BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2011 Update	:	**Docket No. M-00051865**

COMMENTS OF PECO ENERGY COMPANY ON THE PROPOSED UPDATE TO THE TECHNICAL REFERENCE MANUAL

Pursuant to the November 24, 2010 Tentative Order entered by the Pennsylvania Public Utility Commission (the "Commission") in the above-referenced docket, PECO Energy Company ("PECO") hereby submits comments on the Commission's proposed 2011 update to its Technical Reference Manual ("TRM").

I. INTRODUCTION

PECO appreciates the Commission's efforts to complete an updated TRM that will serve as a more effective tool for validating savings and providing support for Act 129 goals. PECO strongly agrees that the scope of the TRM should be broadened to reflect new energy efficiency and conservation ("EE&C") measures being implemented by electric distribution companies ("EDCs") and that TRM protocols should continue to be streamlined and clarified. PECO's general comments in response to the proposed TRM update and key issues identified in the Tentative Order are provided below. Specific, section-by-section comments are attached to this document as Appendix A.

II. GENERAL COMMENTS

A. Considerations Regarding The Implementation Of Changes To Baseline Data

The TRM update proposes changes to baseline data for certain residential compact fluorescent lamp ("CFL") measures, among others. In the Tentative Order, the Commission

acknowledges that the use of these revised baseline data may result in lower deemed savings and seeks comments on how to fairly address the tradeoff between the use of baseline data derived from more recent research and the possibility that such adjustments may require modifications to approved EE&C plans in order to meet statutorily-mandated goals. *See* Tentative Order, p. 5. PECO agrees that the revision of baseline TRM data raises competing and legitimate issues regarding savings accuracy and avoiding potentially disruptive and costly modifications to EE&C plans that have been found cost-effective under existing TRM values and are already being implemented. The Company believes that two key considerations should inform any decision to revise TRM baseline data: (1) the source of the data supporting the revision; and (2) the appropriate implementation timeframe. In the future, these considerations can and should be addressed through the Technical Working Group process.

Any data or research that forms the basis for revisions to baseline TRM values should accurately reflect the energy savings and the associated energy market effects being achieved **in Pennsylvania**. Data from significantly more mature markets or markets that, for geographic reasons, have different daylight hours, even if collected recently, do not provide this necessary accuracy. PECO believes that Pennsylvania-specific research or research from markets that closely resemble Pennsylvania is the only proper basis for revising baseline TRM values.

PECO believes that after appropriate support is gathered for a baseline change, the Commission should phase in the baseline revision over a 12-month period to allow EDCs an adequate amount of time to: (1) assess the impact of those revisions on their ability to meet mandated savings goals and stay within established budget constraints; (2) determine whether EE&C plan modifications are required; and (3) obtain Commission approval of any modifications. PECO understands that other EDCs have recommended different implementation

timeframes and acknowledges that the impact of a baseline change will necessarily vary from EE&C plan to EE&C plan.

It is important to note that PECO's phase-in proposal only relates to changes to substantive TRM components (e.g., baseline data). When corrections or adjustments are recommended by the Technical Working Group for TRM process components (e.g., formulas), the Company supports the immediate implementation of those changes by applying them to measures in the current Program Year and subsequent Program Years.

B. Proposed Revisions To Baseline Residential CFL Hours Of Use

1. The Proposed Change In The TRM Update Is Significant

The TRM update proposes to reduce the deemed hours of use ("HOU") for residential CFLs from 3.0 to 1.9. A change of this magnitude would have significant cost and compliance implications for PECO and other EDCs. For example, if this change were implemented, 37% more CFLs would need to be sold in order to meet the Company's existing savings projections for Program Years 11 and 12 for the residential CFL measure. These additional CFL sales would add substantially to PECO's EE&C Plan costs (an additional 39% in CFL incentive costs alone), and, if the new sale numbers were not achieved, PECO's ability to comply with statutorily-mandated savings targets would be jeopardized.

2. The Data Cited In The TRM Update To Support The Change Are Not Applicable In Pennsylvania

The proposed change in HOU for residential CFLs is based on a study of a significantly more mature CFL market than Pennsylvania – California[1] – as well as a nationwide U.S. Department of Energy ("DOE") study of usage for all residential bulb types.[2] The use of data

[1] KEMA. 2010. "Final Evaluation Report: Upstream Lighting Program."

[2] United States Department of Energy, 2002. "US Lighting Market Characterization, Volume 1: National Lighting Inventory and Energy Consumption Estimate."

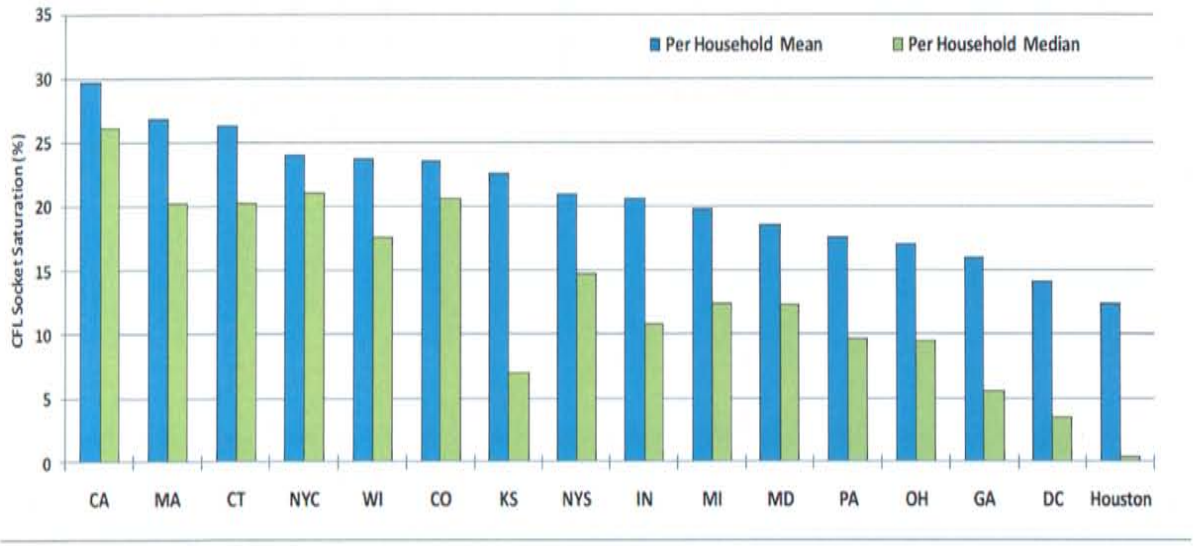
from California as a benchmark for Pennsylvania is inappropriate because utilities in California have been running CFL programs for over 15 years, and have significantly transformed the market. As stated in a recently completed study on the market effects of CFLs in California:

> The California investor owner utility (IOU) programs are among the longest-running energy efficiency efforts in the country, particularly for compact fluorescent lamps (CFLs). Most of the state's IOUs began implementing small-scale pilot programs in the late 1980s, with full-scale programs up and running by 1992. The California IOU efficiency programs are also some of the country's largest in terms of funding.[3]

The median CFL saturation in California households is 2.5 times higher than in Pennsylvania. *See* Figure 1. As CFLs become more commonplace, and their use more widespread, they tend to have lower HOU, on average, because the initial CFL bulb installations are in the most favorable locations in terms of bulb usage and payback. Homeowners will first look to displace inefficient incandescent bulbs in high usage locations such as kitchens, dining rooms, living rooms and outside. Later on, as they gain more experience and become comfortable with the CFL color rendition and light quality, homeowners install CFLs in lower-use locations, such as bathrooms and bedrooms. California has, in fact, experienced a significant decline in average HOU in only the past few years. *See* Table 1.

[3] Cadmus. 2010. "Compact Fluorescent Lamps Market Effects Draft Final Report".

Figure 1 Comparison of CFL Markets.



CFL socket saturations are as high as 20-30% in some parts of the country, depending on how we measure it.

Source: NMR Group Inc, "Final CFL Modeling Report" (2010)

Table 1 CA CFL HOU Studies[4]

Year of Study	HOU
1999	2.34
2005	2.34
2010	1.90

Because California is not a comparable market, the study results do not provide an accurate assessment of the current energy savings being achieved here in Pennsylvania and

[4] The sources used to create this table are as follows: (1) Heschong Mahone Group, 1999. Lighting Efficiency Technology Report. Volume 1: California Baseline. Prepared for the California Energy Commission; (2) KEMA, 2005. CFL Metering Study. Prepared for California's Investor-Owned Utilities (PG&E, SCE, SDG&E, and SoCalGas); (3) KEMA. 2010. "Final Evaluation Report: Upstream Lighting Program."

should not be the basis for significantly lowering the deemed HOU in the TRM. The DOE study also fails to provide an accurate assessment because: (1) its usage data was collected on a nationwide basis and is almost ten years old; and (2) it collected data for *all* residential bulb types, and therefore does not account for the saturation of CFL bulbs in particular. As noted previously, any significant HOU changes should be based on data gathered from Pennsylvania or other states in the Northeast that more readily reflect the current operating and market conditions in the state.

3. Applicable Research Supports An Interim CFL HOU value of 2.77

Several studies have been conducted in markets that are more similar to Pennsylvania with respect to CFLs, and all have found HOU values significantly higher than 1.9. *See* Table 2. The most recent study, conducted in 2009 and covering Connecticut, Massachusetts, and Vermont, found an HOU of 2.77.[5] All three of those states rank higher than Pennsylvania for energy efficiency on the American Council for an Energy Efficiency Economy scorecard, meaning they are more mature markets for energy efficiency measures.[6] This suggests that 2.77 could be a conservative baseline HOU for Pennsylvania. In addition, these studies show that HOU values have declined by **.13** from 2004 to 2009 in Massachusetts, Rhode Island and Vermont, which is significantly less than the HOU reduction of **1.1** proposed by the Commission in this proceeding. *See* Table 2.

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[5] Nexus Market Research, Inc., RLW Analytics, Inc., and GDS Associates, 2009. Residential Lighting Markdown Impact Evaluation. Prepared for Markdown and Buydown Program Sponsors in Connecticut, Massachusetts, Rhode Island, and Vermont.

[6] 8th, 2nd, and 5th, respectively, versus 16th for Pennsylvania. ACEEE. 2010. "ACEEE 2010 State Energy Efficiency Scorecard Ranking."

Table 2 Other Studies in Similar Markets Have Found Higher HOU[7]

Year of Study	Geography	HOU
2004	MA, RI, VT	2.9
2005	MA, RI, VT	2.73
2008	NJ	2.4
2009	CT, MA, RI, VT	2.77

In addition, two preliminary studies of CFL HOU have recently been conducted in Pennsylvania and both found HOU values considerably higher than 1.9. These studies are characterized as "preliminary" because they were not conducted on a state-wide basis and relied, at least in part, on self-reported data by customers. The first preliminary study was conducted by PECO. Using data reported by customers, the Company estimated the annual average HOU per day for PECO customers by using an analysis of covariance (ANCOVA) model adapted from the California Upstream Lighting Program to fit the usage profile of PECO customers. This method was utilized because past evaluations have found that estimates provided by customers are inaccurate and budget constraints did not allow for a lighting logger study of program bulbs. The overall estimated average daily HOU for the randomly selected population of PECO residential customers surveyed on an annualized basis was 2.23. In addition, the study showed that the highest hours of use are observed for bulbs in exterior locations, as well as for bulbs in

[7] The sources used to create this table are as follows: (1) Nexus Market Research, Inc. and RLW Analytics, Inc. 2004. Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs. Prepared for The Cape Light Compact, State of Vermont Public Service Department for Efficiency Vermont, National Grid, Northeast Utilities, NSTAR Electric, Unitil Energy Systems, Inc.; (2) RLW and NMR, 2005. Extended Residential Logging Results, Massachusetts, Rhode Island, and Vermont Electric Utilities and Cape Light Compact; (3) Nexus Market Research, Inc. and RLW Analytics, Inc. 2007. Process and Impact Evaluation of the Efficiency Maine Lighting Program. Prepared for Efficiency Maine; (4) Nexus Market Research, Inc., RLW Analytics, Inc., and GDS Associates, 2009. Residential Lighting Markdown Impact Evaluation. Prepared for Markdown and Buydown Program Sponsors in Connecticut, Massachusetts, Rhode Island, and Vermont; and (5) KEMA, 2010. New Jersey's Clean Energy Program Residential CFL Impact Evaluation and Protocol Review.

the kitchen, living room, and dining room. *See* Table 3. The lowest hours of use are observed for bulbs located in bathrooms, hallways, offices, and other rooms in the home, such as closets, laundry rooms, attics, basements, and spare rooms. *Id.*

Table 3 Distribution of Prior Bulb Type[8]

Room Type	Average Annual Hours of Use
Outside	3.80
Kitchen	2.80
Living Room	2.42
Dining Room	2.19
Garage	2.17
Other Room	1.93
Office	1.79
Bedroom	1.78
Hallway	1.73
Bathroom	1.53
Overall	**2.23**

The second study was conducted by PPL and also relied on self-reporting by customers.[9] The study found an average of 4.6 HOU in kitchens, 4.7 HOU in family rooms and 2.2 HOU in bedrooms. The average HOU for all CFLs in the 5 main rooms of the home was 3.8 hours.

