KENYA STANDARD

DKS 2464-2:2019
ICS

Performance of household electrical Appliances — Refrigerating appliances

Part 2:
Minimum energy performance standard requirements

First Edition, 2019

TECHNICAL COMMITTEE REPRESENTATION

The following organizations were represented on the Technical Committee:

Energy Regulatory Commission
Kenya Association of Manufacturers
Ministry of Energy
New Edge Technologies Ltd.
Consumer Information Network
Intertek International Ltd.
Energy Advisory Ltd
Rift Valley Railways/Kenya Railways Corporation
Ozone Engineering/Frigoglass East Africa
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REVISION OF KENYA STANDARDS

In order to keep abreast of progress in industry, Kenya Standards shall be regularly reviewed. Suggestions for improvements to published standards, addressed to the Managing Director, Kenya Bureau of Standards, are welcome.

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Part 2:
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Foreword

This Kenya Standard was prepared by the Refrigeration and Air Conditioning Technical Committee under the guidance of the Standards Projects Committee, and it is in accordance with the procedures of the Kenya Bureau of Standards.

During the preparation of this standard, reference was made to the following documents:

IEC 62552-2:2015 Kenya Standard — Household refrigerating appliances — Characteristics and test methods Part 2: Performance requirements, First Edition.

IEC 62552-3:2015 Kenya Standard — Household refrigerating appliances — Characteristics and test methods Part 3: Energy consumption and volume, First Edition.

IEC/TR 63061:2017 Kenya Standard — Adjusted volume calculation for refrigerating appliances, First Edition.

ISO 817:2014 Kenya Standard — Refrigerants — Designation and safety classification, Second Edition.

Acknowledgement is hereby made for the assistance derived from these sources.

Performance of household electrical Appliances — Refrigerating appliances

Part 2:
Minimum energy performance standard requirements

1 Scope, general and field of application

1.1 Scope

This Kenya Standard specifies the Minimum Energy Performance Standard (MEPS) requirements for household vapour compression refrigerating appliances, cooled by internal natural convection or forced air circulation that can be connected to mains power.

Such refrigerating appliances that are used in the commercial sector are included within the scope. This Standard does not specify safety requirements. Separate standalone wine storage cabinets are not specifically within the scope of this standard.

In particular, this Standard specifies the following:

a) Projected annual energy consumption (PAEC).
b) Projected MEPS energy consumption (PMEC).
c) Volume.
d) Adjusted volume.
e) Normalized volume.
f) Comparative energy consumption (CEC).
g) Star rating.
h) Performance criteria.
i) MEPS for refrigerating appliances.
j) Registration test report information.
k) Printing requirements for refrigerating appliance energy star rating labels.

All of the above parameters defined in this Standard need to be determined using test measurements conducted in accordance with KS IEC 62552-3.

1.2 Exclusions

The following products are excluded from the scope of this standard:

a) products that are designed exclusively for use in caravans, vehicles (e.g. mobile homes, campervans and/or rail cars) or boats and which have a total gross volume of less than 60 l.

b) portable products that have a gross volume of less than 30 l;

c) products that have a gross volume of less than 30 l where the refrigeration function is secondary (e.g. boiling or cooled water dispensers);

d) products that have no options for connection to a 240 V or 415 V 50 Hz mains electricity supply;

e) products that cool using technologies other than the vapor compression cycle.

1.3 Objective

The objective of this standard is to define performance, energy labelling and MEPS requirements which are to be met such that a refrigerating appliance can carry a valid energy star rating label.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

KS EAS 124, *Rounding off numerical values. Statistical Methods and Basic Measurement*

KS IEC 62552-1, *Household Refrigerating Appliances – Characteristics and Test Methods – Part 1: General requirements*

KS IEC 62552-2, *Household refrigerating appliances — Characteristics and test methods Part 2: Performance requirements*

KS IEC 62552-3, *Household refrigerating appliances — Characteristics and test methods Part 3: Energy consumption and volume*

KS IEC/TR 63061, *Adjusted volume calculation for refrigerating appliances*

KS ISO 817, *Refrigerants — Designation and safety classification*

3 Terms and definitions

For the purposes of this document, the definitions given in KS IEC 62552-1, and the following apply:

3.1
adjusted volume (V)

3.1.1
adjusted volume (V_{adj})
the rated gross volume of a compartment adjusted to compensate for heat loadings on spaces which are at temperatures other than that of fresh food type space. It is determined as specified in 7.5 (Units: litres)

3.1.2
total adjusted volume ($V_{adj\ tot}$)
the total of the V_{adj} of all compartments of the appliance (units: litres)

3.2
base energy consumption (BEC)
the nominal energy consumption of an appliance model of a given group and total adjusted volume with a SRI of 1.00 (refer also to 7.6) (Units: kWh/y)

3.3
check test
a full or part test in accordance with the relevant Standard to verify the performance or energy consumption, or both, of an individual brand and model bearing an energy label

3.4
comparative Energy Consumption (CEC)
the nominal average energy consumption of a model of refrigerating appliance. It is based on the PAEC of the model (refer also to Clause 7.4). The CEC appears on the energy a v label. (Units: kWh/y.)

3.5
compartment and sub-compartment
These are defined as follows:

a) **compartment**, an enclosed space within a refrigerating appliance, which is directly accessible through one or more external doors. A compartment may contain one or more sub-compartments and one or more convenience features;

b) **sub-compartment**, a permanently enclosed space within a compartment or sub-compartment which is designated as being a different type of food storage space, (i.e. has a different operating temperature range) from the compartment or sub-compartment within which it is located.
Throughout this standard, except when referring to door allowances (Ad or A d t ot) or sealing face dimensions (see also Annex A), the term 'compartment' means 'compartment and sub-compartment', or 'compartment or sub-compartment', or 'compartment nor sub-compartment' as appropriate for the context.

3.6
family of models
a range of models of the one brand, to which a single set of test reports is applicable and where each of the models has the same relevant physical characteristics, comparative energy consumption, energy efficiency rating and performance characteristics and which are grouped for the purpose of registration. The term 'model' is synonymous with 'family of models'

3.7
good
a good is a product to which this Standard applies
3.8
grandfathering
refer to Annex F for a definition of 'grandfathering'

3.9
minimum energy performance standard (MEPS)
the mandatory level of energy efficiency which has to be met by each individual unit of an appliance model. The MEPS cut-off level is the maximum allowable energy consumption of the model determined from its size, features and configuration (refer to Clause 8.5). (Units: kWh/y.)

3.10
projected annual energy consumption (PAEC)
the estimate of energy used by a single unit during one year's use. It assumes a particular ambient temperature and normally no door openings (refer also to C.2.3) (units: kWh/y)

3.11
portable products
units that are specifically designed to be moved from place to place as part of their normal use as stated in the accompanying product literature (i.e. operating manual or user instructions)

NOTE Energy labelling and MEPS is only exempt for portable products where they have a gross volume of less than 30 l.

3.12
registration
the completion and submission of the prescribed application form to the regulator as specified in the registration system. An approved registration means a record that has been reviewed and accepted by the relevant regulator and marked with an approved status on the basis that the record is complete, all relevant documents have been provided, all relevant requirements of the standard continue to be met and the relevant fee (where applicable) has been paid

A valid registration is one where the status remains approved on the relevant date. A registration status of 'expired' or 'grandfathered' is valid only for existing stock that was manufactured or imported prior to the expiry or grandfathering date and where it had a status of 'approved' at the time of manufacture or importation.

A registration status of 'cancelled' is not valid for any stock, irrespective of the date of manufacture or importation.

3.13

star rating
the number of stars displayed on the energy label. Available stars are between a minimum of one and a maximum of five. The star rating is calculated from the Star Rating Index (refer also to 2.8.) (dimensionless)

3.14
star rating index (SRI)
an indication of the claimed energy efficiency of a model. A higher SRI indicates higher energy efficiency. It is derived from the CEC. (Refer also to 7.7.) (Dimensionless)

3.15
statements of intention

3.15.1
shall indicates that a statement is mandatory

3.15.2
should indicates a recommendation

3.16
variant
a model variant is an alternative version of a model which has the same sales specification and the same model number or other form of designation as another version of the model, and offers the same performance except that it has a different PAEC av, and may have a different SRI (refer also to 7.4.2)

3.17
measured quantities
quantities used in conjunction with this Standard shall be measured in accordance with KS IEC 62552-3.

3.18
rounding
unless otherwise stated, numbers shall be rounded and recorded to five significant figures in accordance with KS EAS 124

4 Determination of energy consumption

4.1 General

This clause sets out the required methods and settings to be applied when determining the energy consumption of a refrigerating appliance within the scope of this Standard.

The relevant components of energy consumption of a refrigerating appliance shall be determined in accordance with the test methods as described in the test standard and in particular the KS IEC 62552-3, Sections, 4, 5 and 6. Equation numbers from the test standard are indicated in parentheses throughout this Standard. Where required, a test report submitted as part of a registration shall contain the applicable information specified in Annex E.

All refrigerating appliances shall be allocated a Group in accordance with Table 1. Refer to Clause 4.10 where a refrigerating appliance can be configured to be more than one Group.

Different approaches for the determination of energy consumption and required settings are to be applied for: calculations in relation to the energy rating label (see Clause 4.2); and calculations in relation to MEPS requirements (see Clause 4.3).

Unless otherwise stated, calculated numbers shall be rounded and recorded to not less than five significant figures in accordance with KS EAS 124.

Where a single point is used to determine the daily energy consumption for energy labelling or MEPS, the calculated temperature in all compartments shall be at or below the relevant target temperature defined in the KS IEC 62552-3, Table1. Otherwise, a more accurate value for daily energy consumption may be estimated using two or three-point interpolation as follows:

Where two-point interpolation is used to determine daily energy consumption, this shall be performed in accordance with the KS IEC 62552-3, Annex E. The energy-temperature slope *S*i of the compartment used for interpolation in accordance with the KS IEC 62552-3, Equation (32) shall be reported as well as the temperature in all compartments at the point of interpolation.

Where three-point interpolation is used, this shall be performed in accordance with the KS IEC 62552-3, Annex E. The coefficients E0, A and B shall be reported as well as the temperature in all compartments at the point of interpolation.

Where the appliance has an ambient controlled anti-condensation heater, the average heater power $W_{heaters-AU}$ shall be determined using the methodology set out in the KS IEC 62552-3.,

When determining energy consumption, any refrigerating appliance that has smart features shall be configured in accordance with the specifications of the manufacturer for use in the home. Such features shall be configured as ready for use, but should not be actively used by the test laboratory during tests.

Any declared automatic control that reduces energy consumption under energy test conditions (including management of heaters) but which is not generally saving energy during normal use shall be defeated where possible. Where the refrigerating appliance has a declared automatic control that could not be disabled for the energy consumption test, or where a circumvention device is discovered, the energy impact of this feature shall be quantified and this value used to adjust each measured energy consumption in accordance with Equation 2.1. The value of $E_{daily-adjusted}$ is then used (as applicable for each ambient temperature) to calculate the PAEC.

$$E_{daily-adjusted} = E_{daily} + 2 \times P_r \times 0.024(kWh/day) \quad \text{--2.1}$$

where: P_r = the average power reduction resulting from the activation of the feature in watts

Table 1 — Refrigerating appliance designations and groups

Refrigerating appliance designation (see Note 1)	Compartment type								Configuration requirements (see Note 5)	Defrost System Requirements (See Note 6)	Group See Note 14
	Unfrozen compartment					Frozen compartment					
	Wine storage	Cellar or pantry	Fresh food	Chill	Zero-star	One-star	Two-star	Freezer (three or four-star)			
Refrigerator	O	O	Y	O	O	N	N		1		
Cooled appliance	L	L	L	L	L	N	N	N			
Refrigerator	O	O	Y	O	O	Y	N	N	2		
Cooled appliance	L	L	L	L	L	Y	N	N			
Refrigerator	O	O	Y	O	O	O	Y	N	3		
Cooled appliance	L	L	L	L	L	O	Y	N			
Refrigerator/ freezer	O	O	Y	O	O	O	O	Y		Automatic defrost in unfrozen **compartm**	4
Cooled appliance	L	L	L	L	L	O	O	Y			
Refrigerator/ freezer	O	O	Y	O	O	O	O	Y	Bottom freezer	Automatic defrost in	5B

Refrigerator/freezer	O	O	Y	O	O	O	O	Y	Side by side	Automatic defrost in all	5S
Refrigerator/ freezer	O	O	Y	O	O	O	O	Y	Not Group 5S or 5B	Automatic defrost in all	5T
Cooled appliance	L	L	L	L	L	O	O	Y			
Freezer	N	N	N	N	N	O	O	Y	Chest	6C	6C
Cooled appliance	N	N	N	N	N	L	L	L			
Freezer	N	N	N	N	N	O	O	Y	Upright	Manual defrost	6U
Cooled appliance	N	N	N	N	N	L	L	L			
Freezer	N	N	N	N	N	O	O	Y	Upright	Automatic defrost in all	7
Cooled appliance	N	N	N	N	N	L	L	L			

NOTE 1 See Clause 1.6.19 for definitions of refrigerating appliance designations.

