In the event of any doubt or misunderstanding arising from this translation, the standard in Thai will be held to be authoritative.

Unofficial Translation

TIS 2186-2547 (2004)
THAI INDUSTRIAL STANDARD
for
HOUSEHOLD REFRIGERATORS: ENVIRONMENT REQUIREMENTS; ENERGY EFFICIENCY

1. Scope

1.1 This standard specifies energy efficiency for household refrigerators or similar use.

1.2 This standard covers one door refrigerator which is manually defrosted and semi-automatically defrosted and two door refrigerator which is manually defrosted, semi-automatically defrosted and automatically defrosted.

1.3 This standard applies to only compression-type refrigerator.

2. Definitions

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

2.1 **household refrigerator**: (hereinafter referred to as "refrigerator"): Insulated cabinet of suitable volume and equipment for household use, cooled by energy-consuming means.

2.2 **energy efficiency**: The efficiency of electrically energy consumption of the refrigerator, stated value as the electrically energy consumption per year according to adjusted volume of the refrigerator.

2.3 **manully defrosted**: A compartment is manully defrosted where an action is necessary by the user to initiate the removal of frost accumulation and restoration to normal operation requires a further action by the user, the defrost water being removed manually or removed and disposed of automatically.

2.4 **semi-automatically defrosted**: A compartment is semi-automatically defrosted where an action is necessary by the user to initiate the removal of frost accumulation and normal operation is restored automatically, the defrost water being removed manually or removed and disposed of automatically.

Or a compartment is also semi-automatically defrosted where no action is necessary by the user to initiate the removal of frost accumulation nor to restore normal operation, but where the removal of the defrost water is manual.

2.5 **automatically defrosted**: A compartment is automatically defrosted where no action is necessary by the user to initiate the removal of frost accumulation nor to restore normal operation, and where the disposal of the defrost water is automatic.

2.6 **adjusted volume**: Adjusted food storage compartment volume, in accordance with the differential temperature of the food storage compartments based on the main temperature of the fresh food storagecompartment.

2.7 **rated gross volume**: Gross volume stated by the manufacturer on labelling.

2.8 **frozen food storage compartment**: Compartment intended for the storage of frozen food.

2.9 **fresh food storage compartment**: Compartment intended for the storage of unfrozen food.

2.10 **ambient temperature**: Temperature in the space surrounding the refrigerator under test. It is the arithmetical average of the mean value of the temperatures measured at three points (t_{a1}, t_{a2} and t_{a3}) located 350 mm from the vertical centerline of the side walls and the front wall of the refrigerator.

2.11 **fresh food storage temperature, t_m**: Arithmetical average of the mean value of the temperatures t_1, t_2 and t_3 measured at given points as specified in C.4, the arithmetical average of the extreme values at these points during a complete control cycle.

2.12 **frozen food storage temperature**: Temperature measured in the frozen food storage compartment as specified in C.5.

2.13 **control cycle**: Period between two successive starts, or two successive stops, of a refrigerating system, under stable operating conditions.

3. Requirements

3.1 Energy efficiency

The energy efficiency of the refrigerator shall not exceed the value as specified in Table 1.

Table 1 Energy efficiency

(3.1)

Refrigerator type	Electrically Energy consumption (kW·h/y)
One door refrigerator, manually defrosted and semi-automatically defrosted	
- AV < 100	300 + 0.80 x AV
- AV ≥ 100	171 + 0.46 x AV
Two door refrigerator, manually defrosted, semi-automatically and automatically defrosted	
- AV < 450	457 + 0.46 x AV
- AV ≥ 450	457 + 0.80 x AV

Note *AV is adjusted volume of the refrigerator, in cubic decimetres (litres). The measure as specified in Annex A.*

3.2 The electrically energy consumption per year shall not exceed 110% of rated value on labelling.

3.3 The measured food storage compartment volume shall be not less than 110% of rated food storage compartment volume on labelling.

4. Marking and labelling

4.1 Each refrigerator shall have at least number, letter or marking, the following information marked in a permanent, legible maner and preferability readily visible:

(1) the method of defrosting;
(2) the rated food storage compartment volume, in cubic decimeters;
(3) name of manufacturer or factory, or registered trademark;
(4) the designation and mass, in grams, of the refrigerant;
(5) rated voltage, rated frequency and rated curent;
(6) rated electrically energy consumption per year, in kilowatt hours per year;
(7) the model designation.

4.2 In the case of using foreign language, the meaning shall be in accordance with the above in Thai.

5. Sampling and criteria for conformity

5.1 Lot means refrigerators having the same number of door, defrosting method and rated food storage compartment volume, which are manufactured or delivered or purchased at the same period of time.

5.2 Sampling and criteria for conformity shall be in accordance with the following sampling plan or used other sampling plan such that the result is technical equivalent.

5.2.1 Sampling

One sample shall be taken by random from the same lot.

5.2.2 Criteria for conformity

The sample shall meet all requirements in clause 3 and clause 4, the lot shall be deem to comply with this standard.

