
Warehouse West - Outer Cooler	208	6.1	3	230	1.0	1	2.06
Warehouse West - inner Cooler	208	10.0	3	230	2.2	1	3.49
N/A	0	0.0	0	0	0.0	0	0.00
N/A	0	0.0	0	0	0.0	0	0.00

TOTAL KW Load:	14.66
TOTAL KW Load Affected by Economizers:	0.00

- 6a) Percent of total Compressor Load Employed by Coolers Listed above: **100%**
- 7) Total compressor load affected by Economizers in KW **KW** **14.66**
- 8) Compressor duty cycle during winter months: **30%**
- 9) Compressor duty cycle during non-winter months: Many variables affect the compressor duty cycle **52%**
- 9a) such as box design, temperature, age, etc. Avg. Adjusted Winter KW **4.40**
- 9b) Avg. Adjusted Summer KW **7.62**
- 10) Hours that compressor uses Winter Duty Cycle **Hours** **1,715**
- 11) Hours that compressor uses Non-Winter Duty Cycle **Hours** **7,045**
- 12) Compressor energy use per year. (line 7) x ((line 8) x (line 10) + (line 9) x (line 11)) **KWH/yr** **61,235**
- 13a) No. of wall mounted ECONOMIZER units proposed for installation. **NRM-500**
- 13b) No. of large roof/wall mounted ECONOMIZER units proposed for installation. (up to 2000CFM) **NRM-2000**
- 14a) ECONOMIZER load. .285KW | .75KW x (line 13a | 13b) **KW**
- 14b) ECONOMIZER energy use based on 75% duty cycle. 75% x (line 10) x (line 13) x (line 14a) **KWH/yr**
- 15) Reduced compressor energy use. (line 7) x (line 8) x (line 10) **KWH/yr**
- 16) Net compressor energy savings from ECONOMIZER. (line 15) - (line 14) **KWH/yr**

Percent savings from ECONOMIZER of the affected load: Annual & Winter months

WALK-IN COOLER ENERGY CONSERVATION BENEFIT ANALYSIS

1) *Customer:* **Wernersville State Hospital** **#36610-2-JR**
 2) *Address:* **160 Main St, Wernersville, PA 19565**
 3) *Telephone:* **610-678-3411**
Contact: **Mike Fendya, PE**
 4) *Utility Company:*
 5) *Account Number:* **0000-000-0000** **Install Code: 4TC14ECM1EDF**

PART II**ANALYSIS OF CYCLING EVAPORATOR FAN SET(S):**

Evaporator fan sets shall be cycled off when refrigeration supply line temperature rises above set point

1) Current annual operating hours of evaporator fans.	8,760
2) Compressor average run time.	48%
3) Projected annual operating hours of compressor. W/Econ Part I (line9)x(line11) and W/No Econ Part I (line8)x(line10) + Part I (line9)x(line11)	4,178
4) Evap fan off-hours incl off-delay affected by economizer: (line 1) - ((line 3) X 1.16)	3,914

Evaporator fan off-hours including off-delay not affected by Economizer: (line 1) - ((line 3) X 1.16)

Cooler ID:	Fans	Amps X	Volts X	Phase X	Factor	Wattage Load
Warehouse East - Outer Freezer	4	0.50	230	1.00	0.85 PF	391 Watts
Warehouse East - Inner Freezer	5	1.10	230	1.00	0.55 PF	696 Watts
Warehouse West - Outer Cooler	2	1.00	115	1.00	0.85 PF	196 Watts
Warehouse West - inner Cooler	3	2.10	115	1.00	0.55 PF	398 Watts
N/A	0	0.00	0	0.00	0.55 PF	0 Watts
N/A	0	0.00	0	0.00	0.55 PF	0 Watts

5) Total KW demand of all evaporator fan sets: 1.6807 KW

6) Total KW demand of all evaporator fan sets with and without economizer	1.6807
7) Load and No. of installed destratifying fans: (each fan represents 30 Watts) 0.030 KW	0
8) Total load of installed fans:	0.0000
9) Savings due to cycling of evaporator fans: (line 4) X (line 6)	6,578 KWH/yr
10) Savings due to reduced cooling load from evaporator fans. (line 9) X (3413/12000) X 1.6	2,993 KWH/yr
11) Energy used by new recirculating fans: (line 1) X (line 8)	0
12) Energy use due to increased cooling load from recirc fans. (line 11) X (3413/12000) X 1.6	0
13) Net energy saved by cycling evaporator fans: (line 9)+(line 10)-(line 11)-(line 12)	9,571 KWH/yr
a) Percent total reduction of evaporator fan run time:	44.68%

14) Projected Demand Savings average for year: (Line 19) / 8,760 1.4870 KW

ANALYSIS OF SAVINGS FROM DIRECT DIGITAL TEMP CONTROLS:

15) Annual energy use by compressor. Part I (line 12) - Part I (line 16)	61,235 KWH/yr
16) Compressor savings: compressor kwh(line 15) X controller reduce run time (%) 5.0%	3,049 KWH/yr
17) Resulting evaporator savings: (evap load Part II line5) X (evap hours 8,760 Hr/Yr - Part II line4) X controller reduced time	406 KWH/yr
18) Total savings from Direct Digital Controller: (line 16) + (line 17)	3,455 KWH/yr

19) **SAVINGS SUMMARY: Economizer and Digital Evaporator Fan and Temperature Control**
Projected Energy Savings = PART I (line 16) + PART II [(line 13) +(line 17)] 13,026 KWH/yr

WALK-IN COOLER ENERGY CONSERVATION BENEFIT ANALYSIS

1) *Customer:* **Wernersville State Hospital** **#36610-2-JR**
 2) *Address:* **160 Main St, Wernersville, PA 19565**
 3) *Telephone:* **610-678-3411**
Contact: **Mike Fendya, PE**
 4) *Utility Company:*
 5) *Account Number:* **0000-000-0000** *Install Code:* **4TC14ECM1EDF**

PART III**ANALYSIS OF REPLACING EVAPORATOR MOTORS WITH ECM MOTORS**

ECM Motors are designed to reduced the motor and refrigeration load when the fans are on.

1) Does Cooler Currently utilize CoolTrol?	YES	
2) Estimated on time of Evaporator Fans (if system uses CoolTrol, estimated on time = 4,730 otherwise estimated on time of Evaporator Fans is 8,760)	4,730	Hours
3) KW Load of Evaporator Fans	1.681	KW
4) Estimated Percentage Reduction in Motor Load	65%	KWH/yr
5) KWH Motor Savings (line 2 * line 3 * line 4)	5,167	KWH/yr
6) Savings due to reduced cooling load from evaporator fans. (line 5) X .28 X 1.6	2,352	KWH/yr
7) Projected Energy Savings from Installing ECM Motors	7,519	KWH/yr
8) Projected KW Savings from Installing ECM Motors: (Line 7) / (Line 2)	1,590	KW

PART IV**ANALYSIS OF CONTROLLING ELECTRIC DEFROST:**

By Controlling the Electric Defrost, defrosts can be eliminated approximately 35% of time.

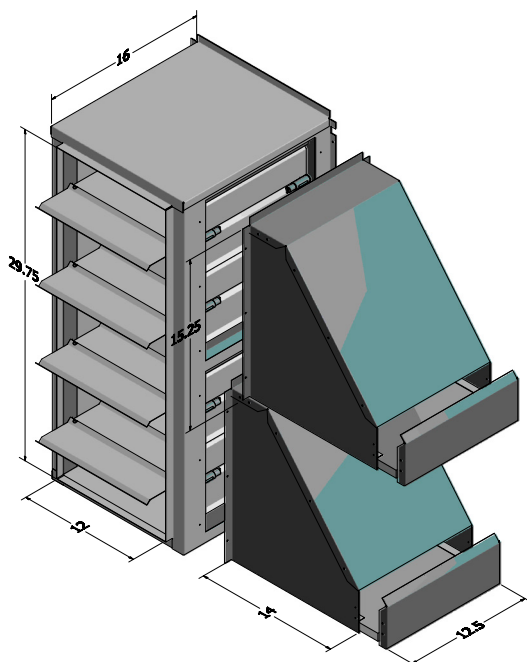
Cooler ID:	Total Watts
Warehouse East - Outer Freezer	0
Warehouse East - Inner Freezer	5,000
Warehouse West - Outer Cooler	0
Warehouse West - inner Cooler	0
N/A	0
N/A	0

1) Total Load from Electric Defrosts	5.000	KW
2) Electric Defrost annual energy use: (line 1) X 365 days X 4 Defrosts/Day X 40 minutes	4,867	KWH/yr
3) Estimated hours that Electric Defrost can be shut off: (365 Days X 4 Defrosts/Day X 40 minutes * .35)	341	Hours
4) Estimated Savings from Electric Defrost Reduction (line 3 X line 1)	1,703	KWH/yr
5) Savings due to reduced cooling load. (line 4) X .28 X 1.6	763	KWH/yr
6) Estimated Savings from Reduction in Electric Defrost Runtime (line 3 * line 1)	2,466	KWH/yr
7) Estimated KW Savings from Reduction in Electric Defrost Runtime	0.282	KW

ECM #12

Evaluate all kitchen and freezer building equipment, controls, and variable speed systems

Equipment Information Sheets



ECONOMIZER 101

Economizers are designed to provide “free” air conditioning when outside conditions are appropriate. When the outside air is cool and dry enough, the economizer automatically opens to introduce the cool air to the interior space, thereby eliminating the need to run the air conditioning compressor.

If the outside air becomes too warm or humid, the economizer automatically closes the fresh air damper and the compressor engages to begin cooling the space mechanically.

If a two stage thermostat is used it is possible to use a combination of economizer and mechanical cooling to condition the space.

The economizer can also be set to allow a minimum amount of fresh air to enter the space when the equipment’s indoor blower is operating.

Economizers are valuable tools to enhance indoor air quality, save energy and prolong the life of the air conditioning equipment.

SEQUENCE OF OPERATION

This sequence assumes employment of a single enthalpy economizer using a two stage thermostat.

1. A call for cooling comes from room thermostat.
2. The enthalpy sensor determines if the atmospheric conditions are conducive for using outside air for cooling. If YES, go to step 3. If NO, or if outdoor air temperature rises above enthalpy set point, go to step 4.

3. The outside air dampers open and modulate to maintain a mixed air temperature (outside air + indoor air) of 53 degrees F. If the outdoor air is insufficient to satisfy the thermostat alone and a second stage of cooling is required, the compressor starts and works in conjunction with the economizer to cool the space. (Go to step 5.)
3. Outdoor air dampers open to minimum position and the compressor engages to provide mechanical cooling.
3. When the thermostat is satisfied the outside air dampers return to a closed position.

INSTALLATION

1. Open carton and inspect contents for shortages and damage.
2. Remove the large evaporator access panel.
3. Remove the horizontal return air opening cover and secure it over the downflow return opening per unit installation instructions.
4. Feed the wiring harness through the return air opening.

NOTE: Ensure that the wiring harness is inside the return air opening and that no part of it is caught between the economizer and the side of the unit.

5. Attach the economizer to the unit over the horizontal return air opening by sliding the top flange of the economizer under the flange on the top of the unit and securing with sheet metal screws. Weatherproof the seam where the economizer and unit attach using silicone or other approved sealant.

NOTE: Ensure neither the wire nor the plugs interfere with the movement of the dampers during operation.

6. Locate the nine pin plug in the unit and remove the jumper plug. Attach the plug from the economizer.
7. Remove the blower access panel and secure the mixed air sensor to the blower housing. (Figure 1)
8. Attach the pink mixed air sensor wires to the sensor and to MAT on the Jade control. (Figure 2)
9. Replace the blower access door and evaporator access door.
10. Attach field supplied duct to return air duct opening on the economizer.

This product is warranted to be free from defects due to workmanship or materials, under normal use, for a period of sixty (60) months from date of installation.



Figure 1

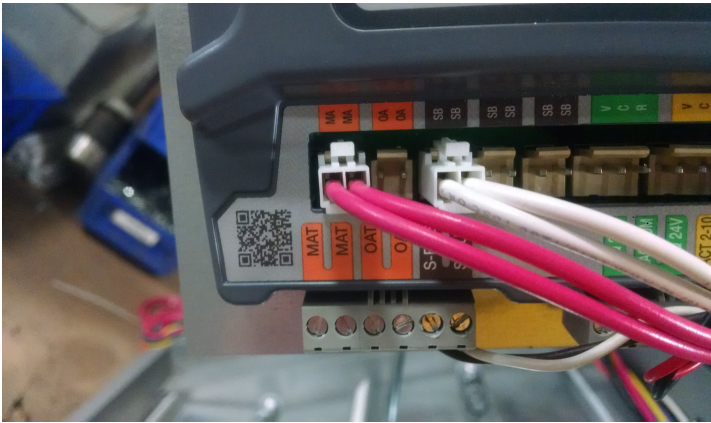


Figure 2

$$(To \times OA) + (Tr \times RA) = Tm$$

To = Outdoor air temperature

OA= Percent of outdoor air

Tr = Return air temperature

RA= Percent of return air

Tm= Resulting mixed air temperature

Example:

Fresh air required is 10% outdoor air.

Outdoor air temperature is 60 degrees F.

Return air temperature is 75 degrees F.

$$(0.1 \times 60) + (0.9 \times 75) =$$

$$6.0 + 67.5 = 73.5$$

Mixed air temperature will be 73.5 degrees F when the OA is 60 degrees F and the RA is 75 degrees F with 10% outdoor air.

CONTENTS

Return Air/Fresh Air Damper Section

Fresh Air Hood Left Sides (2)

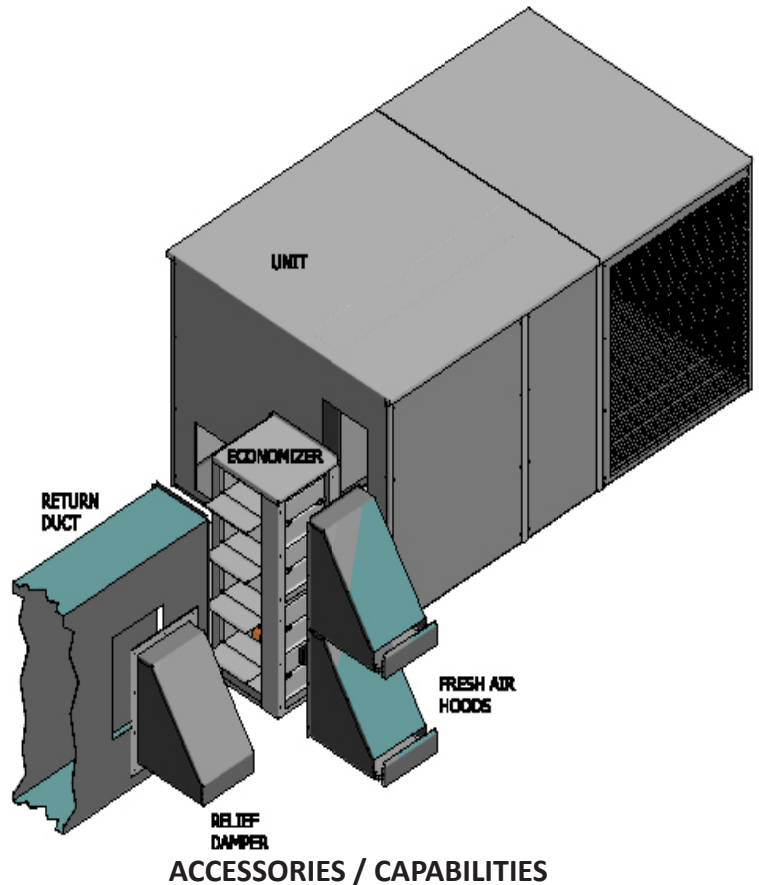
Fresh Air Hood Right Sides (2)

Fresh Air Hood Tops (2)

Fresh Air Hood Front Filter Access (2)

Mist Eliminators (2)

Screw Package



Dual Enthalpy - Requires an additional C7400 enthalpy control installed in the return air duct.

Demand Control Ventilation - Requires a CO2 sensor.

Power Exhaust - DNPE3672 power exhaust used in applications where barometric relief is not sufficient. Requires PE-3672BXHR duct mounted barometric relief damper. See page 3 for instructions.

Important Notes

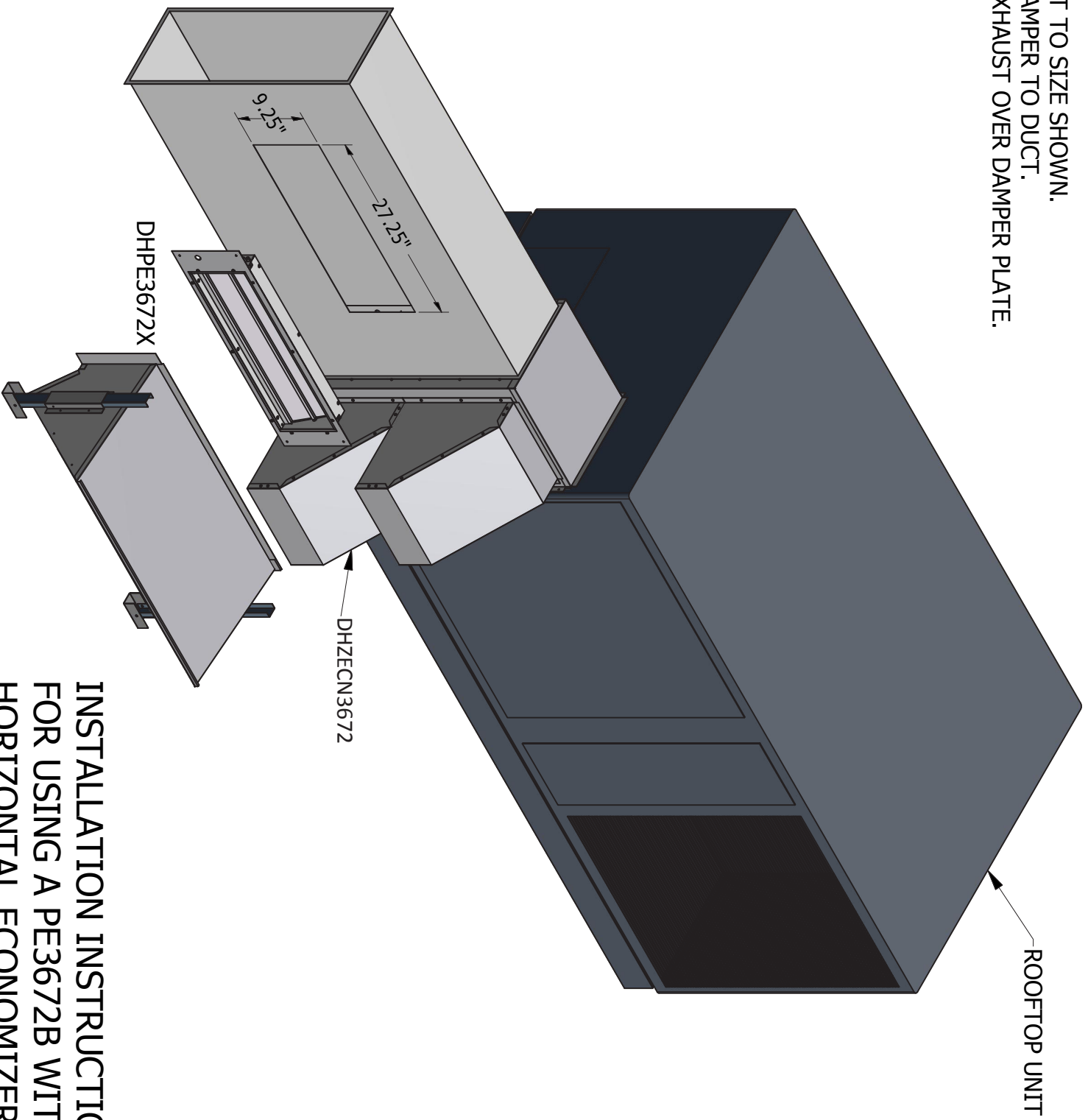
Please see enclosed brochure for Honeywell component trouble shooting and heat pump conversio instructions.

Heat pump applications require Goodman part number IRKT-01.

The fresh air mist eliminator should be flushed periodically with warm soapy water.

A two stage thermostat is recommended with this accessory.

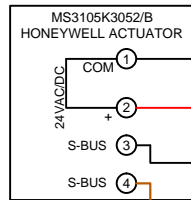
1. CUT HOLE IN DUCT TO SIZE SHOWN.
2. ATTACH RELIEF DAMPER TO DUCT.
3. ATTACH POWER EXHAUST OVER DAMPER PLATE.



INSTALLATION INSTRUCTIONS
FOR USING A PE3672B WITH THE
HORIZONTAL ECONOMIZER

JADE WIRE DIAGRAM 3105 REV4

GROUND
GROUND LUG



BLACK

RED

WHITE

BROWN

PINK

PINK

WHITE

WHITE

BLACK

RED

MAT
MAT
OAT
OAT
S-BUS
S-BUS
IAQ 2-10
IAQ COM
IAQ 24V+
ACT 2-10
ACT COM
ACT 24V+

HONEYWELL
W7220

AUX2-1
OCC
E-GND
EXH1
AUX1-0
Y2-I
Y2-O
Y1-I
Y1-O
C
R

(O)

BLACK

(P)

(P)

(Y)

(Y)

(BL)

(R)

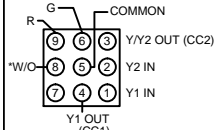
MOLEX 3597706**
50048926-002

CONNECT TO
C7400S1000
ENTHALPY CONTROL

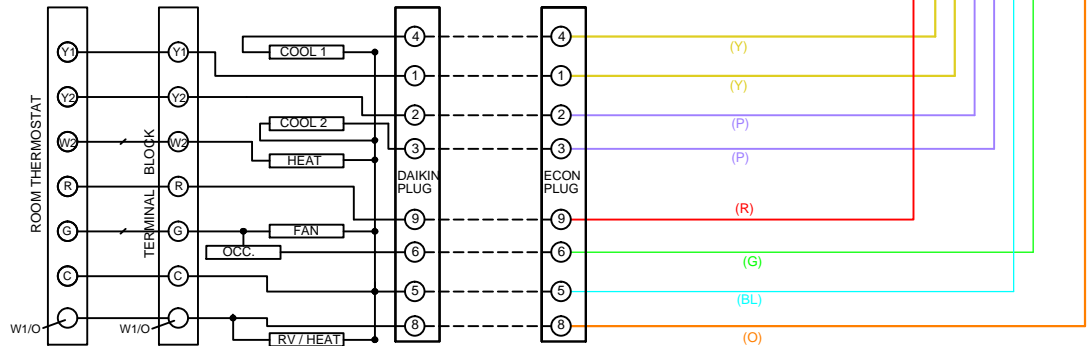
CONNECT TO
C7250A1001
MIXED AIR SENSOR

COLOR CODES FOR 9 PIN PLUG

- ① (Y) YELLOW
- ② (P) PURPLE
- ③ (P) PURPLE
- ④ (Y) YELLOW
- ⑤ (BL) BLUE
- ⑥ (G) GREEN
- ⑦ (O) ORANGE
- ⑧ (R) RED
- ⑨



* WHITE WIRE ON DCG
ORANGE WIRE ON DCH





Motor Model Search

Motor Details



Model : 5SME59BVA1229

Catalog Number : N/A

General:

Application : COMMERCIAL REFRIGERA

Motor Category : COMPLETE MOTOR

Phases : 1

Production Status : PROD

of Speeds : 1

Stock Status :

Testspec : 24X333321-1

Approved For Sale :

Horiz/Vertical : HOR

Restricted Model :

Shell Enclosure : CLOSED

Customer : GEXPRO

Endshield Enclosure : CLOSED

Customer Part# : 1101

Nameplate Data:

Horsepower : 1/15

GE Type : SME

RPM : 1550

Time Rating : CAO

Voltage : 115

Frequency : 60/50

FL Amps : 1.1

Insulation Class: B

Capacitor 1mFd/V : N/R

Capacitor 2mFd/V : N/R

Additional Information : -40 TO +25 DEG C
N/R

Miscellaneous:

Fullload RPM - HI :

GE Frame : 59

Poles : 6

Shell Length : 3.155

Rotation : CCW

Drains : N

Thermal Protection :

Est. Weight : -10

Finish Color: STD GRAY

Capacitor By : N/R

OVERLOAD INFORMATION::

Protector: N/R

Overload Temp : N/A

Catalog No: N/A

Vendor Name: N/A

THERMAL CUT-OFF INFORMATION:

TCO: N/A

Overload Temp : N/A

Catalog No: N/A

Vendor Name: N/A

U.L.CONSTRUCTION FILES:

Motor Construction: E46035(excluding SME)

Class B Insulation : E306343(excluding SME)

Over Load : E27885(excluding SME)

CSA(REY) : MC236833(excluding SME)

Shaft:

PE Type : FLAT

OPE Type : N/R

PE Length : 2.61

OPE Length : N/R

PE Diameter : .31

OPE Diameter : 0

PE Flat Length : 1.75

OPE Flat Length : N/R

Endshields:

PE Material : ST

OPE Material : ST

PE Hub Type : STD

OPE Hub Type : FLAT

PE Oiler : N/R

OPE Oiler : N/R

PE Oil Plug : N/R

OPE Oil Plug : N/R

PE Mounting Holes : N/R

OPE Mounting Holes : N/R

Bearings:

PE Bearing Type : BALL

OPE Bearing Type : BALL

Bearing Protection : No

Rohs Compliant : No

Mounting:

Base : N/R

Lug : N/R

Clamp Screw : Yes

Weld Screw : No

Extended Clamp Screws:

PE Pattern :
PE Length : **0.45**
PE Nut Qty : **0**
Head End : **OPE**
Nut Thickness : **.12**

Lead & Cord :

Lead End : **OPE**
Lead Exit H/W : **N/R**
Lead Exit H/W Orient.
: **N/R**

OPE Pattern :
OPE Length : **0.45**
OPE Nut Qty : **0**
Screw Size : **#8**

Lead Type : **RIPCORD**
Lead Harness Desc : **CORD/PLUG ASM**

Note : Exit position is viewed from the Lead End with the Shell Weld at 6:00.

