



Energy and Internal Volume of Refrigerating Appliances

AHAM HRF-1- 2016



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PREFACE

The Association of Home Appliance Manufacturers develops standards in accordance with AHAM's "Policy and Procedures Governing Technical Standards" which states:

"AHAM Standards shall be in the best interest, mutually, of consumers who use appliances, the industries which provide and service appliances, and other interested parties. They shall relate to actual use conditions and be technically and scientifically sound."

Use or observance of AHAM standards is voluntary.

This standard contains test procedures that may be applied to any brand or model of electric refrigerator, refrigerator-freezer or freezer for measuring energy consumption. The energy test applies only to compressor-driven models. Thermoelectric models or absorption models cannot be tested with the HRF-1 procedure. Results of tests in accordance with this standard may be publicly stated. This standard is a technical revision of ANSI/AHAM HRF-1-2008.

With regard to safety, AHAM recommends that all appliance products—both major and portable—manufactured or marketed in the United States be submitted to an appropriate independent laboratory for inspection and listing in conformance with the safety standards and procedures followed by such laboratories. The relevant standard for refrigerators, refrigerator-freezers and freezers is ANSI/UL 250 / CSA C22.2 No. 63, *Household Refrigerators and Freezers*.

AHAM welcomes comments and suggestions regarding this standard. Any standard may be reviewed and improved as needed. All standards must be updated or reconfirmed at least every five years. Any interested party, at any time, may request a change in an AHAM standard. Such request should be addressed to AHAM's President, and should be accompanied by a statement of reason for the request and a suggested alternate proposal.

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CONTENTS

Section	Page
1 PURPOSE.....	2
2 SCOPE.....	2
3 DEFINITIONS	3
3.1 Refrigerator	3
3.2 All-Refrigerator	3
3.3 Refrigerator-Freezer	3
3.4 Freezer	3
3.5 Wine Chiller	3
3.6 Air Ducts	3
3.7 Anti-Sweat Heater	3
3.8 Automatic Icemaker.....	3
3.9 Baffle	4
3.10 Cabinet Breaker Strip	4
3.11 Cycle	4
3.12 Cycle Type	4
3.13 Defrost System.....	4
3.14 Fan Scroll	4
3.15 Fresh Food Compartment	4
3.16 Freezer Compartment	5
3.17 Ice Tray	5
3.18 Liner	5
3.19 Long-Time Automatic Defrost.....	5
3.20 Quick Cool.....	5
3.21 Shelf	5
3.22 Special Compartments	5
3.23 Butter Conditioner	5
3.24 Chiller or Drip Tray	5
3.25 Crisper.....	5
3.26 Ice Storage Bin.....	5
3.27 Meat Keeper	6
3.28 Separate Auxiliary Compartment	6
3.29 Variable anti-sweat heater control	6

3.30	Stabilization Period.....	6
3.31	Standard Cycle.....	6
3.32	Steady State Condition.....	6
3.33	Variable Defrost Control.....	6
3.34	Volume.....	7
4	METHOD FOR COMPUTING REFRIGERATED VOLUME OF REFRIGERATORS, REFRIGERATOR-FREEZER, WINE CHILLERS, AND FREEZERS.....	7
4.1	Scope.....	7
4.2	Total volume.....	7
4.3	Legend for Figures 4-1 through 4-3.....	8
5	METHOD FOR DETERMINING THE ENERGY CONSUMPTION OF REFRIGERATORS, REFRIGERATOR-FREEZERS, WINE CHILLERS AND FREEZERS.....	10
5.1	Scope.....	10
5.2	Purpose.....	10
5.3	Test Conditions.....	10
5.4	Instruments.....	11
5.5	General Test Requirements.....	11
5.6	Temperature Control Settings.....	19
5.7	Test Period.....	21
5.8	Test Measurements.....	26
5.9	Determination of Results of Average Per-Cycle Energy Consumption.....	29
6	METHOD FOR COMPUTING ADJUSTED VOLUME OF REFRIGERATORS, REFRIGERATOR- FREEZER, WINE CHILLERS, AND FREEZERS.....	34
6.1	Scope.....	34
6.2	Purpose.....	34
6.3	Adjusted Volume.....	34
7	SAFETY OF REFRIGERATORS, WINE CHILLERS AND FREEZERS.....	34

1 PURPOSE

The purpose of this standard is to establish a uniform and repeatable procedure or standard method for measuring specified product characteristics of refrigerators, refrigerator/freezers, wine chillers, and freezers. The standard methods and the recommended levels of performance, where they appear, are intended to provide a means by which different brands and models of refrigerators, wine chillers and freezers can be compared and evaluated.

