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|  | **PENNSYLVANIA**  **PUBLIC UTILITY COMMISSION**  Harrisburg, PA. 17105-3265 |  |

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|  | Public Meeting held January 28, 2010 |
| Commissioners Present: |  |

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| James H. Cawley, Chairman | | |  |
| Tyrone J. Christy, Vice Chairman | | |  |
| Kim Pizzingrilli | | |  |
| Wayne E. Gardner | | |  |
| Robert F. Powelson | | |  |
|  |  |
| Implementation of the Alternative Energy Portfolio  Standards Act of 2004: Standards for the Participation  of Demand Side Management Resources – Technical  Reference Manual Update | Docket No. M‑00051865 |

**TENTATIVE ORDER**

**BY THE COMMISSION:**

In implementing the Alternative Energy Portfolio Standards Act (“AEPS Act”), 73 P.S. §§ 1648.1 – 1648.8,this Commission had previously adopted an *Energy‑Efficiency and DSM Rules for Pennsylvania’s Alternative Energy Portfolio Standard, Technical Reference Manual* (“TRM”).[[1]](#footnote-1) In adopting the original version of the TRM, this Commission directed the Bureau of Conservation, Economics and Energy Planning (“CEEP”) to oversee the implementation, maintenance and periodic updating of the TRM.[[2]](#footnote-2) Additionally, in the Act 129 Energy Efficiency and Conservation Program Implementation Order,[[3]](#footnote-3) this Commission adopted the TRM as a component of the Energy Efficiency and Conservation (“EE&C”) Program evaluation process. In that Implementation Order, this Commission also noted that “as the TRM was initially created to fulfill requirements of the AEPS Act, it will need to be updated and expanded to fulfill the requirements of the EE&C provisions of Act 129.”[[4]](#footnote-4) Soon after the adoption of the EE&C Program Implementation Order, Commission staff initiated a collaborative process to review and update the TRM with the purpose of supporting both the AEPS Act and the Act 129 EE&C program that culminated in the adoption of the 2009 version of the TRM at the May 28, 2009 Public Meeting.[[5]](#footnote-5) In adopting the 2009 version of the TRM, the Commission recognized the importance of updating the TRM on an annual basis.[[6]](#footnote-6) With this Tentative Order, the Commission advances the annual update of the TRM to be applied beginning with the 2010‑2011 AEPS Act and Act 129 EE&C program compliance years.

**BACKGROUND**

Act 129 of 2008, P.L. 1592, specifically directed this Commission to establish an evaluation process that monitors and verifies data collection, quality assurance and the results of each EDC’s EE&C plan and the EE&C program as a whole. *See* 66 Pa. C.S. § 2806.1(a)(2). To assist in meeting this obligation, the Commission contracted with GDS Associates, Inc. in August 2009, to perform these duties as the Act 129 Statewide Evaluator (“SWE”). As part of its duties the SWE, is to review the TRM and the Total Resource Cost Test Manual and to provide suggestions for possible revisions and additions to these manuals. A Technical Working Group (“TWG”)[[7]](#footnote-7) was formed to provide guidance to the SWE in clarifying savings measurement protocols and plans by recommending improvements to the existing TRM and other aspects of the EE&C program. The SWE, in conjunction with a TWG, has reviewed the 2009 version of the TRM and proposed several changes and additions that will be discussed below.

**DISCUSSION**

The improvements to the TRM recommended by the SWE have focused on select commercial and industrial protocols and are made as part of the regular annual TRM update process. If adopted the recommended changes should make the TRM a more effective and professional tool for validating savings and provide support for the Act 129 goals. The major goals of the proposed modifications are as follows:

1. To appropriately balance the integrity and accuracy of savings estimates with costs incurred to measure those savings;
2. To improve the calculation methods in the current TRM;
3. To broaden the scope of the TRM to enable the evaluation of a wider range of prescriptive measures, thereby minimizing the number of measures that must be evaluated through custom protocols;
4. To provide stipulated hours of use and demand coincidence factors, which are not specified in the current TRM, in order to simplify the calculation of savings without requiring extensive measurement to evaluate saving; and
5. To provide reasonable methods for measurement and verification of the incremental energy savings without unduly burdening program or evaluation staff.

A summary of the suggested changes to the May 2009 TRM are as follows:

1. Section numbers added for navigation and cross-referencing.
2. Tables and text formatted consistently.
3. Updated references.
4. Footnotes added for references and notes.
5. Modified “Commercial and Industrial Energy Efficient Construction” to “Commercial and Industrial Electric Efficiency.”
6. Removed existing “Lighting Equipment” section.
7. Removed existing “Prescriptive Lighting” section.
8. Removed existing “Lighting Controls” section.
9. Removed existing “20% Lighting Power Density (“LPD”) Reduction” section.
10. Removed existing “Fluorescent Lighting Fixture” section.
11. Inserted “Lighting Improvement” section with “New Construction and Building Additions”, “Traffic Signal Lighting”, “Prescriptive Lighting”, and “Lighting Controls” subsections.
12. Removed existing “Motors” section.
13. Inserted “Premium Efficiency Motors” section.
14. Inserted “Variable Frequency Drive (“VFD”) Improvements” section.
15. Inserted “Industrial Air Compressors with Variable Frequency Drives” section.
16. Modified EFLH table under the “HVAC Systems” section.
17. Removed existing “Electric Chillers” section.
18. Removed “Variable Frequency Drives” section.
19. Removed “Air Compressors with Variable Frequency Drives” section.
20. Inserted additional appendices.

Below, we will discuss the more significant suggested changes and updates being made to the TRM. Minor administrative changes will not be discussed. Major modifications have been made to the commercial and industrial lighting (6.2), motors (6.3), variable frequency drive (6.4), HVAC systems (6.6), and chiller (removed) sections. In the attached Annex, language in **bold** (other than headings) is proposed new language and proposed deletions are struck-out (~~struck-out~~). In addition, Appendix B, Appendix C and the Motor & VFD Form in Appendix D are proposed additions.

The Commission is seeking comment on these proposed changes. In particular, in addition to comments regarding the appropriateness and correctness of these changes, the Commission seeks comment on whether some or all of the changes should just be applied prospectively beginning June 1, 2010 or also applied retroactively to June 1, 2009. We emphasize that the proposed modifications attempt to clarify existing protocols and algorithms that were difficult to interpret in light of sound engineering principles and to provide values that were referenced in the TRM algorithms but not previously provided. As the existing protocols and algorithms may be difficult to interpret and implement, it may be advantageous and more cost effective to apply these proposed changes retroactively. Specifically, the Commission is seeking comment on whether the proposed changes found in Sections 6.2, 6.3, 6.4 and 6.12, as well as Appendices C and D, should be applied to appropriate approved measures installed since June 1, 2009. Furthermore, the Commission is open to suggestions of additional changes or additions to the TRM. Any proposal for additional measures to be included in the TRM should include supporting reference material and data to substantiate any proposed stipulated values.

**A. Commercial and Industrial Lighting Protocol**

The 2009 TRM provides three classifications of measurement for lighting improvements to existing facilities. Prescriptive Lighting assumes a T12 magnetic ballast baseline, the Super T8 retrofit assumes either a standard T8 baseline or a T12 baseline, and the Custom Measure option anticipates a site specific baseline. The savings protocols for these classes of measurement are neither uniform nor coordinated. The 2009 TRM does not specify a methodology to determine the operating hours for different usage groups and has a limited number of lamp and ballast combinations. The current list of lamp and ballast combinations does not reflect the diversity in the field of preexisting lighting stock and is very limited in retrofit design options relative to what is usually seen in commercial lighting projects. Adding additional lamp and ballast combinations could have a significant positive impact toward achieving savings for the lighting programs.

The Prescriptive Lighting TRM Protocol, while giving the appearance of administrative simplicity, actually introduces some confusion into the process of auditing the savings of real world lighting improvements that may not conform to the categories as defined by Table 12 of the 2009 TRM. This may also have the unintended consequence of encouraging limited lighting design options, which can result in less energy savings than would otherwise be achieved. Currently there are multiple types of T-8 lamps and multiple energy efficient electronic ballasts on the market. This creates many design configurations to optimize the energy use while attaining the required light levels. In the 2009 TRM, there is no methodology to account for the differences between varying wattages and ballast factors, both of which are significant determinants of savings. In addition, the assumption in the 2009 TRM that the C&I lighting baseline is 100% T12 magnetic ballast technology is clearly erroneous and is based on a study done in New Jersey between 1995 and 1999. The proposed changes to the Commercial and industrial Lighting Protocols found in Sections 6.1 and 6.2 on pages 39‑58 and Appendix C should resolve these concerns and provide a more complete and useful TRM.

**B. Commercial and Industrial Motor & VFD Protocol**

The 2009 TRM provides protocols (algorithms and stipulated variables) for the measurement of savings for both motors and variable frequency drives that would be difficult or impossible to implement as currently written. Both protocols rely on a definition of Rated Load Factor (“RLF”) that may be a mischaracterization of a motor’s service factor. An actual motor load factor is the operating input power divided by the nameplate full-load input power. Thus, load factors vary by application and can only be determined by measurement.

In addition, the use of Equivalent Full Load Hours (“EFLH”) in the context of the proposed motor and VFD algorithm does not seem appropriate. There is no table of deemed EFLHs for different types of motor functions, like there is for air conditioning where the term is more appropriate.

The protocol for VFDs is particularly problematic. While on the surface the algorithm seems simple and clear, examination of Energy Savings Factor (“ESF”) and the Demand Savings Factor (“DSF”) reveals cumbersome underlying definitions and supporting documentation that taken as a whole is unintelligible. In Table 22, kWh/motor HP and Full Load Hours of the VSD are not coherently defined and would be impossible to implement in practice without significant creative interpretation.

The actual loading of a motor with a VFD is dependent on the control system employed and the physical design of the system it serves. When making generalizations for the purpose of stipulating VFD savings, they should be made carefully considering these factors. Otherwise it may be most appropriate to consider VFDs as a custom measure with appropriate metering of the pre and post loading on the motor to be controlled by the VFD. The proposed changes to the Commercial and industrial Motor and VFD Protocols found in Sections 6.3 and 6.4 on pages 60‑72 and Appendix D should resolve these concerns and provide a more complete and useful TRM.

**C. Commercial and Industrial HVAC Systems & Chiller Protocol**

The 2009 TRM provides protocols (algorithms and stipulated variables) for the measurement of savings for HVAC systems and chillers that are generally reasonable in theory but overly simplistic when considering the stipulated numbers. In Table 19 of the 2009 TRM,[[8]](#footnote-8) EFLH values are fixed based on location, inferring that every HVAC system in a particular region operates at the same number of hours regardless of building type or function. This assumption is flawed, as one HVAC system could serve a school operating from 7AM to 5PM on weekdays only, while another HVAC system could serve a retail space operating from 9AM to 9PM every day in the same region. Therefore, a more nuanced determination of the stipulated EFLH values is required to function properly in the established algorithms. The proposed new EFLH values for Commercial and Industrial HVAC systems are found in Section 6.6 at pages 72‑84 in the proposed TRM update.

The chiller protocols deem savings according to similar algorithms and stipulated values as those for HVAC systems. In addition to variations by building type, chiller plants are usually more complicated and can have multiple chillers serving the same load. Chiller measures can also represent a large proportion of total program savings due to applications in large commercial and industrial facilities. The SWE recommends that these measures to be moved into a custom category so that loading can be appropriately determined and form the basis for evaluating savings of commercial and industrial chiller measures.

**CONCLUSION**

With this Tentative Order, the Commission is seeking comments on the proposed updates to the TRM. This Tentative Order represents the Commission’s continuing efforts in establishing a comprehensive TRM with a purpose of supporting both the AEPS Act and the EE&C provisions of Act 129. We look forward to receiving comments from interested stakeholders regarding the proposed changes to the TRM. This Tentative Order, the proposed TRM update and filed comments will be made available to the public on the Commission’s Alternative Energy[[9]](#footnote-9) and Act 129 Information[[10]](#footnote-10) web pages. **THEREFORE,**

**IT IS ORDERED:**

1. That the 2010 Technical Reference Manual update contained in the Annex to this Tentative Order is issued for comment.

2. That a copy of this Tentative Order and Annex shall be served upon the Office of Consumer Advocate, the Office of Small Business Advocate, the Office of Trial Staff, all jurisdictional electric distribution companies, all licensed electric generation suppliers, the Pennsylvania Department of Environmental Protection and all parties who commented on the 2009 Technical Reference Manual update.

3. That the Secretary shall deposit a notice of this Tentative Order and Annex with the Legislative Reference Bureau for publication in the *Pennsylvania Bulletin*.

4. That interested parties shall have 20 days from the date of publication of the notice in the *Pennsylvania Bulletin* to file an original and fifteen (15) copies of written comments referencing Docket Number M‑00051865 to the Pennsylvania Public Utility Commission, Attention: Secretary, P.O. Box 3265, Harrisburg, PA 17105‑3265.

5. That interested parties shall have 35 days from the date of publication of the notice in the *Pennsylvania Bulletin* to file an original and fifteen (15) copies of written reply comments referencing Docket Number M‑00051865 to the Pennsylvania Public Utility Commission, Attention: Secretary, P.O. Box 3265, Harrisburg, PA 17105‑3265.

6. That comments and reply comments shall be electronically mailed to Gregory A. Shawley at [gshawley@state.pa.us](mailto:gshawley@state.pa.us) and Kriss Brown at [kribrown@state.pa.us](mailto:kribrown@state.pa.us). Attachments may not exceed three megabytes.

7. That this Tentative Order and Annex and all filed comments and reply comments related this Tentative Order be published on the Commission’s website.

8. That the contact person for technical issues related to this Tentative Order and Annex is Gregory A. Shawley, Bureau of Conservation, Economics and Energy Planning, 717-787-5369 or [gshawley@state.pa.us](mailto:gshawley@state.pa.us). The contact person for legal and process issues related to this Tentative Order and Annex is Kriss Brown, Law Bureau, 717-787-4518 or kribrown@state.pa.us.



**BY THE COMMISSION**

James J. McNulty

Secretary

(SEAL)

ORDER ADOPTED: January 28, 2010

ORDER ENTERED: **February 2, 2010**

**ANNEX**

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**~~Annex~~**

**Technical Reference Manual**

**for**

**Pennsylvania Act 129**

**Energy Efficiency and Conservation Program**

**and**

**Act 213**

**Alternative Energy Portfolio Standards**

**Pennsylvania Public Utility Commission**

2010 Draft – for Review and Comment

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**Pennsylvania Technical Reference Manual**

# 1 Introduction[[11]](#footnote-11)

The Technical Reference Manual (TRM) was developed to measure the resource savings from standard energy efficiency measures. The savings’ algorithms use measured and customer data as input values in industry-accepted algorithms. The data and input values for the algorithms come from AEPS application forms, standard values including Energy Star standards, or data gathered by Electric Distribution Companies (EDCs). The standard input values are based on the best available measured or industry data.

The standard values for most commercial and industrial (C&I) measures are supported by end- use metering for key parameters for a sample of facilities and circuits, based on the metered data from past applications in other states. These C&I standard values are based on five years of data for most measures and two years of data for lighting.

Some electric input values were derived from a review of literature from various industry organizations, equipment manufacturers, and suppliers. These input values are updated to reflect changes in code, federal standards and recent program evaluations.

## 1.1 Purpose

The TRM was developed for the purpose of estimating annual energy savings for a selection of energy efficient technologies and measures. The TRM provides guidance to the Administrator responsible for awarding Alternative Energy Credits (AECs). The revised TRM serves a dual purpose of being used to determine compliance with the ~~Alternative Energy Portfolio Standards (AEPS)~~ AEPS Act, 73 P.S. §§ 1648.1-1648.8, and the energy efficiency and conservation requirements of Act 129 of 2008, 66 Pa.C.S. § 2806.1. The TRM will continue to be updated on an annual basis to reflect the addition of technologies and measures as needed to remain relevant and useful.

Resource savings to be measured include electric energy (kWh) and capacity (kW) savings. The algorithms in this document focus on the determination of the per unit savings for the energy efficiency and demand response measures.

**1.2 Definitions**

The TRM is designed for use with both the AEPS Act and Act 129; however, it contains words and terms that apply only to the AEPS or only to Act 129. The following definitions are provided to identify words and terms that are specific for implementation of the AEPS:

* Administrator/Program Administrator – The Credit Administrator of the AEPS program that receives and processes, and approves AEPS Credit applications.
* AEPS application forms – application forms submitted to qualify and register alternative energy facilities for alternative energy credits.
* Application worksheets – part of the AEPS application forms.
* Alternative Energy Credits (AECs) – A tradable instrument used to establish, verify, and measure compliance with the AEPS. One credit is earned for each 1000kWh of electricity generated (or saved from energy efficiency or conservation measures) at a qualified alternative energy facility.

For the Act 129 program, EDCs may, as an alternative to using the energy savings’ values for standard measures contained in the TRM, submit documentation of alternative measurement methods to support different energy savings’ values. The alternative measurement methods are subject to review and approval by the Commission to ensure their accuracy.

## 1.3 General Framework

In general, energy and demand savings will be measured using measured and customer data as input values in algorithms in the TRM, and information from the AEPS application forms, worksheets and field tools.

Three systems will work together to ensure accurate data on a given measure:

1. The application form that the customer or customer’s agent submits with basic information.
2. Application worksheets and field tools with more detailed, site-specific data, input values and calculations.
3. Algorithms that rely on standard or site-specific input values based on measured data. Parts or all of the algorithms may ultimately be implemented within the tracking system, application forms and worksheets and field tools.

## 1.4 Algorithms

The algorithms that have been developed to calculate the energy and or demand savings are driven by a change in efficiency level for the installed measure compared to a baseline level of efficiency. This change in efficiency is reflected in both demand and energy savings for electric measures and energy savings for gas. The following are the basic algorithms.

Electric Demand Savings = ΔkW = kWbaseline - kWenergy efficient measure

Electric Energy Savings = ΔkW X EFLH

Electric Peak Coincident Demand Savings = ΔkW X Coincidence Factor

Where:

kWbase = kW of baseline case.

kWee = kW of energy efficient case.

EFLH = Equivalent Full Load Hours of operation for the installed measure.

CF = Demand Coincidence Factor, percentage of load connected during peak hours.

Other resource savings will be calculated as appropriate.

Specific algorithms for each of the measures may incorporate additional factors to reflect specific conditions associated with a measure. This may include factors to account for coincidence of multiple installations or interaction between different measures.

## 1.5 Data and Input Values

The input values and algorithms are based on the best available and applicable data. The input values for the algorithms come from the AEPS application forms, EDC data gathering, or from standard values based on measured or industry data.

Many input values, including site-specific data, come directly from the AEPS application forms, EDC data gathering, worksheets and field tools. Site-specific data on the AEPS application forms and EDC data gathering are used for measures with important variations in one or more input values (e.g., delta watts, efficiency level, capacity, etc.).

Standard input values are based on the best available measured or industry data, including metered data, measured data from other state evaluations (applied prospectively), field data, and standards from industry associations. The standard values for most commercial and industrial measures are supported by end-use metering for key parameters for a sample of facilities and circuits. These standard values are based on five years of metered data for most measures[[12]](#footnote-12). Data that were metered over that time period are from measures that were installed over an eight-year period. Many input values are based on program evaluations of New Jersey’s Clean Energy Programs or similar programs in the northeast region.

For the standard input assumptions for which metered or measured data were not available, the input values (e.g., delta watts, delta efficiency, equipment capacity, operating hours, coincidence factors) were based on the best available industry data or standards. These input values were based on a review of literature from various industry organizations, equipment manufacturers and suppliers.

## 1.6 Baseline Estimates

For all new construction and any replacement of non-working equipment appliance, the ΔkW and ΔkWh values are based on the vintage efficiency of the items being replaced versus new high-efficiency products. The approach used for the replacement measures encourages residential and business consumers to replace working inefficient equipment and appliances with new high-efficiency products rather than taking no action to upgrade or only replacing them with new standard-efficiency products. The baseline estimates used in the TRM are documented in baseline studies or other market information. Baselines will be updated to reflect changing codes, practices and market transformation effects.

## 1.7 Resource Savings in Current and Future Program Years

A E Cs and energy efficiency and demand response reduction savings will apply in equal annual amounts corresponding to either PJM planning years or calendar years beginning with the year deemed appropriate by the Administrator, and lasting for the approved life of the measure for AEPS Credits. Energy efficiency and demand response savings associated with Act 129 can claim savings for up to fifteen years.

## 1.8 Prospective Application of the TRM

The TRM will be applied prospectively. The input values are from the AEPS application forms and EDC data gathering and standard input values (based on measured data including metered data and evaluation results). The TRM will be updated annually based on new information and available data and then applied prospectively for future program years. Updates will not alter the number of AEPS Credits, once awarded, by the Administrator, nor will it alter any energy savings or demand reductions already in service and within measure life.~~.~~

## 1.9 Electric Resource Savings

Algorithms have been developed to determine the electric energy and coincident peak demand savings.

Annual electric energy savings are calculated and then allocated separately by season (summer and winter) and time of day (on-peak and off-peak). Summer coincident peak demand savings are calculated using a demand savings algorithm for each measure that includes a coincidence factor. Application of this coincidence factor converts the demand savings of the measure, which may not occur at time of system peak, to demand savings that is expected to occur during the Summer On-Peak period.

**Table 1-1: Periods for Energy Savings and Coincident Peak Demand Savings**

|  |  |  |
| --- | --- | --- |
|  | Energy Savings | Coincident Peak Demand Savings |
| Summer | May through September | June through September |
| Winter | October through April | NA |
| On Peak[[13]](#footnote-13) | 8:00 a.m. to 8:00 p.m. | 12:00 p.m. to 8:00 p.m. |
| Off Peak[[14]](#footnote-14) | 8:00 p.m. to 8:00 a.m. | NA |

The time periods for energy savings and coincident peak demand savings were chosen to best fit the Act 129 requirement, which reflects the seasonal avoided cost patterns for electric energy and capacity that were used for the energy efficiency program cost effectiveness purposes. For energy, the summer period May through September was selected based on the pattern of avoided costs for energy at the PJM level. In order to keep the complexity of the process for calculating energy savings’ benefits to a reasonable level by using two time periods, the knee periods for spring and fall were split approximately evenly between the summer and winter periods.

For capacity, the summer period June through September was selected to match the period of time required to measure the 100 highest hours of demand. This period also correlates with the highest avoided costs’ time period for capacity. The experience in PJM has been that nearly all of the 100 highest hours of an EDC’s peak demand occur during these four months. Coincidence factors are used to determine the impact of energy efficiency measures on peak demand.

## 1.10 Post-Implementation Review

The Administrator will review AEPS application forms and tracking systems for all measures and conduct field inspections on a sample of installations. For some programs and jobs (e.g., custom, large process, large and complex comprehensive design), post-installation review and on-site verification of a sample of AEPS application forms and installations will be used to ensure the reliability of site-specific savings’ estimates.

## 1.11 Adjustments to Energy and Resource Savings

### 1.11.1 Coincidence with Electric System Peak

Coincidence factors are used to reflect the portion of the connected load savings or generation that is coincident with the electric system peak.

### 1.11.2 Measure Retention and Persistence of Savings

The combined effect of measure retention and persistence is the ability of installed measures to maintain the initial level of energy savings or generation over the measure life. Measure retention and persistence effects were accounted for in the metered data that were based on C&I installations over an eight-year period. As a result, some algorithms incorporate retention and persistence effects in the other input values. For other measures, if the measure is subject to a reduction in savings or generation over time, the reduction in retention or persistence is accounted for using factors in the calculation of resource savings (e.g., in-service rates for residential lighting measures).

### 1.11.3 Interaction of Energy Savings

Interaction of energy savings is accounted for as appropriate. For all other measures, interaction of energy savings is zero.

For Residential New Construction, the interaction of energy savings is accounted for in the home energy rating tool that compares the efficient building to the baseline or reference building and calculates savings.

For Commercial and Industrial Efficient Construction, the energy savings for lighting is increased by an amount specified in the algorithm to account for HVAC interaction.

For commercial and industrial custom measures, interaction where relevant is accounted for in the site-specific analysis.

## 1.12 Calculation of the Value of Resource Savings

The calculation of the value of the resources saved is not part of the TRM. The TRM is limited to the determination of the per unit resource savings in physical terms.

In order to calculate the value of the energy savings for reporting and other purposes, the energy savings are determined at the customer level and then increased by the amount of the transmission and distribution losses to reflect the energy savings at the system level. The energy savings at the system level are then multiplied by the appropriate avoided costs to calculate the value of the benefits.

System Savings = (Savings at Customer) X (T&D Loss Factor)

Value of Resource Savings = (System Savings) X (System Avoided Costs ) + (Value of Other Resource Savings)

The value of the benefits for a particular measure will also include other resource savings where appropriate. Maintenance savings will be estimated in annual dollars levelized over the life of the measure.

## 1.13 Transmission and Distribution System Losses

The TRM calculates the energy savings at the customer level. These savings need to be increased by the amount of transmission and distribution system losses in order to determine the energy savings at the system level. The electric loss factor multiplied by the savings calculated from the algorithms will result in savings at the supply level.

The electric loss factor applied to savings at the customer meter is 1.11 for both energy and demand. The electric system loss factor was developed to be applicable to statewide programs. Therefore, average system losses at the margin based on PJM data were utilized. This reflects a mix of different losses that occur related to delivery at different voltage levels. The 1.11 factor used for both energy and capacity is a weighted average loss factor. These electric loss factors reflect losses at the margin.

## 1.14 Measure Lives

Measure lives are provided in Appendix A for informational purposes and for use in other applications such as reporting lifetime savings or in benefit cost studies that span more than one year. For the purpose of calculating the total Resources Cost Test for Act 129, measures cannot claim savings for more than 15 years.

## 1.14 Custom Measures[[15]](#footnote-15)

Custom measures are considered too complex or unique to be included in the list of standard measures provided in the TRM. Also included are measures that may involve metered data, but require additional assumptions to arrive at a ‘typical’ level of savings as opposed to an exact measurement. The qualification for and availability of AEPS Credits and energy efficiency and demand response savings are determined on a case-by-case basis.

An AEPS application must be submitted, containing adequate documentation fully describing the energy efficiency measures installed or proposed and an explanation of how the installed facilities qualify for A E Cs. The AEPS application must include a proposed evaluation plan by which the Administrator may evaluate the effectiveness of the energy efficiency measures provided by the installed facilities. All assumptions should be identified, explained and supported by documentation, where possible. The applicant may propose incorporating tracking and evaluation measures using existing data streams currently in use provided that they permit the Administrator to evaluate the program using the reported data.

To the extent possible, the energy efficiency measures identified in the AEPS application should be verified by the meter readings submitted to the Administrator.

**1.16 Impact of Weather**

To account for weather differences within Pennsylvania Equivalent FullLoad Hours (ELFH) were taken from the US Department of Energy’s Energy Star Calculator that provides ELFH values for seven Pennsylvania cities: Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton, and Williamsport. These cities provide a representative sample of the various climate and utility regions in Pennsylvania.

## 1.17 Algorithms for Energy Efficient Measures

The following pages present measure-specific algorithms.

# 2 Residential Electric HVAC

## 2.1 Algorithms

The measurement plan for residential high-efficiency cooling and heating equipment is based on algorithms that determine a central air conditioner’s or heat pump’s cooling/heating energy use and peak demand. Input data is based both on fixed assumptions and data supplied from the high efficiency equipment AEPS application form or EDC data gathering. The algorithms also include the calculation of additional energy and demand savings due to the required proper sizing of high-efficiency units.

The savings will be allocated to summer/winter and on-peak/off-peak time periods based on load shapes from measured data and industry sources. The allocation factors are documented below in the input value table.

The algorithms applicable for this program measure the energy savings directly related to the more efficient hardware installation. Estimates of energy savings due to the proper sizing of the equipment are also included.

The following is an explanation of the algorithms used and the nature and source of all required input data.

**~~Algorithms~~**

### 2.1.1 Central Air Conditioner (A/C) and Air Source Heat Pump (ASHP)

## 2.1.1.1 Cooling Energy Consumption and Peak Demand Savings – Central A/C and ASHP (High Efficiency Equipment Only)

Energy Impact (kWh) = CAPY/1000 X (1/SEER*b –* 1/SEER*q* ) X EFLH

Peak Demand Impact (kW) = CAPY/1000 X (1/EER*b –* 1/EER*q* ) X CF

*2.1.1.2* Heating Energy Savings – ASHP

Energy Impact (kWh) = CAPY/1000 X (1/HSPF*b* - 1/HSPF*q* ) X EFLH

*2.1.1.3* Cooling Energy Consumption and Demand Savings – Central A/C and ASHP (Proper Sizing)

Energy Impact (kWh) = (CAPY/(SEERq X 1000)) X EFLH X PSF

Peak Demand Impact (kW) = ((CAPY/(EERq X 1000)) X CF) X PSF

*2.1.1.4* Cooling Energy Consumption and Demand Savings – Central A/C and ASHP (QIV)

Energy Impact (kWh) = (((CAPY/(1000 X SEERq)) X EFLH) X (1-PSF) X QIF

Peak Demand Impact (kW) = ((CAPY/(1000 X EERq)) X CF) X (1-PSF) X QIF

*2.1.1.5 Cooling Energy Consumption and Demand Savings – Central A/C and ASHP (Maintenance)*

Energy Impact (kWh) = ((CAPY/(1000 X SEERm)) X EFLH) X MF

Peak Demand Impact (kW) = ((CAPY/(1000 X EERm)) X CF) X MF

*2.1.1.6 Cooling Energy Consumption and Demand Savings– Central A/C and ASHP (Duct Sealing)*

Energy Impact (kWh) = (CAPY/(1000 X SEERq)) X EFLH X DuctSF

Peak Demand Impact (kW) = ((CAPY/(1000 X EERq)) X CF) X DuctSF

### 2.1.2 Ground Source Heat Pumps (GSHP)

Cooling Energy (kWh) Savings = CAPY/1000 X (1/SEER*b –* (1/(EER*g* X GSER))) X EFLH

Heating Energy (kWh) Savings = CAPY/1000 X (1/HSPF*b –* (1/(COP*g* X GSOP))) X EFLH

Peak Demand Impact (kW) = CAPY/1000 X (1/EER*b –* (1/(EER*g* X GSPK))) X CF

### 2.1.3 GSHP Desuperheater

Energy (kWh) Savings = EDSH

Peak Demand Impact (kW) = PDSH

### 2.1.4 Furnace High Efficiency Fan

Heating Energy (kWh) Savings = ((Capy*t* X EFLHHT)/100,000 BTU/therm) X HFS

Cooling Energy (kWh) Savings = CFS

#### 2.2 Definition of Terms

CAPY = The cooling capacity (output in Btuh) of the central air conditioner or heat pump being installed. This data is obtained from the AEPS Application Form based on the model number or from EDC data gathering.

SEER*b =* The Seasonal Energy Efficiency Ratio of the Baseline Unit.

SEER*q* = The Seasonal Energy Efficiency Ratio of the qualifying unit being installed. This data is obtained from the AEPS Application Form or EDC’s data gathering based on the model number.

SEERm = The Seasonal Energy Efficiency Ratio of the Unit receiving maintenance

EER*b* = The Energy Efficiency Ratio of the Baseline Unit.

EER*q* = The Energy Efficiency Ratio of the unit being installed. This data is obtained from the AEPS Application Form or EDC data gathering based on the model number.

EER*g* = The EER of the ground source heat pump being installed. Note that EERs of GSHPs are measured differently than EERs of air source heat pumps (focusing on entering water temperatures rather than ambient air temperatures). The equivalent SEER of a GSHP can be estimated by multiplying EER*g* by 1.02.

GSER = The factor to determine the SEER of a GSHP based on its EER*g.*

EFLH = The Equivalent Full Load Hours of operation for the average unit.

ESF = The Energy Sizing Factor or the assumed saving due to proper sizing and proper installation.

PSF = The Proper Sizing Factor or the assumed savings due to proper sizing of cooling equipment.

QIF = The Quality Installation factor or assumed savings due to a verified quality installation of cooling equipment.

MF = The Maintenance Factor or assumed savings due to completing recommended maintenance on installed cooling equipment.

DuctSF = The Duct Sealing Factor or the assumed savings due to proper sealing of all cooling ducts.

CF = The coincidence factor which equates the installed unit’s connected load to its demand at time of system peak.

DSF = The Demand Sizing Factor or the assumed peak-demand capacity saved due to proper sizing and proper installation.

HSPF*b* = The Heating Seasonal Performance Factor of the Baseline Unit.

HSPF*q* = The Heating Seasonal Performance Factor of the unit being installed. This data is obtained from the AEPS Application Form or EDC’s data gathering.

COP*g* = Coefficient of Performance. This is a measure of the efficiency of a heat pump.

GSOP = The factor to determine the HSPF of a GSHP based on its COP*g.*

GSPK = The factor to convert EER*g* to the equivalent EER of an air conditioner to enable comparisons to the baseline unit.

EDSH = Assumed savings per desuperheater.[[16]](#footnote-16)

PDSH = Assumed peak-demand savings per desuperheater.

Capy*q* = Output capacity of the qualifying heating unit in BTUs/hour.

EFLHHT = The Equivalent Full Load Hours of operation for the average heating unit.

HFS = Heating fan savings~~,.~~

CFS = Cooling fan savings.

The 1000 used in the denominator is used to convert watts to kilowatts.

~~A summary of the input values and their data sources follows:~~

**Table 2-1: Residential Electric HVAC - References**

| **Component** | **Type** | **Value** | **Sources** |
| --- | --- | --- | --- |
| CAPY | Variable |  | AEPS Application; EDC Data Gathering |
| SEER*b* | Fixed | Baseline = 13 | 1 |
| SEER*q* | Variable |  | AEPS Application; EDC Data Gathering |
| SEER*m* | Fixed | 10 | 15 |
| EER*b* | Fixed | Baseline = 11.3 | 2 |
| EER*q* | Fixed | = (11.3/13) X SEERq | 2 |
| EER*g* | Variable |  | AEPS Application; EDC’s Data Gathering |
| EERm | Fixed | 8.69 | 19 |
| GSER | Fixed | 1.02 | 3 |
| EFLH | Fixed | Allentown Cooling = 784 Hours  Allentown Heating = 2,492 Hours  Erie Cooling = 482 Hours  Erie Heating = 2,901 Hours  Harrisburg Cooling = 929 Hours  Harrisburg Heating = 2,371 Hours  Philadelphia Cooling = 1,032 Hours  Philadelphia Heating = 2,328 Hours  Pittsburgh Cooling = 737 Hours  Pittsburgh Heating = 2,380 Hours  Scranton Cooling = 621 Hours  Scranton Heating = 2,532 Hours  Williamsport Cooling = 659 Hours  Williamsport Heating = 2,502 | 4 |
| ESF | Fixed | 2.9% | 5 |
| PSF | Fixed | 5% | 14 |
| QIF | Fixed | 9.2% | 4 |
| MF | Fixed | 10% | 20 |
| DuctSF | Fixed | 18% | 14 |
| CF | Fixed | 70% | 6 |
| DSF | Fixed | 2.9% | 7 |
| HSPF*b* | Fixed | Baseline = 7.7 | 8 |
| HSPF*q* | Variable |  | AEPS Application; EDC’s Data Gathering |
| COP*g* | Variable |  | AEPS Application; EDC’s Data Gathering |
| GSOP | Fixed | 3.413 | 9 |
| GSPK | Fixed | 0.8416 | 10 |
| EDSH | Fixed | 1842 kWh | 11 |
| PDSH | Fixed | 0.34 kW | 12 |
| Cooling - CAC  Time Period Allocation Factors | Fixed | Summer/On-Peak 64.9%  Summer/Off-Peak 35.1%  Winter/On-Peak 0%  Winter/Off-Peak 0% | 13 |
| Cooling – ASHP  Time Period Allocation Factors | Fixed | Summer/On-Peak 59.8%  Summer/Off-Peak 40.2%  Winter/On-Peak 0%  Winter/Off-Peak 0% | 13 |
| Cooling – GSHP  Time Period Allocation Factors | Fixed | Summer/On-Peak 51.7%  Summer/Off-Peak 48.3%  Winter/On-Peak 0%  Winter/Off-Peak 0% | 13 |
| Heating – ASHP & GSHP  Time Period Allocation Factors | Fixed | Summer/On-Peak 0.0%  Summer/Off-Peak 0.0%  Winter/On-Peak 47.9%  Winter/Off-Peak 52.1% | 13 |
| GSHP Desuperheater Time Period Allocation Factors | Fixed | Summer/On-Peak 4.5%  Summer/Off-Peak 4.2%  Winter/On-Peak 43.7%  Winter/Off-Peak 47.6% | 13 |
| Capyq | Variable |  | AEPS Application; EDC’s Data Gathering |
| EFLHHFS | Fixed | Allentown Heating = 2,492 Hours  Erie Heating = 2,901 Hours  Harrisburg Heating = 2,371 Hours  Philadelphia Heating = 2,328 Hours  Pittsburgh Heating = 2,380 Hours  Scranton Heating = 2,532 Hours  Williamsport Heating = 2,502 | 4 |
| HFS | Fixed | 0.5 kWh | 17 |
| CFS | Fixed | 105 kWh | 18 |

Sources:

1. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
2. Average EER for SEER 13 units.
3. VEIC estimate. Extrapolation of manufacturer data.
4. US Department of Energy, Energy Star Calculator. Accessed 3/16/2009.
5. Xenergy, “New Jersey Residential HVAC Baseline Study”, (Xenergy, Washington, D.C., November 16, 2001).
6. Based on an analysis of six different utilities by Proctor Engineering.
7. Xenergy, “New Jersey Residential HVAC Baseline Study”, (Xenergy, Washington, D.C., November 16, 2001).
8. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200.
9. Engineering calculation, HSPF/COP=3.413.
10. VEIC Estimate. Extrapolation of manufacturer data.
11. VEIC estimate, based on PEPCo assumptions.
12. VEIC estimate, based on PEPCo assumptions.
13. Time period allocation factors used in cost-effectiveness analysis.
14. Northeast Energy Efficiency Partnerships, Inc., “Benefits of HVAC Contractor Training”, (February 2006): Appendix C Benefits of HVAC Contractor Training: Field Research Results 03-STAC-01.
15. Minimum Federal Standard for new Central Air Conditioners between 1990 and 2006.
16. NJ utility analysis of heating customers, annual gas heating usage.
17. Scott Pigg (Energy Center of Wisconsin), “Electricity Use by New Furnaces: A Wisconsin Field Study”, Technical Report 230-1, October 2003.
18. Ibid., p. 34. ARI charts suggest there are about 20% more full load cooling hours in NJ than southern WI. Thus, average cooling savings in NJ are estimated at 95 to 115.
19. The same EER to SEER ratio used for SEER 13 units applied to SEER 10 units. EERm = (11.3/13) \* 10.
20. VEIC estimate. Conservatively assumes less savings than for QIV because of the retrofit context.

