$$\Delta kWh = 0.13 \times 0.428 \times 1 \times 8{,}760 \times 1.25$$

$$\Delta kWh = 609.25$$

Default demand reduction for ASDH with controls:

$$\Delta kW = kW_{ASDH} \times DC \times n \times CF \times WHF$$

$$\Delta kW = 0.13 \times 0.428 \times 1 \times 0.21 \times 1.25$$

$$\Delta kWh = 0.03$$

Default energy savings for ASDH without controls:

$$\Delta kWh = kW_{ASDH} \times DC \times n \times HOU \times WHF$$

$$\Delta kWh = 0.13 \times 0.907 \times 1 \times 8{,}760 \times 1.25$$

$$\Delta kWh = 1{,}291$$

Default demand reduction for ASDH with controls:

$$\Delta kW = kW_{ASDH} \times DC \times n \times CF \times WHF$$

$$\Delta kW = 0.13 \times 0.907 \times 1 \times 1.0 \times 1.25$$

$$\Delta kWh = 0.15$$

When the application does not have any information about the baseline ASDH control, select the energy savings and demand reduction for situation of ASDH with controls.

Source

The primary sources for this deemed savings approach is the Mid-Atlantic TRM 2017 p. 407 – p. 409. The method was adapted from the ASDH controls methodology.

16.4.8 Refrigeration Night Covers

Measure Description

This measure realizes energy savings by installing a cover to minimize the energy losses associated with top open-case refrigeration units. Walk-in units are not included in this measure. The cover is used during hours which the business is closed. The baseline equipment is a refrigerated case without a night cover.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Small Business Improvement program, described in Section 15, and the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{load}{12{,}000\ Btu/hour/ton} \times \frac{3.516\ kW/ton}{COP} \times L \times ESF \times HOU$$

Gross coincident demand reductions are assigned as follows:

$$\Delta kW^{297} = 0$$

Where:

ΔkWh/year = gross annual electric energy savings
load = average refrigeration load in Btu/hr per linear foot of refrigerated case without night covers deployed, Btu/ft/hr
L = linear feet of covered refrigerated case, ft
COP = coefficient of performance of refrigerated case, dimensionless
ESF = energy savings factor; reflects the percentage reduction in refrigeration load due to the deployment of night covers, dimensionless
HOU = annual hours of use, hr/year

[297] Mid-Atlantic TRM 2017, p. 405.. Assumed that continuous covers are deployed at night; therefore, no demand savings occur during the peak period.

Input Variables

Table 120: Input Values for Refrigeration Night Cover Savings Calculations

Component	Type	Value	Unit	Source(s)
load	Fixed	See customer application.	Btu/hour/ feet	Customer application
		Default = 1,500		Mid-Atlantic 2017, p. 404[298]
L	Variable	See customer application.	feet	Customer application
		Default = 6		DNV GL Judgment
COP[299]	Fixed	2.2	-	Mid-Atlantic TRM 2017, p. 405
ESF[300]	Fixed	0.09	-	Mid-Atlantic TRM 2017, p. 405
HOU	Variable	Default = 8,760	Hours/year	Mid-Atlantic TRM 2017, p. 405

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\Delta kWh/year = \frac{load}{12{,}000\ Btu/hour/ton} \times L \times 3.156\ kW/ton \times COP \times ESF \times HOU$$

$$= \frac{1{,}500\ Btu/hour/feet}{12{,}000\ Btu/hour/ton} \times \frac{3.516\ kW/ton}{2.2} \times 6\ feet \times 0.09 \times 8{,}760\ hours/year$$

$$= 9{,}45\ kWh/year$$

The default gross coincident demand reductions will be assigned as follows:

$$\Delta kW = 0$$

Source(s)

The primary source for this deemed savings approach is the Mid-Atlantic TRM 2017, p. 404 - 406.

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298 Mid-Atlantic 2017, p. 404. Original source: Davis Energy Group, Analysis of Standard Options for Open Case Refrigerators and Freezers, May 11, 2004. (accessed on 7/7/2010.). http://www.energy.ca.gov/appliances/2003rulemaking/documents/case_studies/CASE_Open_Case_Refrig.pdf.

299 Kuiken et al, Focus on Energy Evaluation, Business Programs: Deemed Savings Manual V1.0, KEMA, March 22, 2010.

300 Mid-Atlantic TRM 2017, p. 405. Original source: Effects of the Low Emissivity Shields on Performance and Power Use of a Refrigerated Display Case, Southern California Edison, August 8, 1997. (accessed on July 7, 2010). http://www.sce.com/NR/rdonlyres/2AAEFF0B-4CE5-49A5-8E2C-3CE23B81F266/0/AluminumShield_Report.pdf. Characterization assumes covers are deployed for six hours per day.

