New York Standard Approach for Estimating Energy Savings from Energy Efficiency Measures in Commercial and Industrial Programs

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INTRODUCTION

This document presents the measure-specific energy and demand savings estimation approach to be used by organizations delivering energy efficiency programs to the citizens of New York that are funded via the Systems Benefits Charge.

The Commission is committed to using the best possible information in the preparation of this Manual. Information contained within this manual may supercede information contained in earlier versions. Program Administrators are reminded to use the most recently approved version of the Manual when reporting savings.

LIFE-CYCLE SAVINGS

The energy savings methodologies presented in this manual are designed to provide first year annual gross energy savings. To calculate life-cycle savings, the annual first year energy savings must be multiplied by the measure life. For program savings purposes, we believe that measure life should represent not only the engineering/rated life of the product but also the degree to which the product might be removed before its rated life. We thus propose that the term "measure life" be consistent with that used in the *Measure Life Report* prepared by GDS Associates for the New England State Program Working Group (SPWG):[1]

"For programs delivered by program administrators in New England, Measure Life includes equipment life and measure persistence (not savings persistence).

- Equipment Life means the [mean] number of years that a measure is installed and will operate until failure, and
- Measure Persistence takes into account business turnover, early retirement of installed equipment, and other reasons measures might be removed or discontinued."

This approach is consistent with the approach taken by the California Database for Energy Efficiency Resources (DEER). The DEER study includes recommendations on effective useful life (EUL). The EUL is an estimate of the point in time when 50% of the measures are expected to be removed or no longer functional, which includes the effects of measure persistence and technical degradation. The measure life assumptions to be used in this manual are shown in the Table below.

[1] GDS Associates, Inc. (2007) *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group for use as an Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM).

Table 1. Measure Effective Useful Life (EUL) Estimates

Measure	Effective Useful Life	Source
ANTI-SWEAT HEATER CONTROLS	12	DEER[2]
CFL LIGHT BULB	Coupon - 5	New England SPWG[1]
	Direct Install - 7	
	Markdown - 7	
CFL LIGHT FIXTURE	7	Residential Lighting Measure Life Study[3]
Chiller	20	DEER
COOL ROOF	15	DEER
Cooling Tower	15	DEER
Duct sealing	18	DEER
ECONOMIZER	10	DEER
ELECTRIC HEAT PUMP WATER HEATER	10	DEER
EVAPORATOR FAN CONTROLS	16	DEER
Furnace	20	DEER
HIGH EFFICIENCY PACKAGED AIR CONDITIONERS	15	DEER
HIGH PERFORMANCE GLAZING	20	DEER
Fluorescent and HID Lighting	70,000 hours/annual operating hours or 15 (whichever is less)	DEER
Lighting controls	8	DEER
Motors	15	DEER
PACKAGED HEAT PUMPS	15	DEER
Photovoltaics	20	LADWP[4]
REFRIGERANT CHARGE CORRECTION	10	DEER
REFRIGERATED CASE NIGHT COVERS	5	DEER
Refrigeraton condenser	15	DEER
REFRIGERATOR LEDS	3.5	US DOE[5]

[2] Effective Useful Life tables to be used by California IOUs for 2009-2011 program cycle planning. From the California DEER website: www.deeresources.com.

[3] Residential Lighting Measure Life Study, prepared for the New England Residential Lighting Program Sponsors by Nexus Market Research Inc. and RLW Analytics Inc., June 4, 2008.

[4] The Los Angeles Department of Water and Power (LADWP) uses a 20 year life for evaluating the cost-effectiveness of Photovoltaic systems

[5] LED life estimated based on 8760 hours per year of operation and 30,000 hour measure life. See "Lifetime of White LEDs," USDOE. www.netl.doe.gov/ssl/PDFs/lifetimeWhiteLEDs_aug16_r1.pdf.

Measure	Effective Useful Life	Source
Commercial Reach-in Refrigerators	12	DEER
Setback Thermostat	11	DEER
Solar water heater	25	CCSE[6]
VENDING MACHINE CENTRAL CONTROLS	5	DEER
VFD	15	DEER
Water heater	15	DEER
WINDOW FILM	10	DEER

EARLY REPLACEMENT

In general, gross savings are defined as the difference in energy and demand between a defined baseline measure or system and the efficient measure or system installed through the program. The appropriate baseline can vary depending on whether the situation involves existing buildings or new construction, a replacement on failure situation (normal replacement), or an early replacement situation. Below are the various definitions of baseline for these four situations:

1. If new construction, the baseline is the typical measure or system that would have been installed without the program. For new construction, building efficiency codes generally define the baseline.

2. If a replace on failure situation (normal replacement) and there is no applicable efficiency code, the baseline is the typical measure or system that would have been installed without the program.

3. If a replace on failure situation (normal replacement) and there is an applicable efficiency code, the baseline is the typical measure or system whose rated energy use is consistent with that code.

4. For early replacement of older but functioning equipment, the measure savings are generally calculated in a two step process. This is called the "dual baseline" approach.

    a) Calculate savings using the existing equipment efficiency as the baseline over the remaining life of the existing equipment.
    b) After the existing equipment has reached the end of its remaining useful life, calculate savings using normal replacement efficiency as the baseline over the remaining effective useful life of the new equipment.

[6] The California Center for Sustainable Energy (CCSE) uses a 25 year measure life for cost effectiveness calculations. See "Solar Water Heating Pilot Program Interim Evaluation Report," prepared by Itron, Inc. Vancouver, WA, January, 209.

To avoid complications associated with conducting separate calculations for each baseline, Program Administrators are offered two options for reporting savings on early replacement measures:

Option 1. Treat the measure as a normal replacement, using the appropriate baseline as described above. The measure life is equal to the effective useful life listed in the table above, and the measure cost is calculated as the incremental cost of the measure relative to the normal replacement baseline equipment.

Option 2. Treat the measure as an early replacement, using the existing equipment as the baseline. The measure life is equal to the remaining useful life, which is defined as 1/3 of the effective useful life listed in the table above. Savings beyond the remaining useful life would be set to zero. The measure cost is calculated as the full cost of the measure.

NET TO GROSS ADJUSTMENTS

The savings approaches presented in this manual provide gross energy saving estimates and specify the approaches for obtaining those estimates. The New York Department of Public Service policy specifies that savings projections used for predicting energy savings will be net savings. To arrive at net savings the gross estimates presented in this manual must be adjusted to account for freeriders and spillover.

Freerider adjustments act to erode the gross savings estimate by subtracting out the savings that would have occurred without the program's incentive or influence. Spillover adjustments act to increase savings by counting the additional savings that occur as a result of two possible conditions. First, participants can replicate that same action (participant spillover) outside of the program participation process, providing additional savings. Second, the program can influence the way non-participants make energy saving decisions that result in additional savings not associated with a specific participation event. Together, the subtraction of savings for freeriders, plus the addition of savings for spillover tend to offset each other to a significant degree. As a result, for the purposes of estimating program impacts, the savings estimates presented in this manual, or the savings produced using the calculation approaches described in this manual, must be multiplied by 0.90 to arrive at an estimated net energy savings for each measure.

As program evaluations are completed this factor will be adjusted up or down as appropriate by program, for each measure included in this manual. Over time, the adjustment factor will evolve to be more accurate and will be focused on specific types of programs and delivery approaches. At the current time, to standardize the net impact estimation approach, a net to gross conversion factor of 0.90 will be applied to the gross saving estimates.

COMMERCIAL AND INDUSTRIAL MEASURES

INTERIOR AND EXTERIOR LIGHTING

Description of Measure

This section covers energy-efficient lighting equipment, such as energy-efficiency lamps, energy-efficiency ballasts, compact fluorescent lamps, and improved lighting fixtures. Energy-efficient lamps may include fluorescent lamps, HID lamps, and incandescent lamps. Improved lighting fixtures may include reflectors and other optical improvements to lighting fixtures. These technologies, taken separately or combined into an energy-efficient lighting fixture, provide the required illumination at reduced input power.

Method for Calculating Summer Peak Demand and Energy Savings

$$\Delta kW_s = units \times \left[\frac{(Watts \times DF)_{base} - (Watts \times DF)_{ee}}{1000} \right] \times CF_s \times (1 + HVAC_{d,s})$$

$$\Delta kWh = units \times \left[\frac{(Watts \times DF)_{base} - (Watts \times DF)_{ee}}{1000} \right] \times FLH \times (1 + HVAC_c)$$

$$\Delta therm = \Delta kWh \times HVAC_g$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
$\Delta therm$	= therm interactions with lighting savings
units	= number of units installed under the program
$Watts_{ee}$	= connected load of the energy-efficient unit
$Watts_{base}$	= connected load of the baseline unit(s) displaced
FLH	= full-load operating hours
DF	= demand diversity factor
CF	= coincidence factor
$HVAC_d$	= HVAC system interaction factor at utility peak hour
$HVAC_c$	= HVAC system interaction factor for annual electricity consumption
$HVAC_g$	= HVAC system interaction factor for gas consumption (therm/kWh)

$Watts_{ee}$ is defined as the fixture wattage of the efficient lighting fixture. See table of standard fixture wattages in Appendix B.

$Watts_{base}$ is defined as the fixture wattage of the baseline lighting fixture. The baseline condition is assumed to be the existing lighting fixture in retrofit applications. See table of standard fixture wattages in Appendix B. Note, depending on local codes, new construction, space renovations or remodels may require a building permit that includes

compliance with local energy codes. In these instances, the energy code defines the baseline.

The average ***full load hours*** are defined by building type, as shown in the Table below:

Facility Type	Lighting Hours	HVAC Int	Facility Type	Lighting Hours	HVAC Int
Auto Related	4,056	BB	Manufacturing Facility	2,857	Ind
Bakery	2,854	FS	Medical Offices	3,748	Ofc
Banks	3,748	Ofc	Motion Picture Theatre	1,954	Asy
Church	1,955	Asy	Multi-Family (Common Areas)	7,665	MFL
College – Cafeteria(1)	2,713	FS	Museum	3,748	Asy
College - Classes/Administrative	2,586	Sch	Nursing Homes	5,840	MFL
College - Dormitory	3,066	MFH	Office (General Office Types) (1)	3,100	Ofc
Commercial Condos(2)	3,100	Ofc	Office/Retail	3,748	Ofc
Convenience Stores	6,376	Ret	Parking Garages	4,368	None
Convention Center	1,954	Asy	Parking Lots	4,100	None
Court House	3,748	Ofc	Penitentiary	5,477	MFL
Dining: Bar Lounge/Leisure	4,182	FS	Performing Arts Theatre	2,586	Asy
Dining: Cafeteria / Fast Food	6,456	FF	Police / Fire Stations (24 Hr)	7,665	Asy
Dining: Family	4,182	FS	Post Office	3,748	Ret
Entertainment	1,952	Asy	Pump Stations	1,949	Ind
Exercise Center	5,836	Ret	Refrigerated Warehouse	2,602	Ind
Fast Food Restaurants	6,376	FF	Religious Building	1,955	Asy
Fire Station (Unmanned)	1,953	Asy	Restaurants	4,182	FS
Food Stores	4,055	BB	Retail	4,057	Ret
Gymnasium	2,586	Asy	School / University	2,187	Sch
Hospitals	7,674	MFH	Schools (Jr./Sr. High)	2,187	Sch
Hospitals / Health Care	7,666	Ofc	Schools (Preschool/Elementary)	2,187	Sch
Industrial - 1 Shift	2,857	Ind	Schools (Technical/Vocational)	2,187	Sch
Industrial - 2 Shift	4,730	Ind	Small Services	3,750	Ofc
Industrial - 3 Shift	6,631	Ind	Sports Arena	1,954	Asy
Laundromats	4,056	Ret	Town Hall	3,748	Asy
Library	3,748	Ofc	Transportation	6,456	Asy
Light Manufacturers(1)	2,613	Ind	Warehouse (Not Refrigerated)	2,602	Ind
Lodging (Hotels/Motels)	3,064	MFL	Waste Water Treatment Plant	6,631	Ind
Mall Concourse	4,833	BB	Workshop	3,750	Ind

(1) FLH data from the 2008 California DEER Update study
(2) FLH data for offices used

The ***demand diversity factor*** is defined as the ratio of the peak lighting demand to the connected load. Because not all of the fixtures in the population are operating at all times, the peak lighting demand is often less than the connected load. Occupant control of the lighting systems and burned-out lamps cause some portion of the fixtures to be non-operational. In lighting retrofit programs, the pre-retrofit (baseline) demand

diversity factor is often lower than the post-retrofit demand diversity factor, due to burned out lamps that are replaced as part of the program.

The ***coincidence factor*** is defined as the portion of the lighting demand reduction that is coincident with the system peak. For many utilities, summer peak demand occurs in the afternoon, indicating a coincidence factor of 1.0 for commercial indoor lighting measures. Since exterior lighting is generally off during daylight hours, the coincidence factor for exterior lighting is 0.0.

Recommended values for the demand diversity factor and coincidence factor are shown below:

Parameter	Interior Lighting	Exterior Lighting
Demand diversity factor	1.0	1.0
Coincidence factor	1.0	0.0

The ***HVAC system interaction factor*** is defined as the ratio of the cooling energy reduction per unit of lighting energy reduction. Most of the input energy for lighting systems is converted to heat which must be removed by the HVAC system. Reductions in lighting heat gains due to lighting power reduction decrease the need for space cooling and increase the need for space heating. HVAC interaction factors vary by climate, HVAC system type and building type. Recommended values for HVAC interaction factors for lighting energy and peak demand savings are shown below. Lighting systems in unconditioned spaces or on the building exterior will have interaction factors of 0.0. The building types for the HVAC interactive effect factors by facility type are shown in the lighting FLH Table above.

Building	City	$HVAC_c$	$HVAC_d$	$HVAC_g$
Assembly (Asy)	Albany	0.1	0.2	-0.031
	Binghamton	0.09	0.2	-0.036
	Buffalo	0.1	0.2	-0.034
	Massena	0.09	0.2	-0.041
	NYC	0.16	0.2	-0.021
	Syracuse	0.11	0.2	-0.029
Big Box (BB)	Albany	0.12	0.2	-0.023
	Binghamton	0.11	0.2	-0.023
	Buffalo	0.11	0.2	-0.023
	Massena	0.1	0.2	-0.027
	NYC	0.17	0.2	-0.013
	Syracuse	0.12	0.2	-0.022
Fast Food (FF)	Albany	0.07	0.2	-0.037
	Binghamton	0.06	0.2	-0.035
	Buffalo	0.07	0.2	-0.036
	Massena	0.07	0.2	-0.036
	NYC	0.11	0.2	-0.028
	Syracuse	0.07	0.2	-0.035
Full Service Restaurant (FS)	Albany	0.07	0.2	-0.039

Building	City	$HVAC_c$	$HVAC_d$	$HVAC_g$
	Binghamton	0.06	0.2	-0.038
	Buffalo	0.07	0.2	-0.037
	Massena	0.06	0.2	-0.038
	NYC	0.11	0.2	-0.03
	Syracuse	0.08	0.2	-0.037
Light Industrial (Ind)	Albany	0.07	0.2	-0.026
	Binghamton	0.06	0.2	-0.028
	Buffalo	0.06	0.2	-0.028
	Massena	0.06	0.2	-0.028
	NYC	0.1	0.2	-0.021
	Syracuse	0.07	0.2	-0.026
Primary School (Sch)	Albany	0.06	0.2	-0.039
	Binghamton	0.04	0.2	-0.041
	Buffalo	0.04	0.2	-0.041
	Massena	0.04	0.2	-0.044
	NYC	0.11	0.2	-0.029
	Syracuse	0.06	0.2	-0.039
Small Office (Ofc)	Albany	0.1	0.2	-0.019
	Binghamton	0.09	0.2	-0.021
	Buffalo	0.09	0.2	-0.02
	Massena	0.09	0.2	-0.021
	NYC	0.12	0.2	-0.015
	Syracuse	0.1	0.2	-0.02
Small Retail (Ret)	Albany	0.1	0.2	-0.027
	Binghamton	0.09	0.2	-0.029
	Buffalo	0.09	0.2	-0.028
	Massena	0.08	0.2	-0.031
	NYC	0.13	0.2	-0.022
	Syracuse	0.09	0.2	-0.028
MF Lowrise (MFL)	Albany	0.02	0.14	-0.017
	Binghamton	0.01	0.14	-0.018
	Buffalo	0.01	0.14	-0.017
	Massena	0.02	0.14	-0.018
	NYC	0.06	0.14	-0.016
	Syracuse	0.02	0.14	-0.018
MF Highrise (MFH)	Albany	0.09	0.12	-0.114
	Binghamton	0.07	0.12	-0.137
	Buffalo	0.08	0.12	-0.091
	Massena	0.08	0.12	-0.176
	NYC	0.10	0.12	-0.143
	Syracuse	0.01	0.12	-0.153

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to be the existing lighting fixture in retrofit applications. Note, depending on local codes, new construction, space renovations or remodels may require a building permit that includes compliance with local energy codes. In these instances, the energy code defines the baseline.

Compliance Efficiency from which incentives are calculated

Efficient lighting fixtures as defined by the program. See table of standard fixture wattages in Appendix B.

Non-Electric Benefits - Annual Fossil Fuel Savings

Reduction in lighting power increases space heating requirements. Interactions with the heating system must be applied to the calculations as shown in the equations above.

Notes & References

1. Lighting operating hour data taken from the CL&P and UI Program Savings Documentation for 2008 Program Year, with exceptions as noted.
2. Typical values for demand diversity factor (DF) and coincidence factor (CF) taken from Engineering Methods for Estimating the Impacts of Demand-Side Management Programs. Volume 2: Fundamental Equations for Residential and Commercial End-Uses. TR-100984S Vol 2. Electric Power Research Institute, Palo Alto, CA August, 1993.
3. Additional lighting operating hour data taken from 2008 DEER Update – Summary of Measure Energy Analysis Revisions, August, 2008. Available at www.deeresources.com

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INTERIOR LIGHTING CONTROLS

Description of Measure

This section covers lighting control measures, including occupancy sensors, photocell controls, timeclocks, daylighing controls, dimmers and programmable control systems. These systems save energy and peak demand by shutting off power to lighting fixtures when the space is unoccupied or illumination is not required. They also save energy and demand by reducing power to lighting systems to correct for over-illumination due to excessive lamp output or the presence of daylight.

$$\Delta kW_s = units \times \left(\frac{Watts_{ctrl}}{1000}\right) \times DF_s \times CF_s \times DSF_s \times (1 + HVAC_{d,s})$$

$$\Delta kWh = units \times \left(\frac{Watts_{ctrl}}{1000}\right) \times DF \times FLH \times ESF \times (1 + HVAC_c)$$

$$\Delta\ therm = \Delta kWh \times HVAC_g$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= number of control units installed under the program
$Watts_{ctrl}$	= connected load of controlled lighting fixtures
DSF	= demand savings factor
ESF	= energy savings factor
FLH	= full-load operating hours
DF	= demand diversity factor
CF	= coincidence factor
$HVAC_c$	= HVAC system interaction factor for annual energy consumption
$HVAC_d$	= HVAC system interaction factor at utility peak hour

$Watts_{ctrl}$. is the connected load of the lighting equipment controlled.

The ***demand savings factor*** is the maximum hourly reduction in lighting demand achieved by a particular control measure. Lighting controls save energy and demand by reducing or shutting off power input to lighting fixtures in response to a control signal. Demand savings can be achieved by the following controllers and their respective control actions:

- occupancy sensors - switching off lights when the space is unoccupied
- daylight sensing controls - reducing electric lighting levels according to the availability of daylight
- dimming controls - reducing lighting levels to suit the occupant

- time clocks - switching off lights according to a fixed schedule
- photocells - controlling outdoor lights according to the availability of daylight; these may be combined with time clock control
- programmable control systems - sophisticated lighting controllers that combine many of the above functions into a single unit; may also be coupled to the building security system

The ***energy savings factor*** is equal to the annual energy savings from a particular control measure. This factor can also be interpreted as the reduction in the full-load operating hours due to the lighting control system.

Energy and Demand Savings Factors for Various Automatic Control Options

Control Type	ESF	DSF
Occupancy sensor	0.30	0.30
Programmable control	0.15	0.15
Daylight dimming control	0.30	0.30
Daylight stepped control	0.20	0.20

The ***full-load hours*** are the average operating hours for all fixtures subject to lighting control measures ***before the lighting controls are installed.*** Full-load hours for a variety of commercial and residential buildings are discussed in the lighting efficiency section above.

The ***demand diversity factor*** is defined as the ratio of the peak lighting demand to the connected load. Because not all of the fixtures in the population are operating at all times, the peak lighting demand is often less than the connected load. Occupant control of the lighting systems and burned-out lamps cause some portion of the fixtures to be non-operational. In lighting retrofit programs, the pre-retrofit (baseline) demand diversity factor is often lower than the post-retrofit demand diversity factor, due to burned out lamps that are replaced as part of the program.

The ***coincidence factor*** is defined as the portion of the lighting demand reduction that is coincident with the system peak. For many utilities, summer peak demand occurs in the afternoon, indicating a coincidence factor of 1.0 for commercial indoor lighting measures.

Recommended values for the demand diversity factor and coincidence factor are shown below:

Parameter	**Value**
Demand diversity factor	1.0
Coincidence factor	1.0

HVAC system interaction factors. See section on lighting efficiency above for more information on HVAC interactions with lighting systems.

Baseline Efficiencies from which savings are calculated
Baseline calculations assume no lighting controls are installed, except those required by local energy code as applicable

Compliance Efficiency from which incentives are calculated
Lighting controls designed and installed in accordance with manufacturers' and/or designer recommendations.

Operating Hours
See section on commercial lighting systems above.

Non-Electric Benefits - Annual Fossil Fuel Savings
Reduction in lighting power increases space heating requirements. Interactions with the heating system must be applied to the calculations.

Notes & References

1. Energy and demand savings factors derived from lighting control power adjustment factors prescribed in the California Title 24 Nonresidential lighting standards.

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REFRIGERATORS

Description of Measure

Energy Star rated commercial reach in refrigerators used in commercial foodservice applications, with an integral compressor and condenser.

$$\Delta kW_s = units \times \left[\frac{kWh_{base}}{8760 \times LF_{base,s}} - \frac{kWh_{ee}}{8760 \times LF_{ee,s}} \right] \times CF_s \times (1 + HVAC_{d,\,s})$$

$$\Delta kWh = units \times (kWh_{base} - kWh_{ee}) \times (1 + HVAC_c)$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= number of refrigerators or freezers installed under the program
LF	= load factor for refrigeration end-use
CF	= coincidence factor
$HVAC_c$	= HVAC system interaction factor for annual energy consumption
$HVAC_d$	= HVAC system interaction factor at utility peak hour
$HVAC_g$	= HVAC system interaction factor for annual gas consumption
8760	= conversion factor (hr/yr)

Commercial refrigerator and freezer energy consumption

Energy Star rated refrigerators must meet the specifications in the table below for maximum daily energy consumption (kWh/day). Multiply by 365 to get annual energy consumption.

Table 1: Maximum Daily Energy Consumption (MDEC) Requirements (kWh/day) for ENERGY STAR Qualified Commercial Food-grade Refrigerators and Freezers		
Product Volume (in cubic feet)	**Refrigerator**	**Freezer**
Vertical Configuration		
Solid Door Cabinets		
0 < V < 15	≤ 0.089V + 1.411	≤ 0.250V + 1.250
15 ≤ V < 30	≤ 0.037V + 2.200	≤ 0.400V – 1.000
30 ≤ V < 50	≤ 0.056V + 1.635	≤ 0.163V + 6.125
50 ≤ V	≤ 0.060V + 1.416	≤ 0.158V + 6.333
Glass Door Cabinets		
0 < V < 15	≤ 0.118V + 1.382	≤ 0.607V + 0.893
15 ≤ V < 30	≤ 0.140V + 1.050	≤ 0.733V – 1.000
30 ≤ V < 50	≤ 0.088V + 2.625	≤ 0.250V + 13.500
50 ≤ V	≤ 0.110V + 1.500	≤ 0.450V + 3.500
Chest Configuration		
Solid or Glass Door Cabinets	≤ 0.125V + 0.475	≤ 0.270V + 0.130

Note: V = AHAM volume, as defined in Section 1, in cubic feet (ft^3).

The ***load factor*** is defined as the ratio of the average demand to the diversified peak demand of a population of refrigerators. The default value for load factor is 0.80.

The ***coincidence factor*** is defined as the fraction of the end-use demand that is coincident with the utility system peak. The default value for coincidence factor is 1.0.

The ***HVAC system interaction factor*** is defined as the ratio of the cooling energy reduction per unit of lighting energy reduction. Most of the input energy for standalone refrigeration systems is converted to heat which must be removed by the HVAC system. Reductions in refrigerator heat gains due to efficient refrigerators decrease the need for space cooling and increase the need for space heating. HVAC interaction factors vary by climate, HVAC system type and building type. Recommended values for HVAC interaction factors for refrigerator energy and peak demand savings are shown below.

HVAC Interaction Factors

Building	City	$HVAC_c$	$HVAC_d$	$HVAC_g$
Assembly	Albany	0.1	0.2	-0.031
	Binghamton	0.09	0.2	-0.036
	Buffalo	0.1	0.2	-0.034
	Massena	0.09	0.2	-0.041
	NYC	0.16	0.2	-0.021
	Syracuse	0.11	0.2	-0.029
Big Box	Albany	0.12	0.2	-0.023
	Binghamton	0.11	0.2	-0.023
	Buffalo	0.11	0.2	-0.023
	Massena	0.1	0.2	-0.027
	NYC	0.17	0.2	-0.013
	Syracuse	0.12	0.2	-0.022
Fast Food	Albany	0.07	0.2	-0.037
	Binghamton	0.06	0.2	-0.035

Building	City	$HVAC_c$	$HVAC_d$	$HVAC_g$
	Buffalo	0.07	0.2	-0.036
	Massena	0.07	0.2	-0.036
	NYC	0.11	0.2	-0.028
	Syracuse	0.07	0.2	-0.035
Full Service Restaurant	Albany	0.07	0.2	-0.039
	Binghamton	0.06	0.2	-0.038
	Buffalo	0.07	0.2	-0.037
	Massena	0.06	0.2	-0.038
	NYC	0.11	0.2	-0.03
	Syracuse	0.08	0.2	-0.037
Light Industrial	Albany	0.07	0.2	-0.026
	Binghamton	0.06	0.2	-0.028
	Buffalo	0.06	0.2	-0.028
	Massena	0.06	0.2	-0.028
	NYC	0.1	0.2	-0.021
	Syracuse	0.07	0.2	-0.026
Primary School	Albany	0.06	0.2	-0.039
	Binghamton	0.04	0.2	-0.041
	Buffalo	0.04	0.2	-0.041
	Massena	0.04	0.2	-0.044
	NYC	0.11	0.2	-0.029
	Syracuse	0.06	0.2	-0.039
Small Office	Albany	0.1	0.2	-0.019
	Binghamton	0.09	0.2	-0.021
	Buffalo	0.09	0.2	-0.02
	Massena	0.09	0.2	-0.021
	NYC	0.12	0.2	-0.015
	Syracuse	0.1	0.2	-0.02
Small Retail	Albany	0.1	0.2	-0.027
	Binghamton	0.09	0.2	-0.029
	Buffalo	0.09	0.2	-0.028
	Massena	0.08	0.2	-0.031
	NYC	0.13	0.2	-0.022
	Syracuse	0.09	0.2	-0.028

Baseline Efficiencies from which savings are calculated

The Foodservice Technology Center has estimated the energy consumption of baseline commercial refrigerators based on data compiled by the California Energy Commission. Baseline daily kWh for solid door and glass door commercial reach-in refrigerators are calculated as shown in the Table below. Multiply by 365 to get annual kWh.

Type	Refrigerator	Freezer
Solid Door	0.10 V + 2.04	0.40 V + 1.38
Glass Door	0.12 V + 3.34	0.75 V + 4.10

V= AHAM volume

Compliance Efficiency from which incentives are calculated

Energy Star rating required

Operating Hours

Unit is a assumed to run year-round

Non-Electric Benefits - Annual Fossil Fuel Savings

Efficient refrigerators reject less heat into the conditioned space, which must be made up by the space heating system. Calculations must include space heating interactions with efficient refrigerators.

Notes & References

1. US EPA energy consumption for Energy Star commercial refrigerators obtained from the Energy Star website: http://www.energystar.gov/index.cfm?c=commer_refrig.pr_commercial_refrigerators
2. Energy consumption for baseline refrigerators taken from the life cycle cost calculators for commercial refrigerators on the Foodservice Technology Center website: http://www.fishnick.com/saveenergy/tools/calculators/

Revision Number
0

REFRIGERATOR LEDS

Measure Description
The installation of LED bulbs in commercial display refrigerators, coolers or freezers. The light bulbs in a typical refrigerator, cooler or freezer add to the load on that unit by increasing power consumption of the unit when the light is on, and by adding heat to the inside of the unit that must be overcome through additional cooling. Replacing incandescent and fluorescent lighting with low heat generating LEDs reduces the energy consumption associated with the lighting components and reduces the amount of waste heat generated from the lighting that must be overcome by the unit's compressor cycles.

Savings Estimation Approach

Annual Savings

kWh Savings
The savings approach is based on the estimated difference in refrigerator / cooler / freezer consumption before the change-out compared to the unit consumption after the change-out for the period of time the unit is turned on during a typical year of operation.

The estimation approach is as follows:

Savings in kWh per year = (Annual lighting kWh B – Annual lighting kWh A) + ComEffSav

Where:

Annual lighting kWh B = The total annual kWh usage of the unit per year with conventional baseline lighting.
Annual lighting kWh A = The total annual kWh usage of the units with the LEDs installed.
ComEffSav = the kWh savings of the refrigeration unit by not needing to cool the heat generated by the inefficient lighting.
kWh B = total lighting run hours per year x wattage of baseline lighting / 1000
kWh A = total lighting run hours per year x wattage of LED lighting / 1000

The ComEffSav from the compressor are estimated using the following approach:

ConEffSav = (Annual lighting kWh B – Annual lighting kWh A) * ComEffFac

Where:

ComEffFac = 0.51 for coolers and 0.65 for freezers * 0.8 for the portion of the saved energy that would have needed to be eliminated via the compressor[7]. Thus, ComEffFac for refrigerators and coolers = (0.51 * .8) = 0.41 and ComEffFac for freezers = (0.65 * .8) = 0.52.

<u>kW Savings</u>
Peak demand savings are calculated using the following approach.

KW = (kW B – kW A)* Compressor factor

Where:

KW = the total average kW savings of the refrigeration system, including both the kW reduction due to the bulb replacement and the kW reduced from the operation of the compressor not having to remove the excess lighting.
kW B = The total power usage of the lighting fixtures that are being replaced, kW.
kW A = The total power usage of the new lighting fixtures that are being installed,
Compressor factor = 0.40 for coolers and 0.51 for freezers. The factors are based on effective refrigeration compressor EER values of 6.7 (1.8 kW/ton) and 5.25 Btu/Wh (2.3 kW/ton), respectively, and the assumption that 20% of the case lighting load is not converted into a case cooling load.

Compressor factor (coolers) = 0.28 ton/kW * 1.8 kW/ton * 0.8 = 0.40

Compressor factor (freezers) = 0.28 ton/kW * 2.3 kW/ton * 0.8 = 0.51

[7] Note: It is assumed that 0.2 of the saved energy escapes via conduction through the display case and does not have to be recaptured by the compressor.

HIGH PERFORMANCE GLAZING

Description of Measure

High performance glazing system with reduced solar heat gain coefficient and U-value replacing single pane clear glass

Method for Calculating Summer Peak Demand and Energy Savings

Gross Summer Coincident Demand Savings

ΔkW_S = Glazing area (100 SF) $\times$ (ΔkW/100 SF) $\times$ $DF_S \times CF_S$

Gross Annual Energy Savings

ΔkWh = Glazing area (100 SF) $\times$ (ΔkWh/ 100 SF)

Δtherm = Glazing area (100 SF) $\times$ (Δtherm/ 100 SF)

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
Glazing area	= Aperture area of glazing system in 100 SF
DF	= demand diversity factor
CF	= coincidence factor
ΔkW/100 SF	= electricity demand savings per 100 SF of glazing area
ΔkWh/100 SF	= electricity consumption savings per 100 SF of glazing area
Δtherm/100 SF	= gas consumption impact per 100 square foot of glazing.

