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| PUC logo | COMMONWEALTH OF PENNSYLVANIAPENNSYLVANIA PUBLIC UTILITY COMMISSIONP.O. BOX 3265, HARRISBURG, PA 17105-3265 | **IN REPLY PLEASE REFER TO OUR FILE**M-2015-2469311 |

March 10, 2017

TO ALL INTERESTED PARTIES:

Re: Implementation of the Alternative Energy Portfolio Standards Act of 2004: Standards for the Participation of Demand Side Management Resources – Technical Reference Manual 2016 Update

 Docket No. M-2015-2469311

On July 8, 2015, the Pennsylvania Public Utility Commission (Commission) entered an Order adopting the 2016 Technical Reference Manual (TRM) update in the above-referenced matter. The TRM Annual Update Order and 2016 TRM update are posted on the Commission’s website at: <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx>.

With this Secretarial Letter, the Commission releases Errata to the 2016 Technical Reference Manual (TRM). The letter includes an attachment with a detailed, itemized account of errata changes (Attachment 1: Errata Details).

More than seventy separate errata were identified and addressed following the release of the 2016 TRM on July 8, 2015. Errata typically fit into one of the following broad categories, in general order of occurrence:

* + typographical errors
	+ inconsistencies (often due to prior, partial updates of common/repeated values)
	+ algorithm/equation errors (missing parentheses, redundant conversion factors)
	+ mathematical errors (incorrectly-calculated default savings values)
	+ Appendix C Lighting Audit & Design Tool for C&I Projects errors
	+ Appendix D Motor & VFD Audit & Design Tool errors

Other, less-common errata include broken links and outdated or missing sources.

Most errata are minor—for instance, typographical corrections and revisions to unit descriptors or variable names—and will have little or no impact on savings estimates or program administration.

More significant errata include:

* + Correction to default ENERGY STAR Clothes Washer annual savings values (Section 2.4.4)
	+ Correction of baseline heating system reference values for ENERGY STAR Manufactured Homes (2.6.5)
	+ Corrections to savings algorithms and terms used for Water Source and Geothermal Heat Pumps (3.2.3)
	+ Corrections to minimum efficiency standards for ENERGY STAR Room Air Conditioners in commercial buildings (3.2.7)
	+ Corrections to default cooling and heating baselines for Economizer Controls (3.2.9)
	+ Corrections to algorithms and default savings values for ENERGY STAR Electric Steam Cookers (3.7.4)

This Secretarial Letter, the corrected 2016 TRM and redlined versions of all affected pages, Appendix C - Lighting Audit & Design Tool for C&I Projects and Appendix D – Motor & VFD Audit and Design Tool are posted on the Commission’s website at the aforementioned link.

 Sincerely,

 Rosemary Chiavetta

 Secretary

Attachment

cc: Darren Gill, Deputy Director, TUS

 Joseph Sherrick, Supervisor, TUS

 Kriss Brown, Attorney, LAW

**Attachment 1: Errata Details**

All page numbers refer to the 2016 TRM pre-updates.

**TRM Section 1.17 – Impact of Weather. The errors are as follows:**

* Typo in the reference to Appendix F: Zip Code Mapping on page 14. The reference was to Appendix E. The reference has been corrected.

**TRM Section 2.1.1 – ENERGY STAR Lighting:**

* Typo in the denominator of the ENERGY STAR Lighting algorithm on page 18. The energy savings algorithm on this page has been corrected to reflect a 1000-Watts-per-kilowatt conversion factor.

**TRM Section 2.1.2 – Residential Occupancy Sensors:**

* Inconsistent hours of use (HOU) value in Table 2-7 on page 25. Baseline *RHold*(daily run hours before installation) values in Table 2-7 were updated for consistency with the Bulb & Fixture Hours of Use in Table 2.5 in Section 2.1.1 on page 22. The *RHold* value in Table 2.7 has been corrected to 2.5 hours, the corresponding source has been updated on page 26, and the associated *RHnew* value was updated to 1.75 accordingly.

**TRM Section 2.2.1 – Electric HVAC:**

* Mathematical error in the GSHP Desuperheater example applied via the algorithm on pages 37-38. The example savings outcome on page 38 has been updated from 534 to 511 to reflect an accurate kWh value for the example.
* Typo in variable names for hot/cold water temperature in Table 2-12. The Component names in Table 2-12 have been updated to Thot and Tcold for consistency with the rest of the TRM.

