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Document Name: ACRI 1200: Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets

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Standards Body: Air Conditioning and Refrigeration Institute

APPROVED

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THE EXECUTIVE DIRECTOR
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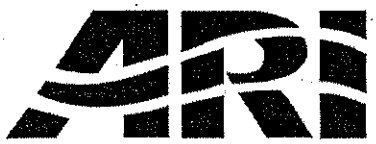
WASHINGTON, D.C.

2006 STANDARD for

PERFORMANCE RATING OF COMMERCIAL REFRIGERATED DISPLAY MERCHANDISERS AND STORAGE CABINETS



AIR-CONDITIONING &
REFRIGERATION
INSTITUTE

Standard 1200

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IMPORTANT

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Note:

This standard supersedes ARI Standard 1200-2004.

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TABLE OF CONTENTS

TABLES

APPENDICES

TABLES FOR APPENDICES

FIGURES FOR APPENDICES

PERFORMANCE RATING OF COMMERCIAL REFRIGERATED DISPLAY MERCHANDISERS AND STORAGE CABINETS

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for Commercial Refrigerated Display Merchandisers and Storage Cabinets: definitions; test requirements; rating requirements; symbols and subscripts; minimum data requirements for Published Ratings; marking and nameplate data and conformance conditions.

1.1.1 *Intent.* This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users. The values reported using this standard allow comparison of energy consumption within each of the following product categories: Remote Commercial Refrigerated Display Merchandisers, Remote Commercial Refrigerated Storage Cabinets, Self-contained Commercial Refrigerated Display Merchandisers and Self-contained Commercial Refrigerated Storage Cabinets.

1.1.2 *Review and Amendment.* This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 *Scope.* This standard applies to the following manufacturers' standard catalog Commercial Refrigerated Display Merchandisers and Storage Cabinets, provided that the cases are equipped and designed to work with electrically driven, direct expansion type systems:

a. Self-contained and Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets
b. Open and Closed Commercial Refrigerated Display Merchandisers
c. Service and Self-service Commercial Refrigerated Display Merchandisers

2.2 *Exclusions.* This standard does not apply to the following:

a. Commercial Refrigerated Display Merchandisers forming the front wall of a refrigerated storage room backed up to a walk-in cooler
b. Miter transition display merchandisers used as a corner section between two refrigerated display merchandisers
c. Floral merchandisers
d. Refrigerated vending machines
e. Ice makers
f. Ice cream dipping cabinets
g. Soft serve extruders
h. Secondary coolant applications

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the current edition of *ASHRAE Terminology of Heating, Ventilation, Air Conditioning and Refrigeration* unless otherwise defined in this section.

3.1 *Anti-condensate Energy Consumption (AEC).* The Total Daily Energy Consumption used in condensate removal on the outside of the Commercial Refrigerated Display Merchandiser or Storage Cabinet, which typically includes fan and condensate heater energy expressed in kW·h/ft [kW·h/m] per day.

3.2 *Calculated Daily Energy Consumption (CDEC).* This is a value for Remote Commercial Refrigerated Display Merchandisers or Storage Cabinets based upon the requirements of this standard expressed in kW·h/ft [kW·h/m] per day.

3.3 *Coefficient of Performance (COP).* A ratio of the cooling capacity in watts [W] to the power input value in watts [W] at any given set of Rating Conditions expressed in watts/watt [W/W].

3.4 *Commercial Refrigerated Display Merchandiser.* A cabinet cooled by a refrigerating system for displaying chilled and/or frozen food to be maintained within prescribed temperature limits.

3.4.1 *Closed Commercial Refrigerated Display Merchandiser.* A refrigerated display merchandiser where food is accessible for removal by opening or moving doors or panels.

3.4.2 *Open Commercial Refrigerated Display Merchandiser.* A refrigerated display merchandiser where food is accessible for removal without opening or moving doors or panels.

3.4.3 *Remote Commercial Refrigerated Display Merchandiser.* A refrigerated display merchandiser that has a remote condensing unit.

3.4.4 *Self-contained Commercial Refrigerated Display Merchandiser.* A refrigerated display merchandiser that has the condensing unit attached to the display case.

3.4.5 *Self-service Commercial Refrigerated Display Merchandiser.* A refrigerated display merchandiser, either open or closed, where food is readily accessible and intended to be removed by the consumer.

3.4.6 *Service Commercial Refrigerated Display Merchandiser.* A closed refrigerated display merchandiser where food is served from behind the unit.

3.5 *Commercial Refrigerated Storage Cabinet.* A closed cabinet cooled by a refrigerating system for storing chilled and/or frozen food to be maintained within prescribed temperature limits.

3.5.1 *Remote Commercial Refrigerated Storage Cabinet.* A refrigerated storage cabinet that has a remote condensing unit.

3.5.2 *Self-contained Commercial Refrigerated Storage Cabinet.* A refrigerated storage cabinet that has the condensing unit attached to the unit.

3.6 *Compressor Energy Consumption (CEC).* The energy consumed by the compressor expressed in kW·h/ft [kW·h/m] per day.

3.7 *Condensate Evaporator Pan Energy Consumption (PEC).* The amount of heat energy required to change condensate from liquid to a vapor in the evaporator pan expressed in kW·h/ft [kW·h/m] per day.

3.8 *Defrost Energy Consumption (DEC).* The energy consumed during defrost cycles expressed in kW·h/ft [kW·h/m] per day.

3.9 *Dew Point.* Refrigerant vapor saturation temperature at a specified pressure expressed in °F [°C].

3.9.1 *Adjusted Dew Point.* An adjusted temperature lower than actual Dew Point temperature expressed in °F [°C], resulting from suction line pressure losses, equal to saturated suction temperature at the compressor.

3.10 *Energy Efficiency Ratio (EER).* A ratio of the cooling capacity in Btu/h to the power input values in watts at any given set of Rating Conditions expressed in Btu/(W·h).

3.11 *Fan Energy Consumption (FEC).* The energy consumed by fan motors expressed in kW·h/ft [kW·h/m] per day.

3.12 *Integrated Average Temperature.* The average of all test package measurements taken during the test expressed in °F [°C].

3.13 *Lighting Energy Consumption (LEC).* The energy consumed by lighted shelves and lighting internal to the refrigerated display merchandiser or storage cabinet expressed in kW·h/ft [kW·h/m] per day.

3.14 *Product Temperature.* Commercial Refrigerated Display Merchandisers or Storage Cabinets shall be tested with one or more of the following Integrated Average Temperatures:

3.14.1 *Ice Cream Applications.* Commercial Refrigerated Display Merchandisers and Storage Cabinets intended for Ice Cream Applications shall have an Integrated Average Temperature of all test package averages of -5.0°F ± 2.0°F [-21°C ± 1.1°C].

3.14.2 *Low Temperature Applications.* Commercial Refrigerated Display Merchandisers and Storage Cabinets intended for Low Temperature Applications shall have an Integrated Average Temperature of all test package averages of 0.0°F ± 2.0°F [-18°C ± 1.1°C].

3.14.3 *Medium Temperature Applications.* Commercial Refrigerated Display Merchandisers and Storage Cabinets intended for Medium Temperature Applications, shall have an Integrated Average Temperature of all test package averages of 38°F ± 2.0°F [3.3°C ± 1.1°C].

3.14.4 *Application Product Temperature.* This test allows Integrated Average Temperatures other than 3.14.1, 3.14.2 and 3.14.3.

3.15 *Published Rating.* A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen for its application. The term Published Rating includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated Rating Conditions.

3.15.1 *Application Rating.* A rating based on tests performed at application Rating Conditions (other than Standard Rating Conditions).

3.15.2 *Standard Rating.* A rating based on tests performed at Standard Rating Conditions.

3.16 *Rating Conditions.* Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur.

3.16.1 *Standard Rating Conditions.* Rating Conditions used as the basis of comparison for performance characteristics.

3.17 *"Shall"* or *"Should".* "Shall" or "should" shall be interpreted as follows:

3.17.1 *Shall.* Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.17.2 *Should.* "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.18 *Total Daily Energy Consumption (TDEC).* A calculated energy consumption value for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets based upon the requirements of this standard expressed in kW·h/ft [kW·h/m] per day.

3.19 *Total Display Area (TDA).* The sum of the projected area(s) for visible product expressed in ft^2 [m^2].

