

**ANSI/AHRI Standard 1200-2023 (I-P)**

**2023 Standard for**

# **Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets**



Approved by ANSI on 12 June 2023



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ICS Code: 97.130.20

Note:

This standard supersedes ANSI/AHRI Standard 1200-2013 (I-P).

For SI ratings, see ANSI/AHRI Standard 1201-2013 (SI).

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## **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.

## **Review and Amendment**

This standard is subject to review and amendment as technology advances.

## **2023 Edition**

This edition of AHRI Standard 1200-2023 (I-P), Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets was prepared by the Commercial Refrigeration Standards Technical Committee. It was approved by the Refrigeration Standards Subcommittee on 12 April 2023. It was approved as an American National Standard (ANS) on 12 June 2023.

## **Origin and Development of AHRI 1200**

In 2002 the Commercial Refrigerator Manufacturers Division of ARI identified the need for a commercial refrigeration standard to assure that perishable foods stored, displayed, and dispensed in retail stores throughout the world for off-premises consumption are protected throughout the final stage in the distribution process. The first edition was developed providing a method whereby electrical energy consumption values of commercial refrigerators and freezers are determined using consistent and repeatable methods.

In 2004 ARI 1200 was harmonized with EN 441. Appendix D was added to provide TDA calculations. Section 3, Section 5.4, Table 3, and Table 4 were revised to include references to TDA calculations.

In 2006 changes were made to Section 5 and Appendix E to address energy differences for ballasts inside and outside the refrigerated area.

In 2008 the rating requirements were updated with a secondary method.

In 2010 the Commercial Refrigerator Manufacturers Section (CRM) made changes to Section 2.2 and Section 3.14. Appendix C was added to have consistency with DOE rule.

In 2013 changes were made to incorporate five interpretations and new DOE rules.

AHRI Standard 1200-2023 (I-P) contains the following update(s) to the previous edition:

- TDA figures and equations were updated for alignment with DOE TP and Standard.
- The Energy Efficiency Ratio (EER) table updated for refrigerant dependability and glide concerns.
- Refrigerant glide updated to in sections 4 and 5 including definition, and rating requirement sections.
- Definitions updated to include Ice cream applications and edits to existing definitions.
- Added lighting options and updates to ASHRAE 72.
- Definition section updated to include lighting, and sensors to align with DOE TP requirements.
- Added various product types.
- Consideration of non-standard operating temperatures.

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#### **Commercial Refrigeration Standards Technical Committee Scope:**

The Commercial Refrigeration Standards Technical Committee (STC) is responsible for the development and maintenance of AHRI standards and guidelines pertaining to the performance ratings of Commercial Refrigerated Equipment that may include Display Merchandisers and Storage Cabinets, Walk-in Coolers and Freezers including insulated envelop and systems.

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**Refrigeration Standards Subcommittee Scope:**

Scope of the Refrigeration Standards Subcommittee is standards and guidelines related to the end products that are part of the AHRI Refrigeration Industry Sector.

These committee lists represent the membership at the time the Technical Committee and Standards Subcommittee were balloted on the final text of this edition. Since that time, changes in the membership may have occurred. Membership on these committees shall not in and of itself constitute an endorsement by the committee members, employers of AHRI, or any document developed by the committee on which the member serves.

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**TABLE OF CONTENTS**

Section

**SECTIONS**

Section 1. Purpose ..... 1  
Section 2. Scope..... 1  
Section 3. Definitions ..... 1  
Section 4. Test Requirements ..... 4  
Section 5. Rating Requirements..... 5  
Section 6. Minimum Data Requirements for Published Ratings ..... 9  
Section 7. Marking and Nameplate Data ..... 11  
Section 8. Conformance Conditions ..... 11  
Section 9. Symbols and Subscripts ..... 11

**FIGURES**

Figure 1. Sample Front View of Commercial Refrigerated Display Merchandisers for Illustrating Length of Refrigerated Space ..... 17  
Figure 2. Sample Cross Section of Commercial Refrigerated Storage Cabinets for Refrigerated Volume Calculation..... 17  
Figure 3. Three-door Vertical Closed Transparent Display Case ..... 18  
Figure 4. Vertical Open Multi-deck..... 20  
Figure 5. Vertical Open Multi-deck with Transparent Front ..... 20  
Figure 6. Semi-vertical Open Multi-deck with Smaller Product Zone ..... 21  
Figure 7. Semi-vertical Open Multi-deck with Transparent Front..... 21  
Figure 8. Horizontal Open Single-deck ..... 22  
Figure 9. Horizontal Open Single-deck with Transparent Front..... 22  
Figure 10. SOC with Flat Transparent Front ..... 23  
Figure 11. SOC with Curved Transparent Front..... 23  
Figure 12. SOC with Flat Transparent Front and Top ..... 24  
Figure 13. Horizontal Open Single-deck Island..... 24  
Figure 14. Horizontal Open Single-deck Island with Transparent Wall..... 25  
Figure 15. Island with Transparent Walls..... 26  
Figure 16. Vertical Closed Multi-deck with Transparent Doors..... 26  
Figure 17. Vertical End Wall with Transparent Section ..... 27  
Figure 18. Semi-vertical End Wall with Transparent Section ..... 28  
Figure 19. Horizontal Single-deck and Single-deck Island End Wall with Transparent Section..... 28  
Figure 20. SOC End Wall with Transparent Section ..... 29  
Figure 21. Example TDA for Unique Geometries ..... 29  
Figure 22. Example TDA for Unique Geometries ..... 30  
Figure 23. Example TDA for Unique Geometries ..... 30  
Figure 24. Radius Cases with Transparent Sides ..... 31  
Figure 25. Mitered Wedge TDA Calculation..... 32  
Figure 26. Curved Wedge TDA Calculation ..... 33

**TABLES**

Table 1. EER for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets ..... 8  
Table 2 Example Presentation of Data for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets .. 10  
Table 3 Example Presentation of Data for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets ..... 11

**APPENDICES**

Appendix A. References – Normative ..... 14  
Appendix B. References - Informative ..... 15  
Appendix C. Commercial Refrigerated Display Merchandiser and Storage Cabinet Refrigerated Volume Calculation – Normative ..... 16  
Appendix D. Commercial Refrigerated Display Merchandiser and Storage Cabinet Total Display Area (TDA) Calculation – Normative ..... 18  
Appendix E. Example – Calculation of CEC for Commercial Refrigerated Display Merchandiser or Storage Cabinet Tested with a High-glide Refrigerant– Informative ..... 34  
Appendix F. Energy Calculations Using Alternate Components – Informative ..... 35



# 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.

## 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 or thermoelectric systems:

- Self-contained and Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets; and
- Open and Closed Commercial Refrigerated Display Merchandisers

### 2.2 *Exclusions*

This standard does not apply to the following:

- Refrigerated vending machines
- Ice makers
- Soft serve extruders
- Secondary coolant applications
- Chef bases
- Buffet tables
- Preparation tables
- Walk-in coolers
- Blast chillers and freezers

## Section 3. Definitions

All terms in this document will follow the standard industry definitions in the ASHRAE Terminology website unless otherwise defined in this section.

### 3.1 *Expressions of Provision*

Terms that provide clear distinctions between requirements, recommendations, permissions, options, and capabilities.

#### 3.1.1 *“Can” or “cannot”*

Express an option or capability.

#### 3.1.2 *“May”*

Signifies a permission expressed by the document.

#### 3.1.3 *“Must”*

Indication of unavoidable situations and does not mean that an external constraint referred to is a requirement of the document.

#### 3.1.4 *“Shall” or “shall not”*

Indication of mandatory requirements to strictly conform to the standard and where deviation is not permitted.

**3.1.5** *“Should” or “should not”*

Indication of recommendations rather than requirements. In the negative form, a recommendation is the expression of potential choices or courses of action that is not preferred but not prohibited.

**3.2** *Standard Specific Definitions:*

**3.2.1** *Anti-condensate Energy Consumption (AEC)*

The energy consumed to prevent collection of or evaporate condensate, or both on the outside of the Commercial Refrigerated Display Merchandiser or Storage Cabinet, that includes fan and condensate heater energy expressed in kW·h per day.

**3.2.2** *Calculated Daily Energy Consumption (CDEC)*

A value for Remote Commercial Refrigerated Display Merchandisers or Storage Cabinets based upon the requirements of this standard expressed in kW·h per day.

**3.2.3** *Commercial Refrigerated Display Merchandiser*

A cabinet cooled by a refrigerating system for displaying chilled or frozen products, or both, maintained within prescribed temperature limits.

**3.2.3.1** *Closed Commercial Refrigerated Display Merchandiser*

A refrigerated display merchandiser where product is accessible for removal by opening or moving doors, drawers, or panels.

**3.2.3.2** *Open Commercial Refrigerated Display Merchandiser*

A refrigerated display merchandiser where product is accessible for removal without opening or moving doors, drawers, or panels.

**3.2.3.3** *Remote Commercial Refrigerated Display Merchandiser*

A refrigerated display merchandiser that is refrigerated by a field-installed condensing unit or refrigerating system.

**3.2.3.4** *Self-contained Commercial Refrigerated Display Merchandiser*

A refrigerated display merchandiser that has all the refrigerant-containing parts of the refrigerating system completely factory assembled and tested.

**3.2.3.5** *Service Over Counter (SOC)*

A commercial refrigerated display merchandiser equipped with sliding or hinged doors, drawers, or open in the back, intended for use by sales personnel, and with glass or other transparent material in the front for displaying merchandise. The equipment has a height not greater than sixty-six inches and is intended to serve as a counter for transactions between sales personnel and customers.

**3.2.4** *Commercial Refrigerated Storage Cabinet*

A closed cabinet cooled by a refrigerating system for storing chilled or frozen products, or both maintained within prescribed temperature limits.

**3.2.4.1** *Remote Commercial Refrigerated Storage Cabinet*

A refrigerated storage cabinet that is refrigerated by a field-installed condensing unit or refrigerating system.

**3.2.4.2** *Self-contained Commercial Refrigerated Storage Cabinet*

A refrigerated storage cabinet that has all the refrigerant-containing parts of the refrigerating system completely factory assembled and tested.

**3.2.5** *Compressor Energy Consumption (CEC)*

The energy consumed by the compressor expressed in kW·h per day.

