SRI LANKA STANDARD 1230 : 2003
UDC 641.546.46

SPECIFICATION FOR

ENERGY EFFICIENCY RATING OF HOUSEHOLD REFRIGERATORS, REFRIGERATOR - FREEZERS AND FREEZERS

SRI LANKA STANDARDS INSTITUTION

- Blank Page -

SPECIFICATION FOR
ENERGY EFFICIENCY RATING OF HOUSEHOLD REFRIGERATORS, REFRIGERATOR - FREEZERS AND FREEZERS

SLS 1230 : 2003

Gr. 19

SRI LANKA STANDARD INSTITUTION
17, Victoria Place,
Elvitigala Mawatha
Colombo 08
SRI LANKA

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

CONTENTS

CLAUSE **PAGE**

Section 01

TABLES

FIGURES

CONTENTS

CLAUSE

PAGE

Section 02

TABLES

FIGURES

APPENDICES

FIGURES

SRI LANKA STANDARD
SPECIFICATION FOR ENERGY EFFICIENCY RATING OF HOUSEHOLD REFRIGERATORS, REFRIGERATOR - FREEZERS AND FREEZERS

FOREWORD

This standard was approved by the Technical Advisory Committee on Energy Efficiency Labelling of Refrigerators constituted under the Ceylon Electricity Board and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2003-01-14.

This standard is presented in two sections, namely Section 1 - Methods of measurement and requirements for Energy Efficiency Labellng and Section 2 – Determination of Star Ratings and Energy Efficiency Label. Section 1 prescribes methods of measurement of power consumption and other methods of tests to ascertain that refrigerators fulfil pre-requisites of the Energy Efficiency Labelling Scheme for certifying. Section 2 specifies method of determination of the energy rating and the requirements for the label.

The Sri Lanka Standard Specification for Energy Efficiency rating of refrigerators has been published for promotion of the use of efficient refrigerators and freezers for saving electrical energy. Five categories of energy efficiency ratings have been identified based on the energy consumption of refrigerators. The best energy efficiency rating is assigned with “five stars”. The number of stars assigned reflects the efficiency of the model of the refrigerators. More stars means more energy efficient.

SLS 723 which deals with the performance and safety requirements for refrigerators, need to be revised to fall in line with test methods prescribed by this standard and **ISO 7371.**

For the purpose of deciding whether a particular requirement of the standard is complied with the final value, observed value or calculated, expressing the result of a test or an analysis, shall be rounded off in accordance with CS 102. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

All the values given in this specification are in SI units.

In the preparation of this standard, the Sri Lanka Standards Institution and the Ceylon Electricity Board gratefully acknowledge the use of the following publications of International Organization for Standardization (ISO), Standards Australia (AS) and Standards Association of New Zealand (NZS).

a) ISO 7371 : 1995	Performance of household refrigerating appliances Refrigerators with or without low temperature compartment
b) AS 2575.2:1989 / NZS 6205.2:1989	Energy labelling of appliances - Part 2 Refrigerators, refrigerator/ freezers and freezers Determination of energy consumption and efficiency rating
c) AS 1430 : 1986	Household refrigerators and freezers

SECTION –1 METHODS OF MEASUREMENT AND REQUIREMENTS FOR ENERGY EFFICIENCY LABELLNG

1 SCOPE

This section of the standard specifies requirements for energy efficiency labelling of household electric refrigerators of the vapour compression type, together with a test method for determining the energy consumption of refrigerators that are capable of complying with

a) Ice-making test;
b) pull down test;
c) temperature performance test; and
d) water vapour condensation test specified in this standard.

2 REFERENCES

CS 102 Presentation of numerical values
Munsell Book of Colour (2.5 R – 10 RP) Matte collection

3 DEFINITIONS

For the purpose of this standard the following definitions shall apply.

3.1 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 condensate from dipping on food; and
c) regulate circulation of refrigerated air .

3.2 chiller or drip tray: A tray or drawer located directly below the freezing compartment for quick chilling or for water collection where defrosting is not automatic.

3.3 compartment: An enclosed space within a refrigerator, accessible via a door, lid or the like, and usually having a specific function. Types of compartments are as follows:

3.3.1 ***fresh food compartment:*** A compartment indented for the storage of unfrozen food and which may be subdivided into smaller zones or compartments allocated .for the storage of particular types of product, sometimes with individual climate control. Such special storages may be for meat, butter, eggs, beverages, or the like.

3.3.2 ***frozen food compartment:*** A compartment intended specifically for the freezing and or storage of frozen food, and which may include an ice making zone or function.

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

3.5 defrost (system) : A means for removing frozen atmospheric moisture from evaporator surfaces. Defrost system may be of the following types.

3.5.1 ***manual*** **:** Defrosting effected by manual termination of electrical supply or by manual adjustment of the thermostat control.

3.5.2 ***semi- automatic defrost :*** A defrosting system that is manually initiated and automatically terminated.

3.5.3 ***automatic partial defrost (automatic fresh food compartment defrost) :*** A defrosting system which is automatic in operation for the fresh food-compartment and which has suitable means of drainage and disposal by evaporation of defrost water from fresh food compartment and provision for collection of defrost water from the frozen food compartment.

3.5.4 ***automatic total defrost :*** A defrosting system which is automatic in operation for both the fresh-food compartment and the frozen food compartment and which has suitable means of drainage and disposal by evaporation of defrost water from both compartments.

3.6 evaporator: A heat exchanger in the refrigerant circuit, in which liquid refrigerant evaporates to cause chilling.

NOTE
Although an evaporator may form part or all of the enclosing walls of a freezing compartment it is a misnomer to refer to such a compartment as an evaporator.

3.7 gross volume: The volume within the inside walls of the appliance, or of a compartment with external door, without internal fittings, doors or lids are not being in place.

3.8 operating cycle: One 'off' period plus one consecutive 'on' period.

3.9 Ice-making compartment : Compartment intended specially for the freezing and storage of water ice-cubes.

3.10 liner: The interior surface of the cabinet compartments.

3.11 long term storage: Storage of frozen food under appropriate conditions of temperature for extended periods of time (see note under **3.17**).

3.12 rated gross volume: Gross volume stated by the manufacturer.

.

3.13 reference temperatures: Temperatures within the fresh-food compartment, if provided, and the frozen-food compartment, if provided, that are used as references for determining the energy consumption of refrigerators.

3.14 refrigerator: A household appliance intended to preserve food by reducing its temperature to a predetermined value, and controlling it within specified limits. The term applies as general term to cover all the types of appliances listed in Table 1 unless otherwise qualified.

3.15 shelf: Any horizontal surface (shelf, partition, etc.,) on which food can be placed. It may be formed by one compartment or by compartments fitted side-by-side, which may be fixed or removable, shelf areas as follows:

3.15.1 *Storage shelf area:* Sum of the areas of all shelves within the storage volume, including door shelves, and the bottom of each compartment where it can be utilized for the storage of food.

3.15.2 *Rated storage shelf area :* Storage shelf area stated by the manufacturer.

3.16 short term storage: Storage of frozen food for short periods of up to approximately a month.

NOTE
The permissible length of storage time of frozen food cannot be precisely stated as this varies with the nature of the food (dairy product, fish, fruit, meat etc.) and with conditions and length of storage prior to purchase.

3.17 thermostat: Device, which automatically regulates the operation of a refrigerating system according to the temperature of an evaporator or of a compartment

3.18 zone: An area or space within a compartment, designated by the manufacturer for the storage, chilling or freezing of foods or beverages requiring particular conditions for optimum storage.

4 CLASSIFICATION

The classification of refrigerators is given in Table **1**

TABLE 1 - Classification of refrigerators

Unit (1)	**Classification** (2)	**Description** (3)
Refrigerator	Class 1	A refrigerator in which the entire storage volume comprises a fresh-food compartment
	Class 2	A refrigerator in which the entire storage volume comprises a fresh-food compartment in which a compartment intended for ice-making is incorporated
	Class 3	A refrigerator in which the entire storage volume comprises a fresh-food compartment in which a frozen-food compartment intended for ice-making and short-term storage of frozen food is incorporated
Refrigerator - freezer	Class 4	A refrigerator with a fresh-food compartment and with a frozen-food compartment intended for long-term storage of frozen food
	Class 5	A class 4 refrigerator incorporating means to prevent the formation of frost on contents
Freezer	Class 6	A refrigerator in which the entire storage volume comprises a frozen-food compartment intended for long-term storage of frozen foods
	Class 7	A class 6 refrigerator incorporating means to prevent the formation of frost on contents

5. VOLUME

5.1 Storage volume

The storage volume shall be the gross volume from which the following is deducted :

a) ***For fresh - food compartments-***

i) the volume of the evaporator space (see Figure **1**);
ii) the volume of any housing (such as those which may be provided for interior lights, thermostats, and other control devices); and
iii) the volume of shelves, partitions, retainers, and other accessories whose thickness is greater than 13 mm (see Figure **2**).

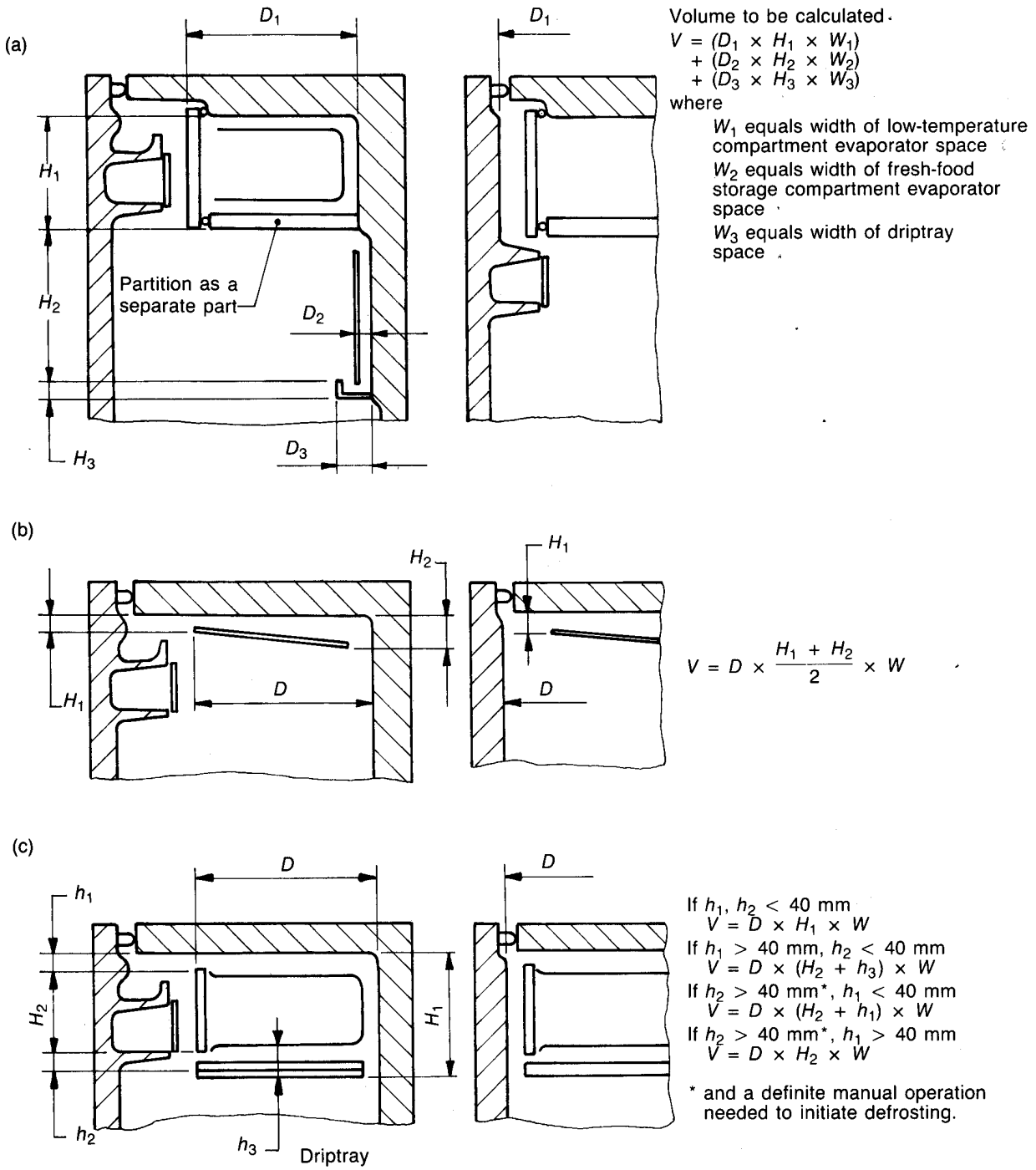
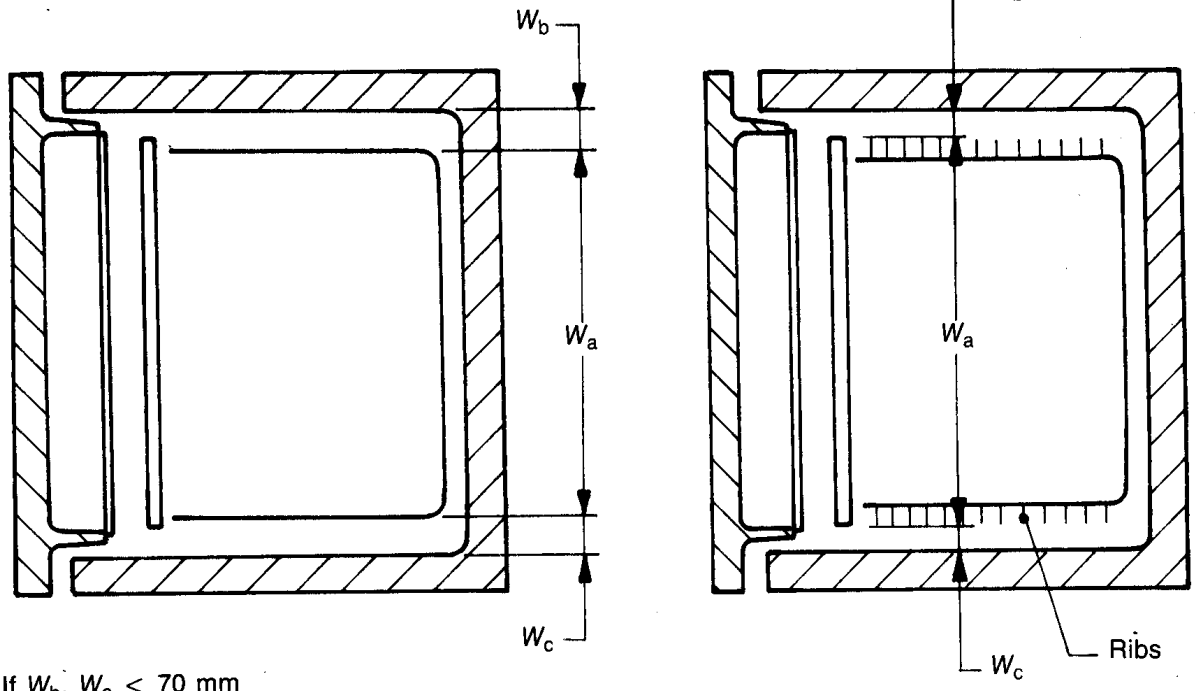
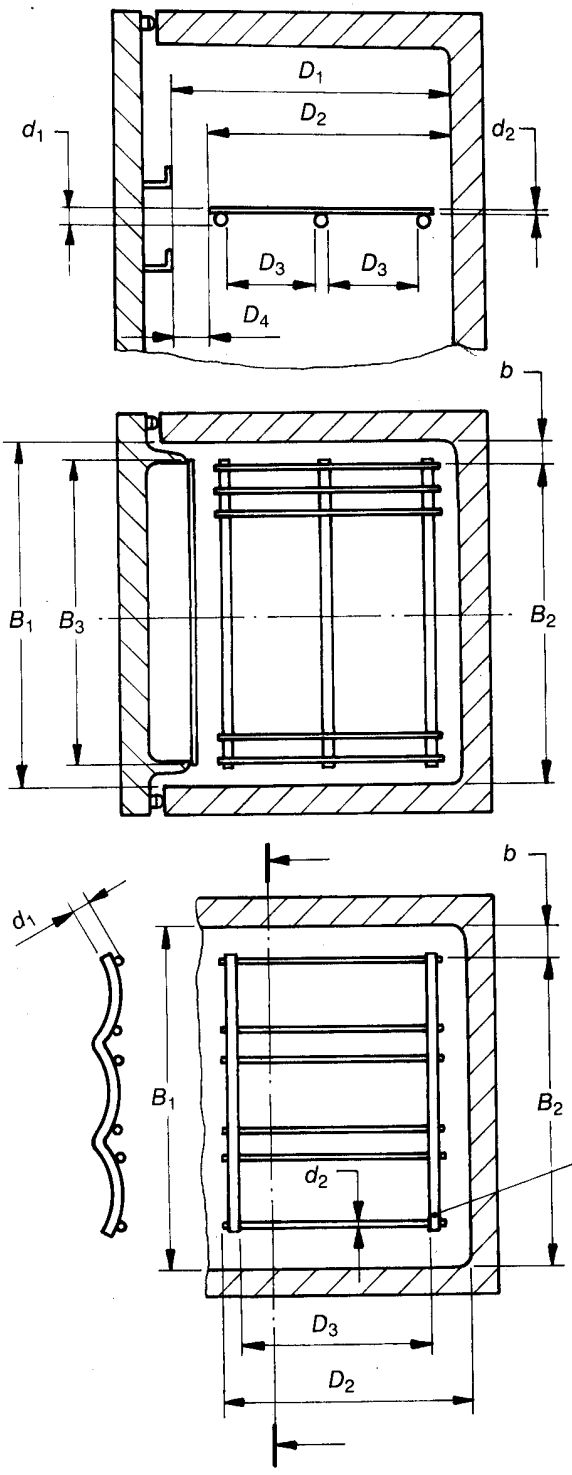