16.4.9 Refrigeration Coil Cleaning

Measure Description

This measure realizes energy savings by cleaning the condenser coils on reach-in and walk-in refrigerators and freezers. Eligible units will have 25% fouling or greater based on visual inspection. This measure may only receive energy savings and demand reduction when combined with the floating head pressure measure.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = load \times \frac{3.516\ kW/ton}{COP} \times HOU \times SF_e$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = load \times 3.156\ kW/ton \times COP \times SF_d$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
load = total capacity of condensers
COP = coefficient of performance of refrigeration unit
HOU = annual hours of use
SF_e = savings factor attributable to coil cleaning for electric energy savings
SF_d = savings factor attributable to coil cleaning for peak demand reductions

Input Variables

Table 121: Input Values for Refrigeration Coil Cleaning Savings Calculations

Component	Type	Value	Unit	Source(s)
load	Variable	See customer application.	tons	Customer application
COP	Fixed	Low Temp (-35°F - -1°F): 1.3 Med Temp (0°F - 30°F): 1.3 High Temp (31°F - 55°F): 2.5	-	Pennsylvania TRM 2016.1, p. 391

Component	Type	Value	Unit	Source(s)
HOU	Fixed	Low Temp (-35°F - -1°F): 6,370 Med Temp (0°F - 30°F): 6,370 High Temp (31°F - 55°F): 6,1735	hours/ year	Calculated duty cycle using weather factor, defrost factor, and capacity factor[301]
SF_e[302]	Fixed	0.048	-	Qureshi and Zubair (2011)
SF_d[303]	Fixed	0.022	-	Qureshi and Zubair (2011)

Default Savings

If the proper values are not supplied, no default savings will be awarded for this measure.

Source(s)

The primary sources for this deemed savings approach are the Pennsylvania TRM 2016 and "Performance degradation of a vapor compression refrigeration system under fouled conditions" by Qureshi and Zubair (2011), published in the *International Journal of Refrigeration*.

301 The duty cycle is calculated using the same method as TVA 2016 TRM for refrigeration measures. For coolers, a defrost factor of 0.995, capacity factor of 0.87 and weather factor of 0.84 is assumed. For freezers, a defrost factor of 0.90, capacity factor of 0.87 and weather factor of 0.90 is assumed.

302 Qureshi B.A. and Zubair S.M., "Performance degradation of a vapor compression refrigeration system under fouled conditioned." International Journal of Refrigeration 24 (2011), p. 1016 – 1027. Figure 2-(a). Assumes a weighting of refrigerant types of 80% R-134 and 20% R-404.

303 Ibid.

16.4.10 Suction Pipe Insulation (Cooler and Freezer)

Measure Description

This measure realizes energy savings by installing insulation on existing bare suction lines (lines that run from evaporator to compressor) that are located outside of the refrigerated space.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{\Delta kWh}{ft} \times L$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{\Delta kW}{ft} \times L$$

Where:

ΔkWh/year = gross annual electric energy savings, kWh/year
ΔkW = gross coincident demand reductions, kW
ΔkWh/ft = gross annual electric energy savings per linear foot, kWh/ft
ΔkW/ft = gross coincident demand reductions per linear foot, kW/ft
L = length of insulation applied in linear feet, ft

Input Variables

Table 122: Input Values for Suction Pipe Insulation Savings Calculations

Component	Type	Value	Unit	Source(s)
ΔkWh/ft	Variable	See Table 71.	kWh/feet	Pennsylvania TRM 2016, p. 418
ΔkW/ft	Variable	See Table 71.	kW/feet	Pennsylvania TRM 2016, p. 418
L	Variable	See customer application	feet	Customer application
		Default = 1.		Per unit savings

Table 123: Suction Pipe Insulation Gross Annual Electric Energy and Gross Coincident Demand Reductions (per Linear Foot)[304]

Refrigeration Type	ΔkWh/year·ft	ΔkW/ft
Low Temperature (-35°F - -1°F)	14.8	0.002726
Medium Temperature (0°F - 30°F)	14.8	0.00219
High Temperature (31°F - 55°F)	11.3	0.00219

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be assigned according to the following calculation:

$$\Delta kWh/year = \frac{\Delta kWh/year}{ft} \times L$$

$$= 11.3\, kWh/ft \times 1\, ft$$

$$= 11.3\, kWh/year$$

The default gross coincident demand reductions will be assigned according to the following calculation:

$$\Delta kW = \frac{\Delta kW}{ft} \times L$$

$$= 0.00219\, kW/ft \times 1 ft$$

$$= 0.00219\, kW$$

304 Pennsylvania TRM 2016, p. 418, original source: Southern California Edison Company, "Insulation of Bare Refrigeration Suction Lines", Work Paper WPSCNRRN0003.

Source(s)

The primary source for this deemed savings approach is the Pennsylvania TRM 2016, p. 417 – 418.