The standard methods are not intended to inhibit improvement and innovation in product testing, design or performance.

The following principles of interpretation shall be applied to AHAM HRF-1, and shall apply to and guide any revisions to the test procedure. The intent of the energy test procedure is to simulate typical room conditions (approximately 70 °F) with door openings, by testing at 90 °F without door openings. This measurement standard only applies to units, which operate in an equivalent manner under 90°F ambient conditions as they would under typical room conditions, except for the operating characteristics that are affected by ambient temperature (for example compressor run time) .

Note: The following guidance shall be used for determining if this measurement standard is applicable to the unit under test.

Energy consuming components that operate in typical room conditions (including as a result of door openings, or a function of humidity), and that are not exempted by this standard, shall operate in an equivalent manner during energy testing under this standard, or be accounted for by all calculations as provided for in the standard.

Examples of units for which the measurement standard is not applicable:

1. Units which have energy saving features that are designed to be activated by a lack of door openings which operate differently at 90°F compared to under typical room conditions (approximately 70 °F).
2. Units where the defrost heater either function or turn off differently during the energy test than it would under typical room conditions.
3. Electric heaters that would normally operate at typical room conditions with door openings operate differently during the energy test.

NOTE: Energy used during adaptive defrost shall continue to be tested and adjusted per the calculation provided for in this standard.

2 SCOPE

This standard applies to refrigerators as defined in Section 3.1, refrigerator freezers as defined in Section 3.2, freezers as defined in Section 3.3 and wine chillers as defined in Section 3.4. This standard covers definitions, methods for computing volumes, methods for determining energy consumption and energy factor, and safety recommendations.

This standard only covers compressor driven refrigerators, refrigerator freezers, wine chillers and freezers.

3 DEFINITIONS

For the purposes of this document, the following definitions apply. All definitions apply to products having a source of refrigeration requiring a single phase, alternating current electric energy input only, and which are intended for household use.

3.1 Refrigerator

A cabinet or any part of a cabinet which is designed for the refrigerated storage of food at temperatures warmer than 32°F (0°C) and colder than 39°F (3.9° C), configured for general refrigerated storage. It may include a compartment for the freezing and storage of ice and/or for storage of food at temperatures colder than 32°F (0°C), but does not provide a separate low temperature compartment designed for the freezing and storage of food at temperatures colder than 8°F (-13.3°C).

NOTE: All temperatures are measured in accordance with Section 5.5.5 when tested at 90°F (32.2° C) ambient.

3.2 All-Refrigerator

A refrigerator which does not include a compartment for the storage of food at temperatures colder than 32°F (0°C). It may include a compartment of 0.5 cubic feet (14.2 liters) or less for freezing and storage of ice.

3.3 Refrigerator-Freezer

A cabinet which consists of two or more compartments, with at least one of the compartments designed for the refrigerated storage of foods at temperatures warmer than 32°F (0°C) and colder than 39°F (3.9° C) and with at least one of the compartments designed for the freezing and storage of frozen foods at temperatures of 8°F (-13.3°C) average or colder, and shall be capable of being adjusted by the user to a temperature of 0°F (-17.8°C) or colder.

3.4 Freezer

A cabinet designed for the freezing and storage of frozen foods at temperatures of 0°F (-17.8°C) or colder.

3.4.1. Chest Type. A freezer which is accessible from the top.

3.4.2. Upright Type. A freezer which is accessible from the front.

3.5 Wine Chiller

A cabinet designed and marketed exclusively for the cooling and storage of wine.

3.6 Air Ducts

Enclosed passages which direct the flow of air.

3.7 Anti-Sweat Heater

A device incorporated into the design of a refrigerator, refrigerator-freezer, wine chiller or freezer to prevent the accumulation of moisture on the exterior or interior surfaces of the cabinet. This heater may be switchable from fully-on to fully-off or to some condition of operation in-between.

3.8 Automatic Ice maker

A device, connected to a water supply, which automatically produces, harvests, and stores ice in a storage bin, with means to automatically interrupt the harvesting operation when the bin is filled to a pre-determined amount.