# 3 Residential New Construction

## 3.1 Algorithms

### 3.1.1 Insulation Up-Grades, Efficient Windows, Air Sealing, Efficient HVAC Equipment and Duct Sealing

Energy savings due to improvements in Residential New Construction will be a direct output of accredited Home Energy Ratings (HERS) software that meets the applicable Mortgage Industry National Home Energy Rating System Standards. REM/Rate is cited here as an example of an accredited software which has a module that compares the energy characteristics of the energy efficient home to the baseline/reference home and calculates savings.

The system peak electric demand savings will be calculated from the software output with the following savings’ algorithms, which are based on compliance and certification of the energy efficient home to the EPA’s ENERGY STAR for New Homes’ program standard:

Peak demand of the baseline home = (PL*b* X OF*b*) / (SEER*b* X BLEER X 1,000).

Peak demand of the qualifying home = (PL*q* X OF*q*) / (EER*q* X 1,000).

Coincident system peak electric demand savings = (Peak demand of the baseline home – Peak demand of the qualifying home) X CF.

### 3.1.2 Lighting and Appliances

Quantification of additional saving due to the addition of high-efficiency lighting and clothes washers will be based on the algorithms presented for these appliances in the Energy Star Lighting Algorithms and the Energy Star Appliances Algorithms, respectively. These algorithms are found in Energy Star Products.

### 3.1.3 Ventilation Equipment

Additional energy savings of 175 kWh and peak-demand saving of 60 Watts will be added to the output of the home energy rating software to account for the installation of high-efficiency ventilation equipment. These values are based on a baseline fan of 80 Watts and an efficient fan of 20 Watts running for eight-hours per day.

#### 3.2 Definition of Terms

PL*b* = Peak load of the baseline home in Btuh.

OF*b* = The over sizing factor for the HVAC unit in the baseline home.

SEER*b* = The Seasonal Energy Efficiency Ratio of the baseline unit.

BLEER = Factor to convert baseline SEER*b* to EER*b.*

PL*q* = The actual predicted peak load for the program qualifying home constructed, in Btuh.

OF*q* = The oversizing factor for the HVAC unit in the program qualifying home.

EER*q* = The EER associated with the HVAC system in the qualifying home.

CF = The coincidence factor which equates the installed HVAC system’s demand to its demand at time of system peak.

A summary of the input values and their data sources follows:

**Table 3-1: ~~Applicable to Building Completions from April 2003 to Present~~ Residential New Construction - References[[17]](#footnote-17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Type** | **Value** | **Sources** |
| PL*b* | Variable |  | 1 |
| OF*b* | Fixed | 1.6 | 2 |
| SEER*b* | Fixed | 13 | 3 |
| BLEER | Fixed | 0.92 | 4 |
| PL*q* | Variable |  | Software Output |
| OF*q* | Fixed | 1.15 | 5 |
| EER*q* | Variable |  | AEPS Application; EDC’s Data Gathering |
| CF | Fixed | 0.70 | 6 |

Sources:

1. Calculation of peak load of baseline home from the home energy rating tool, based on the reference home energy characteristics.
2. PSE&G 1997 Residential New Construction baseline study.
3. Federal Register, Vol. 66, No. 14, Monday, January 22, 2001/Rules and Regulations, p. 7170-7200
4. Engineering calculation.
5. Program guideline for qualifying home.
6. Based on an analysis of six different utilities by Proctor Engineering.

The following tables describe the characteristics of the three reference homes.

T**able 3-2 ENERGY STAR Homes: REMRate User Defined Reference Homes[[18]](#footnote-18) -- ~~Applicable to building completions from pril 2003 to present -- Reflects MEC 95~~** References

| **Data Point** | **~~Single and Multiple Family Except as Noted.~~Value[[19]](#footnote-19)** |
| --- | --- |
|  |  |
| Active Solar | None |
| Ceiling Insulation | U=0.031 (1) |
| Radiant Barrier | None |
| Rim/Band Joist | U=0.141 Type A-1, U=0.215 Type A-2 (1) |
| Exterior Walls - Wood | U=0.141 Type A-1, U=0.215 Type A-2 (1) |
| Exterior Walls - Steel | U=0.141 Type A-1, U=0.215 Type A-2 (1) |
| Foundation Walls | U=0.99 |
| Doors | U=0.141 Type A-1, U=0.215 Type A-2 (1) |
| Windows | U=0.141 Type A-1, U=0.215 Type A-2 (1), No SHGC req. |
| Glass Doors | U=0.141 Type A-1, U=0.215 Type A-2 (1), No SHGC req. |
| Skylights | U=0.031 (1), No SHGC req. |
| Floor over Garage | U=0.050 (1) |
| Floor over Unheated Basement | U=0.050 (1) |
| Floor over Crawlspace | U=0.050 (1) |
| Floor over Outdoor Air | U=0.031 (1) |
| Unheated Slab on Grade | R-0 edge/R-4.3 under |
| Heated Slab on Grade | R-0 edge/R-6.4 under |
| Air Infiltration Rate | 0.51 ACH winter/0.51 ACH summer |
| Duct Leakage | No Observable Duct Leakage |
| Mechanical Ventilation | None |
| Lights and Appliances | Use Default |
| Setback Thermostat | Yes for heating, no for cooling |
| Heating Efficiency |  |
| Furnace | 80% AFUE (3) |
| Boiler | 80% AFUE |
| Combo Water Heater | 76% AFUE (recovery efficiency) |
| Air Source Heat Pump | 7.7 HSPF |
| Geothermal Heat Pump | Open not modeled, 3.0 COP closed |
| PTAC / PTHP | Not differentiated from air source HP |
| Cooling Efficiency |  |
| Central Air Conditioning | 13.0 SEER |
| Air Source Heat Pump | 13.0 SEER |
| Geothermal Heat Pump | 3.4 COP (11.6 EER) |
| PTAC / PTHP | Not differentiated from central AC |
| Window Air Conditioners | Not differentiated from central AC |
| Domestic WH Efficiency |  |
| Electric | 0.97 EF (4) |
| Natural Gas | 0.67 EF (4) |
| Water Heater Tank Insulation | None |
| Duct Insulation | N/A |
|  |  |
| ~~Notes:~~ |  |

**Table ~~5~~ 3-3: ENERGY STAR Homes: REMRate User Defined Reference Homes[[20]](#footnote-20) -- ~~Applicable to building completions from January 2008 to present~~** References

| **Data Point** | **Single and Multiple Family Except as Noted.** |
| --- | --- |
|  |  |
| Domestic WH Efficiency |  |
| Electric | EF = 0.97 - (0.00132 \* gallons) (1) |
| Natural Gas | EF = 0.67 - (0.0019 \* gallons) (1) |
|  |  |
| ~~Notes:~~ |  |

# 4 ENERGY STAR Products

***~~ENERGY STAR Appliances, ENERGY STAR Lighting, ENERGY STAR Windows, and ENERGY STAR Audit~~***

## 4.1 ENERGY STAR Appliances

## 4.1.1 Algorithms

The general form of the equation for the ENERGY STAR Appliance measure savings’ algorithms is:

Number of Units X Savings per Unit

To determine resource savings, the per unit estimates in the algorithms will be multiplied by the number of appliance units. The number of units will be determined using market assessments and market tracking. Some of these market tracking mechanisms are under development. Per unit savings’ estimates are derived primarily from a 2000 Market Update Report by RLW for National Grid’s appliance program and from previous NEEP screening tool assumptions (clothes washers).

Note that the pre-July 2001 refrigerator measure has been deleted given the timing of program implementation. As no field results are expected until July 2001, there was no need to quantify savings relative to the pre-July 2001 efficiency standards improvement for refrigerators.

### 4.1.1.1. ENERGY STAR Refrigerators

Electricity Impact (kWh) = ESavREF

Demand Impact (kW) = DSavREF X CFREF

### 4.1.1.2 ENERGY STAR Clothes Washers

Electricity Impact (kWh) = ESavCW

Demand Impact (kW) = DSavCW X CFCW

### 4.1.1.3 ENERGY STAR Dishwashers

Electricity Impact (kWh) = ESavDW

Demand Impact (kW) = DSavREF X CFDW

### 4.1.1.4 ENERGY STAR Dehumidifiers

Electricity Impact (kWh) = ESavDH

Demand Impact (kW) = DSavDH X CFDH

### 4.1.1.5 ENERGY STAR Room Air Conditioners

Electricity Impact (kWh) = ESavRAC

Demand Impact (kW) = DSavRAC X CFRAC

### 4.1.1.6 ENERGY STAR Freezer

Demand Impact (kW)*=* kWBASE – kWEE

#### Energy Impact (kWh) = ΔkWX HOURS

### 4.1.2 Definition of Terms

ESavREF = Electricity savings per purchased Energy Star refrigerator.

DSavREF = Summer demand savings per purchased Energy Star refrigerator.

ESavCW = Electricity savings per purchased Energy Star clothes washer.

DSavCW = Summer demand savings per purchased Energy Star clothes washer.

ESavDW = Electricity savings per purchased Energy Star dishwasher.

DSavDW = Summer demand savings per purchased Energy Star dishwasher.

ESavDH = Electricity savings per purchased ENERGY STAR dehumidifier

DSavDH = Summer demand savings per purchased ENERGY STAR dehumidifier

ESavRAC = Electricity savings per purchased Energy Star room AC.

DSavRAC = Summer demand savings per purchased Energy Star room AC.

CFREF, CFCW, CFDW, CFDH, CFRAC = Summer demand coincidence factor. The coincidence of average appliance demand to summer system peak equals 1 for demand impacts for all appliances reflecting embedded coincidence in the DSav factor except for room air conditioners where the CF is 58%.

ΔkW= gross customer connected load kW savings for the measure

kWBASE *=* Baseline connected kW

kWEE *=* Energy efficient connected kW

HOURS = average hours of use per year

**Table ~~6~~ 4-1: Energy Star Appliances - References**

| **Component** | **Type** | **Value** | **Sources** |
| --- | --- | --- | --- |
| ESavREF | Fixed | see Table \_ below | 12 |
| DSavREF | Fixed | 0.0125 kW | 1 |
| REF Time Period Allocation Factors | Fixed | Summer/On-Peak 20.9%  Summer/Off-Peak 21.7%  Winter/On-Peak 28.0%  Winter/Off-Peak 29.4% | 2 |
| ESavCW | Fixed | see Table \_ below | 12 |
| DSavCW | Fixed | 0.0147 kW | 3 |
| CW Electricity Time Period Allocation Factors | Fixed | Summer/On-Peak 24.5%  Summer/Off-Peak 12.8%  Winter/On-Peak 41.7%  Winter/Off-Peak 21.0% | 2 |
| ESavDW | Fixed | see Table \_ below | 12 |
| DSavDW | Fixed | 0.0225 | 4 |
| DW Electricity Time Period Allocation Factors | Fixed | 19.8%, 21.8%, 27.8%, 30.6% | 2 |
| ESavDH | Fixed | see Table \_ below | 12 |
| DSavDH | Fixed | .0098 kW | 10 |
| ESavRAC | Fixed | see Table \_ below | 12 |
| DSavRAC | Fixed | 0.1018 kW | 6 |
| CFREF, CFCW, CFDW, CFDH, CFRAC | Fixed | 1.0, 1.0, 1.0, 1.0, 0.58 | 7 |
| RAC Time Period Allocation Factors | Fixed | 65.1%, 34.9%, 0.0%, 0.0% | 2 |
| kWBASE | Fixed | 0.0926 | 11 |
| kWEE | Fixed | 0.0813 | 11 |
| HOURS | Fixed | 5000 | 11 |
| ΔkW | Fixed | 0.0113 | 11 |

Sources:

1. Energy Star Refrigerator Savings Calculator (Calculator updated: 2/15/05; Constants updated 05/07). Demand savings derived using refrigerator load shape.
2. Time period allocation factors used in cost-effectiveness analysis. From residential appliance load shapes.
3. Energy and water savings based on Consortium for Energy Efficiency estimates. Assumes 75% of participants have gas water heating and 60% have gas drying (the balance being electric). Demand savings derived using NEEP screening clothes washer load shape.
4. Energy and water savings from RLW Market Update. Assumes 37% electric hot water market share and 63% gas hot water market share. Demand savings derived using dishwasher load shape.
5. Energy and demand savings from engineering estimate based on 600 hours of use. Based on delta watts for ENERGY STAR and non-ENERGY STAR units in five different size (cooling capacity) categories. Category weights from LBNL *Technical Support Document for ENERGY STAR Conservation Standards for Room Air Conditioners*.
6. Average demand savings based on engineering estimate.
7. Coincidence factors already embedded in summer peak demand reduction estimates with the exception of RAC. RAC CF is based on data from PEPCO.
8. Prorated based on six months in the summer period and six months in the winter period.
9. Energy Star Dehumidifier Savings Calculator (Calculator updated: 2/15/05; Constants updated 05/07). A weighted average based on the distribution of available ENERGY STAR products was used to determine savings.
10. Conservatively assumes same kW/kWh ratio as Refrigerators.
11. Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).
12. All values are taken from the Energy Star Savings Calculators at www.energystar.gov.

Table ~~7~~ 4-2: Energy Savings from Energy Star Calculators

| **Measure** | **Energy Savings** |
| --- | --- |
| **Refrigerator** |  |
| Manual Defrost | 72 kWh |
| Partial Automatic Defrost | 72 kWh |
| Top mount freezer without door ice | 80 kWh |
| Side mount freezer without door ice | 95 kWh |
| Bottom mount freezer without door ice | 87 kWh |
| Top mount freezer with door ice | 94 kWh |
| Side mount freezer with door ice | 100 kWh |
| **Freezers** |  |
| Upright with manual defrost | 55 kWh |
| Upright with automatic defrost | 80 kWh |
| Chest Freezer | 52 kWh |
| Compact Upright with manual defrost | 62 kWh |
| Compact Upright with automatic defrost | 83 kWh |
| Compact Chest Freezer | 55 kWh |
| **Dehumidifier** |  |
| 1-25 pints/day | 54 kWh |
| 25-35 pints/day | 117 kWh |
| 35-45 pints/day | 213 kWh |
| 45-54 pints/day | 297 kWh |
| 54-75 pints/day | 342 kWh |
| 75-185 pints/day | 374 kWh |
| **Room Air Conditioner** (Load hours in parentheses) |  |
| Allentown | 74 kWh (784 hours) |
| Erie | 46 kWh (482 hours) |
| Harrisburg | 88 kWh (929 hours) |
| Philadelphia | 98 kWh (1032 hours) |
| Pittsburgh | 70 kWh (737 hours) |
| Scranton | 59 kWh (621 hours) |
| Williamsport | 62 kWh (659 hours) |
| **Dishwasher** |  |
| With Gas Hot Water Heater | 77 kWh |
| With Electric Hot Water Heater | 137 kWh |
| **Clothes Washer** |  |
| With Gas Hot Water Heater | 26 kWh |
| With Electric Hot Water Heater | 258 kWh |

## 4.2 Residential ENERGY STAR Lighting

### 4.2.1 Algorithms

Savings from installation of screw-in ENERGY STAR CFLs, ENERGY STAR fluorescent torchieres, ENERGY STAR indoor fixtures and ENERGY STAR outdoor fixtures are based on a straightforward algorithm that calculates the difference between existing and new wattage and the average daily hours of usage for the lighting unit being replaced. An “in-service” rate is used to reflect the fact that not all lighting products purchased are actually installed.

The general form of the equation for the ENERGY STAR or other high-efficiency lighting energy savings algorithm is:

Number of Units X Savings per Unit

Per unit savings estimates are derived primarily from a 2004 Nexus Market Research report evaluating similar retail lighting programs in New England (MA, RI and VT)

#### 4.2.1.1 ENERGY STAR CFL Bulbs

Electricity Impact (kWh) = ((CFLwatts X (CFLhours X 365))/1000) X ISRCFL

Peak Demand Impact (kW) = (CFLwatts) X Light CF

#### 4.2.1.2 ENERGY STAR Torchieres

Electricity Impact (kWh) = ((Torchwatts X (Torchhours X 365))/1000) X ISRTorch

Peak Demand Impact (kW) = (Torchwatts) X Light CF

#### 4.2.1.3 ENERGY STAR Indoor Fixture

Electricity Impact (kWh) = ((IFwatts X (IFhours X 365))/1000) X ISRIF

Peak Demand Impact (kW) = (IFwatts) X Light CF

#### 4.2.1.4 ENERGY STAR Outdoor Fixture

Electricity Impact (kWh) = ((OFwatts X (OFhours X 365))/1000) X ISROF

Peak Demand Impact (kW) = (OFwatts) X Light CF

#### 4.2.1.5 Ceiling Fan with ENERGY STAR Light Fixture

Energy Savings (kWh)*=*180 kWh

Demand Savings (kW)*=* 0.01968

## 4.2.2 Definition of Terms

CFLwatts = Average delta watts per purchased Energy Star CFL

CFLhours = Average hours of use per day per CFL

ISRCFL = In-service rate per CFL

Torchwatts = Average delta watts per purchased Energy Star torchiere

Torchhours = Average hours of use per day per torchiere

ISRTorch = In-service rate per Torchier

IFwatts = Average delta watts per purchased Energy Star Indoor Fixture

IFhours = Average hours of use per day per Indoor Fixture

ISRIF = In-service rate per Indoor Fixture

OFwatts = Average delta watts per purchased Energy Star Outdoor Fixture

OFhours = Average hours of use per day per Outdoor Fixture

ISROF = In-service rate per Outdoor Fixture

Light CF = Summer demand coincidence factor.

ΔkWh= Gross customer annual kWh savings for the measure

ΔkW= Gross customer connected load kW savings for the measure

**Table ~~8~~ 4-3: ENERGY STAR Lighting - References**

| **Component** | **Type** | **Value** | **Sources** |
| --- | --- | --- | --- |
| CFLwatts | Fixed | Variable | Data Gathering |
| CFLhours | Fixed | 3.0 | 6 |
| ISRCFL | Fixed | 84% | 3 |
| Torchwatts | Fixed | 115.8 | 1 |
| Torchhours | Fixed | 3.0 | 2 |
| ISRTorch | Fixed | 83% | 3 |
| IFwatts | Fixed | 48.7 | 1 |
| IFhours | Fixed | 2.6 | 2 |
| ISRIF | Fixed | 95% | 3 |
| OFwatts | Fixed | 94.7 | 1 |
| OFhours | Fixed | 4.5 | 2 |
| ISROF | Fixed | 87% | 3 |
| Light CF | Fixed | 5% | 4 |
| ΔkWh | Fixed | 180 kWh | 5 |
| ΔkW | Fixed | 0.01968 | 5 |

Sources:

1. Nexus Market Research, “Impact Evaluation of the Massachusetts, Rhode Island and Vermont 2003 Residential Lighting Programs”, Final Report, October 1, 2004, p. 43 (Table 4-9)
2. Ibid., p. 104 (Table 9-7). This table adjusts for differences between logged sample and the much larger telephone survey sample and should, therefore, have less bias.
3. Ibid., p. 42 (Table 4-7). These values reflect both actual installations and the % of units planned to be installed within a year from the logged sample. The logged % is used because the adjusted values (~~i.e~~ to account for differences between logging and telephone survey samples) were not available for both installs and planned installs. However, this seems appropriate because the % actual installed in the logged sample from this table is essentially identical to the % after adjusting for differences between the logged group and the telephone sample (p. 100, Table 9-3).
4. RLW Analytics, “Development of Common Demand Impacts for Energy Efficiency Measures/Programs for the ISO Forward Capacity Market (FCM)”, prepared for the New England State Program Working Group (SPWG), March 25, 2007, p. IV.
5. Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).
6. US Department of Energy, Energy Star Calculator. Accessed 3-16-2009.

## 4.3 ENERGY STAR Windows

### 4.3.1 Algorithms

The general form of the equation for the ENERGY STAR or other high-efficiency windows energy savings’ algorithms is:

Square Feet of Window Area X Savings per Square Foot

To determine resource savings, the per square foot estimates in the algorithms will be multiplied by the number of square feet of window area. The number of square feet of window area will be determined using market assessments and market tracking. Some of these market tracking mechanisms are under development. The per unit energy and demand savings estimates are based on prior building simulations of windows.

***~~ENERGY STAR Windows~~***

Savings’ estimates for Energy Star Windows are based on modeling a typical 2,500 square foot home using REM Rate, the home energy rating tool.[[21]](#footnote-21) Savings are per square foot of qualifying window area. Savings will vary based on heating and cooling system type and fuel. These fuel and HVAC system market shares will need to be estimated from prior market research efforts or from future program evaluation results.

#### 4.3.1.1 Heat Pump HVAC System

Electricity Impact (kWh) = ESavHP

Demand Impact (kW) = DSavHP X CF

#### 4.3.1.2 Electric Heat/Central Air Conditioning

Electricity Impact (kWh) = ESavRES/CAC

Demand Impact (kW) = DSavCAC X CF

#### 4.3.1.3 Electric Heat/No Central Air Conditioning

Electricity Impact (kWh) = ESavRES/NOCAC

Demand Impact (kW) = DSavNOCAC X CF

### 4.3.2 Definition of Terms

ESavHP= Electricity savings (heating and cooling) with heat pump installed.

ESavRES/CAC = Electricity savings with electric resistance heating and central AC installed.

ESavRES/NOCAC = Electricity savings with electric resistance heating and no central AC installed.

DSavHP= Summer demand savings with heat pump installed.

DSavCAC = Summer demand savings with central AC installed.

DSavNOCAC = Summer demand savings with no central AC installed.

CF = System peak demand coincidence factor. Coincidence of building cooling demand to summer system peak.

**Table ~~94-4~~: Energy Star Windows - References**

| **Component** | **Type** | **Value** | **Sources** |
| --- | --- | --- | --- |
| ESavHP | Fixed | 2.2395 kWh | 1 |
| HP Time Period Allocation Factors | Fixed | Summer/On-Peak 10%  Summer/Off-Peak 7%  Winter/On-Peak 40%  Winter/Off-Peak 44% | 2 |
| ESavRES/CAC | Fixed | 4.0 kWh | 1 |
| Res/CAC Time Period  Allocation Factors | Fixed | Summer/On-Peak 10%  Summer/Off-Peak 7%  Winter/On-Peak 40%  Winter/Off-Peak 44% | 2 |
| ESavRES/NOCAC | Fixed | 3.97 kWh | 1 |
| Res/No CAC Time Period Allocation Factors | Fixed | Summer/On-Peak 3%  Summer/Off-Peak 3%  Winter/On-Peak 45%  Winter/Off-Peak 49% | 2 |
| DSavHP | Fixed | 0.000602 kW | 1 |
| DSavCAC | Fixed | 0.000602 kW | 1 |
| DSavNOCAC | Fixed | 0.00 kW | 1 |
| CF | Fixed | 0.75 | 3 |

Sources:

1. From REMRATE Modeling of a typical 2,500 sq. ft. NJ home. Savings expressed on a per square foot of window area basis. New Brunswick climate data.
2. Time period allocation factors used in cost-effectiveness analysis.
3. Based on reduction in peak cooling load.
4. Prorated based on 12% of the annual degree days falling in the summer period and 88% of the annual degree days falling in the winter period.

### 4.4 ENERGY STAR Audit

## 4.4.1 Algorithms

No algorithm was developed to measure energy savings for this program. The purpose of the program is to provide information and tools that residential customers can use to make decisions about what actions to take to improve energy efficiency in their homes. Many measure installations that are likely to produce significant energy savings are covered in other programs. These savings are captured in the measured savings for those programs. The savings produced by this program that are not captured in other programs would be difficult to isolate and relatively expensive to measure.

## 4.5 Refrigerator/Freezer Retirement

## 4.5.1 Algorithms

The general form of the equation for the Refrigerator/Freezer Retirement savings algorithm is:

Number of Units X Savings per Unit

To determine resource savings, the per unit estimates in the algorithms will be multiplied by the number of appliance units.

Unit savings are the product of average fridge/freezer consumption (gross annual savings).

~~Algorithm~~

Electricity Impact (kWh) = ESavRetFridge

Demand Impact (kW) = DSavRetFridge X CFRetFridge

4.5.2 **Definition of Terms**

ESavRetFridge = Gross annual energy savings per unit retired appliance

DSavRetFridge = Summer demand savings per retired refrigerator/freezer

CFRetFridge = Summer demand coincidence factor.

**Table ~~10~~ 4-5: Refrigerator/Freezer Recycling - References**

| **Component** | **Type** | **Value** | **Sources** |
| --- | --- | --- | --- |
| ESavRetFridge | Fixed | 1,728 kWh | 1 |
| DSavRetFridge | Fixed | .2376 kW | 2 |
| CFRetFridge | Fixed | 1 | 3 |

Sources:

1. The average power consumption of units retired under similar recent programs:

a. Fort Collins Utilities, February 2005. Refrigerator and Freezer Recycling Program 2004 Evaluation Report.

b. Midwest Energy Efficiency Alliance, 2005. 2005 Missouri Energy Star Refrigerator Rebate and Recycling Program Final Report

c. Pacific Gas and Electric, 2007. PGE ARP 2006-2008 Climate Change Impacts Model (spreadsheet)

d. Quantec, Aug 2005. Evaluation of the Utah Refrigerator and Freezer Recycling Program (Draft Final Report).

e. CPUC DEER website, <http://eega.cpuc.ca.gov/deer/measure.asp?s=1&c=2&sc=7&m=389059>

f. Snohomish PUD, February 2007. 2006 Refrigerator/Freezer Recycling Program Evaluation.

g. Ontario Energy Board, 2006. Total Resource Cost Guide.

1. Applied the kW to kWh ratio derived from Refrigerator savings in the ENERGY STAR Appliances Program.
2. Coincidence factor already embedded in summer peak demand reduction estimates

# 5 Home Performance with ENERGY STAR

In order to implement Home Performance with Energy Star, there are various standards a program implementer must adhere to in order to deliver the program. The program implementer must use software that meets a national standard for savings calculations from whole-house approaches such as home performance. The software program implementer must adhere to at least one of the following standards:

* A software tool whose performance has passed testing according to the National Renewable Energy Laboratory’s HERS BESTEST software energy simulation testing protocol.[[22]](#footnote-22)
* Software approved by the US Department of Energy’s Weatherization Assistance Program.[[23]](#footnote-23)
* RESNET approved rating software.[[24]](#footnote-24)

There are numerous software packages that comply with these standards. Some examples of the software packages are REM/Rate, EnergyGauge, TREAT, and HomeCheck. The HomeCheck software is described below as an example of a software that can be used to determine if a home qualifies for Home Performance with Energy Star.

## 5.1 HomeCheck Software Example

Conservation Services Group (CSG) implements Home Performance with Energy Star in several states. CSG has developed proprietary software known as HomeCheck which is designed to enable an energy auditor to collect information about a customer’s site and based on what is found through the energy audit, recommend energy savings measures and demonstrate the costs and savings associated with those recommendations. The HomeCheck software is also used to estimate the energy savings that are reported for this program.

CSG has provided a description of the methods and inputs utilized in the HomeCheck software to estimate energy savings. CSG has also provided a copy of an evaluation report prepared by Nexant which assessed the energy savings from participants in the Home Performance with Energy Star Program managed by the New York State Energy Research and Development Authority (NYSERDA)[[25]](#footnote-25). The report concluded that the savings estimated by HomeCheck and reported to NYSERDA were in general agreement with the savings estimates that resulted from the evaluation.

These algorithms incorporate the HomeCheck software by reference which will be utilized for estimating energy savings for Home Performance with Energy Star. The following is a summary of the HomeCheck software which was provided by CSG: CSG’s HomeCheck software was designed to streamline the delivery of energy efficiency programs. The software provides the energy efficiency specialist with an easy-to-use guide for data collection, site and HVAC testing algorithms, eligible efficiency measures, and estimated energy savings. The software is designed to enable an auditor to collect information about customers’ sites and then, based on what he/she finds through the audit, recommend energy-saving measures, demonstrate the costs and savings associated with those recommendations. It also enables an auditor/technician to track the delivery of services and installation of measures at a site.

This software is a part of an end-to-end solution for delivering high-volume retrofit programs, covering administrative functions such as customer relationship management, inspection scheduling, sub-contractor arranging, invoicing and reporting. The range of existing components of the site that can be assessed for potential upgrades is extensive and incorporates potential modifications to almost all energy using aspects of the home. The incorporation of building shell, equipment, distribution systems, lighting, appliances, diagnostic testing and indoor air quality represents a very broad and comprehensive ability to view the needs of a home.

The software is designed to combine two approaches to assessing energy savings opportunities at the site. One is a measure specific energy loss calculation, identifying the change in use of BTU’s achieved by modifying a component of the site. Second, is the correlation between energy savings from various building improvements, and existing energy use patterns at a site. The use of both calculated savings and the analysis of existing energy use patterns, when possible, provides the most accurate prescription of the impact of changes at the site for an existing customer considering improvements on a retrofit basis.

This software is not designed to provide a load calculation for new equipment or a HERS rating to compare a site to a standard reference site. It is designed to guide facilities in planning improvements at the site with the goal of improved economics, comfort and safety. The software calculates various economic evaluations such as first year savings, simple payback, measure life cost-effectiveness, and Savings-to-Investment ratio (SIR).

**5.1.1 Site-Level Parameters and Calculations**

There are a number of calculations and methodologies that apply across measures and form the basis for calculating savings potentials at a site.

**5.1.2 Heating Degree Days and Cooling Degree Hours**

Heat transfer calculations depend fundamentally on the temperature difference between inside and outside temperature. This temperature difference is often summarized on a seasonal basis using fixed heating degree-days (HDD) and cooling degree-hours CDH). The standard reference temperature for calculating HDD (the outside temperature at which the heating system is required), for example, has historically been 65°F. Modern houses have larger internal gains and more efficient thermal building envelopes than houses did when the 65°F standard was developed, leading to lower effective reference temperatures. This fact has been recognized in ASHRAE Fundamentals, which provides a variable-based degree-day method for calculating energy usage. CSG’s Building Model calculates both HDD and CDH based on the specific characteristics and location of the site being treated.

**5.1.3 Building Loads, Other Parameters, and the Building Model**

CSG is of the opinion that, in practice, detailed building load simulation tools are quite limited in their potential to improve upon simpler approaches due to their reliance on many factors that are not measurable or known, as well as limitations to the actual models themselves. Key to these limitations is the Human Factor (e.g., sleeping with the windows open; extensive use of high-volume extractor fans, etc.) that is virtually impossible to model. As such, the basic concept behind the model was to develop a series of location specific lookup tables that would take the place of performing hourly calculations while allowing the model to perform for any location. The data in these tables would then be used along with a minimum set of technical data to calculate heating and cooling building loads.

In summary, the model uses:

* Lookup tables for various parameters that contain the following values for each of the 239 TMY2 weather stations:
  + Various heating and cooling infiltration factors.
  + Heating degree days and heating hours for a temperature range of 40 to 72°F.
  + Cooling degree hours and cooling hours for a temperature range of 68 to 84°F.
  + Heating and cooling season solar gain factors.
* Simple engineering algorithms based on accepted thermodynamic principles, adjusted to reflect known errors, the latest research and measured results
* Heating season iterative calculations to account for the feedback loop between conditioned hours, degree days, average “system on” indoor and outdoor temperatures and the building
* The thermal behavior of homes is complex and commonly accepted algorithms will on occasion predict unreasonably high savings, HomeCheck uses a proprietary methodology to identify and adjust these cases. This methodology imposes limits on savings projected by industry standard calculations, to account for interactivities and other factors that are difficult to model. These limits are based on CSG’s measured experience in a wide variety of actual installations.

**5.1.4 Usage Analysis**

The estimation of robust building loads through the modeling of a building is not always reliable. Thus, in addition to modeling the building, HomeCheck calculates a normalized annual consumption for heating and cooling, calculated from actual fuel consumption and weather data using a Seasonal Swing methodology. This methodology uses historic local weather data and site-specific usage to calculate heating and cooling loads. The methodology uses 30-year weather data to determine spring and fall shoulder periods when no heating or cooling is likely to be in use. The entered billing history is broken out into daily fuel consumption, and these daily consumption data along with the shoulder periods is used to calculate base load usage and summer and winter seasonal swing fuel consumption.

**5.1.5 Multiple HVAC Systems**

HVAC system and distribution seasonal efficiencies are used in all thermal-shell measure algorithms. HVAC system and distribution seasonal efficiencies and thermostat load reduction adjustments are used when calculating the effect of interactivity between mechanical and architectural measures. If a site has multiple HVAC systems, weighted average seasonal efficiencies and thermostat load reduction adjustments are calculated based on the relative contributions (in terms of percent of total load) of each system.

**5.1.6 Multiple Heating Fuels**

It is not unusual to find homes with multiple HVAC systems using different fuel types. In these cases, it is necessary to aggregate the NACs for all fuel sources for use in shell savings algorithms. This is achieved by assigning a percentage contribution to total NAC for each system, converting this into BTU’s, and aggregating the result. Estimated first year savings for thermal shell measures are then disaggregated into the component fuel types based on the pre-retrofit relative contributions of fuel types.

**5.1.7 Interactivity**

To account for interactivity between architectural and mechanical measures, CSG’s HomeCheck employs the following methodology, in order:

* Noninteracted first year savings are calculated for each individual measure.
* Non-interacted SIR (RawSIR) is calculated for each measure.
* Measures are ranked in descending order of RawSIR,
* Starting with the most cost-effective measure (as defined by RawSIR), first year savings are adjusted for each measure as follows:
  + Mechanical measures (such as thermostats, HVAC system upgrades or distribution system upgrades) are adjusted to account for the load reduction from measures with a higher RawSIR.
  + Architectural measures are adjusted to account for overall HVAC system efficiency changes and thermostat load reduction changes. Architectural measures with a higher RawSIR than that of HVAC system measures are calculated using the existing efficiencies. Those with RawSIR’s lower than that of heating equipment use the new heating efficiencies.
* Interacted SIR is then calculated for each measure, along with cumulative SIR for the entire job.
* All measures are then re-ranked in descending order of SIR.
* The process is repeated, replacing RawSIR with SIR until the order of measures does not change.

### 5.2 Lighting

Quantification of additional saving due to the addition of high efficiency lighting will be based on the algorithms presented for these appliances in the Energy Star Lighting Algorithms found in Energy Star Products.

# 6 Commercial and Industrial ~~Energy~~ Electric Efficient Construction

## ~~C&I Electric~~

### 6.1 Baselines and Code Changes

All baselines are designed to reflect current market practices which are generally the higher of code or available equipment, that are updated periodically to reflect upgrades in code or information from evaluation results.

Pennsylvania has adopted the 2006 International Energy Conservation Code (IECC) per 34 Pa. Code Section 403.21, effective 12/31/06 by reference to the International Building code and the ICC electrical code. This family of codes references ASHRAE 90.1-2004 for minimum energy efficiency standards for commercial and industrial construction projects.