The ***demand diversity factor*** is used to account for the fact that not all HVAC systems in all buildings where high performance glazing systems were installed are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of the HVAC systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

DF = 0.8
CF = 1.0

Unit energy and demand savings were calculated from a DOE-2.2 simulation of a series of prototypical small commercial buildings. The prototype building characteristics are described in Appendix A. The unit energy and demand savings for eight building types across six different cities in NY are shown below:

Electricity Unit Savings

Small commercial buildings

Building Type	City	Unit	KWh/unit	KW/unit
Assembly	Albany	100 sqft glazing	272	0.076
	Binghamton	100 sqft glazing	219	0.119
	Buffalo	100 sqft glazing	234	0.176
	Massena	100 sqft glazing	220	0.071
	NYC	100 sqft glazing	389	0.152
	Syracuse	100 sqft glazing	276	0.190
Big Box Retail	Albany	100 sqft glazing	283	0.169
	Binghamton	100 sqft glazing	231	0.079
	Buffalo	100 sqft glazing	251	0.158
	Massena	100 sqft glazing	277	0.236
	NYC	100 sqft glazing	374	0.158
	Syracuse	100 sqft glazing	288	0.191
Fast Food	Albany	100 sqft glazing	297	0.086
	Binghamton	100 sqft glazing	258	0.086
	Buffalo	100 sqft glazing	282	0.189
	Messina	100 sqft glazing	285	0.086
	NYC	100 sqft glazing	384	0.017
	Syracuse	100 sqft glazing	304	0.207
Full Service Restaurant	Albany	100 sqft glazing	226	0.103
	Binghamton	100 sqft glazing	199	0.120
	Buffalo	100 sqft glazing	214	0.138
	Massena	100 sqft glazing	225	0.120
	NYC	100 sqft glazing	282	0.034
	Syracuse	100 sqft glazing	240	0.155
Light Industrial	Albany	100 sqft glazing	267	0.203
	Binghamton	100 sqft glazing	179	0.226
	Buffalo	100 sqft glazing	227	0.226
	Massena	100 sqft glazing	223	0.226
	NYC	100 sqft glazing	331	0.136
	Syracuse	100 sqft glazing	240	0.248
Primary School	Albany	100 sqft glazing	564	0.328
	Binghamton	100 sqft glazing	474	0.222
	Buffalo	100 sqft glazing	536	0.175
	Massena	100 sqft glazing	536	0.151
	NYC	100 sqft glazing	688	0.308
	Syracuse	100 sqft glazing	549	0.385

Building Type	City	Unit	KWh/unit	KW/unit
Small Office	Albany	100 sqft glazing	312	0.206
	Binghamton	100 sqft glazing	261	0.131
	Buffalo	100 sqft glazing	282	0.140
	Massena	100 sqft glazing	295	0.201
	NYC	100 sqft glazing	366	0.136
	Syracuse	100 sqft glazing	306	0.153
Small Retail	Albany	100 sqft glazing	358	0.186
	Binghamton	100 sqft glazing	312	0.168
	Buffalo	100 sqft glazing	319	0.177
	Massena	100 sqft glazing	332	0.224
	NYC	100 sqft glazing	431	0.168
	Syracuse	100 sqft glazing	362	0.214

Large Office Buildings

HVAC System	Chiller	City	Unit	kWh/unit	kW/unit
CAV no econ	Air cooled	Albany	100 sqft glazing	671	0.086
		Binghamton	100 sqft glazing	614	0.039
		Buffalo	100 sqft glazing	560	0.054
		Massena	100 sqft glazing	671	0.062
		NYC	100 sqft glazing	860	0.046
		Syracuse	100 sqft glazing	641	0.076
CAV econ	Air cooled	Albany	100 sqft glazing	479	0.081
		Binghamton	100 sqft glazing	426	0.025
		Buffalo	100 sqft glazing	395	0.034
		Massena	100 sqft glazing	500	0.041
		NYC	100 sqft glazing	675	0.153
		Syracuse	100 sqft glazing	467	0.000
VAV econ	Air cooled	Albany	100 sqft glazing	465	0.066
		Binghamton	100 sqft glazing	395	0.074
		Buffalo	100 sqft glazing	409	0.060
		Massena	100 sqft glazing	428	0.160
		NYC	100 sqft glazing	673	0.066
		Syracuse	100 sqft glazing	492	0.111
CAV no econ	Water cooled	Albany	100 sqft glazing	592	0.051
		Binghamton	100 sqft glazing	531	0.025
		Buffalo	100 sqft glazing	488	0.026
		Massena	100 sqft glazing	583	0.023
		NYC	100 sqft glazing	757	0.024
		Syracuse	100 sqft glazing	555	0.027
CAV econ	Water cooled	Albany	100 sqft glazing	449	0.009
		Binghamton	100 sqft glazing	408	0.000
		Buffalo	100 sqft glazing	372	0.000
		Massena	100 sqft glazing	470	0.031
		NYC	100 sqft glazing	622	0.026
		Syracuse	100 sqft glazing	434	0.000
VAV econ	Water cooled	Albany	100 sqft glazing	432	0.042
		Binghamton	100 sqft glazing	374	0.017
		Buffalo	100 sqft glazing	382	0.076
		Massena	100 sqft glazing	395	0.155
		NYC	100 sqft glazing	604	0.014
		Syracuse	100 sqft glazing	449	0.101

Hospitals

HVAC System	Chiller	City	Unit	kWh/unit	kW/unit
CAV no econ	Air cooled	Albany	100 sqft glazing	510	0.008
		Binghamton	100 sqft glazing	461	0.008
		Buffalo	100 sqft glazing	439	0.103
		Massena	100 sqft glazing	281	0.104
		NYC	100 sqft glazing	596	0.111
		Syracuse	100 sqft glazing	540	0.113
CAV econ	Air cooled	Albany	100 sqft glazing	319	0.079
		Binghamton	100 sqft glazing	341	0.061
		Buffalo	100 sqft glazing	299	0.069
		Massena	100 sqft glazing	319	0.079
		NYC	100 sqft glazing	255	0.071
		Syracuse	100 sqft glazing	303	0.077
VAV econ	Air cooled	Albany	100 sqft glazing	408	0.008
		Binghamton	100 sqft glazing	318	0.000
		Buffalo	100 sqft glazing	300	0.059
		Massena	100 sqft glazing	408	0.008
		NYC	100 sqft glazing	430	0.196
		Syracuse	100 sqft glazing	412	0.109
CAV no econ	Water cooled	Albany	100 sqft glazing	416	0.079
		Binghamton	100 sqft glazing	388	0.032
		Buffalo	100 sqft glazing	359	0.067
		Massena	100 sqft glazing	416	0.079
		NYC	100 sqft glazing	461	0.071
		Syracuse	100 sqft glazing	418	0.061
CAV econ	Water cooled	Albany	100 sqft glazing	319	0.079
		Binghamton	100 sqft glazing	341	0.061
		Buffalo	100 sqft glazing	299	0.069
		Massena	100 sqft glazing	319	0.079
		NYC	100 sqft glazing	255	0.071
		Syracuse	100 sqft glazing	303	0.077
VAV econ	Water cooled	Albany	100 sqft glazing	320	0.008
		Binghamton	100 sqft glazing	249	0.020
		Buffalo	100 sqft glazing	225	0.018
		Massena	100 sqft glazing	320	0.008
		NYC	100 sqft glazing	330	0.107
		Syracuse	100 sqft glazing	327	0.073

Unit Therm Savings

Small Commercial Buildings

Building Type	City	Unit	Therm/unit
Assembly	Albany	100 sqft glazing	87
	Binghamton	100 sqft glazing	97
	Buffalo	100 sqft glazing	88
	Massena	100 sqft glazing	183
	NYC	100 sqft glazing	30
	Syracuse	100 sqft glazing	69
Big Box Retail	Albany	100 sqft glazing	61
	Binghamton	100 sqft glazing	58
	Buffalo	100 sqft glazing	64
	Massena	100 sqft glazing	79
	NYC	100 sqft glazing	24
	Syracuse	100 sqft glazing	63
Fast Food	Albany	100 sqft glazing	81
	Binghamton	100 sqft glazing	87
	Buffalo	100 sqft glazing	94
	Messina	100 sqft glazing	89
	NYC	100 sqft glazing	65
	Syracuse	100 sqft glazing	83
Full Service Restaurant	Albany	100 sqft glazing	56
	Binghamton	100 sqft glazing	60
	Buffalo	100 sqft glazing	69
	Massena	100 sqft glazing	62
	NYC	100 sqft glazing	52
	Syracuse	100 sqft glazing	65
Light Industrial	Albany	100 sqft glazing	45
	Binghamton	100 sqft glazing	35
	Buffalo	100 sqft glazing	48
	Massena	100 sqft glazing	48
	NYC	100 sqft glazing	21
	Syracuse	100 sqft glazing	39
Primary School	Albany	100 sqft glazing	60
	Binghamton	100 sqft glazing	69
	Buffalo	100 sqft glazing	73
	Massena	100 sqft glazing	69
	NYC	100 sqft glazing	44
	Syracuse	100 sqft glazing	62
Small Office	Albany	100 sqft glazing	43
	Binghamton	100 sqft glazing	48
	Buffalo	100 sqft glazing	51
	Massena	100 sqft glazing	52
	NYC	100 sqft glazing	30
	Syracuse	100 sqft glazing	45

Building Type	City	Unit	Therm/unit
Small Retail	Albany	100 sqft glazing	65
	Binghamton	100 sqft glazing	71
	Buffalo	100 sqft glazing	74
	Massena	100 sqft glazing	72
	NYC	100 sqft glazing	42
	Syracuse	100 sqft glazing	70

Large Office Building (Central Plant)

HVAC System	Chiller	City	Unit	Therm/unit
CAV all	All	Albany	100 sqft glazing	11.2
		Binghamton	100 sqft glazing	17.3
		Buffalo	100 sqft glazing	12.6
		Massena	100 sqft glazing	13.6
		NYC	100 sqft glazing	14.4
		Syracuse	100 sqft glazing	10.4
VAV all	All	Albany	100 sqft glazing	15.7
		Binghamton	100 sqft glazing	15.0
		Buffalo	100 sqft glazing	17.0
		Massena	100 sqft glazing	13.3
		NYC	100 sqft glazing	16.9
		Syracuse	100 sqft glazing	18.0

Hospital (Central Plant)

HVAC System	Chiller	City	Unit	Therm/unit
CAV all	All	Albany	100 sqft glazing	54.4
		Binghamton	100 sqft glazing	80.2
		Buffalo	100 sqft glazing	70.6
		Massena	100 sqft glazing	54.4
		NYC	100 sqft glazing	-23.0
		Syracuse	100 sqft glazing	57.0
VAV all	All	Albany	100 sqft glazing	13.9
		Binghamton	100 sqft glazing	26.3
		Buffalo	100 sqft glazing	25.1
		Massena	100 sqft glazing	13.9
		NYC	100 sqft glazing	-17.0
		Syracuse	100 sqft glazing	6.1

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to be single pane clear glass with a solar heat gain coefficient of 0.87 and U-value of 1.2 Btu/hr-SF-deg F

Compliance Efficiency from which incentives are calculated

The efficient glazing must have a solar heat gain coefficient of 0.40 or less and U-value of 0.57 Btu/hr-SF-deg F or less

Operating Hours

The HVAC system operating hours vary by building type. See Appendix A

Non-Electric Benefits - Annual Fossil Fuel Savings

N/A

Notes & References

1. Glazing properties taken from ASHRAE Handbook of Fundamentals
2. High performance glass conforms to ASHRAE Standard 90.1 – 2004.

Revision Number
0

WINDOW FILM

Description of Measure

Window films with reduced solar heat gain coefficient applied to single pane clear glass in commercial buildings.

Method for Calculating Summer Peak Demand and Energy Savings

Gross Summer Coincident Demand Savings

ΔkW_S = Glazing area (100 SF) $\times$ (ΔkW/100 SF) $\times$ $DF_S \times CF_S$

Gross Annual Energy Savings

ΔkWh = Glazing area (100 SF) $\times$ (ΔkWh/ 100 SF)

Δtherm = Glazing area (100 SF) $\times$ (Δtherm/ 100 SF)

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
Glazing area	= Aperture area of windows treated by window films in 100 SF
DF	= demand diversity factor
CF	= coincidence factor
ΔkW/100 SF	= electricity demand savings per 100 SF of glazing area
ΔkWh/100 SF	= electricity consumption savings per 100 SF of glazing area
Δtherm/100 SF	= gas consumption impact per 100 square foot of glazing.

The ***demand diversity factor*** is used to account for the fact that not all HVAC systems in all buildings treated by window films were installed are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of the HVAC systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

DF = 0.8
CF = 1.0

Unit energy and demand savings were calculated from a DOE-2.2 simulation of a series of prototypical small commercial buildings. The prototype building characteristics are

described in Appendix A. The unit energy and demand savings for eight building types across five different cities in NY are shown below:

Electricity Unit Savings
Small commercial buildings

Building	City	Unit	KWh/unit	KW/unit
Assembly	Albany	100 sqft glazing	388	0.067
	Binghamton	100 sqft glazing	333	0.138
	Buffalo	100 sqft glazing	358	0.214
	Massena	100 sqft glazing	268	0.090
	NYC	100 sqft glazing	591	0.138
	Syracuse	100 sqft glazing	436	0.190
Big Box Retail	Albany	100 sqft glazing	396	0.158
	Binghamton	100 sqft glazing	370	0.090
	Buffalo	100 sqft glazing	368	0.158
	Messina	100 sqft glazing	354	0.236
	NYC	100 sqft glazing	554	0.146
	Syracuse	100 sqft glazing	402	0.180
Fast Food	Albany	100 sqft glazing	286	0.086
	Binghamton	100 sqft glazing	242	0.086
	Buffalo	100 sqft glazing	263	0.189
	Messina	100 sqft glazing	270	0.086
	NYC	100 sqft glazing	390	0.017
	Syracuse	100 sqft glazing	299	0.172
Full Service Restaurant	Albany	100 sqft glazing	180	0.103
	Binghamton	100 sqft glazing	149	0.120
	Buffalo	100 sqft glazing	160	0.138
	Massena	100 sqft glazing	168	0.120
	NYC	100 sqft glazing	244	0.034
	Syracuse	100 sqft glazing	187	0.138
Light Industrial	Albany	100 sqft glazing	265	0.203
	Binghamton	100 sqft glazing	186	0.248
	Buffalo	100 sqft glazing	215	0.158
	Massena	100 sqft glazing	222	0.226
	NYC	100 sqft glazing	352	0.136
	Syracuse	100 sqft glazing	266	0.271
Primary School	Albany	100 sqft glazing	448	0.246
	Binghamton	100 sqft glazing	294	0.207
	Buffalo	100 sqft glazing	380	0.399
	Massena	100 sqft glazing	396	0.189
	NYC	100 sqft glazing	558	0.272
	Syracuse	100 sqft glazing	413	0.470
Small Office	Albany	100 sqft glazing	334	0.188
	Binghamton	100 sqft glazing	273	0.144
	Buffalo	100 sqft glazing	292	0.153

Building	City	Unit	KWh/unit	KW/unit
	Massena	100 sqft glazing	302	0.188
	NYC	100 sqft glazing	406	0.127
	Syracuse	100 sqft glazing	319	0.171
Small Retail	Albany	100 sqft glazing	345	0.177
	Binghamton	100 sqft glazing	296	0.186
	Buffalo	100 sqft glazing	303	0.168
	Massena	100 sqft glazing	293	0.214
	NYC	100 sqft glazing	440	0.140
	Syracuse	100 sqft glazing	334	0.205

Large Office Building (Central Plant)

HVAC System	Chiller	City	Unit	kWh/unit	kW/unit
CAV no econ	Air cooled	Albany	100 sqft glazing	403	0.077
		Binghamton	100 sqft glazing	379	0.040
		Buffalo	100 sqft glazing	333	0.053
		Massena	100 sqft glazing	375	0.064
		NYC	100 sqft glazing	630	0.045
		Syracuse	100 sqft glazing	362	0.075
CAV econ		Albany	100 sqft glazing	282	0.073
		Binghamton	100 sqft glazing	237	0.025
		Buffalo	100 sqft glazing	219	0.034
		Massena	100 sqft glazing	281	0.022
		NYC	100 sqft glazing	502	0.153
		Syracuse	100 sqft glazing	266	0.000
VAV econ		Albany	100 sqft glazing	395	0.063
		Binghamton	100 sqft glazing	336	0.074
		Buffalo	100 sqft glazing	343	0.056
		Massena	100 sqft glazing	335	0.153
		NYC	100 sqft glazing	640	0.068
		Syracuse	100 sqft glazing	414	0.108
CAV no econ	Water cooled	Albany	100 sqft glazing	317	0.046
		Binghamton	100 sqft glazing	279	0.026
		Buffalo	100 sqft glazing	247	0.026
		Massena	100 sqft glazing	290	0.025
		NYC	100 sqft glazing	499	0.023
		Syracuse	100 sqft glazing	262	0.028
CAV econ		Albany	100 sqft glazing	227	0.009
		Binghamton	100 sqft glazing	191	0.000
		Buffalo	100 sqft glazing	168	0.000
		Massena	100 sqft glazing	225	0.021
		NYC	100 sqft glazing	407	0.026
		Syracuse	100 sqft glazing	197	0.000
VAV econ		Albany	100 sqft glazing	332	0.042
		Binghamton	100 sqft glazing	281	0.016

		Buffalo	100 sqft glazing	285	0.083
		Massena	100 sqft glazing	264	0.159
		NYC	100 sqft glazing	539	0.015
		Syracuse	100 sqft glazing	331	0.108

Hospital

HVAC System	Chiller	City	Unit	kWh/unit	kW/unit
CAV no econ	Air cooled	Albany	100 sqft glazing	529	0.008
		Binghamton	100 sqft glazing	477	0.008
		Buffalo	100 sqft glazing	466	0.105
		Massena	100 sqft glazing	307	0.105
		NYC	100 sqft glazing	610	0.109
		Syracuse	100 sqft glazing	561	0.115
CAV econ	Air cooled	Albany	100 sqft glazing	389	0.008
		Binghamton	100 sqft glazing	408	0.008
		Buffalo	100 sqft glazing	372	0.109
		Massena	100 sqft glazing	389	0.008
		NYC	100 sqft glazing	354	0.109
		Syracuse	100 sqft glazing	401	0.117
VAV econ	Air cooled	Albany	100 sqft glazing	470	0.008
		Binghamton	100 sqft glazing	291	0.101
		Buffalo	100 sqft glazing	365	0.063
		Massena	100 sqft glazing	470	0.008
		NYC	100 sqft glazing	472	0.194
		Syracuse	100 sqft glazing	461	0.119
CAV no econ	Water cooled	Albany	100 sqft glazing	420	0.077
		Binghamton	100 sqft glazing	393	0.036
		Buffalo	100 sqft glazing	368	0.069
		Massena	100 sqft glazing	420	0.077
		NYC	100 sqft glazing	464	0.069
		Syracuse	100 sqft glazing	424	0.063
CAV econ	Water cooled	Albany	100 sqft glazing	311	0.077
		Binghamton	100 sqft glazing	320	0.063
		Buffalo	100 sqft glazing	286	0.069
		Massena	100 sqft glazing	311	0.077
		NYC	100 sqft glazing	267	0.069
		Syracuse	100 sqft glazing	306	0.079
VAV econ	Water cooled	Albany	100 sqft glazing	368	0.008
		Binghamton	100 sqft glazing	299	0.020
		Buffalo	100 sqft glazing	279	0.024
		Massena	100 sqft glazing	368	0.008
		NYC	100 sqft glazing	360	0.105
		Syracuse	100 sqft glazing	364	0.081

Unit Therm Savings

Small Commercial Buildings

Building Type	City	Unit	Therm/unit
Assembly	Albany	100 sqft glazing	-84
	Binghamton	100 sqft glazing	-93
	Buffalo	100 sqft glazing	-82
	Messina	100 sqft glazing	-91
	NYC	100 sqft glazing	-58
	Syracuse	100 sqft glazing	-66
Big Box Retail	Albany	100 sqft glazing	-58
	Binghamton	100 sqft glazing	-56
	Buffalo	100 sqft glazing	-50
	Messina	100 sqft glazing	-72
	NYC	100 sqft glazing	-39
	Syracuse	100 sqft glazing	-48
Fast Food	Albany	100 sqft glazing	-85
	Binghamton	100 sqft glazing	-83
	Buffalo	100 sqft glazing	-77
	Messina	100 sqft glazing	-83
	NYC	100 sqft glazing	-73
	Syracuse	100 sqft glazing	-77
Full Service Restaurant	Albany	100 sqft glazing	-69
	Binghamton	100 sqft glazing	-68
	Buffalo	100 sqft glazing	-62
	Massena	100 sqft glazing	-66
	NYC	100 sqft glazing	-60
	Syracuse	100 sqft glazing	-62
Light Industrial	Albany	100 sqft glazing	-69
	Binghamton	100 sqft glazing	-77
	Buffalo	100 sqft glazing	-72
	Massena	100 sqft glazing	-75
	NYC	100 sqft glazing	-63
	Syracuse	100 sqft glazing	-64
Primary School	Albany	100 sqft glazing	-103
	Binghamton	100 sqft glazing	-77
	Buffalo	100 sqft glazing	-98
	Massena	100 sqft glazing	-107
	NYC	100 sqft glazing	-100
	Syracuse	100 sqft glazing	-101
Small Office	Albany	100 sqft glazing	-47
	Binghamton	100 sqft glazing	-49
	Buffalo	100 sqft glazing	-44
	Massena	100 sqft glazing	-52
	NYC	100 sqft glazing	-36
	Syracuse	100 sqft glazing	-44

Building Type	City	Unit	Therm/unit
Small Retail	Albany	100 sqft glazing	-72
	Binghamton	100 sqft glazing	-74
	Buffalo	100 sqft glazing	-68
	Massena	100 sqft glazing	-84
	NYC	100 sqft glazing	-63
	Syracuse	100 sqft glazing	-70

Large Office Buildings (Central Plant)

HVAC System	Chiller	City	Unit	Therm/unit
CAV all	All	Albany	100 sqft glazing	-33.9
		Binghamton	100 sqft glazing	-27.5
		Buffalo	100 sqft glazing	-31.2
		Massena	100 sqft glazing	-39.6
		NYC	100 sqft glazing	-22.8
		Syracuse	100 sqft glazing	-34.5
VAV all		Albany	100 sqft glazing	-17.2
		Binghamton	100 sqft glazing	-15.8
		Buffalo	100 sqft glazing	-14.4
		Massena	100 sqft glazing	-25.9
		NYC	100 sqft glazing	
		Syracuse	100 sqft glazing	-13.1

Hospital

HVAC System	Chiller	City	Unit	Therm/unit
CAV all	All	Albany	100 sqft glazing	-25.4
		Binghamton	100 sqft glazing	-46.2
		Buffalo	100 sqft glazing	-32.6
		Massena	100 sqft glazing	-45.3
		NYC	100 sqft glazing	-37.7
		Syracuse	100 sqft glazing	-36.6
VAV all	All	Albany	100 sqft glazing	-47.5
		Binghamton	100 sqft glazing	-50.3
		Buffalo	100 sqft glazing	-42.4
		Massena	100 sqft glazing	-57.5
		NYC	100 sqft glazing	-26.5
		Syracuse	100 sqft glazing	-44.1

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to be single pane clear glass with a solar heat gain coefficient of 0.87 and U-value of 1.2 Btu/hr-SF-deg F

Compliance Efficiency from which incentives are calculated

The window film is assumed to provide a solar heat gain coefficient of 0.40 or less.

Operating Hours

The HVAC system operating hours vary by building type. See Appendix A

Non-Electric Benefits - Annual Fossil Fuel Savings

N/A

Notes & References

1. Window film properties taken from ASHRAE Handbook of Fundamentals

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COOL ROOF

Description of Measure

Roofing material with reduced solar absorptance. The cool roof is assumed to have a solar absorptance of 0.3 compared to a standard roof with solar absorptance of 0.8.

Method for Calculating Summer Peak Demand and Energy Savings

Gross Summer Coincident Demand Savings

$\Delta kW_S = kSF\ cool\ roof \times (\Delta kW/kSF) \times DF_S \times CF_S$

Gross Annual Energy Savings

$\Delta kWh = kSF\ cool\ roof \times (\Delta kWh/kSF)$

$\Delta therm = kSF\ cool\ roof \times (\Delta therm/kSF)$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
kSF cool roof	= thousand square feet of cool roof installed over a cooled space
DF	= demand diversity factor
CF	= coincidence factor
ΔkW/kSF	= electricity demand savings per thousand square foot of cool roof
ΔkWh/kSF	= electricity consumption savings per square foot of cool roof
Δtherm/kSF	= gas consumption impact per thousand square foot of cool roof installed over a heated space.

The ***demand diversity factor*** is used to account for the fact that not all HVAC systems in all buildings where cool roofs were installed are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of the HVAC systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

DF = 0.8
CF = 1.0

Unit energy and demand savings were calculated from a DOE-2.2 simulation of a series of prototypical small commercial buildings. The prototype building characteristics are described in Appendix A. The unit energy and demand savings for eight building types across five different cities in NY are shown in Table below:

Unit Electricity Impacts

Small Commercial Buildings

Building Type	City	Unit	KWh/unit	KW/unit
Assembly	Albany	1000 sq ft roof area	138	0.071
	Buffalo	1000 sq ft roof area	119	0.056
	Massena	1000 sq ft roof area	135	0.065
	NYC	1000 sq ft roof area	168	0.059
	Syracuse	1000 sq ft roof area	150	0.088
Big Box Retail	Albany	1000 sq ft roof area	155	0.124
	Buffalo	1000 sq ft roof area	132	0.067
	Massena	1000 sq ft roof area	150	0.083
	NYC	1000 sq ft roof area	187	0.065
	Syracuse	1000 sq ft roof area	165	0.106
Fast Food	Albany	1000 sq ft roof area	117	0.050
	Buffalo	1000 sq ft roof area	101	0.050
	Messina	1000 sq ft roof area	124	0.050
	NYC	1000 sq ft roof area	170	0.000
	Syracuse	1000 sq ft roof area	131	0.050
Full Service Restaurant	Albany	1000 sq ft roof area	279	0.200
	Buffalo	1000 sq ft roof area	233	0.150
	Massena	1000 sq ft roof area	282	0.150
	NYC	1000 sq ft roof area	344	0.050
	Syracuse	1000 sq ft roof area	307	0.250
Light Industrial	Albany	1000 sq ft roof area	90	0.073
	Buffalo	1000 sq ft roof area	74	0.080
	Massena	1000 sq ft roof area	87	0.096
	NYC	1000 sq ft roof area	118	0.055
	Syracuse	1000 sq ft roof area	102	0.135
Primary School	Albany	1000 sq ft roof area	196	0.624
	Buffalo	1000 sq ft roof area	152	0.426
	Massena	1000 sq ft roof area	191	0.116
	NYC	1000 sq ft roof area	270	0.652
	Syracuse	1000 sq ft roof area	202	0.506
Small Office	Albany	1000 sq ft roof area	151	0.080
	Buffalo	1000 sq ft roof area	130	0.040
	Massena	1000 sq ft roof area	152	0.080
	NYC	1000 sq ft roof area	169	0.040
	Syracuse	1000 sq ft roof area	157	0.060

Building Type	City	Unit	KWh/unit	KW/unit
Small Retail	Albany	1000 sq ft roof area	175	0.109
	Buffalo	1000 sq ft roof area	143	0.078
	Massena	1000 sq ft roof area	164	0.125
	NYC	1000 sq ft roof area	203	0.062
	Syracuse	1000 sq ft roof area	184	0.109

Hospital

HVAC System	Chiller	City	Unit	kWh/unit	kW/unit
CAV no econ	Air cooled	Albany	1000 sq ft roof area	169	0.001
		Binghamton	1000 sq ft roof area	161	0.001
		Buffalo	1000 sq ft roof area	149	0.067
		Massena	1000 sq ft roof area	135	0.109
		NYC	1000 sq ft roof area	172	0.085
		Syracuse	1000 sq ft roof area	173	0.091
CAV econ	Air cooled	Albany	1000 sq ft roof area	73	0.001
		Binghamton	1000 sq ft roof area	73	0.001
		Buffalo	1000 sq ft roof area	77	0.054
		Massena	1000 sq ft roof area	73	0.001
		NYC	1000 sq ft roof area	114	0.085
		Syracuse	1000 sq ft roof area	95	0.091
VAV econ	Air cooled	Albany	1000 sq ft roof area	144	0.078
		Binghamton	1000 sq ft roof area	122	0.005
		Buffalo	1000 sq ft roof area	126	0.060
		Massena	1000 sq ft roof area	144	0.078
		NYC	1000 sq ft roof area	168	0.130
		Syracuse	1000 sq ft roof area	163	0.166
CAV no econ	Water cooled	Albany	1000 sq ft roof area	123	0.062
		Binghamton	1000 sq ft roof area	115	0.017
		Buffalo	1000 sq ft roof area	108	0.043
		Massena	1000 sq ft roof area	123	0.062
		NYC	1000 sq ft roof area	126	0.052
		Syracuse	1000 sq ft roof area	118	0.041
CAV econ	Water cooled	Albany	1000 sq ft roof area	56	0.062
		Binghamton	1000 sq ft roof area	54	0.031
		Buffalo	1000 sq ft roof area	55	0.035
		Massena	1000 sq ft roof area	56	0.062
		NYC	1000 sq ft roof area	88	0.052
		Syracuse	1000 sq ft roof area	67	0.041
VAV econ	Water cooled	Albany	1000 sq ft roof area	110	0.078
		Binghamton	1000 sq ft roof area	97	0.017
		Buffalo	1000 sq ft roof area	99	0.046
		Massena	1000 sq ft roof area	110	0.078
		NYC	1000 sq ft roof area	125	0.068
		Syracuse	1000 sq ft roof area	125	0.094

Unit therm impacts

Small Commercial Buildings

Building Type	City	Unit	Therm/unit
Assembly	Albany	1000 sq ft roof area	-16
	Buffalo	1000 sq ft roof area	-16
	Massena	1000 sq ft roof area	-19
	NYC	1000 sq ft roof area	-11
	Syracuse	1000 sq ft roof area	-18
Big Box Retail	Albany	1000 sq ft roof area	-11
	Buffalo	1000 sq ft roof area	-10
	Massena	1000 sq ft roof area	-14
	NYC	1000 sq ft roof area	-6
	Syracuse	1000 sq ft roof area	-12
Fast Food	Albany	1000 sq ft roof area	-28
	Buffalo	1000 sq ft roof area	-24
	Messina	1000 sq ft roof area	-25
	NYC	1000 sq ft roof area	-19
	Syracuse	1000 sq ft roof area	-28
Full Service Restaurant	Albany	1000 sq ft roof area	-47
	Buffalo	1000 sq ft roof area	-40
	Massena	1000 sq ft roof area	-47
	NYC	1000 sq ft roof area	-30
	Syracuse	1000 sq ft roof area	-47
Light Industrial	Albany	1000 sq ft roof area	-20
	Buffalo	1000 sq ft roof area	-18
	Massena	1000 sq ft roof area	-21
	NYC	1000 sq ft roof area	-14
	Syracuse	1000 sq ft roof area	-20
Primary School	Albany	1000 sq ft roof area	-29
	Buffalo	1000 sq ft roof area	-27
	Massena	1000 sq ft roof area	-32
	NYC	1000 sq ft roof area	-22
	Syracuse	1000 sq ft roof area	-33
Small Office	Albany	1000 sq ft roof area	-12
	Buffalo	1000 sq ft roof area	-11
	Massena	1000 sq ft roof area	-14
	NYC	1000 sq ft roof area	-8
	Syracuse	1000 sq ft roof area	-14
Small Retail	Albany	1000 sq ft roof area	-17
	Buffalo	1000 sq ft roof area	-15
	Massena	1000 sq ft roof area	-21
	NYC	1000 sq ft roof area	-12
	Syracuse	1000 sq ft roof area	-18

Hospital

HVAC System	Chiller	City	Unit	Therm/unit
CAV all	All	Albany	1000 sq ft roof area	-10.6
		Binghamton	1000 sq ft roof area	-5.9
		Buffalo	1000 sq ft roof area	-6.0
		Massena	1000 sq ft roof area	-10.6
		NYC	1000 sq ft roof area	-8.1
		Syracuse	1000 sq ft roof area	-8.3
VAV all	All	Albany	1000 sq ft roof area	-13.6
		Binghamton	1000 sq ft roof area	-8.6
		Buffalo	1000 sq ft roof area	-8.0
		Massena	1000 sq ft roof area	-13.6
		NYC	1000 sq ft roof area	-3.9
		Syracuse	1000 sq ft roof area	-12.0

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to be roofing material with a solar absorptance of 0.8

Compliance Efficiency from which incentives are calculated

The cool roof is assumed to have a solar absorptance of 0.3 compared to a standard roof with solar absorptance of 0.8.

Operating Hours

The HVAC system operating hours vary by building type. See Appendix A

Non-Electric Benefits - Annual Fossil Fuel Savings

Reducing roofing material solar absorptance increases space heating requirements. The therm impacts are detailed above.

Notes & References

1. Roof absorptivity assumptions taken from California Title 24 Standards for conventional and cool roofs

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PACKAGED AIR CONDITIONERS

Description of Measure

Rooftop and split system AC and heat pumps (cooling mode) in small commercial building applications.

Method for Calculating Summer Peak Demand and Energy Savings

$$\Delta kW_S = units \times \frac{tons}{unit} \times RLF \times \left(\frac{12}{EER_{base,\,pk}} - \frac{12}{EER_{ee,\,pk}} \right) \times DF_S \times CF_S$$

$$\Delta kWh = units \times \frac{tons}{unit} \times RLF \times \left(\frac{12}{\overline{EER}_{base}} - \frac{12}{\overline{EER}_{ee}} \right) \times CLH$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= the number of air conditioning units installed under the program
tons/unit	= tons of air conditioning per unit, based on nameplate data
$\overline{EER}$	= average energy efficiency ratio over the cooling season. (Btu/watt-hour)
EER_{pk}	= energy efficiency ratio under peak conditions (Btu/watt-hour)
CLH	= cooling load hours
RLF	= rated load factor
DF	= demand diversity factor
CF	= coincidence factor
12	= conversion factor (kBtuh/ton)

The ***rated load factor*** is the ratio of the peak cooling load imposed on the cooling equipment to the total rated cooling capacity. This factor compensates for oversizing of the air conditioning unit.

$$RLF = \frac{\text{peak cooling load}}{\text{nameplate capacity}}$$

Cooling load hours are defined as the ratio of the annual cooling load to the peak cooling load:

$$CLH = \frac{\text{Annual Cooling Load (Btu)}}{\text{Peak Cooling Load (Btu / hr)}}$$

Cooling **equivalent full-load hours** (EFLH) are sometimes used to estimate total energy savings. EFLH is defined as follows:

$$\text{EFLH} = \frac{\text{Annual kWh}_{\text{cooling}}}{\text{kW}_{\text{peak, cooling}}}$$

Since EFLH are calculated from the total kWh and peak kW of the air conditioner, the efficiency characteristics of the air conditioner affect the EFLH. EFLH are converted to CLH using the following equation:

$$\text{CLH} = \text{EFLH} \times \frac{\overline{\text{EER}}}{\text{EER}_{\text{pk}}}$$

where:

EFLH = equivalent full-load hours
$\overline{\text{EER}}$ = average air conditioning equipment energy efficiency ratio
EER_{pk} = air conditioning equipment energy efficiency ratio under peak conditions

The ***demand diversity factor*** is used to account for the fact that not all HVAC systems in all buildings in the population are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of a population of HVAC systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

Recommended values for the rated load factor, demand diversity factor and coincidence factors are shown below:

Parameter	Recommended Values
Rated Load Factor	0.8
Demand diversity factor	0.8
Coincidence factor	1.0

The $\overline{\text{EER}}$ is an estimate of the seasonal energy efficiency for an average US city. The $\mathbf{EER_{pk}}$ is an estimate of the efficiency of the unit under peak summer conditions. Recommended values from the 2004-5 DEER update study for baseline and measure efficiency are shown in the table below:

Baseline and Measure Performance Assumptions

Equipment Category	Capacity Range (Btu/hr)	Baseline Efficiency		Measure Efficiency	
		Average	Peak	Average	Peak
Unitary A/C (1) phase	<65,000 1 Ph	13.0	11.1	14.0	12.2
Unitary A/C (3) phase	<65,000 3 Ph	12.0	10.4	13.0	11.1
Unitary A/C (3) phase	65,000 - 135,000	9.1	10.1	9.6	11.0
Unitary A/C (3) phase	135,000 - 240,000	8.5	9.5	9.5	11.0
Unitary A/C (3) phase	240,000 - 760,000	8.4	9.3	8.9	10.0
Unitary A/C (3) phase	>760,000	8.1	9.0	8.9	10.0
Unitary HP (1) phase	<65,000 1 Ph	13.0	11.1	14.0	12.2
Unitary HP (3) phase	<65,000 3 Ph	12.0	10.4	13.0	11.1
Unitary HP (3) phase	65,000 - 135,000	8.8	9.9	9.5	11.0
Unitary HP (3) phase	135,000 - 240,000	8.2	9.1	8.8	10.0
Unitary HP (3) phase	>240,000	8.0	8.8	8.8	10.0

Cooling load hours were calculated from a DOE-2.2 simulation of prototypical small commercial buildings. The prototype building characteristics are described in Appendix A. The CLH for eight building types and six different cities in NY are shown below:

Building	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
Primary School	371	330	305	321	492	342
Assembly	597	545	621	519	836	632
Big Box Retail	961	950	1,033	860	1,599	1,039
Fast Food Restaurant	640	626	649	545	806	680
Light Industrial	500	544	529	463	686	536
Full Service Restaurant	546	642	575	486	718	583
Small Retail	803	805	833	749	1,102	848
Small Office	927	893	931	839	1,194	960

Baseline Efficiencies from which savings are calculated

The baseline efficiency for new construction and normal replacement vary by equipment size, and are shown in the Table above.

Compliance Efficiency from which incentives are calculated

See measure EER criteria by system type and size above.

Operating Hours

The operating hours by climate zone and building type are shown in the Table above

Non-Electric Benefits - Annual Fossil Fuel Savings

None anticipated

Notes & References

1. Unit seasonal and peak efficiency data taken from the California DEER update study: 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Itron, Inc. Vancouver, WA. December, 2005. Available at http://www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf

2. Typical values for demand diversity factor (DF), coincidence factor (CF) and rated load factor (RLF) taken from Engineering Methods for Estimating the Impacts of Demand-Side Management Programs. Volume 2: Fundamental Equations for Residential and Commercial End-Uses. TR-100984S Vol 2. Electric Power Research Institute, Palo Alto, CA August, 1993.

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PACKAGED AIR SOURCE HEAT PUMPS

Description of Measure

A heat pump with improved heating season performance factor (HSPF). Note only the heating savings is presented here; cooling savings from an efficient heat pump is the same as the cooling savings for an efficient air conditioner.

