Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
12-24-2	R	2/7/2025	1/1/2026	R/MF Insulation – Opaque Shell	Insulation quality derate factors adjusted to reflect more conservative assumed values and additional clarification on appropriate value added.	Pg. 124
12-24-5	R	2/7/2025	1/1/2026	R/MF Interior and Exterior Lighting	Added baseline assumption for downlight fixtures.	Pg. 392
12-24-7	R	2/7/2025	1/1/2026	C/I Air Curtain	Expanded scope to include foot traffic entryways. Updated energy savings algorithms.	Pg. 587
12-24-8	R	2/7/2025	1/1/2026	C/I Air Leakage Sealing	Updated latent multipliers to reflect impact associated with implementation of air leakage reduction measures. Included door sweeps in scope of measure.	Pg. 596
12-24-9	R	2/7/2025	1/1/2026	C/I Variable Frequency Drive (VFD) – Fan and Pump	Added provisions for application of VFDs to condenser water pumps. Added Example Calculation for HVAC Pumps	Pg. 998
12-24-10	R	2/7/2025	1/1/2026	Appendix C	Added reference table for standardizing baseline lamp/fixture type and wattage for LED linear lamps/fixtures and high/low bay fixtures.	Pg. 1215
12-24-11	R	2/7/2025	1/1/2026	Appendix P	Entries added for new measures (R/MF Door Sweep, R/MF Cellular Window Shade); Granularity added to R/MF and C/I Steam Trap EULs.	Pg. 1435

Note: Revisions, Additions, Corrections and Removals to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between October 23, 2024 – February 7, 2025.

BUILDING SHELL

INSULATION - OPAQUE SHELL

Measure Description

This measure covers the installation of wall, ceiling, rim joist, and/or floor insulation to reduce the thermal conductance of the building envelope. Energy and demand savings are realized through reductions in the building's heating and cooling loads. Existing (baseline) and installed (qualifying) shell R-values must be captured or estimated to evaluate energy savings. This measure is only applicable to insulation of surfaces separating conditioned spaces from unconditioned spaces or the exterior of the building. Ceiling insulation is applicable to surfaces between the top conditioned floor and the roof. Insulation of a shared wall between two conditioned spaces or the floor/ceiling separating conditioned spaces is not eligible.

This measure includes, but is not limited to, blown-in insulation in walls and ceilings and application of rigid foam insulating boards or fiberglass to floors and rim joists. Cellulose is the most common blown-in insulation material; other materials include mineral fiber, loose-fill fiberglass, and Styrofoam pellets. Cellulose insulation is made from a cellular plant source, most commonly wood or paper, and treated with fire and pest resistant chemicals. Cellulose insulation is installed in three primary forms: loose-fill, stabilized and wall-cavity spray. Loose-fill insulation is a dry install that is blown into joist cavities in uninsulated attics or applied over existing batts. Stabilized cellulose is similar to loose-fill and applied in the same way but contains a moisture-activated adhesive that serves to increase the density of the cellulose and limit settling. Wall-cavity spray is typically applied prior to drywall installation in new construction, however insertion into existing walls is possible.

This measure is only applicable as a retrofit in existing single and multi-family buildings that are three-stories or less.

For applications involving insulation of multiple building envelope components (e.g., wall and ceiling), evaluate each component separately via the method below and sum together to determine total estimated energy savings.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

$$\Delta kWh_{cooling} = \frac{\left(\frac{1}{R_{baseline}} - \frac{1}{R_{baseline} + \Delta R}\right) \times A \times \left(1 - F_{framing}\right) \times CDD \times 24 \times F_{ElecCool}}{1{,}000 \times SEER}$$

$$\Delta kWh_{heating} = \frac{\left(\frac{1}{R_{baseline}} - \frac{1}{R_{baseline} + \Delta R}\right) \times A \times \left(1 - F_{framing}\right) \times HDD \times 24 \times F_{ElecHeat}}{1{,}000 \times HSPF}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \frac{\Delta kWh_{cooling}}{EFLH_{cooling}} \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = \frac{\left(\frac{1}{R_{baseline}} - \frac{1}{R_{baseline} + \Delta R}\right) \times A \times \left(1 - F_{framing}\right) \times HDD \times 24 \times F_{FuelHeat}}{1{,}000{,}000 \times Eff_{FuelHeat}}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
$\Delta kWh_{cooling}$	= Annual electric cooling energy savings
$\Delta kWh_{heating}$	= Annual electric heating energy savings
$R_{baseline}$	= R-value of existing insulation (ft^2-F°-h/BTU)
ΔR	= Difference in R-value between baseline insulation and total post-implementation insulation (ft^2-F°-h/BTU)
A	= Area of insulated surfaces (ft^2)
$F_{framing}$	= Framing factor
$F_{ElecCool}$	= Electric cooling factor; used to account for the presence or absence of an electric cooling system
CDD	= Cooling Degree Days - The number of degrees that a day's average temperature is above some baseline temperature, which represents the temperature above which buildings need to be cooled. The baseline temperature is typically 65°F, but may vary based on application.
HDD	= Heating Degree Days - The number of degrees that a day's average temperature is below some baseline temperature, which represents the temperature below which buildings need to be heated. The baseline temperature is typically 65°F, but may vary based on application.
$F_{ElecHeat}$	= Electric heating factor, used to account for the presence or absence of an electric heating system
$F_{FuelHeat}$	= Fossil fuel heating factor, used to account for the presence or absence of a fossil fuel heating system
SEER	= Seasonal average energy efficiency ratio over the cooling season, BTU/watt-hour, used for average U.S. location/region
HSPF	= Heating seasonal performance factor, BTU/watt-hour, total heating output (supply heat) in BTU (including supplemental heaters) during the heating season / total electric energy heat pump consumed (in watt-hour)

$Eff_{FuelHeat}$ = Efficiency of fuel heating equipment (AFUE, Et, or Ec)
$EFLH_{cooling}$ = Cooling equivalent full-load hours
CF = Coincidence factor
24 = Hours in one day
1,000 = Conversion factor, one kW equals 1,000 watts
1,000,000 = Conversion factor, one MMBtu equals 1,000,000 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
$R_{baseline}$		From application. If unknown, follow guidance provided in the Baseline Efficiency section. Assume default for uninsulated surfaces to be R-4, per the pre-war uninsulated brick vintage values in the table below.
ΔR		From application.
A		From application.
$F_{framing}$	Walls: 0.25 Ceilings: 0.07 Rim Joists: 0.05 Floors: 0.12	ASHRAE.[1]
$F_{ElecCool}$		If an electric cooling system is present, set equal to 1. Otherwise, set equal to 0.
CDD		Lookup based on location in Heating and Cooling Degree Days table below.
HDD		Lookup based on location in Heating and Cooling Degree Days table below.
$F_{ElecHeat}$		Use a value of 1.0 if the building is electrically heated. Otherwise, use 0.0.
$F_{FuelHeat}$		Use a value of 1.0 if the building is fuel heated. Otherwise, use 0.0.
SEER		From application. Use SEER2 rating if equipment has a SEER2 rating. If unknown use 13.4 SEER2, assuming a minimally code compliant, 3-ton, split system AC.[2]
HSPF		From application. For equipment rated in HSPF2, HSPF2 rating shall be used. If unknown use 7.5 HSPF2, assuming a 3-ton central ASHP system.[3] For electric resistance heating and electric furnaces, use 3.4 HSPF. If taken from application, COP must be converted to HSPF using the equivalency HSPF = COP x 3.412.

[1] ASHRAE, 2001, "Characterization of Framing Factors for New Low-Rise Residential Building Envelopes (904-RP)," Table 7.1.
[2] 10 CFR 430.32(c)(5)
[3] Ibid.

Variable	Value	Notes
$Eff_{FuelHeat}$		From application. If unknown, lookup based on system size and type in Baseline Efficiencies from which Energy Savings are Calculated section below.
$EFLH_{cooling}$		Lookup based on building type, vintage, and location from Appendix G.
CF	0.69	

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.69.[4]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is a building envelope with insulation levels that are not compliant with all current applicable construction code requirements. Because baseline for this measure is established using assumed or existing insulation levels that are based on outdated codes and standards, there is no distinction in the approach for baseline determination between market-rate and LMI applications. R-value of existing insulation shall come from application. Because efficacy of insulation is known to degrade over time, R-value adjustment factors are provided in the Insulation Derating Allowances table below. The appropriate value shall be determined based on visual inspection of the quality of existing insulation. As indicated in the US DOE Home Energy Score Insulation Derate Calculator[5], "Good" is defined as few or no gaps, "Fair" corresponds to ~2.5% gaps across the insulated surface, and "Poor" corresponds to 5% or more gaps in existing insulation. If existing insulation cannot be visually inspected, an Insulation Quality of "Good" shall be assumed (i.e., no derating adjustment shall be applied).

Insulation Derating Allowances[6]

Insulation Quality	Derate Factor[7]
Good	1.00
Fair	0.72
Poor	0.28

In the case of removal of existing insulation, $R_{baseline}$ shall be set equal to the estimated existing insulation R-value while $R_{baseline} + \Delta R$ should be set equal to the sum of the new insulation R-value and the R-value of an uninsulated surface (i.e., R-4).

[4] Based on BG&E 'Development of Residential Load Profile for Central Air Conditioners and Heat Pumps' research, the Maryland Peak Definition coincidence factor is 0.69. This study is not publicly available, but is referenced by M. M. Straub, Using Available Information for Efficient Evaluation of Demand-Side Management Programs, Electricity Journal, September 2011 and supported by research conducted by Cadmus on behalf of the TRM Management Committee.

[5] U.S DOE Home Energy Score Insulation Derate Calculator (https://betterbuildingssolutioncenter.energy.gov/sites/default/files/Assessor%20Calculator%20v.020619.xlsx)

[6] Ibid.

[7] The factors presented here reflect the upper bound of the derate factor range for each insulation quality designation from the Home Energy Score Insulation Derate Calculator, based on a conservative assumption.

If existing insulation R-value is unknown, lookup in the Existing Building Envelope R-value: Walls and Ceilings table below based on building vintage and envelope component for walls and ceilings and in the Existing Building Envelope R-value: Floors and Rim Joists table below based on location and envelope component for floor and rim joist insulation. As an alternative to the defaults presented in the tables below, R-3.1 per inch of existing insulation may be applied.[8]

NYS (except NYC) Single Family and Multi-Family Low-Rise (3-stories or less) Default R-Values (for use when insulation cannot be observed) [9,10,11,12]

Vintage	Climate Zone	Wall	Ceiling	Rim Joist	Floor
Pre-war uninsulated brick	N/A	4	4	2	4
Prior to 1979	N/A	4.8	11	2	4
From 1979 through 2006	N/A	11	19	12	19
From 2007 through 2009	4	15	38	10	19
	5	21	38	10	30
	6	21	49	10	30
2010 through 2014	4	13	38	10	19
	5	20	38	10	30
	6	20	49	15	30
2015 through 2019	4 except Marine	20	49	10	19
	5 and Marine 4	20	49	15	30
	6	25	49	15	30
2020 through present	4 except Marine	20	49	10	19
	5 and Marine 4	20	49	15	30
	6	25	49	15	30

NYC Single Family and Multi-Family Low-Rise (3-stories or less) Default R-Values (for use when insulation cannot be observed) [13,14,15,16]

Vintage	Climate Zone	Wall	Ceiling	Rim Joist	Floor
Pre-war uninsulated brick	N/A	4	4	2	4
Prior to 1979	N/A	4.8	11	2	4
From 1979 through 2006	N/A	11	19	12	19
From 2007 through 2010	4	15	38	10	19
2011 through 2015	4	13	38	10	19
2016 through 2019	4 except Marine	25	49	15	30

[8] DOE, Energy Saver, Insulation Materials. Assumes “low-density” fiberglass batts for 2 by 4 inch stud-framed wall (R-11/3.5 inch = R-3.1 per inch of insulation).
[9] Guidehouse, inc. (2024). Downstate New York Weatherization Program: *Residential Sector Impact and Process Evaluation.* Matter No.15-M-0252, item No. 158.
[10] NYS construction codes from 2007 to 2020
[11] IECC Table R402.1.2 Insulation and Fenestration Requirements by Component
[12] "Implementation of Building Energy Standards in New York State”, U-value of basement walls, pg 597
[13] Guidehouse, inc. (2024). Downstate New York Weatherization Program: *Residential Sector Impact and Process Evaluation.* Matter No.15-M-0252, item No. 158.
[14] NYC construction codes from 2007 to 2020
[15] IECC Table R402.1.2 Insulation and Fenestration Requirements by Component
[16] "Implementation of Building Energy Standards in New York State”, U-value of basement walls, pg 597

Vintage	Climate Zone	Wall	Ceiling	Rim Joist	Floor
	5 and Marine 4	20	49	15	30
2020 through present	4	25	49	15	30

The baseline efficiency for fossil fuel fired heating systems serving single-family homes and individual units is the nameplate efficiency of the existing equipment. If unknown, the baseline efficiency is defined by the Code of Federal Regulations as shown in the table below.

Fossil Fuel Fired Heating System Baseline Efficiencies: Systems Serving Single Units[17]

Equipment Type	Size Range	Baseline Efficiency
Warm Air Furnace, Gas Fired	All Capacities	0.80 AFUE
Warm Air Furnace, Oil Fired	All Capacities	0.83 AFUE
Boiler, Hot Water, Gas Fired	All Capacities	0.84 AFUE
Boiler, Hot Water, Oil Fired	All Capacities	0.86 AFUE
Boiler, Steam, Gas Fired	All Capacities	0.82 AFUE
Boiler, Steam, Oil Fired	All Capacities	0.85 AFUE

The baseline efficiency for heating systems serving multiple dwelling units is the nameplate efficiency of the existing system. If unknown, the baseline efficiency is defined by International Energy Conservation Code[18] and subsequently adopted by the Energy Conservation Construction Code of New York State (ECCCNYS) as shown in the table below.

Fossil Fuel Fired Heating System Baseline Efficiencies: Systems Serving Multiple Dwelling Units

Equipment Type	Size Range	Baseline Efficiency
Warm Air Furnace, Gas Fired	< 225 kBTU/h	0.80 AFUE
	≥ 225 kBTU/h	0.80 Et
Warm Air Furnace, Oil Fired	< 225 kBTU/h	0.83 AFUE
	≥ 225 kBTU/h	0.81 Et
Warm Air Unit Heaters, Gas Fired	All Capacities	0.80 Ec
Warm Air Unit Heaters, Oil Fired	All Capacities	0.80 Ec
Boiler, Hot Water, Gas Fired	< 300 kBTU/h	0.84 AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	0.80 Et
	> 2,500 kBTU/h	0.82 Ec
Boiler, Hot Water, Oil Fired	< 300 kBTU/h	0.86 AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	0.82 Et
	> 2,500 kBTU/h	0.84 Ec
Boiler, Steam, Gas Fired, All Except Natural Draft	< 300 kBTU/h	0.82 AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	0.79 Et
	> 2,500 kBTU/h	0.79 Et
Boiler, Steam, Gas Fired, Natural Draft	< 300 kBTU/h	0.82 AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	0.79 Et

[17] 10 CFR 430.32(e)(2)(iii)(A); last reviewed 10/1/2024
[18] ECCCNYS 2020, Table C403.3.2(4) & Table C403.3.2(5).

Equipment Type	Size Range	Baseline Efficiency
	> 2,500 kBTU/h	0.79 Et
Boiler, Steam, Oil Fired	< 300 kBTU/h	0.85 AFUE
	≥ 300 kBTU/h and ≤ 2,500 kBTU/h	0.81 Et
	> 2,500 kBTU/h	0.81 Et

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a residential opaque building shell with increased insulation meeting or exceeding applicable construction code requirements. The installed R-value must be captured and included in the program application.

Opaque shell insulation improvements performed under this measure shall be installed such that all altered envelope components comply with all federal, state, local and municipal codes and standards applicable to alterations to existing buildings, including but not limited to Section R503.1 of ECCCNYS 2020[19] requiring all existing ceiling, wall, and floor cavities exposed during construction to be filled with insulation. Thermal envelope components not altered as part of this measure (e.g., continuous insulation in wood-framed buildings) are not required to meet code for compliance.

Operating Hours

Effective heating and cooling hours associated with benefits of opaque shell insulation are established via the Heating and Cooling Degree Days section below.

Heating and Cooling Degree Days[20]

City	HDD	CDD
Albany	6,391	721
Binghamton	7,200	383
Buffalo	6,502	607
Massena	8,030	406
NYC	4,900	1,017
Poughkeepsie	6,026	745
Syracuse	6,625	618

Example Calculation *(Not to be used as default)*

An existing residential customer in a single-family home located near Binghamton with R-12 roof insulation in fair condition, a gas fired warm air furnace with an efficiency of 0.80 AFUE and no cooling system is adding R-20 of blown-in loose fill cellulose insulation in 500 SF of attic space. Annual Electric Energy Savings and Summer Peak Coincident Demand Savings are not applicable. Annual Fossil Fuel Energy Savings are calculated as below.

[19] ECCCNYS 2020, Section R503 Building Thermal Envelope.
[20] HDD/CDD taken from NCEI 1991-2020 climate normal using a 65 °F balance point.

$$\Delta MMBtu = \frac{\left(\frac{1}{R_{baseline}} - \frac{1}{R_{baseline} + \Delta R}\right) \times A \times \left(1 - F_{framing}\right) \times \ HDD \ \times 24 \times F_{FuelHeat}}{1{,}000{,}000 \times Eff_{FuelHeat}}$$

$R_{baseline}$ = 12 x 0.72 = 8.64, from application, adjusted based on Insulation Derating Allowance table from Baseline Efficiency section
ΔR = 20, from application
A = 500 SF, from application
$F_{framing}$ = 0.07, from Summary of Variables and Data Sources table based on application
HDD = 7,200, from Heating Degree Day table based on location from application
$F_{FuelHeat}$ = 1.0, from Summary of Variables and Data Sources table from HVAC system from application
$Eff_{FuelHeat}$ = 0.80 AFUE, from application

$$\Delta MMBtu = \frac{\left(\frac{1}{8.64} - \frac{1}{8.64 + 20}\right) \times 500 \times (1 - 0.07) \times \ 7{,}200 \ \times 24 \times 1.0}{1{,}000{,}000 \times 0.80} = 8.12 \ MMBtu$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM. Rim joist insulation may yield additional savings resulting from improved air sealing between the first floor and an unconditioned basement or crawlspace.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM. Rim joist insulation may yield additional savings resulting from improved air sealing between the first floor and an unconditioned basement or crawlspace.

References

1. BG&E: Development of Residential Load Profile for Central Air Conditioners and Heat Pumps.
2. ECCCNYS 2020 Section R402 Building Thermal Envelope. Available from: https://codes.iccsafe.org/content/NYSECC2020P1/chapter-4-[ce]-commercial-energy-efficiency#NYSECC2020P1_CE_Ch04_SecC402
3. ECCCNYS 2020 Section R403 Systems. Available from: https://codes.iccsafe.org/content/NYSECC2020P1/chapter-4-[re]-residential-energy-efficiency#NYSECC2020P1_RE_Ch04_SecR403

4. ECCCNYS 2020 Section R503 Alterations.
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16. Guidehouse, Inc. (2024). Downstate New York Weatherization Program: Residential Sector Impact and Process Evaluation. Matter No.15-M-0252, item No. 158.
Available from: https://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?Mattercaseno=16-02180
17. 2018 International Energy Conservation Code (IECC) R402.1.2 Insulation and Fenestration Criteria
Available from: https://codes.iccsafe.org/content/iecc2018/chapter-4-re-residential-energy-efficiency
18. "Implementation of Building Energy Standards in New York State", Raymond J. Albrecht, P.E. and J. Delaine Jones, AIA
Available from:
https://web.ornl.gov/sci/buildings/conf-archive/1979%20B1%20papers/042.pdf

19. U.S. DOE Home Energy Score for Insulation Deration adjustments.
Available from:
https://betterbuildingssolutioncenter.energy.gov/sites/default/files/Assessor%20Calculator%20v.020619.xlsx

Record of Revision

Record of Revision Number	**Issue Date**
1	10/15/2010
7-13-25	7/31/2013
7-13-38	7/31/2013
9-18-2	9/28/2018
3-19-2	3/29/2019
12-19-2	12/23/2019
12-20-2	12/31/2020
3-21-5	4/9/2021
7-21-5	8/30/2021
6-23-1	7/14/2023
6-24-6	7/8/2024
12-24-2	2/7/2025

Return to Table of Contents

LIGHTING

INTERIOR AND EXTERIOR LIGHTING

Measure Description

This measure covers energy efficient lighting equipment, such as energy efficient lamps, LED lamps and improved lighting fixtures installed in interior or exterior locations. These technologies, taken separately or combined into an energy efficient lighting fixture, provide the required illumination at reduced input power.

Beginning January 2012 and phased in through January 2014, the Energy Independence and Security Act of 2007 (EISA) regulations stipulated typical screw-based general service lamps (GSLs) with wattages ranging from 40W to 100W to comply with new lamp wattage standards such that the range of wattages decreased to be from 29W to 72W for rated lumen output ranging from 310 to 2,600 lumens.[21,22] A backstop provision was included in this legislation that would require general service lamps to meet a minimum efficacy of 45 lumens per watt beginning on 1/1/2020 in the absence of a final rule amending GSL standards.[23] Additionally in 2017, final rulings were promulgated expanding GSL and GSIL definitions to eliminate exceptions for certain specialty lamps, reflector lamps and decorative lamps effective 1/1/2020.[24,25] The backstop provision and revised definitions rulings were withdrawn prior to their effectuation date and subsequently reinstated by DOE with phased enforcement between January 2023 and July 2023.[26,27] As such, baseline values for market rate applications of this measure shall apply wattages in accordance with revised GSL and GSIL definitions and the imposed 45 lumen per watt standard established via these rulings. Where existing conditions are available, LMI applications of the primary method prescribed below shall establish baseline wattage aligned with existing conditions.

This measure consists of two methods for estimating energy and demand savings. The primary method represented by the first set of algorithms below is suitable for both market rate and LMI applications. The alternative methodology represented by the second set of algorithms shall be used for LMI applications only. This simplified approach relies on average sampling data to establish wattage and consumption reductions and assumed hours of operation. It is only applicable for LMI projects consisting of 16 LED lamps or fewer. Projects exceeding this limit require a lighting schedule.

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[21] The maximum rated wattage varies for modified spectrum lamps.
[22] Energy Independence and Security Act of 2007. Pub. L. 110-140. Sec. 321. Efficient Light Bulbs H.R.6 – 86.
[23] 42 U.S.C. 6295(i)(6)(A)(v).
[24] DOE 82 FR 7276.
[25] DOE 82 FR 7322.
[26] DOE 87 FR 27439.
[27] DOE 87 FR 27461.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times (1 + HVAC_c)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times (1 + HVAC_d) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times HVAC_{ff}$$

Alternate Method for Calculating Annual Energy Savings for LMI Projects[28]

This methodology for claiming savings is an alternate method that is being tested for future use and will be evaluated for use in both Market-Rate and LMI households.

General Purpose LEDs

$$\Delta kWh = units \times \left(\frac{\Delta W_{LMI,GP} \times 365}{1{,}000}\right) \times hrs$$

Candelabra LEDs[29]

$$\Delta kWh = units \times \Delta kWh_{LMI,Candelbra}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
units	= Number of measures installed under the program
baseline	= Characteristic of baseline condition
ee	= Characteristic of energy efficient condition
W	= Rated wattage of lamp and/or fixture (Watts)

[28] The average wattage reduction per lamp is taken to be 46 watts for A-lamps and 33 watts for candelabra type lamps. The first lamp operating hours for A-lamps prescribed in the Operating Hours section below were determined from the same study used to derive the standard method operating hours. The additional lower hours for larger quantities of A-lamp LEDs are from various sources.

[29] It is assumed that the ΔkWh per Candelabra lamp is 42.2 kWh. This is derived from an assumed ΔW of 33W per lamp and 3.5 hours of usage per day. The savings associated with candelabra lamps is derived from a baseline lamp wattage that is pre-EISA 2020 adjustments. The 2007 baseline maximum for candelabra lamps in EISA states that the wattage cannot exceed 60 watts.

hrs = Lighting operating hours
$HVAC_c$ = HVAC interaction factor for annual electric energy consumption
$HVAC_d$ = HVAC interaction factor at utility summer peak hour
HVACff = HVAC interaction factor for annual fossil fuel consumption (MMBtu/kWh)
CF = Coincidence factor
$\Delta W_{LMI,GP}$ = Wattage reduction per general-purpose lamp (LMI only)
$\Delta kWh_{LMI,Candelabra}$ = Annual electric energy savings per candelabra lamp (LMI only)
1,000 = Conversion factor, one kW equals 1,000 Watts
365 = Days per year

Summary of Variables and Data Sources

Variable	Value	Notes
$W_{baseline}$		Baseline measure watts, from appropriate "Baseline Efficiencies" section below. If applying the primary method in an LMI application, in situ wattage may be used in place of assumed baseline wattage. If the existing wattage is not known for an LMI application, use the "Midstream/Upstream Applications for General Service Lamps" subsection below. For detailed definitions, refer to the NOTE in the "Baseline Efficiency" section.
W_{ee}		Energy efficient measure watts, from application
Hrs		Look up in Operating Hours section below based on project type, installation type and location. "Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting. "Unknown" is not a valid selection for direct install programs. LMI projects may claim up to 16 LED lamps before requiring a lighting schedule.
$HVAC_c$	Exterior and Unconditioned Spaces: 0	HVAC interaction factor for annual electric energy consumption (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_d$	Exterior and Unconditioned Space: 0	HVAC interaction factor for peak demand at utility summer peak hour (dimensionless). Vintage and HVAC type weighted average by city. See Appendix D.
$HVAC_{ff}$	Exterior and Unconditioned Space: 0	HVAC interaction factor for annual fossil fuel energy consumption (MMBtu/kWh). Vintage and HVAC type weighted average by city. See Appendix D.
CF	Interior: 0.16 Exterior: 0	"Interior" designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting.