NOTE 2 To determine the Group to which an appliance belongs, its refrigerating appliance designation (Clause 1.6.19), constituent compartment types (KS IEC 62552-1), configuration (Clause 1.6.10), defrost system (KS IEC 62552-1) and defrost type for each compartment (KS IEC 62552-1) need to first be established. Each row of Table 1 is then considered from the top until the applicable row, and hence the Group, is established. The target temperature for energy determination for each compartment type is defined in the KS IEC 62552-3.

NOTE 3 In determining the Group of an appliance, Table 1 is applied to compartments and sub-compartments. Convenience features are not considered.

NOTE 4 Requirements to be met by the appliance in question regarding food storage compartment types: “Y” — indicates “yes” (i.e. the appliance shall have at least one compartment of each of the types marked Y). “N” — indicates “no” (i.e. the appliance shall have no compartments of the types marked N). “L” — indicates “at least one” (i.e. the appliance shall have at least one compartment from the types marked L within each of the food storages types [unfrozen or frozen, as applicable]). “O” — indicates “optional” (i.e. the appliance may or may not have any compartments from the types marked O).

NOTE 5 This column sets out the requirements to be met by the appliance regarding configuration. A blank cell in this column indicates no particular requirements regarding configuration and therefore includes any configuration. A frost-free cooled appliance with a freezer and unfrozen compartment shall be classified as Group 5T irrespective of configuration.

NOTE 6 This column sets out the system requirements to be met by the appliance regarding the prevention or removal of frost. A blank cell in this column indicates no particular system requirements. The entry “manual defrost” indicates that the appliance shall have at least one frozen compartment that is not automatic defrost.

NOTE 7 Any refrigerating appliance which is configured as a Group 4 appliance but does not meet the defrost type criteria shall be deemed to be a Group 3 appliance. This particular requirement applies even though the appliance contains a freezer compartment.

NOTE 8 An appliance with frozen compartments with both chest and upright configurations shall be classified as Group 6C where the volume of the chest component exceeds 50 % of the total volume. Otherwise it shall be classified in the appropriate upright Group.

NOTE 9 If a product can be classified as either Group 1 or Group 2, it shall be assigned Group 1.

NOTE 10 The following compartment types are defined as unfrozen: pantry, cellar, wine storage, fresh food, chill, zero-star.

NOTE 11 The following compartment types are defined as frozen: ice-making (one-star), short-term frozen food storage (two-star), freezer (three-star and four-star).

NOTE 12 The terms zero-star, one-star, two-star, three-star and four-star are definitions of compartment temperature performance as set out in the KS IEC 62552-1 and are not related to star ratings defined in this Standard.

NOTE 13 See Annex A for examples of hypothetical appliances and the applicable Group for each.

NOTE 14 Where a refrigerating appliance contains variable temperature compartments that may alter the Group, the refrigerating appliance designation is determined for the primary Group as required for energy labelling and MEPS. Where additional Groups are declared for energy labelling, the relevant refrigerating appliance designation is separately determined for each additional Group. See Clause 4.10.

4.2 Energy consumption determination for energy labelling

4.2.1 General

Energy consumption for the energy rating label shall be determined using the following measurements:

a) The steady-state power consumption as determined in accordance with Annex B of the KS IEC 62552-3.

b) The incremental energy for defrost and recovery as determined in accordance with Annex C of the KS IEC 62552-3.

c) The defrost frequency as determined in accordance with Annex D of the KS IEC 62552-3.

d) The energy consumption of specified auxiliaries as determined in accordance with Annex F of the KS IEC 62552-3, where applicable.

e) The load processing efficiency as determined in accordance with Annex G of the KS IEC 62552-3.

4.2.2 Test requirements for energy labelling

Table 2 sets out requirements to be applied when undertaking tests for energy labelling.

Table 2 — Energy consumption testing — requirements for energy labelling

Test Standard	Section or Clause	Aspect	Requirement
Part 1	Section 4	Climate class	Climate class is not specified in this Standard and a declared climate class in the KS IEC 62552-1 does not affect conditions for energy testing
Part 1	Clause A.3.3	Electrical supply	230V and 50Hz
Part 3	Section 5	Target temperatures	As per Table 1
Part 3	Section 6	Ambient temperatures to be used for the determination of energy consumption	Both 16 °C and 32 °C
Part 3	Section 6	Method for calculating and optimizing the estimate of the daily energy consumption for a given ambient temperature	Interpolation in accordance with Annex E — optional
Part 3	Clause A.2.5	Manually switched anti-condensation heaters	These shall be set in the ON position for energy labelling tests or in the maximum (highest energy) position where there is a variable control
Part 3	Clause A.2.6	Automatic icemakers	Storage bin to remain in place and all associated auxiliaries to be operating as per Clause A.2.6
Part 3	Annex B	Ambient temperatures to be used for the determination of steady-state power consumption during stable operation	Both 16 °C and 32 °C
Part 3	Annex B	Ambient temperatures to be used for the determination of compartment internal temperature during stable operation	Both 16 °C and 32 °C

Table 2 (continued)

Test Standard	Section or Clause	Aspect	Requirement

Part 3	Annex C	Ambient temperatures to be used for the determination of the representative incremental energy for defrost and recovery	Both 16°C and 32°C
Part 3	Annex C	Values of *ΔE*df representative incremental energy for defrost and recovery	Measured value times 1.3 for run-time defrost controllers to give *ΔE*df-a Measured value times 1.9 for all other defrost controller types to give *ΔE*df-a NOTE: These values are empirical corrections to account for differences between laboratory measurements and normal use. See Bibliography Item [7].
Part 3	Annex C	Values of *ΔTh*df representative temperature difference for defrost and recovery used for determining the calculated compartment temperature	As measured
Part 3	Annex D	Defrost interval (*tdf*) to be used when determining energy consumption	Defrost interval as determined in the relevant section of Annex D
Part 3	Annex G	Ambient temperatures to be used for the determination of the processing efficiency	32°C, measurement at 16°C is optional
Part 3	Annex G	The deemed processing load to be used for the determination of the load processing efficiency	Processing load as defined in Annex G of the test standard Part 3. The required parameter is the load processing efficiency as defined in Equation (52) of the test standard Part 3.
Part 3	Annex H	Determination of compartment volume	Rated value stated by the supplier.

4.2.3 Calculation of energy consumption for the energy rating label

Energy consumption in relation to the energy rating label shall be calculated as follows:

For separate ambient test temperatures at both 32°C and 16°C, determine the following values:

a) The steady-state power *P*ss for the selected temperature control setting in accordance with the KS IEC 62552-3, Annex B. Ensure that this steady-state power value is corrected for the measured ambient test room temperature in accordance with the KS IEC 62552-3, Equation (15).

b) The representative incremental energy for defrost and recovery *ΔE*df in accordance with the KS IEC 62552-3, Annex C. The number of valid defrost and recovery periods to determine a representative value shall meet the requirements as set out in the KS IEC 62552-3, Clause C.4, Option 1 or Option 2. Any defrost cycle that has been initiated by the test laboratory (forced defrost) shall be omitted when determining representative incremental energy for defrost and recovery.

NOTE An appliance tested with a dry evaporator or subject to forced defrost will give an artificially low value for incremental energy for defrost and recovery.

c) For each valid value for incremental energy for defrost and recovery *ΔE*df in accordance with the KS IEC 62552-3, Annex C, the defrost heater energy *E*df-heater shall be reported and the defrost adder for each defrost as specified in Equation 2.2 shall be calculated and reported.

$$\Delta E_{df-adder} = \Delta E_{dr} - E_{df-heater} \quad 2.2$$

d) Measured values of *ΔE*df shall be multiplied by the Kenya scaling factors set out in Table 2 to give *ΔE*df-a for use in the determination of daily energy consumption *E*daily.

e) The representative temperature difference for defrost and recovery in each compartment *i*

*ΔTh*df-i in accordance with the KS IEC 62552-3, Annex C shall be determined where there is automatic defrost system.

f) The defrost interval *t*df in accordance with the KS IEC 62552-3, Annex D shall be calculated where there is automatic defrost system. For variable defrost controllers, the value for *t*df32 (KS IEC 62552-3, Equation (27)) used for determination of energy consumption *E*daily shall not exceed 24 h at 32°C and shall not exceed 48 h at 16°C.

g) The compartment temperature in each compartment for the selected temperature control setting in accordance with the KS IEC 62552-3, Equation (3), which shall include the representative temperature difference for defrost and recovery in each compartment (where applicable).

h) The daily energy consumption at the selected control setting *E*daily in accordance with the KS IEC 62552-3, Equation (2). The final values, after interpolation where applicable, shall be recorded as *E*daily32C-label and *E*daily16C-label as applicable.

The procedure specified in Annex G of the KS IEC 62552-3 is used to measure the load processing efficiency. This efficiency is then used to calculate the additional energy that the refrigerating appliance would require to remove a known amount of user heat load. A nominal user heat load of 0.75 Wh per day per litre of unfrozen volume and 0.25 Wh per day per litre of frozen volume is assigned for all Groups when determining the PAEC.

Determine the load processing efficiency *E*fficiency load, ambient at an ambient test temperature of 32°C in accordance with the KS IEC 62552-3, Annex G, Equation (52). The supplier may also elect to determine the load processing efficiency *E*fficiency load, ambient at an ambient test temperature of 16°C in accordance with the KS IEC 62552-3, Annex G, Equation (52), in which case the average value for 16°C and 32°C is used for the energy labelling calculation. Where a supplier elects not to measure the load processing efficiency, a default value for *Efficiency* load, ambient is specified in Clause 3.3.

Where one or more defrosts occur during a load processing test, the modified KS IEC 62552-3, Annex G, Equation (51) set out in Equation 2.3 shall be used to calculate *ΔE* additional-test:

$$\Delta E_{additional-test} = (E_{end} - E_{start}) - P_{after} \times (t_{end} - t_{start}) - z \times \Delta E_{df-adder} - \sum E_{df-heater} \quad 2.3$$

Where Σ*E*df-heater is the sum of defrost heater energy for all defrosts that occur during the load processing test and *ΔE*df-adder is the representative defrost adder calculated for all valid defrosts specified in Equation 2.2.

Determine the volume of each compartment in accordance with the KS IEC 62552-3, Annex H. Allocate the volume of each compartment as either frozen (*V*frozen) or unfrozen (*V*unfrozen), as classified under Table 1.

4.3 Energy consumption determination for MEPS

4.3.1 General

Energy consumption for MEPS shall be determined using the following measurements:

a) The steady-state power consumption as determined in accordance with Annex B of the KS IEC 62552-3.
b) The defrost and recovery energy as determined in accordance with Annex C of the KS IEC 62552-3.
c) The defrost frequency as specified in Table 2.3 for the relevant defrost controller type.

d) The energy consumption of specified auxiliaries as determined in accordance with Annex F of the KS IEC 62552-3 where applicable.

NOTE The load processing efficiency is not considered in the energy consumption determination for MEPS.

4.3.2 Test requirements for determining MEPS compliance

Table 2.3 sets out requirements to be applied when undertaking tests for energy consumption demonstrating compliance with the MEPS requirements.

Table 2.3 — Energy consumption testing — Requirements for MEPS compliance

Test Standard	Section or Clause	Aspect	Requirement
Part 1	Section 4	Climate class	Climate class is not specified in this Standard and a declared climate class in the KS IEC 62552-1 does not affect conditions for energy testing
Part 1	Clause A.3.3	Electrical supply	230V and 50Hz
Part 3	Section 5	Target temperatures	As per Table 1
Part 3	Section 6	Ambient temperatures to be used for the determination of energy consumption	28°C only (i.e. a measurement at 16°C is not required for MEPS)
Part 3	Section 6	Method for calculating and optimising the estimate of the daily energy consumption for a given ambient temperature	Interpolation in accordance with Annex E — optional
Part 3	Clause A.2.5	Manually switched anti-condensation heaters	These shall be set in the ON position for MEPS tests or in the maximum (highest energy) position where there is a variable control
Part 3	Clause A.2.6	Automatic icemakers	Storage bin to remain in place and all associated auxiliaries to be operating as per Clause A.2.6
Part 3	Annex B	Ambient temperatures to be used for the determination of power consumption during stable operation	32°C only (i.e. a test at 16°C is not required for MEPS)

Table 2.3 (continued)

Test Standard	Section or Clause	Aspect	Requirement
Part 3	Annex B	Ambient temperatures to be used for the determination of compartment internal temperature during stable operation	32°C only (i.e. a test at 16°C is not required for MEPS)

Part 3	Annex C	Ambient temperatures to be used for the determination of representative incremental energy for defrost and recovery	32°C only (i.e. a test at 16°C is not required for MEPS)
Part 3	Annex C	Values of *ΔEdf* representative incremental energy for defrost and recovery	Measured value used without adjustment
Part 3	Annex C	Assumed value of *ΔThdf* representative temperature difference for defrost and recovery used for determining the calculated compartment temperature	0 K.h (this is a deemed value, measured value is not used)
Part 3	Annex D	The defrost interval (*tdf*) to be used when determining energy consumption according to the relevant defrost controller type	Elapsed time defrost controllers - measured value as set out in the test standard Part 3, Clause D.2. Compressor run time defrost controllers — calculated value in accordance with the test standard Part 3 Clause D.3. Compliant variable defrost controllers — a deemed defrost interval of 60 h is applied where the controller complies with the test standard Part 3, Clause D.4.2 or Clause D.4.3 Non-compliant variable defrost controllers — measured or determined value in accordance with the test standard Part 3, Clause D.4.4
Part 3	Annex H	Determination of compartment volume	Rated value stated by the supplier

4.4 Calculation of energy consumption for MEPS requirements

Energy consumption in relation to MEPS shall be calculated as follows:

For an ambient test temperature of 32°C only determine the following values:

a) The steady-state power *P*ss for the selected temperature control setting in accordance with the KS IEC 62552-3, Annex B. Ensure that this power value is corrected for the measured ambient temperature in accordance with the KS IEC 62552-3, Equation (15).

b) The representative incremental energy for defrost and recovery *ΔE*df in accordance with the KS IEC 62552-3, Annex C. The number of valid defrost and recovery periods to determine a representative value shall meet the requirements as set out in the KS IEC 62552-3, Clause C.4, Option 1 or Option 2. Any defrost cycle that has been initiated by the test laboratory (forced defrost) shall be omitted when determining a representative incremental energy for defrost and recovery.