- 3.2.6** *Condensate Evaporator Pan Heater Energy Consumption (PEC)*  
The energy consumed by the condensate evaporator pan heater expressed in kW·h per day.
- 3.2.7** *Defrost Energy Consumption (DEC)*  
The energy consumed by the defrost heater(s) expressed in kW·h per day.
- 3.2.8** *Dew Point*  
Refrigerant vapor saturation temperature at a specified pressure expressed in °F.
- 3.2.8.1** *Adjusted Dew Point*  
An adjusted temperature lower than actual Dew Point temperature expressed in °F, resulting from suction line pressure losses, equal to saturated suction temperature at the compressor.
- 3.2.9** *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).
- 3.2.10** *Fan Energy Consumption (FEC)*  
The energy consumed by fan motors expressed in kW·h per day.
- 3.2.11** *High Glide Refrigerant*  
A zeotropic refrigerant blend with a temperature glide that is greater than 2°F. Examples include but are not limited to R-407A, R-407C, R-407F, R-448A, and R-449A.
- 3.2.12** *Integrated Average Temperature*  
The average of all test package measurements taken during the test expressed in °F.
- 3.2.13** *Lighting Energy Consumption (LEC)*  
The energy consumed by the refrigerated display merchandiser or storage cabinet lighting used to illuminate interior refrigerated products expressed in kW·h per day.
- 3.2.14** *Product Applications*  
One of four temperature ranges that a Commercial Refrigerated Display Merchandiser or Storage Cabinet is intended to maintain.
- 3.2.14.1** *High Temperature Applications*  
An application where the Integrated Average Temperature is at, or above, 45°F.
- 3.2.14.2** *Ice Cream Applications*  
An application where the Integrated Average Temperature is at, or below, -5°F, and intended for the display, storage, or dispensing of ice cream.
- 3.2.14.3** *Low Temperature Applications*  
An application where the Integrated Average Temperature is at, or below, 32°F, and greater than -5°F.
- 3.2.14.4** *Medium Temperature Applications*  
An application where the Integrated Average Temperature is greater than 32°F, and less than 45°F.
- 3.2.14.5** *Lowest Application Product Temperature (LAPT)*  
For remote condensing equipment that is not capable of operating a successful test at a Standard Rating Condition, the LAPT is the temperature achieved with the Dew Point temperature set to the manufacturer's recommended setpoint. For self-contained equipment that is not capable of operating a successful test at a Standard Rating Condition, the LAPT is the temperature achieved at the lowest thermostat setting.

**3.2.15** *Published Rating*

A statement of the assigned values of those performance characteristics, under stated Rating Conditions, where a unit can be chosen to fit the application. These values apply to all units of the same nominal size and type (identification) produced by the same manufacturer. This 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.

**3.2.15.1** *Application Rating*

A rating based on tests performed at application Rating Conditions other than Standard Rating Conditions.

**3.2.15.2** *Standard Rating*

A rating based on tests performed at Standard Rating Conditions.

**3.2.16** *Rating Conditions*

Any set of operating conditions where a single level of performance results and causes only that level of performance to occur.

**3.2.16.1** *Standard Rating Conditions*

Rating Conditions used as the basis of comparison for performance.

**3.2.17** *Refrigerated Volume ( $V_r$ )*

The interior total volume of a Commercial Refrigerated Display Merchandiser or Storage Cabinet as calculated by Appendix C is intended to provide a uniform means of determining the dimensions used to calculate volume, taking into account the special features or functional components, or both that are located within the refrigerated compartment(s). The calculation is not intended to provide a means of measuring the product-storage capacity. This volume calculation only applies to Closed Commercial Refrigerated Display Merchandisers and Storage Cabinets.

**3.2.18** *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 per day.

**3.2.19** *Angle Normal*

The view from a vector perpendicular to a plane tangent to the surface, or the view that has an angle of 90 degrees from the surface.

**3.2.20** *Total Display Area (TDA)*

The sum of the projected area(s) of visible product, expressed in ft<sup>2</sup> such as portions where product can be viewed from an *angle normal*, or perpendicular, to the transparent area or opening, as calculated by Appendix D.

**3.2.20.1** *Transparent Surface*

A transparent surface has greater than or equal to 45% light transmittance, as determined in accordance with the ASTM Standard E 1084-86 (Reapproved 2015).

## Section 4. Test Requirements

**4.1** *Test Requirements*

The tests required for this standard shall be conducted in accordance with ASHRAE Standard 72-2022, except the applications and conditions included in this section.

**4.1.1** *Integrated Average Temperature*

An Integrated Average Temperature of the test simulators shall be maintained based on the Product Application.

- 4.1.1.1** *High Temperature Applications*  
Commercial Refrigerated Display Merchandisers and Storage Cabinets intended for High Temperature Applications shall have an Integrated Average Temperature of  $55^{\circ}\text{F} \pm 2.0^{\circ}\text{F}$ .
- 4.1.1.2** *Ice Cream Applications*  
Commercial Refrigerated Display Merchandisers and Storage Cabinets intended specifically for the storage, display or dispensing of ice cream shall have an Integrated Average Temperature of  $-15.0^{\circ}\text{F} \pm 2.0^{\circ}\text{F}$ . Equipment that is not designed, marketed, or intended specifically for the storage, display or dispensing of ice cream, is not qualified to be an “ice-cream application”. For example, multi-purpose equipment for *low temperature applications* manufactured for storage and display of frozen foods as well as ice cream do not meet the definition in Section 3.2.14.2.
- 4.1.1.3** *Low Temperature Applications*  
Commercial Refrigerated Display Merchandisers and Storage Cabinets intended for Low Temperature Applications to include storing and displaying frozen products, as well as ice cream products, shall have an Integrated Average Temperature of  $0.0^{\circ}\text{F} \pm 2.0^{\circ}\text{F}$ .
- 4.1.1.4** *Medium Temperature Applications*  
Commercial Refrigerated Display Merchandisers and Storage Cabinets intended for Medium Temperature Applications shall have an Integrated Average Temperature of  $38^{\circ}\text{F} \pm 2.0^{\circ}\text{F}$ .
- 4.1.1.5** *Lowest Application Product Temperature (LAPT)*  
Models not capable of maintaining Integrated Average Temperatures as specified in Section 4.1.1.1, through Section 3.2.14.5 shall be rated at the lowest Integrated Average Temperature a given unit is capable of maintaining to comply with the steady-state stabilization requirements specified in ASHRAE 72. For remote condensing equipment that is not capable of operating a successful test at a Standard Rating Condition, the LAPT is the temperature achieved with the Dew Point temperature set to the manufacturer’s recommended setpoint. For self-contained equipment that is not capable of operating a successful test at a Standard Rating Condition, the LAPT is the temperature achieved at the lowest thermostat setting. The manufacturer shall maintain and provide justification for the reason(s) that the product cannot obtain the Standard Rating Condition.

Note: Commercial Refrigerated Display Merchandisers and Storage Cabinets that are designed for use in multiple temperature applications as defined in Sections 3.2.14.1 through Section 3.2.14.5 by making set point adjustments should be rated under each applicable temperature specified.

- 4.1.2** *Electrical Conditions*  
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 published.
- 4.1.3** *Circulation of Air*  
For self-contained refrigerators designed to be installed next to a wall in the direction of the exhaust or intake, or both, a vertical partition or wall shall be located at the minimum clearance as specified in the installation instructions. If the installation instructions do not provide minimum clearance, the vertical partition or wall shall be located  $4 \pm 0.5$  in from the sides or rear of the cabinet and extend at least 12 in beyond each side of the cabinet from the floor to not less than 12 in above the top of the cabinet.

## Section 5. Rating Requirements

- 5.1** *Rating Requirements for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets*
- 5.1.1** *General*

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

### 5.1.2 CDEC for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets

The total electrical load shall be determined using Equation 1.

CEC shall be calculated as described in Section 5.1.2.1.

All other electrical loads shall be measured, either individually or at any shared power supply. These shall include evaporator fan motors, lighting, surface anti-condensate load including fans and heaters, defrost heaters, condensate evaporator pans and any other applicable electrical loads when these are part of the unit as seen in Equation 1.

The following calculations shall be done to determine the CDEC.

$$\text{CDEC} = \text{CEC} + [\text{FEC} + \text{LEC} + \text{AEC} + \text{DEC} + \text{PEC} + \text{OEC}] \quad 1$$

The values are expressed in kW·h per day.

Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets shall record any measured or calculated loads in the calculation of CDEC. Shown below are formulae for the required individual loads under the calculation approach.

#### 5.1.2.1 Calculation of CEC

The EER values in Table 1 shall be used to calculate CEC for a 24-hour period. See Equation 2.

The EER 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 and High Temperature Applications shall use an adjusted dew point temperature that is 2.0°F lower than the Commercial Refrigerated Display Merchandiser or Storage Cabinet Dew Point.

Commercial Refrigerated Display Merchandisers and Storage Cabinets for Low Temperature/Ice Cream Applications shall use an adjusted dew point temperature that is 3.0°F 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.

$$\text{CEC} = [(Q_{rt}) \cdot (t - \text{tdt})] / (\text{EER} \cdot 1000) \quad 2$$

For High Glide Refrigerants, the EER used in the CEC calculation shall be determined based on adjusted mid-point evaporator temperature.

The mid-point evaporator temperature,  $T_m$ , shall be calculated using the following steps (See Appendix E for example calculation):

- 1) The entering liquid refrigerant temperature and entering liquid refrigerant pressure of the Commercial Refrigerated Display Merchandiser or Storage Cabinet shall be used to calculate the entering refrigerant enthalpy,  $h_i$ .
- 2) The entering refrigerant enthalpy and suction vapor pressure shall be used to calculate the inlet evaporator refrigerant temperature,  $T_i$ .
- 3) The saturated suction refrigerant Dew Point temperature,  $T_{sd}$ , shall be calculated from the suction vapor pressure.
- 4) The inlet evaporator refrigerant temperature shall be subtracted from the saturated suction refrigerant Dew Point temperature to determine the total refrigerant glide in the evaporator.  
 $T_{sd} - T_i = T_g$
- 5) Divide  $T_g$  by 2 and subtract this number from  $T_{sd}$ .
- 6) Round the result to the nearest integer to find  $T_m$ , the mid-point evaporator temperature.

$T_m - 2.0^\circ\text{F}$  (for Medium Temperature and High Temperature Applications) shall then be used as the adjusted dew point to determine the EER from Table 1.

$T_m - 3.0^\circ\text{F}$  (for Low Temperature and Ice Cream Applications) shall then be used as the adjusted dew point to determine the EER from Table 1.