Grounding :

Type : **N/R**
Exit Type : **N/R**
Length : **N/R**
Terminal : **N/R**

Location : **N/R** viewed from **N/R** with Oil boss at
12:00
AWG Size : **0**
Color : **N/R**
Ins.Material &
Thickness **N/R N/R**

Diagrams and Dimensions :

Outline Drawing : **5SME59BVA1229**
Connection Diagram : **NA Fig# 35**

C-Dimension : **6.42**
Connection Label : **N/R**

Notes :

This document is the property of the Regal Beloit Company containing proprietary and confidential information.

Date of last revision : **02-JUL-14**





Motor Model Search

Motor Details



Model : 5SME59BVA2203

Catalog Number : N/A

General:

Application : COMMERCIAL REFRIGERA

Motor Category : COMPLETE MOTOR

Phases : 1

Production Status : PROD

of Speeds : 1

Stock Status :

Testspec : 24X333322-1

Approved For Sale :

Horiz/Vertical : VSD

Restricted Model :

Shell Enclosure : CLOSED

Customer : GEXPRO

Endshield

Customer Part# : 5SME59BVA2203

Enclosure : CLOSED

Nameplate Data:

Horsepower : 1/15

GE Type : SME

RPM : 1550

Time Rating : CAO

Voltage : 208-230

Frequency : 60/50

FL Amps : 0.63

Insulation Class: B

Capacitor 1mFd/V : N/R

Capacitor 2mFd/V : N/R

Additional Information : -40 TO +25 DEG C
N/R

Miscellaneous:

Fullload RPM - HI :

GE Frame : 59

Poles : 6

Shell Length : 3.155

Rotation : CCW

Drains : N

Thermal Protection :

Est. Weight :

Finish Color: STD GRAY

Capacitor By : N/R

OVERLOAD INFORMATION::

Protector: N/R

Overload Temp : N/A

Catalog No: N/A

Vendor Name: N/A

THERMAL CUT-OFF INFORMATION:

TCO: N/A

Overload Temp : N/A

Catalog No: N/A

Vendor Name: N/A

U.L.CONSTRUCTION FILES:

Motor Construction: E46035(excluding SME)

Class B Insulation : E306343(excluding SME)

Over Load : E27885(excluding SME)

CSA(REY) : MC236833(excluding SME)

Shaft:

PE Type : FLAT

OPE Type : N/R

PE Length : 2.61

OPE Length : N/R

PE Diameter : .31

OPE Diameter : 0

PE Flat Length : 1.75

OPE Flat Length : N/R

Endshields:

PE Material : ST

OPE Material : ST

PE Hub Type : STD

OPE Hub Type : FLAT

PE Oiler : N/R

OPE Oiler : N/R

PE Oil Plug : N/R

OPE Oil Plug : N/R

PE Mounting Holes : N/R

OPE Mounting Holes : N/R

Bearings:

PE Bearing Type : BALL

OPE Bearing Type : BALL

Bearing Protection : No

Rohs Compliant : No

Mounting:

Base : N/R

Lug : N/R

Clamp Screw : Yes

Weld Screw : No

Extended Clamp Screws:

PE Pattern :
PE Length : **0.45**
PE Nut Qty : **0**
Head End : **OPE**
Nut Thickness : **.12**

OPE Pattern :
OPE Length : **0.45**
OPE Nut Qty : **0**
Screw Size : **#8**

Lead & Cord :

Lead End : **OPE**
Lead Exit H/W : **N/R**
Lead Exit H/W : **N/R**
Orient. :

Lead Type : **RIPCORDER**
Lead Harness Desc : **CORD/PLUG ASM**

Note : Exit position is viewed from the Lead End with the Shell Weld at 6:00.

Grounding :

Type : **N/R**
Exit Type : **N/R**
Length : **N/R**
Terminal : **N/R**

Location : **N/R** viewed from **N/R** with Oil boss at 12:00
AWG Size : **0**
Color : **N/R**
Ins.Material & Thickness : **N/R N/R**

Diagrams and Dimensions :

Outline Drawing : **5SME59BVA2203**
Connection Diagram : **NA Fig# 35**

C-Dimension : **6.42**
Connection Label : **N/R**

Notes :

This document is the property of the Regal Beloit Company containing proprietary and confidential information.

Date of last revision : **07-MAR-13**



National Resource Management DATA SHEET

CoolTrol®

Integrated Refrigeration Controls

Evaporator fans operate 25%-80% less, saving electricity and reducing compressor run time. In areas with winter temperatures, the compressor and fans can also utilize cold, outside air to run less.

Door and Frame Heater Control

Heaters are controlled based on store dew point, reducing run times by up to 95% in coolers and 50% in freezers.

Cooler Load/Shutdown Button

Safely shuts off the refrigeration when the cooler is being stocked, which lessens the risk of damage to the system and lowers the energy costs during loading.

Service Bypass Button

Allows users and technicians to bypass the control system to service the cooler or freezer and then safely reset the system when finished.

Predictive Fault Detection

Strobe lights, as well as optional email and text alerts, signal when NRM's tools detect a mechanical issue in your equipment. Receive notifications for everything from high space temperatures to compressor short cycling. This helps reduce, and in some cases can even eliminate, product spoilage and loss.

Smart Defrost

Defrost cycles are based on coil temperature and refrigeration run time instead of timed cycling for unparalleled optimization.

Built-in Intelligence

The CoolTrol system logs and provides historical usage patterns, which extends the life of the equipment by exposing potential problematic refrigeration areas.

Novelty Cooler Shutoff

Safely and automatically shuts off novelty (Coke/Pepsi/Sports Drinks) and non-perishable product coolers when the store is closed.

Additional Features

- Simplified display and push-button control panel gives you more adjustment options and greater flexibility.
- Built-in Ethernet port offers easier connection to local network for existing EMS or to monitor and control system over CoolTrol LAN Portal.
- Ability to access NRM's Remote Site Manager, a web-based control and monitoring system.
- Log data and user settings are stored on a removable 8GB SD card - ideal for M+V or compliance reporting.



NRM's CoolTrol® is an optimization solution that improves diagnostics, performance, and energy efficiency for your commercial or industrial refrigeration systems. Through smart controls, predictive fault detection, and efficiency measures, your equipment will run better and last longer. You'll also receive best-in-class insight and support.



■ Visit: NRMinc.com

■ Call: (800) 377-5439

■ Address: 480 Neponset St., Bldg. 2
Canton, MA 02021

■ Email: info@nrminc.com



Menus and Settings for the CCS2

Main Menu

Menu Name	Description
Setup	Adjusts the time, date, temperature, setback, LCD backlight, and temperature units. Also assign names to coolers.
Info	Scrolls through a series of screens that display details about the system setup and status: Local probes, Control probes, 4-20mA inputs, Digital inputs, Pilot relays, Onboard relays, and Version info.
Test	Tests the solenoid, evaporator fan, defrost, economizer, and coil. Also view the relay outputs, coil temperature, and onboard relay outputs. Tests start with all of the equipment shut off, and all short cycle safeties are disabled.
Network	Adjusts the network settings for the system.
Advanced	Adjusts settings related to the cooler system, such as fan delay times, defrost, destratification cycles, shutdown, shutoff, bypass, alarms, and economizer enable and disable.
Defrost	Starts a defrost cycle.
Restart	Restarts the system.

Setup Menu

Menu Item	Description	Default Setting
Time	Sets the time.	
Date	Sets the date.	
Daylight Savings	Enables or disables daylight savings time.	Enabled
Time Zone	Sets the correct time zone.	Eastern
Setpoint	Adjusts the temperature of the cooler.	38° F
Differential	Adjusts the temperature differential value.	3° F
Setback Diff	The additional degrees that the cooler is set back. If the setting is set to OFF, the cooler is shut off.	5° F
Setback – Monday (separate setting for each day)	Sets up the daily schedule for the setback for the cooler’s temperature and the Novelty Shutoff.	
Copy Setback Sched.	Copies the Monday setback schedule and enables/disables to the rest of the week.	
Setback Date 1-7	Configures the seven date range setback schedules. Each setting has a starting day/month, ending day/month, an enable, and an option to turn the cooler off instead of setting the temperature back.	
Cooler Name	A list of names for the controlled cooler.	Default
Custom Name	Creates a name for the cooler using up to 20 characters.	CCS-2
LCD Backlight	Sets the behavior of the display backlight to either On, Off, or Timed. The Timed option turns the on backlight for two minutes.	Timed
Temperature Units	Sets the unit of temperature to either Fahrenheit or Celsius with or without decimal points.	Fahrenheit
Remote Settings	Limits the ability to make changes via the web interface. Options are “Allowed”, “Not Allowed”, “For 60 Minutes”	Allowed

Info Menu (view only)

Menu Item	Description
Control Probes	View the space, coil, and outside temperatures used for control. If there are multiple space temperatures, the average of the temperatures is displayed. For multiple coil temperatures, the lowest temperature is displayed.
Equipment Status	View if the evaporator fans, cooling, defrost heat, and economizer are on or off.
Local Probes	View the temperatures for the physical probes connected to the controller: P1—Space temperature 1, P2—Space temperature 2, P3—Coil temperature 1, P4—Coil temperature 2, and P5—Outside temperature.
Digital Inputs	Shows the state of each digital input, either open or closed. Five inputs are displayed: Input 1—Shutdown button, Input 2—Bypass switch, Input 3—Door sensor, and Inputs 4 and 5—Not used at this point but recorded, so these can be used for testing or monitoring if needed.
Pilot Relays	View the state of the MAIN, SOL, EFAN, DFRST, and ECON pilot relays. The actual state of the relays is displayed, not the state of what is being controlled.
Onboard Relays	OBR1 (alarm) and OBR2 (night shutoff)
4-20mA Inputs	The top line for each input shows the milliamp signal transmitted from the transducer. The bottom line shows the engineering units if set up. Two inputs are displayed.
Door Heat Control	Shows all Door Heat Control input and output info, if enabled.
Version Info	Firmware version and MAC address. The MAC address is also used as the serial number for the CCS2.
RSM Status	Shows status info related to the Remote Site Manager cloud based data service.**
Statistics	Shows the daily, weekly, and monthly runtime percentages on separate screens. The number of statistics available depends on the device configuration.

** The Remote Site Manager subscription service enables end users to review real-time or historical HVAC/R data and modify control parameters remotely over cloud based servers. *An optional paid subscription is required in order to use this service.*

Advanced Menu

Menu Item	Description	Default Setting
Short Cycle	The time the compressor must remain off before it can be restarted.	2 minutes
Min Runtime	The minimum time that the compressor must run before it can be turned off.	2 minutes
Auto Diff Adjust	Automatically increases the Differential (up to 3°F) if compressor runtimes are too short.	Enabled
Off Cycle Adjust	Automatically increases the Differential (up to 3°F) if the cooling off cycles are too short.	Enabled
Sol Fan Delay	The minimum time that the evaporator fans must continue running after a cooling cycle stops.	30 seconds
ED Max Fan Delay	The maximum time that the evaporator fans are kept off at the start of a cooling cycle in an electric defrost application (also known as refreeze time).	75 seconds
Dstrat Off Time	Sets the time between destratification cycles.	7 minutes
Dstrat On Time	Sets the amount of time that the evaporator fans are run during a destratification cycle.	1 minute
Dstrat Cycling	Enables or disables the evaporator fan destratification cycles.	Enabled
Fan Cycling	Enables or disables the off cycle evaporator fan control. If disabled, the fans run continuously during the off cycle.	Enabled
Gravity Mode	Enables or disables the ability to cycle off the cooling when the evaporator reaches very cold temperatures. This can occur when the evaporator fans are turned off, or the evaporator encased in ice.	Enabled
Stuck Sol Detect	Enables or disables the detection of a solenoid valve that is stuck open. If detected, the solenoid valve is cycled 3 times to attempt to close it.	Enabled
Timed Efan - Door	When enabled, the evaporator fans are run for 7 minutes after the door is opened. Requires a door switch on digital input 3.	Disabled
Timed Efan - Occ	When enabled, the evaporator fans are run for 7 minutes after occupancy is sensed. Requires an occupancy sensor on digital input 5.	Disabled
Defrost Enable	Enables or disables defrost.	Enabled
Defrost Type	Sets either an air or electric defrost. This should be set to the correct type of defrost, whether or not the defrost is being controlled.	Air
Interval Type	Controls the timing between defrosts. Select from dynamic (runtime), fixed interval, or Real Time Clock (RTC). The runtime interval is based on the compressor runtime. RTC allows up to 8 start times per day to be set.	Runtime
Thermostatic Dfrst	Applies only to an electric defrost. If enabled, regulates the heating elements to the terminate temperature.	Disabled
Defrost Interval	Sets the time between defrosts.	2.6 hours
Dfrst Min Interval	Sets the minimum time between defrosts, if the Interval Type is set to Runtime.	4.5 hours
Defrost Times 1 - 8	If the defrost interval is set to RTC, these set the defrost start times. Up to 8 defrosts can be set per day.	
Defrost Min Time	Sets the minimum defrost time.	13 minutes
Defrost Max Time	Sets an overall maximum time that the defrost cycle can last.	60 minutes
Dfrst End Temp	Sets the electric defrost terminate temperature.	60° F
Dfrst Drip Time	Sets the amount of extra time to allow water to drip off after ending the heating cycle. Applies to only the electric defrost.	2 minutes
Dfrst Boil Time	Sets the amount of time to allow refrigerant to boil off before starting a heating cycle. Applies to only the electric defrost.	2 minutes
Dual Defrost	Enables the independent termination of a 2 nd electric defrost heater. Both defrosts need to terminate before cooling is resumed. Requires a 2 nd defrost relay to be installed. Coil Probe #1 will control the 1 st heater, and Coil Probe #2 will control the 2 nd heater.	Disabled
Est Dfrst Display	Estimated Defrost Display enable.	Enabled
Display @ Defrost	Display during Defrost. Options are Temperature or Defrost (no temperature shown).	Defrost
Defrost Cancel	Cancels defrost starts if the evaporator temperature has been high for extended periods. This does not affect manual defrosts.	Enabled
DH Enable	Enables or disables the door heater control functionality.	Disabled
DH #1 Setting	0-6 if the control type is auto, or 0 – 100% if the control type is fixed %.	3
DH #2 Setting	0-6 if the control type is auto, or 0 – 100% if the control type is fixed %.	3
DH #1 Xtra Heat	Enables Xtra Heat defrost cycles. Settings are Enabled, Disabled, and Default. If set to Default, it is enabled if the DH #1 Type is set to Freezer, and disabled if the DH #1 Type is set to Cooler.	Default
DH #2 Xtra Heat	Enables Xtra Heat defrost cycles. Settings are Enabled, Disabled, and Default. If set to Default, it is enabled if the DH #2 Type is set to Freezer, and disabled if the DH #2 Type is set to Cooler.	Default
DH PWM1	Enables or disables the PWM1 output to control door heaters.	Enabled
DH PWM2	Enables or disables the PWM2 output to control door heaters.	Enabled
DH #1 Type	Sets the PWM1 output door heaters to be Cooler or Freezer type.	Cooler
DH #2 Type	Sets the PWM2 output door heaters to be Cooler or Freezer type.	Freezer
DH #1 Control	Auto, Fixed %, On, Off	Auto
DH #2 Control	Auto, Fixed %, On, Off	Auto
DH #1 Map	Normal, Lowest, Low, High, Pass-through (Pass-through is used for Freezer type doors, where the door is located in a cooler.)	Normal
DH #2 Map	Normal, Lowest, Low, High, Pass-through	Normal
Economizer Enable	Enables or disables the economizer.	Disabled
Econ Differential	Sets the temperature differential used for the economizer.	2° F
Thermal Storage	Sets the cooler to run at a lower temperature using the Economizer so that the cooler can coast through periods of warmer weather. Please note that if Thermal Storage is enabled, the economizer will run if the cooler is turned off via the setback schedule.	36° F
TS Follows Setback	If enabled, Thermal Storage will only run during a cooler setback.	Disabled
Heat Control	Enables or disables the control of a heater to maintain the controlled space temperature above a temperature based on the Setpoint, Deadband, and Heat Diff. This uses the Defrost Output to control the heating. If the Defrost Output is used for a defrost function, Heat Control cannot be enabled.	Disabled
Heat Diff	The differential below the Deadband at which the heat will be turned on.	3° F
Deadband	The Deadband is the differential below the Setpoint at which the heat is turned off.	1° F
Freeze Protection	If enabled, heat control is used to keep the space temperature above freezing.	Disabled
Efans ON with Heat	If enabled, the evaporator fans will run when the heat is turned on.	Disabled
Shutdown Enable	Enables or disables the cooler shutdown button (external and internal).	Enabled
Shutdown Length	Sets the cooler shutdown time.	20 minutes
Shutdown Limit	Overrides the maximum shutdown time limit. Options are Normal, and Unlimited.	Normal
Shutdown Delay	Enables or disables a slower Shutdown start sequence.	Disabled
Setback Enable	A global setting that either enables or disables the cooler temperature setback.	Enabled
Novelty Shutoff	A global setting that enables or disables the Novelty Shutoff output.	Enabled
Setback Date	A global setting that either enables or disables date range cooler temperature setback.	Disabled

Advanced Menu Continued...		
Menu Item	Description	Default Setting
Bypass Enable	Enables or disables the cooler bypass.	Enabled
Bypass Button	Enables or disables the keypad bypass button.	Enabled
Bypass Switch	Enables or disables a bypass switch on digital input 2.	Disabled
Byp Switch Global	When enabled, all CCS2 units with the same cooler ID go into bypass simultaneously.	Disabled
Bypass Door	When enabled, the CCS2 goes into bypass for 10 minutes after the door is opened. Requires a door switch on digital input 3.	Disabled
Bypass Occ	When enabled, the CCS2 goes into bypass for 10 minutes after occupancy is sensed. Requires an occupancy sensor on digital input 5.	Disabled
Probe 1 Type (total 5 types)	Sets the type of thermistor. Options are 5K Z Curve, 10K Z Curve, and 5K SB Curve.	5K Z Curve
Outside Probe Fn.	Sets an alternate function for the outside temperature probe. Alternate options are Coil 3, Space 3, or Monitor.	Outside Temperature
Out Temp Sharing	Outside Temperature Sharing. Configures the sharing of the outside temperature if Distributed Control is enabled. Options are Enabled, Disabled, Local Priority, Local Only and Remote Only.	Enabled
4-20mA IN1 Type (total 2 types)	Sets the type and units for the transducers connected to these inputs.	4-20 mA
4-20 mA Calibration	Sets the calibration value for the 4-20mA inputs.	326
Comp. Feedback	Sets the input to use to sense if the compressor is on or off. If a 4-20mA input is selected, a 10% F.S. threshold is used to determine if the compressor is on.	Disabled
Cooler Control	Enables or disables the Cooler Control functionality of the controller. A reboot is required after changing this setting. *	Enabled
Demo Mode	If enabled, simulates the control temperatures so that the unit can be used as a demonstration unit.	Disabled
Alarms Enable	A global setting that disables all alarming.	Enabled
Alarm All Hours	If enabled, non-critical alarms can go off at any time.	Disabled
Alarm Relay Enable	Enables or disables the onboard alarm relay.	Enabled
High Alarm Enable	Enables or disables the high-temperature alarming.	Enabled
High Alarm Type	Allows you to choose among auto, fixed, or relative (differential) high-temperature alarm points.	Auto
High Alarm Adjust	If enabled, the high-temperature alarm adjusts for defrost, shutdowns, and setbacks.	Enabled
High Alarm Mode	Sets the high-temperature alarm to operate in run mode, or run and bypass mode.	Run Only
High Alarm Setpoint	Adjusts the setpoint for a fixed high-temperature alarm.	46° F
High Alarm Diff	Sets the temperature differential for a differential type high-temperature alarm.	5° F
High Alarm Time	Sets the high-temperature time for a fixed or differential type high-temperature alarm.	60 minutes
Low Alarm Enable	Enables or disables the low-temperature alarming.	Enabled
Low Alarm Type	Allows you to choose among auto, fixed, or relative (differential) low-temperature alarm points.	Auto
Low Alarm Adjust	If enabled, the low-temperature alarm adjusts for defrost, shutdowns, and setbacks.	Enabled
Low Alarm Mode	Sets the low-temperature alarm to operate in run mode, or run and bypass mode.	Run Only
Low Alarm Setpoint	Adjusts the setpoint for a fixed low-temperature alarm.	34° F
Low Alarm Diff	Sets the temperature differential for a differential type low-temperature alarm.	3° F
Low Alarm Time	Sets the low-temperature time for a fixed type low-temperature alarm.	20 minutes
Alarm Silence 1	Sets the alarm silence time when the alarm goes off the first time	1 hour
Alarm Silence 2	Sets the alarm silence time when the alarm goes off for a second time.	24 hours
Backlight Flashing	The display backlight will flash during an alarm condition.	Enabled
Alarm Scheduling	Enables or disables the Alarm Disable Schedule.	Disabled
Alarm – MON (separate setting for each day)	Sets up the daily schedule for disabling the High Temperature Alarm.	
Set Password	Sets a 4 digit pass code that prevents settings form being changed. Set to 0000 to disable.	Disabled
View All Settings	Enable the display of settings that are usually only used when the system is initially configured.	Disabled

Network Menu

Menu Item	Description	Default Setting
IP Address Type	Sets either a static or DHCP address. Select DHCP to automatically set the IP address for the CCS2.*	Static
DHCP Actions	If DHCP is active, these actions can be run. Items are “Renew”, “Release”, “Save to Static”, “Request Static”.	
IP Address	Sets the static IP address for the CCS2.*	None
Netmask	Sets the subnet mask of the IP address.*	None
Default Gateway	Sets the default gateway used with the CCS2.*	None
DNS #1-3	Sets the IP addresses for the domain name servers (DNSs).	None
SNTP #1-5	Sets the IP addresses for the time servers.	None
Ethernet Link	Sets the Ethernet link connection type. Use this setting to change the link speed and duplex type.*	Auto
Telnet Timeout	Sets the auto logout time of the telnet terminal. (NOTE: Telnet removed in Rev 38 and higher.)	5 minutes
Telnet Enable	Enables or disables the telnet terminal. (NOTE: Telnet removed in Rev 38 and higher.)	Enabled
Web Server	Enables or disables the CCS2’s internal Web Server.	Enabled
Wireless API	Enables or disables the Wireless Probe API Server.	Enabled
IP Filtering	Enable to limit traffic allowed to reach the CCS2 unit.	Disabled
Filter Default	Passes or blocks traffic to the CCS2 unit. If the block is enabled, no traffic will be allowed through unless a trusted IP and subnet mask are enabled. You can also allow traffic from your local network.	Allow
Trusted IP #1-3	Sets up to three IP or network addresses to allow traffic to the CCS2 unit.	None
Trusted Mask #1-3	Sets the mask to 255.255.255.255 to limit to only one IP address. You can also set a different mask to allow traffic from a network.	None
Allow Local IPs	Allows traffic from the local network.	Enabled
Allow Private IPs	Allows traffic from any private IP address.	Enabled
RSM Enable	Enables or disables the system from connecting to the RSM service. **	Enabled
RSM Service	Normal or No Data. Normal mode sends data every 10 seconds. No Data mode establishes a connection but doesn’t send data unless requested.	Normal
RSM Units	Sets the temperature units used with RSM only. Options are Fahrenheit, Celsius, Celsius x10, Kelvin, Internal (Kelvin x10).	Fahrenheit
RSM Write Enable	Limits the ability to make remote settings changes via RSM.	Enabled
RSM Server IP #1-4	Sets the IP addresses for the RSM servers.	
RSM Server Port #1-4	Sets the TCP ports for the RSM service. If set to 0, the default of 6102 is used.	6102
Modbus TCP Enable	Enables or disables the Modbus TCP server on the CCS2.	Disabled
Modbus Units	Sets the temperature units used with Modbus TCP only. Options are Fahrenheit, Celsius, Celsius*10, Kelvin, Internal (Kelvin*10).	Fahrenheit
Modbus Write	Limits the ability to make remote settings changes via Modbus TCP.	Enabled
Modbus Port	Sets the TCP port for the Modbus TCP service. If set to 0, the default of 502 is used.*	502
Distributed Control	Enables or disables synchronized operation between CCS2 controllers.	Disabled
Cooler ID	Identifies the Cooler that a controller is part of for Distributed Control.	1
Point ID	Identifies the individual controller within a Cooler for Distributed Control.	1
Zone ID	Identifies the Zone that a controller is part of within a Cooler for Distributed Control.	1
Group ID	Identifies a Group of Coolers for Distributed Control.	1
Out Temp Sharing	Outside Temperature Sharing. Configures the sharing of the outside temperature if Distributed Control is enabled. Options are Enabled, Disabled, Local Priority, Local Only and Remote Only.	Enabled
Comp Sync	Compressor Synchronization. Configures the coordination of compressor starts in a zone. Options are Disabled, Master, Slave, and Delay. If a Master starts, all Masters and Slaves Start. Starts between different compressors are delayed by a few seconds.	Disabled
Start Delay	Compressor Start Delay in Seconds. Delays the start of a Master, Slave or Delay compressor after any compressor in the same zone starts. Range is 0 – 600 Seconds.	0 seconds
Lag Delay	Compressor Lag in Minutes. Delays the start of a Master or Slave compressor after the 1 st start of a Master in the same zone. Generally used in Multi-Master applications. Range is 0 – 60 Minutes.	0 minutes

Test Menu

Menu Item	Description
Test System	Manually tests each output.
Relay Outputs	Displays the relay outputs and the coil temperature. Shows the equipment state. The test starts with all of the equipment shut off.
Onboard Relay Outputs	Displays the onboard relay outputs: OBR1—Alarm output and OBR2—Night shutoff output.