### 6.2 Lighting ~~Equipment~~ Improvements

Lighting equipment includes fluorescent fixtures (lamps and ballasts), compact fluorescent lamps, LED exit signs, metal halide lamps and lighting controls. The calculation of energy savings is based on algorithms through the stipulation of key variables (i.e. Coincidence Factor, Interactive Factor and Equivalent Full Load Hours) and through end-use metering referenced in historical studies or measured, as may be required, at the project level.

~~For new construction and entire facility rehabilitation projects, savings are calculated using market-driven assumptions that presume a decision to upgrade the lighting system from an industry standard system. For existing commercial lighting, the most efficient T-12 lamp and magnetic ballast fixture serves as the baseline. For T-5 and T-8 fixtures replacing HID, 250 watt or greater T-12 fluorescentor 250 watt or greater incandescent fixtures savings are calculated referencing pre-existing connected lighting load.~~

~~Lighting equipment includes fluorescent fixtures, ballasts, compact fluorescent fixtures, exit signs, LED fixtures and metal halide lamps. The measurement of energy savings is based on algorithms with measurement of key variables (i.e., Coincidence Factor and Operating Hours) through end-use metering data accumulated from a large sample of participating facilities from 1995 through 1999.~~

For all lighting efficiency improvements, with and without control improvements, the following algorithms apply:

#### 6.2.1 Algorithms

ΔkW = kWbase - kWinst

~~Energy Savings (kWh) = ΔkW X EFLH X (1+IF)~~

Demand Savings (kW) = ΔkW X CF X (1+IF demand)

Energy Savings = [kWbase X(1+IF energy) X EFLH] – [kWinst X(1+IF energy) X EFLH X (1 – SVG)]

#### 6.2.2 Definition of Variables

ΔkW = Change in connected load from baseline (pre-retrofit) to installed (post-retrofit) ~~efficient~~ lighting level. ~~The baseline value is expressed in watts/square foot calculated as: (Watts/Sq.Ft. - Watts/Sq.Ft. (qualified equipment by same area))\*Area Sq.Ft./1000 (see table above).~~

kWbase = kW of baseline lighting as defined in Section 6.2.3.

kWinst = kW of installed lighting.

CF = Demand Coincidence Factor – the ~~value represents the~~ percentage of the total lighting connected load ~~which~~ that is on during electric system’s ~~Pp~~eak ~~W~~window as defined in Section 1.9. ~~The Peak Window covers the time period from 12 noon to 8 p.m. These values are based on measured usage in the JCP&L service territory.~~

EFLH = Equivalent Full Load Hours – the average annual operating hours of the baseline lighting equipment, which if applied to full connected load will yield annual energy use.

IF demand = Interactive HVAC Demand Factor – applies to C&I interior lighting in space that has air conditioning or refrigeration only. This represents the secondary demand ~~and energy~~ savings in cooling required which ~~reduced HVAC consumption~~ result~~ing~~sfrom decreased indoor lighting wattage.

~~EFLH = Equivalent Full Load Hours – represents the annual operating hours.~~

IF energy = Interactive HVAC Energy Factor – applies to C&I interior lighting in space that has air conditioning or refrigeration only. This represents the secondary energy savings in cooling required which results from decreased indoor lighting wattage.

SVG = The percent of time that lights are off due to lighting controls relative to the baseline controls system (typically manual switch).

6.2.3 Baseline Assumptions

The baseline assumptions will be adjusted from program year one to program year two. This adjustment will take into account standard building practices in order to estimate savings more accurately.

6.2.3.1 Program Year One

For new construction and building additions (not comprehensive retrofit projects), savings are calculated using assumptions that presume a decision to upgrade the lighting system from a baseline industry standard system, defined as the most efficient T-12 lamp and magnetic ballast.

For retrofit projects, the most efficient T12 lamp and magnetic ballast fixture serves as the baseline for most T8 fixture installations. Where T5 and T8 fixtures replace HID fixtures, 250 watt or greater T12 fluorescent fixtures, or 250 watt or greater incandescent fixtures, savings are calculated referencing pre-existing connected lighting load.

6.2.3.2 Program Year Two

For new construction and facility renovation projects, savings are calculated as described in Section 6.2.6.1 below.

For retrofit projects, the calculation method described below in Section 6.2.6.3 and Section 6.2.6.4 will be followed.

6.2.4 Detailed Inventory Form

For lighting improvement projects, savings are generally proportional to the number of fixtures installed or replaced. The method of savings verification will vary depending on the size of the project because fixtures can be hand-counted to a reasonable degree to a limit.

6.2.4.1 Projects with less than 20 kW of savings

For projects having less than 20kW in savings, a detailed inventory is not required but information sufficient to validate savings according to the algorithm above must be included in the documentation. This includes identification of baseline equipment utilized for quantifying kW base.

6.2.4.2 Projects with 20 kW or higher savings

Using the above algorithms, ΔkW values will be multipled by the number of fixtures installed. The total ΔkW savings is derived by summing the total ΔkW for each installed measure.

In the same project, to the extent there are different control strategies (SVG), hours of use (EFLH) or interactive factors (IF), the ΔkW will be broken out to account for these different factors. This will be accomplished using an inventory in Excel format that specifies the lamp and ballast configuration using the Expanded Prescriptive Lighting Wattage table and SVG, EFLH and IF values for the line entry. The inventory will also specify the location and number of fixtures for reference and validation. A sample of the inventory format incorporating the algorithms for savings calculation and the Expanded Prescriptive Lighting Wattage Table are included in Appendix C.

The Expanded Prescriptive Lighting Wattage Table will be updated periodically to include new fixtures and technologies available as may be appropriate.

6.2.5 Quantifying Annual Hours of Operation

Projects with large impacts will typically include whole building lighting improvements in varying space types, which in turn may have different operating hours.

6.2.5.1 Projects with less than 50kW of savings

For lighting projects with savings less than 50 kW, stipulated whole building hours of use will be used a sshown below in Table 6-6.

6.2.5.2 Projects with 50kW or higher savings

For lighting projects with savings equal to or greater than 50kW, hours of use will be estimated for the Hours of Use Groups specified in Table 6-1, using a combination of facility interviews, prescriptive tables (to be developed by the SWE in conjunction with the TWG), or logging. Interviews alone are not sufficient because results from interviews along could be subject to adjustment by evaluators. Allocations of light fixtures or lamp and ballast retrofits to Hours of Use Groups are made on the electronic inventory form shown in Appendix C.

Table 6‑1: Hours of Use Groups Required per Building Type[[26]](#footnote-26)

| **Building Type** | **Minimum Number of Usage Groups[[27]](#footnote-27)** | **Examples of Usage Group types** |
| --- | --- | --- |
| Office Buildings | 6 | General offices, private offices, hallways, restrooms, conference, lobbies, 24-hr |
| Education (K-12) | 6 | Classrooms, offices, hallways, restrooms, admin, auditorium, gymnasium, 24-hr |
| Education (College/University) | 6 | Classrooms, offices, hallways, restrooms, admin, auditorium, library, dormitory, 24-hr |
| Hospitals/ Health Care Facilities | 8 | Patient rooms, operating rooms, nurses station, exam rooms, labs, offices, hallways |
| Retail Stores | 5 | Sales floor, storeroom, displays, private office, 24-hr |
| Industrial/ Manufacturing | 6 | Manufacturing, warehouse, shipping, offices, shops, 24-hr |
| Other | Variable | All major usage groups within building |

### 6.2.6 Description of Calculation Method by Project Type

#### 6.2.6.1 New Construction and Building Additions

For new construction and building addition projects, savings are calculated using ASHRAE 90.1-2004 as the baseline (kWbase) and the new wattages and fixtures as the post-installation wattage. The existing baseline, pursuant to ASHRAE 90.1-2004, is shown in below, and the new fixture wattages are specified in the Expanded Prescriptive Lighting Wattage Table shown in Appendix C.

EFLH, CF and IF values are the same as those shown in 6 and 7.

Table 6‑2: ASHRAE 90.1-2004 Lighting Baseline for New Construction and Building Additions

| **Common Space Type[[28]](#footnote-28)** | **LPD (W/ft2)** | **Building Specific Space Types** | **LPD (W/ft2)** |
| --- | --- | --- | --- |
| Office-Enclosed | 1.1 | Gymnasium/Exercise Center |  |
| Office-Open Plan | 1.1 | Playing Area | 1.4 |
| Conference/Meeting/Multipurpose | 1.3 | Exercise Area | 0.9 |
| Classroom/Lecture/Training | 1.4 | Courthouse/Police Station/Penitentiary |  |
| For Penitentiary | 1.3 | Courtroom | 1.9 |
| Lobby | 1.3 | Confinement Cells | 0.9 |
| For Hotel | 1.1 | Judges Chambers | 1.3 |
| For Performing Arts Theater | 3.3 | Fire Stations |  |
| For Motion Picture Theater | 1.1 | Fire Station Engine Room | 0.8 |
| Audience/Seating Area | 0.9 | Sleeping Quarters | 0.3 |
| For Gymnasium | 0.4 | Post Office-Sorting Area | 1.2 |
| For Exercise Center | 0.3 | Convention Center-Exhibit Space | 1.3 |
| For Convention Center | 0.7 | Library |  |
| For Penitentiary | 0.7 | Card File and Cataloging | 1.1 |
| For Religious Buildings | 1.7 | Stacks | 1.7 |
| For Sports Arena | 0.4 | Reading Area | 1.2 |
| For Performing Arts Theater | 2.6 | Hospital |  |
| For Motion Picture Theater | 1.2 | Emergency | 2.7 |
| For Transportation | 0.5 | Recovery | 0.8 |
| Atrium—First Three Floors | 0.6 | Nurse Station | 1.0 |
| Atrium—Each Additional Floor | 0.2 | Exam/Treatment | 1.5 |
| Lounge/Recreation | 1.2 | Pharmacy | 1.2 |
| For Hospital | 0.8 | Patient Room | 0.7 |
| Dining Area | 0.9 | Operating Room | 2.2 |
| For Penitentiary | 1.3 | Nursery | 0.6 |
| For Hotel | 1.3 | Medical Supply | 1.4 |
| For Motel | 1.2 | Physical Therapy | 0.9 |
| For Bar Lounge/Leisure Dining | 1.4 | Radiology | 0.4 |
| For Family Dining | 2.1 | Laundry—Washing | 0.6 |
| Food Preparation | 1.2 | Automotive—Service/Repair | 0.7 |
| Laboratory | 1.4 | Manufacturing |  |
| Restrooms | 0.9 | Low (<25 ft Floor to Ceiling Height) | 1.2 |
| Dressing/Locker/Fitting Room | 0.6 | High (>25 ft Floor to Ceiling Height) | 1.7 |
| Corridor/Transition | 0.5 | Detailed Manufacturing | 2.1 |
| For Hospital | 1.0 | Equipment Room | 1.2 |
| For Manufacturing Facility | 0.5 | Control Room | 0.5 |
| Stairs—Active | 0.6 | Hotel/Motel Guest Rooms | 1.1 |
| Active Storage | 0.8 | Dormitory—Living Quarters | 1.1 |
| For Hospital | 0.9 | Museum |  |
| Inactive Storage | 0.3 | General Exhibition | 1.0 |
| For Museum | 0.8 | Restoration | 1.7 |
| Electrical/Mechanical | 1.5 | Bank/Office—Banking Activity Area | 1.5 |
| Workshop | 1.9 | Religious Buildings |  |
|  |  | Worship Pulpit, Choir | 2.4 |
|  |  | Fellowship Hall | 0.9 |
|  |  | Retail [For accent lighting, see 9.3.1.2.1(c)] |  |
|  |  | Sales Area | 1.7 |
|  |  | Mall Concourse | 1.7 |
|  |  | Sports Arena |  |
|  |  | Ring Sports Area | 2.7 |
|  |  | Court Sports Area | 2.3 |
|  |  | Indoor Playing Field Area | 1.4 |
|  |  | Warehouse |  |
|  |  | Fine Material Storage | 1.4 |
|  |  | Medium/Bulky Material Storage | 0.9 |
|  |  | Parking Garage—Garage Area | 0.2 |
|  |  | Transportation |  |
|  |  | Airport—Concourse | 0.6 |
|  |  | Air/Train/Bus—Baggage Area | 1.0 |
|  |  | Terminal—Ticket Counter | 1.5 |

#### 6.2.6.2 Traffic Signal Lighting Improvements

Traffic signal lighting improvements use the lighting algorithms with the assumptions set forth in and **Error! Reference source not found.**.

Table 6‑3: Assumptions for Lighting Algorithm Relative to Traffic Signal Improvements

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Type** | **Value** | **Source** |
| ΔkW | Variable | See **Error! Reference source not found.** | PECo |
| CF | Red Round | 55% | PECo |
| Yellow Round | 2% |
| Round Green | 43% |
| Turn Yellow | 8% |
| Turn Green | 8% |
| Pedestrian | 100% |
| EFLH | Variable | See **Error! Reference source not found.** | PECo |
| IF | Fixed | 0 |  |

~~Using the above alforithms,~~

**Table 6-4: Traffic Signals[[29]](#footnote-29)**

|  | Wattage | % Burn | Burn Hours | kWhs | Demand Savings | Energy Savings |
| --- | --- | --- | --- | --- | --- | --- |
| **Round Traffic Signals** | | | | | | |
| Red 8" | 69 | 55% | 4,818 | 332 | - | - |
| Red 8" LED | 7 | 55% | 4,818 | 34 | 0.062 | 299 |
| Yellow 8" | 69 | 2% | 175 | 12 | - | - |
| Yellow 8" LED | 10 | 2% | 175 | 2 | 0.059 | 10 |
| Green 8" | 69 | 43% | 3,767 | 260 | - | - |
| Green 8" LED | 9 | 43% | 3,767 | 34 | 0.060 | 226 |
| Red 12" | 150 | 55% | 4,818 | 723 | - | - |
| Red 12" LED | 6 | 55% | 4,818 | 29 | 0.144 | 694 |
| Yellow 12" | 150 | 2% | 175 | 26 | - | - |
| Yellow 12" LED | 13 | 2% | 175 | 2 | 70.137 | 24 |
| Green 12" | 150 | 43% | 3,767 | 565 | - | - |
| Green 12" LED | 12 | 43% | 3,767 | 45 | 0.138 | 520 |
| **Turn Arrows** | | | | | | |
| Yellow 8" | 116 | 8% | 701 | 81 | - | - |
| Yellow 8" LED | 7 | 8% | 701 | 5 | 0.109 | 76 |
| Yellow 12" | 116 | 8% | 701 | 81 | - | - |
| Yellow 12" LED | 9 | 8% | 701 | 6 | 0.107 | 75 |
| Green 8" | 116 | 8% | 701 | 81 | - | - |
| Green 8" LED | 7 | 8% | 701 | 5 | 0.109 | 76 |
| Green 12" | 116 | 8% | 701 | 81 | - | - |
| Green 12" LED | 7 | 8% | 3767 | 5 | 0.109 | 76 |
| **Pedestrian Signs** | | | | | | |
| Hand/Man 12" | 116 | 100% | 8,760 | 1,016 | - | - |
| Hand/Man LED | 8 | 100% | 8,760 | 70 | 0.108 | 946 |
| Note: kWh and Energy Savings are Annual; Demand Savings listed are per lamp. | | | | | | |

**~~Reference specifications for above traffic signal wattages are from the following manufacturers:~~**

~~8” Incandescent traffic signal bulb: General Electric Traffic Signal Model 17325-69A21/TS~~

~~12” Incandescent traffic signal bulb: General Electric Signal Model 35327-150PAR46/TS~~

~~Incandescent Arrows & Hand/Man Pedestrian Signs: General Electric Traffic Signal Model 19010-116A21/TS~~

~~8” and 12” LED traffic signals: Leotek Models TSL-ES08 and TSL-ES12~~

~~8” LED Yellow Arrow: General Electric Model DR4-YTA2-01A~~

~~8” LED Green Arrow: General Electric Model DR4-GCA2-01A~~

~~12” LED Yellow Arrow: Dialight Model 431-3334-001X~~

~~12: LED Green Arrow: Dialight Model 432-2324-001X~~

~~LED Hand/Man Pedestrian Sign: dialight 430-6450-001X~~

~~Coincidence factor for demand savings = 55% for red, 43% for green and 2% for yellow.~~

### ~~Prescriptive Lighting~~

~~Prescriptive Lighting is a fixture replacement program for existing commercial customers that are targeted at facilities performing efficiency upgrades to their lighting systems.~~

~~The baseline is existing T-12 fixtures with energy efficient lamps and magnetic ballast.~~

~~The baseline for compact fluorescent is that the fixture replaced was four times the wattage of the replacement compact fluorescent.~~

#### ~~Algorithms~~

~~Energy Savings (kWh) = ΔkW X EFLH~~

~~Demand Savings (kW) = ΔkW X CF~~

~~ΔkW=Number of fixtures installed X (baseline wattage for fixture type(from above baseline))-number of replaced fixtures X (wattage from table)~~

~~Table 12: Prescriptive Lighting Savings Table~~

~~The table will be updated periodically to include new fixtures and technologies available after table publication. Baselines will be established based on the guidelines noted above.~~

| **~~Fixture Type~~** | **~~Type~~** | **~~New Watts (w/fixture)~~** | **~~Baseline (w/fixture)~~** | **~~Savings (w/fixture)~~** |
| --- | --- | --- | --- | --- |
| ~~COMPACT FLUORESCENT (2) 11W CF/HW~~ | ~~CFL2~~ | ~~26~~ | ~~104~~ | ~~78~~ |
| ~~COMPACT FLUORESCENT (2) 13W CF/HW~~ | ~~CFL2~~ | ~~30~~ | ~~120~~ | ~~90~~ |
| ~~COMPACT FLUORESCENT (2) 18W CF/HW~~ | ~~CFL2~~ | ~~36~~ | ~~144~~ | ~~108~~ |
| ~~COMPACT FLUORESCENT (2) 18W QD/ELEC~~ | ~~CFL2~~ | ~~38~~ | ~~152~~ | ~~114~~ |
| ~~COMPACT FLUORESCENT (3) 18W~~ | ~~CFL2~~ | ~~54~~ | ~~225~~ | ~~171~~ |
| ~~COMPACT FLUORESCENT (2) 26W CF/HW~~ | ~~CFL2~~ | ~~53~~ | ~~212~~ | ~~159~~ |
| ~~COMPACT FLUORESCENT (2) 26W QD/ELEC~~ | ~~CFL2~~ | ~~54~~ | ~~216~~ | ~~162~~ |
| ~~COMPACT FLUORESCENT (2) 5W CF/HW~~ | ~~CFL2~~ | ~~14~~ | ~~56~~ | ~~42~~ |
| ~~COMPACT FLUORESCENT (2) 7W CF/HW~~ | ~~CFL2~~ | ~~18~~ | ~~72~~ | ~~54~~ |
| ~~COMPACT FLUORESCENT (2) 9W CF/HW~~ | ~~CFL2~~ | ~~22~~ | ~~88~~ | ~~66~~ |
| ~~COMPACT FLUORESCENT 11W CF/HW~~ | ~~CFL1~~ | ~~13~~ | ~~52~~ | ~~39~~ |
| ~~COMPACT FLUORESCENT 13W CF/HW~~ | ~~CFL1~~ | ~~15~~ | ~~60~~ | ~~45~~ |
| ~~COMPACT FLUORESCENT 18W CF/HW~~ | ~~CFL1~~ | ~~19~~ | ~~76~~ | ~~57~~ |
| ~~COMPACT FLUORESCENT 18W QD/ELEC~~ | ~~CFL1~~ | ~~22~~ | ~~88~~ | ~~66~~ |
| ~~COMPACT FLUORESCENT 20W CF/HW~~ | ~~CFL1~~ | ~~22~~ | ~~88~~ | ~~66~~ |
| ~~COMPACT FLUORESCENT 22W QD/ELEC~~ | ~~CFL1~~ | ~~26~~ | ~~104~~ | ~~78~~ |
| ~~COMPACT FLUORESCENT 26W CF/HW~~ | ~~CFL1~~ | ~~28~~ | ~~112~~ | ~~84~~ |
| ~~COMPACT FLUORESCENT 26W QD/ELEC~~ | ~~CFL1~~ | ~~27~~ | ~~108~~ | ~~81~~ |
| ~~COMPACT FLUORESCENT 28W CF/HW~~ | ~~CFL1~~ | ~~30~~ | ~~120~~ | ~~90~~ |
| ~~COMPACT FLUORESCENT 32W CF/HW~~ | ~~CFL1~~ | ~~34~~ | ~~136~~ | ~~102~~ |
| ~~COMPACT FLUORESCENT 36W CF/HW~~ | ~~CFL1~~ | ~~41~~ | ~~164~~ | ~~123~~ |
| ~~COMPACT FLUORESCENT 40W CF/HW~~ | ~~CFL1~~ | ~~45~~ | ~~180~~ | ~~135~~ |
| ~~COMPACT FLUORESCENT (2) 40W CF/HW~~ | ~~CFL2~~ | ~~71~~ | ~~180~~ | ~~109~~ |
| ~~COMPACT FLUORESCENT 5W CF/HW~~ | ~~CFL1~~ | ~~7~~ | ~~28~~ | ~~21~~ |
| ~~COMPACT FLUORESCENT 7W CF/HW~~ | ~~CFL1~~ | ~~10~~ | ~~40~~ | ~~30~~ |
| ~~COMPACT FLUORESCENT 9W CF/HW~~ | ~~CFL1~~ | ~~11~~ | ~~44~~ | ~~33~~ |
| ~~Low Bay T-5 2L FP54/T5/Elec/Ho~~ | ~~LOBA~~ | ~~117~~ | ~~250~~ | ~~133~~ |
| ~~Low Bay T-5 3L FP54/T5/Elec/Ho~~ | ~~LOBA~~ | ~~179~~ | ~~290~~ | ~~111~~ |
| ~~Low Bay T-5 4L FP54/T5/Elec/Ho~~ | ~~LOBA~~ | ~~234~~ | ~~409~~ | ~~175~~ |
| ~~Low Bay T-5 6L FP54/T5/Elec/Ho~~ | ~~LOBA~~ | ~~351~~ | ~~992~~ | ~~641~~ |
| ~~Low Bay T-8 2L4~~ | ~~LOBA~~ | ~~55~~ | ~~73~~ | ~~18~~ |
| ~~Low Bay T-8 2L8~~ | ~~LOBA~~ | ~~118~~ | ~~158~~ | ~~40~~ |
| ~~Low Bay T-8 3L4~~ | ~~LOBA~~ | ~~79~~ | ~~105~~ | ~~26~~ |
| ~~Low Bay T-8 4L4~~ | ~~LOBA~~ | ~~110~~ | ~~146~~ | ~~36~~ |
| ~~Low Bay T-8 4L8~~ | ~~LOBA~~ | ~~233~~ | ~~316~~ | ~~83~~ |
| ~~Low Bay T-8 6L4~~ | ~~LOBA~~ | ~~224~~ | ~~454~~ | ~~230~~ |
| ~~High Bay T-5 3L FP54/T5/Elec/Ho~~ | ~~HIBA~~ | ~~179~~ | ~~290~~ | ~~111~~ |
| ~~High Bay T-5 4L FP54/T5/Elec/Ho~~ | ~~HIBA~~ | ~~234~~ | ~~409~~ | ~~175~~ |
| ~~High Bay T-5 6L FP54/T5/Elec/Ho~~ | ~~HIBA~~ | ~~351~~ | ~~992~~ | ~~641~~ |
| ~~High Bay T-8 8L4 FP54/T5/Elec/Ho~~ | ~~HIBA~~ | ~~468~~ | ~~1080~~ | ~~612~~ |
| ~~High Bay T-8 3L4~~ | ~~HIBA~~ | ~~79~~ | ~~105~~ | ~~26~~ |
| ~~High Bay T-8 4L4~~ | ~~HIBA~~ | ~~110~~ | ~~146~~ | ~~36~~ |
| ~~High Bay T-8 4L8~~ | ~~HIBA~~ | ~~233~~ | ~~316~~ | ~~83~~ |
| ~~High Bay T-8 6L4~~ | ~~HIBA~~ | ~~224~~ | ~~454~~ | ~~230~~ |
| ~~High Efficiency Fluorescent 1L2 (1) FO17T8/Elec~~ | ~~HEF~~ | ~~18~~ | ~~32~~ | ~~14~~ |
| ~~High Efficiency Fluorescent 1L2 (2) FO17T8/Elec~~ | ~~HEF~~ | ~~34~~ | ~~56~~ | ~~22~~ |
| ~~High Efficiency Fluorescent 1L2 (3) FO17T8/Elec~~ | ~~HEF~~ | ~~50~~ | ~~78~~ | ~~28~~ |
| ~~High Efficiency Fluorescent 1L2 (4) FO17T8/Elec~~ | ~~HEF~~ | ~~62~~ | ~~112~~ | ~~50~~ |
| ~~High Efficiency Fluorescent 1L3 (1) FO25T8/Elec~~ | ~~HEF~~ | ~~30~~ | ~~46~~ | ~~16~~ |
| ~~High Efficiency Fluorescent 1L3 (2) FO25T8/Elec~~ | ~~HEF~~ | ~~48~~ | ~~80~~ | ~~32~~ |
| ~~High Efficiency Fluorescent 1L3 (3) FO25T8/Elec~~ | ~~HEF~~ | ~~68~~ | ~~126~~ | ~~58~~ |
| ~~High Efficiency Fluorescent 1L3 (4) FO25T8/Elec~~ | ~~HEF~~ | ~~90~~ | ~~160~~ | ~~70~~ |
| ~~High Efficiency Fluorescent T-5 3L FP54/T5/Elec/Ho~~ | ~~HEF~~ | ~~179~~ | ~~290~~ | ~~111~~ |
| ~~High Efficiency Fluorescent T-5 4L FP54/T5/Elec/Ho~~ | ~~HEF~~ | ~~234~~ | ~~409~~ | ~~175~~ |
| ~~High Efficiency Fluorescent T-5 6L FP54/T5/Elec/Ho~~ | ~~HEF~~ | ~~351~~ | ~~992~~ | ~~641~~ |
| ~~High Efficiency Fluorescent T-8 1L4~~ | ~~HEF~~ | ~~28~~ | ~~42~~ | ~~14~~ |
| ~~High Efficiency Fluorescent T-8 1L8~~ | ~~HEF~~ | ~~67~~ | ~~78~~ | ~~11~~ |
| ~~High Efficiency Fluorescent T-8 2L2~~ | ~~HEF~~ | ~~62~~ | ~~94~~ | ~~32~~ |
| ~~High Efficiency Fluorescent T-8 2L4~~ | ~~HEF~~ | ~~55~~ | ~~73~~ | ~~18~~ |
| ~~High Efficiency Fluorescent T-8 2L8~~ | ~~HEF~~ | ~~118~~ | ~~158~~ | ~~40~~ |
| ~~High Efficiency Fluorescent T-8 3L4~~ | ~~HEF~~ | ~~79~~ | ~~105~~ | ~~26~~ |
| ~~High Efficiency Fluorescent T-8 4L4~~ | ~~HEF~~ | ~~110~~ | ~~146~~ | ~~36~~ |
| ~~High Efficiency Fluorescent T-8 4L8~~ | ~~HEF~~ | ~~233~~ | ~~316~~ | ~~83~~ |
| ~~LED Exit Sign~~ | ~~EXIT~~ | ~~20~~ | ~~18~~ | ~~2~~ |
| ~~PULSE START METAL HALIDE 1000 W~~ | ~~PSMH~~ | ~~1075~~ | ~~1080~~ | ~~5~~ |
| ~~PULSE START METAL HALIDE 150 W~~ | ~~PSMH~~ | ~~185~~ | ~~200~~ | ~~15~~ |
| ~~PULSE START METAL HALIDE 175 W~~ | ~~PSMH~~ | ~~208~~ | ~~285~~ | ~~77~~ |
| ~~PULSE START METAL HALIDE 200 W~~ | ~~PSMH~~ | ~~235~~ | ~~285~~ | ~~50~~ |
| ~~PULSE START METAL HALIDE 250 W~~ | ~~PSMH~~ | ~~288~~ | ~~454~~ | ~~166~~ |
| ~~PULSE START METAL HALIDE 300 W~~ | ~~PSMH~~ | ~~342~~ | ~~454~~ | ~~112~~ |
| ~~PULSE START METAL HALIDE 320 W~~ | ~~PSMH~~ | ~~368~~ | ~~454~~ | ~~86~~ |
| ~~PULSE START METAL HALIDE 350 W~~ | ~~PSMH~~ | ~~400~~ | ~~454~~ | ~~54~~ |
| ~~PULSE START METAL HALIDE 400 W~~ | ~~PSMH~~ | ~~450~~ | ~~454~~ | ~~4~~ |
| ~~PULSE START METAL HALIDE 750 W~~ | ~~PSMH~~ | ~~815~~ | ~~1075~~ | ~~260~~ |
| ~~Low Bay LED 85 W for 250 Metal Halide~~ | ~~LBLD~~ | ~~85~~ | ~~248~~ | ~~163~~ |
| ~~Low Bay LED 85 W for 2LHO T-8~~ | ~~LBLF~~ | ~~85~~ | ~~118~~ | ~~33~~ |

### ~~Lighting Controls~~

~~Lighting controls include occupancy sensors, daylight dimmer systems, occupancy controlled hi-low controls for fluorescent and HID controls. The measurement of energy savings is based on algorithms with key variables (i.e., coincidence factor, equivalent full load hours) provided through existing end-use metering of a sample of facilities or from other utility programs with experience with these measures (i.e., % of annual lighting energy saved by lighting control). For lighting controls, the baseline is a manual switch.~~

#### ~~Algorithms~~

~~Energy Savings (kWh) =~~ ~~kW~~*~~c~~* ~~X SVG X EFLH X (1+IF)~~

~~Demand Savings (kW) = kW~~*~~c~~* ~~X SVG X CF~~

#### ~~Definition of Variables~~

~~SVG = % of annual lighting energy saved by lighting control; refer to table by control type.~~

~~kW~~*~~c~~* ~~= kW lighting load connected to control.~~

~~IF = Interactive Factor – This applies to C&I interior lighting only. This represents the secondary demand and energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage.~~

~~CF = Coincidence Factor – the percentage of the total load which is on during electric system’s peak window.~~

~~EFLH = Equivalent full load hours.~~

~~Table 13: Lighting Controls~~

| **~~Component~~** | **~~Type~~** | **~~Value~~** | **~~Source~~** |
| --- | --- | --- | --- |
| ~~kWc~~ | ~~Variable~~ | ~~Load connected to control~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~SVG~~ | ~~Fixed~~ | ~~Occupancy Sensor, Controlled Hi-Low Fluorescent Control and controlled HID = 30%~~  ~~Daylight Dimmer System=50%~~ | ~~, 2, and 3~~ |
| ~~CF~~ | ~~Fixed~~ | ~~By building type and size see lighting verification summary table~~ | ~~Assumes same as JCP&L metered data~~ |
| ~~EFLH~~ | ~~Variable~~ | ~~Based on Building Type and Location~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~IF~~ | ~~Variable~~ |  | ~~AEPS Application; EDC Data Gathering~~ |
| ~~Time Period Allocation Factors~~ | ~~Fixed~~ | ~~Summer/On-Peak 26%~~  ~~Summer/Off-Peak 16%~~  ~~Winter/On-Peak 36%~~  ~~Winter/Off-Peak 22%~~ |  |

~~Sources:~~

1. ~~Northeast Utilities,~~ *~~Determination of Energy Savings Document~~*~~, 1992~~
2. ~~Levine, M., Geller, H., Koomey, J., Nadel S., Price, L., "Electricity Energy Use Efficiency: Experience with Technologies, Markets and Policies” ACEEE, 1992~~
3. ~~Lighting control savings fractions consistent with current programs offered by National Grid, Northeast Utilities, Long Island Power Authority, NYSERDA, and Energy Efficient Vermont.~~

### ~~20% Lighting Power Density (LPD) Reduction~~

~~Lighting power density reduction is new construction efficient lighting with a reduced wattage.~~

~~Algorithms~~

~~Energy Savings (kWh)~~ *~~=~~* ~~kW~~~~save~~ ~~X HOURS X WHF~~~~e~~

~~Demand Savings (kW)~~*~~=~~* ~~kW~~~~save~~ ~~X WHF~~~~d~~

~~kW~~~~save~~ ~~= (WSF~~~~base~~ ~~– WSF~~~~effic~~~~)/1000~~

~~Definition of Variables~~

~~kW~~~~save~~ ~~= lighting connected load kW saved~~

~~HOURS = annual lighting hours of use per year~~

~~WHF~~~~e~~ ~~= Waste heat factor for energy to account for cooling savings from efficient lighting.~~

~~WHF~~~~d~~ ~~= Waste heat factor for demand to account for cooling savings from efficient lighting.~~

~~WSF~~~~base~~ ~~= the baseline lighting watts per square foot or linear foot.~~

~~WSF~~~~effic~~ ~~= the actual installed lighting watts per square foot or linear foot.~~

~~Table 14: Lighting Power Density~~

| **~~Component~~** | **~~Type~~** | **~~Value~~** | **~~Source~~** |
| --- | --- | --- | --- |
| ~~kW~~~~save~~ | ~~Variable~~ |  | ~~AEPS Application; EDC Data Gathering~~ |
| ~~WHF~~~~e~~ | ~~Fixed~~ | ~~Cooled space = 1.12~~  ~~Refrigerated space: Freezer spaces = 1.15; Medium-temperature refrigerated spaces = 1.29; High-temperature refrigerated spaces = 1.18~~  ~~Uncooled space =1~~ | ~~1~~ |
| ~~WHF~~~~d~~ | ~~Fixed~~ | ~~Cooled space = 1.34~~  ~~Refrigerated space: Freezer spaces = 1.5; Medium-temperature refrigerated spaces = 1.29; High-temperature refrigerated spaces = 1.18~~  ~~Uncooled space = 1~~ | ~~1~~ |
| ~~HOURS~~ | ~~Variable~~ |  | ~~AEPS Application; EDC Data Gathering~~ |
| ~~WSF~~~~base~~ | ~~Variable~~ |  | ~~ASHRAE 90.1-2004~~ |
| ~~WSF~~~~effic~~ | ~~Variable~~ |  | ~~ASHRAE 90.1-2004~~ |

~~Source:~~

1. ~~Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).~~

### ~~Fluorescent Lighting Fixture~~

~~A fluorescent lighting fixture is a high performance or ‘super’ T8 lamp ballast system.~~

~~Algorithms~~

~~Energy Savings (kWh)~~ ~~= ((Watts~~~~BASE~~ ~~– Watts~~~~EE~~ ~~)/1000) X HOURS X WHF~~~~e~~

~~Demand Savings (kW)~~ ~~=~~ ~~((Watts~~~~BASE~~ ~~– Watts~~~~EE~~~~)/1000) X WHF~~~~d~~

~~Definition of Variables~~

~~Watts~~~~BASE~~ ~~=~~~~Baseline connected kW.~~

~~Watts~~~~EE~~ ~~=~~~~Energy efficient connected kW.~~

~~WHF~~~~d~~ ~~= Waste heat factor for demand to account for cooling savings from efficient lighting.~~

~~HOURS = annual lighting hours of use per year.~~

~~WHF~~~~e~~ ~~= Waste heat factor for energy to account for cooling savings from efficient lighting~~

~~Table 15: Fluorescent Lighting Fixture~~

| **~~Component~~** | **~~Type~~** | **~~Value~~** | **~~Source~~** |
| --- | --- | --- | --- |
| ~~WHF~~~~e~~ | ~~Fixed~~ | ~~Prescriptive measures, default = 1.17~~ | ~~1~~ |
| ~~WHF~~~~d~~ | ~~Fixed~~ | ~~Prescriptive measures, default = 1.06~~ | ~~1~~ |
| ~~HOURS~~ | ~~Variable~~ |  | ~~AEPS Application;~~  ~~EDC Data Gathering~~ |
| ~~Watts~~~~EE~~ | ~~Fixed~~ | ~~See Watt~~~~EE~~ ~~and Watt~~~~BASE~~ ~~Table (below)~~ | ~~1~~ |
| ~~Watts~~~~BASE~~ | ~~Fixed~~ | ~~See Watt~~~~EE~~ ~~and Watt~~~~BASE~~ ~~Table (below)~~ | ~~1~~ |

~~Source:~~

1. ~~Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).~~

**~~Table 16: Watts~~~~EE~~ ~~and Watts~~~~BASE~~**

|  |  |  |
| --- | --- | --- |
| **~~Equipment Description~~** | **~~WattsEE~~** | **~~WattsBASE~~** |
| ~~Relamp/Reballast to Super T8~~  ~~1 Lamp~~  ~~2 Lamp~~  ~~3 Lamp~~  ~~4 Lamp~~ | ~~25~~  ~~49~~  ~~72~~  ~~94~~ | ~~40~~  ~~68~~  ~~110~~  ~~139~~ |
| ~~Super T8 Troffer/Wrap; Super T8 Industrial/Strip; Super T8 Indirect~~  ~~1 Lamp~~  ~~2 Lamp~~  ~~3 Lamp~~  ~~4 Lamp~~ | ~~25~~  ~~49~~  ~~72~~  ~~94~~ | ~~32~~  ~~59~~  ~~88~~  ~~114~~ |

Table 6‑5: Reference Specifications for Above Traffic Signal Wattages

|  |  |
| --- | --- |
| **Type** | **Manufacturer & Model** |
| 8” Incandescent traffic signal bulb | General Electric Traffic Signal Model 17325-69A21/TS |
| 12” Incandescent traffic signal bulb | General Electric Traffic Signal Model 35327-150PAR46/TS |
| Incandescent Arrows &  Hand/Man Pedestrian Signs | General Electric Traffic Signal Model 19010-116A21/TS |
| 8” and 12” LED traffic signals | Leotek Models TSL-ES08 and TSL-ES12 |
| 8” LED Yellow Arrow | General Electric Model DR4-YTA2-01A |
| 8” LED Green Arrow | General Electric Model DR4-GCA2-01A |
| 12” LED Yellow Arrow | Dialight Model 431-3334-001X |
| 12" LED Green Arrow | Dialight Model 432-2324-001X |
| LED Hand/Man Pedestrian Sign | Dialight Model 430-6450-001X |

#### 6.2.6.3 Prescriptive Lighting Improvements

Prescriptive Lighting Improvements include fixture or lamp and ballast replacement in existing commercial and industrial customers’ facilities.