**TRM Section 2.2.3 – Ductless Mini-Split Heat Pumps**

* Clarification needed in Table 2-21 to reflect guidance on air source heat pump efficiency ratios. A footnote has been added to Table 2-21 to clarify that the existing EERbase value for ductless heat pumps applies to air source heat pumps (i.e., the EERbase value for ASHPs equals (12/14) x SEERbase).

**TRM Section 2.2.4 – ENERGY STAR Room Air Conditioners:**

* Typos in Table 2-26 on page 59: less-than-or-equal-to symbols are redundant given that these are minimum standards. The symbols were removed from Table 2-26.

**TRM Section 2.3.2 – Solar Water Heaters:**

* Errors in the Default Unit Energy Savings and Unit Peak Demand Reduction values in the summary table on page 93. Default savings values were inconsistent with the inputs provided in this section when applied via the algorithms on page 93. The energy savings and peak demand reduction values in the summary table have been updated to 1,462.5 kWh and 0.2419 kW, respectively.

**TRM Section 2.4.4 – ENERGY STAR Clothes Washers:**

* Inconsistency in the *Cycles* (per year) value in Table 2-80 on page 148. The value has been updated to ensure consistency with Table 2-87, which uses 260 cycles/year and is from the same source.
* Incorrect default energy and peak demand savings values in Table 2-83 on page 150. Correction of the *Cycles* term in Table 2-80 (see above) directly impacted the default savings values. Values in Table 2-83 have been updated accordingly.

**TRM Section 2.4.8 – ENERGY STAR Dehumidifiers:**

* Typo in the liters-to-pints conversion factor within the kWh algorithm on page 161. The conversion factor has been updated to the correct value of 0.473 liters/pint.

**TRM Section 2.6.5 – ENERGY STAR Manufactured Homes:**

* Incorrect baseline equipment and efficiency level for electric resistance heating systems in Table 2-114 on pages 201-202. Table 2-114 lists Air Source Heat Pump, Geothermal Heat Pump and PTAC / PTHP systems and corresponding federal minimum standards as the baseline equipment. However, the baseline system characteristics should be based on the current Manufactured Homes Construction and Safety Standards (HUD Code; source 8). The current HUD code, in place at the time of TRM publishing, considers electric baseboard heating equipment as meeting minimum standards. Table 2-114 has been updated to reflect the appropriate baseline equipment, specifically by removing Air Source Heat Pump, Geothermal Heat Pump, and PTAC/PTHP, while adding Electric Resistance along with the associated HSPF value.

**TRM Section 3.1.1 – Lighting Improvements:**

* Reference to original ballast factor on page 225 was inconsistent with the assumed fixture wattages in Table 3-2. The reference to the normal ballast factor has been deleted from page 225.
* Repeat/duplicate Source references to Table 3-5 in Table 3-3 on pages 227-228. The extra references to Table 3-5 have been deleted.

**TRM Section 3.1.2 – New Construction Lighting:**

* Typos in the algorithms on page 236. Two terms designated as kWh (energy) have been corrected to refer to kW (demand).
* Inconsistency in the building types listed in Table 3-14 on page 241. The Building Type “Miscellaneous” has been corrected to “Miscellaneous/Other” (note that an equivalent change was made to the App C calculator, as described in the App C section below).

**TRM Section 3.1.7 – LED Refrigeration Display Case Lighting:**

* Typo and inconsistency in the algorithms on page 257 and in Table 3-22 on page 258. The term for the interactive effects factor, previously *IE*, has been corrected to *IF*, and the values now mirror those for *IFenergy* in Section 3.1.1: (refrigerator 0.29, freezer 0.50).

**TRM Section 3.2.1 – HVAC Systems:**

* Transcription errors in Table 3-27 on page 267: Heat Pump EFLHs for Pennsylvania Cities. Several values are clearly off by an order of magnitude, suggesting a transcription error. Replacement EFLH assumptions have been approximated based on simple HDD scaling for three cities (6 values updated in total) based on HDD values for the cities that did not have issues.

