

Refrigeration Energy Consumption

Background

Commercial refrigeration equipment covered by this Tech Topic include the following types, which must be rated by AHRI:

1. Walk-in refrigerators
2. Walk-in freezers
3. Refrigerated casework and/or display cases

As per the *Refrigeration Modeling Method* section of the ANSI/ASHRAE/IEC Standard 90.1-2016 Performance Rating Method Reference Manual (2016 PRM RM¹), two aspects of performance must be accounted for:

1. Electricity consumption of the refrigeration equipment
2. Internal heat gain/removal into the thermal zone for the purposes of HVAC interactivity

Both aspects shall be explicitly captured in the model and the use of any refrigeration specific calculation engine is not required. The refrigeration system electricity consumption and the HVAC system interactivity can be modeled as two separate values as described and calculated in the supporting Excel Refrigeration Energy Calculator.

Process

Step 1 – Certificates and Spreadsheet

Gather AHRI 1200 certificates from manufacturer for each refrigeration unit. Each certificate should mimic the format shown in the AHRI 1200 Data Format tab of the Refrigeration Energy Calculator.

Using the Refrigeration Energy Calculator and the AHRI 1200 certificates, report each refrigeration unit type as separate columns in the *Ref Data Entry* tab.

To determine the applicable equipment class geometry (e.g HZO, SVO, etc) use diagrams of Appendix D of AHRI 1200 for reference. See example excerpt in the figure below

¹ https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf



ANSI/AHRI STANDARD 1200 (I-P)-2013

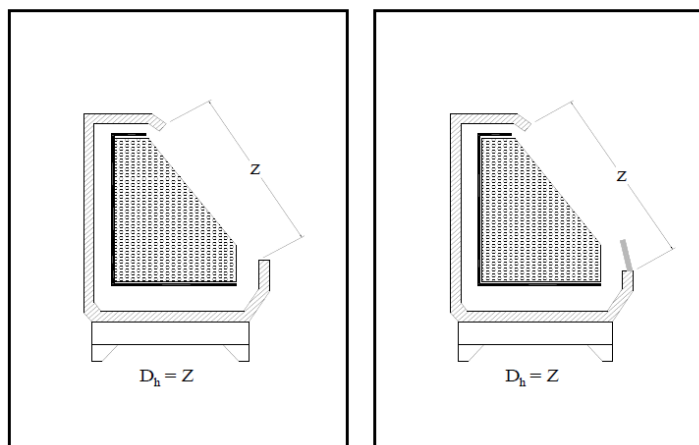


Figure D3. Semi-vertical Open Multi-deck

Figure D4. Semi-vertical Open Multi-deck with Transparent Front

Figure 1: AHRI 1200 - Appendix D

The Refrigeration Energy Calculator will automatically calculate the baseline (existing conditions for retrofit and Appendix G for new construction) kWh/day allowances of each eligible commercial refrigeration unit.

Step 2 – Electricity Modeling Input

Electricity consumption of refrigeration units should be modeled as W or W/SF inputs with a 8760 fractional schedule based on the kWh/day allowances calculated, the rated CDEC values of the proposed units based on standard AHRI 1200, and the allowances of unregulated walk ins.

The electricity consumption should be modeled as a direct load on the electric meter or assigned to a thermal zone but with the zero sensible and latent heat gains to the space. (Modeling internal gains from refrigeration equipment is described in the following steps.)

Step 3 – HVAC Interactivity Modeling Input

The Refrigeration Energy Calculator will auto calculate Q per thermal zone on the *Model Inputs* tab for the purposes of modeling internal heat gain or removal for each thermal zone to capture HVAC system interactivity. Q is the rate of heat removal from the space due to the continuous operation of the refrigeration system (kBtu/h). Q can be positive or negative depending on condenser location.

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Example Screen Shots - DOE2/eQUEST

Electricity Modeling Input

Enter the total kW from the *Model Inputs* tab of the Refrigeration Energy Calculator.

Totals	
Proposed Regulated, kW	17.9
Proposed Unregulated, kW	2.8
Baseline Regulated, kW	27.0
Baseline Unregulated, kW	2.8

Electric Meter Properties

Currently Active Electric Meter: Type: Utility

Basic Specifications | Building and/or Submeters | Direct Loads

Interior Direct Loads

	Load (kW)	Schedule	Enduse
1	27.00	24/7 SCH	Refrig. Displays

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HVAC Interactivity Modeling Input

Enter the total Q for the applicable zone determined from the *Model Inputs* tab of the Refrigeration Energy Calculator.