3.20 *Volume.* Two methods are defined for determining refrigerated volume.

3.20.1 *AHAM Volume Method.* The interior volume of a refrigerator as calculated by ANSI/AHAM HRF-1-2004.

3.20.2 *Load Line Volume Method.* The gross interior volume of the refrigerator contained within the load limit lines. This gross volume calculated without display devices installed.

Section 4. Test Requirements

4.1 *Test Requirements.* The tests required for this standard shall be conducted in accordance with ANSI/ASHRAE Standard 72.

4.1.1 *Dry-Bulb Temperature.* The average test-room dry-bulb temperature shall be 75.2°F ± 1.8°F [24.0°C ± 1.0°C], when measured in accordance with ANSI/ASHRAE Standard 72.

4.1.2 *Wet-Bulb Temperature.* The average test-room wet-bulb temperature shall be 64.4°F ± 1.8°F [18.0°C ± 1.0°C], when measured in accordance with ANSI/ASHRAE Standard 72.

4.1.3 *Electrical Conditions.* Nameplate voltages for 60 Hz systems are shown in Table 1 of ARI Standard 110. Nameplate voltages for 50 Hz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard 60038. Tests shall be performed at the nameplate rated voltage and frequency unless otherwise specified in this standard. For all dual nameplate voltage equipment covered by this standard, tests shall be performed at both voltages or at the lower voltage if only a single rating is to be published.

Section 5. Rating Requirements for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets

5.1 *General.* This section identifies the necessary data required to calculate the CDEC for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets.

5.2 *CDEC for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets.* The total electrical load shall be measured and adjusted to determine CDEC. The electrical load categories shall include compressors, evaporator fan motors, lighting, surface anti-condensate load including fans and heaters, defrost heaters, condensate evaporator pans and any other suitable electrical loads when they are part of the unit. If measured electrical loads are not available, the following calculations shall be done to determine the CDEC.

$$CDEC = CEC + FEC + LEC + AEC + DEC + PEC \quad (1)$$

Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets shall report the individual loads in the calculation of CDEC. Shown below are formulae for the required individual loads.

5.2.1 *Calculation of CEC.* The EER or COP in Table 1 shall be used to calculate CEC for a 24 hour period.

Note: The EER and COP values in Table 1 are based on an evaporator temperature and the Commercial Refrigerated Display Merchandiser or Storage Cabinet classification. Commercial Refrigerated Display Merchandisers and Storage Cabinets for Medium Temperature Applications shall use a temperature that is 2.0°F [1.2°C] lower than the Commercial Refrigerated Display Merchandiser or Storage Cabinet Dew Point.

Commercial Refrigerated Display Merchandisers and Storage Cabinets for Low Temperature Applications shall use a temperature that is 3.0°F [1.7°C] lower than the Commercial Refrigerated Display Merchandiser or Storage Cabinet Dew Point. Table 1 shall be used for consistency, understanding that other compressor selections can lead to a different efficiency.

$$CEC = [(Q_{rt} / L) \cdot (t - t_{dt})] / (EER \cdot 1000) \quad \text{I-P} \quad (2)$$

$$CEC = [(Q_{rt} / L) \cdot (t - t_{dt})] / (COP \cdot 1000) \quad \text{SI} \quad (3)$$

5.2.2 *Calculation of FEC.* The FEC shall be measured data for all fan motors or calculated data using the motor efficiency values in Table 2:

$$FEC = (P_f \cdot t_f) / (L \cdot 1000) \quad (4)$$

where:

$P_f = P_{fi}$ (measured)

$P_f = (P_{fo} \cdot n) / (\eta_m)$ (calculated)

5.2.3 *Calculation of LEC.*

$$LEC = (P_{li} \cdot t_l) / (L \cdot 1000) \quad (5)$$

5.2.4 *Calculation of AEC.*

$$AEC = (P_{ai} \cdot t_a) / (L \cdot 1000) \quad (6)$$

5.2.5 *Calculation of DEC.*

$$DEC = (P_d \cdot t_d) / (L \cdot 1000) \quad (7)$$

5.2.6 *Calculation of PEC.*

$$PEC = (P_c \cdot t_c) / (L \cdot 1000) \quad (8)$$

5.2.7 *Other Electric Energy Consumption.* If there are additional options that decrease or increase the electrical units, they should be noted under "Other Loads" (Section 8) with an appropriate calculation for energy consumption expressed in kW·h/ft [kW·h/m] per day.

5.3 *Alternate Components - Direct Effects.* The energy consumption of substituted or alternate components shall be measured or calculated from the component's nameplate rating. The energy usage of the substituted or alternate components shall be used to recalculate the CDEC in 5.2. The energy consumption of the substituted or alternate components and the recalculated CDEC shall be reported as shown in Section 8.

5.3.1 *FEC.* When removing or substituting a fan motor, the fan energy shall be measured or calculated according to 5.2.2. The energy usage of the substituted or alternate components shall be used to recalculate the CDEC according to 5.2. The energy consumption of the substituted or alternate components and the recalculated CDEC shall be reported according to Section 8. When calculating the fan motor energy for substituting a fan motor, the airflow rate produced from the assembly shall be equal to the original configuration.

5.3.2 *LEC.* When removing or substituting lighting, the lighting energy shall be measured or calculated according to 5.2.3. The energy usage of the substituted or alternate components shall be used to recalculate the CDEC according to 5.2. The energy consumption of the substituted or alternate components and the recalculated CDEC shall be reported according to Section 8.

5.3.3 *AEC.* When removing or substituting an anti-condensate heater, the heater energy shall be measured or calculated according to 5.2.4. The energy usage of the substituted or alternate components shall be used to recalculate the CDEC according to 5.2. The energy consumption of the substituted or alternate components and the recalculated CDEC shall be reported according to Section 8.

Table 1. EER and COP for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets

Medium Temperature				Low Temperature			
Adjusted Dew Point		EER	COP	Adjusted Dew Point		EER	COP
°F	°C			°F	°C		
0.0	-17.8	9.25	2.71	-36.0	-37.8	5.48	1.61
1.0	-17.2	9.37	2.75	-35.0	-37.2	5.56	1.63
2.0	-16.7	9.50	2.78	-34.0	-36.7	5.64	1.65
3.0	-16.1	9.63	2.82	-33.0	-36.1	5.73	1.68
4.0	-15.6	9.76	2.86	-32.0	-35.6	5.81	1.70
5.0	-15.0	9.87	2.89	-31.0	-35.0	5.9	1.73
6.0	-14.4	10.03	2.94	-30.0	-34.4	5.98	1.75
7.0	-13.9	10.19	2.99	-29.0	-33.9	6.06	1.78
8.0	-13.3	10.36	3.04	-28.0	-33.3	6.15	1.80
9.0	-12.8	10.52	3.08	-27.0	-32.8	6.24	1.83
10.0	-12.2	10.69	3.13	-26.0	-32.2	6.33	1.85
11.0	-11.7	10.87	3.18	-25.0	-31.7	6.41	1.88
12.0	-11.1	11.05	3.24	-24.0	-31.1	6.5	1.90
13.0	-10.6	11.22	3.29	-23.0	-30.6	6.6	1.93
14.0	-10.0	11.4	3.34	-22.0	-30.0	6.7	1.96
15.0	-9.4	11.58	3.39	-21.0	-29.4	6.78	1.99
16.0	-8.9	11.79	3.45	-20.0	-28.9	6.88	2.02
17.0	-8.3	11.99	3.51	-19.0	-28.3	6.98	2.05
18.0	-7.8	12.19	3.57	-18.0	-27.8	7.08	2.07
19.0	-7.2	12.39	3.63	-17.0	-27.2	7.19	2.11
20.0	-6.7	12.59	3.69	-16.0	-26.7	7.29	2.14
21.0	-6.1	12.85	3.77	-15.0	-26.1	7.39	2.17
22.0	-5.6	13.04	3.82	-14.0	-25.6	7.49	2.19
23.0	-5.0	13.27	3.89	-13.0	-25.0	7.60	2.23
24.0	-4.4	13.49	3.95	-12.0	-24.4	7.70	2.26
25.0	-3.9	13.72	4.02	-11.0	-23.0	7.81	2.29
26.0	-3.3	13.95	4.09	-10.0	-23.3	7.92	2.32
27.0	-2.8	14.18	4.15	-9.0	-22.8	8.03	2.35
28.0	-2.2	14.47	4.24	-8.0	-22.2	8.14	2.38
29.0	-1.7	14.73	4.32	-7.0	-21.7	8.25	2.42
30.0	-1.1	14.98	4.39	-6.0	-21.1	8.36	2.45
31.0	-0.6	15.27	4.47	-5.0	-20.6	8.48	2.48
32.0	0.0	15.56	4.56	-4.0	-20.0	8.59	2.52
33.0	0.6	15.84	4.64	-3.0	-19.4	8.71	2.55
34.0	1.1	16.13	4.73	-2.0	-18.9	8.83	2.59
35.0	1.7	16.42	4.81	-1.0	-18.3	8.95	2.62

Note:

1. EER and COP values at Medium and Low Temperature Applications are based on a typical reciprocating compressor.
2. Linear interpolation should be used to calculate EER and COP values for temperatures not shown in Table 1.