Linear interpolation shall be used to calculate EER values for temperatures not shown in Table 1

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

Medium Temperature and High Temperature				Low Temperature/Ice Cream	
Adjusted Dew Point	EER	Adjusted Dew Point	EER	Adjusted Dew Point	EER
°F		°F		°F	
0.0	9.25	28.0	14.47	-36.0	5.48
1.0	9.37	29.0	14.73	-35.0	5.56
2.0	9.50	30.0	14.98	-34.0	5.64
3.0	9.63	31.0	15.27	-33.0	5.73
4.0	9.76	32.0	15.56	-32.0	5.81
5.0	9.87	33.0	15.84	-31.0	5.90
6.0	10.03	34.0	16.13	-30.0	5.98
7.0	10.19	35.0	16.42	-29.0	6.06
8.0	10.36	36.0	16.63	-28.0	6.15
9.0	10.52	37.0	16.93	-27.0	6.24
10.0	10.69	38.0	17.23	-26.0	6.33
11.0	10.87	39.0	17.53	-25.0	6.41
12.0	11.05	40.0	17.84	-24.0	6.50
13.0	11.22	41.0	18.15	-23.0	6.60
14.0	11.40	42.0	18.47	-22.0	6.70
15.0	11.58	43.0	18.79	-21.0	6.78
16.0	11.79	44.0	19.12	-20.0	6.88
17.0	11.99	45.0	19.45	-19.0	6.98
18.0	12.19	46.0	19.79	-18.0	7.08
19.0	12.39	47.0	20.13	-17.0	7.19
20.0	12.59	48.0	20.48	-16.0	7.29
21.0	12.85	49.0	20.83	-15.0	7.39
22.0	13.04	50.0	21.19	-14.0	7.49
23.0	13.27	51.0	21.55	-13.0	7.60
24.0	13.49	52.0	21.91	-12.0	7.70
25.0	13.72	53.0	22.28	-11.0	7.81
26.0	13.95	54.0	22.66	-10.0	7.92
27.0	14.18	55.0	23.04	-9.0	8.03
				-8.0	8.14
				-7.0	8.25
				-6.0	8.36
				-5.0	8.48
				-4.0	8.59
				-3.0	8.71
				-2.0	8.83
				-1.0	8.95

## Notes:

- EER values at High, Medium, and Low Temperature/Ice Cream Applications are based on a reciprocating compressor.
- Refer to section 5.1.2.1 when calculating EER.



**5.1.3** *Refrigerated Volume*

The Refrigerated Volume of the Commercial Refrigerated Display Merchandiser or Storage Cabinet shall be calculated and recorded as described in Appendix C.

**5.1.4** *Total Display Area*

The TDA of the Commercial Refrigerated Display Merchandiser shall be calculated and recorded based on the equation as described in Appendix D, if applicable.

**5.1.5** *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%.

**5.1.6** *Multiples*

The CDEC, in kW·h per day, shall be expressed in 0.01 kW·h per day increments.

**5.2** *Rating Requirements for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets***5.2.1** *General*

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

**5.2.2** *TDEC for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets*

The total electrical load shall be measured to determine TDEC (see Equation 3). 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 applicable electrical loads when these are part of the unit:

$$\text{TDEC} = E_t \quad 3$$

The values are expressed in kW·h per day.

**5.2.3** *Refrigerated Volume*

The Refrigerated Volume of the Commercial Refrigerated Display Merchandiser or Storage Cabinet shall be calculated and recorded as described in Appendix C.

**5.2.4** *Total Display Area*

The TDA of the Commercial Refrigerated Display Merchandiser is calculated and recorded as described in Appendix D, if applicable.

**5.2.5** *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%.

**5.2.6** *Multiples*

The TDEC, expressed in kW·h per day, shall be stated in 0.01 kW·h per day increments.

## **Section 6. Minimum Data Requirements for Published Ratings**

**6.1** *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 AHRI Standard 1200 (I-P)". All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of AHRI Standard 1200 (I-P)". Application Ratings within the scope of the standard shall include a statement of the conditions under which the ratings apply.

Table 2 represents an example template for remote Commercial Refrigerated Display Merchandiser or Storage Cabinet data that shall be recorded for each appropriate model(s).

Table 3 represents an example template for Self-contained Commercial Refrigerated Display Merchandiser or Storage Cabinet data that shall be recorded for each appropriate model(s).

**Table 2 Example Presentation of Data for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets (Informative)**

Item Number	Informational Item	Data
1.	Model Number	-
2.	Refrigerant Used	-
3.	Adjusted Dew Point (Refrigerant), °F	-
4.	Load Capacity, $Q_{rt}$ , Btu/h	-
5.	Length of refrigerated space, L, ft	-
6.	Refrigerated Volume, $V_r$ , ft <sup>3</sup> (only for Closed Commercial Refrigerated Display Merchandisers and Storage Cabinets), if applicable	-
7.	TDA, ft <sup>2</sup> , if applicable	-
8.	Unit Test Voltage, Volts	-
9.	Evaporator Dew Point Temperature (Refrigerant) <sup>1</sup> , °F	-
10.	Integrated Average Temperature of Product Simulators, °F	-
11.	CEC, kW·h per day	-
12.	FEC, kW·h per day, if measured individually	-
13.	LEC, kW·h per day, if measured individually	-
14.	PEC, kW·h per day, if measured individually	-
15.	AEC, kW·h per day, if measured individually	-
16.	DEC, kW·h per day, if measured individually	-
17.	Items 11-15, kW·h per day, if measured together	-
18.	CDEC, kW·h per day	-
19.	CDEC/ Refrigerated Volume, kW·h/ft <sup>3</sup> per day (only for closed Commercial Refrigerated Display Merchandisers and Storage Cabinets)	-
20.	CDEC/TDA, kW·h/ft <sup>2</sup> per day	-
21.	Other Loads, Notes:	-
Note: 1. For High Glide Refrigerants the Evaporator Dew Point is the Mid-point Evaporator Temperature ( $T_m$ ), see Section 5.1.2.1 for calculation.		

**Table 3 Example Presentation of Data for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets (Informative)**

Item Number	Informational Item	Data
1.	Model Number	
2.	Length of refrigerated space, L, ft	
3.	Refrigerated Volume, $V_r$ , ft <sup>3</sup> (only for Closed Commercial Refrigerated Display Merchandisers and Storage Cabinets), if applicable	
4.	TDA, ft <sup>2</sup> , if applicable	
5.	Unit Test Voltage, Volts	
6.	Integrated Average Temperature of Product Simulators, °F	
7.	TDEC, kW·h per day	
8.	TDEC/Refrigerated Volume, kW·h/ft <sup>3</sup> per day (only for Closed Commercial Refrigerated Display Merchandisers and Storage Cabinets)	
9.	TDEC/TDA, kW·h/ft <sup>2</sup> per day	
10.	Other Loads, Notes:	

## Section 7. Marking and Nameplate Data

### 7.1 *Marking and Nameplate Data*

As a minimum, the following information shall be shown in a conspicuous place on the equipment:

- 1) Name or trade name of manufacturer
- 2) Manufacturer's model number
- 3) 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 AHRI Standard 110-2016. Nameplate voltages for 50 hertz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard 60038-2009.

## Section 8. Conformance Conditions

### 8.1 *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.

## Section 9. Symbols and Subscripts

### 9.1 *Symbols and Subscripts*

$A_e$	=	Projected area from visible product through end walls, ft <sup>2</sup>
$A_r$	=	Gross refrigerated area, ft <sup>2</sup>
AEC	=	Anti-condensate energy consumption, kW·h per day (See Section 3.2.1)
CDEC	=	Calculated Daily Energy Consumption, kW·h per day (See Section 3.2.2)
CEC	=	Compressor Energy Consumption, kW·h per day (See Section 3.2.5)

$CEC_A$	=	Additional CEC for an alternate component, kW·h per day
$CEC_R$	=	Revised CEC, kW·h per day
DEC	=	Defrost Energy Consumption, kW·h per day (See Section 3.2.7)
$D_h$	=	Dimension of projected visible product, ft
$E_o$	=	Original energy consumption, kW·h
$E_s$	=	Energy consumption with substituted component, kW·h per day
$E_t$	=	Total energy measured or calculated for 24 hour period, kW·h per day
EER	=	Energy Efficiency Ratio (Table 1), Btu/W·h (See Section 3.2.9)
FEC	=	Fan Energy Consumption, kW·h per day (See Section 3.2.10)
$h_i$	=	Enthalpy of refrigerant entering Commercial Refrigerated Display Merchandiser or Storage Cabinet, Btu/lb
LEC	=	Light Energy Consumption, kW·h per day (See Section 3.2.13)
$LEC_R$	=	Revised Light Energy Consumption, kW·h per day
L	=	Interior length of the refrigerated space, ft
n	=	Number of fan motors
OEC	=	Other applicable Energy Consumption, kW·h per day
$P_{ai}$	=	Power anti-condensate heater input, W
$P_c$	=	Power condensate evaporator pan heater input, W
$P_d$	=	Power defrost heater input, W
$P_f$	=	Power fan, W
$P_{fi}$	=	Power fan input, W
$P_{fo}$	=	Power fan output found on part nameplate, W
$P_{li}$	=	Power light input, W
$P_o$	=	Power input calculated for original part, W
$P_s$	=	Power input calculated for substitution part, W
PEC	=	Condensate Evaporator Pan Energy Consumption, kW·h per day (See Section 3.2.6)
$Q_{rt}$	=	Commercial Refrigerated Display Merchandiser or Storage Cabinet average refrigerator load for the running cycle(s) within the test (during total refrigerating time) as determined in section 8.3 of ANSI/ASHRAE Standard 72-2022, Btu/h
t	=	Time unit is tested, h
$t_a$	=	Time anti-condensate heaters are on in 24-hour period, h
$t_c$	=	Time condensate evaporator pan heaters are on in 24-hour period, h
$t_d$	=	Time defrost heaters are on in 24-hour period, h
$t_{dt}$	=	Time unit is in defrost, h
$t_f$	=	Time fans are on in 24-hour period, h
$t_l$	=	Time lights are on in 24-hour period, h
$t_o$	=	Time original part is on in 24-hour period, h
$t_s$	=	Time substitution part is on in 24-hour period, h
$T_g$	=	Temperature glide of refrigerant, °R
$T_i$	=	Temperature at inlet of evaporator coil, °F
$T_m$	=	Temperature at mid-point of evaporator coil, °F
$T_{sd}$	=	Temperature of saturated suction Dew Point of refrigerant, °F

TDA	=	Total Display Area, ft <sup>2</sup> (See Section 3.2.19)
TDEC	=	Total Daily Energy Consumption, kW·h per day (See Section 3.2.18)
TDEC <sub>A</sub>	=	Adjusted Total Daily Energy Consumption, kW·h per day
V <sub>r</sub>		Refrigerated Volume (See Section 3.2.17)
η <sub>m</sub>	=	Motor efficiency

Note: Per day denotes a 24-hour period.

## APPENDIX A. REFERENCES – NORMATIVE

**A.1.** 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 the standard.

**A.1.1.** AHRI Standard 110-2016, *Air-Conditioning, Heating and Refrigerating Equipment Nameplate Voltages*, 2016, Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Boulevard, Suite 400, Arlington, VA 22201, U.S.A.

**A.1.2.** ANSI/ASHRAE Standard 72-2022, *Method of Testing Commercial Refrigerators and Freezers*, 2018, ASHRAE, 180 Technology Parkway, Peachtree Corners, GA 30092, U.S.A.