Method for Calculating Annual Energy Savings

$$\Delta kWh = units \times \frac{kBtuh}{unit} \times RLF_{heat} \times \left(\frac{1}{\overline{COP}_{base}} - \frac{1}{\overline{COP}_{ee}} \right) \times \frac{HLH}{3.413}$$

where:

ΔkWh	= gross annual energy savings
units	= number of heat pumps installed
kBtuh/unit	= the nominal rating of the heating capacity of the heat pumps in kBtu/hr
$\overline{COP}$	= average heating season coefficient of performance of heat pump
HLH	= heating load hours
RLF_{heat}	= heating mode rated load factor
3.413	= conversion factor (Btu/Wh)

The ***rated load factor*** is the ratio of the peak heating load imposed on the heating equipment to the total rated heating capacity, including the supplemental heating (strip heat). This factor compensates for oversizing of the heat pump.

$$RLF = \frac{peak\ heating\ load}{nameplate\ \text{heating}\ capacity}$$

Recommended value for RLF is 0.8

The $\overline{COP}$ is an estimate of the seasonal heating energy efficiency for an average US city. The average COP in the equation above is equal to the HSPF/3.413. Programs should use the manufacturers' rated HSPF or COP until data can be developed that are more appropriate for NY climates. Efficiency assumptions for heat pumps of different size ranges are shown below:

Equipment Type	Size Range	Baseline Heating Seasonal Efficiency	Measure Heating Seasonal Efficiency
Unitary HP (1) phase	<65,000 1 Ph	8.1 HSPF	8.6 HSPF
Unitary HP (3) phase	<65,000 3 Ph	7.7 HSPF	8.1 HSPF
Unitary HP (3) phase	65,000 - 135,000	3.2 COP	3.4 COP
Unitary HP (3) phase	135,000 - 240,000	3.1 COP	3.3 COP
Unitary HP (3) phase	>240,000	3.1 COP	3.3 COP

Heating load hours are defined as the ratio of the annual building heating load to the peak building heating load:

$$\text{HLH} = \frac{\textit{Annual}\ \text{Heating Load (Btu)}}{\textit{Peak}\ \text{Heating Load (Btu/hr)}}$$

Heating load hours were calculated from a DOE-2.2 simulation of prototypical small commercial buildings. The prototype building characteristics are described in Appendix A. The HLH for eight building types and six different cities in NY are shown below:

Building	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
Primary School	1,625	1,612	1,696	1,639	1,050	1,545
Assembly	1,201	1,257	1,237	1,448	754	1,129
Big Box Retail	693	636	696	775	239	653
Fast Food Restaurant	1,782	1,907	1,864	2,112	1,016	1,689
Light Industrial	1,597	1,650	1,485	1,607	892	1,500
Full Service Restaurant	1,878	2,003	1,959	2,182	1,026	1,774
Small Retail	1,230	1,257	1,275	1,417	681	1,211
Small Office	934	991	950	1,076	539	938

Baseline Efficiencies from which savings are calculated

The baseline efficiency for new construction and normal replacement vary by equipment size, and are shown in the Table above.

Compliance Efficiency from which incentives are calculated

See measure efficiency specifications in table above.

Operating Hours

Heating load hours vary by building type and city. See table above.

Non-Electric Benefits - Annual Fossil Fuel Savings

None anticipated – electric heating system

Notes & References

1. Unit seasonal and peak efficiency data taken from the California DEER update study: 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Itron, Inc. Vancouver, WA. December, 2005. Available at http://www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf

2. Typical values for rated load factor (RLF) taken from Engineering Methods for Estimating the Impacts of Demand-Side Management Programs. Volume 2: Fundamental Equations for Residential and Commercial End-Uses. TR-100984S Vol 2. Electric Power Research Institute, Palo Alto, CA August, 1993.

Revision Number
0

HIGH EFFICIENCY FURNACES

Description of Measure

High efficiency furnace sections included in rooftop AC systems and furnaces included in split AC systems. Applications in small commercial buildings utilizing residential gas service.

Method for Calculating Energy Savings

$$\Delta\text{therms} = \text{units} \times \frac{\text{kBtuh}}{\text{unit}} \times \text{RLF}_{\text{heat}} \times \left(\frac{1}{\bar{\eta}_{base} \times \eta_{duct,base}} - \frac{1}{\bar{\eta}_{ee} \times \eta_{duct,ee}} \right) \times \frac{\text{HLH}}{100}$$

where:

Δtherms	= gross annual gas savings
units	= number of furnaces installed
kBtuh/unit	= the nominal rating of the heating capacity of the furnace in kBtu/hr
$\bar{\eta}$	= average heating season efficiency of furnace
η_{duct}	= duct system efficiency
HLH	= heating load hours
RLF_{heat}	= heating mode rated load factor
100	= conversion factor (kBtuh/therm)

The ***rated load factor*** is the ratio of the peak heating load imposed on the heating equipment to the total rated heating capacity. This factor compensates for oversizing of the furnace.

$$\text{RLF}_{\text{heat}} = \frac{peak\ \ heating\ \ load}{nameplate\ \ \text{heating}\ \ capacity}$$

Recommended value for the rated load factor is 0.8.

The ***average seasonal efficiency*** of the furnace is the ratio of the heating output to the fuel input (in consistent units) over a heating season. This factor accounts for combustion efficiency, standby losses, cycling losses, and other sources of inefficiency within the furnace itself. The ***AFUE*** is an estimate of the seasonal heating energy efficiency for an average US city calculated according to a standard US DOE method and reported by the furnace manufacturer. Programs should use the manufacturers' rated AFUE until data can be developed that are more appropriate for NY climates.

The ***duct system efficiency*** accounts for losses from duct systems due to leakage and inadequate insulation. See section on duct leakage sealing and insulation for more information.

Heating load hours are defined as the ratio of the annual building heating load to the peak building heating load:

$$\text{HLH} = \frac{\textit{A}\text{nnual Heating Load (Btu)}}{\textit{Peak}\text{ Heating Load (Btu/hr)}}$$

Heating load hours were calculated from a DOE-2.2 simulation of prototypical small commercial buildings. The prototype building characteristics are described in Appendix A. The HLH for eight building types and six different cities in NY are shown below:

Building	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
Primary School	1,625	1,612	1,696	1,639	1,050	1,545
Assembly	1,201	1,257	1,237	1,448	754	1,129
Big Box Retail	693	636	696	775	239	653
Fast Food Restaurant	1,782	1,907	1,864	2,112	1,016	1,689
Light Industrial	1,597	1,650	1,485	1,607	892	1,500
Full Service Restaurant	1,878	2,003	1,959	2,182	1,026	1,774
Small Retail	1,230	1,257	1,275	1,417	681	1,211
Small Office	934	991	950	1,076	539	938

<u>Baseline Efficiencies from which savings are calculated</u>

The baseline efficiency ($\bar{\eta}_{base}$) is as follows: For new construction and replace on failure: minimum AFUE for new gas furnaces per NAECA is 78%. Common practice generally leads code, but there are no New York specific baseline data on baseline furnace efficiency available at this time.

Distribution system efficiency ($\bar{\eta}_{\text{dist,base}}$) should be set to the unsealed (30% leakage) and uninsulated values from the duct leakage sealing section for the appropriate building type.

<u>Compliance Efficiency from which incentives are calculated</u>

The measure efficiency ($\bar{\eta}_{ee}$) is as follows:
ACEEE recommends two tiers: > 92% and > 95% AFUE

<u>Operating Hours</u>

Operating hour assumptions for the prototypical building models are described in Appendix A.

Non-Gas Benefits - Annual Electric Savings

High efficiency furnaces may be packaged with high efficiency cooling equipment and/or electronically commutated (EC) motors, which may provide electricity savings. Draft fans, when present, will increase electricity consumption.

Notes & References

1. Typical value for rated load factor (RLF) taken from Engineering Methods for Estimating the Impacts of Demand-Side Management Programs. Volume 2: Fundamental Equations for Residential and Commercial End-Uses. TR-100984S Vol 2. Electric Power Research Institute, Palo Alto, CA August, 1993.
2. The HLH values assumed in this section include a 3°F setback of the room temperature setpoint during unoccupied hours. See the section on programmable setback thermostats and Appendix A for more information.

PROGRAMMABLE SETBACK THERMOSTAT

Description of Measure

Programmable setback thermostats applied to air conditioners, heat pumps and/or furnaces and boilers in small commercial buildings.

Method for Calculating Energy Savings

$$\Delta kWh = units \times \left[\frac{ton}{unit} \times RLF_{cool} \times \frac{12}{\overline{EER}_{base} \times \overline{\eta}_{dist,base}} \times CLH \times ESF_{cool} + \frac{kBtuh}{unit} \times RLF_{heat} \times \frac{1}{\overline{\eta}_{base} \times \overline{\eta}_{dist,base}} \times \frac{HLH}{3413} \times ESF_{heat} \right]$$

$$\Delta therms = units \times \frac{kBtuh}{unit} \times RLF_{heat} \times \frac{1}{\overline{\eta}_{base} \times \overline{\eta}_{dist,base}} \times \frac{HLH}{100} \times ESF$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
$\Delta therms$	= gross annual gas savings
units	= the number of air conditioning units installed under the program
tons/unit	= tons of air conditioning per unit, based on nameplate data
$\overline{EER}$	= average energy efficiency ratio over the cooling season. (Btu/watt-hour)
EER_{pk}	= energy efficiency ratio under peak conditions (Btu/watt-hour)
CLH	= cooling load hours
RLF	= rated load factor
DF	= demand diversity factor
CF	= coincidence factor
12	= conversion factor (kBtuh/ton)
ESF	= energy savings factor
kBtuh/unit	= the nominal rating of the heating capacity of the heat pumps in kBtu/hr
$\overline{COP}$	= average heating season coefficient of performance of heat pump
$\overline{\eta}$	= average seasonal efficiency of furnace or boiler
$\overline{\eta}_{dist}$	= average seasonal distribution system efficiency
HLH	= heating load hours
RLF_{heat}	= heating mode rated load factor
3.413	= conversion factor (Btu/Wh)
100	= conversion factor (kBtuh/therm)

The $\overline{EER}$ is an estimate of the seasonal energy efficiency for an average US city. The $\mathbf{EER_{pk}}$ is an estimate of the efficiency of the unit under peak summer conditions. See the section on packaged air conditioners above for more information.

The $\overline{COP}$ is an estimate of the seasonal heating energy efficiency for an average US city. The average COP in the equation above is equal to the HSPF/3.413. See section on air source heat pumps above for more information.

The ***average seasonal efficiency*** of the furnace is the ratio of the heating output to the fuel input (in consistent units) over a heating season. See section on high efficiency furnaces above for more information.

The ***nominal rating of the cooling capacity of the air conditioner or heat pump*** should set equal to the rated capacity of all cooling equipment controlled by a setback thermostat in the building.

The ***nominal rating of the heating capacity of the furnace*** should set equal to the rated output capacity of all heating equipment controlled by a setback thermostat in the commercial facility. .

The ***distribution system efficiency*** accounts for losses from the distribution system due to leakage and/or inadequate insulation. See section on duct leakage sealing and insulation for more information.

The ***Energy Savings Factor*** (ESF) is the ratio of the energy savings resulting from installation of a programmable setback thermostat to the annual cooling energy.

Baseline Efficiencies from which savings are calculated

The baseline efficiency for air conditioners and heat pumps should be set to according to the sections on air conditioner and heat pump efficiency above. Distribution system efficiency ($\overline{\eta}_{dist,base}$) should be set to the unsealed and uninsulated values from the duct leakage sealing section for the appropriate building type.

Studies of residential heating thermostat setpoint behavior indicate some amount of manual setback adjustment in homes without programmable thermostats. This behavior is assumed to be present in the small commercial buildings addressed in this manual. An assumption of 3°F of night time setback behavior is embedded in the prototypical simulation models.

Efficiency from which incentives are calculated

The energy savings factor (ESF) assumption is taken from a study of programmable thermostat savings in Massachusetts conducted by GDS Associates for KeySpan Energy Delivery. The study estimated an energy savings of 3.6% of the annual heating energy

consumption for programmable setback thermostats in residential applications. This assumption is also applied to the small commercial buildings addressed in this manual

Operating Hours

Heating load hours calculated from building energy simulation models described in Appendix A and summarized in the heat pump and furnace sections above.

Non-Electric Benefits - Annual Fossil Fuel Savings

N/A

Notes & References

1. Typical value for rated load factor (RLF) taken from Engineering Methods for Estimating the Impacts of Demand-Side Management Programs. Volume 2: Fundamental Equations for Residential and Commercial End-Uses. TR-100984S Vol 2. Electric Power Research Institute, Palo Alto, CA August, 1993.
2. Energy Saving Factor for setback thermostats taken from "Programmable Thermostats. Report to KeySpan Energy Delivery on Energy Savings and Cost Effectiveness," GDS Associates, Marietta, GA. 2002.

DUCT INSULATION AND LEAKAGE SEALING

Description of Measure

Improvements to duct systems made separately or in conjunction with high efficiency rooftop AC or heat pump and/or furnace installation Duct systems are assumed to be located in an unconditioned plenum space between insulated finished ceiling and roof surface.

Method for Calculating Energy Savings

$$\Delta kW = units \times \frac{ton}{unit} \times RLF_{cool} \times \left[\frac{12}{EER_{pk,base} \times \eta_{duct,base}} - \frac{12}{EER_{pk,ee} \times \eta_{duct,ee}} \right] \times DF \times CF$$

$$\Delta kWh = units \times \left[\frac{ton}{unit} \times RLF_{cool} \times \left[\frac{12}{\overline{EER}_{base} \times \eta_{duct,base}} - \frac{12}{\overline{EER}_{ee} \times \eta_{duct,ee}} \right] \times CLH + \frac{kBtuh}{unit} \times RLF_{heat} \times \left[\frac{1}{\overline{COP}_{base} \times \eta_{duct,base}} - \frac{1}{\overline{COP}_{ee} \times \eta_{duct,ee}} \right] \times \frac{HLH}{3413} \right]$$

$$\Delta therms = units \times \frac{kBtuh}{unit} \times RLF_{heat} \times \left(\frac{1}{\overline{\eta}_{base} \times \eta_{duct,base}} - \frac{1}{\overline{\eta}_{ee} \times \eta_{duct,ee}} \right) \times \frac{HLH}{100}$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
$\Delta therms$	= gross annual gas savings
units	= the number of air conditioning units installed under the program
tons/unit	= tons of air conditioning per unit, based on nameplate data
$\overline{EER}$	= average energy efficiency ratio over the cooling season. (Btu/watt-hour)
EER_{pk}	= energy efficiency ratio under peak conditions (Btu/watt-hour)
CLH	= cooling load hours
RLF	= rated load factor
DF	= demand diversity factor
CF	= coincidence factor
12	= conversion factor (kBtuh/ton)
kBtuh/unit	= the nominal rating of the heating capacity of the heat pumps in kBtu/hr
$\overline{COP}$	= average heating season coefficient of performance of heat pump
$\overline{\eta}$	= average heating season efficiency of furnace
η_{duct}	= duct system efficiency
HLH	= heating load hours

RLF_{heat} = heating mode rated load factor
3.413 = conversion factor (Btu/Wh)
100 = conversion factor (kBtuh/therm)

The $\overline{EER}$ is an estimate of the seasonal energy efficiency for an average US city. The $\mathbf{EER_{pk}}$ is an estimate of the efficiency of the unit under peak summer conditions. See the section on packaged air conditioners above for more information.

The $\overline{COP}$ is an estimate of the seasonal heating energy efficiency for an average US city. The average COP in the equation above is equal to the HSPF/3.413. See section on air source heat pumps above for more information.

The ***average seasonal efficiency*** of the furnace is the ratio of the heating output to the fuel input (in consistent units) over a heating season. See section on high efficiency furnaces above for more information.

The ***rated load factor*** is the ratio of the peak heating load imposed on the heating equipment to the total rated heating capacity. This factor compensates for oversizing of the furnace.

$$RLF_{heat} = \frac{peak\ heating\ load}{nameplate\ \text{heating}\ capacity}$$

Recommended value for the rated load factor is 0.8.

The ***duct system efficiency*** accounts for losses from duct systems due to leakage and inadequate insulation. Duct system efficiencies were calculated for duct systems located in unconditioned plenum space between an insulated finished ceiling and roof surface in four small commercial building types and six New York cities.

Assembly Building Heating

Duct total leakage (%)	Duct system R-value (supply and return)	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
8%	Uninsulated	0.909	0.923	0.918	0.925	0.857	0.881
15%	Uninsulated	0.879	0.890	0.889	0.890	0.829	0.851
20%	Uninsulated	0.858	0.868	0.867	0.869	0.810	0.831
25%	Uninsulated	0.835	0.848	0.846	0.849	0.793	0.812
30%	Uninsulated	0.816	0.829	0.828	0.829	0.776	0.795
8%	R-6	0.951	0.961	0.959	0.956	0.896	0.915
15%	R-6	0.917	0.930	0.926	0.923	0.863	0.883
20%	R-6	0.895	0.906	0.902	0.901	0.841	0.861
25%	R-6	0.871	0.884	0.879	0.881	0.821	0.840
30%	R-6	0.849	0.862	0.860	0.862	0.801	0.819

Assembly Building Cooling

Duct total leakage (%)	Duct system R-value (supply and return)	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
8%	Uninsulated	0.870	0.845	0.857	0.869	0.922	0.898
15%	Uninsulated	0.859	0.835	0.846	0.858	0.908	0.887
20%	Uninsulated	0.850	0.825	0.838	0.850	0.897	0.878
25%	Uninsulated	0.840	0.815	0.828	0.840	0.886	0.867
30%	Uninsulated	0.829	0.805	0.817	0.829	0.873	0.856
8%	R-6	0.948	0.930	0.936	0.951	0.986	0.980
15%	R-6	0.932	0.916	0.921	0.936	0.967	0.964
20%	R-6	0.920	0.904	0.909	0.924	0.954	0.951
25%	R-6	0.906	0.891	0.896	0.910	0.939	0.938
30%	R-6	0.892	0.877	0.882	0.896	0.924	0.923

Fast Food Restaurant Heating

Duct total leakage (%)	Duct system R-value (supply and return)	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
8%	Uninsulated	0.809	0.807	0.804	0.820	0.766	0.805
15%	Uninsulated	0.784	0.784	0.781	0.797	0.734	0.778
20%	Uninsulated	0.766	0.768	0.765	0.780	0.714	0.759
25%	Uninsulated	0.750	0.753	0.749	0.765	0.693	0.742
30%	Uninsulated	0.734	0.739	0.734	0.750	0.675	0.725
8%	R-6	0.901	0.904	0.901	0.905	0.875	0.898
15%	R-6	0.862	0.867	0.864	0.867	0.825	0.858
20%	R-6	0.836	0.844	0.840	0.844	0.794	0.831
25%	R-6	0.813	0.822	0.817	0.822	0.765	0.806
30%	R-6	0.791	0.801	0.796	0.801	0.739	0.783

Fast Food Restaurant Cooling

Duct total leakage (%)	Duct system R-value (supply and return)	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
8%	Uninsulated	0.853	0.843	0.853	0.845	0.866	0.848
15%	Uninsulated	0.843	0.834	0.843	0.837	0.853	0.839
20%	Uninsulated	0.836	0.827	0.835	0.830	0.844	0.831
25%	Uninsulated	0.827	0.819	0.827	0.822	0.834	0.823
30%	Uninsulated	0.818	0.810	0.817	0.814	0.823	0.814
8%	R-6	0.950	0.950	0.953	0.948	0.945	0.947
15%	R-6	0.933	0.935	0.937	0.932	0.925	0.930
20%	R-6	0.921	0.924	0.925	0.919	0.911	0.917
25%	R-6	0.908	0.912	0.912	0.907	0.896	0.904
30%	R-6	0.895	0.899	0.898	0.894	0.881	0.891

Full Service Restaurant Heating

Duct total leakage (%)	Duct system R-value (supply and return)	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
8%	Uninsulated	0.816	0.821	0.816	0.819	0.797	0.810
15%	Uninsulated	0.789	0.797	0.791	0.794	0.765	0.782
20%	Uninsulated	0.770	0.781	0.775	0.776	0.743	0.763
25%	Uninsulated	0.753	0.765	0.760	0.759	0.721	0.745
30%	Uninsulated	0.736	0.750	0.745	0.744	0.701	0.728
8%	R-6	0.904	0.910	0.905	0.902	0.893	0.901
15%	R-6	0.866	0.876	0.869	0.866	0.848	0.861
20%	R-6	0.840	0.853	0.847	0.841	0.818	0.834
25%	R-6	0.816	0.832	0.825	0.818	0.789	0.809
30%	R-6	0.794	0.812	0.805	0.797	0.763	0.786

Full Service Restaurant Cooling

Duct total leakage (%)	Duct system R-value (supply and return)	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
8%	Uninsulated	0.827	0.827	0.840	0.814	0.854	0.821
15%	Uninsulated	0.825	0.826	0.839	0.813	0.845	0.819
20%	Uninsulated	0.821	0.824	0.836	0.811	0.837	0.815
25%	Uninsulated	0.818	0.821	0.832	0.808	0.829	0.812
30%	Uninsulated	0.813	0.817	0.827	0.804	0.820	0.807
8%	R-6	0.959	0.968	0.975	0.955	0.954	0.957
15%	R-6	0.955	0.970	0.975	0.953	0.941	0.952
20%	R-6	0.950	0.968	0.971	0.948	0.931	0.947
25%	R-6	0.943	0.963	0.966	0.942	0.919	0.940
30%	R-6	0.934	0.957	0.958	0.934	0.907	0.931

Small Retail Heating

Duct total leakage (%)	Duct system R-value (supply and return)	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
8%	Uninsulated	0.657	0.646	0.648	0.670	0.614	0.656
15%	Uninsulated	0.624	0.614	0.617	0.637	0.581	0.623
20%	Uninsulated	0.602	0.594	0.596	0.615	0.559	0.601
25%	Uninsulated	0.582	0.574	0.577	0.594	0.538	0.581
30%	Uninsulated	0.563	0.556	0.559	0.575	0.520	0.562
8%	R-6	0.792	0.787	0.788	0.798	0.767	0.789
15%	R-6	0.742	0.736	0.739	0.748	0.714	0.738
20%	R-6	0.710	0.704	0.707	0.716	0.679	0.705
25%	R-6	0.680	0.674	0.678	0.686	0.648	0.676
30%	R-6	0.652	0.646	0.652	0.659	0.619	0.648

Small Retail Cooling

Duct total leakage (%)	Duct system R-value (supply and return)	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
8%	Uninsulated	0.825	0.822	0.825	0.816	0.838	0.817
15%	Uninsulated	0.818	0.817	0.819	0.809	0.827	0.810
20%	Uninsulated	0.812	0.812	0.813	0.804	0.818	0.804
25%	Uninsulated	0.805	0.806	0.807	0.798	0.809	0.797
30%	Uninsulated	0.798	0.800	0.800	0.791	0.799	0.790
8%	R-6	0.932	0.934	0.935	0.927	0.931	0.928
15%	R-6	0.921	0.926	0.924	0.917	0.915	0.916
20%	R-6	0.912	0.918	0.916	0.908	0.904	0.907
25%	R-6	0.903	0.910	0.907	0.899	0.891	0.897
30%	R-6	0.892	0.902	0.897	0.889	0.879	0.887

Baseline Efficiencies from which savings are calculated

The baseline efficiency for air conditioners, heat pumps and/or furnaces should be set to according to the sections on this equipment above. Distribution system efficiency ($\bar{\eta}_{dist,base}$) should be set as follows:

Overall baseline duct leakage is assumed to be 30%, based on work done by Modera and Proctor on small commercial buildings in California. The baseline duct system is assumed to be uninsulated.

Compliance Efficiency from which incentives are calculated

The measure efficiency ($\bar{\eta}_{ee}$) for air conditioners, heat pumps and/or furnaces should be set according to the sections on this equipment above. The improved duct system efficiency ($\bar{\eta}_{dist,ee}$) should be set assuming 15% total leakage in existing construction and 8% total leakage in new construction, with R-6 duct insulation.

Operating Hours

Heating load hours calculated from building energy simulation models described in Appendix A and summarized in previous sections.

Non-Gas Benefits - Annual Electric Savings

N/A – gas and electric benefits described above.

Notes & References

:

1. For the purposes of this manual, duct efficiency calculations should only be done on buildings with duct systems located in unconditioned plenum spaces. For all other buildings, a duct efficiency value of 1.0 should be used.
2. Typical duct leakage values in small commercial buildings can be found in Modera, M. and J. Proctor, 2002. *Combining Duct Sealing and Refrigerant Charge Testing to Reduce Peak Electricity Demand in Southern California*, Final Project Report for Southern California Edison.
3. The fraction of the duct leakage assumed to be made up with outside air is 0.50. See: Cummings, J.B., C.R. Withers, N. Moyer, P. Fairey, and B. McKendry. 1996. "Uncontrolled Air Flow in Non–Residential Buildings; Final Report" FSEC-CR-878-96 Florida Solar Energy Center, Cocoa, FL, April, 1996.
4. The CLH and HLH values assumed in this section include a 3°F setback of the room temperature setpoint during unoccupied hours. See the section on programmable setback thermostats and Appendix A for more information.

CHILLERS

Description of Measure

Air cooled and water cooled chillers in large office buildings and hospitals with built-up HVAC systems.

Method for Calculating Summer Peak Demand and Energy Savings

$$\Delta kW_S = \text{units} \times \frac{\text{tons}}{\text{unit}} \times RLF \times \left(\frac{3.516}{COP_{base,pk}} - \frac{3.516}{COP_{ee,pk}} \right) \times DF_S \times CF_S$$

$$\Delta kWh = \text{units} \times \frac{\text{tons}}{\text{unit}} \times RLF \times \left(\frac{3.516}{\overline{COP}_{base}} - \frac{3.516}{\overline{COP}_{ee}} \right) \times CLH$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= the number of air conditioning units installed under the program
tons/unit	= tons of air conditioning per unit, based on nameplate data
$\overline{COP}$	= average coefficient of performance
COP_{pk}	= coefficient of performance under peak conditions
CLH	= cooling load hours
RLF	= rated load factor
DF	= demand diversity factor
CF	= coincidence factor
3.516	= conversion factor kW/ton-COP

The ***rated load factor*** is the ratio of the peak cooling load imposed on the cooling equipment to the total rated cooling capacity. This factor compensates for oversizing of the air conditioning unit.

$$RLF = \frac{\text{peak cooling load}}{\text{nameplate capacity}}$$

Cooling load hours are defined as the ratio of the annual cooling load to the peak cooling load:

$$CLH = \frac{\text{Annual Cooling Load (Btu)}}{\text{Peak Cooling Load (Btu / hr)}}$$

The ***demand diversity factor*** is used to account for the fact that not all HVAC systems in all buildings in the population are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of a population of HVAC systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

Recommended values for the rated load factor, demand diversity factor and coincidence factors are shown below:

Parameter	Recommended Values
Rated Load Factor	0.8
Demand diversity factor	0.8
Coincidence factor	1.0

Recommended values for baseline and measure efficiency are shown in the table below:

Baseline and Measure Performance Assumptions

Equipment Category	Capacity Range	Baseline Efficiency (COP)		Measure Efficiency (COP)	
		Average	Peak	Average	Peak
Air Cooled Chiller	All	3.05	2.8	3.36	3.08
Water cooled Recip	All	5.05	4.2	5.56	4.62
Water cooled screw and scroll	< 150 tons	5.2	4.45	5.72	4.90
	150 – 300 tons	5.6	4.9	6.16	5.39
	> 300 tons	6.15	5.5	6.77	6.05
Water cooled centrifugal	< 150 tons	5.25	5.00	5.78	5.50
	150 – 300 tons	5.90	5.55	6.49	6.11
	> 300 tons	6.40	6.10	7.04	6.71

Note, the rated full load COP at ARI conditions was used to define the efficiency under peak conditions. The IPLV as defined by ARI was used to define the seasonal average efficiency. These values represent average conditions across the US, and will be used until data specific to New York can be developed.

Cooling load hours were calculated from a DOE-2.2 simulation of prototypical large office building. The prototype building characteristics are described in Appendix A. The CLH for several built-up HVAC system types and six different cities in NY are shown below:

Office Building

System	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
CAV no econ	2,367	2,233	2,520	2,284	2,812	2,695
CAV econ	882	668	734	762	900	834
VAV econ	779	649	630	631	895	715

Hospital

System	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
CAV no econ	2160	2077	2385	2162	2796	2382
CAV econ	1297	1147	1393	1297	1780	1434
VAV econ	1201	1069	1283	1202	1521	1313

Baseline Efficiencies from which savings are calculated

The baseline efficiency for new construction vary by equipment size, and are shown in the Table above.

Compliance Efficiency from which incentives are calculated

See high efficiency measure specifications listed in the table above.

Operating Hours

The operating hours by climate zone and building type are shown in the Tables above

Non-Electric Benefits - Annual Fossil Fuel Savings

None anticipated

Notes & References

1. Unit seasonal and peak efficiency data taken from ASHRAE Standard 90.1-2003 for baseline units. Measure efficiency set to 10% higher than ASHRAE 90.1 per the FEMP guidelines.

2. Typical values for demand diversity factor (DF), coincidence factor (CF) and rated load factor (RLF) taken from Engineering Methods for Estimating the Impacts of Demand-Side Management Programs. Volume 2: Fundamental Equations for Residential and Commercial End-Uses. TR-100984S Vol 2. Electric Power Research Institute, Palo Alto, CA August, 1993.

Revision Number
0

COOLING TOWER

Description of Measure

Close approach cooling towers applied to water cooled chillers in office and hospital buildings.

Method for Calculating Energy Savings

Gross Annual Energy Savings

$\Delta kWh = \text{cooling tons} \times (\Delta kWh/\text{ton})$

Gross Summer Demand Savings

$\Delta kW = \text{cooling tons} \times (\Delta kW/\text{ton})$

where:

ΔkWh = gross annual energy savings
ΔkW = gross summer demand savings
cooling tons = size of cooling system retrofitted with a close approach tower
ΔkWh/ton = electricity consumption savings per ton of cooling system retrofitted with close approach tower
ΔkW/ton = summer peak demand savings per ton of cooling system retrofitted with close approach tower

Unit energy savings were calculated from a DOE-2.2 simulation of an office and hospital prototype. The prototype building characteristics are described in Appendix A. The unit energy savings for these two building types across six different cities in NY are shown below:

Office Building

City	System type	kWh/ton	kW/ton
Albany	CV no econ	12	0.01
	CV econ	5	0.00
	VAV econ	7	0.00
Binghamton	CV no econ	11	0.00
	CV econ	5	0.00
	VAV econ	5	0.00
Buffalo	CV no econ	11	0.00
	CV econ	5	0.00
	VAV econ	6	0.00
Massena	CV no econ	12	0.00

City	System type	kWh/ton	kW/ton
	CV econ	5	0.00
	VAV econ	5	-0.01
NYC	CV no econ	14	0.01
	CV econ	5	-0.01
	VAV econ	7	-0.01
Syracuse	CV no econ	11	0.00
	CV econ	5	0.00
	VAV econ	7	0.00

Hospital

City	System type	kWh/ton	kW/ton
Albany	CV no econ	14	0.00
	CV econ	9	0.00
	VAV econ	7	-0.01
Binghamton	CV no econ	14	-0.01
	CV econ	8	-0.01
	VAV econ	6	-0.01
Buffalo	CV no econ	14	0.00
	CV econ	8	0.00
	VAV econ	6	0.00
Massena	CV no econ	13	0.01
	CV econ	8	0.01
	VAV econ	6	0.02
NYC	CV no econ	16	-0.02
	CV econ	10	-0.02
	VAV econ	7	-0.02
Syracuse	CV no econ	14	0.00
	CV econ	9	0.00
	VAV econ	6	0.00

Note, demand savings are near zero or slightly negative due to interactions between the close approach tower and the chiller. The chiller uses less energy on peak due a lower condensing temperature, but the larger tower uses more fan energy on peak.

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to be a standard cooling tower with a 10°F approach temperature under standard rating conditions.

Compliance Efficiency from which incentives are calculated

The measure is assumed to be a close approach cooling tower with a 6°F approach temperature under standard rating conditions.

Operating Hours

The HVAC system operating hours vary by building type. See Appendix A

Non-Electric Benefits - Annual Fossil Fuel Savings

No therm impacts are anticipated from this measure

Notes & References

1. The measure addresses approach temperature only. Changes in condenser water setpoint control strategies are not included.

Revision Number
0

REFRIGERANT CHARGE CORRECTION

Description of Measure

Correcting refrigerant charge on air conditioners and heat pumps in small commercial applications

Method for Calculating Summer Peak Demand and Energy Savings

$$\Delta kW_S = units \times \frac{tons}{unit} \times RLF \times \left(\frac{12}{EER_{uncorr,\,pk}} - \frac{12}{EER_{corr,\,pk}} \right) \times DF_S \times CF_S$$

$$\Delta kWh = units \times \frac{tons}{unit} \times RLF \times \left(\frac{12}{\overline{EER}_{uncorr}} - \frac{12}{\overline{EER}_{corr}} \right) \times CLH$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= the number of air conditioning units installed under the program
tons/unit	= tons of air conditioning per unit, based on nameplate data
$\overline{EER}$	= average energy efficiency ratio over the cooling season. (Btu/watt-hour)
EER_{pk}	= energy efficiency ratio under peak conditions (Btu/watt-hour)
CLH	= cooling load hours
RLF	= rated load factor
DF	= demand diversity factor
CF	= coincidence factor
12	= conversion factor (kBtuh/ton)

The ***rated load factor*** is the ratio of the peak cooling load imposed on the cooling equipment to the total rated cooling capacity. This factor compensates for oversizing of the air conditioning unit.

$$RLF = \frac{\text{peak cooling load}}{\text{nameplate capacity}}$$

Cooling load hours are defined as the ratio of the annual cooling load to the peak cooling load:

$$CLH = \frac{\text{Annual Cooling Load (Btu)}}{\text{Peak Cooling Load (Btu / hr)}}$$

The ***demand diversity factor*** is used to account for the fact that not all HVAC systems in all buildings in the population are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of a population of HVAC systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

Recommended values for the rated load factor, demand diversity factor and coincidence factors are shown below:

Parameter	Recommended Values
Rated Load Factor	0.8
Demand diversity factor	0.8
Coincidence factor	1.0

Efficiency assumptions for properly charged air conditioners and heat pumps in several size classes are shown below:

Baseline and Measure Performance Assumptions

Equipment Category	Capacity Range (Btu/hr)	Efficiency	
		Average	Peak
Unitary A/C (1) phase	<65,000 1 Ph	13.0	11.1
Unitary A/C (3) phase	<65,000 3 Ph	12.0	10.4
Unitary A/C (3) phase	65,000 - 135,000	9.1	10.1
Unitary A/C (3) phase	135,000 - 240,000	8.5	9.5
Unitary A/C (3) phase	240,000 - 760,000	8.4	9.3
Unitary A/C (3) phase	>760,000	8.1	9.0
Unitary HP (1) phase	<65,000 1 Ph	13.0	11.1
Unitary HP (3) phase	<65,000 3 Ph	12.0	10.4
Unitary HP (3) phase	65,000 - 135,000	8.8	9.9
Unitary HP (3) phase	135,000 - 240,000	8.2	9.1
Unitary HP (3) phase	>240,000	8.0	8.8

Refrigerant charge adjustments are assumed to have a 10% improvement in unit efficiency. That is, the efficiency of an uncorrected unit is 10% below that of a corrected unit.

Parameter	Recommended Values
$EER_{pk,\ uncorr}$	$0.9 \times EER_{pk,\ corr}$
$\overline{EER}_{uncorr}$	$0.9 \times \overline{EER}_{corr}$

Cooling load hours were calculated from a DOE-2.2 simulation of prototypical small commercial buildings. See section on commercial building packaged air conditioners.