* This setting requires a reboot for a change to take effect.

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**OPERATION INSTRUCTIONS
FOR**

CCS2

**COOLER AND FREEZER
ENERGY CONTROL SYSTEM**



National Resource Management, Inc.

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Table of Contents

Introduction.....	1
Using the Keypad.....	3
Menus Accessible from the Keypad	5
Setup Menu	6
Info Menu.....	11
Test Menu	14
Network Menu.....	17
Advanced Menu	25
Manual Defrost Menu	42
Restart System Menu.....	45
Bypass	47
The Economizer System	48
The Alarm System	48
Cooler Shutdown.....	49
Novelty Shutoff Option for Free-Standing Coolers.....	50
Connectivity	51
Log File Downloads	51
Internal Web Server	51
ModbusTCP Server	51
Setup and Test Instructions	52
Tools Needed for Startup and Post Inspections	52
Using the Info Display.....	52
Changing the Set Point	54
Post-Installation Inspection Checklist	55
Alarm Event Record.....	56
Two-Year Limited Warranty	57
Appendix: Differences between the CCS1 and CCS2	60

Introduction

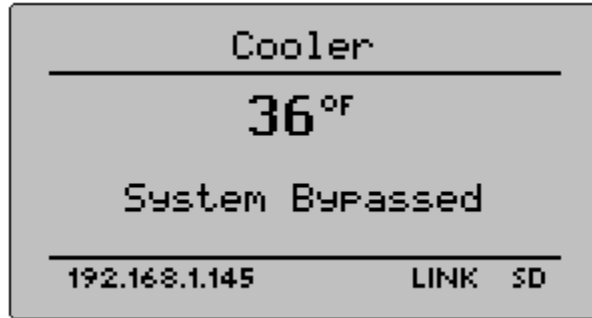
The CoolTrol Cooler and Freezer Energy Management System is a microprocessor-based digital controller that is designed and programmed to operate a walk-in cooler in an energy-efficient manner. The controller features a graphic display and keypad, which allows operating parameters to be viewed and changed. The system can control one cooler and an outside air economizer.

Figure 1. Controller



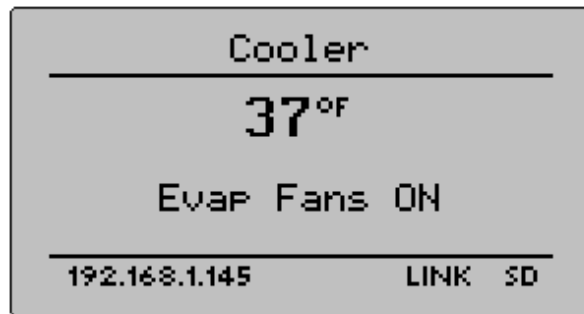
The control box has a bypass button (see Figure 1 and Figure 4). When the bypass button is pressed, the system goes into bypass mode, where all control relays are de-energized. The relays go to their normally closed (NC) positions, and the original control circuit is reestablished. The cooler is now operating on the original thermostat. **If the cooler is serviced by someone unfamiliar with the NRM Cooler Controller, the bypass mode should be used during servicing (see Figure 2).** When the bypass mode is deactivated and the system returns to run mode, there is a delay before the compressor turns on. This delay is set to 2 minutes by default.

Figure 2. Controller Display in Bypass Mode



During normal operation, the controller displays the current temperature and operating mode (See Figure 3.)

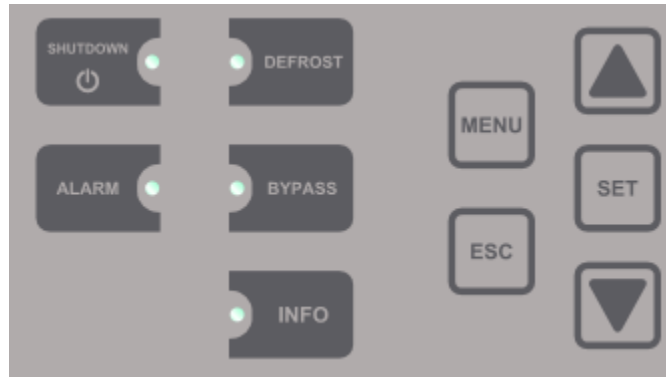
Figure 3. Controller Display in Normal Operation



Using the Keypad

The keypad layout of the CoolTrol Cooler Controller is shown in Figure 4.

Figure 4. Keypad Layout



These keys and their functions are described in the table below.

Table 1. CoolTrol Controller Keys and Functions

Key Name	Description
Shutdown	Press to start or end a timed shutdown. The LED is lit when the cooler is in a timed shutdown. If the timed shutdown is starting or ending, the light flashes. If the cooler cannot be shut down at the moment, such as when it is in bypass mode, the light flashes quickly.
Alarm	Press to silence the alarm.
Defrost	Press to manually start or stop a defrost cycle. The LED is lit when the cooler is in a defrost cycle. The LED flashes when a defrost cycle is starting.
Bypass	Press to manually bypass the controller or to put into run mode if bypassed. The LED is lit when the system is in bypass mode. The LED flashes while transitioning from bypass to run mode or vice-versa. Press for 3 Seconds to bypass or put into run mode all controllers in a cooler if Distributed Control is enabled.
Info	Scrolls through a series of screens that display details about the system setup and status. The screens available are: <ul style="list-style-type: none"> • Control probes • Equipment Status • Local probes • Digital inputs • Pilot relays • Onboard relays • 4-20mA inputs

Key Name	Description
	<ul style="list-style-type: none"> • Version info, which displays the firmware version and MAC address • Daily, weekly, monthly runtime percentages. • Door Heat probe and output percentages.
Menu	<p>Scrolls through the menus, where you can view or adjust the controller's operating parameters. Press [▲], [▼], or [MENU] to scroll through the options. Press [SET] to select the menu you want. Move back one screen by pressing the [ESC] key, and continue pressing this key to return to the normal operating screen. When you have finished changing an item, you save the value by pressing the [SET] key. If you decide not to change a value before pressing the [SET] key, press either [MENU] or [ESC] to cancel.</p> <p>See Table 2 for details about the menus. Tables 3-7 describe the functions in each menu.</p>
Escape (ESC)	Cancels the current display.
Up and down arrows (▲, ▼)	Increments and decrements values in the setup menu.
Set	Selects a function, initiates an action, or saves a setting.

Menus Accessible from the Keypad

Table 3 contains the basic user settings, and Table 7 contains the advanced settings.

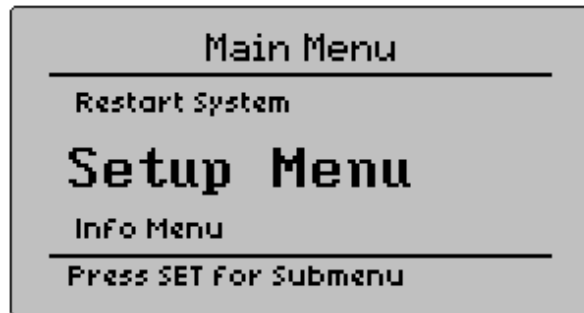
Table 2. Menus

Menu Name	Description
Setup	Adjust the time, date, temperature, setback, LCD backlight, and temperature units. Also assign names to coolers.
Info	<p>Scrolls through a series of screens that display details about the system setup and status. The screens available are:</p> <ul style="list-style-type: none"> • Control probes • Equipment Status • Local probes • Digital inputs • Pilot relays • Onboard relays • 4-20mA inputs • Version info, which displays the firmware version and MAC address • Daily, weekly, monthly runtime percentages. • Door Heat probe and output percentages. • Remote Site Manager connection status. <p>TIP: For quicker access to these screens, press the [INFO] key. Then use the up and down arrow keys to scroll to the screens you want to view.</p> <p>Some screens are not displayed if that functionality has been disabled.</p>
Test	Tests the solenoid, evaporator fan, defrost, economizer, and coil. Also view the relay outputs, coil temperature, and onboard relay outputs. Tests start with all of the equipment shut off, and all short cycle safeties are disabled.
Network	Adjusts the network settings for the system.
Advanced	Adjusts settings related to the cooler system, such as fan delay times, defrost, destratification cycles, shutdown, shutoff, bypass, alarms, and economizer enable and disable.
Manual Defrost	Starts or Stops a defrost cycle.
Restart	Restarts the system.

Setup Menu

To access the settings in the Setup menu:

1. Press **[MENU]**. The **Setup Menu** displays by default. The active menu in the list displays in large letters in the center of the screen.



2. Press **[SET]** to go to the **Setup Menu**.



3. Follow the steps in the table below to adjust the setting you selected.

To exit the Setup menu, press **[ESC]**, or just wait a minute, and the controller will return to normal operation.

Table 3. Setup Menu Settings

To adjust this:	Do this:
Time	<ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Time." Then press [SET]. 2. Use the up and down arrow keys to adjust the hour. Press [SET] to move to the minutes, and use the up and down arrow keys to adjust. Then press [SET] and repeat to set the seconds. 3. When you are finished, press [SET] to save the time.
Date	<ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Date." Then press [SET]. 2. Use the up and down arrow keys to adjust the month. Press [SET] to move to the day, and use the up and down arrow keys to adjust. Then press [SET] and repeat to set the year. 3. When you are finished, press [SET] to save the time.
Daylight Savings	<ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Daylight Savings." Then press [SET]. 2. Daylight savings time is enabled by default. Press the down arrow to "Disabled" to deactivate this setting. Then press [SET] to select and save your change.
Time Zone	<ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Time Zone." Then press [SET]. 2. By default, the controller is set to Eastern. Press the down arrow repeatedly to find your time zone. The options available are: <ul style="list-style-type: none"> • Eastern • Atlantic • UTC-3:30 • UTC-3:00 • UTC-2:00 • UTC-1:00 • UTC • Samoa • Hawaii • Alaska • Pacific • Mountain • Central <p>When you find your time zone, press [SET] to select and save it.</p>

To adjust this:	Do this:
Setpoint	<p>This sets the operating temperature. The default setting is 38° F.</p> <p>NOTE: When controlling an air defrost, the Setpoint is limited to a minimum setting of 32°F.</p> <p>To adjust the Setpoint:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Setpoint." Then press [SET]. 2. Use the up and down arrow keys to adjust the temperature of the cooler. Press [SET] to save the new temperature setting.
Differential	<ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Differential." Then press [SET]. 2. Use the up and down arrow keys to adjust the temperature differential value. Press [SET] to save your changes.
Setback Diff	<p>The additional degrees that the cooler is set back. When the setback differential is set to OFF, the cooler is shut off.</p> <p>To adjust the setback differential:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Setback Diff." Then press [SET]. 2. Use the up and down arrow keys to adjust the setback differential value. Press [SET] to save your changes.
Setback – Monday Setback – Tuesday Setback – Wednesday Setback – Thursday Setback – Friday Setback – Saturday Setback – Sunday	<p>Sets up the daily schedule for the setback for the cooler's temperature and the Novelty Shutoff.</p> <p>To set up the setback schedule:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Setback," for the desired day of the week. Then press [SET]. 2. Set the store's close time by using the up and down arrow keys to adjust the hour. Press [SET] to move to the minutes, and use the up and down arrow keys to adjust. When you are finished, press [SET] to move to the store's open time. 3. Set the store's open time by using the up and down arrow keys to adjust the hour. Press [SET] to move to the minutes, and use the up and down arrow keys to adjust. When you are finished, press [SET] to move to the Setback setting. 4. The Setback setting is disabled by default. To retain this setting, press [SET] to move to the next setting. Otherwise, to enable setback, press the down arrow key to select Enabled. Then press [SET] to move to the Novelty Shutoff setting. 5. The Novelty Shutoff (N.S.) setting is disabled by default. To retain this setting, press [SET] to move to the next setting. Otherwise, to enable setback, press the down arrow key to select Enabled. Then press [SET] to save your change and move to the Shutoff setting. 6. When you are finished, press [SET] to save all of your setback settings

To adjust this:	Do this:
	<p>for the day selected.</p> <p>7. Repeat the above steps to set the setback schedule for another day.</p>
Copy Setback Schedule	Copies the Monday configuration to the rest of the week.
Setback Date 1 Setback Date 2 Setback Date 3 Setback Date 4 Setback Date 5 Setback Date 6 Setback Date 7	<p>Sets up the date range setback schedules for the setback of the cooler's temperature. Each setting has a starting day/month, ending day/month, an enable, and an option to turn the cooler off instead of setting the temperature back.</p> <p>To set up the setback schedule:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Setback," for one of the desired settings. Then press [SET]. 2. Set the start date by using the up and down arrow keys to adjust the month. Press [SET] to move to the day, and use the up and down arrow keys to adjust. When you are finished, press [SET] to move to the end date. 3. Set the end date by using the up and down arrow keys to adjust the month. Press [SET] to move to the day, and use the up and down arrow keys to adjust. When you are finished, press [SET] to move to the enable setting. 4. This date range setting is disabled by default. To retain this setting, press [SET] to move to the next setting. Otherwise, to enable setback, press the down arrow key to select Enabled. Then press [SET] to move to the Novelty Shutoff setting. 5. The Cooler Off setting is disabled by default. This turns the cooler off during the date range instead of setting back the temperature. To retain this setting, press [SET] to move to the next setting. Otherwise, to turn the cooler off during this date range, press the down arrow key to select Enabled. Then press [SET] to save your change and move to the Shutoff setting. 6. When you are finished, press [SET] to save these date range setback settings. 7. Repeat the above steps to set the schedule for range of dates.
Cooler Name	<p>A list of names for the controlled cooler.</p> <p>To choose a cooler name from the list:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Cooler Name." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the name you want. Then press [SET] to select and save the name. <p>If you want to create a unique name for the cooler, select Custom Name from Setup menu. See the next row of this table for further instructions.</p>
Custom Name	Creates a name for the cooler using up to 20 characters.

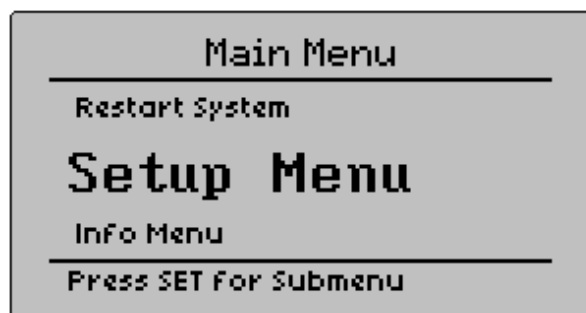
To adjust this:	Do this:
	<p>To create a custom cooler name:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Custom Name." Then press [SET]. 2. Use the up and down arrows to scroll through the alphabet and number list to create the first character of the custom name. Use [SET] to move to the next character in the name and [MENU] to move to the previous character. 3. Continue repeating step 2 until you have completed creating the custom name for the cooler. Then press [SET] to save the cooler name.
LCD Backlight	<p>Sets the behavior of the display backlight to either On, Off, or Timed. The Timed option turns the on backlight for two minutes.</p> <p>To set the LCD backlight:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "LCD Backlight." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Temperature Units	<p>Sets the unit of temperature to either Fahrenheit or Celsius with or without decimal points.</p> <p>To set the temperature units:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Temperature Units." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Remote Settings	<p>Allows settings changes to be made via the local web interface. Options are "Allowed", "Not Allowed", and "60 Minutes". The default is "Allowed".</p> <p>The "60 Minutes" option allows settings changes to be made for one hour from the time this option is selected, after which it changes to "Not Allowed".</p>

Info Menu

You can access the Info Menu in two ways: by pressing the **[MENU]** key or by pressing the **[INFO]** key.

To access the Info Menu through the **[MENU]** key:

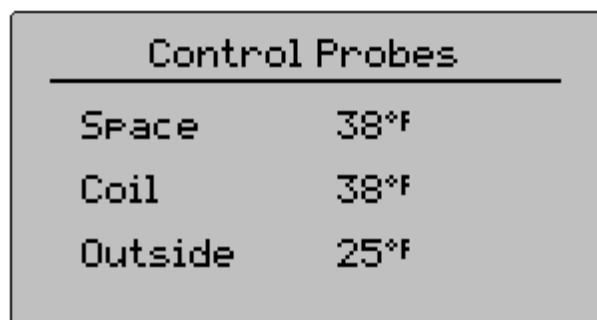
1. Press **[MENU]**. The **Setup Menu** displays by default. The active menu in the list displays in large letters in the center of the screen.



2. Press the down arrow key until the **Info Menu** appears in large letters.



3. Press **[SET]**. The **Control Probes** screen displays.



4. Press the up and down arrow keys scroll through the setting screens.

To view settings in the Info Menu through the **[INFO]** key:

1. Press **[INFO]**. The **Control Probes** screen displays.

Control Probes	
Space	38°F
Coil	38°F
Outside	25°F

2. Press the up or down arrow keys to scroll through the screens.

To exit the Info Menu from either location, press **[ESC]**, or just wait a minute, and the controller will return to normal operation.

Cooler	
36°F	
192.168.1.145	LINK SD

Table 4. Info Menu Screens

Menu Item	Description
Control Probes	View the space, coil, and outside temperatures used for control. If there are multiple space temperatures, the average of the temperatures is displayed. For multiple coil temperatures, the lowest temperature is displayed.
Equipment Status	View if the evaporator fans, cooling, defrost heat and economizer are on or off. If compressor feedback is enabled, "(CP)" will appear next to the solenoid status when the compressor is on.
Local Probes	View the temperatures for the physical probes connected to the controller. <ul style="list-style-type: none"> • P1—Space temperature 1 • P2—Space temperature 2 • P3—Coil temperature 1 • P4—Coil temperature 2 • P5—Outside temperature

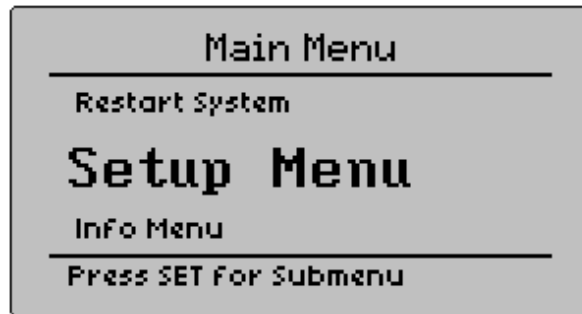
Menu Item	Description
Digital Inputs	Shows the state of each digital input, either open or closed. Five inputs are displayed: <ul style="list-style-type: none"> • Input 1—Shutdown button • Input 2—Bypass switch • Input 3—Door sensor • Input 4—Compressor on/off feedback. • Input 5—Not used at this point but recorded, so these can be used for testing or monitoring if needed.
Pilot Relays	View the state of the MAIN, SOL, EFAN, DFRST, and ECON pilot relays from this screen. NOTE: The actual state of the relays is displayed, not the state of what is being controlled.
Onboard Relays	OBR1 (alarm) and OBR2 (night shutoff)
4-20mA Inputs	The top line for each input shows the milliamp signal transmitted from the transducer. The bottom line shows the engineering units if set up. Two inputs are displayed.
Door Heat Control	View Dew Point probe values, and Door Heat power %, if enabled.
Version Info	Firmware version, Hardware revision, and MAC address of the Ethernet interface. The MAC address is also used as the serial number for the CCS2.
RSM Status	The top line shows the RSM configuration. The 2 nd line shows the connection status if enabled. The bottom line shows the IP address and port of the server that the controller is contacting, or connected to. **
Statistics info	Daily, weekly, monthly runtime percentages. The number of screens displayed is dependent on the device configuration.

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Test Menu

From the Test Menu, you can test the solenoid, evaporator fan, defrost, and economizer. To start a test:

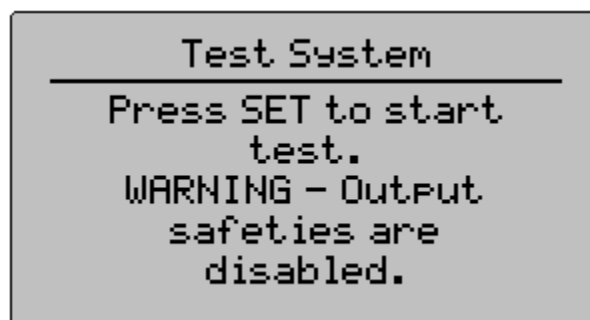
1. Press **[MENU]**. The **Setup Menu** displays by default. The active menu in the list displays in large letters in the center of the screen.



2. Press the down arrow key until the **Test Menu** appears in large letters.



3. Press **[SET]** to select the **Test Menu**.



4. Press **[SET]** again to start the test. At this point, all of the equipment will turn off. The PWM outputs used with the Door Heat control option are run at 60% and 70%.

```

Test System
-----
Starting Test
System...

```

```

Test System
-----
Sol      off    Coil
Efan     off    41°F
Dfrst    off    Space
Econ     off    42°F

```

5. Press **[Menu]** to switch between the equipment outputs and on-board relays.

```

Test System
-----
OBR1  off
OBR2  off

```

6. Follow the steps in the table below to adjust test each output.

To exit the Test Menu, press **[ESC]**, and the controller will return to normal operation. The test will time out after 45 minutes of inactivity, and the controller will return to normal operation.

If compressor feedback is enabled, "CP" will appear above the coil temperature if the compressor is running.