Variable	Value	Notes
$\Delta W_{LMI,GP}$	46	Wattage reduction per general-purpose lamp.[30]
$\Delta kWh_{LMI,Candelabra}$	42.2	This is derived from an assumed ΔW of 33W per lamp and 3.5 hours of usage per day.

HVAC system interaction factors are defined as the ratios of the cooling energy and demand reduction and heating energy increase per unit of lighting energy reduction. Much of the input energy for lighting systems is converted to heat that 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. Prescribed values for HVAC interaction factors for lighting energy and peak demand savings are shown in Appendix D. Lighting systems in unconditioned spaces or on the building exterior will have interaction factors of 0.0.

Coincidence Factor (CF)

The prescribed value for the coincidence factor for interior lighting is 0.16.[31] This value shall also be used if the installation location is unknown.

Because exterior lighting is assumed to operate during off-peak hours only, the prescribed coincidence factor for exterior lighting is 0.0.

Baseline Efficiencies from which Energy Savings are Calculated

NOTE: For the purposes of establishing baseline efficiencies for this measure, "Downstream" encompasses any program delivery mechanism that allows for the determination of housing type (Market Rate vs. LMI) and, in the case of LMI programs, existing lamp wattage. "Midstream/Upstream" baselines are intended for program delivery mechanisms where housing type cannot be identified or for LMI programs where existing lamp wattage cannot be identified.

Downstream Market Rate Applications for General Service Lamps

In accordance with DOE final rules published in May 2022, baseline wattage for General Service Lamps (GSLs) (as defined in DOE 87 FR 27461)[32] in market rate applications shall be established

[30] A sampling of recorded pre- and post- wattage of 100 completed EmPower projects, Data reported by a New York City agency (AEA), Inspections completed by Nexant, during a program evaluation ("M&V Evaluation EmPower New York[SM] Program," March 2007)., EmPCalc Honeywell Narrative 10_04_16 10 AM.

[31] NMR Group Inc., "Northeast Residential Lighting Hours-of-Use Study", May 5, 2014. Table 4-4: Peak Period Coincidence Factors and Confidence Intervals – Efficient Bulbs. CF referenced reflects Average Summer for NYSERDA based on ISO-NE peak period. The NYSERDA model includes UNY and DNY. The NYSERDA model does not differentiate between interior and exterior lighting. The interior lighting sample size is significantly larger than the exterior sample size. Thus, reported Coincidence Factor is appropriate for interior lighting and unknown installations.

[32] DOE 87 FR 27461.

based on a minimum standard efficacy of 45 lumens per watt.[33] Baseline wattage shall be derived as follows:

$$W_{baseline} = \frac{Lumens_{ee}}{45}$$

where:

$W_{baseline}$	= Baseline lamp wattage
$Lumens_{ee}$	= Rated light output of efficient lamp
45	= Minimum lumens per watt standard established by DOE final rule

Downstream Market Rate Applications for Exempt Lamps

A general service lamp, as defined in the Code of Federal Regulations, is a lamp, including but not limited to general service incandescent lamps, compact fluorescent lamps, general service light-emitting diode lamps, and general service organic light emitting diode lamps used in general lighting applications that:

(1) Has an ANSI base;
(2) Is able to operate at a voltage of 12 volts or 24 volts, at or between 100 to 130 volts, at or between 220 to 240 volts, or of 277 volts for integrated lamps, or is able to operate at any voltage for non-integrated lamps;
(3) Has an initial lumen output of greater than or equal to 310 lumens (or 232 lumens for modified spectrum general service incandescent lamps) and less than or equal to 3,300 lumens;
(4) Is capable of being operated at voltage range at least partially within 110 and 130 volts.

Certain lamp types were exempt from the original EISA legislation and subsequent final rule amending the definition of GSLs, though several exemptions were discontinued in the latter. For a complete list and definitions of exempt lamp types, as well as discussion of discontinued and maintained exemptions, reference final rules 82 FR 7276 and 82 FR 7322.[34,35]

For products that are not governed by the 45 lumen per watt standard (i.e., do not meet the definition of general service lamp or fall under an exempt product category), the baseline wattage shall be established per manufacturer recommended baseline wattage. By default, a 45 lumen per watt baseline shall be applied.

Midstream/Upstream Applications for General Service Lamps

Due to lack of availability of customer and existing conditions data in midstream and upstream program delivery mechanisms and the blend of market rate and LMI customer participation in these programs, distinct baseline guidance for these program types that endeavors to account for the proportion of LMI participants across NY state has been developed. The intent of this guidance is a blended baseline applying a 45 lumen per watt standard for market rate participants and an approximated existing condition baseline across the LMI participant population. For the purposes

[33] DOE 87 FR 27439.
[34] DOE 82 FR 7276.
[35] DOE 82 FR 7322.

of this exercise, the approximated existing condition baseline for LMI customers was assumed to align with baselines established for residential lighting prior to the effectuation of the 45 lumen per watt backstop.

Evaluation of 2021 retail LED bulb sales suggest that approximately 37% of residential LEDs are purchased by LMI customers.[36] As such, the baselines prescribed for midstream and upstream applications in the tables below apply a weighting reflecting 37% LMI and 63% market rate participation.

The baselines established below are applicable to midstream and upstream programs as well as downstream LMI programs where the primary calculation methodology above is utilized and existing lamp wattage cannot be collected. For lamps that are not covered by the tables below, either based on bulb type or lumen output, the manufacturer recommended baseline wattage should be used.

Standard Lamps

Bulb Type (a)	**Lumen Range (b)**	**$W_{baseline}$ (c)**
A-Lamp (A15, A17, A19, A21)	< 310	Use manufacturer recommended baseline wattage or assume 45 lm/W
	310 – 749	22
	750 – 1,049	35
	1,050 – 1,489	46
	1,490 – 2,600	66
	> 2,600	Use manufacturer recommended baseline wattage or assume 45 lm/W

Specialty Lamps

Baseline wattage for specialty lamps are found in the table below. Specialty lamps are defined as screw-base lamps that are globe, bullet, candle or decorative shaped. These can be medium base, intermediate base, or candelabra base lamps.

Bulb Type (a)	**Base Type (b)**	**Lumen Range (c)**	**$W_{baseline}$ (d)**
Globe All G (G30, G25, G16.5)	E26 and E17	< 90	Use manufacturer recommended baseline wattage or assume 45 lm/W
		90 – 179	6
		180 – 249	10
		250 – 349	13
		350 – 749	22

[36] Cadmus & Demand Side Analytics, "Residential Retail Lighting Impact Evaluation Final Report", Prepared for Central Hudson, April 20, 2022 – Slide 33.

Bulb Type (a)	Base Type (b)	Lumen Range (c)	$W_{baseline}$ (d)
		750 – 1,049	29
		1,050 – 1,489	37
		1,490 – 2,600	55
		> 2,600	Use manufacturer recommended baseline wattage or assume 45 lm/W
	E12 (Candelabra)	< 90	Use manufacturer recommended baseline wattage or assume 45 lm/W
		90 – 179	6
		180 – 249	10
		250 – 349	13
		350 – 499	21
		500 – 1,049	33
		> 1,049	Use manufacturer recommended baseline wattage or assume 45 lm/W
Globe (G40)	E26 (Medium), E17, and E12	< 90	Use manufacturer recommended baseline wattage or assume 45 lm/W
		90 – 179	6
		180 – 249	10
		250 – 349	13
		350 – 499	21
		500 – 1,049	33
		> 1,049	Use manufacturer recommended baseline wattage or assume 45 lm/W
Decorative (Shapes B10, B11, B13, BA10, BA11, CA10, C7, C9, F10, F15, ST, S14)	E26 (Medium) and E17	< 70	Use manufacturer recommended baseline wattage or assume 45 lm/W
		70 – 89	5
		90 – 149	7
		150 – 299	12
		300 – 749	22
		750 – 1,049	29
		1050 – 1,489	37
		1,490 – 2,600	55
		> 2,600	Use manufacturer recommended baseline wattage or assume 45 lm/W

Bulb Type (a)	Base Type (b)	Lumen Range (c)	$W_{baseline}$ (d)
	Candelabra base E12	< 70	Use manufacturer recommended baseline wattage or assume 45 lm/W
		70 – 89	5
		90 – 149	7
		150 – 299	12
		300 – 449	20
		450 – 1,049	33
		> 1,049	Use manufacturer recommended baseline wattage or assume 45 lm/W

Reflector/Flood Lamps

Baseline wattage for reflector and flood type lamps are found in the table below. For reflector and flood lamps that are not covered by the table below, either based on bulb type or lumen output, the manufacturer recommended baseline wattage should be used.

Bulb Type (a)	Lumen Range (b)	$W_{baseline}$ (c)
R20	200 - 299	15
	300 – 718	24
	719 – 810	29
	811 – 1,002	33
	1,003 – 1,202	39
	1,203 – 1,516	47
	1,517 – 1,733	56
	1,734 – 2,184	64
	> 2,184	75
PAR20	200 - 299	15
	300 – 718	22
	719 – 810	29
	811 – 1,002	33
	1,003 – 1,202	39
	1,203 – 1,516	47
	1,517 – 1,733	56
	1,734 – 2,184	64
	> 2,184	75
BR30, BR40, ER40	200 – 299	15
	300 – 399	20
	400 – 649	26
	650 – 1,419	39
	1,420 – 1,789	50
	1,790 – 2,045	60

Bulb Type (a)	Lumen Range (b)	$W_{baseline}$ (c)
	2,046 – 2,578	69
	> 2,578	80
ER30	200 – 299	15
	300 – 399	20
	400 – 956	28
	957 – 1183	35
	1184 – 1419	42
	1420 – 1789	50
	1790 – 2045	60
	2046 – 2578	69
	> 2578	80
PAR30, PAR38, R40	639 – 847	25
	848 – 956	31
	957 – 1,183	35
	1,184 – 1,419	42
	1,420 – 1,789	50
	1,790 – 2,045	60
	2,046 – 2,578	69
	> 2,578	80
R14, PAR16, R16	200 – 299	15
	300 – 399	20
	400 – 499	25
	500 – 599	30
	600 – 1,000	35
MR16	< 450	19
	450 – 600	26
	> 600	36
For any lamps/bulb types for reflector lamps not captured in the criteria above	All	Use manufacturer recommended baseline wattage or assume 45 lm/W

<u>Downlight Fixtures</u>

Baseline wattage for downlight fixtures is found in the table below. For downlight fixtures that are not covered by the table below, either based on bulb type or lumen output, the manufacturer recommended baseline wattage should be used.

Fixture Type (a)	Lumen Range (b)	$W_{baseline}$ (c)
Downlight Solid State Retrofit	All	72.8[37]

[37] Baseline is an average of lumen-equivalent EISA wattages for Energy Star downlight fixtures

Compliance Efficiency from which Incentives are Calculated

The compliance condition for individual fixture/lamp replacement scenarios is an efficient lighting product (lamp or fixture) meeting the minimum requirements of the current effective version of Design Lights Consortium qualified products list or the minimum efficacy (lm/W) ratings based on Lamp / Fixture Type per the table below.[38]

Product categories/applications covered by DLC must meet all DLC qualified product technical specifications. Only products not covered by DLC shall be qualified based on minimum efficacy in provided table.

Lamp / Fixture Type	Minimum Efficacy (lm/W)
Omnidirectional Lamp w/ CRI ≥ 90	70
Omnidirectional Lamp w/ CRI < 90	80
Directional Lamp w/ CRI ≥ 90	61
Directional Lamp w/ CRI < 90	70
Non-Directional Luminaire	65
Cove or Under Cabinet Mount Directional Luminaire	50
Outdoor, Wall-, Porch-, Pendant-, Post-Mounted and Security Luminaires	60
Accent Lights (including Track Light Luminaires & Line Voltage Track Heads)	55
Portable Desk Task Light	50
Inseparable Other SSL Luminaire	70

ENERGY STAR has sunset specifications for lamps and luminaires, while downlight fixtures and retrofit kits are covered by a new standard.[39] Compliance for downlight products shall align with the effective version of the ENERGY STAR Program Requirements for Downlights.

Operating Hours

Look up operating hours from the table below, based on lamp location and city. See details below for derivation of operating hours. “Interior” designation extends to any covered area not adequately lit during daylight hours by sunlight, thus requiring daytime operation of lighting. “Unknown” is not a valid selection for direct install programs.

City	Interior	Exterior	Unknown
Albany	999	2,273	1,125
Binghamton	999	2,273	1,125
Buffalo	999	2,273	1,125
Massena	999	2,273	1,125
NYC	1,752	1,606	1,752

[38] ENERGY STAR Program Requirements for Luminaires - Eligibility Criteria Version 2.2, August 15, 2019 & ENERGY STAR Program Requirements for Lamps - Eligibility Criteria Version 2.1, June 2, 2022

[39] ENERGY STAR Program Requirements for Downlights - Eligibility Criteria Version 1.0, April 2024.

City	Interior	Exterior	Unknown
Poughkeepsie	999	2,273	1,125
Syracuse	999	2,273	1,125

NYS cities other than NYC, Interior
Hours of operation for NYS cities other than NYC are taken from an Impact and Process Evaluation Study.[40]

NYC, Interior
Hours of operation for interior lighting is estimated to be 4.8 operating hours per day or 1,752 (4.8 x 365) hours per year. This value is derived from on-site lighting inventories of homes in New York City and Westchester County.[41]

NYC, Exterior
Hours of operation for exterior lighting is estimated to be 4.4 operating hours per day or 1,606 (4.4 x 365) hours per year. This value is derived from on-site lighting inventories of homes in New York City and Westchester County.[42]

NYC, Unknown
Hours of operation for lighting installed in an unknown location is estimated to be 4.8 operating hours per day or 1,752 (4.8 x 365) hours per year. This value is a weighted average of interior and exterior lighting hours derived from on-site lighting inventories of homes in New York City and Westchester County.[43]

LMI LED Table of Hours per Day by Unit Count
The hours per day values prescribed in the table below are intended for use with the Alternate Method for Calculating Annual Energy Savings for LMI Projects established above for General Purpose LEDs. The values in this table are based on the observation that program participants tend to prioritize replacement of the most used bulbs first and, as additional bulbs are replaced, the average hours of use per bulb decreases. For this reason, the hours per day applied to a project replacing 1 -2 bulbs shall be 3.2, while a project replacing 3 – 5 bulbs shall use an hours per day value of 3 and so on.

The values established below reflect the findings and guidance presented in the DOE Residential End-Use Lighting Study, which found average daily hours of use for all residential lamps to be

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[40] NMR Group Inc., "ONLINE MARKETPLACE & ELECTRIC RESIDENTIAL CONSUMER PRODUCTS, Impact and Process Evaluation", June 9, 2023. Table 4-16. Modeled HOU compared to HOU listed in TRMs.
[41] NMR Group Inc., "Northeast Residential Lighting Hours-of-Use Study", May 5, 2014. Table ES-6: HOU by Area Adjusted for Snapback and Table 3-2: Sample Sizes, Overall HOU Estimates by Area and Room. HOU referenced is a weighted average for interior room types for DNY and is Snapback Adjusted.
[42] NMR Group Inc., "Northeast Residential Lighting Hours-of-Use Study", May 5, 2014. Table ES-6: HOU by Area Adjusted for Snapback. HOU referenced is the value for Exterior for DNY and is Snapback Adjusted.
[43] NMR Group Inc., "Northeast Residential Lighting Hours-of-Use Study", May 5, 2014. Table ES-6: HOU by Area Adjusted for Snapback. HOU referenced is the value for Household for DNY, which is a weighted average of all room types and is Snapback Adjusted. The study's sample size included far more interior to exterior lights, thus a weighted distribution heavily favors the interior lighting hours.

1.6 nationally and in NY state.[44] These values are consistent with those applied in the EmPower New York program and are subject to change pending future program evaluations.

# of Bulbs	Hours/day (Rest of NY)	Hours/day (NYC)[45]
1 - 2	3.2	5.6
3 - 5	3.0	5.3
6 - 7	2.5	4.4
8 - 9	1.5	2.6
10 - 16	1.0	1.8

Example Calculation *(Not to be used as default)*

A residential LMI customer replaces ten 60-watt incandescent lamps with 10-watt LED lamps throughout the interior of their home located near Albany. The home has a central AC and gas-furnace. Annual Electric Energy Savings, Summer Peak Coincident Demand Savings and Annual Fossil Fuel Energy Savings are calculated as below.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times (1 + HVAC_c)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times (1 + HVAC_d) \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times HVAC_{ff}$$

units = 10, from application
$W_{baseline}$ = 60, from application
W_{ee} = 10, from application
hrs = 999, from Operating Hours section table based on lamp location and city from application
$HVAC_c$ = 0.043, from Appendix D based on building type, HVAC type, and location from application

[44] DOE Residential Lighting End-Use Consumption Study: Estimation Framework and Initial Estimates, December 2012; Table 4.1

[45] Hours/Day values in this table reflect a direct linear ratio of the values in the market rate HOU table above for NYC compared to other NY locations (i.e., NYC HOU are adjusted by a factor of 1,752/999 = 1.78).

$HVAC_d$ = 0.073, from Appendix D based on building type, HVAC type, and location from application
CF = 0.16, from Summary of Variables and Data Sources table based on lamp location from application
$HVAC_{ff}$ = -0.003, from Appendix D based on building type, HVAC type, and location from application

$$\Delta kWh = 10 \times \frac{(60 - 10)}{1{,}000} \times 999 \times (1 + 0.043) = 521\ kWh$$

$$\Delta kW = 10 \times \frac{(60 - 10)}{1{,}000} \times (1 + 0.073) \times 0.16 = 0.09\ kW$$

$$\Delta MMBtu = 10 \times \frac{(60 - 10)}{1{,}000} \times 999 \times (-0.003) = -1.50\ MMBtu$$

Alternate Method for Calculating Annual Energy Savings for LMI Projects

General Purpose LEDs

$$\Delta kWh = units\ \times \left(\frac{\Delta W_{LMI,GP} \times 365}{1{,}000}\right) \times hrs$$

units = 10, from application
$\Delta W_{LMI,GP}$ = 46, from application
hrs = 1, from Operating Hours section, LMI LED Table of Hours per Day by Unit Count

$$\Delta kWh = 10\ \times \left(\frac{46 \times 365}{1{,}000}\right) \times 1 = 168\ kWh$$

Effective Useful Life (EUL)

For Downstream Market Rate applications, see Appendix P.

For LMI applications relying on existing conditions to serve as baseline, and for the alternative method presented for LMI applications, use 3.3 years.[46]

For Midstream and Upstream applications relying on a blended baseline, use 10.7 years.[47]

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[46] The EUL is established based on the expected ratio of lifetime savings to annual savings. Given an incandescent existing condition (with an assumed 1-year remaining useful life), installation of an LED with a 15-year lifetime and an efficacy ratio of 6:1 for LED vs. incandescent technology, the EUL is established as Lifetime Savings/Annual Savings = ((Annual Savings * 1 Year) + (Annual Savings * 1/6 * 14 Years)) / Annual Savings = 1 + 14/6 = 3.3.
[47] Midstream and Upstream methods use the same approach, but apply a blended weighting, in alignment with the blended baseline weighting. Applying the same weighting as used to establish blended baselines for Midstream and

Ancillary Fossil Fuel Savings Impacts

Reduction in lighting power increases space heating requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

Ancillary Electric Savings Impacts

Reduction in lighting power decreases cooling requirements in conditioned spaces. Interactive HVAC impacts are addressed in prescribed energy savings calculation methodology.

References

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3. NMR Group Inc., "ONLINE MARKETPLACE & ELECTRIC RESIDENTIAL CONSUMER PRODUCTS, Impact and Process Evaluation", June 9, 2023

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4. Energy Savings Forecast of Solid-State Lighting in General Illumination Applications, US Department of Energy, December 2019, pg. 82.
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5. Electronic Code of Federal Regulations, Title 10: Energy, PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS, Subpart C—Energy and Water Conservation Standards.
   Available from: https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32
6. Energy Efficiency and Renewable Energy Office, Energy Conservation Program: Energy Conservation Standards for General Service Lamps; Final Rule (DOE 82 FR 7276), January 19, 2017.

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Upstream applications (37% LMI and 63% Market Rate) to assumed downstream market rate and LMI application lifetimes (15 years and 3.3 years, respectively).

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Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
7-13-2	7/31/2013
6-15-3	6/1/2015
1-16-3	12/31/2015
1-17-4	12/31/2016
9-17-2	9/30/2017
12-19-6	12/23/2019
12-19-7	12/23/2019
12-20-13	12/31/2020
7-21-9	8/30/2021
3-22-5	4/29/2022
6-22-19	12/30/2022
3-23-11	3/31/2023
6-23-8	7/14/2023

Record of Revision Number	Issue Date
6-24-7	7/8/2024
9-24-3	10/22/2024
12-24-5	2/7/2025

Return to Table of Contents

BUILDING SHELL

AIR CURTAIN

Measure Description

This measure is applicable to the installation of air curtains, which act as air barriers between conditioned and unconditioned environments in commercial, industrial, and multifamily settings. Also known as air doors, air curtains act as a controlled barrier for environmental and thermal separation between conditioned and unconditioned air when a building's doors are opened. They reduce cross mitigation of warm, lighter air flowing through the upper part of the opening and cold, heavier air flowing through the lower part of the opening while allowing an uninterrupted flow of traffic and unobstructed vision through the opening.