If the sample does not meet the requirements in 3.1, three samples shall be taken for retests as specified in Annex C, the average of the electrically energy consumption per year of the three samples shall not exceed the value as specified in table 1, the lot shall be deemed to comply with this standard.

6. Testing

6.1 The manufacturer shall provide the technical information of the refrigerator for testing as defined in Annex B.

6.2 Testing

6.2.1 Marking and labelling

Checked by visible inspection.

6.2.2 Energy efficiency

The test shall be carried out as defined in Annex C.

Annex A

Determination of storage volume

(Table 1)

A.1 One door refrigerator

The measurement shall be started to measure the frozen food storage compartment volume, then measured the fresh food storage compartment volume.

A.1.1 Frozen food storage compartment volume (V_f)

Determined the frozen food storage compartment volume by measured the volume of the evaporator space (see figure A.1), the result shall be the product of the depth, width and height, defined as follows.

A.1.1.1 Depth

The depth of the evaporator space which a food storage space is not located in front of the evaporator shall be the mean horizontal distance between the front surface and the rear surface of the enclosed space of the cabinet, measured at the level of the evaporator.

If a food storage space is located in front of the evaporator, the depth of the evaporator space shall be taken as the mean horizontal distance from the inner surface of the rear of the enclosed space of the cabinet to the foremost part of the evaporator, or of the evaporator door if fitted.

A.1.1.2 Width

The width of the evaporator space shall be the overall horizontal width of the evaporator itself (neglecting suction headers near the top of the evaporator) or, if side ribs are used, the overall width including the ribs.

If there is less than 70 mm horizontal distance between the evaporator or the ribs and an inside wall of the enclosed space of the cabinet, such space shall be computed as part of the evaporator space.

A.1.1.3 Height

The height of the evaporator space shall be the mean vertical distance between the lower limit of the evaporator and the upper partition of the food storage compartment.

If the free space between the upper surface or top of the evaporator and the upper partition of the food storage compartment exceeds 40 mm, it shall be added to the storage volume of the fresh food storage compartment.

If the free space between the upper surface or top of the evaporator and the upper partition of the food storage compartment is not exceeding 40 mm, it shall be added to the storage volume of the frozen food storage compartment.

The evaporator height shall include any internal drip tray and/or drip collector, except in the case when the storage height of the drip tray is greater than 40 mm and definite manual operation is needed by switched on to initiate defrosting.