NOTE An appliance tested with a dry evaporator or subject to forced defrost will give an artificially low value for incremental energy for defrost and recovery.

The defrost interval *t*df in accordance with the KS IEC 62552-3, Annex D, except for a qualifying variable defrost control, the defrost interval is set to a default value of 60 h.

c) The daily energy consumption at the selected control setting E_{daily} in accordance with the KS IEC 62552-3, Equation (2).
d) The steady-state compartment temperature in each compartment for the selected temperature control setting in accordance with the KS IEC 62552-3, Annex B.

NOTE For MEPS energy determination, the temperature difference during defrost and recovery *ΔThdf* is not taken into account (this is set to a value of zero), so only the measured steady-state temperature is used for single point values and interpolation.

4.5 Calculations for the energy rating label

4.5.1 General

This section sets out the equations and procedures for calculating values of the CEC and the star rating, which appear on an energy rating label.

The process consists of measuring the energy consumption and other relevant characteristics of each unit tested (see Section 2), then calculating the projected annual energy consumption (PAEC) of the unit. The comparative energy consumption (CEC) for the appliance model is determined from the values of PAEC for the units tested to determine the label particulars. The CEC and normalized volume (*V*norm) are then used to calculate the BEC, star rating index and the star rating.

NOTE For example of calculations carried out on a typical set of test results, see Annex B.

4.5.2 Number of tests and processing of data

4.5.2.1 Number of units required

When determining the CEC of a model for labelling, at least one unit of the nominated model shall be tested for energy consumption in accordance with the requirements of Clause 4.2. At the supplier's discretion, energy consumption tests can be performed on multiple units and the results aggregated into a single test report for a representative single unit. Suppliers may choose to run tests on multiple units of the same model and submit a test report for more than one unit.

The energy consumption declared on the energy rating label is based on the samples submitted for registration. All products supplied to the market need to comply with the relevant regulatory requirements.

4.5.2.2 Number of tests per unit

Each unit shall be tested with sufficient test runs to enable a valid value of PAEC to be determined for that unit. This determination shall be documented in a test report containing the test results for all test runs used to derive PAEC. (See Clause 4.2.)

4.5.3 Projected annual energy consumption (PAEC)

5.4.1 PAEC calculation for one appliance

The PAEC of a single refrigerating appliance shall be calculated to represent energy consumption at 22 °C according to Equation 3.1 as follows:

$$PAEC = 259 \times E_{daily32C-label} + 106 \times E_{daily16C-label} + W_{heaters} \times 8.76 + \frac{V_{frozen} \times 0.091 + V_{unfrozen} \times 0.274}{Efficiency_{load}} \quad 3.1$$

where

259 = the prescribed number of days operating at an ambient temperature of 32°C

*E*daily32C-label	=	the daily energy consumption in kWh/day determined at an ambient temperature of 32°C as specified in Clause 4.2
106	=	the prescribed number of days operating at an ambient temperature of 16°C
*E*daily16C-label	=	the daily energy consumption in kWh/day determined at an ambient temperature of 16°C as specified in Clause 4.3
*W*heaters	=	the average power in watts of any ambient controlled anti-condensation heater present in accordance with the test standard Part 3, Annex F (this is a value of 0 where these auxiliaries are not present)
8.76	=	a factor that converts average power in watts to kWh/year
*V*frozen	=	the total volume of all frozen compartments in accordance with the test standard Part 3, Annex H and Table 1 of this Standard in litres
*V*unfrozen	=	the total volume of all unfrozen compartments in accordance with the test standard Part 3, Annex H and Table 1 of this Standard in litres
0.091 and 0.274	=	the deemed user processing load for frozen and unfrozen compartments in kWh/year/litre of volume (equivalent to factors of 0.25 Wh/day/litre and 0.75 Wh/day/litre respectively)
*Efficiency*load-label	=	the load processing efficiency. At the supplier's discretion, one of the following three values shall be used for Efficiencyload-label —

a) the measured value of *Efficiency*load in accordance with the test standard Part 3, Annex G at an ambient temperature of 32°C divided by two plus the measured value of *Efficiency*load in accordance with the test standard Part 3, Annex G at an ambient temperature of 16°C divided by two; or

b) the measured value of *Efficiency*load in accordance with the test standard Part 3, Annex G at an ambient temperature of 32°C only; or

c) the rated compressor COP (W/W) according to ASHRAE rating conditions times a factor of 0.4. Where a variable output compressor is used, the COP shall be determined at the highest speed. The ASHRAE rating conditions for:

i) Low Back Pressure compressors used in Groups 4, 5T, 5B, 5S, 6U, 6C and 7 are: evaporating temperature −23.3°C and a condensing temperature of +54.4°C.

ii) Medium to High Back Pressure compressors used in Groups 2 and 3 are: evaporating temperature −15°C and a condensing temperature of +54.4°C.

iii) Medium to High Back Pressure compressors used in Group 1 are: evaporating temperature −10°C and a condensing temperature of +54.4°C.

Where the load processing efficiency is measured, the measured value shall be reported for each ambient temperature, as applicable.

Where a value is based on the compressor rated value, the compressor brand, model, cooling capacity (W), power consumption (W) and COP (W/W) at rated output under ASHRAE conditions shall be reported. The compressor technical data sheet should be supplied.

NOTE 1 The highest value for load processing efficiency and lowest PAEC will be obtained from the average of measured values at 16°C and 32°C. See Table 1 for the classification of unfrozen compartments and frozen compartments.

NOTE 2 According to Kenya metrological data temperature is 28 °C and this ambient is assumed in this Standard when determining the PAEC. The IEC has published a technical report that outlines a methodology that is used to incorporate this target ambient in Equation 3.1 (IEC TR 63061).

Where a refrigerating appliance contains a declared automatic control that could not be defeated for the test, or where a circumvention device is detected, the values for *E*daily32C-label and *E*daily16C-label are adjusted in accordance with Equation 2.1 prior to the calculation of PAEC.

Where only a single unit is tested, the value of PAEC determined in accordance with Equation 3.1 is deemed to be *PAEC*av.

5.4.2 PAEC calculation for multiple units

If more than a single unit is tested in accordance with Clause 5.2.1, the separate values of PAEC for each unit determined in accordance with Equation 3.1 shall be averaged to give *PAEC*av.

5.5 Comparative energy consumption (CEC)

The CEC for a model shall not be less than the *PAEC*av. The CEC shall be an integer with units of kWh/y. The CEC declared on the energy rating label should be representative of the average production energy consumption.

The declared CEC may be greater than the *PAEC*av to allow for variations such as manufacturing tolerances.

5.6 Normalized volume (*V*norm)

5.6.1 Volume normalization factor

The normalized volume is a value that is used to determine the appliance star rating and uses the compartment size and temperature of operation at an ambient temperature of 28 °C to determine a comparative relative overall volume for each appliance. Normalized volume is used in the calculation of the BEC.

To determine the normalized volume, the volume normalization factor for each compartment (*Nf*) shall be determined firstly from Table 3.

Table 3 — Volume normalization factors for specified types of compartments

Compartment type	Volume normalization factor (N_f)
Pantry	0.456
Cellar, Wine Storage	0.666
Fresh food	1.000
Chill	1.083
Ice-making (zero-star)	1.166
Ice-making (one-star)	1416
Short-term frozen food storage (two-star)	1.666
Freezer (three-star and four-star)	1.916
NOTE The volume normalization factor assumes an average ambient temperature of 28°C to calculate a relative heat gain factor for each compartment type (relative to fresh food) at its target temperature for energy consumption.	

5.6.2 Variable temperature compartments

The volume normalization factor to be applied to any variable temperature compartment shall be determined by the compartment type that is applicable when it is set to the function selected for continuous operation during the determination of energy consumption. The primary function selected for energy labelling determination is the function that results in the highest energy consumption (usually the coldest function). Additional functions can be selected as set out in Clause 4.10 (see Table 4).

Table 4 — Group configuration adjusters for determination of normalized volume

Group	Representative layout	Compartment temperature (normalization factor)	Group configuration adjuster (*Jnorm*)
1, 2 and 3	90 % Fresh food 10 % one-star	+4.0 °C (1.0) −6.0 °C (1.416)	1.0417
4, 5T, 5B and 5S	70 % Fresh food 30 % Freezer	+4.0 °C (1.0) -18.0 °C (1.916)	1.2748
6C, 6U and 7	100 % Freezer	-18.0 °C 1.916)	1.916

The normalized volume of an appliance (for determination of energy labelling) is then given by the following equation:

$$V_{norm} = \frac{\sum_{i=1}^{n}\left(V_i \times N_{fi}\right)}{J_{norm}} \qquad 3.2$$

where

*V*norm = the calculated normalized volume for the appliance in litres;

*V*i = the volume for compartment*i* (from I to *n*compartments) in litres determined in accordance with the test standard Part 3, Annex H;

*N*fi = the volume normalization factor for compartment*i* (from I to *n*compartments) from Table 3; and

*J*norm = the Group configuration adjuster from Table 4 for the relevant Group.

NOTE for most appliance layouts, the normalized volume should be similar to the total volume.

5.7 Base energy consumption (BEC)

5.7.1 General

The base energy consumption for an appliance model shall be calculated using the following equation:

$$BEC = C_f + C_v \times V_{norm}^{0.67}\left(\mathrm{kWh/y}\right) \qquad 3.3$$

where

*C*f = fixed allowance factor for its Group in kilowatt hours per year;

*C*v = variable allowance factor for its Group in kilowatt hours per litre per year; and

*V*norm = normalized volume for the model in litres in accordance with Clause 5.6.

The BEC is not rounded.

Factors C_f and C_v shall be in accordance with Table 5.

5.7.2 Calculation of normalized volume

To determine normalized volume for a refrigerating appliance, the relevant Group configuration adjuster is selected. These are based on prescribed representative layouts for each Group.

Table 5 — Fixed and variable allowance factors

Appliance Group	Fixed allowance factor (*Cf*) kWh/y	Variable allowance factor (*Cv*) kWh/L/y
1, 2 and 3	90	4.5
4, 5T, 5B and 5S	55	10.0
6C, 6U and 7	120	7.5

5.8 Star rating index (SRI)

To determine the star rating index of a refrigerating appliance, an energy reduction factor (ERF) of 0.18 shall be used for all Groups.

The star rating index shall then be given by the following equation:

$$Star\ rating\ index = 1 + \left[\frac{\log_e\left(\frac{CEC}{BEC}\right)}{\log_e(1-ERF)}\right] \qquad 3.4$$

where

CEC = comparative energy consumption for the model in kWh/y (see Clause 5.5

BEC = base energy consumption for the model in kWh/y (see Clause 5.7)

ERF = energy reduction factor, which equals 0.18 for all appliance Groups

NOTE 1 Where the CEC of a model is equal to its base energy consumption (BEC), its star rating index is 1.00.

NOTE 2 The energy reduction factor (ERF) is the proportion by which the CEC of a model would have to be reduced to increase its star rating index by 1.00. For all Groups this represents 18 % reduction in energy consumption per additional star earned.

5.9 Star rating

The star rating shall be obtained from Table 6 using the star rating index (SRI) determined according to Clause 5.8

NOTE 1 See Annex C for a method to estimate the CEC required for any particular target star rating.

NOTE 2 For an example of calculations carried out on a typical set of test results, see Annex B.

Table 6 — Determination of star rating

SRI	Star rating
$SRI < 2.0$	1
$2.0 \geq SRI < 3.0$	2
$3.0 \geq SRI < 4.5$	3
$4.5 \geq SRI < 6.0$	4
$6.0 \geq SRI$	5

5.9.1 Energy labelling and MEPS for products with variable temperature compartments and multiple Groups

Where a refrigerating appliance contains one or more variable temperature compartments, the compartment function selected for each variable temperature compartment for the determination of energy consumption shall be that which results in the highest energy consumption for the refrigerating appliance. This value shall be used to determine the primary comparative energy consumption and the star rating for the appliance shown on the energy rating label.

However, where one or more variable temperature compartments can be operated in a way that can change the Group, the manufacturer may elect to claim the energy consumption and star rating for each such Group in addition to the primary comparative energy consumption.

Any claimed additional Groups for a model which are documented in the product literature shall be separately registered for energy labelling and MEPS for the model. Each Group registered will be individually listed on the energy rating website. Each additional Group registered shall comply with the relevant MEPS requirements for the Group registered.