Qualifying air curtains must cover the entire door opening and operate only during the cooling and heating seasons. Compliant products shall be rated in accordance with ANSI/AMCA Standard 220-21. This measure is applicable to entryways with overhead doors and pedestrian doorways, including sliding door entryways between indoor conditioned and outdoor unconditioned spaces.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = units \times \left\{ \left(\Delta kWh_{cooling} + \Delta kWh_{heating} \right) - hp_{curtain} \times 0.746 \times hrs \times \left(days_{cooling} + days_{heating} \right) \right\}$$

$$\Delta kWh_{cooling} = \left[\frac{\Delta (kBTU/h)_{cooling}}{Eff_{ElecCool}} \right] \times hrs \times days_{cooling}$$

$$\Delta kWh_{cooling} = \left[\frac{\Delta (kBTU/h)_{heating}}{Eff_{ElecHeat}} \right] \times F_{ElecHeat} \times hrs \times days_{cooling}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times \frac{\Delta kWh_{cooling}}{days_{cooling} \times hrs} \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = units \times \left[\frac{\Delta (kBTU/h)_{heating}}{Eff_{FuelHeat} \times 1{,}000} \right] \times F_{FuelHeat} \times hrs \times days_{heating}$$

where:

$$\Delta(kBTU/h)_{cooling} = \frac{4.5 \times Q_{A,cooling} \times \left(H_{outdoor,cooling} - H_{indoor,cooling}\right)}{1{,}000} \times Eff_{curtain} \times Adj_{vestibule}$$

$$Q_{A,cooling} = \sqrt{Q_{wind,cooling}{}^{2} + Q_{thermal,cooling}{}^{2}}$$

$$Q_{wind,cooling} = MPH_{cooling} \times ht \times l \times F_{opening} \times 88$$

$$Q_{thermal,cooling} = 60 \times ht \times l \times F_{discharge} \times \sqrt{32.2 \times ht \times \frac{\left(T_{outdoor,cooling} - T_{indoor,cooling}\right)}{\left(T_{outdoor,cooling} + 459.67\right)}}$$

$$\Delta(kBTU/h)_{heating} = \frac{1.08 \times Q_{A,heating} \times \left(T_{indoor,heating} - T_{outdoor,heating}\right)}{1{,}000} \times Eff_{curtain} \times Adj_{vestibule}$$

$$Q_{A,heating} = \sqrt{Q_{wind,heating}{}^{2} + Q_{thermal,heating}{}^{2}}$$

$$Q_{wind,heating} = MPH_{heating} \times ht \times l \times F_{opening} \times 88$$

$$Q_{thermal,heating} = 60 \times ht \times l \times F_{discharge} \times \sqrt{32.2 \times ht \times \frac{\left(T_{indoor,heating} - T_{outdoor,heating}\right)}{\left(T_{indoor,heating} + 459.67\right)}}$$

where:

ΔkWh	= Annual electricity energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
units	= Number of measures installed under the program
$_{heating}$	= Property of heating season
$_{cooling}$	= Property of cooling season
Δ(kBTU/h)	= Change in rate of heat transfer through doorway
$Eff_{ElecCool}$	= Seasonal average energy efficiency of electric cooling equipment, BTU/watt-hour, using either SEER (<65,000 BTU/h) or IEER (≥65,000 BTU/h)
$Eff_{ElecHeat}$	= Seasonal average energy efficiency of electric heating equipment. Heating Seasonal Performance Factor, BTU/watt-hour, total heating output (supply heat)

in BTU (including resistance heating) during the heating season / total electric energy heat pump consumed (in watt-hour); if equipment efficiency is reported in COP, convert to HSPF using the equivalency HSPF = COP x 3.412

$Eff_{FuelHeat}$ = Fossil fuel heating system efficiency

$F_{ElecHeat}$ = Electric heating factor, used to include electric heating system impacts as applicable

$F_{FuelHeat}$ = Fossil fuel heating factor, used to include fossil fuel heating system impacts as applicable

$hp_{curtain}$ = Horsepower of air curtain motor

hrs = Daily run hours of air curtains (or equivalently, hours per day door is open)

days = Annual days of operation of air curtains

CF = Coincident factor

Q_A = Total air flow entering doorway, in Cubic Feet per Minute

H_{indoor} = Average indoor enthalpy

$H_{outdoor}$ = Average outdoor enthalpy

T_{indoor} = Average indoor set temperature

$T_{outdoor}$ = Average outdoor temperature

$Eff_{curtain}$ = Effectiveness of air curtain

$Adj_{vestibule}$ = Adjustment to account for the presence of a vestibule in pedestrian entryways

Q_{wind} = Air flow entering doorway due to wind

$Q_{thermal}$ = Air flow entering doorway due to thermal factors

MPH = Wind speed, in miles per hour

ht = height of doorway, in feet

l = length of doorway, in feet

$F_{opening}$ = Effectiveness of opening factor

$F_{discharge}$ = Discharge coefficient for opening

0.746 = Conversion factor (kW/hp), 746 watts equals one electric horsepower

24 = Hours in one day

1,000 = Conversion factor, one MMBtu equals 1,000 kBTU

4.5 = Density of inlet air at 70ºF x 60 min/hr, in lb-min/ft^3-hr

1.08 = Specific heat of air x density of inlet air at 70ºF x 60 min/hr, in BTU/h-ºF-CFM

1,000 = Conversion factor, on kBTU equals 1,000 BTU

88 = Conversion factor, one mile per hour equals 88 feet per minute

60 = Conversion factor, one minute equals 60 seconds

32.2 = Gravitational Constant, in ft/s^2

459.67 = Conversion factor, Fahrenheit to Rankine

Summary of Variables and Data Sources

Variable	Value	Notes
$\Delta(kBTU/h)_{cooling}$		Calculate per prescribed algorithms above. Using suggested default values in this methodology, there is a fixed linear relationship between $\Delta(kBTU/h)_{cooling}$ and the area of the entryway served by the air curtain. As such, a simplified approach for establishing default $\Delta(kBTU/h)_{cooling}$ values based on location and entryway area (A = ht x l) in ft^2 are provided in the Default Values table below.
$\Delta(kBTU/h)_{heating}$		Calculate per prescribed algorithms above. Using suggested default values in this methodology, there is a fixed linear relationship between $\Delta(kBTU/h)_{heating}$ and the area of the entryway served by the air curtain. As such, a simplified approach for establishing default $\Delta(kBTU/h)_{heating}$ values based on location and entryway area (A = ht x l) in ft^2 are provided in the Default Values table below.
$Eff_{ElecCool}$		From application. SEER or IEER shall be used, based on nameplate rating metric of existing equipment. For equipment rated in SEER2, SEER2 rating shall be used.
$Eff_{ElecHeat}$		From application. HSPF shall be used, based on nameplate rating metric of existing equipment. If equipment is rated in COP, convert to HSPF using the equivalency HPSF = COP x 3.412. For equipment rated in HSPF2, HSPF2 rating shall be used.
$Eff_{FuelHeat}$		From application. E_c, E_t, or AFUE shall be used, based on nameplate rating metric of existing equipment.
$F_{ElecHeat}$		Use a value of 1.0 if the building is electrically heated. Otherwise, use 0.0.
$F_{FuelHeat}$		Use a value of 1.0 if the building is fossil fuel heated. Otherwise use 0.0.
$hp_{curtain}$		From application.
hrs		Use a value of 1.93 hours.[48]
$days_{cooling}$		From application, or lookup based on location and season in table below.
$days_{heating}$		From application, or lookup based on location and season in table below.
CF	0.8	

[48] Calculated based on door opening frequency and door opening schedule from Pacific Northwest National Laboratory, "Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings," DOE, 2010. Assumes standalone retail facility with 153 door openings per hour during peak periods (8 peak hours) and 15 door openings per hour during off peak periods (4 off peak hours). Time per door opening taken from Yuill, G.K. 1996. Impact of High Use Automatic Doors on Infiltration. Project 763-TRP, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA, Table 2. Analysis assumes average open time is equivalent to 50% of Opening and Closing Time plus 100% of Full Open Time. Thus, [(153 x 8) + (15 x 4)] x [(0.5 x 3.27) + (0.5 x 4.15) + (1.0 x 1.69)] / 60 (s/min) / 60 (min/h) = 1.93 hours.

Variable	Value	Notes
$H_{indoor,cooling}$	34.6	Based on 85°F and 50% RH.
$H_{outdoor,cooling}$		Lookup from Climate Data table below based on location.[49]
$T_{indoor,cooling}$		From application or use 85°F as a default.[50]
$T_{outdoor,cooling}$		Lookup from Climate Data table below based on location.[51]
$T_{indoor,heating}$		From application or use 60°F as a default.[52]
$T_{outdoor,heating}$		Lookup from Climate Data table below based on location.[53]
$Eff_{curtain}$	0.7	Curtain effectiveness, based on midpoint of expected range (0.6 – 0.8).[54]
$Adj_{vestibule}$	Pedestrian doorway w/ vestibule: 0.66 All others: 1.0	Based on effectiveness of vestibule in reducing air infiltration rate relative to entryways with no vestibule.[55]
$MPH_{cooling}$		Lookup from Climate Data table below based on location.[56]
$MPH_{heating}$		Lookup from Climate Data table below based on location.[57]
ht		From application.
l		From application.
$F_{opening}$	0.3	Assumes diagonal wind.[58]
$F_{discharge}$	0.4	The discharge coefficient accounts for all viscous effects such as surface drag and interfacial mixing through the door, dependent on number of entry points into the conditioned space.[59] A single entrance is assumed for simplicity. Effects of indoor and outdoor temperature differential are expected to have negligible impact on this factor and are therefore ignored.

<u>Default Values[60]</u>

[49] NCEI 1991-2020 Annual/Seasonal Climate Normals.
[50] ECCNYS 2020; Table C403.4.1.4 Heated or Cooled Vestibules (Mandatory).
[51] NCEI 1991-2020 Annual/Seasonal Climate Normals.
[52] ECCCNYS 2020; Table C403.4.1.4 Heated or Cooled Vestibules (Mandatory).
[53] NCEI 1991-2020 Annual/Seasonal Climate Normals.
[54] 2019 ASHARE Handbook – HVAC Applications, Chapter 58, pg. 58.34.
[55] Based on Pacific Northwest National Laboratory, "Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings," DOE, 2010, Table 6. Calculated as the ratio of Air infiltration rate (cfm) through doors with vestibule to those without in the standalone retail building type during peak hours (i.e., 1,986 / 3,006 = 0.66).
[56] Ibid.
[57] Ibid.
[58] 2017 ASHRAE Handbook – Fundamentals, Chapter 16, pg. 16.14
[59] 2017 ASHRAE Handbook – Fundamentals, Chapter 16, pg. 16.14. eqn. 39.
[60] "A" represents the area of the doorway in ft^2 (A = ht x l).

City	$\Delta(kBTU/h)_{cooling}$	$\Delta(kBTU/h)_{heating}$
Albany	4.12A - 0.48	2.57A - 1.06
Binghamton	3.68A - 0.16	2.82A - 0.95
Buffalo	4.92A - 0.14	3.15A - 0.76
Massena	3.72A - 0.36	2.41A - 0.95
NYC	7.00A - 0.56	2.43A - 0.35
Poughkeepsie	3.15A - 0.66	1.25A - 0.76
Syracuse	4.16A - 0.42	2.68A - 0.93

Climate Data[61,62,63,64]

City	$T_{outdoor, cooling}$ (ºF)	$T_{outdoor, heating}$ (ºF)	$H_{outdoor,cooling}$ (BTU/lb)	$MPH_{cooling}$ (mph)	$MPH_{heating}$ (mph)
Albany	87.3	45.5	36.2	6.43	8.46
Binghamton	86.1	45.5	35.3	7.23	9.41
Buffalo	86.0	46.0	35.3	8.67	10.99
Massena	86.8	46.3	35.9	6.23	8.41
NYC	88.7	50.1	37.3	9.70	12.09
Poughkeepsie	86.9	49.7	35.9	4.30	5.70
Syracuse	87.2	45.8	36.1	6.77	9.14

Days of Operation[65]

City	Heating Season Days	Cooling Season Days
Albany	227	72
Binghamton	227	7
Buffalo	203	45
Massena	209	68
NYC	180	98
Poughkeepsie	205	58
Syracuse	217	70

[61] NCEI 1991-2020 Annual/Seasonal Climate Normals.
[62] 2017 ASHRAE Handbook – Fundamentals, Chapter 14, Climate Data Tables.
[63] The cooling season is defined as the date range over which the outdoor air temperature is above 85°F for at least one hour in a day. The cooling season is defined as the date range over which the outdoor air temperature is below 60°F for at least one hour in a day. Temperature values are based on the 90th percentile hourly temperature during the cooling and heating seasons.
[64] Enthalpy values are based on psychrometric analysis of air at average dry bulb and wet bulb temperatures across the cooling season when the outdoor dry bulb temperature is above the assumed balance point of 65F. MPH values reflect the average monthly values throughout the respective season (cooling/heating) identified by the ASHRAE Handbook.
[65] Derived from NCEI 1991-2020 Annual/Seasonal Climate Normals. Heating Season Days reflect the number of days in the year on which the 90th percentile hourly temperature falls below 60°F for at least one hour. Similarly, Cooling Season Days reflect the number of days in the year on which the 90th percentile hourly temperature falls above 85°F for at least one hour.

Coincidence Factor (CF)

The prescribed coincidence factor for this measure is 0.8.[66]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition for this measure is an entryway with overhead doors or a pedestrian doorway with no air curtains installed.

Compliance Efficiency from which Incentives are Calculated

The compliance condition for this measure is an air curtain over an entryway with overhead doors or a pedestrian doorway between conditioned and unconditioned spaces. Qualifying air curtains must cover the entire door opening and be rated in accordance with ANSI/AMCA Standard 220-21. Air curtains shall operate only during the cooling and heating seasons.

Operating Hours

Air curtain operating hours shall be based on application. Default values for number of operating days in cooling and heating seasons are provided in the Summary of Variables and Data Sources table above.

Example Calculation *(Not to be used as default)*

An air curtain with a 1/4 hp fan motor is installed in the 7 x 3 ft entryway without a vestibule in a small grocery store near Albany. The store has central AC with a SEER of 13 and gas heating with 82% AFUE. The door is open on average 227 days per year in the heating season and 72 days per year in the cooling season. Annual Electric Energy Savings, Summer Peak Coincident Demand Savings and Annual Fossil Fuel Energy Savings are calculated as below.

$$\Delta kWh = units \times \left\{\left(\Delta kWh_{cooling} + \Delta kWh_{heating}\right) - hp_{curtain} \times 0.746 \times hrs \times (days_{cooling} + days_{heating})\right\}$$

$$\Delta kW = units \times \frac{\Delta kWh_{cooling}}{days_{cooling} \times hrs} \times CF$$

$$\Delta MMBtu = units \times \left[\frac{\Delta(kBTU/h)_{heating}}{Eff_{FuelHeat} \times 1{,}000}\right] \times F_{FuelHeat} \times hrs \times days_{heating}$$

where:

[66] *No source specified – update pending availability and review of applicable references.*

$$\Delta kWh_{cooling} = \left[\frac{\Delta(kBTU/h)_{cooling}}{Eff_{ElecCool}}\right] \times hrs \times days_{cooling}$$

$$\Delta(kBTU/h)_{cooling} = \frac{4.5 \times Q_{A,cooling} \times \left(H_{outdoor,cooling} - H_{indoor,cooling}\right)}{1,000} \times Eff_{curtain} \times Adj_{vestibule}$$

$$Q_{A,cooling} = \sqrt{Q_{wind,cooling}{}^2 + Q_{thermal,cooling}{}^2}$$

$$Q_{wind,cooling} = MPH_{cooling} \times ht \times l \times F_{opening} \times 88$$

$$Q_{thermal,cooling} = 60 \times ht \times l \times F_{discharge} \times \sqrt{32.2 \times ht \times \frac{\left(T_{outdoor,cooling} - T_{indoor,cooling}\right)}{\left(T_{outdoor,cooling} + 459.67\right)}}$$

$$\Delta kWh_{heating} = \left[\frac{\Delta(kBTU/h)_{heating}}{Eff_{ElecHeat}}\right] \times F_{ElecHeat} \times hrs \times days_{heating}$$

$$\Delta(kBTU/h)_{heating} = \frac{1.08 \times Q_{A,heating} \times \left(T_{indoor,heating} - T_{outdoor,heating}\right)}{1,000} \times Eff_{curtain} \times Adj_{vestibule}$$

$$Q_{A,heating} = \sqrt{Q_{wind,heating}{}^2 + Q_{thermal,heating}{}^2}$$

$$Q_{wind,heating} = MPH_{heating} \times ht \times l \times F_{opening} \times 88$$

$$Q_{thermal,heating} = 60 \times ht \times l \times F_{discharge} \times \sqrt{32.2 \times ht \times \frac{\left(T_{indoor,heating} - T_{outdoor,heating}\right)}{\left(T_{indoor,heating} + 459.67\right)}}$$

$hp_{curtain}$ = 0.25, from application
$Eff_{ElecCool}$ = 13, from application
$Eff_{FuelHeat}$ = 0.82, from application
$F_{FuelHeat}$ = 1.0, from Summary of Variables and Data Sources table
hrs = 1.93, from Summary of Variables and Data Sources table
$days_{heating}$ = 227, from application

$days_{cooling}$ = 72, from application
CF = 0.8, from Summary of Variables and Data Sources table
$H_{indoor,cooling}$ = 34.6, from Summary of Variables and Data Sources table
$H_{outdoor,cooling}$ = 36.2, from Climate Data table based on location
$T_{indoor,cooling}$ = 85°F, default value from Summary of Variables and Data Sources table
$T_{outdoor,cooling}$ = 87.3°F, from Climate Data table based on location
$T_{indoor,heating}$ = 60°F, default value from Summary of Variables and Data Sources table
$T_{outdoor,heating}$ = 45.5°F, from Climate Data table based on location
$Eff_{curtain}$ = 0.7, from Summary of Variables and Data Sources table
$Adj_{vestibule}$ = 1.0, from Summary of Variables and Data Sources table
$MPH_{cooling}$ = 6.43, from Climate Data table based on location
$MPH_{heating}$ = 8.46, from Climate Data table based on location
ht = 7 ft, from application
l = 3 ft, from application
$F_{opening}$ = 0.3, from Summary of Variables and Data Sources table
$F_{discharge}$ = 0.4, from Summary of Variables and Data Sources table
CF = 0.8, from Summary of Variables and Data Sources table

$$Q_{wind,cooling} = 6.43 \times 7 \times 3 \times 0.3 \times 88 = 3{,}564.79$$

$$Q_{thermal,cooling} = 60 \times 7 \times 3 \times 0.4 \times \sqrt{32.2 \times 7 \times \frac{(87.3 - 85)}{(87.3 + 459.67)}} = 490.67$$

$$Q_{A,cooling} = \sqrt{3{,}564.79^2 + 490.67^2} = 3{,}601.37$$

$$\Delta\left(\frac{kBTU}{h}\right)_{cooling} = \frac{4.5 \times 3{,}601.37 \times (36.2 - 34.6)}{1{,}000} \times 0.7 \times 1.0$$
$$= 18.15$$

$$\Delta kWh_{cooling} = \left[\frac{18.15}{13}\right] \times 1.93 \times 72 = 194.01$$

$$Q_{wind,heating} = 8.46 \times 7 \times 3 \times 0.3 \times 88 = 4{,}690.22$$

$$Q_{thermal,heating} = 60 \times 7 \times 3 \times 0.4 \times \sqrt{32.2 \times 7 \times \frac{(60 - 45.5)}{(60 + 459.67)}} = 1{,}263.94$$

$$Q_{A,heating} = \sqrt{4{,}690.22^2 + 1{,}263.94^2} = 4{,}857.54$$

$$\Delta(kBTU/h)_{heating} = \frac{1.08 \times 4{,}857.54 \times (60 - 45.5)}{1{,}000} \times 0.7 \times 1.0 = 53.25$$

$$\Delta kWh_{heating} = \left\{\left[\frac{53.25}{N/A}\right] \times 0\right\} \times 1.93 \times 227 = 0$$

$$\Delta kWh = \ 1 \times \{(194.01 + 0) - 0.25 \times 0.746 \ \times 1.93 \times (72 + 227)\} = 86.39\ kWh$$

$$\Delta kW\ = 1 \times \frac{194.01}{72 \times 1.93} \times 0.8 = 1.12\ kW$$

$$\Delta MMBtu = 1 \times \left[\frac{53.25}{0.82 \times 1{,}000}\right] \times 1 \times 1.93 \times 227 = 28.46\ MMBtu$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

In addition to cooling and heating savings, installation of an air curtain results in increased electric load due to added fan power.

References

1. Pacific Northwest National Laboratory, "Energy Saving Impact of ASHRAE 90.1 Vestibule Requirements: Modeling of Air Infiltration through Door Openings," DOE, 2010 Available from: https://www.pnnl.gov/main/publications/external/technical_reports/pnnl-20026.pdf
2. Yuill, G.K. 1996. Impact of High Use Automatic Doors on Infiltration. Project 763-TRP, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA

Available from: https://www.aivc.org/sites/default/files/airbase_12996.pdf

3. NOAA National Center for Environmental Information – NCEI 1991 – 2020 Annual/Seasonal Climate Normals.
   Available from: https://www.ncdc.noaa.gov/cdo-web/datatools/normals
4. ECCCNYS 2020 Table C403.4.1.4 Heated or Cooled Vestibules (Mandatory).
   Available from: https://codes.iccsafe.org/content/NYSECC2020P1/chapter-4-[ce]-commercial-energy-efficiency#NYSECC2020P1_CE_Ch04_SecC403
5. 2019 ASHRAE Handbook – HVAC Applications, Chapter 58: Room Air Distribution.
6. 2017 ASHRAE Handbook – Fundamentals, Chapter 16: Ventilation and Infiltration.
7. 2017 ASHRAE Handbook – Fundamentals, Chapter 14: Climate Design Information.

Record of Revision

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3-20-6	3/30/2020
12-24-7	2/7/2025

Return to Table of Contents

BUILDING SHELL

AIR LEAKAGE SEALING

Measure Description

This measure covers methods of sealing air leakage paths to reduce the natural air infiltration rate of a building through the installation of products and repairs to the building envelope, including, but not limited to, caulking, gasketing, door sweeps, and weather stripping. Sealing the thermal envelope reduces passive convective heat transfer between conditioned and unconditioned spaces or outside air, thereby reducing heating and cooling loads and improving occupant comfort. This measure is only applicable as a retrofit in existing buildings.

The exterior envelope, as well as interior walls/partitions between conditioned and unconditioned spaces should be inspected and all gaps sealed. At a minimum, the following items shall be inspected, and sealing measures may be implemented based upon inspection results:

- Caulk and weather strip doors and windows that leak air, and install door sweeps on doors leading to the exterior or an unconditioned space.
- Repair doors and windows leading from conditioned to unconditioned space, including replacement of damaged components (e.g., frame jamb, threshold).
- Seal air leaks between unconditioned (including unconditioned basement and attics) and conditioned spaces, to include, but not limited to, plumbing, ducting, electrical wiring, wall top plates, chimneys, flues, and dropped soffits.
- Use foam sealant on larger gaps around windows, baseboards, and other places where air leakage, either infiltration or exfiltration may occur.

This method shall be used in air sealing applications with and without blower door testing. In cases where blower door testing is conducted before and after implementation of air sealing treatments, those measurements shall be utilized in the estimation of energy impacts via the method below. Default values for baseline and efficient case leakage rates are provided in the method below; these default values shall only be used when blower door testing is not feasible. Blower door test results can only be used if it is deemed that the test is reliable, such as but not limited to confirmation that all openings to the exterior can be verified closed during pre- and post-implementation testing. A blower door test is performed to measure the leakage rate by depressurizing the building to a standard pressure difference of 75 Pascals or 0.3 inches of water. The flowrate indicates the leakage rate, or infiltration and exfiltration rate, of the building shell.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

$$\Delta kWh_{cooling} = \frac{\left[\frac{(CFM_{75}/SF)_{baseline} - (CFM_{75}/SF)_{ee}}{F_{n,cooling} \times F_h}\right] \times SF \times LM \times 1.08 \times CDD \times 24}{Eff_{ElecCool} \times 1{,}000}$$

$$\Delta kWh_{heating} = \frac{\left[\frac{(CFM_{75}/SF)_{baseline} - (CFM_{75}/SF)_{ee}}{F_{n,heating} \times F_h}\right] \times SF \times 1.08 \times HDD \times 24 \times F_{ElecHeat}}{HSPF \times 1{,}000}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \frac{\left[\frac{(CFM_{75}/SF)_{baseline} - (CFM_{75}/SF)_{ee}}{F_{n,cooling} \times F_h}\right] \times SF \times LM \times 1.08}{EER \times 1{,}000} \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = \frac{\left[\frac{(CFM_{75}/SF)_{baseline} - (CFM_{75}/SF)_{ee}}{F_{n,heating} \times F_h}\right] \times SF \times 1.08 \times HDD \times 24 \times F_{FuelHeat}}{Eff_{FuelHeat} \times 1{,}000{,}000}$$

where:

ΔkWh = Annual electric energy savings
ΔkW = Peak coincident demand electric savings
ΔMMBtu = Annual fossil fuel energy savings
$\Delta kWh_{cooling}$ = Annual electric cooling energy savings
$\Delta kWh_{heating}$ = Annual electric heating energy savings
baseline = Characteristic of baseline condition
ee = Characteristic of energy efficient condition
(CFM_{75}/SF) = Infiltration rate (cubic foot per minute per building square foot) at a negative pressure differential of 75 Pa or 0.3 inches of water[67]
$F_{n,cooling}$ = Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, climate zone factor during cooling season
$F_{n,heating}$ = Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, climate zone factor during heating season
F_h = Infiltration-Leakage Ratio, used to convert pressurized blower door testing results to natural infiltration rates, building height factor
LM = Latent Multiplier, used to convert the sensible cooling savings calculated to a value representing sensible and latent cooling loads
SF = Square footage of the above- and below-grade building envelope[68] (ft^2) impacted by air leakage sealing treatment
CDD = Cooling Degree Day
HDD = Heating Degree Day

[67] ECCCNYS 2020 C402.5 Air leakage – thermal envelope (Mandatory).
[68] ECCCNYS 2020 C406.9 Reduced air infiltration.

$Eff_{ElecCool}$	= Seasonal average energy efficiency of electric cooling equipment, BTU/watt-hour, using either SEER (<65,000 BTU/h) or IEER (>65,000 BTU/h)
$Eff_{ElecHeat}$	= Seasonal average energy efficiency of electric heating equipment. Heating Seasonal Performance Factor, BTU/watt-hour, total heating output (supply heat) in BTU (including resistance heating) during the heating season / total electric energy heat pump consumed (in watt-hour); if equipment efficiency is reported in COP, convert to HSPF using the equivalency HSPF = COP x 3.412
EER	= Energy efficiency ratio under peak conditions (BTU/watt-hour)
$Eff_{FuelHeat}$	= Efficiency of fossil fuel heating equipment (AFUE, E_t, or E_c)
$F_{ElecHeat}$	= Electric heating factor; used to account for the presence or absence of an electric heating system
$F_{FuelHeat}$	= Fossil fuel heating factor; used to account for the presence or absence of a fossil fuel heating system
CF	= Coincidence factor
1.08	= Specific heat of air x density of inlet air @ 70ºF x 60 min/hr, in BTU/h-ºF-CFM[69]
24	= Hours in a day
1,000	= Conversion factor, one kW equals 1,000 Watts
1,000,000	= Conversion factor, one MMBtu equals 1,000,000 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
$(CFM_{75}/SF)_{baseline}$		From application, results from blower door test. If pre-implementation blower door test results are unavailable, use 0.40 CFM_{75}/SF as default.[70]
$(CFM_{75}/SF)_{ee}$		From application, results from blower door test. If post-implementation blower door test results are unavailable, use 0.25 CFM_{75}/SF as default.[71,72,73]
SF		From application.
$F_{n,cooling}$		Look up in Infiltration-Leakage Ratio, Climate Zone table below based on location and building shielding class, as defined below.