Table 2. Motor Efficiency Values, η_m	
Motor Type	Motor Efficiency Value
Shaded Pole	0.20
PSC	0.29
Electronic	0.66

5.3.4 *DEC.* When removing or substituting a defrost heater, the heater energy shall be measured or calculated according to 5.2.5. The energy usage of the substituted or alternate components shall be used to recalculate the CDEC according to 5.2. The energy consumption of the substituted or alternate components and the recalculated CDEC shall be reported according to Section 8.

5.3.5 *PEC.* When removing or substituting a condensate evaporator pan, the pan energy shall be measured or calculated according to 5.2.6. The energy usage of the substituted or alternate components shall be used to recalculate the CDEC according to 5.2. The energy consumption of the substituted or alternate components and the recalculated CDEC shall be reported according to Section 8.

5.4 *Alternate Component Indirect Effects.* The revised Compressor Energy Consumption (CEC_R) is the indirect effect of alternate component(s) on the Compressor Energy Consumption (CEC) and shall be measured or calculated. The total revised Compressor Energy Consumption (CEC_R) is the sum of the CEC and the additional Compressor Energy Consumption (CEC_A) for each component.

$$CEC_R = CEC + \sum CEC_A \quad (9)$$

5.4.1 *Fans.* When substituting a fan motor located in the refrigerated space, the change in energy affects the CEC. The change in CEC shall be calculated by multiplying the difference in power usage between the alternate components by the operating time and dividing by the compressor's COP rating. This change in CEC shall be added back to the original CEC:

$$CEC_A = [(P_s \cdot t_s) - (P_o \cdot t_o)] \ / \ (COP \cdot L \cdot 1000) \quad (10)$$

5.4.2 *Lights.* When substituting internal lighting located in the refrigerated space, the change in energy affects the CEC. The change in CEC shall be calculated by multiplying the difference in power usage between the alternate components by the operating time and dividing by the compressor's COP rating. This change in CEC shall be added back to the original CEC.

For ballast located internal or external to the refrigerated space:

$$CEC_A = [(P_s \cdot t_s) - (P_o \cdot t_o)] / (COP \cdot L \cdot 1000) \quad (11)$$

5.4.3 *Anti-Condensate Heater.* When substituting an anti-condensate heater located in the refrigerated space, the change in energy affects the CEC. The change in CEC shall be calculated by dividing the difference in energy usage between the alternate components by the compressor's COP rating. This change in CEC shall be added back to the original CEC:

$$CEC_A = [(P_s \cdot t_s) - (P_o \cdot t_o)] / (COP \cdot L \cdot 1000) \quad (12)$$

5.4.4 *Condensate Evaporator Pans.* When substituting a condensate evaporator pan located in the refrigerated space, the change in energy affects the CEC. The change in CEC shall be calculated by dividing the difference in energy usage between the alternate components by the compressor's COP rating.

This change in CEC shall be added back to the original *CEC*:

$$CEC_A = [(P_s \cdot t_s) - (P_o \cdot t_o)] / (COP \cdot L \cdot 1000) \quad (13)$$

5.5 *Refrigerated Volume.* The refrigerated volume of the Commercial Refrigerated Display Merchandiser or Storage Cabinet shall be calculated based on the equation below using the load line Volume as described in Appendix C:

$$V_r = A_r \cdot L \quad (14)$$

5.6 *Total Display Area.* The total display area of the Commercial Refrigerated Display Merchandiser shall be calculated based on the equation below and as described in Appendix D:

$$TDA = (D_h \cdot L) + A_e \quad (15)$$

5.7 *Tolerances.* To comply with this standard, published CDEC ratings shall be based on data obtained in accordance with this section, and shall be such that any production unit, when tested, shall not exceed these ratings by more than 5%. Values obtained using calculated component substitutions must also meet these tolerances.

5.8 *Multiples.* The CDEC, in kW·h/ft [kW·h/m] per day, shall be expressed in 0.01 kW·h/ft [kW·h/m] per day increments.

Section 6. Rating Requirements for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets

6.1 *General.* This section identifies the necessary data required to calculate the TDEC for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets.

6.2 *TDEC for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets.* The total electrical load shall be measured to determine TDEC. The electrical load measurement shall include compressors, evaporator fan motors, condensing fan motors, lighting, anti-condensate loads including fans and heaters, defrost heaters, condensate evaporator pans and any other suitable electrical loads when they are part of the unit:

$$TDEC = E_t / L \quad (16)$$

The values are expressed in kW·h/ft [kW·h/m] per day.

6.3 *Alternate Components for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets.* The direct energy consumption of alternate components shall be measured or calculated from the component's nameplate rating. A calculated change in the energy usage for the alternate component shall be substituted for the energy usage of the component used in the total energy test only if the alternate component uses less energy than the original component. A credit for a reduction in the CEC due to alternate components in a Self-contained Commercial Refrigerated Display Merchandiser or Storage Cabinet shall not be taken if a calculated value is used. A direct measurement of the total electrical load shall be made if the alternate component uses more energy than the original component or it is desired to take a credit for the compressor energy reduction.

The calculated direct effect in energy usage shall be added back to the original TDEC and the adjusted Total Daily Energy Consumption ($TDEC_A$) determined for each component substitution.

$$TDEC_A = (E_s - E_o) / L \quad (17)$$

Where:

$E_s = P_s \cdot t_s$

$E_o = P_o \cdot t_o$

6.3.1 *FEC.* When removing or substituting a fan motor, the fan energy shall be measured or calculated according to 5.2.2. The adjusted Total Daily Energy Consumption ($TDEC_A$) shall be measured or calculated using equation 17. When calculating the fan motor energy for substituting a fan motor, the airflow produced from the assembly shall be equal to the original configuration.

6.3.2 *LEC. Lights.* When removing or substituting internal lighting, lighting energy shall be measured or calculated from the product nameplate according to 5.2.3. The adjusted Total Daily Energy Consumption ($TDEC_A$) shall be measured or calculated using equation 17. It does not matter if the ballast is internal or external to refrigerated space because the CEC adjustment cannot be made for the Self-contained Commercial Refrigerated Display Merchandiser or Storage Cabinet.

6.3.3 *AEC. Anti-Condensate Heater.* When removing or substituting an anti-condensate heater, the heater energy shall be measured or calculated from the product's nameplate according to 5.2.4. The adjusted Total Daily Energy Consumption ($TDEC_A$) shall be measured or calculated using equation 17.

6.3.4 *DEC. Defrost Heaters.* When removing or substituting a defrost heater, the change in energy shall be measured or calculated according to 5.2.5. The adjusted Total Daily Energy Consumption ($TDEC_A$) shall be measured or calculated using equation 17.

6.3.5 *PEC. Condensate Evaporator Pans.* When removing or substituting a condensate evaporator pan, the change in energy shall be measured or calculated according to 5.2.6. The adjusted Total Daily Energy Consumption ($TDEC_A$) shall be measured or calculated using equation 17.

6.4 *Refrigerated Volume.* The refrigerated volume of the Commercial Refrigerated Display Merchandiser or Storage Cabinet shall be calculated using one of the two following methods.

6.4.1 *AHAM Volume Method.* The refrigerated volume of closed Self Service Commercial Refrigerated Display Merchandisers and Commercial Refrigerated Storage Cabinets is determined using the AHAM volume.