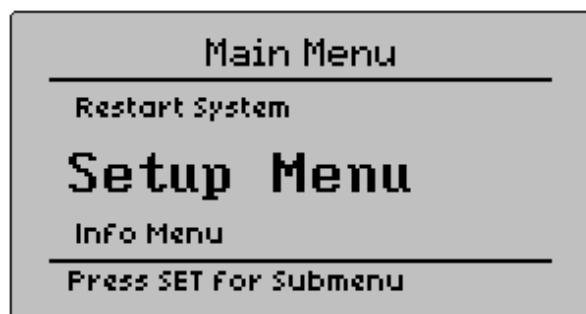
Table 5. Test Menu Settings

Setting Name	Description
Test System	<p>Manually tests each output.</p> <p>Warning: All short cycle safeties are disabled.</p> <p>To run a test from the Test Menu:</p> <ol style="list-style-type: none"> 1. Press the arrow keys to select the items you want to test: <ul style="list-style-type: none"> • Solenoid • Evaporator fan • Defrost • Economizer <p>Press [SET] to toggle each item on or off. Use the [MENU] key to move between the different sets of output types.</p> <ol style="list-style-type: none"> 2. Press the [ESC] key to end the test. <p>The test mode ends automatically after 45 minutes of inactivity.</p>
Relay outputs	Displays the relay outputs and the coil temperature. Shows the equipment state. The test starts with all of the equipment shut off.
Onboard relay outputs	<p>Displays the onboard relay outputs:</p> <ul style="list-style-type: none"> • OBR1—Alarm output • OBR2—Night shutoff output

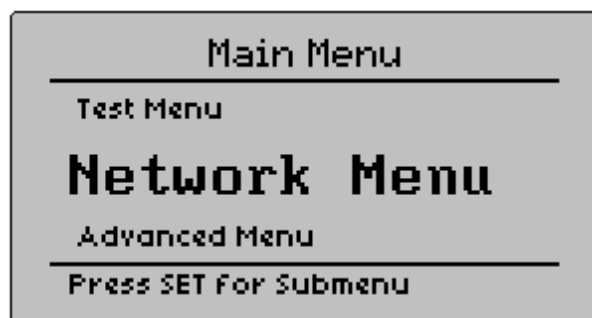
Network Menu

To access the settings in the Network Menu:

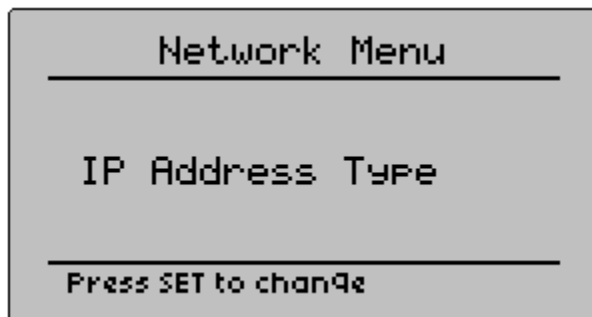
1. Press **[MENU]**. The **Setup Menu** displays by default. The active menu in the list displays in large letters in the center of the screen.



2. Press the down arrow key until the **Network Menu** appears in large letters.



3. Press **[SET]** to display the **Network** menu.



4. Follow the steps in the table below to adjust the setting you selected.

To exit the Network Menu, press **[ESC]**, or just wait a minute, and the controller will return to normal operation.

Table 6. Network Menu Settings

Setting Name	Description
IP Address Type	<p>Sets either a static or DHCP address. The static IP address type is selected by default. Select DHCP to automatically set the IP address for the CCS2.</p> <p>To set the IP address type to DHCP:</p> <ol style="list-style-type: none"> 1. In the Network Menu, and press the down arrow repeatedly until the display reads, "IP Address Type." Then press [SET]. 2. Use the down arrow key to select DHCP. Then press [SET] to save your change. <p>A reboot is requires for a change to take effect.</p>
DHCP Actions	<p>If DHCP is active, this menu item will be available. The following actions can be run:</p> <p>Renew – Renew the DHCP lease, requesting the same address.</p> <p>Displays the onboard relay outputs:</p> <ul style="list-style-type: none"> • Renew – Renew the DHCP lease, requesting the same address. • Release – Restart DHCP without requesting a specific address. • Save to Static – Save the current DHCP assigned address to the static settings. • Request Static – Restart DHCP and request the address set in the static IP configuration.
IP Address	<p>Sets the static IP address for the CCS2.</p> <p>To set the IP address:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "IP Address." Then press [SET]. 2. The first set of numbers, before the first decimal point, are highlighted. Use the up and down arrow keys to adjust the first set numbers. Press [SET] to move to the next set of numbers between the first and second decimal points, and use the up and down arrow keys to adjust. Then press [SET] and repeat this step until all of the number sets are correct. 3. When you are finished, press [SET] to save the IP address. <p>A reboot is requires for a change to take effect.</p>
Netmask	<p>Sets the subnet mask of the IP address.</p> <p>To set the subnet mask:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Netmask." Then press [SET]. 2. The first set of numbers, before the first decimal point, are highlighted. Use the up and down arrow keys to adjust the first set numbers. Press [SET] to move to the next set of numbers between the first and second decimal points, and use the up and down arrow keys

Setting Name	Description
	<p>to adjust. Then press [SET] and repeat this step until all of the number sets are correct.</p> <p>3. When you are finished, press [SET] to save the subnet mask.</p> <p>A reboot is requires for a change to take effect.</p>
Default Gateway	<p>Sets the default gateway used with the CCS2.</p> <p>To set the default gateway address:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Default Gateway." Then press [SET]. 2. The first set of numbers, before the first decimal point, are highlighted. Use the up and down arrow keys to adjust the first set numbers. Press [SET] to move to the next set of numbers between the first and second decimal points, and use the up and down arrow keys to adjust. Then press [SET] and repeat this step until all of the number sets are correct. 3. When you are finished, press [SET] to save the default gateway address. <p>A reboot is requires for a change to take effect.</p>
DNS #1 DNS #2 DNS #3	<p>Sets the IP addresses for the domain name servers (DNSs).</p> <p>To set the IP address for a domain name server:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "DNS #1." Then press [SET]. 2. The first set of numbers, before the first decimal point, are highlighted. Use the up and down arrow keys to adjust the first set numbers. Press [SET] to move to the next set of numbers between the first and second decimal points, and use the up and down arrow keys to adjust. Then press [SET] and repeat this step until all of the number sets are correct. 3. When you are finished, press [SET] to save the IP address. 4. Repeat these steps to change the IP address for another DNS.
SNTP #1 SNTP #2 SNTP #3 SNTP #4 SNTP #5	<p>Sets the IP addresses for the time servers.</p> <p>To set the IP address for a time server:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "SNTP #1." Then press [SET]. 2. The first set of numbers, before the first decimal point, are highlighted. Use the up and down arrow keys to adjust the first set numbers. Press [SET] to move to the next set of numbers between the first and second decimal points, and use the up and down arrow keys to adjust. Then press [SET] and repeat this step until all of the number sets are correct. 3. When you are finished, press [SET] to save the IP address.

Setting Name	Description
	4. Repeat these steps to change the IP address for another time server.
Ethernet Link	<p>Sets the Ethernet link connection type. The default is Auto. Use this setting to change the link speed and duplex type.</p> <p>To change the Ethernet link connection type:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Ethernet Link." Then press [SET]. 2. By default, the Ethernet link is set to Auto. Press the down arrow repeatedly to find your time zone. The options available are: <ul style="list-style-type: none"> • Auto • Disable • 10 Half • 10 Full • 100 Half • 100 Full <p>When you find the Ethernet link connection type you want to use, press [SET] to select and save it.</p> <p>A reboot is required for a change to take effect.</p>
Telnet Timeout Note: Telnet removed in Rev 38 and higher.	<p>Sets the auto logout time of the telnet terminal. The default is 2 minutes.</p> <p>To adjust the telnet timeout:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Telnet Timeout." Then press [SET]. 2. Use the up and down arrow keys to adjust the telnet timeout value. Press [SET] to save your changes.
Telnet Enable Note: Telnet removed in Rev 38 and higher.	<p>Enables or disables the telnet terminal. This setting is enabled by default.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Telnet Enable." Then press [SET]. 2. Use down arrow key to select Disabled. Then press [SET] to save your change.
Web Server	<p>Enables or disables the CCS2's internal Web Server. This setting is enabled by default. To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "WEB Server." Then press [SET]. 2. Use down arrow key to select Disabled. Then press [SET] to save your change.
Wireless API	<p>Enables or disables the CCS2's Wireless Tag API. This API allows the CCS2 to receive data from a Wireless Tag Manager. This setting is enabled by default.</p> <p>This API requires the internal Web Server to be enabled.</p>

Setting Name	Description
	<p>To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Wireless API." Then press [SET]. 2. Use down arrow key to select Disabled. Then press [SET] to save your change.
IP Filtering	<p>Enable to limit traffic allowed to reach the CCS2 unit. This setting is disabled by default. To enable this setting:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "IP Filtering." Then press [SET]. 2. Use down arrow key to select Enabled. Then press [SET] to save your change.
Filter Default	<p>Passes or blocks traffic to the CCS2 unit. If the block is enabled, no traffic will be allowed through unless a trusted IP and subnet mask are enabled. You can also allow traffic from your local network. The default is Allow.</p> <p>To allow or block this setting:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Filter Default." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Trusted IP #1 Trusted IP #2 Trusted IP #3	<p>Sets up to three IP or network addresses to allow traffic to the CCS2 unit.</p> <p>To change the trusted IP address:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Trusted IP #1." Then press [SET]. 2. The first set of numbers, before the first decimal point, are highlighted. Use the up and down arrow keys to adjust the first set numbers. Press [SET] to move to the next set of numbers between the first and second decimal points, and use the up and down arrow keys to adjust. Then press [SET] and repeat this step until all of the number sets are correct. 3. When you are finished, press [SET] to save the trusted IP address. 4. Repeat these steps to change another trusted IP address.
Trusted Mask #1 Trusted Mask #2 Trusted Mask #3	<p>Sets the mask to 255.255.255.255 to limit to only one IP address. You can also set a different mask to allow traffic from a network.</p> <p>To change a trusted mask address:</p> <ol style="list-style-type: none"> 1. In the Network Menu, press the down arrow repeatedly until the display reads, "Trusted Mask #1." Then press [SET]. 2. The first set of numbers, before the first decimal point, are highlighted. Use the up and down arrow keys to adjust the first set numbers. Press [SET] to move to the next set of numbers between the first and second decimal points, and use the up and down arrow keys

Setting Name	Description
	<p>to adjust. Then press [SET] and repeat this step until all of the number sets are correct.</p> <ol style="list-style-type: none"> When you are finished, press [SET] to save the trusted mask address. Repeat these steps to change another trusted mask address.
Allow Local IPs	<p>Allows traffic from the local network. This setting is enabled by default.</p> <p>To enable or disable this setting:</p> <ol style="list-style-type: none"> In the Network Menu, press the down arrow repeatedly until the display reads, "Allow Local IPs." Then press [SET]. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Allow Private IPs	<p>Allows traffic from any private IP address. This setting is enabled by default.</p> <p>To enable or disable this setting:</p> <ol style="list-style-type: none"> In the Network Menu, press the down arrow repeatedly until the display reads, "Allow Private IPs." Then press [SET]. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
RSM Enable	Enables or disables the system from connecting to the RSM service. **
RSM Service	Normal or No Data. Normal mode sends data every 10 seconds. No Data mode establishes a connection but doesn't send data unless requested.
RSM Units	Sets the temperature units used with RSM only. Options are Fahrenheit, Celsius, Celsius x10, Kelvin, Internal (Kelvin x10).
RSM Write Enable	Limits the ability to make remote settings changes via RSM.
RSM Server IP #1-4	Sets the IP addresses for the RSM servers.
RSM Server Port #1-4	Sets the TCP ports for the RSM service. If set to 0, the default of 6102 is used.
Modbus TCP Enable	Enables or disables the Modbus TCP server on the CCS2. Default is Disabled.
Modbus Units	Sets the temperature units used with Modbus TCP only. Options are Fahrenheit, Celsius, Celsius*10, Kelvin, Internal (Kelvin*10).
Modbus Write Enable	Limits the ability to make remote settings changes via Modbus TCP.
Modbus Port	<p>Sets the TCP port for the Modbus TCP service. If set to 0, the default of 502 is used.</p> <p>A reboot is required for a setting change to take effect.</p>

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Setting Name	Description
Distributed Control	<p>Enables or disables synchronized operation between CCS2 controllers. The default is disabled.</p> <p>Shutdown, Defrost, Bypass, and Outside temperature are synchronized between controllers with the same Cooler ID.</p>
Cooler ID	Identifies the cooler that a controller is part of for Distributed Control.
Point ID	Identifies the individual controller within a cooler for Distributed Control.
Zone ID	Identifies the zone that a controller is part of within a cooler for Distributed Control.
Group ID	Identifies a group of coolers for Distributed Control.
Out Temp Sharing	<p>Configures the sharing of the outside temperature between controllers. The options available are:</p> <ul style="list-style-type: none"> • Enabled • Disabled • Local Priority • Local Only • Remote Only <p>This feature requires that Distributed Control be enabled. If one or more CCS2 controllers have an outside temperature probe connected, the temperature will be shared between the controllers. If multiple temperatures are received by a controller, the coldest value will be used. The Local Priority setting will use the local outside temperature probe unless it is not present.</p>
Comp Sync	<p>Compressor Synchronization. Configures the coordination of compressors starting and stopping in a zone.</p> <p>The options available are:</p> <ul style="list-style-type: none"> • Disabled • Master • Slave • Delay <p>This feature requires that Distributed Control be enabled. The Cooler ID and Zone ID need to be the same for the synchronized compressors.</p> <p>If a Master starts, all Masters and Slaves Start. Starts between different compressors are delayed by a few seconds. The cooling runs until ALL Masters are satisfied. (There is a low limit on individual units. If the</p>

Setting Name	Description
	<p>temperature goes too far below the setpoint, cooling is halted on that unit as a safety.)</p> <p>A slave can start and stop as long as no other Master is running. If a Master is running, the Slave will run until the Master stops.</p> <p>The Delay setting does not coordinate compressor starts. It prevents compressors in the same zone from starting at the same time.</p>
Start Delay	<p>Compressor Start Delay in Seconds. Delays the start of a Master, Slave or Delay compressor after any compressor in the same zone starts.</p> <p>Default is 0 Seconds. Range is 0 – 600 Seconds.</p> <p>The Delay is enforced after every compressor start in a zone. This requires Comp Sync to be functioning.</p>
Lag Delay	<p>Compressor Lag in Minutes. Delays the start of a Master or Slave compressor after a Master in the same zone starts.</p> <p>Default is 0 Minutes. Range is 0 – 60 Minutes.</p> <p>This is usually used in Multi-Master applications. The Delay is enforced only after the 1st Master to start in a zone. A 2nd or 3rd Master will both start after Lag Delay. This requires Comp Sync to be functioning.</p>

Advanced Menu

To access the settings in the Advanced Menu:

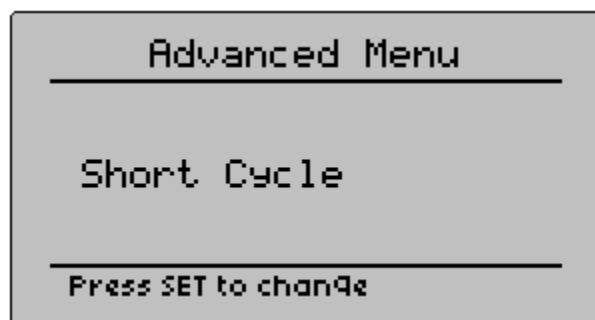
1. Press **[MENU]**. The **Setup Menu** displays by default. The active menu in the list displays in large letters in the center of the screen.



2. Press the down arrow key until the **Advanced Menu** appears in large letters.



3. Press **[SET]** to display the **Advanced Menu**.



4. Follow the steps in the table below to adjust the setting you selected.

To exit the Advanced Menu, press **[ESC]**, or just wait a minute, and the controller will return to normal operation.

Table 7. Advanced Menu Settings

Setting Name	Description
Short Cycle	<p>The time the compressor must remain off before it can be restarted. The default is 2 minutes.</p> <p>To adjust the short cycle:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Short Cycle.” Then press [SET]. 2. Use the up and down arrow keys to adjust the short cycle value. Press [SET] to save your changes.
Min Runtime	<p>The minimum time that the compressor must run before it can be turned off. The default is 2 minutes.</p> <p>To adjust the minimum runtime:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Min Runtime.” Then press [SET]. 2. Use the up and down arrow keys to adjust the minimum runtime value. Press [SET] to save your changes.
Auto Diff Adjust	<p>This algorithm automatically increases the Differential (up to 3°F) if compressor runtimes are too short. This setting is enabled by default.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Auto Diff Adjust.” Then press [SET]. 2. Use down arrow key to select Disabled. Then press [SET] to save your change.
Off Cycle Adjust	<p>This algorithm automatically increases the Differential (up to 3°F) if the cooling off cycles are consistently shorter than 4 minutes. This setting is enabled by default. If both “Auto Diff Adjust” and “Off Cycle Adjust” are enabled, the maximum differential increase is limited to 5°F.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Off Cycle Adjust.” Then press [SET]. 2. Use down arrow key to select Disabled. Then press [SET] to save your change.
Sol Fan Delay	<p>The minimum time that the evaporator fans must continue running after a cooling cycle stops. The default is 30 seconds.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Sol Fan Delay.” Then press [SET]. 2. Use the up and down arrow keys to adjust the delay value. Press [SET] to save your changes.

Setting Name	Description
ED Max Fan Delay	<p>The maximum time that the evaporator fans are kept off at the start of a cooling cycle in an electric defrost application (also known as refreeze time). The default is 75 seconds.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “ED Max Fan Delay.” Then press [SET]. 2. Use the up and down arrow keys to adjust the delay value. Press [SET] to save your changes.
Dstrat Off Time	<p>Sets the time between destratification cycles. The default is 7 minutes.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Dstrat Off Time.” Then press [SET]. 2. Use the up and down arrow keys to adjust the destratification off time. Press [SET] to save your changes.
Dstrat On Time	<p>Sets the amount of time that the evaporator fans are run during a destratification cycle. The default is 1 minute.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Dstrat On Time.” Then press [SET]. 2. Use the up and down arrow keys to adjust the destratification on time. Press [SET] to save your changes.
Destrat Cycling	<p>Enables or disables the evaporator fan destratification. This setting is enabled by default.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Destrat Cycling.” Then press [SET]. 2. Use down arrow key to select Disabled. Then press [SET] to save your change.
Fan Cycling	<p>Enables or disables the off cycle evaporator fan control. If disabled, the fans run continuously during the off cycle. This setting is enabled by default.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Fan Cycling.” Then press [SET]. 2. Use down arrow key to select Disabled. Then press [SET] to save your change.
Gravity Mode	<p>Enables or disables defrost. This setting is enabled by default.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Gravity Mode.” Then press [SET].

Setting Name	Description
	<ol style="list-style-type: none"> Use down arrow key to select Disabled. Then press [SET] to save your change.
Stuck Sol Detect	<p>Enables or disables an algorithm that detects if the solenoid valve is stuck open. If it is determined that the valve is stuck open, the solenoid valve is cycled 3 times to attempt to close it. This setting is enabled by default.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> In the Advanced Menu, press the down arrow repeatedly until the display reads, "Stuck Sol Detect." Then press [SET]. Use down arrow key to select Disabled. Then press [SET] to save your change.
Timed Efan - Door	<p>If enabled, the evaporator fans are run for 7 minutes after the door is opened. This requires a door switch be connected to digital input 3. This setting is disabled by default.</p> <p>To enable this setting:</p> <ol style="list-style-type: none"> In the Advanced Menu, press the down arrow repeatedly until the display reads, "Timed Efan - Door." Then press [SET]. Use down arrow key to select Enabled. Then press [SET] to save your change.
Timed Efan - Occ	<p>If enabled, the evaporator fans are run for 7 minutes after occupancy is sensed. This requires an occupancy sensor be connected to digital input 5. This setting is disabled by default.</p> <p>To enable this setting:</p> <ol style="list-style-type: none"> In the Advanced Menu, press the down arrow repeatedly until the display reads, "Timed Efan - Occ." Then press [SET]. Use down arrow key to select Enabled. Then press [SET] to save your change.
Defrost Enable	<p>Enables or disables the ability to cycle off the cooling when the evaporator reaches very cold temperatures. This can occur when the evaporator fans are turned off, or the evaporator encased in ice. This setting is enabled by default.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> In the Advanced Menu, press the down arrow repeatedly until the display reads, "Defrost Enable." Then press [SET]. Use down arrow key to select Disabled. Then press [SET] to save your change.
Defrost Type	<p>Sets either an air or electric defrost. This should be set to the correct type of defrost, whether or not the defrost is being controlled. The default is Air.</p> <p>To change this setting:</p> <ol style="list-style-type: none"> In the Advanced Menu, press the down arrow repeatedly until the display reads, "Defrost Type." Then press [SET].

Setting Name	Description
	<ol style="list-style-type: none"> 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Interval Type	<p>Controls the timing between defrosts. Select from dynamic (runtime), fixed intervals or Real Time Clock (RTC). The runtime interval is based on the compressor runtime. RTC allows up to 8 start times per day to be set. The default is Runtime.</p> <p>To change this setting to Fixed:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Interval Type." Then press [SET]. 2. Use down arrow key to select Fixed. Then press [SET] to save your change.
Thermostatic Dfrst	<p>Applies only to an electric defrost. If enabled, regulates the heating elements to the terminate temperature. This setting is disabled by default.</p> <p>To enable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Thermostatic Dfrst." Then press [SET]. 2. Use down arrow key to select Enabled. Then press [SET] to save your change.
Defrost Interval	<p>Sets the time between defrosts. The default is 2.6 hours.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Defrost Interval." Then press [SET]. 2. Use the up and down arrow keys to adjust the defrost interval. Press [SET] to save your changes.
Dfrst Min Interval	<p>Sets the minimum time between defrosts, if the interval type is Runtime. The default is 4.5 hours. This is used to limit the maximum number of defrosts per day when the cooling is running at a very high percentage. Some typical values are:</p> <ul style="list-style-type: none"> 5.7 hours - 4 defrosts per day. 4.5 hours - 5 defrosts per day. 3.8 hours - 6 defrosts per day. 3.2 hours - 7 defrosts per day. <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Dfrst Min Interval." Then press [SET]. 2. Use the up and down arrow keys to adjust the defrost interval. Press [SET] to save your changes.
Defrost Times 1 - 8	<p>Sets the defrost start times if the interval type is set to RTC. The setting is in Hours and Minutes of the day. If "Not Used" is selected, the time slot is disabled.</p>

Setting Name	Description
	<p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Defrost Time 1.” Then press [SET]. 2. Use the up and down arrow keys to adjust the start time, or select “Not Used”. Press [SET] to save your changes.
Defrost Min Time	<p>Sets the minimum defrost time. The default is 13 minutes.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Defrost Min Time.” Then press [SET]. 2. Use the up and down arrow keys to adjust the minimum defrost time. Press [SET] to save your changes.
Defrost Max Time	<p>Sets an overall maximum time that the defrost cycle can last. The default is 60 minutes.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Defrost Max Time.” Then press [SET]. 2. Use the up and down arrow keys to adjust the maximum defrost time. Press [SET] to save your changes.
Dfrst End Temp	<p>Sets the electric defrost terminate temperature. The default is 60° F.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Dfrst End Temp.” Then press [SET]. 2. Use the up and down arrow keys to adjust the defrost terminate temperature. Press [SET] to save your changes.
Dfrst Drip Time	<p>Sets the amount of extra time to allow water to drip off after ending the heating cycle. Applies to only the electric defrost. The default is 2 minutes.</p> <p>To adjust the defrost drip time:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Dfrst Drip Time.” Then press [SET]. 2. Use the up and down arrow keys to adjust the defrost drip time. Press [SET] to save your changes.
Dfrst Boil Time	<p>Sets the amount of time to allow refrigerant to boil off before starting a heating cycle. Applies to only the electric defrost. The default is 2 minutes.</p> <p>To adjust defrost boil time:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Defrost Max Time.” Then press [SET]. 2. Use the up and down arrow keys to adjust the defrost boil time. Press [SET] to save your changes.

