



BSI Standards Publication

Household refrigerating appliances — Characteristics and test methods

Part 3: Energy consumption and volume

National foreword

This British Standard is the UK implementation of EN 62552-3:2020+A11:2024. It is derived from IEC 62552-3:2015. It supersedes BS EN 62552-3:2020, which is withdrawn.

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The UK participation in its preparation was entrusted to Technical Committee CPL/59, Performance of household electrical appliances.

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Caractéristiques et méthodes d'essai - Partie 3:
Consommation d'énergie et volume
(IEC 62552-3:2015 , modifiée)

Haushaltskühlergeräte - Eigenschaften und Prüfverfahren -
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(IEC 62552-3:2015 , modifiziert)

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European foreword

This document (EN 62552-3:2020) consists of the text of IEC 62552-3:2015 prepared by IEC/TC 59 “Performance of household and similar electrical appliances”, together with the common modifications prepared by CLC/TC 59X “Performance of household and similar electrical appliances”.

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2021-02-24
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2023-02-24

This standard in combination with standards EN 62552-1:2020 and EN 62552-2:2020 will supersede EN 62552:2013.

This standard shall be read in combination with standards EN 62552-1:2020 and EN 62552-2:2020.

EN 62552-3:2020 includes the following significant technical changes:

- a) definition of the “regional function”, i.e. calculation formula for annual energy consumption for Europe;
- b) some clauses have been completely modified, i.e. D.3, F.1 and H.2.2;
- c) adding of H.Z1 and Figures H.Z1, H.Z2, H.Z3, H.Z4 and H.Z5.

Clauses, subclauses, notes, tables, figures and annexes which are additional to those in IEC 62552-3:2015 are prefixed “Z”.

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This document has been prepared under Standardization Request M/459 given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

Endorsement notice

The text of IEC 62552-3:2015 was approved by CENELEC as a European Standard with agreed common modifications.

European foreword to amendment A11

This document (EN 62552-3:2020/A11:2024) has been prepared by CLC/TC 59X, "Performance of household and similar electrical appliances".

The following dates are fixed:

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This document is read in conjunction with EN 62552-1:2020 and EN 62552-2:2020 and their amendments.

EN 62552-3:2020/A11:2024 includes the following significant technical modifications to EN 62552-3:2020:

- a) determination of $E_{daily16^{\circ}C}$ for mobile refrigerating appliances which are placed on the market with an AC/DC converter and having only a pantry compartment and which are not falling under the category low noise refrigerating appliances.
- b) interpolation of test results.

Clauses, subclauses, notes, tables, figures and annexes which are additional to those in IEC 62552-3:2015 are prefixed "Z".

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This document has been prepared under a standardization request addressed to CENELEC by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annexes ZZA and ZZB, which are an integral part of this document.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Annex ZA (normative)

Chill compartment temperature control test

A chill compartment shall be able to control its average temperature within a certain range without user-adjustments of its control. This shall be checked during a set of temperature control tests which consists of two parts: reference tests at 32 °C and verification tests at 16 °C. All temperature control tests shall be performed as prescribed for the energy consumption tests. The controller setting of the chill compartment, if present, shall be the same for all temperature control tests.

Note Z1 In general all or part of the temperature control tests can also be used for the energy consumption determination.

Determine the reference chill compartment temperature $T_{ccma,ref}$ by performing one or more reference tests at 32 °C ambient. $T_{ccma,ref}$ is the interpolated value of T_{ccma} according Annex E and all reference tests shall be valid tests for interpolation subject to the following conditions:

- a) If the temperature control of the chill compartment is not adjustable by the user, the chill compartment is tested in the condition as delivered.
- b) If the temperature control of the chill compartment is accessible to the user (e.g. visible control on the display or by following manufacturer instructions), it is set to a position which leads to an interpolated temperature of T_{ccma} at or as close as possible below the target temperature (+2 °C) .

The interpolation can be to the target temperature(s) of any controlled compartment present, with the exception of the chill compartment as the controller setting shall be the same for each reference test.

Perform one or more verification tests at 16 °C ambient temperature with the same temperature control setting of the chill compartment as applied at 32 °C. Other control settings shall be such that the controlled compartments are within 4 K of their target temperature, with the exception of the fresh food compartment, where, if present, the fresh food compartment temperature T_{ma} shall be in the range from 2 °C to 6 °C.

For each of these verification tests, T_{ccma} shall be within $T_{ccma,ref} \pm 1,5$ K. An example of a temperature control diagram is given in Figure Z1. In case any of the verification tests is not complying with this requirement, the compartment shall not be classified as a chill compartment.