PECO believes that additional, Pennsylvania-specific research should be conducted to determine the most appropriate and accurate HOU value for residential CFLs. Because empirical

[8] Navigant and Itron. 2010. "Evaluation Research Report: PECO Smart Lighting Discounts Program."

[9] PPL. 2010. "Lighting/CFL Survey."

research using lighting loggers is the most accurate way to assess HOUs, a statewide lighting logger study should be conducted in Program Year 3 for the purpose of updating the 2010 TRM.

At this time, an interim HOU value of 2.77 is supported by existing empirical data collected from similar Northeast state markets.[10] PECO recommends that this interim HOU become effective in June 2012 in order to provide EDCs with adequate time to assess the cost and energy savings implications of the revision, determine whether EE&C plan modifications are required, and, if they are, obtain Commission approval of those modifications.

C. Changes To Baseline Data Driven By Federal Legislation And Regulation

The Commission seeks comments on how the TRM should account for baselines changes which are driven by Federal legislation and regulations, such as EPAct 2005, that prohibit the production and sale of less efficient lighting. *See* Tentative Order, pp. 11-12. Consistent with PECO's comments in Section I.A, *supra*, PECO believes that federally mandated regulatory changes impacting TRM baselines should be phased-in over an appropriate amount of time. The appropriate "phase-in" period and annual reductions in baseline wattage are technology and measure specific and should be established through a collaborative process with the Technical Working Group and the Statewide Evaluator ("SWE").

[10] Further, the 2009 TRM defined Energy Star Lighting values from various reference sources based on then available research including the 2003 Nexus Market Research Study Final Report dated October 1, 2004, "Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs", from which the deemed average delta watts per purchased Energy Star Indoor and Outdoor Fixture were based. The 2009 Northeast study is an updated version of the 2003 Northeast study that contributed to shaping the 2009 TRM.

D. Expansion of Deemed Savings for HVAC, Motors, Unitary Office Equipment and Appliances to New Construction

As described in detail in Appendix A, PECO requests that the SWE expand a variety of TRM sections related to equipment performance where the baseline is new "code-minimum" equipment to apply to new construction projects. The Company believes that new construction projects can use the same algorithms, baseline equipment performance, operating hours and other operating factors that the TRM provides for retrofit projects. Including new construction in these areas would be an appropriate and beneficial expansion of the TRM.

E. Expansion of Residential Measures To Apply To C&I Applications

PECO believes that certain residential measures could be extended to the commercial and industrial ("C&I") TRM with relative ease. The Company requests that the SWE consider adopting new appropriate savings factors (or, at the very least, adopt the residential savings factors as conservative estimates) for the C&I applications identified below. In some cases, PECO believes that the savings for C&I applications may be much greater than for the residential applications. PECO requests the opportunity to prepare and submit workpapers justifying appropriate C&I savings factors prior to publication of the Commission's final order regarding the 2011 TRM update.

- Solar Window Film
- Window Upgrades
- Cool Roofs and Roof Insulation
- Electric Clothes Dryer with Moisture Sensor
- Efficient Electric Water Heaters
- Heat Pump Water Heater
- Ductless Mini-Split Heat Pumps

- Fuel Switching: DHW Electric to Gas
- Fuel Switching Electric Heat (or Reheat) to Gas
- Refrigerator /Freezer Recycling and Replacement
- Energy Star Appliances
- Energy Star Televisions

III. CONCLUSION

PECO appreciates the opportunity to comment on this important matter and believes that the Company's recommended revisions can improve the effectiveness of the Technical Reference Manual.

Respectfully Submitted

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For PECO Energy Company

BEFORE THE
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APPENDIX A

Acknowledgements

These comments were prepared by PECO, with input from Navigant Consulting, Inc., its partner Itron Consulting, and KEMA, PECO's C&I implementation Contractor Service Provider (CSP).

TABLE OF CONTENTS

Specific Comments to the Proposed Technical Reference Manual Update

Section 1: Introduction

1.2 Definitions

- In the last paragraph providing the EDCs with an alternative to using the energy savings' values for standard measures contained in the TRM through the use of a Commission approved alternative measurement method, add the following sentence: "The Commission's review and approval process for an EDC's alternative measurement measure shall follow the same process as used for the review and approval of Custom Measure Protocols as described in the Statewide Evaluation Team Custom Measure Protocol Process Policy Paper dated November 24, 2010".

1.3 General Framework

- The first sentence should be modified to read, "In general, energy and demand savings will be estimated using stipulated, measured, and customer data as input values…"

1.4 Algorithms

- The current definition for CF is incorrect. Revise the definition for coincidence factor, and use it consistently throughout the document.
    - TRM currently shows: "CF = Demand Coincidence Factor, percentage of load connected during peak hours."
    - Consider revising to: "CF = Coincidence Factor, defined as the fraction of the technology demand that is coincident with the utility peak."

1.7 Resource Savings in Current and Future Program Years

- PECO suggests adding language to clarify when savings can begin to be claimed. The current language leaves it to the discretion of the "Administrator" with no clear definition. PECO recommends the following language: "For Act 129 requirements, annual savings may be claimed starting in the month of the in-service date for the measure."

1.8 Prospective Application of the TRM

- PECO recommends adding language which allows newly-approved measures, whether officially added to the TRM or Interim Approved TRM Protocols, to be applied retrospectively consistent with the EDC approved filing. PECO proposes the following language: "Any newly approved measure, whether in the TRM or approved as an interim protocol, may be applied retrospectively consistent with the EDC's approved plan."