Baseline Efficiencies from which savings are calculated

The baseline (uncorrected) efficiency is assumed to be 10% lower than the nominal (corrected) unit efficiency.

Compliance Efficiency from which incentives are calculated

Charge corrected to manufacturers' specifications; restoring unit to nameplate efficiency.

Operating Hours

The operating hours by climate zone and building type are shown above

Non-Electric Benefits - Annual Fossil Fuel Savings

None anticipated

Notes & References

1. Unit seasonal and peak efficiency data taken from the California DEER update study: 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Itron, Inc. Vancouver, WA. December, 2005. Available at http://www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf

2. Typical values for demand diversity factor (DF), coincidence factor (CF) and rated load factor (RLF) taken from Engineering Methods for Estimating the Impacts of Demand-Side Management Programs. Volume 2: Fundamental Equations for Residential and Commercial End-Uses. TR-100984S Vol 2. Electric Power Research Institute, Palo Alto, CA August, 1993.

Revision Number
0

AIR-SIDE ECONOMIZER

Description of Measure

Dual-enthalpy air-side economizer installed on packaged rooftop units serving small commercial buildings

Method for Calculating Energy Savings

Gross Annual Energy Savings
ΔkWh = cooling tons $\times$ (ΔkWh/ton)

where:

ΔkWh = gross annual energy savings
cooling tons = size of cooling system retrofitted with an economizer
ΔkWh/ton = electricity consumption savings per ton of cooling system retrofitted with an economizer

No peak demand savings are expected from this measure.

Unit energy savings were calculated from a DOE-2.2 simulation of a series of prototypical small commercial buildings. The prototype building characteristics are described in Appendix A. The unit energy savings for eight building types across six different cities in NY are shown below:

Building Type	City	unit	KWh/unit
Assembly	Albany	ton	39
	Binghamton	ton	36
	Buffalo	ton	45
	Massena	ton	33
	NYC	ton	27
	Syracuse	ton	42
Big Box Retail	Albany	ton	165
	Binghamton	ton	152
	Buffalo	ton	167
	Massena	ton	138
	NYC	ton	152
	Syracuse	ton	165
Fast Food	Albany	ton	49
	Binghamton	ton	47
	Buffalo	ton	53
	Messina	ton	44
	NYC	ton	39
	Syracuse	ton	49

Building Type	City	unit	KWh/unit
Full Service Restaurant	Albany	ton	38
	Binghamton	ton	35
	Buffalo	ton	41
	Massena	ton	32
	NYC	ton	31
	Syracuse	ton	38
Light Industrial	Albany	ton	45
	Binghamton	ton	39
	Buffalo	ton	38
	Massena	ton	33
	NYC	ton	25
	Syracuse	ton	54
Primary School	Albany	ton	49
	Binghamton	ton	44
	Buffalo	ton	52
	Massena	ton	38
	NYC	ton	42
	Syracuse	ton	41
Small Office	Albany	ton	202
	Binghamton	ton	195
	Buffalo	ton	195
	Massena	ton	188
	NYC	ton	186
	Syracuse	ton	186
Small Retail	Albany	ton	107
	Binghamton	ton	101
	Buffalo	ton	113
	Massena	ton	95
	NYC	ton	95
	Syracuse	ton	111

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to be a rooftop unit with fixed outside air (no economizer)

Compliance Efficiency from which incentives are calculated

Dual enthalpy economizer installed on existing rooftop unit and commissioned to ensure correct operation.

Operating Hours

The HVAC system operating hours vary by building type. See Appendix A

Non-Electric Benefits - Annual Fossil Fuel Savings

No therm impacts are anticipated from this measure

Notes & References

2. Dual enthalpy economizers assumed as best available technology for humid applications.

Revision Number
0

VFD PUMPING

Description of Measure

Variable frequency drives applied to variable volume secondary chilled water pumping loops.

Method for Calculating Summer Peak Demand and Energy Savings

$$\Delta kW_S = units \times \frac{hp}{unit} \times \frac{RLF}{\eta_{motor}} \times 0.746 \times DSF_S \times DF_S \times CF_S$$

$$\Delta kWh = units \times \frac{hp}{unit} \times \frac{RLF}{\eta_{motor}} \times 0.746 \times ESF \times FLH_{base}$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= number of VSDs installed under the program
hp	= horsepower of motor(s) controlled by each VSD
RLF	= rated load factor
η_{motor}	= motor efficiency
FLH_{base}	= full-load operating hours of base fan or pump
ESF	= energy savings factor
DSF	= demand savings factor
DF	= demand diversity factor
CF	= coincidence factor
0.746	= conversion factor (kW/hp)

Units refers to the number of VSDs installed under the program.

Horsepower refers to the nameplate horsepower rating of the motor.

The ***rated load factor*** is the ratio of the motor load at the design flow rate to the nameplate rating.

The ***motor efficiency*** refers to the efficiency of the motor subject to variable-speed drive control.

The ***demand savings factor*** is calculated by determining ratio of the power requirements for baseline and VSD control at peak summer conditions.

$$DSF = 1 - \left.\frac{kW_{VSD}}{kW_{base}}\right|_{peak\ conditions}$$

The ***energy savings*** factor is used to calculate annual energy savings for VSD controls as follows:

$$ESF = 1 - \frac{kWh_{VSD}}{kWh_{base}}$$

Data compiled from the large office prototypical simulation model are shown below:

City	System type	FLH_{base}	ESF	DSF
Albany	CV no econ	5,992	0.616	-0.02
	CV econ	5,864	0.680	-0.02
	VAV econ	5,992	0.633	-0.02
Binghamton	CV no econ	5,889	0.644	-0.02
	CV econ	5,825	0.698	-0.02
	VAV econ	5,889	0.676	-0.02
Buffalo	CV no econ	5,802	0.647	-0.02
	CV econ	5,772	0.700	-0.02
	VAV econ	5,802	0.670	-0.02
Massena	CV no econ	6,211	0.638	-0.02
	CV econ	6,080	0.694	-0.02
	VAV econ	6,211	0.654	-0.02
NYC	CV no econ	5,362	0.617	-0.02
	CV econ	5,394	0.675	-0.02
	VAV econ	5,362	0.599	-0.02
Syracuse	CV no econ	5,823	0.640	-0.02
	CV econ	5,705	0.693	-0.02
	VAV econ	5,823	0.648	-0.02

Data compiled from the hospital prototypical simulation model are shown below:

City	System type	FLH_{base}	ESF	DSF
Albany	CV no econ	8760	.723	-0.02
	CV econ	8760	.738	-0.02
	VAV econ	8760	.736	-0.02
Binghamton	CV no econ	8760	.726	-0.02
	CV econ	8760	.741	-0.02
	VAV econ	8760	.741	-0.02
Buffalo	CV no econ	8760	.732	-0.02
	CV econ	8760	.744	-0.02
	VAV econ	8760	.744	-0.02

City	System type	FLH_{base}	ESF	DSF
Massena	CV no econ	8760	.734	-0.02
	CV econ	8760	.738	-0.02
	VAV econ	8760	.736	-0.02
NYC	CV no econ	8760	.720	-0.02
	CV econ	8760	.736	-0.02
	VAV econ	8760	.733	-0.02
Syracuse	CV no econ	8760	.728	-0.02
	CV econ	8760	.741	-0.02
	VAV econ	8760	.740	-0.02

DSF data above assume a 2% drive loss and no oversizing.

The ***rated load factor*** is the ratio of peak running load to nameplate rating of the pump motor.

The ***demand diversity factor*** is used to account for the fact that not all pumping systems in all buildings in the population are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of a population of pumping systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

Recommended values for demand diversity factor and coincidence factors are shown below:

Parameter	Recommended Values
Rated load factor	1.0
Demand diversity factor	1.0
Coincidence factor	1.0

Baseline Efficiencies from which savings are calculated

Constant volume secondary pumping system assumed as the baseline

Compliance Efficiency from which incentives are calculated

VFD controlled variable volume secondary chilled water loop, with 2-way control valves at cooling coils and VFD controlled on loop pressure.

Operating Hours

See appendix A for a description of the large office and hospital prototypes.

Non-Electric Benefits - Annual Fossil Fuel Savings

None anticipated

Notes & References

Revision Number
0

VARIABLE FREQUENCY DRIVE FOR HVAC FAN

Description of Measure

Variable frequency drives applied to variable air volume air handler supply fans.

Method for Calculating Summer Peak Demand and Energy Savings

Gross Summer Coincident Demand Savings

$$\Delta kW_S = units \times \frac{hp}{unit} \times \frac{RLF}{\eta_{motor}} \times 0.746 \times DSF_S \times DF_S \times CF_S$$

Gross Annual Energy Savings

$$\Delta kWh = units \times \frac{hp}{unit} \times \frac{RLF}{\eta_{motor}} \times 0.746 \times ESF \times FLH_{base}$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= number of VSDs installed under the program
hp	= horsepower of motor(s) controlled by each VSD
RLF	= rated load factor
η_{motor}	= motor efficiency
FLH_{base}	= full-load operating hours of base fan or pump
ESF	= energy savings factor
DSF	= demand savings factor
DF	= demand diversity factor
CF	= coincidence factor
0.746	= conversion factor (kW/hp)

Units refers to the number of VSDs installed under the program.

Horsepower refers to the nameplate horsepower rating of the motor.

The ***rated load factor*** is the ratio of the motor load at the design flow rate to the nameplate rating.

The ***motor efficiency*** refers to the efficiency of the motor subject to variable-speed drive control.

The ***demand savings factor*** is calculated by determining ratio of the power requirements for baseline and VSD control at peak summer conditions.

$$DSF = 1 - \left.\frac{kW_{VSD}}{kW_{base}}\right|_{peak\ conditions}$$

The ***energy savings*** factor is used to calculate annual energy savings for VSD controls as follows:

$$ESF = 1 - \frac{kWh_{VSD}}{kWh_{base}}$$

Data compiled from the large office prototypical simulation model are shown below:

City	System type	FLH	ESF	DSF
Albany	VAV econ	5,992	0.616	-0.02
Binghamton	VAV econ	5,889	0.644	-0.02
Buffalo	VAV econ	5,802	0.647	-0.02
Massena	VAV econ	6,211	0.638	-0.02
NYC	VAV econ	5,362	0.617	-0.02
Syracuse	VAV econ	5,823	0.640	-0.02

Data compiled from the hospital prototypical simulation model are shown below:

City	System type	FLH	ESF	DSF
Albany	VAV econ	5276	0.253	-0.02
Binghamton	VAV econ	5400	0.266	-0.02
Buffalo	VAV econ	5475	0.265	-0.02
Massena	VAV econ	5276	0.248	-0.02
NYC	VAV econ	5180	0.322	-0.02
Syracuse	VAV econ	5252	0.278	-0.02

DSF data above assume a 2% drive loss and no oversizing.

The ***rated load factor*** is the ratio of peak running load to nameplate rating of the fan motor.

The ***demand diversity factor*** is used to account for the fact that not all fan systems in all buildings in the population are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of a population of fan systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

Recommended values for demand diversity factor and coincidence factors are shown below:

Parameter	Recommended Values
Rated load factor	1.0
Demand diversity factor	1.0
Coincidence factor	1.0

Baseline Efficiencies from which savings are calculated

VAV system with inlet vane control

Compliance Efficiency from which incentives are calculated

VFD controlled supply fan on VAV system. VFD controlled on duct static pressure.

Operating Hours

See appendix A for a description of the large office and hospital prototypes.

Non-Electric Benefits - Annual Fossil Fuel Savings

None anticipated

Notes & References

Revision Number
0

WATER HEATERS

Description of Measure

Efficient water heaters installed in whole-building applications.

Method for Calculating Energy Savings

$$\Delta kW_S = \text{units} \times \frac{(UA_{base} - UA_{ee}) \times \Delta T_s}{3413} \times DF_s \times CF_s$$

$$\Delta kWh = units \times \frac{GPD \times 365 \times 8.33 \times \overline{\Delta T_w}}{3413} \times \left[\frac{1}{E_{t,base}} - \frac{1}{E_{t,ee}} \right]$$

$$\Delta therm = units \times \frac{GPD \times 365 \times 8.33 \times \overline{\Delta T_w}}{100{,}000} \times \left[\frac{1}{E_{t,base}} - \frac{1}{E_{t,ee}} \right]$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
$\Delta therm$	= gross annual gas savings
units	= number of high efficiency water heaters installed under the program
UA_{base}	= overall heat loss coefficient of base water heater (Btu/hr-°F)
UA_{ee}	= overall heat loss coefficient of efficient water heater (Btu/hr-°F)
ΔT_s	= temperature difference between the stored hot water and the surrounding air (°F)
GPD	= average daily water consumption (gallons/day)
$\overline{\Delta T}_w$	= average difference between the cold inlet temperature and the hot water delivery temperature (°F)
$E_{t,base}$	= baseline water heater thermal efficiency
$E_{t,ee}$	= baseline water heater thermal efficiency
DF	= demand diversity factor
CF	= coincidence factor
8.33	= conversion factor (Btu/gallon-°F)
100,000	= conversion factor (Btu/therm)
365	= conversion factor (days/yr)

Water heating energy consumption is calculated from the daily hot water use and the difference in the water heater delivery temperature and entering cold water temperature. If the supplemental water heater has sufficient capacity to meet the load, hot water will be

delivered at the water heater setpoint temperature. Water heater setpoint for commercial buildings is usually in the range of 150°F to 190°F. The water heater setpoint should be consistent with temperature assumed in the water use data. If the water heater does not have sufficient capacity to meet the load, the hot water delivery temperature may need to be reduced from the setpoint temperature.

Cold water entering temperatures vary according to water source and climate. Ground water temperatures from wells tend to be fairly stable year-round, and are approximately equal to the annual average outdoor temperature. Ground and surface water temperatures from water utilities fluctuate seasonally due to the influence of climate on reservoir or storage tank water temperature. Cold water entering temperatures estimated for this manual are shown below:

City	Annual average outdoor temperature (°F)
Albany	48.2
Binghamton	46.9
Buffalo	48.3
Massena	44.7
NYC	49.4
Syracuse	48.6

The ***thermal efficiency*** is a measure of the efficiency of the instantaneous and storage water heaters excluding standby losses. Larger water heaters used in commercial applications are rated with thermal efficiency instead of energy factor.

The ***average daily hot water usage***, expressed in gallons per day, normalized for occupancy or restaurant meal volume is shown below:

Building Type	Average gallons per day (ASHRAE)
Office Building	1.0 gal/day per person
Full service restaurant	2.4 gal / day per meal
Fast food restaurant	0.7 gal /day per meal
Elementary schools	0.6 gal/day-student (1)
Junior and senior high schools	1.8 gal/day-student (1)

Note 1: Daily values averaged while school is in session. The 365 day/yr conversion factor needs to be adjusted to the school calendar.

Tank overall heat loss coefficient ***(UA)*** is calculated from the standby loss specification:

UA = SL/70 (Btu/hr-deg F)

Where:

SL = standby loss (Btu/hr)
70 = temperature difference associated with standby loss specification

Baseline Efficiencies from which savings are calculated

Baseline thermal efficiency for electric water heaters is assumed to be 1.0. Baseline thermal efficiency for gas water heaters is assumed to be 0.80.

Standby losses (SL) for large electric storage type water heaters (> 12kW and > 20 gallons):

$SL = 20 + 35\sqrt{V}$ (Btu/hr)

Standby losses (SL) for large gas storage type water heaters (> 75,000 Btu/hr input capacity (Q) and storage size <4000 Btu/hr/gal):

$SL = Q/800 + 110\sqrt{V}$ (Btu/hr)

Compliance Efficiency from which incentives are calculated

Program administrators should use the thermal efficiency specifications for qualifying water heaters under their respective programs.

Operating Hours

Water heater assumed to be available at all hours

Non-Gas Benefits - Annual Electric Impacts

Some high-efficiency water heaters may incorporate a draft fan, which increases electricity consumption.

Notes & References

1. Average annual outdoor temperature taken from the National Renewable Energy Laboratory TMY 3 long-term average weather data sets, processed with the DOE-2.2 weather data statistics package. www.nrel.gov
2. Average hot water use data taken from the 2007 ASHRAE HVAC Applications Handbook, Chapter 49 – Service Water Heating. American Society of Heating, Refrigeration and Air Conditioning Engineers, Atlanta GA.

SOLAR HOT WATER

Description of Measure

Solar water heaters convert radiant energy from the sun to thermal energy, which is used to meet a portion of the hot water load. Active systems generally use roof mounted flat plate collectors, with water or an antifreeze solution as the collector fluid, and a pump to circulate the collector fluid through a tank-mounted heat exchanger. Water is sometimes run directly through the collector in non-freezing climates, eliminating the need for a heat exchanger. A separate water heater is generally used as a supplemental heat source for all systems.

Method for Calculating Energy Savings

$$\Delta kW_s = units \times \frac{GPH_{pk} \times 8.33 \times \Delta T_{pk,s}}{E_{t,base} \times 3413} \times DSF_s \times DF_s \times CF_s$$

$$\Delta kWh = units \times \frac{GPD \times 365 \times 8.33 \times \overline{\Delta T}}{E_{t,base} \times 3413} \times ESF$$

$$\Delta therm = units \times \frac{GPD \times 365 \times 8.33 \times \overline{\Delta T}}{E_{t,base} \times 100{,}000} \times ESF$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
$\Delta therm$	= gross annual gas savings
units	= number of solar water heaters installed under the program
GPH_{pk}	= peak hourly hot water demand (gallons/hr)
ΔT_{pk}	= difference between the cold inlet temperature and the hot water delivery temperature under peak conditions (°F)
DSF	= demand savings factor
$E_{t,base}$	= thermal efficiency of supplemental electric water heater
GPD	= average daily water consumption (gallons/day)
$\overline{\Delta T}$	= average difference between the cold inlet temperature and the hot water delivery temperature (°F)
ESF	= energy savings factor
100,000	= conversion factor (therm/Btu)
365	= conversion factor (days/yr)
8.33	= conversion factor (Btu/gallon-°F)
3413	= conversion factor (Btu/kWh)

The ***thermal efficiency*** is a measure of the overall efficiency of the supplemental water heater. The thermal efficiency applies to large commercial water heaters , both storage type and instantaneous.

The ***average daily hot water usage***, expressed in gallons per day, normalized for occupancy or restaurant meal volume is shown below:

Building Type	**Average gallons per day (ASHRAE)**
Office Building	1.0 gal/day per person
Full service restaurant	2.4 gal / day per meal
Fast food restaurant	0.7 gal /day per meal
Elementary schools	0.6 gal/day-student (1)
Junior and senior high schools	1.8 gal/day-student (1)

Note 1: Daily values averaged while school is in session. The 365 day/yr conversion factor needs to be adjusted to the school calendar.

The ***peak hourly hot water draw*** is a function of the type of water use (e.g., hand washing, dish washing, laundry, etc) and the frequency of occurrence during the peak hour.

The ***energy savings factor*** (ESF) is the fraction of the annual water heating load which is met by solar energy. This factor is also called the ***solar savings fraction***. Small commercial active solar DHW systems are typically analyzed by a solar water heater sizing program such as the FCHART program.

The ***demand savings factor*** is equal to the fraction of the peak hourly load met by the solar water heater. Field studies on commercial solar water heaters are not generally available. The calculations should assume a DSF of 1.0 until better data are available.

The ***demand diversity factor*** is used to account for the fact that not all solar water heaters in all buildings in the population are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of a population of solar water heating systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

Recommended values for demand diversity factor and coincidence factors are shown below:

Parameter	**Recommended Values**
Demand diversity factor	1.0
Coincidence factor	1.0

The ***energy savings factor*** for a commercial solar DHW system varies widely based on the magnitude of the hot water load and available roof are for solar collectors. Solar water heater performance is influenced by climate, collector area, water heating load, collector efficiency, heat exchanger performance, pipe heat losses, storage tank heat losses, and storage tank size. The method used to calculate ESF should account for these parameters.

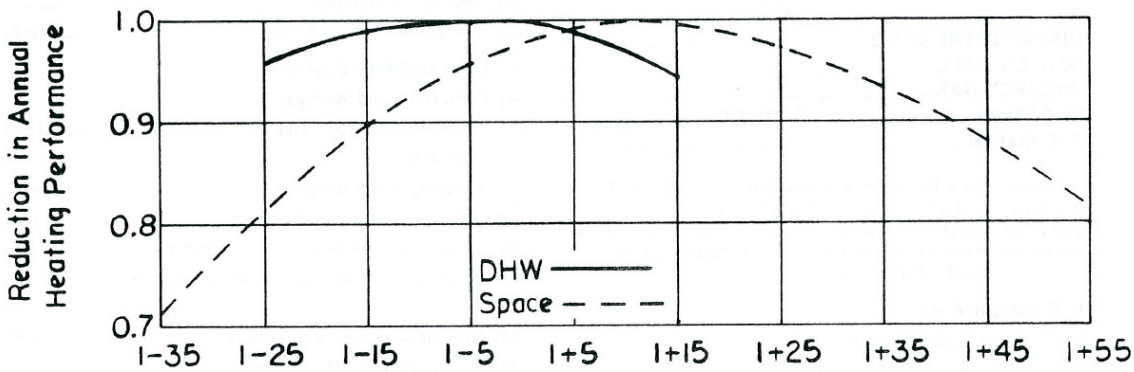
Since the size of commercial solar hot water projects can vary widely, the ESF is calculated from the ratio of the collector array size (in square feet) to the daily hot water use (in gallons per day). Values for typical solar hot water systems for a derived from the FCHART[8] program are shown below:

Collector to load ratio (SF/GPD)	ESF					
	Albany	Binghamton	Buffalo	Massena	NYC	Syracuse
0.2	0.13	0.122	0.121	0.127	0.144	0.127
0.4	0.246	0.232	0.229	0.241	0.272	0.241
0.6	0.35	0.33	0.326	0.344	0.385	0.343
0.8	0.442	0.419	0.413	0.436	0.483	0.434
1	0.524	0.498	0.49	0.517	0.569	0.514
1.2	0.595	0.567	0.557	0.588	0.642	0.584
1.4	0.657	0.629	0.616	0.651	0.704	0.644
1.6	0.711	0.682	0.668	0.705	0.756	0.697

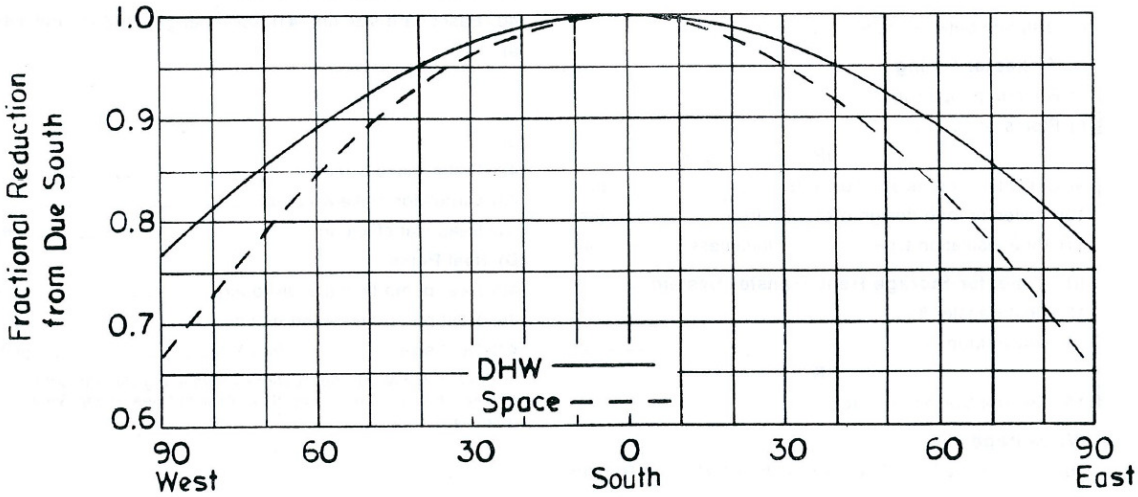
The calculations are based on a hot water setpoint temperature of 135°F, with the collector array tilted at 45 degrees and facing due south. The calculations assume a good quality flat plate collector with a heat exchanger separating the collector fluid and the solar storage tank[9]. Note: solar hot water systems should have an unrestricted access to sunlight without shading from adjacent buildings or trees. Maximum annual solar collection is obtained when the collectors are faced due south and with a tilt angle equal to the site latitude. However, deviations of ± 10° will have minimal impact on annual collected solar energy, as shown in the Figures below.

[8] Standard FCHART outputs show ESF as a fraction of hot water load not including backup tank efficiency. These data were modified to account for backup water heater efficiency consistent with the equation above.

[9] Collector performance specs: $F_R\tau\alpha = 0.75$, $F_RU_L = 0.74$. Incident angle modifier constant = -0.28. Heat exchanger modifier (F_R'/F_R) = 0.9.



Effect of Solar Collector Tilt on Annual Heating Performance (l = local latitiude)



Effect of Solar Collector Orientation on Annual Heating Performance

<u>Baseline Efficiencies from which savings are calculated</u>

The baseline thermal efficiency ($E_{t,base}$) is as follows:

New construction and replace on failure: Solar water heater is assumed to supplement a standard efficiency tank-type water heater.

<u>Compliance Efficiency from which incentives are calculated</u>

ESF for solar water heaters in commercial applications vary widely. Calculations showing the expected ESF for solar water heaters in commercial applications should be submitted.

Operating Hours

The backup water heater is assumed to be available during all hours. The solar water heater operates only when useful solar energy can be collected.

Other Electricity Impacts

The equations presented above do not incorporate parasitic losses from electric pumps in forced circulation systems.

Notes & References

1. Solar water heater performance can be estimated using the FCHART method: Beckman, W.A., S.A. Klein, and J.A. Duffie; Solar Heating Design by the FCHART Method; Wiley and Sons, New York, 1977.
2. Average annual outdoor temperature taken from the National Renewable Energy Laboratory TMY 3 long-term average weather data sets, processed with the DOE-2.2 weather data statistics package. www.nrel.gov

EVAPORATOR FAN CONTROLS

Measure Description
Walk-in cooler and freezer evaporator fans often run continually, requiring more air to be blown across the evaporator than needed to cool the evaporator. This measure consists of a control system that turns the fan on only when the unit's thermostat is calling for the compressor to operate, shutting the fan off shortly after the desired temperature is reached and the compressor is turned off.

Savings Estimation Approach
The savings from this measure is highly dependent on the type, size and condition of the coolers and freezers fitted with fan controls. As a result an estimate of the typical unit must be based on the program's projection of what types and sizes of units will be served and the condition of those units to function.

In general the following estimate approach must be made for the typical units that the program is expected to control:

<u>kWh Savings</u>
Annual kWh savings = (Hs * kW)
Where:

Hs = Annual hours per year shut off by the control system
kW = kW demand for the typical fan shut off (included system efficiency adjustments)

<u>kW Savings</u>
The units are expected to be operating at peak period. Peak savings are estimated as follows:

Peak demand savings = D * kW
Where:

D = diversity factor (23%)
kW = kW draw of operating fan

<u>Notes & References</u>

1. Diversity factor taken from "New England Power Service Co. study of Economizers and Evaporator Fan Controls", HEC, June 28, 1996

EFFICIENT AIR-COOLED REFRIGERATION CONDENSER

Description of Measure

Install an efficient, close approach air-cooled refrigeration system condenser. This measure savings energy by reduces condensing temperatures and improving the efficiency of the condenser fan system.

Method for Calculating Summer Peak Demand and Energy Savings

Gross Summer Coincident Demand Savings

ΔkW_S = compressor tons $\times$ (ΔkW/ton) $\times$ $DF_S \times CF_S$

Gross Annual Energy Savings

ΔkWh = compressor tons $\times$ (ΔkWh/ton)

where:

ΔkW = gross summer peak demand savings
ΔkWh = gross annual energy savings
compressor tons = refrigeration system compressor capacity
ΔkWh/ton = electricity consumption savings per ton of compressor capacity
DF = demand diversity factor
CF = coincidence factor

The ***demand diversity factor*** is used to account for the fact that refrigeration systems in all buildings in the population are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of a population of refrigeration systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

The recommended values for demand diversity and coincidence factors are shown below:

Factor	Recommended Value
DF	1.0
CF	1.0

Unit energy and demand savings were calculated from a DOE-2.2 simulation of a prototypical grocery store. The prototype building characteristics are described in

Appendix A. The unit energy and demand savings for five different cities in NY are shown below:

City	Unit	KWh /unit	KW/unit
Albany	per ton of compressor capacity	1296	0.136
Buffalo	per ton of compressor capacity	1297	0.103
Massena	per ton of compressor capacity	1301	0.123
NYC	per ton of compressor capacity	1220	0.152
Syracuse	per ton of compressor capacity	1283	0.149

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to a standard efficiency air-cooled refrigeration system condenser, with a 20ºF approach temperature on low temperature applications and a 15ºF approach temperature on medium temperature applications. Standard efficiency specific fan power of 45 Btu/hr of heat rejection capacity per watt of fan power.

Compliance Efficiency from which incentives are calculated

Must provide an efficient air-cooled refrigeration system condenser, with an approach temperature of 13ºF or less on low temperature applications and an approach temperature of 8ºF or less on medium temperature applications. Specific fan power must be greater than or equal to 85 Btu/hr of heat rejection capacity per watt of fan power.

Operating Hours

The refrigeration system is assumed to be active 24/7

Non-Electric Benefits - Annual Fossil Fuel Savings

No therm impacts anticipated for this measure

Notes & References

1. Measure performance characteristics taken from the California DEER update study: 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Itron, Inc. Vancouver, WA. December, 2005. Available at http://www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf

Revision Number
0

ANTI-SWEAT HEATER CONTROLS

Description of Measure

Anti-sweat heater controls for glass reach-in doors on grocery store freezer cases

Method for Calculating Summer Peak Demand and Energy Savings

Gross Summer Coincident Demand Savings

ΔkW_S = qty doors × (ΔkW/door) × DF_S × CF_S

Gross Annual Energy Savings

ΔkWh = qty doors × (ΔkWh/door)

Δtherm = qty doors × (Δtherm/door)

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
qty doors	= quantity of reach-in freezer doors controlled
DF	= demand diversity factor
CF	= coincidence factor
ΔkW/door	= electricity demand savings per reach-in freezer doors controlled
ΔkWh/door	= electricity consumption savings per reach-in freezer doors controlled

The ***demand diversity factor*** is used to account for the fact that not all anti-sweat heaters in all buildings in the population are operating at the same time. The demand diversity factor is defined as the average fraction of installed capacity of a population of control systems that are operating at the time of the end-use peak.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the end-use demand reduction that is coincident with the system peak.

Recommended values for the demand diversity factor and coincidence factor are shown below:

Parameter	Value
Demand diversity factor	1.0
Coincidence factor	1.0

Unit energy and demand savings were calculated from a DOE-2.2 simulation of a prototypical grocery store. The prototype building characteristics are described in Appendix A. The unit energy and demand savings for five different cities in NY are shown below

Unit Energy and Demand Savings for Anti-sweat Heater Controls

Climate	Units	kWh/unit	kW/unit
Albany	per door	1850	0
Binghamton	per door	1873	0
Buffalo	per door	1843	0
Massena	per door	1896	0
NYC	per door	1764	0
Syracuse	per door	1784	0

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to be no anti-sweat heater controls

Compliance Efficiency from which incentives are calculated

TBD

Operating Hours

The control system is assumed to be active 24/7

Non-Electric Benefits - Annual Fossil Fuel Savings

Controlling door anti-sweat heaters increases space heating requirements. The therm impacts are shown below:

Δtherm = qty doors $\times$ (Δtherm/door)

where:

Δtherm/door = gas consumption change per reach-in freezer doors controlled

Therm impacts per unit are shown below:

Antisweat Heater Control Therm Impacts

Climate	Units	therm/unit
Albany	per door	-15
Binghamton	per door	-15
Buffalo	per door	-13
Massena	per door	-16
NYC	per door	-13
Syracuse	per door	-11

Notes & References

1. Measure performance characteristics taken from the California DEER update study: 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Itron, Inc. Vancouver, WA. December, 2005. Available at http://www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf

Revision Number

0

REFRIGERATED CASE NIGHT COVERS

Description of Measure

Night covers installed on medium temperature open multi-deck cases in grocery stores to reduce energy consumption by reducing infiltration into the case during unoccupied hours. The analysis assumes a night cover is deployed 4 hours per night, reducing store air infiltration into the case by 50%.

Method for Calculating Energy Savings

Gross Annual Energy Savings

$\Delta kWh = LF \text{ of case} \times (\Delta kWh/LF)$
$\Delta therm = LF \text{ case} \times (\Delta therm/LF)$

where:

ΔkWh	= gross annual energy savings
LF of cover	= Lineal feet of case fitted with a night cover
$\Delta kWh/SF$	= electricity consumption savings per LF of case
$\Delta therm/LF$	= gas consumption change per lineal foot of case

No summer peak demand savings are expected from this measure.

Unit energy savings were calculated from a DOE-2.2 simulation of a prototypical grocery store. The prototype building characteristics are described in Appendix A. The unit electricity savings for five different cities in NY are shown below:

City	Unit	KWh/unit
Albany	per lineal foot	27
Buffalo	per lineal foot	28
Massena	per lineal foot	28
NYC	per lineal foot	29
Syracuse	per lineal foot	27

Installing night covers reduces space heating requirements, since the introduction of cold air into the conditioned space is reduced. The therm impacts are calculated as follows:

City	Unit	Therm/unit
Albany	per lineal foot	2
Buffalo	per lineal foot	5
Massena	per lineal foot	2
NYC	per lineal foot	1
Syracuse	per lineal foot	4

Baseline Efficiencies from which savings are calculated

The baseline condition is assumed to be no night covers installed

Compliance Efficiency from which incentives are calculated

TBD

Operating Hours

The night curtains are assumed to be deployed 4 hours per night.

Notes & References

1. Measure performance characteristics taken from the California DEER update study: 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, Final Report, Itron, Inc. Vancouver, WA. December, 2005. Available at http://www.calmac.org/publications/2004-05_DEER_Update_Final_Report-Wo.pdf

Revision Number
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VENDING MACHINE CENTRAL CONTROLS

Measure Description

This measure is essentially an approach for controlling the operations of vending machines so that they are only operating when needed. The controls are typically a time-control system that allows the machines to be turned on and reach desired temperatures during the hours of business operations, but turned off during other time.

Savings Estimation Approach

kWh Savings

The savings approach is based on the estimated difference in machine consumption between a unit operating full time and operating only during controlled on-cycles. The estimation approach is as follows:

Savings in kWh per year = (Annual kWh B – Annual kWh A)

Where:

> Annual kWh $_B$ = The total annual kWh usage of the vending machines that are being controlled without the control system installed.
> Annual kWh $_A$ = The total annual kWh usage of the vending machines with the control system installed.

Because different vending machines have different operational characteristics, consumption of the vending machines will need to be estimated for the pre-installation period for the typical program-covered unit. Where possible, this estimate should be based on a metered sample of units operated with kWh/kW meters to establish the baseline conditions. If metered data of a sample of machines in New York is not available, metered samples from other states or programs can be used. If metered data from other states are not available, manufacturer's data on unit consumption can be used. The consumption of the units for the baseline condition will be assumed to operate 8,760 hours per year. Savings for the post-installation period will be estimated using the percent of time the units are turned on as a fraction of the total estimated consumption for 8,760 hours per year.

kW savings

Because the timer based units typically operate during peak hours, the peak demand reduction will be set to zero.