It is allowed to perform the reference tests for determining $T_{ccma,ref}$ at 16 °C ambient temperature and perform the verification tests at 32 °C.

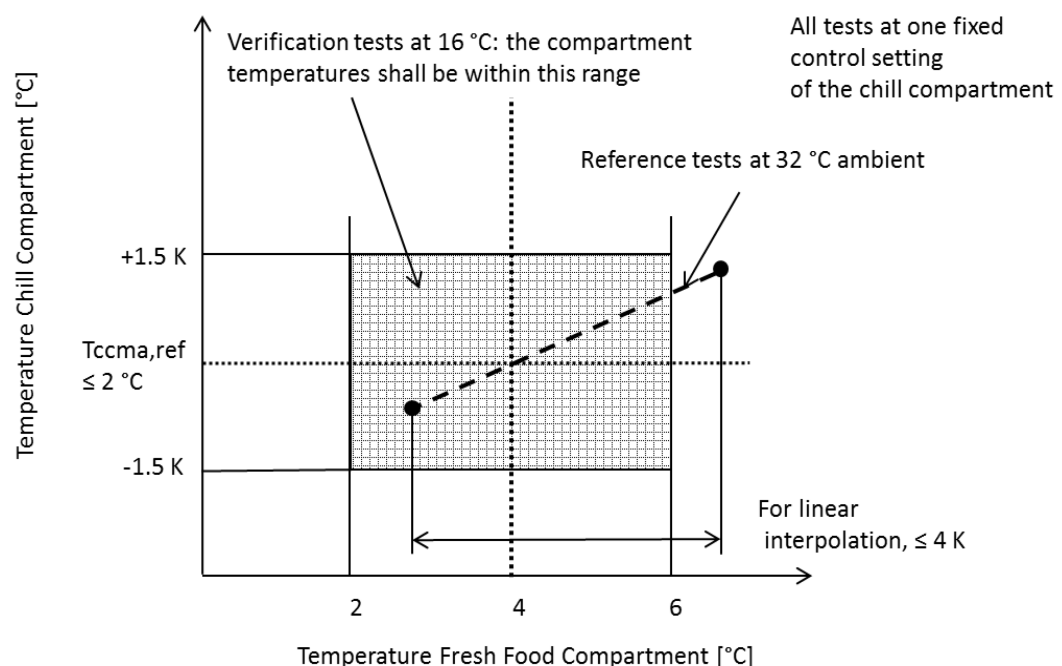


Figure Z1 – Example of a temperature control diagram for a combination appliance with a fresh food and chill compartment

A11 Annex ZB
(normative)

**Normative references to international publications with their
corresponding European publications**

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.

NOTE Z1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE Z2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cencenelec.eu

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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			+ 11	2024
IEC 62552-2	2015	Household refrigerating appliances – Characteristics and test methods – Part 2: Performance requirements	EN 62552-2	2020
			+ 11	2024 A11

Annex ZZA (informative)

Relationship between this European Standard and the ecodesign requirements of Commission Regulation (EU) No 2019/2019 aimed to be covered

This European standard has been prepared under a Commission's standardization request 'M/586' / 'C (2022) 6047 final' to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) 2019/2019 of 01 October 2019 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to eco-design requirements for (EC) No 643/2009 [OJEU L315/187 of 05.12.2019].

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Table ZZA.1 — Correspondence between this European Standard and Commission Regulation (EU) No 2019/2019 of 01 October 2019 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to eco-design requirements (EC) No 643/2009 [OJEU L315/187 of 05.12.2019] and Commission's standardization request 'M/586' / 'C(2022) 6047 final'

Ecodesign requirements of Regulation No 2019/2019 [OJEU L315/187 of 05.12.2019]	Clause(s) / sub-clause(s) of this EN	Remarks / Notes
Daily energy consumption at 25°C for low noise refrigerating appliances Annex III, part 3 (b);	Clause 6.8.5 "Total energy consumption" Annex B "Determination of steady state power and temperature"	
Performance of wine storage with regards to volume measurement Annex III, part 3, Table 3: note (2) and (6), Annex III, part 4 (a)	Clause 5.1 "General" table 1 "target temperature for energy determination of compartment type" Annex H "Determination of volume"	
Total volume Annex III, part 4 (a)	Annex H "Determination of volume"	
Compartment volume Annex III, part 4 (a)	Annex H "Determination of volume"	
Auxiliary energy consumption, Annex III, part 3 (a)	Clause 6.7 "Specified auxiliaries" Annex F.2 "Ambient controlled anti-condensation heaters"	