- PECO suggests adding language to clarify how the TRM is to be applied, or for corrections to specific TRM measure savings errors to be applied retrospectively to the current program year. PECO suggests the following language: "If any errors are discovered in the TRM or clarifications are required, those corrections or clarifications should be applied to the associated measure calculations for the current program year."

1.9 Electric Resource Savings

- Remove footnotes 3 and 4 for Table 1-1 as they are now redundant.

1.15 Custom Measures

- Because the information provided in footnote 5 is very important, PECO recommends that the content be moved into the body of the section and boxed or highlighted or made its own section/paragraph.
- Guidance should be provided on estimating remaining useful life as referenced in footnote 5.

1.16 Impact of Weather

- As currently written, there is no direction on how to decide which of the seven cities listed should be used for any particular project. A zip-code mapping table which maps all zip-codes in the state to a specific representative city should be developed and included within the TRM so that the correct EFLH and corresponding savings value can be applied at the site-level. It is recommended that the zip-code mapping table be developed using similar climate zones rather than EDC territory locations. The use of ASHRAE 90.1 climate zone maps is one possible option for developing a mapping table.

Section 2: Residential Measures

- This text should be moved under Section 2.1 Electric HVAC.

2.1 Electric HVAC

2.1.1 Algorithms

- Each measure listed should have a brief description of the conditions to which the deemed savings apply. It appears to be installation of a ground source heat pump versus a standard-efficiency ASHP or central AC, but this is not clear. It could alternatively be interpreted as the installation of a high efficiency GSHP vs. a standard efficiency GSHP.

Furnace High Efficiency Fan

- The calculation of energy savings for a high efficiency furnace fan is inconsistent between cooling energy savings and heating energy savings. For cooling, a deemed value is provided whereas for heating the savings are related to capacity. Furnace fan sizes are fairly typical in capacity and have little variation in size for residential units. The energy savings for the fan are primarily a function of fan wattage, EFLH and fan efficiency. This holds true for heating and cooling. The calculations should be based on these factors, not heating capacity. The savings algorithm should be:

$$\Delta kWh = kW_{motor} * LF * (EFLHcool + EFLHheat) * \left(\frac{1}{\eta_{motor} * \eta_{fan\ base}} - \frac{1}{\eta_{motor} * \eta_{fan\ ee}}\right)$$

Stipulated values can be provided for the kW_{motor}, LF, and efficiencies to develop a fully deemed measure savings.

2.1.2 Definition of Terms

- The definition of CAPY specifies the use of "cooling capacity" for this variable, but the variable is also used in several heating equations. The definition of CAPY should be corrected to specify either the cooling or heating capacity of the unit depending on if cooling or heating savings are being calculated. Alternatively, a subscript could be added and the different terms could be used in the appropriate equations: $CAPY_{cool}$, $CAPY_{heat}$.
- Include definition for Load Factor (LF = Load factor).
- Definition of CF should match that in Section 1.4.
- Currently the Furnace High Efficiency Fan Measure includes an $EFLH_{HT}$ term which is also defined in this section, however, Table 2-1 does not define any values for this term, nor does the definition clearly describe how it is calculated. Table 2-1 includes an $EFLH_{HFS}$ term which does

not have a definition and is not included in any of the measure algorithms. If the recommendations for the Furnace High Efficiency Fan measure as described above are followed, the $EFLH_{HT}$ and $EFLH_{HFS}$ terms should be removed from the TRM and η_{base} and η_{ee} should be added.

2.7 Home Audit Conservation Kits

2.7.3 Definition of Terms

- In Table 2-14, CFL hours, currently set to 3.0 in the 2010 PA TRM, are proposed to be revised to 1.9 hours. The final value for CFL hours is currently in dispute. PECO notes that the CFL hours for this measure will need to be updated to the agreed upon number when a final value is reached. Similarly, if any other default values change for the individual measures this Conservation Kit measure is based on, the defaults shown in Table 2-14 should also be updated accordingly.

2.9 Low Flow Faucet Aerators

2.9.2 Measure Description

- The measure description should be revised to apply to bathroom faucet aerators as well as kitchen faucet aerators, and the word "kitchen" should be replaced with "kitchen and bathroom."

2.15 Water Heater Pipe Insulation

- The measure description fails to mention that the primary savings for this measure come from the ability to turn the water heater setpoint down 2-4 degrees Fahrenheit because of reduced heat loss in the pipes. This is described on the US DOE website:
  http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13060
  This description should be included in the measure and education along the same lines should be encouraged as part of the measure implementation.

2.17 Ductless Mini-Split Heat Pumps

PECO has discussed some errors in this measure with the other PA EDCs and we are in agreement with the redlined version of this measure protocol put forth by PPL and reviewed/edited by PECO. Our recommendation is to revise the TRM measure protocol based on the revisions in the redlined version put forth by PPL.

2.25 ENERGY STAR Appliances

2.25.1 Algorithms; Table 2-41

- For all the ESav components in Table 2-41, the Value is listed as "see below." This should be modified to say, "See Table 2-42".
- Sources 5, 8 and 9 under Table 2-41 do not appear to be referenced anywhere. If there are no references to the sources, they should be removed.

2.26 ENERGY STAR Lighting

2.26.2 Definition of Terms

- The definition of CF should be adjusted to match the definition in Section 1.4.

Section 3: Commercial and Industrial Measures

3.2 Lighting Equipment Improvements

3.2.1 Eligibility

Solid State Lighting

Comments:

- A typo was noted.
    - "2x2 Luminares"

The operating frequency of the lamp should be listed as it is a key criteria in SSL 101 for manufacturers from ENERGY STAR.

3.2.2 Algorithms

The first part of the section heading should be one of the bulleted, stand-alone sentences positioned above the heading as part of section 3.2.1 Option 2.

3.2.5 Detailed Inventory Form

Projects with connected load savings less than 20 kW

- Refer to the algorithms in section (3.2.2) instead of 'algorithms above'.
- To the last sentence after the word "condition" add "and information on pre retrofit (baseline) conditions should include, at a minimum:(lamp type, lamp wattage, ballast types, and fixture configurations (2 lamp, 4 lamp, etc.)".

3.2.6 Quantifying Annual Hours of Operation

Projects with connected load savings less than 50kW

- The TRM currently states, "For lighting projects with savings less than 50 kW, stipulated whole building hours of use will be used as shown below in Table 3-4." This sentence should reference Table 3-5 not Table 3-4.
- For lighting projects with savings less than 50 kW, hours of use should be able to be modified based on customer self report.