FIGURE 1 - Volume of evaporator space (Continued)



If W_b, W_c < 70 mm
$W = W_a + W_b + W_c$
If W_b < 70 mm, W_c > 70 mm
$W = W_a + W_b$
If W_b, W_c > 70 mm
$W = W_a$

FIGURE 1 - Volume of evaporator space (concluded)



Conditions			Volumes to be deducted
(1) d_1, d_2	<	13 mm	0
(2) d_1	>	13 mm	0
d_2	<	13 mm	
D_3	>	100 mm	
(3) d_1	>	13 mm	$d_1 \times D_1 \times B_1$
$d_2 < d_1$			
D_3	<	100 mm	
D_4	<	70 mm	
b	<	70 mm	
(4) d_1	>	13 mm	$d_1 \times D_2 \times B_1$
$d_2 < d_1$			
d_3	<	100 mm	
D_4	>	70 mm	
b	<	70 mm	
(5) d_2	>	13 mm	$d_2 \times D_1 \times B_1$
D_3	>	100 mm	
D_4	<	70 mm	
b	<	70 mm	
(6) d_2	>	13 mm	$d_2 \times D_2 \times B_1$
D_3	>	100 mm	
D_4	>	70 mm	
b	<	70 mm	

(7) If b > 70 mm, take B_2 instead of B_1 (fractional shelf).

FIGURE 2 – Volume of shelves and partitions

b) For frozen - food compartments-

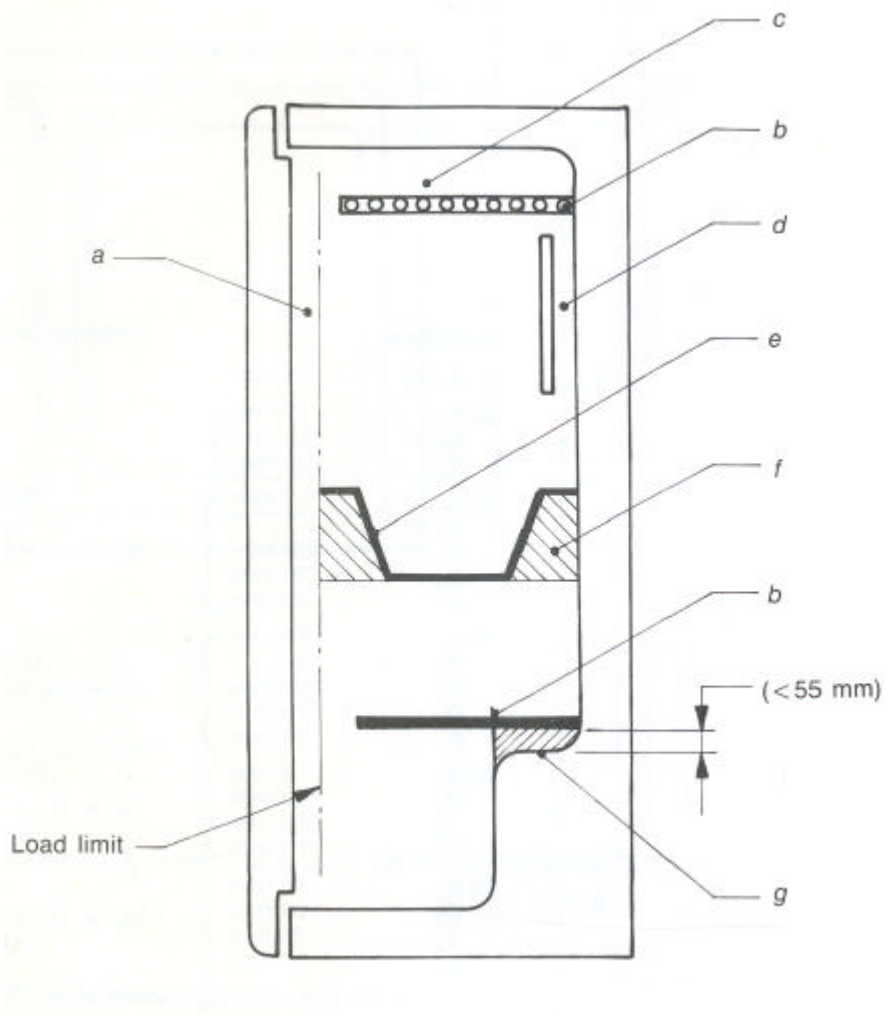
i) the volume of spaces situated outside any load limits marked by the manufacturer;
ii) the volume of all fixed components included within the load limits;
iii) the volume of spaces which are to be kept free for correct performance of the refrigerating system;
iv) the volume of all included removable parts, and the volume rendered unusable by the use of such removable parts, which are stated by the manufacturer to be necessary for the proper functioning of the appliance, except shelves and partitions whose thickness is not greater than 13 mm;
v) any volume which is not usable because of its dimensions or its location (see Figure **3**); and
vi) where the horizontal distance between the face of a stack of test packages and the inner surface of a door exceeds 15 mm, the volume between the stack and the door surface or projection therefrom.

NOTE

1. *The volumes occupied by the following are included as part of the storage volume of each compartment and should not be deducted.*
   i) Convenience features such as crispers, meat keepers, chillers, ice trays and can or package racks, dividers or dispensers (provided that such features are not projections), compartment fronts, and icemakers.
   ii) Door-shelf fronts and bottoms, and doors of special feature compartments located within the door.
   iii) Features such as trims and shelf, pan and basket rails, and aesthetic items, which are removable without the aid of tools.
2. *There is no equivalence between the value of the storage volume determined in accordance with the principles above and the volume of the packages loaded into the appliance for the storage and freezing tests. The free spaces specified in the test methods could be utilized in normal use and their volume should not be deducted from the gross volume when calculating the storage volume.*

5.2 rated volumes: The rated gross and storage volumes shall be derived from the values determined in accordance with **5.1**, and with the following limitations for rounding:

a) any rated volume for a compartment shall not exceed the measured value rounded to the nearest 1 litre.
b) any rated total volume shall not exceed the sum of the measured volumes for individual compartments, rounded to the nearest 10 litre.
c) Any model designation which may be interpreted as indicating a rated volume shall not be numerically greater than the rated total gross volume.



NOTE:

*The volumes marked a, b, c, d, e and f should be deducted from the gross volume (see **3.7**) with the following qualifications:*

a) If no load limit is specified, a natural load limit will be assumed to exist 20 mm in from of any shelf edge, or at any restricting shelf rails, or the inner door or lid liner, whichever results in the least value of volume.
b) The shelf dimension qualifications of Fig.2 apply.
c) Deduct only if the height above the shelf/evaporator is less than 40 mm.
d) Deduct, see Fig.1 for calculation.
e) Deduct if thickness exceeds 13 mm.
f) Deduct for all hanging baskets but not for any loose baskets or containers that rest on shelves. Reinstate the volume of any door shelf if it protrudes into f.
g) Deduct only of under 55 mm.

FIGURE 3 – Storage volume – freezer

6. REQUIREMENTS

6.1 General

Refrigerators shall comply with the requirements for Ice-making, pull down, temperature performance, and water vapour condensation when tested as in **8.3**, **8.4, 8.5 and 8.6** respectively for qualifying energy labelling.

The refrigerator shall continue to run in for a period of not less than 24 h prior to the tests. The purpose of running-in a refrigerator is to ensure a thorough working-in of mechanical parts and to achieve the stabilization. For the refrigerators with automatic defrosting, if the first defrosting cycle is not completed during the 24 h, running-in shall be extended for another 24 h till it complete the first defrost cycle. But if no defrost cycle starts even after the second 24 h, the tests shall be started and defrosting shall not be taken to consideration. The running-in of the refrigerator shall be carried out at specified room temperature for that particular test.

6.2 Ice-making

The purpose of this test is to check the claim of the manufacturer/supplier, if any, for the ice-making capability of the appliance (**see 8.3**). This test does not apply for automatic ice-makers.

6.3 Pull Down

The purpose of this test is to check the ability of stimulating cooling down of a load in extreme weather conditions when tested as per **8.4.**

After the test (see **8.4**), the time taken for the average air temperature in each compartment to be reduced from an ambient temperature of 38 ^{o}C to that specified in Table **2** for the particular class, shall be not more than 6 hours.

6.4 Temperature Performance

Refrigerator is able to store food within the range of temperature likely to occur within its operating environment by the test specified in **8.5**.

After the test (see **8.5**), in each ambient temperature condition there must be at least one temperature control setting at which the freezer test package temperature is equal to or less than the stated limit, and concurrently the average temperature in the fresh-food compartment is within the limits of 1 ^{0}C and 7 ^{0}C.

6.5 Water Vapour Condensation

The thermal insulation of the refrigerator should be efficient and permanently maintained. In particular, the insulating material should not be subjected to shrinkage and should not allow under normal working conditions an excessive accumulation of moisture. The extent of condensation of water on the external surface of the cabinet is determined under specified ambient conditions. No running water shall appear externally when the refrigerator is subjected to the water vapour condensation test specified in **8.6**.

6.6 Energy consumption

The average air temperature within the fresh food compartment, if provided and the frozen food compartment, if provided, together with the amount of energy consumed for a number of settings of the compartment temperature-controls, if provided shall be determined.

Air Temperature sensors are positioned within the refrigerator and then the refrigerator is operated at thermal equilibrium under ambient temperature of $32 \pm 0.5\ ^{o}C$.

Graphical procedures given in **8.7**, is used to determine the energy consumption.

7. MARKING

7.1 Each refrigerator shall have the following information marked in a permanent and legible manner on one or several locations where it is readily visible, either when the refrigerator is away from a wall or after the removal, without the help of tools, of a flap or grill.

a) The manufacturer's name or the trade mark or name or trade mark of responsible vendor.
b) The model (or commercial designation) of the refrigerators.
c) The rated gross volume in litres.
d) Identification of the model for refrigerating system.
e) The designation of the fluid refrigerant used, and its mass.
f) Rated voltage & rated power input in watts.
g) The rated storage volume of the fresh food storage compartment and frozen food compartment expressed in litres.

7.2 Instruction for use and maintenance and other indications relating to safety regulations and complementary information (i.e. full load current wiring diagram, voltage frequency of supply etc.) shall be provided by the manufacturer.

8 TESTS

8.1 Sampling

One sample containing three refrigerators of each model shall be tested according to this standard for determination of energy efficiency rating of a particular model. The average of the three measurements shall be taken as the power consumption for the particular model.

The sample shall be selected randomly from a population containing a minimum of 10 units.

NOTE

$$\text{Variance} = \frac{(\text{Energy consumption of ref}_1 - \text{Energy consumption of ref}_2) \times 2 \times 100}{\text{Energy consumption of ref}_1 + \text{Energy consumption of ref}_2}$$

8.2 Test requirements

8.2.1 *Measuring instruments*

8.2.1.1 Temperature measuring instruments

a) Temperature measuring instruments (recording type is preferable) accuracy ± 0.3 ^{o}C
b) Air temperature sensors: The temperature sensitive part of a thermometric device for measuring air temperatures should comply with the following:

   i) It shall posses or be in good thermal contact with a metallic mass having total heat capacity equivalent to not less than 10 g and not more than 20 g of water. A copper cylinder of 25 mm diameter and 25 mm length is considered suitable for this purpose.
   ii) It shall have not less than 10 mm air space separating it from contact with heat conducting surfaces.
   iii) It should be shielded from direct heat radiation.

8.2.1.2 Electrical measuring instruments

a) Watt hour meter – readable to 0.01 kWh and Class 2
b) Voltmeter, class 1.0, (limits of error ± 1%)
c) Voltage stabilizer – The voltage should be maintained ± 2% of 230 V. Frequency should be maintained within ± 1% of 50 Hz

8.2.1.3 Time measuring instruments

Operating time of the refrigerator shall be obtained by means of instruments having accuracy of ± 0.1%.

8.2.2 *Test Packages*

When tests are carried out on an appliance loaded with test packages which shall be as specified below.

a) Shape – parallelepiped

b) Sizes of 25×50×100, 50×100×100 and 50×100×200 in mm×mm×mm and corresponding mass of 125 g, 500 g and 1000 g respectively.

c) Tolerances on linear dimensions
   i) ±1.5 mm for 25 mm and 50 mm dimensions
   ii) ±3.0 mm for 100 mm and 200 mm dimensions

d) Tolerances on mass shall be ± 2%.

e) Composition

   A suitable filling material of 1000 g shall contain
   i) 230 g of hydroxyethyl methylcellulose
   ii) 764.2 g of water
   iii) 5 g sodium chloride
   iv) 0.8 g parachlorometacresol

The constituents shall be thoroughly mixed and kneaded until homogeneous, allowed to set, and then formed to correct size and shape for wrapping. A wrapper consisting of clear plastics film that will permit negligible transfer of water vapours, and sealed after wrapping.

8.2.3 *M Packages (Measurement packages)*

M packages are test packages of 500 g equipped for temperature measurements being fitted with thermocouples which are installed in the geometrical center of the packages in direct contacts with the filling material.

Dimensions*:* 50 mm x 100 mm x100 mm

Thermocouple: the diameter of the thermocouple wire shall be not greater than 0.6 mm. Premature failure of the thermocouple by corrosion shall be prevented by coating it with a thin layer of a protective material such as epoxy resin or silicone

Thermocouple location: The thermocouple junction shall lie in a horizontal plane, centrally in the test package. At least 50 mm length of the wire adjacent to the junction shall lie in the same plane as the junction. The wire may be looped within the package, if necessary, to comply with this requirement.

8.2.4 Thermal equilibrium

8.2.4.1 Test room

Thermal equilibrium of test room shall be deemed to be attained when the ambient air temperature remains at $32^{o}C \pm 5^{o}C$ throughout the test period. The relative humidity shall be between 70% and 80%.

8.2.4.2 Refrigerator

Thermal equilibrium of the refrigerator shall be deemed to be attained when the average temperature, as determined in **8.2.5**, within the fresh-food compartment, if provided, and the frozen-food compartment, if provided, of at least two consecutive determinations for not vary by more than a) $0.5\ ^{0}C$, if the refrigerator cycle; or

b) $0.3\ ^{0}C$, if the refrigerator does not cycle.

NOTE

Since the test period for the determination of the average temperature is at least 3 hours and thermal equilibrium must be established over at least two consecutive average temperature determinations, the test period for establishing thermal equilibrium will be at least 6 hours.