69 The sensible heat constant at standard conditions of 1.08 is applied in accordance with standard HVAC industry practice. While the underlying assumptions are not representative characteristics of a NY heating season, the impacts to this value due to average heating season temperature and NY mean elevation offset such that the NY heating season specific value is approximately 1.08.
70 ECCCNYS 2020 C402.5 Air leakage – thermal envelope (Mandatory).
71 ECCCNYS 2020 C406.9 Reduced air infiltration.
72 U.S. Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes, Version 3, May 11, 2012, p. 7
73 NIST, Analysis of U.S. Commercial Building Envelope Air Leakage Database to Support Sustainable Building Design. Analysis of air sealing in commercial buildings demonstrates buildings exceeding ECCCNYS Additional Efficiency Packages requirements.

Variable	Value	Notes
$F_{n,heating}$		Look up in Infiltration-Leakage Ratio, Climate Zone table below based on location and building shielding class, as defined below.
F_h	$= N_{stories}{}^{-0.3}$	Based on the number of conditioned stories in the building, from application.[74] The selected value should reflect the number of stories located inside the conditioned envelope of the building. Unconditioned basements and attics should not be included. Upper levels without full height perimeter walls shall be considered as half-stories (0.5).
LM		Look up in the Latent Multiplier table below, based on location.
CDD		Lookup based on location in Heating and Cooling Degree Days table in the Operating Hours section below.
HDD		Lookup based on location in Heating and Cooling Degree Days table in the Operating Hours section below.
$Eff_{ElecCool}$		From application. SEER or IEER shall be used, based on nameplate rating metric of existing equipment. For equipment rated in SEER2, SEER2 rating shall be used.
$Eff_{ElecHeat}$		From application. HSPF shall be used, based on nameplate rating metric of existing equipment. If equipment is rated in COP, convert to HSPF using the equivalency HPSF = COP x 3.412. For equipment rated in HSPF2, HSPF2 rating shall be used.
EER		From application. For equipment rated in EER2, EER2 rating shall be used. If unknown, baseline EER is established as follows[75]: $EER = (1.12 \times \mathrm{Eff}_{\mathrm{ElecCool}}) - \left(0.02 \times \mathrm{Eff}_{\mathrm{ElecCool}}{}^{2}\right)$
$Eff_{heating}$		From application. E_c, E_t, or AFUE shall be used, based on nameplate rating metric of existing equipment.
$F_{ElecHeat}$		Use a value of 1.0 if the building is electrically heated. Otherwise, use 0.0.

[74] LBL, Exegesis of Proposed ASHRAE Standard 119: Air Leakage Performance for Detached Single-Family Residential Buildings, M. Sherman, July 1986, pg. 12.

[75] DOE, Building America House Simulation Protocols, October 2010; for equipment rated in SEER2, replace SEER with SEER2 and EER with EER2 in the derivation formula.

Variable	Value	Notes
$F_{FuelHeat}$		Use a value of 1.0 if the building is fossil fuel heated. Otherwise use 0.0.
CF	NYC: 0.822 Outside of NYC: 0.477[76]	

<u>Infiltration-Leakage Ratio, Climate Zone</u>
The Infiltration-Leakage Ratio, Climate Zone converts pressurized blower door testing results to natural infiltration rates with consideration for climate zone. Look up $F_{n,cooling}$ and $F_{n,heating}$ in the tables below based on climate zone and shielding class, as defined below, based on application.[77]
Shielding Class[78]:

(1) No shielding on any side
(2) A few nearby obstructions
(3) A collection of obstructions within 25 feet
(4) Substantial number of obstructions shield most of the perimeter – typical suburban setting
(5) Building surrounded by large structures – typical urban setting

Shielding Class	$F_{n,cooling}$						
	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
1	12	11	10	11	9	11	12
2	14	13	11	12	10	13	14
3	16	15	13	15	12	15	16
4	20	19	17	19	16	19	20
5	34	32	29	32	27	33	34

Shielding Class	$F_{n,heating}$						
	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
1	12	10	9	10	8	10	11
2	13	11	10	11	9	11	12

[76] C&I Unitary HVAC Load Shape Project Final Report, KEMA, 2011, Table 0-5: NY - Inland and NY - Urban/Coastal.
[77] Infiltration-Leakage Ratio is calculated based on the derivation for air flow rate as outlined in ASHRAE Handbook – Fundamentals, 2017, Chapter 16 Ventilation and Infiltration, Section 10 Simplified Models of Residential Ventilation and Infiltration, p. 16.24: Airflow Rate (CFM) = Effective Air Leakage Area Conversion Factor * SQRT(Stack Coefficient * | Temperature Difference | + Wind Coefficient * (Wind Velocity)^2). Stack Coefficient and Wind Coefficient values are applied from Table 4 Basic Model Stack Coefficient C_s and Table 6 Basic Model Wind Coefficient C_w. Hourly wind speeds and ambient air temperatures are downloaded from NCEI. Effective Air Leakage Area Conversion Factor is calculated as outlined in Computing Manual J Infiltration Loads Based Upon a Target Envelope Leakage Requirement (ACCA, October 2016) Sections 2 and 5. At a pressurization of 75 CFM and assuming sea level, Equivalent Leakage Ratio = (0.2835*(4)^0.65)/(75)^0.65 = 0.042. Applying a building balance point of 65, hourly Normalized Airflow Rates are calculated for the heating season (below 65F) and the cooling season (above 65F). The inverse of the average of the hourly airflow rates are applied as the seasonal factors, $F_{n,cooling}$ and $F_{n,heating}$, as outlined in Infiltration Factor Calculation Methodology, Bruce Harley, Senior Manager, Applied Building Science, CLEAResult, 11/18/2015, as published in a IL TRM Memo, November 25, 2015.
[78] ASHRAE Handbook – Fundamentals, 2017. Chapter 16 Ventilation and Infiltration, Section 10 Simplified Models of Residential Ventilation and Infiltration, Table 5 Local Shelter Classes.

Shielding Class	$F_{n,heating}$						
	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
3	15	13	12	13	10	13	15
4	19	17	15	17	13	17	18
5	28	26	24	26	22	26	27

Latent Multiplier[79]

The Latent Multiplier converts the sensible cooling load savings captured in the savings equation to a savings capturing both latent and sensible load savings. The multiplier accommodates for the energy savings impacts associated with decreased humidity influx in a building with improved air sealing. During the cooling season, humidity poses an additional load on the cooling system. The Latent Multiplier is the ratio of total heat load (latent and sensible) to sensible heat load and is calculated in accordance with the recommended approach outlined in Harley, B., Infiltration Factor Calculation Methodology, November 2015, using NCEI 1991-2020 climate normals and default indoor air conditions of 74ºF and 50% rh. See “NY TRM Commercial Air Leakage Sealing Latent Multiplier Supplement.xlsx” for details.[80]

Location	Latent Multiplier (LM)
Albany	3.36
Binghamton	5.24
Buffalo	4.03
Massena	3.87
NYC	4.92
Poughkeepsie	3.05
Syracuse	3.53

Coincidence Factor (CF)

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79 ASHRAE Journal, Dehumidification and Cooling Loads from Ventilation Air, Lewis Harriman, November 1997.

80 These values were derived using NCEI 30-year climate normals hourly dry bulb and dewpoint temperature data. Hourly relative humidity (RH) was calculated using the August-Roche-Magnus approximation method for array psychrometric calculations across 8,760 hours:

RH: =100*(EXP((17.625*TD)/(243.04+TD))/EXP((17.625*T)/(243.04+T)))

Enthalpy was derived algorithmically based on RH and dry bulb temperature using a multi-order polynomial equation. The calculations outlined in the Infiltration Factor Calculation Methodology cited above were then applied to determine sensible and total loads per CFM of air, assuming indoor air conditions of 74°F and 50% RH:

- Sensible Load: btu_sens=(Tout−74)×1.08
- Total Load: btutot=max[btu_sens, (h_out - h_ref) x 4.5], where href=28 Btuh_{ref} = 28 \, Btuhref=28Btu
-

Latent multipliers were established by calculating the ratio of btutot to btusens across 8,760 hours:

LM=∑btutot / ∑btusens

The prescribed coincidence factor for this measure is 0.822 for NYC and 0.477 outside of NYC.[81]

Baseline Efficiencies from which Energy Savings are Calculated

Baseline flow rate CFM_{75}/SF shall come from blower door testing. If pre-implementation blower door results are unavailable, use default of 0.4 CFM_{75}/SF.[82] For all buildings, if a blower door test can be conducted, pre-implementation results will serve as existing conditions.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is the application of air leakage sealing treatments to an existing building envelope such that the exterior envelope, as well as interior walls/partitions between conditioned and unconditioned spaces have been inspected and all identified significant air gaps sealed. Compliance flow rate CFM_{75}/SF shall come from blower door testing. If post-implementation blower door results are unavailable, use default of 0.25 CFM_{75}/SF. For all buildings, if a blower door test can be conducted, post-implementation results will serve as efficient condition. This method may be used in partial treatment applications, where the SF term shall reflect the conditioned floor area impacted by air leakage sealing inspection and remediation.

See Measure Description for minimum inspection compliance, and examples of air sealing measures.

Operating Hours

Effective heating and cooling hours associated with benefits of air sealing are established via the Heating and Cooling Degree Days table below.

Heating and Cooling Degree Days[83]

City	HDD	CDD
Albany	6,391	721
Binghamton	7,200	383
Buffalo	6,502	607
Massena	8,030	406
NYC	4,900	1017
Poughkeepsie	6,026	745
Syracuse	6,625	618

Example Calculation *(Not to be used as default)*

Caulking was performed to seal air leakage in a 3 story, 15,000 square foot commercial building located near Albany after a blower door test was conducted. The building has central air conditioning with an IEER of 13 and EER of 10.8 and a gas heating system with 82% thermal efficiency. The building is surrounded by multiple structures of equal or greater height. The

[81] C&I Unitary HVAC Load Shape Project Final Report, KEMA, 2011, Table 0-5: NY - Inland and NY - Urban/Coastal.
[82] ECCCNYS 2020 C402.5 Air leakage – thermal envelope (Mandatory).
[83] HDD/CDD taken from NCEI 1991-2020 climate normal climate normal using a 65ºF balance point.

pre-implementation blower door test results yielded a $(CFM_{75}/SF)_{baseline}$ of 0.44 whereas the post-implementation blower door test results yielded $(CFM_{75}/SF)_{ee}$ of 0.27. Annual Electric Energy Savings, Summer Peak Coincident Demand Savings and Annual Fossil Fuel Energy Savings are calculated as below.

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

$$\Delta kWh_{cooling} = \frac{\left[\frac{(CFM_{75}/SF)_{baseline} - (CFM_{75}/SF)_{ee}}{F_{n,cooling} \times F_h}\right] \times SF \times LM \times 1.08 \times CDD \times 24}{Eff_{ElecCool} \times 1{,}000}$$

$$\Delta kWh_{heating} = \frac{\left[\frac{(CFM_{75}/SF)_{baseline} - (CFM_{75}/SF)_{ee}}{F_{n,heating} \times F_h}\right] \times SF \times 1.08 \times HDD \times 24 \times F_{ElecHeat}}{HSPF \times 1{,}000}$$

$$\Delta kW = \frac{\left[\frac{(CFM_{75}/SF)_{baseline} - (CFM_{75}/SF)_{ee}}{F_{n,cooling} \times F_h}\right] \times SF \times LM \times 1.08}{EER \times 1{,}000} \times CF$$

$$\Delta MMBtu = \frac{\left[\frac{(CFM_{75}/SF)_{baseline} - (CFM_{75}/SF)_{ee}}{F_{n,heating} \times F_h}\right] \times SF \times 1.08 \times HDD \times 24 \times F_{FuelHeat}}{Eff_{FuelHeat} \times 1{,}000{,}000}$$

$(CFM_{75}/SF)_{baseline}$ = 0.44, from application
$(CFM_{75}/SF)_{ee}$ = 0.27, from application
SF = 15,000, from application
LM = 3.36, from Latent Multiplier table
CDD = 721, from <u>Heating and Cooling Degree Days</u> table
HDD = 6,391, from <u>Heating and Cooling Degree Days</u> table
$F_{n,cooling}$ = 34, from Infiltration-Leakage Ratio, Climate Zone table based on Shielding Class (5) and City
$F_{n,heating}$ = 28, from Infiltration-Leakage Ratio, Climate Zone table based on Shielding class and City
$F_h = N_{stories}^{-0.3} = 3^{-0.3} = 0.719$
$N_{stories}$ = 3, from application
$Eff_{ElecCool}$ = 13, from application
EER = 10.8, from application
$Eff_{FuelHeat}$ = 0.82, from application
$F_{ElecHeat}$= 0, from Summary of Variables and Data Sources, since building is fossil fuel heated
$F_{FuelHeat}$ = 1, from Summary of Variables and Data Sources, since building is fossil fuel heated
CF = 0.477, from Summary of Variables and Data Sources, based on location

$$\Delta kWh_{cooling} = \frac{\left[\frac{0.44 - 0.27}{34 \times 0.719}\right] \times 15{,}000 \times 3.36 \times 1.08 \times 721 \times 24}{13 \times 1{,}000}$$
$$= 503.85$$

$$\Delta kWh_{heating} = \frac{\left[\frac{0.44 - 0.27}{28 \times 0.719}\right] \times 15{,}000 \times 1.08 \times 6{,}391 \times 24 \times 0}{N/A \times 1{,}000} = 0$$

$$\Delta kWh = 503.85 + 0 = 503.85\ kWh$$

$$\Delta kW = \frac{\left[\frac{0.44 - 0.27}{34 \times 0.719}\right] \times 15{,}000 \times 3.6 \times 1.08}{10.8 \times 1{,}000} \times 0.477$$
$$= 0.018\ kW$$

$$\Delta MMBtu = \frac{\left[\frac{0.44 - 0.27}{28 \times 0.719}\right] \times 15{,}000 \times 1.08 \times 6{,}391 \times 24 \times 1}{0.82 \times 1{,}000{,}000} = 25.59\ MMBtu$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

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3-21-11	4/9/2021
6-24-8	7/8/2024
12-24-8	2/7/2025

Return to Table of Contents

MOTORS AND DRIVES

VARIABLE FREQUENCY DRIVE (VFD) – HVAC FAN AND PUMP

Measure Description

This measure covers the installation of Variable Frequency Drives (VFDs) applied to HVAC fans and pumps in commercial and industrial buildings. Applications covered by this method include supply fans, return fans, exhaust fans, chilled water pumps, condenser water pumps, and heating hot water pumps. VFDs allow for the speed of the fan or pump to be adjusted to maintain the desired system flow rate and/or pressure based on varying system demand, reducing motor energy consumption. This requires a system with varying loads and appropriate controls like two-way valves or Variable Air Volume (VAV) boxes.

Distinct methods are provided for application of Variable Frequency Drives (VFDs) to HVAC fans and pump motors. This measure does not address other applications, which should be evaluated via a custom analysis method.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings *(HVAC Fan Applications)*

Annual Electric Energy Savings

$$\Delta kWh = (kWh_{baseline} - kWh_{ee})$$

$$kWh_{baseline} = 0.746 \times hp \times \frac{LF}{Eff_{motor}} \times hrs \times PLR_{baseline}$$

$$kWh_{ee} = 0.746 \times hp \times \frac{LF}{Eff_{motor}} \times hrs \times PLR_{ee}$$

Summer Peak Coincident Demand Savings

$$\Delta kW = (kW_{baseline} - kW_{ee})$$

$$kW_{baseline} = 0.746 \times hp \times \frac{LF}{Eff_{motor}} \times PLR_{peak,baseline}$$

$$kW_{ee} = 0.746 \times hp \times \frac{LF}{Eff_{motor}} \times PLR_{peak,ee}$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = N/A$$

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings *(HVAC Pump Applications)*

Annual Electric Energy Savings

$$\Delta kWh = \frac{hp \times 0.746 \times LF}{Eff_{motor}} \times hrs \times ESF$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \frac{hp \times 0.746 \times LF}{Eff_{motor}} \times DSF \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = N/A$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
baseline	= Characteristic of baseline condition
ee	= Characteristic of the efficient condition
kWh	= kW = Peak coincident demand electric usage
hp	= Rated horsepower of controlled motor
LF	= Motor load factor at design flow rate
Eff_{motor}	= Rated full-load efficiency of controlled motor
hrs	= Annual motor run hours
%FF	= Percentage of run-hours spent within a given flow fraction range
PLR	= Part load ratio at a given flow fraction range based on fan and control type
PLR_{peak}	= Part load ratio during summer peak period based on fan and control type
ESF	= Energy Savings Factor
DSF	= Demand Savings Factor
CF	= Coincidence Factor
0.746	= Conversion factor (kW/hp), 746 watts equals one electric horsepower

Summary of Variables and Data Sources

Variable	Value	Notes
hp		From application.
LF		From application. If actual load factor is unknown, assume 65%.[84]
Eff_{motor}		From application. If unknown, lookup from Appendix L based on motor type (open or enclosed), number of poles (2, 4 or 6) and horsepower.

[84] Lawrence Berkeley National Laboratory, and Resource Dynamics Corporation. (2014). "Improving Motor and Drive System Performance; A Sourcebook for Industry". U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Golden, CO: National Renewable Energy Laboratory.

Variable	Value	Notes
hrs		From application. If actual hours are unknown, lookup based on motor application, building type, and location in the Operating Hours section below.
$PLR_{baseline}$		Lookup in Default Average PLR by Control and Fan Type table below based on the existing fan and control type.
PLR_{ee}		Lookup in Default Average PLR by Control and Fan Type table below based on the proposed fan and control type.
$PLR_{peak,baseline}$		Lookup in the Part Load Ratios table below based on baseline fan and control type and flow fraction at summer peak, if known. If summer peak flow fraction is unknown, assume PLR at 90% load.
$PLR_{peak,ee}$		Lookup in the Part Load Ratios table below based on efficient fan and control type and flow fraction at summer peak, if known. If summer peak flow fraction is unknown, assume PLR at 90% load.
ESF		Lookup based on Pump Type in the Energy and Demand Savings Factors table below.
DSF		Lookup based on Pump Type in the Energy and Demand Savings Factors table below.
CF	Pumps: 0.835	Peak coincident demand savings for fan applications consider load ratio at system peak; therefore, no coincidence factor is applied.

Default Average PLR by Control and Fan Type ($\sum_{0\%}^{100\%}(\%FF \times PLR)$)

Fan/Control Type	$PLR_{baseline}$ & PLR_{ee}
No Control or Bypass Damper	1.00
Discharge Dampers	0.80
Outlet Damper, Bl & Airfoil Fans	0.78
Inlet Damper Box	0.69
Inlet Guide Vane, Bl & Airfoil Fans	0.63
Inlet Vane Dampers	0.53
Outlet Damper, FC Fans	0.53
Eddy Current Drives	0.49
Inlet Guide Vane, FC Fans	0.39
VFD with duct static pressure controls	0.30
VFD with low/no duct static pressure	0.27

Default Fan Duty Cycle[85]

Flow Fraction (% of Design CFM)	Percent of Time at Flow Fraction (%FF)
0% to 10%	0.0%
10% to 20%	1.0%
20% to 30%	5.5%
30% to 40%	15.5%
40% to 50%	22.0%
50% to 60%	25.0%
60% to 70%	19.0%
70% to 80%	8.5%
80% to 90%	3.0%
90% to 100%	0.5%

Part Load Ratios by Control and Fan Type and Flow Fraction (PLR @ %FF)[86]

Fan/Control Type	Flow Fraction									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
No Control or Bypass Damper	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Discharge Dampers	0.46	0.55	0.63	0.70	0.77	0.83	0.88	0.93	0.97	1.00
Outlet Damper, Bl & Airfoil Fans	0.53	0.53	0.57	0.64	0.72	0.80	0.89	0.96	1.02	1.05
Inlet Damper Box	0.56	0.6	0.62	0.64	0.66	0.69	0.74	0.81	0.92	1.07
Inlet Guide Vane, Bl & Airfoil Fans	0.53	0.56	0.57	0.59	0.60	0.62	0.67	0.74	0.85	100
Inlet Vane Dampers	0.38	0.40	0.42	0.44	0.48	0.53	0.60	0.70	0.83	0.99
Outlet Damper, FC Fans	0.22	0.26	0.30	0.37	0.45	0.54	0.65	0.77	0.91	1.06
Eddy Current Drives	0.17	0.20	0.25	0.32	0.41	0.51	0.63	0.76	0.90	1.04
Inlet Guide Vane, FC Fans	0.21	0.22	0.23	0.26	0.31	0.39	0.49	0.63	0.81	1.04
VFD with duct static pressure controls	0.09	0.10	0.11	0.15	0.20	0.29	0.41	0.57	0.76	1.01
VFD with low/no duct static pressure	0.05	0.06	0.09	0.12	0.18	0.27	0.39	0.55	0.75	1.00

85 Default Fan Duty Cycle based on 2024 ASHRAE Handbook; HVAC Systems and Equipment, page 45.13, Figure 16.

86 Del Balso, Ryan Joseph. "Investigation into the Reliability of Energy Efficiency/Demand Side Management Savings Estimates for Variable Frequency Drives in Commercial Applications", A project report submitted to the Faculty of the Graduate School of the University of Colorado, 2013. This report is not publicly available but is cited as a reference to establish part load ratio values for fan/control type combinations by several state TRMs, including V12 of the IL TRM (2024).

Energy and Demand Savings Factors for Pumps[87]

Pump Type	ESF	DSF
Chilled/Condenser Water Pump[88]	0.250	0.281
Hot Water Pump	0.237	0.000

Coincidence Factor (CF)

Peak coincident demand savings for fan applications consider load ratio at system peak; therefore, no coincidence factor is applied. For chilled/condenser water pump applications, the prescribed value for the coincidence factor is 0.835.[89] Heating hot water pumps are assumed not to operate during summer peak, thus a DSF of 0.00 is prescribed and no CF value is assigned.

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is a supply, return, or exhaust air fan or a chilled, condenser, or heating hot water pump motor without a VFD installed. This measure is only applicable to retrofit and new construction scenarios where VFD control is not required by code. Baseline control type shall be established based on the existing motor control strategy.

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a supply, return, or exhaust air fan or a chilled, condenser, or heating hot water pump motor equipped with a VFD. Compliance is restricted to applications involving three-phase induction motors only. VFDs must be automatically controlled via input signal based on system demand. The application must have a variable load, and installation is to include the necessary controls. Savings are based on application of VFDs to a range of baseline load conditions including no control, inlet guide vanes, outlet guide vanes and throttling valves.

Operating Hours

Annual motor operating hours shall be taken from application when available. If unknown, the hours from the table below based on Facility Type and motor application shall be applied.

VFD Operating Hours for Fan Motors by Building Type (hrs)[90]

Facility Type	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Auto Related	6,781	7,230	6,779	8,044	5,641	6,456	6,906
Bakery	4,877	5,200	4,875	5,785	4,057	4,643	4,967

[87] ESF and DSF for pump motors established using NEEP VSD Loadshape Tool (V8). ESF and DSF values are assigned based on average and maximum kW/hp reductions, respectively, over 8,760 loadshape for Cooling and Hot Water Pumps, divided by 0.746 to convert results to kW/kW. DSF for Hot Water Pumps set to 0 as they are assumed not to operate during summer peak.
[88] Per NEEP Variable Speed Drive Loadshape Project, August 2014, pg. 8, Cooling Water Pump designation includes both chilled water pumps and condenser water pumps. As such, this method prescribes equivalent values for these pump types.
[89] Based on analysis of NREL ComStock 15-minute interval electric cooling consumption data for New York State and defined system peak period. See "NY TRM Commercial VFD Coincidence Factor Analysis.xlsx" for details.
[90] Default fan operating hours are established based on 2022 CT PSD default hours, scaled on relative cooling and heating degree days between Hartford, CT and each NY weather city. See "NY TRM Commercial VFD Hour Scaling Supplement.xlsx" for details.