Ecodesign requirements of Regulation No 2019/2019 [OJEU L315/187 of 05.12.2019]	Clause(s) / sub-clause(s) of this EN	Remarks / Notes
Daily energy consumption at 16°C for refrigerating appliances except low noise refrigerating appliances, Annex III, part 3 (a)	Clause 5.1 “General” table 1 “target temperature for energy determination of compartment type” Clause 6.8.2 “Daily energy consumption” Annex B “Determination of steady state power and temperature” Annex C “Defrost and recovery energy and temperature change” Annex D “Defrost interval”	
Incremental defrost and recovery energy consumption at 16°C for refrigerating appliances except low noise refrigerating appliances, Annex III, part 3 (a)	Clause 6.8.2 “Daily energy consumption” Annex C “Defrost and recovery energy and temperature change”	
Defrost interval at 16°C for refrigerating appliances except low noise refrigerating appliances, Annex III, part 3 (a)	Clause 6.8.2 “Daily energy consumption” Annex D “Defrost interval”	
Daily energy consumption at 32°C for refrigerating appliances except low noise refrigerating appliances, Annex III, part 3 (a)	Clause 5.1 “General” table 1 “target temperature for energy determination of compartment type” Clause 6.8.2 “Daily energy consumption” Annex B “Determination of steady state power and temperature” Annex C “Defrost and recovery energy and temperature change” Annex D “Defrost interval”	
Incremental defrost and recovery energy consumption at 32°C for refrigerating appliances except low noise refrigerating appliances, Annex III, part 3 (a)	Clause 6.8.2 “Daily energy consumption” Annex C “Defrost and recovery energy and temperature change”	
Defrost interval at 32°C for refrigerating appliances except low noise refrigerating appliances Annex III, part 3 (a),	Clause 6.8.2 “Daily energy consumption” Annex D “Defrost interval”	

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Annex ZZB (informative)

Relationship between this European Standard and the energy labelling requirements of Commission Delegated Regulation (EU) No 2019/2016 aimed to be covered

This European standard has been prepared under a Commission's standardization request 'M/586' / 'C(2022) 6047 final' to provide one voluntary means of conforming to the energy labelling requirements of Commission Delegated Regulation (EU) 2019/2016 of 11 March 2019 supplementing Regulation (EU) 2017/1369 of the European Parliament and of the Council with regard to energy labelling of refrigerating appliances [OJEU L315/102 of 05.12.2019].

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Table ZZB.1 — Correspondence between this European Standard and Commission Delegated Regulation (EU) 2019/2016 of 11 March 2019 supplementing Regulation (EU) 2017/1369 of the European Parliament and of the Council with regard to energy labelling of refrigerating appliances [OJEU L315/102 of 05.12.2019] and Commission's standardization request 'M/586' / C(2022) 6047 final'

Energy labelling requirements of Regulation 2019/2016 [OJEU L315/102 of 05.12.2019]	Clause(s) / sub-clause(s) of this EN	Remarks / Notes
Daily energy consumption at 25°C for low noise refrigerating appliances; Annex IV, part 3 (b)	Clause 6.8.5 "Total energy consumption" Annex B "Determination of steady state power and temperature"	
Performance of wine storage with regards to volume measurement Annex IV, part 3, Table 3: note (2) and (6), Annex IV, part 4 (a)	Clause 5.1 "General" table 1 "target temperature for energy determination of compartment type" Annex H "Determination of volume"	
Total volume Annex IV, part 4 (a)	Annex H "Determination of volume"	
Compartment volume, Annex IV, part 4 (a)	Annex H "Determination of volume"	
Auxiliary energy consumption, Annex IV, part 3 (a)	Clause 6.7 "Specified auxiliaries" Annex F.2 "Ambient controlled anti-condensation heaters"	

Energy labelling requirements of Regulation 2019/2016 [OJEU L315/102 of 05.12.2019]	Clause(s) / sub-clause(s) of this EN	Remarks / Notes
Daily energy consumption at 16°C for refrigerating appliances except low noise refrigerating appliances, Annex IV, part 3 (a)	Clause 5.1 "General" table 1 "target temperature for energy determination of compartment type" Clause 6.8.2 "Daily energy consumption" Annex B "Determination of steady state power and temperature" Annex C "Defrost and recovery energy and temperature change" Annex D "Defrost interval"	
Incremental defrost and recovery energy consumption at 16°C for refrigerating appliances except low noise refrigerating appliances, Annex IV, part 3 (a)	Clause 6.8.2 "Daily energy consumption" Annex C "Defrost and recovery energy and temperature change"	
Defrost interval at 16°C for refrigerating appliances except low noise refrigerating appliances Annex IV, part 3 (a)	Clause 6.8.2 "Daily energy consumption" Annex D "Defrost interval"	
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD REFRIGERATING APPLIANCES – CHARACTERISTICS AND TEST METHODS –