16.4.11 Strip Curtain (Cooler and Freezer)

Measure Description

The measure realizes energy savings by installing strip curtains on walk-in coolers and freezers. Strip curtains reduce the refrigeration load by minimizing infiltration of non-refrigerated air into the refrigerated space of walk-in coolers or freezers. Strip curtains are assumed to be operational only during building operating hours. When buildings are not operational, coolers and freezers doors will be closed.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Small Business Improvement program, described in Section 15, and the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \Delta kWh/ft^2 \times A$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{\Delta kWh}{HOU}$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
ΔkWh/ft^2 = average annual kilowatt hour savings per square foot of infiltration barrier
A = doorway area, ft^2
HOU = annual hours of use, hr/year

Input Variables

Table 124: Input Values for Strip Curtain Savings Calculations

Component	Type	Value	Unit	Source(s)
ΔkWh/ft²	Variable	See Table 69.	kWh/sqft	Pennsylvania TRM 2016, p. 400 (Table 3-107)
A	Variable	Small Business Improvement: See customer application	sqft	Customer application
		Default for Non-Residential Energy Audit, Small Business Improvement, and Non-Residential Prescriptive: Supermarkets: 35 Convenience Store: 21 Restaurant: 21 Refrigerated Warehouse: 80		Pennsylvania TRM 2016, p. 401, Table 3-108 (Supermarkets), Table 3-109 (Convenience Stores), Table 3-110 (Restaurant), Table 3-111 (Refrigerated Warehouse)
HOU	Fixed	8,760	hour/year	Pennsylvania TRM 2016, p. 394 (Table 3-107)

Table 125: Strip Curtain Gross Annual Electric Energy Savings (per Square Foot)[305]

Type	Pre-Existing Curtain	Gross Annual Electric Energy Savings per Square Foot (ΔkWh/ year·ft^2)
Supermarket - Cooler	Yes	37
Supermarket - Cooler	No	108
Supermarket - Cooler	Unknown	108
Supermarket - Freezer	Yes	119
Supermarket - Freezer	No	349
Supermarket - Freezer	Unknown	349
Convenience Store - Cooler	Yes	5
Convenience Store - Cooler	No	20
Convenience Store - Cooler	Unknown	11
Convenience Store - Freezer	Yes	8
Convenience Store - Freezer	No	27
Convenience Store - Freezer	Unknown	17
Restaurant - Cooler	Yes	8
Restaurant - Cooler	No	30
Restaurant - Cooler	Unknown	18
Restaurant - Freezer	Yes	34
Restaurant - Freezer	No	119
Restaurant - Freezer	Unknown	81
Refrigerated Warehouse	Yes	254
Refrigerated Warehouse	No	729
Refrigerated Warehouse	Unknown	287
Other[306]	Yes	5
Other	No	20
Other	Unknown	11
Not applicable	Yes	0
Not applicable	No	0
Not applicable	Unknown	0

[305] Pennsylvania TRM 2016, p. 400. "The assumption is based on general observation that refrigeration is constant for food storage, even outside of normal conditions. The most conservative approach, in lieu of a more sophisticated model, is based on continuous operation [8,760 hours/year of operation]."

[306] Assigned most conservative savings and reductions values for a known building subcategory.

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values. However, per Table 69 above, the gross annual electric energy savings per ft^2 varies widely based on the space type, therefore the default savings must be calculated for individual space types obtained from the application.

The default gross annual electric energy savings for the Convenience Store - Cooler will be assigned according to the following calculation:

$$\Delta kWh/year = \frac{\Delta kWh/year}{ft^2} \times A$$

$$= 5\ kWh/ft^2/year \times 21\ ft^2$$

$$= 105\ kWh/year$$

The default gross coincident demand reductions will be assigned according to the following calculation:

$$\Delta kW = \frac{\Delta kWh/year}{HOU}$$

$$= \frac{105\ kWh/year}{8{,}760\ hour/year}$$

$$= 0.012\ kW$$

Source(s)

The primary source for this deemed savings approach is the Pennsylvania TRM 2016, p. 397 - 405.

16.4.12 Vending Machine Miser

Measure Description

This measure realizes energy savings by installing vending misers that control the vending machine lighting and refrigeration systems power consumption of distributed closed-door cases. Miser controls power down these systems during periods of inactivity while ensuring that the product stays cold. Qualifying machines include glass front refrigerated coolers, non-refrigerated snack vending machines, and refrigerated beverage vending machines, but this measure does not apply to ENERGY STAR® vending machines that have built-in internal controls or distributed open door cases.

This measure is offered in the Non-Residential Energy Audit program as well as the Non-Residential Prescription program, described in Section 16.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = kW_{rated} \times HOU \times ESF$$

Gross coincident demand reductions are calculated according to the following equation:

$$\Delta kW = \frac{\Delta kWh}{8{,}760}$$

Where:

ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident demand reductions
kW_{rated} = rated kilowatts of connected equipment
HOU = annual operating hours, hr/year

ESF = energy savings factor

Input Variables

Table 126: Input Values for Vending Miser Savings Calculations

Component	Type	Value	Unit	Source(s)
kW_{rated}	Variable	See customer application.	kW	Customer application
		Default: Non-Refrigerated Snack Vending Machine (see Table 73)		Massachusetts TRM 2014, p. 266; Default: Assigned most conservative value
ESF	Variable	See Table 73.	-	Massachusetts TRM 2014, p. 266
HOU	Fixed	8,760	hours/year	Massachusetts TRM 2014, p 267

Table 127: Vending Miser Rated Kilowatts and ESFs[307]

Equipment Type	kW_{rated} (kW)	ESF
Refrigerated Beverage Vending Machine	0.40	0.46
Non-Refrigerated Snack Vending Machine	0.085	0.46
Glass Front Refrigerated Cooler	0.46	0.30

Default Savings

If the proper values are not supplied, a default savings may be applied using conservative input values.