Facility Type	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Banks, Financial Centers	5,828	6,214	5,826	6,914	4,849	5,549	5,936
Church	3,689	3,933	3,688	4,376	3,069	3,512	3,757
College — Cafeteria	6,162	6,570	6,160	7,310	5,127	5,867	6,276
College - Classes/ Administrative	6,331	6,750	6,329	7,510	5,267	6,028	6,448
College - Dormitory	4,048	4,316	4,047	4,802	3,368	3,854	4,123
Commercial Condos	8,760	8,760	8,760	8,760	7,696	8,760	8,760
Convenience Stores	5,499	5,863	5,497	6,523	4,575	5,236	5,600
Convention Center	8,760	8,760	8,760	8,760	7,696	8,760	8,760
Court House	5,828	6,214	5,826	6,914	4,849	5,549	5,936
Dining: Bar Lounge/ Leisure	5,559	5,927	5,557	6,594	4,625	5,293	5,662
Dining: Cafeteria / Fast Food	6,162	6,570	6,160	7,310	5,127	5,867	6,276
Dining: Family	5,559	5,927	5,557	6,594	4,625	5,293	5,662
Exercise Center	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Fast Food Restaurants	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Fire Station (Unmanned)	6,162	6,570	6,160	7,310	5,127	5,867	6,276
Food Stores	4,048	4,316	4,047	4,802	3,368	3,854	4,123
Gymnasium	4,800	5,117	4,798	5,694	3,993	4,570	4,888
Hospitals	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Hospitals / Health Care	8,760	8,760	8,760	8,760	7,629	8,731	8,760
Industrial - 1 Shift	8,760	8,760	8,760	8,760	7,629	8,731	8,760
Industrial - 2 Shift	4,877	5,200	4,875	5,785	4,057	4,643	4,967
Industrial - 3 Shift	7,151	7,624	7,148	8,482	5,949	6,808	7,283
Laundromats	8,760	8,760	8,760	8,760	7,696	8,760	8,760
Library	5,499	5,863	5,497	6,523	4,575	5,236	5,600
Light Manufacturers	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Lodging (Hotels/ Motels)	4,877	5,200	4,875	5,785	4,057	4,643	4,967
Mall Concourse	3,613	3,852	3,612	4,286	3,006	3,440	3,680
Manufacturing Facility	4,953	5,281	4,951	5,875	4,121	4,716	5,044
Medical Offices	4,877	5,200	4,875	5,785	4,057	4,643	4,967
Motion Picture Theatre	5,064	5,399	5,062	6,007	4,213	4,821	5,157
Multi-Family (Common Areas)	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Museum	4,048	4,316	4,047	4,802	3,368	3,854	4,123
Nursing Homes	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Office (General Office Types)	8,760	8,760	8,760	8,760	7,696	8,760	8,760
Office/Retail[91]	5,064	5,399	5,062	6,007	4,213	4,821	5,157
Parking Garages & Lots	5,064	5,399	5,062	6,007	4,213	4,821	5,157
Penitentiary	6,781	7,230	6,779	8,044	5,641	6,456	6,906

[91] This applies to mixed-use retail/office buildings, where both retail and office spaces are integrated within the same development.

Facility Type	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Performing Arts Theatre	8,760	8,760	8,760	8,760	7,696	8,760	8,760
Police / Fire Stations (24 Hr)	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Post Office	7,158	7,632	7,156	8,491	5,955	6,815	7,290
Pump Stations	5,064	5,399	5,062	6,007	4,213	4,821	5,157
Refrigerated Warehouse	2,367	2,523	2,366	2,807	1,969	2,253	2,410
Religious Building	3,806	4,058	3,805	4,515	3,166	3,624	3,876
Residential (Except Nursing Homes)	3,689	3,933	3,688	4,376	3,069	3,512	3,757
Restaurants	4,048	4,316	4,047	4,802	3,368	3,854	4,123
Retail	5,559	5,927	5,557	6,594	4,625	5,293	5,662
School / University	5,499	5,863	5,497	6,523	4,575	5,236	5,600
Schools (Jr./Sr. High)	6,331	6,750	6,329	7,510	5,267	6,028	6,448
Schools (Preschool/ Elementary)	2,367	2,523	2,366	2,807	1,969	2,253	2,410
Schools (Technical/ Vocational)	4,067	4,336	4,066	4,824	3,383	3,872	4,142
Small Services	5,384	5,740	5,382	6,386	4,479	5,126	5,483
Sports Arena	5,064	5,399	5,062	6,007	4,213	4,821	5,157
Entertainment	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Town Hall	6,059	6,460	6,057	7,187	5,040	5,769	6,171
Transportation	6,781	7,230	6,779	8,044	5,641	6,456	6,906
Warehouse (Not Refrigerated)	3,806	4,058	3,805	4,515	3,166	3,624	3,876
Waste Water Treatment Plant	2,367	2,523	2,366	2,807	1,969	2,253	2,410
Workshop	4,877	5,200	4,875	5,785	4,057	4,643	4,967

VFD Operating Hours for Chilled/Condenser Water Pumps by Building Type (hrs)[92]

Facility Type	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Auto Related	1,269	674	1,069	715	1,791	1,312	1,089
Bakery	913	485	769	514	1,288	944	783
Banks, Financial Centers	2,405	1,277	2,026	1,354	3,393	2,486	2,063
Church	691	367	582	389	975	714	593
College - Cafeteria	1,154	613	972	650	1,628	1,193	990
College - Classes/ Administrative	2,075	1,102	1,748	1,168	2,927	2,145	1,780
College - Dormitory	3,374	1,792	2,842	1,899	4,760	3,488	2,895
Commercial Condos	3,935	2,089	3,314	2,215	5,551	4,068	3,376
Convenience Stores	1,030	547	867	580	1,453	1,065	884
Convention Center	3,935	2,089	3,314	2,215	5,551	4,068	3,376
Court House	2,405	1,277	2,026	1,354	3,393	2,486	2,063

[92] Default chilled/condenser water pump operating hours are established based on 2022 CT PSD default hours based on simulation of DOE-2 commercial building prototypes in eQUEST using Hartford weather data, scaled on relative cooling degree days between Hartford, CT and each NY weather city. See "NY TRM Commercial VFD Hour Scaling Supplement.xlsx" for details.

Facility Type	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Dining: Bar Lounge/ Leisure	1,041	553	877	586	1,469	1,077	893
Dining: Cafeteria / Fast Food	1,154	613	972	650	1,628	1,193	990
Dining: Family	1,041	553	877	586	1,469	1,077	893
Exercise Center	1,135	603	956	639	1,601	1,173	973
Fast Food Restau-rants	1,135	603	956	639	1,601	1,173	973
Fire Station (Un-manned)	1,154	613	972	650	1,628	1,193	990
Food Stores	3,374	1,792	2,842	1,899	4,760	3,488	2,895
Gymnasium	899	477	757	506	1,268	929	771
Hospitals	1,135	603	956	639	1,601	1,173	973
Hospitals / Health Care	6,762	3,591	5,696	3,807	8,760	6,990	5,802
Industrial - 1 Shift	6,762	3,591	5,696	3,807	8,760	6,990	5,802
Industrial - 2 Shift	913	485	769	514	1,288	944	783
Industrial - 3 Shift	913	485	769	514	1,288	944	783
Laundromats	913	485	769	514	1,288	944	783
Library	1,030	547	867	580	1,453	1,065	884
Light Manufacturers	1,135	603	956	639	1,601	1,173	973
Lodging (Hotels/ Motels)	913	485	769	514	1,288	944	783
Mall Concourse	677	359	570	381	955	700	581
Manufacturing Fa-cility	2,652	1,408	2,234	1,493	3,742	2,742	2,275
Medical Offices	913	485	769	514	1,288	944	783
Motion Picture The-atre	948	503	799	534	1,337	980	813
Multi-Family (Com-mon Areas)	1,135	603	956	639	1,601	1,173	973
Museum	3,374	1,792	2,842	1,899	4,760	3,488	2,895
Nursing Homes	1,135	603	956	639	1,601	1,173	973
Office (General Of-fice Types)	3,935	2,089	3,314	2,215	5,551	4,068	3,376
Office/Retail[93]	948	503	799	534	1,337	980	813
Parking Garages & Lots	948	503	799	534	1,337	980	813
Penitentiary	1,269	674	1,069	715	1,791	1,312	1,089
Performing Arts Theatre	3,935	2,089	3,314	2,215	5,551	4,068	3,376
Police / Fire Sta-tions (24 Hr)	1,135	603	956	639	1,601	1,173	973
Post Office	2,442	1,297	2,057	1,375	3,445	2,524	2,095
Pump Stations	948	503	799	534	1,337	980	813
Refrigerated Ware-house	1,846	980	1,555	1,039	2,604	1,908	1,584
Religious Building	713	379	601	401	1,006	737	612
Residential (Except Nursing Homes)	691	367	582	389	975	714	593

[93] This applies to mixed-use retail/office buildings, where both retail and office spaces are integrated within the same development.

Facility Type	Albany	Binghamton	Buffalo	Massena	NYC	Poughkeepsie	Syracuse
Restaurants	3,374	1,792	2,842	1,899	4,760	3,488	2,895
Retail	1,041	553	877	586	1,469	1,077	893
School / University	1,030	547	867	580	1,453	1,065	884
Schools (Jr./Sr. High)	2,075	1,102	1,748	1,168	2,927	2,145	1,780
Schools (Preschool/ Elementary)	1,846	980	1,555	1,039	2,604	1,908	1,584
Schools (Technical/ Vocational)	761	404	641	429	1,074	787	653
Small Services	1,910	1,014	1,609	1,075	2,695	1,975	1,639
Sports Arena	948	503	799	534	1,337	980	813
Entertainment	1,135	603	956	639	1,601	1,173	973
Town Hall	1,135	603	956	639	1,601	1,173	973
Transportation	1,269	674	1,069	715	1,791	1,312	1,089
Warehouse (Not Re-frigerated)	713	379	601	401	1,006	737	612
Waste Water Treat-ment Plant	1,846	980	1,555	1,039	2,604	1,908	1,584
Workshop	913	485	769	514	1,288	944	783

VFD Operating Hours for Hot Water Pumps by Building Type (hrs)[94]

Facility Type	Albany	Binghamton	Buffalo	Mas-sena	NYC	Poughkeep-sie	Syra-cuse
Auto Related	2,684	3,023	2,730	3,372	2,058	2,531	2,782
Bakery	1,931	2,175	1,964	2,426	1,480	1,820	2,001
Banks, Financial Centers	6,082	6,851	6,187	7,642	4,663	5,734	6,304
Church	1,460	1,644	1,485	1,834	1,119	1,376	1,513
College - Cafeteria	2,440	2,748	2,482	3,065	1,870	2,300	2,529
College - Classes/ Adminis-trative	6,991	7,876	7,113	8,760	5,360	6,592	7,247
College - Dormitory	4,141	4,665	4,213	5,203	3,175	3,905	4,293
Commercial Condos	8,760	8,760	8,760	8,760	7,256	8,760	8,760
Convenience Stores	2,177	2,452	2,215	2,735	1,669	2,053	2,257
Convention Center	8,760	8,760	8,760	8,760	7,256	8,760	8,760
Court House	6,082	6,851	6,187	7,642	4,663	5,734	6,304
Dining: Bar Lounge/ Leisure	2,201	2,479	2,239	2,765	1,687	2,075	2,281
Dining: Cafeteria / Fast Food	2,440	2,748	2,482	3,065	1,870	2,300	2,529
Dining: Family	2,201	2,479	2,239	2,765	1,687	2,075	2,281
Exercise Center	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Fast Food Restaurants	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Fire Station (Unmanned)	2,440	2,748	2,482	3,065	1,870	2,300	2,529
Food Stores	4,141	4,665	4,213	5,203	3,175	3,905	4,293
Gymnasium	1,899	2,140	1,932	2,387	1,456	1,791	1,969
Hospitals	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Hospitals / Health Care	8,760	8,760	8,760	8,760	7,256	8,760	8,760
Industrial - 1 Shift	8,760	8,760	8,760	8,760	7,256	8,760	8,760
Industrial - 2 Shift	1,931	2,175	1,964	2,426	1,480	1,820	2,001

[94] Default hot water pump operating hours are established based on 2022 CT PSD default hours based on simulation of DOE-2 commercial building prototypes in eQUEST using Hartford weather data, scaled on relative heating degree days between Hartford, CT and each NY weather city. See “NY TRM Commercial VFD Hour Scaling Supplement.xlsx” for details.

Facility Type	Albany	Binghamton	Buffalo	Mas-sena	NYC	Poughkeep-sie	Syra-cuse
Industrial - 3 Shift	2,831	3,189	2,880	3,557	2,170	2,669	2,934
Laundromats	3,745	4,218	3,810	4,705	2,871	3,531	3,882
Library	2,177	2,452	2,215	2,735	1,669	2,053	2,257
Light Manufacturers	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Lodging (Hotels/ Motels)	1,931	2,175	1,964	2,426	1,480	1,820	2,001
Mall Concourse	1,430	1,611	1,455	1,797	1,097	1,349	1,483
Manufacturing Facility	5,329	6,003	5,421	6,695	4,085	5,024	5,523
Medical Offices	1,931	2,175	1,964	2,426	1,480	1,820	2,001
Motion Picture Theatre	2,004	2,258	2,039	2,518	1,537	1,890	2,077
Multi-Family (Common Areas)	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Museum	4,141	4,665	4,213	5,203	3,175	3,905	4,293
Nursing Homes	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Office (General Office Types)	8,760	8,760	8,760	8,760	7,256	8,760	8,760
Office/Retail[95]	2,004	2,258	2,039	2,518	1,537	1,890	2,077
Parking Garages & Lots	2,004	2,258	2,039	2,518	1,537	1,890	2,077
Penitentiary	2,684	3,023	2,730	3,372	2,058	2,531	2,782
Performing Arts Theatre	8,760	8,760	8,760	8,760	7,256	8,760	8,760
Police / Fire Stations (24 Hr)	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Post Office	5,735	6,460	5,835	7,206	4,397	5,407	5,944
Pump Stations	2,004	2,258	2,039	2,518	1,537	1,890	2,077
Refrigerated Warehouse	5,216	5,876	5,307	6,554	3,999	4,918	5,407
Religious Building	1,506	1,697	1,532	1,892	1,155	1,420	1,561
Residential (Except Nursing Homes)	1,460	1,644	1,485	1,834	1,119	1,376	1,513
Restaurants	4,141	4,665	4,213	5,203	3,175	3,905	4,293
Retail	2,201	2,479	2,239	2,765	1,687	2,075	2,281
School / University	2,177	2,452	2,215	2,735	1,669	2,053	2,257
Schools (Jr./Sr. High)	6,991	7,876	7,113	8,760	5,360	6,592	7,247
Schools (Preschool/ Elementary)	5,216	5,876	5,307	6,554	3,999	4,918	5,407
Schools (Technical/ Vocational)	1,610	1,813	1,638	2,023	1,234	1,518	1,669
Small Services	6,072	6,840	6,177	7,629	4,655	5,725	6,294
Sports Arena	2,004	2,258	2,039	2,518	1,537	1,890	2,077
Entertainment	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Town Hall	2,398	2,702	2,440	3,014	1,839	2,262	2,486
Transportation	2,684	3,023	2,730	3,372	2,058	2,531	2,782
Warehouse (Not Refrigerated)	1,506	1,697	1,532	1,892	1,155	1,420	1,561
Waste Water Treatment Plant	5,216	5,876	5,307	6,554	3,999	4,918	5,407
Workshop	1,931	2,175	1,964	2,426	1,480	1,820	2,001

Example Calculation - *HVAC Fan* *(Not to be used as default)*

A 10 hp HVAC supply fan with a rated motor efficiency of 85% and outlet damper control is equipped with a VFD with duct static pressure controls in a high school building near NYC.

[95] This applies to mixed-use retail/office buildings, where both retail and office spaces are integrated within the same development.

Annual Fossil Fuel Energy Savings are not applicable. Annual Electric Energy Savings and Summer Peak Coincident Demand Savings are calculated as below.

$$\Delta kWh = (kWh_{baseline} - kWh_{ee})$$

$$kWh_{baseline} = 0.746 \times hp \times \frac{LF}{Eff_{motor}} \times hrs \times PLR_{baseline}$$

$$kWh_{ee} = 0.746 \times hp \times \frac{LF}{Eff_{motor}} \times hrs \times PLR_{ee}$$

$$\Delta kW = (kW_{baseline} - kW_{ee})$$

$$kW_{baseline} = 0.746 \times hp \times \frac{LF}{Eff_{motor}} \times PLR_{peak,baseline}$$

$$kW_{ee} = 0.746 \times hp \times \frac{LF}{Eff_{motor}} \times PLR_{peak,ee}$$

hp = 10, from application
LF = 0.65, from Summary of Variables and Data Sources table
Eff_{motor} = 0.85, from application
hrs = 5,267, from Operating Hours section based on motor application and facility type
$PLR_{baseline}$ = 0.78, from Default Average PLR table based on fan and baseline control type
PLR_{ee} = 0.30, from Default Average PLR table based on fan and efficient control type
$PLR_{peak,baseline}$ = 1.02, from Part Load Ratios table based on fan and baseline control type at 90% load
$PLR_{peak,ee}$ = 0.76, from Part Load Ratios table based on fan and efficient control type at 90% load

$$kWh_{baseline} = 0.746 \times 10 \times \frac{0.65}{0.85} \times 5{,}267 \times 0.78 = 23{,}436\ kWh$$

$$kWh_{ee} = 0.746 \times 10 \times \frac{0.65}{0.85} \times 5{,}267 \times 0.30 = 9{,}014\ kWh$$

$$\Delta kWh = (23{,}436 - 9{,}014) = 14{,}422\ kWh$$

$$kW_{baseline} = 0.746 \times 10 \times \frac{0.65}{0.85} \times 1.02 = 5.8\ kW$$

$$kW_{ee} = 0.746 \times 10 \times \frac{0.65}{0.85} \times 0.76 = 4.3\ kW$$

$$\Delta kW = (5.8 - 4.3) = 1.5\ kW$$

Example Calculation - *HVAC Pump* *(Not to be used as default)*

A 10 hp Condenser Water Pump with a rated motor efficiency of 85% and constant flow control is upgraded to a VFD with differential pressure setpoint control in a College - Cafeteria building near NYC.

Annual Electric Energy Savings

$$\Delta kWh = \frac{hp \times 0.746 \times LF}{Eff_{motor}} \times hrs \times ESF$$

Summer Peak Coincident Demand Savings

$$\Delta kW = \frac{hp \times 0.746 \times LF}{Eff_{motor}} \times DSF \times CF$$

Annual Fossil Fuel Energy Savings

$$\Delta MMBtu = N/A$$

hp = 10, from application
LF = 0.65, from Summary of Variables and Data Sources table
Eff_{motor} = 0.85, from application
hrs = 5,267, from Operating Hours section based on motor application and facility type
ESF = 0.250, from Energy and Demand Savings Factors for Pumps table
DSF = 0.281, from Energy and Demand Savings Factors for Pumps table
CF = 0.835, from Summary of Variables and Data Sources table

$$\Delta kWh = \frac{10 \times 0.746 \times 0.65}{0.85} \times 5{,}267 \times 0.250 = 7{,}511.67\ kWh$$

$$\Delta kW = \frac{10 \times 0.746 \times 0.65}{0.85} \times 0.281 \times 0.835 = 1.34\ kW$$

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

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6. NREL ComStock Data Viewer
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7. NY TRM Commercial VFD Coincidence Factor Analysis.xlsx
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Record of Revision

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1	10/15/2010
7-13-12	7/31/2013
9-17-8	9/30/2017
3-24-12	3/29/2024
6-24-14	7/8/2024
12-24-9	2/7/2025

Return to Table of Contents

APPENDIX C

NOTE: The wattage values found in the tables of this appendix shall only be referenced where existing conditions are collected or prescribed as part of a program's delivery mechanism and are permitted to be used as baseline (e.g., C&I Lighting).

As a cross reference, the Effective Useful life (in hours) used for some lighting products, including LEDs, may be found in Appendix P which relies upon estimates established by the Design Lights Consortium and ENERGY STAR®.[96]

Standard Fixture Watts [97]

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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

[96] Some of the EULs of LED lighting products are based on the listing found in the Qualified Products List by the Design Light Consortium (DLC) at 35,000 or 50,000 hours, according to the appropriate Application Category as specified in the DLC"s *Product Qualification Criteria, Technical Requirement Table* version 2.0 or higher. The EUL of other LED products are based on the listing found in *the ENERGY STAR® Qualified Fixture List*, according to the appropriate luminaire classification as specified in the *ENERGY STAR® Program requirements for Luminaires*, version 1.2. The total hours are divided by estimated annual use, but capped at 15 years regardless (consistent with C&I redecoration and business type change patterns.)

[97] (Reference: NYSERDA Existing Buildings Lighting Table with Circline Additions from CA SPC Table).

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
CF26/8-L	CF26W	Compact Fluorescent, (8) 26W lamp	Elec-tronic	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	Elec-tronic	1	28	28
CF32/3-L	CF32W	Compact Fluorescent, (3) 32W lamp	Elec-tronic	3	32	114
CF32/4-L	CF32W	Compact Fluorescent, (4) 32W lamp	Elec-tronic	4	32	152
CF32/6-L	CF32W	Compact Fluorescent, (6) 32W lamp	Elec-tronic	6	32	228
CF32/8-L	CF32W	Compact Fluorescent, (8) 32W lamp	Elec-tronic	8	32	304
CF38/2D	CFD38W	Compact Fluorescent, 2D, (1) 38W lamp	Mag-STD	1	38	46
CF38/2D-L	CFD38W	Compact Fluorescent, 2D, (1) 38W lamp	Elec-tronic	1	38	36
CF42/1-L	CF42W	Compact Fluorescent, (1) 42W lamp	Elec-tronic	1	42	48
CF42/2-L	CF42W	Compact Fluorescent, (2) 42W lamp	Elec-tronic	2	42	100
CF42/3-L	CF42W	Compact Fluorescent, (3) 42W lamp	Elec-tronic	3	42	141
CF42/4-L	CF42W	Compact Fluorescent, (4) 42W lamp	Elec-tronic	4	42	188
CF42/6-L	CF42W	Compact Fluorescent, (6) 42W lamp	Elec-tronic	6	42	282
CF42/8-L	CF42W	Compact Fluorescent, (8) 42W lamp	Elec-tronic	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	Elec-tronic	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	Elec-tronic	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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
CFQ18/1-L	CFQ18W	Compact Fluorescent, quad, (1) 18W lamp, BF=1.0	Elec-tronic	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	Elec-tronic	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
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	Elec-tronic	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	Elec-tronic	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	Elec-tronic	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	Elec-tronic	1	7	7
CFS9/1	CFS9W	Compact Fluorescent, spiral, (1) 9W lamp	Elec-tronic	1	9	9
CFS11/1	CFS11W	Compact Fluorescent, spiral, (1) 11W lamp	Elec-tronic	1	11	11

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
CFT36/6-L	CFT36W	Compact Fluorescent, long Twin, (6) 36W lamp/ High Ballast Factor	Elec-tronic	6	36	210
CFT36/8-BX	CFT36W	Compact Fluorescent, Biax, (8) 36W lamp	Elec-tronic	8	36	296
CFT36/8-L	CFT36W	Compact Fluorescent, long Twin, (8) 36W lamp	Elec-tronic	8	36	270
CFT36/8-L	CFT36W	Compact Fluorescent, long Twin, (8) 36W lamp/ High Ballast Factor	Elec-tronic	8	36	286
CFT36/9-BX	CFT36W	Compact Fluorescent, Biax, (9) 36W lamp	Elec-tronic	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	Elec-tronic	12	40	408
CFT40/1-BX	CFT40W	Compact Fluorescent, Biax, (1) 40W lamp	Elec-tronic	1	40	46
CFT40/1-L	CFT40W	Compact Fluorescent, long twin, (1) 40W lamp	Elec-tronic	1	40	43
CFT40/2	CFT40W	Compact Fluorescent, twin, (2) 40W lamp	Mag-STD	2	40	85
CFT40/2-BX	CFT40W	Compact Fluorescent, Biax, (2) 40W lamp	Elec-tronic	2	40	72
CFT40/2-L	CFT40W	Compact Fluorescent, long twin, (2) 40W lamp	Elec-tronic	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	Elec-tronic	3	40	102
CFT40/3-L	CFT40W	Compact Fluorescent, long twin, (3) 40W lamp	Elec-tronic	3	40	105
CFT40/4-BX	CFT40W	Compact Fluorescent, Biax, (4) 40W lamp	Elec-tronic	4	40	144
CFT40/5-BX	CFT40W	Compact Fluorescent, Biax, (5) 40W lamp	Elec-tronic	5	40	190
CFT40/6-BX	CFT40W	Compact Fluorescent, Biax, (6) 40W lamp	Elec-tronic	6	40	204
CFT40/6-L	CFT40W	Compact Fluorescent, long Twin, (6) 40W lamp	Elec-tronic	6	40	220
CFT40/6-L	CFT40W	Compact Fluorescent, long Twin, (6) 40W lamp/ High Ballast Factor	Elec-tronic	6	40	233