8.2.5 ***Temperature measurement***

The average air temperature within the refrigerator, for each of the temperature control setting, if one or more temperature controls are provided, shall be determined as follows:

a) where the refrigerator cycles, for each temperature sensor within the refrigerator, record
   i) for an automatic defrost refrigerator, the temperature readings immediately after the compressor motor switches "off" and immediately after the compressor motor switches "on" for an equal number of "off" and "on" periods for at least 3 hours duration prior to the initiation of defrost; or

   ii) for a refrigerator other than an automatic defrost refrigerator the temperature readings, immediately after the compressor motor switches "off" and immediately after the compressor motor switches "on" for an equal number of "off" and "on" periods for at least 3 hours duration.

b) where the refrigerator does not cycle, for each temperature sensor within the refrigerator, record the temperature readings at the end of each 30 minutes interval for at least 3 hours duration.

NOTE

If the thermostat on the refrigerator is set on coldest, for example, it is possible that the compressor motor may not cycle but will operate continuously in order to maintain the required temperature.

c) using the temperature recorded in steps (a), (b) above, whichever is appropriate, calculate the average temperature of each temperature sensor.

d) where the refrigerator has a fresh-food compartment, using all of the appropriate average temperatures determined in steps (c) above, calculate the average air temperature of the fresh-food compartment.

e) where the refrigerator has a frozen-food compartment, using all except the coldest, of the appropriate average temperatures determined in step (c) above, calculate the average air temperature of the frozen-food compartment.

NOTE

Because it is possible that a temperature sensor may be located in cold spot of the refrigerator, e.g. in a stream of cold air of a frost-free refrigerator, the coldest average temperature is not used in the determination of the average air temperature of the frozen-food compartment.

8. 2.6 ***Test Room***

The test room shall be arranged and equipped so that the conditions specified for each test can be maintained.

a) Air circulation

Air velocity in the room shall be maintained less than 0.25 m/s. Air circulation in the test room shall be such that the vertical temperature gradient in the test room from the floor to a height of 2 m shall not exceed 1 ^{o}C/m, except where it may be affected by local heat emission, e.g. in the vicinity of a condenser.

Circulation of air about the appliance shall be restricted by surrounding the appliance by three vertical partitions made of plywood, thickness 20 mm, painted dull black, arranged as follows:

One of the partitions shall be placed parallel to the rear of the appliance, against the stops or at the distance specified by the manufacturer in connection with the required overall space. In case if the manufacturer has not specified the distance, it shall be taken as 300 mm. The two other partitions shall be parallel to the sides of the cabinet, and shall be fixed on the platform 300 mm from the side of the cabinet; they shall be 300 mm wide. The vertical partitions shall present no discontinuity. They shall be of such a height that they extend at least 300 mm above the top of the appliance.

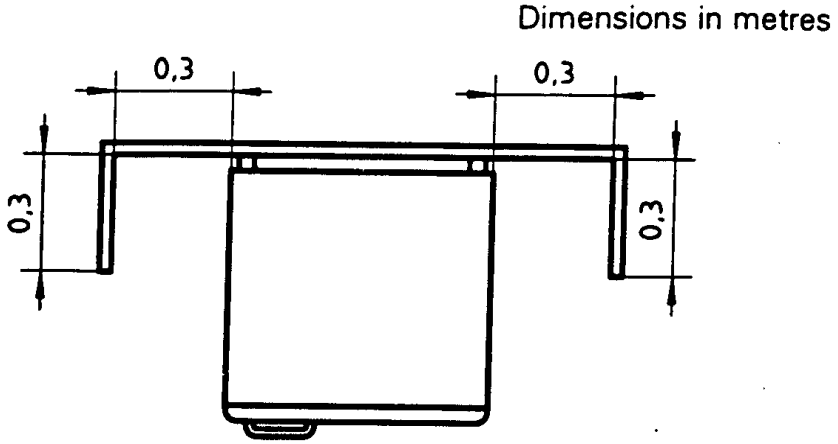


FIGURE 4 – Partitions to restrict air circulation

b) Temperature conditions

Where the temperature difference between the surface of the test room floor, at the place were a test refrigerator is required to stand during testing, and the ambient air temperature immediately above the floor is greater than 1°C, the refrigerator shall be placed on a solid-top platform with all sides open to allow free circulation of air under the platform. The top of the platform shall 300 ± 10 mm above the floor level and shall extend a distance not less than 300 mm nor more than 600 mm horizontally beyond the front and each side of the refrigerator.

c) Radiation shields

Windows, where incorporated in the test room, shall be provided with suitable heat radiation shields. The appliance shall be so placed or shielded as to prevent direct radiation to or from the space cooling or heating equipment in test room.

8.2.7 Test conditions

The test procedure shall be performed under the following conditions:

a) the refrigerator shall be "run-in"
b) The refrigerator shall contain, in their intended locations, the fittings (e.g. meat keepers, crispers, defrosting trays, ice trays, ice storage bins) that are intended to be supplied with a complete appliance.
c) The inside of the refrigerator shall be frost-free, clean and dry.
d) Where controls are provided for convenience items such as lights, butter conditioners, automatic ice-makers, chilled water dispensers, ice-cream makers, fast-freezer devices , without removing any components, these controls shall be set at the least energy-consuming position.

e) Where controls are provided for anti-sweat heaters (not being the convenience items) referred to in (d) above, these controls shall be set at the greatest energy consuming positions.

f) Where controls (e.g. baffles) are provided on zones such as meat keepers, crispers or cellar type zones, such controls shall be set so that the temperature within these zones is lowest.

g) If the refrigerator is of the automatic defrost type, the defrost mechanisms shall be allowed to operate as intended by the refrigerator manufacturer.

h) Where the refrigerator is designed so that the volume of the fresh-food compartment or the frozen-food compartment or both is adjustable, the compartments, shall be adjusted so that the refrigerator will consume the greatest amount of energy

j) Where a fresh-food compartment is provided, air temperature sensors (t_{c1} to t_{c3}) shall be positioned as specified in Appendix **B**

k) Where a frozen – food compartment is provided, air temperature sensors (t_{ft} to t_{f3}) shall be positioned as shown in Figures **5** to **7** whichever is appropriate.

NOTE

If, because of the design of the refrigerator, it is not possible to position air temperature sensors at the locations specified then the sensors are to be positioned as near as practicable to the specified locations.

l) The refrigerator shall be positioned in the test room as specified in **8.2.6**
m) Unless specified the test room conditions shall be maintained as specified in **8.2.4** throughout the run in and test.
n) The voltage of electricity power supply throughout the test shall be maintained as specified in **8.2.1.2 (c).**

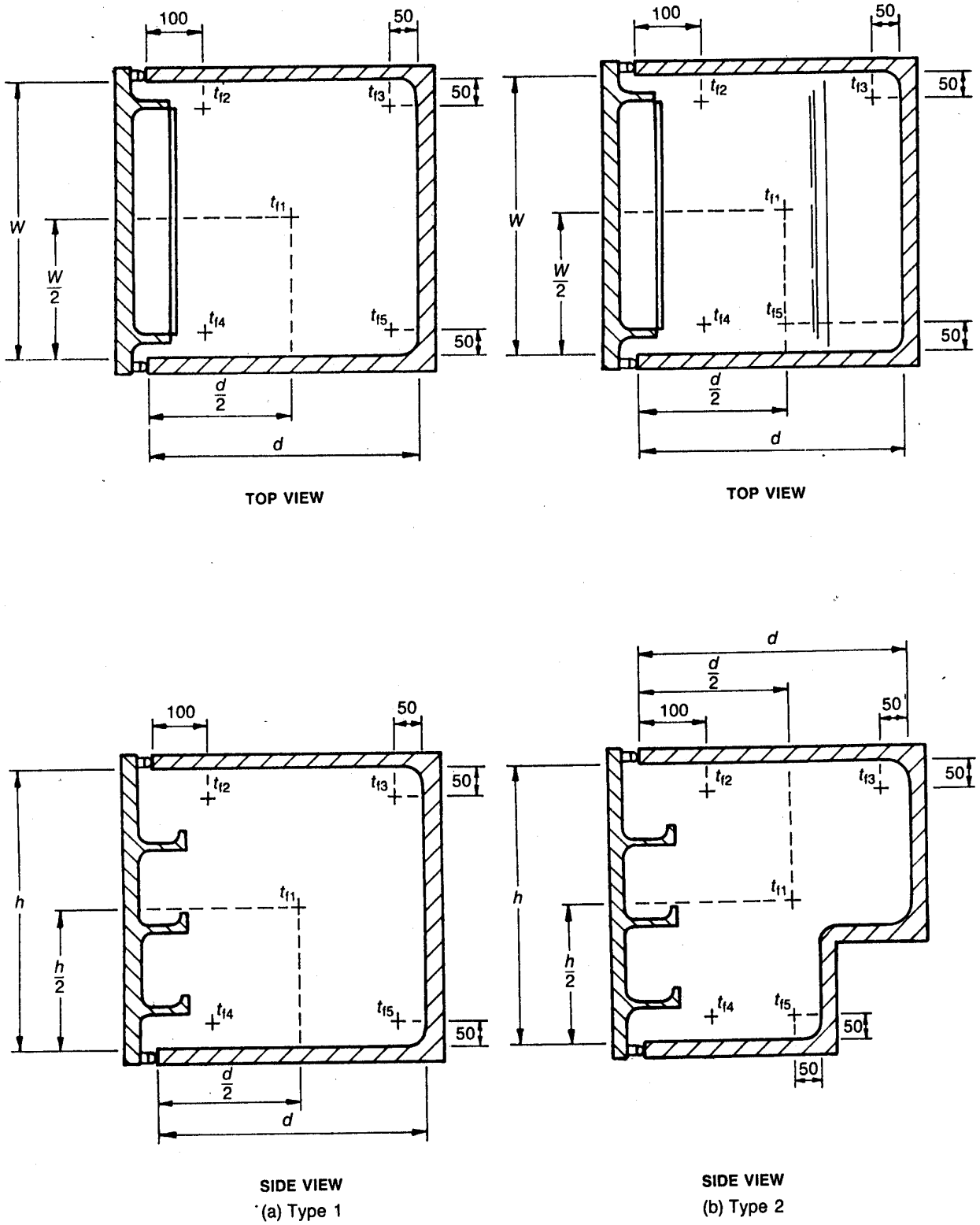


FIGURE 5 - Location of temperature sensors within freezer compartments

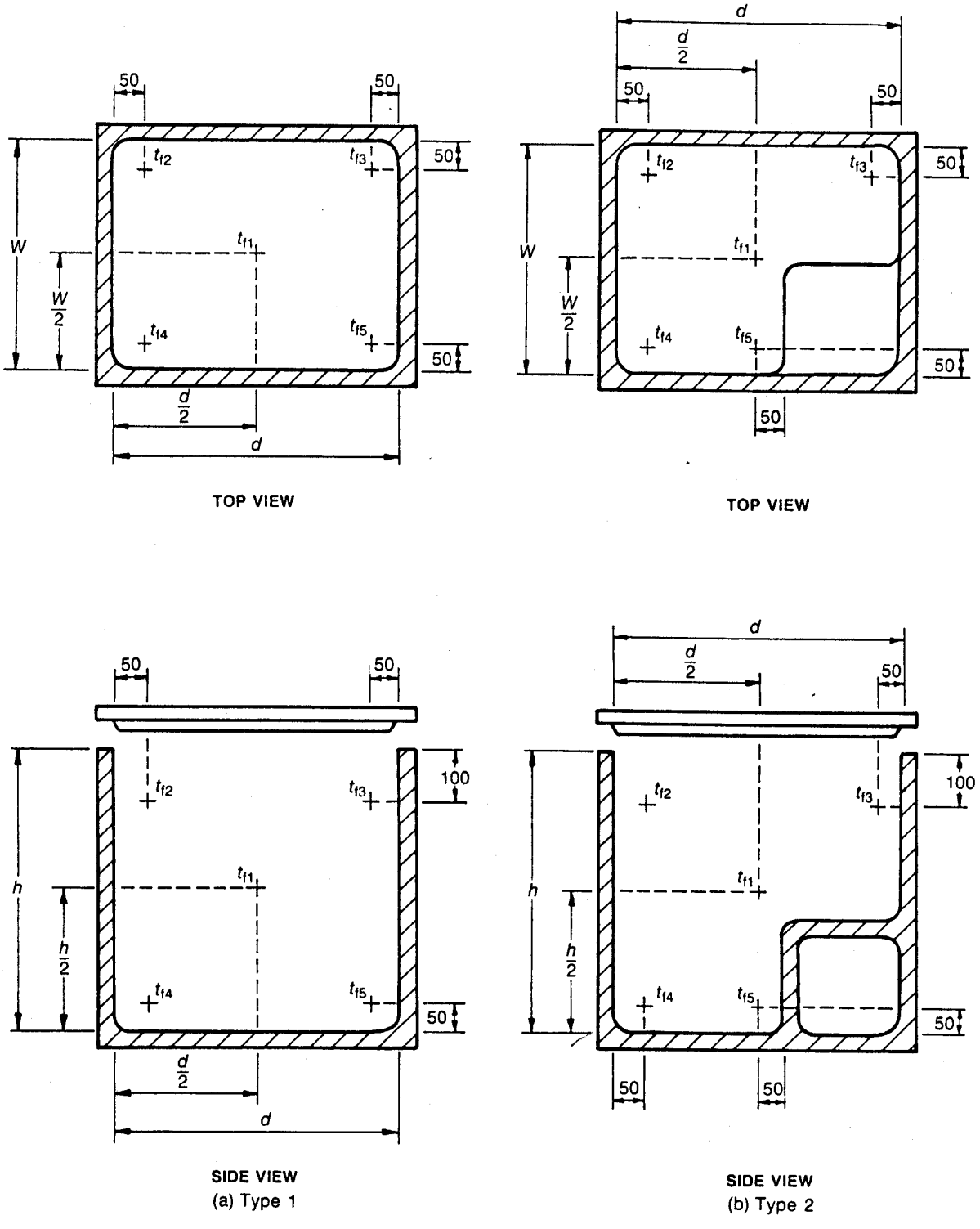
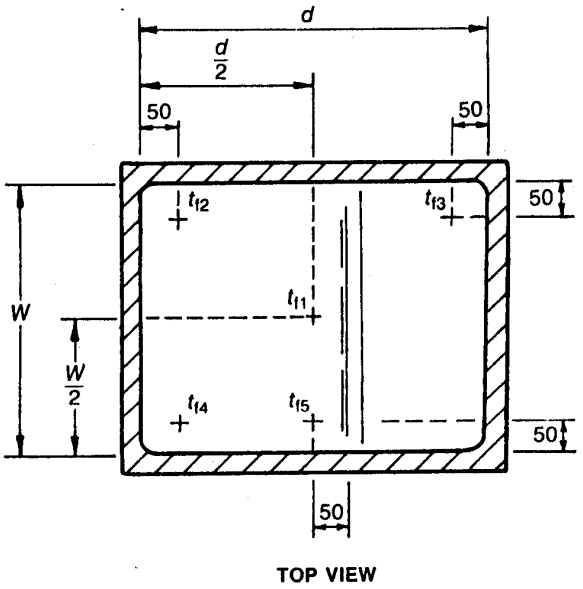
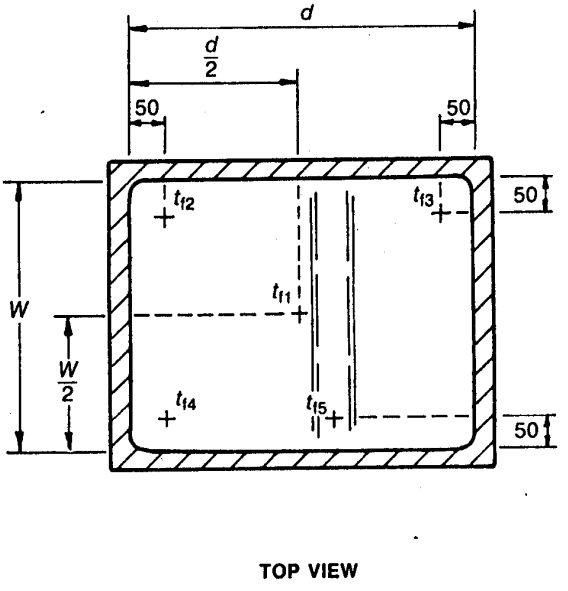