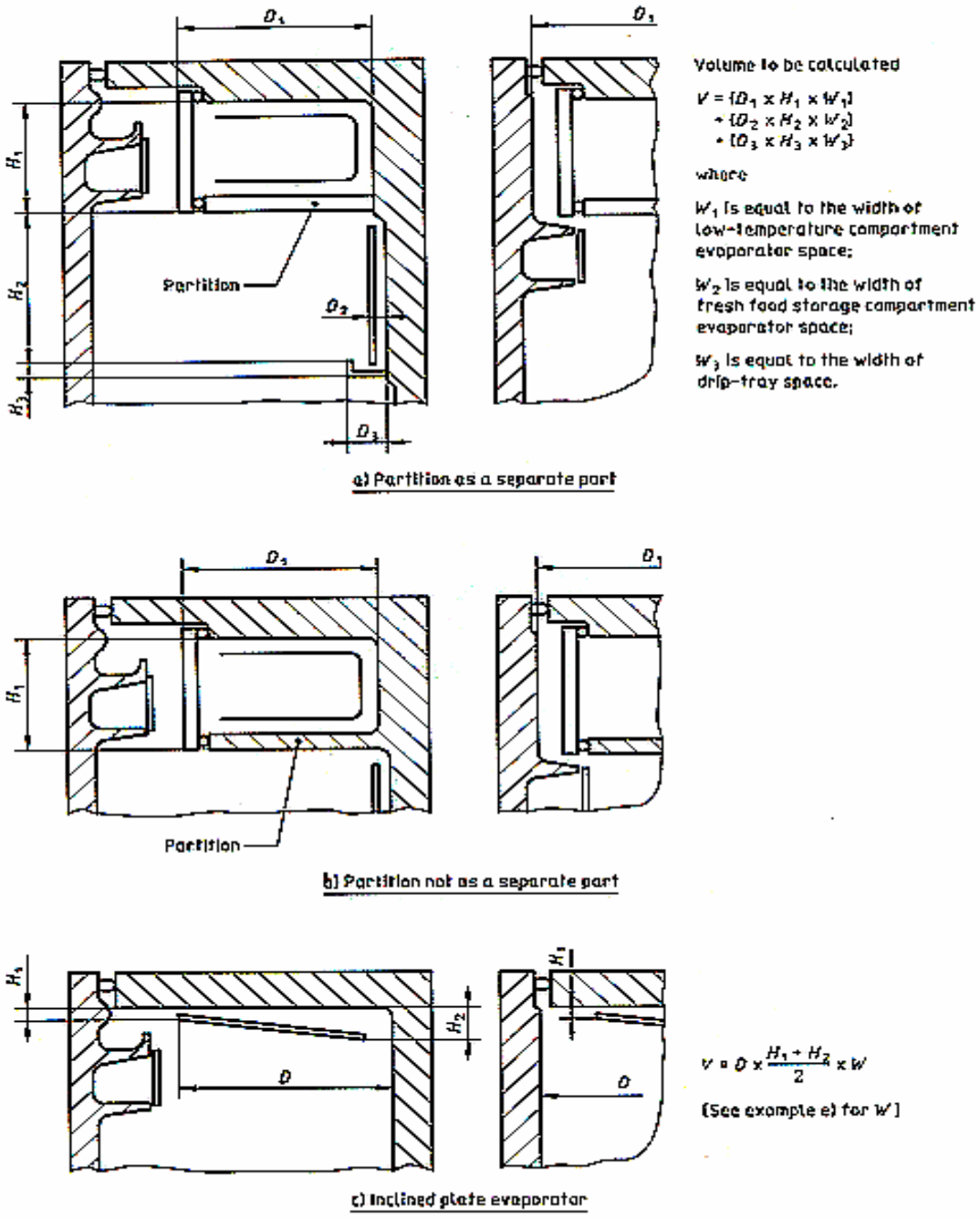


Figure A.1 Determination of volume of evaporator space
(A.1.1)

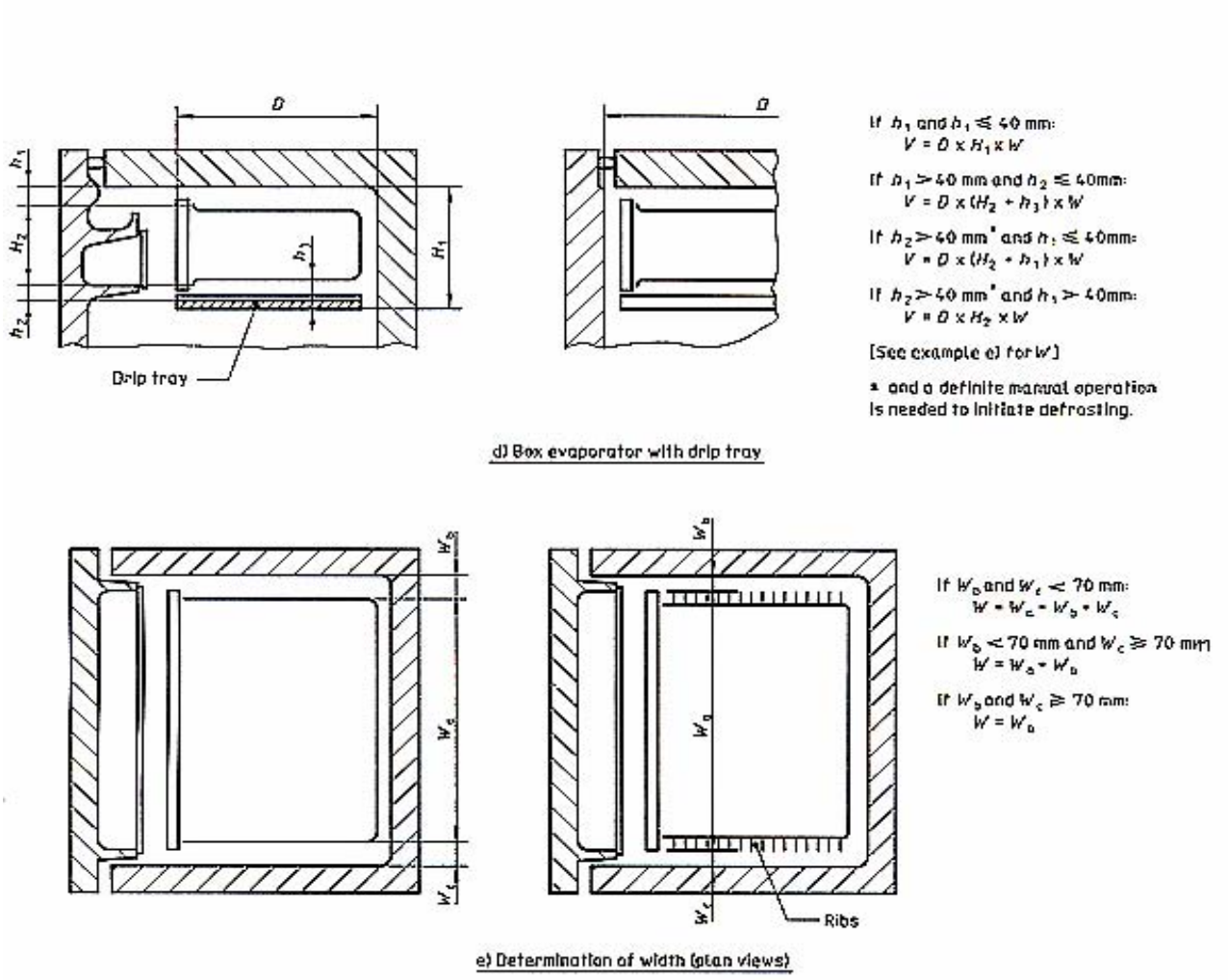


Figure A.1 Determination of volume of evaporator space (concluded)
(A.1.1)

A.1.2 Fresh food storage compartment volume (V_r)

A.1.2.1 After carried out the test as specified in A.1.1, the components of the frozen food compartment, shelves or partitions in the fresh food compartment shall be removed by manually operation.