The default gross annual electric energy savings will be applied according to the following calculation:

$$\Delta kWh/year = kW_{rated} \times HOU \times ESF$$

$$= 0.085\ kw \times 8{,}760\ hours/year \times 0.46$$

$$= 343\ kWh/year$$

The default gross coincident demand reductions will be applied according to the following calculation:

$$\Delta kW = \frac{\Delta kWh/year}{HOU}$$

$$= \frac{343\ kWh/year}{8{,}760\ hours/year}$$

$$= 0.039\ kW$$

[307] Massachusetts TRM 2014 – Report Version. Original source is USA Technologies Energy Management Product Sheets (2006).
https://www.usatech.com/energy_management/energy_productsheets.php (accessed on April 18, 2012.).

Source(s)

The primary source for this deemed savings approach is the Massachusetts TRM 2014, p. 266 – 268.

17 RESIDENTIAL RETAIL LED LIGHTING PROGRAM

Measure Description

The Residential Retail LED Lighting Program is an instant discount for a variety of qualifying Light-Emitting Diode (LED) light bulb purchases from participating retailers. Participating vendors will pay manufacturers of eligible bulbs an incentive, which will enable the manufacturer to sell the eligible bulbs at a discount to area retailers, who then would sell the bulbs to consumers at the agreed discounted price. The incentive participants will receive is in the form of a discount on the price of the bulbs at the point of sale. Dominion estimates it will pay an average[308] incentive of $3.00 per LED bulb. Customers are limited to 12 discounted bulbs per purchase.

This program would operate the Program on a North Carolina-only basis. The benefits and the costs of the Program would flow 100% to North Carolina. The company is offering the Program for a two-year period, with the intent that a system-wide program which includes a residential lighting component is planned to be offered in the future.

Savings Estimation Approach

Gross annual electric energy savings are calculated according to the following equation:

$$\Delta kWh/year = \frac{Total\ units\ \times (Watts_{base} - Watts_{ee})}{1{,}000\, W/kW} \times ISR \times HOU \times (WHF_{eHeat} + (WHF_{eCool} - 1))$$

Gross summer coincident peak demand savings are calculated according to the following equation:

$$\Delta kW = \frac{Total\ units \times (Watts_{base} - Watts_{ee})}{1{,}000\, W/kW} \times ISR \times WHF_d \times CF$$

Where:

Total Units = Total quanity of lighting units sold/to be replaced
ΔkWh/year = gross annual electric energy savings
ΔkW = gross coincident peak demand savings
$watts_{base}$ = assumed wattage of incandescent bulb being replaced based on lumens of LED
$watts_{ee}$ = wattage of new efficient LED bulb
ISR = in service rate
HOU = hours of use per year
WHF_{eHeat} = waste heat factor to account for electric heating increase due to reduced waste heat from efficient lighting
WHF_{eCool} = waste heat factor to account for electric cooling savings due to reduced waste heat from efficient lighting
WHF_d = waste heat factor for summer coincident peak demand savings to account for cooling savings from efficient lighting
CF = peak coincidence factor

[308] Through a data request, this was determined to be a weighted average across all bulb types and incentive amounts.

Input Variables

Table 128: Input Parameters for LED Lighting Savings

Component	Type	Value	Units	Sources
Total Units	Variable	Total quantity of lighting bulbs	No. of bulbs	Customer application
ISR	Variable	All LED (non-recessed downlight luminaire) = 0.98; Recessed Downlight Luminaire =1	-	Mid-Atlantic TRM 2017, p. 30, p. 21
$watts_{base}$	Variable	See Table 129: Baseline Wattage Determination	watts	Mid-Atlantic TRM 2017, p. 29-30
$watts_{ee}$	Variable	See customer application.	watts	Customer application
HOU	Fixed	1,059	Hours/year	Opinion Dynamics 2016, p. 23
WHF_{eHeat}	Fixed	0.899	-	Mid-Atlantic TRM 2017, p. 32
WHF_{eCool}	Fixed	1.077	-	Mid-Atlantic TRM 2017, p. 31
WHF_{d}	Fixed	1.17	-	Mid-Atlantic TRM 2017, p. 33
CF	Fixed	0.084	-	Mid-Atlantic TRM 2017, p. 34

For time of sale, the baseline wattage is assumed to be an incandescent or EISA compliant (where applicable) bulb installed in a screw-base socket. Note that the baseline will be EISA compliant bulbs for all categories to which EISA applies.