3.8.1. Harvest. The process of freeing or removing ice pieces from an icemaker.

3.9 Baffle

A plate, wall or partition which is designed to perform one or more of the following functions:

- (a) prevent contact of food with refrigerated surfaces;
- (b) prevent dripping of condensate on food;
- (c) regulate and/or direct circulation of refrigerated air.

3.10 Cabinet Breaker Strip

A separate insulating element or integral extension of the cabinet interior surfaces around the periphery of the cabinet door or drawer opening(s) which functions as a thermal barrier to minimize heat flow to the interior of the cabinet.

3.11 Cycle

The period of 24 hours for which the energy use is calculated as though the consumer activated compartment temperature controls were set so that the standardized compartment temperatures were maintained.

3.12 Cycle Type

The set of test conditions having the calculated effect of operating a unit under test for a period of 24 hours, with the consumer activated controls other than those that control compartment temperatures set to establish various operating characteristics.

3.13 Defrost System

A means to remove frost and/or ice from the refrigerated surfaces. Types of defrost systems that apply to refrigerators and freezers are defined in Sections 3.13.1 through 3.13.4 below.

3.13.1. Manual Defrost. Manual defrost is one in which defrosting of the refrigerated surface is accomplished by natural or manual means with manual initiation and manual or automatic termination of the overall defrost operation.

3.13.2. Automatic Defrost. A system in which the defrost cycle is automatically initiated and terminated, with resumption of normal refrigeration at the conclusion of the defrost operation. The system automatically prevents the permanent formation of frost on all refrigerated surfaces. Nominal refrigerated food temperatures are maintained during operation of the automatic defrost system(s). The defrost water is disposed of automatically.

3.13.3. Partial Automatic Defrost. A system in which the refrigerated surfaces of the freezer compartment are defrosted manually and the refrigerated surfaces of the fresh food compartment are defrosted automatically. Defrost water from the fresh food compartment is disposed of automatically or collected in a container for subsequent manual removal.

3.14 Fan Scroll

Swept volume of the fan blade.

3.15 Fresh Food Compartment

In a refrigerator, that compartment(s) designed for the refrigerated storage of food at an average temperature warmer than 32°F (0°C) and colder than 39°F (3.9° C). Special compartments of

refrigerator-freezers operating at average temperatures above 8°F (-13.3°C) shall be considered part of the fresh food compartment.

3.16 Freezer Compartment

In a refrigerator-freezer, the compartment(s) designed for storage of foods at temperatures of 8°F (-13.3°C) average or (lower) colder; and shall be capable of being adjusted by the user to a temperature of 0°F (-17.8°C) or (below) colder.

In a freezer the compartment(s) designed for extended storage of frozen foods at an average temperature of 0°F (-17.8°C) or (below) colder and having inherent capability for freezing of food.

3.17 Ice Tray

A container that holds water while it turns to ice to be manually harvested.

3.18 Liner

The enclosure forming the interior of the fresh food compartment and/or some freezer compartment(s). The complete liner comprises the compartment liner in the cabinet, the exposed breaker strip surfaces and the door liner(s).

3.19 Long-Time Automatic Defrost

An automatic defrost system where successive defrost cycles are separated by 14 hours or more of compressor-operating time.

3.20 Quick Cool

An optional feature on freezers or refrigerators that is initiated manually. It bypasses the thermostat control and operates continually until the feature is terminated either manually or automatically.

3.21 Shelf

Any generally horizontal surface within the cabinet which is provided for the storage of food.

3.22 Special Compartments

Any compartment other than a butter conditioner without doors directly accessible from the exterior and with separate temperature controls (such as crispers convertible to meat keepers) that is not convertible from fresh food temperature range to freezer temperature range.

3.23 Butter Conditioner

An enclosed compartment which is provided for the storage of butter and which has an auxiliary temperature control.

3.24 Chiller or Drip Tray

A tray or drawer which is located beneath the refrigerated surfaces of a manual or semi-automatic defrosting refrigerator for chilling of food and/or collecting of water during defrosting. It may also serve as a baffle (Section 3.9) to regulate compartment temperature.

3.25 Crisper

An enclosed compartment or container provided primarily to retard the dehydration of fruits and vegetables.