A.1.2.2 The door or lid shall be bored an approximately 70 mm diameter hole for filling water at the maximum curving part inside of the door or lid.
Note *the number of hols is equal to the number of door*

A.1.2.3 Bored approximately 10 mm diameter hole on the door or lid area or the storage area stated by the manufacturer at the maximum curving part inside of the door or lid.

A.1.2.4 Aluminium tape shall be sticked at the ventilating hole or other similar use stated by the manufacturer, then coated the silicone on the aluminium tape.

A.1.2.5 The gasket of the door or lid having rubber strip, shall be coated the silicone on the rubber strip as to prevent the water during the test.

A.1.2.6 For the approximately 70 mm diameter hole, the aluminium tape shall be sticked around the hole, then coated the silicone on the aluminium tape. For the approximately 10 mm diameter hole, a pipe shall be inserted into the hole, where the end of the pipe is horizontally to the ininer surface plane of the door or lid.

A.1.2.7 The refrigerator shall be closed after the silicone has been dry, covered the any area of the seal with the oil clay as to prevent the water leakage.

A.1.2.8 The refrigerator shall be horizontally placed on the platform of the weighing machine, switched on the machine and set the indicating result as “o”

A.1.2.9 The refrigerator shall be filled the water reaching the bottom surface of the hole, leaved for 1 min to check the water leakage. If there is no water leakage, recorded the value of the water volume which reading from weighing machine in the test report. (If there is some water leakage, it shall be reset and retested as specified in A.1.2.9).

A.1.2.10 The measured volume as specified in A.1.2.9 shall be the total storage volume (V_T).

A.1.2.11 The value of fresh food storage compartment volume (V_r) shall be calculated from the total storage volume (V_T) minus the frozen food storage compartment volume (V_f)

A.2 Two door refrigerator

The measurement shall be started to measure the fresh food storage compartment volume, then measured the frozen food storage compartment volume.

A.2.1 Fresh food storage compartment volume (V_r)

Determined the frozen food storage compartment volume by measured the volume of the evaporator space (see figure A.1), the result shall be the product of the depth, width and height, defined as follows.

A.2.1.1 Removed the shelves or partitions by manually operation.

A.2.1.2 The test shall be carried out as defined in A.1.2.2 to A.1.2.9.

A.2.1.3 The measured volume as specified in A.1.2.9 shall be the fresh food storage compartment volume.

A.2.2 Frozen food storage compartment volume (V_f)

A.2.1.2 The test shall be carried out as specified in A.1.2.2 to A.1.2.9.

A.2.1.3 The measured volume as specified in A.1.2.9 shall be the frozen food storage compartment volume.

A.3 Adjusted volume

The adjusted volume shall be calculated by the formula as follow:

$$AV = (V_f \times K) + V_r$$

where AV is adjusted volume, in cubic decimeters

V_f is frozen food storage compartment volume, in cubic decimeters

V_r is fresh food storage compartment volume, in cubic decimeters

K is constant factor, calculated by the formula as follow:

$$K = \frac{32 - t_f}{32 - t_m}$$

Where t_f is frozen food storage compartment temperature, in degrees Celsius (from C.6.1.6 (2) or C.6.2.5)

t_m is fresh food storage compartment temperature, in degrees Celsius (from C.6.1.6 (2) or C.6.2.4)

Annex B

Technical information of the refrigerator

(6.1)

(1) Refrigerator type ……..door;
(2) Method of defrosting (...) manual (...) semi-automatic (...) automatic;
(3) Model designation …….;
(4) The rated food storage compartment volume …… dm^3;
(5) Rated voltage …….. V;
(6) Rated frequency …….. Hz;
(7) Rated power ……...…. W;
(8) Rated current ……... A;
(9) The designation and mass of the refrigerant ……... g.

Annex C

Test method for energy efficiency

(6.2.2)

C.1 Test room

C.1.1 Ambient temperature

Test room shall be set up under the condition of ambient temperature at 32 ^{o}C $\pm$ 0.5 ^{o}C

C.1.2 Humidity

The relative humidity shall be kept at 70% $\pm$ 5%

C.2 Measuring instrument

C.2.1 Temperatures shall be measured with temperature probes, the sensors of which are inserted for measuring the ambient temperature and measuring temperatures t_1 t_2 and t_3 in the center of tin-covered solid copper or brass cylinders having a mass of 25 g and of minimum external area (diameter = height = about 15.2 mm). The temperature shall be recorded. Temperature-measuring instruments shall be accurate to within $\pm$ 0.3 K.