The product needs to be capable of meeting the pull down test and the storage test requirements (see Clauses 5.3 and 5.4) for all claimed Groups. However, only a single set of test reports for the Group that has the highest energy consumption is required to demonstrate compliance with the storage test or pull down test requirements for the purposes of energy labelling and MEPS registration.

The details on the energy rating label displayed on the product shall show the registered details for the primary Group nominated.

NOTE A separate application for each Group claimed needs to be submitted for the model.

6 Performance criteria

6.1 General

The criteria set out in Clauses 6.1 to 6.11 shall be met by each unit tested, for the refrigerating appliance model to comply with energy labelling and MEPS requirements.

6.2 Total volume

The volume of each compartment and total volume of the appliance shall be measured in accordance with Annex H of the KS IEC 62552-3.

6.3 Pull-down

The refrigerating appliance shall be tested in accordance with Annex A of the test standard Part 2. The test shall be conducted in an ambient temperature of 43°C, irrespective of the climate class of the product.

All refrigerating appliances shall achieve a pull down time of 6 h or less in all relevant compartments.

While all units within a model are required to meet the pull down requirements, a test report for at least one unit is required to confirm this for the purposes of energy labelling and MEPS registration.

6.4 Storage test

The refrigerating appliance shall meet the requirements set out in Section 6 of the test standard Part 2 when tested at ambient temperatures + 10 °C and + 32 °C, irrespective of the claimed climate class for the refrigerating appliance.

While all units within a model are required to meet the storage test requirements in the test standard Part 2, a test report for at least one unit is required to confirm this for the purposes of energy labelling and MEPS registration.

6.5 Adjusted volume (V_{adj})

6.5.1 Volume adjustment factors

The adjusted volume is a value that is determined for the purposes of MEPS assessment and uses the relative temperature of operation for each compartment at an ambient temperature of 32°C to weight the volume of each compartment.

To determine the adjusted volume of each compartment to assess compliance with MEPS, the volume adjustment factor for each compartment (*K*s) shall be determined from Table 7.

Table 7 — Volume adjustment factors for specified types of compartments

Compartment type	Volume adjustment factor (*K*s)
Pantry	0.5357
Cellar	0.7143
Fresh food	1.0000
Chill	1.0714
Ice-making (zero-star)	1.1429
Ice-making (one star)	1.3571
Short-term frozen food storage (two-star)	1.5714
Freezer (three-star and four-star)	1.7857

6.5.2 Variable temperature compartments

The volume adjustment factor to be applied to any variable temperature compartment shall be determined by the compartment type that is applicable when it is set to the function selected for continuous operation during the determination of energy consumption. The function selected for MEPS determination shall be the function that results in the highest energy consumption (usually the coldest function).

6.5.3 Determination of total adjusted volume

The adjusted volume of a compartment is given by the following equation:

$$V_{adj} = V_i \times K_{si}(litres) \qquad 4.1$$

where

*V*i = rated volume of compartment*i* in litres determined in accordance with the test standard Part 3, Annex H; and

Ksi = volume adjustment factor for the compartment type for compartmenti as specified in Table 7.

The total adjusted volume *V***adj-tot** is the sum of the adjusted volume values for all compartments.

6.6 Projected MEPS energy consumption (PMEC)

Determine the projected MEPS energy consumption (PMEC) for each unit tested as follows:

365	=	the prescribed number of days operating at an ambient temperature of 32 °C
*E*daily32C-MEPS	=	the daily energy consumption in kWh/day determined at an ambient temperature of 32°C as specified in Clause 4.3

*W*heaters-	=	the average power in watts of any ambient controlled anti-condensation heater present in accordance with the test standard Part 3
8.76	=	a factor that converts average power in Watts to kWh/year

$$PMEC = 365 \times Edaily_{32} + 8.76 \times W_{heater} \quad 4.2$$

where

Where a refrigerating appliance contains a declared automatic control that could not be defeated for the test, or where a circumvention device is detected, the value for *E*daily32C-MEPS is adjusted in accordance with Equation 2.1 prior to the calculation of PMEC

.

6.7 MEPS

6.7.1 General

For all refrigerating appliances, the MEPS cut-off levels are defined in Clause 4.7.2. For compact refrigerating appliances only (with a footprint that is less than 0.36m2), the supplier may elect to use the MEPS levels defined in Clause 4.7.3 as specified.

6.7.2 MEPS — All Groups

From the date set out in the relevant legislation, the PMEC for each unit when determined in accordance with Clause 4.6 shall not exceed the MEPS cut-off level, which is determined as follows:

MEPS cut-off level = $K_f + K_V \times V_{adjtot} + A_{wi} + A_{bi}\left(kWh/_y\right)$ 4.3

where

*K*f = fixed allowance factor for its appliance Group (see Table 8) (kWh/year);

*K*v = variable allowance factor (see Table 8) (kWh/y/L);

*V*adj tot = total adjusted volume (see Clause 4.5) (litres);

Awi = an allowance of 52 kWh/y which applies where an appliance has a “through-the-door ice dispenser”, that is, it has an automatic ice-maker coupled with a device for delivery on demand of ice externally through a door (without opening the door). This allowance also applies if the through-the-door dispenser also dispenses chilled water. A chilled water dispenser alone is not eligible for this allowance. Multiple “through-the-door ice dispensers” are only eligible for one allowance; and

Abi = an allowance of 40 kWh/y for all Groups except Group 5S, which has an allowance of 100 kWh/year, that applies where an appliance complies with the definition of a built in product as set out in Clause 1.6.3.

NOTE 1 An example of a calculation of a MEPS cut off level is included in Annex B.

NOTE 2 If any of the individual test results are close to the MEPS limit or if there is significant variation in the sample results, manufacturers should only proceed with caution after additional testing indicates that they are confident that all production units are likely to pass the MEPS requirement.

6.7.3 MEPS Option — Compact refrigerating appliances

For a model that complies with the definition of a compact refrigerating appliance as set out in Clause 1.6.6, the supplier may elect to use the Compact MEPS level below instead of the MEPS level defined in Clause 4.7.2. Group 6C are not eligible for the Compact MEPS level, irrespective of the footprint area. In the

case where the Compact MEPS level is used, no allowances for a “through-the-door ice dispenser” or for built in products can be included. If a supplier wishes to claim these feature allowances, the MEPS levels for standard products in Clause 4.7.2 shall be used.

From the date set out in the relevant legislation, a compact refrigerating appliance the PMEC for each unit when determined in accordance with Clause 4.6 shall not exceed the Compact MEPS cut-off level, which is determined as follows:

Compact MEPS cut-off level =

$$= K_f + \frac{0.36}{W \times D} \times \left(K_v \times V_{adj\text{-}tot}\right)\left(\text{kWh/y}\right) \quad 4.4$$

where

*K*f = fixed allowance factor for its appliance Group (see Table 8) (kWh/year);
*K*v = variable allowance factor (see Table 8) (kWh/y/L);
*V*adj-tot = total adjusted volume (see Clause 4.5) (litres);
W = is the external width of the refrigerating appliance in metres; and
D = is the external depth of the refrigerating appliance in metres.

NOTE A refrigerating appliance has to have a base area of less than 0.36m^2 (W × D) to qualify as a compact product under this Standard.

6.7.4 Fixed and variable allowance factors (K_f and K_v)

The fixed and variable allowance factors used in Equation 4.3 or Equation 4.4 (as applicable) are determined from the Group as specified in Table 8.

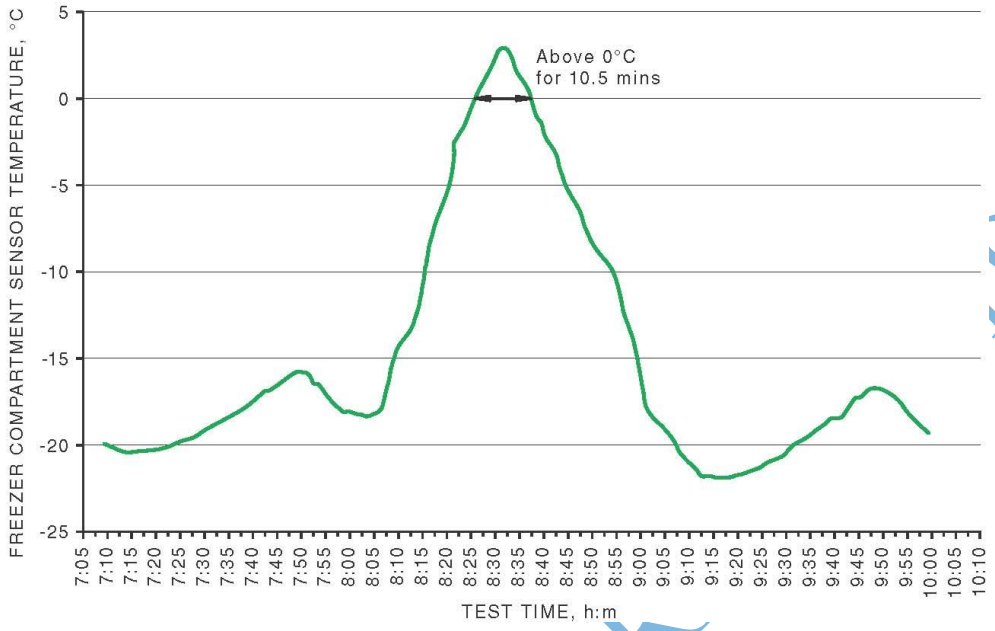
Table 8 — MEPS cut-off level factors

Appliance Group	Fixed Allowance Factor(Kf) kWh/y	Variable Allowance Factor(Kv) kWh/y/l
1	219.3	0.2717
2	181.4	0.2247
3	270.9	0.3397
4	247.3	0.3101
5T	256.9	0.3133
5B	348.1	0.3431
5S	327.4	0.3304
6C	182.2	0.4375
6U	252.0	0.2559
7	296.9	0.3960

6.8 Temperature excursions during defrost and recovery

The intent of this clause is to ensure that the refrigerating appliance limits the duration and extent of any defrost temperature excursion to ensure that food safety and quality is maintained during normal operation.
Where a product has a defrost control cycle, during the defrosting operation in an energy consumption test, the maximum temperature of any freezer compartment air temperature sensor shall not exceed 0°C for a period of more than 20 min. This assessment should be undertaken for each freezer compartment temperature sensor for each defrost. See Figure 1 and Figure 2 for examples. For verification tests, the test run selected

shall be valid for a single point energy determination where the freezer compartment average temperature is at or below the target temperature.



NOTE This figure is a schematic representation of requirement as defined in Clause 4.8 and it passes the performance requirements of Clause 6.8.

Figure 1 — Example of meeting the requirement defined in Clause 6.8

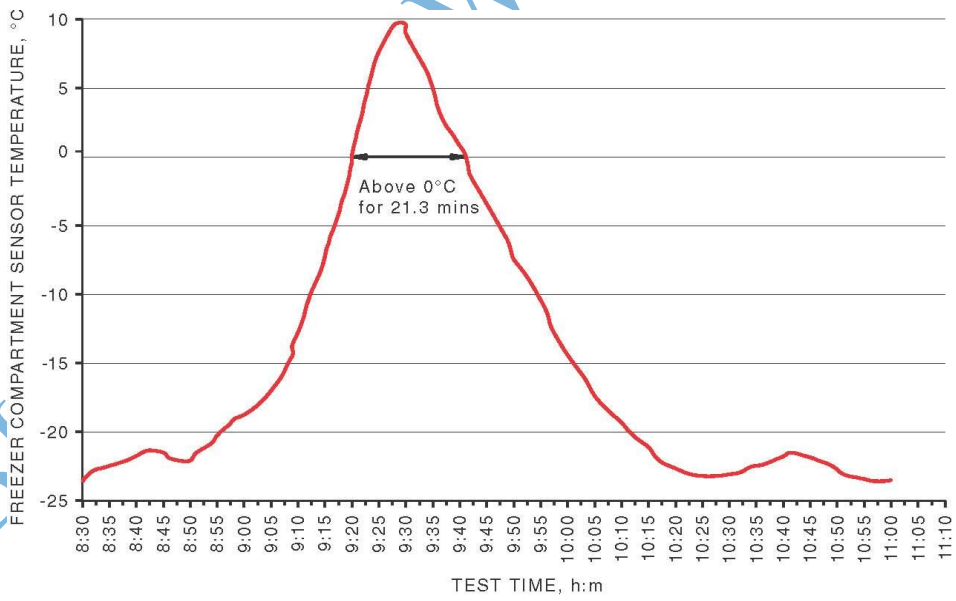


Figure 2 — Example of failing the requirement defined in Clause 6.8

6.9 Requirements regarding disposal of moisture

Any automatic defrost system shall meet all ongoing defrosting needs, without any user intervention, as may occur under a wide range of normal use conditions.

Under any ambient condition or test control setting specified in this Standard, any excess melting or condensed water from an evaporator or other refrigerated surface of the appliance shall be collected, evaporated or otherwise disposed without the need for user intervention.

6.10 Declared automatic controls

When a refrigerating appliance contains a declared automatic control, it shall be declared in the product registration. Information on the purpose and operation of the control shall be provided by the supplier in the product registration. When a declared automatic control is present, the refrigerating appliance shall meet all the relevant performance requirements of Section 6, with and without the declared automatic control operating.