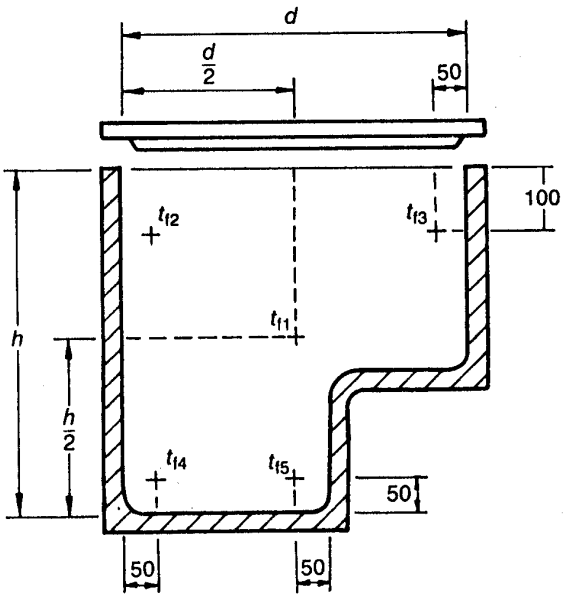
FIGURE 6 - Location of temperature sensors within chest freezers (continued)



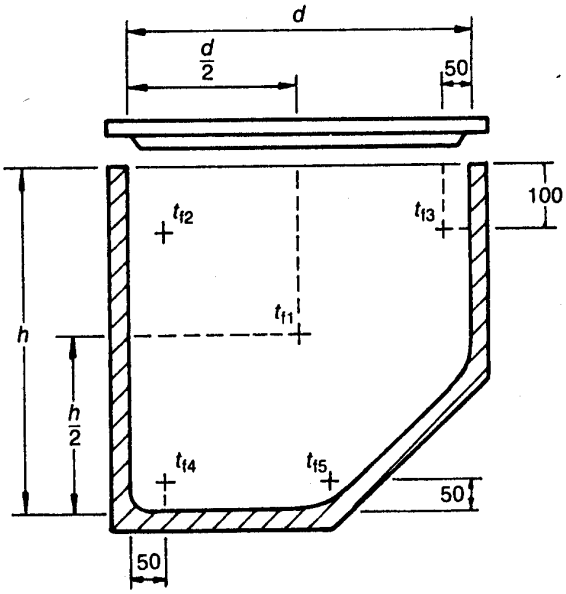
TOP VIEW



TOP VIEW

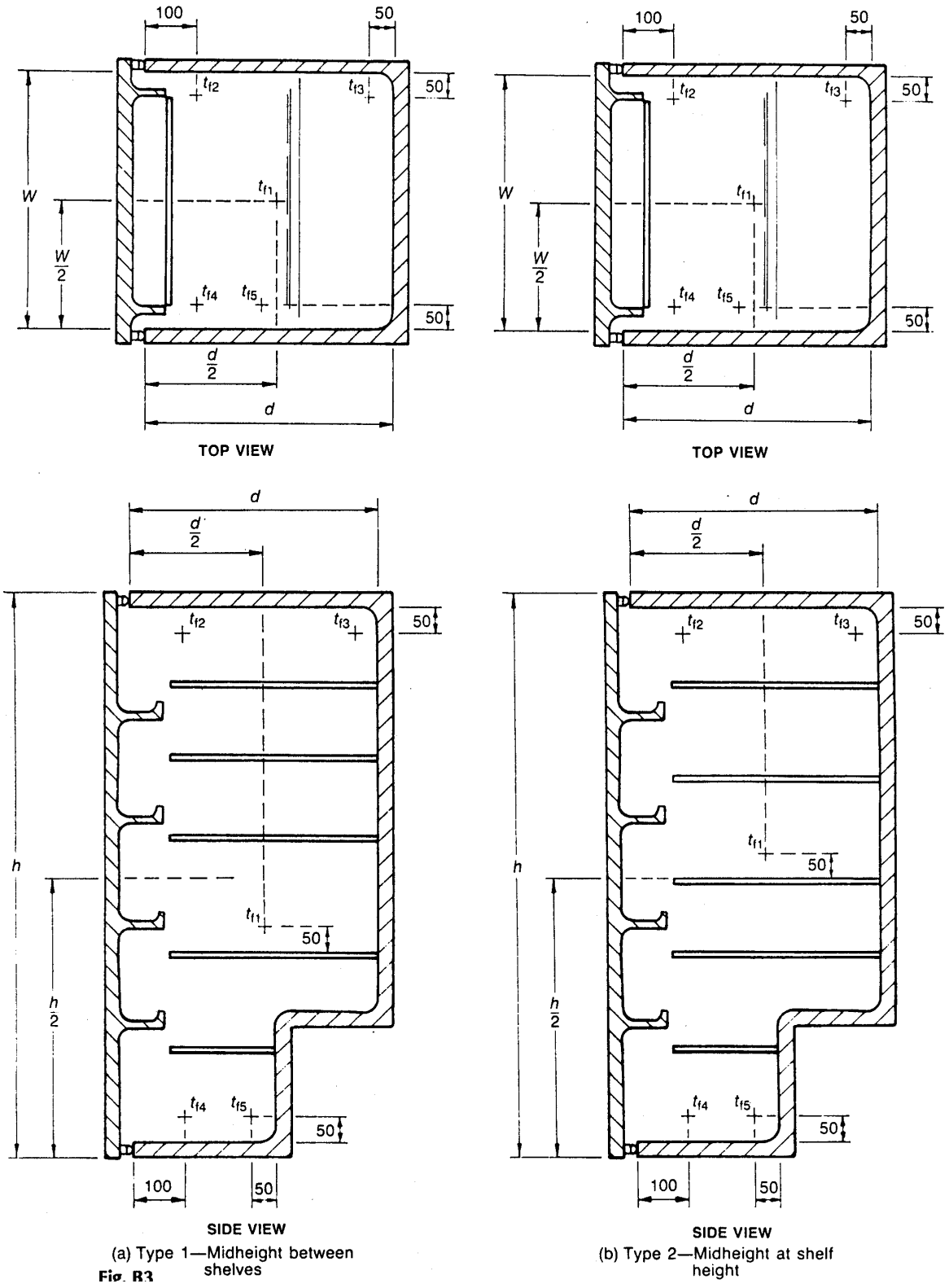


SIDE VIEW
(a) Type 3



SIDE VIEW
(b) Type 4

FIGURE 6 - Location of temperature sensors within chest freezers (concluded)



(a) Type 1—Midheight between shelves

(b) Type 2—Midheight at shelf height

Fig. B3

FIGURE 7 - Location of temperature sensors within shelf – type upright freezers

8.3 Ice-making test:

The purpose of this test is to check the claim, if any, for the ice-making capability of the appliance.

NOTE

This test does not apply to automatic ice-makers.

8.3.1 Procedure

8.3.1.1 Ambient temperature

The ambient temperature shall be 32 ºC and controlled with the tolerances specified in **8.2.4.1.**

8.3.2 Preparation of the appliance

The appliance shall be installed in the test room in accordance with **8.2.6** and set up as in service in accordance with the manufacturer's instructions. The evaporator shall be defrosted, if necessary, and the means of access (doors or lids) shall be kept closed during the test.

Ice tray shall be removed, the frozen food storage compartment(s) shall not be equipped with test packages and "M' packages.

The thermostat shall be set in accordance with the manufacturer's instructions. When the thermostat adjustments are not designed for adjustment by the user the measurement shall be carried out on the appliance as delivered.

The cellar compartment, if any, shall be as small as possible (if the volume is adjustable), with temperature control devices (flaps, etc.) set in the position in accordance with the manufacturer's instructions or the same as above.

8.3.3 Measurements

After stable operating conditions have been attained, the ice tray (s) shall be filled with water up to a level leaving 5 mm from the top and place in the appliance as recommended by the manufacturer.

If a subdivision is provided specifically for making and storing ice, and is not removable without the use of tools, the ice trays shall be placed in that subdivision.

The water temperature at the moment of placing the ice tray(s) in the appliance shall be 27 ° C ± 5ºC . The contact surface of the ice tray(s) shall be wetted to provide good contact with the evaporator.

The ice tray(s) shall be examined by breaking the ice cubes for complete freezing of the water after an interval equal to the ice-making times stated by the manufacturer has elapsed or as estimated from the stated ice-making capabilities of the appliances.

Throughout the ice-making test, none of the mean temperatures t_{c1}, t_{c2}, or t_{c3} (see Figure b) shall fall below 0 ° C.

8.3.4 Test report

The test report shall contain information on the quantity, in kilograms, of ice produced in a 24 h period or the time, expressed in hours and minutes, necessary to freeze the water in the ice tray(s) supplied with the refrigerator.

If the ice making capability is given by time, a conversion shall be made to determine the ice-making capacity in kilograms per 24 h.

8.4 Pull down test:

The purpose of this test is to check the ability of the refrigerator to cooling down of a load of food under extreme weather conditions in compliance with 6.3.

In this test the refrigerator door is left open and the ambient temperature raised to 38 ° C ± 5 ° C and leaves the refrigerator inoperative in this environment for not less than 12 hours with all cabinet and compartment doors open. Then the door is closed and then the refrigerator is switched on.

The internal temperatures must be pulled down to specified temperatures within six hours (see Table **2**). The time taken for the average air temperature in each compartment to be reduced from an ambient temperature of 38 ° C to that specified in Table **2** for the particular class shall be not more than 6 hours.

TABLE 2 Pull – down temperatures

Refrigerator class (1)	**Compartment average air temperature, °C**	
	Fresh – food (2)	**Frozen – food** (3)
1 and 2	8	Not applicable
3	8	-8
4 and 5	8	-13
6 and 7	Not applicable	-13

8.5 Temperature performance test:

The purpose of this test is to check the ability of cooling the food in compliance with the requirements of 6.4 under the specified conditions.

The appliance shall be capable of complying with the temperature requirements given in Table **3**. Refrigerator must be able to maintain appropriate internal temperatures while running in ambient temperatures of 16 ^{o}C and 32 ^{o}C. Location plan for test packages is given in Appendix A.

NOTE

It is not intended that the appliance comply with the temperature performance requirements of Table 3 at every thermostat setting and in every ambient temperature.

TABLE 3 Temperature performance requirements and test conditions

Refrigerator class	**Test ambient temperatures ^{o}C**	**Average air temperature of fresh-food compartment ^{o}C**		**Warmest temperature of any freezer test package (locations shown in Appendix A)**
		Min.	**Max.**	
(1)	(2)	(3)	(4)	(5)
1	16, 32	3	7	Not applicable
2	16, 32	3	7	Intended for ice-making -2
3	16, 32	3	7	-9
4 and 5	16, 32	3	7	-15
6 and 7	16, 32	Not applicable		-15

8.6 Water vapour condensation test

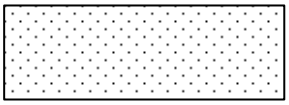
The purpose of this test is to determine the extent of condensation of water on the external surface of the cabinet under specified conditions.

The thermostat setting, the positioning and the loading of appliance shall be the same as for the energy consumption. If anti-condensation heaters are provided, they shall not switch on. If, however, the sample does not comply with the test then the test shall be repeated with the anti-condensation heaters switched on. The ambient temperature shall be + 32 ± 0.5 ^{0}C. The relative humidity shall be between 65% and 75%.

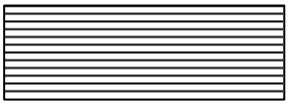
After stable operating conditions have been attained, all external surfaces of the cabinet shall be carefully wiped dry with a clean cloth and the test continued for a period of 24 h. If appliance is fitted with automatic defrosting equipment, test period shall be selected during the period when condensation is most likely to occur.

During this test period, external surface areas exhibiting fog, droplets or running water shall be outlined as per Figure **8** and designated with the letters F, D and R respectively.

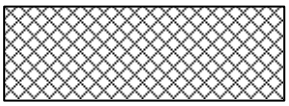
The duration of the period of observation shall also be indicated in the test report.



F: Fog



D: Droplets



R: Running water

FIGURE 8— Condensation code

8.7 Energy consumption test

The purpose of this test is to check the energy consumption of appliances under the specified test conditions.

The refrigerator shall be installed in the test room in accordance with **8.2.6 and 8.2.7**

Air temperature sensors are positioned within the refrigerator, which shall then be operated at thermal equilibrium under a specified ambient temperature, remains at 32 ± 0.5 ^{0}C throughout the test period. The average temperature within the fresh food compartment, if provided and the frozen food compartment, if provided, together with the amount of energy consumed for a number of settings of the compartment temperature-controls, if provided are determined. Graphical procedures given here in shall be used to determine the energy consumption.

The reference temperature or temperatures within a compartment or compartments of refrigerator of freezer shall be as given in Table **4**.

TABLE 4 - Reference temperatures

Unit (1)	Classification (Table 1) (2)	Average air temperature in fresh-food compartment ^{0}C (3)	Average air temperature in frozen-food compartment ^{0}C (4)
Refrigerator	Classes 1 and 2	5	-
	Class 3	5	- 9
Refrigerator/freezer	Classes 4 and 5	5	- 15
Freezer	Classes 6 and 7	-	- 15

8.7.1 Calculation of energy consumption per 24-hour period

Energy consumption of the refrigerator per 24-hour period shall be determined as follows:

a) where the refrigerator cycles, using the watt hour meter and the timing device, determine the actual energy consumed and the time taken

   i) for an automatic defrost refrigerator, as measured from a point in one defrost cycle to a corresponding point in the next or multiple of that cycle, until either at least 1 kWh of energy is consumed or the refrigerator has operated for at least 16 hours, whichever is the lesser; or

   ii) for a refrigerator other than an automatic defrost refrigerator, as measured immediately after the compressor motor switches "on" to immediately after the compressor motor switches "off" for an equal number of "on" and "off" periods until either at least 1 kWh of energy is consumed or the refrigerator has operated for at least 16 hours, whichever is the lesser

b) where the refrigerator does not cycle, using the watt hour meter and the timing device, determine actual energy consumed and the time taken for the refrigerator either consume at least 1 kWh or to operate for at least 16 hours, whichever is the lesser

c) using actual energy consumption value and the time taken as noted in step (a) or (b), whichever is appropriate, calculate to the nearest 0.01 kWh the energy consumption over a 24-hour period from the following equation:

$$\text{Energy consumption 24-hour (kWh)} = \frac{\text{Energy consumed (kWh)} \times 24}{\text{Time taken (h)}}$$

8.7.2 *Refrigerators without compartment– temperature controls*

The procedure shall be as follows:

a. Ensuring that all appropriate test conditions specified in **8.2.7** are complied with, position an ambient air temperature sensor at a point not less than 250 mm from the refrigerator, at mid height of the refrigerator, and in a position that is unaffected by the flow of warm air form the condenser coil.
b. Close door(s) of the refrigerator so that it is properly sealed especially around the leads of the temperature sensors positioned with the refrigerator.
c. Ensuring that for the duration of the test the voltage is maintained to within ± 2 per cent of the supply voltage, and the conditions required in **6.1** and **8.2.4** are maintained.
d Determine the energy consumption per 24 hours as specified in **8.7.1**
e. Calculate the energy consumption per year by multiplying the value obtained in step (d) by 365, and rounding off the result to the nearest 10 kWh.

8.7.3 ***Refrigerators having a single compartment and a single compartment-temperature control***

The number of readings required to determine the energy consumption of a single compartment, single compartment-temperature control refrigerator, is minimized by setting the compartment-temperature control so that the average temperatures within the compartment are on either side and within 2^{o} C (see Figures **9 (a)** and **(b)**) of the temperature at which the energy consumption is determined.
If the above specified limits on the average temperatures within the compartment are not satisfied, then , a further reading using a third compartment-temperature control setting will be required in order to determine the energy consumption of the appliance (see Fig. **9 (c)**).

The procedure specified in this paragraph applies generally to refrigerators of Classes 1, 2, 6 and 7.