C.2.2 The relative humidity shall be measured and recorded at a point which is representative. The accuracy of the measurung instruments shall be such that the result, expressed as the dew point, is accurate to within $\pm$ 3 K.

C.2.3 Watt-hours meters shall be readable to 0.01 kW·h and be accurate to within $\pm$ 1%. The measuring accuracy shall be stated in the test report.

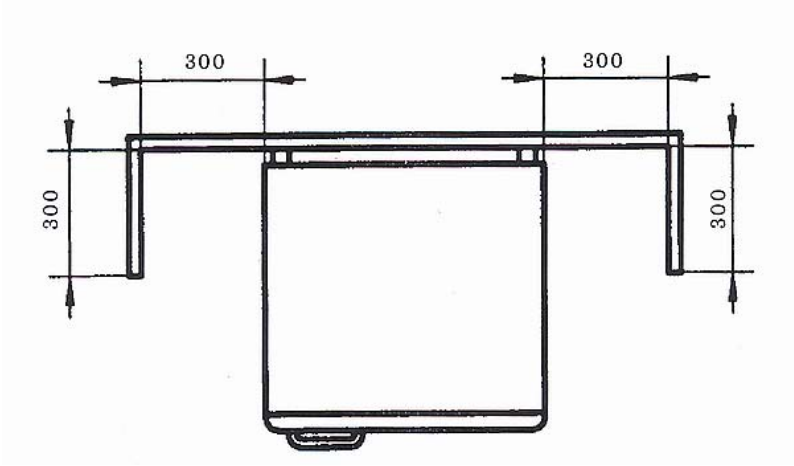
C.3 Installation of refrigerator

Each refrigerator shall be placed on a wooden solid-top platform, painted dull black, open for free air circulation under the platform. The top of the platform shall be 300 mm above the test room floor and shall extend at least 300 mm, but not more than 600 mm, beyond all sides of the refrigerator, except at the rear where it shall extend to the vertical partition.

Circulation of air about the refrigerator shall be restricted by surrounding the refrigerator by three vertical partitions, painted dull black. The whole partition structure shall have the form and dimension shown in figure C.1, one of the partition shall be placed parallel to the rear of the refrigerator, againt the stops or at the distance specied by the manufacturer in connection with the required overall space; the two other partitions shall be parallel to the sides of the carbinet, and shall be fixed on the platform 300 mm from the sides of the carbinet; they shall be 300 mm wide.

The vertical partical partitions shall present no discontinuity. They shall be of such a height that they extend at least 300 mm above the top of the refrigerator. The refrigerator shall be so placed or shielded as to prevent direct radiation to or from the space cooling or heating equipment in the test room, and shall be placed far enough away from all other objects in the test room to eliminate any possibility of any point in the space in which it is situated being at a temperature other than ambient.

Air circulation in the test room shall be such that the specified ambient temperatures are obtained within the limits of the specified tolerances. The refrigerator under test shall be shielded from any air currents of velocity above 0.25 m/s.



Dimensions in millimeters

Figure C.1 Partitions of restrict air circulation
(C.3)

C.4 Measurement of the fresh food storage compartment temperature (t_m)

The temperatures t_1, t_2 and t_3 shall be measured in tin-covered solid copper or brass cylinders suspended and located at the temperature-sensing points T_1 T_2 T_3 as shown in figures C.2 halfway between the rear internal wall of the refrigerator and the internal wall of the closed door. The mean internal temperature t_m shall then be calculated.

The means of suspension shall have the smallest possible cross-section and the lowest possible thermal conductivity, arranged in such a way that they do not significantly interfere with the normal air circulation.