**TRM Section 3.2.3 – Water Source & Geothermal Heat Pumps:**

* Redundant efficiency factors (for both pump motor & pump) in pump savings algorithms on pages 276-277. Pump efficiency factor terms have been removed from these algorithms and from Table 3-33 on page 278.
* Inconsistent application of GSER factor in heat pump energy savings algorithms on page 277. GSER factor has been added to algorithm for air-cooled base case units with capacities less than 65 kBtu/h, aligning the commercial and residential approaches, and the GSER term added to Table 3-33 on page 278 accordingly. The Sources section on page 282 has also been updated with the GSER source.
* Typo in Table 3-34 on page 281 for the Nominal Full-Load Efficiency of 1 HP 6-pole open motors. The efficiency value for 1 HP 6 pole open motors has been corrected to 82.5

**TRM Section 3.2.4 – Ductless Mini-Split Heat Pumps - Commercial > 5.4 Tons:**

* Typos in Table 3-37 on pages 285-286 for a factor definition and value. The definition of the Heating Seasonal Performance Factor (*HSPFb)* term has been corrected to refer to the baseline unit. The *HSPFb* value for electric resistance heat has been corrected to 3.412.

**TRM Section 3.2.5 – Fuel Switching: Small Commercial Electric Heat to Natural Gas/Propane/Oil Heat:**

* Inconsistent requirements for HVAC systems in Table 3-39 on page 289 and Table 3-40 on page 290. These requirements are inconsistent with ENERGY STAR requirements used throughout the rest of the TRM. Annual Fuel Utilization Efficiency Rating (AFUE) values for boilers in Table 3-40 have been updated to reflect the ENERGY STAR 3.0 requirements in effect at the time of TRM publication, and the boiler AFUE ENERGY STAR requirement in Table 3-39 has been replaced with a reference to Table 3-40. Footnote 304 was also added for clarification.

**TRM Section 3.2.7 – ENERGY STAR Room Air Conditioner:**

* Inconsistent minimum efficiency standards were present throughout this section, along with several typos in table column headings. Tables 3-45 (p. 300), 3-46 (p. 300), and 3-47 (p. 301) were inconsistent with the Residential Room A/C protocol in TRM Section 2.2.4, which was updated for the 2016 TRM. These tables have been corrected to reflect the ENERGY STAR Version 4.0 standards.

**TRM Section 3.2.9 – Controls: Economizer:**

* Inconsistent default HVAC efficiency values in Table 3-55 on page 308. This table has been extensively modified to mirror Table 3-24, titled HVAC Baseline Efficiencies, on pages 263-265 (tables 3-24 and 3-55 are now identical).

**TRM Section 3.3.1 – Premium Efficiency Motors:**

* Typo in Table 3-57 on page 313 for the Nominal Full-Load Efficiency of 1 HP 6-pole open motors. The efficiency value for 1 HP 6 pole open motors has been corrected to 82.5.

**TRM Section 3.3.3 – ECM Circulating Fan:**

* Incorrect peak seasonal correction factor in the default algorithm for the Energy Interactive Factor (*IFkWh*) in Table 3-66 on page 327: this was the reciprocal of the correct value. As stated in Source 6 on page 328, the correction factor should account for the lower peak cooling efficiency (EER=11.3) compared to seasonal cooling efficiency (SEER=13.0). The algorithm in Table 3-66 has been updated to reflect the appropriate (11.3/13) correction factor called for in source six.
* Incorrect source references in Table 3-66 on page 327. The Energy Interactive Factor (*IFkWh*) is based on Source 6 and the Demand Interactive Factor (*IFkW*) is based on Source 5. Table 3-66 has been updated to reference the correct sources.
* Inclusion of refrigeration fan motor sizes only in Table 3-67 on page 328 when the intended application of the measure is the HVAC circulating fan in commercial air handler units. Table 3-67 has been updated to include default wattage values for ½ HP, ¾ HP, and 1 HP fan motors. Footnote 342 was also added for further clarification.

**TRM Section 3.4.2 – Low-Flow Pre-Rinse Sprayers for Retrofit Programs:**

* Incorrect value for hot water temperature *Thfs*assumption in Table 3-74 on page 343. This value has been corrected to align with the source.
* Inconsistencies between summary table on page 340 and narrative on pages 343-344. Default energy and demand savings values have been corrected on both pages to make the grocery values consistent and show the corrected default annual energy and peak demand savings for sprayers in food service buildings, calculated using the revised *Thfs* assumption as noted above.