Projects with connected load savings of 50kW or Higher

PECO notes that Table 3-2 (which provides stipulated hours of use for certain "usage areas" which are acceptable for projects with connected load savings of 50 kW or greater) is not comprehensive and the

hours for some usage areas appear to be overly conservative. PECO notes that hours are not provided for warehouse and large industrial production spaces which comprise a significant proportion of these larger projects. PECO further notes that the requirements for at least six usage areas as shown in Table 3-1 do not make sense when one usage area, such as the sales area in a retail store, or the manufacturing floor in an industrial plant, may often comprise greater than 90% of the facility lighting power. PECO believes that language should be added to allow the use of operating hours based on interviews for EX ANTE savings for these larger lighting projects, and that an appropriate monitoring protocol and sample should be required only for the sample selected for evaluation.

Table 3-1

- The number of prescribed usage groups in Table 3-1 should be modified to indicate that these figures are suggested numbers of usage groups.

Table 3-5

- The prescriptive EFLH values described in Table 3-5 differ from EFLH values in Table 3-2 for similar building types – the tables should be consistent.

Table 3-7

- Please provide additional source verification lighting control savings in Table 3-7.

Table 3-8

- Source should be PECO not PECo.

3.2.7 Calculation Method Descriptions by Project Classification

Table 3-11: LED Exit Signs

- For exit signs, incandescent baseline fixtures assume 40 watts per sign. This figure should be reconsidered. A single sided incandescent exit sign may have only a single 20W incandescent lamp.
- There were numerous prescriptive exit sign measures in previous versions of Appendix C. It should be indicated that the calculation in the TRM replaces these or can be used in default if other specific exit sign information (baseline or installed) is unavailable.

3.3 Premium Efficiency Motors

Applicability of Section 3.3 of the TRM relating to Motors for New Construction

The issue of New Construction is not addressed in TRM Section 3.3 discussing motors. PECO believes that the applicability should be extended to New Construction using the same baseline efficiency values and other algorithms for savings. This can be accomplished by adding a sentence in the introduction to Section 3.3 and adding a new description for η_{base} in Table 3-12.

The added sentence in the introduction should state:

"This Section also applies to New Construction applications. All of the same algorithms and factors would apply, with the exception of η_{base}. For New Construction the baseline efficiency will be the efficiencies listed in Tables 3-13 and 3-14.

The "Value" column for η_{base} in Table 3-12 should be modified by adding the words "New Motor, New Construction …" in place of the word "New ..."

3.3.1 Algorithms

- Add an algorithm to calculate load factor to avoid inaccuracies associated with load factor estimations.
  The typical load factor calculation is referred to as the ratio of measured load to rated load. It should be noted that for calculating the rated load of the motor, the efficiency of the motor needs to be included in the calculation. This is a common error observed during load factor calculations.

  LF = Measured motor kW / (Rated motor HP x 0.746 /nameplate efficiency)

  Also, motor efficiency varies with load and decreases dramatically below 50% load. The calculation method does not account for variations in efficiency with load. This becomes a major issue for motors with low load factors. A more robust method or custom method (e.g., use of the DOE MotorMaster+ tool) should be considered for accurate results. Efficiency 'bins' should be considered (e.g., above 75% LF, < 25% LF, etc.)

3.3.2 Definition of Variables

Load Factor Definition

In Section 3.3.2 the definition of "Load Factor" is:

> "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."

In Section 3.4.2 (for VFDs) the definition of "Load Factor" is:

> "Load Factor. Ratio of the average operating load to the nameplate rating of the motor."

In Appendix D the definition of Load Factor is:

> "Load Factor" is the ratio between the actual load and the rated load. Motor efficiency curves typically result in motors being most efficient at approximately 75% of the rated load. The default value is 0.75. Variable loaded motors should use custom measure protocols.

Although they are intended to refer to the same motor, these definitions are not consistent. PECO believes that this definition does not precisely convey the meaning of Load Factor in the context of this algorithm and the Appendix D calculation and should be clarified to say:

"Load Factor = the ratio of the motor average operating load experienced *at full load* to the nameplate load rating of the motor. The default load factor for the purpose of this algorithm is 0.75. The motor load may vary with the control technology indicated."

3.3.3 Description of Calculation Method

- Refer to algorithms in section (3.3.1) rather than 'above algorithms'.
- The baseline efficiency values should be specified as nominal or minimal values (nominal values are believed to be more representative and preferred). This should be performed for Table 3-13 (PY1 and PY2) and Table 14 (PY3 and PY4). Likewise, the values reported for the energy efficiency motor should be specified as the nominal or the minimum efficiency for the replacement (or new) motor.

Table 3-13: Baseline Motor Efficiencies for PY1 and PY2:

- The baseline motor efficiencies for PY1 and PY2 should be EPAct motor efficiencies. The source listed for Table 3-13 is not for EPAct motor efficiencies. The baseline efficiencies should be verified and the values updated as appropriate. The source provided is for Premium motor efficiencies, not EPAct motor efficiencies, and does not match the values reported in the table.

Table 3-15: Stipulated Hours of Use for Motors in Commercial Buildings:

- Remove the word Pumps from the Building Type description for Hospitals & Healthcare.

3.4 Variable Frequency Drive (VFD) Improvements

Applicability of Section 3.4 of the TRM relating to VFDs for New Construction

The issue of New Construction is not addressed in TRM Section 3.4 discussing VFDs. PECO believes that the applicability of this Section should be extended to New Construction using the same algorithms and variables to calculate savings. This can be accomplished by adding a new paragraph after the first paragraph in the introduction to Section 3.4. The added paragraph should state:

"This section also applies to New Construction applications of VFDs to the extent that the VFDs are not required by the applicable Energy Code (IECC 2009 or ASHRAE 90.1 2007). All the same algorithms, factors and default values will apply."

VFDs – Applicability of TRM

The introduction of Section 3.4, which discusses Variable Frequency Drive Improvements, says (emphasis added):

"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 shown in Table 3 18 HVAC fans, cooling tower fans, chilled water pumps, condenser water pumps and hot water pumps. *This protocol estimates savings relative to a constant volume system as the baseline condition.*

"*VFDs in any other application than those referenced Table 3-18 must follow a custom measure protocol*, including industrial applications. 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. *For systems in which the baseline condition is not a constant volume system (e.g. vortex dampers), a custom measure protocol must be used*. When changes in run hours are anticipated in conjunction with the installation of a VFD, a custom path must also be used."