6.4.2 *Load Line Volume Method.* The Refrigerated Volume of all other Commercial Refrigerated Display Merchandisers is determined using Load Line volume.

6.5 *Total Display Area.* The total display area of the Commercial Refrigerated Display Merchandiser is calculated according to 5.6.

6.6 *Tolerances.* To comply with this standard, published TDEC ratings whether measured or calculated shall be based on data obtained in accordance with this section, and shall be such that any production unit, when tested, shall not exceed these ratings by more than 5%.

6.7 *Multiples.* The TDEC, expressed in kW·h/ft [kW·h/m] per day, shall be stated in 0.01 kW·h/ft [kW·h/m] per day increments.

Section 7. Symbols and Subscripts

7.1 *Symbols and Subscripts.* The symbols and subscripts used in this standard are as follows:

A_e = Projected area from visible product through end walls, ft^2 [m^2]
A_r = Gross refrigerated area, ft^2 [m^2]
AEC = Anti-condensate energy consumption, kW·h/ft [kW·h/m] per day
CDEC = Calculated Daily Energy Consumption, kW·h/ft [kW·h/m] per day
CEC = Compressor Energy Consumption, kW·h/ft [kW·h/m] per day
CEC_A = Additional Compressor Energy Consumption for an alternate component, kW·h/ft [kW·h/m] per day
CEC_R = Revised Compressor Energy Consumption, kW·h/ft [kW·h/m] per day
COP = Coefficient of Performance (Table 1)
DEC = Defrost Energy Consumption, kW·h/ft [kW·h/m] per day
D_h = Dimension of projected visible product, ft [m]
E_o = Original energy consumption, kW·h [kW·h]

E_s = Energy consumption with substituted component, kW·h [kW·h] per day
E_t = Total energy measured or calculated for 24 hour period, kW·h [kW·h] per day
EER = Energy Efficiency Ratio (Table 1)
FEC = Fan Energy Consumption, kW·h/ft [kW·h/m] per day
LEC = Light Energy Consumption, kW·h/ft [kW·h/m] per day
LEC_R = Revised Light Energy Consumption,kW·h/ft [kW·h/m] per day
L = Length of unit, ft [m]
n = Number of fan motors
P_{ai} = Power anti-condensate heater input, W [W]
P_c = Power condensate evaporator pan heater input, W [W]
P_d = Power defrost heater input, W [W]
P_f = Power fan, W [W]
P_{fi} = Power fan input, W [W]
P_{fo} = Power fan output found on part nameplate, W [W]
P_{li} = Power light input, W [W]
P_o = Power input calculated for original part, W [W]
P_s = Power input calculated for substitution part, W [W]
PEC = Condensate Evaporator Pan Energy Consumption, kW·h/ft [kW·h/m] per day
Q_{rt} = Commercial refrigerated display merchandiser or storage cabinet load, Btu/h [W]
t = Time unit is tested in 24 h period, h [h]
t_a = Time anti-condensate heaters are on in 24 hour period, h [h]
t_c = Time condensate evaporator pan heaters are on in 24 hour period, h [h]
t_d = Time defrost heaters are on in 24 hour period, h [h]
t_{dt} = Time unit is in defrost, h [h]
t_f = Time fans are on in 24 hour period, h [h]
t_l = Time lights are on in 24 hour period, h [h]
t_o = Time original part is on in 24 hour period, h [h]
t_s = Time substitution part is on in 24 hour period, h [h]
TDA = Total Display Area, ft^2 [m^2]/Unit of Length, ft [m]
TDEC = Total Daily Energy Consumption,kW·h/ft [kW·h/m] per day
$TDEC_A$ = Adjusted Total Daily Energy Consumption, kW·h/ft [kW·h/m] per day
V_r = Refrigerated Volume, ft^3 [m^3]
η_m = Motor efficiency

Note: Per day denotes a 24-hour period.

Section 8. Minimum Data Requirements for Published Ratings

8.1 *Minimum Data Requirements for Published Ratings.* As a minimum, Published Ratings shall include all Standard Ratings. All claims to ratings within the scope of this standard shall include the statement "Rated in accordance with ARI Standard 1200". All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of ARI Standard 1200". Wherever Application Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply.

8.2 Table 3 represents the remote commercial refrigerated display merchandiser or storage cabinet data that shall be reported for each appropriate model(s). Only one set of units should be printed in the data table.

8.3 Table 4 represents the self-contained commercial refrigerated display merchandiser or storage cabinet data that shall be reported for each appropriate model (s). Only one set of units should be printed in the data table.

Section 9. Marking and Nameplate Data

Marking and Nameplate Data. As a minimum, the following information shall be shown in a conspicuous place on the equipment:

a. Name or trade name of manufacturer
b. Manufacturer's model number
c. Heat transfer fluid (where appropriate)

Nameplate voltages for 60 Hertz systems shall include one or more of the equipment nameplate voltage ratings shown in Table 1 of ARI Standard 110. Nameplate voltages for 50 Hertz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard 60038.

Section 10. Conformance Conditions

Conformance. While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication.

Table 3. Presentation of Data for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets		
Item Number	Informational Item	Data
1	Commercial Refrigerated Display Merchandiser or Storage Cabinet Model Number	
2	Adjusted Dew Point, °F [°C]	
3	Load Capacity, Btu/h [kW]	
4	Refrigerated Volume, ft^3 [m^3]/Unit of Length, ft [m]	
5	Total Display Area, ft^2 [m^2]/Unit of Length, ft [m]	
6	Commercial Refrigerated Display Merchandiser or Storage Cabinet Test Voltage, V	
7	Commercial Refrigerated Display Merchandiser or Storage Cabinet Evaporator Dew Point Temperature, °F [°C]	
8	Integrated Average Temperature of Product Simulators, °F [°C]	
9	CEC, kW·h/ft [kW·h/m] per day	
10	FEC, kW·h/ft [kW·h/m] per day	
11	LEC, kW·h/ft [kW·h/m] per day	
12	PEC, kW·h/ft [kW·h/m] per day	
13	AEC, kW·h/ft [kW·h/m] per day	
14	DEC, kW·h/ft [kW·h/m] per day	
15	CDEC, kW·h/ft [kW·h/m] per day	
16	Other Loads, Notes:	

Table 4. Presentation of Data for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets		
Item Number	Informational Item	Data
1	Commercial Refrigerated Display Merchandiser or Storage Cabinet Model Number	
2	Refrigerated Volume, ft^3[m^3]/Unit of Length, ft [m]	
3	Total Display Area, ft^2[m^2]/Unit of Length, ft [m]	
4	Commercial Refrigerated Display Merchandiser or Storage Cabinet Test Voltage, V	
5	Integrated Average Temperature of Product Simulators, °F [°C]	
6	TDEC, kW·h/ft [kW·h/m] per day	
7	Other Loads, Notes:	

APPENDIX A. REFERENCES – NORMATIVE

A1 Listed here are all standards, handbooks, and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of this standard.

A1.1 ANSI/AHAM Standard HRF-1-2004, *Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers, and Freezers,* 2004 Association of Home Appliance Manufacturers, 1111 19th Street NW, Suite 402, Washington, DC 20036 .

A1.2 ANSI/ASHRAE Standard 72-2005, *Method of Testing Commercial Refrigerators and Freezers,* 2005, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A1.3 ARI Standard 110-2002, *Air-Conditioning and Refrigerating Equipment Nameplate Voltages*, 2002, Air-Conditioning and Refrigeration Institute, 4100 N. Fairfax Drive, Suite 200, Arlington, VA 22203, U.S.A.

A1.4 ASHRAE, *Terminology of Heating, Ventilation Air Conditioning and Refrigeration*, Second Edition, 1991, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E. Atlanta, GA 30329, U.S.A.

A1.5 IEC Standard 60038, *IEC Standard Voltages*, 2002, International Electrotechnical Commission, 3, rue de Varembe, P. O. Box 131, 1211 Geneva 20, Switzerland.