3.26 Ice Storage Bin

A container in which ice can be stored.

3.27 Meat Keeper

An enclosed compartment or container which is designed for the storage of meat at or near 32°F (0°C).

3.28 Separate Auxiliary Compartment

A freezer compartment or a fresh food compartment of a refrigerator or refrigerator-freezer having more than two compartments that is not the largest freezer compartment or the largest fresh food compartment. Access to separate auxiliary compartment is through a separate exterior door or doors rather than through the door or doors of another compartment. Separate auxiliary compartments may not be larger than the largest fresh food compartment, but such size restrictions do not apply to separate auxiliary convertible compartments.

3.29 Variable anti-sweat heater control

An anti-sweat heater control that varies the average power input of the anti-sweat heater(s) based on operating condition variable(s) and/or ambient condition variable(s).

3.30 Stabilization Period

The total period of time during which steady state conditions are being attained or evaluated.

3.31 Standard Cycle

The cycle type (Section 3.12) in which the anti-sweat heater (Section 3.7) control, when provided, is set in the highest energy consuming position.

3.32 Steady State Condition

Steady state conditions exist if the average temperature in each measured compartment taken at 4 minute intervals, or less, during a stabilization period are not changing at a rate greater than 0.042°F (0.023°C) per hour as determined by the applicable condition of (a) or (b) below.

(a) The average of the measurements during a 2-hour period if no cycling occurs or during a number of complete repetitive compressor cycles through a period of no less than 2 hours is compared to the average over an equivalent time period with at least 3 hours elapsed between the two measurement periods.

(b) If defrost controls are operative during the test and (a) above cannot be used, the average of the measurements during a number of complete repetitive compressor cycles through a period of no less than 2 hours and including the last complete cycle prior to a defrost period, or if no cycling occurs, the average of the measurements during the last 2 hours prior to a defrost period is compared to the same averaging period prior to the following defrost period.

3.33 Variable Defrost Control

A long-time automatic defrost system (except the 14-hour defrost qualification does not apply) where successive defrost cycles are determined by an operating condition variable or variables other than solely compressor operating time. This includes any electrical or mechanical device.

A control scheme that changes the defrost interval from a fixed length to an extended length (without any intermediate steps) is not considered a variable defrost control. A variable defrost control feature should predict the accumulation of frost on the evaporator and react accordingly. Therefore, the times between defrost should vary with different usage patterns and include a continuum of lengths of time between defrosts as inputs vary.

3.34 Volume

3.34.1 Fresh Food Compartment Volume. The refrigerated volume (Section 4) of the fresh food compartment(s) (Section 3.15).

3.34.2 Freezer Compartment Volume. The refrigerated volume (Section 4) of the freezer compartment(s) (Section 3.16).

3.34.3 Total Volume. For refrigerator and refrigerator-freezers, the sum of the fresh food compartments' volume and the freezer compartments' volume.

For a freezer, the freezer compartment volume.

3.34.4 Adjusted Total Volume. For refrigerators and refrigerator-freezers: The sum of (i) the fresh food compartment volume in cubic feet and (ii) the product of an adjustment factor and the freezer compartment volume in cubic feet (see Section 6.3).

4 METHOD FOR COMPUTING REFRIGERATED VOLUME OF REFRIGERATORS, REFRIGERATOR-FREEZER, WINE CHILLERS, AND FREEZERS

4.1 Scope

This section describes methods for computing total volume (Section 3.34.3) of refrigerators, refrigerator-freezers, wine chillers and freezers. It is not intended to provide a means of measuring the food-storage capacity.

4.2 Total volume

4.2.1 Volume measurements

The fresh food compartment volume is to be recorded to the nearest 0.01 cubic feet (nearest 0.1 liter). The freezer compartment volume is to be recorded to the nearest 0.01 cubic feet (nearest 0.1 liter). The total volume shall be the sum of the volumes of all compartments and be recorded to the nearest 0.1 cubic feet (nearest 1.0 liter).

4.2.2 Determination of volume

The volume shall take into account the exact shapes of the walls including all depressions or projections. For through the door ice and water dispensers, the ice chute will be included in the volume up to the dispensing function.

When the volume is determined, internal fittings such as shelves, removable partitions, containers, automatic ice makers and interior light housings shall be considered as not being in place.