Setting Name	Description
Dual Defrost	<p>This setting enables the independent termination of a 2nd electric defrost heater. This requires a 2nd defrost relay to be installed, connected to the ECON output on the CCS2. Coil Probe #1 will control the 1st heater, and Coil Probe #2 will control the 2nd heater. Both coils need to terminate before cooling is resumed.</p> <p>This setting is disabled by default. To enable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Dual Defrost.” Then press [SET]. 2. Use down arrow key to select Enabled. Then press [SET] to save your change.
Est Dfst Display	<p>Enables or disables display of an “Estimated” defrost. If the controller senses that a defrost clock has initiated an electric defrost, the unit will display “Estimated Defrost”. This option only applies if defrost control is disabled, and the defrost type is set to electric. This setting is enabled by default.</p> <p>To disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Defrost Enable.” Then press [SET]. 2. Use down arrow key to select Disabled. Then press [SET] to save your change.
Display @ Defrost	<p>Sets what to display while a defrost is active. The options are Temperature and Defrost. “Temperature” displays the controlled space temperature that is normally shown. “Defrost” turns off the display of the space temperature. “Defrost” is the default.</p>
Defrost Cancel	<p>If enabled, defrosts are not started if the evaporator has been at high temperatures for an extended time. This does not affect manual defrosts. This setting is enabled by default.</p> <p>To enable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Defrost Cancel.” Then press [SET]. 2. Use down arrow key to select Enabled. Then press [SET] to save your change.
DH Enable	<p>Enables or disables the door heater control functionality. This is disabled by default.</p> <p>To enable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “DH Enable.” Then press [SET]. 2. Use down arrow key to select Enabled. Then press [SET] to save your change.
DH #1 Setting DH #2 Setting	<p>0-6 if the control type is auto, or 0 – 100% if the control type is fixed %. The default is 3.</p>

Setting Name	Description
DH #1 Xtra Heat DH #2 Xtra Heat	Enables Xtra Heat defrost cycles. Settings are Enabled, Disabled, and Default. If set to Default, the Xtra Heat cycle is enabled if the DH Type is set to Freezer, and disabled if the DH Type is set to Cooler.
DH PWM #1 DH PWM #2	Enables or disables the given PWM output to control door heaters.
DH #1 Type DH #2 Type	Sets the door type per output. The options are Cooler or Freezer doors. The defaults are Cooler for DH #1, and Freezer for DH #2.
DH #1 Control DH #2 Control	Sets the control type per output. The options are Auto, Fixed %, On, Off. The default is Auto.
DH #1 Map DH #2 Map	Set the Auto output algorithm to different power output curves. The options are Normal, Lowest, Low, and High, Pass-through. The map setting selects different heat output vs. dewpoint curves. The map name indicates lower or higher heat output. Pass-through is used for freezer type doors, where the door is located within a cooler.
Economizer Enable	Enables or disables the economizer. This setting is disabled by default. To enable or disable this setting: <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Economizer Enable." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Econ Differential	Sets the temperature differential used for the economizer. The default is 2°F. To adjust this setting: <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Econ Differential." Then press [SET]. 2. Use the up and down arrow keys to adjust the temperature differential. Press [SET] to save your changes.
Thermal Storage	Sets the cooler to run at a lower temperature using the Economizer so that the cooler can coast through periods of warmer weather. Please note that if Thermal Storage is enabled, the economizer will run if the cooler is turned off via the setback schedule. The default is 36° F. To adjust the thermal storage temperature: <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Thermal Storage." Then press [SET]. 2. Use the up and down arrow keys to adjust the thermal storage temperature. Press [SET] to save your changes.
TS Follows Setback	If enabled, Thermal Storage will only run during a cooler setback. This setting is disabled by default.

Setting Name	Description
	<p>To enable or disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "TS Follows Setback." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Heat Control	<p>Enables or disables the control of a heater to maintain the controlled space temperature above a temperature based on the Setpoint, Deadband, and Heat Diff.</p> <p>This uses the Defrost Output to control the heating. If the Defrost Output is used for a defrost function, Heat Control cannot be enabled.</p> <p>This setting is disabled by default.</p> <p>To enable or disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Heat Control." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Heat Diff	<p>Sets the differential below the Deadband at which the heat will be turned on. The default setting is 3°F.</p> <p>To adjust the Heating Differential:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Heat Diff." Then press [SET]. 2. Use the up and down arrow keys to adjust the differential. Press [SET] to save the new temperature setting.
Deadband	<p>Sets the cooling to heating deadband. The deadband is the differential below the Setpoint at which the heat is turned off. The default setting is 1°F.</p> <p>To adjust the Heating Differential:</p> <ol style="list-style-type: none"> 1. In the Setup Menu, press the down arrow repeatedly until the display reads, "Deadband." Then press [SET]. 2. Use the up and down arrow keys to adjust the deadband. Press [SET] to save the new temperature setting.
Freeze Protection	<p>If enabled, heat control is used to keep the space temperature above freezing. This is typically used for outdoor coolers in cold climates to prevent freezing of product. If this setting is enabled, the setpoint is limited to a minimum of 34°F. This setting is disabled by default.</p> <p>To enable or disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Freeze Protection." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.

Setting Name	Description
Efans ON with Heat	<p>If enabled, the evaporator fans will run when the heat is turned on. This setting is disabled by default.</p> <p>To enable or disable this setting:</p> <ol style="list-style-type: none"> 3. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Efans ON with Heat.” Then press [SET]. 4. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Shutdown Enable	<p>Enables or disables the cooler shutdown button (external and internal). This setting is enabled by default.</p> <p>To enable or disable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Shutdown Enable.” Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Shutdown Length	<p>Sets the cooler shutdown time. The default is 20 minutes.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Shutdown Length.” Then press [SET]. 2. Use the up and down arrow keys to adjust the shutdown time. Press [SET] to save your changes.
Shutdown Limit	<p>This setting overrides normal maximum shutdown time limit. The options are “Normal” and “Unlimited”.</p>
Shutdown Delay	<p>Enables or disables a slower Shutdown start sequence. This will cause the evaporator fans to be run for a longer time if the refrigeration was running when the shutdown was started.</p>
Setback Enable	<p>A global setting that either enables or disables the cooler temperature setback. This setting is enabled by default.</p> <p>To adjust the setback on a daily basis, use the appropriate setback option for each day in the Setup menu.</p> <p>To enable or disable the global setback setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Setback Enable.” Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Novelty Shutoff	<p>A global setting that enables or disables the Novelty Shutoff output. This setting is enabled by default.</p> <p>To enable or disable the shutoff output globally:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Shutoff Enable.” Then press [SET].

Setting Name	Description
	<ol style="list-style-type: none"> 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Setback Date	<p>A global setting that either enables or disables the date range setback. This setting is disabled by default.</p> <p>To adjust the setback date ranges, use the appropriate setback date setting in the Setup menu.</p> <p>To enable or disable the global setback setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Setback Date." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Bypass Enable	<p>Enables or disables the cooler bypass. This setting is enabled by default.</p> <p>To enable or disable the cooler bypass:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Bypass Enable." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Bypass Button	<p>Enables or disables the keypad bypass button. This setting is enabled by default.</p> <p>To enable or disable the bypass button:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Bypass Button." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Bypass Switch	<p>Enables or disables a bypass switch on digital input 2. This setting is disabled by default.</p> <p>To enable or disable the bypass switch:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Bypass Switch." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Byp Switch Global	<p>When enabled, all CCS2 units with the same cooler ID go into bypass simultaneously. This setting is disabled by default.</p> <p>To enable or disable the bypass switches:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Byp Switch Global." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.

Setting Name	Description
Bypass Door	<p>When enabled, the CCS2 goes into bypass for 10 minutes after the door is opened. Requires a door switch on digital input 3. This setting is disabled by default.</p> <p>To enable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Bypass Door." Then press [SET]. 2. Use down arrow key to select Enabled. Then press [SET] to save your change.
Bypass Occ	<p>When enabled, the CCS2 goes into bypass for 10 minutes after occupancy is sensed. Requires an occupancy sensor on digital input 5. This setting is disabled by default.</p> <p>To enable this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Bypass Occ." Then press [SET]. 2. Use down arrow key to select Enabled. Then press [SET] to save your change.
Probe 1 Type Probe 2 Type Probe 3 Type Probe 4 Type Probe 5 Type	<p>Sets the type of thermistor. The default is 5 K Z Curve.</p> <p>To set a thermistor type:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Probe 1 Type." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the thermistor type you want. Then press [SET] to select and save your change. 3. Repeat these steps to change another thermistor type.
Outside Probe Fn.	<p>Sets an alternate function for the outside probe. Alternate options are Coil 3, Space 3, or Monitor. Monitor is used in RSM applications to report a general purpose temperature point.</p>
Out Temp Sharing	<p>Configures the sharing of the outside temperature between controllers. The options available are:</p> <ul style="list-style-type: none"> • Enabled • Disabled • Local Priority • Local Only • Remote Only <p>This feature requires that Distributed Control be enabled. If one or more CCS2 controllers have an outside temperature probe connected, the temperature will be shared between the controllers. If multiple temperatures are received by a controller, the coldest value will be used. The Local Priority setting will use the local outside temperature probe unless it is not present.</p>

Setting Name	Description
4-20mA IN1 Type 4-20mA IN2 Type	<p>Sets the type and units for the transducers connected to these inputs. The default is 4-20 mA.</p> <p>To change this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “4-20mA IN1 Type,” or 4-20mA IN2 Type.” Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
4-20mA Calibration	<p>Sets the calibration value for the 4-20 mA inputs. The default is 326.</p> <p>To change the calibration value:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “4-20mA Calibration.” Then press [SET]. 2. Use the up and down arrow keys to adjust the calibration value. Press [SET] to save your changes.
Comp. Feedback	<p>Sets the input to use to sense if the compressor is on or off. If a 4-20mA input is selected, a 10% F.S. threshold is used to determine if the compressor is on. The default is disabled.</p>
Cooler Control	<p>Enables or Disables the Cooler Control functionality of the controller. This is used in cases when the unit is used for only Door Heat Control or only remote monitoring. A reboot is required after changing this setting.</p>
Demo Mode	<p>If enabled, simulates the control temperatures so that the unit can be used as a demonstration unit. This setting is disabled by default.</p> <p>To enable or disable demo mode:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Demo Mode.” Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Alarms Enable	<p>A global setting that disables all alarming. This setting is enabled by default.</p> <p>To enable or disable all alarming:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Alarms Enable.” Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Alarm All Hours	<p>If enabled, non-critical alarms can go off at any time. This setting is disabled by default.</p> <p>To enable or disable the non-critical alarms:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, “Alarm All Hours.” Then press [SET].

Setting Name	Description
	2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Alarm Relay Enable	Enables or Disables the onboard alarm relay (OBR1). The default is enabled. To enable or disable the alarm relay: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, " Alarm Relay Enable. " Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
High Alarm Enable	Enables or disables the high-temperature alarming. This setting is enabled by default. To enable or disable the high-temperature alarming: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, " High Alarm Enable. " Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
High Alarm Type	Allows you to choose among auto, fixed, or differential high-temperature alarm points. The default is Auto. To change the settings for the high-temperature alarm points: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, " High Alarm Type. " Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
High Alarm Adjust	If enabled, the high-temperature alarm adjusts for defrost, shutdowns, and setbacks. This setting is enabled by default. To enable or disable this setting: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, " High Alarm Adjust. " Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
High Alarm Mode	Sets the high-temperature alarm to operate in run mode, or run and bypass mode. The default is Run Only. To change the high alarm mode: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, " High Alarm Mode. " Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
High Alarm Setpoint	Adjusts the setpoint for a fixed high-temperature alarm. The default is 46° F. To adjust the high alarm setpoint: 1. In the Advanced Menu , press the down arrow repeatedly until the

Setting Name	Description
	display reads, “ High Alarm Setpoint. ” Then press [SET] . 2. Use the up and down arrow keys to adjust the high alarm setpoint. Press [SET] to save your changes.
High Alarm Diff	Sets the temperature differential for a differential type high-temperature alarm. The default is 5° F. To adjust the high alarm differential: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, “ High Alarm Setpoint. ” Then press [SET] . 2. Use the up and down arrow keys to adjust the high alarm differential value. Press [SET] to save your changes.
High Alarm Time	Sets the high-temperature time for a fixed type high-temperature alarm. The default is 60 minutes. To adjust this setting: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, “ High Alarm Time. ” Then press [SET] . 2. Use the up and down arrow keys to adjust the high-temperature time. Press [SET] to save your changes.
Low Alarm Enable	Enables or disables the low-temperature alarming. This setting is enabled by default. To enable or disable the low-temperature alarming: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, “ Low Alarm Enable. ” Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Low Alarm Type	Allows you to choose among auto, fixed, or differential low-temperature alarm points. The default is Auto. To change the settings for the low-temperature alarm points: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, “ Low Alarm Type. ” Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Low Alarm Adjust	If enabled, the low-temperature alarm adjusts for defrost, shutdowns, and setbacks. This setting is enabled by default. To enable or disable this setting: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, “ Low Alarm Adjust. ” Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.

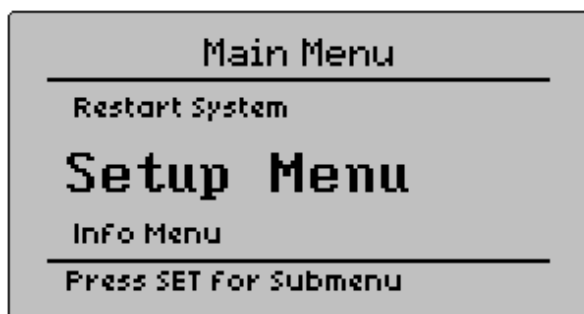
Setting Name	Description
Low Alarm Mode	<p>Sets the low-temperature alarm to operate in run mode, or run and bypass mode. The default is Run Only.</p> <p>To change the low alarm mode:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Low Alarm Mode." Then press [SET]. 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Low Alarm Setpoint	<p>Adjusts the setpoint for a fixed low-temperature alarm. The default is 34° F.</p> <p>To adjust the low alarm setpoint:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Low Alarm Setpoint." Then press [SET]. 2. Use the up and down arrow keys to adjust the low alarm setpoint. Press [SET] to save your changes.
Low Alarm Diff	<p>Sets the temperature differential for a differential type low-temperature alarm. The default is 3° F.</p> <p>To adjust the low alarm differential:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Low Alarm Setpoint." Then press [SET]. 2. Use the up and down arrow keys to adjust the low alarm differential value. Press [SET] to save your changes.
Low Alarm Time	<p>Sets the low-temperature time for a fixed type low-temperature alarm. The default is 20 minutes.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Low Alarm Time." Then press [SET]. 2. Use the up and down arrow keys to adjust the low-temperature time. Press [SET] to save your changes.
Alarm Silence 1	<p>Sets the alarm silence time when the alarm goes off the first time. The default is 1 hour.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Alarm Silence 1." Then press [SET]. 2. Use the up and down arrow keys to adjust the first alarm silence time. Press [SET] to save your changes.
Alarm Silence 2	<p>Sets the alarm silence time when the alarm goes off for a second time. The default is 24 hours.</p> <p>To adjust this setting:</p> <ol style="list-style-type: none"> 1. In the Advanced Menu, press the down arrow repeatedly until the display reads, "Alarm Silence 2." Then press [SET].

Setting Name	Description
	2. Use the up and down arrow keys to adjust the second alarm silence time. Press [SET] to save your changes.
Backlight Flashing	Enables or disables the flashing of the display backlight during an alarm condition. The default is enabled.
Alarm Scheduling	Enables or Disables the Alarm Disable Schedule. The default is disabled. To enable or disable the alarm scheduling: 1. In the Advanced Menu , press the down arrow repeatedly until the display reads, " Alarm Scheduling ." Then press [SET] . 2. Use the up and down arrow keys to scroll through the list to find the setting you want. Then press [SET] to select and save your change.
Alarm – MON Alarm – TUE Alarm – WED Alarm – THU Alarm – FRI Alarm – SAT Alarm – SUN	Sets up the daily schedule for the High Temperature Alarm Disable. To disable the High Temperature alarm during certain time periods: 1. In the Setup Menu , press the down arrow repeatedly until the display reads, " Setback ," for the desired day of the week. Then press [SET] . 2. Set the start of the alarm disable time by using the up and down arrow keys to adjust the hour. Press [SET] to move to the minutes, and use the up and down arrow keys to adjust. When you are finished, press [SET] to move to the end time. 3. Set the end of the alarm disable time by using the up and down arrow keys to adjust the hour. Press [SET] to move to the minutes, and use the up and down arrow keys to adjust. When you are finished, press [SET] to move to the Alarm OFF setting. 4. The " Alarm OFF " setting is disabled by default. To disable the High Temperature alarm during the set time, press the down arrow key to select Enabled. Then press [SET] to save all of your setback settings for the day selected. 5. Repeat the above steps to set the Alarm Disable schedule for another day.
Set Password	Sets a 4 digit passcode that prevents settings from being changed. Set to 0000 to disable.
View All Settings	Enables or Disables the display of normally hidden configuration settings. These are settings that are used to initially configure the system.

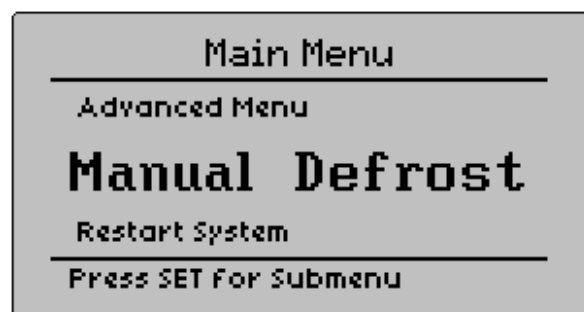
Manual Defrost Menu

The Defrost Menu allows you to start or stop a defrost cycle. To start a defrost:

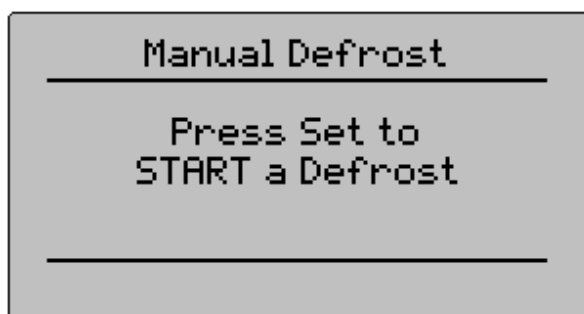
1. Press **[MENU]**. The **Setup Menu** displays by default. The active menu in the list displays in large letters in the center of the screen.



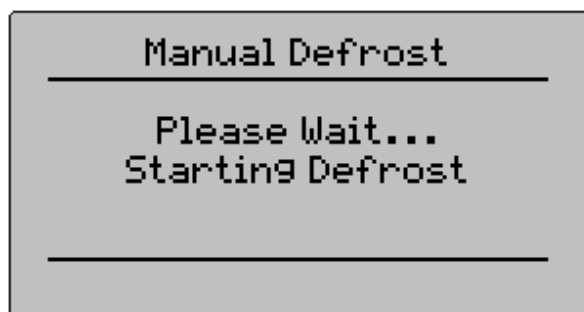
2. Press the down arrow key until the **Defrost Menu** appears in large letters.



3. Press **[SET]** to display the **Defrost Menu**.

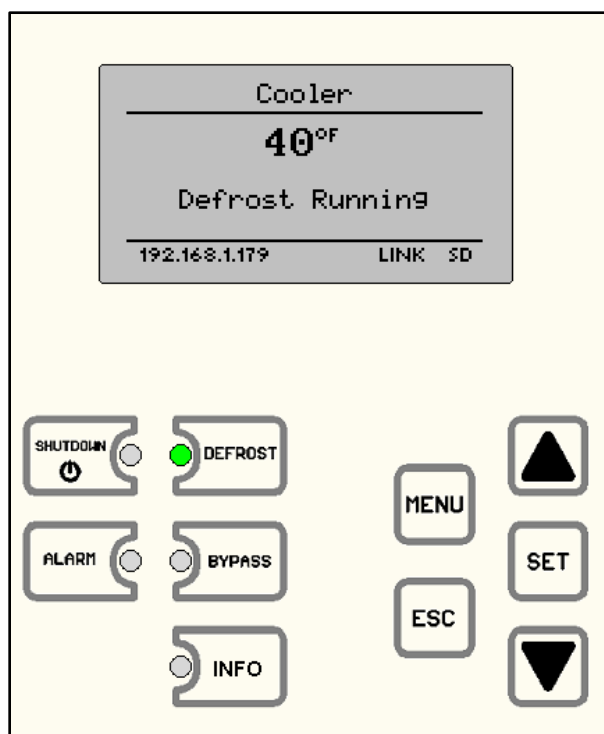


4. Press **[SET]** again to start a defrost. The message below displays:



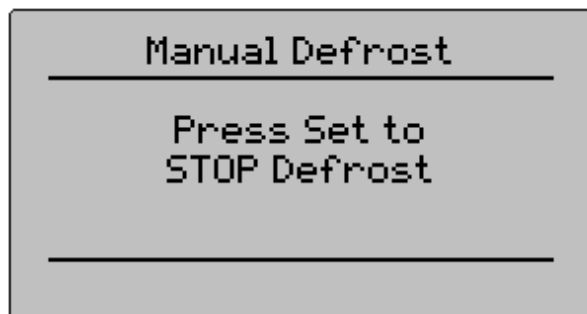
After the defrost starts, the LED at the left of the DEFROST button illuminates.

The main screen displays a "Defrost Running" message. This message continues displaying and the LED at the left of the DEFROST button remains illuminated until the defrost cycle ends.

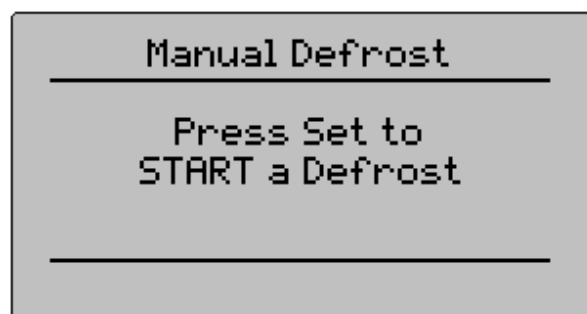
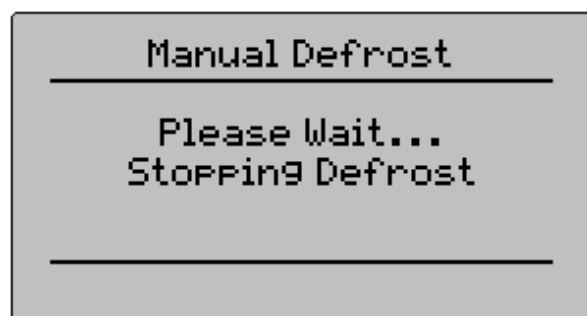


To end a defrost:

1. Press the **DEFROST** button. The following message displays:



2. Press **[SET]**. The following two messages display in order:

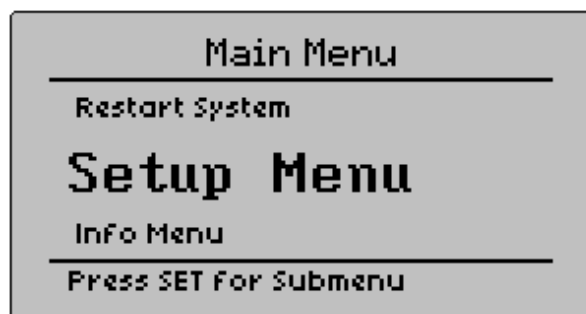


3. To exit the Defrost Menu, press **[ESC]**, or just wait a minute, and the controller will return to the normal display.

Restart System Menu

To access the settings in the Restart System Menu:

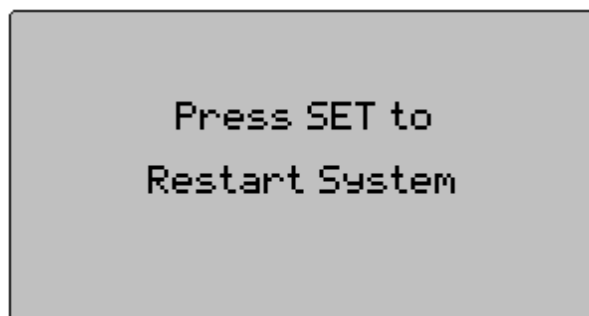
1. Press **[MENU]**. The **Setup Menu** displays by default. The active menu in the list displays in large letters in the center of the screen.



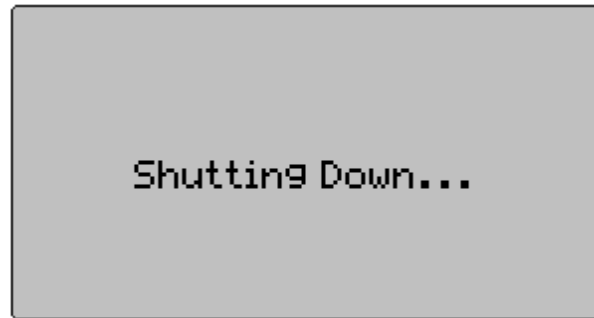
2. Press the down arrow key until the **Restart System Menu** appears in large letters.