The procedure shall be as follows:

a) position the ambient air temperature sensor in accordance with **8.7.2 (a)**
b) set the compartment-temperature control to attain , if possible, an average compartment temperature within t_x ^{o}C and (t_x+2) $_{o}$C, where t_x is the temperature at which energy consumption per 24 h is to be determined.

NOTE

*t_x is equal to the appropriate reference temperature specified in Table **4.***

c) carry out steps (b) and (c) of **8.7.2**

d) determine the average compartment temperature in accordance with **8.2.5**

e) determine the energy consumption of the refrigerator at that particular compartment-temperature control setting in accordance with **8.7.1**

f) set the compartment-temperature control to attain, if possible, an average compartment temperature within t_x ^oC, and (t_x -2) ^oC, where t_x is the temperature at which energy consumption per 24 h is to be determined.

NOTE

See Note to step (b)

g) repeat steps (c) to (e) above.

h) If the average temperature at both compartment-temperature control settings are within the ranges specified in steps (b) and (f), determine the energy consumption per 24 hour by the appropriate method in accordance with **8.7.7.1**

j) If the average temperature at either or both compartment-temperature control settings is outside the range specified in step (b) or (f), set the compartment temperature control for a third determination of the average compartment temperature so that, if possible, two of the three average compartment temperatures fall within the ranges specified in steps (b) and (f).

k) Determine the average compartment temperature, at the third compartment temperature control setting, in accordance with **8.2.5**

l) Determine the energy consumption of the refrigerator at the third compartment temperature control setting, in accordance with **8.7.1**

m) If the average compartment temperature obtained in step (k) is such that two of the three average compartment temperatures fall within the specified ranges, ignore the average compartment temperature that is outside the specified ranges and determine the energy consumption per 24 h by the appropriate method in accordance with **8.7.7.1**

n) If the average compartment temperature obtained in step (k) is such that no two of the three average compartment temperatures fall within the specified ranges, determined the energy consumption per 24 h by the appropriate method in accordance with **8.7.7.1**

o) Determine the energy consumption per year by multiplying the energy consumption as obtained in step (h), (l), or (m), whichever is appropriate, by 365 and rounding off the result to the nearest 10 kWh

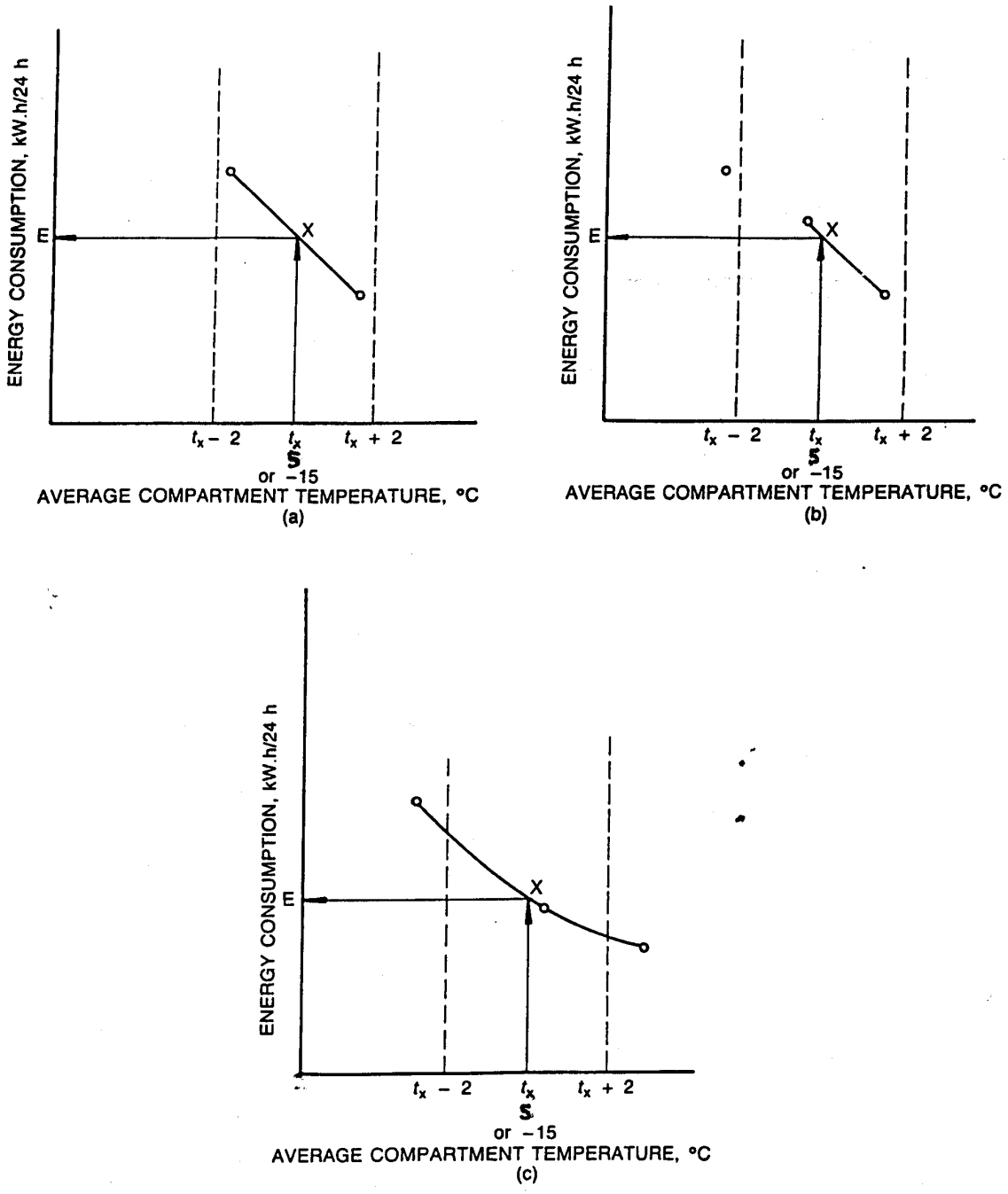


FIGURE 9 – Determination of energy consumption of a single compartment refrigerator having a single compartment temperature control

8.7.4 *Refrigerators having two compartments and a single compartment-temperature control*

The number of readings required to determine the energy consumption of a two-compartment, single compartment-temperature control refrigerator, is minimized by setting the compartment-temperature controls that the average temperature in each of the compartments complies with the limits specified in step (b) and (f) below (see also Figures **10 (a)** and **(b)**).

If the specified limits for the average temperature within each of the compartments are not satisfied, a further reading using a third compartment- temperature control setting will be required in order to determined the energy consumption of the refrigerator (see Fig. **10 (c)**).

The procedure specified in this paragraph applies generally to refrigerators of Classes 2, 3 and 4.

The procedure shall be as follows:

a) Position the ambient air temperature sensor in accordance with **8.7.2 (a)**

b) set the compartment-temperature control to attain, if possible, an average temperature in -
   i) the frozen –food compartment that is within t_x ^{o}C and (t_x + 2) ^{o}C; and
   ii) the fresh-food compartment that is 3 ^{o}C or less

NOTE

*See Note to **8.7.3(b)***

c) carry out steps (b) and (c) of **8.7.2**
d) determine the average temperatures within each of the compartments in accordance with **8.2.5**
e) determine the energy consumption of the refrigerator at that particular compartment-temperature control setting in accordance with **8.7.1**
f) Set the compartment-temperature control to attain, if possible, an average temperature in
   i) the frozen-food compartment that is within t_x ^{o}C and (t_x – 2) ^{o}C; and
   ii) the fresh-food compartment that is greater than either or both of the reference temperatures

NOTE

*See Note to **8.7.5 (b)***

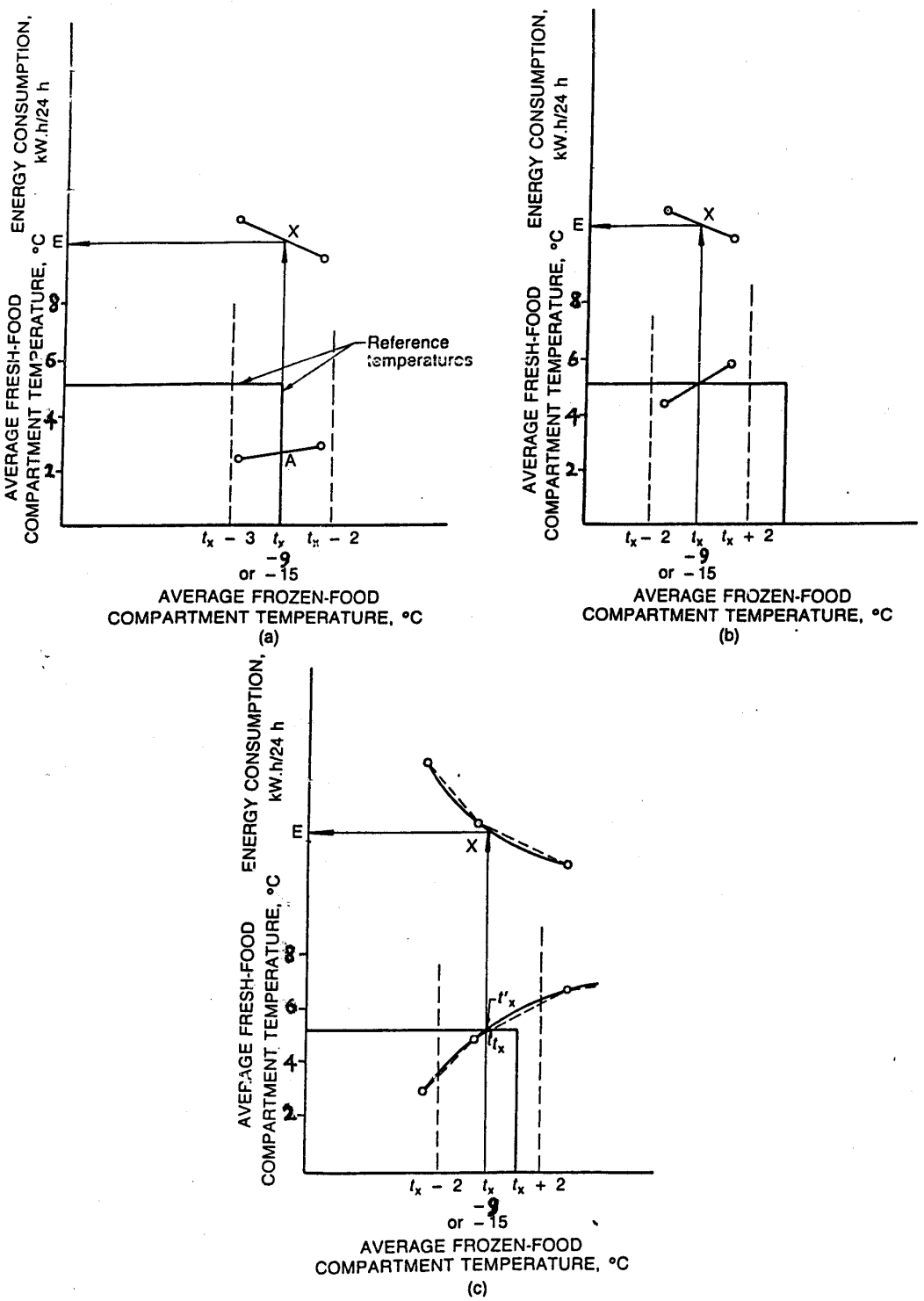


FIGURE 10 – Determination of energy consumption of a refrigerator having two compartments, a single compartment - temperature control, with or without a two - position buffle

g) repeat steps (c) to (e) above.
h) If the average temperatures at both compartment-temperature control settings are within the ranges specified ins steps (b) and (f), determine the energy consumption per 24 h, by the appropriate method in accordance with **8.7.7.2**
j) If the average temperature at either or both compartment-temperature control settings is outside the range specified in steps (b) and (f), set the compartment temperature control for a third determination of the average compartment temperature, so that, if possible, two of the three average compartment temperatures fall within the ranges specified in steps (b) and (f).
k) Determine the average compartment temperatures at the third temperature control setting, in accordance with **8.2.5**
l) Determine the energy consumption of the refrigerator at the third compartment-temperature control setting, in accordance with **8.7.1**
m) If the average compartment temperature obtained in step (k) are such that two of the three average compartment temperature fall within the specified ranges, ignore the average compartment temperature that is outside the specified range and determine the energy consumption per 24 h by the appropriate method in accordance with **8.7.7.2**
n) If the average compartment temperature obtained in step (k) is such that no two of the three average compartment temperatures fall within the specified ranges, determined he energy consumption per 24 h, by the appropriate method in accordance with **8.7.7.2**
o) If the average temperature obtained in step (k) is such that two of the three average temperatures do not fall within the specified ranges, and a continuous line drawn through a plot of these temperature does not interest either boundary of the reference temperature, set the temperature control for a further average temperature determination so that when all the resultant average temperatures are plotted and a continuous line is drawn through them the line intersects a boundary of the reference temperature. Then determine the energy consumption per 24 h by the appropriate method in accordance with **8.7.7.2**

p) Determine the energy consumption per year by multiplying the energy consumption as obtained in step (h), (m), (n), (o), whichever is appropriate, by 365, and rounding off the result to the nearest 10 kW.h.

8.7.5 Refrigerators having two compartments, single compartment-temperature control and a two position baffle

The procedure is the same as that of **8.7.4** and shall be as follows:

a) position the ambient air temperature sensor in accordance with **8.7.2 (a)**
b) With the baffle maintained in such a position (i.e. either open or closed) as will cause the refrigerator to consume the least amount of energy, carry out steps (b) to (e) of **8.7.4**

NOTE

Generally, if the refrigerator is to consume the least amount of energy and achieve the appropriate temperatures in the frozen food and fresh-food compartments to enable the energy consumption to be determined, the baffle will need to be left open.

c) with the baffle maintained in the same position as in step (b) above, carry out steps f) to (o)m whichever are appropriate, of **8.7.4**

NOTE

The reason for maintaining the baffle in the same position as that specified in step (b), is to obtain an energy consumption value that may be achieved in practice. That is, if the refrigerator were tested with the baffle opened and then closed, the resultant energy consumption for the refrigerator would be equivalent to the baffle being partially opened, which is not possible for a two-position baffle. Therefore the energy consumption obtained in such a test would be theoretical only and could not be attained in practice.

8.7.6 Refrigerators having two compartments and two compartment-temperature controls

The number of readings required to obtain the energy consumption of a two compartment, two-compartment-temperature controls refrigerator, is minimized by setting the temperature controls to warmest in order to ascertain whether the temperatures within each of the compartments are lower than the reference temperatures. If they are, then the energy consumption is determined from a plot of the compartment temperatures (see Figure **11 (a)**). If not, then one of the compartment-temperature controls is left on warmest while the other is adjusted so as to reduce the temperature in each of compartments to a value lower than the appropriate reference temperature. If the temperatures within the compartments are reduced to lower than their appropriate reference temperature, then the energy consumption is determined from a plot of these compartment temperatures and the compartment temperatures obtained when both controls were on warmest (see Figures **11 (b**), and **(c)**). If the temperature within each of the compartments is not or cannot be reduced sufficiently to be lower than the reference temperatures, then both compartment-temperature controls are to be adjusted to reduce the compartment temperatures. In this instance, the energy consumption is determined using a plot of all the compartment temperatures at the various compartments –temperature control settings (see Figures **11 (d)** and **(e)**).

The procedure specified in this paragraph applies generally to refrigerators of Classes 2, 3,4, and 5.