**TRM Section 3.4.3 – Low-Flow Pre-Rinse Sprayers for Time of Sale/Retail Programs:**

* Incorrect value for hot water temperature *Th* assumption in Table 3-75 on pages 347-348, which leads to incorrect default savings values in Table 3-76 on page 348. The *Th* value in Table 3-75 has been corrected, and the corresponding default energy and peak demand savings values have been updated in Table 3-76.
* Typo in the Energy factor term in table 2-75. The Energy Factor term in Table 2-75 has been corrected for consistency with the energy savings equation.

**TRM Section 3.5.1 – High-Efficiency Refrigeration/Freezer Cases:**

* Redundant coincidence factor in the algorithm on page 365 for peak demand savings. The Demand Coincidence Factor (*CF*) is unnecessary because the *kWhbase* and *kWhee* terms have operating characteristics built in. The *CF* term and its source have been removed from the algorithm and the rest of section 3.5.1, including Table 3-84 on page 366.
* Incorrect/incomplete table numbering throughout part of this section. Table 3-85 has been combined with the previously un-numbered table directly after it (both on page 366), to preserve subsequent table numbering, resulting in a single table containing both refrigeration and freezer values. Table 3-84 references 3-85, therefore has also been updated to reflect this change. Table 88 on page 367 has been renamed as Table 3-88 to include the chapter number.

**TRM Section 3.5.3 – High-Efficiency Evaporator Fan Motors for Walk-In Refrigerated Cases:**

* Outdated/erroneous statement about a default savings option in the Eligibility section on page 373. Two sentences related to default savings have been deleted from the eligibility section.

**TRM Section 3.5.4 – Controls: Evaporator Fan Controllers:**

* Typo in Table 3-97 on page 379. The HP-to-kW term name has been corrected.
* Typos in equations 1 and 2 on page 382. Two delta symbols were removed from the algorithms on this page.

**TRM Section 3.5.6 – Controls: Anti-Sweat Heater Controls:**

* Typo in the peak demand freezer algorithm on page 386. The algorithm has been corrected by removal of a “1” from the numerator above *COPfreeze.*

**TRM Section 3.7.4 – ENERGY STAR Electric Steam Cooker:**

* Inconsistencies in the algorithms for electric steam cookers. An annual conversion factor and other corrections were made to algorithms on page 439 to align with the calculation method in the ENERGY STAR protocol, and the *HOURSpre* term was subsequently removed from Table 3-139 on page 440 since it is not included in the ENERGY STAR protocol.
* Erroneous/inconsistent default savings values in Table 3-140 on page 441. These savings were miscalculated. Default energy and peak demand savings values in Table 3-140 have been updated to reflect corrections to the Electric Steam Cooker algorithms.

**TRM Section 4.1.1 – Automatic Milker Takeoffs:**

* Redundancy in algorithm on page 481 used to calculate annual energy savings from agricultural milker takeoff systems. The milkings per day *(MPD)* factor was removed from the algorithm on page 481 and from Table 4-1 on page 482.

**TRM Section 4.1.2 – Dairy Scroll Compressors:**

* Redundancy in algorithm to calculate energy savings. The operating hours *(HRS)* factor was removed from the algorithm on page 484 and from Table 4-2 on page 485.
* Typo in units for EER Terms in Table 4-2. Units have been updated to $\frac{Btu}{hr∙W}$ for two terms in table 4-2.

**TRM Section 4.1.7 – Variable Speed Drive (VSD) Controller on Dairy Vacuum Pumps:**

* Typo in algorithm to calculate energy savings for VSDs on page 500. A horsepower-to-kWh conversion factor (0.746) has been added to the energy savings algorithm and to Table 4-12 on page 502.
* Missing source for Demand Coincidence Factor (*CF*) in Table 4-12 on page 502. The source has been added to the Sources section at the end of Section 4.1.7 on page 503.

**TRM Section 6.1 – Appendix A: Measure Lives:**

* Discrepancy between two sources of measure lives for CFLs and LEDs. Measure lives in the table in section 6.1 of Appendix A (page 516) have been updated to mirror those in the ENERGY STAR Lighting summary table on Page 17.