From our experience the restrictions in these paragraphs will require custom treatment for a significant fraction of the applications for VFDs.

An alternative (and preferable) approach would be for the SWE to develop an expanded table with ESF and DSF for different base-case technologies, prior to the publication of the Final TRM document which would expand the VSD applications to which the TRM would apply.

3.4.1 Algorithms

- Add an algorithm to calculate load factor to avoid inaccuracies associated with load factor estimations.
  The typical load factor calculation is referred to as the ratio of measured load to rated load. It should be noted that for calculating rated load of the motor the efficiency of the motor needs to be included in the calculation. This is a common error observed during load factor calculations.

  LF = Measured motor kW / (Rated motor HP x 0.746 /nameplate efficiency)

- For calculating new usage and demand, the terms ESF and DSF are indicated as savings factors. The terminology should be adjusted or the values adjusted. The present values seem to represent the new usage factors as compared to the baseline usage. The energy savings factors (ESFs) listed seem to reflect the new use of the motor and appear to be somewhat low compared to expected actual use, especially for pump systems. The sources for these values should be checked and more conservative values inserted.

3.4.2 Definition of Variables

Load Factor Definition

In Section 3.3.2 the definition of "Load Factor" says:

> "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."

In Section 3.4.2 (for VFDs) the definition of Load Factor Says:

> Please see discussion regarding Section 3.3.2.

3.4.3 Description of Calculation Method

- Refer to algorithms in section (3.4.1) rather than 'above algorithms'.

Table 3-17

- Run hours are stipulated to be as measured or default to Table 3-15. However, run hours must be divided among operation of duplex or triplex systems if equipment is for standby operation. A

column in the calculation spreadsheet (Appendix D) would help clarify the use of the equipment and ensure realistic operating hours were used. Similar observations apply to the use of the coincidence factors (CF).

- The latest version of Appendix D does not include formulae for validating savings or automatic lookup of values.

3.5 Variable Frequency Drive Improvement for Industrial Air Compressors

This section may be removed in future versions of the protocol. A custom approach is a more accurate approach to estimate savings for industrial air compressors as the operating conditions vary significantly based on site specific conditions.

3.5.1 Algorithms

- Need to apply LF to calculate ΔkW and ΔkW_{peak}. Currently, the LF is only used to calculate kWh (kWh = ΔkW x RHRS). The LF has an impact on KW usage. The algorithm should be adjusted to read:

  ΔkW = 0.129 X HP x LF/η_{motor}

3.5.2 Definition of Variables

Table 3-19

The document listed as the source for the two factors (0.129 and 0.106) used in the savings algorithms is a manufacturer's document. The validity of the two factors should be verified and compared to other available sources (e.g., DOE's Compressed Air Challenge and AirMaster).

3.6 HVAC Systems

Systems with variable speed controllers for compressors should be listed as excluded or the protocol expanded to include treatment (including possible adjustment of EFLH values).

3.6.1 Algorithms

- The EFLH term in the ΔkWh algorithm for Air Conditioning Units should be revised to read:

  "ΔkWh = (BtuH / 1000) X ($1/EER_{base}$ – $1/EER_{ee}$) X $EFLH_{cool}$"

- A factor for adjustment for older buildings or buildings with high thermal mass should be added to account for changes in EFLH for heating and cooling.

3.6.2 Definition of Terms

- The definition for BtuH should be adjusted to read:

  "BtuH = The rated heating or cooling capacity of the energy efficient unit in Btu/hour."

Table 3-20

- All variables in Table 3-20, particularly coincidence factor, should be supported with additional sources.
- The use of heating and cooling time period allocation factors is not explained in Table 3-20. A sentence should be added which explains how these allocation factors are used, or they should be removed from the table.

Table 3-21

- The Algorithms Section 3.6.1 under HVAC Systems includes room AC, but no baseline efficiency values are shown for Room AC in Table 3-21.
- Table 3-21 Baseline SEER and EER Values should be adjusted as shown below. See recommended changes and corrections **in red.** New Construction values should be added in the last two rows. Please note that the corresponding footnote for Table 3-21 in the TRM Update is footnote 146.

Table 3-21: HVAC Baseline Efficiencies[1]

Equipment Type and Capacity	Cooling Baseline	Heating Baseline
Air-Source Air Conditioners		
< 5.41 tons	13.0 SEER	N/A
≥ 5.41 tons and <11.25 tons	11.2 EER	N/A
≥ 11.25 tons and < 20.00 tons	11.0 EER	N/A
≥ 20.00 tons and < 63.33 tons (IPLV for units with capacity-modulation only)	10.0 EER/9.7 IPLV	N/A
≥ 63.33 tons (IPLV for units with capacity modulation only)	9.7 EER/9.4 IPLV	N/A
Water-Source and Evaporatively-Cooled Air Conditioners		
< 5.41 tons	12.1 EER	N/A
≥ 5.41 tons and < 11.25 tons	11.5 EER	N/A
≥ 11.25 tons and < 20.00 tons	11.0 EER	N/A
≥ 20.00 tons	11.5 EER	N/A
Air-Source Heat Pumps		
< 5.41 tons:	13 SEER	7.7 HSPF
≥ 5.41 tons and < 11.25 tons	11.0 EER	3.3 COP
≥ 11.25 tons and < 20.00 tons	10.6 EER	3.2 COP
≥ 20.00 tons (IPLV for units with capacity modulation only)	9.5 EER/ 9.2 IPLV	3.2 COP
Water-Source Heat Pumps		
< 1.42 tons	11.2 EER	4.2 COP
≥ 1.42 tons and ≤ 5.41 tons	12.0 EER	4.2 COP

[1] Baseline values from IECC 2009, after Jan 1, 2010 or Jan 23, 2010 as applicable.