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
CFT40/8-BX	CFT40W	Compact Fluorescent, Biax, (8) 40W lamp	Elec-tronic	8	40	288
CFT40/8-L	CFT40W	Compact Fluorescent, long Twin, (8) 40W lamp	Elec-tronic	8	40	300
CFT40/8-L	CFT40W	Compact Fluorescent, long Twin, (8) 40W lamp/ High Ballast Factor	Elec-tronic	8	40	340
CFT40/9-BX	CFT40W	Compact Fluorescent, Biax, (9) 40W lamp	Elec-tronic	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	Elec-tronic	12	50	648
CFT50/1-BX	CFT50W	Compact Fluorescent, Biax, (1) 50W lamp	Elec-tronic	1	50	54
CFT50/2-BX	CFT50W	Compact Fluorescent, Biax, (2) 50W lamp	Elec-tronic	2	50	108
CFT50/3-BX	CFT50W	Compact Fluorescent, Biax, (3) 50W lamp	Elec-tronic	3	50	162
CFT50/4-BX	CFT50W	Compact Fluorescent, Biax, (4) 50W lamp	Elec-tronic	4	50	216
CFT50/5-BX	CFT50W	Compact Fluorescent, Biax, (5) 50W lamp	Elec-tronic	5	50	270
CFT50/6-BX	CFT50W	Compact Fluorescent, Biax, (6) 50W lamp	Elec-tronic	6	50	324
CFT50/8-BX	CFT50W	Compact Fluorescent, Biax, (8) 50W lamp	Elec-tronic	8	50	432
CFT50/9-BX	CFT50W	Compact Fluorescent, Biax, (9) 50W lamp	Elec-tronic	9	50	486
CFT55/12-BX	CFT55W	Compact Fluorescent, Biax, (12) 55W lamp	Elec-tronic	12	55	672
CFT55/1-BX	CFT55W	Compact Fluorescent, Biax, (1) 55W lamp	Elec-tronic	1	55	56
CFT55/2-BX	CFT55W	Compact Fluorescent, Biax, (2) 55W lamp	Elec-tronic	2	55	112
CFT55/3-BX	CFT55W	Compact Fluorescent, Biax, (3) 55W lamp	Elec-tronic	3	55	168
CFT55/4-BX	CFT55W	Compact Fluorescent, Biax, (4) 55W lamp	Elec-tronic	4	55	224
CFT55/5-BX	CFT55W	Compact Fluorescent, Biax, (5) 55W lamp	Elec-tronic	5	55	280
CFT55/6-BX	CFT55W	Compact Fluorescent, Biax, (6) 55W lamp	Elec-tronic	6	55	336
CFT55/6-L	CFT55W	Compact Fluorescent, long Twin, (6) 55W lamp	Elec-tronic	6	55	352

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
CFT55/6-L	CFT55W	Compact Fluorescent, long Twin, (6) 55W lamp/ High Ballast Factor	Elec-tronic	6	55	373
CFT55/8-BX	CFT55W	Compact Fluorescent, Biax, (8) 55W lamp	Elec-tronic	8	55	448
CFT55/8-L	CFT55W	Compact Fluorescent, long Twin, (8) 55W lamp	Elec-tronic	8	55	468
CFT55/8-L	CFT55W	Compact Fluorescent, long Twin, (8) 55W lamp/ High Ballast Factor	Elec-tronic	8	55	496
CFT55/9-BX	CFT55W	Compact Fluorescent, Biax, (9) 55W lamp	Elec-tronic	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 Fluo-rescent, (1) 5W lamp	Mag-STD	1	5	9
ECF5/2	CFT5W	EXIT Compact Fluo-rescent, (2) 5W lamp	Mag-STD	2	5	20
ECF7/1	CFT7W	EXIT Compact Fluo-rescent, (1) 7W lamp	Mag-STD	1	7	10
ECF7/2	CFT7W	EXIT Compact Fluo-rescent, (2) 7W lamp	Mag-STD	2	7	21
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 Fluo-rescent, (1) 9W lamp	Mag-STD	1	9	12
ECF9/2	CFT9W	EXIT Compact Fluo-rescent, (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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
F21ILX-R	F17T8	Fluorescent, (1) 24", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	1	17	15
F21ILX	F17T8	Fluorescent, (1) 24", T-8 lamp, HE Instant/Program Start Ballast, NLO (BF: .85-.95)	Electronic	1	17	16
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
F22ILX-R	F17T8	Fluorescent, (2) 24", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	2	17	27
F22ILX	F17T8	Fluorescent, (2) 24", T-8 lamp, HE Instant/Program Start Ballast, NLO (BF: .85-.95)	Electronic	2	17	31
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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
F23ILX	F17T8	Fluorescent, (3) 24", T-8 lamp, HE Instant/Program Start Ballast, NLO (BF: .85-.95)	Electronic	3	17	45
F23ILX-R	F17T8	Fluorescent, (3) 24", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	3	17	40
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
F24ILX-R	F17T8	Fluorescent, (4) 24", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Elec-tronic	4	17	53
F24LL	F17T8	Fluorescent, (4) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95)	Elec-tronic	4	17	68
F24LL-R	F17T8	Fluorescent, (4) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Elec-tronic	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	Elec-tronic	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)	Elec-tronic	1	25	26
F31ILL/T2	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Elec-tronic	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	Elec-tronic	1	25	24
F31ILL/T2-R	F25T8	Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF: .85-.95), Tandem 2 Lamp Ballast	Elec-tronic	1	25	23

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
F31LL-R	F25T8	Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Electronic	1	25	23
F31ILX-R	F25T8	Fluorescent, (1) 36", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	1	25	21
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
F32ILL-R	F25T8	Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Electronic	2	25	46
F32ILX-R	F25T8	Fluorescent, (2) 36", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	2	25	39
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
F41SILL	F30T8	Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Electronic	1	30	28

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
F41ILL-H	F32T8	Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Electronic	1	32	36
F41ILX-H	F32T8	Fluorescent, (1) 48", T-8 lamp, HE Instant/Program Start Ballast, HLO (BF:.96-1.1)	Electronic	1	32	35
F41ILX-R	F32T8	Fluorescent, (1) 48", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	1	32	25
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
F41LL/T4	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Elec-tronic	1	32	30
F41LL/T4-R	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast	Elec-tronic	1	32	26
F41LL-H	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1)	Elec-tronic	1	32	39
F41LL-R	F32T8	Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85)	Elec-tronic	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	Elec-tronic	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, Elec-tronic ballast	Elec-tronic	1	39	46
F41SIL/T2	F48T12	Fluorescent, (1) 48", STD IS lamp, Elec-tronic ballast, tandem wired	Elec-tronic	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	Elec-tronic	1	28	32
F41SL/T2	F40T12	Fluorescent, (1) 48", T-12 STD lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Bal-last	Elec-tronic	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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
F42ILX-H	F32T8	Fluorescent, (2) 48", T-8 lamp, HE Instant/Program Start Ballast, HLO (BF:.96-1.1)	Electronic	2	32	63

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
F42ILX-R	F32T8	Fluorescent, (2) 48", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	2	32	48
F42ILX-V	F32T8	Fluorescent, (2) 48", T-8 lamp, HE Instant/Program Start Ballast, VHLO (BF>1.1)	Electronic	2	32	74
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
F43ILL-V	F32T8	Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, VHLO (BF>1.1)	Electronic	3	32	112
F43ILX-H	F32T8	Fluorescent, (3) 48", T-8 lamp, HE Instant/Program Start Ballast, HLO (BF:.96-1.1)	Electronic	3	32	90
F43ILX-R	F32T8	Fluorescent, (3) 48", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	3	32	73
F43ILX-R/2	F32T8	Fluorescent, (3) 48", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85), (2) ballast	Electronic	3	32	73
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
F44SILL-H	F30T8	Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-4.4)	Electronic	4	30	140

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
F44ILX-R	F32T8	Fluorescent, (4) 48", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85)	Electronic	4	32	96
F44ILX-R/2	F32T8	Fluorescent, (4) 48", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF<0.85), (2) ballast	Electronic	4	32	96
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
F46ILX-R	F32T8	Fluorescent, (6) 48", T-8 lamp, HE Instant/Program Start Ballast, RLO (BF< .85)	Electronic	6	32	146
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
F48ILL-R	F32T8	Fluorescent, (8) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Elec-tronic	8	32	204
F48ILX-R	F32T8	Fluorescent, (8) 48", T-8 lamp, HE In-stant/Program Start Ballast, RLO (BF<0.85)	Elec-tronic	8	32	192
F48GHL	F48T5/HO	Fluorescent, (8) 48", STD HO T5 lamp	Elec-tronic	8	54	468
F51ILHL	F60T12/HO	Fluorescent, (1) 60", T-8 HO lamp, Instant Start Ballast	Elec-tronic	1	55	59
F51ILL	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Elec-tronic	1	40	36
F51ILL/T2	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Elec-tronic	1	40	36
F51ILL/T3	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast	Elec-tronic	1	40	35
F51ILL/T4	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast	Elec-tronic	1	40	34
F51ILL-R	F40T8	Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Elec-tronic	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	Elec-tronic	1	75	69
F51GHL	F60T5/HO	Fluorescent, (1) 60", STD HO T5 lamp	Elec-tronic	1	80	89
F51SHS	F60T12/HO	Fluorescent, (1) 60", STD HO lamp	Mag-STD	1	75	92
F51SL	F60T12	Fluorescent, (1) 60", STD lamp	Elec-tronic	1	50	44
F51GL	F60T5	Fluorescent, (1) 60", STD T5 lamp	Elec-tronic	1	35	39
F51SS	F60T12	Fluorescent, (1) 60", STD lamp	Mag-STD	1	50	63

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
F81EHL/T2	F96T12/HO/ES	Fluorescent, (1) 96", ES HO lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Elec-tronic	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	Elec-tronic	1	60	60
F81EL/T2	F96T12/ES	Fluorescent, (1) 96", ES lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Elec-tronic	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)	Elec-tronic	1	59	58
F81ILL/T2	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Elec-tronic	1	59	55
F81ILL/T2-R	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 2 Lamp Ballast	Elec-tronic	1	59	49
F81ILL-H	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1)	Elec-tronic	1	59	68
F81ILL-R	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Elec-tronic	1	59	57
F81ILL-V	F96T8	Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, VHLO (BF>1.1)	Elec-tronic	1	59	71
F81LHL	F96T8/HO	Fluorescent, (1) 96", T8 HO lamp	Elec-tronic	1	86	85

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
F81LHL/T2	F96T8/HO	Fluorescent, (1) 96", T8 HO lamp, tandem wired to 2-lamp bal-last	Elec-tronic	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	Elec-tronic	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)	Elec-tronic	1	75	70
F81SL/T2	F96T12	Fluorescent, (1) 96", STD lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast	Elec-tronic	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	Elec-tronic	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	Elec-tronic	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)	Elec-tronic	2	59	109
F82ILL-R	F96T8	Fluorescent, (2) 96", T-8 lamp, Instant Start Ballast, RLO (BF<0.85)	Elec-tronic	2	59	98

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
F82LHL	F96T8/HO	Fluorescent, (2) 96", T8 HO lamp	Electronic	2	86	160
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
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
F84ILL	F96T8	Fluorescent, (4) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95)	Elec-tronic	4	59	219
F84LHL	F96T8/HO	Fluorescent, (4) 96", T8 HO lamp	Elec-tronic	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	Elec-tronic	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)	Elec-tronic	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)	Elec-tronic	6	59	328
CIRCLINE FLUORESCENT FIXTURES						
FC12/1	FC12T9	Fluorescent, (1) 12" circular lamp, RS bal-last	Mag-STD	1	32	31
FC12/2	FC12T9	Fluorescent, (2) 12" circular lamp, RS bal-last	Mag-STD	2	32	62
FC16/1	FC16T9	Fluorescent, (1) 16" circular lamp	Mag-STD	1	40	35
FC20	FC6T9	Fluorescent, Circline, (1) 20W lamp, Preheat ballast	Mag-STD	1	20	20
FC22/1	FC8T9	Fluorescent, Circline, (1) 22W lamp, preheat ballast	Mag-STD	1	22	20
FC22/32/1	FC22/32T9	Fluorescent, Circline, (1) 22W/32W lamp, preheat ballast	Mag-STD	1	22/32	58

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
FC32/1	FC12T9	Fluorescent, Circline, (1) 32W lamp, preheat ballast	Mag-STD	1	32	40
FC32/40/1	FC32/40T9	Fluorescent, Circline, (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, Circline, (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
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
FU1ILX-R	FU31T8/6	Fluorescent, (1) U-Tube, T-8 lamp, HE Instant/Program Start Ballast RLO (BF<0.85)	Electronic	1	31	25
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
FU2ILX-R	FU31T8/6	Fluorescent, (2) U-Tube, T-8 lamp, HE Instant/Program Start Ballast RLO (BF<0.85)	Electronic	2	31	48
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	N/A	1	100	100
I100/2	I100	Incandescent, (2) 100W lamp	N/A	2	100	200
I100/3	I100	Incandescent, (3) 100W lamp	N/A	3	100	300
I100/4	I100	Incandescent, (4) 100W lamp	N/A	4	100	400
I100/5	I100	Incandescent, (5) 100W lamp	N/A	5	100	500
I1000/1	I1000	Incandescent, (1) 1000W lamp	N/A	1	1000	1000
I100E/1	I100/ES	Incandescent, (1) 100W ES lamp	N/A	1	90	90
I100EL/1	I100/ES/LL	Incandescent, (1) 100W ES/LL lamp	N/A	1	90	90

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
I120/1	I120	Incandescent, (1) 120W lamp	N/A	1	120	120
I120/2	I120	Incandescent, (2) 120W lamp	N/A	2	120	240
I125/1	I125	Incandescent, (1) 125W lamp	N/A	1	125	125
I135/1	I135	Incandescent, (1) 135W lamp	N/A	1	135	135
I135/2	I135	Incandescent, (2) 135W lamp	N/A	2	135	270
I15/1	I15	Incandescent, (1) 15W lamp	N/A	1	15	15
I15/2	I15	Incandescent, (2) 15W lamp	N/A	2	15	30
I150/1	I150	Incandescent, (1) 150W lamp	N/A	1	150	150
I150/2	I150	Incandescent, (2) 150W lamp	N/A	2	150	300
I1500/1	I1500	Incandescent, (1) 1500W lamp	N/A	1	1500	1500
I150E/1	I150/ES	Incandescent, (1) 150W ES lamp	N/A	1	135	135
I150EL/1	I150/ES/LL	Incandescent, (1) 150W ES/LL lamp	N/A	1	135	135
I170/1	I170	Incandescent, (1) 170W lamp	N/A	1	170	170
I20/1	I20	Incandescent, (1) 20W lamp	N/A	1	20	20
I20/2	I20	Incandescent, (2) 20W lamp	N/A	2	20	40
I200/1	I200	Incandescent, (1) 200W lamp	N/A	1	200	200
I200/2	I200	Incandescent, (2) 200W lamp	N/A	2	200	400
I2000/1	I2000	Incandescent, (1) 2000W lamp	N/A	1	2000	2000
I200L/1	I200/LL	Incandescent, (1) 200W LL lamp	N/A	1	200	200
I25/1	I25	Incandescent, (1) 25W lamp	N/A	1	25	25
I25/2	I25	Incandescent, (2) 25W lamp	N/A	2	25	50
I25/4	I25	Incandescent, (4) 25W lamp	N/A	4	25	100
I250/1	I250	Incandescent, (1) 250W lamp	N/A	1	250	250
I300/1	I300	Incandescent, (1) 300W lamp	N/A	1	300	300
I34/1	I34	Incandescent, (1) 34W lamp	N/A	1	34	34
I34/2	I34	Incandescent, (2) 34W lamp	N/A	2	34	68

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
I36/1	I36	Incandescent, (1) 36W lamp	N/A	1	36	36
I40/1	I40	Incandescent, (1) 40W lamp	N/A	1	40	40
I40/2	I40	Incandescent, (2) 40W lamp	N/A	2	40	80
I400/1	I400	Incandescent, (1) 400W lamp	N/A	1	400	400
I40E/1	I40/ES	Incandescent, (1) 40W ES lamp	N/A	1	34	34
I40EL/1	I40/ES/LL	Incandescent, (1) 40W ES/LL lamp	N/A	1	34	34
I42/1	I42	Incandescent, (1) 42W lamp	N/A	1	42	42
I448/1	I448	Incandescent, (1) 448W lamp	N/A	1	448	448
I45/1	I45	Incandescent, (1) 45W lamp	N/A	1	45	45
I50/1	I50	Incandescent, (1) 50W lamp	N/A	1	50	50
I50/2	I50	Incandescent, (2) 50W lamp	N/A	2	50	100
I500/1	I500	Incandescent, (1) 500W lamp	N/A	1	500	500
I52/1	I52	Incandescent, (1) 52W lamp	N/A	1	52	52
I52/2	I52	Incandescent, (2) 52W lamp	N/A	2	52	104
I54/1	I54	Incandescent, (1) 54W lamp	N/A	1	54	54
I54/2	I54	Incandescent, (2) 54W lamp	N/A	2	54	108
I55/1	I55	Incandescent, (1) 55W lamp	N/A	1	55	55
I55/2	I55	Incandescent, (2) 55W lamp	N/A	2	55	110
I60/1	I60	Incandescent, (1) 60W lamp	N/A	1	60	60
I60/2	I60	Incandescent, (2) 60W lamp	N/A	2	60	120
I60/3	I60	Incandescent, (3) 60W lamp	N/A	3	60	180
I60/4	I60	Incandescent, (4) 60W lamp	N/A	4	60	240
I60/5	I60	Incandescent, (5) 60W lamp	N/A	5	60	300
I60E/1	I60/ES	Incandescent, (1) 60W ES lamp	N/A	1	52	52
I60EL/1	I60/ES/LL	Incandescent, (1) 60W ES/LL lamp	N/A	1	52	52
I65/1	I65	Incandescent, (1) 65W lamp	N/A	1	65	65

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
I65/2	I65	Incandescent, (2) 65W lamp	N/A	2	65	130
I67/1	I67	Incandescent, (1) 67W lamp	N/A	1	67	67
I67/2	I67	Incandescent, (2) 67W lamp	N/A	2	67	134
I67/3	I67	Incandescent, (3) 67W lamp	N/A	3	67	201
I69/1	I69	Incandescent, (1) 69W lamp	N/A	1	69	69
I7.5/1	I7.5	Tungsten exit light, (1) 7.5 W lamp, used in night light application	N/A	1	7.5	8
I7.5/2	I7.5	Tungsten exit light, (2) 7.5 W lamp, used in night light application	N/A	2	7.5	15
I72/1	I72	Incandescent, (1) 72W lamp	N/A	1	72	72
I75/1	I75	Incandescent, (1) 75W lamp	N/A	1	75	75
I75/2	I75	Incandescent, (2) 75W lamp	N/A	2	75	150
I75/3	I75	Incandescent, (3) 75W lamp	N/A	3	75	225
I75/4	I75	Incandescent, (4) 75W lamp	N/A	4	75	300
I750/1	I750	Incandescent, (1) 750W lamp	N/A	1	750	750
I75E/1	I75/ES	Incandescent, (1) 75W ES lamp	N/A	1	67	67
I75EL/1	I75/ES/LL	Incandescent, (1) 75W ES/LL lamp	N/A	1	67	67
I80/1	I80	Incandescent, (1) 80W lamp	N/A	1	80	80
I85/1	I85	Incandescent, (1) 85W lamp	N/A	1	85	85
I90/1	I90	Incandescent, (1) 90W lamp	N/A	1	90	90
I90/2	I90	Incandescent, (2) 90W lamp	N/A	2	90	180
I90/3	I90	Incandescent, (3) 90W lamp	N/A	3	90	270
I93/1	I93	Incandescent, (1) 93W lamp	N/A	1	93	93
I95/1	I95	Incandescent, (1) 95W lamp	N/A	1	95	95
I95/2	I95	Incandescent, (2) 95W lamp	N/A	2	95	190
HALOGEN INCANDESCENT FIXTURES						

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
H100/1	H100	Halogen Incandescent, (1) 100W lamp	N/A	1	100	100
H1000/1	H1000	Halogen Incandescent, (1) 1000W lamp	N/A	1	1000	1000
H1200/1	H1200	Halogen Incandescent, (1) 1200W lamp	N/A	1	1200	1200
H150/1	H150	Halogen Incandescent, (1) 150W lamp	N/A	1	150	150
H150/2	H150	Halogen Incandescent, (2) 150W lamp	N/A	2	150	300
H1500/1	H1500	Halogen Incandescent, (1) 1500W lamp	N/A	1	1500	1500
H200/1	H200	Halogen Incandescent, (1) 200W lamp	N/A	1	200	200
H250/1	H250	Halogen Incandescent, (1) 250W lamp	N/A	1	250	250
H300/1	H300	Halogen Incandescent, (1) 300W lamp	N/A	1	300	300
H35/1	H35	Halogen Incandescent, (1) 35W lamp	N/A	1	35	35
H350/1	H350	Halogen Incandescent, (1) 350W lamp	N/A	1	350	350
H40/1	H40	Halogen Incandescent, (1) 40W lamp	N/A	1	40	40
H400/1	H400	Halogen Incandescent, (1) 400W lamp	N/A	1	400	400
H42/1	H42	Halogen Incandescent, (1) 42W lamp	N/A	1	42	42
H425/1	H425	Halogen Incandescent, (1) 425W lamp	N/A	1	425	425
H45/1	H45	Halogen Incandescent, (1) 45W lamp	N/A	1	45	45
H45/2	H45	Halogen Incandescent, (2) 45W lamp	N/A	2	45	90
H50/1	H50	Halogen Incandescent, (1) 50W lamp	N/A	1	50	50
H50/2	H50	Halogen Incandescent, (2) 50W lamp	N/A	2	50	100
H500/1	H500	Halogen Incandescent, (1) 500W lamp	N/A	1	500	500
H52/1	H52	Halogen Incandescent, (1) 52W lamp	N/A	1	52	52
H55/1	H55	Halogen Incandescent, (1) 55W lamp	N/A	1	55	55
H55/2	H55	Halogen Incandescent, (2) 55W lamp	N/A	2	55	110
H60/1	H60	Halogen Incandescent, (1) 60W lamp	N/A	1	60	60
H72/1	H72	Halogen Incandescent, (1) 72W lamp	N/A	1	72	72
H75/1	H75	Halogen Incandescent, (1) 75W lamp	N/A	1	75	75

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
H75/2	H75	Halogen Incandescent, (2) 75W lamp	N/A	2	75	150
H750/1	H750	Halogen Incandescent, (1) 750W lamp	N/A	1	750	750
H90/1	H90	Halogen Incandescent, (1) 90W lamp	N/A	1	90	90
H90/2	H90	Halogen Incandescent, (2) 90W lamp	N/A	2	90	180
H900/1	H900	Halogen Incandescent, (1) 900W lamp	N/A	1	900	900
HLV20/1	H20/LV	Halogen Low Voltage Incandescent, (1) 20W lamp	N/A	1	20	30
HLV25/1	H25/LV	Halogen Low Voltage Incandescent, (1) 25W lamp	N/A	1	25	35
HLV35/1	H35/LV	Halogen Low Voltage Incandescent, (1) 35W lamp	N/A	1	35	45
HLV42/1	H42/LV	Halogen Low Voltage Incandescent, (1) 42W lamp	N/A	1	42	52
HLV50/1	H50/LV	Halogen Low Voltage Incandescent, (1) 50W lamp	N/A	1	50	60
HLV65/1	H65/LV	Halogen Low Voltage Incandescent, (1) 65W lamp	N/A	1	65	75
HLV75/1	H75/LV	Halogen Low Voltage Incandescent, (1) 75W lamp	N/A	1	75	85
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
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 Bal-last	LR	1	100	118
MHPS/LR/150/1	MHPS150	Metal Halide Pulse Start, (1) 150W lamp w/ Linear Reactor Bal-last	LR	1	150	170
MHPS/LR/175/1	MHPS175	Metal Halide Pulse Start, (1) 175W lamp w/ Linear Reactor Bal-last	LR	1	175	194
MHPS/LR/200/1	MHPS200	Metal Halide Pulse Start, (1) 200W lamp w/ Linear Reactor Bal-last	LR	1	200	219
MHPS/LR/250/1	MHPS250	Metal Halide Pulse Start, (1) 250W lamp w/ Linear Reactor Bal-last	LR	1	250	275
MHPS/LR/300/1	MHPS300	Metal Halide Pulse Start, (1) 300W lamp w/ Linear Reactor Bal-last	LR	1	300	324
MHPS/LR/320/1	MHPS320	Metal Halide Pulse Start, (1) 320W lamp w/ Linear Reactor Bal-last	LR	1	320	349
MHPS/LR/350/1	MHPS350	Metal Halide Pulse Start, (1) 350W lamp w/ Linear Reactor Bal-last	LR	1	350	380
MHPS/LR/400/1	MHPS400	Metal Halide Pulse Start, (1) 400W lamp w/ Linear Reactor Bal-last	LR	1	400	435
MHPS/LR/450/1	MHPS450	Metal Halide Pulse Start, (1) 450W lamp w/ Linear Reactor Bal-last	LR	1	450	485
MHPS/LR/750/1	MHPS750	Metal Halide Pulse Start, (1) 750W lamp w/ Linear Reactor Bal-last	LR	1	750	805