**A.1.3.** ASHRAE Terminology. ASHRAE. Accessed April 12, 2022.  
<https://www.ashrae.org/technicalresources/free-resources/ashrae-terminology>.

**A.1.4.** ASTM Standard E 1084-86 (Reapproved 2015), *Standard Test Method for Solar Transmittance (Terrestrial) of Sheet Materials Using Sunlight*, 1986, ASTM International, 100 Barr Harbor Drive, PO Box C7, West Conshohocken, PA, 19428, USA.

**A.1.5.** IEC Standard 60038, *IEC Standard Voltages*, 2021, International Electrotechnical Commission, 3, rue de Varembe, P. O. Box 131, 1211 Geneva 20, Switzerland.

**A.1.6.** 10 CFR Part 431.64. 2014. "Energy Efficiency Program for Certain Commercial and Industrial Equipment." *U.S. Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, 800 North Capitol Street, NW, Washington, DC 20402, U.S.A.

## APPENDIX B. REFERENCES - INFORMATIVE

B1 Listed here are standards, handbooks and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered part of the standard.

**B.1.1.** Reference Fluid Thermodynamic and Transport Properties Database (REFPROP), National Institute of Standards and Technology, Version 10.0

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

## C.1. *Refrigerated Volume Measurements*

The Refrigerated Display Merchandiser and Storage Cabinet volume shall be recorded to the nearest 0.01 cubic feet, considering the exact shape of the walls including all depressions or projections. The use of 3-dimensional models can be used for determining Refrigerated Volume. This volume calculation only applies to Closed Commercial Refrigerated Display Merchandisers and Storage Cabinets.

### C.1.1. *Determining Volume*

Refrigerated Volume shall encompass the entire interior of the display merchandiser or storage cabinet.

#### C.1.1.1. *Disregarded Items*

The following items shall be disregarded for the determination of volume.

- 1) Internal fittings such as shelves
- 2) Removable partitions
- 3) Containers
- 4) Interior light housings

#### C.1.1.2. *Deducted Items*

The volume of the following items, if present, shall be deducted in the determination of volume.

- 1) The volume of control housings
- 2) The volume of the evaporator space (Figure 2)
- 3) The volume of air ducts required for proper cooling and operation of the unit

## C.1.2. *Evaporator Space*

The volume of the evaporator space to be deducted from the Refrigerated Volume shall include forced air evaporators and plate style (or roll-bond) evaporators.

### C.1.2.1. *Forced Air Evaporators*

The total volume to be deducted shall include the total volume of the space occupied by the evaporator, evaporator cover, the evaporator fan, and fan scroll.

### C.1.2.2. *Plate Style (or Roll-bond) Evaporators*

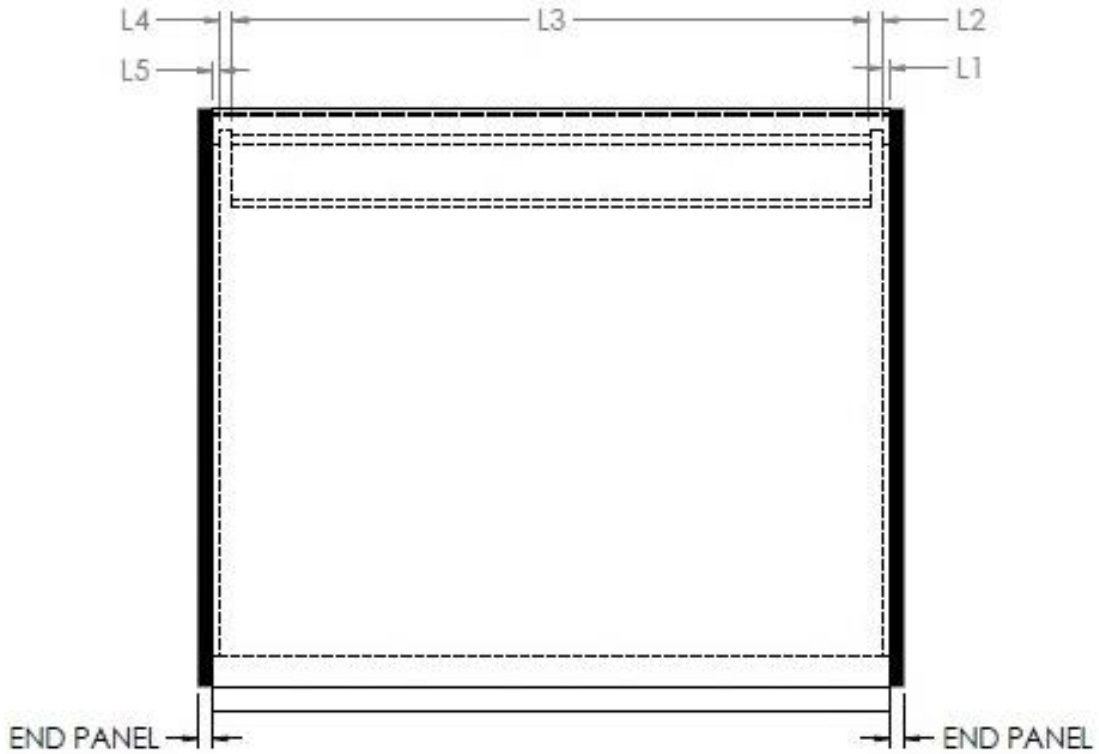
The volume behind vertically mounted plate style evaporator and the volume above horizontally mounted plate style evaporators shall be included if the distance between the horizontal plate style evaporator and the nearest above liner surface is less than 2 in (50 mm). Removable drip trays/troughs shall not be included.

## C.1.3. *Commercial Refrigerated Storage Cabinet Refrigerated Volume*

The Commercial Refrigerated Storage Cabinet Refrigerated Volume ( $V_r$ ) equals the refrigerated area cross-sectional area multiplied by the length of refrigerated space ( $L$ ). The sample front view and cross section in Figures 1 and 2 is used as an example in Equation 4.

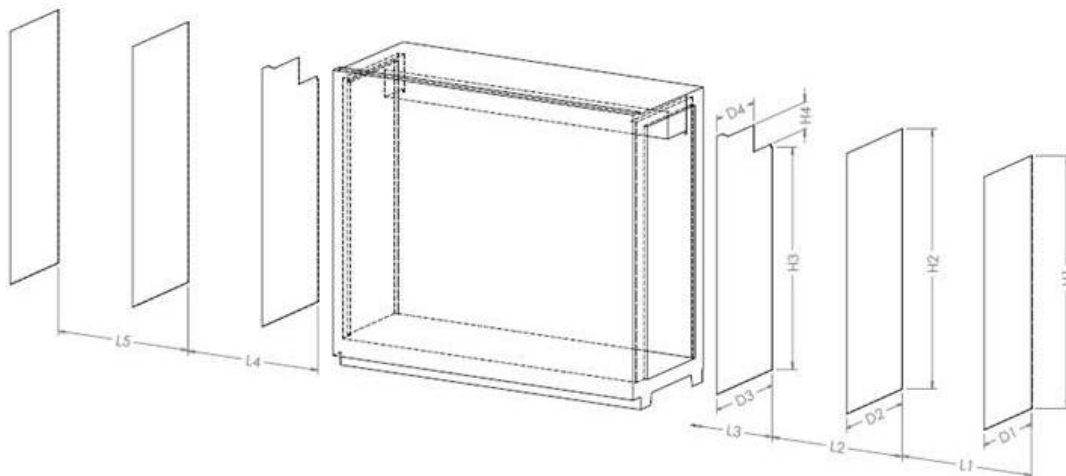
$$V_r = (L_1 \cdot D_1 \cdot H_1) + (L_2 \cdot D_2 \cdot H_2) + (L_3 \cdot D_3 \cdot H_3) + (L_4 \cdot D_4 \cdot H_4) + (L_5 \cdot D_5 \cdot H_5) \quad 4$$





**Figure 1. Sample Front View of Commercial Refrigerated Display Merchandisers for Illustrating Length of Refrigerated Space**

Note: The internal length (L in Figure 1) is measured from the internal panel at one end of the case to the internal panel at the other end of the case.



**Figure 2. Sample Cross Section of Commercial Refrigerated Storage Cabinets for Refrigerated Volume Calculation**

## APPENDIX D. COMMERCIAL REFRIGERATED DISPLAY MERCHANDISER AND STORAGE CABINET TOTAL DISPLAY AREA (TDA) CALCULATION – NORMATIVE

### D.1. Total Display Area

The TDA is the sum of the projected area(s) for visible product, ft<sup>2</sup>. See Equation 5.

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

5

Where:

$A_e$  = Projected area from visible product through end walls as shown in Figure 17 through Figure 20.

$D_h$  = Dimension of projected visible product as shown in Figure 4 to Figure 16.

$L$  = Length of Commercial Refrigerated Display Merchandiser or Storage Cabinets as shown in Figure 3.

The TDA shall be calculated manually for unique geometries. Refer to Figure 21 through Figure 26.