Table 129: Baseline Wattage Determination

Bulb Type	Lower Lumen Range	Upper Lumen Range	$watts_{base}$
Standard A-Type	250	449	25
	450	799	29
	800	1099	43
	1100	1599	53
	1600	1999	72
	2000	2599	72
	2600	3000	150
	3001	3999	200
	4000	6000	300
3-Way (Highest Setting), bug, marine, rough service, infrared	250	449	25
	450	799	40

Bulb Type	Lower Lumen Range	Upper Lumen Range	$watts_{base}$
	800	1099	60
	1100	1599	75
	1600	1999	100
	2000	2549	125
	2550	2999	150
Globe (medium and intermediate bases less than 750 lumens)	90	179	10
	180	249	15
	250	349	25
	350	749	40
Decorative (Shapes B, BA, C, CA, DC, F, G, medium and intermediate bases less than 750 lumens)	70	89	10
	90	149	15
	150	299	25
	300	749	40
Globe (candelabra bases less than 1050 lumens)	90	179	10
	180	249	15
	250	349	25
	350	499	40
	500	1049	60
Decorative (Shapes B, BA, C, CA, DC, F, G, candelabra bases less than 1050 lumens)	70	89	10
	90	149	15
	150	299	25
	300	499	40
	500	1049	60
Reflector with medium screw bases w/ diameter <=2.25"	400	449	40
	450	499	45
	500	649	50
	650	1199	65
R, PAR, ER, BR, BPAR or similar bulb shapes with medium screw bases w/ diameter >2.5" (*see exceptions below)	640	739	40
	740	849	45
	850	1179	50
	1180	1419	65
	1420	1789	75
	1790	2049	90
	2050	2579	100

Bulb Type	Lower Lumen Range	Upper Lumen Range	$watts_{base}$
	2580	3429	120
	3430	4270	150
R, PAR, ER, BR, BPAR or similar bulb shapes with medium screw bases w/ diameter > 2.26'' and ≤ 2.5" (*see exceptions below)	540	629	40
	630	719	45
	720	999	50
	1000	1199	65
	1200	1519	75
	1520	1729	90
	1730	2189	100
	2190	2899	120
	2900	3850	150
*ER30, BR30, BR40, or ER40	400	449	40
	450	499	45
	500	649-1179	50
*BR30, BR40, or ER40	650	1419	65
*R20	400	449	40
	450	719	45
*All reflector lamps below lumen ranges specified above	200	299	20
	300	399-639	30
Recessed Downlight Luminaire	400	449	40
	450	449	45
	500	649	50
	650	1419	65

Appendix F contains a list of Dominion-approved residential LED's for North Carolina as of December 2017. The column "STEP Bulb Type" categorizes each bulb according the types defined in Table 96. DNV GL assigned these categories based on online model number lookups.

Source

The primary sources for this deemed savings approach include the Mid-Atlantic TRM 2017, p. 21-30.

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19 APPENDIX A: REFERENCE HEATING AND COOLING DEGREE DAYS

Table 130 provides the reference cooling degree days (CDD-65 °F) and heating degree days (HDD-65 °F) using TMY3 data found in the National Solar Radiation Data Base, 1991 – 2005 Update: Typical Meteorological Year 3 produced by the Renewable Resource Data Center (RRDC) of the National Renewable Energy Laboratory (NREL) for weather stations at Baltimore BLT-Washington International AP (Weather station number 724060), Richmond International AP (Weather station number 724010), and Charlotte Douglas International Airport. (Weather station number 723140).

Weather station identification codes can be found at https://www.google.com/fusiontables/DataSource?docid=1EsB07O-9SiqyJDlzl69GO8jTHsomsNIpkA1SLL8#rows:id=1.

TMY3 data can be found at http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3.

TMY3 data spans a base time period between 1976 to 2005 wherever they are available (out of 1020 locations) and from 1991 to 2005 for the remaining locations. The TMY data set provides a reasonably sized annual data set that holds hourly meteorological values that typify conditions at a specific location over a longer period of time. It represents a typical climatic condition for a location and does not provide extremes. For the purposes of this document, DNV GL determined that it is more appropriate to use weather data that represents typical climatic conditions. Also, DNV GL uses actual temperatures from USAF stations in modeling consumption in post-installation evaluations. The corresponding temperatures from TMY3 are then used to predict a weather-adjusted or normalized consumption. The goal is that models and predictions based on temperature data are using data from the same stations.

The TMY3 hourly data are available for 1,020 USAF stations. For each station, DNV GL calculates the average hourly temperature for each day. The CDD and HDD are calculated using a range of cooling and heating base temperature. If the average daily temperature is greater than the cooling base temperature, CDD is the deviation in degrees Fahrenheit from the average daily temperature with respect to a cooling base temperature and zero otherwise. If the average daily temperature is less than the heating base temperature, HDD is the deviation in degrees Fahrenheit from the average daily temperature with respect to a heating base temperature and zero otherwise. Daily CDD and HDD are summed up for each station to come up with an annual estimate of CDD and HDD shown in this section, based on a typical meteorological year.

Table 130: Reference Cooling Degree Days and Heating Degree Days.