The baseline is the existing fluorescent fixtures with the existing lamps and ballast as defined in Expanded Prescriptive Lighting Wattage Table shown in Appendix C. Other factors required to calculate savings are shown in and . Note that if run hours are stated and verified by logging lighting hours of use groupings, actual hours should be applied. The IF factors shown in are to be used only when the facilities are air conditioned and only for fixtures in conditioned or refrigerated space. The EFLH for refrigerated spaces are to be estimated or logged separately.

Table 6‑6: Lighting EFLH and CF by Building Type or Function

|  |  |  |
| --- | --- | --- |
| **Building Type** | **EFLH** | **CF[[30]](#footnote-30)** |
| Education – Primary School | 1,440 | 0.57 |
| Education – Secondary School | 2,305 | 0.57 |
| Education – Community College | 3,792 | 0.64 |
| Education – University | 3,073 | 0.64 |
| Grocery | 5,824 | 0.94 |
| All Hospitals | 6,588[[31]](#footnote-31) | 0.84 |
| Medical – Clinic | 4,212 | 0.86 |
| Lodging – Hotel Guest Rooms | 1,145 | 0.84 |
| Lodging – Motel Common Spaces | 8,736[[32]](#footnote-32) | 1.00 |
| Manufacturing – Light Industrial | 4,290 | 0.63 |
| Office- Large | 2,808 | 0.84 |
| Office-Small | 2,808 | 0.84 |
| Restaurant – Sit-Down | 4,368 | 0.88 |
| Restaurant – Fast-Food | 6,188 | 0.88 |
| Retail – 3-Story Large | 4,259 | 0.89 |
| Retail – Single-Story Large | 4,368 | 0.89 |
| Retail – Small | 4,004 | 0.89 |
| Storage Conditioned | 4,290 | 0.85 |
| Storage Unconditioned | 4,290 | 0.85 |
| Warehouse | 3,900 | 0.85 |
| Other[[33]](#footnote-33) | As Measured | As Measured |

Sources:

1. New Jersey’s Clean Energy Program Protocols, November 2009
   1. California Public Utility Commission. *Database for Energy Efficiency Resources,* 2005
   2. RLW Analytics, *Coincident Factor Study, Residential and Commercial & Industrial Lighting Measures*, 2007.
   3. Quantum Consulting, Inc., for Pacific Gas & Electric Company , *Evaluation of Pacific Gas & Electric Company’s 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies*”, March 1, 1999
   4. KEMA. *New Jersey’s Clean Energy Program Energy Impact Evaluation and Protocol Review*. 2009.

Table 6-7: Interactive Factors and Other Lighting Variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Type** | **Value** | **Source** |
| IFdemand | Fixed | Cooled space = 0.34 | 1 |
| Freezer spaces = 0.5 |
| Medium-temperature refrigerated spaces = 0.29 |
| High-temperature refrigerated spaces = 0.18 |
| Uncooled space = 0 |
| IFenergy | Fixed | Cooled space = 0.12 | 1 |
| Freezer spaces = 0.5 |
| Medium-temperature refrigerated spaces = 0.29 |
| High-temperature refrigerated spaces = 0.18 |
| Uncooled space = 0 |
| kWbase | Variable | Expanded Prescriptive Lighting Wattage Table | 2 |
| kWinst | Variable | Expanded Prescriptive Lighting Wattage Table | 2 |

Sources:

1. PA TRM, Efficiency Vermont. Technical Reference User Manual: Measure Savings Algorithms and Cost Assumptions (July 2008).
2. NYSERDA Table of Standard Wattages (November 2009)

#### 6.2.6.4 Lighting Controls

Lighting controls include HID controls, daylight dimmer systems, occupancy sensors, and occupancy controlled hi-low controls for fluorescent fixtures. The measurement of energy savings is based on algorithms with key variables (e.g. coincidence factor, equivalent full load hours) provided through existing end-use metering of a sample of facilities or from other utility programs with experience with these measures (i.e., % of annual lighting energy saved by lighting control). These key variables are listed in .

If a lighting improvement consists of solely lighting controls, the lighting fixture baseline is the existing fluorescent fixtures with the existing lamps and ballasts or, if retrofitted, new fluorescent fixtures with new lamps and ballasts as defined in Expanded Prescriptive Lighting Wattage Table shown in Appendix C. In either case, the kWinstfor the purpose of the algorithm is set to kWbase.

Table 6-8: Lighting Controls

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Type** | **Value** | **Source** |
| kW*base* | Variable | Expanded Prescriptive Lighting Wattage Table | 1 |
| kW*inst* | Variable | Expanded Prescriptive Lighting Wattage Table | 1 |
| SVG | Fixed | Occupancy Sensor, Controlled Hi-Low Fluorescent Control and controlled HID = 30%[[34]](#footnote-34) | 2 and 3*[[35]](#footnote-35)* |
| Daylight Dimmer System=50%[[36]](#footnote-36) |
| CF | Variable | By building type and size | See |
| EFLH | Variable | By building type and size | See |
| IF | Variable | By building type and size | See |

Sources:

1. NYSERDA Table of Standard Wattages
2. Levine, M., Geller, H., Koomey, J., Nadel S., Price, L., "Electricity Energy Use Efficiency: Experience with Technologies, Markets and Policies” ACEEE, 1992
3. Lighting control savings fractions consistent with current programs offered by National Grid, Northeast Utilities, Long Island Power Authority, NYSERDA, and Energy Efficient Vermont.

***~~Motors~~***

#### ~~Algorithms~~

~~From AEPS application form or EDC data gathering calculate ΔkW where:~~

~~ΔkW = 0.746 X [(hp~~~~base~~ ~~X RLF~~~~base~~~~)/η~~~~base~~ ~~– (hp~~~~ee~~ ~~X RLF~~~~ee~~~~)/η~~~~ee~~~~]~~

~~Energy Savings (kWh) = (ΔkW) X EFLH~~

~~Demand Savings (kW) = (ΔkW) X CF~~

#### ~~Definition of Variables~~

~~hp~~~~base~~ ~~= Rated horsepower of the baseline motor~~

~~hp~~~~ee~~ ~~= Rate horsepower of the energy-efficient motor~~

~~RLF~~~~base~~ ~~= Rated load factor of the baseline motor~~

~~RLF~~~~ee~~ ~~= Rated load factor of the energy-efficient motor~~

~~η~~~~base~~ ~~= Efficiency of the baseline motor~~

~~η~~~~ee~~ ~~= Efficiency of the energy-efficient motor~~

~~Table 17: Motors~~

| **~~Component~~** | **~~Type~~** | **~~Value~~** | **~~Source~~** |
| --- | --- | --- | --- |
| ~~Motor kW~~ | ~~Variable~~ | ~~Based on horsepower and efficiency~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~EFLH~~ | ~~Variable~~ | ~~Based on Building Type and Location~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~hp~~~~base~~ | ~~Fixed~~ | ~~Comparable EPACT Motor Table Below~~ | ~~EPACT Directory~~ |
| ~~hp~~~~ee~~ | ~~Variable~~ | ~~Nameplate~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~RLF~~~~base~~ | ~~Fixed~~ | ~~0.70-0.80~~ | ~~Industry Data~~ |
| ~~RLF~~~~ee~~ | ~~Variable~~ | ~~Nameplate~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~Efficiency – η~~~~base~~ | ~~Fixed~~ | ~~Comparable EPACT Motor Table Below~~ | ~~From EPACT directory.~~ |
| ~~Efficiency - η~~~~ee~~ | ~~Variable~~ | ~~Nameplate~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~CF~~ | ~~Fixed~~ | ~~35%~~ | ~~JCP&L metered data~~ |
| ~~Time Period Allocation Factors~~ | ~~Fixed~~ | ~~Summer/On-Peak 25%~~  ~~Summer/Off-Peak 16%~~  ~~Winter/On-Peak 36%~~  ~~Winter/Off-Peak 23%~~ |  |

**~~Table 18: Baseline Motor Efficiencies - nbase (EPAct)~~**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **~~Open Drip Proof (ODP) # of Poles~~** | | | **~~Totally Enclosed Fan-Cooled (TEFC)~~** | | |
|  | *~~6~~* | *~~4~~* | *~~2~~* | *~~6~~* | *~~4~~* | *~~2~~* |
|  | **~~Speed (RPM)~~** | | | **~~Speed (RPM)~~** | | |
| **~~Size HP~~** | *~~1200~~* | *~~1800~~* | *~~3600~~* | *~~1200~~* | *~~1800~~* | *~~3600~~* |
| ~~1~~ | ~~80.0%~~ | ~~82.5%~~ | ~~75.5%~~ | ~~80.0%~~ | ~~82.5%~~ | ~~75.5%~~ |
| ~~1.5~~ | ~~84.0%~~ | ~~84.0%~~ | ~~82.5%~~ | ~~85.5%~~ | ~~84.0%~~ | ~~82.5%~~ |
| ~~2~~ | ~~85.5%~~ | ~~84.0%~~ | ~~84.0%~~ | ~~86.5%~~ | ~~84.0%~~ | ~~84.0%~~ |
| ~~3~~ | ~~86.5%~~ | ~~86.5%~~ | ~~84.0%~~ | ~~87.5%~~ | ~~87.5%~~ | ~~85.5%~~ |
| ~~5~~ | ~~87.5%~~ | ~~87.5%~~ | ~~85.5%~~ | ~~87.5%~~ | ~~87.5%~~ | ~~87.5%~~ |
| ~~7.5~~ | ~~88.5%~~ | ~~88.5%~~ | ~~87.5%~~ | ~~89.5%~~ | ~~89.5%~~ | ~~88.5%~~ |
| ~~10~~ | ~~90.2%~~ | ~~89.5%~~ | ~~88.5%~~ | ~~89.5%~~ | ~~89.5%~~ | ~~89.5%~~ |
| ~~15~~ | ~~90.2%~~ | ~~91.0%~~ | ~~89.5%~~ | ~~90.2%~~ | ~~91.0%~~ | ~~90.2%~~ |
| ~~20~~ | ~~91.0%~~ | ~~91.0%~~ | ~~90.2%~~ | ~~90.2%~~ | ~~91.0%~~ | ~~90.2%~~ |
| ~~25~~ | ~~91.7%~~ | ~~91.7%~~ | ~~91.0%~~ | ~~91.7%~~ | ~~92.4%~~ | ~~91.0%~~ |
| ~~30~~ | ~~92.4%~~ | ~~92.4%~~ | ~~91.0%~~ | ~~91.7%~~ | ~~92.4%~~ | ~~91.0%~~ |
| ~~40~~ | ~~93.0%~~ | ~~93.0%~~ | ~~91.7%~~ | ~~93.0%~~ | ~~93.0%~~ | ~~91.7%~~ |
| ~~50~~ | ~~93.0%~~ | ~~93.0%~~ | ~~92.4%~~ | ~~93.0%~~ | ~~93.0%~~ | ~~92.4%~~ |
| ~~60~~ | ~~93.6%~~ | ~~93.6%~~ | ~~93.0%~~ | ~~93.6%~~ | ~~93.6%~~ | ~~93.0%~~ |
| ~~75~~ | ~~93.6%~~ | ~~94.1%~~ | ~~93.0%~~ | ~~93.6%~~ | ~~94.1%~~ | ~~93.0%~~ |
| ~~100~~ | ~~94.1%~~ | ~~94.1%~~ | ~~93.0%~~ | ~~94.1%~~ | ~~94.5%~~ | ~~93.6%~~ |
| ~~125~~ | ~~94.1%~~ | ~~94.5%~~ | ~~93.6%~~ | ~~94.1%~~ | ~~94.5%~~ | ~~94.5%~~ |
| ~~150~~ | ~~94.5%~~ | ~~95.0%~~ | ~~93.6%~~ | ~~95.0%~~ | ~~95.0%~~ | ~~94.5%~~ |
| ~~200~~ | ~~94.5%~~ | ~~95.0%~~ | ~~94.5%~~ | ~~95.0%~~ | ~~95.0%~~ | ~~95.0%~~ |

## 

## 6.3 Premium Efficiency Motors

For constant speed and uniformly loaded motors with commercial applications, the prescriptive measurement and verification protocols described below apply for replacement of old motors with new energy efficient motors of the same rated horsepower. Replacements where the old motor and new motor have different horsepower ratings are considered custom measures. For motors with variable speeds, variable loading, or industrial applications, Custom Measure Protocols and Measurement and Verification Plans are required.

Note that the Coincidence Factor and Run Hours of Use for motors specified below do not take into account systems with multiple motors serving the same load, such as duplex motor sets with one motor in a lead and the other in back up mode. Under these circumstances, the Coincidence Factor (CF) and Run Hours of Use (RHRS) will need to be adjusted accordingly based on the proposed loading of the new motor.

### 6.3.1 Algorithms

From AEPS application form or EDC data gathering calculate ΔkW where:

ΔkW = 0.746 X HP X (1/ηbase –1/ηee) X LF

Energy Savings (kWh) = (ΔkW) X RHRS

Demand Savings (kW) = (ΔkW) X CF

### 6.3.2 Definition of Variables

HP = Rated horsepower of the baseline motor and energy efficient motor

LF = Load Factor. Ratio of the average operating load to the nameplate rating of the baseline motor or, if installed, an existing energy efficient motor

ηbase = Efficiency of the baseline motor

ηee = Efficiency of the energy-efficient motor

RHRS = Annual run hours of the motor

CF = Demand Coincidence Factor. The percentage of the connected load that is on during electric system’s peak window as defined in Section **Error! Reference source not found.**.

6.3.3 Description of Calculation Method

Relative to the above algorithm, ΔkW values will be calculated for each motor improvement in any project (account number). Each motor and the respective variables required to calculate the demand and energy savings for that motor will be entered into an inventory in Excel format, the Motor & VFD Inventory Form. The inventory will also specify the location for reference and validation. A sample of the Motor & VFD Inventory Form incorporating the algorithms for savings calculation is included in Appendix D.

Table 6-9: Variables for Premium Efficiency Motor Calculations

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Type** | **Value** | **Source** |
| Motor HP | Variable | Nameplate (pre and post same) | EDC Data Gathering |
| RHRS[[37]](#footnote-37) | Variable | Based on logging and modeling | EDC Data Gathering |
| Default | See table references |
| LF[[38]](#footnote-38) | Variable | Based on spot metering/ nameplate | EDC Data Gathering |
| Default 75% | 1 |
| Efficiency – ηbase | Variable | Nameplate | EDC Data Gathering |
| Default comparable standard EPACT Motor | From |
| Efficiency - ηee | Variable | Comparable EE NEMA Motor | From |
| CF[[39]](#footnote-39) | Fixed | 74% | 1 |

Sources:

1. California Public Utility Commission. *Database for Energy Efficiency Resources* 2005

Table 6-10: Baseline Motor Efficiencies - ηbase (EPAct) [[40]](#footnote-40)

| **Size HP** | **Open Drip Proof (ODP) # of Poles** | | | **Totally Enclosed Fan-Cooled (TEFC)**  **# of Poles** | | |
| --- | --- | --- | --- | --- | --- | --- |
| ***6*** | ***4*** | ***2*** | ***6*** | ***4*** | ***2*** |
| **Speed (RPM)** | | | **Speed (RPM)** | | |
| ***1200*** | ***1800*** | ***3600*** | ***1200*** | ***1800*** | ***3600*** |
| 1 | 80.0% | 82.5% | 75.5% | 80.0% | 82.5% | 75.5% |
| 1.5 | 84.0% | 84.0% | 82.5% | 85.5% | 84.0% | 82.5% |
| 2 | 85.5% | 84.0% | 84.0% | 86.5% | 84.0% | 84.0% |
| 3 | 86.5% | 86.5% | 84.0% | 87.5% | 87.5% | 85.5% |
| 5 | 87.5% | 87.5% | 85.5% | 87.5% | 87.5% | 87.5% |
| 7.5 | 88.5% | 88.5% | 87.5% | 89.5% | 89.5% | 88.5% |
| 10 | 90.2% | 89.5% | 88.5% | 89.5% | 89.5% | 89.5% |
| 15 | 90.2% | 91.0% | 89.5% | 90.2% | 91.0% | 90.2% |
| 20 | 91.0% | 91.0% | 90.2% | 90.2% | 91.0% | 90.2% |
| 25 | 91.7% | 91.7% | 91.0% | 91.7% | 92.4% | 91.0% |
| 30 | 92.4% | 92.4% | 91.0% | 91.7% | 92.4% | 91.0% |
| 40 | 93.0% | 93.0% | 91.7% | 93.0% | 93.0% | 91.7% |
| 50 | 93.0% | 93.0% | 92.4% | 93.0% | 93.0% | 92.4% |
| 60 | 93.6% | 93.6% | 93.0% | 93.6% | 93.6% | 93.0% |
| 75 | 93.6% | 94.1% | 93.0% | 93.6% | 94.1% | 93.0% |
| 100 | 94.1% | 94.1% | 93.0% | 94.1% | 94.5% | 93.6% |
| 125 | 94.1% | 94.5% | 93.6% | 94.1% | 94.5% | 94.5% |
| 150 | 94.5% | 95.0% | 93.6% | 95.0% | 95.0% | 94.5% |
| 200 | 94.5% | 95.0% | 94.5% | 95.0% | 95.0% | 95.0% |

Table 6-11: Energy Efficient Motor Efficiencies- ηee (NEMA)[[41]](#footnote-41)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Size HP** | **Open Drip Proof (ODP) # of Poles** | | | **Totally Enclosed Fan-Cooled (TEFC)**  **# of Poles** | | |
|
| ***6*** | ***4*** | ***2*** | ***6*** | ***4*** | ***2*** |
| **Speed (RPM)** | | | **Speed (RPM)** | | |
| ***1200*** | ***1800*** | ***3600*** | ***1200*** | ***1800*** | ***3600*** |
| 1 | 82.50% | 85.50% | 77.00% | 82.50% | 85.50% | 77.00% |
| 1.5 | 86.50% | 86.50% | 84.00% | 87.50% | 86.50% | 84.00% |
| 2 | 87.50% | 86.50% | 85.50% | 88.50% | 86.50% | 85.50% |
| 3 | 88.50% | 89.50% | 85.50% | 89.50% | 89.50% | 86.50% |
| 5 | 89.50% | 89.50% | 86.50% | 89.50% | 89.50% | 88.50% |
| 7.5 | 90.20% | 91.00% | 88.50% | 91.00% | 91.70% | 89.50% |
| 10 | 91.70% | 91.70% | 89.50% | 91.00% | 91.70% | 90.20% |
| 15 | 91.70% | 93.00% | 90.20% | 91.70% | 92.40% | 91.00% |
| 20 | 92.40% | 93.00% | 91.00% | 91.70% | 93.00% | 91.00% |
| 25 | 93.00% | 93.60% | 91.70% | 93.00% | 93.60% | 91.70% |
| 30 | 93.60% | 94.10% | 91.70% | 93.00% | 93.60% | 91.70% |
| 40 | 94.10% | 94.10% | 92.40% | 94.10% | 94.10% | 92.40% |
| 50 | 94.10% | 94.50% | 93.00% | 94.10% | 94.50% | 93.00% |
| 60 | 94.50% | 95.00% | 93.60% | 94.50% | 95.00% | 93.60% |
| 75 | 94.50% | 95.00% | 93.60% | 94.50% | 95.40% | 93.60% |
| 100 | 95.00% | 95.40% | 93.60% | 95.00% | 95.40% | 94.10% |
| 125 | 95.00% | 95.40% | 94.10% | 95.00% | 95.40% | 95.00% |
| 150 | 95.40% | 95.80% | 94.10% | 95.80% | 95.80% | 95.00% |
| 200 | 95.40% | 95.80% | 95.00% | 95.80% | 96.20% | 95.40% |
| 250 | 95.40% | 95.80% | 95.00% | 95.80% | 96.20% | 95.80% |
| 300 | 95.40% | 95.80% | 95.40% | 95.80% | 96.20% | 95.80% |
| 350 | 95.40% | 95.80% | 95.40% | 95.80% | 96.20% | 95.80% |
| 400 | 95.80% | 95.80% | 95.80% | 95.80% | 96.20% | 95.80% |
| 450 | 96.20% | 96.20% | 95.80% | 95.80% | 96.20% | 95.80% |
| 500 | 96.20% | 96.20% | 95.80% | 95.80% | 96.20% | 95.80% |

Table 6-12: Stipulated Hours of Use for Motors in Commercial Buildings

| **Building Type** | **Motor Usage Group** | **Motor Operating Hours[[42]](#footnote-42)** |
| --- | --- | --- |
| Office - Large | Chilled Water Pump | 1610 |
| Heating Hot Water Pump | 4959 |
| Condenser Water Pump | 1610 |
| HVAC Fan | 4414 |
| Cooling Tower Fan | 1032 |
| Office - Small | Chilled Water Pump | 1375 |
| Heating Hot Water Pump | 4959 |
| Condenser Water Pump | 1375 |
| HVAC Fan | 3998 |
| Cooling Tower Fan | 1032 |
| Hospitals & Healthcare - Pumps | Chilled Water Pump | 3801 |
| Heating Hot Water Pump | 4959 |
| Condenser Water Pump | 3801 |
| HVAC Fan | 7243 |
| Cooling Tower Fan | 1032 |
| Education - K-12 | Chilled Water Pump | 1444 |
| Heating Hot Water Pump | 4959 |
| Condenser Water Pump | 1444 |
| HVAC Fan | 4165 |
| Cooling Tower Fan | 1032 |
| Education - College & University | Chilled Water Pump | 1718 |
| Heating Hot Water Pump | 4959 |
| Condenser Water Pump | 1718 |
| HVAC Fan | 4581 |
| Cooling Tower Fan | 1032 |
| Retail | Chilled Water Pump | 2347 |
| Heating Hot Water Pump | 4959 |
| Condenser Water Pump | 2347 |
| HVAC Fan | 5538 |
| Cooling Tower Fan | 1032 |
| Restaurants - Fast Food | Chilled Water Pump | 2901 |
| Heating Hot Water Pump | 4959 |
| Condenser Water Pump | 2901 |
| HVAC Fan | 6702 |
| Cooling Tower Fan | 1032 |
| Restaurants - Sit Down | Chilled Water Pump | 2160 |
| Heating Hot Water Pump | 4959 |
| Condenser Water Pump | 2160 |
| HVAC Fan | 5246 |
| Cooling Tower Fan | 1032 |
| Other | All | As Measured |

Source:

1. Motor Inventory Form, PA Technical Working Group. (See notes below in )

Table 6-13: Notes for Stipulated Hours of Use Table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CALCULATION METHOD FOR TABLE 6-12** | | | | | |
| **Motor Usage Group** | **Method of Operating Hours Calculation** | | | | |
| Chilled Water Pump | Hours when ambient temperature is above 60°F during building operating hours | | | | |
| Heating Hot Water Pump | Hours when ambient temperature is below 60°F during all hours | | | | |
| Condenser Water Pump | Hours when ambient temperature is above 60°F during building operating hours | | | | |
| HVAC Fan | Operating hours plus 20% of unoccupied hours | | | | |
| Cooling Tower Fan | Cooling EFLH according to EPA 2002[[43]](#footnote-43) (1032 hours for Philadelphia) | | | | |
|  |  |  |  |  |  |
| **NOTES FOR TABLE 6-12** | | | | | |
| 1. Ambient temperature is derived from BIN Master weather data from Philadelphia. | | | | | |
| 2. Operating hours for each building type is estimated for typical use using assumptions from Appendix E. | | | | | |
| 3. Hospital & Healthcare operating hours differ for pumps and HVAC. | | | | | |
| 4. Back up calculations and reference material can be found on the PA  PUC website at the following address: <http://www.puc.state.pa.us/electric/xls/Act129/TRM-Motor_Operating_Hours_Worksheet.xls> | | | | | |

## 6.4 Variable Frequency Drive (VFD) Improvements

The following protocol for the measurement of energy and demand savings applies to the installation of Variable Frequency Drives (VFDs) in standard commercial building applications: HVAC fans, cooling tower fans, chilled water pumps, condenser water pumps and hot water pumps. Relative to HVAC fans, the protocol applies to conventional variable air volume (VAV) systems with terminal VAV boxes on the supply registers. A VAV system without terminal VAV boxes is subject to various control strategies and system configurations and must be evaluated using the custom approach. VFDs in industrial applications should also follow the custom path.

Note that when changes in run hours are anticipated in conjunction with the installation of a VFD, a custom path must also be used.

### 6.4.1 Algorithms

Energy Savings (kWh) = kWhbase - kWhpost

Demand Savings (kW) = kWbase - kWpost

kWhbase = 0.746 X HP X LF/ηmotor X RHRSbase

kWhpost = kWhbase X ESF

kWbase = 0.746 X HP X LF/ηmotor X CF

kWpost = kWbase X DSF

### 6.4.2 Definitions of Variables

HP = Rated horsepower of the motor

LF = Load Factor. Ratio of the average operating load to the nameplate rating of the motor

ηmotor = Motor efficiency at the full-rated load. For VFD installations, this can be either an energy efficient motor or standard efficiency motor. Motor efficiency varies with load and decreases dramatically below 50% load; this is reflected in the ESF term of the algorithm.

RHRSbase = Annual run hours of the baseline motor

CF = Demand Coincidence Factor. The percentage of the connected load that is on during electric system’s peak window as defined in Section **Error! Reference source not found.**.

ESF = Energy Savings Factor. The energy savings factor is the percent baseline kWh consumption anticipated to occur as a result of the installation of the VFD. This factor can also be computed according to fan and pump affinity laws by modeling the flow reduction and related efficiency factors for both the motor and VFD under different load conditions. Hourly temperature bin data is used for this purpose.

DSF = Demand Savings Factor. The demand savings factor is calculated by determining the ratio of the power requirement for the baseline and the VFD control at peak conditions. Since systems are customarily sized to 95% of cooling conditions and the peak 100 hours load represent a loading condition of 99%, and because VFDs are not 100% efficient, the demand savings for VFDs is relatively low for commercial HVAC applications where system loads tracks cooling requirements (DSF approaches 1).

### 6.4.3 Description of Calculation Method

Relative to the above algorithm, ΔkW values will be calculated for each VFD improvement in any project (account number). Each motor and the respective variables required to calculate the demand and energy savings for that motor will be entered into an inventory in Excel format, the Motor & VFD Inventory Form. The inventory will also specify the location for reference and validation. A sample of the Motor & VFD Inventory Form incorporating the algorithms for savings calculation is included in Appendix D.

Table 6-14: Variables for VFD Calculations

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Type** | **Value** | **Source** |
| Motor HP | Variable | Nameplate | EDC Data Gathering |
| RHRS[[44]](#footnote-44) | Variable | Based on logging and modeling | EDC Data Gathering |
| Default | See table references |
| LF[[45]](#footnote-45) | Variable | Based on spot metering and nameplate | EDC Data Gathering |
| Default 75% | 1 |
| ESF | Variable | Default | See table references |
| DSF | Variable | Default | See table references |
| Efficiency - ηbase | Fixed | Comparable EPACT Motor | EPACT, , |
| CF[[46]](#footnote-46) | Fixed | 74% | 1 |

Sources:

1. California Public Utility Commission. *Database for Energy Efficiency Resources* 2005

Table 6-15: ESF and DSF for Typical Commercial VFD Installations

| **Building Type** | **Motor Usage Group** | **PECO,**  **First Energy** | | **Alleghany, Duquesne** | | **PPL** | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ESF** | **DSF** | **ESF** | **DSF** | **ESF** | **DSF** |
| Office - Large | Chilled Water Pump | 0.305 | 0.792 | 0.283 | 0.596 | 0.282 | 0.548 |
| Heating Hot Water Pump | 0.321 | 1.000 | 0.278 | 1.000 | 0.275 | 1.000 |
| Condenser Water Pump | 0.270 | 0.792 | 0.244 | 0.596 | 0.245 | 0.548 |
| HVAC Fan | 0.293 | 0.849 | 0.278 | 0.694 | 0.276 | 0.657 |
| Cooling Tower Fan | 0.270 | 0.792 | 0.244 | 0.596 | 0.245 | 0.548 |
| Office - Small | Chilled Water Pump | 0.308 | 0.781 | 0.286 | 0.586 | 0.286 | 0.548 |
| Heating Hot Water Pump | 0.321 | 1.000 | 0.278 | 1.000 | 0.275 | 1.000 |
| Condenser Water Pump | 0.273 | 0.781 | 0.246 | 0.586 | 0.248 | 0.548 |
| HVAC Fan | 0.295 | 0.841 | 0.279 | 0.686 | 0.278 | 0.657 |
| Cooling Tower Fan | 0.273 | 0.781 | 0.246 | 0.586 | 0.248 | 0.548 |
| Hospitals & Healthcare | Chilled Water Pump | 0.275 | 0.869 | 0.262 | 0.675 | 0.257 | 0.594 |
| Heating Hot Water Pump | 0.321 | 1.000 | 0.278 | 1.000 | 0.275 | 1.000 |
| Condenser Water Pump | 0.231 | 0.869 | 0.211 | 0.750 | 0.206 | 0.594 |
| HVAC Fan | 0.276 | 0.907 | 0.261 | 0.758 | 0.260 | 0.694 |
| Cooling Tower Fan | 0.245 | 0.869 | 0.222 | 0.675 | 0.217 | 0.594 |
| Education –  K-12 | Chilled Water Pump | 0.300 | 0.770 | 0.280 | 0.571 | 0.278 | 0.535 |
| Heating Hot Water Pump | 0.321 | 1.000 | 0.278 | 1.000 | 0.275 | 1.000 |
| Condenser Water Pump | 0.263 | 0.771 | 0.238 | 0.571 | 0.237 | 0.535 |
| HVAC Fan | 0.288 | 0.832 | 0.271 | 0.675 | 0.270 | 0.646 |
| Cooling Tower Fan | 0.263 | 0.771 | 0.238 | 0.571 | 0.237 | 0.535 |
| Education – College & University | Chilled Water Pump | 0.304 | 0.796 | 0.283 | 0.599 | 0.280 | 0.548 |
| Heating Hot Water Pump | 0.321 | 1.000 | 0.278 | 1.000 | 0.275 | 1.000 |
| Condenser Water Pump | 0.270 | 0.796 | 0.243 | 0.599 | 0.243 | 0.548 |
| HVAC Fan | 0.293 | 0.852 | 0.277 | 0.696 | 0.275 | 0.657 |
| Cooling Tower Fan | 0.270 | 0.796 | 0.243 | 0.599 | 0.243 | 0.548 |
| Retail | Chilled Water Pump | 0.305 | 0.869 | 0.283 | 0.675 | 0.239 | 0.594 |
| Heating Hot Water Pump | 0.321 | 1.000 | 0.278 | 1.000 | 0.275 | 1.000 |
| Condenser Water Pump | 0.271 | 0.869 | 0.244 | 0.675 | 0.239 | 0.594 |
| HVAC Fan | 0.295 | 0.907 | 0.278 | 0.758 | 0.276 | 0.694 |
| Cooling Tower Fan | 0.271 | 0.869 | 0.244 | 0.675 | 0.239 | 0.594 |
| Restaurants - Fast Food | Chilled Water Pump | 0.291 | 0.869 | 0.229 | 0.675 | 0.267 | 0.594 |
| Heating Hot Water Pump | 0.321 | 1.000 | 0.278 | 1.000 | 0.275 | 1.000 |
| Condenser Water Pump | 0.253 | 0.869 | 0.273 | 0.675 | 0.224 | 0.594 |
| HVAC Fan | 0.282 | 0.907 | 0.266 | 0.758 | 0.264 | 0.694 |
| Cooling Tower Fan | 0.253 | 0.869 | 0.273 | 0.675 | 0.224 | 0.594 |
| Restaurants - Sit Down | Chilled Water Pump | 0.307 | 0.869 | 0.284 | 0.675 | 0.279 | 0.594 |
| Heating Hot Water Pump | 0.321 | 1.000 | 0.278 | 1.000 | 0.275 | 1.000 |
| Condenser Water Pump | 0.272 | 0.869 | 0.246 | 0.675 | 0.241 | 0.594 |
| HVAC Fan | 0.295 | 0.907 | 0.278 | 0.758 | 0.277 | 0.694 |
| Cooling Tower Fan | 0.272 | 0.869 | 0.246 | 0.675 | 0.241 | 0.594 |
| Other | All | As determined by worksheet | | | | | |

|  |
| --- |
| **NOTE FOR TABLE 6-15** |
| 1. Back up calculations and reference material can be found on the PA PUC website at the following address: <http://www.puc.state.pa.us/electric/xls/Act129/TRM-ESF-DSF_Worksheet.xls> |

Source:

1. Motor Inventory Workbook, PA Technical Working Group (See Appendix F for calculation method and assumptions used for derivation of ESF & DSF values).

## 6.5 Industrial Air Compressors with Variable Frequency Drives

The energy and demand savings for variable frequency drives (VFDs) installed on industrial air compressors is based on the loading and hours of use of the compressor. In industrial settings, these factors can be highly variable and may be best evaluated using a custom path. The method for measurement set forth below may be appropriate for specific applications and has some of the elements of both a deemed and custom approach.

In systems with multiple compressors serving a common load, care must be taken to determine the loading on each compressor serving the plant such that the load factor and run hours for each compressor are taken into account.

### 6.5.1 Algorithms

Energy Savings (kWh) = 0.129 X HP X LF/ηmotor X RHRSbase

Demand Savings (kW) = 0.129 X HP

Coincident Peak Demand Savings (kW) = 0.106 X HP

### 6.5.2 Definitions of Variables

HP = Rated horsepower of the motor

LF = Load Factor. Ratio of the average operating load to the nameplate rating of the motor

ηbase = Efficiency of the baseline motor

RHRS = Annual run hours of the motor

CF = Demand Coincidence Factor. The percentage of the connected load that is on during electric system’s peak window as defined in Section **Error! Reference source not found.**.

Table 6-16: Variables for Industrial Air Compressor Calculation

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Type** | **Value** | **Source** |
| Motor HP | Variable | Nameplate | EDC Data Gathering |
| RHRS | Variable | Based on logging and modeling | EDC Data Gathering |
| kW/motor HP, Saved | Fixed | 0.129 | 1 |
| Coincident Peak kW/motor HP | Fixed | 0.106 | 1 |
| LF | Variable | Based on spot metering/ nameplate | EDC Data Gathering |

Sources:

### 1. Aspen Systems Corporation, Prescriptive Variable Speed Drive Incentive Development Support for Industrial Air Compressors, Executive Summary, June 20, 2005.[[47]](#footnote-47)

### 6.6 HVAC Systems

The ~~measurement of~~ energy and demand savings for Commercial and industrial ~~Efficient~~ HVAC for ~~Room AC, Central AC and air cooled DX is based on algorithms. (Includes split systems, air to air heat pumps, packaged terminal systems, water source heat pumps, ground water or ground source heat pumps)~~ is determined from the algorithms listed in below.

#### 6.6.1 Algorithms

6.6.1.2 Air Conditioning ~~Algorithms:~~ (includes room AC, central AC, air- cooled DX, split systems, and packaged terminal AC).