Part 3: Energy consumption and volume

FOREWORD

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International Standard IEC 62552-3 has been prepared by subcommittee 59M: Performance of electrical household and similar cooling and freezing appliances, of IEC technical committee 59: Performance of household and similar electrical appliances

IEC 62552-1, IEC 62552-2 and IEC 62552-3 cancel and replace the first edition of IEC 62552 published in 2007. IEC 62552-1, IEC 62552-2 and IEC 62552-3 together constitute a technical revision and include the following significant technical changes with respect to IEC 62552:2007:

- a) All parts of the standard have been largely rewritten and updated to cope with new testing requirements, new product configurations, the advent of electronic product controls and computer based test-room data collection and processing equipment.
- b) In Part 1 there are some changes to test room equipment specifications and the setup for testing to provide additional flexibility especially when testing multiple appliances in a single test room.

- c) For more efficient analysis and to better characterise the key product characteristics under different operating conditions, the test data from many of the energy tests in Part 3 (this part) is now split into components (such as **steady state** operation and defrost and recovery). The approach to determination of energy consumption has been completely revised, with many internal checks now included to ensure that data complying with the requirements of the standard is as accurate as possible and of high quality.
- d) Part 3 (this part) now provides a method to quantify each of the relevant energy components and approaches on how these can be combined to estimate energy under different conditions on the expectation that different regions will select components and weightings that are most applicable when setting both their local performance and energy efficiency criteria while using a single set of global test measurements.
- e) For energy consumption measurements in Part 3 (this part), no thermal mass (test packages) is included in any compartment and compartment temperatures are based on the average of air temperature sensors (compared to the temperature in the warmest test package). There are also significant differences in the position of temperature sensors in unfrozen compartments.
- f) The energy consumption test in Part 3 (this part) now has two specified ambient temperatures (16°C and 32°C).
- g) While, in Part 2 test packages are still used for the storage test to confirm performance in different operating conditions, in Part 1 they have been standardised to one size (100 mm × 100 mm × 50 mm) to simplify loading and reduce test variability. A clearance of at least 15 mm is now specified between test packages and the compartment liner.
- h) A load processing energy efficiency test has been added in Part 3 (this part).
- i) A tank-type ice making energy efficiency test has been added in Part 3 (this part).
- j) A cooling capacity test has been added in Part 2.
- k) A pull-down test has been added in Part 2.
- l) Shelf area and storage volume measurement methods are no longer included. In Part 3 the volume measurement has been revised to be the total internal volume with only components necessary for the satisfactory operation of the refrigeration system considered as being in place.
- m) Tests (both performance (Part 2) and energy (Part 3 – this part)) have been added for wine storage appliances.

The following print types are used in this international standard:

- requirements: in roman type;
- test specifications: in *italic type*;
- notes: in small roman type.
- Words in **bold** are defined in IEC 62552-1:2015, Clause 3 or in this part.

The text of this standard is based on the following documents:

FDIS	Report on voting
59M/63/FDIS	59M/66/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62252 series, published under the general title *Household refrigerating appliances – characteristics and test methods*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

IEC 62552 is split into 3 parts as follows:

- IEC 62552-1: Scope, definitions, instrumentation, test room and set up of refrigerating products;
- IEC 62552-2: General performance requirements for **refrigerating appliances** and methods for testing them;
- IEC 62552-3: **Energy consumption** and **volume** determination (this part).

 This document was developed in relationship with Regulation (EU) 2019/2016 of 11 March 2019 and its amendments on energy labelling and Regulation (EU) 2019/2019 of 01 October 2019 and its amendments on ecodesign for refrigerating appliances. 

HOUSEHOLD REFRIGERATING APPLIANCES – CHARACTERISTICS AND TEST METHODS –

Part 3: Energy consumption and volume

1 Scope

This part of IEC 62552 specifies the essential characteristics of household and similar **refrigerating appliances** cooled by internal natural convection or forced air circulation, and establishes test methods for checking these characteristics.

This part of IEC 62552 describes the methods for the determination of **energy consumption** characteristics and defines how these can be assembled to estimate **energy consumption** under different usage and climate conditions. This part of IEC 62552 also defines the determination of **volume**.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62552-1:2015, *Household refrigerating appliances – Characteristics and test methods – Part 1: General requirements*

IEC 62552-2:2015, *Household refrigerating appliances – Characteristics and test methods – Part 2: Performance requirements*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62552-1, as well as the following apply.