Declared automatic controls are to be set up and configured to operate during energy tests as they would under normal use conditions. Information on whether these controls operate during normal use, whether they are likely to operate during energy tests (in the absence of normal use activities) and how to correctly configure these controls for energy testing (in order to minimize the impact on the energy measurement), shall be provided by the supplier.

NOTE A declared automatic control could include, for example, a "holiday" mode that defers defrosting when there are no door openings for an extended period. This type of control is permitted but has to be defeated during energy tests because it does not operate during normal use.

Any declared automatic control that may activate during an energy test shall be noted in the product registration. The test laboratory may undertake appropriate (minimal) actions, where applicable, to ensure that such controls do not operate as per normal use during an energy test. Where a low ambient temperature compensation heater is present, it shall be noted in the product registration.

Declared automatic controls are generally not treated as circumvention devices where information about their purpose and operation is included in the registration.

The following controls and devices are not included in the scope of declared automatic controls —

a) automatic controls that are required for the maintenance of satisfactory food preservation temperatures within unfrozen compartments in a refrigerator-freezer when operating at low ambient temperatures (low ambient temperature compensation heaters); or

b) compliant variable defrost controls that comply with the requirements of the KS IEC 62552-3, Annex D; or

c) ambient controlled anti-condensation heaters (within the scope of the KS IEC 62552-3, Annex F).

Specific requirements regarding ambient controlled anti-condensation heaters are set out in the KS IEC 62552-3, Annex F. Low ambient temperature compensation heaters are allowed to operate normally for energy tests. Additional controls that are outside the scope of declared automatic controls may be added by amendment to this clause.

6.11 Circumvention devices

6.11.1 General

Any refrigerating appliance that is found to contain a circumvention device which reduces energy consumption shall have the additional energy penalty quantified as specified in Section 4.1 and this shall be included in the appliance's measured energy consumption for verification tests.

A refrigerating appliance may contain a declared automatic control that alters the energy consumption during normal use or under other specific conditions. Declared automatic controls are controls that could be interpreted as circumvention devices if they are not declared by the supplier but are subsequently detected. Suppliers are required to declare these in the product registration, including information on how they work, the basis for the operation and how to ensure that they do not operate during energy tests as set out in Clause 4.10.

6.11.2 Circumvention detection during a check test

Where the presence of a circumvention device is suspected during a check test, the test laboratory should report the suspected circumvention to the relevant regulator, who will determine appropriate action. Regulators may request test laboratories to undertake investigative tests to identify possible circumvention devices.

7 Marking requirements

7.1 General

Refrigerating appliances markings shall comply with Clauses 5.2 to 5.7. Refer to KS IEC 60335.1 for requirements on legible and durable marking.

7.2 Model details

The model, serial number and Group shall be durably and legibly marked on the appliance.
Where an appliance can be configured to operate as more than one Group and this option is claimed, then the Group and the refrigerating appliance designation for each configuration shall be marked.

7.3 Model identification

Any model identification, either on the appliance or in the product literature, and which may be interpreted as indicating a rated total volume in litres shall not be numerically greater than the rated volume.

7.4 Volume

The total volume and the volume and type of each compartment shall be durably and legibly marked on the appliance in litres.

7.5 Intended use markings

The marking on the appliance and all other indications of intended use, including compartment type and refrigerating appliance designation, appearing either on the appliance or in the product literature shall not be inconsistent with the classification of the appliance in accordance with Clauses 1.6.14 and 1.6.19.

7.6 Marking location

Markings of brand, model, Group (see Clause 5.2) and rated volumes (see Clause 5.4) shall be visible when the appliance is installed as in normal use.

7.7 Date of manufacture

The date of manufacture of each appliance shall be able to be determined from information legibly and durably marked on the appliance. The date of manufacture may be non-encrypted, encrypted or able to be determined from a serial number or other markings on the appliance and shall be visible when the appliance is in its position of normal use. Information on how to determine the date of manufacture shall be provided in the registration

8 Printing and placement of energy rating labels

8.1 Placement

At the time of supply, the energy rating label shall be

a) clearly visible; and
b) affixed to the packaging and product

The energy rating label shall be adhered to the upper portion of each appliance; either

a) for an upright appliance, on the outside of the door; or
b) for an appliance of chest configuration, on the lid.

In the case of a chest-configured appliance where the lid is of the lift-off type (i.e. not attached by a hinge or similar), or if the lid surface is unsuitable for attachment of a label, the label shall be adhered in a conspicuous location on the front of the appliance.

8.2 Material and shape

The label shall be designed as set out in Clause 6.5.

The label shall be a self-adhesive label.

All labels shall be suitably affixed to the product to ensure that they remain in place and visible while on display at the point of sale.

NOTE Where labels are removed from products which are on display at the point of sale, the retailer may be subject to fines under energy labelling regulations.

8.3 Label specifications

Refer to Annex D.

Annex A
(informative)

Example determinations of appliance Group

This Annex sets out a number of hypothetical refrigerating appliances and the applicable Group for each. Details of the calculations are summarized in Table A.1.

EXAMPLE 1

Unfrozen compartments:	fresh food — 330 l, cellar — 80 l
Unfrozen defrost system:	cyclic
Frozen compartments:	none
Therefore:	Refrigerating appliance designation is refrigerator
Group = 1	

EXAMPLE 2

Unfrozen compartments: fresh food — 100 l, cellar — 140 l

Unfrozen defrost system: cyclic

Frozen compartments: none

Therefore: Refrigerating appliance designation is cooled appliance (fresh food is less than 50 % of unfrozen volume — see Clause 1.6.19(b)(i) and (ii) as appropriate, and Clause 1.6.19(d))

Group = 1

EXAMPLE 3

Unfrozen compartments: fresh food — 380 l

Unfrozen defrost system: automatic but not cyclic

Frozen compartments: none

Therefore: Refrigerating appliance designation is refrigerator

Group = 1

EXAMPLE 4

Unfrozen compartments: fresh food — 260 l

Unfrozen defrost system: manual

Frozen compartments: sub-compartment — 30 l ice-making (one-star)

Frozen defrost system: manual

EXAMPLE 5

Unfrozen compartments: fresh food — 260 l, cellar — 60 l

Unfrozen defrost system: manual

Frozen compartments: sub-compartment — 50 l short-term frozen food (two-star)

Frozen defrost system: manual

Therefore: Refrigerating appliance designation is refrigerator

Group = 3

EXAMPLE 6

Unfrozen compartments: cellar — 200 l

Unfrozen defrost system: manual

Frozen compartments: sub-compartment — 40 l; short-term frozen food (two-star)

Frozen defrost system: manual

Therefore: Refrigerating appliance designation is cooled appliance (no fresh food)

Group = 3

EXAMPLE 7

Unfrozen compartments: fresh food — 350 l

Unfrozen defrost system: cyclic

Frozen compartments: freezer — 90 l

Frozen defrost system: manual

Therefore: Refrigerating appliance designation is refrigerator/freezer

Group = 4

EXAMPLE 8

Unfrozen compartments: fresh food — 350 l, cellar — 80 l

Unfrozen defrost system: cyclic

Frozen compartments: freezer — 140 l; short-term frozen food (two-star) — 80 l

Frozen defrost system: manual

Configuration: side by side

Therefore: Refrigerating appliance designation is cooled appliance [less than 80 % of frozen compartment volume is freezer and the volume of other frozen compartments exceeds 30 l – see Clause 1.6.19(b)(i) and (ii) as appropriate and Clause 1.6.19(d)]

Group = 4 (note that side by side configuration does not affect Group in this case)

EXAMPLE 9

Unfrozen compartments: fresh food — 200 l

Unfrozen defrost system: manual

Frozen compartments: freezer sub-compartment — 80 l; ice-making sub-compartment — 20 l

Frozen defrost system: manual

Therefore: Refrigerating appliance designation is refrigerator/freezer [80 % of frozen compartment volume is freezer — see Clause 1.6.19(b)(i) and (ii) as appropriate]

Group = 3 (as unfrozen compartment is not automatic defrost)

EXAMPLE 10

Unfrozen compartments: fresh food — 400 l

Unfrozen defrost system: cyclic

Frozen compartments: freezer — 150 l

Frozen defrost system: automatic

Configuration: upright: freezer compartment is at the bottom

Therefore: Refrigerating appliance designation is refrigerator/freezer

Group = 5B

EXAMPLE 11

Unfrozen compartments: fresh food — 420 l

Unfrozen defrost system: automatic

Frozen compartments: freezer — 160 l

Frozen defrost system: automatic

Configuration: upright: freezer compartment is not at the bottom

Therefore: Refrigerating appliance designation is refrigerator/freezer

Group = 5T

EXAMPLE 12

Unfrozen compartments: fresh food — 420 l

Unfrozen defrost system: automatic

Frozen compartments: freezer — 210 l

Frozen defrost system: automatic

Configuration: side by side
Therefore: Refrigerating appliance designation is refrigerator/freezer

Group = 5S

EXAMPLE 13
Unfrozen compartments: fresh food — 420 l

Unfrozen defrost system: automatic

Frozen compartments: freezer — 160 l; short-term frozen food (two-star) — 50 l

Frozen defrost system: automatic

Configuration: side by side
Therefore: Refrigerating appliance designation is cooled appliance [less than 80 % of frozen compartment volume is freezer and the volume of other frozen compartments exceeds 30 l — see Clause 1.6.19(b)(i) and (ii) as appropriate, Clause 1.6.19(d) and NOTE 4 of Table 1]

Group = 5T

EXAMPLE 14
Unfrozen compartments: chill compartment — 60 l; cellar compartment — 90 l; fresh food — 380 l

Unfrozen defrost system: automatic

Frozen compartments: freezer 1 — 100 l; freezer 2 — 80 l

Frozen defrost system: automatic

Configuration: upright — cellar and chill compartments are at the top, fresh food compartment in the middle, freezer compartments at the bottom

Therefore: Refrigerating appliance designation is refrigerator/freezer

Group = 5B

EXAMPLE 15
Unfrozen compartments: chill compartment — 50 l; cellar compartment — 80 l; fresh food — 375 l

Unfrozen defrost system: automatic

Frozen compartments: freezer — 130 l; two-star — 30 l (ice-making)

Frozen defrost system: automatic

Configuration: upright — Layer 1 (top): fresh food, Layer 2: two-star and chill. Layer 3: freezer, Layer 4: cellar

Therefore: Refrigerating appliance designation is refrigerator/freezer (more than than 80 % of frozen compartment volume is freezer, other frozen do not exceed 30 l)

Group = 5T (freezer is not at the bottom, not side by side)

EXAMPLE 16

Unfrozen compartments: none

Frozen compartments: freezer — 250 l

Frozen defrost system: automatic

Configuration: chest

Therefore: Refrigerating appliance designation is freezer

Group = 6C (defrost system does not affect Group for chest type)

EXAMPLE 17

Unfrozen compartments: none

Frozen compartments: freezer — 250 l

Frozen defrost system: manual

Configuration: chest

Therefore: Refrigerating appliance designation is freezer

Group = 6C

EXAMPLE 18

Unfrozen compartments: none

Frozen compartments: freezer — 250 l; short-term frozen food (two-star) — 60 l

Frozen defrost system: automatic

Configuration: upright

Therefore: Refrigerating appliance designation is cooled appliance [more than 80 % frozen compartment volume is freezer but the volume of other frozen compartments exceeds 30 l — see Clause 1.6.19(b)(i) and (ii) as appropriate]

Group = 7

EXAMPLE 19

Unfrozen compartments: none

Frozen compartments: freezer — 250 l; short-term frozen food (two-star) — 70 l

Frozen defrost system: manual

Configuration: upright

Therefore: Refrigerating appliance designation is cooled appliance [as less than 80 % of frozen compartment volume is freezer — see Clause 1.6.19(b)(i) and (ii) as appropriate and Clause 1.6.19(d)]

Group = 6U

Annex B
(informative)

Example of energy efficiency calculations

B.1 General

This Annex assesses the energy consumption and performance of a hypothetical refrigerating appliance against the requirements of this Standard. Using the appliance details and test results provided, calculations are performed to determine the energy rating label details and to assess MEPS compliance. Calculation of the following parameters is illustrated:

a) Normalized volume.
b) Adjusted volume.
c) Daily energy consumption for energy labelling.
d) Daily energy consumption for MEPS.
e) Projected Annual Energy Consumption (PAEC).
f) Comparative Energy Consumption (CEC).
g) Base energy consumption (BEC).
h) Star Rating Index (SRI).
i) Star rating.
j) Projected MEPS Energy Consumption (PMEC).
k) The MEPS cut-off level.
l) Whether the model complies with MEPS requirements.

B.2 Classification of the appliance

Using the information given and the relevant clauses in this Standard and the test standard, the classification of the appliance is as follows:

a) Compartment type — details for compartments are shown in Figure B.1.
b) Appliance configuration — upright (see Clause 1.6.10).
c) Refrigerating appliance designation — refrigerator/freezer (see Clause 1.6.19).

Appliance Group — 5T (see Table 1).
Defrost type: Automatic (all compartments).
Defrost controller type — variable.