#### D.1.1. Nominal Length of Commercial Refrigerated Display Merchandisers or Storage Cabinets

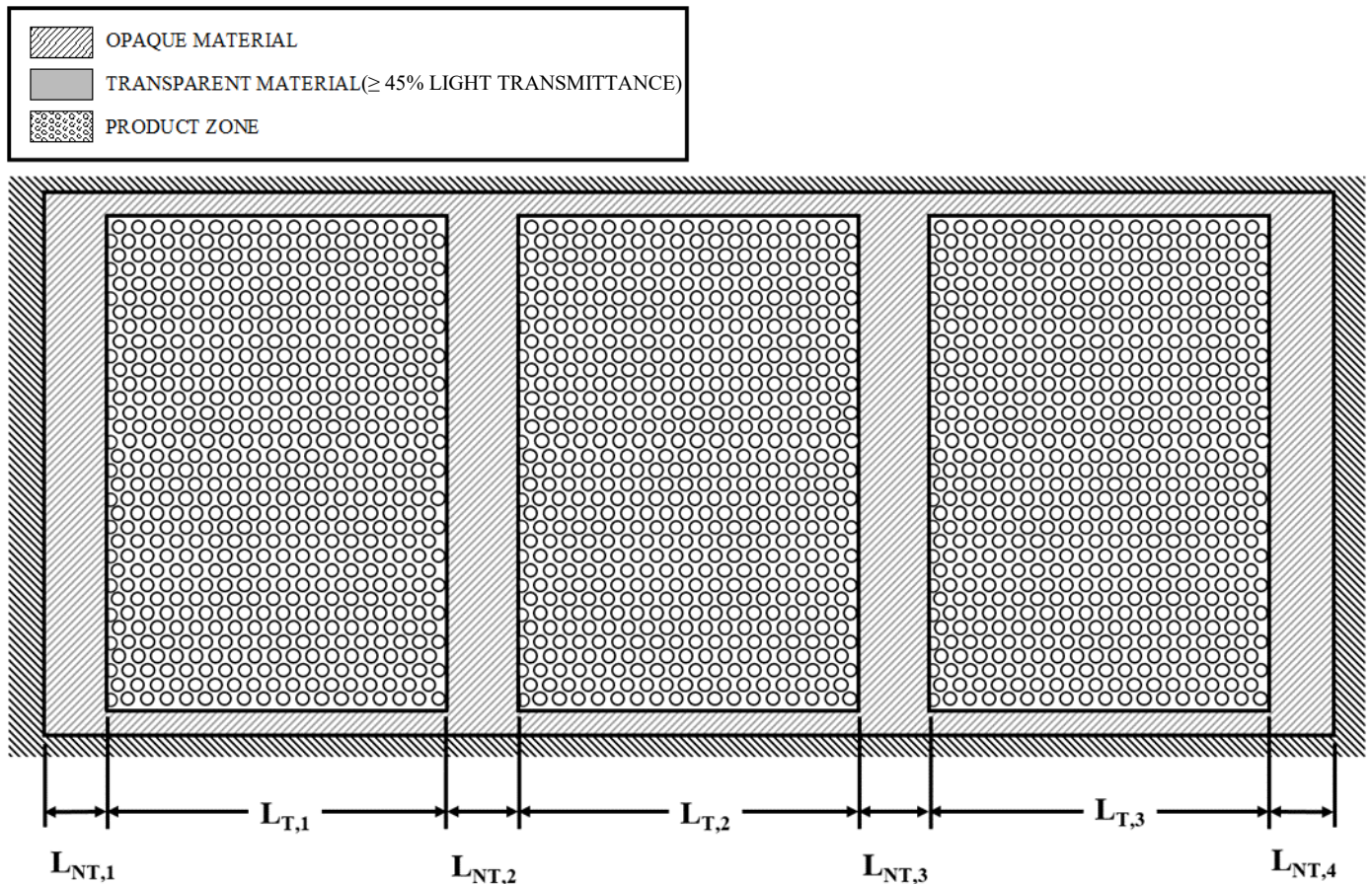


Figure 3. Three-door Vertical Closed Transparent Display Case

**D.1.1.1.** *Determining the Length of Commercial Refrigerated Display Merchandiser or Storage Cabinets*

Use Equations 6 and Equation 7 to determine the Length of Commercial Refrigerated Display Merchandiser or Storage Cabinets, L, if the interior length consist of not more than 10% non-transparent material.

When measuring a three-door vertical closed transparent display case as seen in Figure 3:

If

$$L_{NT,1} + L_{NT,2} + L_{NT,3} + L_{NT,4} \leq 0.10(L_{NT,1} + L_{T,1} + L_{NT,2} + L_{T,2} + L_{NT,3} + L_{T,3} + L_{NT,4}) \quad 6$$

Then

$$L = L_{NT,1} + L_{T,1} + L_{NT,2} + L_{T,2} + L_{NT,3} + L_{T,3} + L_{NT,4} \quad 7$$

Where:

$L_{NT,n}$  = Linear length of non-transparent area

$L_{T,n}$  = Linear length of transparent area

**D.1.1.2.** *Determining the Length of Commercial Refrigerated Display Merchandiser or Storage Cabinets with Greater than 10% Non-transparent Area*

Use Equation 8 and Equation 9 for those cases with greater than 10% of non-transparent area. The Length of Commercial Refrigerated Display Merchandiser or Storage Cabinets, L, shall be determined as the projected linear dimension(s) of visible product plus 10% of the linear dimension(s) of visible product to account for non-transparent area.

When determining the length for a three-door vertical closed transparent display case as seen in Figure 3:

If

$$L_{NT,1} + L_{NT,2} + L_{NT,3} + L_{NT,4} > 0.10(L_{NT,1} + L_{T,1} + L_{NT,2} + L_{T,2} + L_{NT,3} + L_{T,3} + L_{NT,4}) \quad 8$$

Then

$$L = \frac{L_{T,1} + L_{T,2} + L_{T,3}}{0.9} \quad 9$$

**D.1.2.** *Dimension of Projected Visible Product, D<sub>h</sub>*

Measuring D<sub>h</sub> shall include only the visible dimensions. Opaque door frames, light shades, and non-transparent silk screens that impede visibility shall be excluded from the measurement. Figure 4 through Figure 16 present solutions for determining the dimension of projected visible product.

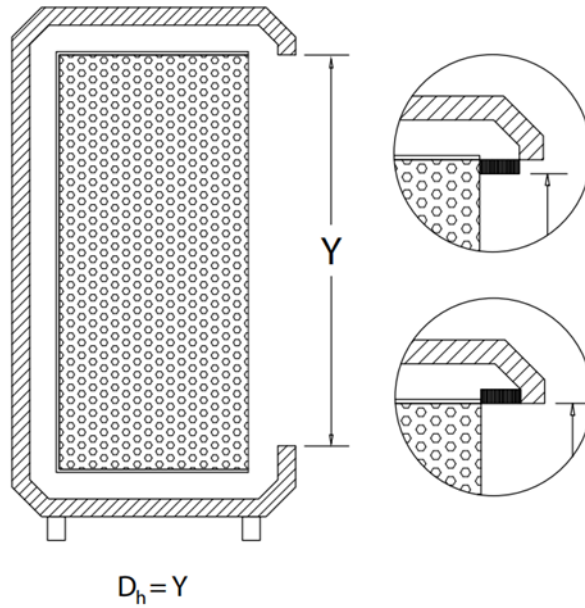


Figure 4. Vertical Open Multi-deck

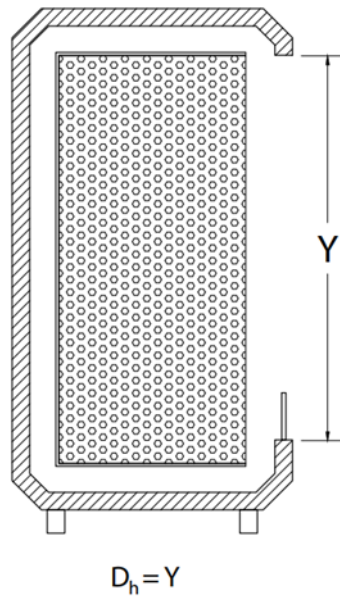


Figure 5. Vertical Open Multi-deck with Transparent Front

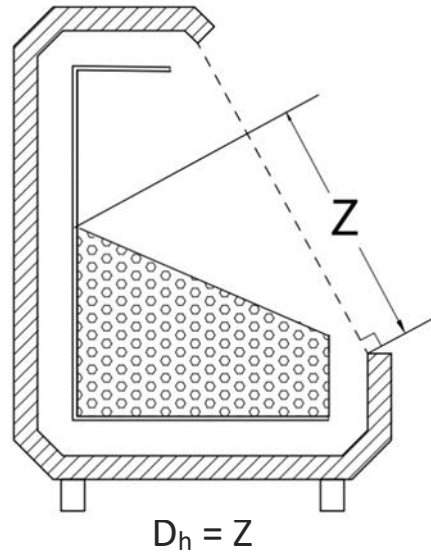


Figure 6. Semi-vertical Open Multi-deck with Smaller Product Zone

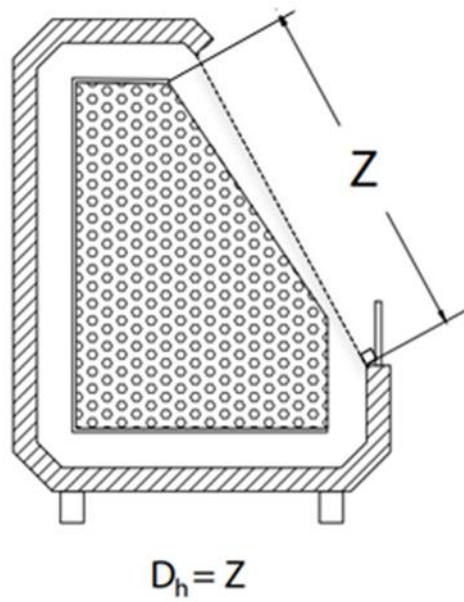
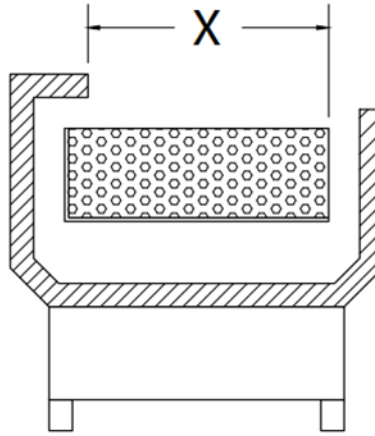
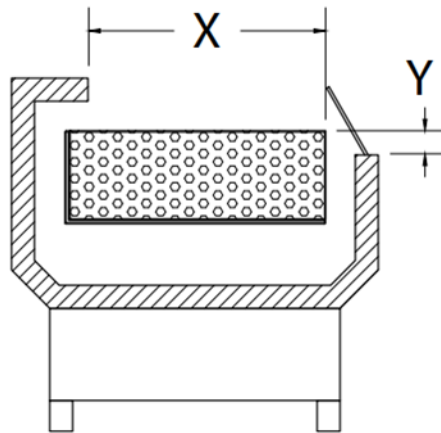