3.1.1

specified auxiliaries

functions or features that affect the **energy consumption** of a **refrigerating appliance** and where their actual **energy consumption** depends on the conditions of use or operation

Note 1 to entry: This standard makes optional provision for determining the **energy consumption** impacts of these functions or features in accordance with regional requirements.

Note 2 to entry: Test requirements for specified auxiliaries, where applicable, are set out in Annex F and their application specified in 6.8.4. The only specified auxiliaries in this edition of the standard are ambient controlled anti-condensation heaters and tank type automatic icemakers.

3.1.2

defrost interval

the measured or estimated length of a **defrost control cycle**, starting from the point of initiation of one **defrost control cycle** to the point of initiation of the subsequent **defrost control cycle**, expressed in hours of elapsed (clock) time

3.1.Z1

low noise refrigerator

refrigerating appliance without vapour compression and with airborne acoustical noise emission lower than 27 A-weighted decibel referred to 1 pico Watt [dB(A) re 1 pW] 

3.2 Symbols

For the purposes of this document, the following symbols apply.

E	electrical energy consumption over a specified period (day, year, etc.) in Wh or kWh
P	average steady power consumption over a defined period in W
T	compartment temperature average over a specified period in degrees Celsius (°C)
TMP_n	temperature measurement position of a specific temperature sensor
t	time at a specific moment
Δt	time interval in hours between two defined times or for a defined period
ΔE_{df}	additional energy associated with a defrost and recovery period , over and above the relevant steady state power consumption at the same temperature control settings , in Wh
ΔTh_{df-i}	the accumulated temperature difference over time (relative to the steady state temperature) during a defrost and recovery period in Kh for compartment i
Rt	actual compressor run time in hours for a defined period (actual compressor on period)
CRt	percentage of compressor run time for a defined period ($Rt/\text{total time interval}$ as %)
P_{Hi}	average heater power associated with an ambient controlled anti-condensation heater at a specified temperature and humidity in W (Annex F)
M	mass of water used for a processing load (Annex G) or the mass of water or ice during an ice making test (Annex F)

4 Applicable test steps for determination of energy and volume

4.1 Setup for energy testing

Prior to the measurement of **energy consumption** for a **refrigerating appliance**, it shall be set up in a test room as specified in Annex A.

4.2 Steady state power consumption

The **steady state power consumption** of the **refrigerating appliance** shall be determined in accordance with Annex B.

4.3 Defrost and recovery energy and temperature change

For products with one or more defrost systems (each with its own **defrost control cycle**), the incremental **defrost and recovery** energy for a representative number of **defrost and recovery periods** shall be determined in accordance with Annex C for each system. The temperature change associated with **defrost and recovery** shall also be determined in accordance with Annex C for each system.

4.4 Defrost frequency

For products with one or more defrost systems (each with its own **defrost control cycle**), the **defrost interval** for each system shall be determined in accordance with Annex D, depending on the control type.

4.5 Number of test points and interpolation

Where the **energy consumption** of a **refrigerating appliance** is interpolated in accordance with Clause 6, one of the methods specified in Annex E shall be used.

4.6 Load processing efficiency

Where the **load processing efficiency** of a **refrigerating appliance** is claimed or determined, it shall be measured in accordance with the method specified in Annex G.

4.7 Specified auxiliaries

Where a **refrigerating appliance** contains a specified auxiliary, the energy impact of this auxiliary shall be determined in accordance with Annex F.

4.8 Volume determination

The **volume** of each **compartment** of the **refrigerating appliance** shall be determined in accordance with Annex H.

5 Target temperatures for energy determination

5.1 General

The **energy consumption** of an appliance is determined from measurements taken when tested as specified in Clause 6 in an **ambient temperature** of 32 °C and an **ambient temperature** of 16 °C. The value for **energy consumption** determined in accordance with this standard shall be for a **temperature control setting** (or equivalent point) where all average **compartment** air temperatures are at or below the **target temperatures** specified in Table 1 for each **compartment** type claimed by the supplier. Values above and below **target temperatures** may be used to estimate the **energy consumption** at the **target temperature** for each relevant **compartment** by interpolation, as specified in Clause 6.

NOTE Refer to the requirements in IEC 62552-1:2015 Annex B for **variable temperature compartments**. For energy testing, these are operated on the function (continuous temperature operating range) that uses the most energy.

Table 1 – Target temperatures for energy determination by compartment type

Compartment type	Target average air temperature °C
Pantry	17
Wine storage	12
Cellar	12
Fresh food	4
Chill	2
Zero-star	0
One-star	–6
Two-star	–12
Three-star and Four-star	–18

For energy testing, each **compartment** shall be operated as the claimed **compartment** type, except as set out below.