**TRM Section 6.3 – Appendix C: Lighting Audit and Design Tool:**

* Missing/broken link to Appendix C Tool on page 523. The link has been updated to reference the PA PUC Technical Reference Manual page at <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx>

**TRM Section 6.4 – Appendix D: Motor & VFD Audit and Design Tool**

* Missing/broken link to Appendix D Tool on page 524. The link has been updated to reference the PA PUC Technical Reference Manual page at <http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx>

**TRM Appendix C: Lighting Audit & Design Tool for Commercial and Industrial Projects (Microsoft Excel workbook):**

* Incorrect calculation of custom coincidence factors (CF). On the General Information worksheet, Cells R28:AD28 (Lighting Operation Schedule section) have been corrected to enable accurate coincidence factor calculations for custom schedule designations. The prior formula used the reciprocal of the ratio of Unoccupied Peak Weeks (user input, cells R26:AD26) to total peak weeks (13), returning a negative coincidence factor for schedules where Unoccupied Peak Weeks were greater than 10, and returning inaccurate coincidence factors for any non-zero values in the Unoccupied Peak Weeks input. The formulas in cells R28:AD28 formerly took the form: “…AC48-(R26/13))” to reproduce …CFb - $\frac{\# summer unoccupied weeks}{13}$. These formulas have been corrected to: “…AC48-(1-(R26/13)))” equivalent to: …CFb \* (1-$\frac{\# summer unoccupied weeks}{13})$.
* Erroneous defaulting to general service hours of use (HOU) in instances where screw-in HOU is the specified baseline condition. For example, in the case of a custom LED fixture replacement of a halogen screw-in lamp, the LED fixture code builder function within the App C Tool automatically defaulted HOU and coincidence factor (CF) values to general service. In practice, users need to have the capability to build custom LED codes for both screw-in and general service lighting applications. Several related changes were made to remedy this issue, enabling the user to decide which baseline values are more appropriate when constructing the custom LED fixture:
	+ Data validation for array Fixture Identities F9:F28 (Description) has been changed to reference Lookups V9:V15 (formerly V9:V14), where a "Custom" option was added to the array along with a corresponding Fixture Code of "C." Accordingly, Range Name "LED\_Codes" has been extended by 1 row to include Lookups V15:X15, and this table renamed from “Non-Integral Ballast LED Fixture Codes” to “LED Code Builder” to reflect the inclusion of screw-in lamps.
	+ HOU Type was converted to a user-defined field by adding Data Validation criteria to array Fixture Identities M9:M28, enabling user to select General or Screw-In (mirroring the inputs for other custom fixtures near the bottom of the Fixture Identities worksheet).
	+ Data Validation criteria for array Fixture Identities K9:K28 was changed from Whole Number to Decimal to enable non-integer fixture wattages.
* Lookup error caused by an inconsistency in the *New Construction SVG Accountability* table on the Lookups worksheet. The existence of “Miscellaneous” as a control type is inconsistent with the term “Miscellaneous / Other,” which is used throughout the rest of the workbook. This causes an error in the *SVGbase* calculation (column X of the Lighting Inventory worksheet), which subsequently causes an error in the energy savings calculations. To remedy the error, cell P35 on the Lookups worksheet has been changed from “Miscellaneous” to “Miscellaneous / Other” (note that a related change has been made to Table 3-14, as described in the Section 3.1.2 – New Construction Lighting paragraph above).
* No capability to input user-defined SVG values for new construction buildings according to code. Capabilities have been added to App C tool that enable user-defined SVGbase values for New Construction facilities where the defaults do not reflect actual code requirements. Specifically, a new column (X) has been added to the LightingInventory workbook to enable user-defined Custom New Construction facility types and corresponding SVGbase assumptions. The Lookups worksheet has been modified accordingly by expanding the *New Construction SVG Accountability* table, enabling the App C tool user to name and define custom facility types, and adjusting data validation parameters on the Lighting Inventory worksheet. Corresponding changes have been made to Table 3-10 and Table 3-14 in the TRM.
* No capability to input user-defined SVG values for Custom control types, inconsistent with the option to use EDC Data Gathering in the TRM (Table 3-15). Capabilities have been added to the App C tool that enable user-defined SVGee values for Controls where EDC metering takes place. Specifically, the *SVG by Control Type* table on the Lookups worksheet was expanded to include inputs for custom control types and associated SVG values, and Data Validation parameters were adjusted on the Lighting Inventory worksheet (columns I and S), also enabling custom user-defined control schemes in the pre-retrofit period.

**TRM Appendix D: Motor & VFD Audit & Design Tool (Microsoft Excel workbook):**

* Incorrect date range on the Lookup Tables worksheet was preventing entry of projects with an installation date after 5/31/16 (the end of Phase II). Cells B71 and B72 of this worksheet have been updated with Phase III dates.