Energy Savings (kWh) = (Btu/H1000) X (1/EER*b*-1/EER*q*) X EFLH

Demand Savings (kW) = (Btu/H1000) X (1/EER*b*-1/EER*q*) X CF

6.6.1.2 Heat Pump ~~Algorithms~~ (includes air-to-air HP, packaged

terminal HP, water source HP, and groundwater source

HP).

Energy Savings-Cooling (kWh) = (Btu/H*c*1000) X (1/EER*b*-1/EER*q*) X EFLH*c*

Energy Savings-Heating (kWh) = Btu/H*h*1000X(1/EER*b*-1/EER*q* ) X EFLH*h*

Where *c* is for cooling and *h* is for heating.

#### 6.6.2 Definition of Variables

BtuH = Cooling capacity in Btu/Hour.

EER*b* = Efficiency rating of the baseline unit. For units < 65,000, SEER and HSPF should be used for cooling and heating savings, respectively.

EER*q* = Efficiency rating of the High Efficiency unit. For units < 65,000, SEER and HSPF should be used for cooling and heating savings, respectively.

CF = Demand Coincidence Factor. The percentage of the ~~total load which is on during electric system’s Peak Window, based on existing measured usage and determined as the average number of operating hours during the peak window period.~~ Connected load that occurs during the electric system’s peak window as defined in Section 1.9.

EFLH = Equivalent Full Load Hours – ~~A measure of energy use by season during the on-peak and off peak periods. Value is determined by existing measured data of kWh during the period divided by kW at design conditions.~~ The measured kWh during the entire operating season divided by the kW at design conditions.

Table ~~19~~ 6-17: ~~HV~~Variables for AC and Heat Pumps

| **Component** | **Type** | **Value** | **Source** |
| --- | --- | --- | --- |
| BtuH | Variable | ARI or AHAM or Manufacturer Data | ~~AEPS Application;~~ EDC’s Data Gathering |
| EERb | Variable | ~~See Table below~~ Nameplate data  Default values from Table 6-18 | ~~AEPS Application;~~ EDC’s Data Gathering  See Table |
| EERq | Variable | Nameplate data (ARI or AHAM) ~~Values~~ | ~~AEPS Application;~~ EDC’s Data Gathering |
| CF | Fixed | 67% | Engineering estimate[[48]](#footnote-48) |
| EFLH | Fixed | Based on Logging or Modeling  Default values from Table 6-19 and table 6-20  ~~Allentown Cooling = 784 Hours~~  ~~Allentown Heating = 2,492 Hours~~  ~~Erie Cooling = 482 Hours~~  ~~Erie Heating = 2,901 Hours~~  ~~Harrisburg Cooling = 929 Hours~~  ~~Harrisburg Heating = 2,371 Hours~~  ~~Philadelphia Cooling = 1,032 Hours~~  ~~Philadelphia Heating = 2,328 Hours~~  ~~Pittsburgh Cooling = 737 Hours~~  ~~Pittsburgh Heating = 2,380 Hours~~  ~~Scranton Cooling = 621 Hours~~  ~~Scranton Heating = 2,532 Hours~~  ~~Williamsport Cooling = 659 Hours~~  ~~Williamsport Heating = 2,502~~ | EDC’s Data Gathering  See Tables  ~~1~~ |
| Cooling Time Period Allocation Factors | Fixed | Summer/On-Peak 45%  Summer/Off-Peak 39%  Winter/On-Peak 7%  Winter/Off-Peak 9% |  |
| Heating Time Period Allocation Factors | Fixed | Summer/On-Peak 0%  Summer/Off-Peak 0%  Winter/On-Peak 41%  Winter/Off-Peak 58% |  |

Sources:

1. US Department of Energy. Energy Star Calculator and Bin Analysis Models

~~Table 20~~: ~~HVAC Baseline Table~~

| **~~Equipment Type~~** | **~~Baseline = ASHRAE Std. 90.1 - 2007~~** |
| --- | --- |
| ~~Unitary HVAC/Split Systems~~  ~~.<=5.4 tons:~~  ~~· >5.4 to 11.25 tons~~  ~~· >11.25 to 20 tons~~  ~~.> 20 to 63.33 tons~~  ~~.> 63.33 tons~~ | ~~13 SEER~~  ~~10.1 EER~~  ~~9.5 EER~~  ~~9.3 EER~~  ~~9 EER~~ |
| ~~Air-Air Heat Pump Systems (cooling)~~  ~~· <=5.4 tons:~~  ~~· >5.4 to 11.25 tons~~  ~~· >11.25 to 20 tons~~  ~~.>= 21 to 30 tons~~ | ~~13 SEER~~  ~~9.9 EER~~  ~~9.1 EER~~  ~~8.8 EER~~ |
| ~~Water Source Heat Pumps (cooling)~~  ~~< 1.42 tons~~  ~~≥ 1.42 tons~~ | ~~11.2 EER~~  ~~12.0 EER~~ |
| ~~GWSHPs~~  ~~Open and Closed Loop All Capacities~~ | ~~16.2 EER~~ |
| ~~Package Terminal Systems (Replacements)~~  ~~PTAC (cooling)~~  ~~PTHP (cooling)~~  ~~PTHP (heating)~~ | ~~10.9 - (0.213 x Cap / 1000) EER~~  ~~10.8 - (0.213 x Cap / 1000) EER~~  ~~2.9 - (0.213 x Cap / 1000) EER~~ |

Table 6-18: HVAC Baseline Efficiencies[[49]](#footnote-49)

| **Equipment Type** | | **Baseline** |
| --- | --- | --- |
| Unitary HVAC/Split Systems | |  |
| < | 5.4 tons | 13 SEER |
| > | 5.4 to 11.25 tons | 10.1 EER |
| > | 11.25 to 20 tons | 9.5 EER |
| > | 20 to 63.33 tons | 9.3 EER |
| > | 63.33 tons | 9 EER |
| Air-Air Heat Pump Systems (cooling) | |  |
| < | 5.4 tons: | 13 SEER |
| > | 5.4 to 11.25 tons | 9.9 EER |
| > | 11.25 to 20 tons | 9.1 EER |
| > | 21 to 30 tons | 8.8 EER |
| Water Source Heat Pumps (cooling) | |  |
| < | 1.42 tons | 11.2 EER |
| > | 1.42 tons | 12.0 EER |
| GWSHPs | |  |
| Open and Closed Loop, All Capacities | | 16.2 EER |
| Packaged Terminal Systems (Replacements) | |  |
| PTAC (cooling) | | 10.9 - (0.213 x Cap / 1000) EER |
| PTHP (cooling) | | 10.8 - (0.213 x Cap / 1000) EER |
| PTHP (heating) | | 2.9 - (0.213 x Cap / 1000) EER |

Table 6-19: Cooling and Heating EFLH for Erie, Harrisburg, and Pittsburgh[[50]](#footnote-50)

|  | **Erie** | | **Harrisburg** | | **Pittsburgh** | |
| --- | --- | --- | --- | --- | --- | --- |
| **Space Type** | **Cooling EFLH** | **Heating EFLH** | **Cooling EFLH** | **Heating EFLH** | **Cooling EFLH** | **Heating EFLH** |
| Auto Related | 493 | 1,383 | 950 | 1,130 | 754 | 1,135 |
| Bakery | 401 | 1,737 | 773 | 1,420 | 613 | 1,425 |
| Banks, Financial centers | 469 | 1,474 | 905 | 1,205 | 718 | 1,209 |
| Church | 332 | 2,001 | 640 | 1,635 | 508 | 1,641 |
| College - Cafeteria | 671 | 1,431 | 1,293 | 1,169 | 1,026 | 1,174 |
| College - Classes/Administrative | 380 | 1,815 | 733 | 1,484 | 582 | 1,489 |
| College - Dormitory | 418 | 1,675 | 805 | 1,369 | 638 | 1,374 |
| Commercial - Condos | 493 | 1,384 | 950 | 1,131 | 754 | 1,136 |
| Convenience Stores | 671 | 3,148 | 1,293 | 2,573 | 1,026 | 2,582 |
| Convention Center | 332 | 2,002 | 640 | 1,636 | 508 | 1,642 |
| Court House | 469 | 1,474 | 905 | 1,205 | 718 | 1,209 |
| Dining: Bar Lounge/Leisure | 503 | 1,346 | 969 | 1,100 | 769 | 1,104 |
| Dining: Cafeteria / Fast Food | 677 | 2,066 | 1,304 | 1,689 | 1,035 | 1,695 |
| Dining: Family | 503 | 1,346 | 969 | 1,100 | 769 | 1,104 |
| Entertainment | 332 | 2,002 | 640 | 1,636 | 508 | 1,642 |
| Exercise Center | 630 | 1,669 | 1,213 | 1,364 | 963 | 1,369 |
| Fast Food Restaurants | 671 | 2,066 | 1,293 | 1,689 | 1,026 | 1,695 |
| Fire Station (Unmanned) | 332 | 2,002 | 640 | 1,636 | 508 | 1,642 |
| Food Stores | 493 | 1,384 | 950 | 1,131 | 754 | 1,136 |
| Gymnasium | 380 | 1,815 | 733 | 1,484 | 582 | 1,489 |
| Hospitals | 770 | 319 | 1,485 | 261 | 1,178 | 262 |
| Hospitals/Health care | 770 | 321 | 1,483 | 263 | 1,177 | 264 |
| Industrial - 1 Shift | 401 | 1,736 | 773 | 1,419 | 613 | 1,424 |
| Industrial - 2 Shift | 545 | 1,184 | 1,050 | 968 | 833 | 972 |
| Industrial - 3 Shift | 690 | 626 | 1,330 | 512 | 1,055 | 513 |
| Laundromats | 493 | 1,383 | 950 | 1,130 | 754 | 1,135 |
| Library | 469 | 1,474 | 905 | 1,205 | 718 | 1,209 |
| Light Manufacturers | 401 | 1,736 | 773 | 1,419 | 613 | 1,424 |
| Lodging (Hotels/Motels) | 417 | 1,675 | 804 | 1,369 | 638 | 1,374 |
| Mall Concourse | 552 | 1,608 | 1,065 | 1,314 | 845 | 1,319 |
| Manufacturing Facility | 401 | 1,736 | 773 | 1,419 | 613 | 1,424 |
| Medical Offices | 469 | 1,474 | 905 | 1,205 | 718 | 1,209 |
| Motion Picture Theatre | 332 | 2,002 | 640 | 1,636 | 508 | 1,642 |
| Multi-Family (Common Areas) | 769 | 3,148 | 1,482 | 2,573 | 1,176 | 2,582 |
| Museum | 469 | 1,474 | 905 | 1,205 | 718 | 1,209 |
| Nursing Homes | 630 | 3,148 | 1,213 | 2,573 | 963 | 2,582 |
| Office (General Office Types | 469 | 835 | 905 | 682 | 718 | 685 |
| Office/Retail | 469 | 884 | 905 | 722 | 718 | 725 |
| Parking Garages & Lots | 517 | 1,292 | 997 | 1,056 | 791 | 1,060 |
| Penitentiary | 602 | 3,148 | 1,160 | 2,573 | 920 | 2,582 |
| Performing Arts Theatre | 380 | 1,815 | 733 | 1,484 | 582 | 1,489 |
| Police/Fire Stations (24 Hr) | 769 | 3,148 | 1,482 | 2,573 | 1,176 | 2,582 |
| Post Office | 469 | 1,474 | 905 | 1,205 | 718 | 1,209 |
| Pump Stations | 332 | 2,003 | 639 | 1,637 | 507 | 1,643 |
| Refrigerated Warehouses | 382 | 1,810 | 735 | 1,480 | 583 | 1,485 |
| Religious Buildings | 332 | 2,001 | 640 | 1,635 | 508 | 1,641 |
| Residential (Except Nursing Homes) | 418 | 1,675 | 805 | 1,369 | 638 | 1,374 |
| Restaurants | 503 | 1,346 | 969 | 1,100 | 769 | 1,104 |
| Retail | 493 | 1,383 | 950 | 1,130 | 754 | 1,135 |
| School/University | 350 | 1,120 | 674 | 916 | 535 | 919 |
| Schools (Jr./Sr. High) | 350 | 984 | 674 | 805 | 535 | 808 |
| Schools (Preschool/Elementary) | 350 | 984 | 674 | 805 | 535 | 808 |
| Schools (Technical/Vocational) | 350 | 984 | 674 | 805 | 535 | 808 |
| Small Services | 470 | 1,473 | 906 | 1,204 | 719 | 1,208 |
| Sports Arena | 332 | 2,002 | 640 | 1,636 | 508 | 1,642 |
| Town Hall | 469 | 567 | 905 | 463 | 718 | 465 |
| Transportation | 677 | 1,810 | 1,304 | 1,480 | 1,035 | 1,485 |
| Warehouses (Not Refrigerated) | 382 | 567 | 735 | 463 | 583 | 465 |
| Waste Water Treatment Plant | 690 | 1,473 | 1,330 | 1,204 | 1,055 | 1,208 |

Table 6-20: Cooling and Heating EFLH for Williamsport, Philadelphia and Scranton[[51]](#footnote-51)

|  | **Williamsport** | | **Philadelphia** | | **Scranton** | |
| --- | --- | --- | --- | --- | --- | --- |
| **Space Type** | **Cooling EFLH** | **Heating EFLH** | **Cooling EFLH** | **Heating EFLH** | **Cooling EFLH** | **Heating EFLH** |
| Auto Related | 674 | 1,193 | 1,055 | 1,110 | 635 | 1,207 |
| Bakery | 548 | 1,498 | 859 | 1,394 | 517 | 1,516 |
| Banks, Financial centers | 642 | 1,271 | 1,005 | 1,183 | 605 | 1,286 |
| Church | 454 | 1,725 | 711 | 1,605 | 428 | 1,746 |
| College - Cafeteria | 917 | 1,234 | 1,436 | 1,148 | 864 | 1,249 |
| College - Classes/Administrative | 520 | 1,565 | 815 | 1,457 | 490 | 1,584 |
| College - Dormitory | 571 | 1,444 | 894 | 1,344 | 538 | 1,462 |
| Commercial - Condos | 674 | 1,194 | 1,055 | 1,111 | 635 | 1,208 |
| Convenience Stores | 917 | 2,715 | 1,436 | 2,526 | 864 | 2,747 |
| Convention Center | 454 | 1,726 | 711 | 1,606 | 428 | 1,747 |
| Court House | 642 | 1,271 | 1,005 | 1,183 | 605 | 1,286 |
| Dining: Bar Lounge/Leisure | 688 | 1,161 | 1,077 | 1,080 | 648 | 1,175 |
| Dining: Cafeteria / Fast Food | 925 | 1,782 | 1,449 | 1,658 | 872 | 1,803 |
| Dining: Family | 688 | 1,161 | 1,077 | 1,080 | 648 | 1,175 |
| Entertainment | 454 | 1,726 | 711 | 1,606 | 428 | 1,747 |
| Exercise Center | 861 | 1,439 | 1,348 | 1,339 | 811 | 1,456 |
| Fast Food Restaurants | 917 | 1,782 | 1,436 | 1,658 | 864 | 1,803 |
| Fire Station (Unmanned) | 454 | 1,726 | 711 | 1,606 | 428 | 1,747 |
| Food Stores | 674 | 1,194 | 1,055 | 1,111 | 635 | 1,208 |
| Gymnasium | 520 | 1,565 | 815 | 1,457 | 490 | 1,584 |
| Hospitals | 1,053 | 275 | 1,649 | 2,526 | 992 | 278 |
| Hospitals/Health care | 1,052 | 277 | 1,648 | 2,526 | 992 | 280 |
| Industrial - 1 Shift | 548 | 1,497 | 859 | 1,393 | 517 | 1,515 |
| Industrial - 2 Shift | 745 | 1,022 | 1,166 | 951 | 702 | 1,034 |
| Industrial - 3 Shift | 944 | 540 | 1,478 | 502 | 889 | 546 |
| Laundromats | 674 | 1,193 | 1,055 | 1,110 | 635 | 1,207 |
| Library | 642 | 1,271 | 1,005 | 1,183 | 605 | 1,286 |
| Light Manufacturers | 548 | 1,497 | 859 | 1,393 | 517 | 1,515 |
| Lodging (Hotels/Motels) | 570 | 1,444 | 893 | 1,344 | 537 | 1,462 |
| Mall Concourse | 755 | 1,386 | 1,183 | 1,290 | 712 | 1,403 |
| Manufacturing Facility | 548 | 1,497 | 859 | 1,393 | 517 | 1,515 |
| Medical Offices | 642 | 1,271 | 1,005 | 1,183 | 605 | 1,286 |
| Motion Picture Theatre | 454 | 1,726 | 711 | 1,606 | 428 | 1,747 |
| Multi-Family (Common Areas) | 1,052 | 2,715 | 1,647 | 2,526 | 991 | 2,747 |
| Museum | 642 | 1,271 | 1,005 | 1,183 | 605 | 1,286 |
| Nursing Homes | 861 | 2,715 | 1,348 | 2,526 | 811 | 2,747 |
| Office (General Office Types | 642 | 720 | 1,005 | 670 | 605 | 729 |
| Office/Retail | 642 | 762 | 1,005 | 709 | 605 | 771 |
| Parking Garages & Lots | 707 | 1,114 | 1,107 | 1,037 | 666 | 1,128 |
| Penitentiary | 823 | 2,715 | 1,289 | 2,526 | 775 | 2,747 |
| Performing Arts Theatre | 520 | 1,565 | 815 | 1,457 | 490 | 1,584 |
| Police/Fire Stations (24 Hr) | 1,052 | 2,715 | 1,647 | 2,526 | 991 | 2,747 |
| Post Office | 642 | 1,271 | 1,005 | 1,183 | 605 | 1,286 |
| Pump Stations | 453 | 1,727 | 710 | 1,607 | 427 | 1,748 |
| Refrigerated Warehouses | 522 | 1,561 | 817 | 1,453 | 492 | 1,580 |
| Religious Buildings | 454 | 1,725 | 711 | 1,605 | 428 | 1,746 |
| Residential (Except Nursing Homes) | 571 | 1,444 | 894 | 1,344 | 538 | 1,462 |
| Restaurants | 688 | 1,161 | 1,077 | 1,080 | 648 | 1,175 |
| Retail | 674 | 1,193 | 1,055 | 1,110 | 635 | 1,207 |
| School/University | 478 | 966 | 749 | 899 | 451 | 978 |
| Schools (Jr./Sr. High) | 478 | 849 | 749 | 790 | 451 | 859 |
| Schools (Preschool/Elementary) | 478 | 849 | 749 | 790 | 451 | 859 |
| Schools (Technical/Vocational) | 478 | 849 | 749 | 790 | 451 | 859 |
| Small Services | 642 | 1,270 | 1,006 | 1,182 | 605 | 1,285 |
| Sports Arena | 454 | 1,726 | 711 | 1,606 | 428 | 1,747 |
| Town Hall | 642 | 489 | 1,005 | 455 | 605 | 495 |
| Transportation | 925 | 1,561 | 1,449 | 1,453 | 872 | 1,580 |
| Warehouses (Not Refrigerated) | 522 | 489 | 817 | 455 | 492 | 495 |
| Waste Water Treatment Plant | 944 | 1,270 | 1,478 | 1,182 | 889 | 1,285 |

### ~~Electric Chillers~~

~~The measurement of energy and demand savings for C/I Chillers is based on algorithms with key variables (i.e., kW/ton, Coincidence Factor, Equivalent Full Load Hours) measured through existing end-use metering of a sample of facilities.~~

#### ~~Algorithms~~

~~Energy Savings (kWh) = Tons X (kW/ton~~*~~b~~* ~~– kW/ton~~*~~q~~*~~) X EFLH~~

~~Demand Savings (kW) = Tons X (kW/ton~~*~~b~~* ~~– kW/ton~~*~~q~~*~~) X CF~~

#### ~~Definition of Variables~~

~~Tons = The capacity of the chiller (in tons) at site design conditions accepted by the program.~~

~~kW/ton~~*~~b~~* ~~= Baseline, found in the Chiller verification summary table.~~

~~kW/ton~~*~~q~~* ~~= This is the manufacturer data and equipment ratings in accordance with ARI Standard 550/590 latest edition.~~

~~CF = Coincidence Factor – Represents the percentage of the total load which is on during electric system’s Peak Window derived from JCP&L metered data.~~

~~EFLH = Equivalent Full Load Hours – A measure of chiller use by season determined by measured kWh during the period divided by kW at design conditions from JCP&L measurement data.~~

~~Table 21: Electric Chillers~~

| **~~Component~~** | **~~Type~~** | **~~Value~~** | **~~Source~~** |
| --- | --- | --- | --- |
| ~~Tons~~ | ~~Variable~~ | ~~From AEPS Application; EDC Data Gathering~~ |  |
| ~~kW/ton~~~~b~~ | ~~Fixed~~ | **~~Water Cooled Chillers (=<150 tons)~~**  ~~Baseline:…………… 0.703 kW/Ton~~  **~~Water Cooled Chillers (151 to <300 tons)~~**  ~~Baseline:…………… 0.634 kW/Ton~~  **~~Water Cooled Chillers (>301 tons)~~**  ~~Baseline:…………… 0.577 kW/Ton~~  **~~Air Cooled Chillers (<150 tons)~~**  ~~Baseline:…………… 1.256 kW/Ton~~ | ~~ASHRAE 90.1 2004~~ |
| ~~kW/ton~~~~q~~ | ~~Variable~~ | ~~ARI Standards 550/590-Latest edition~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~CF~~ | ~~Fixed~~ | ~~67%~~ | ~~Engineering estimate~~ |
| ~~EFLH~~ | ~~Fixed~~ | ~~Allentown Cooling = 784 Hours~~  ~~Erie Cooling = 482 Hours~~  ~~Harrisburg Cooling = 929 Hours~~  ~~Philadelphia Cooling = 1,032 Hours~~  ~~Pittsburgh Cooling = 737 Hours~~  ~~Scranton Cooling = 621 Hours~~  ~~Williamsport Cooling = 659 Hours~~ | ~~1~~ |
| ~~Time Period Allocation Factors~~ | ~~Fixed~~ | ~~Summer/On-Peak 45%~~  ~~Summer/Off-Peak 39%~~  ~~Winter/On-Peak 7%~~  ~~Winter/Off-Peak 9%~~ |  |

~~Sources:~~

1. ~~US Department of Energy. Energy Star Calculator~~

~~For certain fixed components, studies and surveys developed based on a review of manufacturer’s data, other utilities, regulatory commissions or consultant’s reports will be used to update the values for future filings.~~

### ~~Variable Frequency Drives~~

~~The measurement of energy and demand savings for C/I Variable Frequency Drive for VFD AEPS applications is for HVAC fans and water pumps only. VFD AEPS applications for other than this use should follow the custom path.~~

#### ~~Algorithms~~

~~Energy Savings (kWh) = 0.746 X HP X RLF/η~~~~motor~~ ~~X ESF X FLH~~~~base~~

~~Demand Savings (kW) = 0.746 X HP X RLF/η~~~~motor~~ ~~X DSF~~

#### ~~Definitions of Variables~~

~~HP = nameplate motor horsepower.~~

~~RLF = Rated Load Factor. Ratio of the peak running load to the nameplate rating of the motor.~~

~~η~~~~motor~~ ~~= Motor efficiency at the peak load. Motor efficiency varies with load. At low loads of relative to the rated hp (usually below 50%) efficiency often drops dramatically.~~

~~ESF = Energy Savings Factor. The energy savings factor is equal to 1 – FLH~~~~asd~~~~/FLH~~~~base~~~~. This factor can also be computed according to fan and pump laws assuming an average flow reduction and a cubic relationship between flow rate reduction and power draw savings.~~

~~FLH~~~~asd~~ ~~= Full Load Hours of the fan/pump with the VSD.~~

~~FLH~~~~base~~ ~~= Full Load Hours of the fan/pump with baseline drive.~~

~~DSF = Demand Savings Factor, calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions.~~

~~DSF = 1 – (kW~~~~asd~~~~/kW~~~~base~~~~)~~~~peak.~~

~~kW~~~~asd~~ ~~= peak demand of the motor under the variable control conditions.~~

~~kW~~~~base~~ ~~= peak demand of the motor under the base operating conditions.~~

~~Table 22: Variable Frequency Drives~~

| **~~Component~~** | **~~Type~~** | **~~Value~~** | **~~Source~~** |
| --- | --- | --- | --- |
| ~~Motor HP~~ | ~~Variable~~ | ~~Nameplate~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~kWh/motor HP~~ | ~~Fixed~~ | ~~1,653 for VAV air handler systems. 1,360 for chilled water pumps.~~ | ~~JCP&L metered data for VFD’s[[52]](#footnote-52) and chillers[[53]](#footnote-53).~~ |
| ~~RLF~~ | ~~Variable~~ | ~~Dependent on HP and peak running load~~ |  |
| ~~η~~~~motor~~ | ~~Variable~~ | ~~Nameplate or manufacturer specs~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~ESF~~ | ~~Variable~~ | ~~Dependent on full load of base and VFD~~ |  |
| ~~FLH~~~~asd~~ | ~~Variable~~ | ~~Nameplate~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~FLH~~~~base~~ | ~~Fixed~~ |  | ~~Manufacturer Data~~ |
| ~~DSF~~ | ~~Variable~~ | ~~Dependent on base and variable peak demand~~ |  |
| ~~kW~~~~asd~~ | ~~Variable~~ | ~~Nameplate~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~kW~~~~base~~ | ~~Fixed~~ |  | ~~Manufacturer Data~~ |
| ~~Time Period Allocation Factors~~ | ~~Fixed~~ | ~~Summer/On-Peak 22%~~  ~~Summer/Off-Peak 10%~~  ~~Winter/On-Peak 47%~~  ~~Winter/Off-Peak 21%~~ |  |

### ~~Air Compressors with Variable Frequency Drives~~

~~The measurement of energy and demand savings for variable frequency drive (VFD) air compressors.~~

#### ~~Algorithms~~

~~Energy Savings (kWh) = 774 X HP~~

~~Demand Savings (kW) = 0.129 X HP~~

~~Coincident Peak Demand Savings (kW) = 0.106 X HP~~

#### ~~Definitions of Variables~~

~~HP = nameplate motor horsepower~~

**~~Table 23: Air Compressors with VFDs~~**

|  |  |  |  |
| --- | --- | --- | --- |
| **~~Component~~** | **~~Type~~** | **~~Value~~** | **~~Source~~** |
| ~~Motor HP~~ | ~~Variable~~ | ~~Nameplate~~ | ~~AEPS Application; EDC Data Gathering~~ |
| ~~kWh/motor HP~~ | ~~Fixed~~ | ~~774~~ | ~~1~~ |
| ~~kW/motor HP~~ | ~~Fixed~~ | ~~0.129~~ | ~~1~~ |
| ~~Coincident Peak kW/motor HP~~ | ~~Fixed~~ | ~~0.106~~ | ~~1~~ |
| ~~Time Period Allocation Factors~~ | ~~Fixed~~ | ~~Summer/On-Peak 28%~~  ~~Summer/Off-Peak 39%~~  ~~Winter/On-Peak 14%~~  ~~Winter/Off-Peak 19%~~ |  |

~~Sources:~~

~~1. Aspen Systems Corporation, Prescriptive Variable Speed Drive Incentive Development Support for Industrial Air Compressors, Executive Summary, June 20, 2005.~~

# 7 Demand Response Programs

***~~Commercial and Industrial Application, Residential Applications~~***

## 7.1 Commercial and Industrial Applications

Each commercial and industrial application will be treated independently as a custom program. An application must be submitted, containing adequate documentation fully describing the energy efficiency measures installed or proposed and an explanation of how the installed facilities qualify for A E Cs. Each program application will be required to include[[54]](#footnote-54):

1. Program Name
2. Program Utility Company
3. Program Location (s)
4. Type of facilities in which the measures, systems, processes, or strategies will be implemented
5. Customer class and end-use served
6. Estimated demand reduction value (kW) per measure including supporting documentation (i.e. engineering estimates or documentation of verified savings from comparable projects)
7. Estimated energy reduction value (kWh) throughout the year
8. The date by which commercial operation is expected

The required application information is the minimum requirement for submitting a program. If a submitter relies on PJM protocols for participation in the PJM market, the PJM methodology will be accepted as a reporting method.

## 7.2 Residential Applications

## 7.2.1 Algorithms

The general form of the equation for the residential demand response measure savings algorithms is:

Number of Units X Savings per Unit

To determine resource savings, the per unit estimates in the algorithms will be multiplied by the number of demand response units. The number of units will be determined by the program. Per unit savings estimates will be estimated by each specific measure.

### 7.2.1.1 Direct Load Control (Air Conditioning Cycling and Pool Pump Load Control)

Electricity Impact (kWh) = ESav X Units X Hours

Demand Impact (kW) = ESav X Units

7.2.2 Definition of Terms

ESav = Energy Saved in One Hour in kW

Units = Number of Units in the Program

Hours = Number or hours throughout the year the measure operates

Table 7-1: Variables for Residential Applications of Demand Response Programs

| **Component** | **Type** | **Value** | **Sources** |
| --- | --- | --- | --- |
| ESav | Fixed | Air conditioning Cycling = 0.72 kW  Pool Pump Load Control = 0.75 kW | 1 |
| Units | Variable |  | AEPS Application; EDC Data Gathering |
| Hours | Variable |  | AEPS Application; EDC Data Gathering |

Sources:

1. Public Service Electric and Gas Company. *Petition for Approval of Demand Response Programs*. August 5, 2008.

8 Appendices

8*.*1 Appendix A: Measure Lives

|  |
| --- |
| **Measure Lives Used in Cost-Effectiveness Screening**  **February 2008[[55]](#footnote-55)** |

| **Program/Measure**  \*For the purpose of calculating the total Resource Cost Test for Act 129, measure cannot claim savings for more than fifteen years. | **Measure Life** |
| --- | --- |
| ***Residential Programs*** |  |
| *Energy Star Appliances* |  |
| Energy Star Refrigerator post-2001 | 13 |
| Energy Star Refrigerator 2001 | 13 |
| Energy Star Dishwasher | 11 |
| Energy Star Clothes Washer | 11 |
| Energy Star Dehumidifier | 12 |
| Energy Star Room Air Conditioners | 10 |
|  |  |
| *Energy Star Lighting* |  |
| Compact Fluorescent Light Bulb | 6.4 |
| Recessed Can Fluorescent Fixture | 20\* |
| Torchieres (Residential) | 10 |
| Fixtures Other | 20\* |
|  |  |
| *Energy Star Windows* |  |
| WINDOW -heat pump | 20\* |
| WINDOW -gas heat with central air conditioning | 20\* |
| WIN-oil heat/CAC | 20 |
| WIN-oil No CAC | 20 |
| WINDOW – electric heat without central air conditioning | 20\* |
| WINDOW – electric heat with central air conditioning | 20\* |
|  |  |
| *Refrigerator/Freezer Retirement* |  |
| Refrigerator/Freezer retirement | 8 |
|  |  |
| *Residential New Construction* |  |
| Single Family - gas heat with central air conditioner | 20\* |
| Single Family - oil heat with central air conditioner | 20\* |
| Single Family - all electric | 20\* |
| Multiple Single Family (Townhouse) – gas heat with central air conditioner | 20\* |
| Multiple Single Family (Townhouse) – oil heat with central air conditioner | 20\* |
| Multiple Single Family (Townhouse) - all electric | 20\* |
| Multi-Family – gas heat with central air conditioner | 20\* |
| Multi-Family - oil heat with central air conditioner | 20\* |
| Multi-Family - all electric | 20\* |
| Energy Star Clothes Washer | 11 |
| Recessed Can Fluorescent Fixture | 20\* |
| Fixtures Other | 20\* |
| Efficient Ventilation Fans with Timer | 10 |
|  |  |
| *Residential Electric HVAC* |  |
| Central Air Conditioner SEER 13 | 14 |
| Central Air Conditioner SEER 14 | 14 |
| Air Source Heat Pump SEER 13 | 12 |
| Air Source Heat Pump SEER 14 | 12 |
| Central Air Conditioner proper sizing/install | 14 |
| Central Air Conditioner Quality Installation Verification | 14 |
| Central Air Conditioner Maintenance | 7 |
| Central Air Conditioner duct sealing | 14 |
| Air Source Heat Pump proper sizing/install | 12 |
| Energy Star Thermostat (Central Air Conditioner) | 15 |
| Energy Star Thermostat (Heat Pump) | 15 |
| Ground Source Heat Pump | 30\* |
| Central Air Conditioner SEER 15 | 14 |
| Air Source Heat Pump SEER 15 | 12 |
|  |  |
| **Home Performance with ENERGY STAR** |  |
| Blue Line Innovations – PowerCost MonitorTM | 5 |
|  |  |
| ***Non-Residential Programs*** |  |
| *C&I Construction* |  |
| Commercial Lighting — New | 15 |
| Commercial Lighting — Remodel/Replacement | 15 |
| Commercial Custom — New | 18\* |
| Commercial Chiller Optimization | 18\* |
| Commercial Unitary HVAC — New - Tier 1 | 15 |
| Commercial Unitary HVAC — Replacement - Tier 1 | 15 |
| Commercial Unitary HVAC — New - Tier 2 | 15 |
| Commercial Unitary HVAC — Replacement Tier 2 | 15 |
| Commercial Chillers — New | 20\* |
| Commercial Chillers — Replacement | 20\* |
| Commercial Small Motors (1-10 horsepower) — New or Replacement | 20\* |
| Commercial Medium Motors (11-75 horsepower) — New or Replacement | 20\* |
| Commercial Large Motors (76-200 horsepower) — New or Replacement | 20\* |
| Commercial Variable Speed Drive — New | 15 |
| Commercial Variable Speed Drive — Retrofit | 15 |
| Commercial Comprehensive New Construction Design | 18\* |
| Commercial Custom — Replacement | 18\* |
| Industrial Lighting — New | 15 |
| Industrial Lighting — Remodel/Replacement | 15 |
| Industrial Unitary HVAC — New - Tier 1 | 15 |
| Industrial Unitary HVAC — Replacement - Tier 1 | 15 |
| Industrial Unitary HVAC — New - Tier 2 | 15 |
| Industrial Unitary HVAC — Replacement Tier 2 | 15 |
| Industrial Chillers — New | 20\* |
| Industrial Chillers — Replacement | 20\* |
| Industrial Small Motors (1-10 horsepower) — New or Replacement | 20\* |
| Industrial Medium Motors (11-75 horsepower) — New or Replacement | 20\* |
| Industrial Large Motors (76-200 horsepower) — New or Replacement | 20\* |
| Industrial Variable Speed Drive — New | 15 |
| Industrial Variable Speed Drive — Retrofit | 15 |
| Industrial Custom — Non-Process | 18\* |
| Industrial Custom — Process | 10 |
|  |  |
| *Building O&M* |  |
| O&M savings | 3 |

## 8.2 Appendix B: Relationship between Program Savings and Evaluation Savings

There is a distinction between activities required to conduct measurement and verification of savings at the program participant level and the activities conducted by program evaluators and the SWE to validate those savings. However, the underlying standard for the measurement of the savings for both of these activities is the measurement and verification protocols approved by the PA PUC. These protocols are of three different types:

1. TRM specified protocols for standard measures, originally approved in the May 2009 order adopting the TRM, and updated annually thereafter
2. Interim Protocols for standard measures, reviewed and recommended by the SWE and approved for use by the Director of the CEEP, subject to modification and incorporation into succeeding TRM versions to be approved by the PA PUC
3. Custom Measure Protocols reviewed and recommended by the SWE and approved for use by the Director of the CEEP

These protocols are to be uniform and used to measure and calculate savings throughout Pennsylvania. The TRM protocols are comprised of Deemed Measures and Partially Deemed Measures. Deemed Measures specify saving per energy efficiency measure and require verifying that the measure has been installed, or in cases where that is not feasible, that the measure has been purchased by a utility customer. Partially Deemed Measures require both verification of installation and the measurement or quantification of open variables in the protocol.

Stipulated and deemed numbers are valid relative to a particular classification of “standard” measures. In the determination of these values, a normal distribution of values should have been incorporated. Therefore, during the measurement and verification process, participant savings measures cannot be arbitrarily treated as “custom measures” if the category allocation is appropriate.

Utility evaluators and the SWE will adjust the savings reported by program staff based on the application of the PA PUC approved protocols to a sample population and realization rates will be based on the application of these same standards. To the extent that the protocols or deemed values included in these protocols require modification, the appropriate statewide approval process will be utilized. These changes will be prospective.