The procedure shall be as follows:

a) position the ambient air temperature sensor in accordance with **8.7.2 (a)**
b) set each of the compartment-temperature controls to the warmest setting.
c) carry out steps (b) and (c) of **8.7.2**
d) Determine the average temperate within each of the compartments in accordance with clause **8.2.5**
e) Determine the energy consumption of the refrigerator at those particular temperature control settings in accordance with **8.7.1**.
f) If the average temperature for each of the compartments, as obtained in step (d), is lower than its respective reference temperature, the energy consumption for the appliance is as obtained in step (e) above.

g) If the average temperature for each of the compartments, as obtained in step (d), is not lower than its respective reference temperature, keeping one of the temperature controls on the warmest setting, adjust the other temperature control to a sufficiently cold setting so that, if possible, the resultant average temperature with in each of the compartments would be lower than the respective reference temperature.

h) Repeat steps (c) to (e) with the temperature controls set in accordance with step (g).

j) If the average temperature for each of the compartments as obtained in step (h), is lower than the respective reference temperature, determine the energy consumption per 24 h by the appropriate method in accordance with **8.7.7.3**

k) If the average temperature for each of the compartments, as obtained in step (h), is not lower than the respective reference temperature, reverse the temperature control settings from those set in step (g).

l) Repeat steps (c) to (e) with the temperature controls set in accordance with step (j).

m) If the average temperature for each of the compartments, as obtained in step (i) is lower than the respective reference temperature, determine the energy consumption per 24h by the appropriate method in accordance with **8.7.7.3**

n) If the average temperature for each of the compartments, as obtained in step (l), is not lower than the respective reference temperature, set each of the compartment-temperature controls to a sufficiently cold setting so that the resultant average temperature within each of the compartments would be lower than the respective reference temperature.

o) Repeat step (c) to (e) with the temperature controls set in accordance with step (n)

p) Determine the energy consumption per 24 hour by the appropriate method in accordance with **8.7.7.3**

q) Determine the energy consumption per year by multiplying the energy consumption as obtained in step (f), (j), (m), or (p), whichever is appropriate, by 365, and rounding off the result to the nearest 10 kWh.

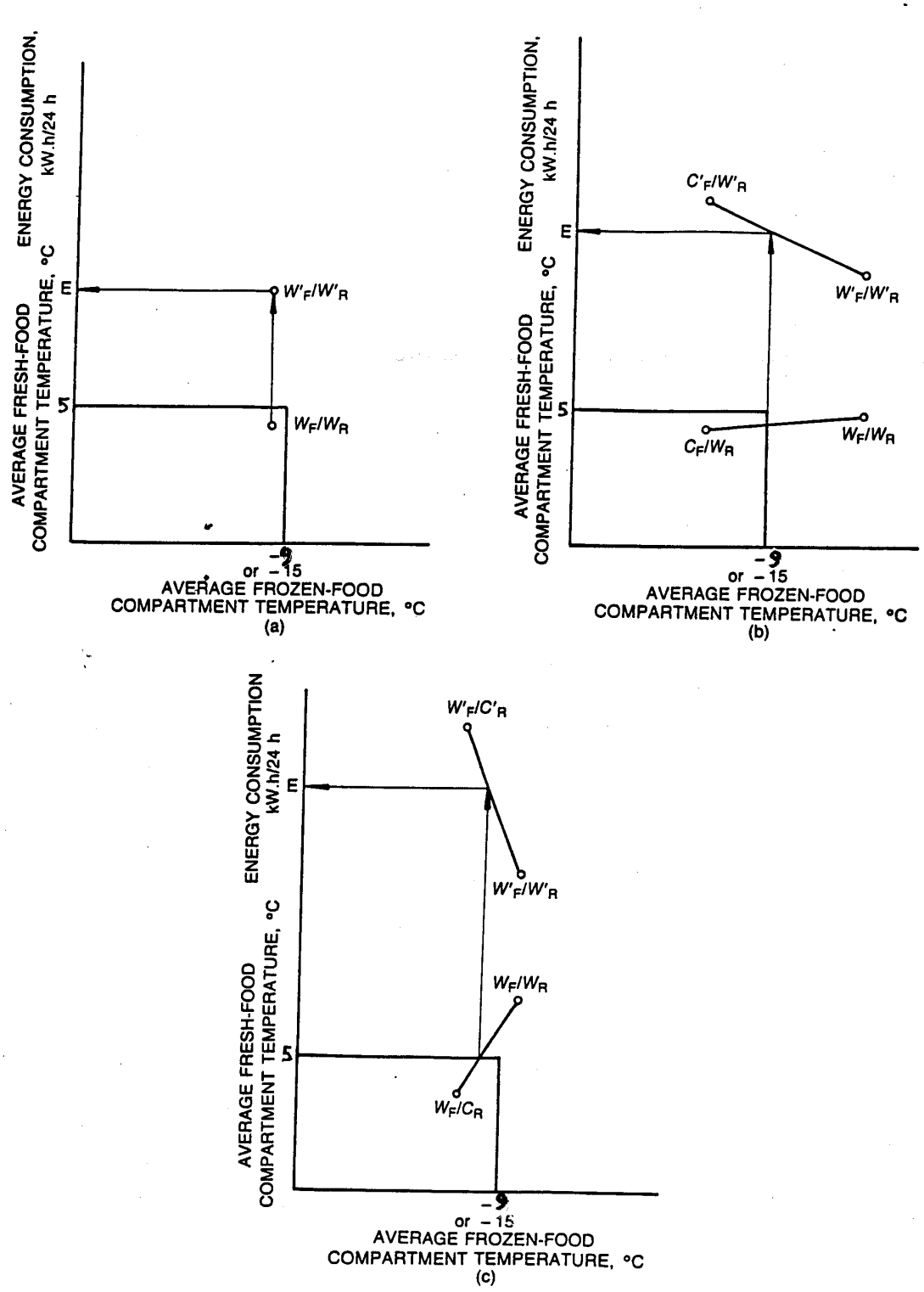


FIGURE 11 – Determination of energy consumption of a refrigerator having two compartments and two compartments –temperature controls (continued)

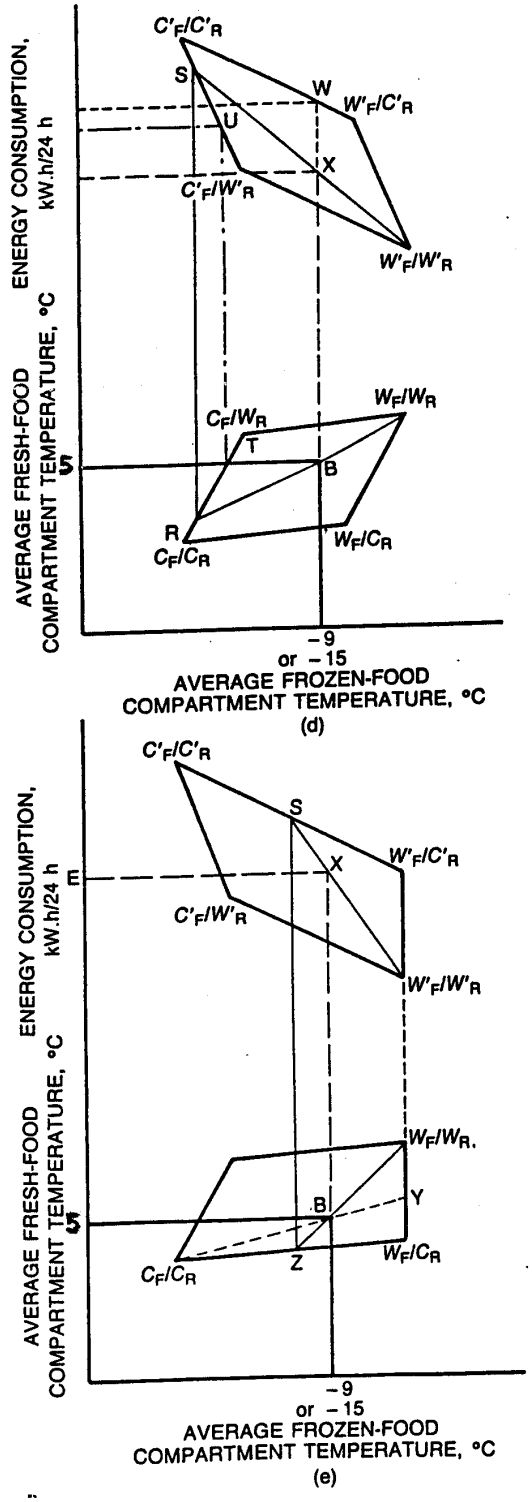


FIGURE 11– Determination of energy consumption of a refrigerator having two compartments and two compartments –temperature controls (concluded)

8.7.7 Determination of rated energy consumption

NOTE

The graphical procedure specified in this clause can be formulated mathematically. The resulting formulas can then be programmed on a computer in terms of algorithms. The results could then be calculated and plotted graphically. The mathematical determination of rated energy provides a rapid method for determining and presenting the results.

8.7.7.1 *Refrigerators having a single compartment and a single compartment-temperature control*

Where a refrigerator has a single compartment and a single compartment-temperature control, the energy consumption per 24 hour shall be determined as follows:

a) for each of the temperature control settings specified in **8.7.3** (b), (f), and, if necessary, (j), plot on a linear graph the average temperature in the compartment, as determined in **8.7.3** (d), (g), and in necessary , (k), against the energy consumption per 24 h, as determined in **8.7.3** (e), (g), and, if necessary, (l).

b) If the plots are such that
   ii) one of the points is within the range specified in **8.7.3** and another point is in the range specified in **8.7.3** (f), draw a straight line joining the two points (see Figures **9 (a)** and **(b)); or**
   iii) the points do not fall within the appropriate ranges specified in **8.7.3** (b) and (f) , draw a continuous line, usually a curve , by joining all three points (see Fig.**9 (c)**).

a) project a line that represents the appropriate reference temperature of that particular refrigerator, until it intersects, at point X, the line obtained in step (b).

NOTE

*The appropriate reference temperatures are specified in Table **4.***

b) determine the energy consumption per 24 hour, at point X, from the energy consumption scale on the graph.

8.7.7.2 ***Refrigerators having two compartments, a single compartment-temperature control and, if provided, a two position baffle***.

Where a refrigerator has two compartments, a single compartment-temperature control, and , if provided , a two position baffle, the energy consumption per 24 hour shall be determined as follows :

a) on a linear-linear graph that plots the average temperature in the fresh-food compartment against the average temperature in the frozen-food compartment project two lines each of which represents the respective reference temperature, until they intersect (see (Figure **10 (a)**).

NOTE

1) Table 4 specifies the reference temperatures for each class of refrigerator.

*For ease of graphically determining the energy consumption per 24 hour, it is recommended that the plot in the above step be in tandem with a plot of the energy consumption against the average temperature in the frozen-food compartment, which is required in step (b) (ii) below (see Figure **10**).*

b) For each of the compartment-temperature control settings specified in clauses **8.7.4** or **8.7.5,** whichever is appropriate , plot.

i) the determined average temperature within each compartment, on the graph in step (a); and
ii) the determined energy consumption , against the average temperature in the frozen-food compartment on a separate linear-linear graph.

c) Join, by a straight line, each of the respective points plotted in step (b).

d) Determine the frozen-food compartment temperature (t_x) where the plots in steps (a) and (b) (i) intersect (see Figures **10 (a)** and **(b)**).

e) Determine whether or not the points in step (b) (i) are such that one of the points is within the ranges specified in the **8.7.4** (b) and the other or another appoint is within the ranges specified in **8.7.4** (f)

f) If the points are such that the condition in step (e) is –

i) satisfied, then using the plot in step (b) (ii), determine the energy consumption per 24 hour at the temperature obtained in step (d); or
ii) not satisfied, then join each of the points in step (b) (i) by a continuous line (usually a curve), determine the new frozen – food compartment temperature (t^1_x) where the curve line intersects the plot in step (a) and then, using the plot in step (b) (ii), determine the energy consumption per 24 hour at the new temperature (t^1_x) (see Figure **10 (c)**).

8.7.7.3 *Refrigerators having two compartments and two compartment-temperature controls*

Where a refrigerator has two compartments and two compartment-temperature controls, the energy consumption per 24 hour shall be determined as follows:

a) on a linear-linear graph that plots the average temperature in the fresh-food compartment against the average temperature in the frozen-food compartment, project two line's each of which represents the respective reference temperature, until they intersect.

NOTE

*See Notes in **8.7.7.2 (a)***

b) For the compartment-temperature control settings as specified in **8.7.6** (b) plot -

   i) the average temperature within each compartment, as determined in **8.7.6** (d) on the graph in step (a) and
   ii) the energy consumed, as determined in **8.7.6** (e), against the average temperature in the frozen-food compartment on a separate linear-linear graph.

c) If the plot in step (b) (i) lies within the reference temperature boundaries (see Figure **11 (a)**), the energy consumption is as determined in **8.7.6** (e)

NOTE

For a plot to lie within the reference temperature boundaries, the average temperature within each of the compartments must be lower than their respective reference temperatures (see Table 4)

d) If the plot in step (b) (i) does not lie within the reference temperature boundaries, the, plot on the graphs ins steps (b) (i) and (b) (ii), the average temperature for each of the compartments as determined in **8.7.6**.(h) and if appropriate **8.7.6** (l) when the temperature controls are set as specified in **8.7.6** (g) and if appropriate **8.7.6** (k)
e) Joint , by a straight line, the plot in step (b) to the plot or each of the plots, in step (d).
f) If the plots in steps (b)(i) and (e) are such that the appropriate line obtained in step (e) intersects either of the reference temperature lines obtained in step (a), using the plot in step (b) (ii) and the average frozen-food temperature (t_x) at which the lines intersect (see Figures **11 (b)** and **(c)**), determine the energy consumption of the appliance at that temperature.

g) If neither of the plots in step (d) lie within the reference temperature boundaries, then plot on the graphs in steps (b) (i) and (b) (ii) the average temperature for each of the compartments as determined in paragraph **8.7.6** (o), when the temperature controls are set as specified in **8.7.6** (n).

h) determine the minimum energy consumption as follows :

i. join, by straight lines, the plots in step (e) to the plots obtained in step (g) to form two quadrilaterals (see Figures **11 (d)** and (e)).

ii. Project a line (e.g. W_f/W_R R, which will result in the greatest accuracy for determining energy consumption) form one of the four corners (e.g. $W_p//W_R$) of the quadrilateral to pass through the intersection of the reference temperature projections instep (a) (i.e. point B), and intersect the appropriate side of the quadrilateral (e.g. at point R).

iii. Project point R obtained in (ii) above, (at constant average temperature in the frozen-food compartment) to intersect (at point S) the corresponding side of the resultant quadrilateral obtained on the energy consumption graph.

iv. From the energy consumption scale ascertain the energy consumption of the refrigerator at point X, which is at the intersection of a line projected through point S and the order (W^1_p/W^1_R) on the energy consumption graph, which corresponds to the corner chosen in (iii) above, and a line corresponding to the reference temperature of the frozen-food compartment.

NOTE

1) *An example of unacceptable accuracy would be if corner C_F/C_R in Figure 11 (e) was chosen to make the initial projection through point B to intersect side $W_F/C/_R/W_F/W_R$ at point Y. When point Y is projected onto the corresponding side $W^1_F/C^1/_R//W^1_F/W^1_R$, which is substantially vertical, the point of intersection is indeterminate because it could lie anywhere along side $W^1_F/C^1/_R//W^1_F/W^1_R$. Accordingly, in order to determine the energy consumption of a refrigerator with the greatest accuracy, the corner of the quadrilateral which is to be chosen for projecting a line through it and point B, and a all other subsequent projections within the quadrilaterals, as well as the sides of the quadrilateral to which projections are made, should be such that these are minimal degrees relative to the horizontal axis.*
2) *The energy consumption value determined by the method specified above, results in the minimum energy consumption value for the refrigerator. To illustrate, if points T and P, which intersect the quadrilateral in Figure **11 (d),** are projected to intersect the corresponding sides of the energy consumption quadrilateral, at points U and W respectively, the energy consumption value at these points will be substantially greater than that determined by the method specified above.*

SECTION 2 – DETERMINATION OF STAR RATINGS AND ENERGY EFFICIENCY LABEL

1 DETRMINATION OF STAR RATINGS

1.1 Calculation of efficiency ratings

The efficiency rating shall be derived from the following formula and the results rounded off to three decimal places.

$$E_r = \frac{EC}{V^1}$$

Where, $V^1 = V_f \times K_f + V_c \times K_c$

V_f = Volume of frozen food storage compartment in litres
V_c = Volume of fresh food storage compartment in litres
EC = Energy consumption in kWh/year
$K_f = 32 - T_f$, T_f = Temperature of the frozen food storage compartment in C
$K_c = 32 - T_c$, T_c = Temperature of the fresh food storage compartment in C

1.2 Determination of Star rating

TABLE 1 – Star ratings for class 1 and class 2 refrigerators

Energy rating class	Number of stars
E_r 0.090	*****
0.090 < E_e 0.108	****
0.108 < E_e 0.138	***
0.138 < E_e 0.156	**
0.156 < E_e 0.174	*
0.174 < E_e	No starts

TABLE 2 – Star ratings for class 3 refrigerators

Energy rating class	Number of stars
E_r 0.075	*****
0.075 < E_e 0.090	****
0.090 < E_e 0.115	***
0.115 < E_e 0. 130	**
0.130 < E_e 0.145	*
0.145 < E_e	No starts

TABLE 3 – Star ratings for class 4 and class 5 refrigerators of capacity less than 500 l

Energy rating class	Number of stars
E_r 0.060	*****
0.060 < E_e 0.072	****
0.072 < E_e 0.092	***
0.092 < E_e 0.104	**
0.104 < E_e 0.116	*
0.116 < E_e	No starts

TABLE 4 – Star ratings for class 4 and class 5 refrigerators of capacity greater than 500 l

Energy rating class	Number of stars
E_r 0.045	*****
0.045 < E_e 0.054	****
0.054 < E_e 0.069	***
0.069 < E_e 0.078	**
0.078 < E_e 0.087	*
0.087 < E_e	No starts

Where E_r is the Energy Rating of the refrigerator under test.