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fix-ture	Watt / Lamp	Watt / Fix-ture
MHPS/SCWA/100/1	MHPS100	Metal Halide Pulse Start, (1) 100W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	100	128
MHPS/SCWA/1000/1	MHPS1000	Metal Halide Pulse Start, (1) 1000W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	1000	1080
MHPS/SCWA/150/1	MHPS150	Metal Halide Pulse Start, (1) 150W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	150	190
MHPS/SCWA/175/1	MHPS175	Metal Halide Pulse Start, (1) 175W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	175	208
MHPS/SCWA/200/1	MHPS200	Metal Halide Pulse Start, (1) 200W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	200	232
MHPS/SCWA/250/1	MHPS250	Metal Halide Pulse Start, (1) 250W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	250	288
MHPS/SCWA/300/1	MHPS300	Metal Halide Pulse Start, (1) 300W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	300	342
MHPS/SCWA/320/1	MHPS320	Metal Halide Pulse Start, (1) 320W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	320	368
MHPS/SCWA/350/1	MHPS350	Metal Halide Pulse Start, (1) 350W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	350	400
MHPS/SCWA/400/1	MHPS400	Metal Halide Pulse Start, (1) 400W lamp w/ Super Constant Wattage Autotrans-former Ballast	SCWA	1	400	450

Fixture Code	Lamp Code	Description	Ballast	Lamp/Fixture	Watt / Lamp	Watt / Fixture
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
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

TYPICAL BASELINE WATTAGES FOR LINEAR LAMPS & FIXTURES AND HID INTERIOR AND EXTERIOR FIXTURES

Efficient Lamp or Fixture	Minimum Lumen	Maximum Lumen	$Watts_{baseline}$	Note	Source
Linear Lamp, 2 ft			16.5	Baseline is standard T8 lamp adjusted for fixture and ballast	References: 1, 2 4 ft 2 lamp T8 fixture: 59 watt/2 = 29.5 watt / lamp
Linear Lamp, < 3,200 lumen, 4 ft			29.5	Baseline is standard T8 lamp adjusted for fixture and ballast	
Linear Lamp, ≥ 3,200 lumen, 4 ft			54	Baseline is T5 HO	
Linear Lamp, 5 ft			40	Baseline is standard T8	
Linear Lamp, 6 ft			65	Baseline is standard T8	
Linear Lamp, 8 ft		4,000	59	Baseline is standard T8	
Linear Lamp, 8 ft HO	4,001		86	Baseline is HO T8	
Linear LED Fixture, 2 ft	1,500	3,500	33	Baseline is standard 2L T8	References: 3, 4, 5 Linear LED Fixture: Max Lumen = Number lamps x Lumen Output x Fixture Efficiency x Ballast Factor; where 4' T8 mean lumen = 3,199, fixture efficiency = 74%, ballast factor = 0.90
Linear LED Fixture, 2 ft	3,501	5,500	61	Baseline is standard 4L T8	
Linear LED Fixture, 4 ft		2,132	31	Baseline is standard 1L T8	
Linear LED Fixture, 4 ft	2,132	4,261	59	Baseline is standard 2L T8	
Linear LED Fixture, 4 ft	4,262	6,392	89	Baseline is standard 3L T8	
Linear LED Fixture, 4 ft	6,393	9,400	112	Baseline is standard 4L T8	
Linear LED Fixture, 8 ft		3,290	58	Baseline is standard 1L T8	
Linear LED Fixture, 8 ft	3,291	6,580	109	Baseline is standard 2L T8	
Linear LED Fixture, 8 ft	6,581	9,870	167	Baseline is standard 3L T8	
Linear LED Fixture, 8 ft	9,871		219	Baseline is standard 4L T8	

Efficient Lamp or Fixture	Minimum Lumen	Maximum Lumen	Watts-baseline	Note	Source
Highbay & Lowbay LED Fixture	3,850	6,550	135	Average 150 watt HID lamp/ T8 HLO	References: 4, 6, 7 LED Lumen Equivalent = HID Initial Lamp Lumen x HID LLD at 40% rated life x HID Fixture Efficiency HID LLD = 75.8%, HID Fixture Efficiency = 80.4%; survey of manufacturer data, MH, PSMH
	6,551	9,300	168	Average 175 watt HID lamp/ T8 HLO	
	9,301	11,150	198	Average 200 watt HID lamp/ T8 HLO	
	11,151	12,200	236	Average 250 watt HID lamp/ T8 HLO	
	12,201	15,550	289	Average 320 watt HID lamp/ T8 HLO	
	15,551	20,100	367	Average 400 watt HID lamp/ T8 HLO	
	20,101	34,700	634	Average 750 watt HID lamp/ T8 HLO	
	34,701	57,250	901	Average 1,000 watt HID lamp/ T8 HLO	
Exterior Fixture (Pole, Wall Pack or Parking Garage)	250	4,650	133	100 watt HID lamp	References: 4, 6, 7, 8 LED Lumen Equivalent = HID Initial Lamp Lumen x HID LLD at 40% rated life x HID Fixture Efficiency x DLC adjustment DLC Adjust = 80/70 lumen/watt where 80 is DLC minimum for indoor highbay, 70 for outdoor, HID LLD = 75.8%, HID Fixture Efficiency = 81.5%; survey of manufacturer data, MH, PSMH, HPS
	4,651	7,900	215	175 watt HID lamp	
	7,901	11,050	295	250 watt HID lamp	
	11,051	24,700	462	400 watt HID lamp	
	24,701	40,750	843	750 watt HID lamp	
	40,751	54,650	1,090	1,000 watt HID lamp	

References

1. Pennsylvania Public Utility Commission. 2021 TRM Appendix C: Lighting Audit & Design Tool for Commercial and Industrial Projects.
   Available from: https://www.puc.pa.gov/pcdocs/1630953.xlsx
2. The Pennsylvania Statewide Act 129 2018 SWE Commercial and Industrial Baseline study, Table 16. On average, 13% of statewide connected load is controlled by advanced controls (occupancy sensors, photocells, EMS, etc.), resulting in a weighted average 3.47% baseline controls factor

Available from: https://www.puc.pa.gov/Electric/pdf/Act129/Act129-SWE_AR_Y8_022818.pdf

3. ECFR. Code of Federal Regulations, Title 10. General service lamps. Beginning July 25, 2022, the sale of any general service lamp that does not meet a minimum efficacy standard of 45 lumens per watt is prohibited.

   Available from: https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430.
4. Design Lights Consortium, Qualified Products List

   Available from: www.designlights.org
5. US Department of Energy, CALiPER Benchmark Report. Performance of T12 and T8 Fluorescent Lamps and Troffers and LED Linear Replacement Lamps. Page 5. January 2009

   Available from: https://www.osti.gov/servlets/purl/1218286
6. US Department of Energy, Lumen Maintenance and Light Loss Factors, September 2013

   Available from: www.pnnl.gov/main/publications/external/technical_reports/PNNL-22727.pdf
7. Lithonia, 2016

   Available from: http://www.lithonia.com/psg/.
8. DOE LED Lighting Facts

   Available from: https://www.energy.gov/eere/ssl/led-lighting-facts

Record of Revision

Record of Revision Number	Issue Date
0	10/15/2010
7-13-23	7/31/2013
12-24-10	2/7/2025

Return to Table of Contents

APPENDIX P

EFFECTIVE USEFUL LIFE (EUL)

SINGLE AND MULTI-FAMILY RESIDENTIAL MEASURES

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Appliance	Air Purifier	Residential	9	ENERGY STAR® Calc[98]
	Clothes Dryer (incl. Heat Pump Clothes Dryer)	Residential	14	ENERGY STAR® M&I Scoping Report[99]
	Clothes Washer	Residential	14	Department of Energy EERE 2014[100]
	Dehumidifier	Residential	12	ENERGY STAR® Calc[101]
	Dishwasher	Residential	12	DOE EERE 2014[102]
	Fireplace	Residential	15	Department of Energy EERE 2014 BT[103]
	Induction Cooktop	Residential	17.9	DOE 2016[104]
	Refrigerator and Freezer	Residential	19	Department of Energy EERE 2014[105]
	Soundbar	Residential	7	RPP Product Analysis[106]
Appliance Control	Advanced Power Strip (APS)	Residential	10	New York State Energy Research and Development Authority[107]

[98] Savings Calculator for ENERGY STAR® Qualified Appliances (last updated October 2016). https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/purchase-energy-saving-products
[99] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.
[100] Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Hearth Products. Department of Energy (DOE). January 30, 2015, pg. 9A-3. https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0002
[101] ENERGY STAR® Dehumidifier Calculator. https://www.energystar.gov/ia/partners/promotions/cool_change/downloads/CalculatorConsumerDehumidifier.xls
[102] Ibid, pg. 2-12.
[103] Ibid, pg. 2-12. https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0002
[104] U.S. Department of Energy (DOE) Energy Conservation Program. Accessed by https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.caetrm.com%2Fmedia%2Freference-documents%2FCooking_Pds_LCC_SNOPR_DOE_2016_publication.xlsm&wdOrigin=BROWSELINK
[105] Ibid, pg. 2-12.
[106] Retail Products Platform Product Analysis, Last Updated May 25, 2016. https://www.energystar.gov/sites/default/files/asset/document/ESPPM_Increasing%20the%20Volume%20on%20Sound%20Bars_Littlehales.pdf
[107] New York State Energy Research and Development Authority (NYSERDA), Advanced Power Strip Research Report, p. 30. August 2011.

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Appliance Recycling	Air Conditioner - Room (RAC) Recycling	Residential	3.5	Department of Energy EERE 2007[108]
	Dehumidifier Recycling	Residential	4	CPUC DEER[109]
	Refrigerator Recycling	Residential	5	CPUC DEER[110]
	Freezer Recycling	Residential	4	DEER 2014 EUL ID: Appl-RecFrzr
Building Shell	Air Conditioner – Room (RAC) Cover and Gap Sealer	Residential	3	See note below[111]
	Air Leakage Sealing	Residential	15	GDS[112]
	Attic Access Insulation & Sealing	Residential	15	GDS[113]
	Cellular Window Shade	Residential	13.7	Xcel Energy DSM & BE Plan[114]
	Door and Window Seal Caulking	Residential	15	GDS[115]
	Insulation – Hot Water and Steam Pipe	Residential	Electric: 13 Gas: 11	DEER 2014 EUL ID: WtrHt-WH-R4PipeIns-Elec & WtrHt-WH-R4PipeIns-Gas
	Insulation – Opaque Shell	Residential	30	CPUC[116]
	Plastic Window Insulation	Residential	1	See Note[117]
	Storm Window	Residential	20	DOE[118]
	Window	Residential	20	DEER 2014 EUL ID: BS-Win
	Window - Film	Residential	10	DEER 2014 EUL ID: Glaz-Daylt-WinFilm
	Heat Pump Water Heater – Air Source (HPWH)	Residential	20	CPUC[119]

108 One third of assumed measure life for Room AC, which was assumed to be 10.5 years, according to the Department of Energy, Office of Energy Efficiency and Renewable Energy; "Energy Conservation Program, Energy Conservation Standards for Residential Clothes Dryers and Room Air Conditioners", 10 CFR Part 430 (Docket: EERE-2007-BT-STD-0010, pg. 22514).
109 California Public Utilities Commission Database for Energy Efficient Resources (DEER) EUL Support Table for 2020, http://www.deeresources.com/files/DEER2020/download/SupportTable-EUL2020.xlsx
110 Ibid.
111 Average/typical manufacturer warranty period for AC covers.
112 GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures.
113 Ibid.
114 2024 – 2026 Demand – Site Management & Beneficial Electrification Plan. https://www.xcelenergy.com/company/rates_and_regulations/filings/colorado_demand-side_management
115 Pacific Northwest National Laboratory. Advanced Energy Retrofit Guide: Office Buildings. September 2011. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20761.pdf
116 https://pda.energydataweb.com/api/view/3893/CPUC%20Group%20A%202023%20Residential%20Insulation%20EUL%20Study%20DRAFT_PDA.pdf
117 1 year is assumed to be the EUL since plastic window insulation comes in the form of single-use kits that are disposed of when the heating season ends.
118 https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22864rev2.pdf
119 https://www.calmac.org/publications/CPUC_Group_A_2023_Res_HVAC_and_DHW_EUL_Study_Final_Report.pdf.

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Domestic Hot Water (DHW)	Indirect Water Heater	Residential	11	DEER 2014 EUL ID: WtrHt-Res-Gas
	Storage Water Heater - Gas	Residential	25	CPUC[120]
	Storage Water Heater - Electric	Residential	20	CPUC[121]
	Instantaneous Water Heater	Residential	20	CPUC[122]
	Low-Flow – Faucet Aerator	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Aertr
DHW - Control	Low-Flow – Showerhead	Residential	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Thermostatic Shower Valve	Residential	10	UPC[123]
	Air Conditioner – Central (CAC)	Residential	15	DEER 2014 EUL ID: HV-ResAC
Heating, Ventilation and Air Conditioning (HVAC)	Air Conditioner – Room (RAC)	Residential	12	GDS[124]
	Air Conditioner – PTAC	Residential	15	DEER 2014 EUL ID: HVAC-PTAC
	Boiler, Hot Water – Steel Water Tube	Residential	24	ASHRAE Handbook, 2015
	Boiler, Hot Water – Steel Fire Tube	Residential	25	ASHRAE Handbook, 2015
	Boiler, Hot Water – Cast Iron	Residential	35	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Water Tube	Residential	30	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Fire Tube	Residential	25	ASHRAE Handbook, 2015
	Boiler, Steam – Cast Iron	Residential	30	ASHRAE Handbook, 2015
	Boiler and Furnace - Combination (“Combi”) Boiler	Residential	22	DOE[125]
	Boiler and Furnace - Combination (“Combi”) Furnace	Residential	20	DEER 2014[126] EUL ID: HVAC-Frnc

[120] Ibid.
[121] Ibid.
[122] Ibid.
[123] UPC certification under the International Association of Plumbing and Mechanical Officials standard IGC 244-2007a. A standard that includes a lifecycle test consisting of 10,000 cycles without fail. 10,000 cycles is the equivalent of three users showering daily for more than nine years.
[124] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures.
[125] Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces, February 10, 2015, Table 8.2.17. Product definition of furnaces includes electric boilers with firing rates of less than 300,000 BTU/h.
https://energy.mo.gov/sites/energy/files/technical-support-document---residential-furances_doe.pdf
[126] Based on DEER value for high efficiency boiler and instantaneous water heater.

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Duct Sealing and Insulation	Residential	18	DEER 2014 EUL ID: HV-DuctSeal
	Electronically Commutated (EC) Motor – HVAC Blower Fan	Residential	15	DEER 2014 EUL ID: Motors-fan
	Electronically Commutated (EC) Motor – Hydronic Circulator Pump	Residential	15	DEER 2014 EUL ID: Motors-pump
	Energy and Heat Recovery Ventilator	Residential	20	GDS[127]
	Furnace, Gas Fired	Residential	30	CPUC[128]
	Heat Pump - Air Source (ASHP) and Air-to-Water (AWHP)	Residential	15	DEER 2014 EUL ID: HV-Res HP
	Heat Pump – Ground Source (GSHP) or Desuperheater for Ground Source Heat Pump (GSHP)	Residential	25	ASHRAE[129]
	Heat Pump – PTHP	Residential	15	DEER 2014 EUL ID: HVAC-PTHP
	Refrigerant Charge Correction & Tune-Up – Air Conditioner and Heat Pump	Residential	10	DEER 2014 EUL ID: HV-Ref-Chrg
	Tune-Up - Boiler	Residential	5	DEER 2014 EUL ID: BlrTuneup
	Tune-Up - Furnace	Residential	5	DEER 2014 EUL ID: BlrTuneup
	Unit Heater, Gas Fired	Residential	13	ASHRAE Handbook, 2015
	Adaptive Photonic Control	Residential	EUL = Retrofitted motor RUL = Retrofitted motor EUL – (Current Year – Mfr. Year) **Default = 5**	DEER 2014 EUL ID: Motors-fan

[127] Natural Gas Energy Efficiency Potential in Massachusetts, GDS Associates, 2009. https://ma-eeac.org/wp-content/uploads/5_Natural-Gas-EE-Potenial-in-MA.pdf
[128] https://www.calmac.org/publications/CPUC_Group_A_2023_Res_HVAC_and_DHW_EUL_Study_Final_Report.pdf.
[129] ASHRAE: Owning and Operating Cost Database, Equipment Life/Maintenance Cost Survey: https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
HVAC - Control	Advanced Boiler Control	Residential	EUL = Boiler RUL = Boiler EUL – (Current Year – Mfr. Year) **Default = 5**	N/A
	Outdoor Temperature Setback Control for Hydronic Boiler	Residential	EUL = Boiler RUL = Boiler EUL – (Current Year – Mfr. Year) **Default = 5**	N/A
	Steam Trap	Residential	6	DEER 2014 EUL ID: HVAC-StmTrp
	Steam Trap w/ Strainer/Integral Strainer & Blowdown Valve	Residential	7.5	Energy Solutions[130]
	Venturi Steam Trap	Residential	10	GTI[131]
	Submetering	Multifamily	10	NYSERDA[132]
	Thermostat – All Types	Residential	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Thermostatic Radiator Valve – One Pipe Steam Radiator	Multifamily	15	DOE[133]
	Smart Thermostatic Radiator Enclosure	Residential	15	DEER 2014 EUL ID: Motors-fan[134]

130 Energy Solutions, A., Inc. ,. (2022). Steam trap monitoring. https://title24stakeholders.com. https://title24stakeholders.com/wp-content/uploads/2020/10/NR_Steam-Trap-Monitoring_Final-CASE-Report.pdf

131 G. T. I. (GTI) for Nicor Gas, Southern California Gas Company (SoCalGas®), and Peoples Gas and North Shore Gas. (2019). Venturi Steam Trap – Functional Laboratory Study. https://www.nicorgas.com/. https://www.nicorgas.com/content/dam/southern-co-gas/shared/pdf/business/rebates-and-assessments/public-project-reports/GTI_Venturi%20Steam%20Trap%20Laboratory%20Study_Final%20Report(Revised%2003262019)%20v2a_KG_approved%208%201%202019.pdf

132 NYSERDA Residential Electric Submetering Manual.

133 U.S. DOE, "Thermostatic Radiator Valve Evaluation", January 2015, Table 4. pg. 16.

134 Based on assumed EUL of integrated fan, which is expected to be the first component to fail.

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
	LED Lamp	Residential	Rated life listed by manufacturer or default to 15,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known (cap at 20 years)	See note[135]
Lighting[136]	Light Fixture	LED (Interior)	Residential	Rated Life listed by DLC or default to 50,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known (cap at 20 years)

[135] Default 15,000 hours based on ENERGY STAR® Program Requirements Product Specification for Lamps (Light Bulbs) V2.1, June 2017, pg. 19. Although this standard has been sunset as of 12/31/2024, this default is retained based on assumed continuity in program requirement standards relating to quality of incentivized products. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2.1%20Final%20Specification.pdf

[136] In response to codification of a 45 lm/W backstop requirement for general service lamps (GSLs), EULs for select lighting measures are currently under review by the TRM Management Committee. Revisions will take effect concurrent with other action taken in response to the imposed GSL standard. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=4

Category	Single and Multi-family Residential Measures		Sector	EUL (years)	Source
Lighting[137]	Light Fixture	LED (Interior)	Residential	Rated Life listed by manufacturer or default to 25,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known (cap at 20 years)	DLC[138]
	Light Fixture	LED (Exterior)	Residential	Rated life listed by manufacturer or default to 35,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known (cap at 20 years)	See note[139]

137 In response to codification of a 45 lm/W backstop requirement for general service lamps (GSLs), EULs for select lighting measures are currently under review by the TRM Management Committee. Revisions will take effect concurrent with other action taken in response to the imposed GSL standard. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=4

138 Placed on the Qualified Products List by the Design Light Consortium (DLC) 50,000 hours, according to the appropriate Application Category as specified in the DLC's Product Qualification Criteria, Technical Requirement Table version 4.4 or higher.

139 Default 25,000 hours based on ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.2, August 2019, pg. 18. Although this standard has been sunset as of 12/31/2024, this default is retained based on assumed continuity in program requirement standards relating to quality of incentivized products. https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf

Category	Single and Multi-family Residential Measures		Sector	EUL (years)	Source
Lighting[140]	Light Fixture	LED (Inseparable)	Residential	Rated life listed by manufacturer or default to 50,000 hrs/ annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hours are not known (cap at 20 years)	See note[141]
	Bi-Level Lighting	Multifamily Common Area	15	ComEd[142]	See note[143]

140 In response to codification of a 45 lm/W backstop requirement for general service lamps (GSLs), EULs for select lighting measures are currently under review by the TRM Management Committee. Revisions will take effect concurrent with other action taken in response to the imposed GSL standard. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=4

141 Default 35,000 hours based on ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.2, August 2019, pg. 18. Although this standard has been sunset as of 12/31/2024, this default is retained based on assumed continuity in program requirement standards relating to quality of incentivized products. https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf

142 ComEd Luminaire Level Lighting Control IPA Program Impact Evaluation Report prepared by Navigant. https://www.ilsag.info/wp-content/uploads/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY9_Evaluation_Reports_Final/ComEd_PY9_LLLC_IPA_Program_Impact_Evaluation_Report_2018-06-05_Final.pdf

143 Default 50,000 hours based on ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.2, August 2019, pg. 18. Although this standard has been sunset as of 12/31/2024, this default is retained based on assumed continuity in program requirement standards relating to quality of incentivized products. https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf

Category	Single and Multi-family Residential Measures	Sector	EUL (years)	Source
Lighting Control	Connected Lighting	Residential	3	GE and Philips Hue Bridge[144]
	Pool Pump	Residential	10	DEER 2014 EUL ID: OutD-PoolPump
Motors and Drives	Pool Circulator Timer	Residential	10	DEER 2014 EUL ID: OutD-PoolPump
	Heat Pump Pool Heater	Residential	15	DEER 2014 EUL ID: HV-Res HP
Other	Pool Heater	Residential	8	DOE[145]
	Shade Tree	Residential	40	i-Tree Planting Tool[146]
	Solar Pool Heater	Residential	15	DOE[147]

144 Cync by General Electric Limited Warranty for Smart Bulbs and Light Strips. https://www.gelighting.com/smart-home/warranty and Philips End of Support Policy: End of Support Policy | Philips Hue (philips-hue.com)
145 DOE, Chapter 8, Life-Cycle Cost and Payback Period Analyses, Table 8.75. https://www.regulations.gov/document?D=EERE-2006-STD-0129-0170
146 Software prescribes a default lifetime of 40 years
147 https://www.energy.gov/energysaver/solar-swimming-pool-heaters

Commercial and Industrial Measures

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Agricultural Equipment	High Speed Fans	C&I	10	PG&E[148]
	Livestock Waterer	C&I	10	PA Consulting Group[149]
	Milk Pre-Cooler Heat Ex-changer	C&I	15	Ibid
	Refrigeration Heat Recovery	C&I	14	DEER 2014 EUL ID: HVAC-ChlrComp-Ag
	Scroll Compressor	C&I	12	DEER 2014 EUL ID: RefgWrhs-Scroll-Comp
Agricultural Equipment - Control	Engine Block Heater Timer	C&I	8	See note below[150]
	Variable Speed Drive Milk Pump Plate Cooler	C&I	15	PA Consulting Group[151]
	Variable Speed Drive Vacuum Pump	C&I	15	PA Consulting Group[152]
Appliance	Air Purifier	C&I	9	ENERGY STAR® Calc[153]
	Clothes Dryer	C&I	14	ENERGY STAR®M&I Report[154]
	Clothes Washer	C&I	11	DEER 2014 EUL ID: Appl-EffCW
	Cooking Equipment[155]	C&I	12	DEER 2014 EUL IDs: Various
	Dehumidifier	C&I	12	ENERGY STAR® Calc[156]
	Dishwasher	C&I	10 – Under Counter 15 – Single Door 20 – Conveyor Type 10 – Pots, Pans & Utensils	ENERGY STAR®Calc[157]

[148] PG&E Work Paper PGE3PAGR117, October 12, 2017.
[149] PA Consulting Group Inc., Focus on Energy Evaluation Business Programs: Measure Life Study, final report dated August 25, 2009. https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf
[150] Based on EUL's for Advanced Power Strips.
[151] PA Consulting Group Inc., Focus on Energy Evaluation Business Programs: Measure Life Study, final report dated August 25, 2009. https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf
[152] PA Consulting Group Inc., Focus on Energy Evaluation Business Programs: Measure Life Study, final report dated August 25, 2009. https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf
[153] Savings Calculator for ENERGY STAR® Qualified Appliances (last updated October 2016). https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/save-energy/purchase-energy-saving-products
[154] ENERGY STAR® Market & Industry Scoping Report: Residential Clothes Dryer, November 2011.
[155] Applicable to all kitchen cooking equipment not otherwise listed.
[156] ENERGY STAR® Dehumidifier Calculator. https://www.energystar.gov/ia/partners/promotions/cool_change/downloads/CalculatorConsumerDehumidifier.xls
[157] ENERGY STAR® Savings Calculator for ENERGY STAR® Certified Commercial Kitchen Equipment. www.energystar.gov/buildings/sites/default/uploads/files/commercial_kitchen_equipment_calculator.xlsx?5da4-3d90&5da4-3d90

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Appliance	Fireplace	C&I	15	DOE[158]
	Ice Maker	C&I	10	DEER 2014 EUL ID: Cook-IceMach
	Induction Cooktop	C&I	16	DEER 2014 EUL ID: Appl-Elec_Cook-ing
	Refrigerator and Freezer	C&I	12	DEER 2014 EUL ID: Cook-SDRef
Appliance - Control	Advanced Power Strip (APS)	C&I	8	DEER 2014 EUL ID: Plug-OccSens
	Vending Machine and Novelty Cooler Control	C&I	5	DEER 2014 EUL ID: Plug-VendCtrler
Appliance Re-cycling	Air Conditioner – Room (RAC)	C&I	3	DEER 2014 EUL ID: HV-RAC-RUL
Building Shell	Air Curtains	C&I	15	DEER 2014 EUL ID: Motors-fan
	Air Leakage Sealing	C&I	15	GDS[159]
	Insulation - Hot Water and Steam Pipe	C&I	Electric: 13 Gas: 11	DEER 2014 EUL ID: WtrHt-PipeIns-Elec & WtrHt-PipeIns-Gas
	Insulation - Opaque Shell	C&I	35	Cadmus 2024[160]
	Window - Film	C&I	10	DEER 2014 EUL ID: GlazDaylt-Win-Film
	Window - Glazing	C&I	20	DEER 2014 EUL ID: BS-Win
Compressed Air	Air Compressor	C&I	13	Other State TRMs[161]
	Engineered Air Nozzle	C&I	15	Wisconsin PSC[162]
	No Air Loss Water Drain	C&I	13	MA Measure Life Study[163]
	Refrigerated Air Dryer	C&I	13	Other State TRMs [164]
	Compressed Air Heat Recovery	C&I	13	Other State TRMs [165]
	Flow Controller	C&I	13	Other State TRMs [166]

[158] Technical Support Document: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Hearth Products. Chapters 7 and 8. Department of Energy (DOE). January 30, 2015, pg. 2-12. https://www.regulations.gov/document?D=EERE-2014-BT-STD-0036-0002
[159] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007, Table 1 – Residential Measures.
[160] https://www.michigan.gov/mpsc/-/media/Project/Websites/mpsc/workgroups/EWR_Collaborative/2024/Insulation-EUL-Review-2024-07-16.pdf?rev=1fd5c43e242841dabd1f4121c3facf60&hash=19568BB5F1EB5468298361C822B80E5F
[161] Based on a review of TRM assumptions from Ohio (August 2010), Massachusetts (October 2015), Illinois (February 2017) and Vermont (December 2018). Estimates range from 10 to 15 years. Cited TRMs are reviewed annually for updates and potential to replace TRM citations with primary reference material.
[162] PA Consulting Group (2009). *Business Programs: Measure Life Study*.
[163] Measure Life Study prepared for The Massachusetts Joint Utilities, Energy & Resource Solutions, 2005. http://www.ers-inc.com/wp-content/uploads/2018/04/Measure-Life-Study_MA-Joint-Utilities_ERS.pdf
[164] Based on a review of TRM assumptions from Ohio (August 2010), Massachusetts (October 2015), Illinois (February 2017) and Vermont (December 2018). Estimates range from 10 to 15 years. Cited TRMs are reviewed annually for updates and potential to replace TRM citations with primary reference material.
[165] Ibid.
[166] Ibid.