Figure 7. Semi-vertical Open Multi-deck with Transparent Front



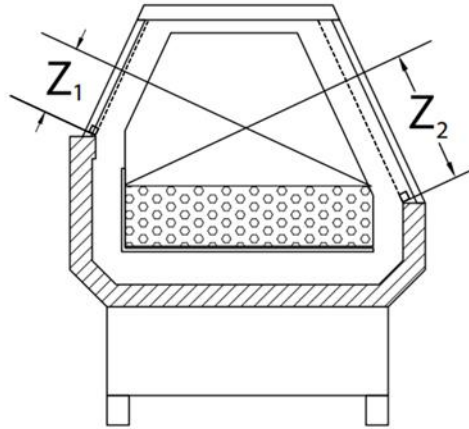
$$D_h = X$$

Figure 8. Horizontal Open Single-deck



$$D_h = X + Y$$

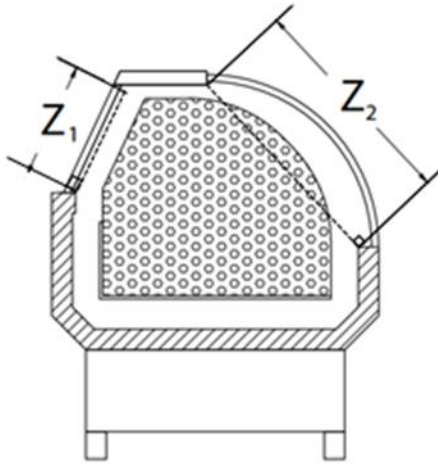
Figure 9. Horizontal Open Single-deck with Transparent Front



$$D_h = Z_1 + Z_2$$

$Z_1$  AND  $Z_2$  = TRANSPARENT DIMENSION

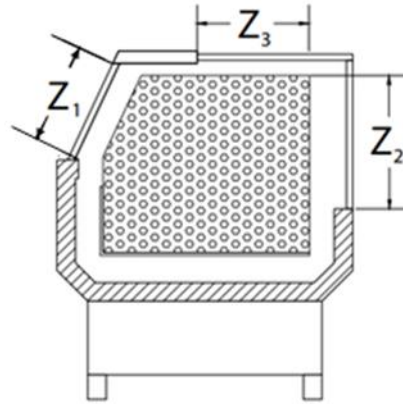
Figure 10. SOC with Flat Transparent Front



$$D_h = Z_1 + Z_2$$

$Z_1$  AND  $Z_2$  = TRANSPARENT DIMENSION

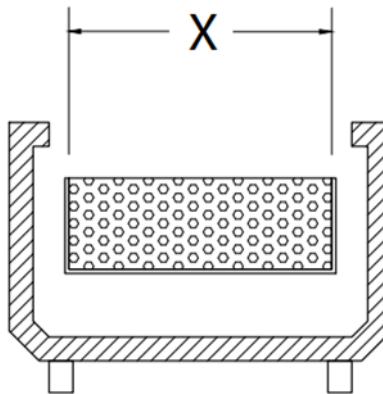
Figure 11. SOC with Curved Transparent Front



$$D_h = Z_1 + Z_2 + Z_3$$

$Z_1, Z_2,$  AND  $Z_3 =$  TRANSPARENT DIMENSION

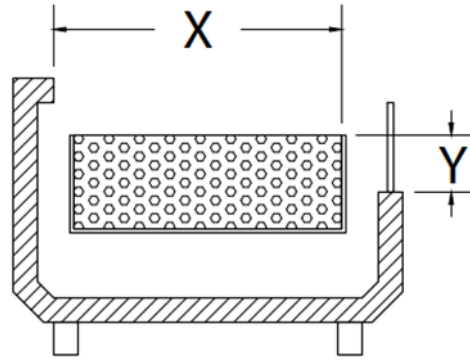
Figure 12. SOI with Flat Transparent Front and Top



$$D_h = X$$

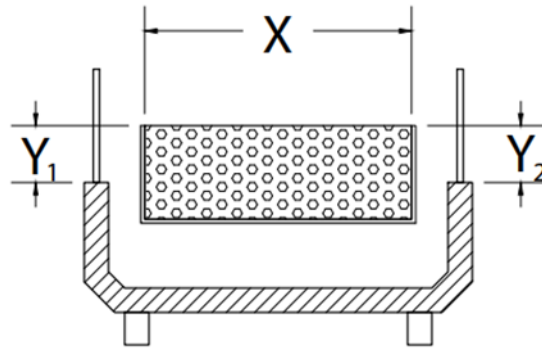
Figure 13. Horizontal Open Single-deck Island





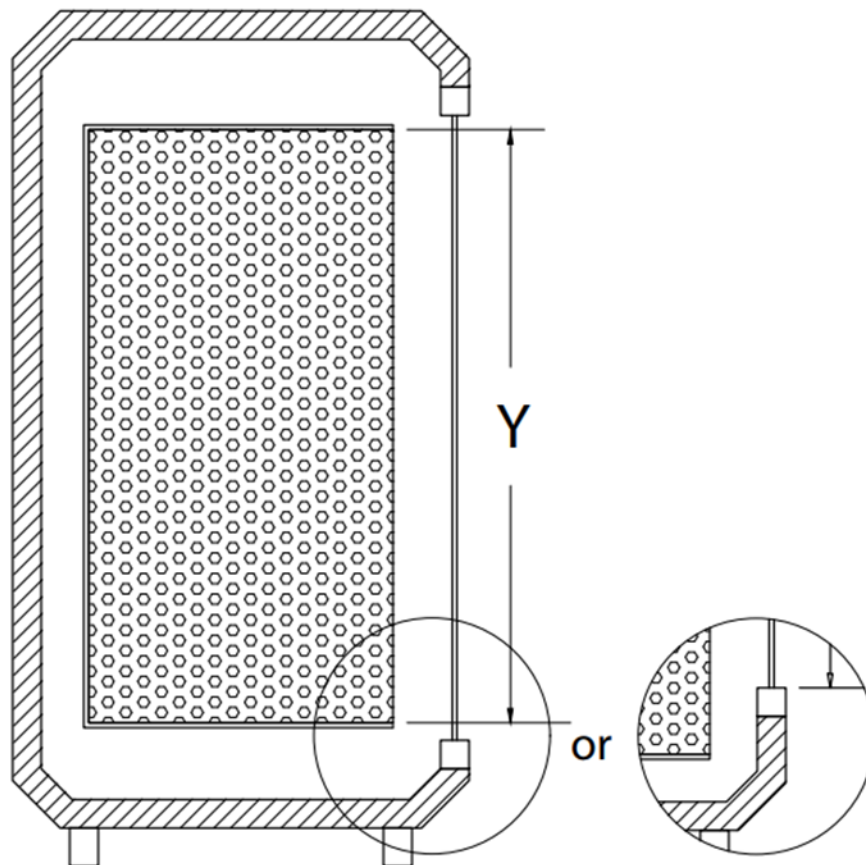
$$D_h = X + Y$$

Figure 14. Horizontal Open Single-deck Island with Transparent Wall



$$D_h = Y_1 + Y_2 + X$$

Figure 15. Island with Transparent Walls

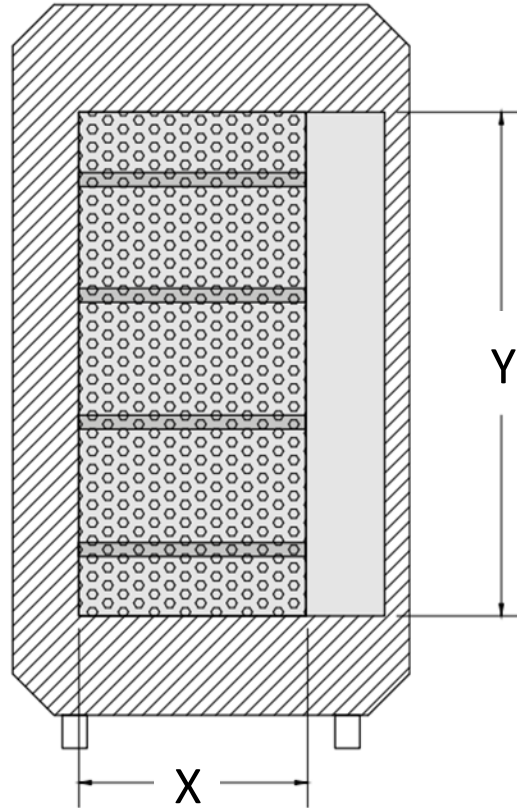


$$D_h = Y$$

Figure 16. Vertical Closed Multi-deck with Transparent Doors

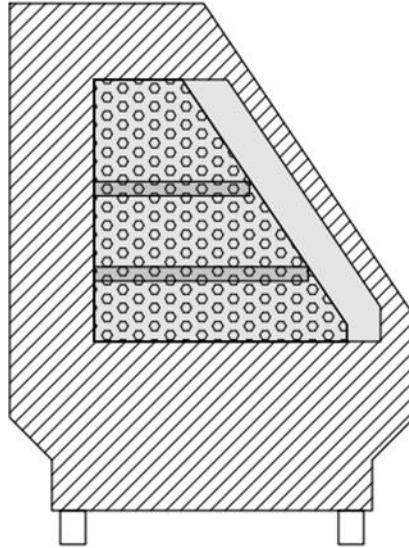
**D.1.3. Projected Area From Visible Product Through End Walls,  $A_e$** 

Figure 17 through Figure 20 present solutions for determining the projected area of visible product.



$$A_e = (X)(Y)$$

**Figure 17. Vertical End Wall with Transparent Section**



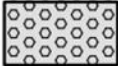
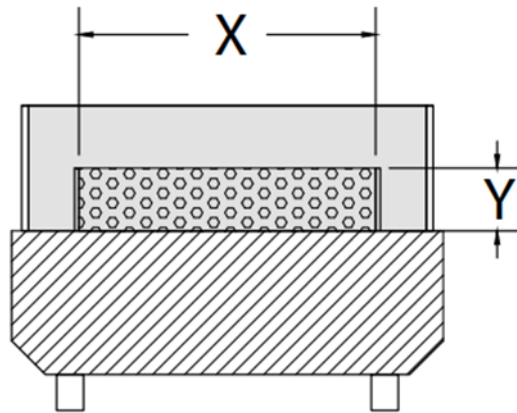
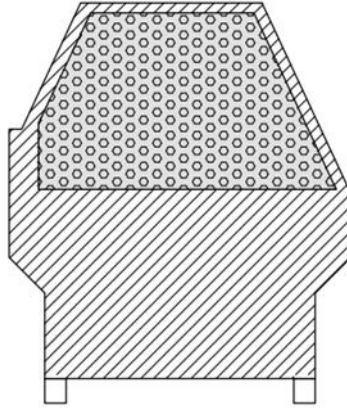
$A_e =$  CALCULATED AREA OF 

Figure 18. Semi-vertical End Wall with Transparent Section



$$A_e = (X)(Y)$$

Figure 19. Horizontal Single-deck and Single-deck Island End Wall with Transparent Section

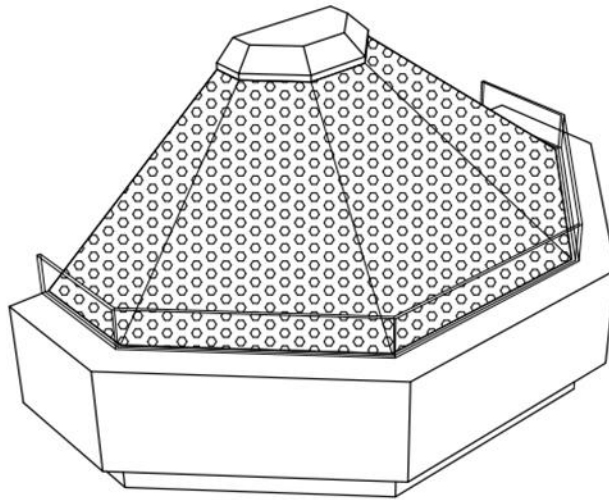


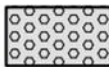
$A_e =$  CALCULATED AREA OF 

**Figure 20. SOC End Wall with Transparent Section**

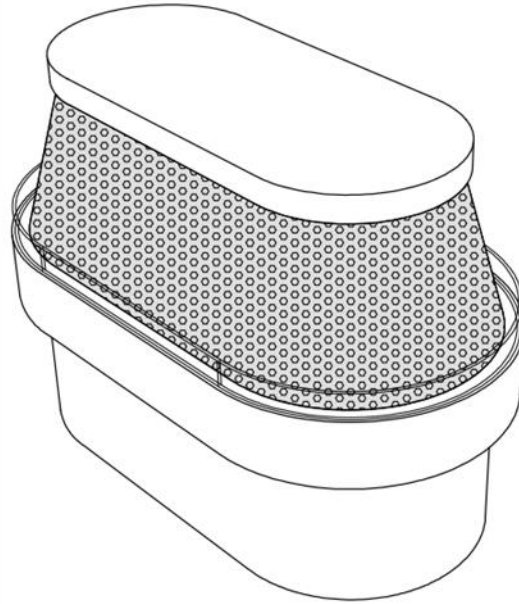
**D.1.4. Unique Geometries**

For unique geometries, the TDA shall be calculated manually.