COMPRESSED AIR

Description of Measure

In compressed air programs, energy auditors assess compressed air systems and make specific recommendations to plant operators regarding how they can achieve and sustain large improvements in the efficiency of their compressed air systems through a combination of capital improvements and better operating and maintenance practices. The list of possible measures and behaviors is long and can include such things as:

- Add control storage
- Add dedicated end-use storage
- Add remote storage
- Equipment Add mist eliminator
- Add/ replace central dryers
- Coalescing filters
- Dedicated end use dryers/filters
- Upgrade end use filters, regulators and lubricators
- Zero-loss condensate drains
- Add auto-shutoff timer
- Adjust pressure setpoint range
- Cascade control setpoints
- Implement load/unload controls
- Reduce pressure
- Relocate control pressure transducer
- Use sequencer
- Demand controller
- Correctly size piping
- Isolate unused branches of distribution system
- Remove abandoned orifice plates
- Remove unnecessary valves
- Baghouse improvements
- Repair malfunctioning equipment
- Replace air drives with electric drives
- Replace open-tube blowing with nozzles
- Replace venturi vacuum generators
- Use blowers
- Add heat recovery
- Duct intake air from outside
- Increase cooling water flows
- Reduce cooling water temperatures
- Clean heat transfer surfaces
- Repair leaks

- Replace dirty filter elements
- Run smaller compressor(s)
- Turn off unneeded compressors

Since the list of possible compressed air measures is large, with potential interactive effects between measures, the use of unit savings estimates per measure is not recommended.

Method for Calculating Summer Peak Demand and Energy Savings

Measurement of annual energy and demand impacts from compressed air systems must be based on the AIRMaster+ model[10].This method embodies elements of the IPMVP Options B and D. Their isolated end use metering (power and pressure for the affected compressed air system) is consistent with IPMVP Option B. In addition, they calibrate the AIRMaster+ model to measured short-term power consumption and use it to model impact for a full year. This element of their method is consistent with IPMVP Option D.

Some of the specific measures (such as those listed above) may need to be aggregated for the AIRMaster+ model. For example, the effects of (a) installing low-pressure drop filters, (b) removing an orifice plate from the main supply header, and (c) adjusting an end use so that it could operate at a lower pressure might all fall under a single AIRMaster+ efficiency measure, namely, *Reduce system air pressure*. The general categories of measures available in AIRMaster+ are:

- Reduce air leaks (demand side)
- Improve end use efficiency (demand side)
- Reduce system air pressure (demand side)
- Use unloading controls (supply side)
- Adjust cascading set points (supply side)
- Use automatic sequencer (supply side)
- Reduce run time (supply side)
- Add primary receiver volume (supply side)

It is also possible to modify the inputs to an AIRMaster+ model to simulate other capital measures, such as:

- Compressor replacement (supply side)
- Compressor with variable-speed drive (supply side)
- Intermediate controller (supply side)

Energy and Demand Impacts

[10] Copies of the latest AIRMaster+ software can be ordered via e-mail from Clearinghouse@ee.doe.gov or by calling the Clearinghouse at 800-862-2086. It can also be downloaded from the Internet at (www1.eere.energy.gov/industry/bestpractices/software.html).

The ex ante expected first-year annual energy and peak demand impacts per comprehensive compressed air project are[11]:

- 353,345 kWh
- 42.2 kW

Expresssed in terms of compressor horsepower,

Energy Savings (kWh) = 774*HP
Demand Savings (kW) = 0.129*HP
Coincident Peak Demand Savings (kW) = 0.106*HP

Where:

HP = nameplate motor horsepower
Motor HP Variable Nameplate Application

- The SBW Compressed Air Management Program (CAMP) Web site calculator lists a low savings estimate of 15% and a high savings estimate of 30%[12].
- Rogers Machinery conducts an average of 50 project implementations, with pre- and post-install metering, for compressor systems ranging from 50 hp to 2,000 hp – the bulk of which are between 200 hp and 1,000 hp. These projects have documented energy use and demand savings between 20% and 30%.
- A May 2005 evaluation of New York State Energy Research and Development Authority estimates energy savings between 15% and 20% for compressed air measures[13].
- The 2001 Xenergy report prepared for PG&E lists estimated savings opportunities for compressed air systems at 17%[14].

Baseline Efficiencies from which savings are calculated

See above

Compliance Efficiency from which incentives are calculated

See above

[11] Ridge, Richard, Frank Moskovitz, and Mary Sutter. "Evaluation of the PY 2004-05 SBW Compressed Air Program." Prepared for SBW Consulting, Inc., March 2007; Ridge, Richard and Frank Moskovitz. "Evaluation of the PY 2002-03 SBW Compressed Air Program." Prepared for SBW Consulting, Inc., March 2004.

[12] http://www.sbwconsulting.com/CACost.htm
[13] "New York Energy $mart Program Evaluation and Status Report," May 2005, Section 8, page 8-106.
[14] Xenergy Inc., "California Industrial Energy Efficiency Market Characterization Study," 2001, p. 4-6.

Operating Hours

Available 24/7

Non-Electric Benefits - Annual Fossil Fuel Savings
None anticipated

Notes & References

1. Copies of the latest AIRMaster+ software can be ordered via e-mail from Clearinghouse@ee.doe.gov or by calling the Clearinghouse at 800-862-2086. It can also be downloaded from the Internet at (www1.eere.energy.gov/industry/bestpractices/software.html).
2. Ridge, Richard, Frank Moskovitz, and Mary Sutter. "Evaluation of the PY 2004-05 SBW Compressed Air Program." Prepared for SBW Consulting, Inc., March 2007;
3. Ridge, Richard and Frank Moskovitz. "Evaluation of the PY 2002-03 SBW Compressed Air Program." Prepared for SBW Consulting, Inc., March 2004.

Revision Number
0

MOTORS

Description of Measure

NEMA premium efficiency motors replacing standard efficiency motors in commercial and industrial applications

Method for Calculating Summer Peak Demand and Energy Savings

Gross Summer Coincident Demand Savings

$$\Delta kW_S = units \times 0.746 \times \left[\frac{hp_{base} \times RLF_{base}}{\eta_{base}} - \frac{hp_{ee} \times RLF_{ee}}{\eta_{ee}} \right] \times DF_S \times CF_S$$

Gross Annual Energy Savings

$$\Delta kWh = units \times 0.746 \times \left[\frac{hp_{base} \times RLF_{base}}{\eta_{base}} - \frac{hp_{ee} \times RLF_{ee}}{\eta_{ee}} \right] \times FLH$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
units	= number of motors installed under the program
η_{base}	= efficiency of base motor
η_{ee}	= efficiency of high-efficiency motor
hp_{base}	= horsepower of base motor (hp)
hp_{ee}	= horsepower of high-efficiency motor (hp)
RLF_{base}	= rated load factor for the base motor
RLF_{ee}	= rated load factor for the high-efficiency motor
FLH	= full-load hours
DF	= demand diversity factor
CF	= coincidence factor
0.746	= conversion factor (kW/hp)

The ***motor horsepower*** refers to the nameplate or rated power output of the motor. Motors are commonly oversized for the loads served. An energy-efficient motor with a lower nameplate horsepower rating may be installed to correct for oversizing.

The ***rated load factor*** is the ratio of peak running load to nameplate rating of the motor. The rated load factor for the energy-efficient motor will be greater than the rated load factor of the base case motor if a smaller energy-efficient motor is used to correct for oversizing. If a smaller motor is installed, but the shaft power requirements stay the same, the product of the rated horsepower and the rated load factor should be constant. Lower torque from efficient motors may prevent downsizing of the motor.

$$(RLF \times hp)_{base} = (RLF \times hp)_{ee}$$

Motor ***full-load hours*** are defined as the total annual energy consumption divided by the peak hourly demand.

$$\text{FLH} = \frac{\text{kWh}}{\text{kW}_{\text{max}}}$$

For loads that do not vary with time (i.e., a motor driving a constant load), full-load hours are simply equal to the operating hours.

Note: efficient motors generally run at slightly higher RPM than standard motors. Unless the motor drive system is modified to correct for higher RPM operation, the power delivered by the motor may increase. The increase in power delivery may negate the effects of improved efficiency.

The ***demand diversity factor*** is used to account for the fact that not all motors installed under a DSM program will be drawing maximum demand at the same time. The demand diversity factor is estimated by comparing the peak demand of a population of motors to the inventory and maximum load of all motors in the population. Note: The demand diversity factor may vary by season.

The ***coincidence factor*** is used to account for the fact that peak measure savings may not be coincident with utility peak demands. The coincidence factor is defined as the portion of the motor demand reduction that is coincident with the system peak.

Recommendations for demand diversity factor and coincidence factor are as follows:

Factor	Recommendation
Demand Diversity (DF)	0.8
Coincidence (CF)	1.0

These values should be used as default values until better data are identified or developed through EM&V studies.

Baseline Efficiencies from which savings are calculated

Baseline motor Efficiencies (EPACT 1992)						
	Open Drip Proof			**Totally Enclosed Fan Cooled**		
HP	**1200 rpm**	**1800 rpm**	**3600 rpm**	**1200 rpm**	**1800 rpm**	**3600 rpm**
1	80.0	82.5	77.5	80.0	82.5	75.5
1.5	84.0	84.0	82.5	85.5	84.0	82.5
2	85.5	84.0	84.0	86.5	84.0	84.0
3	86.5	86.5	84.0	87.5	87.5	85.5
5	87.5	87.5	85.5	87.5	87.5	87.5
7.5	88.5	88.5	87.5	89.5	89.5	88.5
10	90.2	89.5	88.5	89.5	89.5	89.5
15	90.2	91.0	89.5	90.2	91.0	90.2
20	91.0	91.0	90.2	90.2	91.0	90.2
25	91.7	91.7	91.0	91.7	92.4	91.0
30	92.4	92.4	91.0	91.7	92.4	91.0
40	93.0	93.0	91.7	93.0	93.0	91.7
50	93.0	93.0	92.4	93.0	93.0	92.4
60	93.6	93.6	93.0	93.6	93.6	93.0
75	93.6	94.1	93.0	93.6	94.1	93.0
100	94.1	94.1	93.0	94.1	94.5	93.6
125	94.1	94.5	93.6	94.1	94.5	94.5
150	94.5	95.0	93.6	95.0	95.0	94.5
200	94.5	95.0	94.5	95.0	95.0	95.0

Compliance Efficiency from which incentives are calculated

Minimum Motor Compliance Efficiencies						
	Open Drip Proof			**Totally Enclosed Fan Cooled**		
HP	**1200 rpm**	**1800 rpm**	**3600 rpm**	**1200 rpm**	**1800 rpm**	**3600 rpm**
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	97.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

Operating Hours

Facility Type	Fan Motor Hours	CHWP & Cooling Towers	Heating Pumps
Auto Related	4,056	1,878	6,000
Bakery	2,854	1,445	6,000
Banks, Financial Centers	3,748	1,767	6,000
Church	1,955	1,121	6,000
College - Cafeteria	6,376	2,713	6,000
College - Classes/Administrative	2,586	1,348	6,000
College - Dormitory	3,066	1,521	6,000
Commercial Condos	4,055	1,877	6,000
Convenience Stores	6,376	2,713	6,000
Convention Center	1,954	1,121	6,000
Court House	3,748	1,767	6,000
Dining: Bar Lounge/Leisure	4,182	1,923	6,000
Dining: Cafeteria / Fast Food	6,456	2,742	6,000
Dining: Family	4,182	1,923	6,000
Entertainment	1,952	1,120	6,000
Exercise Center	5,836	2,518	6,000
Fast Food Restaurants	6,376	2,713	6,000
Fire Station (Unmanned)	1,953	1,121	6,000
Food Stores	4,055	1,877	6,000
Gymnasium	2,586	1,348	6,000
Hospitals	7,674	3,180	6,000
Hospitals / Health Care	7,666	3,177	6,000
Industrial - 1 Shift	2,857	1,446	6,000
Industrial - 2 Shift	4,730	2,120	6,000
Industrial - 3 Shift	6,631	2,805	6,000
Laundromats	4,056	1,878	6,000
Library	3,748	1,767	6,000
Light Manufacturers	2,857	1,446	6,000
Lodging (Hotels/Motels)	3,064	1,521	6,000
Mall Concourse	4,833	2,157	6,000
Manufacturing Facility	2,857	1,446	6,000
Medical Offices	3,748	1,767	6,000
Motion Picture Theatre	1,954	1,121	6,000
Multi-Family (Common Areas)	7,665	3,177	6,000
Museum	3,748	1,767	6,000
Nursing Homes	5,840	2,520	6,000
Office (General Office Types)	3,748	1,767	6,000
Office/Retail	3,748	1,767	6,000
Parking Garages & Lots	4,368	1,990	6,000
Penitentiary	5,477	2,389	6,000
Performing Arts Theatre	2,586	1,348	6,000

Facility Type	Fan Motor Hours	CHWP & Cooling Towers	Heating Pumps
Police / Fire Stations (24 Hr)	7,665	3,177	6,000
Post Office	3,748	1,767	6,000
Pump Stations	1,949	1,119	6,000
Refrigerated Warehouse	2,602	1,354	6,000
Religious Building	1,955	1,121	6,000
Residential (Except Nursing Homes)	3,066	1,521	6,000
Restaurants	4,182	1,923	6,000
Retail	4,057	1,878	6,000
School / University	2,187	1,205	6,000
Schools (Jr./Sr. High)	2,187	1,205	6,000
Schools (Preschool/Elementary)	2,187	1,205	6,000
Schools (Technical/Vocational)	2,187	1,205	6,000
Small Services	3,750	1,768	6,000
Sports Arena	1,954	1,121	6,000
Town Hall	3,748	1,767	6,000
Transportation	6,456	2,742	6,000
Warehouse (Not Refrigerated)	2,602	1,354	6,000
Waste Water Treatment Plant	6,631	2,805	6,000
Workshop	3,750	1,768	6,000

Non-Electric Benefits - Annual Fossil Fuel Savings

None anticipated

Notes & References

1. Motor efficiency and operating hour data taken from the CL&P and UI Program Savings Documentation for 2008 Program Year.
2. Typical values for demand diversity factor (DF) and coincidence factor (CF) taken from Engineering Methods for Estimating the Impacts of Demand-Side Management Programs. Volume 2: Fundamental Equations for Residential and Commercial End-Uses. TR-100984S Vol 2. Electric Power Research Institute, Palo Alto, CA August, 1993.

Revision Number

0

PHOTOVOLTIACS

Description of Measure

Grid tied photovoltaic systems applied to commercial buildings

Method for Calculating Summer Peak Demand and Energy Savings

kWh = kW_{rated} x annual full sun hours

kW = kW_{rated} x Peak output factor x CF

Annual estimated energy production and peak system output for six NY cities are shown below:

City	kWh/kW rated DC output	July pk kW/kW rated DC output
Albany	1159	.710
Binghamton	1109	.712
Buffalo	1075	.735
Massena	1163	.721
NYC	1218	.677
Syracuse	1123	.688

Baseline Efficiencies from which savings are calculated

NA

Compliance Efficiency from which incentives are calculated

Grid tied fixed tilt PV system with tilt = site latitude. DC to AC Derate Factor = 0.77

Operating Hours

Grid tied system is assumed to be operating whenever solar energy resource is available, regardless of home occupancy. Excess energy production is added to the grid.

Non-Electric Benefits - Annual Fossil Fuel Savings

None anticipated

Notes & References

1. System output calculated from NREL PVWatts performance calculator for grid-connected PV systems (ver 1.0) See http://www.nrel.gov/rredc/pvwatts/

Revision Number
0

CUSTOM MEASURES

Measure Description

The term "custom" is used to describe any measure not specifically covered by a prescribed approach for estimating measure-level kWh or kW savings. Custom measures are project-based. That is, the savings that can be projected are for a specific project rather than a group of projects.

Custom measures are typically segregated into two estimation categories; those that are weather sensitive (also called weather dependant) measures and those that are not weather sensitive. Savings from weather sensitive measures involve savings calculations that are based on normal weather conditions within a given geographical area. For example, weather sensitive measures installed in up-state New York will have different savings than those same measures installed in a different climate zone, such as in New York City where the climate is buffered by the thermal effects of the Atlantic Ocean and the Gulf Stream. Custom measures that are not weather sensitive, but are similar in type, size, function and user conditions can be expected to have similar energy impacts regardless of where they are installed.

Savings Estimation Approach

<u>kWh Savings</u>

Weather Sensitive

Estimating weather sensitive measures involves the use of climate adjustments that apply for the geographical area in which the measure is installed. In general, the savings for weather sensitive custom measures are based on project-specific consumption calculations taking into account the energy consumption of the baseline equipment and operating environment and the expected equipment and operating environment of the post-installation condition. These calculations are based on a specific set of weather conditions that apply to that individual project. To estimate savings, the calculation must first establish the baseline condition for a give set of equipment, operational conditions and weather. Typically this is "normal-weather" for a location based on the average daily weather over 30 or 40 years. For expediency, the state can be broken down into climate zones so that there are only a few pre-defined "typical" climate zones so that the same weather data is used for all custom projects within the same weather zone regardless of the utility or organization conducting the program or the service territory in which that program is offered. Next the post installation consumption is estimated for the equipment and operational conditions that apply to the new equipment under the same weather conditions. The difference in kWh consumption between the estimated baseline energy use and the post-installation estimated consumption is defined as the custom project estimated savings. For projects in which savings can be affected by customer use and application conditions, the savings are adjusted for expected changes in those conditions.

Non-Weather Sensitive
Non-weather sensitive custom measures do not need to adjust savings for normal or expected weather. In these cases the consumption calculations for the energy use of the baseline condition are compared to the consumption calculations for the custom project's post-installation conditions. In these cases the savings estimates are adjusted for expected changes in the post-installation conditions. However, in most cases the pre and post installation conditions are not significantly different enough to require adjustments for changing conditions. However, this assumption needs to be documented in the estimate of savings.

kW Savings[15]
Weather Sensitive Measures:
The methodology used to determine the annual kWh savings for temperature-dependent measures depends on the type of analysis used to estimate savings. Savings from temperature-dependent measures are typically determined by either full load hour analysis, bin temperature analysis, or a detailed computer simulation. The following will be the procedure used to estimate the kWh savings for these measures:

When annual savings are calculated using a full load hour analysis, an appropriately derived coincidence factor will be used for a measure that has a connected load that can be determined from rated or nameplate data. Demand savings will be the connected load kW savings times the appropriate coincidence factor. When using a temperature bin analysis to calculate the energy savings, the demand (kW) savings are averaged over the appropriate temperature bins. When a computer simulation is used to calculate savings, the demand savings will be averaged over the appropriate peak time period.

Non Weather Sensitive Measures:
Demand savings for measures that are not temperature-dependent will be determined by estimating the average estimated savings at the coincident peak time. For example, for a process VFD measure, the savings will depend on cycling of the load. This cycling may occur many times during an hour. If the process is operating throughout the summer period, the average demand savings will be:

(annual kWh savings)/(annual equivalent full load hours of operation).

If the process is operated only a portion of that time period the demand savings will be prorated based on that portion.

Documentation Requirements
Custom project savings calculations must include all engineering equations along with a list input parameters. Computer software used to estimate project savings must be identified, with the software maker and version number. The data source for each

[15] This portion of the savings estimate approach is based on the Connecticut Energy Efficiency Funds Program Savings Documentation approach for 2008 published by Connecticut Light and Power Company.

engineering parameter or computer model input must be referenced. Documentation on software algorithms must be available for review.

Project Review

The Department will review selected custom project calculations prior to acceptance and approval. The documentation supplied with each project must be complete to facilitate an accurate and timely review.

APPENDIX A PROTOTYPICAL BUILDING DESCRIPTIONS

SMALL RETAIL

A prototypical building energy simulation model for a small retail building was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the small retail building prototype are summarized in Table 2.

Table 2. Small Retail Prototype Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	6400 square foot sales area 1600 square foot storage area 8000 square feet total
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Sales area: 3.4 W/SF Storage area: 0.9 W/SF
Plug load density	Sales area: 1.2 W/SF Storage area: 0.2 W/SF
Operating hours	10 – 10 Monday-Saturday 10 – 8 Sunday
HVAC system type	Packaged single zone, no economizer
HVAC system size	230 – 250 SF/ton depending on climate
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 79 cooling, 69 heating

A computer-generated sketch of the small retail building prototype is shown in Figure 1.

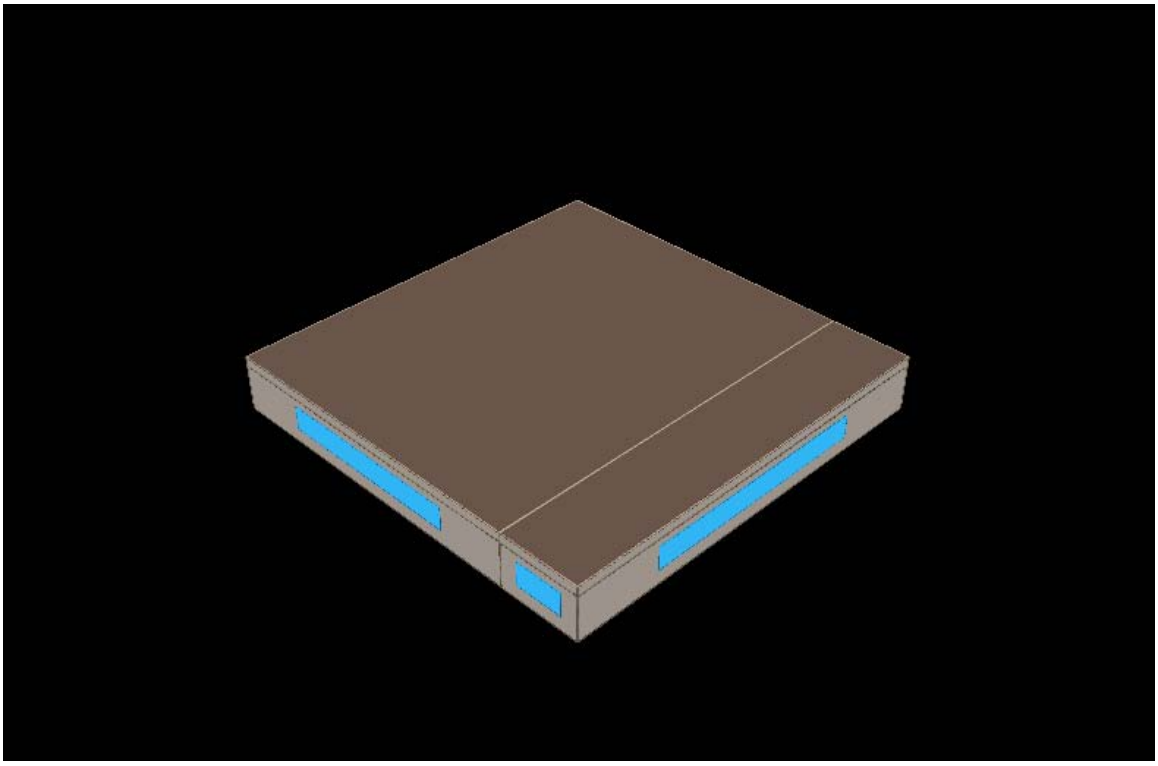

Figure 1. Small Retail Prototype Building Rendering

FULL-SERVICE RESTAURANT

A prototypical building energy simulation model for a full-service restaurant was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the full service restaurant prototype are summarized in Table 3.

Table 3. Full Service Restaurant Prototype Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2000 square foot dining area 600 square foot entry/reception area 1200 square foot kitchen 200 square foot restrooms
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Dining area: 1.7 W/SF Entry area: 2.5 W/SF Kitchen: 4.3 W/SF Restrooms: 1.0 W/SF
Plug load density	Dining area: 0.6 W/SF Entry area: 0.6 W/SF Kitchen: 3.1 W/SF Restrooms: 0.2 W/SF
Operating hours	9am – 12am
HVAC system type	Packaged single zone, no economizer
HVAC system size	140 – 160 SF/ton depending on climate
Thermostat setpoints	Occupied hours: 77 cooling, 72 heating Unoccupied hours: 80 cooling, 69 heating

A computer-generated sketch of the full-service restaurant prototype is shown in Figure 2.

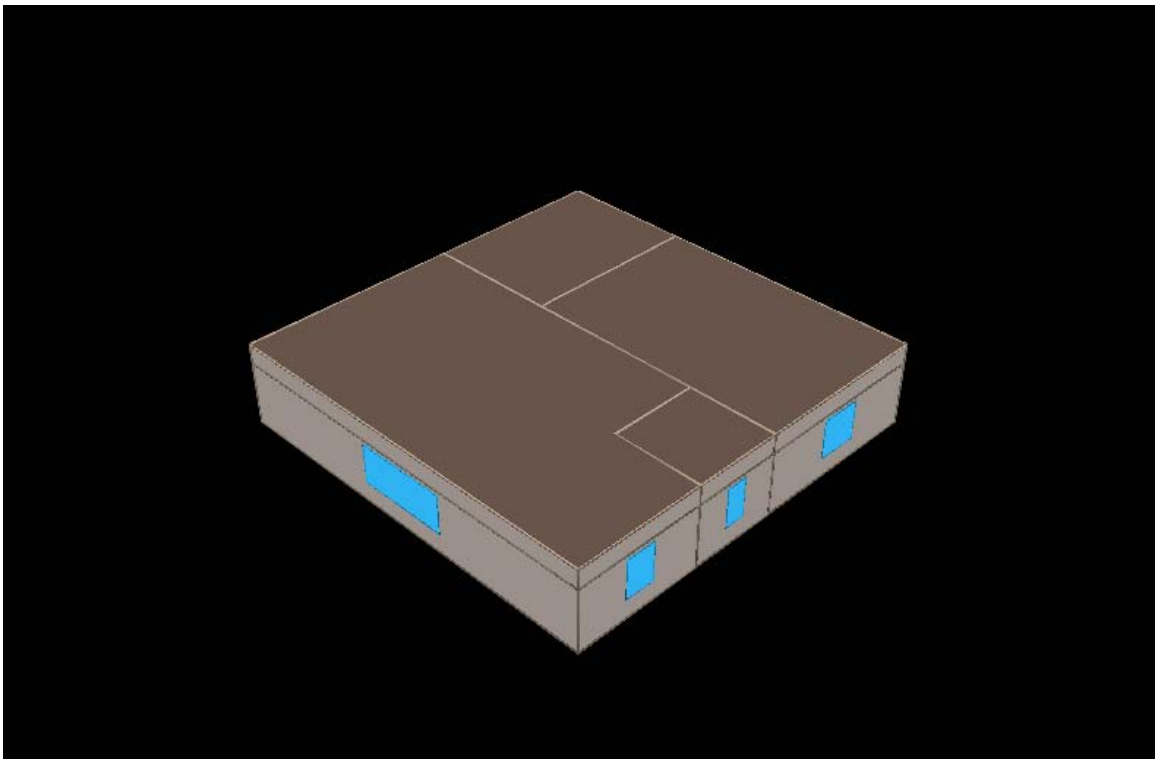

Figure 2. Full Service Restaurant Prototype Rendering

SMALL OFFICE

A prototypical building energy simulation model for a small office was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the small office prototype are summarized in Table 4.

Table 4. Small Office Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	10,000 square feet
Number of floors	2
Wall construction and R-value	Wood frame with brick veneer, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Perimeter offices: 2.2 W/SF Core offices: 1.5 W/SF
Plug load density	Perimeter offices: 1.6 W/SF Core offices: 0.7 W/SF
Operating hours	Mon-Sat: 9am – 6pm Sun: Unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	230 - 245 SF/ton depending on climate
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 79 cooling, 69 heating

A computer-generated sketch of the small office prototype is shown in Figure 3.

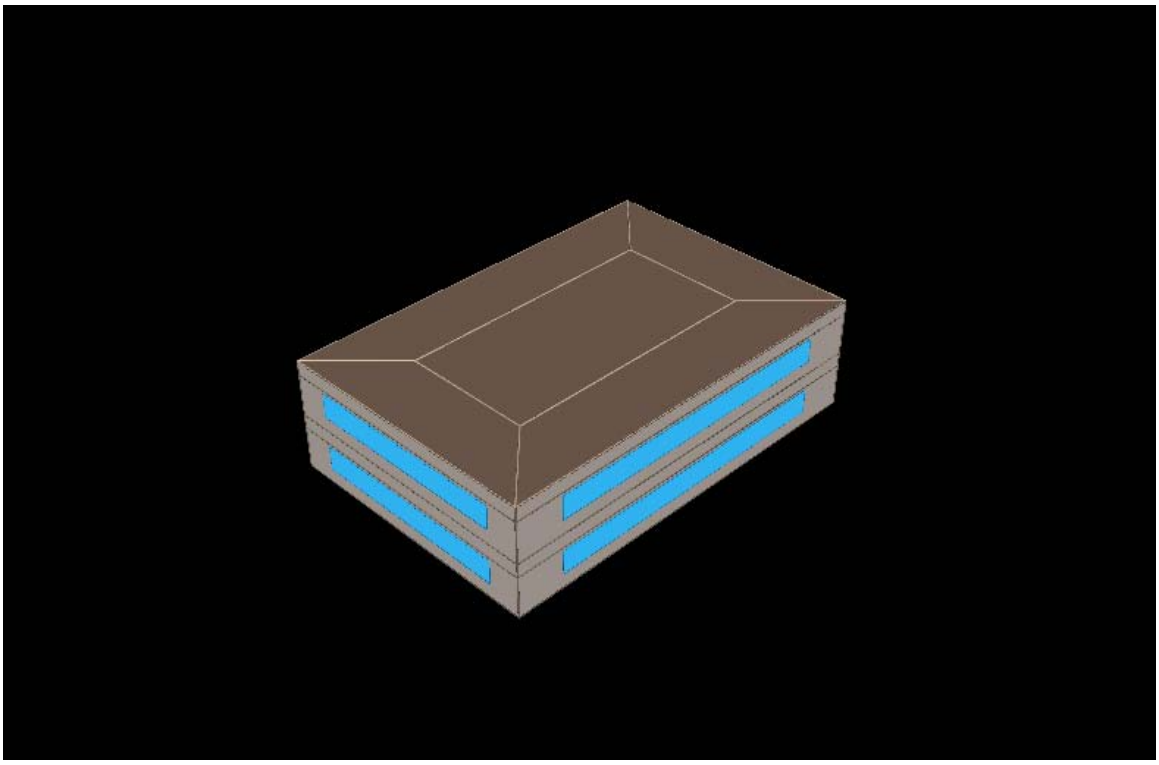

Figure 3. Small Office Prototype Building Rendering

LIGHT INDUSTRIAL

A prototypical building energy simulation model for a light industrial building was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized in Table 5.

Table 5. Light Industrial Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	100,000 square feet total 80,000 SF factory 20,000 SF warehouse
Number of floors	1
Wall construction and R-value	Concrete block with insulation, R-5
Roof construction and R-value	Concrete deck with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Factory – 2.1 W/SF Warehouse – 0.9 W/SF
Plug load density	Factory – 1.2 W/SF Warehouse – 0.2 W/SF
Operating hours	Mon-Fri: 6am – 6pm Sat Sun: Unoccupied
HVAC system type	Packaged single zone, no economizer
HVAC system size	500 - 560 SF/ton depending on climate
Thermostat setpoints	Occupied hours: 78 cooling, 70 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the prototype is shown in Figure 4.

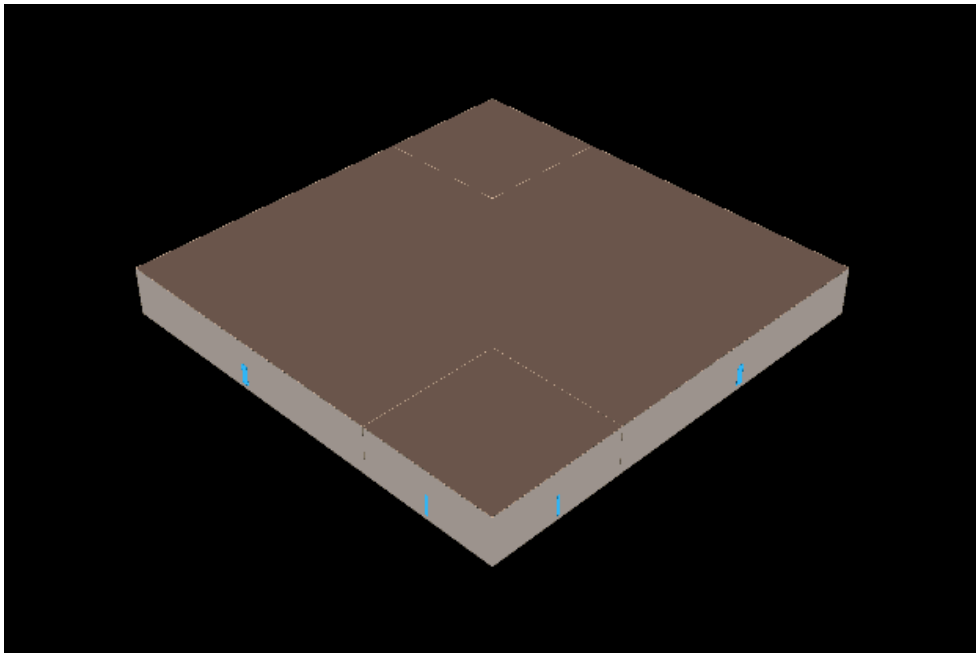

Figure 4. Light Industrial Building Rendering

BIG BOX RETAIL

A prototypical building energy simulation model for a big box retail building was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized in Table 6.

Table 6. Big Box Retail Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	130,500 square feet Sales: 107,339 SF Storage: 11,870 SF Office: 4,683 SF Auto repair: 5,151 SF Kitchen: 1,459 SF
Number of floors	1
Wall construction and R-value	Concrete block with insulation, R-5
Roof construction and R-value	Metal frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Sales: 3.36 W/SF Storage: 0.88 W/SF Office: 2.2 W/SF Auto repair: 2.15 W/SF Kitchen: 4.3 W/SF
Plug load density	Sales: 1.15 W/SF Storage: 0.23 W/SF Office: 1.73 W/SF Auto repair: 1.15 W/SF Kitchen: 3.23 W/SF
Operating hours	Mon-Sun: 10am – 9pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	230 - 260 SF/ton depending on climate
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 79 cooling, 69 heating

A computer-generated sketch of the prototype is shown in Figure 5.

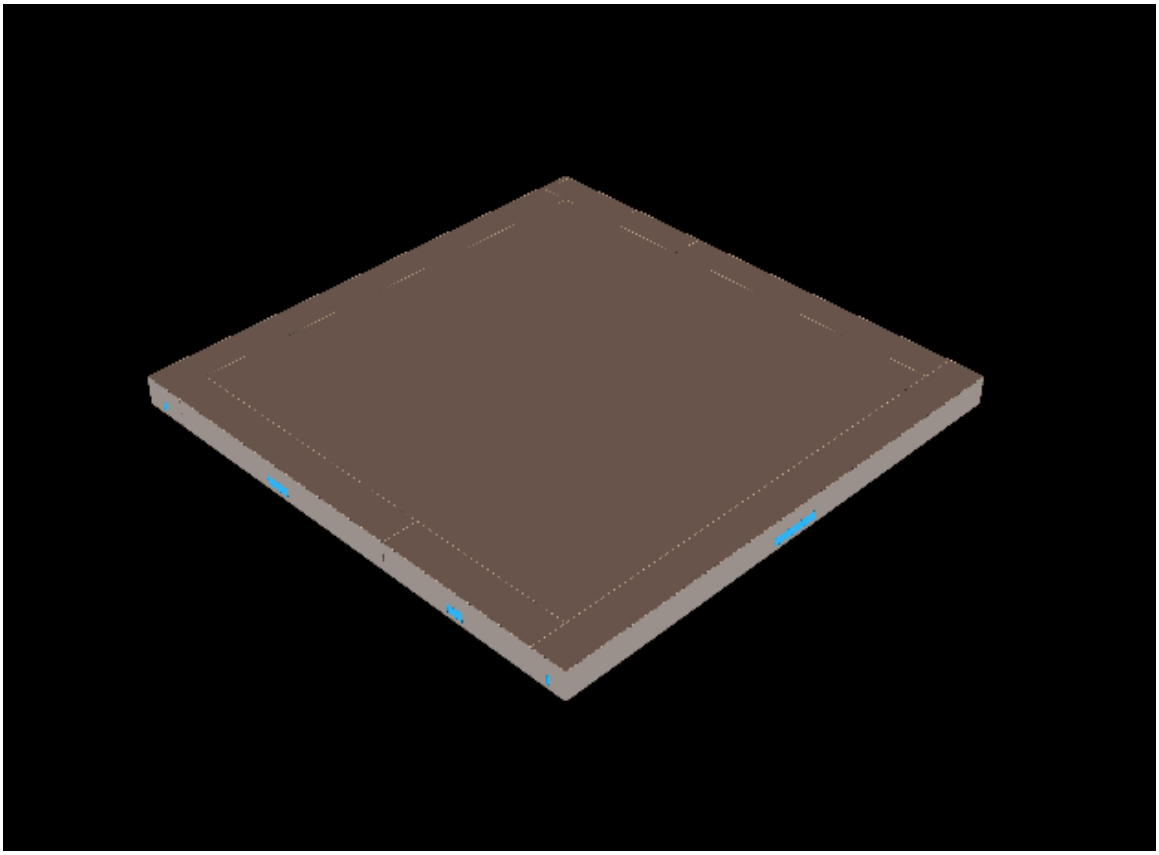

Figure 5. Big Box Retail Building Rendering

FAST FOOD RESTAURANT

A prototypical building energy simulation model for a fast food restaurant was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized in Table 7.