Dimensions in millimetres

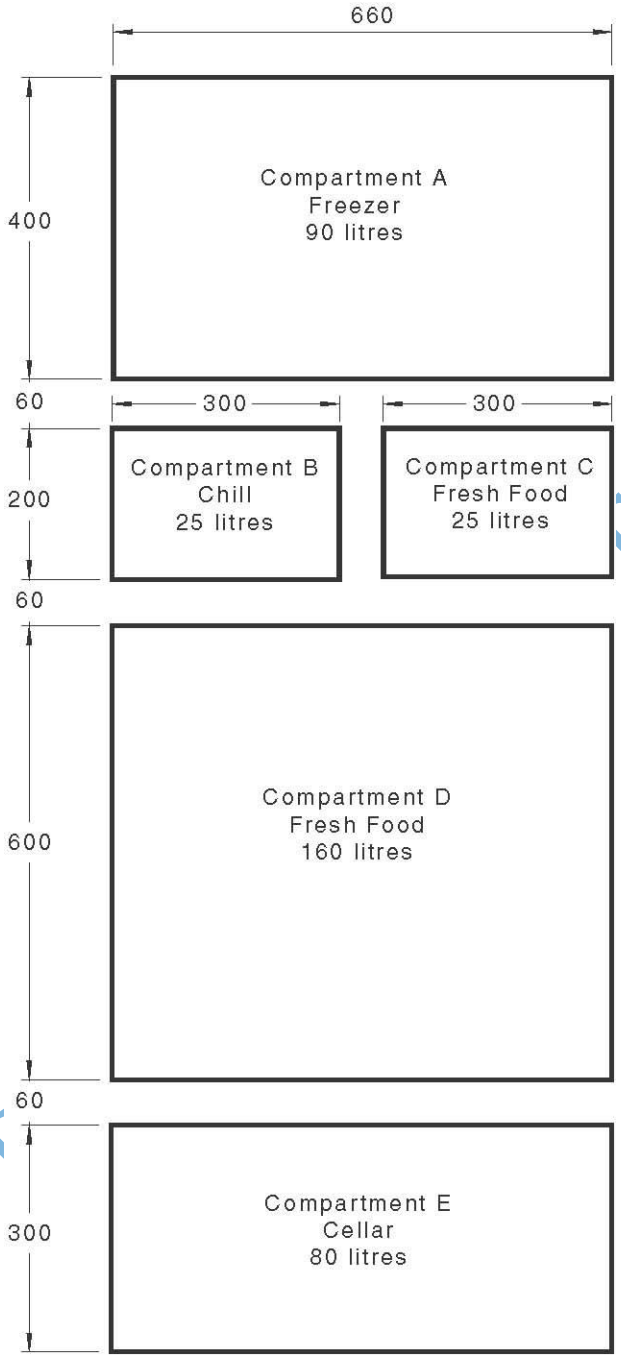


Figure B.1 — Layout and volume by compartment type of the example appliance

B.3 Appliance details

B.3.1 General

The appliance is a 380 l frost-free unit with a variable defrost control. The rated volume in accordance with the KS IEC 62552-3, the location and type of each compartment are shown in Figure B.1. The appliance does not have a through-the-door ice dispenser. However, the appliance does have an ambient controlled anti-condensation heater.

B.3.2 Normalized volume and adjusted volume

The volume for each compartment and the relevant adjustment factors are set out in Table B.1.

The normalized volume is given by Equation B.3.2 (1) as follows:

$$V_{\text{norm}} = \frac{\sum_{i=1}^{n} V_{\text{i}} \times N_{\text{fi}}}{J_{\text{norm}}} \quad \text{B.1}$$

=

$$\frac{457.235}{1.367} = 334.481 \text{ litres}$$

The adjusted volume for each compartment *i* is given by Equation B.3.2 (2) as follows:

***V*adj** = *V*i × *K*si (litres)B.2

The sum of the adjusted volume for each compartment is 429.642 l as shown in Table B.1.
The total volume of frozen compartments, as set out in Table B.1, is 90 l, while the total volume of **unfrozen compartments is 290 l.**

B.3.3 Other declared values

The unit has a variable defrost system. The longest and shortest possible defrost intervals in an ambient temperature of 32°C have been declared by the manufacturer as 75 h and 5.5 h respectively.

The appliance has an ambient controlled anti-condensation heater. The declared heater power map for the defined temperature and humidity bins in the KS IEC 62552-3, Annex F are set out in Table B.2.

Table B.2 — Ambient controlled anti-condensation heater: Declared power map

Relative Humidity bin	Power W at 16 °C	Power W at 22 °C	Power W at 32 °C
0 % – 10 %	0	1	3
10 % – 20 %	0	1	3
20 % – 30 %	1	2	4
30 % – 40 %	1	2	4
40 % – 50 %	2	3	5
50 % – 60 %	2	4	6
60 % – 70 %	3	5	7
70 % – 80 %	4	6	8
80 % – 90 %	5	7	9
90 % – 100 %	6	8	10

The appliance does not have any manually switched anti-condensation heaters. The appliance does not have an automatic ice maker or water dispenser. The appliance is not built in and does not have a compact footprint.

B.4 Energy data measured for the appliance

Energy data measured in accordance with the KS IEC 62552-3 is summarized in Table B.3 and Table B.4.

Note that the KS IEC 62552-3, Annex I has detailed examples on the calculation of daily energy consumption and the use of interpolation across a range of different cases.

Table B.3 — Measured steady-state power results at 16°C

Test Point	Point 1	Point 2	Point 3	Target Temperature
Compartment A °C	−18.8	−17.1	−19.8	−18
Compartment B °C	−2.1	−0.1	−0.7	0
Compartment C °C	0.7	3.3	2.3	4
Compartment D °C	1.2	5.3	4.3	4
Compartment E °C	8.6	11.2	9.3	12
Steady-state power W *Pss*	17.6	15.6	17.2	
NOTE Measured values for steady-state power *Pss1* or *Pss2* as specified in the test standard Part 3 are corrected back to the nominal ambient test temperature as set out in the test standard Part 3, Equation (15) to give values for *P*SS as shown.				

Table B.4 — Measured steady-state power results at 32 °C

Test Point	Point 1	Point 2	Point 3	Target Temperature
Compartment A °C	−20.7	−17.5	−16.0	−18
Compartment B °C	−2.1	−0.1	−0.7	0
Compartment C °C	0.7	3.3	2.3	4
Compartment D °C	6.5	0.8	7.1	4
Compartment E °C	8.6	11.2	9.3	12
Steady-state power W *Pss*	39.0	36.8	31.7	
NOTE Measured values for steady-state power *Pss1* or *Pss2* as specified in the test standard Part 3 are corrected back to the nominal ambient test temperature as set out in the test standard Part 3, Equation (15) to give values for *P*SS shown.				

During energy tests, the following load processing efficiency results were measured in accordance with the KS IEC 62552-3, Annex G, Clause G.5.4, Equation (52) as follows:

Load processing efficiency at a test temperature of 16°C: 1.638 (dimensionless, Wh/Wh)
Load processing efficiency at a test temperature of 32°C: 1.350 (dimensionless, Wh/Wh)

Defrost events did not occur during the load processing efficiency test, so no correction to the measured values in accordance with Equation 2.2 is required.
During test measurements, the representative energy and temperature change for defrost and recovery were determined as set out in Table B.5.

Table B.5 — Measured defrost characteristics

Test Point	Ambient 16 °C	Ambient 32 °C

Comp A *ΔThdf-A* K.h	4.6	5.3
Comp B *ΔThdf-B* K.h	0.1	0.2
Comp C *ΔThdf-C* K.h	0.2	0.5
Comp D *ΔThdf-D* K.h	1.1	0.9
Comp E *ΔThdf-E* K.h	0.5	0.8
Representative incremental energy for defrost and recovery *ΔEdf* Wh (measured)	105.6	112.3

B.5 Calculation of key energy parameters

B.5.1 General

Prior to the calculation of energy rating label values and assessment of MEPS compliance, it is necessary to calculate several key parameters.

B.5.2 Defrosting parameters

The KS IEC 62552-3, Annex D sets out the calculation of defrost interval for different controller types. For variable controllers, the default defrost interval is given by the KS IEC 62552-3, Equation (27) as follows:

$$t_{\text{df-32}} = \frac{t_{\text{d-max}} \times t_{\text{d-min}}}{\left[0.2 \times (t_{\text{d-max}} - t_{\text{d-min}}) + t_{\text{d-min}}\right]} \qquad \text{B.3}$$

For this appliance, the default defrost interval is given by:

$$t_{\text{df-32}} = \frac{75 \times 5.5}{\left[0.2 \times (75 - 5.5) + 5.5\right]} = 21.263 \text{ hours} \qquad \text{B.4}$$

This value does not exceed 24 h as specified in Clause 5.2.2 (f), so it is acceptable for energy labelling.

As specified in the KS IEC 62552-3, Clause D.4.2, the calculated defrost interval for 16°C is double that of 32°C, which is equal to 42.526 h for energy labelling.

As specified in Clause 4.3, the deemed defrost interval for MEPS for a complying variable defrost controller is 60 h.

As specified in Clause 5.2, the measured representative incremental energy for defrost and recovery used for energy labelling is adjusted by a factor of 1.9 for variable defrost systems as set out in Table B.6.

Table B.6 — Adjusted defrost energy

Test Point	Ambient 16°C	Ambient 32°C
Measured incremental defrost and recovery energy for MEPS Δ*E*df Wh	N/A	112.3

Adjusted incremental defrost and recovery energy for labelling *ΔE*df-a Wh	200.64	213.37

B.5.3 Calculation of daily energy values for energy labelling

Using steady-state power values, measured steady-state temperatures and defrosting characteristics, calculate the daily energy values and average compartment temperatures for energy labelling, including the energy and temperature impacts of defrosting. These are set out in the KS IEC 62552-3, Equation (2) and the KS IEC 62552-3, Equation (3) as follows:

$$E_{\text{daily}} = P \times 24 + \frac{\Delta E_{\text{df-a}} \times 24}{t_{\text{df}}} \quad \text{B.5}$$

Note that *ΔEdf-a* in KS IEC 62552-3, Equation (2) is the adjusted value as specified in Table B.6 and Clause 4.2.1.

$$T_{\text{average}} = T_{\text{ss}} + \frac{\Delta Th_{\text{df}}}{t_{\text{df}}} \quad \text{B.6}$$

Accordingly, the temperature and energy values for energy labelling calculations for each test point are calculated and shown in Table B.7 and Table B.8.

Table B.7 — Compartment temperature and daily energy for labelling at 16° C

Compartment A °C	−18.6918	−16.9918	−19.6918	−18
Compartment B °C	−2.0976	−0.0976	−0.6976	0
Compartment C °C	0.7047	3.3047	2.3047	4
Compartment D °C	1.2259	5.3259	4.3259	4
Compartment E °C	8.6118	11.2118	9.3118	12
Daily energy Wh/day	535.634	487.634	526.034	

Table B.8 — Compartment temperature and daily energy for labelling at 32 °C

Test Point	Point 1	Point 2	Point 3	Target Temperature
Compartment A °C	−20.4507	−17.2507	−15.7507	−18

Compartment B °C	−2.0906	−0.0906	−0.6906	0
Compartment C °C	0.7235	3.3235	2.3235	4
Compartment D °C	6.5423	0.8423	7.1423	4
Compartment E °C	8.6376	11.2376	9.3376	12
Daily energy Wh/day	1176.84	1124.04	1001.64	
NOTE Energy values used to calculate PAEC are in kWh/day.				

B.5.4 Interpolation of energy values for energy labelling

As there are three test points at each test temperature for energy labelling, it is then possible to estimate an optimum energy value at the target temperature by the interpolation of at least two compartments. Review of the data shows that Compartment A (freezer) and Compartment D (larger fresh food) are the most suitable compartments for triangulation. Inspection of the data confirms that all other compartments are at or below target temperature for each of the test points, so can be ignored for the purposes of interpolation.

Two approaches to interpolation are possible. The first is manual interpolation. With this approach, a line is drawn from Point 2 through the target temperature (Point Q) to intersect with a line from Point 1 to Point 3 at Point 4. Interpolation can be performed along the line from Point 2 to Point 4 to determine energy consumption at the target temperature for both compartments (Point Q). This is illustrated in Figure B.2 and Figure B.3. Details of this approach are set out in the KS IEC 62552-3, Clause E.4.3.