NOTE:

1. Table 1 Table 2 Table 3and Table 4 have been established assuming average energy rating (E_{av}) values for different classes as follows:

TABLE 5 – Average energy ratings (E_{av}) for different classes of refrigerators

Class	*Average energy rating*
1 and 2	*0.12*
3	*0.10*
4 and 5 less than 500 l capacity	*0.08*
4 and 5 greater than 500 l capacity	*0.06*

2. The average Energy Rating for each class of refrigerator need to be determined after testing samples of refrigerators available in the market. After determination of average energy rating for each class, the tables may need revision.

2. LABELLING

2.1 The energy consumption label shall be a sticker and affixed to the front portion of the refrigerator, so that the label is prominent and clearly visible. The label shall display the approved star rating for the model of the refrigerator. The format of the label shall be as given in Figure **1**.

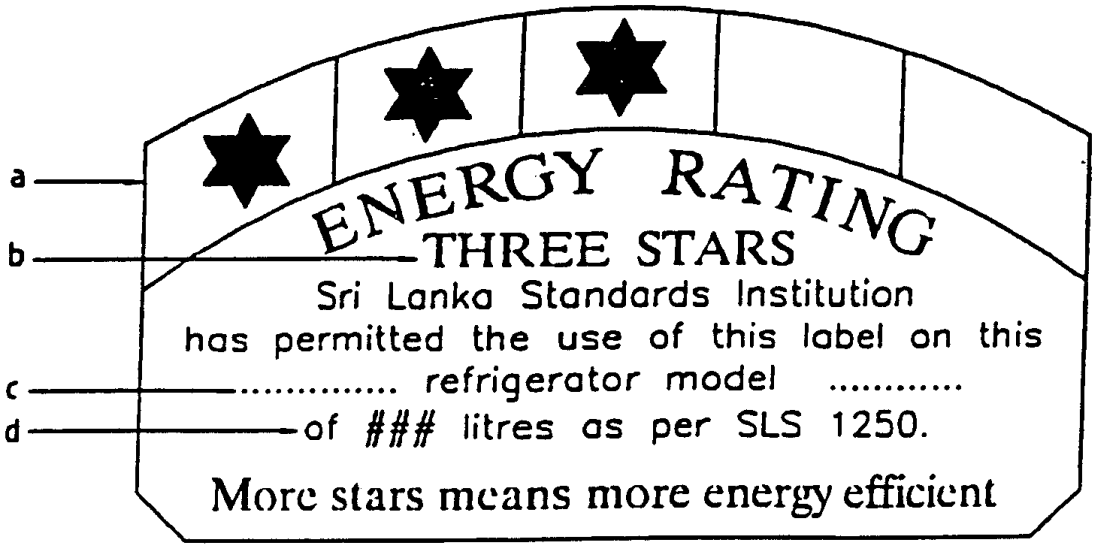


FIGURE 1 – Format for the energy efficiency-rating label

a) Number of stars appearing on the curved band depends on the energy rating determined as per **1.2**. The more stars means more energy efficient.

b) Number of stars (in words) permitted for the model

c) Brand name and model number of the refrigerator, refrigerator-freezer and freezer shall be printed in the space provided

d) Volume of the refrigerator in litres

2.2 Sample energy rating label is given in Figure 2 for information only and the colours of the label shall be the following colours as specified by the Munsell Book of Colour (2.5.R-10 RP matte collection). Yellow : Hue 10 Y, Value/Chroma 9/10 Green : Hue 2.5 G Value/Chroma 5/10

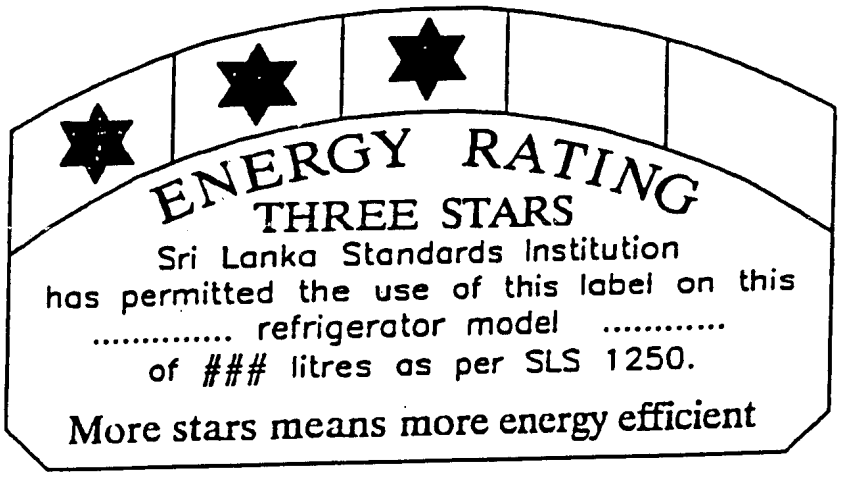


FIGURE 2 – Sample of printed energy rating label

2.3 Dimensions of the label shall be as given in Figure **3.**

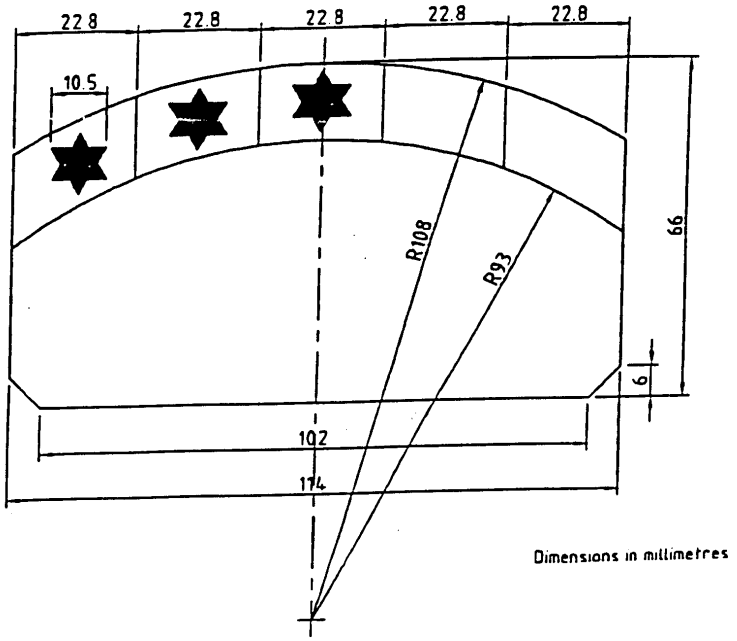


FIGURE 3 – Dimensions of the label

2.4 Character size (height) of the label shall be as given in Figure **4.**

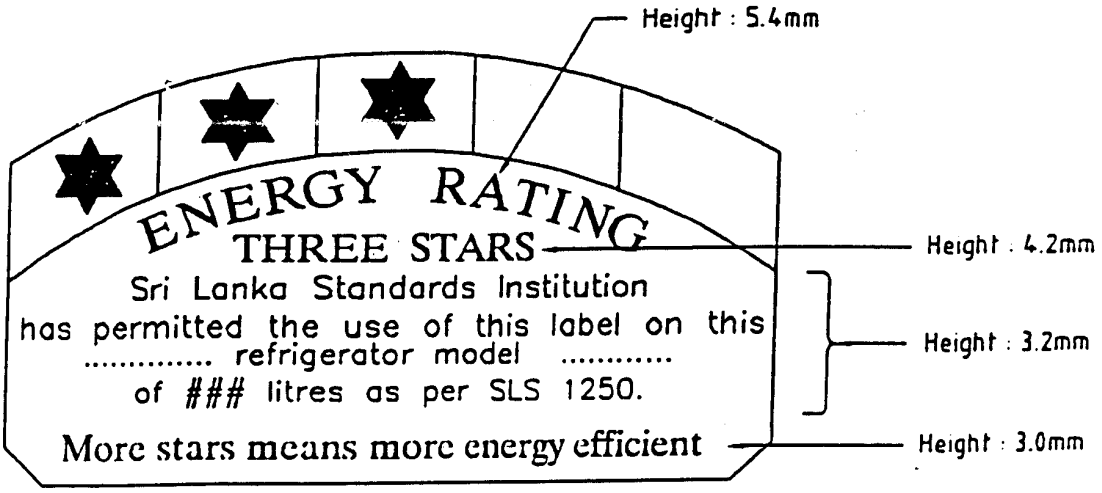


FIGURE 4 – Print type and the character size of the label

3 REPORTING RESULTS OF THE MEASUREMENT

The following items shall be described in the test report:

a) Name and identification number of the refrigerator and class

Brand	:
Model	:
Make	:
Manufacturer	:
Vender	:
Class	:
Identification No	:
Remarks	:

b) Measurement results

i) Pull down

Time taken (hrs)	Average temperature of fresh food compartment (^{0}C)	Average temperature of frozen food compartment (^{0}C)	Compliance	
			yes	no

ii) Temperature performance

Ambient temperature (^{0}C)	Average temperature of fresh food compartment (^{0}C)	Warmest temperature of any freezer test package (^{0}C)	Compliance	
16			yes	no
32				

iii) Water vapour condensation

Observation				Compliance	
F	D	R	nil	yes	no

iv) Volume of fresh food and frozen food compartments

Volume of fresh food compartment (m^3)	Volume of frozen food compartment (m^3)

v) Total energy consumption

Total Energy Consumption (kWh)	

c) Other item for information reference

APPENDIX A

LOCATION OF FREEZER TEST PACKAGES

A.1 This Appendix describes the loading plan for the location of freezer test packages for testing the operation of the freezing function of nay refrigerator of Classes 3, 4, 5, 6 and 7.

Some of the packages are measurement packages (termed M packs) incorporating thermocouples and specific locations are set down for them. The remainder are filler packages, whose function is to provide thermal ballast and fill up space.

The test packages are brought to a temperature approximately equal to the classification temperature of the compartment before loading.

A.2 Arrangement (See Figure A.1)

On each horizontal surface intended for storage, the largest possible number of stacks of test packages having a base of 100 mm x 200 mm is made using 1 kg packages (50 mm x 100 mm x 200 mm) laid flat. When an M pack (500 g and 50 mm x 100 mm x 100 mm) has to be placed in a stack, it is also placed flat, side by side with another 500 g package.

The loading may, if necessary, be completed by stacks having a base of 100 mm x 100 mm made with 500 g packages laid flat, and then finally by stacks having a base of 50 mm x 100 mm with 125 g packages also laid flat.

Four 125 g packages may be replaced by one 500 g package placed vertically.

A.3. Top clearance.

The vertical clearance between the upper edge of the highest package and the load limit, the shelf or the horizontal surface situated immediately above is not greater than 25 mm.

If it is greater than 25 mm, another package is introduced, provided that there is no physical contact between the highest package and shelf or the horizontal surface situated immediately above.

For a top-opening cabinet without load limit line, a vertical clearance greater than 10 mm but less than 35 mm is provided between the upper edge of the highest package and the inner surface of the lid.

In order to comply with these requirements, 125 g packages (25 mm x 50 mm x 100 mm) laid flat may be introduced in or immediately above, as appropriate, the middle of any stack.

A.4 Surface contact

Stacks of packages are not in direct contact with any surfaces other than the horizontal loading surfaces. The nominal clearance from vertical surfaces is 155 mm.

A.5. Air passages

Free air spaces of 15 mm minimum (calculated from the nominal dimensions of the test packages), as far as possible equal, are left between adjacent stacks of test packages.

The use of spacers to maintain free air spaces between stacks of test packages is permissible provided that the spacers are of the smallest possible cross-section and of the lowest possible thermal conductivity and are placed in such a way that they do not significantly interfere with normal air circulation.

A.6. Ice storage

If a subdivision is provided specifically for making and storing ice and is not removable without the use of tools, the icetrays shall be filled with water, the contents frozen and placed in position before the compartment is loaded with test packages; otherwise the icetrays and the subdivisions shall be removed and the whole compartment loaded with packages

A.7 Measurement packages

M packs are placed where prescribed in Figure A1.

A.8 Door storage

Door shelves and compartments are loaded with as many packages as possible. Packages are placed in such positions that the free air spaces between the packages and the inner surface of the door and between the packages and the retainer are equal. For door shelves and compartments the packages may, if necessary, be placed on end. However, 125 g packages only be placed flat and shall not be used as vertical wedges.

APPENDIX B

DETERMINATION OF CABINET AIR TEMPERATURES

B.1 Location of measurement points.

Nominal locations for temperature sensors for the measurement of air temperatures in fresh-food compartments are shown in Figure **B.1.** All locations are midway between front and rear of the compartment; locations directly below evaporators are on the vertical centreline of the evaporator. Locations for frozen food compartments are the same as those given for freezer test packages in Appendix **A**.

Locations for temperature measurement, evaporators, and crispers are shown thus

t_c: fresh-food compartment measurement point
t_f : frozen-food compartment measurement point

Evaporator

Crisper

B.2. Averaging

B.2.1 Temperature at a point

The average temperature at a typical temperature measurement point shall be determined from the following equation :

$$T_{cl} = \frac{T_{cl}\,\max + t_{cl}\,\min}{2}$$

Where t_{cl} max and t_{cl} min are the highest and lowest temperatures recorded at point t_{cl} during a complete operating cycle.

The average air temperature at other points in a compartment is determined in a similar manner.

B.2.2 Compartment temperature

The average air temperature for a compartment shall be the average of the determinations at all measurement points within the compartment determined form the following equation.

$$T_c = \frac{(t_{cl} + t_{c2} + \ldots\ldots t_{cn})}{N}$$

Where t_{ct} etc are determined as in B.2.2, and n is the number of measurement points.