Table 7. Fast Food Restaurant Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2000 square feet 1000 SF dining 600 SF entry/lobby 300 SF kitchen 100 SF restroom
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-5
Roof construction and R-value	Concrete deck with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	1.7 W/SF dining 2.5 W/SF entry/lobby 4.3 W/SF kitchen 1.0 W/SF restroom
Plug load density	0.6 W/SF dining 0.6 W/SF entry/lobby 4.3 W/SF kitchen 0.2 W/SF restroom
Operating hours	Mon-Sun: 6am – 11pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	100 – 120 SF/ton depending on climate
Thermostat setpoints	Occupied hours: 77 cooling, 72 heating Unoccupied hours: 80 cooling, 69 heating

A computer-generated sketch of the prototype is shown in Figure 6.

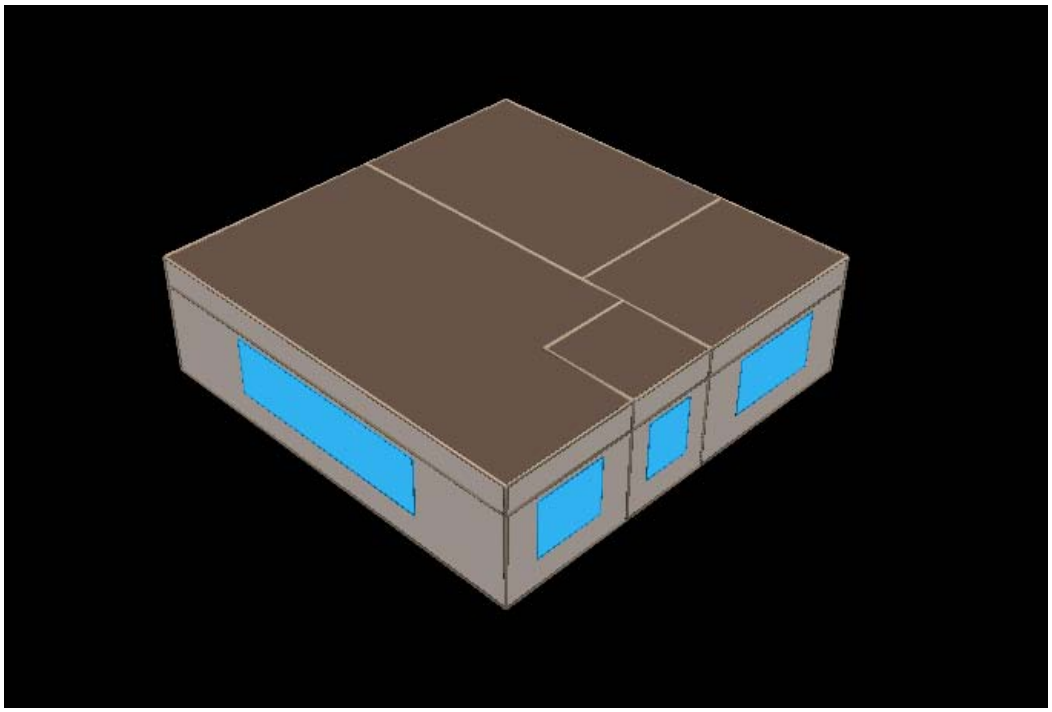

Figure 6. Fast Food Restaurant Building Rendering

SCHOOL

A prototypical building energy simulation model for an elementary school was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The model is really of two identical buildings oriented in two different directions. The characteristics of the prototype are summarized in Table 8.

Table 8. Elementary School Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2 buildings, 25,000 square feet each; oriented 90° from each other Classroom: 15,750 SF Cafeteria: 3,750 SF Gymnasium: 3,750 SF Kitchen: 1,750 SF
Number of floors	1
Wall construction and R-value	Wood frame with brick veneer, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Classroom: 4.4 W/SF Cafeteria: 1.7 W/SF Gymnasium: 2.1 W/SF Kitchen: 4.3 W/SF
Plug load density	Classroom: 1.2 W/SF Cafeteria: 0.6 W/SF Gymnasium: 0.6 W/SF Kitchen: 4.2 W/SF
Operating hours	Mon-Fri: 8am – 6pm Sun: 8am – 4pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	160 - 180 SF/ton depending on climate
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 79 cooling, 69 heating

A computer-generated sketch of the prototype is shown in Figure 7.

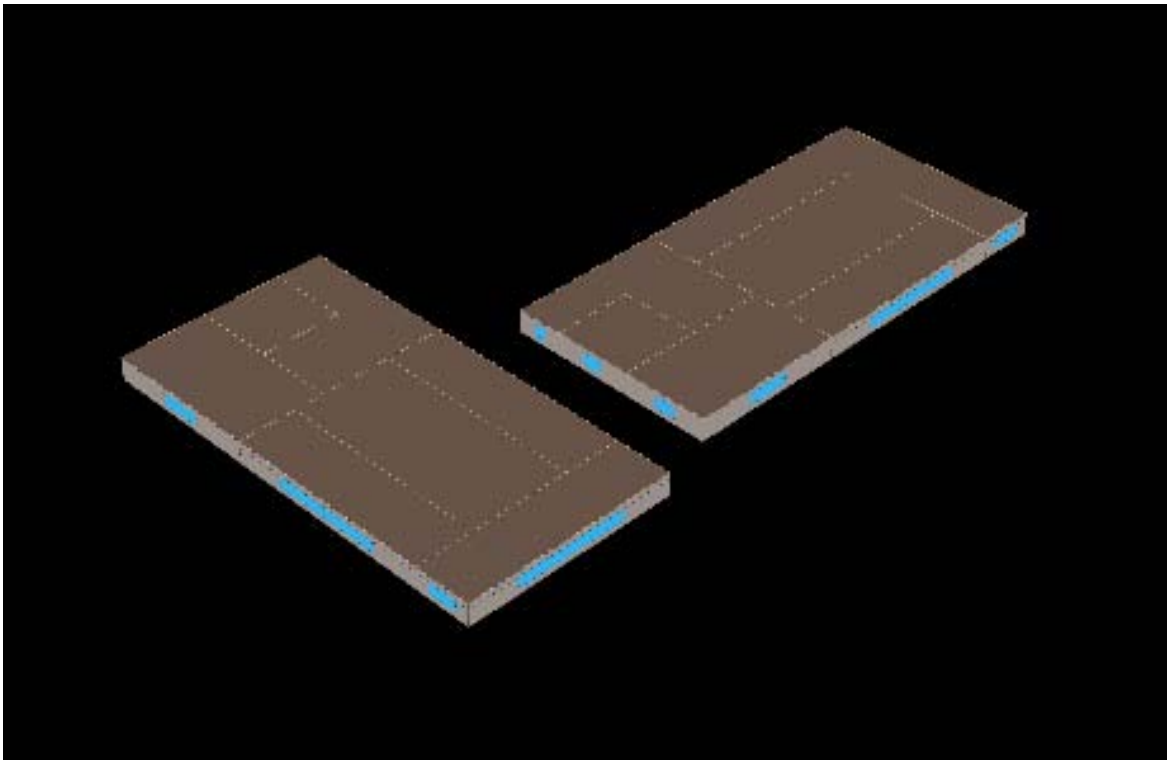

Figure 7. School Building Rendering

ASSEMBLY

A prototypical building energy simulation model for an assembly building was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized in Table 9.

Table 9. Assembly Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	34,000 square feet Auditorium: 33,240 SF Office: 760 SF
Number of floors	1
Wall construction and R-value	Concrete block, R-5
Roof construction and R-value	Wood frame with built-up roof, R-12
Glazing type	Single pane clear
Lighting power density	Auditorium: 3.4 W/SF Office: 2.2 W/SF
Plug load density	Auditorium: 1.2 W/SF Office: 1.7 W/SF
Operating hours	Mon-Sun: 8am – 9pm
HVAC system type	Packaged single zone, no economizer
HVAC system size	100 - 110 SF/ton depending on climate
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating

	Unoccupied hours: 79 cooling, 69 heating

A computer-generated sketch of the prototype is shown in Figure 8.

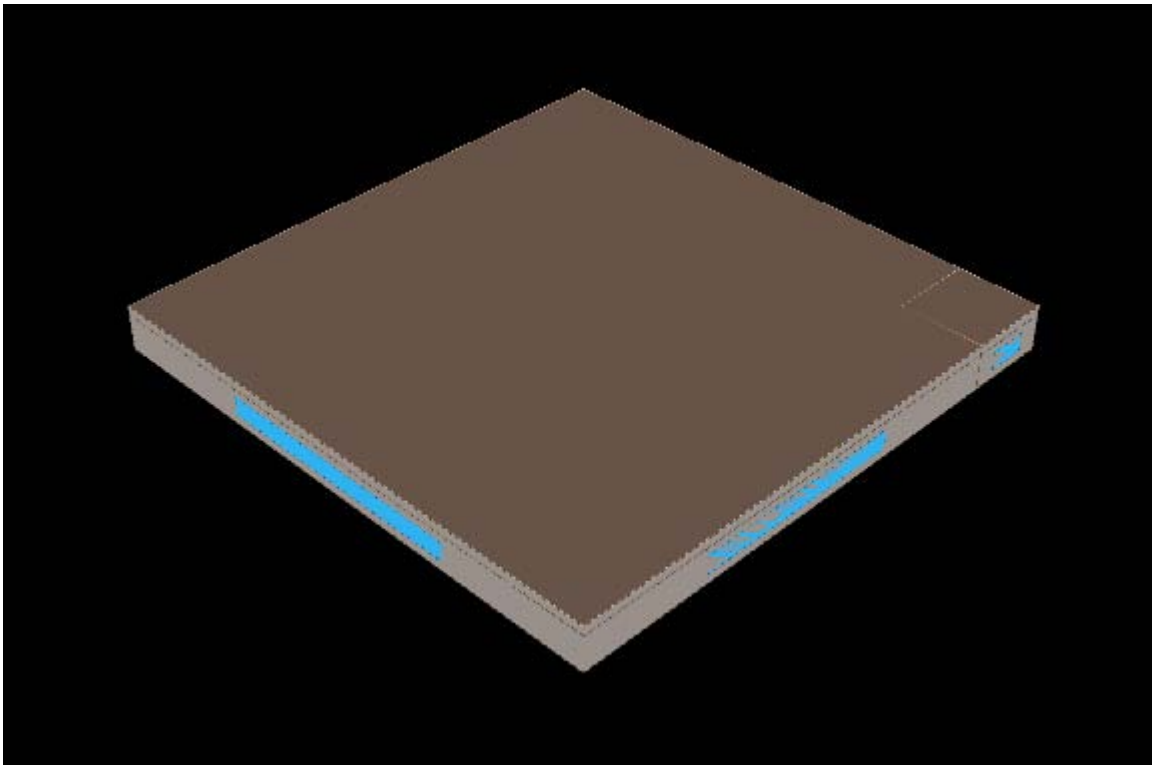

Figure 8. Assembly Building Rendering

GROCERY

A prototypical building energy simulation model for a grocery building was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized in Table 10.

Table 10. Grocery Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	50,000 square feet Sales: 40,000 SF Office and employee lounge: 3,500 SF Dry storage: 2,860 SF 50 °F prep area: 1,268 SF 35 °F walk-in cooler: 1,560 SF - 5 °F walk-in freezer: 812 SF
Number of floors	1
Wall construction and R-value	Concrete block with insulation, R-5
Roof construction and R-value	Metal frame with built-up roof, R-12

Characteristic	Value
Glazing type	Single pane clear
Lighting power density	Sales: 3.36 W/SF Office: 2.2 W/SF Storage: 1.82 W/SF 50°F prep area: 4.3 W/SF 35°F walk-in cooler: 0.9 W/SF - 5°F walk-in freezer: 0.9 W/SF
Equipment power density	Sales: 1.15 W/SF Office: 1.73 W/SF Storage: 0.23 W/SF 50°F prep area: 0.23 W/SF + 36 kBtu/hr process load 35°F walk-in cooler: 0.23 W/SF + 17 kBtu/hr process load - 5°F walk-in freezer: 0.23 W/SF+ 29 kBtu/hr process load
Operating hours	Mon-Sun: 6am – 10pm
HVAC system type	Packaged single zone, no economizer
Refrigeration system type	Air cooled multiplex
Refrigeration system size	Low temperature (-20°F suction temp): 23 compressor ton Medium temperature (18°F suction temp): 45 compressor ton
Refrigeration condenser size	Low temperature: 535 kBtu/hr THR Medium temperature: 756 kBtu/hr THR
Thermostat setpoints	Occupied hours: 74°F cooling, 70°F heating Unoccupied hours: 79°F cooling, 65°F heating

A computer-generated sketch of the prototype is shown in Figure 9.

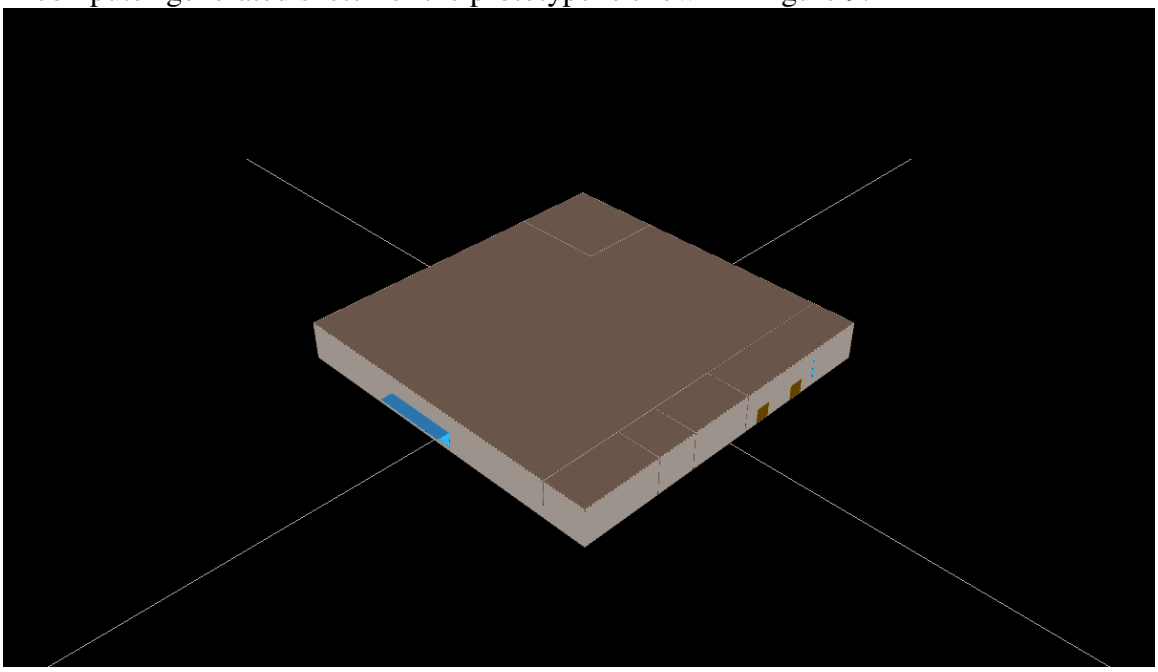

Figure 9. Grocery Building Rendering

LARGE OFFICE

A prototypical building energy simulation model for a large office building was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized in Table 11.

Table 11. Large Office Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	350,000 square feet
Number of floors	10
Wall construction and R-value	Glass curtain wall, R-7.5
Roof construction and R-value	Built-up roof, R-13.5
Glazing type	Multipane; Shading-coefficient = 0.84 U-value = 0.72
Lighting power density	Perimeter offices: 1.55 W/SF Core offices: 1.45 W/SF
Plug load density	Perimeter offices: 1.6 W/SF Core offices: 0.7 W/SF
Operating hours	Mon-Sat: 9am – 6pm Sun: Unoccupied
HVAC system types	1. Central constant volume system with hydronic reheat, without economizer; 2. Central constant volume system with hydronic reheat, with economizer; 3. Central VAV system with hydronic reheat, with economizer
HVAC system size	Based on ASHRAE design day conditions, 10% oversizing assumed.
Chiller type	Water cooled and air cooled
Chilled water system type	Constant volume with 3 way control valves,
Chilled water system control	Constant CHW Temp, 45 deg F setpoint
Boiler type	Hot water, 80% efficiency
Hot water system type	Constant volume with 3 way control valves,
Hot water system control	Constant HW Temp, 180 deg F setpoint
Thermostat setpoints	Occupied hours: 75 cooling, 70 heating Unoccupied hours: 78 cooling, 67 heating

Each set of measures was run using each of three different HVAC system configurations – a constant volume reheat system without economizer, a constant volume reheat system with economizer and a VAV system with economizer. The constant volume reheat system without economizer represents system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. This presents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the prototype is shown in Figure 10. Note, the middle floors, since they thermally equivalent, are simulated as a single floor, and the results are multiplied by 8 to represent the energy consumption of the 8 middle floors.

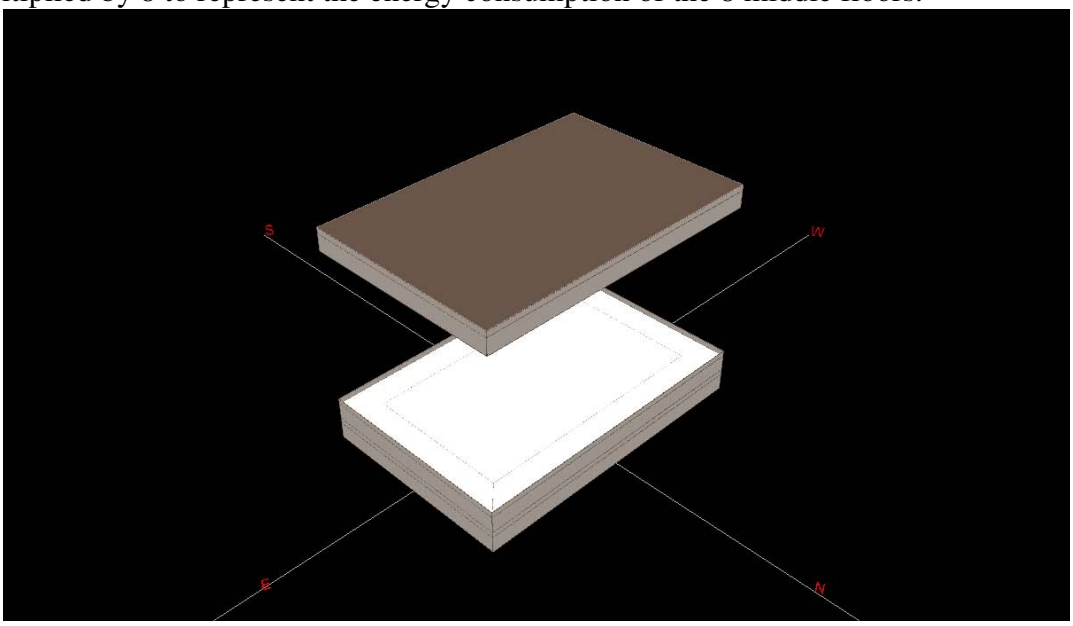

Figure 10. Large Office Building Rendering

HOSPITAL

A prototypical building energy simulation model for a large hospital building was developed using the DOE-2.2 building energy simulation program. The simulations were driven using TMY3 long-term average weather data. The characteristics of the prototype are summarized in Table 11.

Table 12. Large Hospital Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	250,000 square feet
Number of floors	3
Wall construction and R-value	Brick and CMU, R=7.5
Roof construction and R-value	Built-up roof, R-13.5
Glazing type	Multipane; Shading-coefficient = 0.84 U-value = 0.72
Lighting power density	Patient rooms: 2.3 W/SF Office: 2.2 W/SF Lab: 4.4 Dining: 1.7 Kitchen and food prep: 4.3
Plug load density	Patient rooms: 1.7 W/SF Office: 1.7 W/SF Lab: 1.7 Dining: 0.6 Kitchen and food prep: 4.6
Operating hours	24/7, 365
HVAC system types	Patient Rooms: 4 pipe fan coil Kitchen: Rooftop DX Remaining space; 1. Central constant volume system with hydronic reheat, without economizer; 2. Central constant volume system with hydronic reheat, with economizer; 3. Central VAV system with hydronic reheat, with economizer
HVAC system size	Based on ASHRAE design day conditions, 10% oversizing assumed.
Chiller type	Water cooled and air cooled
Chilled water system type	Constant volume with 3 way control valves,
Chilled water system control	Constant CHW Temp, 45 deg F setpoint
Boiler type	Hot water, 80% efficiency
Hot water system type	Constant volume with 3 way control valves,
Hot water system control	Constant HW Temp, 180 deg F setpoint
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 79 cooling, 69 heating

Each set of measures was run using each of three different HVAC system configurations – a constant volume reheat system without economizer, a constant volume reheat system with economizer and a VAV system with economizer. The constant volume reheat system without economizer represents system with the most heating and cooling operating hours, while the VAV system with economizer represents a system with the least heating and cooling hours. This presents a range of system loads and energy savings for each measure analyzed.

A computer-generated sketch of the prototype is shown in Figure 10

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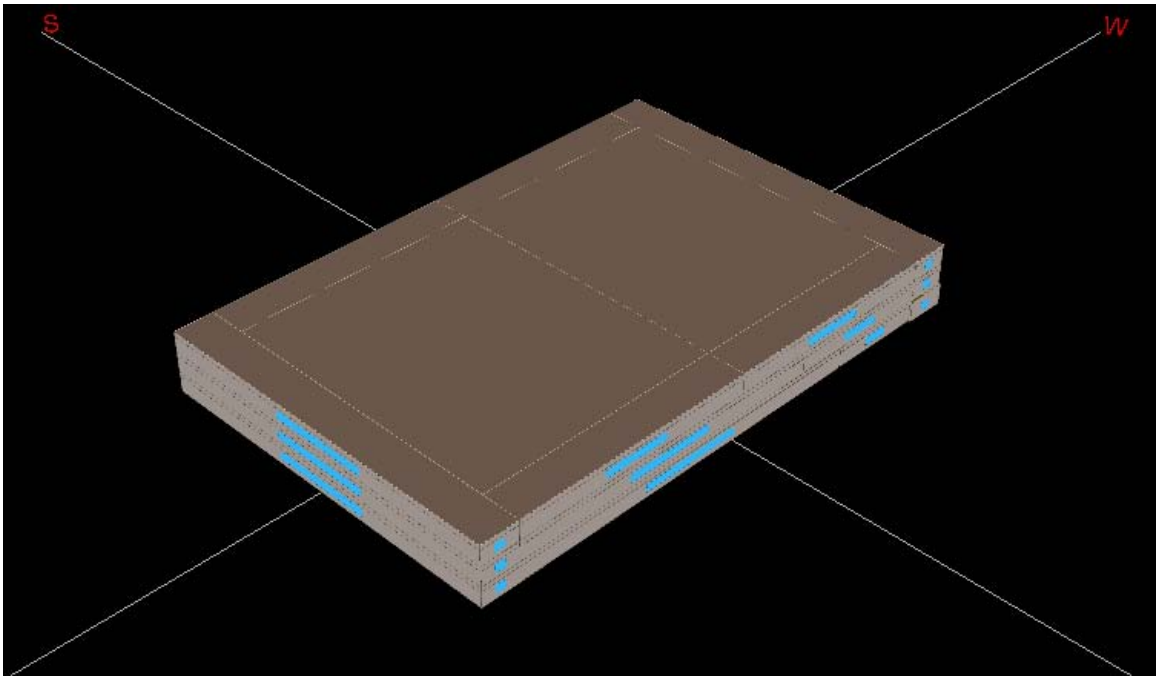

Figure 11. Hospital Building Rendering

APPENDIX B. STANDARD FIXTURE WATTS

(Reference: NYSERDA Existing Buildings Lighting Table)

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
		Compact Fluorescent Fixtures* Hard-Wired or Pin-Based Only				
CF10/2D	CFD10W	Compact Fluorescent, 2D, (1) 10W lamp	Mag-STD	1	10	16
CF10/2D-L	CFD10W	Compact Fluorescent, 2D, (1) 10W lamp	Electronic	1	10	12
CF11/1	CF11W	Compact Fluorescent, (1) 11W lamp	Mag-STD	1	11	13
CF11/2	CF11W	Compact Fluorescent, (2) 11W lamp	Mag-STD	2	11	26
CF16/2D	CFD16W	Compact Fluorescent, 2D, (1) 16W lamp	Mag-STD	1	16	26
CF16/2D-L	CFD16W	Compact Fluorescent, 2D, (1) 16W lamp	Electronic	1	16	18
CF18/3-L	CF18W	Compact Fluorescent, (3) 18W lamp	Electronic	3	18	60
CF21/2D	CFD21W	Compact Fluorescent, 2D, (1) 21W lamp	Mag-STD	1	21	26
CF21/2D-L	CFD21W	Compact Fluorescent, 2D, (1) 21W lamp	Electronic	1	21	22
CF23/1	CF23W	Compact Fluorescent, (1) 23W lamp	Mag-STD	1	23	29
CF23/1-L	CF23W	Compact Fluorescent, (1) 23W lamp	Electronic	1	23	25
CF26/3-L	CF26W	Compact Fluorescent, (3) 26W lamp	Electronic	3	26	82
CF26/4-L	CF26W	Compact Fluorescent, (4) 26W lamp	Electronic	4	26	108
CF26/6-L	CF26W	Compact Fluorescent, (6) 26W lamp	Electronic	6	26	162
CF26/8-L	CF26W	Compact Fluorescent, (8) 26W lamp	Electronic	8	26	216
CF28/2D	CFD28W	Compact Fluorescent, 2D, (1) 28W lamp	Mag-STD	1	28	35
CF28/2D-L	CFD28W	Compact Fluorescent, 2D, (1) 28W lamp	Electronic	1	28	28
CF32/3-L	CF32W	Compact Fluorescent, (3) 32W lamp	Electronic	3	32	114
CF32/4-L	CF32W	Compact Fluorescent, (4) 32W lamp	Electronic	4	32	152
CF32/6-L	CF32W	Compact Fluorescent, (6) 32W lamp	Electronic	6	32	228
CF32/8-L	CF32W	Compact Fluorescent, (8) 32W lamp	Electronic	8	32	304

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
CF38/2D	CFD38W	Compact Fluorescent, 2D, (1) 38W lamp	Mag-STD	1	38	46
CF38/2D-L	CFD38W	Compact Fluorescent, 2D, (1) 38W lamp	Electronic	1	38	36
CF42/1-L	CF42W	Compact Fluorescent, (1) 42W lamp	Electronic	1	42	48
CF42/2-L	CF42W	Compact Fluorescent, (2) 42W lamp	Electronic	2	42	100
CF42/3-L	CF42W	Compact Fluorescent, (3) 42W lamp	Electronic	3	42	141
CF42/4-L	CF42W	Compact Fluorescent, (4) 42W lamp	Electronic	4	42	188
CF42/6-L	CF42W	Compact Fluorescent, (6) 42W lamp	Electronic	6	42	282
CF42/8-L	CF42W	Compact Fluorescent, (8) 42W lamp	Electronic	8	42	376
CFQ10/1	CFQ10W	Compact Fluorescent, quad, (1) 10W lamp	Mag-STD	1	10	15
CFQ13/1	CFQ13W	Compact Fluorescent, quad, (1) 13W lamp	Mag-STD	1	13	17
CFQ13/1-L	CFQ13W	Compact Fluorescent, quad, (1) 13W lamp, BF=1.05	Electronic	1	13	15
CFQ13/2	CFQ13W	Compact Fluorescent, quad, (2) 13W lamp	Mag-STD	2	13	31
CFQ13/2-L	CFQ13W	Compact Fluorescent, quad, (2) 13W lamp, BF=1.0	Electronic	2	13	28
CFQ13/3	CFQ13W	Compact Fluorescent, quad, (3) 13W lamp	Mag-STD	3	13	48
CFQ15/1	CFQ15W	Compact Fluorescent, quad, (1) 15W lamp	Mag-STD	1	15	20
CFQ17/1	CFQ17W	Compact Fluorescent, quad, (1) 17W lamp	Mag-STD	1	17	24
CFQ17/2	CFQ17W	Compact Fluorescent, quad, (2) 17W lamp	Mag-STD	2	17	48
CFQ18/1	CFQ18W	Compact Fluorescent, quad, (1) 18W lamp	Mag-STD	1	18	26
CFQ18/1-L	CFQ18W	Compact Fluorescent, quad, (1) 18W lamp, BF=1.0	Electronic	1	18	20
CFQ18/2	CFQ18W	Compact Fluorescent, quad, (2) 18W lamp	Mag-STD	2	18	45
CFQ18/2-L	CFQ18W	Compact Fluorescent, quad, (2) 18W lamp, BF=1.0	Electronic	2	18	38
CFQ18/4	CFQ18W	Compact Fluorescent, quad, (4) 18W lamp	Mag-STD	2	18	90
CFQ20/1	CFQ20W	Compact Fluorescent, quad, (1) 20W lamp	Mag-STD	1	20	23
CFQ20/2	CFQ20W	Compact Fluorescent, quad, (2) 20W lamp	Mag-STD	2	20	46

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
CFQ22/1	CFQ22W	Compact Fluorescent, quad, (1) 22W lamp	Mag-STD	1	22	24
CFQ22/2	CFQ22W	Compact Fluorescent, quad, (2) 22W lamp	Mag-STD	2	22	48
CFQ22/3	CFQ22W	Compact Fluorescent, quad, (3) 22W lamp	Mag-STD	3	22	72
CFQ25/1	CFQ25W	Compact Fluorescent, quad, (1) 25W lamp	Mag-STD	1	25	33
CFQ25/2	CFQ25W	Compact Fluorescent, quad, (2) 25W lamp	Mag-STD	2	25	66
CFQ26/1	CFQ26W	Compact Fluorescent, quad, (1) 26W lamp	Mag-STD	1	26	33
CFQ26/1-L	CFQ26W	Compact Fluorescent, quad, (1) 26W lamp, BF=0.95	Electronic	1	26	27
CFQ26/2	CFQ26W	Compact Fluorescent, quad, (2) 26W lamp	Mag-STD	2	26	66
CFQ26/2-L	CFQ26W	Compact Fluorescent, quad, (2) 26W lamp, BF=0.95	Electronic	2	26	50
CFQ26/3	CFQ26W	Compact Fluorescent, quad, (3) 26W lamp	Mag-STD	3	26	99
CFQ26/6-L	CFQ26W	Compact Fluorescent, quad, (6) 26W lamp, BF=0.95	Electronic	6	26	150
CFQ28/1	CFQ28W	Compact Fluorescent, quad, (1) 28W lamp	Mag-STD	1	28	33
CFQ9/1	CFQ9W	Compact Fluorescent, quad, (1) 9W lamp	Mag-STD	1	9	14
CFQ9/2	CFQ9W	Compact Fluorescent, quad, (2) 9W lamp	Mag-STD	2	9	23
CFS7/1	CFS7W	Compact Fluorescent, spiral, (1) 7W lamp	Electronic	1	7	7
CFS9/1	CFS9W	Compact Fluorescent, spiral, (1) 9W lamp	Electronic	1	9	9
CFS11/1	CFS11W	Compact Fluorescent, spiral, (1) 11W lamp	Electronic	1	11	11
CFS15/1	CFS15W	Compact Fluorescent, spiral, (1) 15W lamp	Electronic	1	15	15
CFS20/1	CFS20W	Compact Fluorescent, spiral, (1) 20W lamp	Electronic	1	20	20
CFS23/1	CFS23W	Compact Fluorescent, spiral, (1) 23W lamp	Electronic	1	23	23
CFS27/1	CFS27W	Compact Fluorescent, spiral, (1) 27W lamp	Electronic	1	27	27
CFT13/1	CFT13W	Compact Fluorescent, twin, (1) 13W lamp	Mag-STD	1	13	17
CFT13/2	CFT13W	Compact Fluorescent, twin, (2) 13W lamp	Mag-STD	2	13	31
CFT13/3	CFT13W	Compact Fluorescent, twin, (3) 13 W lamp	Mag-STD	3	13	48

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
CFT18/1	CFT18W	Compact Fluorescent, long twin., (1) 18W lamp	Mag-STD	1	18	24
CFT22/1	CFT22W	Compact Fluorescent, twin, (1) 22W lamp	Mag-STD	1	22	27
CFT22/2	CFT22W	Compact Fluorescent, twin, (2) 22W lamp	Mag-STD	2	22	54
CFT22/4	CFT22W	Compact Fluorescent, twin, (4) 22W lamp	Mag-STD	4	22	108
CFT24/1	CFT24W	Compact Fluorescent, long twin, (1) 24W lamp	Mag-STD	1	24	32
CFT28/1	CFT28W	Compact Fluorescent, twin, (1) 28W lamp	Mag-STD	1	28	33
CFT28/2	CFT28W	Compact Fluorescent, twin, (2) 28W lamp	Mag-STD	2	28	66
CFT32/1-L	CFM32W	Compact Fluorescent, twin or multi, (1) 32W lamp	Electronic	1	32	34
CFT32/2-L	CFM32W	Compact Fluorescent, twin or multi, (2) 32W lamp	Electronic	2	32	62
CFT32/6-L	CFM32W	Compact Fluorescent, twin or multi, (2) 32W lamp	Electronic	6	32	186
CFT36/1	CFT36W	Compact Fluorescent, long twin, (1) 36W lamp	Mag-STD	1	36	51
CFT36/4-BX	CFT36W	Compact Fluorescent, Biax, (4) 36W lamp	Electronic	4	36	148
CFT36/6-BX	CFT36W	Compact Fluorescent, Biax, (6) 36W lamp	Electronic	6	36	212
CFT36/6-L	CFT36W	Compact Fluorescent, long Twin, (6) 36W lamp	Electronic	6	36	198
CFT36/6-L	CFT36W	Compact Fluorescent, long Twin, (6) 36W lamp/ High Ballast Factor	Electronic	6	36	210
CFT36/8-BX	CFT36W	Compact Fluorescent, Biax, (8) 36W lamp	Electronic	8	36	296
CFT36/8-L	CFT36W	Compact Fluorescent, long Twin, (8) 36W lamp	Electronic	8	36	270
CFT36/8-L	CFT36W	Compact Fluorescent, long Twin, (8) 36W lamp/ High Ballast Factor	Electronic	8	36	286
CFT36/9-BX	CFT36W	Compact Fluorescent, Biax, (9) 36W lamp	Electronic	9	36	318
CFT40/1	CFT40W	Compact Fluorescent, twin, (1) 40W lamp	Mag-STD	1	40	46
CFT40/12-BX	CFT40W	Compact Fluorescent, Biax, (12) 40W lamp	Electronic	12	40	408
CFT40/1-BX	CFT40W	Compact Fluorescent, Biax, (1) 40W lamp	Electronic	1	40	46
CFT40/1-L	CFT40W	Compact Fluorescent, long twin, (1) 40W lamp	Electronic	1	40	43
CFT40/2	CFT40W	Compact Fluorescent, twin, (2) 40W lamp	Mag-STD	2	40	85