Weather Station Number	Location	Cooling Degree Days (CDD – 65 °F) [309]	Cooling Degree Hours (CDH - 65 °F)[310]	Heating Degree Days (HDD – 65 °F)[311]
724010	Richmond International Airport	1,448	7,786	3,849
723140	Charlotte Douglas International Airport	1,598	8,040	3,140
724060	Baltimore -Washington International Airport	1,233	5,684	4,600

[309] National Solar Radiation Data Base. 1991-2005 Update: Typical Meteorological Year 3. Accessed June, 2017. http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3

[310] For consistency across all measures, DNV GL calculated cooling degree hours at the base 65 °F temperature to be used in the attic insulation measure.

[311] Ibid.

20 APPENDIX B: FULL LOAD HOURS AND EQUIPMENT EFFICIENCIES FOR RESIDENTIAL HVAC EQUIPMENT

The following tables (Table 131 and Table 132) provide the full load heating and cooling hours and baseline HVAC equipment efficiencies that are used as defaults when customer specific data is not available or appropriate for multiple residential programs (Residential Home Energy Check-Up, Residential Duct Sealing, Residential Heat Pump Tune-Up, Residential Heat Pump Upgrade and Residential Income and Age Qualifying Home Improvement).

The Richmond, VA and Charlotte, NC full load cooling and heating hours (Table 131) in this document are adjusted using ratios of the annual full load cooling and heating hours listed in the ENERGY STAR® heat pump and central AC savings calculators to the Mid-Atlantic TRM 2017 for Baltimore, MD.

The Mid-Atlantic TRM 2017 hours are based on an evaluation of the EmPOWER Maryland program of utilities in the state of Maryland. According to the Mid-Atlantic TRM 2017, the values are "based on average 5 utilities in Maryland from Navigant Consulting 'EmPOWER Maryland Draft Final Evaluation Report Evaluation Year 4 (June 1, 2012 - May 31, 2013) Residential HVAC Program." April 4, 2014, table 30, page 48. Since that evaluation only produced full load hours for Baltimore, DNV GL calculated full load hours for Richmond and Charlotte using the same adjustment method the Mid-Atlantic TRM 2017 used to convert the Baltimore full load hours to Wilmington, DE and Washington, DC hours (see footnote 126 in the Mid-Atlantic TRM 2017). It appears that the Mid-Atlantic TRM 2017 considers the ENERGY STAR® air source heat pump and central AC calculator full load hours to be different from "full load cooling" and "full load heating hours" that it imputed using the methods described in its footnote and also used here. DNV GL is using the methods and values from the Mid-Atlantic TRM 2017 for full load cooling and heating hours in this document.

The conversion method is to calculate the ratio of Baltimore full load cooling and heating hours in the Mid-Atlantic TRM to Baltimore full load cooling and heating hours in the ENERGY STAR® heat pump and central AC calculators. Then, multiply that ratio against the ENERGY STAR® calculator hours for Richmond and Charlotte to get the respective full load hours for each city. Below is an example of the calculation for Richmond full load cooling hours:

Mid-Atlantic TRM 2017 Baltimore FLHcool = 744 hours/year

ENERGY STAR® Baltimore FLHcool = 1,050 hours/year

ENERGY STAR® Richmond FLHcool = 1,188 hours/year

STEP Richmond FLHcool = $ENERGY\ STAR^{®}\ Richmond\ FLH_{cool} \times \frac{Mid\text{–}Atlantic\ TRM\ 2017\ Baltimore\ FLHcool}{ENERGY\ STAR^{®}\ Baltimore\ FLHcool}$

$=1{,}188\ hours/year \times \frac{774\ hours/year}{1050\ hours/year}$

= 842 hours/year

Table 131: Full Load Heating and Cooling Hours for the Mid-Atlantic Region.

System Type	Location	ENERGY STAR® Annual Full Load Cooling Hours[312]	ENERGY STAR® Annual Full Load Heating Hours[313]	FLH_{cool}	FLH_{heat}
Heat Pump	Baltimore, MD – Reference city from Mid-Atlantic TRM	1,050	2,172	744[314]	866[315]
	Richmond, VA	1,188	1,980	842	789
	Charlotte, NC	1,325	1,865	939	744
Central AC	Baltimore, MD – Reference city from Mid-Atlantic TRM	1,050	-	542[316]	-
	Richmond, VA	1,188	-	613	-
	Charlotte, NC	1,325	-	684	-
Window Unit or Room AC	Baltimore, MD – Reference city from Mid-Atlantic TRM	-	-	326[317]	-
	Richmond, VA	-	-	368[318]	-
	Charlotte, NC	-	-	411[319]	-

The baseline HVAC equipment efficiencies (Table 132) are from the 2012 International Energy Conservation Code.

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312 ENERGY STAR®. Heat Pumps savings calculator, annual full load cooling hours for Baltimore, Richmond and Charlottehttps://www.energystar.gov/sites/default/uploads/buildings/old/files/ASHP_Sav_Calc.xls; and ENERGY STAR® Central Air Conditioner savings calculator, annual full load cooling hours for Baltimore, Richmond and Charlotte http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls. Accessed July 14, 2016.