If a **compartment** operating range spans none of the **target temperatures** for the defined **compartment** types in Table 1 at either an **ambient temperature** of 16 °C or 32 °C (because it has no **user-adjustable temperature control** or a limited range of active control), then it shall be classified as the **compartment** type with the next warmest **target temperature** (based on the warmest test result for both **ambient temperatures**) and operated at its warmest setting while still staying at or below the **target temperature** of the next warmest **target temperature** (where adjustable) for the energy test at both **ambient temperatures**. The test report shall note that the claimed **compartment** type and the **compartment** type assumed for energy testing.

Where the **compartment** is a **variable temperature compartment** type (that spans the operating range of several compartment types), the primary configuration for energy testing shall be the **compartment** type that has the highest **energy consumption**. A **variable temperature compartment** can be set and tested as other **compartment** types, if required, in addition to the primary configuration for energy testing. The test report shall note that the **compartment** is the **variable temperature compartment** type and the **compartment** type selected for each energy test.

5.2 Temperature control settings for energy consumption test

When tested for **energy consumption** in accordance with Clause 6, the **refrigerating appliance** shall have at least one **temperature control setting** (or combination of **temperature control settings**) at which the average temperatures of each **compartment** is concurrently at or below the **energy consumption target temperatures** specified in Table 1. The data points used for **energy consumption** determination should demonstrate that the product is capable of meeting this requirement, but this specific point need not be measured directly.

Where an appliance has no **user-adjustable temperature controls**, **energy consumption** shall be determined from the results of one measurement test run of the appliance as supplied.

5.2.1 Controllability of temperatures in a compartment

The standard does generally not include tests for the controllability of temperatures in a compartment (i.e. how well the temperature is kept constant during changing environmental conditions without the user having to adjust temperature control settings). The exception is the chill compartment for which a chill compartment temperature control test has been included in Annex ZA. 

6 Determination of energy consumption

6.1 General

The key **energy consumption** components as specified in Clause 6 shall be determined for each **refrigerating appliance** tested in accordance with this standard. This shall be based on data measured in accordance with Annexes B to H, as applicable.

Clause 6 also specifies the method to be used to determine the components of **energy consumption** for a **refrigerating appliance** when tested in accordance with this standard.

The main components of **energy consumption** determined in accordance with this standard are:

- **A11** Steady state power consumption – this is determined at ambient temperatures of 16 °C and 32 °C – see Annex B, with the exception of low noise appliances which is determined at 25 °C. **A11**
- **Defrost and recovery** energy and temperature change – for products with one or more defrost systems (each with its own **defrost control cycle**), the **defrost and recovery** energy for a representative number of **defrost and recovery periods** for each system shall be determined – see Annex C.
- Defrost frequency – for products with one or more defrost systems (each with its own **defrost control cycle**), the **defrost interval** shall be determined for each system under a range of conditions – see Annex D.
- Specified auxiliaries – Where a **refrigerating appliance** contains a specified auxiliary, the energy impact of this auxiliary shall be determined – see Annex F.
- **Load processing efficiency** – where a **load processing efficiency** is measured or claimed, the specified method shall be used – see Annex G.

The lowest conceivable value of **energy consumption** for a **refrigerating appliance** under this standard (i.e. the theoretical optimum), is the value where the temperature of every **compartment** is exactly equal to its **target temperature** for **energy consumption** (see Clause 5). Not every appliance is capable of operating at this condition, nor is it practicable for a laboratory to continue testing in an attempt to precisely obtain this condition during a specific set of tests. Under this standard there is the option of undertaking several tests with different **temperature control settings** (where available). This is to facilitate interpolation to estimate the **energy consumption** for a point where all **compartments** are at or below their relevant target for **energy consumption** (see 6.3).

6.2 Objective

In order to determine the characteristics of a household **refrigerating appliance** in accordance with this standard, it is necessary to measure the temperature and **energy consumption** for a representative period of **steady state** operation that complies with the relevant requirements (i.e. **compartment** temperatures at or below their target for **energy consumption**). Several test points at different **temperature control settings** may be required to obtain the most favourable (optimal) result for **energy consumption**.

In the case of products with **automatic defrost** functions that affect the power consumption of the product (i.e. has a **defrost control cycle**), the incremental energy during **defrost and recovery** (i.e. the additional energy ΔE_{df} over and above the underlying **steady state** power) shall be determined for a specified number of representative and valid **defrost and recovery periods**.

These values are measured at each of the specified **ambient temperatures** for energy determination.