APPENDIX B. REFERENCES – INFORMATIVE

None

APPENDIX C. COMMERCIAL REFRIGERATED DISPLAY MERCHANDISER AND STORAGE CABINET LOAD LINE VOLUME CALCULATION – NORMATIVE

C1 The commercial refrigerated display merchandiser refrigerated Volume (V_r) equals the gross refrigerated area (A_r) multiplied by the case length (L). The gross refrigerated area shall be calculated within the manufacturer's specified load limit lines, without display devices installed in the Commercial Refrigerated Display Merchandiser, and shall be calculated using straight-line segments following the interior of the Commercial Refrigerated Display Merchandiser without display devices installed. The sample cross sections shown in Figure C1 shall be used as a guide in equation C1.

$$V_r = A_r \cdot L \qquad \text{C1}$$

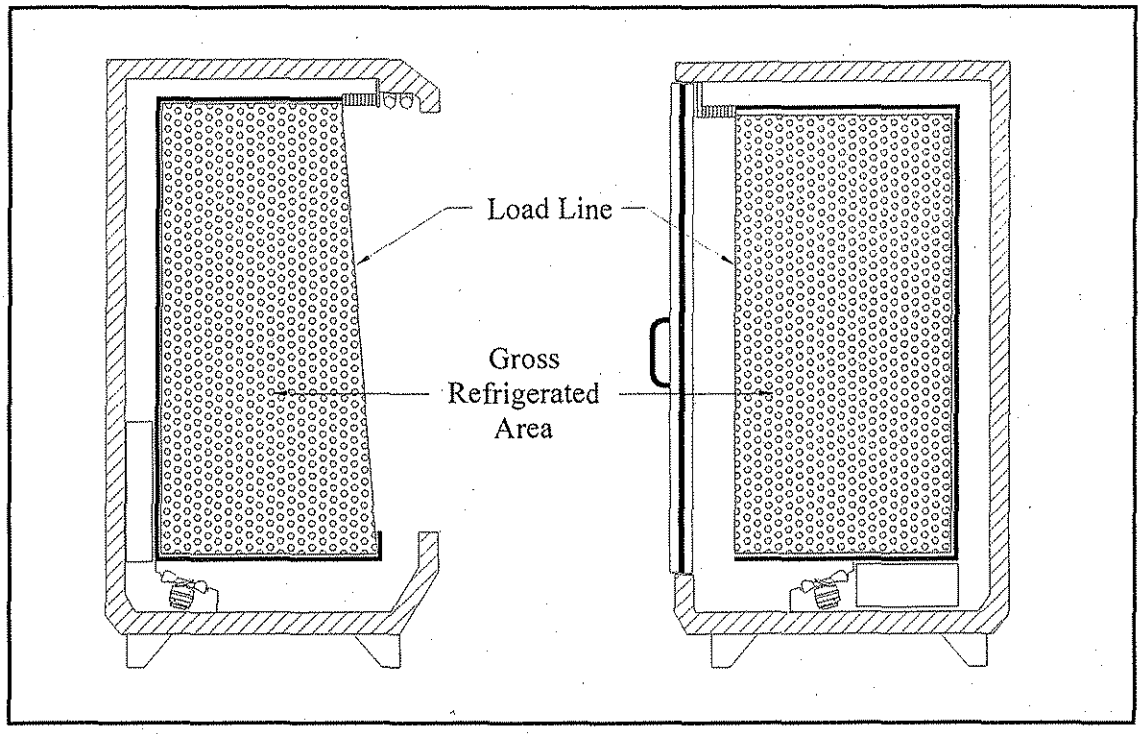


Figure C1: Sample Cross Sections of Commercial Refrigerated Display Merchandisers for Load Line Volume Calculation

C2 The commercial refrigerated storage cabinet refrigerated Volume (V_r) equals the gross refrigerated area (A_r) multiplied by the case length (L). The gross refrigerated area shall be calculated within the manufacturer's specified load limit. The gross refrigerated area shall be calculated using straight-line segments following the interior of the Commercial Refrigerated Storage Cabinet without display devices installed. The sample cross section in Figure C2 shall be used as a guide in equation C1.

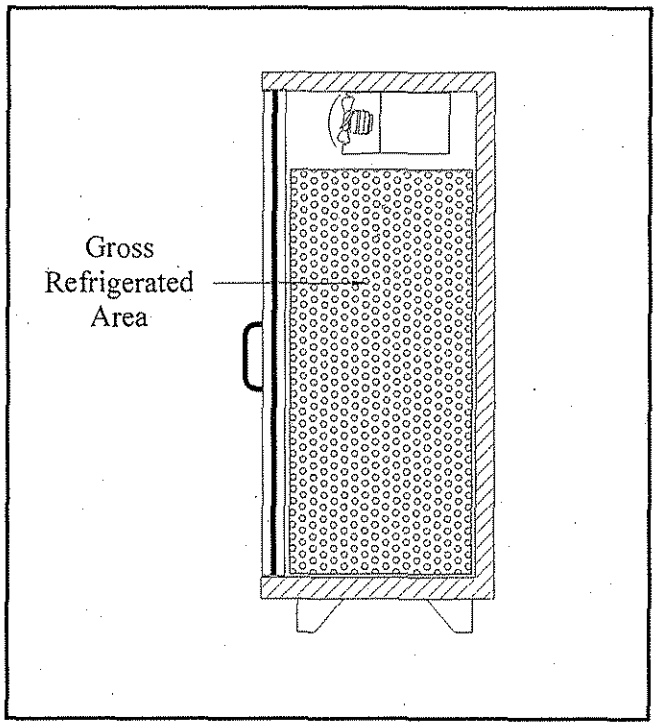


Figure C2: Sample Cross Section of Commercial Refrigerated Storage Cabinets for Volume Calculation

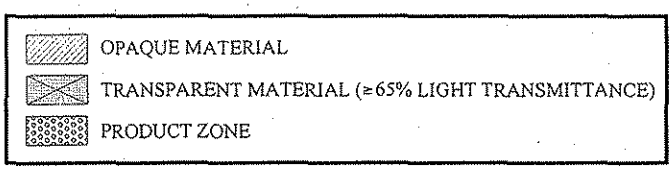
APPENDIX D. COMMERCIAL REFRIGERATED DISPLAY MERCHANDISER TOTAL DISPLAY AREA (TDA) CALCULATION - NORMATIVE

The Total Display Area (TDA) is the sum of the projected area(s) for visible product, ft^2 [m^2].

$$TDA = D_h \cdot L + A_e \qquad D1$$

A_e = Projected area from visible product through end walls (Figures D13 to D16)
D_h = Dimension of projected visible product (Figures D1 to D12)
L = Length of Commercial Refrigerated Display Merchandiser

Note: For unique geometries, the TDA shall be calculated manually. Refer to Figure D17



Nominal Length Display Merchandisers:

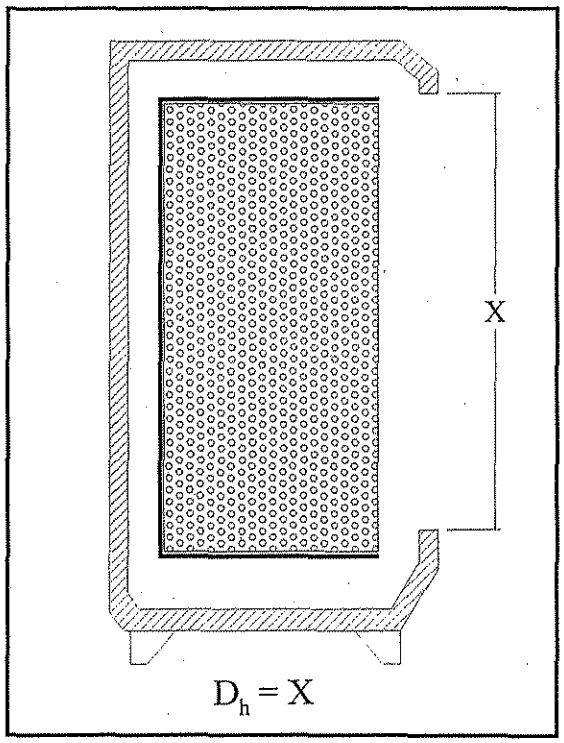


Figure D1: Vertical Multi-deck

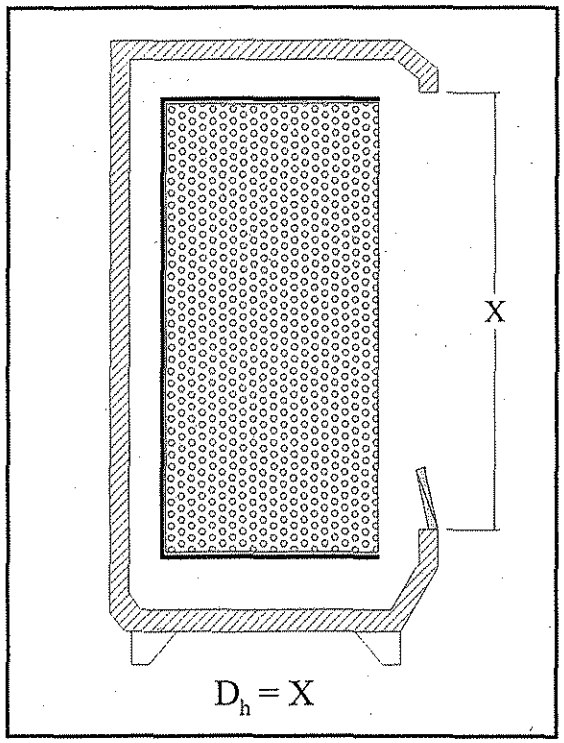


Figure D2: Vertical Multi-deck with Transparent Front

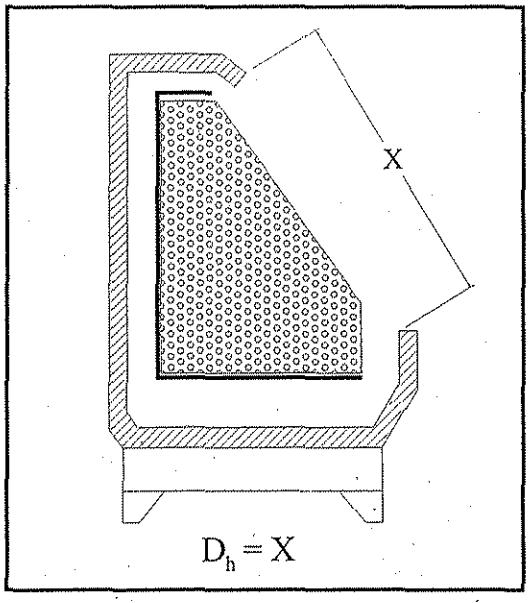


Figure D3: Semi-vertical Multi-deck

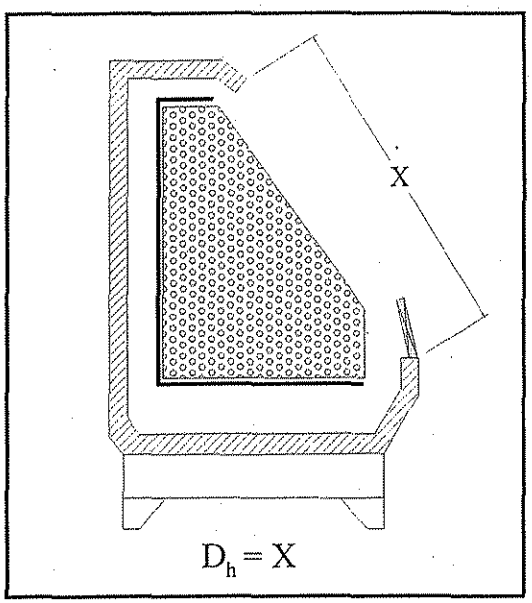


Figure D4: Semi-vertical Multi-deck with Transparent Front

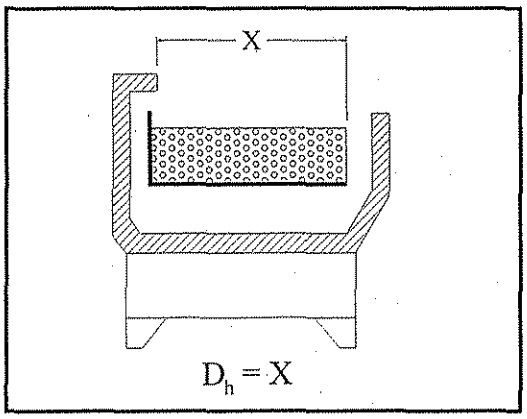


Figure D5: Horizontal Single-deck

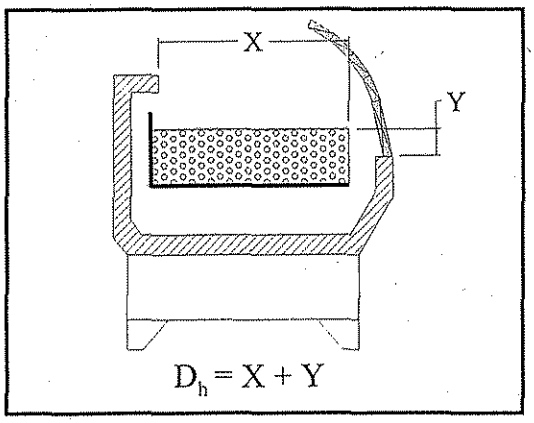


Figure D6: Horizontal Single-deck with Transparent Front

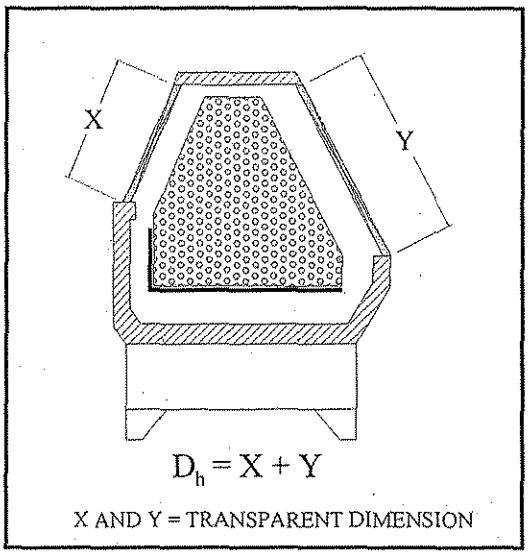


Figure D7: Serve Over Counter with Flat Transparent Front

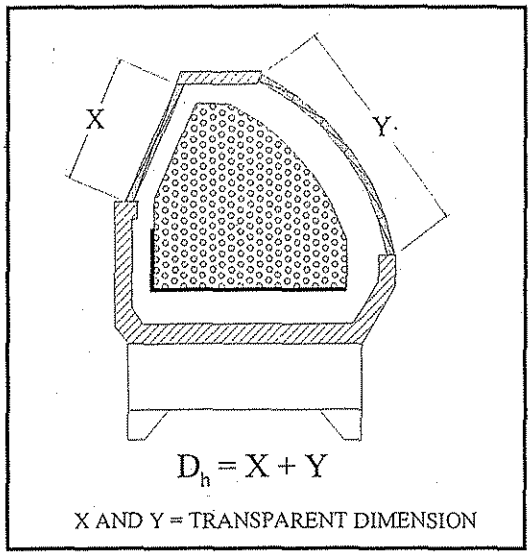


Figure D8: Serve Over Counter with Curved Transparent Front

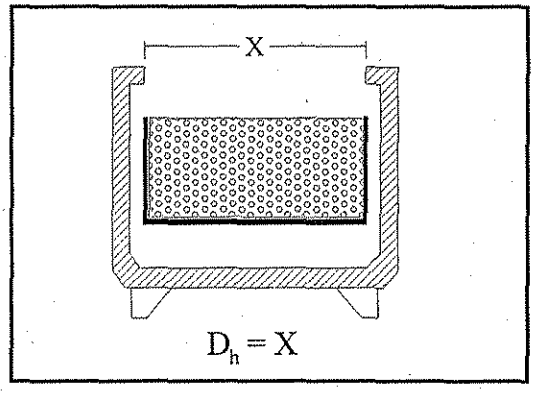


Figure D9: Horizontal Single-deck Island

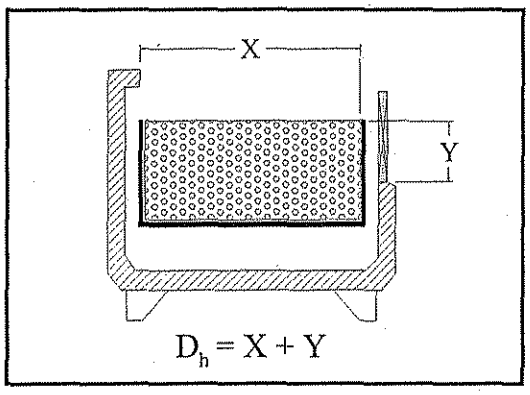


Figure D10: Horizontal Single-deck Island with Transparent Wall

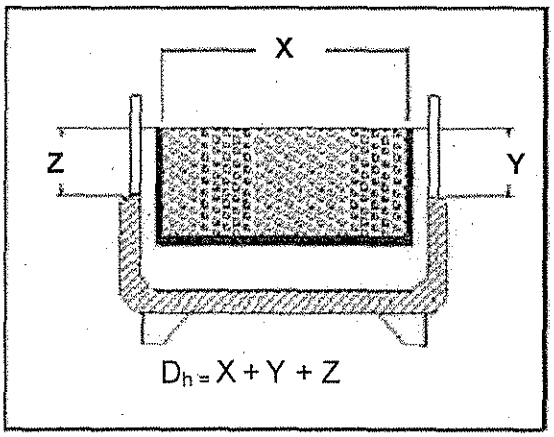


Figure D11: Horizontal Single-deck Island with Transparent Walls

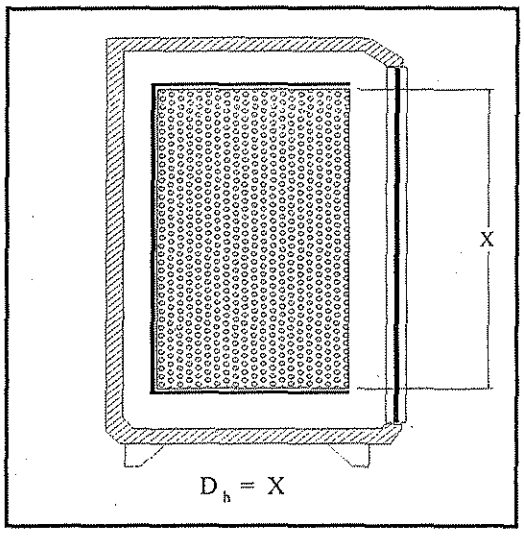


Figure D12: Vertical Multi-deck with Transparent Door

End Walls:

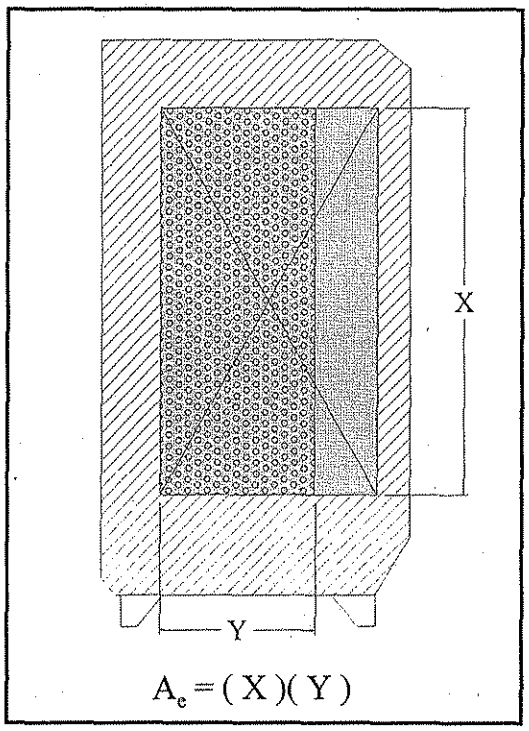


Figure D13: Vertical Multi-deck End Wall With Transparent Section

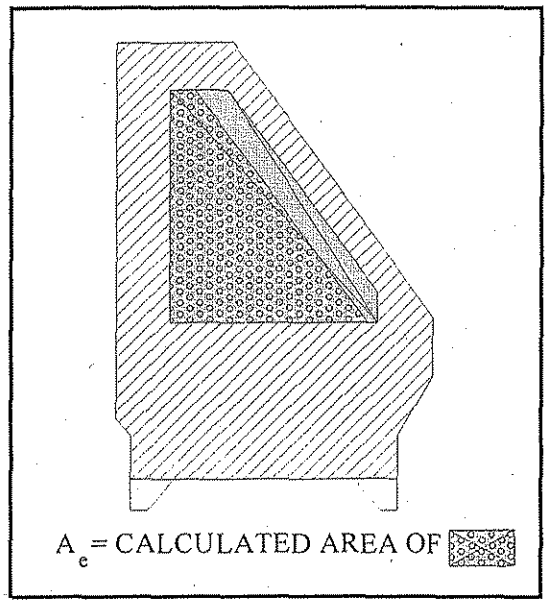


Figure D14: Semi-vertical Multi-deck End Wall with Transparent Section

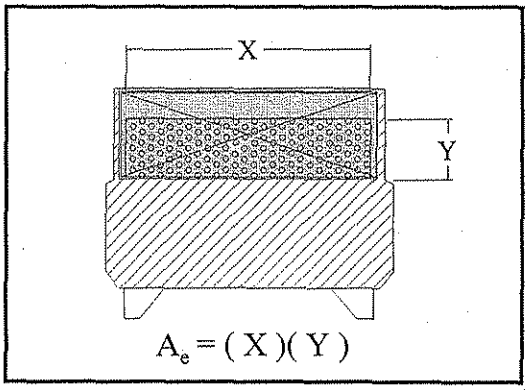


Figure D15: Horizontal Single-deck and Single-deck Island End Wall with Transparent Section

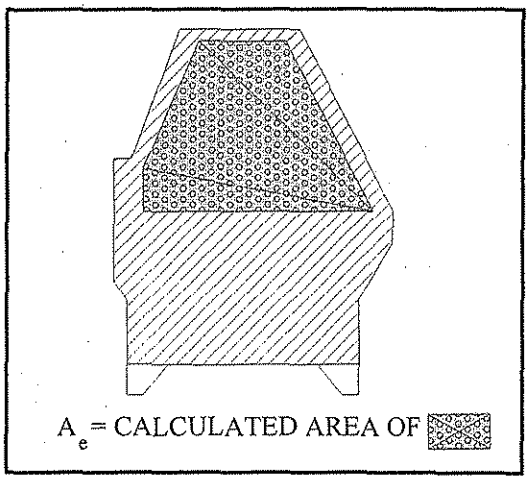


Figure D16: Serve Over Counter End Wall with Transparent Section

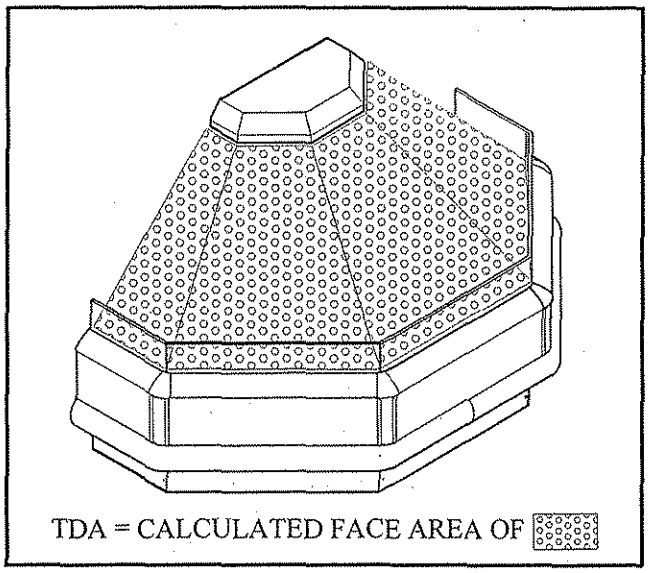


Figure D17: Example TDA for Unique Geometries

APPENDIX E. EXAMPLE – ENERGY PERFORMANCE REPRESENTATION FOR A REMOTE COMMERCIAL REFRIGERATED DISPLAY MERCHANDISER OR STORAGE CABINET – INFORMATIVE

E1 *Example of Performance Calculation and Presentation (I-P Units Only).*

E1.1 *Situation.* A manufacturer produces a remote commercial refrigerated display dairy merchandiser for Medium Temperature Applications in 4.0 ft, 6.0 ft, 8.0 ft, and 12.0 ft lengths. The gross refrigerated area of these cases is 11.67 ft^2 and the dimension of projected visible product is 4.35 ft. The cross-sections of all cases with this model are identical. The display case is rated at 120 V.