## 8.3 Appendix C: Lighting Inventory Form

- Lighting Inventory Form

* Table of Standard Wattages
* Fixture Code Legend and Notes



| **TABLE OF STANDARD WATTAGES** | | |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| FIXTURE CODE | LAMP CODE | DESCRIPTION | BALLAST | LAMP/FIXT | WATT/LAMP | WATT/FIXT |
| CF10/2D | CFD10W | Compact Fluorescent, 2D, (1) 10W lamp | Mag-STD | 1 | 10 | 16 |
| CF10/2D-L | CFD10W | Compact Fluorescent, 2D, (1) 10W lamp | Electronic | 1 | 10 | 12 |
| CF11/1 | CF11W | Compact Fluorescent, (1) 11W lamp | Mag-STD | 1 | 11 | 13 |
| CF11/2 | CF11W | Compact Fluorescent, (2) 11W lamp | Mag-STD | 2 | 11 | 26 |
| CF16/2D | CFD16W | Compact Fluorescent, 2D, (1) 16W lamp | Mag-STD | 1 | 16 | 26 |
| CF16/2D-L | CFD16W | Compact Fluorescent, 2D, (1) 16W lamp | Electronic | 1 | 16 | 18 |
| CF18/3-L | CF18W | Compact Fluorescent, (3) 18W lamp | Electronic | 3 | 18 | 60 |
| CF21/2D | CFD21W | Compact Fluorescent, 2D, (1) 21W lamp | Mag-STD | 1 | 21 | 26 |
| CF21/2D-L | CFD21W | Compact Fluorescent, 2D, (1) 21W lamp | Electronic | 1 | 21 | 22 |
| CF23/1 | CF23W | Compact Fluorescent, (1) 23W lamp | Mag-STD | 1 | 23 | 29 |
| CF23/1-L | CF23W | Compact Fluorescent, (1) 23W lamp | Electronic | 1 | 23 | 25 |
| CF26/3-L | CF26W | Compact Fluorescent, (3) 26W lamp | Electronic | 3 | 26 | 82 |
| CF26/4-L | CF26W | Compact Fluorescent, (4) 26W lamp | Electronic | 4 | 26 | 108 |
| CF26/6-L | CF26W | Compact Fluorescent, (6) 26W lamp | Electronic | 6 | 26 | 162 |
| CF26/8-L | CF26W | Compact Fluorescent, (8) 26W lamp | Electronic | 8 | 26 | 216 |
| CF28/2D | CFD28W | Compact Fluorescent, 2D, (1) 28W lamp | Mag-STD | 1 | 28 | 35 |
| CF28/2D-L | CFD28W | Compact Fluorescent, 2D, (1) 28W lamp | Electronic | 1 | 28 | 28 |
| CF32/3-L | CF32W | Compact Fluorescent, (3) 32W lamp | Electronic | 3 | 32 | 114 |
| CF32/4-L | CF32W | Compact Fluorescent, (4) 32W lamp | Electronic | 4 | 32 | 152 |
| CF32/6-L | CF32W | Compact Fluorescent, (6) 32W lamp | Electronic | 6 | 32 | 228 |
| CF32/8-L | CF32W | Compact Fluorescent, (8) 32W lamp | Electronic | 8 | 32 | 304 |
| CF38/2D | CFD38W | Compact Fluorescent, 2D, (1) 38W lamp | Mag-STD | 1 | 38 | 46 |
| CF38/2D-L | CFD38W | Compact Fluorescent, 2D, (1) 38W lamp | Electronic | 1 | 38 | 36 |
| CF42/1-L | CF42W | Compact Fluorescent, (1) 42W lamp | Electronic | 1 | 42 | 48 |
| CF42/2-L | CF42W | Compact Fluorescent, (2) 42W lamp | Electronic | 2 | 42 | 100 |
| CF42/3-L | CF42W | Compact Fluorescent, (3) 42W lamp | Electronic | 3 | 42 | 141 |
| CF42/4-L | CF42W | Compact Fluorescent, (4) 42W lamp | Electronic | 4 | 42 | 188 |
| CF42/6-L | CF42W | Compact Fluorescent, (6) 42W lamp | Electronic | 6 | 42 | 282 |
| CF42/8-L | CF42W | Compact Fluorescent, (8) 42W lamp | Electronic | 8 | 42 | 376 |
| CFQ10/1 | CFQ10W | Compact Fluorescent, quad, (1) 10W lamp | Mag-STD | 1 | 10 | 15 |
| CFQ13/1 | CFQ13W | Compact Fluorescent, quad, (1) 13W lamp | Mag-STD | 1 | 13 | 17 |
| CFQ13/1-L | CFQ13W | Compact Fluorescent, quad, (1) 13W lamp, BF=1.05 | Electronic | 1 | 13 | 15 |
| CFQ13/2 | CFQ13W | Compact Fluorescent, quad, (2) 13W lamp | Mag-STD | 2 | 13 | 31 |
| CFQ13/2-L | CFQ13W | Compact Fluorescent, quad, (2) 13W lamp, BF=1.0 | Electronic | 2 | 13 | 28 |
| CFQ13/3 | CFQ13W | Compact Fluorescent, quad, (3) 13W lamp | Mag-STD | 3 | 13 | 48 |
| CFQ15/1 | CFQ15W | Compact Fluorescent, quad, (1) 15W lamp | Mag-STD | 1 | 15 | 20 |
| CFQ17/1 | CFQ17W | Compact Fluorescent, quad, (1) 17W lamp | Mag-STD | 1 | 17 | 24 |
| CFQ17/2 | CFQ17W | Compact Fluorescent, quad, (2) 17W lamp | Mag-STD | 2 | 17 | 48 |
| CFQ18/1 | CFQ18W | Compact Fluorescent, quad, (1) 18W lamp | Mag-STD | 1 | 18 | 26 |
| CFQ18/1-L | CFQ18W | Compact Fluorescent, quad, (1) 18W lamp, BF=1.0 | Electronic | 1 | 18 | 20 |
| CFQ18/2 | CFQ18W | Compact Fluorescent, quad, (2) 18W lamp | Mag-STD | 2 | 18 | 45 |
| CFQ18/2-L | CFQ18W | Compact Fluorescent, quad, (2) 18W lamp, BF=1.0 | Electronic | 2 | 18 | 38 |
| CFQ18/4 | CFQ18W | Compact Fluorescent, quad, (4) 18W lamp | Mag-STD | 2 | 18 | 90 |
| CFQ20/1 | CFQ20W | Compact Fluorescent, quad, (1) 20W lamp | Mag-STD | 1 | 20 | 23 |
| CFQ20/2 | CFQ20W | Compact Fluorescent, quad, (2) 20W lamp | Mag-STD | 2 | 20 | 46 |
| CFQ22/1 | CFQ22W | Compact Fluorescent, quad, (1) 22W lamp | Mag-STD | 1 | 22 | 24 |
| CFQ22/2 | CFQ22W | Compact Fluorescent, quad, (2) 22W lamp | Mag-STD | 2 | 22 | 48 |
| CFQ22/3 | CFQ22W | Compact Fluorescent, quad, (3) 22W lamp | Mag-STD | 3 | 22 | 72 |
| CFQ25/1 | CFQ25W | Compact Fluorescent, quad, (1) 25W lamp | Mag-STD | 1 | 25 | 33 |
| CFQ25/2 | CFQ25W | Compact Fluorescent, quad, (2) 25W lamp | Mag-STD | 2 | 25 | 66 |
| CFQ26/1 | CFQ26W | Compact Fluorescent, quad, (1) 26W lamp | Mag-STD | 1 | 26 | 33 |
| CFQ26/1-L | CFQ26W | Compact Fluorescent, quad, (1) 26W lamp, BF=0.95 | Electronic | 1 | 26 | 27 |
| CFQ26/2 | CFQ26W | Compact Fluorescent, quad, (2) 26W lamp | Mag-STD | 2 | 26 | 66 |
| CFQ26/2-L | CFQ26W | Compact Fluorescent, quad, (2) 26W lamp, BF=0.95 | Electronic | 2 | 26 | 50 |
| CFQ26/3 | CFQ26W | Compact Fluorescent, quad, (3) 26W lamp | Mag-STD | 3 | 26 | 99 |
| CFQ26/6-L | CFQ26W | Compact Fluorescent, quad, (6) 26W lamp, BF=0.95 | Electronic | 6 | 26 | 150 |
| CFQ28/1 | CFQ28W | Compact Fluorescent, quad, (1) 28W lamp | Mag-STD | 1 | 28 | 33 |
| CFQ9/1 | CFQ9W | Compact Fluorescent, quad, (1) 9W lamp | Mag-STD | 1 | 9 | 14 |
| CFQ9/2 | CFQ9W | Compact Fluorescent, quad, (2) 9W lamp | Mag-STD | 2 | 9 | 23 |
| CFS7/1 | CFS7W | Compact Fluorescent, spiral, (1) 7W lamp | Electronic | 1 | 7 | 7 |
| CFS9/1 | CFS9W | Compact Fluorescent, spiral, (1) 9W lamp | Electronic | 1 | 9 | 9 |
| CFS11/1 | CFS11W | Compact Fluorescent, spiral, (1) 11W lamp | Electronic | 1 | 11 | 11 |
| CFS15/1 | CFS15W | Compact Fluorescent, spiral, (1) 15W lamp | Electronic | 1 | 15 | 15 |
| CFS20/1 | CFS20W | Compact Fluorescent, spiral, (1) 20W lamp | Electronic | 1 | 20 | 20 |
| CFS23/1 | CFS23W | Compact Fluorescent, spiral, (1) 23W lamp | Electronic | 1 | 23 | 23 |
| CFS27/1 | CFS27W | Compact Fluorescent, spiral, (1) 27W lamp | Electronic | 1 | 27 | 27 |
| CFT13/1 | CFT13W | Compact Fluorescent, twin, (1) 13W lamp | Mag-STD | 1 | 13 | 17 |
| CFT13/2 | CFT13W | Compact Fluorescent, twin, (2) 13W lamp | Mag-STD | 2 | 13 | 31 |
| CFT13/3 | CFT13W | Compact Fluorescent, twin, (3) 13 W lamp | Mag-STD | 3 | 13 | 48 |
| CFT18/1 | CFT18W | Compact Fluorescent, long twin., (1) 18W lamp | Mag-STD | 1 | 18 | 24 |
| CFT22/1 | CFT22W | Compact Fluorescent, twin, (1) 22W lamp | Mag-STD | 1 | 22 | 27 |
| CFT22/2 | CFT22W | Compact Fluorescent, twin, (2) 22W lamp | Mag-STD | 2 | 22 | 54 |
| CFT22/4 | CFT22W | Compact Fluorescent, twin, (4) 22W lamp | Mag-STD | 4 | 22 | 108 |
| CFT24/1 | CFT24W | Compact Fluorescent, long twin, (1) 24W lamp | Mag-STD | 1 | 24 | 32 |
| CFT28/1 | CFT28W | Compact Fluorescent, twin, (1) 28W lamp | Mag-STD | 1 | 28 | 33 |
| CFT28/2 | CFT28W | Compact Fluorescent, twin, (2) 28W lamp | Mag-STD | 2 | 28 | 66 |
| CFT32/1-L | CFM32W | Compact Fluorescent, twin or multi, (1) 32W lamp | Electronic | 1 | 32 | 34 |
| CFT32/2-L | CFM32W | Compact Fluorescent, twin or multi, (2) 32W lamp | Electronic | 2 | 32 | 62 |
| CFT32/6-L | CFM32W | Compact Fluorescent, twin or multi, (2) 32W lamp | Electronic | 6 | 32 | 186 |
| CFT36/1 | CFT36W | Compact Fluorescent, long twin, (1) 36W lamp | Mag-STD | 1 | 36 | 51 |
| CFT36/4-BX | CFT36W | Compact Fluorescent, Biax, (4) 36W lamp | Electronic | 4 | 36 | 148 |
| CFT36/6-BX | CFT36W | Compact Fluorescent, Biax, (6) 36W lamp | Electronic | 6 | 36 | 212 |
| CFT36/6-L | CFT36W | Compact Fluorescent, long Twin, (6) 36W lamp | Electronic | 6 | 36 | 198 |
| CFT36/6-L | CFT36W | Compact Fluorescent, long Twin, (6) 36W lamp/ High Ballast Factor | Electronic | 6 | 36 | 210 |
| CFT36/8-BX | CFT36W | Compact Fluorescent, Biax, (8) 36W lamp | Electronic | 8 | 36 | 296 |
| CFT36/8-L | CFT36W | Compact Fluorescent, long Twin, (8) 36W lamp | Electronic | 8 | 36 | 270 |
| CFT36/8-L | CFT36W | Compact Fluorescent, long Twin, (8) 36W lamp/ High Ballast Factor | Electronic | 8 | 36 | 286 |
| CFT36/9-BX | CFT36W | Compact Fluorescent, Biax, (9) 36W lamp | Electronic | 9 | 36 | 318 |
| CFT40/1 | CFT40W | Compact Fluorescent, twin, (1) 40W lamp | Mag-STD | 1 | 40 | 46 |
| CFT40/12-BX | CFT40W | Compact Fluorescent, Biax, (12) 40W lamp | Electronic | 12 | 40 | 408 |
| CFT40/1-BX | CFT40W | Compact Fluorescent, Biax, (1) 40W lamp | Electronic | 1 | 40 | 46 |
| CFT40/1-L | CFT40W | Compact Fluorescent, long twin, (1) 40W lamp | Electronic | 1 | 40 | 43 |
| CFT40/2 | CFT40W | Compact Fluorescent, twin, (2) 40W lamp | Mag-STD | 2 | 40 | 85 |
| CFT40/2-BX | CFT40W | Compact Fluorescent, Biax, (2) 40W lamp | Electronic | 2 | 40 | 72 |
| CFT40/2-L | CFT40W | Compact Fluorescent, long twin, (2) 40W lamp | Electronic | 2 | 40 | 72 |
| CFT40/3 | CFT40W | Compact Fluorescent, twin, (3) 40 W lamp | Mag-STD | 3 | 40 | 133 |
| CFT40/3-BX | CFT40W | Compact Fluorescent, Biax, (3) 40W lamp | Electronic | 3 | 40 | 102 |
| CFT40/3-L | CFT40W | Compact Fluorescent, long twin, (3) 40W lamp | Electronic | 3 | 40 | 105 |
| CFT40/4-BX | CFT40W | Compact Fluorescent, Biax, (4) 40W lamp | Electronic | 4 | 40 | 144 |
| CFT40/5-BX | CFT40W | Compact Fluorescent, Biax, (5) 40W lamp | Electronic | 5 | 40 | 190 |
| CFT40/6-BX | CFT40W | Compact Fluorescent, Biax, (6) 40W lamp | Electronic | 6 | 40 | 204 |
| CFT40/6-L | CFT40W | Compact Fluorescent, long Twin, (6) 40W lamp | Electronic | 6 | 40 | 220 |
| CFT40/6-L | CFT40W | Compact Fluorescent, long Twin, (6) 40W lamp/ High Ballast Factor | Electronic | 6 | 40 | 233 |
| CFT40/8-BX | CFT40W | Compact Fluorescent, Biax, (8) 40W lamp | Electronic | 8 | 40 | 288 |
| CFT40/8-L | CFT40W | Compact Fluorescent, long Twin, (8) 40W lamp | Electronic | 8 | 40 | 300 |
| CFT40/8-L | CFT40W | Compact Fluorescent, long Twin, (8) 40W lamp/ High Ballast Factor | Electronic | 8 | 40 | 340 |
| CFT40/9-BX | CFT40W | Compact Fluorescent, Biax, (9) 40W lamp | Electronic | 9 | 40 | 306 |
| CFT5/1 | CFT5W | Compact Fluorescent, twin, (1) 5W lamp | Mag-STD | 1 | 5 | 9 |
| CFT5/2 | CFT5W | Compact Fluorescent, twin, (2) 5W lamp | Mag-STD | 2 | 5 | 18 |
| CFT50/12-BX | CFT50W | Compact Fluorescent, Biax, (12) 50W lamp | Electronic | 12 | 50 | 648 |
| CFT50/1-BX | CFT50W | Compact Fluorescent, Biax, (1) 50W lamp | Electronic | 1 | 50 | 54 |
| CFT50/2-BX | CFT50W | Compact Fluorescent, Biax, (2) 50W lamp | Electronic | 2 | 50 | 108 |
| CFT50/3-BX | CFT50W | Compact Fluorescent, Biax, (3) 50W lamp | Electronic | 3 | 50 | 162 |
| CFT50/4-BX | CFT50W | Compact Fluorescent, Biax, (4) 50W lamp | Electronic | 4 | 50 | 216 |
| CFT50/5-BX | CFT50W | Compact Fluorescent, Biax, (5) 50W lamp | Electronic | 5 | 50 | 270 |
| CFT50/6-BX | CFT50W | Compact Fluorescent, Biax, (6) 50W lamp | Electronic | 6 | 50 | 324 |
| CFT50/8-BX | CFT50W | Compact Fluorescent, Biax, (8) 50W lamp | Electronic | 8 | 50 | 432 |
| CFT50/9-BX | CFT50W | Compact Fluorescent, Biax, (9) 50W lamp | Electronic | 9 | 50 | 486 |
| CFT55/12-BX | CFT55W | Compact Fluorescent, Biax, (12) 55W lamp | Electronic | 12 | 55 | 672 |
| CFT55/1-BX | CFT55W | Compact Fluorescent, Biax, (1) 55W lamp | Electronic | 1 | 55 | 56 |
| CFT55/2-BX | CFT55W | Compact Fluorescent, Biax, (2) 55W lamp | Electronic | 2 | 55 | 112 |
| CFT55/3-BX | CFT55W | Compact Fluorescent, Biax, (3) 55W lamp | Electronic | 3 | 55 | 168 |
| CFT55/4-BX | CFT55W | Compact Fluorescent, Biax, (4) 55W lamp | Electronic | 4 | 55 | 224 |
| CFT55/5-BX | CFT55W | Compact Fluorescent, Biax, (5) 55W lamp | Electronic | 5 | 55 | 280 |
| CFT55/6-BX | CFT55W | Compact Fluorescent, Biax, (6) 55W lamp | Electronic | 6 | 55 | 336 |
| CFT55/6-L | CFT55W | Compact Fluorescent, long Twin, (6) 55W lamp | Electronic | 6 | 55 | 352 |
| CFT55/6-L | CFT55W | Compact Fluorescent, long Twin, (6) 55W lamp/ High Ballast Factor | Electronic | 6 | 55 | 373 |
| CFT55/8-BX | CFT55W | Compact Fluorescent, Biax, (8) 55W lamp | Electronic | 8 | 55 | 448 |
| CFT55/8-L | CFT55W | Compact Fluorescent, long Twin, (8) 55W lamp | Electronic | 8 | 55 | 468 |
| CFT55/8-L | CFT55W | Compact Fluorescent, long Twin, (8) 55W lamp/ High Ballast Factor | Electronic | 8 | 55 | 496 |
| CFT55/9-BX | CFT55W | Compact Fluorescent, Biax, (9) 55W lamp | Electronic | 9 | 55 | 504 |
| CFT7/1 | CFT7W | Compact Fluorescent, twin, (1) 7W lamp | Mag-STD | 1 | 7 | 10 |
| CFT7/2 | CFT7W | Compact Fluorescent, twin, (2) 7W lamp | Mag-STD | 2 | 7 | 21 |
| CFT9/1 | CFT9W | Compact Fluorescent, twin, (1) 9W lamp | Mag-STD | 1 | 9 | 11 |
| CFT9/2 | CFT9W | Compact Fluorescent, twin, (2) 9W lamp | Mag-STD | 2 | 9 | 23 |
| CFT9/3 | CFT9W | Compact Fluorescent, twin, (3) 9W lamp | Mag-STD | 3 | 9 | 34 |
|  |  | ***EXIT Sign Fixtures*** |  |  |  |  |
| ECF5/1 | CFT5W | EXIT Compact Fluorescent, (1) 5W lamp | Mag-STD | 1 | 5 | 9 |
| ECF5/2 | CFT5W | EXIT Compact Fluorescent, (2) 5W lamp | Mag-STD | 2 | 5 | 20 |
| ECF7/1 | CFT7W | EXIT Compact Fluorescent, (1) 7W lamp | Mag-STD | 1 | 7 | 10 |
| ECF7/2 | CFT7W | EXIT Compact Fluorescent, (2) 7W lamp | Mag-STD | 2 | 7 | 21 |
| ECF8/1 | F8T5 | EXIT T5 Fluorescent, (1) 8W lamp | Mag-STD | 1 | 8 | 12 |
| ECF8/2 | F8T5 | EXIT T5 Fluorescent, (2) 8W lamp | Mag-STD | 2 | 8 | 24 |
| ECF9/1 | CFT9W | EXIT Compact Fluorescent, (1) 9W lamp | Mag-STD | 1 | 9 | 12 |
| ECF9/2 | CFT9W | EXIT Compact Fluorescent, (2) 9W lamp | Mag-STD | 2 | 9 | 20 |
| EI10/2 | I10 | EXIT Incandescent, (2) 10W lamp |  | 2 | 10 | 20 |
| EI15/1 | I15 | EXIT Incandescent, (1) 15W lamp |  | 1 | 15 | 15 |
| EI15/2 | I15 | EXIT Incandescent, (2) 15W lamp |  | 2 | 15 | 30 |
| EI20/1 | I20 | EXIT Incandescent, (1) 20W lamp |  | 1 | 20 | 20 |
| EI20/2 | I20 | EXIT Incandescent, (2) 20W lamp |  | 2 | 20 | 40 |
| EI25/1 | I25 | EXIT Incandescent, (1) 25W lamp |  | 1 | 25 | 25 |
| EI25/2 | I25 | EXIT Incandescent, (2) 25W lamp |  | 2 | 25 | 50 |
| EI34/1 | I34 | EXIT Incandescent, (1) 34W lamp |  | 1 | 34 | 34 |
| EI34/2 | I34 | EXIT Incandescent, (2) 34W lamp |  | 2 | 34 | 68 |
| EI40/1 | I40 | EXIT Incandescent, (1) 40W lamp |  | 1 | 40 | 40 |
| EI40/2 | I40 | EXIT Incandescent, (2) 40W lamp |  | 2 | 40 | 80 |
| EI5/1 | I5 | EXIT Incandescent, (1) 5W lamp |  | 1 | 5 | 5 |
| EI5/2 | I5 | EXIT Incandescent, (2) 5W lamp |  | 2 | 5 | 10 |
| EI50/2 | I50 | EXIT Incandescent, (2) 50W lamp |  | 2 | 50 | 100 |
| EI7.5/1 | I7.5 | EXIT Tungsten, (1) 7.5 W lamp |  | 1 | 7.5 | 8 |
| EI7.5/2 | I7.5 | EXIT Tungsten, (2) 7.5 W lamp |  | 2 | 7.5 | 15 |
| ELED0.5/1 | LED0.5W | EXIT Light Emitting Diode, (1) 0.5W lamp, Single Sided |  | 1 | 0.5 | 0.5 |
| ELED0.5/2 | LED0.5W | EXIT Light Emitting Diode, (2) 0.5W lamp, Dual Sided |  | 2 | 0.5 | 1 |
| ELED1.5/1 | LED1.5W | EXIT Light Emitting Diode, (1) 1.5W lamp, Single Sided |  | 1 | 1.5 | 1.5 |
| ELED1.5/2 | LED1.5W | EXIT Light Emitting Diode, (2) 1.5W lamp, Dual Sided |  | 2 | 1.5 | 3 |
| ELED10.5/1 | LED10.5W | EXIT Light Emitting Diode, (1) 10.5W lamp, Single Sided |  | 1 | 10.5 | 10.5 |
| ELED10.5/2 | LED10.5W | EXIT Light Emitting Diode, (2) 10.5W lamp, Dual Sided |  | 2 | 10.5 | 21 |
| ELED2/1 | LED2W | EXIT Light Emitting Diode, (1) 2W lamp, Single Sided |  | 1 | 2 | 2 |
| ELED2/2 | LED2W | EXIT Light Emitting Diode, (2) 2W lamp, Dual Sided |  | 2 | 2 | 4 |
| ELED3/1 | LED3W | EXIT Light Emitting Diode, (1) 3W lamp, Single Sided |  | 1 | 3 | 3 |
| ELED3/2 | LED3W | EXIT Light Emitting Diode, (2) 3W lamp, Dual Sided |  | 2 | 3 | 6 |
| ELED5/1 | LED5W | EXIT Light Emitting Diode, (1) 5W lamp, Single Sided |  | 1 | 5 | 5 |
| ELED5/2 | LED5W | EXIT Light Emitting Diode, (2) 5W lamp, Dual Sided |  | 2 | 5 | 10 |
| ELED8/1 | LED8W | EXIT Light Emitting Diode, (1) 8W lamp, Single Sided |  | 1 | 8 | 8 |
| ELED8/2 | LED8W | EXIT Light Emitting Diode, (2) 8W lamp, Dual Sided |  | 2 | 8 | 16 |
|  |  | ***Linear Fluorescent Fixtures*** |  |  |  |  |
| F1.51LS | F15T8 | Fluorescent, (1) 18" T8 lamp | Mag-STD | 1 | 15 | 19 |
| F1.51SS | F15T12 | Fluorescent, (1) 18" T12 lamp | Mag-STD | 1 | 15 | 19 |
| F1.52LS | F15T8 | Fluorescent, (2) 18" T8 lamp | Mag-STD | 2 | 15 | 36 |
| F1.52SS | F15T12 | Fluorescent, (2) 18", T12 lamp | Mag-STD | 2 | 15 | 36 |
| F21HS | F24T12/HO | Fluorescent, (1) 24", HO lamp | Mag-STD | 1 | 35 | 62 |
| F21ILL | F17T8 | Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 17 | 20 |
| F21ILL/T2 | F17T8 | Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 17 | 17 |
| F21ILL/T2-R | F17T8 | Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 2 Lamp Ballast | Electronic | 1 | 17 | 15 |
| F21ILL/T3 | F17T8 | Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 17 | 16 |
| F21ILL/T3-R | F17T8 | Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 3 Lamp Ballast | Electronic | 1 | 17 | 14 |
| F21ILL/T4 | F17T8 | Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 17 | 15 |
| F21ILL/T4-R | F17T8 | Fluorescent, (1) 24", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 4 Lamp Ballast | Electronic | 1 | 17 | 14 |
| F21LL | F17T8 | Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 17 | 16 |
| F21LL/T2 | F17T8 | Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 17 | 16 |
| F21LL/T3 | F17T8 | Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 17 | 17 |
| F21LL/T4 | F17T8 | Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 17 | 17 |
| F21LL-R | F17T8 | Fluorescent, (1) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 1 | 17 | 15 |
| F21LS | F17T8 | Fluorescent, (1) 24", T8 lamp, Standard Ballast | Mag-STD | 1 | 17 | 24 |
| F21GL | F24T5 | Fluorescent, (1) 24", STD T5 lamp | Electronic | 1 | 14 | 18 |
| F21SE | F20T12 | Fluorescent, (1) 24", STD lamp | Mag-ES | 1 | 20 | 26 |
| F21SS | F20T12 | Fluorescent, (1) 24", STD lamp | Mag-STD | 1 | 20 | 28 |
| F21GHL | F24T5/HO | Fluorescent, (1) 24", STD HO T5 lamp | Electronic | 1 | 24 | 29 |
| F22SHS | F24T12/HO | Fluorescent, (2) 24", HO lamp | Mag-STD | 2 | 35 | 90 |
| F22GHL | F24T5/HO | Fluorescent, (2) 24", STD HO T5 lamp | Electronic | 2 | 24 | 55 |
| F22ILE | F17T8 | Fluorescent, (2) 24", T-8 Instant Start lamp, Energy Saving Magnetic Ballast | Mag-ES | 2 | 17 | 45 |
| F22ILL | F17T8 | Fluorescent, (2) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 17 | 33 |
| F22ILL/T4 | F17T8 | Fluorescent, (2) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 2 | 17 | 31 |
| F22ILL/T4-R | F17T8 | Fluorescent, (2) 24", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 4 Lamp Ballast | Electronic | 2 | 17 | 28 |
| F22ILL-R | F17T8 | Fluorescent, (2) 24", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 2 | 17 | 29 |
| F22LL | F17T8 | Fluorescent, (2) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 17 | 31 |
| F22LL/T4 | F17T8 | Fluorescent, (2) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 2 | 17 | 34 |
| F22LL-R | F17T8 | Fluorescent, (2) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 2 | 17 | 28 |
| F22GL | F24T5 | Fluorescent, (2) 24", STD T5 lamp | Electronic | 2 | 14 | 35 |
| F22SE | F20T12 | Fluorescent, (2) 24", STD lamp | Mag-ES | 2 | 20 | 51 |
| F22SS | F20T12 | Fluorescent, (2) 24", STD lamp | Mag-STD | 2 | 20 | 56 |
| F23ILL | F17T8 | Fluorescent, (3) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 17 | 47 |
| F23ILL-H | F17T8 | Fluorescent, (3) 24", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 3 | 17 | 49 |
| F23ILL-R | F17T8 | Fluorescent, (3) 24", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 3 | 17 | 43 |
| F23LL | F17T8 | Fluorescent, (3) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 17 | 52 |
| F23LL-R | F17T8 | Fluorescent, (3) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 3 | 17 | 41 |
| F23SE | F20T12 | Fluorescent, (3) 24", STD lamp | Mag-ES | 3 | 20 | 77 |
| F23SS | F20T12 | Fluorescent, (3) 24", STD lamp | Mag-STD | 3 | 20 | 84 |
| F24ILL | F17T8 | Fluorescent, (4) 24", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 17 | 61 |
| F24ILL-R | F17T8 | Fluorescent, (4) 24", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 4 | 17 | 55 |
| F24LL | F17T8 | Fluorescent, (4) 24", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 17 | 68 |
| F24LL-R | F17T8 | Fluorescent, (4) 24", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 4 | 17 | 57 |
| F24SE | F20T12 | Fluorescent, (4) 24", STD lamp | Mag-ES | 4 | 20 | 102 |
| F24SS | F20T12 | Fluorescent, (4) 24", STD lamp | Mag-STD | 4 | 20 | 112 |
| F26SE | F20T12 | Fluorescent, (6) 24", STD lamp | Mag-ES | 6 | 20 | 153 |
| F26SS | F20T12 | Fluorescent, (6) 24", STD lamp | Mag-STD | 6 | 20 | 168 |
| F31EE | F30T12/ES | Fluorescent, (1) 36", ES lamp | Mag-ES | 1 | 25 | 38 |
| F31EE/T2 | F30T12/ES | Fluorescent, (1) 36", ES lamp, Tandem wired | Mag-ES | 1 | 25 | 33 |
| F31EL | F30T12/ES | Fluorescent, (1) 36", ES lamp | Electronic | 1 | 25 | 26 |
| F31ES | F30T12/ES | Fluorescent, (1) 36", ES lamp | Mag-STD | 1 | 25 | 42 |
| F31ES/T2 | F30T12/ES | Fluorescent, (1) 36", ES lamp, Tandem wired | Mag-STD | 1 | 25 | 37 |
| F31ILL | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 25 | 26 |
| F31ILL/T2 | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 25 | 23 |
| F31ILL/T2-H | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, HLO (BF: .96-1.1), Tandem 2 Lamp Ballast | Electronic | 1 | 25 | 24 |
| F31ILL/T2-R | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 25 | 23 |
| F31ILL/T3 | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 25 | 22 |
| F31ILL/T3-R | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 3 Lamp Ballast | Electronic | 1 | 25 | 22 |
| F31ILL/T4 | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 25 | 22 |
| F31ILL/T4-R | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 4 Lamp Ballast | Electronic | 1 | 25 | 22 |
| F31ILL-H | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 1 | 25 | 28 |
| F31ILL-R | F25T8 | Fluorescent, (1) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 1 | 25 | 27 |
| F31LL | F25T8 | Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 25 | 24 |
| F31LL/T2 | F25T8 | Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 25 | 23 |
| F31LL/T3 | F25T8 | Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 25 | 24 |
| F31LL/T4 | F25T8 | Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 25 | 22 |
| F31LL-H | F25T8 | Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1) | Electronic | 1 | 25 | 26 |
| F31LL-R | F25T8 | Fluorescent, (1) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 1 | 25 | 23 |
| F31SE/T2 | F30T12 | Fluorescent, (1) 36", STD lamp, Tandem wired | Mag-ES | 1 | 30 | 37 |
| F31GHL | F36T5/HO | Fluorescent, (1) 36", STD HO T5 lamp | Electronic | 1 | 39 | 43 |
| F31SHS | F36T12/HO | Fluorescent, (1) 36", HO lamp | Mag-STD | 1 | 50 | 70 |
| F31SL | F30T12 | Fluorescent, (1) 36", STD lamp | Electronic | 1 | 30 | 31 |
| F31GL | F36T5 | Fluorescent, (1) 36", STD T5 lamp | Electronic | 1 | 21 | 27 |
| F31SS | F30T12 | Fluorescent, (1) 36", STD lamp | Mag-STD | 1 | 30 | 46 |
| F31SS/T2 | F30T12 | Fluorescent, (1) 36", STD lamp, Tandem wired | Mag-STD | 1 | 30 | 41 |
| F32EE | F30T12/ES | Fluorescent, (2) 36", ES lamp | Mag-ES | 2 | 25 | 66 |
| F32EL | F30T12/ES | Fluorescent, (2) 36", ES lamp | Electronic | 2 | 25 | 50 |
| F32ES | F30T12/ES | Fluorescent, (2) 36", ES lamp | Mag-STD | 2 | 25 | 73 |
| F32ILL | F25T8 | Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 25 | 46 |
| F32ILL/T4 | F25T8 | Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 2 | 25 | 44 |
| F32ILL/T4-R | F25T8 | Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 4 Lamp Ballast | Electronic | 2 | 25 | 43 |
| F32ILL-H | F25T8 | Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 2 | 25 | 48 |
| F32ILL-R | F25T8 | Fluorescent, (2) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 2 | 25 | 46 |
| F32LE | F25T8 | Fluorescent, (2) 36", T-8 lamp | Mag-ES | 2 | 25 | 65 |
| F32LL | F25T8 | Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 25 | 46 |
| F32LL/T4 | F25T8 | Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 2 | 25 | 45 |
| F32LL-H | F25T8 | Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1) | Electronic | 2 | 25 | 50 |
| F32LL-R | F25T8 | Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 2 | 25 | 42 |
| F32LL-V | F25T8 | Fluorescent, (2) 36", T-8 lamp, Rapid Start Ballast, VHLO (BF>1.1) | Electronic | 2 | 25 | 70 |
| F32SE | F30T12 | Fluorescent, (2) 36", STD lamp | Mag-ES | 2 | 30 | 74 |
| F32GHL | F36T5/HO | Fluorescent, (1) 36", STD HO T5 lamp | Electronic | 2 | 39 | 85 |
| F32SHS | F36T12/HO | Fluorescent, (2) 36", HO, lamp | Mag-STD | 2 | 50 | 114 |
| F32SL | F30T12 | Fluorescent, (2) 36", STD lamp | Electronic | 2 | 30 | 58 |
| F32GL | F36T5 | Fluorescent, (1) 36", STD T5 lamp | Electronic | 2 | 21 | 52 |
| F32SS | F30T12 | Fluorescent, (2) 36", STD lamp | Mag-STD | 2 | 30 | 81 |
| F33ES | F30T12/ES | Fluorescent, (3) 36", ES lamp | Mag-STD | 3 | 25 | 115 |
| F33ILL | F25T8 | Fluorescent, (3) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 25 | 67 |
| F33ILL-R | F25T8 | Fluorescent, (3) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 3 | 25 | 66 |
| F33LL | F25T8 | Fluorescent, (3) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 25 | 72 |
| F33LL-R | F25T8 | Fluorescent, (3) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 3 | 25 | 62 |
| F33SE | F30T12 | Fluorescent, (3) 36", STD lamp, (1) STD ballast and (1) ES ballast | Mag-ES | 3 | 30 | 120 |
| F33SS | F30T12 | Fluorescent, (3) 36", STD lamp | Mag-STD | 3 | 30 | 127 |
| F34ILL | F25T8 | Fluorescent, (4) 36", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 25 | 87 |
| F34ILL-R | F25T8 | Fluorescent, (4) 36", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 4 | 25 | 86 |
| F34LL | F25T8 | Fluorescent, (4) 36", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 25 | 89 |
| F34LL-R | F25T8 | Fluorescent, (4) 36", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 4 | 25 | 84 |
| F34SE | F30T12 | Fluorescent, (4) 36", STD lamp | Mag-ES | 4 | 30 | 148 |
| F34SL | F30T12 | Fluorescent, (4) 36", STD lamp | Electronic | 4 | 30 | 116 |
| F34SS | F30T12 | Fluorescent, (4) 36", STD lamp | Mag-STD | 4 | 30 | 162 |
| F36EE | F30T12/ES | Fluorescent, (6) 36", ES lamp | Mag-ES | 6 | 25 | 198 |
| F36ILL-R | F25T8 | Fluorescent, (6) 36", T-8 lamp, Instant Start Ballast, RLO (BF<.85) | Electronic | 6 | 25 | 134 |
| F36SE | F30T12 | Fluorescent, (6) 36", STD lamp | Mag-ES | 6 | 30 | 238 |
| F40EE/D1 | None | Fluorescent, (0) 48" lamp, Completely delamped fixture with (1) hot ballast | Mag-ES | 0 | 0 | 4 |
| F40EE/D2 | None | Fluorescent, (0) 48" lamp, Completely delamped fixture with (2) hot ballast | Mag-ES | 0 | 0 | 8 |
| F41EE | F40T12/ES | Fluorescent, (1) 48", ES lamp | Mag-ES | 1 | 34 | 43 |
| F41EE/D2 | F40T12/ES | Fluorescent, (1) 48", ES lamp, 2 ballast | Mag-ES | 1 | 34 | 43 |
| F41EE/T2 | F40T12/ES | Fluorescent, (1) 48", ES lamp, tandem wired, 2-lamp ballast | Mag-ES | 1 | 34 | 36 |
| F41EHS | F48T12/HO/ES | Fluorescent, (1) 48", ES HO lamp | Mag-STD | 1 | 55 | 80 |
| F41EIS | F48T12/ES | Fluorescent, (1) 48" ES Instant Start lamp. Magnetic ballast | Mag-STD | 1 | 30 | 51 |
| F41EL | F40T12/ES | Fluorescent, (1) 48", T12 ES lamp, Electronic Ballast | Electronic | 1 | 34 | 32 |
| F41EL/T2 | F40T12/ES | Fluorescent, (1) 48", T-12 ES lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 34 | 32 |
| F41ES | F40T12/ES | Fluorescent, (1) 48", ES lamp | Mag-STD | 1 | 34 | 50 |
| F41EVS | F48T12/VHO/ES | Fluorescent, (1) 48", VHO ES lamp | Mag-STD | 1 |  | 123 |
| F41IAL | F25T12 | Fluorescent, (1) 48", F25T12 lamp, Instant Start Ballast | Electronic | 1 | 25 | 25 |
| F41IAL/T2-R | F25T12 | Fluorescent, (1) 48", F25T12 lamp, Instant Start, Tandem 2-Lamp Ballast, RLO (BF<0.85) | Electronic | 1 | 25 | 19 |
| F41IAL/T3-R | F25T12 | Fluorescent, (1) 48", F25T12 lamp, Instant Start, Tandem 3-Lamp Ballast, RLO (BF<0.85) | Electronic | 1 | 25 | 20 |
| F41ILL | F32T8 | Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 32 | 31 |
| F41SILL | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 30 | 28 |
| F41SILL/T2 | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 30 | 27 |
| F41SILL/T3 | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 30 | 27 |
| F41SILL/T4 | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 30 | 26 |
| F41SILL-R | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 1 | 30 | 25 |
| F41SILL/T2-R | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 2 Lamp Ballast | Electronic | 1 | 30 | 24 |
| F41SILL/T3-R | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 3 Lamp Ballast | Electronic | 1 | 30 | 24 |
| F41SILL/T4-R | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast | Electronic | 1 | 30 | 23 |
| F41SILL-H | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 1 | 30 | 37 |
| F41SILL/T2-H | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 2 Lamp Ballast | Electronic | 1 | 30 | 36 |
| F41SILL/T3-H | F30T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 3 Lamp Ballast | Electronic | 1 | 30 | 36 |
| F41SSILL | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 28 | 26 |
| F41SSILL/T2 | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 28 | 25 |
| F41SSILL/T3 | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 28 | 25 |
| F41SSILL/T4 | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 28 | 24 |
| F41SSILL-R | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 1 | 28 | 23 |
| F41SSILL/T2-R | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 2 Lamp Ballast | Electronic | 1 | 28 | 22 |
| F41SSILL/T3-R | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 3 Lamp Ballast | Electronic | 1 | 28 | 22 |
| F41SSILL/T4-R | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast | Electronic | 1 | 28 | 21 |
| F41SSILL-H | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 1 | 28 | 33 |
| F41SSILL/T2-H | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 2 Lamp Ballast | Electronic | 1 | 28 | 32 |
| F41SSILL/T3-H | F28T8 | Fluorescent, (1) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 3 Lamp Ballast | Electronic | 1 | 28 | 32 |
| F41ILL/T2 | F32T8 | Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 32 | 30 |
| F41ILL/T2-H | F32T8 | Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 2 Lamp Ballast | Electronic | 1 | 32 | 33 |
| F41ILL/T2-R | F32T8 | Fluorescent, (1) 48", T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 2 Lamp Ballast | Electronic | 1 | 32 | 26 |
| F41ILL/T3 | F32T8 | Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 32 | 30 |
| F41ILL/T3-H | F32T8 | Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1), Tandem 3 Lamp Ballast | Electronic | 1 | 32 | 31 |
| F41ILL/T3-R | F32T8 | Fluorescent, (1) 48", T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 3 Lamp Ballast | Electronic | 1 | 32 | 26 |
| F41ILL/T4 | F32T8 | Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 32 | 28 |
| F41ILL/T4-R | F32T8 | Fluorescent, (1) 48", T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast | Electronic | 1 | 32 | 26 |
| F41ILL-H | F32T8 | Fluorescent, (1) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 1 | 32 | 36 |
| F41LE | F32T8 | Fluorescent, (1) 48", T-8 lamp | Mag-ES | 1 | 32 | 35 |
| F41LL | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 32 | 32 |
| F41LL/T2 | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 32 | 30 |
| F41LL/T2-H | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1), Tandem 2 Lamp Ballast | Electronic | 1 | 32 | 39 |
| F41LL/T2-R | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 2 Lamp Ballast | Electronic | 1 | 32 | 27 |
| F41LL/T3 | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 32 | 31 |
| F41LL/T3-H | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1), Tandem 3 Lamp Ballast | Electronic | 1 | 32 | 33 |
| F41LL/T3-R | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 3 Lamp Ballast | Electronic | 1 | 32 | 25 |
| F41LL/T4 | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 32 | 30 |
| F41LL/T4-R | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast | Electronic | 1 | 32 | 26 |
| F41LL-H | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1) | Electronic | 1 | 32 | 39 |
| F41LL-R | F32T8 | Fluorescent, (1) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 1 | 32 | 27 |
| F41SE | F40T12 | Fluorescent, (1) 48", STD lamp | Mag-ES | 1 | 40 | 50 |
| F41GHL | F48T5/HO | Fluorescent, (1) 48", STD HO T5 lamp | Electronic | 1 | 54 | 59 |
| F41SHS | F48T12/HO | Fluorescent, (1) 48", STD HO lamp | Mag-STD | 1 | 60 | 85 |
| F41SIL | F48T12 | Fluorescent, (1) 48", STD IS lamp, Electronic ballast | Electronic | 1 | 39 | 46 |
| F41SIL/T2 | F48T12 | Fluorescent, (1) 48", STD IS lamp, Electronic ballast, tandem wired | Electronic | 1 | 39 | 37 |
| F41SIS | F48T12 | Fluorescent, (1) 48", STD IS lamp | Mag-STD | 1 | 39 | 60 |
| F41SIS/T2 | F48T12 | Fluorescent, (1) 48", STD IS lamp, tandem to 2-lamp ballast | Mag-STD | 1 | 39 | 52 |
| F41GL | F48T5 | Fluorescent, (1) 48", STD T5 lamp | Electronic | 1 | 28 | 32 |
| F41SL/T2 | F40T12 | Fluorescent, (1) 48", T-12 STD lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 40 | 36 |
| F41SS | F40T12 | Fluorescent, (1) 48", STD lamp | Mag-STD | 1 | 40 | 57 |
| F41SVS | F48T12/VHO | Fluorescent, (1) 48", STD VHO lamp | Mag-STD | 1 | 110 | 135 |
| F41TS | F40T10 | Fluorescent, (1) 48", T-10 lamp | Mag-STD | 1 | 40 | 51 |
| F42EE | F40T12/ES | Fluorescent, (2) 48", ES lamp | Mag-ES | 2 | 34 | 72 |
| F42EE/D2 | F40T12/ES | Fluorescent, (2) 48", ES lamp, 2 Ballasts (delamped) | Mag-ES | 2 | 34 | 76 |
| F42EHS | F48T12/HO/ES | Fluorescent, (2) 42", HO lamp (3.5' lamp) | Mag-STD | 2 | 55 | 135 |
| F42EIS | F48T12/ES | Fluorescent, (2) 48" ES Instant Start lamp. Magnetic ballast | Mag-STD | 2 | 30 | 82 |
| F42EL | F40T12/ES | Fluorescent, (2) 48", T12 ES lamps, Electronic Ballast | Electronic | 2 | 34 | 60 |
| F42ES | F40T12/ES | Fluorescent, (2) 48", ES lamp | Mag-STD | 2 | 34 | 80 |
| F42EVS | F48T12/VHO/ES | Fluorescent, (2) 48", VHO ES lamp | Mag-STD | 2 |  | 210 |
| F42IAL/T4-R | F25T12 | Fluorescent, (2) 48", F25T12 lamp, Instant Start, Tandem 4-Lamp Ballast, RLO (BF<0.85) | Electronic | 2 | 25 | 40 |
| F42IAL-R | F25T12 | Fluorescent, (2) 48", F25T12 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 2 | 25 | 39 |
| F42ILL | F32T8 | Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 32 | 59 |
| F42SILL | F30T8 | Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 30 | 53 |
| F41SILL/T4 | F30T8 | Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 2 | 30 | 52 |
| F42SILL-R | F30T8 | Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 2 | 30 | 47 |
| F41SILL/T4-R | F30T8 | Fluorescent, (2) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast | Electronic | 2 | 30 | 46 |
| F42SILL-H | F30T8 | Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-2.2) | Electronic | 2 | 30 | 72 |
| F42SSILL | F28T8 | Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 28 | 48 |
| F41SSILL/T4 | F28T8 | Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 2 | 28 | 47 |
| F42SSILL-R | F28T8 | Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 2 | 28 | 45 |
| F41SSILL/T4-R | F28T8 | Fluorescent, (2) 48", Super T-8 lamp, IS Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast | Electronic | 2 | 28 | 44 |
| F42SSILL-H | F28T8 | Fluorescent, (2) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-2.2) | Electronic | 2 | 28 | 67 |
| F42ILL/T4 | F32T8 | Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 2 | 32 | 56 |
| F42ILL/T4-R | F32T8 | Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast | Electronic | 2 | 32 | 51 |
| F42ILL-H | F32T8 | Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 2 | 32 | 65 |
| F42ILL-R | F32T8 | Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 2 | 32 | 52 |
| F42ILL-V | F32T8 | Fluorescent, (2) 48", T-8 lamp, Instant Start Ballast, VHLO (BF>1.1) | Electronic | 2 | 32 | 79 |
| F42LE | F32T8 | Fluorescent, (2) 48", T-8 lamp | Mag-ES | 2 | 32 | 71 |
| F42LL | F32T8 | Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 32 | 60 |
| F42LL/T4 | F32T8 | Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 2 | 32 | 59 |
| F42LL/T4-R | F32T8 | Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85), Tandem 4 Lamp Ballast | Electronic | 2 | 32 | 53 |
| F42LL-H | F32T8 | Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1) | Electronic | 2 | 32 | 70 |
| F42LL-R | F32T8 | Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 2 | 32 | 54 |
| F42LL-V | F32T8 | Fluorescent, (2) 48", T-8 lamp, Rapid Start Ballast, VHLO (BF>1.1) | Electronic | 2 | 32 | 85 |
| F42SE | F40T12 | Fluorescent, (2) 48", STD lamp | Mag-ES | 2 | 40 | 86 |
| F42GHL | F48T5/HO | Fluorescent, (2) 48", STD HO T5 lamp | Electronic | 2 | 54 | 117 |
| F42SHS | F48T12/HO | Fluorescent, (2) 48", STD HO lamp | Mag-STD | 2 | 60 | 145 |
| F42SIL | F48T12 | Fluorescent, (2) 48", STD IS lamp, Electronic ballast | Electronic | 2 | 39 | 74 |
| F42SIS | F48T12 | Fluorescent, (2) 48", STD IS lamp | Mag-STD | 2 | 39 | 103 |
| F42GL | F48T5 | Fluorescent, (2) 48", STD T5 lamp | Electronic | 2 | 28 | 63 |
| F42SS | F40T12 | Fluorescent, (2) 48", STD lamp | Mag-STD | 2 | 40 | 94 |
| F42SVS | F48T12/VHO | Fluorescent, (2) 48", STD VHO lamp | Mag-STD | 2 | 110 | 242 |
| F43EE | F40T12/ES | Fluorescent, (3) 48", ES lamp | Mag-ES | 3 | 34 | 115 |
| F43EHS | F48T12/HO/ES | Fluorescent, (3) 48", ES HO lamp (3.5' lamp) | Mag-STD | 3 | 55 | 215 |
| F43EIS | F48T12/ES | Fluorescent, (3) 48" ES Instant Start lamp. Magnetic ballast | Mag-STD | 3 | 30 | 133 |