3. Press **[SET]** to restart the system. The following message then displays:



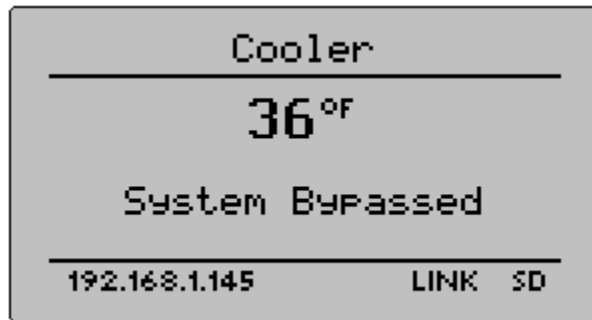
4. Press **[SET]** again to shut down the system. The message below displays:



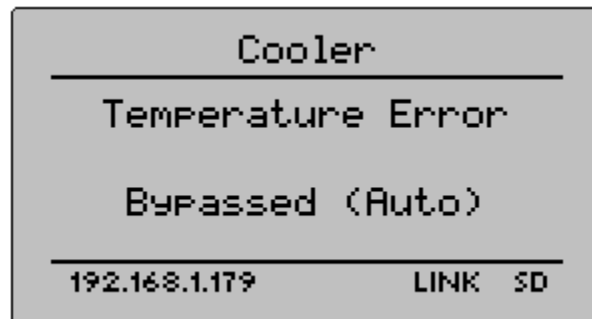
5. The above message displays for a few seconds, and then the system restarts automatically.

Bypass

The CCS2 has a bypass mode, which switches back control to the original thermostat and (whenever possible) defrost clock. This is useful during a controller malfunction or when the cooler is serviced by someone unfamiliar with the controller. The controller also automatically goes into bypass mode if power is removed from the controller or when the controller detects a malfunction (i.e., out-of-range temperature readings from a shorted or loose sensor wire). Bypass mode is controlled by the BYPASS button or an optional bypass switch. When the controller is in bypass mode, the LED next to the BYPASS button is lit and the display indicates that the controller is in bypass mode.



If the controller bypasses itself because of a sensor failure, the system will not go into run mode until the sensor is fixed.



Other Bypass messages that can appear are:

- "Bypassed (IO)" - The output drivers reset. The message should clear after a few seconds.
- "Bypassed (Reboot)" - Several quick reboots have occurred and the controller is delaying going into run mode at startup to prevent the short cycling of equipment equipment.
- "Bypassed (CFG Err)" - The controller started with the settings set to defaults.
- "Bypassed (Timed)" - A Timed Door Bypass or Timed Occupancy Bypass is active.

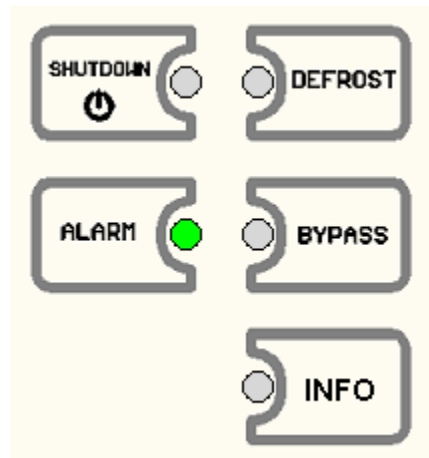
Note: An optional bypass switch can be installed.

The Economizer System

The economizer is allowed to operate when the outside temperature is at least 3° F below the cooler's set point. However, depending on the dynamics of the system, the economizer may not be able to remove all of the BTUs from the cooler by itself, and the compressor will only come on when needed to assist the free-cooling device. As the outside temperature falls, the set point for allowing the mechanical cooling to operate raises automatically to prevent the compressor from running when the economizer should be capable of maintaining the set temperature.

The Alarm System

During an alarm condition, the strobe light flashes, the screen displays the problem, and the LED next to the ALARM button on the CCS2 keypad flashes quickly. The display backlight can be enabled to flash during an alarm, if desired. To silence the alarm, press the ALARM button. During a silenced alarm, the alarm LED is illuminated.



If the alarm condition persists, the strobe light will start blinking again in 1 hour. If the alarm condition continues, the alarm activates every 24 hours.

The alarm system is currently set to signal an alarm under these conditions when configured to auto:

- If the temperature of the cooler is more than 5 degrees plus the differential above the set point for more than 45 minutes (except during defrost or when the cooler shutdown button was pressed).
- If the alarm is configured for NC operation, when the controller is unplugged or loses power, the strobe light will flash. This indicates that the controller is offline (in bypass mode). While in bypass mode, the back-up system takes control, but the back-up defrost clock may have been disabled. If the cooler is in bypass mode for more than a few hours, the defrost clock should be enabled by setting pins to schedule defrosts.
- If a temperature sensor fails: The purpose of this alarm is to alert someone that there is a problem. If the cooler sensor fails, the problem may not be apparent immediately, because the

controller automatically bypasses itself so that the original thermostat (back up) regulates the temperature. This alarm flashes only during normal business hours to inform you of the problem.

Cooler Shutdown

The cooler can be shut down while it is being loaded, or the door is open. A shutdown button is usually located next to the cooler door. In addition, a shutdown button is located on the front panel of the CCS2 unit, and an LED is located at the right of this button. Pressing either of these buttons starts or ends a timed shutdown. The LED is lit when the cooler is in a timed shutdown. If the timed shutdown is starting or ending, the light flashes. If the cooler cannot be shut down at the moment, such as when it is in bypass mode, the light flashes quickly.

The default shutdown time is 20 minutes. After 20 minutes have elapsed, the cooler automatically restarts, and you can press the shutdown button again to shut down the cooler for an additional 20 minutes. After 40 minutes, the cooler must run for 30 minutes before it can be shut down again. The display shows how many minutes are left before the cooler comes on again. While the cooler is in the shutdown state, you can press either shutdown button at any time to return the cooler to normal operation.

Novelty Shutoff Option for Free-Standing Coolers

With this option, you can turn off any number of free-standing display coolers on a seven-day schedule. The time schedule is programmed in the Setup Menu, where you can set up the daily schedule for the setback for the cooler's temperature and the night shutoff. The setback is the temperature setback of the cooler being controlled, and the Novelty Shutoff option turns off standalone coolers at night.

To set up the setback schedule:

1. In the **Setup Menu**, press the down arrow repeatedly until the display reads, "Setback," for the desired day of the week. Then press **[SET]**.
2. Set the store's close time (setback start time) by using the up and down arrow keys to adjust the hour. Press **[SET]** to move to the minutes, and use the up and down arrow keys to adjust. When you are finished, press **[SET]** to move to the setback end time, or press **[Menu]** to move to the previous item.
3. Set the store's open time (setback end time) by using the up and down arrow keys to adjust the hour. Press **[SET]** to move to the minutes, and use the up and down arrow keys to adjust. When you are finished, press **[SET]** to move to the **N.S.** setting, or press **[Menu]** to move to the previous item.
4. The Setback setting is disabled by default. To retain this setting, press **[SET]** to move to the next setting. Otherwise, to disable setback, press the down arrow key to select **Disabled**. Then press **[SET]** to move to the **Shutoff** setting, or press **[Menu]** to move to the previous item.
5. The Novelty Shutoff (N.S.) setting is disabled by default. To retain this setting, press **[SET]** to move to the next setting. Otherwise, to enable the Novelty Shutoff, press the down arrow key to select **Enabled**. Then press **[SET]** to save your change, or press **[Menu]** to move to the previous item.
6. When you are finished, press **[SET]** to save all of your setback settings for the day selected.
7. Repeat the above steps to set the setback schedule for another day.

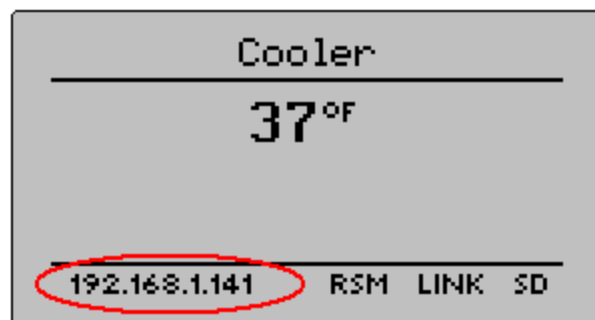
Connectivity

Log File Downloads

While the controller is operating, it records temperature and runtime data in binary format. This data can be retrieved by downloading it to another computer through a FTP client, or copying the data directly from the Micro SD Card. The log files are downloaded as binary files, which can be converted to a text file by a conversion program that is run on a PC. The converted file can then be imported into spreadsheet programs for analysis and graphing.

Internal Web Server

An internal Web Server can be used to view operating information and change settings. To access the Web Server, enter the IP address shown in the lower left hand corner of the display into a Web Browser.



ModbusTCP Server

An internal ModbusTCP server can be used to connect the CCS2 to a building automation system. Please call NRM for more information.

Setup and Test Instructions

Tools Needed for Startup and Post Inspections

- Non-contact A/C voltage probe
- Accurate fast-response temperature probe
- Flat-head screwdriver (medium-size tip)
- Flashlight
- Ladder
- Post-Installation Checklist and Customer Warranty Form
- Operations manual for the controller

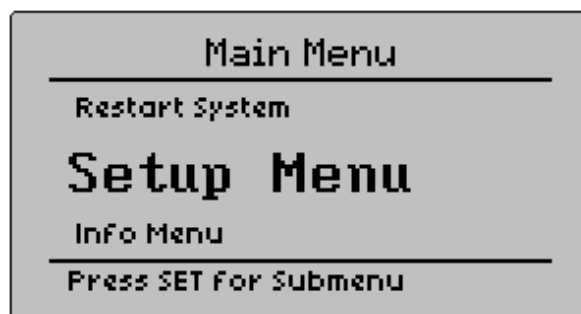
Using the Info Display

The purpose of info display is to give you a quick view of all cooler temperatures and equipment states in real time. This information saves time at startup and helps diagnose problems with the refrigeration equipment.

You can access the Info Menu in two ways: by pressing the **[MENU]** key or by pressing the **[INFO]** key.

To access the Info Menu through the **[MENU]** key:

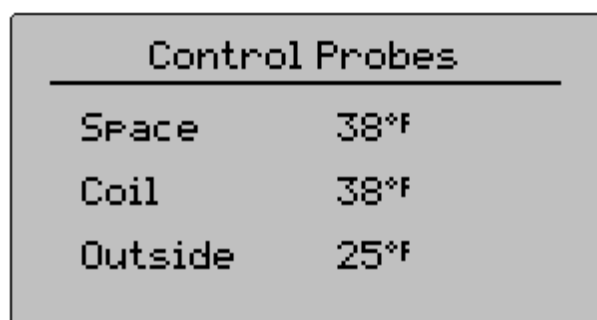
1. Press **[MENU]**. The **Setup Menu** displays by default. The active menu in the list displays in large letters in the center of the screen.



2. Press the down arrow key until the **Info Menu** appears in large letters.



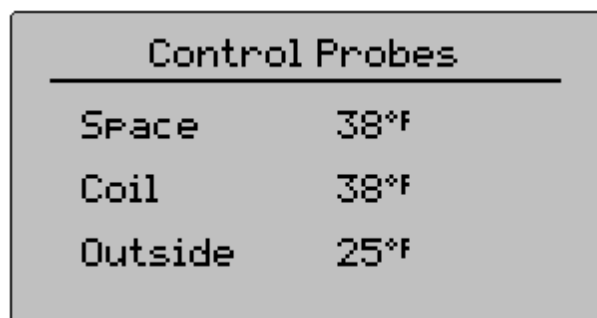
3. Press **[SET]**. The **Control Probes** screen displays.



4. Press the up and down arrow keys scroll through the setting screens.

To view settings in the Info Menu through the **[INFO]** key:

1. Press **[INFO]**. The **Control Probes** screen displays.



2. Press the up or down arrow keys to scroll through the screens.

To exit the Info Menu from either location, press **[ESC]**, or just wait a minute, and the controller will return to normal operation.

Changing the Set Point

1. Press the **[Menu]**.
2. Press **[SET]** to select the **Setup Menu**.
3. Press the down arrow **[▼]** four times until the screen displays **Setpoint**.
4. Press **[SET]** to display the current setpoint.
5. Adjust the setpoint by the up arrow and down arrow keys **[▲]**, **[▼]** to the desired temperature.
6. Press **[SET]** to save your changes.

Tip: Pressing the **[ESC]** key cancels any changes. To cancel changes, however, you must press **[ESC]** before pressing **[SET]**. Otherwise, your changes will be saved.

Post-Installation Inspection Checklist

After you have installed the controller system, review the following checklist and follow the test procedure to make sure all systems are functioning properly.

- ☐ Verify that the controller is in a safe location, away from potential abuse.
- ☐ Check the wiring to ensure that the connections are secure.
- ☐ Verify that the sensors are in the proper locations. Relocate if necessary.
- ☐ Make sure that any cooler penetrations are sealed to prevent condensation from entering through conduits or holes for low-voltage wiring.
- ☐ Verify that the night shutoff cord is in a safe location. Relocate if necessary.
- ☐ Test the controller system using the test procedure outlined in the installation manual.
- ☐ Note any special wiring or control issues that may be useful during future service calls and leave this information with the controller information packet. Important information would be the location of door heater relays that may be hidden from plain sight or special wiring schematics for controlling the cooler. Note any unusual operation of the compressor and evaporator fans, or other malfunctions observed during installation. (Report this to the owner/manager.)
- ☐ Make sure that the Economizer filter is installed correctly.

Contacting Technical Support

If you have questions or need help with installation, call National Resource Management at:

(800) 377-5439, ext. 1

or via email at **service@nrminc.com**

Alarm Event Record

Whenever there is an alarm, the controller displays the reason. This information should be recorded in the table below, along with the time and date of each event, the action taken, and the results.

[illegible]

Two-Year Limited Warranty

WARRANTY

The warranty statement contained herein supersedes all warranty statements dated prior to July 1, 2000.

WARRANTY: NRM warrants to the End User that Equipment manufactured by NRM shall be free from defects in material and workmanship for a period of two (2) years ("Warranty Period"), commencing on the first day such Equipment is installed and successfully tested ("Commissioned") at End User's place of business (the "Installation Location"). This warranty does not apply to the alarm strobe light, or to transformers or relays ("Non-NRM Parts"); Non-NRM Parts are warranted for 90 days. For service requested of NRM apart from this warranty, for travel, transportation, and labor at Installation Location, charges shall be billed to End User at NRM's standard hourly rates, plus costs and expenses. NRM salesmen, distributors, representatives, or agents may have made oral statements about the equipment described herein. Such statements do not constitute warranties, shall not be relied on by the End User and are not part of any contract of sale. The terms of this warranty replace and supersede all such prior statements. **EXCEPT AS SET FORTH ABOVE, NRM MAKES NO WARRANTY, EXPRESS OR IMPLIED, TO END USER OR ANY OTHER PERSON OR ENTITY, AS TO THE EQUIPMENT'S FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, DESIGN, CONDITION, OR ANY OTHER ASPECT OF THE EQUIPMENT, ITS COMPONENTS, OR NRM'S WORKMANSHIP AND MATERIALS; END USER TAKES AND ACCEPTS THE EQUIPMENT AS IS.** By reason of your acceptance of delivery of the Equipment, You agree that the Equipment is in proper operating order, conforms to your specifications, and that You have accepted the Equipment in its condition on delivery as the Equipment described herein.

LIMITATIONS OF REMEDIES: Your remedies for damages due to breach of any warranty set forth herein shall be limited to repair or replacement of non-conforming goods or parts within the Warranty Period. The parties agree that the End User's sole and exclusive remedy against NRM shall be for the repair or replacement of defective parts or goods as provided herein. End User agrees that no other remedy, including but not limited to incidental or consequential damages for lost profits, lost sales, injury to persons or property, or any other incidental or consequential loss, shall be available to it. NRM further disclaims liability for any loss, damage or injury to any person as a result of any defects, latent or otherwise, in the Equipment whether arising from NRM's negligence, application of the law of strict liability, or breach of warranty.

REQUIRED PROCEDURE - YOU MUST FIRST CONTACT DEALER/INSTALLER AND REQUEST TELEPHONIC DIAGNOSTIC ASSISTANCE FROM NRM:

As a condition to NRM's obligations under this warranty, when you suspect a problem with the Equipment, you must initially contact and report the problem to the dealer who installed the Equipment. If the dealer/installer cannot or will not correct the problem, you or your agent (which may or may not be the dealer/installer) must then telephone NRM Diagnostic Assistance (number below) from the Installation Location (1) to report and describe to NRM the nature of the suspected problem, (2) to attempt diagnostic repair of the problem via telephone with NRM's assistance, and (3) if appropriate in NRM's sole discretion, to obtain a Return Authorization ("RA") number from NRM. All Equipment returned to NRM **MUST** be accompanied by an RA number assigned by NRM in order to receive warranty service, repair, or replacement. Additionally, every new and re-manufactured NRM component has affixed to it a 4-digit code, which is used in part to determine and validate the warranty. Any NRM product returned for service without a code-or with a code which has been altered for any reason will be considered out of warranty.

Many of the components that we receive for service are found to have no problem. Please emphasize to your service technicians, that they must call our service department for diagnostic assistance from the **Installation Location**. When it is necessary to send an item to NRM for service, a brief description of the symptoms should be included with the unit; this can save a considerable amount of troubleshooting time.

REPAIR/REPLACEMENT POLICY: During the Warranty Period, defective NRM Equipment for which NRM has assigned an RA number may be returned, freight prepaid, to NRM. NRM will repair or replace at no charge, and return, freight prepaid, such NRM Equipment (or components thereof) that are judged to be defective in materials or workmanship in accordance with the terms of this warranty. A repair under warranty does not extend or renew the original Warranty Period. Our policy is to repair and return warranted Equipment, or to exchange for re-manufactured Equipment or components. At NRM's sole discretion, NRM may replace Equipment returned under this warranty with re-manufactured Equipment or components. We do not send out new Equipment as service repair/replacement of used Equipment. We will in some cases agree to ship re-manufactured replacement components with the understanding that the defective Equipment it is replacing will be returned for core credit at a later date. You will be billed for the full price of the replacement Equipment at the time of shipping and a core credit will be issued when the old Equipment is returned to NRM. In such cases, the **defective Equipment must be returned within 60 days; otherwise, no credit will be given.** Any request for advance shipment of a warranty exchange component must be accompanied by the date code on the defective unit to be returned for credit. If the replacement component that we ship has a new 24-month warranty, we will issue credit only for the unused portion of the warranty on the component returned to us. Advance shipment of a warranty exchange item may result in a cosmetic charge to cover the cost of cleaning, replacing labels, painting, etc.

WARRANTY VOID: This warranty is automatically void and of no effect in the event of defect, damage, injury or failure of the Equipment due to any of the following causes: Acts of God; improper installation; failure to maintain the equipment in accordance with NRM instructions; use of the equipment in any manner other than the use for which NRM has designed and intended the Equipment; attempt to install, repair, replace, move, or tamper with the Equipment by any person other than a NRM authorized employee or agent; modifications or changes to the equipment of any kind or nature; excessive or improper usage; and electrical burnouts or surges. This warranty does not apply to parts or Equipment which have been damaged by accident, lightning, physical abuse, mis-wiring, misapplication, or improper operation. NRM strongly recommends that End User have a qualified professional install an electrical surge suppressor on all electrical service and all circuits to be connected to or with the Equipment.

This writing contains the final expression of the parties' agreement concerning warranties and is a complete and exclusive statement of the terms of the agreement. Parol evidence shall not be admissible to supplement, modify, or add to the terms hereof for any purpose.

INSTRUCTIONS: End User or installing or servicing contractor/dealer:

When replacing a National Resource Management product under warranty, you should rely on your Distributor for prompt and efficient replacement service. If you have obtained an RA number from NRM and you are returning in-warranty product to National Resource Management, send the product, freight prepaid (NRM will not accept COD shipments) to:

National Resource Management, Inc. 800 377-5439 Fax: 844 828-8877
480 Neponset Street, Bldg. 2
Canton, MA 02021

It is very important that you include your name, return address phone number and a description of the problem. If the product date code is older 30 months, include an invoice showing date of sale or installation within the warranty period. NRM will inspect, repair, or replace the product and ship it back freight prepaid. Products that exhibit evidence of abuse, misuse, field damage (water/fire damage, line voltage applied to low voltage terminals, missing parts, etc.), or that have been installed for more than the warranty period are not eligible for warranty repair or replacement.

RETURN MATERIAL FORM

Bill To: _____ Ship To: _____
This form must accompany each individual product being returned - Failure to submit this form with any item will result in immediate return to sender.

Product Information:

Part Number or Part Description: _____

Serial Number: _____ (if applicable)

Disposition information (check one only)

- | | | |
|--|---|---|
| ___ in warranty return or previously replaced item | - | item will not be returned to sender - Credit will be issued on invoice of prior placement shipment less freight. |
| ___ in warranty replacement | - | item will be repaired or replaced and returned to address listed above - No charges will apply. |
| ___ Non - warranty repair | - | item will be repaired and returned to address listed above - Invoice will be issued for the repair cost plus freight. |

NOTICE: Non warranty items which are damaged beyond repair, or those which the repair cost will exceed the cost of a new item will be discarded. Notification of inability to repair will be forwarded for your records.

CUSTOMER REMARKS:

Appendix: Differences between the CCS1 and CCS2

- The CCS1 has a serial port. The CCS2 has a virtual serial port over a USB connection.
- The CCS2 does not have a bypass switch, but there is a bypass button located on the front of the unit. An optional bypass switch can be installed remotely or on the unit.
- The CCS2 is a single-point controller, while the CCS1 could control up to three points.
- On the CCS2, all of the inputs and outputs are protected against short-circuits. When the short circuit is removed, the affected function resumes normal operation.
- The CCS2 operates from a 24 VAC supply, while the CCS1 operates from a 16 VAC supply.
- The CCS2 has two PWM outputs for directly controlling ECM motors, or SSRs for Door Heat control.
- The CCS2 has two 4-20 mA inputs.
- The CCS2 uses an 8 GB SD card for storing log data and settings. If a board fails, the SD card can be moved to another unit and all of the control settings and logs transferred to the new system. An EEPROM also backs up the settings in case the card fails.
- The CCS2 has an Ethernet jack for remote communications and management.
- The CCS2 does not have the additional temperature alarming option.
- The log downloads from the CCS2 are all in binary format. The ccs2decode program is used to convert the binary file to the desired log format.




ALARM MESSAGES

Alarm Message	Possible Cause	Solution
HIGH TEMP. IN COOLER	Cooler door is open.	Close all cooler doors.
	Warm product is close to sensor.	Move warm product away from sensor.
	Fans or compressor are shut off at breaker or switch.	Make sure all equipment is turned on and plugged in. Turn all cooler circuit breakers off and then back on.
	Refrigeration problem.	Call refrigeration mechanic.
	CoolTrol problem.	Put into Bypass. Call NRM.
LOW TEMP. IN COOLER	Cold air entering cooler.	Close all cooler doors.
	Refrigeration problem.	Shut off compressor at the circuit breaker. Call refrigeration mechanic immediately.
	CoolTrol problem.	Put into Bypass. Call NRM.
Any message that includes "TEMPERATURE ERROR" or "SENSOR ERROR"	Failed sensor.	Call NRM.
No message (display is blank)	No power to controller.	Make sure all switches are turned on. Reset circuit breakers.
	Faulty controller.	Call NRM.

Ask about **Remote Site Manager, NRM's cloud-based monitoring platform**, to get alarms instantly to your smartphone or email.

FREQUENTLY ASKED QUESTIONS

How can I change the Cooler setpoint?

1. Press the MENU key.
2. Press the SET key when the Setup menu displays.
3. Press the  key **four times** until the setpoint setting displays. Press SET to see the setpoint.
4. Use the  and  keys to change the setpoint. Then press "Set" to save your changes.

Can my refrigeration technician still service my cooler?

Absolutely! If your refrigeration technician is unfamiliar with the CCS2 system, they can simply bypass it, revert back to mechanical thermostat control, and service your equipment as if CoolTrol was never installed. After successful troubleshooting, your technician simply switches the CCS2 out of Bypass mode, and your settings and energy-saving features are restored.

What if my CCS2 needs service?

If you need service for your CCS2 system, call NRM for phone support or to schedule an appointment for a technician to come to your location. You can also work through your regular service technician. NRM is always happy to provide phone support and parts to your preferred technician.

NRM Tech Support:
800.377.5439 Ext. 1

RETHINK REFRIGERATION

COOLTROL[®] CCS2

Quick Reference Guide



National Resource Management, Inc.

 www.nrm-inc.com

 800.377.5439

 info@nrm-inc.com

COOLTROL[®] CCS2 OVERVIEW

LCD Display Screen

The LCD display provides a real-time snapshot of what your cooler is doing. From current temperature, to door heaters, to evaporator fan status, as well as cooling schedules and compressor runtimes, there's a wealth of data at your fingertips.