Modeling Inputs (Pr = Proposed Design, BL = Baseline Design)			
	Thermal Zone:	EL1 Core Spc (G.C5)	EL1 Core Spc (G.C6)
Pr	Rate of heat removal, Q, kBtu/hr	21.40	-7.22
BL	Rate of heat removal, Q, kBtu/hr	30.17	-6.27

Space Properties

Currently Active Space: Zone Type: Conditioned

Basic Specs | Equipment | Infiltration | Daylighting | Contents | Lighting

Equipment

	Equipment Schedule	Input Power Density (W/ft2)	Input Power (kW)	Sensible HG (ratio)	Latent HG (ratio)
1	EL1 Bldg Misc Sch	0.422		1.00	0.00
2	EL1 Bldg OffEq Sch	0.000	n/a	1.00	0.00
3	EL1 Bldg OffEq Sch	0.000	n/a	1.00	0.00
4	EL1 Bldg OffEq Sch	0.000	n/a	1.00	0.00

Internal Energy Sources

	Source Schedule	Source Type	Input Power (Btu/h)	Sensible HG (ratio)	Latent HG (ratio)
1	24/7 SCH	Process	30,170.0	1.00	0.00

DOE2/eQUEST Productivity Tip

This tip is for the purposes of simplifying the formal reporting of regulated and unregulated refrigeration energy in the ERP.

In the Electric Meter input as shown in Step 1, assign the unregulated refrigeration energy to an available end use category that is not being used in the project. For example, if the models do not use the Task Lighting end use consumption category, it can be used for the purposes of isolating unregulated refrigeration energy for use of the Parms.csv file and pasting results into the ERP.

If all end uses are used in the simulation, then manual adjustment of the results will be required when using the pasting features associated with the *Results from eQUEST* tab.

Unregulated Electricity Modeling Input

Totals	
Proposed Regulated, kW	17.9
Proposed Unregulated, kW	2.8
Baseline Regulated, kW	27.0
Baseline Unregulated, kW	2.8

Electric Meter Properties

Currently Active Electric Meter: Type: Utility

Basic Specifications | Building and/or Submeters | Direct Loads

Interior Direct Loads

	Load (kW)	Schedule	Enduse
1	27.00	24/7 SCH	Refrig. Displays
2	2.80	24/7 SCH	Task Lighting



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Adjustments to the ERP

M11 =AVERAGE(M7:M10)

1 Results from eQUEST Params.csv File(s)

2 Instructions

1) Open Params.csv file(s) that include results for baseline and proposed models and all ECMs for this project.
 2) For Appendix G projects, copy baseline runs from the appropriate Params.csv file and paste values into rows 7-10 below. For ASHRAE IEQ projects, paste the proposed design in row 7 and leave rows 8-10 blank.
 3) For Appendix G projects, copy proposed run from the appropriate Params.csv file and paste values into row 12 below. For ASHRAE IEQ projects, paste the baseline run into row 12 below. For both paths, this will be the last parametric run modeled (For ASHRAE IEQ projects, the "Measure Simulation" tab accounts for energy consumption increasing in each subsequent parametric run).
 4) Copy runs that correspond to each ECM from the appropriate Params.csv file(s), including final run from Step 3, and paste into rows 13-35 (leave un-needed rows blank). Do not include the baseline runs.
 5) For unregulated lighting systems, specific those loads in the "Task Lighting" input section under Space Properties of the Internal Loads tab.

Run Type	Internal Loads	Case #s	Short Name	Carry Fwd	Incremental First Cost (\$)	Incremental Annual Maint. (\$)	Date & Time of Run	File Name	Case Description	SS-D Peak Cooling Coil Load kBtu	PS-E Ambient Lights kWh	PS-E Task Lights kWh	PS-E Misc Equip kWh	PS-E Space Heating kWh	PS-E Space Cooling kWh	PS-E Heat Reject kWh	PS-E Pump & Aux kWh	Electric Usage: PS-E Ventilation Fans kWh
Average Baseline										#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

F26 =Results from eQuest!M11*0.003413

End Use	Baseline Electricity (MMBtu)	Proposed Electricity (MMBtu)
Energy Cost \$/MMBtu	\$ -	\$ -
Space Heating (Regulated)	-	-
Cooling (Regulated)	-	-
Ventilation (Regulated)	-	-
Water Heating (Regulated)	-	-
Lighting (Regulated)	-	-
Lighting (Unregulated)	-	-
Pumps (Regulated)	-	-
Heat Rejection (Regulated)	-	-
Supplemental Heat Pump (Regulated)	-	-
Exterior Usage (Regulated)	-	-
Plug and Process Load (Unregulated)	-	-
Elevator Misc. Energy (Regulated)	-	-
Misc. Energy (Unregulated)	-	-
Refrigeration (Regulated)	-	-
Refrigeration (Unregulated)	#DIV/0!	-

M12 =AVERAGE(M7:M10)

1 Results from eQUEST Params.csv File(s)

2 Instructions

1) Open Params.csv file(s) that include results for baseline and proposed models and all ECMs for this project.
 2) For Appendix G projects, copy baseline runs from the appropriate Params.csv file and paste values into rows 7-10 below. For ASHRAE IEQ projects, paste the proposed design in row 7 and leave rows 8-10 blank.
 3) For Appendix G projects, copy proposed run from the appropriate Params.csv file and paste values into row 12 below. For ASHRAE IEQ projects, paste the baseline run into row 12 below. For both paths, this will be the last parametric run modeled (For ASHRAE IEQ projects, the "Measure Simulation" tab accounts for energy consumption increasing in each subsequent parametric run).
 4) Copy runs that correspond to each ECM from the appropriate Params.csv file(s), including final run from Step 3, and paste into rows 13-35 (leave un-needed rows blank). Do not include the baseline runs.
 5) For unregulated lighting systems, specific those loads in the "Task Lighting" input section under Space Properties of the Internal Loads tab.