| F43EL | F40T12/ES | Fluorescent, (3) 48", T12 ES lamps, Electronic Ballast | Electronic | 3 | 34 | 92 |
| F43ES | F40T12/ES | Fluorescent, (3) 48", ES lamp | Mag-STD | 3 | 34 | 130 |
| F43EVS | F48T12/VHO/ES | Fluorescent, (3) 48", VHO ES lamp | Mag-STD | 3 |  | 333 |
| F43IAL-R | F25T12 | Fluorescent, (3) 48", F25T12 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 3 | 25 | 60 |
| F43ILL | F32T8 | Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 32 | 89 |
| F43SILL | F30T8 | Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 30 | 78 |
| F43SILL-R | F30T8 | Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 3 | 30 | 70 |
| F43SILL-H | F30T8 | Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-3.3) | Electronic | 3 | 30 | 105 |
| F43SSILL | F28T8 | Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 28 | 72 |
| F43SSILL-R | F28T8 | Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 3 | 28 | 66 |
| F43SSILL-H | F28T8 | Fluorescent, (3) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-3.3) | Electronic | 3 | 28 | 98 |
| F43ILL/2 | F32T8 | Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), (2) ballast | Electronic | 3 | 32 | 90 |
| F43ILL-H | F32T8 | Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 3 | 32 | 93 |
| F43ILL-R | F32T8 | Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 3 | 32 | 78 |
| F43ILL-V | F32T8 | Fluorescent, (3) 48", T-8 lamp, Instant Start Ballast, VHLO (BF>1.1) | Electronic | 3 | 32 | 112 |
| F43LE | F32T8 | Fluorescent, (3) 48", T-8 lamp | Mag-ES | 3 | 32 | 110 |
| F43LL | F32T8 | Fluorescent, (3) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 32 | 93 |
| F43LL/2 | F32T8 | Fluorescent, (3) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), (2) ballast | Electronic | 3 | 32 | 92 |
| F43LL-H | F32T8 | Fluorescent, (3) 48", T-8 lamp, Rapid Start Ballast, HLO (BF:.96-1.1) | Electronic | 3 | 32 | 98 |
| F43LL-R | F32T8 | Fluorescent, (3) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 3 | 32 | 76 |
| F43SE | F40T12 | Fluorescent, (3) 48", STD lamp | Mag-ES | 3 | 40 | 136 |
| F43GHL | F48T5/HO | Fluorescent, (3) 48", STD HO T5 lamp | Electronic | 3 | 54 | 177 |
| F43SHS | F48T12/HO | Fluorescent, (3) 48", STD HO lamp | Mag-STD | 3 | 60 | 230 |
| F43SIL | F40T12 | Fluorescent, (3) 48", STD IS lamp, Electronic ballast | Electronic | 3 | 39 | 120 |
| F43SIS | F48T12 | Fluorescent, (3) 48", STD IS lamp | Mag-STD | 3 | 39 | 162 |
| F43SS | F40T12 | Fluorescent, (3) 48", STD lamp | Mag-STD | 3 | 40 | 151 |
| F43SVS | F48T12/VHO | Fluorescent, (3) 48", STD VHO lamp | Mag-STD | 3 | 110 | 377 |
| F44EE | F40T12/ES | Fluorescent, (4) 48", ES lamp | Mag-ES | 4 | 34 | 144 |
| F44EE/D4 | F40T12/ES | Fluorescent, (4) 48", ES lamp, 4 Ballasts (delamped) | Mag-ES | 4 | 34 | 152 |
| F44EHS | F48T12/HO/ES | Fluorescent, (4) 48", ES HO lamp | Mag-STD | 4 | 55 | 270 |
| F44EIS | F48T12/ES | Fluorescent, (4) 48" ES Instant Start lamp, Magnetic ballast | Mag-STD | 4 | 30 | 164 |
| F44EL | F40T12/ES | Fluorescent, (4) 48", T12 ES lamp, Electronic Ballast | Electronic | 4 | 34 | 120 |
| F44ES | F40T12/ES | Fluorescent, (4) 48", ES lamp | Mag-STD | 4 | 34 | 160 |
| F44EVS | F48T12/VHO/ES | Fluorescent, (4) 48", VHO ES lamp | Mag-STD | 4 |  | 420 |
| F44IAL-R | F25T12 | Fluorescent, (4) 48", F25T12 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 4 | 25 | 80 |
| F44ILL | F32T8 | Fluorescent, (4) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 32 | 112 |
| F44SILL | F30T8 | Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 30 | 105 |
| F44SILL-R | F30T8 | Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 4 | 30 | 91 |
| F44SILL-H | F30T8 | Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-4.4) | Electronic | 4 | 30 | 140 |
| F44SSILL | F28T8 | Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 28 | 96 |
| F44SSILL-R | F28T8 | Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 4 | 28 | 86 |
| F44SSILL-H | F28T8 | Fluorescent, (4) 48", Super T-8 lamp, Instant Start Ballast, HLO (BF:.96-4.4) | Electronic | 4 | 28 | 131 |
| F44ILL/2 | F32T8 | Fluorescent, (4) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), (2) ballast | Electronic | 4 | 32 | 118 |
| F44ILL-R | F32T8 | Fluorescent, (4) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 4 | 32 | 102 |
| F44LE | F32T8 | Fluorescent, (4) 48", T-8 lamp | Mag-ES | 4 | 32 | 142 |
| F44LL | F32T8 | Fluorescent, (4) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 32 | 118 |
| F44LL/2 | F32T8 | Fluorescent, (4) 48", T-8 lamp, Rapid Start Ballast, NLO (BF: .85-.95), (2) ballast | Electronic | 4 | 32 | 120 |
| F44LL-R | F32T8 | Fluorescent, (4) 48", T-8 lamp, Rapid Start Ballast, RLO (BF<0.85) | Electronic | 4 | 32 | 105 |
| F44SE | F40T12 | Fluorescent, (4) 48", STD lamp | Mag-ES | 4 | 40 | 172 |
| F44GHL | F48T5/HO | Fluorescent, (4) 48", STD HO T5 lamp | Electronic | 4 | 54 | 234 |
| F44SHS | F48T12/HO | Fluorescent, (4) 48", STD HO lamp | Mag-STD | 4 | 60 | 290 |
| F44SIL | F48T12 | Fluorescent, (4) 48", STD IS lamp, Electronic ballast | Electronic | 4 | 39 | 148 |
| F44SIS | F48T12 | Fluorescent, (4) 48", STD IS lamp | Mag-STD | 4 | 39 | 204 |
| F44SS | F40T12 | Fluorescent, (4) 48", STD lamp | Mag-STD | 4 | 40 | 188 |
| F44SVS | F48T12/VHO | Fluorescent, (4) 48", STD VHO lamp | Mag-STD | 4 | 110 | 484 |
| F45ILL | F32T8 | Fluorescent, (5) 48", T-8 lamp, (1) 3-lamp IS ballast and (1) 2-lamp IS ballast, NLO (BF: .85-.95) | Electronic | 5 | 32 | 148 |
| F45GHL | F48T5/HO | Fluorescent, (5) 48", STD HO T5 lamp | Electronic | 5 | 54 | 294 |
| F46EE | F40T12/ES | Fluorescent, (6) 48", ES lamp | Mag-ES | 6 | 34 | 216 |
| F46EL | F40T12/ES | Fluorescent, (6) 48", ES lamp | Electronic | 6 | 34 | 186 |
| F46ES | F40T12/ES | Fluorescent, (6) 48", ES lamp | Mag-STD | 6 | 34 | 236 |
| F46ILL | F32T8 | Fluorescent, (6) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 6 | 32 | 175 |
| F46ILL-R | F32T8 | Fluorescent, (6) 48", T-8 lamp, Instant Start Ballast, RLO (BF< .85) | Electronic | 6 | 32 | 156 |
| F46LL | F32T8 | Fluorescent, (6) 48", T-8 lamp, NLO (BF: .85-.95) | Electronic | 6 | 32 | 182 |
| F46GHL | F48T5/HO | Fluorescent, (6) 48", STD HO T5 lamp | Electronic | 6 | 54 | 351 |
| F46SE | F40T12 | Fluorescent, (6) 48", STD lamp | Mag-ES | 6 | 40 | 258 |
| F46SS | F40T12 | Fluorescent, (6) 48", STD lamp | Mag-STD | 6 | 40 | 282 |
| F48EE | F40T12/ES | Fluorescent, (8) 48", ES lamp | Mag-ES | 8 | 34 | 288 |
| F48ILL | F32T8 | Fluorescent, (8) 48", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 8 | 32 | 224 |
| F48ILL-R | F32T8 | Fluorescent, (8) 48", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 8 | 32 | 204 |
| F48GHL | F48T5/HO | Fluorescent, (8) 48", STD HO T5 lamp | Electronic | 8 | 54 | 468 |
| F51ILHL | F60T12/HO | Fluorescent, (1) 60", T-8 HO lamp, Instant Start Ballast | Electronic | 1 | 55 | 59 |
| F51ILL | F40T8 | Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 40 | 36 |
| F51ILL/T2 | F40T8 | Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 40 | 36 |
| F51ILL/T3 | F40T8 | Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 3 Lamp Ballast | Electronic | 1 | 40 | 35 |
| F51ILL/T4 | F40T8 | Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 4 Lamp Ballast | Electronic | 1 | 40 | 34 |
| F51ILL-R | F40T8 | Fluorescent, (1) 60", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 1 | 40 | 43 |
| F51SHE | F60T12/HO | Fluorescent, (1) 60", STD HO lamp | Mag-ES | 1 | 75 | 88 |
| F51SHL | F60T12/HO | Fluorescent, (1) 60", STD HO lamp | Electronic | 1 | 75 | 69 |
| F51GHL | F60T5/HO | Fluorescent, (1) 60", STD HO T5 lamp | Electronic | 1 | 49 | 54 |
| F51GHL | F60T5/HO | Fluorescent, (1) 60", STD HO T5 lamp | Electronic | 1 | 80 | 89 |
| F51SHS | F60T12/HO | Fluorescent, (1) 60", STD HO lamp | Mag-STD | 1 | 75 | 92 |
| F51SL | F60T12 | Fluorescent, (1) 60", STD lamp | Electronic | 1 | 50 | 44 |
| F51GL | F60T5 | Fluorescent, (1) 60", STD T5 lamp | Electronic | 1 | 35 | 39 |
| F51SS | F60T12 | Fluorescent, (1) 60", STD lamp | Mag-STD | 1 | 50 | 63 |
| F51SVS | F60T12/VHO | Fluorescent, (1) 60", VHO ES lamp | Mag-STD | 1 | 135 | 165 |
| F52ILHL | F60T12/HO | Fluorescent, (2) 60", T-8 HO lamp, Instant Start Ballast | Electronic | 2 | 55 | 123 |
| F52ILL | F40T8 | Fluorescent, (2) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 40 | 72 |
| F52ILL/T4 | F40T8 | Fluorescent, (2) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 2 | 40 | 67 |
| F52ILL-H | F40T8 | Fluorescent, (2) 60", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 2 | 40 | 80 |
| F52ILL-R | F40T8 | Fluorescent, (2) 60", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 2 | 40 | 73 |
| F52SHE | F60T12/HO | Fluorescent, (2) 60", STD HO lamp | Mag-ES | 2 | 75 | 176 |
| F52SHL | F60T12/HO | Fluorescent, (2) 60", STD HO lamp | Electronic | 2 | 75 | 138 |
| F52GHL | F60T5/HO | Fluorescent, (2) 60", STD HO T5 lamp | Electronic | 2 | 49 | 106 |
| F52SHS | F60T12/HO | Fluorescent, (2) 60", STD HO lamp | Mag-STD | 2 | 75 | 168 |
| F52SL | F60T12 | Fluorescent, (2) 60", STD lamp | Electronic | 2 | 50 | 88 |
| F52GL | F60T5 | Fluorescent, (2) 60", STD T5 lamp | Electronic | 2 | 35 | 76 |
| F52SS | F60T12 | Fluorescent, (2) 60", STD lamp | Mag-STD | 2 | 50 | 128 |
| F52SVS | F60T12/VHO | Fluorescent, (2) 60", VHO ES lamp | Mag-STD | 2 | 135 | 310 |
| F53ILL | F40T8 | Fluorescent, (3) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 40 | 106 |
| F53ILL-H | F40T8 | Fluorescent, (3) 60", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 3 | 40 | 108 |
| F54ILL | F40T8 | Fluorescent, (4) 60", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 40 | 134 |
| F54ILL-H | F40T8 | Fluorescent, (4) 60", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 4 | 40 | 126 |
| F61ISL | F72T12 | Fluorescent, (1) 72", STD lamp, IS electronic ballast | Electronic | 1 | 55 | 68 |
| F61SE | F72T12 | Fluorescent, (1) 72", STD lamp | Mag-ES | 1 | 55 | 76 |
| F61SHS | F72T12/HO | Fluorescent, (1) 72", STD HO lamp | Mag-STD | 1 | 85 | 120 |
| F61SS | F72T12 | Fluorescent, (1) 72", STD lamp | Mag-STD | 1 | 55 | 90 |
| F61SVS | F72T12/VHO | Fluorescent, (1) 72", VHO lamp | Mag-STD | 1 | 160 | 180 |
| F62ILHL | F72T8 | Fluorescent, (2) 72", T-8 HO lamp, Instant Start Ballast | Electronic | 2 | 65 | 147 |
| F62ISL | F72T12 | Fluorescent, (2) 72", STD lamp, IS electronic ballast | Electronic | 2 | 55 | 108 |
| F62SE | F72T12 | Fluorescent, (2) 72", STD lamp | Mag-ES | 2 | 55 | 122 |
| F62SHE | F72T12/HO | Fluorescent, (2) 72", STD HO lamp | Mag-ES | 2 | 85 | 194 |
| F62SHS | F72T12/HO | Fluorescent, (2) 72", STD HO lamp | Mag-STD | 2 | 85 | 220 |
| F62SL | F72T12 | Fluorescent, (2) 72", STD lamp | Electronic | 2 | 55 | 108 |
| F62SS | F72T12 | Fluorescent, (2) 72", STD lamp | Mag-STD | 2 | 55 | 145 |
| F62SVS | F72T12/VHO | Fluorescent, (2) 72", VHO lamp | Mag-STD | 2 | 160 | 330 |
| F63ISL | F72T12 | Fluorescent, (3) 72", STD lamp, IS electronic ballast | Electronic | 3 | 55 | 176 |
| F63SS | F72T12 | Fluorescent, (3) 72", STD lamp | Mag-STD | 3 | 55 | 202 |
| F64ISL | F72T12 | Fluorescent, (4) 72", STD lamp, IS electronic ballast | Electronic | 4 | 55 | 216 |
| F64SE | F72T12 | Fluorescent, (4) 72", STD lamp | Mag-ES | 4 | 55 | 230 |
| F64SHE | F72T12/HO | Fluorescent, (4) 72", STD HO lamp | Mag-ES | 4 | 85 | 388 |
| F64SS | F72T12 | Fluorescent, (4) 72", STD lamp | Mag-STD | 4 | 55 | 244 |
| F81EE/T2 | F96T12/ES | Fluorescent, (1) 96", ES lamp, tandem to 2-lamp ballast | Mag-ES | 1 | 60 | 62 |
| F81EHL | F96T12/HO/ES | Fluorescent, (1) 96", ES HO lamp | Electronic | 1 | 95 | 80 |
| F81EHL/T2 | F96T12/HO/ES | Fluorescent, (1) 96", ES HO lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 95 | 85 |
| F81EHS | F96T12/HO/ES | Fluorescent, (1) 96", ES HO lamp | Mag-STD | 1 | 95 | 125 |
| F81EL | F96T12/ES | Fluorescent, (1) 96", ES lamp | Electronic | 1 | 60 | 60 |
| F81EL/T2 | F96T12/ES | Fluorescent, (1) 96", ES lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 60 | 55 |
| F81ES | F96T12/ES | Fluorescent, (1) 96", ES lamp | Mag-STD | 1 | 60 | 83 |
| F81ES/T2 | F96T12/ES | Fluorescent, (1) 96", ES lamp, tandem to 2-lamp ballast | Mag-STD | 1 | 60 | 64 |
| F81EVS | F96T12/VHO/ES | Fluorescent, (1) 96", ES VHO lamp | Mag-STD | 1 | 185 | 200 |
| F81ILL | F96T8 | Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 59 | 58 |
| F81ILL/T2 | F96T8 | Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 59 | 55 |
| F81ILL/T2-R | F96T8 | Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, RLO (BF<.85), Tandem 2 Lamp Ballast | Electronic | 1 | 59 | 49 |
| F81ILL-H | F96T8 | Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, HLO (BF:.96-1.1) | Electronic | 1 | 59 | 68 |
| F81ILL-R | F96T8 | Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 1 | 59 | 57 |
| F81ILL-V | F96T8 | Fluorescent, (1) 96", T-8 lamp, Instant Start Ballast, VHLO (BF>1.1) | Electronic | 1 | 59 | 71 |
| F81LHL | F96T8/HO | Fluorescent, (1) 96", T8 HO lamp | Electronic | 1 | 86 | 85 |
| F81LHL/T2 | F96T8/HO | Fluorescent, (1) 96", T8 HO lamp, tandem wired to 2-lamp ballast | Electronic | 1 | 86 | 80 |
| F81SE | F96T12 | Fluorescent, (1) 96", STD lamp | Mag-ES | 1 | 75 | 91 |
| F81EHS | F96T12/HO | Fluorescent, (1) 96", ES HO lamp | Mag-STD | 1 | 95 | 125 |
| F81SHE | F96T12/HO | Fluorescent, (1) 96", STD HO lamp | Mag-ES | 1 | 110 | 132 |
| F81SHL/T2 | F96T12/HO | Fluorescent, (1) 96", STD HO lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 110 | 98 |
| F81SHS | F96T12/HO | Fluorescent, (1) 96", STD HO lamp | Mag-STD | 1 | 110 | 145 |
| F81SL | F96T12 | Fluorescent, (1) 96", STD lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 1 | 75 | 70 |
| F81SL/T2 | F96T12 | Fluorescent, (1) 96", STD lamp, Rapid Start Ballast, NLO (BF: .85-.95), Tandem 2 Lamp Ballast | Electronic | 1 | 75 | 67 |
| F81SS | F96T12 | Fluorescent, (1) 96", STD lamp | Mag-STD | 1 | 75 | 100 |
| F81SVS | F96T12/VHO | Fluorescent, (1) 96", STD VHO lamp | Mag-STD | 1 | 215 | 230 |
| F82EE | F96T12/ES | Fluorescent, (2) 96", ES lamp | Mag-ES | 2 | 60 | 123 |
| F82EHE | F96T12/HO/ES | Fluorescent, (2) 96", ES HO lamp | Mag-ES | 2 | 95 | 207 |
| F82EHL | F96T12/HO/ES | Fluorescent, (2) 96", ES HO lamp | Electronic | 2 | 95 | 170 |
| F82EHS | F96T12/HO/ES | Fluorescent, (2) 96", ES HO lamp | Mag-STD | 2 | 95 | 227 |
| F82EL | F96T12/ES | Fluorescent, (2) 96", ES lamp | Electronic | 2 | 60 | 110 |
| F82ES | F96T12/ES | Fluorescent, (2) 96", ES lamp | Mag-STD | 2 | 60 | 138 |
| F82EVS | F96T12/VHO/ES | Fluorescent, (2) 96", ES VHO lamp | Mag-STD | 2 | 185 | 390 |
| F82ILL | F96T8 | Fluorescent, (2) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 59 | 109 |
| F82ILL-R | F96T8 | Fluorescent, (2) 96", T-8 lamp, Instant Start Ballast, RLO (BF<0.85) | Electronic | 2 | 59 | 98 |
| F82LHL | F96T8/HO | Fluorescent, (2) 96", T8 HO lamp | Electronic | 2 | 86 | 160 |
| F82SE | F96T12 | Fluorescent, (2) 96", STD lamp | Mag-ES | 2 | 75 | 158 |
| F82SHE | F96T12/HO | Fluorescent, (2) 96", STD HO lamp | Mag-ES | 2 | 110 | 237 |
| F82SHL | F96T12/HO | Fluorescent, (2) 96", STD HO lamp | Electronic | 2 | 110 | 195 |
| F82SHS | F96T12/HO | Fluorescent, (2) 96", STD HO lamp | Mag-STD | 2 | 110 | 257 |
| F82SL | F96T12 | Fluorescent, (2) 96", STD lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 2 | 75 | 134 |
| F82SS | F96T12 | Fluorescent, (2) 96", STD lamp | Mag-STD | 2 | 75 | 173 |
| F82SVS | F96T12/VHO | Fluorescent, (2) 96", STD VHO lamp | Mag-STD | 2 | 215 | 450 |
| F83EE | F96T12/ES | Fluorescent, (3) 96", ES lamp | Mag-ES | 3 | 60 | 210 |
| F83EHE | F96T12/HO/ES | Fluorescent, (3) 96", ES HO lamp, (1) 2-lamp ES Ballast, (1) 1-lamp STD Ballast | Mag-ES/STD | 3 | 95 | 319 |
| F83EHS | F96T12/HO/ES | Fluorescent, (3) 96", ES HO lamp | Mag-STD | 3 | 95 | 352 |
| F83EL | F96T12/ES | Fluorescent, (3) 96", ES lamp | Electronic | 3 | 60 | 179 |
| F83ES | F96T12/ES | Fluorescent, (3) 96", ES lamp | Mag-STD | 3 | 60 | 221 |
| F83EVS | F96T12/VHO/ES | Fluorescent, (3) 96", ES VHO lamp | Mag-STD | 3 | 185 | 590 |
| F83ILL | F96T8 | Fluorescent, (3) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 3 | 59 | 167 |
| F83SHS | F96T12/HO | Fluorescent, (3) 96", STD HO lamp | Mag-STD | 3 | 110 | 392 |
| F83SS | F96T12 | Fluorescent, (3) 96", STD lamp | Mag-STD | 3 | 75 | 273 |
| F83SVS | F96T12/VHO | Fluorescent, (3) 96", STD VHO lamp | Mag-STD | 3 | 215 | 680 |
| F84EE | F96T12/ES | Fluorescent, (4) 96", ES lamp | Mag-ES | 4 | 60 | 246 |
| F84EHE | F96T12/HO/ES | Fluorescent, (4) 96", ES HO lamp | Mag-ES | 4 | 95 | 414 |
| F84EHL | F96T12/HO/ES | Fluorescent, (4) 96", ES HO lamp | Electronic | 4 | 95 | 340 |
| F84EHS | F96T12/HO/ES | Fluorescent, (4) 96", ES HO lamp | Mag-STD | 4 | 95 | 454 |
| F84EL | F96T12/ES | Fluorescent, (4) 96", ES lamp | Electronic | 4 | 60 | 220 |
| F84ES | F96T12/ES | Fluorescent, (4) 96", ES lamp | Mag-STD | 4 | 60 | 276 |
| F84EVS | F96T12/VHO/ES | Fluorescent, (4) 96", ES VHO lamp | Mag-STD | 4 | 185 | 780 |
| F84ILL | F96T8 | Fluorescent, (4) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 59 | 219 |
| F84LHL | F96T8/HO | Fluorescent, (4) 96", T8 HO lamp | Electronic | 4 | 86 | 320 |
| F84SE | F96T12 | Fluorescent, (4) 96", STD lamp | Mag-ES | 4 | 75 | 316 |
| F84SHE | F96T12/HO | Fluorescent, (4) 96", STD HO lamp | Mag-ES | 4 | 110 | 474 |
| F84SHL | F96T12/HO | Fluorescent, (3) 96", STD HO lamp | Electronic | 4 | 110 | 390 |
| F84SHS | F96T12/HO | Fluorescent, (4) 96", STD HO lamp | Mag-STD | 4 | 110 | 514 |
| F84SL | F96T12 | Fluorescent, (4) 96", STD lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 4 | 75 | 268 |
| F84SS | F96T12 | Fluorescent, (4) 96", STD lamp | Mag-STD | 4 | 75 | 346 |
| F84SVS | F96T12/VHO | Fluorescent, (4) 96", STD VHO lamp | Mag-STD | 4 | 215 | 900 |
| F86EHS | F96T12/HO/ES | Fluorescent, (6) 96", ES HO lamp | Mag-STD | 6 | 95 | 721 |
| F86ILL | F96T8 | Fluorescent, (6) 96", T-8 lamp, Instant Start Ballast, NLO (BF: .85-.95) | Electronic | 6 | 59 | 328 |
|  |  | ***Circline Fluorescent Fixtures*** |  |  |  |  |
| FC12/1 | FC12T9 | Fluorescent, (1) 12" circular lamp, RS ballast | Mag-STD | 1 | 32 | 31 |
| FC12/2 | FC12T9 | Fluorescent, (2) 12" circular lamp, RS ballast | Mag-STD | 2 | 32 | 62 |
| FC16/1 | FC16T9 | Fluorescent, (1) 16" circular lamp | Mag-STD | 1 | 40 | 35 |
| FC20 | FC6T9 | Fluorescent, Circlite, (1) 20W lamp, Preheat ballast | Mag-STD | 1 | 20 | 20 |
| FC22/1 | FC8T9 | Fluorescent, Circlite, (1) 22W lamp, preheat ballast | Mag-STD | 1 | 22 | 20 |
| FC22/32/1 | FC22/32T9 | Fluorescent, Circlite, (1) 22W/32W lamp, preheat ballast | Mag-STD | 1 | 22/32 | 58 |
| FC32/1 | FC12T9 | Fluorescent, Circline, (1) 32W lamp, preheat ballast | Mag-STD | 1 | 32 | 40 |
| FC32/40/1 | FC32/40T9 | Fluorescent, Circlite, (1) 32W/40W lamp, preheat ballast | Mag-STD | 1 | 32/40 | 80 |
| FC40/1 | FC16T9 | Fluorescent, Circline, (1) 32W lamp, preheat ballast | Mag-STD | 1 | 32 | 42 |
| FC44/1 | FC44T9 | Fluorescent, Circlite, (1) 44W lamp, preheat ballast | Mag-STD | 1 | 44 | 46 |
| FC6/1 | FC6T9 | Fluorescent, (1) 6" circular lamp, RS ballast | Mag-STD | 1 | 20 | 25 |
| FC8/1 | FC8T9 | Fluorescent, (1) 8" circular lamp, RS ballast | Mag-STD | 1 | 22 | 26 |
| FC8/2 | FC8T9 | Fluorescent, (2) 8" circular lamp, RS ballast | Mag-STD | 2 | 22 | 52 |
|  |  | ***U-Tube Fluorescent Fixtures*** |  |  |  |  |
| FU1EE | FU40T12/ES | Fluorescent, (1) U-Tube, ES lamp | Mag-ES | 1 | 34 | 43 |
| FU1ILL | FU31T8/6 | Fluorescent, (1) U-Tube, T-8 lamp, Instant Start ballast | Electronic | 1 | 32 | 31 |
| FU1LL | FU31T8/6 | Fluorescent, (1) U-Tube, T-8 lamp | Electronic | 1 | 32 | 32 |
| FU1LL-R | FU31T8/6 | Fluorescent, (1) U-Tube, T-8 lamp, RLO (BF<0.85) | Electronic | 1 | 31 | 27 |
| FU2SS | FU40T12 | Fluorescent, (2) U-Tube, STD lamp | Mag-STD | 2 | 40 | 96 |
| FU2SE | FU40T12 | Fluorescent, (2) U-Tube, STD lamp | Mag-ES | 2 | 40 | 85 |
| FU2EE | FU40T12/ES | Fluorescent, (2) U-Tube, ES lamp | Mag-ES | 2 | 34 | 72 |
| FU2ES | FU40T12/ES | Fluorescent, (2) U-Tube, ES lamp | Mag-STD | 2 | 34 | 82 |
| FU2ILL | FU31T8/6 | Fluorescent, (2) U-Tube, T-8 lamp, Instant Start Ballast | Electronic | 2 | 32 | 59 |
| FU2ILL/T4 | FU31T8/6 | Fluorescent, (2) U-Tube, T-8 lamp, Instant Start Ballast, tandem wired | Electronic | 2 | 32 | 56 |
| FU2ILL/T4-R | FU31T8/6 | Fluorescent, (2) U-Tube, T-8 lamp, Instant Start Ballast, RLO, tandem wired | Electronic | 2 | 32 | 51 |
| FU2ILL-H | FU31T8/6 | Fluorescent, (2) U-Tube, T-8 lamp, Instant Start HLO Ballast | Electronic | 2 | 32 | 65 |
| FU2ILL-R | FU31T8/6 | Fluorescent, (2) U-Tube, T-8 lamp, Instant Start RLO Ballast | Electronic | 2 | 32 | 52 |
| FU2LL | FU31T8/6 | Fluorescent, (2) U-Tube, T-8 lamp | Electronic | 2 | 32 | 60 |
| FU2LL/T2 | FU31T8/6 | Fluorescent, (2) U-Tube, T-8 lamp, Tandem 4 lamp ballast | Electronic | 2 | 32 | 59 |
| FU2LL-R | FU31T8/6 | Fluorescent, (2) U-Tube, T-8 lamp, RLO (BF<0.85) | Electronic | 54 | 31 | 54 |
| FU3EE | FU40T12/ES | Fluorescent, (3) U-Tube, ES lamp | Mag-ES | 3 | 35 | 115 |
| FU3ILL | FU31T8/6 | Fluorescent, (3) U-Tube, T-8 lamp, Instant Start Ballast | Electronic | 3 | 32 | 89 |
| FU3ILL-R | FU31T8/6 | Fluorescent, (3) U-Tube, T-8 lamp, Instant Start RLO Ballast | Electronic | 3 | 32 | 78 |
|  |  | ***Standard Incandescent Fixtures*** |  |  |  |  |
| I100/1 | I100 | Incandescent, (1) 100W lamp |  | 1 | 100 | 100 |
| I100/2 | I100 | Incandescent, (2) 100W lamp |  | 2 | 100 | 200 |
| I100/3 | I100 | Incandescent, (3) 100W lamp |  | 3 | 100 | 300 |
| I100/4 | I100 | Incandescent, (4) 100W lamp |  | 4 | 100 | 400 |
| I100/5 | I100 | Incandescent, (5) 100W lamp |  | 5 | 100 | 500 |
| I1000/1 | I1000 | Incandescent, (1) 1000W lamp |  | 1 | 1000 | 1000 |
| I100E/1 | I100/ES | Incandescent, (1) 100W ES lamp |  | 1 | 90 | 90 |
| I100EL/1 | I100/ES/LL | Incandescent, (1) 100W ES/LL lamp |  | 1 | 90 | 90 |
| I120/1 | I120 | Incandescent, (1) 120W lamp |  | 1 | 120 | 120 |
| I120/2 | I120 | Incandescent, (2) 120W lamp |  | 2 | 120 | 240 |
| I125/1 | I125 | Incandescent, (1) 125W lamp |  | 1 | 125 | 125 |
| I135/1 | I135 | Incandescent, (1) 135W lamp |  | 1 | 135 | 135 |
| I135/2 | I135 | Incandescent, (2) 135W lamp |  | 2 | 135 | 270 |
| I15/1 | I15 | Incandescent, (1) 15W lamp |  | 1 | 15 | 15 |
| I15/2 | I15 | Incandescent, (2) 15W lamp |  | 2 | 15 | 30 |
| I150/1 | I150 | Incandescent, (1) 150W lamp |  | 1 | 150 | 150 |
| I150/2 | I150 | Incandescent, (2) 150W lamp |  | 2 | 150 | 300 |
| I1500/1 | I1500 | Incandescent, (1) 1500W lamp |  | 1 | 1500 | 1500 |
| I150E/1 | I150/ES | Incandescent, (1) 150W ES lamp |  | 1 | 135 | 135 |
| I150EL/1 | I150/ES/LL | Incandescent, (1) 150W ES/LL lamp |  | 1 | 135 | 135 |
| I170/1 | I170 | Incandescent, (1) 170W lamp |  | 1 | 170 | 170 |
| I20/1 | I20 | Incandescent, (1) 20W lamp |  | 1 | 20 | 20 |
| I20/2 | I20 | Incandescent, (2) 20W lamp |  | 2 | 20 | 40 |
| I200/1 | I200 | Incandescent, (1) 200W lamp |  | 1 | 200 | 200 |
| I200/2 | I200 | Incandescent, (2) 200W lamp |  | 2 | 200 | 400 |
| I2000/1 | I2000 | Incandescent, (1) 2000W lamp |  | 1 | 2000 | 2000 |
| I200L/1 | I200/LL | Incandescent, (1) 200W LL lamp |  | 1 | 200 | 200 |
| I25/1 | I25 | Incandescent, (1) 25W lamp |  | 1 | 25 | 25 |
| I25/2 | I25 | Incandescent, (2) 25W lamp |  | 2 | 25 | 50 |
| I25/4 | I25 | Incandescent, (4) 25W lamp |  | 4 | 25 | 100 |
| I250/1 | I250 | Incandescent, (1) 250W lamp |  | 1 | 250 | 250 |
| I300/1 | I300 | Incandescent, (1) 300W lamp |  | 1 | 300 | 300 |
| I34/1 | I34 | Incandescent, (1) 34W lamp |  | 1 | 34 | 34 |
| I34/2 | I34 | Incandescent, (2) 34W lamp |  | 2 | 34 | 68 |
| I36/1 | I36 | Incandescent, (1) 36W lamp |  | 1 | 36 | 36 |
| I40/1 | I40 | Incandescent, (1) 40W lamp |  | 1 | 40 | 40 |
| I40/2 | I40 | Incandescent, (2) 40W lamp |  | 2 | 40 | 80 |
| I400/1 | I400 | Incandescent, (1) 400W lamp |  | 1 | 400 | 400 |
| I40E/1 | I40/ES | Incandescent, (1) 40W ES lamp |  | 1 | 34 | 34 |
| I40EL/1 | I40/ES/LL | Incandescent, (1) 40W ES/LL lamp |  | 1 | 34 | 34 |
| I42/1 | I42 | Incandescent, (1) 42W lamp |  | 1 | 42 | 42 |
| I448/1 | I448 | Incandescent, (1) 448W lamp |  | 1 | 448 | 448 |
| I45/1 | I45 | Incandescent, (1) 45W lamp |  | 1 | 45 | 45 |
| I50/1 | I50 | Incandescent, (1) 50W lamp |  | 1 | 50 | 50 |
| I50/2 | I50 | Incandescent, (2) 50W lamp |  | 2 | 50 | 100 |
| I500/1 | I500 | Incandescent, (1) 500W lamp |  | 1 | 500 | 500 |
| I52/1 | I52 | Incandescent, (1) 52W lamp |  | 1 | 52 | 52 |
| I52/2 | I52 | Incandescent, (2) 52W lamp |  | 2 | 52 | 104 |
| I54/1 | I54 | Incandescent, (1) 54W lamp |  | 1 | 54 | 54 |
| I54/2 | I54 | Incandescent, (2) 54W lamp |  | 2 | 54 | 108 |
| I55/1 | I55 | Incandescent, (1) 55W lamp |  | 1 | 55 | 55 |
| I55/2 | I55 | Incandescent, (2) 55W lamp |  | 2 | 55 | 110 |
| I60/1 | I60 | Incandescent, (1) 60W lamp |  | 1 | 60 | 60 |
| I60/2 | I60 | Incandescent, (2) 60W lamp |  | 2 | 60 | 120 |
| I60/3 | I60 | Incandescent, (3) 60W lamp |  | 3 | 60 | 180 |
| I60/4 | I60 | Incandescent, (4) 60W lamp |  | 4 | 60 | 240 |
| I60/5 | I60 | Incandescent, (5) 60W lamp |  | 5 | 60 | 300 |
| I60E/1 | I60/ES | Incandescent, (1) 60W ES lamp |  | 1 | 52 | 52 |
| I60EL/1 | I60/ES/LL | Incandescent, (1) 60W ES/LL lamp |  | 1 | 52 | 52 |
| I65/1 | I65 | Incandescent, (1) 65W lamp |  | 1 | 65 | 65 |
| I65/2 | I65 | Incandescent, (2) 65W lamp |  | 2 | 65 | 130 |
| I67/1 | I67 | Incandescent, (1) 67W lamp |  | 1 | 67 | 67 |
| I67/2 | I67 | Incandescent, (2) 67W lamp |  | 2 | 67 | 134 |
| I67/3 | I67 | Incandescent, (3) 67W lamp |  | 3 | 67 | 201 |
| I69/1 | I69 | Incandescent, (1) 69W lamp |  | 1 | 69 | 69 |
| I7.5/1 | I7.5 | Tungsten exit light, (1) 7.5 W lamp, used in night light application |  | 1 | 7.5 | 8 |
| I7.5/2 | I7.5 | Tungsten exit light, (2) 7.5 W lamp, used in night light application |  | 2 | 7.5 | 15 |
| I72/1 | I72 | Incandescent, (1) 72W lamp |  | 1 | 72 | 72 |
| I75/1 | I75 | Incandescent, (1) 75W lamp |  | 1 | 75 | 75 |
| I75/2 | I75 | Incandescent, (2) 75W lamp |  | 2 | 75 | 150 |
| I75/3 | I75 | Incandescent, (3) 75W lamp |  | 3 | 75 | 225 |
| I75/4 | I75 | Incandescent, (4) 75W lamp |  | 4 | 75 | 300 |
| I750/1 | I750 | Incandescent, (1) 750W lamp |  | 1 | 750 | 750 |
| I75E/1 | I75/ES | Incandescent, (1) 75W ES lamp |  | 1 | 67 | 67 |
| I75EL/1 | I75/ES/LL | Incandescent, (1) 75W ES/LL lamp |  | 1 | 67 | 67 |
| I80/1 | I80 | Incandescent, (1) 80W lamp |  | 1 | 80 | 80 |
| I85/1 | I85 | Incandescent, (1) 85W lamp |  | 1 | 85 | 85 |
| I90/1 | I90 | Incandescent, (1) 90W lamp |  | 1 | 90 | 90 |
| I90/2 | I90 | Incandescent, (2) 90W lamp |  | 2 | 90 | 180 |
| I90/3 | I90 | Incandescent, (3) 90W lamp |  | 3 | 90 | 270 |
| I93/1 | I93 | Incandescent, (1) 93W lamp |  | 1 | 93 | 93 |
| I95/1 | I95 | Incandescent, (1) 95W lamp |  | 1 | 95 | 95 |
| I95/2 | I95 | Incandescent, (2) 95W lamp |  | 2 | 95 | 190 |
|  |  | ***Halogen Incandescent Fixtures*** |  |  |  |  |
| H100/1 | H100 | Halogen Incandescent, (1) 100W lamp |  | 1 | 100 | 100 |
| H1000/1 | H1000 | Halogen Incandescent, (1) 1000W lamp |  | 1 | 1000 | 1000 |
| H1200/1 | H1200 | Halogen Incandescent, (1) 1200W lamp |  | 1 | 1200 | 1200 |
| H150/1 | H150 | Halogen Incandescent, (1) 150W lamp |  | 1 | 150 | 150 |
| H150/2 | H150 | Halogen Incandescent, (2) 150W lamp |  | 2 | 150 | 300 |
| H1500/1 | H1500 | Halogen Incandescent, (1) 1500W lamp |  | 1 | 1500 | 1500 |
| H200/1 | H200 | Halogen Incandescent, (1) 200W lamp |  | 1 | 200 | 200 |
| H250/1 | H250 | Halogen Incandescent, (1) 250W lamp |  | 1 | 250 | 250 |
| H300/1 | H300 | Halogen Incandescent, (1) 300W lamp |  | 1 | 300 | 300 |
| H35/1 | H35 | Halogen Incandescent, (1) 35W lamp |  | 1 | 35 | 35 |
| H350/1 | H350 | Halogen Incandescent, (1) 350W lamp |  | 1 | 350 | 350 |
| H40/1 | H40 | Halogen Incandescent, (1) 40W lamp |  | 1 | 40 | 40 |
| H400/1 | H400 | Halogen Incandescent, (1) 400W lamp |  | 1 | 400 | 400 |
| H42/1 | H42 | Halogen Incandescent, (1) 42W lamp |  | 1 | 42 | 42 |
| H425/1 | H425 | Halogen Incandescent, (1) 425W lamp |  | 1 | 425 | 425 |
| H45/1 | H45 | Halogen Incandescent, (1) 45W lamp |  | 1 | 45 | 45 |
| H45/2 | H45 | Halogen Incandescent, (2) 45W lamp |  | 2 | 45 | 90 |
| H50/1 | H50 | Halogen Incandescent, (1) 50W lamp |  | 1 | 50 | 50 |
| H50/2 | H50 | Halogen Incandescent, (2) 50W lamp |  | 2 | 50 | 100 |
| H500/1 | H500 | Halogen Incandescent, (1) 500W lamp |  | 1 | 500 | 500 |
| H52/1 | H52 | Halogen Incandescent, (1) 52W lamp |  | 1 | 52 | 52 |
| H55/1 | H55 | Halogen Incandescent, (1) 55W lamp |  | 1 | 55 | 55 |
| H55/2 | H55 | Halogen Incandescent, (2) 55W lamp |  | 2 | 55 | 110 |
| H60/1 | H60 | Halogen Incandescent, (1) 60W lamp |  | 1 | 60 | 60 |
| H72/1 | H72 | Halogen Incandescent, (1) 72W lamp |  | 1 | 72 | 72 |
| H75/1 | H75 | Halogen Incandescent, (1) 75W lamp |  | 1 | 75 | 75 |
| H75/2 | H75 | Halogen Incandescent, (2) 75W lamp |  | 2 | 75 | 150 |
| H750/1 | H750 | Halogen Incandescent, (1) 750W lamp |  | 1 | 750 | 750 |
| H90/1 | H90 | Halogen Incandescent, (1) 90W lamp |  | 1 | 90 | 90 |
| H90/2 | H90 | Halogen Incandescent, (2) 90W lamp |  | 2 | 90 | 180 |
| H900/1 | H900 | Halogen Incandescent, (1) 900W lamp |  | 1 | 900 | 900 |
| HLV20/1 | H20/LV | Halogen Low Voltage Incandescent, (1) 20W lamp |  | 1 | 20 | 30 |
| HLV25/1 | H25/LV | Halogen Low Voltage Incandescent, (1) 25W lamp |  | 1 | 25 | 35 |
| HLV35/1 | H35/LV | Halogen Low Voltage Incandescent, (1) 35W lamp |  | 1 | 35 | 45 |
| HLV42/1 | H42/LV | Halogen Low Voltage Incandescent, (1) 42W lamp |  | 1 | 42 | 52 |
| HLV50/1 | H50/LV | Halogen Low Voltage Incandescent, (1) 50W lamp |  | 1 | 50 | 60 |
| HLV65/1 | H65/LV | Halogen Low Voltage Incandescent, (1) 65W lamp |  | 1 | 65 | 75 |
| HLV75/1 | H75/LV | Halogen Low Voltage Incandescent, (1) 75W lamp |  | 1 | 75 | 85 |
|  |  | ***QL Induction Fixtures*** |  |  |  |  |
| QL55/1 | QL55 | QL Induction, (1) 55W lamp | Generator | 1 | 55 | 55 |
| QL85/1 | QL85 | QL Induction, (1) 85W lamp | Generator | 1 | 85 | 85 |
| QL165/1 | QL165 | QL Induction, (1) 165W lamp | Generator | 1 | 165 | 165 |
|  |  | ***High Pressure Sodium Fixtures*** |  |  |  |  |
| HPS100/1 | HPS100 | High Pressure Sodium, (1) 100W lamp | CWA | 1 | 100 | 138 |
| HPS1000/1 | HPS1000 | High Pressure Sodium, (1) 1000W lamp | CWA | 1 | 1000 | 1100 |
| HPS150/1 | HPS150 | High Pressure Sodium, (1) 150W lamp | CWA | 1 | 150 | 188 |
| HPS200/1 | HPS200 | High Pressure Sodium, (1) 200W lamp | CWA | 1 | 200 | 250 |
| HPS225/1 | HPS225 | High Pressure Sodium, (1) 225W lamp | CWA | 1 | 225 | 275 |
| HPS250/1 | HPS250 | High Pressure Sodium, (1) 250W lamp | CWA | 1 | 250 | 295 |
| HPS310/1 | HPS310 | High Pressure Sodium, (1) 310W lamp | CWA | 1 | 310 | 365 |
| HPS35/1 | HPS35 | High Pressure Sodium, (1) 35W lamp | CWA | 1 | 35 | 46 |
| HPS360/1 | HPS360 | High Pressure Sodium, (1) 360W lamp | CWA | 1 | 360 | 414 |
| HPS400/1 | HPS400 | High Pressure Sodium, (1) 400W lamp | CWA | 1 | 400 | 465 |
| HPS50/1 | HPS50 | High Pressure Sodium, (1) 50W lamp | CWA | 1 | 50 | 66 |
| HPS600/1 | HPS600 | High Pressure Sodium, (1) 600W lamp | CWA | 1 | 600 | 675 |
| HPS70/1 | HPS70 | High Pressure Sodium, (1) 70W lamp | CWA | 1 | 70 | 95 |
| HPS750/1 | HPS750 | High Pressure Sodium, (1) 750W lamp | CWA | 1 | 750 | 835 |
|  |  | ***Metal Halide Fixtures*** |  |  |  |  |
| MH100/1 | MH100 | Metal Halide, (1) 100W lamp | CWA | 1 | 100 | 128 |
| MH1000/1 | MH1000 | Metal Halide, (1) 1000W lamp | CWA | 1 | 1000 | 1080 |
| MH150/1 | MH150 | Metal Halide, (1) 150W lamp | CWA | 1 | 150 | 190 |
| MH1500/1 | MH1500 | Metal Halide, (1) 1500W lamp | CWA | 1 | 1500 | 1610 |
| MH175/1 | MH175 | Metal Halide, (1) 175W lamp | CWA | 1 | 175 | 215 |
| MH1800/1 | MH1800 | Metal Halide, (1) 1800W lamp | CWA | 1 | 1800 | 1875 |
| MH200/1 | MH200 | Metal Halide, (1) 200W lamp | CWA | 1 | 200 | 232 |
| MH250/1 | MH250 | Metal Halide, (1) 250W lamp | CWA | 1 | 250 | 295 |
| MH32/1 | MH32 | Metal Halide, (1) 32W lamp | CWA | 1 | 32 | 43 |
| MH300/1 | MH300 | Metal Halide, (1) 300W lamp | CWA | 1 | 300 | 342 |
| MH320/1 | MH320 | Metal Halide, (1) 320W lamp | CWA | 1 | 320 | 365 |
| MH350/1 | MH350 | Metal Halide, (1) 350W lamp | CWA | 1 | 350 | 400 |
| MH360/1 | MH360 | Metal Halide, (1) 360W lamp | CWA | 1 | 360 | 430 |
| MH400/1 | MH400 | Metal Halide, (1) 400W lamp | CWA | 1 | 400 | 458 |
| MH400/2 | MH400 | Metal Halide, (2) 400W lamp | CWA | 2 | 400 | 916 |
| MH450/1 | MH450 | Metal Halide, (1) 450W lamp | CWA | 1 | 450 | 508 |
| MH35/1 | MH35 | Metal Halide, (1) 35W lamp | CWA | 1 | 35 | 44 |
| MH50/1 | MH50 | Metal Halide, (1) 50W lamp | CWA | 1 | 50 | 72 |
| MH70/1 | MH70 | Metal Halide, (1) 70W lamp | CWA | 1 | 70 | 95 |
| MH750/1 | MH750 | Metal Halide, (1) 750W lamp | CWA | 1 | 750 | 850 |
| MHPS/LR/100/1 | MHPS100 | Metal Halide Pulse Start, (1) 100W lamp w/ Linear Reactor Ballast | LR | 1 | 100 | 118 |
| MHPS/LR/150/1 | MHPS150 | Metal Halide Pulse Start, (1) 150W lamp w/ Linear Reactor Ballast | LR | 1 | 150 | 170 |
| MHPS/LR/175/1 | MHPS175 | Metal Halide Pulse Start, (1) 175W lamp w/ Linear Reactor Ballast | LR | 1 | 175 | 194 |
| MHPS/LR/200/1 | MHPS200 | Metal Halide Pulse Start, (1) 200W lamp w/ Linear Reactor Ballast | LR | 1 | 200 | 219 |
| MHPS/LR/250/1 | MHPS250 | Metal Halide Pulse Start, (1) 250W lamp w/ Linear Reactor Ballast | LR | 1 | 250 | 275 |
| MHPS/LR/300/1 | MHPS300 | Metal Halide Pulse Start, (1) 300W lamp w/ Linear Reactor Ballast | LR | 1 | 300 | 324 |
| MHPS/LR/320/1 | MHPS320 | Metal Halide Pulse Start, (1) 320W lamp w/ Linear Reactor Ballast | LR | 1 | 320 | 349 |
| MHPS/LR/350/1 | MHPS350 | Metal Halide Pulse Start, (1) 350W lamp w/ Linear Reactor Ballast | LR | 1 | 350 | 380 |
| MHPS/LR/400/1 | MHPS400 | Metal Halide Pulse Start, (1) 400W lamp w/ Linear Reactor Ballast | LR | 1 | 400 | 435 |
| MHPS/LR/450/1 | MHPS450 | Metal Halide Pulse Start, (1) 450W lamp w/ Linear Reactor Ballast | LR | 1 | 450 | 485 |
| MHPS/LR/750/1 | MHPS750 | Metal Halide Pulse Start, (1) 750W lamp w/ Linear Reactor Ballast | LR | 1 | 750 | 805 |
| MHPS/SCWA/100/1 | MHPS100 | Metal Halide Pulse Start, (1) 100W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 100 | 128 |
| MHPS/SCWA/1000/1 | MHPS1000 | Metal Halide Pulse Start, (1) 1000W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 1000 | 1080 |
| MHPS/SCWA/150/1 | MHPS150 | Metal Halide Pulse Start, (1) 150W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 150 | 190 |
| MHPS/SCWA/175/1 | MHPS175 | Metal Halide Pulse Start, (1) 175W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 175 | 208 |
| MHPS/SCWA/200/1 | MHPS200 | Metal Halide Pulse Start, (1) 200W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 200 | 232 |
| MHPS/SCWA/250/1 | MHPS250 | Metal Halide Pulse Start, (1) 250W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 250 | 288 |
| MHPS/SCWA/300/1 | MHPS300 | Metal Halide Pulse Start, (1) 300W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 300 | 342 |
| MHPS/SCWA/320/1 | MHPS320 | Metal Halide Pulse Start, (1) 320W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 320 | 368 |
| MHPS/SCWA/350/1 | MHPS350 | Metal Halide Pulse Start, (1) 350W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 350 | 400 |
| MHPS/SCWA/400/1 | MHPS400 | Metal Halide Pulse Start, (1) 400W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 400 | 450 |
| MHPS/SCWA/450/1 | MHPS450 | Metal Halide Pulse Start, (1) 450W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 450 | 506 |
| MHPS/SCWA/750/1 | MHPS750 | Metal Halide Pulse Start, (1) 750W lamp w/ Super Constant Wattage Autotransformer Ballast | SCWA | 1 | 750 | 815 |
|  |  | ***Mercury Vapor Fixtures*** |  |  |  |  |
| MV100/1 | MV100 | Mercury Vapor, (1) 100W lamp | CWA | 1 | 100 | 125 |
| MV1000/1 | MV1000 | Mercury Vapor, (1) 1000W lamp | CWA | 1 | 1000 | 1075 |
| MV175/1 | MV175 | Mercury Vapor, (1) 175W lamp | CWA | 1 | 175 | 205 |
| MV250/1 | MV250 | Mercury Vapor, (1) 250W lamp | CWA | 1 | 250 | 290 |
| MV40/1 | MV40 | Mercury Vapor, (1) 40W lamp | CWA | 1 | 40 | 50 |
| 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 |
|  |  | ***Removed Fixture*** |  |  |  |  |
| Removed | None | This post-fixture code should be used when the fixture(s) is(are) completely removed from service. | | 0 | 0 | 0 |
|  |  | ***Additional Fixture*** |  |  |  |  |
| Add | None | This pre-fixture code should be used as a placeholder when adding new additional fixtures. | | 0 | 0 | 0 |
|  |  | ***Custom Fixtures*** |  |  |  |  |
| Custom Fixture 1 | |  |  |  |  |  |
| Custom Fixture 2 | |  |  |  |  |  |
| Custom Fixture 3 | |  |  |  |  |  |
| Custom Fixture 4 | |  |  |  |  |  |
| Custom Fixture 5 | |  |  |  |  |  |
| Custom Fixture 6 | |  |  |  |  |  |
| Custom Fixture 7 | |  |  |  |  |  |
| Custom Fixture 8 | |  |  |  |  |  |
| Custom Fixture 9 | |  |  |  |  |  |
| Custom Fixture 10 | |  |  |  |  |  |
| Custom Fixture 11 | |  |  |  |  |  |
| Custom Fixture 12 | |  |  |  |  |  |
| Custom Fixture 13 | |  |  |  |  |  |
| Custom Fixture 14 | |  |  |  |  |  |
| Custom Fixture 15 | |  |  |  |  |  |
| Custom Fixture 16 | |  |  |  |  |  |
| Custom Fixture 17 | |  |  |  |  |  |
| Custom Fixture 18 | |  |  |  |  |  |
| Custom Fixture 19 | |  |  |  |  |  |
| Custom Fixture 20 | |  |  |  |  |  |
| Custom Fixture 21 | |  |  |  |  |  |
| Custom Fixture 22 | |  |  |  |  |  |
| Custom Fixture 23 | |  |  |  |  |  |
| Custom Fixture 24 | |  |  |  |  |  |
| Custom Fixture 25 | |  |  |  |  |  |