The items below shall be considered as being in place and their volumes deducted:

- The enclosed volume of control housings.
- The enclosed volume of the evaporator space (see Section 4.2.3).
- The enclosed volume of air ducts required for proper cooling and operation of the unit.

For clarification, the through the door ice and water dispensers and the insulating hump are not included in the volume (See Figures 4-2 and 4-3).

4.2.3 Volume of evaporator space

In the case of a forced air evaporator, the total volume of and behind the evaporator cover including volume occupied by the evaporator fan and the fan scroll. In the case of

plate style (or roll-bond) evaporators, the volume behind vertically installed plate style evaporators and the volume above horizontally installed plate style evaporators if the distance between the horizontal plate style evaporator and the nearest above liner surface is

- a) less than 2 inches (50 mm). Removable drip trays/troughs shall be considered as not present.
- b) In the case of refrigerant filled shelving, the volume above the uppermost shelf and below the lowermost shelf, if the distance between the shelf and the nearest horizontal plane of the cabinet inner wall is less than 50 mm (or 2 inches). All other refrigerated shelves are considered as not present.

4.3 Legend for Figures 4-1 through 4-3

Figures 4-1 through 4-3 show typical configurations and are not intended to cover all design variations. A combination of components from the various figures may be used for other designs.

These figures graphically support procedures for determination of volume described in Sections 4.2.2 and 4.2.3.