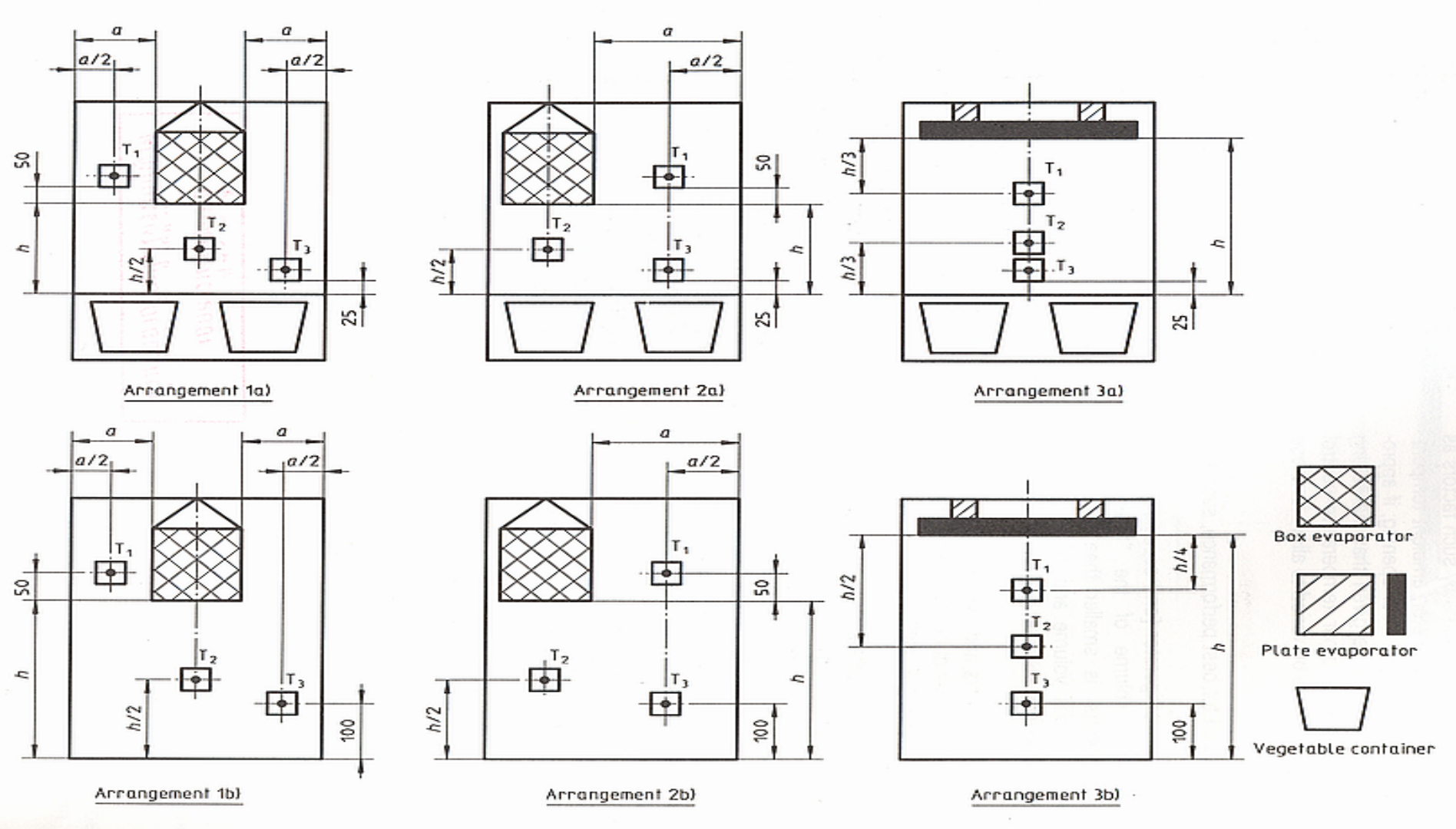
If internal components do not allow the temperatures t_1, t_2 and t_3 to be read at the points specified, readings may be taken in positions such that the tin-covered solid copper or brass cylinders is no more than 25 mm from the point specified. If the interior arrangement of the evaporator does not confirm to those shown in figure C.2, the temperatures t_1, t_2 and t_3 shall be read in the positions determined by analog with the positions indicated as shown in figures C.2.

The temperatures shall be recorded. The copper or brass cylinders shall be separated from any heat conducting surface by at least 25 mm of air space. Connections from the measuring instruments shall be arranged in such a manner as not to interfere with the air seal of the fresh food storage compartment.

C.5 Measurement of the frozen food storage compartment temperature (t_f)

The temperature shall be measured in tin-covered solid copper or brass cylinders located between the rear internal wall and the internal wall of the closed door of the frozen food storage compartment at the height 1/3 of the height of the frozen food storage compartment. The internal temperature t_f shall then be recorded.