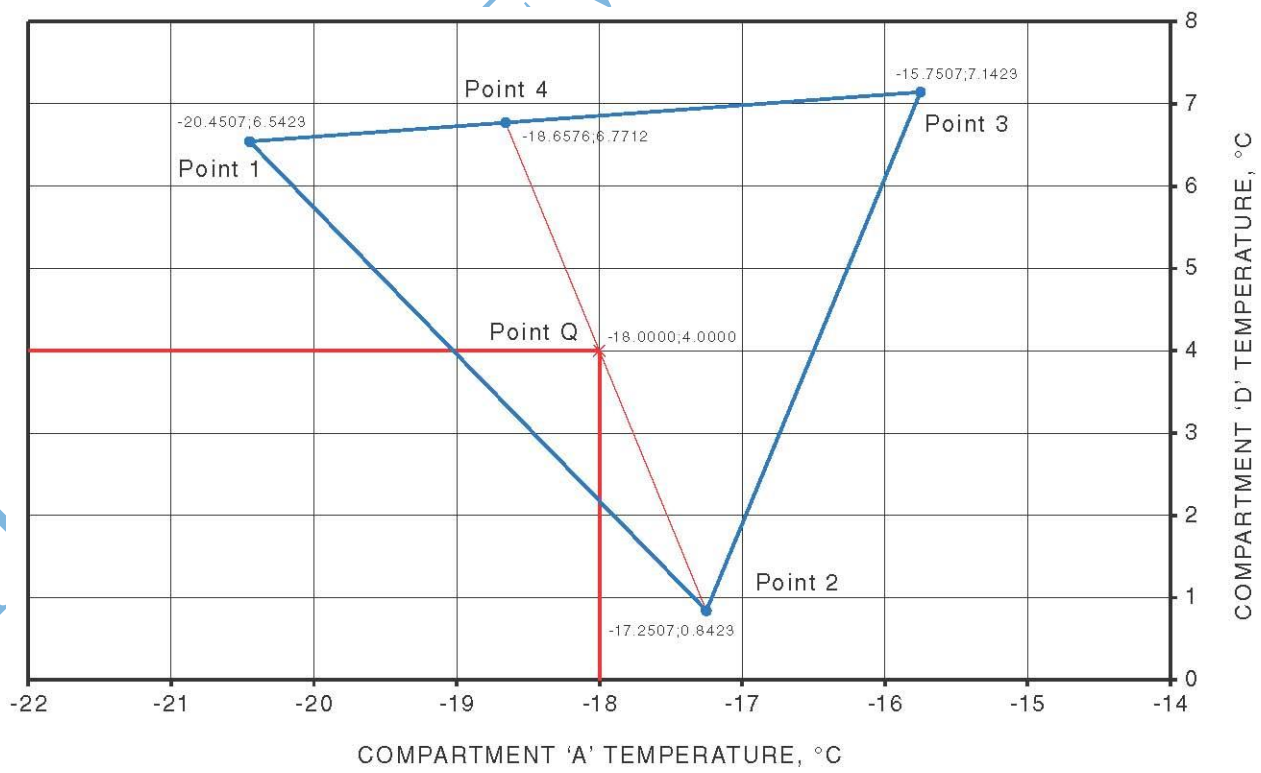


Figure B.2 — Interpolation of compartment temperatures at test temperature of 32 °C

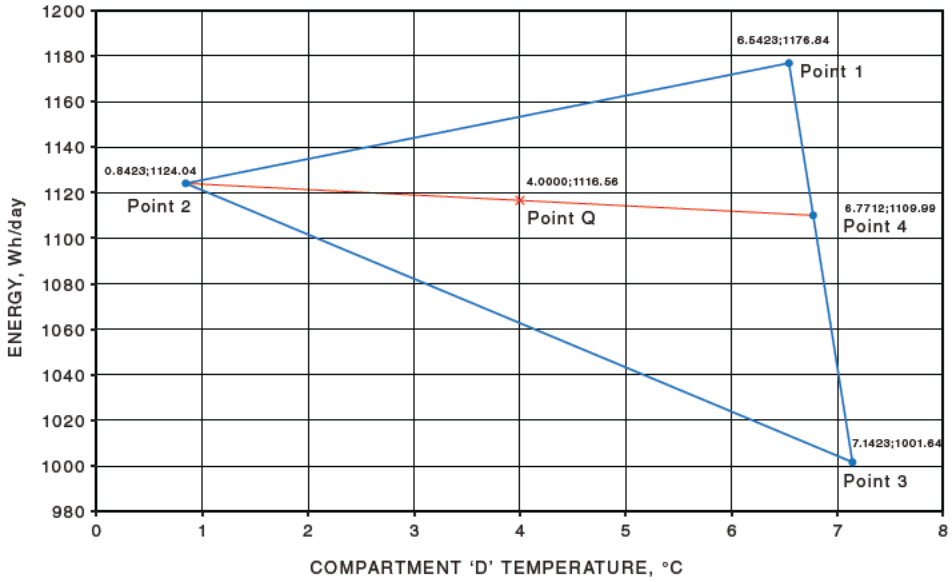


Figure B.3 — Interpolation of compartment temperature and energy at test temperature of 32 °C

Manual interpolation gives an energy value of 1116.56 Wh/day at the target temperature for Compartment A (freezer) and Compartment D (larger fresh food). Table B.9 provides the results of the calculations for 32 °C ambient temperature. Similar calculations can be done for the 16 °C ambient temperature results, as set out in Table B.10.

Table B.9 — Compartment temperature and daily energy for labelling at 28°C

Test Point	Compartment A °C	Compartment D °C	Daily energy Wh/day
Point 1	−20.4507	6.5423	1176.84
Point 2	−17.2507	0.8423	1124.04
Point 3	−15.7507	7.1423	1001.64
Point 4	−18.6576	6.7712	1109.99
Point Q	−18.0	4.0	1116.56
NOTE Energy values used to calculate PAEC are in kWh/day.			

Table B.10 — Compartment temperature and daily energy for labelling at 16°C

Test Point	Compartment A °C	Compartment D °C	Daily energy Wh/day
Point 1	−18.6918	1.2259	535.63
Point 2	−16.9918	5.3259	487.63
Point 3	−19.6918	4.3259	526.03

Point 4	−19.1141	2.5348	531.58
Point Q	18.0	4.0	508.51

An alternative approach is to use matrices as set out in the KS IEC 62552-3, Annex E Clause E.4.4. The concept is to generate 3 simultaneous equations as follows, which can then be solved:

E0 + *A* × *TA1* + *B* × *TB1* = *E1*
E0 + *A* × *TA2* + *B* × *TB2* = *E2*
E0 + *A* × *TA3* + *B* × *TB3* = *E3*

where

TAk = temperature in Compartment A for test point k (1 to 3);

TBk = temperature in Compartment B for test point k (1 to 3); and

Ek = energy consumption for test point k (1 to 3).

E0 is a constant value for the refrigerating appliance at the ambient test temperature (in theory this is the energy consumption when both compartments are at 0°C, but in practice this is not normally possible to achieve) — variable to be solved.

A is a constant value for the refrigerating appliance at the ambient test temperature that provides an estimate of the influence of the temperature in compartment A on the energy consumption — variable to be solved.

B is a constant value for the refrigerating appliance at the ambient test temperature that provides an estimate of the influence of the temperature in compartment B on the energy consumption — variable to be solved.
In These values can be organized into matrices as follows:
[*M*33] × [*C*31] = [*E*31] B.7

longhand this is set out as follows:

$$\begin{bmatrix} 1 & T_{A1} & T_{B1} \\ 1 & T_{A2} & T_{B2} \\ 1 & T_{A3} & T_{B3} \end{bmatrix} \times \begin{bmatrix} E_0 \\ A \\ B \end{bmatrix} = \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix}$$

The solution to find the constants matrix *C*31 is to multiply the energy matrix by the inverse of the temperature matrix [*M*33]−1 as follows:

[*C*31] = [*E*31] × [*M*33]−1 B.1

In the example for the test temperature of 32°C, the values are as follows:

[*M*33] × [*C*31] = [*E*31]

$$\begin{bmatrix} +1.000 & -20.4507 & +6.5423 \\ +1.000 & -17.2507 & +0.8423 \\ +1.000 & -15.7507 & +7.1423 \end{bmatrix} \times \begin{bmatrix} E_0 \\ A \\ B \end{bmatrix} = \begin{bmatrix} +1176.84 \\ +1124.04 \\ +1001.64 \end{bmatrix}$$

The inverse of [*M*33] can be calculated using a spreadsheet as follows:

$$M_{33}^{-1} = \begin{bmatrix} -3.8294 & +1.4984 & +3.3310 \\ -0.2194 & +0.0209 & +0.1985 \\ +0.0522 & -0.1637 & +0.1115 \end{bmatrix}$$

The solution to the constants matrix [*C*31] can be calculated as follows:

$$\begin{bmatrix} E_0 \\ A \\ B \end{bmatrix} = \begin{bmatrix} +1176.84 \\ +1124.04 \\ +1001.64 \end{bmatrix} \times \begin{bmatrix} -3.8294 & +1.4984 & +3.3310 \\ -0.2194 & +0.0209 & +0.1985 \\ +0.0522 & -0.1637 & +0.1115 \end{bmatrix}$$

This gives values as follows:

*E*0 = 514.125
A = −35.887
B = −10.884

The energy consumption at Point Q is then given by:

EQ = 514.125 + (−35.887)×(−18) + (−10.884)×(4) = 1116.56 Wh/day = 1.11656 kWh/day

Note that interpolation using manual triangulation and matrices gives the same result. Energy values used to calculate PAEC are in kWh/day so energy values in Wh/day need to be divided by 1,000.

The energy slope of the interpolated compartments is given by the parameters *A* and *B* in Wh/K. At the target energy consumption of 1,116.56 Wh/day, the impact of changes in the freezer compartment temperature equates to −3.2 % per K while the impact of changes in the fresh food temperature equates to −1.0 % per K.
A similar calculation can be undertaken for the data at a test temperature of 16°C. The solution to the constants matrix [*C*31] can be calculated as follows:

[*C*31] = [*E*31] × [*M*33]−1

$$\begin{bmatrix} E_0 \\ A \\ B \end{bmatrix} = \begin{bmatrix} +535.63 \\ +487.63 \\ +526.03 \end{bmatrix} \times \begin{bmatrix} +3.3481 & +6.0532 & -8.4013 \\ +0.1067 & +0.3308 & -0.4376 \\ -0.2882 & +0.1067 & +0.1814 \end{bmatrix}$$

This gives values as follows:

E0 = 325.731
A = −11.6798
B = −6.8645

The energy consumption at Point Q is then given by:
EQ = 325.731 + (−11.6798)×(−18) + (−6.8645)×(4) = 508.51 Wh/day = 0.50851 kWh/day

B.5.5 Load processing efficiency for energy labelling

The load processing efficiency has been measured at both 16 °C and 32 °C, so in accordance with Clause 3.3, the load processing efficiency for energy labelling is calculated as the average of the measured value at 16°C and 32°C.

Load processing efficiency at a test temperature of 16°C: 1.638 (dimensionless, Wh/Wh)
Load processing efficiency at a test temperature of 32°C: 1.350 (dimensionless, Wh/Wh)
Load processing efficiency for energy labelling: 1.4940 (dimensionless, Wh/Wh)

B.5.6 Calculation of daily energy values for MEPS

Using steady-state power values, measured steady-state temperatures and defrosting characteristics, it is necessary to calculate daily energy values for MEPS. It is only necessary to calculate these additional values at a test temperature of 32 °C. For energy consumption for MEPS, the unadjusted incremental defrost and recovery energy is used *ΔEdf*. For a variable defrost system, the assumed defrost interval is 60 h to align with US requirements. Note also that for the MEPS calculations, the compartment temperatures are not adjusted to take into account temperature excursions during defrosting and recovery. This is to align with US requirements. For example, the daily energy consumption for Point 1 is calculated as follows:

$$E_{\text{daily-MEPS}} = P \times 24 + \frac{\Delta E_{\text{df}} \times 24}{t_{\text{df-MEPS}}} = 39.0 \times 24 + \frac{112.3 \times 24}{60} = 980.92$$

The resulting values for MEPS assessment are as set out in Table B.11.

Table B.11 — Compartment temperature and daily energy for MEPS at 32 °C

Test Point	Point 1	Point 2	Point 3	Target Temperature
Compartment A °C	−20.70	−17.50	−16.00	−18
Compartment B °C	−2.10	−0.10	−0.70	0
Compartment C °C	0.70	3.30	2.30	4
Compartment D °C	6.50	0.80	7.10	4
Compartment E °C	8.60	11.20	9.30	12
Daily MEPS energy Wh/day	980.92	928.12	805.72	
NOTE The measured temperatures as set out in Table B.4 are used without adjustment for MEPS calculations.				

B.5.7 Interpolation of energy values for MEPS

Interpolation of MEPS energy data are the same as for energy labelling data. The results from manual interpolation are given in Table B.12.

Table B.12 — Compartment temperature and daily energy for MEPS at 32 °C

Test Point	Compartment A °C	Compartment D °C	Daily energy Wh/day
Point 1	−20.7	6.5	980.92
Point 2	−17.5	0.8	928.12
Point 3	−16.0	7.1	805.72
Point 4	−18.4358	6.7890	896.52
Point Q	−18.0	4.0	911.23

The matrix solution is given as follows:

[*C*31] = [*E*31] × [*M*33]−1

$$\begin{bmatrix} E_0 \\ A \\ B \end{bmatrix} = \begin{bmatrix} +980.92 \\ +928.12 \\ +805.72 \end{bmatrix} \times \begin{bmatrix} -3.88192 & +1.49669 & +3.38523 \\ -0.21944 & +0.02090 & +0.19854 \\ +0.05225 & -0.16371 & +0.11146 \end{bmatrix}$$

This gives values as follows:

*E*0 = 308.802
A = −35.887
B = −10.884

Note that the values for *A* and *B* are approximately the same for MEPS and energy labelling at a test room temperature of 32°C. The energy consumption at Point Q is then given by:

EQ = 308.802 + (−35.887)×(−18) + (−10.884)×(4) = 911.235 Wh/day = 0.911235 kWh/day

B.6 Calculation energy rating label values

B.6.1 General

The daily energy consumption values calculated previously are used to calculate the values on the energy rating label.