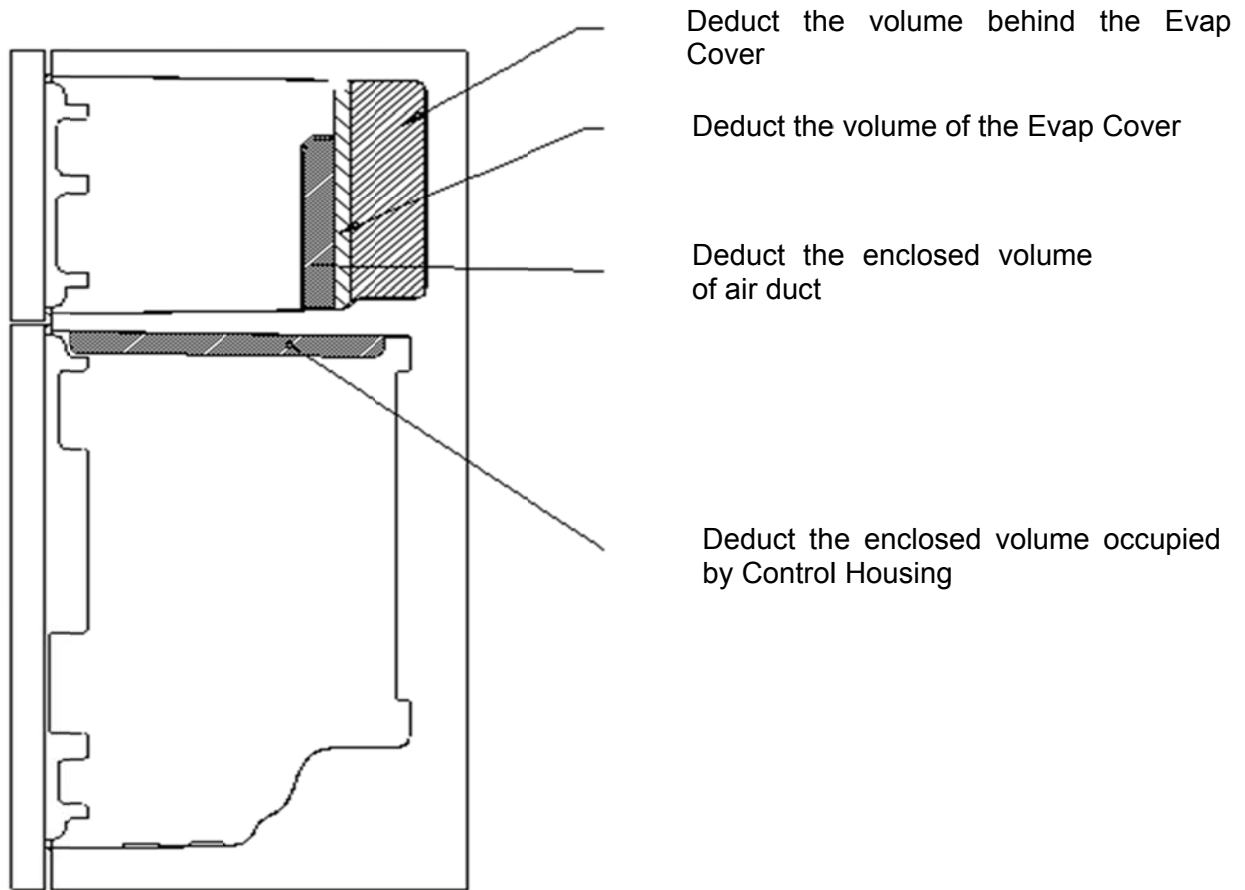


Figure 4-1: This view is a Basic TM Model but applies to all SxS, BM, FF, FZ etc. All deducts are the same. See the next figures for Dispenser Unit clarification.