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
CFT40/2-BX	CFT40W	Compact Fluorescent, Biax, (2) 40W lamp	Electronic	2	40	72
CFT40/2-L	CFT40W	Compact Fluorescent, long twin, (2) 40W lamp	Electronic	2	40	72
CFT40/3	CFT40W	Compact Fluorescent, twin, (3) 40 W lamp	Mag-STD	3	40	133
CFT40/3-BX	CFT40W	Compact Fluorescent, Biax, (3) 40W lamp	Electronic	3	40	102
CFT40/3-L	CFT40W	Compact Fluorescent, long twin, (3) 40W lamp	Electronic	3	40	105
CFT40/4-BX	CFT40W	Compact Fluorescent, Biax, (4) 40W lamp	Electronic	4	40	144
CFT40/5-BX	CFT40W	Compact Fluorescent, Biax, (5) 40W lamp	Electronic	5	40	190
CFT40/6-BX	CFT40W	Compact Fluorescent, Biax, (6) 40W lamp	Electronic	6	40	204
CFT40/6-L	CFT40W	Compact Fluorescent, long Twin, (6) 40W lamp	Electronic	6	40	220
CFT40/6-L	CFT40W	Compact Fluorescent, long Twin, (6) 40W lamp/ High Ballast Factor	Electronic	6	40	233
CFT40/8-BX	CFT40W	Compact Fluorescent, Biax, (8) 40W lamp	Electronic	8	40	288
CFT40/8-L	CFT40W	Compact Fluorescent, long Twin, (8) 40W lamp	Electronic	8	40	300
CFT40/8-L	CFT40W	Compact Fluorescent, long Twin, (8) 40W lamp/ High Ballast Factor	Electronic	8	40	340
CFT40/9-BX	CFT40W	Compact Fluorescent, Biax, (9) 40W lamp	Electronic	9	40	306
CFT5/1	CFT5W	Compact Fluorescent, twin, (1) 5W lamp	Mag-STD	1	5	9
CFT5/2	CFT5W	Compact Fluorescent, twin, (2) 5W lamp	Mag-STD	2	5	18
CFT50/12-BX	CFT50W	Compact Fluorescent, Biax, (12) 50W lamp	Electronic	12	50	648
CFT50/1-BX	CFT50W	Compact Fluorescent, Biax, (1) 50W lamp	Electronic	1	50	54
CFT50/2-BX	CFT50W	Compact Fluorescent, Biax, (2) 50W lamp	Electronic	2	50	108
CFT50/3-BX	CFT50W	Compact Fluorescent, Biax, (3) 50W lamp	Electronic	3	50	162
CFT50/4-BX	CFT50W	Compact Fluorescent, Biax, (4) 50W lamp	Electronic	4	50	216
CFT50/5-BX	CFT50W	Compact Fluorescent, Biax, (5) 50W lamp	Electronic	5	50	270
CFT50/6-BX	CFT50W	Compact Fluorescent, Biax, (6) 50W lamp	Electronic	6	50	324
CFT50/8-BX	CFT50W	Compact Fluorescent, Biax, (8) 50W lamp	Electronic	8	50	432

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
CFT50/9-BX	CFT50W	Compact Fluorescent, Biax, (9) 50W lamp	Electronic	9	50	486
CFT55/12-BX	CFT55W	Compact Fluorescent, Biax, (12) 55W lamp	Electronic	12	55	672
CFT55/1-BX	CFT55W	Compact Fluorescent, Biax, (1) 55W lamp	Electronic	1	55	56
CFT55/2-BX	CFT55W	Compact Fluorescent, Biax, (2) 55W lamp	Electronic	2	55	112
CFT55/3-BX	CFT55W	Compact Fluorescent, Biax, (3) 55W lamp	Electronic	3	55	168
CFT55/4-BX	CFT55W	Compact Fluorescent, Biax, (4) 55W lamp	Electronic	4	55	224
CFT55/5-BX	CFT55W	Compact Fluorescent, Biax, (5) 55W lamp	Electronic	5	55	280
CFT55/6-BX	CFT55W	Compact Fluorescent, Biax, (6) 55W lamp	Electronic	6	55	336
CFT55/6-L	CFT55W	Compact Fluorescent, long Twin, (6) 55W lamp	Electronic	6	55	352
CFT55/6-L	CFT55W	Compact Fluorescent, long Twin, (6) 55W lamp/ High Ballast Factor	Electronic	6	55	373
CFT55/8-BX	CFT55W	Compact Fluorescent, Biax, (8) 55W lamp	Electronic	8	55	448
CFT55/8-L	CFT55W	Compact Fluorescent, long Twin, (8) 55W lamp	Electronic	8	55	468
CFT55/8-L	CFT55W	Compact Fluorescent, long Twin, (8) 55W lamp/ High Ballast Factor	Electronic	8	55	496
CFT55/9-BX	CFT55W	Compact Fluorescent, Biax, (9) 55W lamp	Electronic	9	55	504
CFT7/1	CFT7W	Compact Fluorescent, twin, (1) 7W lamp	Mag-STD	1	7	10
CFT7/2	CFT7W	Compact Fluorescent, twin, (2) 7W lamp	Mag-STD	2	7	21
CFT9/1	CFT9W	Compact Fluorescent, twin, (1) 9W lamp	Mag-STD	1	9	11
CFT9/2	CFT9W	Compact Fluorescent, twin, (2) 9W lamp	Mag-STD	2	9	23
CFT9/3	CFT9W	Compact Fluorescent, twin, (3) 9W lamp	Mag-STD	3	9	34
		EXIT Sign Fixtures				
ECF5/1	CFT5W	EXIT Compact Fluorescent, (1) 5W lamp	Mag-STD	1	5	9
ECF5/2	CFT5W	EXIT Compact Fluorescent, (2) 5W lamp	Mag-STD	2	5	20
ECF7/1	CFT7W	EXIT Compact Fluorescent, (1) 7W lamp	Mag-STD	1	7	10
ECF7/2	CFT7W	EXIT Compact Fluorescent, (2) 7W lamp	Mag-STD	2	7	21

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
ECF8/1	F8T5	EXIT T5 Fluorescent, (1) 8W lamp	Mag-STD	1	8	12
ECF8/2	F8T5	EXIT T5 Fluorescent, (2) 8W lamp	Mag-STD	2	8	24
ECF9/1	CFT9W	EXIT Compact Fluorescent, (1) 9W lamp	Mag-STD	1	9	12
ECF9/2	CFT9W	EXIT Compact Fluorescent, (2) 9W lamp	Mag-STD	2	9	20
EI10/2	I10	EXIT Incandescent, (2) 10W lamp		2	10	20
EI15/1	I15	EXIT Incandescent, (1) 15W lamp		1	15	15
EI15/2	I15	EXIT Incandescent, (2) 15W lamp		2	15	30
EI20/1	I20	EXIT Incandescent, (1) 20W lamp		1	20	20
EI20/2	I20	EXIT Incandescent, (2) 20W lamp		2	20	40
EI25/1	I25	EXIT Incandescent, (1) 25W lamp		1	25	25
EI25/2	I25	EXIT Incandescent, (2) 25W lamp		2	25	50
EI34/1	I34	EXIT Incandescent, (1) 34W lamp		1	34	34
EI34/2	I34	EXIT Incandescent, (2) 34W lamp		2	34	68
EI40/1	I40	EXIT Incandescent, (1) 40W lamp		1	40	40
EI40/2	I40	EXIT Incandescent, (2) 40W lamp		2	40	80
EI5/1	I5	EXIT Incandescent, (1) 5W lamp		1	5	5
EI5/2	I5	EXIT Incandescent, (2) 5W lamp		2	5	10
EI50/2	I50	EXIT Incandescent, (2) 50W lamp		2	50	100
EI7.5/1	I7.5	EXIT Tungsten, (1) 7.5 W lamp		1	7.5	8
EI7.5/2	I7.5	EXIT Tungsten, (2) 7.5 W lamp		2	7.5	15
ELED0.5/1	LED0.5W	EXIT Light Emitting Diode, (1) 0.5W lamp, Single Sided		1	0.5	0.5
ELED0.5/2	LED0.5W	EXIT Light Emitting Diode, (2) 0.5W lamp, Dual Sided		2	0.5	1
ELED1.5/1	LED1.5W	EXIT Light Emitting Diode, (1) 1.5W lamp, Single Sided		1	1.5	1.5
ELED1.5/2	LED1.5W	EXIT Light Emitting Diode, (2) 1.5W lamp, Dual Sided		2	1.5	3

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
ELED10.5/1	LED10.5W	EXIT Light Emitting Diode, (1) 10.5W lamp, Single Sided		1	10.5	10.5
ELED10.5/2	LED10.5W	EXIT Light Emitting Diode, (2) 10.5W lamp, Dual Sided		2	10.5	21
ELED2/1	LED2W	EXIT Light Emitting Diode, (1) 2W lamp, Single Sided		1	2	2
ELED2/2	LED2W	EXIT Light Emitting Diode, (2) 2W lamp, Dual Sided		2	2	4
ELED3/1	LED3W	EXIT Light Emitting Diode, (1) 3W lamp, Single Sided		1	3	3
ELED3/2	LED3W	EXIT Light Emitting Diode, (2) 3W lamp, Dual Sided		2	3	6
ELED5/1	LED5W	EXIT Light Emitting Diode, (1) 5W lamp, Single Sided		1	5	5
ELED5/2	LED5W	EXIT Light Emitting Diode, (2) 5W lamp, Dual Sided		2	5	10
ELED8/1	LED8W	EXIT Light Emitting Diode, (1) 8W lamp, Single Sided		1	8	8
ELED8/2	LED8W	EXIT Light Emitting Diode, (2) 8W lamp, Dual Sided		2	8	16
		Linear Fluorescent Fixtures				
F1.51LS	F15T8	Fluorescent, (1) 18" T8 lamp	Mag-STD	1	15	19
F1.51SS	F15T12	Fluorescent, (1) 18" T12 lamp	Mag-STD	1	15	19
F1.52LS	F15T8	Fluorescent, (2) 18" T8 lamp	Mag-STD	2	15	36
F1.52SS	F15T12	Fluorescent, (2) 18", T12 lamp	Mag-STD	2	15	36
F21HS	F24T12/HO	Fluorescent, (1) 24", HO lamp	Mag-STD	1	35	62
F21ILL	F17T8	Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	17	20
F21ILL/T2	F17T8	Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	17	17
F21ILL/T2-R	F17T8	Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 2 Lamp Ballast	Electronic	1	17	15
F21ILL/T3	F17T8	Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	17	16
F21ILL/T3-R	F17T8	Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 3 Lamp Ballast	Electronic	1	17	14
F21ILL/T4	F17T8	Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	17	15
F21ILL/T4-R	F17T8	Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 4 Lamp Ballast	Electronic	1	17	14

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F21LL	F17T8	Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	1	17	16
F21LL/T2	F17T8	Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	17	16
F21LL/T3	F17T8	Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	17	17
F21LL/T4	F17T8	Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	17	17
F21LL-R	F17T8	Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	1	17	15
F21LS	F17T8	Fluorescent, (1) 24", T8 lamp, Standard Ballast	Mag-STD	1	17	24
F21GL	F24T5	Fluorescent, (1) 24", STD T5 lamp	Electronic	1	14	18
F21SE	F20T12	Fluorescent, (1) 24", STD lamp	Mag-ES	1	20	26
F21SS	F20T12	Fluorescent, (1) 24", STD lamp	Mag-STD	1	20	28
F21GHL	F24T5/HO	Fluorescent, (1) 24", STD HO T5 lamp	Electronic	1	24	29
F22SHS	F24T12/HO	Fluorescent, (2) 24", HO lamp	Mag-STD	2	35	90
F22GHL	F24T5/HO	Fluorescent, (2) 24", STD HO T5 lamp	Electronic	2	24	55
F22ILE	F17T8	Fluorescent, (2) 24", T-8 Instant Start lamp, Energy Saving Magnetic Ballast	Mag-ES	2	17	45
F22ILL	F17T8	Fluorescent, (2) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	2	17	33
F22ILL/T4	F17T8	Fluorescent, (2) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	2	17	31
F22ILL/T4-R	F17T8	Fluorescent, (2) 24", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 4 Lamp Ballast	Electronic	2	17	28
F22ILL-R	F17T8	Fluorescent, (2) 24", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	17	29
F22LL	F17T8	Fluorescent, (2) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	2	17	31
F22LL/T4	F17T8	Fluorescent, (2) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	2	17	34
F22LL-R	F17T8	Fluorescent, (2) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	2	17	28
F22GL	F24T5	Fluorescent, (2) 24", STD T5 lamp	Electronic	2	14	35
F22SE	F20T12	Fluorescent, (2) 24", STD lamp	Mag-ES	2	20	51
F22SS	F20T12	Fluorescent, (2) 24", STD lamp	Mag-STD	2	20	56

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F23ILL	F17T8	Fluorescent, (3) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	3	17	47
F23ILL-H	F17T8	Fluorescent, (3) 24", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	3	17	49
F23ILL-R	F17T8	Fluorescent, (3) 24", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	3	17	43
F23LL	F17T8	Fluorescent, (3) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	3	17	52
F23LL-R	F17T8	Fluorescent, (3) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	3	17	41
F23SE	F20T12	Fluorescent, (3) 24", STD lamp	Mag-ES	3	20	77
F23SS	F20T12	Fluorescent, (3) 24", STD lamp	Mag-STD	3	20	84
F24ILL	F17T8	Fluorescent, (4) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	4	17	61
F24ILL-R	F17T8	Fluorescent, (4) 24", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	4	17	55
F24LL	F17T8	Fluorescent, (4) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	4	17	68
F24LL-R	F17T8	Fluorescent, (4) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	4	17	57
F24SE	F20T12	Fluorescent, (4) 24", STD lamp	Mag-ES	4	20	102
F24SS	F20T12	Fluorescent, (4) 24", STD lamp	Mag-STD	4	20	112
F26SE	F20T12	Fluorescent, (6) 24", STD lamp	Mag-ES	6	20	153
F26SS	F20T12	Fluorescent, (6) 24", STD lamp	Mag-STD	6	20	168
F31EE	F30T12/ES	Fluorescent, (1) 36", ES lamp	Mag-ES	1	25	38
F31EE/T2	F30T12/ES	Fluorescent, (1) 36", ES lamp, Tandem wired	Mag-ES	1	25	33
F31EL	F30T12/ES	Fluorescent, (1) 36", ES lamp	Electronic	1	25	26
F31ES	F30T12/ES	Fluorescent, (1) 36", ES lamp	Mag-STD	1	25	42
F31ES/T2	F30T12/ES	Fluorescent, (1) 36", ES lamp, Tandem wired	Mag-STD	1	25	37
F31ILL	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	25	26
F31ILL/T2	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	25	23
F31ILL/T2-H	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, HLO (BF: .96-1.1), Tandem 2 Lamp Ballast	Electronic	1	25	24
F31ILL/T2-R	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	25	23

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F31ILL/T3	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	25	22
F31ILL/T3-R	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 3 Lamp Ballast	Electronic	1	25	22
F31ILL/T4	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	25	22
F31ILL/T4-R	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 4 Lamp Ballast	Electronic	1	25	22
F31ILL-H	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	1	25	28
F31ILL-R	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	1	25	27
F31LL	F25T8	Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	1	25	24
F31LL/T2	F25T8	Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	25	23
F31LL/T3	F25T8	Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	25	24
F31LL/T4	F25T8	Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	25	22
F31LL-H	F25T8	Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1)	Electronic	1	25	26
F31LL-R	F25T8	Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	1	25	23
F31SE/T2	F30T12	Fluorescent, (1) 36", STD lamp, Tandem wired	Mag-ES	1	30	37
F31GHL	F36T5/HO	Fluorescent, (1) 36", STD HO T5 lamp	Electronic	1	39	43
F31SHS	F36T12/HO	Fluorescent, (1) 36", HO lamp	Mag-STD	1	50	70
F31SL	F30T12	Fluorescent, (1) 36", STD lamp	Electronic	1	30	31
F31GL	F36T5	Fluorescent, (1) 36", STD T5 lamp	Electronic	1	21	27
F31SS	F30T12	Fluorescent, (1) 36", STD lamp	Mag-STD	1	30	46
F31SS/T2	F30T12	Fluorescent, (1) 36", STD lamp, Tandem wired	Mag-STD	1	30	41
F32EE	F30T12/ES	Fluorescent, (2) 36", ES lamp	Mag-ES	2	25	66
F32EL	F30T12/ES	Fluorescent, (2) 36", ES lamp	Electronic	2	25	50
F32ES	F30T12/ES	Fluorescent, (2) 36", ES lamp	Mag-STD	2	25	73
F32ILL	F25T8	Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	2	25	46

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F32ILL/T4	F25T8	Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	2	25	44
F32ILL/T4-R	F25T8	Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 4 Lamp Ballast	Electronic	2	25	43
F32ILL-H	F25T8	Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	2	25	48
F32ILL-R	F25T8	Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	25	46
F32LE	F25T8	Fluorescent, (2) 36", T-8 lamp	Mag-ES	2	25	65
F32LL	F25T8	Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	2	25	46
F32LL/T4	F25T8	Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	2	25	45
F32LL-H	F25T8	Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1)	Electronic	2	25	50
F32LL-R	F25T8	Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	2	25	42
F32LL-V	F25T8	Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, VHLO (BF>1.1)	Electronic	2	25	70
F32SE	F30T12	Fluorescent, (2) 36", STD lamp	Mag-ES	2	30	74
F32GHL	F36T5/HO	Fluorescent, (1) 36", STD HO T5 lamp	Electronic	2	39	85
F32SHS	F36T12/HO	Fluorescent, (2) 36", HO, lamp	Mag-STD	2	50	114
F32SL	F30T12	Fluorescent, (2) 36", STD lamp	Electronic	2	30	58
F32GL	F36T5	Fluorescent, (1) 36", STD T5 lamp	Electronic	2	21	52
F32SS	F30T12	Fluorescent, (2) 36", STD lamp	Mag-STD	2	30	81
F33ES	F30T12/ES	Fluorescent, (3) 36", ES lamp	Mag-STD	3	25	115
F33ILL	F25T8	Fluorescent, (3) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	3	25	67
F33ILL-R	F25T8	Fluorescent, (3) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	3	25	66
F33LL	F25T8	Fluorescent, (3) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	3	25	72
F33LL-R	F25T8	Fluorescent, (3) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	3	25	62
F33SE	F30T12	Fluorescent, (3) 36", STD lamp, (1) STD ballast and (1) ES ballast	Mag-ES	3	30	120
F33SS	F30T12	Fluorescent, (3) 36", STD lamp	Mag-STD	3	30	127
F34ILL	F25T8	Fluorescent, (4) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	4	25	87

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F34ILL-R	F25T8	Fluorescent, (4) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	4	25	86
F34LL	F25T8	Fluorescent, (4) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	4	25	89
F34LL-R	F25T8	Fluorescent, (4) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	4	25	84
F34SE	F30T12	Fluorescent, (4) 36", STD lamp	Mag-ES	4	30	148
F34SL	F30T12	Fluorescent, (4) 36", STD lamp	Electronic	4	30	116
F34SS	F30T12	Fluorescent, (4) 36", STD lamp	Mag-STD	4	30	162
F36EE	F30T12/ES	Fluorescent, (6) 36", ES lamp	Mag-ES	6	25	198
F36ILL-R	F25T8	Fluorescent, (6) 36", T-8 lamp, Instant Start Ballast, RLO (BF<.85)	Electronic	6	25	134
F36SE	F30T12	Fluorescent, (6) 36", STD lamp	Mag-ES	6	30	238
F40EE/D1	None	Fluorescent, (0) 48" lamp, Completely delamped fixture with (1) hot ballast	Mag-ES	0	0	4
F40EE/D2	None	Fluorescent, (0) 48" lamp, Completely delamped fixture with (2) hot ballast	Mag-ES	0	0	8
F41EE	F40T12/ES	Fluorescent, (1) 48", ES lamp	Mag-ES	1	34	43
F41EE/D2	F40T12/ES	Fluorescent, (1) 48", ES lamp, 2 ballast	Mag-ES	1	34	43
F41EE/T2	F40T12/ES	Fluorescent, (1) 48", ES lamp, tandem wired, 2-lamp ballast	Mag-ES	1	34	36
F41EHS	F48T12/HO/ES	Fluorescent, (1) 48", ES HO lamp	Mag-STD	1	55	80
F41EIS	F48T12/ES	Fluorescent, (1) 48" ES Instant Start lamp. Magnetic ballast	Mag-STD	1	30	51
F41EL	F40T12/ES	Fluorescent, (1) 48", T12 ES lamp, Electronic Ballast	Electronic	1	34	32
F41EL/T2	F40T12/ES	Fluorescent, (1) 48", T-12 ES lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	34	32
F41ES	F40T12/ES	Fluorescent, (1) 48", ES lamp	Mag-STD	1	34	50
F41EVS	F48T12/VHO/ES	Fluorescent, (1) 48", VHO ES lamp	Mag-STD	1		123
F41IAL	F25T12	Fluorescent, (1) 48", F25T12 lamp, Instant Start Ballast	Electronic	1	25	25
F41IAL/T2-R	F25T12	Fluorescent, (1) 48", F25T12 lamp, Instant Start, Tandem 2-Lamp Ballast, RLO (BF<0.85)	Electronic	1	25	19
F41IAL/T3-R	F25T12	Fluorescent, (1) 48", F25T12 lamp, Instant Start, Tandem 3-Lamp Ballast, RLO (BF<0.85)	Electronic	1	25	20
F41ILL	F32T8	Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	32	31

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F41SILL	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	30	28
F41SILL/T2	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	30	27
F41SILL/T3	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	30	27
F41SILL/T4	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	30	26
F41SILL-R	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	1	30	25
F41SILL/T2-R	F30T8	Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 2 Lamp Ballast	Electronic	1	30	24
F41SILL/T3-R	F30T8	Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 3 Lamp Ballast	Electronic	1	30	24
F41SILL/T4-R	F30T8	Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Electronic	1	30	23
F41SILL-H	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	1	30	37
F41SILL/T2-H	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 2 Lamp Ballast	Electronic	1	30	36
F41SILL/T3-H	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 3 Lamp Ballast	Electronic	1	30	36
F41SSILL	F28T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	28	26
F41SSILL/T2	F28T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	28	25
F41SSILL/T3	F28T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	28	25
F41SSILL/T4	F28T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	28	24
F41SSILL-R	F28T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	1	28	23
F41SSILL/T2-R	F28T8	Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 2 Lamp Ballast	Electronic	1	28	22
F41SSILL/T3-R	F28T8	Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 3 Lamp Ballast	Electronic	1	28	22
F41SSILL/T4-R	F28T8	Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Electronic	1	28	21
F41SSILL-H	F28T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	1	28	33
F41SSILL/T2-H	F28T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 2 Lamp Ballast	Electronic	1	28	32

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F41SSILL/T3-H	F28T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 3 Lamp Ballast	Electronic	1	28	32
F41ILL/T2	F32T8	Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	32	30
F41ILL/T2-H	F32T8	Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 2 Lamp Ballast	Electronic	1	32	33
F41ILL/T2-R	F32T8	Fluorescent, (1) 48", T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 2 Lamp Ballast	Electronic	1	32	26
F41ILL/T3	F32T8	Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	32	30
F41ILL/T3-H	F32T8	Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 3 Lamp Ballast	Electronic	1	32	31
F41ILL/T3-R	F32T8	Fluorescent, (1) 48", T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 3 Lamp Ballast	Electronic	1	32	26
F41ILL/T4	F32T8	Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	32	28
F41ILL/T4-R	F32T8	Fluorescent, (1) 48", T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Electronic	1	32	26
F41ILL-H	F32T8	Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	1	32	36
F41LE	F32T8	Fluorescent, (1) 48", T-8 lamp	Mag-ES	1	32	35
F41LL	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	1	32	32
F41LL/T2	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	32	30
F41LL/T2-H	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1), Tandem 2 Lamp Ballast	Electronic	1	32	39
F41LL/T2-R	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 2 Lamp Ballast	Electronic	1	32	27
F41LL/T3	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	32	31
F41LL/T3-H	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1), Tandem 3 Lamp Ballast	Electronic	1	32	33
F41LL/T3-R	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 3 Lamp Ballast	Electronic	1	32	25
F41LL/T4	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	32	30
F41LL/T4-R	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Electronic	1	32	26
F41LL-H	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1)	Electronic	1	32	39

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F41LL-R	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	1	32	27
F41SE	F40T12	Fluorescent, (1) 48", STD lamp	Mag-ES	1	40	50
F41GHL	F48T5/HO	Fluorescent, (1) 48", STD HO T5 lamp	Electronic	1	54	59
F41SHS	F48T12/HO	Fluorescent, (1) 48", STD HO lamp	Mag-STD	1	60	85
F41SIL	F48T12	Fluorescent, (1) 48", STD IS lamp, Electronic ballast	Electronic	1	39	46
F41SIL/T2	F48T12	Fluorescent, (1) 48", STD IS lamp, Electronic ballast, tandem wired	Electronic	1	39	37
F41SIS	F48T12	Fluorescent, (1) 48", STD IS lamp	Mag-STD	1	39	60
F41SIS/T2	F48T12	Fluorescent, (1) 48", STD IS lamp, tandem to 2-lamp ballast	Mag-STD	1	39	52
F41GL	F48T5	Fluorescent, (1) 48", STD T5 lamp	Electronic	1	28	32
F41SL/T2	F40T12	Fluorescent, (1) 48", T-12 STD lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	40	36
F41SS	F40T12	Fluorescent, (1) 48", STD lamp	Mag-STD	1	40	57
F41SVS	F48T12/VHO	Fluorescent, (1) 48", STD VHO lamp	Mag-STD	1	110	135
F41TS	F40T10	Fluorescent, (1) 48", T-10 lamp	Mag-STD	1	40	51
F42EE	F40T12/ES	Fluorescent, (2) 48", ES lamp	Mag-ES	2	34	72
F42EE/D2	F40T12/ES	Fluorescent, (2) 48", ES lamp, 2 Ballasts (delamped)	Mag-ES	2	34	76
F42EHS	F48T12/HO/ES	Fluorescent, (2) 42", HO lamp (3.5' lamp)	Mag-STD	2	55	135
F42EIS	F48T12/ES	Fluorescent, (2) 48" ES Instant Start lamp. Magnetic ballast	Mag-STD	2	30	82
F42EL	F40T12/ES	Fluorescent, (2) 48", T12 ES lamps, Electronic Ballast	Electronic	2	34	60
F42ES	F40T12/ES	Fluorescent, (2) 48", ES lamp	Mag-STD	2	34	80
F42EVS	F48T12/VHO/ES	Fluorescent, (2) 48", VHO ES lamp	Mag-STD	2		210
F42IAL/T4-R	F25T12	Fluorescent, (2) 48", F25T12 lamp, Instant Start, Tandem 4-Lamp Ballast, RLO (BF<0.85)	Electronic	2	25	40
F42IAL-R	F25T12	Fluorescent, (2) 48", F25T12 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	25	39
F42ILL	F32T8	Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	2	32	59
F42SILL	F30T8	Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	2	30	53

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F41SILL/T4	F30T8	Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	2	30	52
F42SILL-R	F30T8	Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	30	47
F41SILL/T4-R	F30T8	Fluorescent, (2) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Electronic	2	30	46
F42SILL-H	F30T8	Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-2.2)	Electronic	2	30	72
F42SSILL	F28T8	Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	2	28	48
F41SSILL/T4	F28T8	Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	2	28	47
F42SSILL-R	F28T8	Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	28	45
F41SSILL/T4-R	F28T8	Fluorescent, (2) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Electronic	2	28	44
F42SSILL-H	F28T8	Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-2.2)	Electronic	2	28	67
F42ILL/T4	F32T8	Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	2	32	56
F42ILL/T4-R	F32T8	Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Electronic	2	32	51
F42ILL-H	F32T8	Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	2	32	65
F42ILL-R	F32T8	Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	32	52
F42ILL-V	F32T8	Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, VHLO (BF>1.1)	Electronic	2	32	79
F42LE	F32T8	Fluorescent, (2) 48", T-8 lamp	Mag-ES	2	32	71
F42LL	F32T8	Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	2	32	60
F42LL/T4	F32T8	Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	2	32	59
F42LL/T4-R	F32T8	Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Electronic	2	32	53
F42LL-H	F32T8	Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1)	Electronic	2	32	70
F42LL-R	F32T8	Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	2	32	54
F42LL-V	F32T8	Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, VHLO (BF>1.1)	Electronic	2	32	85
F42SE	F40T12	Fluorescent, (2) 48", STD lamp	Mag-ES	2	40	86

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F42GHL	F48T5/HO	Fluorescent, (2) 48", STD HO T5 lamp	Electronic	2	54	117
F42SHS	F48T12/HO	Fluorescent, (2) 48", STD HO lamp	Mag-STD	2	60	145
F42SIL	F48T12	Fluorescent, (2) 48", STD IS lamp, Electronic ballast	Electronic	2	39	74
F42SIS	F48T12	Fluorescent, (2) 48", STD IS lamp	Mag-STD	2	39	103
F42GL	F48T5	Fluorescent, (2) 48", STD T5 lamp	Electronic	2	28	63
F42SS	F40T12	Fluorescent, (2) 48", STD lamp	Mag-STD	2	40	94
F42SVS	F48T12/VHO	Fluorescent, (2) 48", STD VHO lamp	Mag-STD	2	110	242
F43EE	F40T12/ES	Fluorescent, (3) 48", ES lamp	Mag-ES	3	34	115
F43EHS	F48T12/HO/ES	Fluorescent, (3) 48", ES HO lamp (3.5' lamp)	Mag-STD	3	55	215
F43EIS	F48T12/ES	Fluorescent, (3) 48" ES Instant Start lamp. Magnetic ballast	Mag-STD	3	30	133
F43EL	F40T12/ES	Fluorescent, (3) 48", T12 ES lamps, Electronic Ballast	Electronic	3	34	92
F43ES	F40T12/ES	Fluorescent, (3) 48", ES lamp	Mag-STD	3	34	130
F43EVS	F48T12/VHO/ES	Fluorescent, (3) 48", VHO ES lamp	Mag-STD	3		333
F43IAL-R	F25T12	Fluorescent, (3) 48", F25T12 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	3	25	60
F43ILL	F32T8	Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	3	32	89
F43SILL	F30T8	Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	3	30	78
F43SILL-R	F30T8	Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	3	30	70
F43SILL-H	F30T8	Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-3.3)	Electronic	3	30	105
F43SSILL	F28T8	Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	3	28	72
F43SSILL-R	F28T8	Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	3	28	66
F43SSILL-H	F28T8	Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-3.3)	Electronic	3	28	98
F43ILL/2	F32T8	Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), (2) ballast	Electronic	3	32	90
F43ILL-H	F32T8	Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	3	32	93
F43ILL-R	F32T8	Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	3	32	78

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F43ILL-V	F32T8	Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, VHLO (BF>1.1)	Electronic	3	32	112
F43LE	F32T8	Fluorescent, (3) 48", T-8 lamp	Mag-ES	3	32	110
F43LL	F32T8	Fluorescent, (3) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	3	32	93
F43LL/2	F32T8	Fluorescent, (3) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), (2) ballast	Electronic	3	32	92
F43LL-H	F32T8	Fluorescent, (3) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1)	Electronic	3	32	98
F43LL-R	F32T8	Fluorescent, (3) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	3	32	76
F43SE	F40T12	Fluorescent, (3) 48", STD lamp	Mag-ES	3	40	136
F43GHL	F48T5/HO	Fluorescent, (3) 48", STD HO T5 lamp	Electronic	3	54	177
F43SHS	F48T12/HO	Fluorescent, (3) 48", STD HO lamp	Mag-STD	3	60	230
F43SIL	F40T12	Fluorescent, (3) 48", STD IS lamp, Electronic ballast	Electronic	3	39	120
F43SIS	F48T12	Fluorescent, (3) 48", STD IS lamp	Mag-STD	3	39	162
F43SS	F40T12	Fluorescent, (3) 48", STD lamp	Mag-STD	3	40	151
F43SVS	F48T12/VHO	Fluorescent, (3) 48", STD VHO lamp	Mag-STD	3	110	377
F44EE	F40T12/ES	Fluorescent, (4) 48", ES lamp	Mag-ES	4	34	144
F44EE/D4	F40T12/ES	Fluorescent, (4) 48", ES lamp, 4 Ballasts (delamped)	Mag-ES	4	34	152
F44EHS	F48T12/HO/ES	Fluorescent, (4) 48", ES HO lamp	Mag-STD	4	55	270
F44EIS	F48T12/ES	Fluorescent, (4) 48" ES Instant Start lamp, Magnetic ballast	Mag-STD	4	30	164
F44EL	F40T12/ES	Fluorescent, (4) 48", T12 ES lamp, Electronic Ballast	Electronic	4	34	120
F44ES	F40T12/ES	Fluorescent, (4) 48", ES lamp	Mag-STD	4	34	160
F44EVS	F48T12/VHO/ES	Fluorescent, (4) 48", VHO ES lamp	Mag-STD	4		420
F44IAL-R	F25T12	Fluorescent, (4) 48", F25T12 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	4	25	80
F44ILL	F32T8	Fluorescent, (4) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	4	32	112
F44SILL	F30T8	Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	4	30	105
F44SILL-R	F30T8	Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	4	30	91

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F44SILL-H	F30T8	Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-4.4)	Electronic	4	30	140
F44SSILL	F28T8	Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	4	28	96
F44SSILL-R	F28T8	Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	4	28	86
F44SSILL-H	F28T8	Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-4.4)	Electronic	4	28	131
F44ILL/2	F32T8	Fluorescent, (4) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), (2) ballast	Electronic	4	32	118
F44ILL-R	F32T8	Fluorescent, (4) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	4	32	102
F44LE	F32T8	Fluorescent, (4) 48", T-8 lamp	Mag-ES	4	32	142
F44LL	F32T8	Fluorescent, (4) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Electronic	4	32	118
F44LL/2	F32T8	Fluorescent, (4) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), (2) ballast	Electronic	4	32	120
F44LL-R	F32T8	Fluorescent, (4) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	4	32	105
F44SE	F40T12	Fluorescent, (4) 48", STD lamp	Mag-ES	4	40	172
F44GHL	F48T5/HO	Fluorescent, (4) 48", STD HO T5 lamp	Electronic	4	54	234
F44SHS	F48T12/HO	Fluorescent, (4) 48", STD HO lamp	Mag-STD	4	60	290
F44SIL	F48T12	Fluorescent, (4) 48", STD IS lamp, Electronic ballast	Electronic	4	39	148
F44SIS	F48T12	Fluorescent, (4) 48", STD IS lamp	Mag-STD	4	39	204
F44SS	F40T12	Fluorescent, (4) 48", STD lamp	Mag-STD	4	40	188
F44SVS	F48T12/VHO	Fluorescent, (4) 48", STD VHO lamp	Mag-STD	4	110	484
F45ILL	F32T8	Fluorescent, (5) 48", T-8 lamp, (1) 3-lamp IS ballast and (1) 2-lamp IS ballast, NLO (BF: .85-.95)	Electronic	5	32	148
F45GHL	F48T5/HO	Fluorescent, (5) 48", STD HO T5 lamp	Electronic	5	54	294
F46EE	F40T12/ES	Fluorescent, (6) 48", ES lamp	Mag-ES	6	34	216
F46EL	F40T12/ES	Fluorescent, (6) 48", ES lamp	Electronic	6	34	186
F46ES	F40T12/ES	Fluorescent, (6) 48", ES lamp	Mag-STD	6	34	236
F46ILL	F32T8	Fluorescent, (6) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	6	32	175
F46ILL-R	F32T8	Fluorescent, (6) 48", T-8 lamp, Instant Start Ballast, RLO (BF< .85)	Electronic	6	32	156