To assess whether a proposed period of test data is acceptable for the determination of **energy consumption**, the data are analysed and examined to assess whether changes in internal temperatures and power consumption are within acceptable limits. In terms of energy assessments, there are two alternative approaches to the determination of **steady state** power consumption:

- **SS1: Steady state** power and internal temperature determination where there is no **defrost control cycle** or where **steady state** conditions according to Annex B can be established between **defrost and recovery periods** (generally where defrost events are widely spaced);
- **SS2: Steady state** power and internal temperature determination where **steady state** conditions according to Annex B cannot be established between **defrosts and recovery periods** (generally where defrost events are more closely spaced).

The incremental **energy consumption** and temperature change during a **defrost and recovery period** also needs to be assessed (relative to the **steady state** power and internal temperatures before and after the **defrost and recovery period**).

In each case, criteria are established to determine whether the periods are representative of the operation of the appliance.

6.3 Number of test runs

The **energy consumption** shall be determined at **ambient temperatures** of 16 °C and 32 °C either:

- a) directly from the results of a single test run during which the temperatures of all **compartments** of the appliance are at or below the **target temperatures** specified in Table 1; or
- b) by interpolation between the results of two or more test runs, conducted at different settings of one or more **user-adjustable temperature controls**, as follows:
 - Where results have been measured at two **temperature control settings**, interpolation in accordance with Clause E.3.
 - Where the appliance has at least two independent **user-adjustable temperature controls** and results have been measured at three **temperature control setting combinations**, interpolation in accordance with Clause E.4.
 - Options for interpolating using three or more independent **user-adjustable temperature controls** are also set out in Clause E.4.

In the case of b) above, test results shall demonstrate that the temperatures of all **compartments** in the **refrigerating appliance** are at or below the **target temperatures** specified in Table 1 at the point of interpolation. There are several requirements associated with interpolation to ensure that this has been achieved.

6.4 Steady state power consumption

For a **refrigerating appliance** that does not have a **defrost control cycle**, the **steady state** power consumption at each **temperature control setting** selected and for each **ambient temperature** shall be determined in accordance with Annex B.

For a **refrigerating appliance** with one or more **defrost control cycles**, the **steady state** power consumption between **defrost and recovery periods** at each **temperature control setting** selected and for each **ambient temperature** shall be determined in accordance with Annex B.

The **steady state** power consumption is reported in watt (W).

6.5 Defrost and recovery energy and temperature change

For a **refrigerating appliance** with one or more defrost systems (each with its own **defrost control cycle**), the additional energy and temperature change associated with **defrost and recovery** shall be determined for each system for a representative number of **defrost and recovery periods** in accordance with Annex C, at **ambient temperatures** of both 16 °C and 32 °C.

Where there is more than one defrost system (each with its own **defrost control cycle**), the characteristics of each system shall be documented.

The additional energy associated with **defrost and recovery** is reported in watt-hour (Wh).

The temperature change associated with **defrost and recovery** is reported in degree Kelvin-hour (Kh).

6.6 Defrost interval

For a **refrigerating appliance** with one or more defrost systems (each with its own **defrost control cycle**), the estimated **defrost interval** shall be determined in accordance with Annex D at an **ambient temperature** of 16 °C and at an **ambient temperature** of 32 °C.

Where there is more than one defrost systems (each with its own **defrost control cycle**), the **defrost interval** for each system shall be documented.

The **defrost interval** shall be expressed in hours, rounded to the nearest 0,1 h. Depending on the defrost control type, the **defrost interval** may be a function of a number of parameters.

6.7 Specified auxiliaries

Where the **refrigerating appliance** contains a specified auxiliary, the impact of this device shall be determined in accordance with Annex F.

The impact of specified auxiliaries is expressed in watt or watt-hour for a range of ambient conditions. These values are then weighted in accordance with regional requirements and conditions in order to provide a relevant estimate of energy associated with the auxiliary.

6.8 Calculation of energy consumption

6.8.1 General

The individual components of **energy consumption** and **steady state** power measured in accordance with this standard shall be combined using the following rules.

6.8.2 Daily energy consumption

All values of **energy consumption** and power shall be converted to daily **energy consumption** values in accordance with the following equations for each **temperature control setting** and **ambient temperature**.

For **refrigerating appliances** without a **defrost control cycle**, the daily **energy consumption** for each **ambient temperature** and each **temperature control setting** is given by:

$$E_{\text{daily}} = P \times 24 \quad (1)$$

Where

E_{daily} is the energy in Wh over a period of 24 h

24 is h/d

P is the **steady state** power in watt for the selected **temperature control setting** as per Annex B.

The measured **steady state** temperature for each **compartment** shall be recorded with this value (for the test report and/or for interpolation).