TDA = CALCULATED AREA OF 

**Figure 21. Example TDA for Unique Geometries**



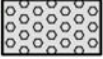
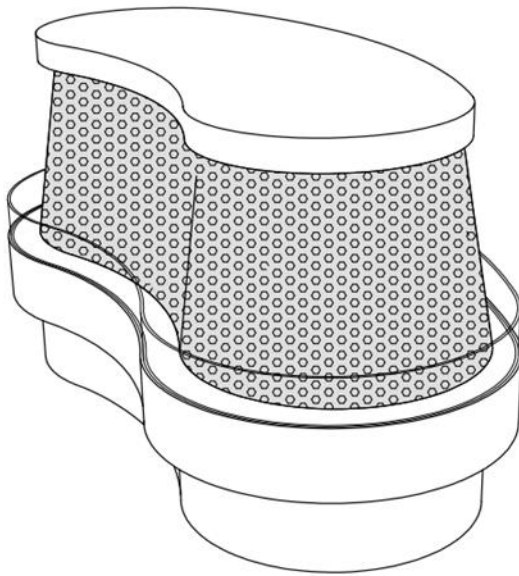
TDA = CALCULATED AREA OF 

Figure 22. Example TDA for Unique Geometries



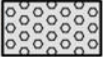
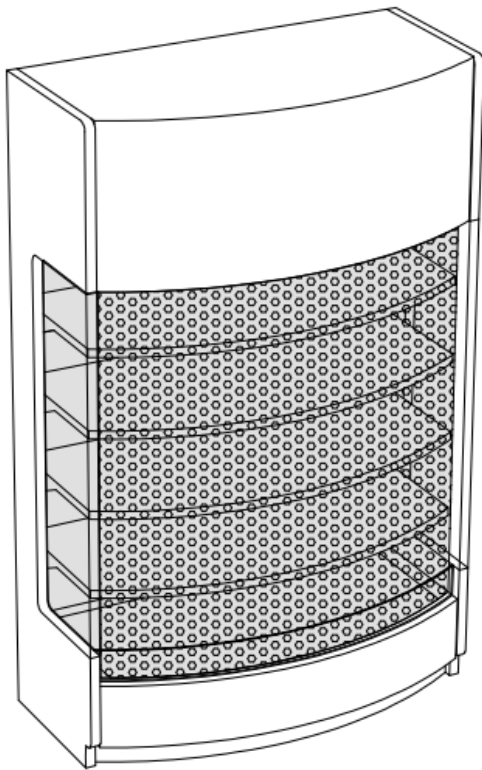
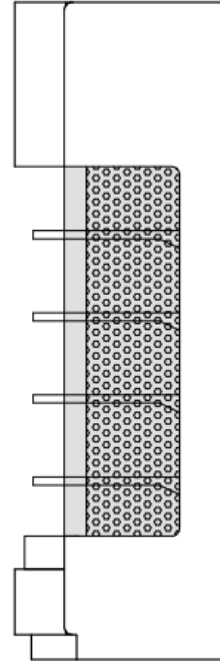
TDA = CALCULATED AREA OF 

Figure 23. Example TDA for Unique Geometries



FRONT AREA

L = ARC LENGTH OF THE CURVED SECTION OF VISIBLE PRODUCT AREA



SIDE AREA

$A_e$  = CALCULATED AREA OF TOTAL AREA OF GLASS MINUS PORTION INCLUDED AS PART OF FRONT AREA MEASUREMENT

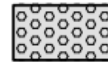
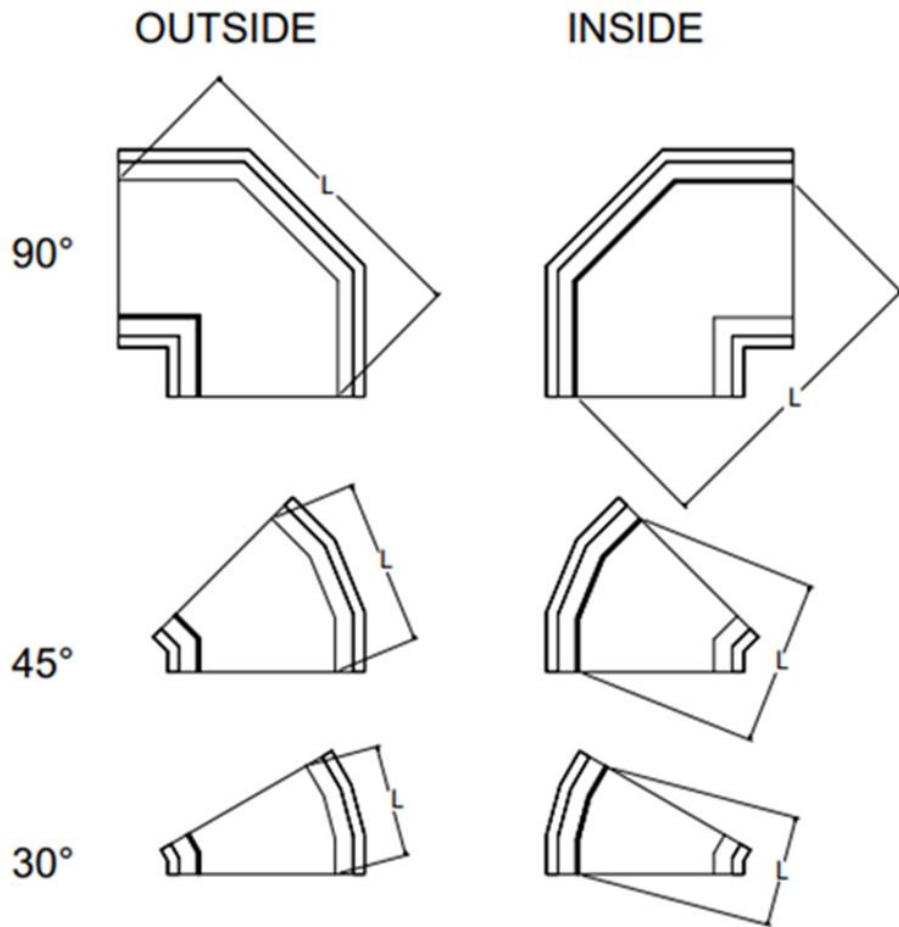
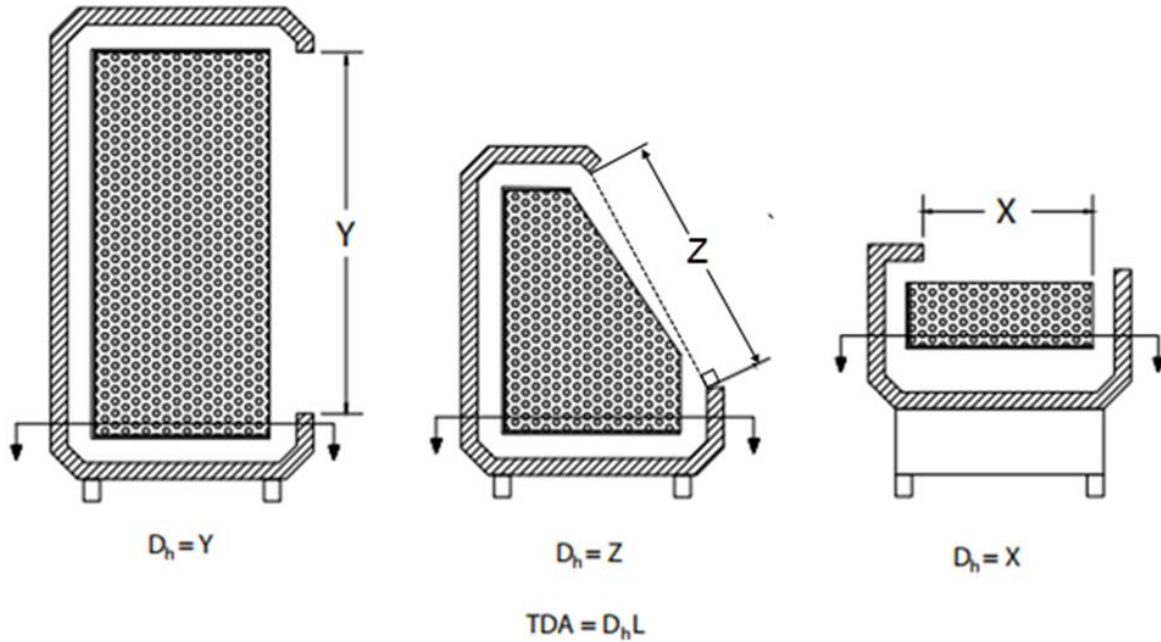