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
	Low Pressure Drop Filter	C&I	10	Navigant EUL Report [167]
Domestic Hot Water (DHW)	Heat Pump Water Heater – Air Source (HPWH	C&I	13	CPUC[168]
	Indirect Water Heater	C&I	15	DEER 2014 EUL ID: WtrHt-Com
	Instantaneous Water Heater	C&I	20	CPUC[169]
	Storage Tank Water Heater	C&I	13	CPUC[170]
DHW - Control	DHW Temperature Turndown	C&I	RUL of DHW System **Default = 5**	N/A
	Drain Water Heat Recovery (DWHR)	C&I	30	2019 Title 24[171]
	Low-Flow – Faucet Aerator	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Aertr
	Low-Flow – Pre-Rinse Spray Valve (PRSV)	C&I	5	GDS
	Low-Flow – Salon Valve	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Low-Flow – Showerhead	C&I	10	DEER 2014 EUL ID: WtrHt-WH-Shrhd
	Central DHW Control	C&I	15	NREL[172]
Heating, Ventilation and Air Conditioning (HVAC)	Air Conditioner – PTAC	C&I	15	DEER 2014 EUL ID: HVAC-PTAC
	Air Conditioner – Unitary	C&I	20	CPUC[173]
	Boiler and Furnace - Combination (“Combi”) Boiler	C&I	22	DOE[174]
	Boiler and Furnace -Combination (“Combi”) Furnace	C&I	20	DEER 2014[175] EUL ID: HVAC-Frnc
	Boiler, Hot Water – Steel Water Tube	C&I	24	ASHRAE Handbook, 2015
	Boiler, Hot Water – Steel Fire Tube	C&I	25	ASHRAE Handbook, 2015

[167] Navigant ComEd Effective Useful Life Research Report. https://www.icc.illinois.gov/docket/P2017-0312/documents/287811/files/501915.pdf
[168] https://pda.energydataweb.com/api/view/3965/CPUC%20Group%20A%202023%20Commercial%20HVAC%20and%20Water%20Heating%20EUL%20Study%20Draft%20Report.pdf
[169] https://pda.energydataweb.com/api/view/3965/CPUC%20Group%20A%202023%20Commercial%20HVAC%20and%20Water%20Heating%20EUL%20Study%20Draft%20Report.pdf
[170] https://pda.energydataweb.com/api/view/3965/CPUC%20Group%20A%202023%20Commercial%20HVAC%20and%20Water%20Heating%20EUL%20Study%20Draft%20Report.pdf
[171] 2019 Title 24, Part 6 CASE Report. “Drain Water Heat Recovery – Final Report.” http://title24stakeholders.com/wp-content/uploads/2017/09/2019-T24-CASE-Report_DWHR_Final_September-2017.pdf
[172] https://www.nrel.gov/docs/fy16osti/64541.pdf
[173] https://pda.energydataweb.com/api/view/3965/CPUC%20Group%20A%202023%20Commercial%20HVAC%20and%20Water%20Heating%20EUL%20Study%20Draft%20Report.pdf
[174] Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces, February 10, 2015, Table 8.2.17. https://energy.mo.gov/sites/energy/files/technical-support-document---residential-furances_doe.pdf
[175] Based on DEER value for high efficiency boiler and instantaneous water heater.

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Boiler, Hot Water – Cast Iron	C&I	35	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Water Tube	C&I	30	ASHRAE Handbook, 2015
	Boiler, Steam – Steel Fire Tube	C&I	25	ASHRAE Handbook, 2015
	Boiler, Steam – Cast Iron	C&I	30	ASHRAE Handbook, 2015
	Chiller – Air & Water Cooled	C&I	20	DEER 2014 EUL ID: HVAC-Chlr
	Chiller – Cooling Tower	C&I	15	DEER 2014 EUL ID: HVAC- ClT-wrPkgSys
	Condensing Unit Heater	C&I	18	Ecotope[176]
	Duct Sealing and Insulation	C&I	18	DEER 2014 EUL ID: HVAC-DuctSeal
	Economizer –Dual Enthalpy Air Side	C&I	10	DEER 2014 EUL ID: HVAC-addEcono
	Electronically Commutated (EC) Motor - HVAC Blower Fan	C&I	15	DEER 2014 EUL ID: Motors-Fan
	Electronically Commutated (EC) Motor – Hydronic Circulator Pump	C&I	15	DEER 2014 EUL ID: Motors-pump
	Energy and Heat Recovery Ventilator	C&I	14	PA Consulting Group[177]
	Furnace, Gas Fired	C&I	23	DOE[178,179]
	Heat Pump – Unitary & Applied	C&I	20	CPUC[180]
	Heat Pump – PTHP	C&I	15	DEER 2014 EUL ID: HVAC-PTHP
	Heat Pump – Ground Source (GSHP) or Desuperheater for Ground Source Heat Pump (GSHP)	C&I	25	ASHRAE[181]
	High Volume Low Speed Fan	C&I	15	PA Consulting Group[182]

[176] Ecotope Natural Gas Efficiency and Conservation Measure Resource Assessment (2003).
[177] PA Consulting Group Inc., Focus on Energy Evaluation Business Programs: Measure Life Study, final report dated August 25, 2009. https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf
[178] U.S. DOE. "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces" and "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Warm Air Furnaces." August 30, 2016. https://www.regulations.gov/document?D=EERE-2014-BT-STD-0031-0217
[179] U.S. DOE. "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Warm Air Furnaces." December 30, 2015. https://www.regulations.gov/document?D=EERE-2013-BT-STD-0021-0050
[180] https://pda.energydataweb.com/api/view/3965/CPUC%20Group%20A%202023%20Commercial%20HVAC%20and%20Water%20Heating%20EUL%20Study%20Draft%20Report.pdf
[181] ASHRAE Owning and Operating Cost Database. https://xp20.ashrae.org/publicdatabase/system_service_life.asp?selected_system_type=1
[182] PA Consulting Group Inc., Focus on Energy Evaluation Business Programs: Measure Life Study, final report dated August 25, 2009. https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Heating, Ventilation and Air Conditioning (HVAC)	Infrared Heater	C&I	17	GDS[183]
	Refrigerant Charge Correction & Tune Up – Air Conditioner and Heat Pump	C&I	10	DEER 2014 EUL ID: HVAC-RefChg
	Tune-Up – Boiler	C&I	5	DEER 2014 EUL ID: BlrTuneup
	Tune-Up – Chiller System	C&I	5	WI EUL DB[184]
	Tune-Up – Furnace	C&I	5	DEER 2014 EUL ID: BlrTuneup
	Variable Refrigerant Flow (VRF) System	C&I	15	DEER 2014 EUL ID: HVAC-VSD-pump
	Unit Heater, Gas Fired	C&I	13	ASHRAE Handbook, 2015
HVAC – Control	Adaptive Photonic Control	C&I	EUL = Retrofitted motor RUL = Retrofitted motor EUL – (Current Year – Mfr. Year) **Default = 5**	DEER 2014 EUL ID: Motors-fan
	Advanced Rooftop Control	C&I	16	NYSERDA[185]
	Direct Digital Control (DDC) System	C&I	15	DEER 2014 EUL ID: HVAC-EMS
	Demand Control Ventilation (DCV)	C&I	15	DEER 2014 EUL ID: HVAC-VSD-DCV
	Energy Management System	C&I	15	DEER 2014 EUL ID: HVAC-EMS
	Energy Management System – Guest Room	C&I	15	DEER 2014 EUL ID: HVAC-EMS
	Boiler Economizer	C&I	EUL = Boiler RUL = Boiler EUL – (Current Year – Mfr. Year) **Default = 5**	GDS[186]
	Kitchen Demand Ventilation Control	C&I	15	PG&E[187]
	Outdoor Temperature Setback Control for Hydronic Boiler	C&I	EUL = Boiler RUL = Boiler EUL – (Current Year – Mfr. Year) **Default = 5**	N/A

[183] GDS Associates, Inc. "Natural Gas Efficiency Potential Study." DTE Energy. July 29, 2016. https://www.michigan.gov/documents/mpsc/DTE_2016_NG_ee_potential_study_w_appendices_vFINAL_554360_7.pdf

[184] Wisconsin Public Service Commission: Equipment Useful Life Database, 2013. https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf

[185] NYSERDA Methodology Appendix: Assessment of Energy Efficiency and Electrification Potential in New York State Residential and Commercial Buildings study (revised April 2023), Table 3-11: HVAC Controls https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/building-stock-potential-studies/AppendixAMethodologyNYSEEandElectrificationPotentialStudyApril2023-acc.pdf

[186] Natural Gas Energy Efficiency Potential in Massachusetts, GDS Associates, 2009. https://ma-eeac.org/wp-content/uploads/5_Natural-Gas-EE-Potenial-in-MA.pdf

[187] PG&E Work Paper WPSDGENRCC0019, June 15, 2012.

Category	Commercial & Industrial Measures		Sector	EUL (years)	Source
HVAC – Control	Steam Trap – Low-Pressure Space Heating		C&I	6	DEER 2014 EUL ID: HVAC-StmTrp
	Steam Trap w/ Strainer/Integral Strainer & Blowdown Valve		C&I	7.5	Energy Solutions[188]
	Venturi Steam Trap		C&I	10	GTI[189]
	Steam Trap Monitoring System – Low-Pressure Space Heating		C&I	15	DEER 2014 EUL ID: HVAC-EMS
	Thermostat – Programmable Thermostat – Wi-Fi (Communicating)		C&I	11	DEER 2014 EUL ID: HVAC-ProgTStats
	Thermostatic Radiator Valve		C&I	15	DOE[190]
Lighting[191]	Light Fixture	LED Fixture (DLC)	C&I	50,000 hrs /annual lighting operating hrs or 15 yrs if annual operating hrs are not known (cap at 20 years)	DLC[192]
		LED Fixture (Interior)	C&I	Rated life listed by manufacturer or default to 25,000 hrs/annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hrs are not known (cap at 20 years)	See note[193]

[188] Energy Solutions, A., Inc. ,. (2022). Steam trap monitoring. https://title24stakeholders.com. https://title24stakeholders.com/wp-content/uploads/2020/10/NR_Steam-Trap-Monitoring_Final-CASE-Report.pdf

[189] G. T. I. (GTI) for Nicor Gas, Southern California Gas Company (SoCalGas®), and Peoples Gas and North Shore Gas. (2019). Venturi Steam Trap – Functional Laboratory Study. https://www.nicorgas.com/. https://www.nicorgas.com/content/dam/southern-co-gas/shared/pdf/business/rebates-and-assessments/public-project-reports/GTI_Venturi%20Steam%20Trap%20Laboratory%20Study_Final%20Report(Revised%2003262019)%20v2a_KG_approved%208%201%202019.pdf

[190] U.S. DOE. "Thermostatic Radiator Valve Evaluation." January 2015. https://www.nrel.gov/docs/fy15osti/63388.pdf

[191] In response to codification of a 45 lm/W backstop requirement for general service lamps (GSLs), EULs for select lighting measures are currently under review by the TRM Management Committee. Revisions will take effect concurrent with other action taken in response to the imposed GSL standard. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=4

[192] 50,000 hours per L_{70} requirements prescribed by the DLC's Product Qualification Criteria, Technical Requirement Table version 4.4.

[193] Default 25,000 hours based on ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.2, August 2019, pg. 18. Although this standard has been sunset as of 12/31/2024, this default is retained based on assumed continuity in program requirement standards relating to quality of incentivized products. https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf

Category	Commercial & Industrial Measures		Sector	EUL (years)	Source
Lighting[194]	Light Fixture	LED Fixture (Exterior)	C&I	Rated life listed by manufacturer or default to 35,000 hrs/annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hrs are not known (cap at 20 years)	See note[195]
		LED Fixture (Inseparable)	C&I	Rated life listed by manufacturer or default to 50,000/annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hrs are not known (cap at 20 years)	See note[196]
	LED Lamp		C&I	50,000 hrs /annual lighting operating hrs or 15 yrs if annual operating hrs are not known (cap at 20 years)	DLC[197]
				Rated life listed by manufacturer or default to 15,000 hrs /annual lighting operating hrs or 15 yrs if rated lifetime or annual operating hrs are not known (cap at 20 years)	See note[198]

[194] In response to codification of a 45 lm/W backstop requirement for general service lamps (GSLs), EULs for select lighting measures are currently under review by the TRM Management Committee. Revisions will take effect concurrent with other action taken in response to the imposed GSL standard. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=4

[195] Default 35,000 hours based on ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.2, August 2019, pg. 18. Although this standard has been sunset as of 12/31/2024, this default is retained based on assumed continuity in program requirement standards relating to quality of incentivized products. https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf

[196] Default 50,000 hours based on ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures) V2.2, August 2019, pg. 18. Although this standard has been sunset as of 12/31/2024, this default is retained based on assumed continuity in program requirement standards relating to quality of incentivized products. https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf

[197] DesignLights Consortium (DLC): Technical Requirement Table version 4.4 or higher.

[198] Default 15,000 hours based on ENERGY STAR® Program Requirements Product Specification for Lamps (Light Bulbs) V2.1, June 2017, pg. 19. Although this standard has been sunset as of 12/31/2024, this default is retained based on assumed continuity in program requirement standards relating to quality of incentivized products. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2.1%20Final%20Specification.pdf

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
Lighting[199]	LED Exit Signs & Open Signs	C&I	16	DEER 2014 EUL ID: LED-sign
	Refrigerated Case LED	C&I	16	DEER 2014 EUL ID: GrocDisp-FixtLtg-LED
	Lighting Power Density (LPD)	C&I	15	GDS[200]
Lighting - Control	Bi-Level Lighting	C&I	15	ComEd[201]
	Integrated Interior Control	C&I	15	ComEd[202]
	Non-Integrated Interior Control	C&I	10	GDS[203]
	Plug-Load Occupancy Sensor	C&I	8	DEER[204]
Motors and Drives	Motor (incl. PEI Pumps)	C&I	15	DEER 2014 EUL ID: Motors-HiEff
	Notched & Synchronous Belt	C&I	5	DEER 2014 EUL ID: HV-CoggedBelt
	Pool Pump	C&I	10	DEER 2014 EUL ID: OutD-PoolPump
	Variable Frequency Drive (VFD) – Fan and Pump	C&I	RUL of the controlled equipment (if known) **Default EUL** = 15	DEER 2014 EUL ID: HVAC-VSDSup-Fan
	Elevator Modernization	C&I	15	DEER 2014[205]
Other	Heat Pump Pool Heater	C&I	15	DEER 2014 EUL ID: HV-Res HP
	High Efficiency Transformer	C&I	32	DOE[206]
	High Frequency Battery Charger	C&I	15	PG&E[207]
	High Viscosity Industrial Lubricant	C&I	10	ExxonMobil[208]

[199] In response to codification of a 45 lm/W backstop requirement for general service lamps (GSLs), EULs for select lighting measures are currently under review by the TRM Management Committee. Revisions will take effect concurrent with other action taken in response to the imposed GSL standard. https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=4

[200] Measure Life Report, Residential and Commercial/Industrial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. As directed in the Interior and Exterior Lighting measure, new construction projects may be evaluated based on LPD. This value is provided for use with new construction LPD projects only. https://energy.mo.gov/sites/energy/files/measure-life-report-2007.pdf

[201] ComEd Luminaire Level Lighting Control IPA Program Impact Evaluation Report prepared by Navigant. https://www.ilsag.info/wp-content/uploads/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY9_Evaluation_Reports_Final/ComEd_PY9_LLLC_IPA_Program_Impact_Evaluation_Report_2018-06-05_Final.pdf

[202] Ibid.

[203] Measure Life Report, Residential and Commercial/Industrial/Industrial Lighting and HVAC Measures, GDS Associates, June 2007. https://energy.mo.gov/sites/energy/files/measure-life-report-2007.pdf

[204] DEER value for lighting occupancy sensors.

[205] Assumes same EUL as VFD measure.

[206] https://www.federalregister.gov/documents/2019/06/18/2019-12761/energy-conservation-program-energy-conservation-standards-for-distribution-transformers

[207] https://www.kannahconsulting.com/wp-content/uploads/2016/08/2010-10-11_Battery_Charger_Title_20_CASE_Report_v2-2-2.pdf, pg. 43.

[208] Information presented in the ExxonMobil study is confidential.

Category	Commercial & Industrial Measures	Sector	EUL (years)	Source
	Pool Heater	C&I	8	DOE[209]
	Solar Pool Cover	C&I	5	CALMAC[210]
Process Equipment	Steam Trap – Other Applications	C&I	6	DEER 2014 EUL ID: HVAC-StmTrp
	Steam Trap Monitoring System – Other Applications	C&I	15	DEER 2014 EUL ID: HVAC-EMS
	Ozone Laundry	C&I	10	PG&E[211]
	Process Exhaust Filtration	C&I	15	CIBSE[212]
Refrigeration	Air-Cooled Refrigeration Condenser	C&I	15	DEER 2014 EUL ID: GrocSys-Cndsr
	Automatic Door Closer for Walk-In Cooler/Freezer	C&I	8	DEER 2014 EUL ID: GrocWlkIn-DrClsr
	Cooler and Freezer Door Gasket	C&I	4	DEER 2014 EUL ID: GrocWlkIn-WDr-Gask
	Cooler and Freezer Door Strip	C&I	4	DEER 2014 EUL ID: GrocWlkIn-Strip-Crtn
	EC Motor – Refrigerated Case or Walk-In Cooler/Freezer Evaporator Fan	C&I	15	DEER 2014 EUL ID: GrocDisp-FEvap-FanMtr
	Equipment (Condenser, Compressor, and Sub-cooling)	C&I	15	DEER 2014 EUL ID: GrocSys-MechSubcl
	Evaporator Fan Motor – with Permanent Magnet Synchronous Motor (PMSM)	C&I	15	DEER 2014 EUL ID: GrocDisp-FEvap-FanMtr
	Refrigerated Case Door	C&I	12	DEER 2014 EUL ID: GrocDisp-FixtDoors
	Refrigerated Case Night Cover	C&I	5	DEER 2014 EUL ID: GrocDisp-DispCvrs
Refrigeration - Control	Anti-Condensation Heater Control	C&I	12	DEER 2014 EUL ID: GrocDisp-ASH
	Condenser Pressure and Temperature Control	C&I	15	DEER 2014 EUL ID: GrocSys-Cndsr
	Evaporator Fan Control	C&I	16	DEER 2014 EUL ID: Groc-WlkIn-WEvapFMtrCtrl
	Floating Head Pressure Control	C&I	10	PA Consulting Group [213]

[209] DOE, Chapter 8, Life-Cycle Cost and Payback Period Analyses, Table 8.75. https://www.regulations.gov/document?D=EERE-2006-STD-0129-0170
[210] http://www.calmac.org/publications/PoolCoverReport_2015_Final_Report_Appendices.pdf
[211] PG&E Work Paper PGECOAPP123, August 22, 2017.
[212] Chartered Institution of Building Services Engineers. "Probabilistic Estimation of Service Life." An industrial ventilation system consists of a fan and a set of filters; Fan and Filter EUL are 15 to 20 years depending on type. https://www.cibse.org/knowledge-research/knowledge-portal/probabilistic-estimation-of-service-life
[213] PA Consulting Group Inc. "State of Wisconsin Public Service Commission of Wisconsin Focus on Energy Evaluation Business Programs: Measure Life Study. Final Report." August 25, 2009. https://focusonenergy.com/sites/default/files/bpmeasurelifestudyfinal_evaluationreport.pdf

Common References

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   Available from: http://www.deeresources.com/files/DEER2013codeUpdate/download/DEER2014-EUL-table-update_2014-02-05.xlsx
2. GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, June 2007.
   Available from: https://library.cee1.org/system/files/library/8842/CEE_Eval_MeasureLifeStudyLights%2526HVACGDS_1Jun2007.pdf
3. U.S. Department of Energy (DOE) Energy Conservation Program, Energy Conservation Standards for Residential Conventional Cooking Products as part of the 2016 supplemental notice of proposed rulemaking (SNOPR).
   Available from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.caetrm.com%2Fmedia%2Freference-documents%2FCooking_Pds_LCC_SNOPR_DOE_2016_publication.xlsm&wdOrigin=BROWSELINK
4. Duke Energy. Final Report. Process and Impact Evaluation of the 2013-2014 Residential Neighborhood Program in the Carolina System.
   Available from: https://psc.ky.gov/pscecf/2015-00277/adele.frisch%40duke-energy.com/10132015125446/Case_No._2015-00277_-_Part_3_-_DEK_responses_to_Staffs_1st_Set_of_Data_Requests.pdf

Record of Revision

Record of Revision Number	Issue Date
EUL's originally listed in July 18, 2011 Order	7/18/2011
Additional EUL's posted on web site	Subsequent to 7/18/2011 Order
7-13-28	7/31/2013
6-14-1	6/19/2014
6-14-2	6/19/2014
6-15-4	6/1/2015
6-16-2	6/30/2016
1-17-8	12/31/2016
6-17-16	6/30/2017
9-17-11	9/30/2017
12-17-17	12/31/2017
3-18-21	3/31/2018
6-18-23	6/30/2018
9-18-21	9/30/2018
12-18-17	12/28/2018
3-19-16	3/29/2019
6-19-14	6/30/2019
9-19-10	9/30/2019
12-19-17	12/23/2019
3-20-17	3/30/2020

Record of Revision Number	Issue Date
7-20-20	7/31/2020
12-20-12	12/31/2020
3-21-18	3/31/2021
7-21-21	8/30/2021
12-21-25	1/28/2022
6-22-13	9/2/2022
3-23-21	3/31/2023
6-23-16	7/14/2023
9-23-5	10/31/2023
12-23-20	1/5/2024
3-24-16	3/29/2024
9-24-11	10/22/2024
12-24-11	2/7/2025

Return to Table of Contents