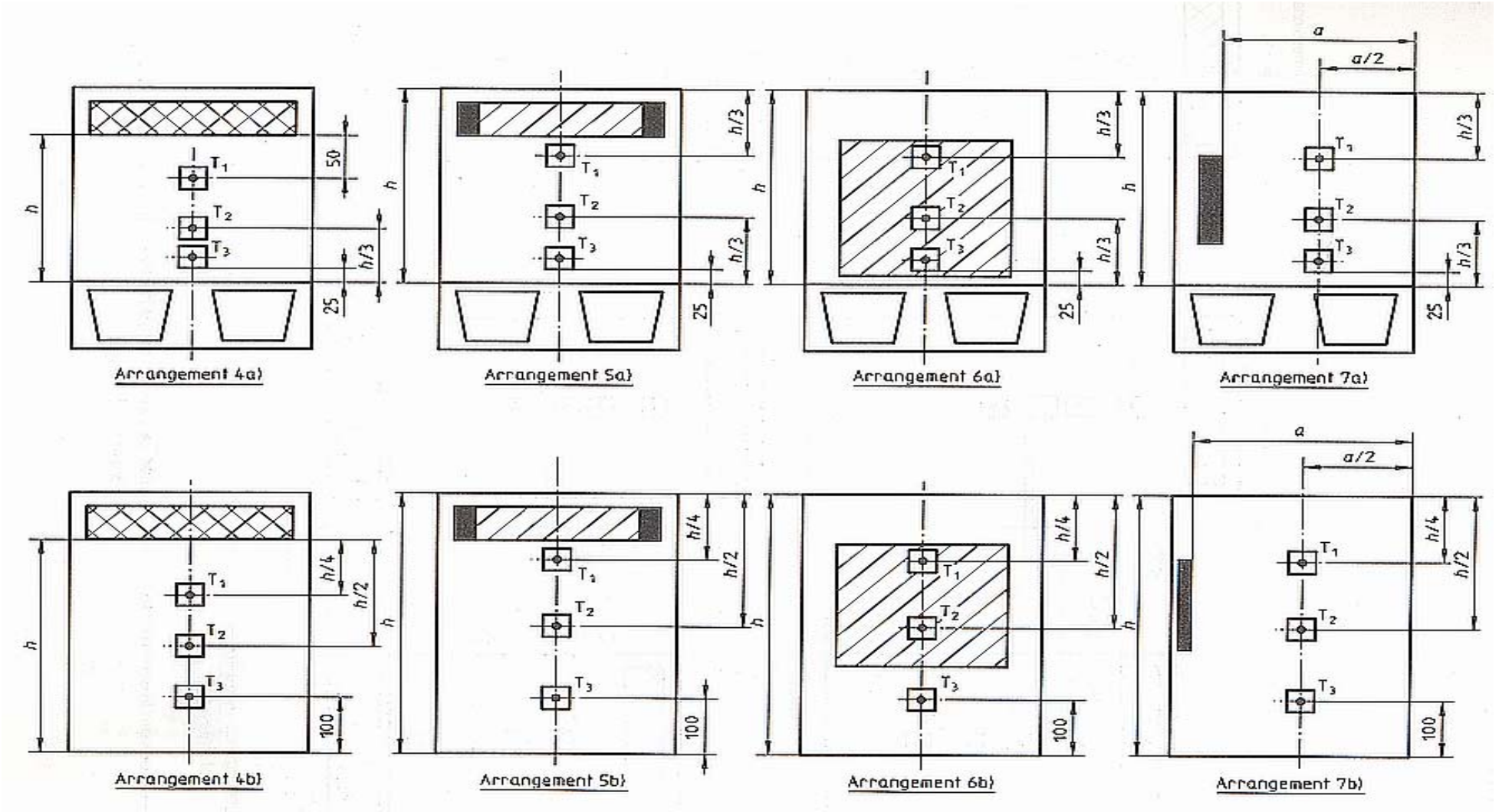
If internal components do not allow the temperature t_f to be read at the points specified, readings may be taken in positions such that the tin-covered solid copper or brass cylinders is no more than 25 mm from the point specified. The copper or brass cylinders shall be separted from any heat conducting surface by at least 25 mm of air space. Connections from the measuring instruments shall be arranged in such a manner as not to interfere with the air seal of the frozen food storage compartment.



Dimensions in millimeters

Figure C.2 Temperature-measurement points in refrigerators with different arrangements of evaporator

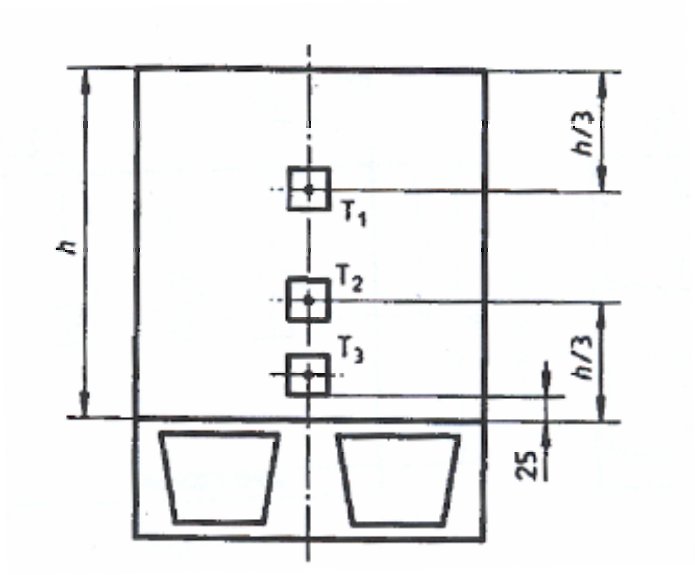
(C.4)



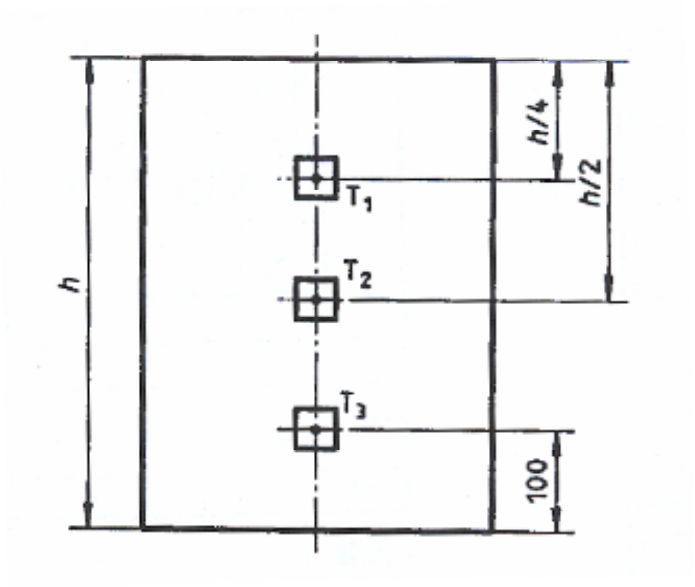
Dimensions in millimeters

Figure C.2 Temperature-measurement points in refrigerators with different arrangements of evaporator (concluded)