Timed Shutdown Button

Safely turn off the refrigeration system for a period of 20 minutes, an ideal way to save energy and ensure worker comfort while performing duties such as loading/unloading, stocking, and taking inventory. The system will automatically turn back on.

Alarm Reset Button

If an alarm is active, read the LCD display then log what the error message is. Consult the alarm message chart to gain clarity on what might be causing the issue. Then press the alarm reset button to clear the alarm and revert the display back to info.

Info Button

The info button allows you to quickly scroll through various metrics associated with your system's performance. Including, but not limited to: Control Probe Readings, Equipment Status, Runtime Percentages, Setback Settings



On-Demand Defrost Button

Manually initiate a defrost whenever you need one. Coils icing up is one of the most common issues that cause damage to refrigeration equipment. And sometimes, the factory instituted defrost schedule isn't optimal.

System Bypass Button

If maintenance or diagnostics is required on the refrigeration equipment, the system bypass button allows the operator to revert the system back to mechanical thermostat control. Press the button a second time to put CoolTrol back in control.

Setup Menu and Keypad

Easily view and adjust settings such as temperature setpoints in the Setup Menu. Press the Menu key then the Set key to enter the Setup Menu. When satisfied with the new setting, press the Set key to exit out of the menu.

Looking for more in-depth instruction on the CCS2 system? Check out:

www.nrminc.com/videos

ECM #13

Replace windows in buildings 34, 35 & 37. Reduce window areas

Savings Calculations

	EXISTING CONDITIONS										PROPOSED UPGRADE							SAVINGS				
BLD	Rate	ECM Code	QTY	Sq Ft Needed	Existing R Value	Proposed R Value	Description	Current Heating MMBTU's	Current Cooling MMBTU's	x	QTY	Sq Ft Needed	Description	Proposed Heating MMBTU's	Proposed Cooling MMBTU's	Notes	x	Heating MMBTU's	Therm Savings	Cooling MMBTU's	kWh Savings	
BUILDING 37	1	1A	176	1,995	2.56	3.56	EXISTING SINGLE PANE WINDOW	96.68	18.70		176	1,995	INSTALL NEW ENERGY EFFICIENT DOUBLE PANE WINDOW	69.56	13.45	Counts and savings calculations are based on drawing take offs and limited site access. If awarded ABT will need to re audit and provide an actual quantity, cost and savings.		27.12	361.62	5.25	179.24	
BUILDING 37	1	1B	115	1,303	2.56	3.56	EXISTING SINGLE PANE WINDOW	63.17	12.22		115	1,303	INSTALL NEW ENERGY EFFICIENT DOUBLE PANE WINDOW	45.45	8.79			17.72	236.29	3.43	117.11	
BUILDING 37	1	1B-2	75	650	2.56	3.56	EXISTING SINGLE PANE WINDOW	31.50	6.09		75	650	INSTALL NEW ENERGY EFFICIENT DOUBLE PANE WINDOW	22.67	4.38			8.84	117.84	1.71	58.41	
BUILDING 37	1	2A	22	303	2.56	3.56	EXISTING SINGLE PANE WINDOW	14.66	2.84		22	303	INSTALL NEW ENERGY EFFICIENT DOUBLE PANE WINDOW	10.55	2.04			4.11	54.84	0.80	27.18	
BUILDING 37	1	6-A	4	88	2.56	3.56	EXISTING SINGLE PANE WINDOW	4.27	0.83		4	88	INSTALL NEW ENERGY EFFICIENT DOUBLE PANE WINDOW	3.07	0.59			1.20	15.95	0.23	7.91	
BUILDING 37	1	1A-TP	176	1,995	2.56	11.04	EXISTING SINGLE PANE WINDOW	96.68	18.70		176	1,995	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	22.42	4.34			74.26	990.14	14.36	490.76	
BUILDING 37	1	1B-TP	115	1,303	2.56	11.04	EXISTING SINGLE PANE WINDOW	63.17	12.22		115	1,303	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	14.65	2.83			48.52	646.97	9.39	320.67	
BUILDING 37	1	1B-2-TP	75	650	2.56	11.04	EXISTING SINGLE PANE WINDOW	31.50	6.09		75	650	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	7.31	1.41			24.20	322.66	4.68	159.92	
BUILDING 37	1	2A-TP	22	303	2.56	11.04	EXISTING SINGLE PANE WINDOW	14.66	2.84		22	303	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	3.40	0.66			11.26	150.16	2.18	74.43	
BUILDING 37	1	6-A-TP	4	88	2.56	11.04	EXISTING SINGLE PANE WINDOW	4.27	0.83		4	88	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	0.99	0.19			3.28	43.68	0.63	21.65	
BUILDING 34	2	W1	288	3,456	2.56	3.56	EXISTING SINGLE PANE WINDOW	167.51	32.40		288	3,456	INSTALL NEW ENERGY EFFICIENT DOUBLE PANE WINDOW	120.52	23.31			46.99	626.55	9.09	310.55	
BUILDING 34	2	W2	30	480	2.56	3.56	EXISTING SINGLE PANE WINDOW	23.27	4.50		30	480	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	16.74	3.24			6.53	87.02	1.26	43.13	
BUILDING 34	2	W1-TP	288	3,456	2.56	11.04	EXISTING SINGLE PANE WINDOW	167.51	32.40		288	3,456	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	38.84	7.51			128.67	1,715.54	24.89	850.30	
BUILDING 35	3	W1	288	3,456	2.56	3.56	EXISTING SINGLE PANE WINDOW	167.51	32.40		288	3,456	INSTALL NEW ENERGY EFFICIENT DOUBLE PANE WINDOW	120.52	23.31			46.99	626.55	9.09	310.55	
BUILDING 35	3	W2	30	480	2.56	3.56	EXISTING SINGLE PANE WINDOW	23.27	4.50		30	480	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	16.74	3.24			6.53	87.02	1.26	43.13	
BUILDING 35	3	W1-TP	288	3,456	2.56	11.04	EXISTING SINGLE PANE WINDOW	167.51	32.40		288	3,456	INSTALL THERMAL PANEL INTO SECTION OF NEW WINDOW	38.84	7.51			128.67	1,715.54	24.89	850.30	
X			1,996	23,461					1,137	220		1,996	23,461			552	107		585	7,798	113	3,865

dTherms	Bldg	kWh
294	37	1,457
243	34	1,204
243	35	1,204

ECM #13

Replace windows in buildings 34, 35 & 37. Reduce window areas

Equipment Information Sheets

THERMOLITE™

Technical Data Sheet

PRODUCT: Thermolite™
EFFECTIVE: January 24, 2020

Description: Thermolite™ is an insulated glazing panel that consists of a foam plastic core bonded on both sides to thermoplastic stabilizers with finished sheets of aluminum on each face. Intended for use in window, glazing, and curtain wall systems, panels are available in thicknesses ranging from 3/4 to 3-1/2 in.

Properties:

Thickness	1 in (nom), standard	
Weight	1.40 psf (+/-), standard	
Core	Expanded Polystyrene (EPS): 2.0 pcf density (Type IX)	Polyisocyanurate (ISO): 2.0 pcf density (Type I)
Stabilizers	Extruded Corrugated Polypropylene	
Sheets (ASTM B209)	3003-H14/24, 3105-H14/24 & H26/28, 5005-H34 Aluminum 0.0125 to 0.032 in	
Texture Finish	Smooth or Stucco-Embossed	
Color Finish (AAMA 2605)	PVDF/Kynar 500®, Polyester, or Anodized	
Thermal Expansion	13.1x10 ⁻⁶ in/in/°F	

R-Values:

	Thickness (in)	R-Value (hr °F ft ² / BTU)		Thickness (in)	R-Value (hr °F ft ² / BTU)
	3/4	2.2 [†]		3/4	2.6 [†]
EPS Core	1	3.3 [*]	ISO Core	1	3.9 [*]
	1-1/2	5.5 [†]		1-1/2	6.6 [†]
	2	7.7 [†]		2	9.3 [†]
	2-1/2	9.8 [†]		2-1/2	12.0 [†]
	3	12.0 [†]		3	14.7 [†]
	3-1/2	14.2 [†]		3-1/2	17.4 [†]

Notes:

- * R-Value based on ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus performed by independent laboratory per ASHRAE 90.1-2010.

2. † Calculated value based on Carpenter Company published R-Value for 2.0 pcf density (Type IX) EPS foam at 75°F.
3. ‡ Calculated value based on Elliot Company published aged R-Value for 2.0 pcf density (Type I) ISO foam.
4. Linear interpolation between values is permitted.

Performance:

Fire Performance (ASTM E84)	Class A (2 in w/ EPS) Flame Spread Index (FSI) = 0 Smoke Developed Index (SDI) = 100	Class A (1 in w/ ISO) Flame Spread Index (FSI) = 15 Smoke Developed Index (SDI) = 350
--------------------------------	--	---

Notes:

1. Surface-burning characteristics are applicable to exterior conditions only and are not applicable to interior conditions.
2. Per International Building Code (IBC), panels shall be separated from the interior of a building with 1/2 in gypsum wallboard or other material tested in accordance with and meeting the acceptance criteria of NFPA 275.

Available Load-Carrying Capacities (R_n / Ω):

0.0125 to 0.015 in Sheets (Double-Sided)

Panel Span (in)	12	18	24	30	36	42	48	54	60
Wind Load (psf)	120*	120*	85	60	50	40	35	30	25

0.022 to 0.024 in Sheets (Double-Sided)

Panel Span (in)	12	18	24	30	36	42	48	54	60
Wind Load (psf)	120*	120*	100	80	65	60	50	45	40

0.027 to 0.032 in Sheets (Double-Sided)

Panel Span (in)	12	18	24	30	36	42	48	54	60
Wind Load (psf)	120*	120*	100	85	70	65	55	50	45

Notes:

1. Capacities are calculated for a 1 in (nom), standard panel with EPS core. Contact Laminators Technical Support for capacities of panels less than 1 in.
2. Double-Sided refers to matching sheet thickness on each face (typical construction). For Single-Sided panels (i.e. non-matching sheet thickness), refer to the chart corresponding to the lesser sheet thickness for capacities.
3. Panel Span applies to shortest dimension of finished panel.
4. Capacities are governed by the 2010 Aluminum Design Manual (ADM) using a minimum Factor of Safety = 1.65 for yield strength.
5. Strength conditions govern for given capacities; therefore, 2015 International Building Code (IBC) deflection limits have been met. Capacities noted * are capped at 120 psf.
6. Project-specific Components and Cladding wind loads (Required Strength, R_a) shall not exceed Available Load-Carrying Capacities (Allowable Strength, R_n / Ω) for given spans. Wind loads are to be calculated per ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures.
7. Testing was performed in conjunction with ASTM E529 Standard Guide for Conducting Flexural Tests on Beams and Girders for Building Construction.



PRODUCT SUMMARY & PERFORMANCE DATA

5000CW Series - Casement, Awning, Hopper, & Fixed - Aluminum Window

AAMA 101/I.S. 2/A440-08	Outswing Casement	Inswing Casement	Project-out Awning	Project-in Hopper	Fixed Lite
AAMA Rating	C - CWPG80	C - CWPG50	P - CWPG100	P - CWPG40	F - CW100
Test Size	2'8" x 5'0"	2'8" x 5'0"	4'0" x 2'8"	4'0" x 2'8"	5'0" x 5'0"
Frame Depth	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"
Insulated Glass Thickness	1"	1"	1"	1"	1"
Air Infiltration @ 1.57	0.01	0.03	0.01	0.01	0.01
Water Test Pressure (psf)	12.0	7.5	12.0	6.0	12.0
Structural Load (psf)	120	75	150	60	150
U-Value range	0.44 - 0.65	0.44 - 0.65	0.45 - 0.66	0.45 - 0.66	0.28 - 0.56
SHGC range	0.17 - 0.52	0.17 - 0.52	0.17 - 0.52	0.17 - 0.52	0.21 - 0.66
Condensation Resistance range	31 - 34	31 - 34	31 - 34	31 - 34	36 - 40
STC Range	30-39	30-39	30-39	30-39	28-37
OITC Range	24-32	24-32	24-32	24-32	22-31

The Wintech Series 5000 consists of 2 1/2" frame heavy commercial aluminum windows with poured urethane thermal barriers. Series 5000 consists of Outswing and Inswing casements, Awning, Hopper and Fixed Lite windows. All windows have the versatility of mulling and stacking. Windows may be supplied pre-assembled with common jamb mullions and continuous headers and sills. These windows are available with equal leg frames and 1" new construction fin frames for replacement or new construction applications. The windows are supplemented with a complete line of panning, trim, mullions, and other accessories

1.7.20



518-899-9000 • 518-899-4104fx

www.windowtechsystems.net



ESCO A
Cogeneration

Savings Calculations

NORMALIZED DATA				SEE NOTE 1		SEE NOTE 1		MAX OPERATING KW = 750		SEE NOTE 1		SEE NOTE 1	
				AVERAGE OPERATING KW = 594									
MONTH	Sum of STEAM MLB	Sum of ELECT KWH	Max of ELECT KWH2	Sum of COGEN OPERATION (MLB)	Sum of COGEN OPERATION (KWH)	Sum of COGEN NG MCF	Sum of SUPPLIMENTAL HEAT MLB	Sum of BOILER NG MCF	Sum of PURCHASED KWH	Sum of Chiller kW	Max of Chiller kW2	% OF STEAM DELIVERED	% OF ELECT DELIVERED
01	9,437	424,938	571	1,692	424,938	5,126	7,745	10,327	-	-	-	18%	100%
02	7,939	396,609	590	1,579	396,609	4,785	6,360	8,480	-	-	-	20%	100%
03	6,414	419,650	774	1,671	419,626	5,062	4,744	6,325	24	7,576	211	26%	100%
04	4,683	406,945	1,115	1,608	404,023	4,874	3,074	4,099	2,922	41,774	262	34%	99%
05	3,323	429,519	1,324	1,619	406,754	4,907	1,704	2,272	22,765	95,164	280	49%	95%
06	2,720	516,959	1,425	1,819	456,840	5,511	901	1,202	60,119	133,665	280	67%	88%
07	2,619	651,700	1,637	2,081	522,614	6,305	539	718	129,087	164,099	302	79%	80%
08	2,685	592,971	1,601	1,970	494,862	5,970	715	953	98,108	151,315	293	73%	83%
09	2,903	485,284	1,456	1,745	438,434	5,289	1,158	1,544	46,850	120,157	293	60%	90%
10	4,767	402,219	856	1,598	401,294	4,841	3,170	4,226	925	40,932	211	34%	100%
11	6,238	409,183	700	1,629	409,183	4,936	4,609	6,145	-	18,649	179	26%	100%
12	7,702	425,350	695	1,693	425,350	5,131	6,008	8,011	-	-	-	22%	100%
Grand Total	61,430	5,561,326	1,637	20,703	5,200,526	62,737	40,727	54,302	360,800	773,331	302		
EXISTING NON-NORMALIZED	61,646	6,042,606											
% OF EXISTING	100%	92%											
REFRESH THE PIVOT TABLE AFTER MAKING INPUT CHANGES.													
THIS MODEL													
							NG	COAL	OIL	ELECT			
							MCF	TON	GAL	KWH			
EXISTING							25,611	2,179	7,948	5,561,326			
PROPOSED							117,040			360,800			
SAVINGS							(91,428)	2,179	7,948	5,200,526			
SAVINGS \$							\$ (484,305)	\$ 323,250	\$ 15,261	\$ 385,427			
BOILER ONLY MODEL													
							NG	COAL	OIL	ELECT			
							MCF	TON	GAL	KWH			
EXISTING							25,611	2,179	7,948	6,334,657			
PROPOSED							81,907	-	-	6,334,657			
SAVINGS							(56,295)	2,179	7,948	-			
SAVINGS \$							\$ (298,203)	\$ 323,250	\$ 15,261	\$ -			
INCREMENTAL SAVINGS													
							NG	COAL	OIL	ELECT			
							MCF	TON	GAL	KWH			
EXISTING							0	0	0	(773,331)			
PROPOSED							35,133	-	-	(5,973,857)			
SAVINGS							(35,133)	0	0	5,200,526			
SAVINGS \$							\$ (186,102)	\$ 0	\$ 0	\$ 385,427			
UTILITY SAVINGS 239,633													
COGEN MAINT (78,008)													
TRANSMISSION AND CAPACITY REDUCTION (PLC) \$ 81,000													
ENERGY EFFICIENCY \$ 10,200.00													
CSP ANNUAL FEE (15,000)													
SAVINGS TOTAL 237,825													
SUMMARY:													
THIS MODEL ESTIMATES ELECTRIC AND FUEL CONSUMPTION OF A COMBINED HIGH PRESSURE BOILER PLANT AND COGENERATION FACILITY UNDER THE FOLLOWING ASSUMPTIONS:													
1. THE COGEN IS INTERCONNECTED WITH THE DUAL 2400KV FEEDS ENTERING AT THE CENTRAL PLANT AND DOES NOT CONSIDER ELETRIC BEING USED BY THE CHILLERS IN BLDGS 34,35,36 AS FED FROM A SEPARATE 13.2KV FEED.													
2. UTILITY DATA IS NORMALIZED.													
3. OTHER ASSUMPTIONS AS ILLUSTRATED WITHIN THE MODEL.													

GENERATOR	
PERFORMANCE DATA	
RATED POWER	800.00 KW
PARASITIC LOADS	50.00 KW
NET POWER	750.00 KW
FUEL INPUT	9.14 MMBTU
USEFUL THERMAL	3.34 MMBTU
POWER TO HEAT RATIO	0.77 KW
ELECTRIC EFF	28% PERC
THERMAL EFF	33% PERC
OVERALL EFF	65% MMBTU
CAPITAL AND O&M COSTS	MMBTU
INSTALLED COST	2,500.00 \$/KWH
MAINT COST	0.015 \$/KWH
MODEL OUTPUTS	
PEAK USAGE	750 KW
AVERAGE USAGE	594 KW
MIN USAGE	430 KW
% OF TOTAL KWH	94%
% OF TOTAL MBH	34%
NEW PLANT EFF	75%
OLD PLANT EFF	70%
EXISTING NG BOILER	750.00 BHP
	25,050.00 LB/HR
EXISTING PEAK	18,000.00 LB/HR
	521.74 BHP

**ESCO A
Cogeneration**

Equipment Information Sheets

C800S Power Package

Low-pressure Natural Gas, ICHP



The Signature Series Microturbine provides ultra-low emissions and reliable electrical/thermal generation from natural gas.

- + Ultra-low emissions
- + One moving part – minimal maintenance and downtime
- + Patented air bearings – no lubricating oil or coolant
- + Integrated utility synchronization – no external switchgear
- + Internal fuel gas compressor housed within enclosure
- + Compact modular design allows for easy, low-cost installation
- + High electrical efficiency over a very wide operating range
- + High availability – part load redundancy
- + Remote monitoring and diagnostic capabilities
- + Proven technology with tens of millions of operating hours
- + Various Factory Protection Plans available



C800S ICHP Power Package

Electrical Performance⁽¹⁾

Electrical Power Output	760kW
Voltage	400/480 VAC
Electrical Service	3-Phase, 4 Wire Wye
Frequency	50/60 Hz
Electrical Efficiency LHV	31%

Fuel/Engine Characteristics⁽¹⁾

Natural Gas HHV	35.4–42.8 MJ/m ³ (950–1,150 BTU/scf)
Inlet Pressure	1.7–34.5 kPa gauge (0.25– 5.0 psig)
Fuel Flow HHV	9,720 MJ/hr (9,200,000 BTU/hr)
Net Heat Rate LHV	11.6 MJ/kWh (11,000 BTU/kWh)

Exhaust Characteristics⁽¹⁾

NO _x Emissions @ 15% O ₂	< 9 ppmvd (18 mg/m ³)
Exhaust Mass Flow	5.3 kg/s (11.7 lbm/s)
Exhaust Gas Temperature	280°C (535°F) (Heat Recovery Bypassed)

Dimensions & Weight⁽²⁾

Width x Depth x Height	3.0 x 7.5 x 4.0 m (117 x 295 x 157 in)
Weight - Grid Connect Model, dry	18,500 kg (40,800 lbs)
Weight - Dual Mode Model, dry	21,300 kg (47,000 lbs)

Reliable power when and where you need it. Clean and simple.

Minimum Clearance Requirements⁽³⁾

Horizontal Clearance	
Left	1.5 m (60 in)
Right	0.0 m (0 in)
Front	1.7 m (65 in)
Rear	2.2 m (85 in)

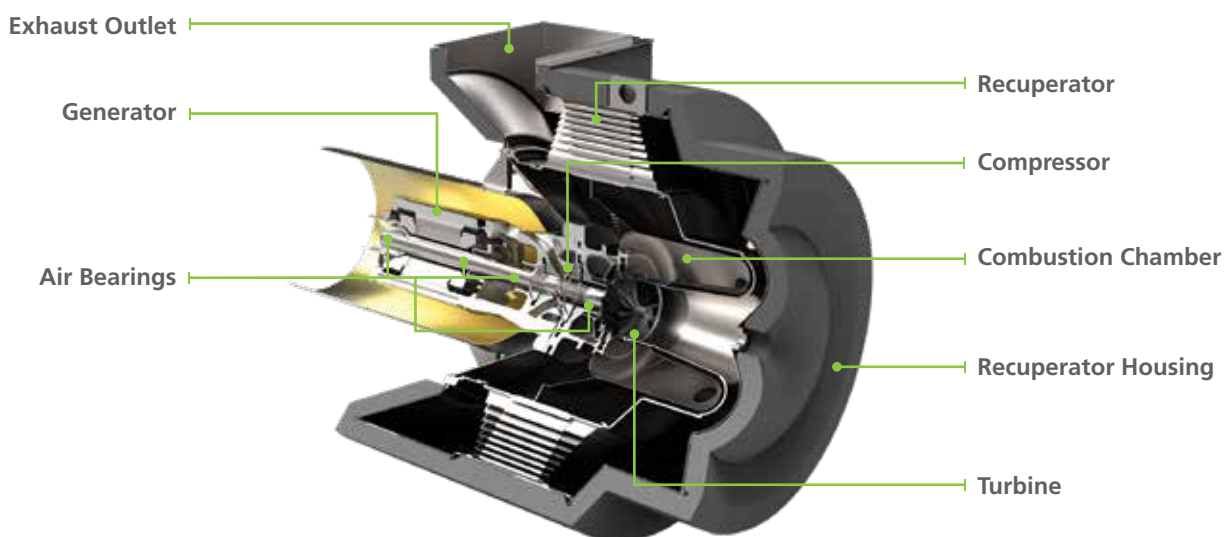
ICHP Heat Recovery⁽⁴⁾

Hot Water Heat Recovery	1.2 MW (4.1 MMBtu/hr)
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Certifications

- UL 2200 Listed
- CE Certified
- Certified to the following grid interconnection standards: UL 1741-SA, VDE, BDEW, CEI 0-16 and AS4447
- Compliant to California Rule 21

C200 Engine Components



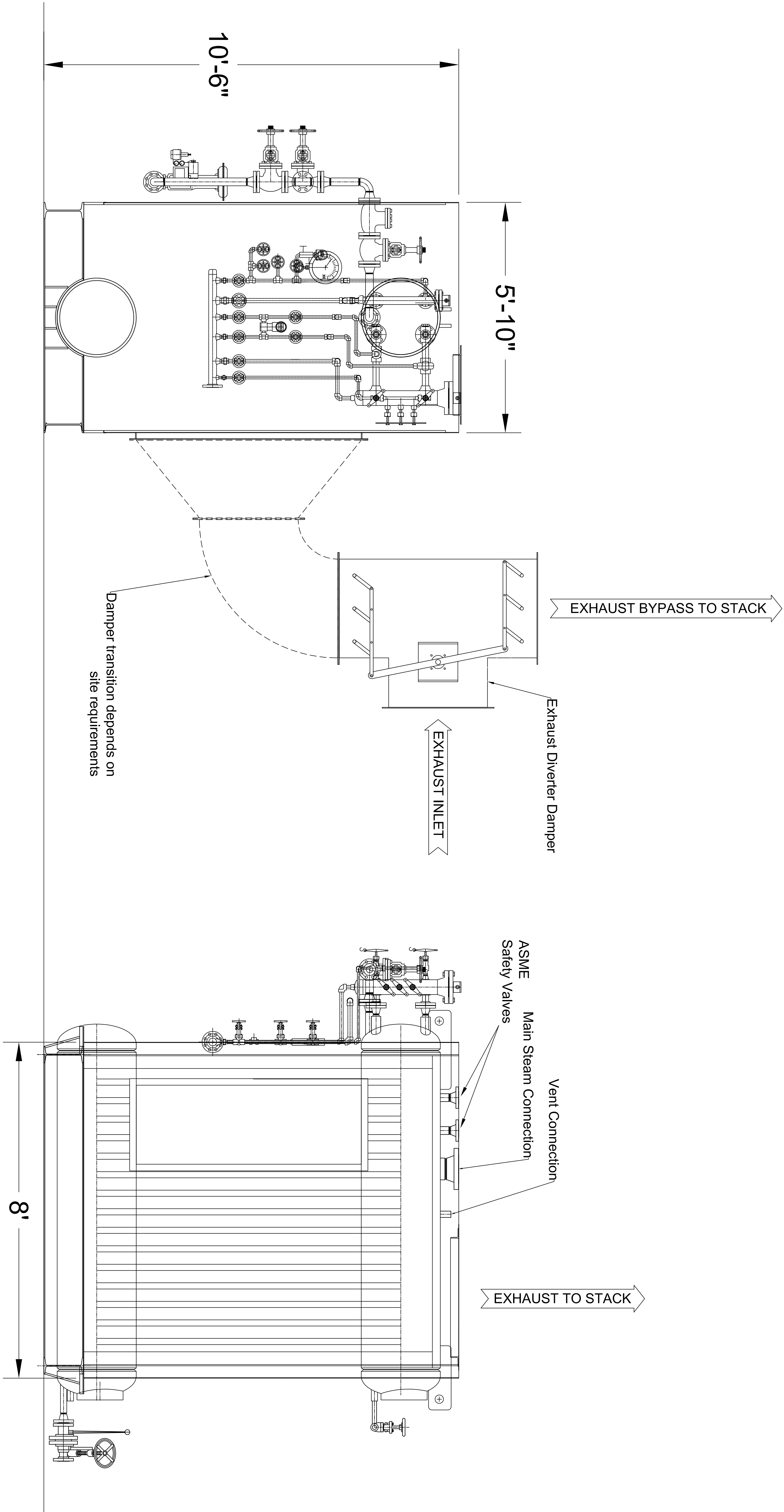
(1) Nominal full power performance at ISO conditions: 15°C (59°F), 14.696 psia, 60% RH

(2) Approximate dimensions and weights

(3) Clearance requirements may increase due to local code considerations

(4) Nominal heat recovery using 4 Heat Recovery Modules (HRM). Inlet water temperature of 38°C (100°F) and flow rate of 6.3 l/s (100 gpm) per HRM. Specifications are not warranted and are subject to change without notice.