313 Ibid, annual full load heating hours for Baltimore, Richmond and Charlotte.

314 Mid-Atlantic TRM 2017, p. 72. Based on average of 5 utilities in Maryland from Navigant Consulting "EmPOWER Maryland Draft Final Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Residential HVAC Program." April 4, 2014, table 30, page 48.

315 Ibid.

316 Mid-Atlantic TRM 2017, p. 66. Based on average of 5 utilities in Maryland from Navigant Consulting "EmPOWER Maryland Draft Final Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Residential HVAC Program." April 4, 2014, table 30, page 48.

317 Mid-Atlantic TRM 2017, p. 61. "VEIC calculated the average ratio of FLH for Room AC (provided in RLW Report: Final Report Coincidence Factor Study Residential Room Air Conditioners, June 23, 2008) to FLH for Central Cooling (provided by AHRI: http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls) at 31%. Applying this to the FLH for Central Cooling provided for Baltimore (1050) we get 325 FLH for Room AC." DNV GL replicated the equation and calculated 325.5 FLH and rounded to 326 FLH.

318 Used the same approach as Mid-Atlantic TRM 2017, and multiplied Richmond full load cooling hours (1,188) by 31% and calculated 368 FLH_{cool}.

319 Ibid.

Table 132: Baseline Cooling and Heating System Efficiencies for Air Conditioning Systems, Air Source Heat Pumps and Resistance Heat[320]

System Type	SEER (Btu/Wh)	EER[321] (Btu/Wh)	HSPF (Btu/Wh)	COP
Air Conditioning System	14[322]	11.8	-	-
Air Source Heat Pump	14[323]	11.8	8.2[324]	2.40
Resistance Heat	-	-	3.4[325]	1.00

[320] Mid-Atlantic TRM 2017, p. 70. Baseline system efficiencies are based on the applicable minimum federal standards, consistent with 2015 IECC Table C403.2.3(2) – Minimum Efficiency Requirements: Electrically Operated Unitary and Applied Heat Pump. Further, the table provides minimum efficiency values for units less than 65,000 Btu/h. While one would expect the average system efficiency to be higher than this minimum, the likely degradation of efficiencies over time mean that using the minimum standard is appropriate.

[321] Estimate calculated according to $EER = -0.02 \times SEER^2 + 1.12 \times SEER$. Equation found in National Renewable Energy Laboratory document, "Building American House Simulation Protocols," p. 7.

[322] Mid-Atlantic TRM 2017, p. 66. Baseline system efficiencies are based on the applicable minimum federal standards.

[323] Mid-Atlantic TRM 2017, p. 70. Baseline system efficiencies are based on the applicable minimum federal standards. Air-source heat pump federal standard was adjusted as of 1/1/2015.

[324] Ibid.

[325] New York TRM 2016, p. 121. Calculated according to the following equation: COP = HSPF/3.412.

21 APPENDIX C: ANNUAL EQUIVALENT HOURS, COINCIDENCE FACTORS AND WASTE HEAT FACTORS BY NON-RESIDENTIAL FACILITY TYPE AND LIGHTING TYPE

For the purposes of this STEP Manual, Table 135 provide the annual lighting (interior CFL and non-CFL) hours of use, summer seasonal peak coincidence factors, and waste heat factors by building types for interior lighting fixtures that are designated for the Dominion territory. All of these are gathered from the Mid-Atlantic TRM, which pulls from a combinations of the Connecticut Program Savings Document (PSD) and the EmPOWER Maryland 2014 Evaluation Report.

Table 133 give the same variables for exterior lights and LED exit signs.

Since the building types in the Mid-Atlantic TRM do not map directly to those used in this STEP Manual, a separate mapping was conducted to arrive at the values. Under each STEP Manual building type in Table 134 and Table 135, are listings of the Mid-Atlantic TRM and Connecticut PSD building types that were mapped to this document.

For all non-residential lighting measures, DNV GL assigns these variables based on the measure characteristics in this descending order:

1. measure location (interior or exterior)
2. fixture name, and
3. building type

For example, when calculating savings for a specific non-residential lighting type (fixtures), variables (hours of use, coincidence factor, waste heat factors) are assigned based on if the fixture indicates it is for "exterior" use. All fixtures that contain the word "exterior" in the fixture name should assign parameters based on the lighting type in

Table 133. All fixtures that contain the phrase "24/7" in the fixture name should assign variables for "LED Exit Sign" in

Table 133. All fixtures that do not specify "exterior" in the fixture name are assumed to be for interior use and should assign variables based on the building type as shown in Table 135.