Run Type	Internal Loads	Case #s	Short Name	Carry Fwd	Incremental First Cost (\$)	Incremental Annual Maint. (\$)	Date & Time of Run	File Name	Case Description	SS-D Peak Cooling Coil Load kBtu	PS-E Ambient Lights kWh	PS-E Task Lights kWh
Average Baseline										#DIV/0!	#DIV/0!	#DIV/0!

Pay for Performance Technical Topic

G26 =Results from eQuest!M12*0.003413

End Use	Baseline Electricity (MMBtu)	Proposed Electricity (MMBtu)
Energy Cost \$/MMBtu	\$ -	\$ -
Space Heating (Regulated)	-	-
Cooling (Regulated)	-	-
Ventilation (Regulated)	-	-
Water Heating (Regulated)	-	-
Lighting (Regulated)	-	-
Lighting (Unregulated)	-	-
Pumps (Regulated)	-	-
Heat Rejection (Regulated)	-	-
Supplemental Heat Pump (Regulated)	-	-
Exterior Usage (Regulated)	-	-
Plug and Process Load (Unregulated)	-	-
Elevator/ Misc. Energy (Regulated)	-	-
Misc. Energy (Unregulated)	-	-
Refrigeration (Regulated)	-	-
Refrigeration (Unregulated)	#DIV/0!	-

Complete Results from eQUEST tab in the ERP

Results from eQUEST Params.csv File(s)

Instructions:

- Open Params.csv file(s) that include results for baseline and proposed models and all ECMs for this project.
- For Appendix G projects, copy baseline runs from the appropriate Params.csv file and paste values into rows 7-10 below. For ASHRAE 90.1 projects, paste the proposed design in row 7 and leave rows 8-10 blank.
- For Appendix G projects, copy proposed run from the appropriate Params.csv file and paste values into row 12 below. For ASHRAE 90.1 projects, paste the baseline run into row 12 below. For both paths, this will be the last parametric run modeled. For ASHRAE 90.1 projects, the "Measure Simulation" tab accounts for energy consumption increasing in each subsequent parametric run.
- Copy runs that correspond to each ECM from the appropriate Params.csv file(s), including final run from Step 3, and paste into rows 13-35 (leave un-needed rows blank). Do not include the baseline runs.
- For unregulated lighting systems, specify those loads in the "Task Lighting" input section under Space Properties of the Internal Loads tab.

Run Type	Internal Loads	Case #	Short Name	Carry Forward	Incremental First Cost (\$)	Incremental Annual Maint. (\$)	Date & Time of Run	File Name	Case Description	SS-D Peak Cooling Coil Load Mbtu	Electric Usage									
											PS-E Ambient Lights kWh	PS-E Task Lights kWh	PS-E Misc Equip kWh	PS-E Space Heating kWh	PS-E Space Cooling kWh	PS-E Heat Reject kWh	PS-E Pumps & Aux kWh	PS-E Ventilation Fans kWh	PS-E Refrig Display kWh	
n/a	n/a	0	0	1	\$0	\$0	07-20-20@11:50	Project 19 - Baseline Desi Base Design		590.083	90465	6047	46271	0	26656	0	494	20820	58309	
n/a	n/a	0	0	1	\$0	\$0	07-20-20@11:50	Project 19 - Baseline Desi Base Design		590.083	90465	6047	46271	0	26656	0	494	20820	58309	
n/a	n/a	0	0	1	\$0	\$0	07-20-20@11:50	Project 19 - Baseline Desi Base Design		590.083	90465	6047	46271	0	26656	0	494	20820	58309	
n/a	n/a	0	0	1	\$0	\$0	07-20-20@11:50	Project 19 - Baseline Desi Base Design		590.083	90465	6047	46271	0	26656	0	494	20820	58309	
Average Baseline										590.083	90465	6047	46271	0	26656	0	494	20820	58309	

Measure Simulation Tab

Baseline regulated and unregulated energy have been assigned appropriately.

F26 =Results from eQuest!M11*0.003413

End Use	Baseline Electricity (MMBtu)	Proposed Electricity (MMBtu)
Energy Cost \$/MMBtu	\$ -	\$ -
Space Heating (Regulated)	-	-
Cooling (Regulated)	91	-
Ventilation (Regulated)	71	-
Water Heating (Regulated)	-	-
Lighting (Regulated)	329	-
Lighting (Unregulated)	-	-
Pumps (Regulated)	2	-
Heat Rejection (Regulated)	-	-
Supplemental Heat Pump (Regulated)	-	-
Exterior Usage (Regulated)	-	-
Plug and Process Load (Unregulated)	158	-
Elevator/ Misc. Energy (Regulated)	-	-
Misc. Energy (Unregulated)	-	-
Refrigeration (Regulated)	199	-
Refrigeration (Unregulated)	21	-