FRONT VIEW

SIDE VIEW

**** PRELIMINARY ****

2890 SEVEN HILLS BLVD., RICHMOND, VA. 23231 PHONE: 1-804-526-9321 FAX: 1-804-526-9321				DIMENSION LIMITS UNLESS OTHERWISE SPECIFIED ARE: XX Equivalents ±0.06 XXX Equivalents ±0.015 XXXX Equivalents ±0.005 Angles ±0.50° Fractions ±1/16				DRAWING NAME ENGLISH BOILER AND TUBE, INC.				2890 SEVEN HILLS BLVD., RICHMOND, VA. 23231 PHONE: 1-804-526-9321 FAX: 1-804-526-9321			
CONTRACTOR				1000 kW UNFIRED ARRANGEMENT				PROJECT				DRAWING NUMBER			
SCALE				DATE				DRAWN BY				CHECKED BY			
NTS				2/8/16				CL				APPROVED BY			
SIZE				MODEL NUMBER				36-000-101				REV. #			
REVISION #		DRAWN	CHECK	APPROVED	REVISION #		DRAWN	CHECK	APPROVED	REVISION #		DRAWN	CHECK	APPROVED	REVISION #
REVISION #		DRAWN	CHECK	APPROVED	REVISION #		DRAWN	CHECK	APPROVED	REVISION #		DRAWN	CHECK	APPROVED	REVISION #

ESCO B
Solar

Savings Calculations

PVSYST v6.75**Project** DHS Wernersville Ground Mou**Geographical Site****Meteo data** Reading PA**Simulation variant** 31/03/20 15h41**Simulation date** 31/03/20 15h42 493,171 kWh**Hourly Values**

Date/Time	GlobHor	GlobInc	WindVel	T Amb	PV Size (kW) 400
	W/m ²	W/m ²	m/s	°C	
1/1/2019 0:00	0	0	2.6	7.9998	-0.634
1/1/2019 1:00	0	0	2.6	8.9997	-0.634
1/1/2019 2:00	0	0	3.0996	9.9997	-0.634
1/1/2019 3:00	0	0	3.0996	11	-0.634
1/1/2019 4:00	0	0	3.0996	11	-0.634
1/1/2019 5:00	0	0	3.0996	11	-0.634
1/1/2019 6:00	0	0	4.0996	12	-0.634
1/1/2019 7:00	0	0	2.6	12	-0.634
1/1/2019 8:00	128	262	4.0996	12	70.400
1/1/2019 9:00	262.99	492.92	2.6	12	163.082
1/1/2019 10:00	376.99	653.07	2.0996	15	218.475
1/1/2019 11:00	427	717.58	4.6	17	239.647
12/31/2019 19:00	0	0	6.2	5.9999	-0.634
12/31/2019 20:00	0	0	3.6	5.9999	-0.634
12/31/2019 21:00	0	0	5.0996	5.9999	-0.634
12/31/2019 22:00	0	0	3.0996	5.9999	-0.634
12/31/2019 23:00	0	0	8.2	5.9999	-0.634

ESCO B
Solar

Equipment Information Sheets

100/125kW, 1500Vdc String Inverters for North America



CPS SCH100/125KTL-DO/US-600

The 100 & 125kW high power CPS three phase string inverters are designed for ground mount applications. The units are high performance, advanced and reliable inverters designed specifically for the North American environment and grid. High efficiency at 99.1% peak and 98.5% CEC, wide operating voltages, broad temperature ranges and a NEMA Type 4X enclosure enable this inverter platform to operate at high performance across many applications. The CPS 100/125kW products ship with the Standard or Centralized Wire-box, each fully integrated and separable with AC and DC disconnect switches. The Standard Wire-box includes touch safe fusing for up to 20 strings. The CPS Flex Gateway enables communication, controls and remote product upgrades.

Key Features

- NFPA 70, NEC 2014 and 2017 compliant
- Touch safe DC Fuse holders adds convenience and safety
- CPS Flex Gateway enables remote FW upgrades
- Integrated AC & DC disconnect switches
- 1 MPPT with 20 fused inputs for maximum flexibility
- Copper and Aluminum compatible AC connections
- NEMA Type 4X outdoor rated, tough tested enclosure
- Advanced Smart-Grid features (CA Rule 21 certified)
- kVA Headroom yields 100kW @ 0.9PF and 125kW @ 0.95PF
- Generous 1.87 and 1.5 DC/AC Inverter Load Ratios
- Separable wire-box design for fast service
- Standard 5 year warranty with extensions to 20 years



100/125KTL Standard Wire-box



100/125KTL Centralized Wire-box

Model Name	CPS SCH100KTL-DO/US-600	CPS SCH125KTL-DO/US-600
DC Input		
Max. PV Power	187.5kW	
Max. DC Input Voltage	1500V	
Operating DC Input Voltage Range	860-1450Vdc	
Start-up DC Input Voltage / Power	900V / 250W	
Number of MPP Trackers	1	
MPPT Voltage Range ¹	870-1300Vdc	
Max. PV Input Current (Isc x1.25)	275A	
Number of DC Inputs	20 PV source circuits, pos. & neg. fused (Standard Wire-box) 1 PV output circuit, 1-2 terminations per pole, non-fused (Centralized Wire-box)	
DC Disconnection Type	Load-rated DC switch	
DC Surge Protection	Type II MOV (with indicator/remote signaling), Up=2.5kV, In=20kA (8/20uS)	
AC Output		
Rated AC Output Power	100kW	125kW
Max. AC Output Power ²	100kVA (111KVA @ PF>0.9)	125kVA (132KVA @ PF>0.95)
Rated Output Voltage	600Vac	
Output Voltage Range ³	528-660Vac	
Grid Connection Type ⁴	3Φ / PE / N (Neutral optional)	
Max. AC Output Current @600Vac	96.2/106.8A	120.3/127.2A
Rated Output Frequency	60Hz	
Output Frequency Range ³	57-63Hz	
Power Factor	>0.99 (±0.8 adjustable)	>0.99 (±0.8 adjustable)
Current THD	<3%	
Max. Fault Current Contribution (1-cycle RMS)	41.47A	
Max. OCPD Rating	150A	175A
AC Disconnection Type	Load-rated AC switch	
AC Surge Protection	Type II MOV (with indicator/remote signaling), Up=2.5kV, In=20kA (8/20uS)	
System		
Topology	Transformerless	
Max. Efficiency	99.1%	
CEC Efficiency	98.5%	
Stand-by / Night Consumption	<4W	
Environment		
Enclosure Protection Degree	NEMA Type 4X	
Cooling Method	Variable speed cooling fans	
Operating Temperature Range	-22°F to +140°F / -30°C to +60°C (derating from +113°F / +45°C)	
Non-Operating Temperature Range ⁵	-40°F to +158°F / -40°C to +70°C maximum	
Operating Humidity	0-100%	
Operating Altitude	8202ft / 2500m (no derating)	
Audible Noise	<65dBA@1m and 25°C	
Display and Communication		
User Interface and Display	LED Indicators, WiFi + APP	
Inverter Monitoring	Modbus RS485	
Site Level Monitoring	CPS Flex Gateway (1 per 32 inverters)	
Modbus Data Mapping	SunSpec/CPS	
Remote Diagnostics / FW Upgrade Functions	Standard / (with Flex Gateway)	
Mechanical		
Dimensions (WxHxD)	45.28x24.25x9.84in (1150x616x250mm) with Standard Wire-box 39.37x24.25x9.84in (1000x616x250mm) with Centralized Wire-box	
Weight	Inverter: 121lbs / 55kg; Wire-box: 55lbs / 25kg (Standard Wire-box); 33lbs / 15kg (Centralized Wire-box)	
Mounting / Installation Angle	15 - 90 degrees from horizontal (vertical or angled)	
AC Termination	M10 Stud Type Terminal [3Φ] (Wire range: 1/0AWG - 500kcmil CU/AL, Lugs not supplied) - Standard Wire-box Screw Clamp Terminal Block [N] (#12 - 1/0AWG CU/AL) M8 Stud Type Terminal [3Φ, N] (Wire range: 1/0 - 3/0AWG CU/AL, Lugs not supplied) - Centralized Wire-box	
DC Termination	Screw Clamp Fuse Holder (Wire range: #12 - #6AWG CU) - Standard Wire-box Busbar, M8 PEMserts (Wire range: #1AWG - 250kcmil CU/AL, Lugs not supplied) - Centralized Wire-box	
Fused String Inputs	20A fuses provided (Fuse values of 15A or 20A acceptable)	
Safety		
Safety and EMC Standard	UL1741-SA-2016, CSA-C22.2 NO.107.1-01, IEEE1547a-2014; FCC PART15	
Selectable Grid Standard	IEEE 1547a-2014, CA Rule 21, ISO-NE	
Smart-Grid Features	Volt-RideThru, Freq-RideThru, Ramp-Rate, Specified-PF, Volt-VAR, Freq-Watt, Volt-Watt	
Warranty		
Standard ⁶	5 years	
Extended Terms	10, 15 and 20 years	

1) See user manual for further information regarding MPPT Voltage Range when operating at non-unity PF

2) "Max. AC Apparent Power" rating valid within MPPT voltage range and temperature range of -30°C to +40°C (-22°F to +104°F) for 100KW PF≥0.9 and 125KW PF≥0.95

3) The "Output Voltage Range" and "Output Frequency Range" may differ according to the specific grid standard.

4) Wye neutral-grounded, Delta may not be corner-grounded.

5) See user manual for further requirements regarding non-operating conditions.

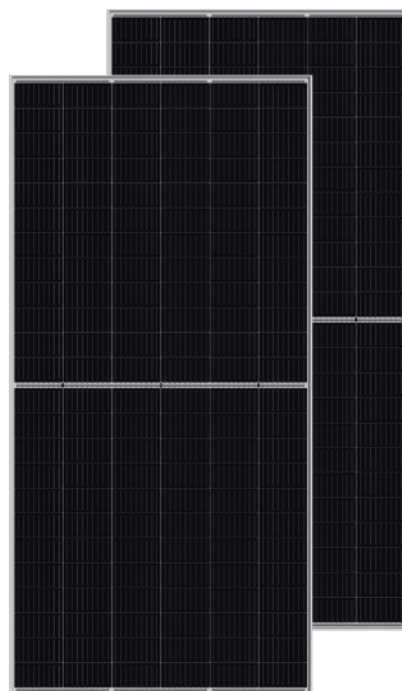
6) 5 year warranty effective for units purchased after October 1st, 2019.

BISTAR

TP6F72M **144 half-cell**

395 - 415W

9BB half-cut mono perc



KEY FEATURES



9BB half-cut cell technology

New circuit design, lower internal current, lower Rs loss



Significantly lower the risk of hot spot

Special circuit design with much lower hot spot temperature



Lower LCOE

2% more power generation, lower LCOE



Excellent Anti-PID performance

2 times of industry standard Anti-PID test by TUV SUD



IP68 junction box

High waterproof level

SYSTEM & PRODUCT CERTIFICATES

- IEC 61215 / IEC 61730 / UL 1703
- ISO 9001: 2015 Quality Management System
- ISO 14001: 2015 Environment Management System
- ISO 45001: 2018 Occupational Health and Safety Management Systems

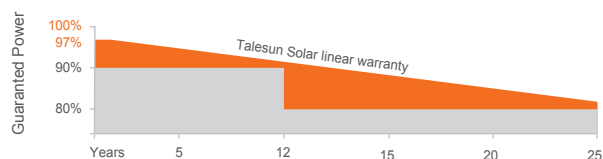


PERFORMANCE WARRANTY

12 years
Quality assurance

25 years
Power output guarantee

■ Talesun standard
■ Industry standard



ELECTRICAL PARAMETERS

Performance at STC (Power Tolerance 0 ~ +3%)

Maximum Power (P _{max} /W)	395	400	405	410	415
Operating Voltage (V _{mpp} /W)	40.3	40.5	40.7	40.9	41.1
Operating Current (I _{mpp} /A)	9.81	9.89	9.96	10.04	10.11
Open-Circuit Voltage (V _{oc} /V)	48.9	49.1	49.3	49.5	49.8
Short-Circuit Current (I _{sc} /A)	10.35	10.43	10.50	10.58	10.66
Module Efficiency η m(%)	19.6	19.9	20.1	20.4	20.6

Performance at NMOT

Maximum Power (P _{max} /W)	294.6	298.5	302.1	305.9	309.5
Operating Voltage (V _{mpp} /W)	37.5	37.7	37.9	38.0	38.3
Operating Current (I _{mpp} /A)	7.85	7.93	7.98	8.04	8.09
Open-Circuit Voltage (V _{oc} /V)	45.5	45.7	45.9	46.1	46.4
Short-Circuit Current (I _{sc} /A)	8.35	8.42	8.48	8.54	8.60

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5 NMOT: Irradiance at 800W/m², Ambient Temperature 20°C, Air Mass AM1.5, Wind Speed 1m/s

MECHANICAL SPECIFICATION

Cell Type	Mono-Crystalline Silicon (9Busbar)
Cell Dimensions	158.75*158.75mm (6inches)
Cell Arrangement	144 (6*24)
Weight	22.5kg (49.6lbs)
Module Dimensions	2008*1002*35 (79.06*39.45*1.38inches)
Cable Length	300mm (11.81inches)
Cable Cross Section Size	4mm ² (0.006inches ²)
Front Glass	3.2mm High Transmission, Tempered Glass
No. of Bypass Diodes	3/6
Packing Configuration(1)	31pcs/carton, 682pcs/40hq
Packing Configuration(2)	31+4pcs/carton, 726pcs/40hq
Frame	Anodized Aluminium Alloy
Junction Box	IP68

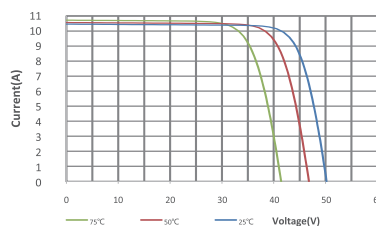
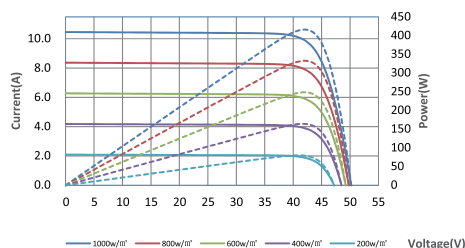
OPERATING CONDITIONS

Maximum System Voltage	1500V/DC
Operating Temperature	-40°C ~ +85°C
Maximum Series Fuse	20A
Static Loading	5400pa
Conductivity at Ground	≤0.1Ω
Safety Class	II
Resistance	≥100MΩ
Connector	MC4 Compatible

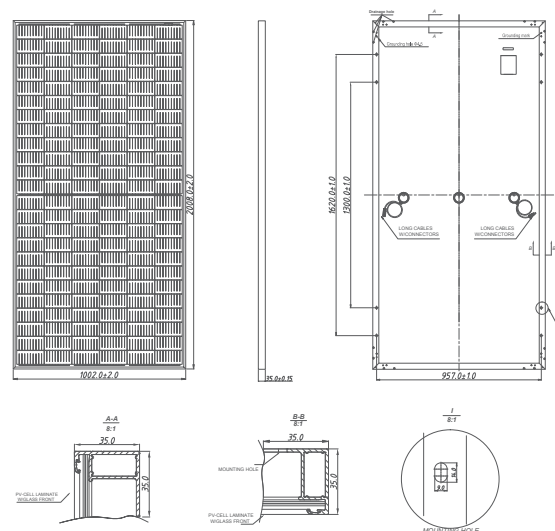
TEMPERATURE COEFFICIENT

Temperature Coefficient P _{max}	-0.36%/°C
Temperature Coefficient V _{oc}	-0.26%/°C
Temperature Coefficient I _{sc}	+0.043%/°C
NMOT	43±2°C

I-V CURVE



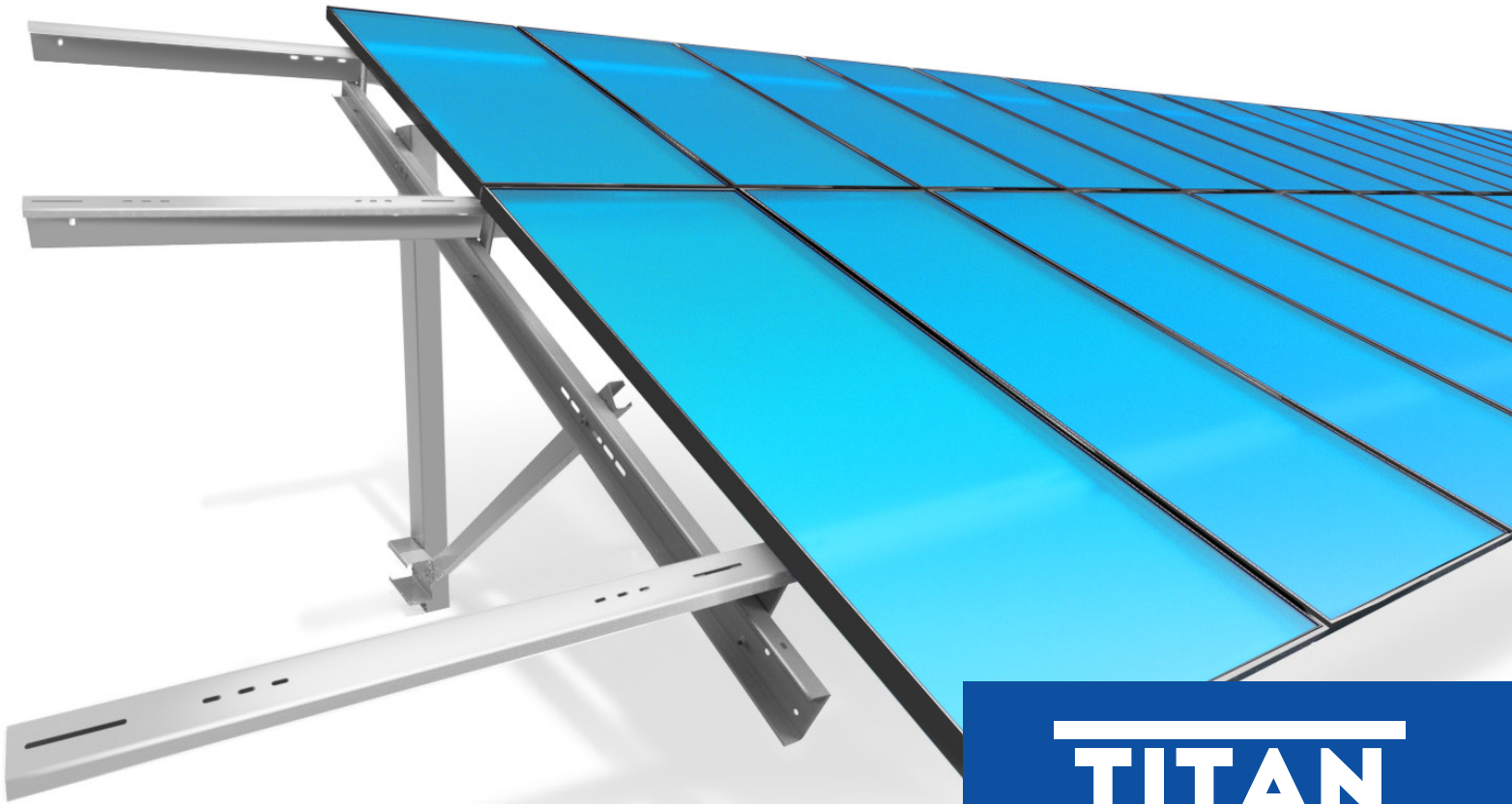
TECHNICAL DRAWINGS





APALTERNATIVES.COM

WHERE INNOVATION MEETS AUTOMATION



STANDARD SPECIFICATIONS

Engineering: ASCE 7-10/CPP Wind Tunnel Tested

Grounding: Fully Integrated UL2703

Rack Coating: Galvanized; G90

Pile Coating: G235

Wind Loading: Up to 165 mph

Snow Loading: Up to 100 psf

Mounting Orientation: 2 High Portrait

Warranty: 25 Years

Foundation: Driven C-Pile

Tilt Angles: 5-35 degree tilt options

POWERHOUSE PILES

The TITAN comes standard with the industry's strongest C-pile. The Powerhouse Pile allows APA to use a cost-effective C-pile, while maintaining the strength of a driven I-beam. Roll forming C-piles allow for additional hole patterns for adjustability, heavy galvanized coatings, and shorter lead times, all while still maintaining an aggressive price point.

TITAN

Designed by installers for installers, the **TITAN** is the most advanced hardware in the industry. The TITAN's unique asymmetrical design and innovative features allow for flexibility in the field while streamlining the install process.

With the lowest part count per MW, integrated grounding and cable trays, and fully integrated module Gravity Clip, the TITAN is installers preferred choice. The 3-rail design is an excellent solution for bifacial modules with low backside shading.

In business since 2008, APA offers the most versatile line of racking and foundation solutions for projects in even the most challenging environments. With projects nationwide, APA is a trusted quality racking partner.

WHAT MAKES THE **TITAN** SYSTEM SO ADVANCED?

ASYMMETRICAL 3-RAIL DESIGN

- 25% Less East-West rails
- Lowest part count per MW
- 2-High Portrait ideal for split cell modules
- Low back panel shading for bifacial modules

BUILT IN ADJUSTABILITY

The TITAN has incorporated hole patterns into several key connections. This allows for in the field adjustments which improve both installation and aesthetics

POWERHOUSE PILES

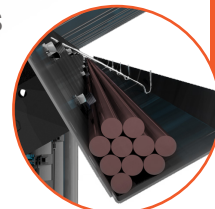
Made from extra heavy gauge steel, our roll formed C-Piles are the strongest in the industry allowing for long spans and excellent drivability even in very dense soils

PILE PLACEMENT

Our racking is designed with the installer in mind. That's why we have forgiving pile placement tolerances in the North-South and East-West directions

WIRE MANAGEMENT

Integrated cable trays and custom wire clips keep your project organized, safe, and code compliant for the life of the project, without costly third-party solutions



PATENT PENDING GRAVITY CLIP

- Fully integrated module grounding
- Allows for rapid installation of modules
- Accommodates different module widths
- Lock clip won't loosen from ice or vibrations