Equipment Type and Capacity	Cooling Baseline	Heating Baseline
Ground Water Source Heat Pumps		
< 11.25 tons	16.2 EER	3.6 COP
Ground Source Heat Pumps		
< 11.25 tons	13.4 EER	3.1 COP
Packaged Terminal Systems (Replacements)		
PTAC (cooling)	10.9 - (0.213 x Cap / 1000)* EER	
PTHP DELETE "(cooling)"	10.8 - (0.213 x Cap / 1000) * EER	2.9 - (0.026 x Cap / 1000) * COP
Packaged Terminal Systems (New Construction)		
PTAC (cooling)	12.5 - (0.213 x Cap / 1000)* EER	
PTHP	12.3 - (0.213 x Cap / 1000)* EER	3.2 - (0.026 x Cap / 1000)* COP

In addition we recommend that a footer be added to Table 3-21 stating

"* Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7,000 Btu/h, 7,000 Btu/h is used in the calculation. If the unit's capacity is greater than 15,000 Btu/h, 15,000 Btu/h is used in the calculation." (This text is from ASHRAE 90.1 2007)"

Tables 3-22 and 3-23

A zip code mapping table should be developed and included in the TRM which maps all PA zip codes to an appropriate city as listed in Tables 3-22 and 3-23. The nearest geographic location may not be most applicable.

3.7 Electric Chillers

- In the introductory paragraph, the first sentence states:
  "This protocol estimates savings for installing high efficiency electric chillers compared to standard efficiency chillers."

This statement is incorrect as the baseline set by the standard is the "Code-minimum performance" chiller of the same type. The first sentence should be corrected to read:

> "This protocol estimates savings for installing high efficiency electric chillers as compared to chillers that meet the minimum performance allowed by the current PA Energy Code."

- In the introductory paragraph, the last sentence states,

  > "The savings calculated using the prescriptive algorithms need to be supported by a certification that the chiller is operating at site design load condition."

  This statement should be tempered to read as follows:

  > "The savings calculated using the prescriptive algorithms need to be supported by certification that the chiller operates above 70 percent load for a majority (50% or more) of operating hours AND the estimated load during peak periods (Path A), or below 70% load for a majority of operating hours (Path B) and estimated load during peak periods."

Measure Applicability to VFD Chillers

The third sentence of the first paragraph in the introductory section limits the scope of this measure as follows:

> "These prescriptive algorithms and stipulated values are valid for standard commercial applications, defined as unitary electric chillers serving a single load at the system or sub-system level."

The second paragraph of the introductory section further limits this measure with the following language:

> "All other chiller applications, including multiple chiller configurations, chillers with Variable Frequency Drives (VFDs), chillers serving multiple load groups, and chillers in industrial applications are defined as non-standard applications and must follow a site specific custom protocol."

PECO notes that these statements specifically remove from the applicability of this section chillers with Variable Frequency Drives. As the character of the load is not impacted by the chiller type and VFD-driven chillers are rated according to the same AHRI protocol as non-VFD chillers, PECO does not agree with the elimination of all VFD chillers under this section.

PECO also notes that these constraints will essentially remove a significant fraction of the chiller project applications from the TRM "deemed savings" approach and force them into a Custom Protocol approach that will stretch program M&V resources and costs. At present, PECO has 11 applications for chillers in PY2. More than half of them are eliminated from consideration under this protocol. This will add many site specific protocols and M&V activities to the Program M&V burden.

PECO recommends that the foregoing limitations should be adjusted to allow a single chiller with a VFD through the prescriptive route. More specifically, the language in the first paragraph should be changed to read:

> "These prescriptive algorithms and stipulated values are valid for standard commercial applications, defined as unitary electric chillers serving a single load at the system or sub-system level, including a single chiller with a VFD."

The language in the second paragraph should be changed to read as follows:

> "All other chiller applications, including multiple chiller configurations, single VFD chillers in a plant with other chillers serving the same loop, chillers serving multiple load groups, and chillers in industrial applications are defined as non-standard applications and must follow a site specific custom protocol."

Applicability to New Construction

Section 3.7 does not address chillers installed as a part of New Construction projects. PECO believes that the Section 3.7.1 algorithms and the various factors in Tables 3-24 and 3-26 apply to new construction applications as well as retrofit applications and, in addition, the baseline "Code-minimum" performance factors expressed in Table 3-25 (as modified in these comments) apply to new equipment. PECO therefore believes that the coverage of this Section can be extended to New Construction applications with the simple addition of a statement at the end of the second paragraph in the introductory section, as follows:

> "The algorithms, assumptions and default factors in this Section may be applied to New Construction applications."

3.7.1 Algorithms

- The PLCF term in the demand savings calculations should be termed as CF (coincidence factor) for consistency with other TRM sections.
- The term "Tons" should be adjusted to read "$Tons_{ee}$"
- An adjustment factor should be added in the energy savings algorithms to account for changes in EFLH for heating and cooling for older buildings or buildings with high thermal mass.

3.7.2 Definition of Terms

- A definition for the terms EER_{base} and EER_{ee} should be added.

Table 3-25

- PECO believes that the modification and truncation of the values from IECC 2009 Table 503-2-3(7) and the addition of the qualifiers "Primarily Full Load" and "Primarily Part Load" in the Path A and Path B headers of Table 3-25 are unclear and will result in inconsistent application of the baseline values in the savings algorithms. As stated, this protocol also does not allow for trade-offs between peak demand impacts and annual kWh impacts. We recommend that Table 3-25 be modified to be consistent with the source table from IECC 2009 as shown below **in red.**

Table 3-25 Electric Chiller Baseline Efficiencies (IECC 2009)[2]

Chiller Type	Size	Path A[3] ~~(Primarily Full Load)[4]~~	Path B[5] ~~(Primarily Part Load)[6]~~	Source
Air Cooled Chillers	< 150 tons	Full load: 9.562 EER IPLV: 12.500 EER	~~IPLV: 12.500 EER~~NA	IECC 2009 Table 503.2.3 (7) Post 1/1/2010
	>=150 tons	Full load: 9.562 EER IPLV: 12.750 EER	~~IPLV: 12.500 EER~~NA	
Water Cooled Positive Displacement or Reciprocating Chiller	< 75 tons	Full load: 0.780 kW/ton IPLV: 0.630 kW/ton	Full load: 0.800 kW/ton IPLV: 0.600 kW/ton	
	>=75 tons and < 150 tons	Full load: 0.775 kW/ton IPLV: 0.615 kW/ton	Full load: 0.790 kW/ton IPLV: 0.586 kW/ton	
	>=150 tons and < 300 tons	Full load: 0.680 kW/ton IPLV: 0.580 kW/ton	Full load: 0.718 kW/ton IPLV: 0.540 kW/ton	
	>=300 tons	Full load: 0.620 kW/ton IPLV: 0.540 kW/ton	Full load: 0.639 kW/ton IPLV: 0.490 kW/ton	
Water Cooled Centrifugal Chiller	<300 tons	Full load: 0.634 kW/ton IPLV: 0.596 kW/ton	Full load: 0.639 kW/ton IPLV: 0.450 kW/ton	
	>=300 tons and < 600 tons	Full load: 0.576 kW/ton IPLV: 0.549 kW/ton	Full load: 0.600 kW/ton IPLV: 0.400 kW/ton	
	>=600 tons	Full load: 0.570 kW/ton IPLV: 0.539 kW/ton	Full load: 0.590 kW/ton IPLV: 0.400 kW/ton	