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F46LL	F32T8	Fluorescent, (6) 48", T-8 lamp, NLO (BF: .85-.95)	Electronic	6	32	182
F46GHL	F48T5/HO	Fluorescent, (6) 48", STD HO T5 lamp	Electronic	6	54	351
F46SE	F40T12	Fluorescent, (6) 48", STD lamp	Mag-ES	6	40	258
F46SS	F40T12	Fluorescent, (6) 48", STD lamp	Mag-STD	6	40	282
F48EE	F40T12/ES	Fluorescent, (8) 48", ES lamp	Mag-ES	8	34	288
F48ILL	F32T8	Fluorescent, (8) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	8	32	224
F48ILL-R	F32T8	Fluorescent, (8) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	8	32	204
F48GHL	F48T5/HO	Fluorescent, (8) 48", STD HO T5 lamp	Electronic	8	54	468
F51ILHL	F60T12/HO	Fluorescent, (1) 60", T-8 HO lamp, Instant Start Ballast	Electronic	1	55	59
F51ILL	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	40	36
F51ILL/T2	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	40	36
F51ILL/T3	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Electronic	1	40	35
F51ILL/T4	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Electronic	1	40	34
F51ILL-R	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	1	40	43
F51SHE	F60T12/HO	Fluorescent, (1) 60", STD HO lamp	Mag-ES	1	75	88
F51SHL	F60T12/HO	Fluorescent, (1) 60", STD HO lamp	Electronic	1	75	69
F51GHL	F60T5/HO	Fluorescent, (1) 60", STD HO T5 lamp	Electronic	1	49	54
F51GHL	F60T5/HO	Fluorescent, (1) 60", STD HO T5 lamp	Electronic	1	80	89
F51SHS	F60T12/HO	Fluorescent, (1) 60", STD HO lamp	Mag-STD	1	75	92
F51SL	F60T12	Fluorescent, (1) 60", STD lamp	Electronic	1	50	44
F51GL	F60T5	Fluorescent, (1) 60", STD T5 lamp	Electronic	1	35	39
F51SS	F60T12	Fluorescent, (1) 60", STD lamp	Mag-STD	1	50	63
F51SVS	F60T12/VHO	Fluorescent, (1) 60", VHO ES lamp	Mag-STD	1	135	165
F52ILHL	F60T12/HO	Fluorescent, (2) 60", T-8 HO lamp, Instant Start Ballast	Electronic	2	55	123

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F52ILL	F40T8	Fluorescent, (2) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	2	40	72
F52ILL/T4	F40T8	Fluorescent, (2) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	2	40	67
F52ILL-H	F40T8	Fluorescent, (2) 60", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	2	40	80
F52ILL-R	F40T8	Fluorescent, (2) 60", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	40	73
F52SHE	F60T12/HO	Fluorescent, (2) 60", STD HO lamp	Mag-ES	2	75	176
F52SHL	F60T12/HO	Fluorescent, (2) 60", STD HO lamp	Electronic	2	75	138
F52GHL	F60T5/HO	Fluorescent, (2) 60", STD HO T5 lamp	Electronic	2	49	106
F52SHS	F60T12/HO	Fluorescent, (2) 60", STD HO lamp	Mag-STD	2	75	168
F52SL	F60T12	Fluorescent, (2) 60", STD lamp	Electronic	2	50	88
F52GL	F60T5	Fluorescent, (2) 60", STD T5 lamp	Electronic	2	35	76
F52SS	F60T12	Fluorescent, (2) 60", STD lamp	Mag-STD	2	50	128
F52SVS	F60T12/VHO	Fluorescent, (2) 60", VHO ES lamp	Mag-STD	2	135	310
F53ILL	F40T8	Fluorescent, (3) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	3	40	106
F53ILL-H	F40T8	Fluorescent, (3) 60", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	3	40	108
F54ILL	F40T8	Fluorescent, (4) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	4	40	134
F54ILL-H	F40T8	Fluorescent, (4) 60", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	4	40	126
F61ISL	F72T12	Fluorescent, (1) 72", STD lamp, IS electronic ballast	Electronic	1	55	68
F61SE	F72T12	Fluorescent, (1) 72", STD lamp	Mag-ES	1	55	76
F61SHS	F72T12/HO	Fluorescent, (1) 72", STD HO lamp	Mag-STD	1	85	120
F61SS	F72T12	Fluorescent, (1) 72", STD lamp	Mag-STD	1	55	90
F61SVS	F72T12/VHO	Fluorescent, (1) 72", VHO lamp	Mag-STD	1	160	180
F62ILHL	F72T8	Fluorescent, (2) 72", T-8 HO lamp, Instant Start Ballast	Electronic	2	65	147
F62ISL	F72T12	Fluorescent, (2) 72", STD lamp, IS electronic ballast	Electronic	2	55	108
F62SE	F72T12	Fluorescent, (2) 72", STD lamp	Mag-ES	2	55	122

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F62SHE	F72T12/HO	Fluorescent, (2) 72", STD HO lamp	Mag-ES	2	85	194
F62SHS	F72T12/HO	Fluorescent, (2) 72", STD HO lamp	Mag-STD	2	85	220
F62SL	F72T12	Fluorescent, (2) 72", STD lamp	Electronic	2	55	108
F62SS	F72T12	Fluorescent, (2) 72", STD lamp	Mag-STD	2	55	145
F62SVS	F72T12/VHO	Fluorescent, (2) 72", VHO lamp	Mag-STD	2	160	330
F63ISL	F72T12	Fluorescent, (3) 72", STD lamp, IS electronic ballast	Electronic	3	55	176
F63SS	F72T12	Fluorescent, (3) 72", STD lamp	Mag-STD	3	55	202
F64ISL	F72T12	Fluorescent, (4) 72", STD lamp, IS electronic ballast	Electronic	4	55	216
F64SE	F72T12	Fluorescent, (4) 72", STD lamp	Mag-ES	4	55	230
F64SHE	F72T12/HO	Fluorescent, (4) 72", STD HO lamp	Mag-ES	4	85	388
F64SS	F72T12	Fluorescent, (4) 72", STD lamp	Mag-STD	4	55	244
F81EE/T2	F96T12/ES	Fluorescent, (1) 96", ES lamp, tandem to 2-lamp ballast	Mag-ES	1	60	62
F81EHL	F96T12/HO/ES	Fluorescent, (1) 96", ES HO lamp	Electronic	1	95	80
F81EHL/T2	F96T12/HO/ES	Fluorescent, (1) 96", ES HO lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	95	85
F81EHS	F96T12/HO/ES	Fluorescent, (1) 96", ES HO lamp	Mag-STD	1	95	125
F81EL	F96T12/ES	Fluorescent, (1) 96", ES lamp	Electronic	1	60	60
F81EL/T2	F96T12/ES	Fluorescent, (1) 96", ES lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	60	55
F81ES	F96T12/ES	Fluorescent, (1) 96", ES lamp	Mag-STD	1	60	83
F81ES/T2	F96T12/ES	Fluorescent, (1) 96", ES lamp, tandem to 2-lamp ballast	Mag-STD	1	60	64
F81EVS	F96T12/VHO/ES	Fluorescent, (1) 96", ES VHO lamp	Mag-STD	1	185	200
F81ILL	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	59	58
F81ILL/T2	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	59	55
F81ILL/T2-R	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 2 Lamp Ballast	Electronic	1	59	49

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F81ILL-H	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	1	59	68
F81ILL-R	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	1	59	57
F81ILL-V	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, VHLO (BF>1.1)	Electronic	1	59	71
F81LHL	F96T8/HO	Fluorescent, (1) 96", T8 HO lamp	Electronic	1	86	85
F81LHL/T2	F96T8/HO	Fluorescent, (1) 96", T8 HO lamp, tandem wired to 2-lamp ballast	Electronic	1	86	80
F81SE	F96T12	Fluorescent, (1) 96", STD lamp	Mag-ES	1	75	91
F81EHS	F96T12/HO	Fluorescent, (1) 96", ES HO lamp	Mag-STD	1	95	125
F81SHE	F96T12/HO	Fluorescent, (1) 96", STD HO lamp	Mag-ES	1	110	132
F81SHL/T2	F96T12/HO	Fluorescent, (1) 96", STD HO lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	110	98
F81SHS	F96T12/HO	Fluorescent, (1) 96", STD HO lamp	Mag-STD	1	110	145
F81SL	F96T12	Fluorescent, (1) 96", STD lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	75	70
F81SL/T2	F96T12	Fluorescent, (1) 96", STD lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Electronic	1	75	67
F81SS	F96T12	Fluorescent, (1) 96", STD lamp	Mag-STD	1	75	100
F81SVS	F96T12/VHO	Fluorescent, (1) 96", STD VHO lamp	Mag-STD	1	215	230
F82EE	F96T12/ES	Fluorescent, (2) 96", ES lamp	Mag-ES	2	60	123
F82EHE	F96T12/HO/ES	Fluorescent, (2) 96", ES HO lamp	Mag-ES	2	95	207
F82EHL	F96T12/HO/ES	Fluorescent, (2) 96", ES HO lamp	Electronic	2	95	170
F82EHS	F96T12/HO/ES	Fluorescent, (2) 96", ES HO lamp	Mag-STD	2	95	227
F82EL	F96T12/ES	Fluorescent, (2) 96", ES lamp	Electronic	2	60	110
F82ES	F96T12/ES	Fluorescent, (2) 96", ES lamp	Mag-STD	2	60	138
F82EVS	F96T12/VHO/ES	Fluorescent, (2) 96", ES VHO lamp	Mag-STD	2	185	390
F82ILL	F96T8	Fluorescent, (2) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	2	59	109
F82ILL-R	F96T8	Fluorescent, (2) 96", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	59	98
F82LHL	F96T8/HO	Fluorescent, (2) 96", T8 HO lamp	Electronic	2	86	160

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F82SE	F96T12	Fluorescent, (2) 96", STD lamp	Mag-ES	2	75	158
F82SHE	F96T12/HO	Fluorescent, (2) 96", STD HO lamp	Mag-ES	2	110	237
F82SHL	F96T12/HO	Fluorescent, (2) 96", STD HO lamp	Electronic	2	110	195
F82SHS	F96T12/HO	Fluorescent, (2) 96", STD HO lamp	Mag-STD	2	110	257
F82SL	F96T12	Fluorescent, (2) 96", STD lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	2	75	134
F82SS	F96T12	Fluorescent, (2) 96", STD lamp	Mag-STD	2	75	173
F82SVS	F96T12/VHO	Fluorescent, (2) 96", STD VHO lamp	Mag-STD	2	215	450
F83EE	F96T12/ES	Fluorescent, (3) 96", ES lamp	Mag-ES	3	60	210
F83EHE	F96T12/HO/ES	Fluorescent, (3) 96", ES HO lamp, (1) 2-lamp ES Ballast, (1) 1-lamp STD Ballast	Mag-ES/STD	3	95	319
F83EHS	F96T12/HO/ES	Fluorescent, (3) 96", ES HO lamp	Mag-STD	3	95	352
F83EL	F96T12/ES	Fluorescent, (3) 96", ES lamp	Electronic	3	60	179
F83ES	F96T12/ES	Fluorescent, (3) 96", ES lamp	Mag-STD	3	60	221
F83EVS	F96T12/VHO/ES	Fluorescent, (3) 96", ES VHO lamp	Mag-STD	3	185	590
F83ILL	F96T8	Fluorescent, (3) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	3	59	167
F83SHS	F96T12/HO	Fluorescent, (3) 96", STD HO lamp	Mag-STD	3	110	392
F83SS	F96T12	Fluorescent, (3) 96", STD lamp	Mag-STD	3	75	273
F83SVS	F96T12/VHO	Fluorescent, (3) 96", STD VHO lamp	Mag-STD	3	215	680
F84EE	F96T12/ES	Fluorescent, (4) 96", ES lamp	Mag-ES	4	60	246
F84EHE	F96T12/HO/ES	Fluorescent, (4) 96", ES HO lamp	Mag-ES	4	95	414
F84EHL	F96T12/HO/ES	Fluorescent, (4) 96", ES HO lamp	Electronic	4	95	340
F84EHS	F96T12/HO/ES	Fluorescent, (4) 96", ES HO lamp	Mag-STD	4	95	454
F84EL	F96T12/ES	Fluorescent, (4) 96", ES lamp	Electronic	4	60	220
F84ES	F96T12/ES	Fluorescent, (4) 96", ES lamp	Mag-STD	4	60	276
F84EVS	F96T12/VHO/ES	Fluorescent, (4) 96", ES VHO lamp	Mag-STD	4	185	780

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
F84ILL	F96T8	Fluorescent, (4) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	4	59	219
F84LHL	F96T8/HO	Fluorescent, (4) 96", T8 HO lamp	Electronic	4	86	320
F84SE	F96T12	Fluorescent, (4) 96", STD lamp	Mag-ES	4	75	316
F84SHE	F96T12/HO	Fluorescent, (4) 96", STD HO lamp	Mag-ES	4	110	474
F84SHL	F96T12/HO	Fluorescent, (3) 96", STD HO lamp	Electronic	4	110	390
F84SHS	F96T12/HO	Fluorescent, (4) 96", STD HO lamp	Mag-STD	4	110	514
F84SL	F96T12	Fluorescent, (4) 96", STD lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	4	75	268
F84SS	F96T12	Fluorescent, (4) 96", STD lamp	Mag-STD	4	75	346
F84SVS	F96T12/VHO	Fluorescent, (4) 96", STD VHO lamp	Mag-STD	4	215	900
F86EHS	F96T12/HO/ES	Fluorescent, (6) 96", ES HO lamp	Mag-STD	6	95	721
F86ILL	F96T8	Fluorescent, (6) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	6	59	328
		Circline Fluorescent Fixtures				
FC12/1	FC12T9	Fluorescent, (1) 12" circular lamp, RS ballast	Mag-STD	1	32	31
FC12/2	FC12T9	Fluorescent, (2) 12" circular lamp, RS ballast	Mag-STD	2	32	62
FC16/1	FC16T9	Fluorescent, (1) 16" circular lamp	Mag-STD	1	40	35
FC20	FC6T9	Fluorescent, Circlite, (1) 20W lamp, Preheat ballast	Mag-STD	1	20	20
FC22/1	FC8T9	Fluorescent, Circlite, (1) 22W lamp, preheat ballast	Mag-STD	1	22	20
FC22/32/1	FC22/32T9	Fluorescent, Circlite, (1) 22W/32W lamp, preheat ballast	Mag-STD	1	22/32	58
FC32/1	FC12T9	Fluorescent, Circline, (1) 32W lamp, preheat ballast	Mag-STD	1	32	40
FC32/40/1	FC32/40T9	Fluorescent, Circlite, (1) 32W/40W lamp, preheat ballast	Mag-STD	1	32/40	80
FC40/1	FC16T9	Fluorescent, Circline, (1) 32W lamp, preheat ballast	Mag-STD	1	32	42
FC44/1	FC44T9	Fluorescent, Circlite, (1) 44W lamp, preheat ballast	Mag-STD	1	44	46
FC6/1	FC6T9	Fluorescent, (1) 6" circular lamp, RS ballast	Mag-STD	1	20	25
FC8/1	FC8T9	Fluorescent, (1) 8" circular lamp, RS ballast	Mag-STD	1	22	26

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
FC8/2	FC8T9	Fluorescent, (2) 8" circular lamp, RS ballast	Mag-STD	2	22	52
		U-Tube Fluorescent Fixtures				
FU1EE	FU40T12/ES	Fluorescent, (1) U-Tube, ES lamp	Mag-ES	1	34	43
FU1ILL	FU31T8/6	Fluorescent, (1) U-Tube, T-8 lamp, Instant Start ballast	Electronic	1	32	31
FU1LL	FU31T8/6	Fluorescent, (1) U-Tube, T-8 lamp	Electronic	1	32	32
FU1LL-R	FU31T8/6	Fluorescent, (1) U-Tube, T-8 lamp, RLO (BF<0.85)	Electronic	1	31	27
FU2SS	FU40T12	Fluorescent, (2) U-Tube, STD lamp	Mag-STD	2	40	96
FU2SE	FU40T12	Fluorescent, (2) U-Tube, STD lamp	Mag-ES	2	40	85
FU2EE	FU40T12/ES	Fluorescent, (2) U-Tube, ES lamp	Mag-ES	2	34	72
FU2ES	FU40T12/ES	Fluorescent, (2) U-Tube, ES lamp	Mag-STD	2	34	82
FU2ILL	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp, Instant Start Ballast	Electronic	2	32	59
FU2ILL/T4	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp, Instant Start Ballast, tandem wired	Electronic	2	32	56
FU2ILL/T4-R	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp, Instant Start Ballast, RLO, tandem wired	Electronic	2	32	51
FU2ILL-H	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp, Instant Start HLO Ballast	Electronic	2	32	65
FU2ILL-R	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp, Instant Start RLO Ballast	Electronic	2	32	52
FU2LL	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp	Electronic	2	32	60
FU2LL/T2	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp, Tandem 4 lamp ballast	Electronic	2	32	59
FU2LL-R	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp, RLO (BF<0.85)	Electronic	54	31	54
FU3EE	FU40T12/ES	Fluorescent, (3) U-Tube, ES lamp	Mag-ES	3	35	115
FU3ILL	FU31T8/6	Fluorescent, (3) U-Tube, T-8 lamp, Instant Start Ballast	Electronic	3	32	89
FU3ILL-R	FU31T8/6	Fluorescent, (3) U-Tube, T-8 lamp, Instant Start RLO Ballast	Electronic	3	32	78
		Standard Incandescent Fixtures				
I100/1	I100	Incandescent, (1) 100W lamp		1	100	100
I100/2	I100	Incandescent, (2) 100W lamp		2	100	200

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
I100/3	I100	Incandescent, (3) 100W lamp		3	100	300
I100/4	I100	Incandescent, (4) 100W lamp		4	100	400
I100/5	I100	Incandescent, (5) 100W lamp		5	100	500
I1000/1	I1000	Incandescent, (1) 1000W lamp		1	1000	1000
I100E/1	I100/ES	Incandescent, (1) 100W ES lamp		1	90	90
I100EL/1	I100/ES/LL	Incandescent, (1) 100W ES/LL lamp		1	90	90
I120/1	I120	Incandescent, (1) 120W lamp		1	120	120
I120/2	I120	Incandescent, (2) 120W lamp		2	120	240
I125/1	I125	Incandescent, (1) 125W lamp		1	125	125
I135/1	I135	Incandescent, (1) 135W lamp		1	135	135
I135/2	I135	Incandescent, (2) 135W lamp		2	135	270
I15/1	I15	Incandescent, (1) 15W lamp		1	15	15
I15/2	I15	Incandescent, (2) 15W lamp		2	15	30
I150/1	I150	Incandescent, (1) 150W lamp		1	150	150
I150/2	I150	Incandescent, (2) 150W lamp		2	150	300
I1500/1	I1500	Incandescent, (1) 1500W lamp		1	1500	1500
I150E/1	I150/ES	Incandescent, (1) 150W ES lamp		1	135	135
I150EL/1	I150/ES/LL	Incandescent, (1) 150W ES/LL lamp		1	135	135
I170/1	I170	Incandescent, (1) 170W lamp		1	170	170
I20/1	I20	Incandescent, (1) 20W lamp		1	20	20
I20/2	I20	Incandescent, (2) 20W lamp		2	20	40
I200/1	I200	Incandescent, (1) 200W lamp		1	200	200
I200/2	I200	Incandescent, (2) 200W lamp		2	200	400
I2000/1	I2000	Incandescent, (1) 2000W lamp		1	2000	2000

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
I200L/1	I200/LL	Incandescent, (1) 200W LL lamp		1	200	200
I25/1	I25	Incandescent, (1) 25W lamp		1	25	25
I25/2	I25	Incandescent, (2) 25W lamp		2	25	50
I25/4	I25	Incandescent, (4) 25W lamp		4	25	100
I250/1	I250	Incandescent, (1) 250W lamp		1	250	250
I300/1	I300	Incandescent, (1) 300W lamp		1	300	300
I34/1	I34	Incandescent, (1) 34W lamp		1	34	34
I34/2	I34	Incandescent, (2) 34W lamp		2	34	68
I36/1	I36	Incandescent, (1) 36W lamp		1	36	36
I40/1	I40	Incandescent, (1) 40W lamp		1	40	40
I40/2	I40	Incandescent, (2) 40W lamp		2	40	80
I400/1	I400	Incandescent, (1) 400W lamp		1	400	400
I40E/1	I40/ES	Incandescent, (1) 40W ES lamp		1	34	34
I40EL/1	I40/ES/LL	Incandescent, (1) 40W ES/LL lamp		1	34	34
I42/1	I42	Incandescent, (1) 42W lamp		1	42	42
I448/1	I448	Incandescent, (1) 448W lamp		1	448	448
I45/1	I45	Incandescent, (1) 45W lamp		1	45	45
I50/1	I50	Incandescent, (1) 50W lamp		1	50	50
I50/2	I50	Incandescent, (2) 50W lamp		2	50	100
I500/1	I500	Incandescent, (1) 500W lamp		1	500	500
I52/1	I52	Incandescent, (1) 52W lamp		1	52	52
I52/2	I52	Incandescent, (2) 52W lamp		2	52	104
I54/1	I54	Incandescent, (1) 54W lamp		1	54	54
I54/2	I54	Incandescent, (2) 54W lamp		2	54	108

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
I55/1	I55	Incandescent, (1) 55W lamp		1	55	55
I55/2	I55	Incandescent, (2) 55W lamp		2	55	110
I60/1	I60	Incandescent, (1) 60W lamp		1	60	60
I60/2	I60	Incandescent, (2) 60W lamp		2	60	120
I60/3	I60	Incandescent, (3) 60W lamp		3	60	180
I60/4	I60	Incandescent, (4) 60W lamp		4	60	240
I60/5	I60	Incandescent, (5) 60W lamp		5	60	300
I60E/1	I60/ES	Incandescent, (1) 60W ES lamp		1	52	52
I60EL/1	I60/ES/LL	Incandescent, (1) 60W ES/LL lamp		1	52	52
I65/1	I65	Incandescent, (1) 65W lamp		1	65	65
I65/2	I65	Incandescent, (2) 65W lamp		2	65	130
I67/1	I67	Incandescent, (1) 67W lamp		1	67	67
I67/2	I67	Incandescent, (2) 67W lamp		2	67	134
I67/3	I67	Incandescent, (3) 67W lamp		3	67	201
I69/1	I69	Incandescent, (1) 69W lamp		1	69	69
I7.5/1	I7.5	Tungsten exit light, (1) 7.5 W lamp, used in night light application		1	7.5	8
I7.5/2	I7.5	Tungsten exit light, (2) 7.5 W lamp, used in night light application		2	7.5	15
I72/1	I72	Incandescent, (1) 72W lamp		1	72	72
I75/1	I75	Incandescent, (1) 75W lamp		1	75	75
I75/2	I75	Incandescent, (2) 75W lamp		2	75	150
I75/3	I75	Incandescent, (3) 75W lamp		3	75	225
I75/4	I75	Incandescent, (4) 75W lamp		4	75	300
I750/1	I750	Incandescent, (1) 750W lamp		1	750	750
I75E/1	I75/ES	Incandescent, (1) 75W ES lamp		1	67	67

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
I75EL/1	I75/ES/LL	Incandescent, (1) 75W ES/LL lamp		1	67	67
I80/1	I80	Incandescent, (1) 80W lamp		1	80	80
I85/1	I85	Incandescent, (1) 85W lamp		1	85	85
I90/1	I90	Incandescent, (1) 90W lamp		1	90	90
I90/2	I90	Incandescent, (2) 90W lamp		2	90	180
I90/3	I90	Incandescent, (3) 90W lamp		3	90	270
I93/1	I93	Incandescent, (1) 93W lamp		1	93	93
I95/1	I95	Incandescent, (1) 95W lamp		1	95	95
I95/2	I95	Incandescent, (2) 95W lamp		2	95	190
		Halogen Incandescent Fixtures				
H100/1	H100	Halogen Incandescent, (1) 100W lamp		1	100	100
H1000/1	H1000	Halogen Incandescent, (1) 1000W lamp		1	1000	1000
H1200/1	H1200	Halogen Incandescent, (1) 1200W lamp		1	1200	1200
H150/1	H150	Halogen Incandescent, (1) 150W lamp		1	150	150
H150/2	H150	Halogen Incandescent, (2) 150W lamp		2	150	300
H1500/1	H1500	Halogen Incandescent, (1) 1500W lamp		1	1500	1500
H200/1	H200	Halogen Incandescent, (1) 200W lamp		1	200	200
H250/1	H250	Halogen Incandescent, (1) 250W lamp		1	250	250
H300/1	H300	Halogen Incandescent, (1) 300W lamp		1	300	300
H35/1	H35	Halogen Incandescent, (1) 35W lamp		1	35	35
H350/1	H350	Halogen Incandescent, (1) 350W lamp		1	350	350
H40/1	H40	Halogen Incandescent, (1) 40W lamp		1	40	40
H400/1	H400	Halogen Incandescent, (1) 400W lamp		1	400	400
H42/1	H42	Halogen Incandescent, (1) 42W lamp		1	42	42

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
H425/1	H425	Halogen Incandescent, (1) 425W lamp		1	425	425
H45/1	H45	Halogen Incandescent, (1) 45W lamp		1	45	45
H45/2	H45	Halogen Incandescent, (2) 45W lamp		2	45	90
H50/1	H50	Halogen Incandescent, (1) 50W lamp		1	50	50
H50/2	H50	Halogen Incandescent, (2) 50W lamp		2	50	100
H500/1	H500	Halogen Incandescent, (1) 500W lamp		1	500	500
H52/1	H52	Halogen Incandescent, (1) 52W lamp		1	52	52
H55/1	H55	Halogen Incandescent, (1) 55W lamp		1	55	55
H55/2	H55	Halogen Incandescent, (2) 55W lamp		2	55	110
H60/1	H60	Halogen Incandescent, (1) 60W lamp		1	60	60
H72/1	H72	Halogen Incandescent, (1) 72W lamp		1	72	72
H75/1	H75	Halogen Incandescent, (1) 75W lamp		1	75	75
H75/2	H75	Halogen Incandescent, (2) 75W lamp		2	75	150
H750/1	H750	Halogen Incandescent, (1) 750W lamp		1	750	750
H90/1	H90	Halogen Incandescent, (1) 90W lamp		1	90	90
H90/2	H90	Halogen Incandescent, (2) 90W lamp		2	90	180
H900/1	H900	Halogen Incandescent, (1) 900W lamp		1	900	900
HLV20/1	H20/LV	Halogen Low Voltage Incandescent, (1) 20W lamp		1	20	30
HLV25/1	H25/LV	Halogen Low Voltage Incandescent, (1) 25W lamp		1	25	35
HLV35/1	H35/LV	Halogen Low Voltage Incandescent, (1) 35W lamp		1	35	45
HLV42/1	H42/LV	Halogen Low Voltage Incandescent, (1) 42W lamp		1	42	52
HLV50/1	H50/LV	Halogen Low Voltage Incandescent, (1) 50W lamp		1	50	60
HLV65/1	H65/LV	Halogen Low Voltage Incandescent, (1) 65W lamp		1	65	75
HLV75/1	H75/LV	Halogen Low Voltage Incandescent, (1) 75W lamp		1	75	85

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
		QL Induction Fixtures				
QL55/1	QL55	QL Induction, (1) 55W lamp	Generator	1	55	55
QL85/1	QL85	QL Induction, (1) 85W lamp	Generator	1	85	85
QL165/1	QL165	QL Induction, (1) 165W lamp	Generator	1	165	165
		High Pressure Sodium Fixtures				
HPS100/1	HPS100	High Pressure Sodium, (1) 100W lamp	CWA	1	100	138
HPS1000/1	HPS1000	High Pressure Sodium, (1) 1000W lamp	CWA	1	1000	1100
HPS150/1	HPS150	High Pressure Sodium, (1) 150W lamp	CWA	1	150	188
HPS200/1	HPS200	High Pressure Sodium, (1) 200W lamp	CWA	1	200	250
HPS225/1	HPS225	High Pressure Sodium, (1) 225W lamp	CWA	1	225	275
HPS250/1	HPS250	High Pressure Sodium, (1) 250W lamp	CWA	1	250	295
HPS310/1	HPS310	High Pressure Sodium, (1) 310W lamp	CWA	1	310	365
HPS35/1	HPS35	High Pressure Sodium, (1) 35W lamp	CWA	1	35	46
HPS360/1	HPS360	High Pressure Sodium, (1) 360W lamp	CWA	1	360	414
HPS400/1	HPS400	High Pressure Sodium, (1) 400W lamp	CWA	1	400	465
HPS50/1	HPS50	High Pressure Sodium, (1) 50W lamp	CWA	1	50	66
HPS600/1	HPS600	High Pressure Sodium, (1) 600W lamp	CWA	1	600	675
HPS70/1	HPS70	High Pressure Sodium, (1) 70W lamp	CWA	1	70	95
HPS750/1	HPS750	High Pressure Sodium, (1) 750W lamp	CWA	1	750	835
		Metal Halide Fixtures				
MH100/1	MH100	Metal Halide, (1) 100W lamp	CWA	1	100	128
MH1000/1	MH1000	Metal Halide, (1) 1000W lamp	CWA	1	1000	1080
MH150/1	MH150	Metal Halide, (1) 150W lamp	CWA	1	150	190
MH1500/1	MH1500	Metal Halide, (1) 1500W lamp	CWA	1	1500	1610

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
MH175/1	MH175	Metal Halide, (1) 175W lamp	CWA	1	175	215
MH1800/1	MH1800	Metal Halide, (1) 1800W lamp	CWA	1	1800	1875
MH200/1	MH200	Metal Halide, (1) 200W lamp	CWA	1	200	232
MH250/1	MH250	Metal Halide, (1) 250W lamp	CWA	1	250	295
MH32/1	MH32	Metal Halide, (1) 32W lamp	CWA	1	32	43
MH300/1	MH300	Metal Halide, (1) 300W lamp	CWA	1	300	342
MH320/1	MH320	Metal Halide, (1) 320W lamp	CWA	1	320	365
MH350/1	MH350	Metal Halide, (1) 350W lamp	CWA	1	350	400
MH360/1	MH360	Metal Halide, (1) 360W lamp	CWA	1	360	430
MH400/1	MH400	Metal Halide, (1) 400W lamp	CWA	1	400	458
MH400/2	MH400	Metal Halide, (2) 400W lamp	CWA	2	400	916
MH450/1	MH450	Metal Halide, (1) 450W lamp	CWA	1	450	508
MH35/1	MH35	Metal Halide, (1) 35W lamp	CWA	1	35	44
MH50/1	MH50	Metal Halide, (1) 50W lamp	CWA	1	50	72
MH70/1	MH70	Metal Halide, (1) 70W lamp	CWA	1	70	95
MH750/1	MH750	Metal Halide, (1) 750W lamp	CWA	1	750	850
MHPS/LR/100/1	MHPS100	Metal Halide Pulse Start, (1) 100W lamp w/ Linear Reactor Ballast	LR	1	100	118
MHPS/LR/150/1	MHPS150	Metal Halide Pulse Start, (1) 150W lamp w/ Linear Reactor Ballast	LR	1	150	170
MHPS/LR/175/1	MHPS175	Metal Halide Pulse Start, (1) 175W lamp w/ Linear Reactor Ballast	LR	1	175	194
MHPS/LR/200/1	MHPS200	Metal Halide Pulse Start, (1) 200W lamp w/ Linear Reactor Ballast	LR	1	200	219
MHPS/LR/250/1	MHPS250	Metal Halide Pulse Start, (1) 250W lamp w/ Linear Reactor Ballast	LR	1	250	275
MHPS/LR/300/1	MHPS300	Metal Halide Pulse Start, (1) 300W lamp w/ Linear Reactor Ballast	LR	1	300	324
MHPS/LR/320/1	MHPS320	Metal Halide Pulse Start, (1) 320W lamp w/ Linear Reactor Ballast	LR	1	320	349
MHPS/LR/350/1	MHPS350	Metal Halide Pulse Start, (1) 350W lamp w/ Linear Reactor Ballast	LR	1	350	380

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
MHPS/LR/400/1	MHPS400	Metal Halide Pulse Start, (1) 400W lamp w/ Linear Reactor Ballast	LR	1	400	435
MHPS/LR/450/1	MHPS450	Metal Halide Pulse Start, (1) 450W lamp w/ Linear Reactor Ballast	LR	1	450	485
MHPS/LR/750/1	MHPS750	Metal Halide Pulse Start, (1) 750W lamp w/ Linear Reactor Ballast	LR	1	750	805
MHPS/SCWA/100/1	MHPS100	Metal Halide Pulse Start, (1) 100W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	100	128
MHPS/SCWA/1000/1	MHPS1000	Metal Halide Pulse Start, (1) 1000W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	1000	1080
MHPS/SCWA/150/1	MHPS150	Metal Halide Pulse Start, (1) 150W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	150	190
MHPS/SCWA/175/1	MHPS175	Metal Halide Pulse Start, (1) 175W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	175	208
MHPS/SCWA/200/1	MHPS200	Metal Halide Pulse Start, (1) 200W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	200	232
MHPS/SCWA/250/1	MHPS250	Metal Halide Pulse Start, (1) 250W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	250	288
MHPS/SCWA/300/1	MHPS300	Metal Halide Pulse Start, (1) 300W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	300	342
MHPS/SCWA/320/1	MHPS320	Metal Halide Pulse Start, (1) 320W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	320	368
MHPS/SCWA/350/1	MHPS350	Metal Halide Pulse Start, (1) 350W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	350	400
MHPS/SCWA/400/1	MHPS400	Metal Halide Pulse Start, (1) 400W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	400	450
MHPS/SCWA/450/1	MHPS450	Metal Halide Pulse Start, (1) 450W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	450	506
MHPS/SCWA/750/1	MHPS750	Metal Halide Pulse Start, (1) 750W lamp w/ Super Constant Wattage Autotransformer Ballast	SCWA	1	750	815
		Mercury Vapor Fixtures				
MV100/1	MV100	Mercury Vapor, (1) 100W lamp	CWA	1	100	125
MV1000/1	MV1000	Mercury Vapor, (1) 1000W lamp	CWA	1	1000	1075
MV175/1	MV175	Mercury Vapor, (1) 175W lamp	CWA	1	175	205
MV250/1	MV250	Mercury Vapor, (1) 250W lamp	CWA	1	250	290
MV40/1	MV40	Mercury Vapor, (1) 40W lamp	CWA	1	40	50

FIXTURE CODE	LAMP CODE	DESCRIPTION	BALLAST	LAMP/ FIXT	WATT/ LAMP	WATT/ FIXT
MV400/1	MV400	Mercury Vapor, (1) 400W lamp	CWA	1	400	455
MV400/2	MV400	Mercury Vapor, (2) 400W lamp	CWA	2	400	910
MV50/1	MV50	Mercury Vapor, (1) 50W lamp	CWA	1	50	74
MV700/1	MV700	Mercury Vapor, (1) 700W lamp	CWA	1	700	780
MV75/1	MV75	Mercury Vapor, (1) 75W lamp	CWA	1	75	93