## 8.4 Appendix D: Motor & VFD Inventory Form

* Motor and Variable Frequency Drive Inventory Form



1. Order entered on October 3, 2005, under the above‑referenced caption and Docket Number. [↑](#footnote-ref-1)
2. *Id*. at page 13. [↑](#footnote-ref-2)
3. Order entered on January 16, 2009, at Docket No. M‑2008‑2069887, at page 13 (Implementing the energy efficiency and conservation program requirements of Act 129 of 2008, 66 Pa.C.S. §§ 2806.1). [↑](#footnote-ref-3)
4. See page 13 of Implementation Order at Docket No. M‑2008‑2069887, entered January 16, 2009. [↑](#footnote-ref-4)
5. *See Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual Update* Order at Docket No. M‑00051865, entered June 1, 2009. [↑](#footnote-ref-5)
6. *Id*. at pages 17 and 18. [↑](#footnote-ref-6)
7. The TWG is chaired by the SWE and is comprised of representatives from the EDCs and Commission staff for the purpose of encouraging discussion of the technical issues related to the evaluation, measurement and verification of savings programs to be implemented pursuant to Act 129. [↑](#footnote-ref-7)
8. See pages 47 and 48 of the 2009 TRM. [↑](#footnote-ref-8)
9. http://www.puc.state.pa.us/electric/electric\_alt\_energy.aspx [↑](#footnote-ref-9)
10. http://www.puc.state.pa.us/electric/Act\_129\_info.aspx [↑](#footnote-ref-10)
11. Note: Information in the TRM specifically relating to the AEPS Act are shaded in gray. [↑](#footnote-ref-11)
12. Values for lighting, air conditioners, chillers and motors are based on measured usage from a large sample of participants from 1995 through 1999. Values for heat pumps reflect metered usage from 1996 through 1998 and variable speed drives reflect metered usage from 1995 through 1998. [↑](#footnote-ref-12)
13. Monday through Friday. [↑](#footnote-ref-13)
14. Weekends and Holidays. [↑](#footnote-ref-14)
15. Note: Programs where measures are replaced before the end of their useful life are considered Custom Measures. In these programs, savings are measured from the efficient unit versus the replaced unit for the existing life of the unit, then from the efficiency unit versus a new standard unit for the remaining life of the efficient measure. [↑](#footnote-ref-15)
16. Desuperheaters are generally utilized to reduce the temperature of superheated steam to a desired set point for the protection of downstream piping and equipment or for the supply of saturated steam for heat transfer purposes.  [↑](#footnote-ref-16)
17. Applicable to buildings completed from April 2003 to present. [↑](#footnote-ref-17)
18. Applicable to buildings completed from April 2003 to present. Reflects MEC 95. [↑](#footnote-ref-18)
19. Single and multiple family as noted. [↑](#footnote-ref-19)
20. Applicable to buildings completed from January 2008 to present. [↑](#footnote-ref-20)
21. Energy Information Administration. *Residential Energy Consumption Survey*. 2005. <http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/detailed_tables2005.html> [↑](#footnote-ref-21)
22. A new standard for BESTEST is currently being developed. The existing 1995 standard can be found at <http://www.nrel.gov/docs/legosti/fy96/7332a.pdf> . [↑](#footnote-ref-22)
23. A listing of the approved software available at <http://www.waptac.org/si.asp?id=736> . [↑](#footnote-ref-23)
24. A listing of the approved software available at <http://resnet.us> . [↑](#footnote-ref-24)
25. M&V Evaluation, Home Performance with Energy Star Program, Final Report, Prepared for the New York State Energy Research and Development Authority, Nexant, June 2005. [↑](#footnote-ref-25)
26. CenterPoint Energy Program Manual v4.0 [↑](#footnote-ref-26)
27. EDC’s have the option to provide additional data in support of different numbers of lighting hours of use sub-groups on a case by case basis. [↑](#footnote-ref-27)
28. In cases where both a common space type and a building specific type are listed, the building specific space type shall apply. [↑](#footnote-ref-28)
29. Source: PECO Comments on the PA TRM, received March30, 2009. [↑](#footnote-ref-29)
30. Average of CF in NJ Clean Energy Program Protocols and 1.0 for CFs above 65% in NJ Protocol. Compromise based on PECO proposal to account for potential selection of high use circuits for retrofit. Subject to revision based on detailed measurement or additional research in subsequent TRM Updates. [↑](#footnote-ref-30)
31. Average of NJ Clean Energy from JCP&L data and 2004-2005 DEER update study (December 2005). [↑](#footnote-ref-31)
32. To be used only for lights illuminated on a continuous basis. [↑](#footnote-ref-32)
33. To be used only when no other category is applicable. Actual hours of operation must be documented by building facility staff interviews or logging hours of use. The SWE reserves the right to require logging hours of use groups for evaluation purposes. [↑](#footnote-ref-33)
34. Subject to verification by EDC Evaluation or SWE [↑](#footnote-ref-34)
35. This reference cannot be validated and is rooted in the NJ Clean Energy Program Protocols to Measure Resource Savings dated 12/23/2004 [↑](#footnote-ref-35)
36. Subject to verification by EDC Evaluation or SWE [↑](#footnote-ref-36)
37. Default Value can be used by EDC but is subject to metering and adjustment by evaluators or SWE [↑](#footnote-ref-37)
38. Default Value can be used by EDC but is subject to metering and adjustment by evaluators or SWE [↑](#footnote-ref-38)
39. Need to confirm source through TWG [↑](#footnote-ref-39)
40. http://www.nema.org/stds/complimentary-docs/upload/MG1premium.pdf [↑](#footnote-ref-40)
41. http://www.nema.org/stds/complimentary-docs/upload/MG1premium.pdf [↑](#footnote-ref-41)
42. Operating hours subject to adjustment with data provided by EDCs and accepted by SWE [↑](#footnote-ref-42)
43. http://www.energystar.gov/ia/business/bulk\_purchasing/bpsavings\_calc/Calc\_CAC.xls [↑](#footnote-ref-43)
44. Default Value can be used by EDC but is subject to metering and adjustment by evaluators or SWE [↑](#footnote-ref-44)
45. Default Value can be used by EDC but is subject to metering and adjustment by evaluators or SWE [↑](#footnote-ref-45)
46. Need to confirm source through TWG [↑](#footnote-ref-46)
47. The basis for these factors has not been determined or independently verified. [↑](#footnote-ref-47)
48. Need to confirm source through TWG. [↑](#footnote-ref-48)
49. Baseline values from ASHRAE 90.1-2007 [↑](#footnote-ref-49)
50. US Department of Energy. Energy Star Calculator and Bin Analysis Models [↑](#footnote-ref-50)
51. US Department of Energy. Energy Star Calculator and Bin Analysis Models [↑](#footnote-ref-51)
52. Results reflect metered use from 1995 – 1998. [↑](#footnote-ref-52)
53. Results reflect metered use from 1995 – 1999. [↑](#footnote-ref-53)
54. Application criteria for submittals is taken from ISO New England’s *Measurement and Verification of Demand Reduction Value from Demand Resources*. October 1, 2007. [↑](#footnote-ref-54)
55. Energy Star Appliances, Energy Star Lighting, and several Residential Electric HVAC measures lives updated February 2008. U.S. Environmental Protection Agency and U.S. Department of Energy, Energy Star. <http://www.energystar.gov/>. [↑](#footnote-ref-55)