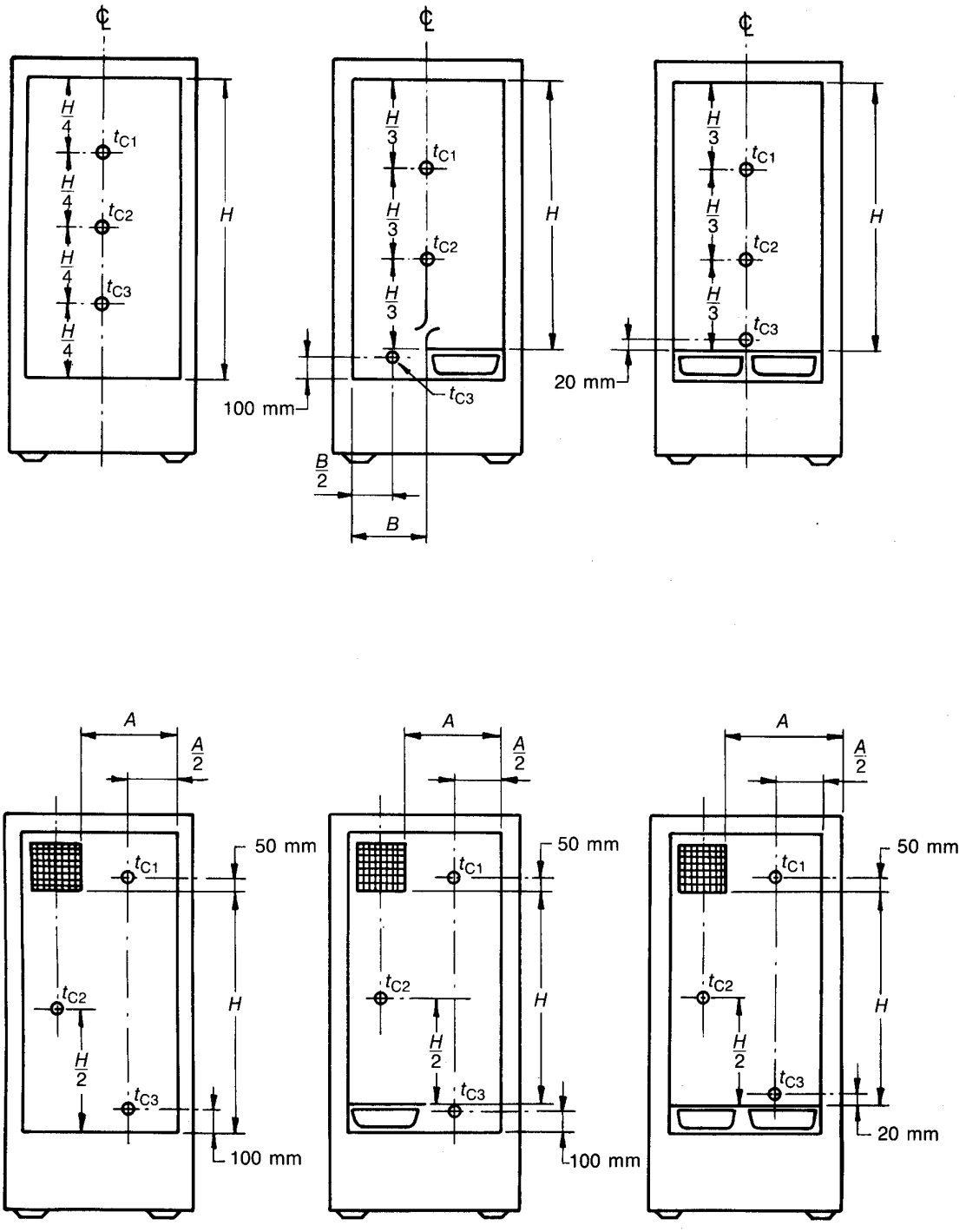


FIGURE B.1 - Air temperature measuring points – fresh-food compartment (continued)

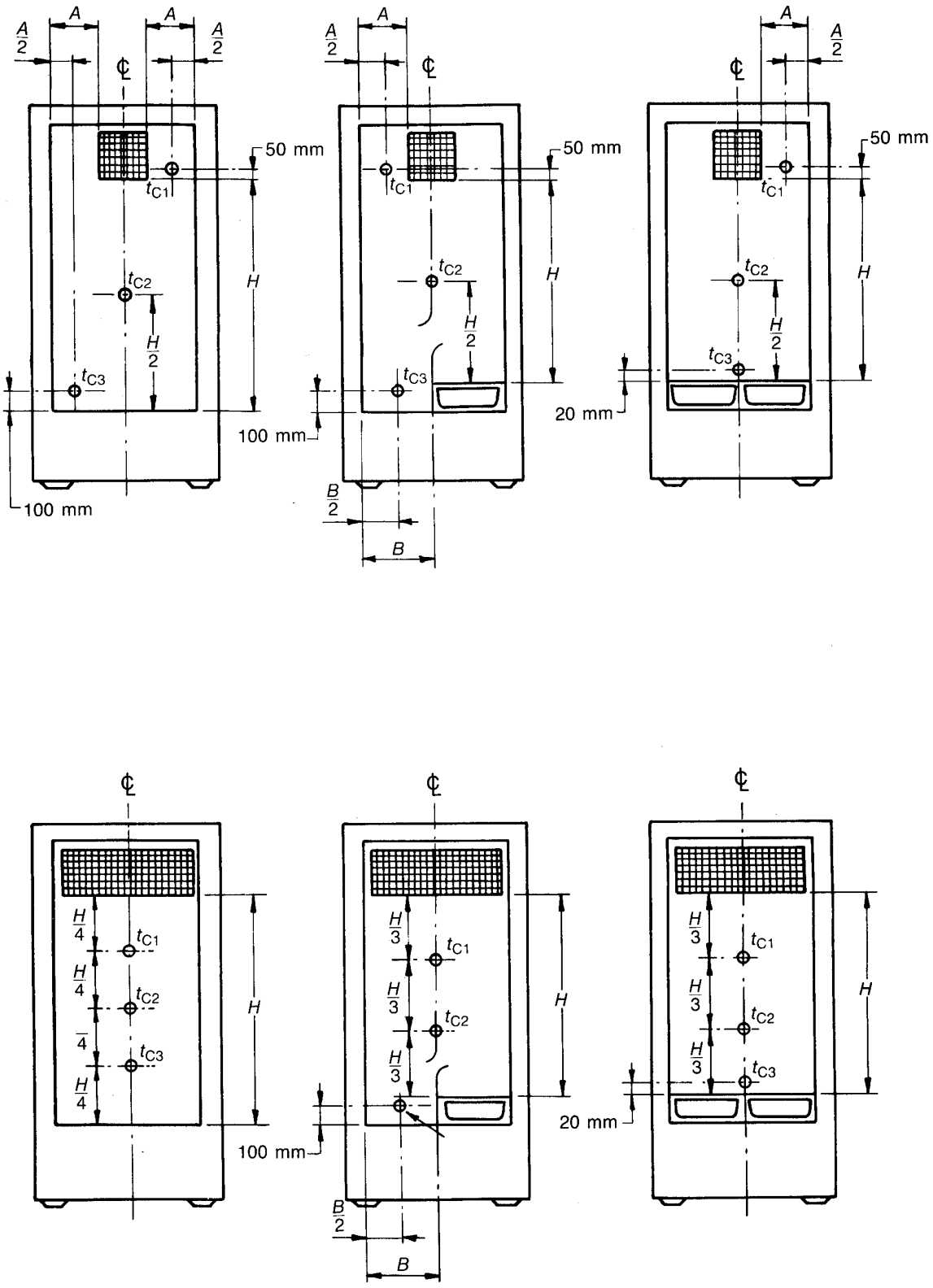
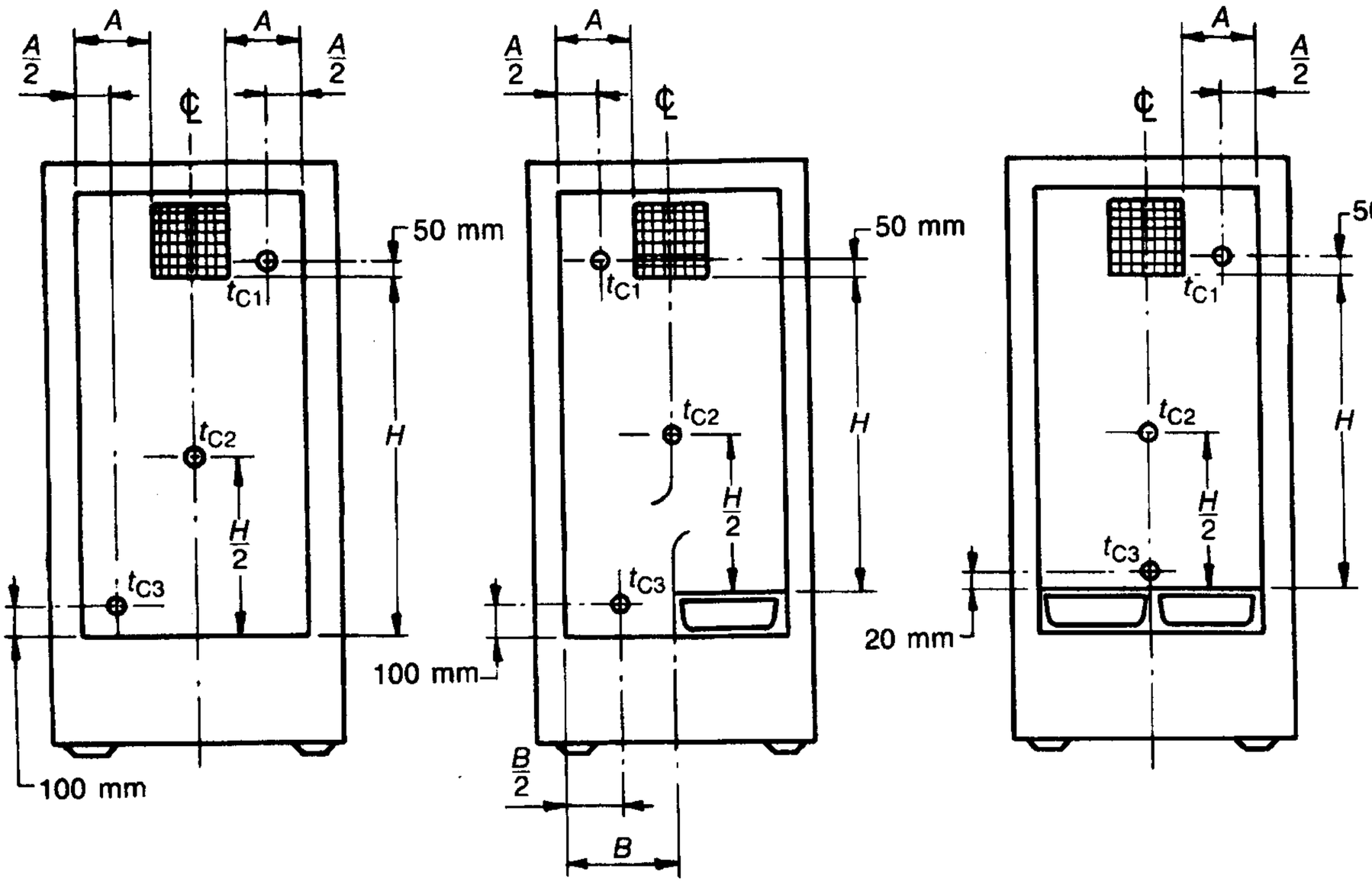


FIGURE B.1 - Air temperature measuring points – fresh-food compartment



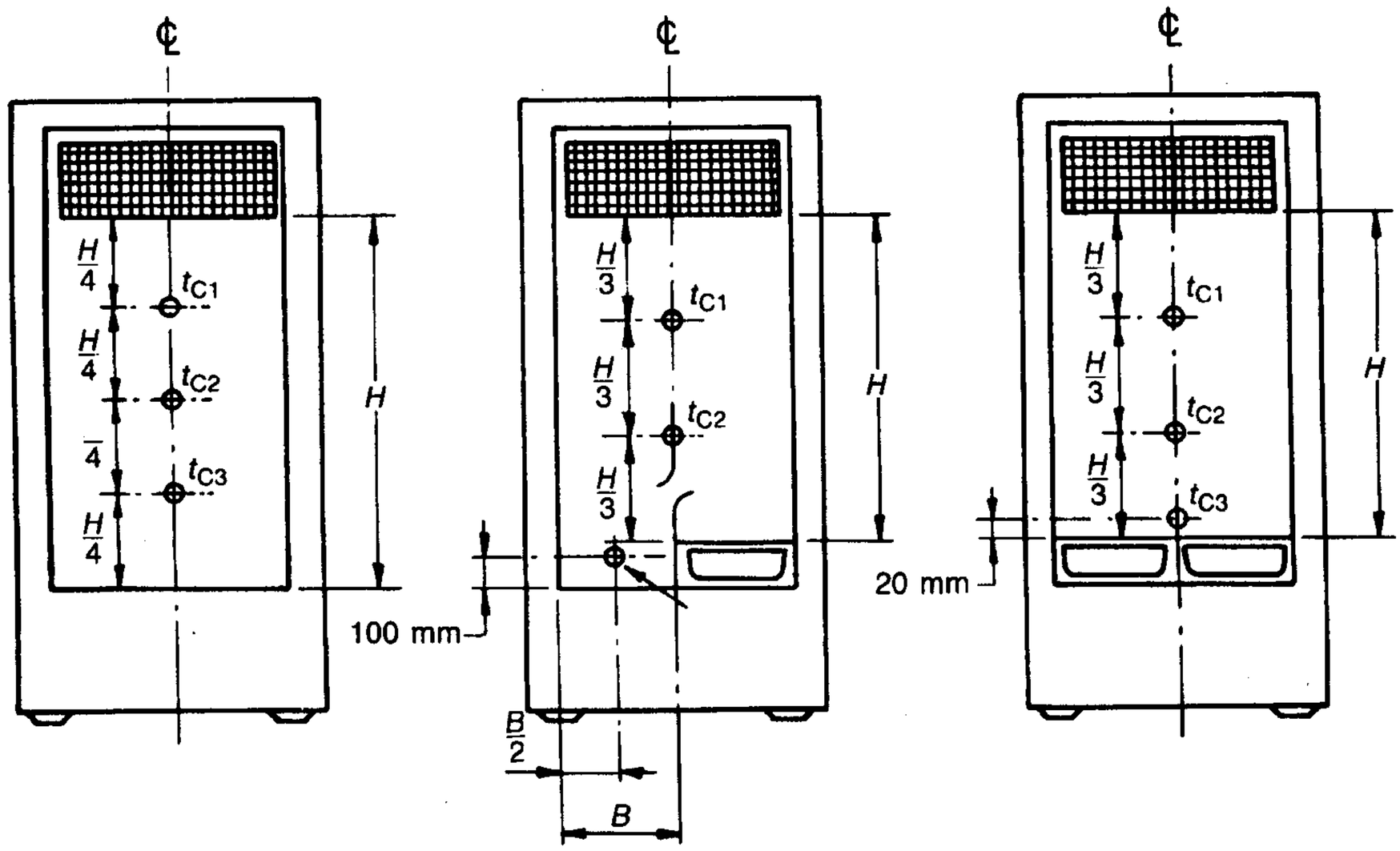


FIGURE B.1 - Air temperature measuring points – fresh-food compartment

(concluded)

SRI LANKA STANDARDS INSTITUTION

The Sri Lanka Standards Institution (SLSI) is the National Standards Organization of Sri Lanka established under the Sri Lanka Standards Institution Act No. 6 of 1984 which repealed and replaced the Bureau of Ceylon Standards Act No. 38 of 1964. The Institution functions under the Ministry of Science & Technology.

The principal objects of the Institution as set out in the Act are to prepare standards and promote their adoption, to provide facilities for examination and testing of products, to operate a Certification Marks Scheme, to certify the quality of products meant for local consumption or exports and to promote standardization and quality control by educational, consultancy and research activity.

The Institution is financed by Government grants, and by the income from the sale of its publications and other services offered for Industry and Business Sector. Financial and administrative control is vested in a Council appointed in accordance with the provisions of the Act.

The development and formulation of National Standards is carried out by Technical Experts and representatives of other interest groups, assisted by the permanent officers of the Institution. These Technical Committees are appointed under the purview of the Sectoral Committees which in turn are appointed by the Council. The Sectoral Committees give the final Technical approval for the Draft National Standards prior to the approval by the Council of the SLSI.

All members of the Technical and Sectoral Committees render their services in an honorary capacity. In this process the Institution endeavours to ensure adequate representation of all view points.

In the International field the Institution represents Sri Lanka in the International Organization for Standardization (ISO), and participates in such fields of standardization as are of special interest to Sri Lanka.

Printed at the Sri Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.

SLS CERTIFICATION MARK

The Sri Lanka Standards Institution is the owner of the registered certification mark shown below. Beneath the mark, the number of the Sri Lanka Standard relevant to the product is indicated. This mark may be used only by those who have obtained permits under the SLS certification marks scheme. The presence of this mark on or in relation to a product conveys the assurance that they have been produced to comply with the requirements of the relevant Sri Lanka Standard under a well designed system of quality control inspection and testing operated by the manufacturer and supervised by the SLSI *which includes surveillance inspection of the factory, testing of both factory and market samples.*

Further particulars of the terms and conditions of the permit may be obtained from the Sri *Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.*

Printed at SLSI (Printing Unit)