(C.4)



Arrangement 8a)



Arrangement 8b)

Dimensions in millimeters

Figure C.2 Temperature-measurement points in refrigerators with different arrangements of evaporator (concluded)

(C.4)

C.6 Test procedure

C.6.1 One door refrigerator

C.6.1.1 Tests are carried out with a no loaded refrigerator.

C.6.1.2 Tests for electrically energy consumption shall be carried out two successive tests. The first test, the thermostat shall be set at the temperature where the fresh food compartment temperature is higher than the specified temperature (at 5 ^{o}C) as 5 ^{o}C $< t_{m1} \leq 6$ ^{o}C; and the second test shall be set at the temperature where the fresh food compartment temperature is lower than the specified temperature as 4 ^{o}C $\leq t_{m2} <$ 5 ^{o}C, which the temperatures t_1, t_2 and t_3 are between 0 ^{o}C and 10 ^{o}C

C.6.1.3 For refrigerator with cyclic operation and without automatic defroting, after stable operating condition, the test period for determining electrically energy consumption shall comprise a whole number of control cycles and start at least 24 h.

C.6.1.4 The fresh food compartment temperature shall be measured as specified in C.4.

C.6.1.5 The frozen food compartment temperature shall be measured as specified in C.5.

C.6.1.6 Test report

(1) The value of electrically energy consumption (at t_m = 5 ^oC) shall be calculated from the two measured values by the formula as follow:

$$E_c = E_{c1} + [(E_{c2} - E_{c1}) \times \frac{(t_m - t_{m1})}{t_{m2} - t_m}]$$

where E_c is the electrically energy consumption (at t_m = 5 ^oC), in kilowatt hours per test period, to three decimal places;

E_{c1} is the measured electrically energy consumption, from the first test, to three decimal places;

E_{c2} is the measured electrically energy consumption, from the second test, to three decimal places;

t_m is the specified fresh food compartment temperature, at 5 ^oC;

t_{m1} is the measured fresh food compartment temperature, from the first test;

t_{m2} is the measured fresh food compartment temperature, from the second test.

(2) The value of the frozen food compartment temperature (at t_m = 5 ^oC) shall be calculated from the two measured values by the formula as follow:

$$t_f = t_{f1} + [(t_{f2} - t_{f1}) \times \frac{(t_m - t_{m1})}{t_{m2} - t_m}]$$

where t_f is the frozen food compartment temperature (at t_m = 5 ^oC), in degrees Celsius;

t_{f1} is the measured frozen food compartment temperature, from the first test;

t_{f2} is the measured frozen food compartment temperature, from the second test;

t_m is the specified fresh food compartment temperature, at 5 ^oC;

t_{m1} is the measured fresh food compartment temperature, from the first test;

t_{m2} is the measured fresh food compartment temperature, from the second test.

(3) The value of electrically energy consumption per year shall be calculated from the value of electrically energy consumption (at t_m = 5 ^oC), expressed in kilowatt hours per year, to two decimal places.

C.6.2 Two door refrigerator

C.6.2.1 Tests are carried out with a no loaded refrigerator.

C.6.2.2 The thermostat shall be set at the temperature where is t_m = 5 ^oC $\pm$ 1 ^oC, the temperatures t_1, t_2 and t_3 are between 0 ^oC and 10 ^oC and the frozen food compartment temperature (t_f) shall not exceed -15 ^oC.

C.6.2.3 Measured the electrically energy consumption, to three decimal places; the test period shall start at least 24 h after stable operating condition have been attained.

(1) For refrigerator with cyclic operation and without automatic defroting, the test period shall comprise a whole number of control cycles.

(2) For refrigerator with automatic defroting, the test period shall be as follows:

(2.1) at least 24 h and comprising a whole number of defrost cycles;

(2.2) if the first defrost cycle starts but is not completed during the 24 h period, the test shall be terminated at the end of that defrost cycle;

(2.3) if no defrost cycle starts during the 24 h period, the test period shall be extended to 48 h, and the provisions of C.6.2.3 (2.1) and C.6.2.3 (2.2) above shall be applied for the extended period;

(2.4) if no defrost cycle starts during the 48 h period, defrosting shall not be taken into consideration.

C.6.2.4 The fresh food compartment temperature shall be measured as specified in C.4.

C.6.2.5 The frozen food compartment temperature shall be measured as specified in C.5.

C.6.2.6 Test report

The value of electrically energy consumption per year shall be calculated from the measured electrically energy consumption, expressed in kilowatt hours per year, to two decimal places.