E1.2 *Measured Results* (per ANSI/ASHRAE Standard 72 Energy Calculations).

-Remote unit 12.0 ft long (actual measured interior length) with two solid end walls.
-Capacity load: 16,400 Btu/h at 23.0°F evaporator temperature
-Integrated Average Temperature = 37.6°F
-Fan power = 60 W (fans on during defrost)
-Anti-condensate power = 0 W
-Lighting watts = 294 W (located in the refrigerated space)
-Electric defrost power = 0 W (off cycle)
-Condensate pan power = 0 W (none)
-Number of defrosts in 24 h = 4
-Length of each defrost = 0.6 h

E1.3 *Energy Performance Calculations.*

E1.3.1 *Calculation of Refrigerated Volume.*

$$V_r = A_r \cdot L$$
$$= 11.67 \cdot 12.0 = 140 \text{ ft}^3 \quad \text{E1}$$

E1.3.2 *Calculation of TDA.*

$$TDA = (D_h \cdot L) + A_e$$
$$= (4.35 \cdot 12) + 0 = 52.2 \text{ ft}^2 \quad \text{E2}$$

E1.3.3 *Calculation of CEC.*

EER (Table 1) based on 21.0°F Adjusted Dew Point (23.0°F for Medium Temperature Applications) = 12.82

Defrost total time = 4 x 0.6 = 2.4 h

$$CEC = [(Q_n / L) \cdot (t - t_d)] / (EER \cdot 1000) \quad \text{E3}$$
$$= [(16{,}400 / 12.0) \cdot (24 - 2.4)] / (12.82 \cdot 1000)$$
$$= 2.30 \text{ kW·h/ft per day}$$

E1.3.4 *Calculation of FEC.*

$$FEC = (P_{fi} \cdot t_f) / (L \cdot 1000) \quad \text{E4}$$
$$= (60 \cdot 24) / (12.0 \cdot 1000)$$
$$= 0.12 \text{ kW·h/ft per day}$$

E1.3.5 *Calculation of LEC.*

$$LEC = (P_{li} \cdot t_l) / (L \cdot 1000) \quad \text{E5}$$
$$= (294 \cdot 24) / (12.0 \cdot 1000)$$
$$= 0.59 \text{ kW·h/ft per day}$$

E1.3.6 *Calculation of AEC.*

$$AEC = 0 \text{ kW·h/ft per day}$$

E1.3.7 *Calculation of DEC.*

$$DEC = 0 \text{ kW·h/ft per day}$$

E1.3.8 *Calculation of PEC.*

$$PEC = 0 \text{ kW·h/ft per day}$$

E1.3.9 *Calculation of CDEC.*

$$CDEC = CEC + FEC + LEC + AEC + DEC + PEC \quad \text{E6}$$
$$= 2.30 + 0.12 + 0.59 + 0 + 0 + 0$$
$$= 3.01 \text{ kW·h/ft per day}$$

E1.4 *Presentation of CDEC Data.* Refer to Table E1 for correct display of performance data.

E2 *Example of Performance Calculation and Presentation with Component Substitution (I-P Units Only).*

E2.1 *Situation.* The manufacturer of the case in the situation shown in Section E1 substitutes the lamp ballasts with new ballasts.

E2.2 *Nameplate Data.* The original ballast had a nameplate rating of 294 W. The new ballast has a nameplate rating of 360 W.

E2.3 *Energy Performance Calculations with Component Substitution.*

E2.3.1 *Calculation of Revised Light Energy Consumption.*

$$LEC_R = (P_s \cdot t_l) / (L \cdot 1000) \quad \text{E7}$$
$$= (360 \cdot 24) / (12.0 \cdot 1000)$$
$$= 0.72 \text{ kW·h/ft per day}$$

E2.3.2 *Calculation of revised Compressor Energy Consumption.*

a. *Calculation of CEC_A.*

$$CEC_A = [(P_s \cdot t_s) - (P_o \cdot t_o)] / (COP \cdot L \cdot 1000) \quad \text{E8}$$
$$= [(360 \cdot 24) - (294 \cdot 24)] / (3.76 \cdot 12 \cdot 1000)$$
$$= 0.04 \text{ kW·h/ft per day}$$

b. *Calculation of CEC_R.*

$$CEC_R = CEC + CEC_A \quad \text{E9}$$
$$= 2.30 + 0.04$$
$$= 2.34 \text{ kW·h/ft per day}$$

c. *Calculation of Revised CDEC.*

$$CDEC = CEC_R + FEC + LEC_R + AEC + DEC + PEC \quad \text{E10}$$
$$= 2.34 + 0.12 + 0.72 + 0 + 0$$
$$= 3.18 \text{ kW·h/ft per day}$$

Table E1. Sample Presentation of Data for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets

Item Number	Informational Item	I-P Data
1	Commercial Refrigerated Display Merchandiser or Storage Cabinet Model Number	Model X
2	Adjusted Dew Point, °F	21
3	Load Capacity, Btu/h	16,400
4	Refrigerated Volume, ft^3/Unit of Length, ft	11.67
5	Total Display Area, ft^2	52.2
6	Commercial Refrigerated Display Merchandiser or Storage Cabinet Test Voltage, V	120
7	Commercial Refrigerated Merchandiser or Storage Cabinet Case Evaporator Dew Point Temperature, °F	23.0
8	Integrated Average Temperature of Product Simulators, °F	37.6
9	CEC, kW·h/ft per day	2.30
10	FEC, kW·h/ft per day	0.120
11	LEC, kW·h/ft per day	0.59
12	PEC, kW·h/ft per day	N/A
13	AEC, kW·h/ft per day	0.0
14	DEC, kW·h/ft per day	0.0
15	CDEC, kW·h/ft per day	3.01
16	Other Loads, Notes:	

APPENDIX F. EXAMPLE – ENERGY PERFORMANCE REPRESENTATION FOR A SELF-CONTAINED COMMERCIAL REFRIGERATED DISPLAY MERCHANDISER OR STORAGE CABINET– INFORMATIVE

F1 *Example of Performance Calculation and Presentation (I-P Units).*

F1.1 *Situation.* A manufacturer produces a self-contained commercial refrigerated display bakery merchandiser for Medium Temperature Applications in 4.0 ft, 6.0 ft, and 8.0 ft lengths. The gross refrigerated area of these cases is 3.95 ft^2 and the dimension of projected visible product is 3.81 ft. The cross-sections of all cases with this model are identical. The display merchandiser is rated at 120 V.

F1.2 *Measured Results* (per ANSI/ASHRAE Standard 72).

- Self-contained commercial refrigerated display bakery merchandiser, 4.0 ft long (actual measured interior length) with two end walls each containing 2.74 ft^2 of transparent area.
- Integrated Average Temperature = 38.2°F (measured 24 hour total)
- Total energy measured for 24 hour period = 21.2 kW·h per day

F1.3 *Energy Performance Calculations.*

F1.3.1 *Calculation of Gross Volume.*

$$V_r = A_r \cdot L \qquad \text{F1}$$
$$= 3.95 \cdot 4.0$$
$$= 15.8 \text{ ft}^3$$

F1.3.2 *Calculation of TDA.*

$$TDA = (D_h \cdot L) + A_e \qquad \text{F2}$$
$$= (3.81 \cdot 4) + (2.74 \cdot 2)$$
$$= 20.7 \text{ ft}^2$$

F1.3.3 *Calculation of TDEC.*

$$TDEC = E_t / L \qquad \text{F3}$$
$$= 21.2 / 4.0$$
$$= 5.30 \text{ kW·h/ft per day}$$

F1.4 *Presentation of TDEC Data.* Refer to Table F1 for display of performance data.

Table F1. Sample Presentation of Data for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets		
Item Number	Informational Item	I-P Data
1	Commercial Refrigerated Display Merchandiser or Storage Cabinet Model Number	Model X
2	Refrigerated Volume, ft^3/Unit of Length, ft	3.95
3	Total Display Area, ft^2	20.7
4	Commercial Refrigerated Display Merchandiser or Storage Cabinet Test Voltage, V	120
5	Integrated Average Temperature of Product Simulators, °F	38.2
6	TDEC, kW·h/ft per day	5.30
7	Other Loads, Notes:	
	E_t, Total energy for 24 hour period, kW·h [kW·h] per day	21.2