Summary of terms used in

Table 133 through Table 136:

- CF_{PJM} – PJM summer peak coincidence factor is from June to August, weekdays between 2pm and 6pm EST.
- CF_{SSP} – Summer system peak coincidence factor refers to the hour ending 5pm EST on the hottest summer weekday.
- Interior CFL lighting refers to general purpose CFL screw base bulbs
- Interior Non-CFL lighting type includes:
    - T5 Lighting
    - Pulse-Start Metal Halide fixture – interior
    - Solid State Lighting (LED) Recessed Downlight Luminaire

- Delamping
- Occupancy Sensor - wall box

Table 133: Non-residential Exterior Lighting Parameters By Lighting Type (for all programs except the Non-residential Energy Audit Program)

Lighting Type	Exterior Lighting Annual Hours (hours/year)	CF_{SSP}	Demand Waste Heat Factor and Annual Energy Waste Heat Factor[326]	Source
Pulse Start Metal Halide - exterior	3,338	0	1.0	Mid-Atlantic TRM 2017 p.335
High Pressure Sodium	3,338	0	1.0	Mid-Atlantic TRM 2017 p.335
LED Exit Sign and "24/7" lights[327]	8,760	1	1.0	Mid-Atlantic TRM 2017 p.271 DNV GL judgement
LED Parking Garage	3,338 for canopy applications	0 for canopy applications	1.0	Mid-Atlantic TRM 2017 p.320
	8,760 for parking garage applications	1.0 for parking garage applications	1.0	
Outdoor LED and Roadway Lighting	3,338	0	1.0	Mid-Atlantic TRM 2017 p.308

Table 134: Non-residential Exterior Lighting Parameter by Lighting Type (for Non-residential Energy Audit Program)

Lighting Type	Hours (hours/year)	CF_{SSP}	Source
Pulse Start Metal Halide - exterior	3,338	0.037	Mid-Atlantic TRM 2013 p.216, 217
High Pressure Sodium	3,338	0.0374	Mid-Atlantic TRM 2013 p.219, 220

326 "If cooling and heating equipment types are unknown or the space is unconditioned, assume WHFd = WHFe = 1.0." Mid-Atlantic TRM v 7. p.465.

327 DNV GL judgement that if non-residential lighting measure name contains "24/7", treat it the same as "LED Exit Sign" when calculating savings.

Lighting Type	Hours (hours/year)	CF_{SSP}	Source
LED Exit Sign	8,760	1	Mid-Atlantic TRM 2016 p.314
LED Parking Garage	3,338 for canopy applications	0 for canopy applications	Mid-Atlantic TRM 2015 p.337, 338
	8,760 for parking garage applications	1.0 for parking garage applications	
Outdoor LED and Roadway Lighting	3,338	0	Mid-Atlantic TRM 2015 p.325

The following hours and CF values apply only to the Non-Residential Duct Testing and Sealing, Non-Residential Energy Audit, Non-Residential Lighting, and Non-Residential Cooling and Heating Programs.

Table 135: Non-Residential Interior Lighting Parameters by Facility Type (for all Non-residential Programs except the Non-residential Energy Audit Program)[328],[329]

Building Types	Interior Lighting Annual Hours (hours/year)	CF_{SSP}	Demand Waste Heat Factor[330]	Annual Energy Waste Heat Factor[331]
Education – **1. College - Classes/ Administrative** **2. School / University** **3. Schools - Jr./Sr. High** **4. Schools - Preschool/ Elementary** **5. Schools - Technical/Vocational**	2,575	0.50	1.45	0.96
Education – College and University	2,575	0.50	1.45	0.96
Education – High School	2,575	0.50	1.45	0.96
Education – Elementary and Middle School	2,575	0.50	1.45	0.96
Food Sales – **1. Bakery** **2. Convenience Stores** **3. Food Stores**	7,134	0.96	1.27	0.95

328 Full building type list was consolidated to map directly to 2003 U.S. DOE CBECS building types. Full building type list and hours of use from Mid-Atlantic TRM 2017 p. 462-465.. Original sources: Connecticut Program Savings Document for 2012 Program Year (Sept. 2011), p. 219-220. http://www.ctenergyinfo.com/2012%20CT%20Program%20Savings%20Documentation%20FINAL.pdf. 2003 US DOE CBECS building type definitions. http://www.eia.gov/emeu/cbecs/building_types.html. Lighting hours. CF_{SSP} are mapped from the Mid-Atlantic TRM 2016, "C&I Interior Lighting Coincidence Factors by building Type". table on p. 505, with the exception of the "Public Order and Safety (Police and Fire Station)" building type, which had no lighting HOU, CF_{SSP} listed. In that case, the CT TRM (Sept 2011) HOU was used.

329 WHFd and WHFe assume lighting is installed in spaces with air coniditioning and non-electric heating equipment. The application does not collect heating and cooling system type.

330 Mid-Atlantic TRM 2017, p. 464-465. Selected waste heat factors from "Washington, D.C. All utilities", AC (utility) WHFd and heat pump WHF_e. Waste heat factors were provided for only 5 building types (1. Office, 2. Retail, 3. School, 4. Warehouse, 5. Other), therefore they were mapped to the full list of building types in Table 135 as appropriate. Original source of waste heat factor values are from the "EmPOWER Maryland DRAFT Final Impact Evaluation Report Evaluation Year 4 (June 1, 2012 – May 31, 2013) Commercial & Industrial Prescriptive & Small Business Programs, Navigant, March 31, 2014. Values for Washington D.C. and Delaware assume values from Maryland, Pepco and Maryland, DPL, respectively."

331 Ibid.