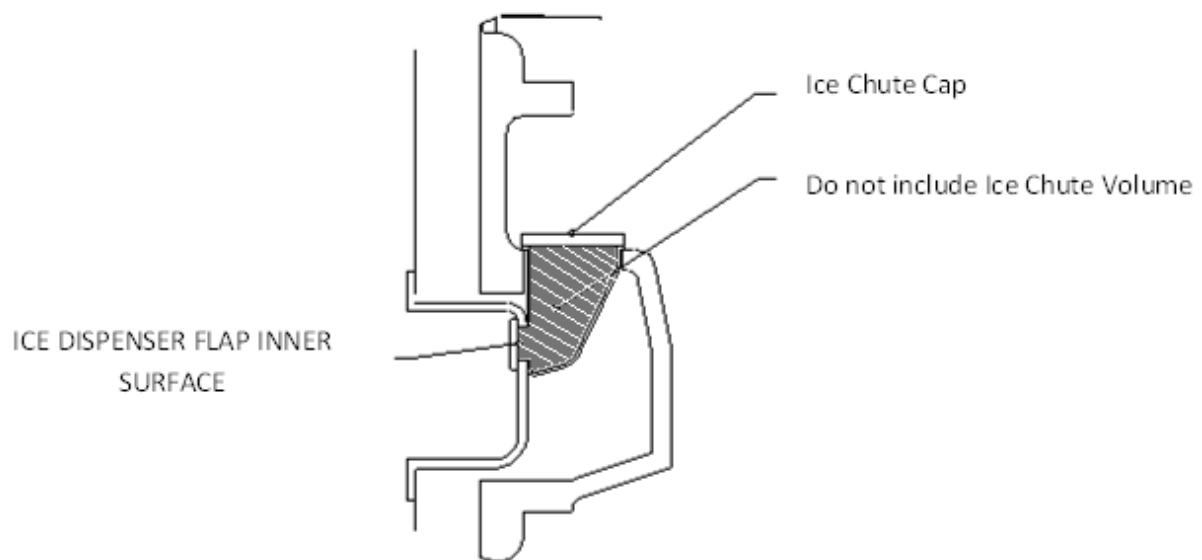


Figure 4-2: Through the door Dispenser with Plug or Cover over the Ice Chute

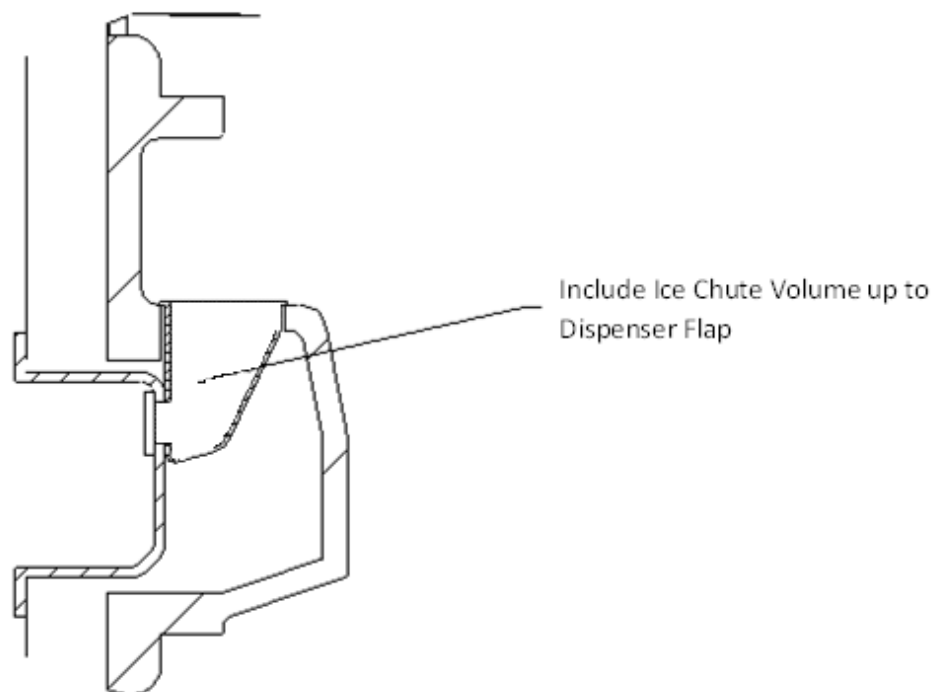


Figure 4-3: Through the door Dispenser without Plug or Cover over the Ice Chute

5 METHOD FOR DETERMINING THE ENERGY CONSUMPTION OF REFRIGERATORS, REFRIGERATOR-FREEZERS, WINE CHILLERS AND FREEZERS

5.1 Scope

This section describes a standard method for determining the electrical energy consumption for refrigerators, refrigerator-freezers, wine chillers and freezers.

5.2 Purpose

The purpose of this test method is to establish a uniform and repeatable procedure for measuring electrical energy consumption at various control settings and provide a standard procedure for determining energy consumption.

5.3 Test Conditions

5.3.1 Ambient Temperature. The ambient temperature shall be recorded at points located 3 feet (91.5 cm) above the floor and 10 inches (25.4 cm) from the center of the two sides of the unit under test. The ambient temperature shall be 90.0 ± 1.0 °F (32.2 ± 0.6 °C) during the stabilization period (Section 3.26) and the test period.

The test room vertical ambient temperature gradient in any foot of vertical distance from 2 inches (5.1 cm) above the floor or supporting platform to a height of 1 foot (30.5 cm) above the top of the unit under test is not to exceed 0.5 °F per foot (0.9 °C per meter). The vertical ambient temperature gradient at locations 10 inches (25.4 cm) out from the centers of the two sides of the unit being tested is to be maintained during the test. To demonstrate that this requirement has been met, test data must include measurements taken using temperature sensors at locations 10 inches (25.4 cm) from the center of the two sides of the unit under test at heights of 2 inches (5.1 cm) and 36 inches (91.4 cm) above the floor or supporting platform and at a height of 1 foot (30.5 cm) above the unit under test. The unit shall be located on a solid surface. If a platform is used, it is to have a solid top with all sides open for air circulation underneath, and its top shall extend at least 1 foot (30.5 cm) beyond each side and front of the cabinet and extend to the wall in the rear.

This platform must be used if the floor temperature is not within 3°F (1.7°C) of the specified ambient temperature. Floor temperature must be verified on an annual basis if a platform is not used under the unit.

Temperature measuring devices shall be shielded so that indicated temperatures are not affected by the operation of the condensing unit or adjacent units.

5.3.2 Ambient Relative Humidity. The ambient relative humidity need not be controlled.

5.3.3 Air Circulation. The cabinet under test shall be shielded from forced air currents having a velocity of more than 50 feet/minute (0.254 m/second). At a minimum, measurements are to be taken at a height of 36 inches from the floor and 10 inches out from the centers of the two sides of the unit under test. Air circulation must be verified at least on an annual basis.

5.3.4 Radiation. Shields shall be provided to prevent direct radiation from or to any heated or cooled surfaces whose temperature differs from the air temperature by more than 10°F (5.6°C).

5.4 Instruments

5.4.1 Temperature.

Temperature readings shall be accurate to $\pm 1^{\circ}\text{F}$ ($\pm 0.6^{\circ}\text{C}$).

5.4.2 Electrical. Electrical measurements shall be made with the following instruments or their equivalents:

- (a) Watt-hour meters. Instruments must have a resolution of 0.001 kWh or better.
- (b) Voltmeters. The resolution must be 0.1 V or better.

Instruments used for measuring voltage and energy shall be accurate to within $\pm 0.5\%$ of the quantity measured.