[2] Table shows the efficiency rating to be used in the savings estimation algorithms. ~~See IECC 2009 for complete Full Load and IPLV minimum efficiency requirements for each category.~~ Measure savings should be based on the efficiency for the expected operating conditions of the chiller. Generally the measure savings will be based on IPLV efficiency, however, the installed chiller must meet the minimum efficiencies for both full load and IPLV under the path chosen for calculating savings.

[3] Compliance with this measure can be met by meeting the minimum requirements of Path A or B. However, both the full load and IPLV must be met to fulfill the requirements of Path A or B.

~~[4] Use Path A when chiller will be running primarily at Full load~~

[5] Ibid.

~~[6] Use Path B when chiller will be running primarily at Part load.~~

Tables 3-26

- A zip code mapping table should be developed and included in the TRM which maps all PA zip codes to an appropriate city as listed in Tables 3-22 and 3-23. As commented on ealier in section 1.16 there is no direction on how to decide which of the seven cities listed should be used for any particular project. A zip-code mapping table which maps all zip codes in the state to a specific representative city should be developed and included within the TRM so that the correct EFLH and corresponding savings value can be applied at the site-level. It is recommended that the zip-code mapping table be developed using similar climate zones rather than EDC territory locations. The use of ASHRAE 90.1 climate zone maps is one possible option for developing a mapping table.

Appendix C: Lighting Audit and Design Tool

Comments:

User Input: Table 5 - Stipulated EFLH by Usage Group (For Use with Table 2): EFLH values differ from Table 3-5 'Lighting EFLH and CF by Building Type or Function' of the TRM.

Although 'Prescriptive Lighting Improvements' do not cover LED traffic signs, Table 3-9 'LED Traffic Signals' of the TRM can be used to prescribe this measure in Appendix C as feasible. It should be indicated if this is the desired approach.

Consistent terminology should be applied in the TRM and Appendix C (pre-installation/baseline, post-installation/retrofit, etc,).

The TRM should also recommend the use of a prescriptive table approach instead of a 'Cut Sheet' method approach for occupancy sensors (watts controlled) – Use of existing (pre-retrofit or post-retrofit) lighting fixtures without controls as baseline and with appropriate controls for the post-retrofit condition. These can be separate line items, if necessary as opposed to using one line item for both efficiency and controls retrofit /installation. The TRM and Appendix C should prescribe a preferred approach.

Manual Tab, #7B, Section III

The language of the TRM states, "B) If the manufacturer's cut sheet indicates that the fixture wattage is more than **15%** above or under the Wattage Table value, the cut sheet value may be used. Select the "User Input" sheet and fill out the "Description" and "Watts/Fixture" categories for cut sheets submitted. Wattage must be easily identifiable on the cut sheet. On the "Lighting Form" sheet, fixture codes "Cut Sheet #" can now be used." (emphasis added)

This conflicts with the following:

#5 under Section II: Table 4: "Defining a fixture wattage according to specification sheets. This table is required when (1) a fixture is not listed in the Wattage Table, or (2) the manufacturer's specified wattage differs from the Wattage Table value by more than **10%**." (emphasis added)

From TRM, Section 3.2.5: "Actual wattages of fixtures determined by manufacturer's equipment specification sheets or other independent sources may not be used unless (1) the wattage differs from the

Standard Wattage Table referenced wattage by more than **10%**[7] or (2) the corresponding fixture code is not listed in the Standard Wattage Table." (emphasis added)

Lighting Form Tab, User Input Tab Tables 1 and 2

CF values in lookup are fixed at cell J4, which pulls from cell D4 in User Input tab (CF in Table 1). PECO believes a separate column be added next to EFLH in Table 2 of the User Input tab to allow for user to enter CF values?

[7] This value was agreed upon by the Technical Working Group convened to discuss updates to the TRM. This value is subject to adjustment for the 2012 Update based on implementation feedback during PY2 and PY3.

Appendix D: Motor & VFD Audit and Design Tool

Comments for Motor and VFD Form Tab

The source for baseline motor efficiencies and premium motor efficiencies reported in the spreadsheet should be verified. Different values for baseline motors will apply for different program years. Different tabs or versions of this tool should be identified for the different program years. Refer to the comments for Tables 3-13 and 3-14 above.

Demand Coincidence Factor (CF) is reported to be 74% in the TRM. However, the worksheet does not use the same CF; the CF used in worksheet is 1. Therefore, the worksheet should be set up to use the correct CF. For duplex (backup or standby) motors, the CF will be 37% (0.37) as indicated in the TRM. Defaults for CF values in the RHRS tables would yield more accurate estimates. Similarly, values from EDC data collection in Table 3-12 should be allowed for more accurate estimates.

VFDs

Section 3.3 discussing Motors states: "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 & Variable Frequency Drive (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."

Section 3.4 discussing VFDs states: "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."

These paragraphs seem to suggest (and have been interpreted by the SWE to mean) that the completed Appendix D worksheet is required for *all* Motor and VFD projects regardless of size. The savings for VFDs average 637 kWh per horsepower. In view of the size issue stated above, and in view of the potential for small total savings for low-horsepower VFDs, we suggest that a sentence be added to each of the above paragraphs that states that the Appendix D form is not required for motor-only projects and is only required for VFD projects totaling more than 25 horsepower. (This would also be roughly equivalent to the 20 kW lower limit for lighting applications)

Motor and VFD Form Tab

The equations for ESF and DSF in columns O and P incorrectly reference the motor function of the first line item as a value lookup, instead of their respective line item motor functions. Ex: If the motor function of line item 1 is CWP and the motor function of line item 2 is HVACF, the ESF and DSF equations for line item 2 will use CWP as the lookup value instead of HVACF.

Load Factor Definition

Please refer to the discussion in Section 3.3.2.