B.6.2 Projected Annual Energy Consumption (PAEC)

$$\mathrm{PAEC} = 259 \times \mathrm{E}_{\mathrm{daily\,32C-label}} + 106 \times \mathrm{E}_{\mathrm{daily16C-label}} + \mathrm{W}_{\mathrm{heaters-AU}} \times 8.76 + \frac{[(\mathrm{V_E} \times 0.091) + (\mathrm{V_{unfrozen}} \times 0.274)]}{\mathrm{Efficiency_{load-label}}}$$

$$\mathrm{PAEC} = 259 \times 1.11656 + 106 \times 0.50851 + 0 + \frac{[(90 \times 0.091) + (290 \times 0.274)]}{1.4940}$$

$$\mathrm{PAEC} = 289.18904 + 53.90206 + 58.668$$

$$\mathrm{PAEC} = 401.759 \text{ kWh/year}$$

B.6.3 Comparative Energy Consumption (CEC)

In accordance with Clause 3.4, the CEC on the energy rating label shall be an integer not less than the PAEC, so the lowest value that can be claimed is 402 kWh/year. A higher value could be claimed at the discretion of the supplier.

B.6.4 Base energy consumption (BEC)

In accordance with Clause 3.6, the BEC is calculated in accordance with Equation 3.3. The appliance is Group 5T, so the fixed and variable energy values are as specified in Table 5 and as shown below.

Fixed label allowance *Cf* = 55

Variable label allowance Cv = 10.0

$$BEC = C_f + C_v \times V_{norm}^{0.67}$$

$$BEC = 55 + 10.0 \times 334.48^{0.67}$$

$$BEC = 546.279\,\mathrm{kWh/year}$$

B.6.5 Star Rating Index (SRI) and Star Rating

$$\text{Star rating index} = 1 + \left[\frac{log_e\left(\frac{CEC}{BEC}\right)}{log_e\,(1 - ERF)}\right]$$

$$\text{Star rating index} = 1 + \left[\frac{log_e\left(\frac{402}{546.279}\right)}{log_e\,(1 - 0.18)}\right]$$

$Star\ rating\ index = 2.54535$ stars

In accordance with Clause 3.8 and Table 6, the Star Rating of the appliance is 2.0 star.

B.7 Assessment of MEPS compliance

B.7.1 General

The daily energy consumption values calculated previously are used to assess compliance with MEPS requirements.

B.7.2 Projected MEPS Energy Consumption (PMEC)

The PMEC is calculated in accordance with Clause 4.6 and Equation 4.2 as set out below.

$$PMEC = 365 \times E_{\text{daily32C-MEPS}} + 8.76 \times W_{\text{heaters-US}}$$

$$PMEC = 365 \times 0.911235 + 8.76 \times 3.4346$$

$$PMEC = 362.688\,\text{kWh/year}$$

B.7.3 Projected MEPS cut-off level

MEPS cut-off level is specified in Clause 4.7.2 Equation 4.3.

MEPS cut-off level = [*K*f + (*K*v × *V*adj tot)] + *A*wi + *A*bi (kWh/year)

The appliance is Group 5T so *Kf* from Table 8 is 256.9 while *Kv* is 0.3133. As the appliance is not built in, nor does it have a through the door icemaker, both *A*wi + *A*bi are zero.

MEPS cut-off level = 256.9 + (0.3133 × 429.64) + 0 + 0 kWh/year

MEPS cut-off level = 391.507 kWh/year

The appliance PMEC is 7.4 % lower than the MEPS cut-off level so it complies with the MEPS requirements.

Annex C
(informative)

Determination of the maximum CEC value at which a model would qualify for a desired star rating

C.1 General

This Annex presents two methods for determining the maximum value of the CEC (*CEC*max) at which a refrigerating appliance model of a given Group and total adjusted volume will qualify for a desired star rating.

The first method entails the use of an equation and is exact. The second uses a conversion factor that is rounded so the resulting value would be an approximation.

Equations provided in this Annex are for information only and do not take precedence over the equations provided in Section 3 of this standard.

C.2 Determination of target *CEC*max by formula

C.2.1 Method

The maximum CEC to achieve a desired star rating of an appliance model of a given Group and given total adjusted volume may be obtained from the following formula:

$$CECmax = BEC \times (1 - ERF)(\text{Desired SRI} - 1) \quad \text{C.1}$$

$$CECmax = BEC \times 0.82\ (\text{Desired SRI} - 1) \quad \text{C.2}$$

where

BEC base energy consumption

ERF energy reduction factor

C.2.2 Example

The product is a Group 5T refrigerating appliance with a freezer volume of 90 l and a fresh food volume of 300 l, with a total volume of 390 l.

The desired star rating is 3.

The normalized volume is calculated from Equation 3.2 using the volume normalization factors in Table 3 and the Group configuration adjustor in Table 4 as follows:

*V*norm =

$$\frac{300 \times 1.00 + 90 \times 2.222}{1.367}$$

Therefore —
*V*norm = 365.75 l

From Equation 3.3 the base energy consumption is calculated as

$BEC = 55 + (10.0 \times (365.75)^{0.67})$

From Equation 3.4, the energy reduction factor (ERF) is 0.18.

From Equation C.1, the *CEC*max is calculated as—

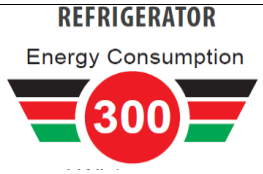
$CECmax = 576.595 \times (1 - 0.18)^{(3-1)}$

Annex D
(informative)

Energy rating label dimensions

Most of the dimensional information required to create a valid base label is given in table below

Item	Description & measurement
Overall Length	9 cm
Overall Height	15 cm
	Inner Semicircle – Radius 3.5 cm, Stroke Weight -40 pt Sector Divider: Sector line divider for each of the five sectors of the semicircle - 5 pt Star: The apex for each star point lies on the corner of a pentagon. Angles are 108º for the pentagon and 36º for each star apex. The pentagon side for the smaller star is 8 mm and side for the larger star 9mm (middle)
	Location: Center Distance between Semicircle and object: 10 pt Length: 8.5 cm. Stroke Weight -40 pt Font Type: Regular Font Size: 20 pt

	Location: Center Distance between Object and previous from top: 15 pt Length: 8.5 cm. Overall Height 1.5 cm Font Type: Regular Font Size: 25 pt
	Location: Center Distance between text and object: 15 pt Font Type: Regular REFRIGERATOR/Energy Consumption: Font Size: 25 pt 300: 25 Circle Radius: Inner 1.2 cm Outer: 1.5 cm Length of tampering flag: (4 cm,
Other fonts	16 pt, evenly distributed over remaining space
Colours	The label shall be printed in the following colours on a white background Red: Pantone Warm Red Green: #006600 Black: Pantone Black

Annex E
(informative)

Items to be included in registration test reports

E.1 Introduction

The following Test Report Items (Clause F.2) should be included in test reports that are submitted for household refrigerating appliances to be registered.

All parameters are to be measured in accordance with the test standard.

E.2 Test report items

E.2.1 Testing laboratory

Laboratory address where testing was conducted.
Contact details.
Test officer.
Date(s) of specific tests.
Relevant accreditation(s) (where applicable).
Authorizing person.

E.2.2 Client

a) Supplier name.

b) Supplier address.
c) Contact name.
d) Contact phone number.

E.2.3 Test standards

a) Test Standards and editions used.
b) Document any permitted variations.
c) Document any non-conformance or deviations.
d) Relevant regulation (e.g. GEMS Regulation).

E.2.4 Refrigerating appliance

a) Test item description.
b) Brand (Trade Mark).
c) Manufacturer.
d) Model.
e) Serial number(s).
f) Rated voltage and frequency.
g) Climate class.
h) Ratings and marking plates, including photographs.
i) Refrigerant.
j) Product characteristics:
    1) Type of refrigerating appliance designation (Refrigerator/Refrigerator-Freezer/Freezer/Cooled Appliance).
    2) Frost-free or not.
    3) Defrost controller type (variable, run-time, fixed time, other).
    4) Condenser type (grill (stack)/skin (smooth wall)/fan forced (including direction of the exhaust)/other, as applicable).
    5) Condenser location (back/side/underneath, as applicable).
    6) Features (chill compartment/automatic ice maker/ through the door ice and/or water dispenser/ other).
    7) Compressor details: single speed, variable speed, multiple compressors.
    8) For variable defrost controls, min and max defrost interval (where known).
    9) For ambient controlled anti-condensation heater, suppliers should provide an operation map as per the KS IEC 62552-3, Annex F.
    10) For user controlled anti-condensation heaters, describe the switch and any associated controls.
    11) Does the appliance have a compact footprint? (smaller than 0.36 m^2)
    12) Is the appliance built-in?
    13) Rated linear dimensions [mm] (width × depth × height):
        i. Overall dimensions.
        ii. Space required in use.
        iii. Overall space required in use.

F.2.5 List of compartments

List of all compartments and sub-compartments, including:

a) Compartment type as specified in Clause 3.3 (in the case of a variable temperature compartment, also specify the warmest and coldest compartment type that can be selected and the compartment type selected for the primary configuration, compartment type with the highest energy).
b) volume determined to the KS IEC 62552-3, Annex H.
c) Defrost type (manual defrost/cyclic defrost/frost-free).
d) Number of external doors.
e) Access (top/front/drawer/internal).
f) Temperature control description (where applicable).
g) Total rated volume of all compartments in litres.
h) Normalized volume for the appliance (energy labelling) in litres.
i) Adjusted volume for the appliance (MEPS) in litres.

E.2.6 Summary of testing

E.2.6.1 General

Lists a summary of the test results.

E.2.6.2 Storage test results

For each ambient temperature tested, indicate whether the product complies.

Indicate the relevant temperature control settings used to achieve compliance.

See Clause 4.4.

E.2.6.3 Pull down test

Where applicable, indicate the time for each compartment to reach the specified pull down temperatures and the ambient temperature for the test.

Indicate the relevant temperature control settings used to achieve compliance (See Clause 5.3).

E.2.6.4 Temperature excursion during defrost

Where applicable, indicate maximum temperature that occurs for each sensor in each frozen compartment during defrost and the time above 0°C (if applicable) and for sensors that are warmer than 0°C, the time the sensor remains above 0 °C (See Clause 4.8).

E.2.6.5 Energy consumption

IEC values at 16 °C and 32 °C as applicable:

a) Measured ambient temperature [°C].
b) Steady-state power at each temperature control setting selected.
c) Method of establishing stability [SS1 or SS2], total test time.
d) Measured representative incremental energy for defrost and recovery ΔEdf and the number of valid defrost events used to estimate this value.
e) Scaled representative incremental energy for defrost and recovery ΔEdf-a used to determine energy consumption for energy labelling.
f) The representative defrost and recovery temperature change in each compartment ΔThdf in accordance with the KS IEC 62552-3, Annex C used for energy labelling.
g) Average defrost heater energy Edf-heater for these valid defrost events.
h) Average defrost adder ΔEdf-adder (ΔEdf – Edf-heater).
i) *Defrost interval* used to determine each daily energy consumption value, where applicable and how this was determined (run-time for run-time controllers, calculated defrost interval in accordance with the KS IEC 62552-3, Annex D for variable controllers), including declared values for td-max and td-min at 32°C.
j) Daily energy consumption E_{daily} [Wh/day] for each control setting used for energy labelling.
k) Daily energy consumption E_{daily} [Wh/day] for each control setting used for MEPS.
l) Where interpolation has been used to determine the optimum daily energy consumption, indicate the method used.
m) Daily energy consumption E_{daily} [Wh/day] declared (optimum) for energy labelling.
n) Daily energy consumption E_{daily} [Wh/day] declared (optimum) for MEPS.
o) Load processing energy input test Einput-test [Wh].
p) Additional energy for load processing ΔEadditional-test [Wh].
q) Indicate whether any defrosts occurred during the load processing test.
r) Load processing *Efficiency* load, ambient [W/W].
s) Confirm that all KS IEC validity criteria have been met for all performance and energy tests
t) Regional values can be reported where applicable:
    1) Days at each ambient temperature.
    2) Load processing factors.

3) Load processing energy.
4) Value for *Efficiency* load-label used for labelling calculations and how this is determined.
5) Where load processing efficiency *Efficiency* load-label is not based on a measured value, report the brand and model of compressor, the cooling capacity, power input and COP at the relevant ASHRAE rated conditions. If a variable speed compressor, report the frequency for these rated conditions.
6) Additional power associated with ambient controlled anti-condensation heaters (noting that this requires use of a regional humidity-temperature distribution) including climate profile adopted for calculations.
7) Total energy consumption E_{total} ($PAEC_{av}$).
8) Base energy consumption (BEC).
9) Energy reduction factor used.
10) Star rating index.
11) Star rating.

E.2.6.6 Dimensions and volume

Measured linear dimensions [mm] (width × depth × height):

i. Overall dimensions.
ii. Space required in use.
iii. Overall space required in use.
iv. List of all compartments and sub-compartments, including:
    a) Compartment type.
    b) Measured volume in litres.
    c) Total measured volume (sum of all compartments).