5.4.3 Time. Time measurements shall be accurate to within 1 minute/24 hours.

5.5 General Test Requirements

For each test the cabinet shall be operated at the specified test conditions for a sufficient length of time to establish steady state condition (Section 3.32).

5.5.1 Power Supply. The electrical power supply shall be $115 \pm 1\text{ V}$, 60 Hz at the product service connection. The actual voltage shall be maintained and recorded throughout the test. Momentary voltage fluctuations caused by turning on or off of electrical components shall not be considered.

5.5.2 Test Set-up. The cabinet with its refrigerating mechanism shall be assembled and set up as nearly as practical in accordance with the printed instructions supplied with the cabinet. All packing materials and skid boards shall be removed. Chiller or drip trays shall be in their proper places during all tests. Outer door gaskets shall be checked for adequacy of seal to the cabinet and adjusted, if required. Containers and covers, and food shelves are not to be removed. Unless otherwise specified, the following conditions apply.

- a) Shelves and door bins shall be evenly spaced throughout the compartment unless otherwise specified in the manufacturer's instructions.
- b) Baffles (Section 3.9) shall be open unless otherwise specified in the manufacturer's instructions.
- c) Automatic icemakers (Section 3.8) shall be inoperative during the energy test. Only devices or components directly associated with the harvesting (Section 3.8.1) of ice shall be inoperative during the energy test. All components not explicitly associated with the harvesting of ice must be operative during the energy test and shall be energized in a manner consistent with the duty cycle necessary to perform the respective functions. Turning off the ice maker for the purposes of the energy test shall only stop the further harvesting of ice. Thus, an ice maker is "inoperative" when the ice maker has "interrupt[ed] the harvesting operation, such as when the unit senses that "the bin is filled to a predetermined amount.'
- d) Butter conditioners shall be set in the lowest energy usage position when adjustment is provided.
- e) Customer accessible features not required for maintaining temperature in the refrigerator and/or freezer compartments, which are electrically powered, manually initiated, and manually terminated (such as customer operated dispensers, radios,

televisions, lights, etc.), shall be set at their lowest energy usage positions when adjustment is provided.

- f) Features which are electrically powered, manually initiated, and automatically terminated within 168 hours (such as fast chill compartments, electric door openers, etc.) are operated at their lowest energy usage position.
- g) Compartments that are convertible (e.g., from fresh food to freezer) shall be operated in the highest energy use position.

For the special case of convertible separate auxiliary compartments, this means that the compartment shall be treated as a freezer compartment or a fresh food compartment, depending on which of these represents higher energy use.

Special compartments shall be tested with controls set to provide the coldest temperature. However, for special compartments in which temperature control is achieved using the addition of heat (including resistive electric heating, refrigeration system waste heat, or heat from any other source, but excluding the transfer of air from another part of the interior of the product) for any part of the controllable temperature range of that compartment, the product energy use shall be determined by averaging two sets of tests. The first set of tests shall be conducted with such special compartments at their coldest settings, and the second set of tests shall be conducted with such special compartments at their warmest settings.

The requirements for the warmest or coldest temperature settings of this section do not apply to features or functions associated with temperature control (such as fast chill compartments) that are initiated manually and terminated automatically within 168 hours.

- h) The evaporator in manual defrost models need not be defrosted prior to each test unless frost accumulation exceeds ¼ inch (6 mm) in average thickness. Chiller and drip trays and interior of cabinet shall be dried prior to start of test after evaporator has been manually defrosted.
- i) Ice trays (Section 3.18) and ice buckets related to non-automatic ice making shall be removed from the freezer section. Ice storage bins of automatic icemakers are to remain in place.
- j) Storage baskets in chest freezers shall be removed if they are removable without the use of tools.
- k) Defrost controls shall be operative for all tests.
- l) Tests shall be run with the manual anti-sweat heater (Section 3.7) switch in the highest and lowest energy use positions for each temperature control setting if the product is shipped with the switch in the lowest energy use position. Otherwise, it shall be run only in the highest energy use position for each temperature control setting. Heaters used to prevent internal or external moisture build-up, to keep gaskets pliable, to keep water reservoirs or lines not directly related to ice production from freezing, or deemed as necessary for the operation and reliability of the product shall be functioning during the energy test, unless specifically excluded by the standard.
- m) The quick cool (Section 3.20) option shall be switched off.