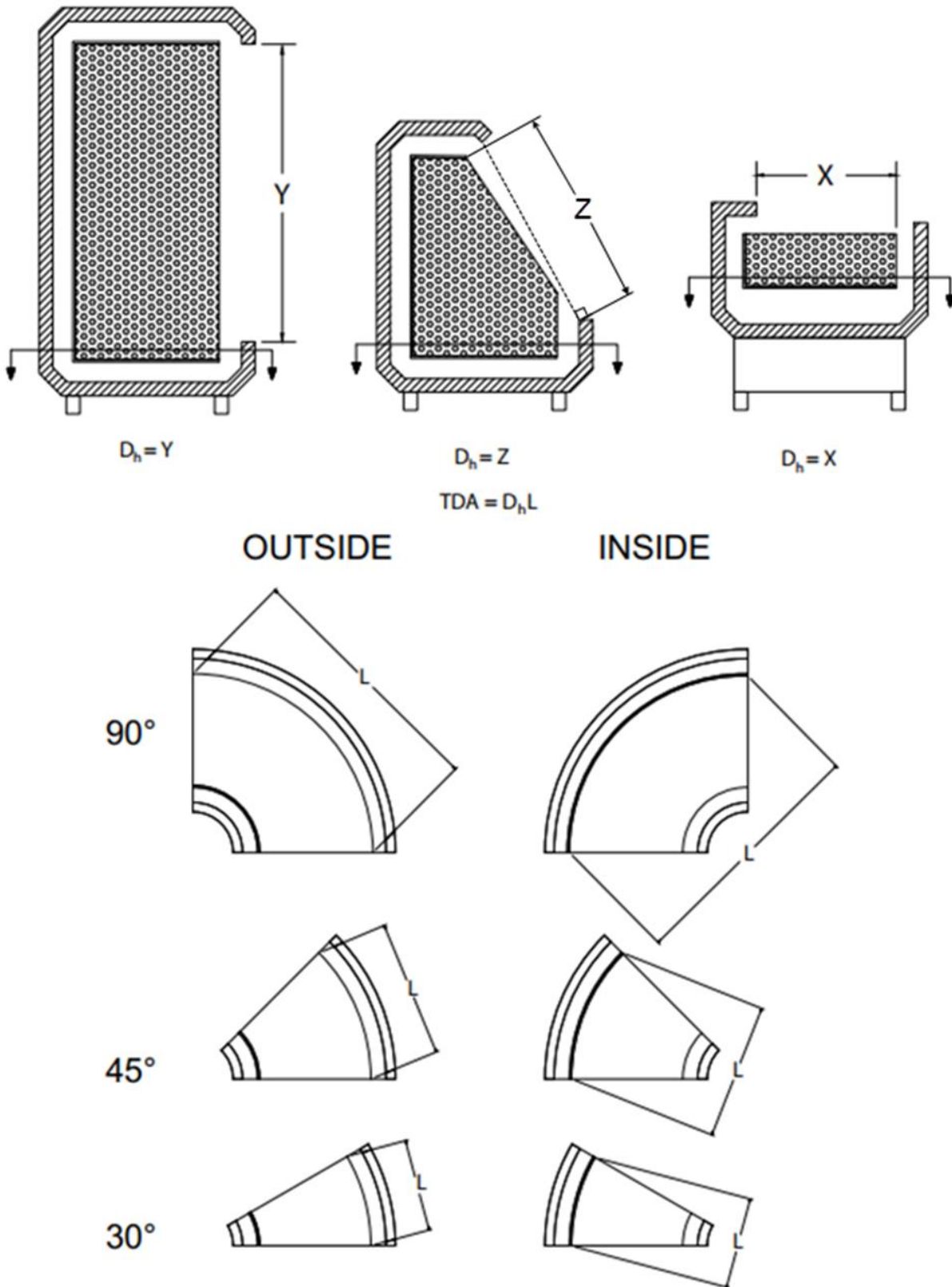
Figure 24. Radius Cases with Transparent Sides



**Figure 25. Mitered Wedge TDA Calculation**

Note: Dimension  $L$  in Figure 25 is shown from the customer facing side of the unit.





**Figure 26. Curved Wedge TDA Calculation**

Note: Dimension L in Figure 26 is shown from the customer facing side of the unit.

## APPENDIX E. EXAMPLE – CALCULATION OF CEC FOR COMMERCIAL REFRIGERATED DISPLAY MERCHANDISER OR STORAGE CABINET TESTED WITH A HIGH-GLIDE REFRIGERANT– INFORMATIVE

**E.1.** Example calculation of CEC for commercial refrigerated display merchandiser or storage cabinet tested with a high-glide refrigerant– informative.

**E.2.** *Medium-temp Remote Display Merchandiser with R-407A*

Entering liquid refrigerant temperature = 79.77°F (measured)

Entering liquid refrigerant pressure = 203.7 psia (measured)

Entering liquid refrigerant enthalpy = 102.62 Btu/lb (calculated from REFPROP 10.0)

Inlet evaporator temperature,  $T_i = 23.87^\circ\text{F}$  (calculated from REFPROP 10.0)

$T_{sd} = 32.0^\circ\text{F}$  (72.4 psia) (Pressure measured, temperature calculated)

$T_g = 32.0 - 23.87 = 8.13$

$8.13 / 2 = 4.07$

$T_{sd}$  (as tested) – 4.07 = 27.93, that is then rounded to the nearest integer, 28, therefore  $T_m = 28^\circ\text{F}$

$T_m$  (as calculated) – 2 (for Med Temp) is then used to look up the EER from Table 1

$28 - 2 = 26^\circ\text{F}$ ,

Therefore, the EER used in the CEC calculation is 13.95 (corresponding to a 26°F Adjusted Dew Point in Table 1)

## APPENDIX F. ENERGY CALCULATIONS USING ALTERNATE COMPONENTS – INFORMATIVE

The total energy consumption of a commercial refrigerator can be estimated when components are changed from the original equipment's design. The following instructions can be followed to make those estimates. These calculations can be the basis for developing an alternative energy determination method (AEDM). Manufacturers must adjust these calculations to make detailed energy estimates for their product.

### F.1. Remote Refrigerators

#### F.1.1. Alternate Components - Direct Effects

The energy consumption of substituted or alternate components can be measured or calculated from the component's nameplate rating. The energy usage of the substituted or alternate components can be used to recalculate the CDEC initially calculated in Section 5.1.2 as determined in the initial test with all electric loads measured, except for CEC.

##### F.1.1.1. FEC

When removing or substituting a fan motor, the fan energy can be measured or calculated according to Equation 10. The energy usage of the substituted or alternate components can be used to recalculate the CDEC according to Section 5.1.2. When calculating the fan motor energy for substituting a fan motor, the airflow rate produced from the assembly can be equal to the original configuration.

$$FEC = (P_f \cdot t_f) / (1000) \quad 10$$

Where:

$$P_f = (P_{f0} \cdot n) / (\eta_m)$$

##### F.1.1.2. LEC

When removing or substituting lighting, the lighting energy can be measured or calculated according to Equation 11. The energy usage of the substituted or alternate components can be used to recalculate the CDEC according to Section 5.1.2.

$$LEC = (P_{li} \cdot t_i) / (1000) \quad 11$$

##### F.1.1.3. AEC

When removing or substituting an anti-condensate heater, the heater energy can be measured or calculated according to Equation 12. The energy usage of the substituted or alternate components can be used to recalculate the CDEC according to Section 5.2.

$$AEC = (P_{ai} \cdot t_a) / (1000) \quad 12$$

##### F.1.1.4. DEC

When removing or substituting a defrost heater, the heater energy can be measured or calculated according to Equation 13. The energy usage of the substituted or alternate components can be used to recalculate the CDEC according to Section 5.2.

$$DEC = (P_d \cdot t_d) / (1000) \quad 13$$

##### F.1.1.5. PEC

When removing or substituting a condensate evaporator pan, the pan energy can be measured or calculated according to Equation 14. The energy usage of the substituted or alternate components can be used to recalculate the CDEC according to Section 5.2.

$$PEC = (P_c \cdot t_c) / (1000) \quad 14$$

**F.1.2.** *Alternate Component Indirect Effects*

The revised Compressor Energy Consumption ( $CEC_R$ ) is the indirect effect of alternate component(s) on the CEC and can be measured or calculated. The total revised  $CEC_R$  is the sum of the CEC and the additional Compressor Energy Consumption ( $CEC_A$ ) for each component as seen in Equation 15.

$$CEC_R = CEC + \sum CEC_A \quad 15$$

**F.1.2.1.** *Fans*

When substituting a fan motor located in the refrigerated space, the change in energy affects the CEC. The change in CEC can be calculated by multiplying the difference in power usage between the alternate components by the operating time and dividing by the compressor's EER rating. This change in CEC can be added to the original CEC as seen in Equation 16:

$$CEC_A = 3.4121 \cdot [(P_s \cdot t_s) - (P_o \cdot t_o)] / (EER \cdot 1000) \quad 16$$

**F.1.2.2.** *Lights*

When substituting internal lighting located in the refrigerated space, the change in energy affects the CEC. The change in CEC can be calculated by multiplying the difference in power usage between the alternate components by the operating time and dividing by the compressor's EER rating. This change in CEC can be added to the original CEC as seen in Equation 17.

For ballast located internal or external to the refrigerated space:

$$CEC_A = 3.4121 \cdot [(P_s \cdot t_s) - (P_o \cdot t_o)] / (EER \cdot 1000) \quad 17$$

**F.1.2.3.** *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 can be calculated by dividing the difference in energy usage between the alternate components by the compressor's EER rating. This change in CEC can be added to the original CEC as seen in Equation 18.

$$CEC_A = 3.4121 \cdot [(P_s \cdot t_s) - (P_o \cdot t_o)] / (EER \cdot 1000) \quad 18$$

**F.1.2.4.** *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 can be calculated by dividing the difference in energy usage between the alternate components by the compressor's EER rating as seen in Equation 19.

This change in CEC can be added to the original CEC:

$$CEC_A = 3.4121 \cdot [(P_s \cdot t_s) - (P_o \cdot t_o)] / (EER \cdot 1000) \quad 19$$

**F.2.** *Self-contained.***F.2.1.** *Alternate Components for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets*

The direct energy consumption of alternate components can be measured or calculated from the component's nameplate rating. A calculated change in the energy usage for the alternate component should 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. There should not be a credit for a reduction in the CEC due to alternate components in a Self-contained Commercial Refrigerated Display Merchandiser or Storage Cabinet if a calculated value is used. A direct measurement of the total electrical load should be made if the alternate component uses more energy than the original component or to take a credit for the compressor energy reduction.

The calculated direct effect in energy usage can be added to the original TDEC and the  $TDEC_A$  determined for each component substitution.

$$\text{TDEC}_A = E_s - E_o$$

20

Where:

$$E_s = P_s \cdot t_s$$

$$E_o = P_o \cdot t_o$$

**F.2.1.1.** *FEC*

When removing or substituting a fan motor, the fan energy can be measured or calculated according to Equation 10. The  $\text{TDEC}_A$  can be measured or calculated using Equation 20. When calculating the fan motor energy for substituting a fan motor, the airflow produced from the assembly can be equal to the original configuration.

**F.2.1.2.** *LEC*

When removing or substituting internal lighting, lighting energy can be measured or calculated from the product nameplate according to Equation 11. The  $\text{TDEC}_A$  can be measured or calculated using Equation 20.

**F.2.1.3.** *AEC*

When removing or substituting an anti-condensate heater, the heater energy can be measured or calculated from the product's nameplate according to Equation 12. The  $\text{TDEC}_A$  can be measured or calculated using Equation 20.

**F.2.1.4.** *DEC*

When removing or substituting a defrost heater, the change in energy can be measured or calculated according to Equation 13. The  $\text{TDEC}_A$  can be measured or calculated using Equation 20.

**F.2.1.5.** *PEC*

When removing or substituting a condensate evaporator pan, the change in energy can be measured or calculated according to Equation 14. The  $\text{TDEC}_A$  can be measured or calculated using Equation 20.