For **refrigerating appliances** with one defrost system (with its own **defrost control cycle**), the daily **energy consumption** for each **ambient temperature** and each **temperature control setting** is based on the **steady state** power consumption as determined in accordance with Annex B, the incremental **defrost and recovery** energy determined in accordance with Annex C and the **defrost interval** determined in accordance with Annex D as follows:

$$E_{\text{daily}} = P \times 24 + \frac{\Delta E_{df} \times 24}{\Delta t_{df}} \quad (2)$$

Where

E_{daily} is the energy in Wh over a period of 24 h

24 is h/d

P is the **steady state** power in watt for the selected **temperature control setting** as per Annex B.

ΔE_{df} is the representative incremental energy for **defrost and recovery** in Wh in accordance with Annex C (see C.5).

Δt_{df} is the estimated **defrost interval** in hours in accordance with Annex D.

Where there are additional defrost systems (each with its own **defrost control cycle**), the value of term based on ΔE_{df} and Δt_{df} is also added in Formula (2) for each additional defrost system.

The average temperature for each **compartment** for this **temperature control setting** and **energy consumption** is given by:

$$T_{\text{average}} = T_{ss} + \frac{\Delta Th_{df}}{\Delta t_{df}} \quad (3)$$

Where

T_{average} is the average temperature for the **compartment** over a complete **defrost control cycle**.

T_{ss} is the average **steady state** temperature in the **compartment** for the **temperature control setting** in ° C in accordance with Annex B.

ΔTh_{df} is the representative accumulated temperature difference over time for **defrost and recovery** (relative to the **steady state** temperature) in degree Kelvin-hour (Kh) for the relevant **compartment** in accordance with Annex C (see Clause C.5).

Δt_{df} is the estimated **defrost interval** in hours in accordance with Annex D.

The value of ΔTh_{df} may be positive (if the temperature is warmer during **defrost and recovery**) or negative (if it is cooler, due to a pre-cool and low heat leakage during defrost).

Where there are additional defrost systems (each with its own **defrost control cycle**), the value of term based on ΔTh_{df} and Δt_{df} is also added in Formula (3) for each additional defrost system.

6.8.3 Interpolation

Where interpolation is performed in order to obtain a more optimum estimate of the daily **energy consumption** for a given **ambient temperature**, the calculations for each **compartment** temperature and **energy consumption** determined in accordance with 6.8.2 shall be used as set out in Annex E.

6.8.4 Specified auxiliaries

Where the **refrigerating appliance** contains specified auxiliaries, the increase in **energy consumption** associated with these auxiliaries is calculated according to the relevant local regional operating schedule specified and using the parameters set out in Annex F. The impact of these auxiliaries is typically estimated over a year, so care is required when attempting to add these to other energy values calculated in this standard – annual values need to be determined for the other energy values before these figures can be added.

6.8.5 Total energy consumption

The total **energy consumption** of an appliance can be estimated from the following values:

$E_{\text{daily}16^{\circ}\text{C}}$ at an **ambient temperature** of 16 °C

$E_{\text{daily}32^{\circ}\text{C}}$ at an **ambient temperature** of 32 °C

The value of E_{daily} at **ambient temperatures** of 16 °C and 32 °C may be calculated by interpolation in accordance with Annex E. Annex I provides some examples of how these two values can be combined to provide an annual energy estimate.

[C] Text deleted **[C]**

NOTE 1 The ice-making test is performed at **ambient temperatures** of 16 °C and 32 °C so E_{aux} is a regional function of $\{E_{\text{aux}16^{\circ}\text{C}}, E_{\text{aux}32^{\circ}\text{C}}\}$.

[C] The total annual energy consumption of a refrigerating appliance E_{total} (except for **low noise refrigerating appliances**) can be given by:

$$E_{\text{total}} = f\{E_{\text{daily}16^{\circ}\text{C}}, E_{\text{daily}32^{\circ}\text{C}}\} + E_{\text{aux}} \quad (4)$$

where

f is a regional function to give the annual energy based on daily energy at 16 °C and 32 °C. In this standard this function is defined as:

$$f\{E_{\text{daily}16^{\circ}\text{C}}, E_{\text{daily}32^{\circ}\text{C}}\} = (Day_{16^{\circ}\text{C}} \times E_{\text{Daily}16^{\circ}\text{C}}) + (Day_{32^{\circ}\text{C}} \times E_{\text{Daily}32^{\circ}\text{C}})$$

where $Day_{16^{\circ}\text{C}} = Day_{32^{\circ}\text{C}} = 365/2$ days = 182,5 days;

see Annex I for examples by taking into account $D_{16^{\circ}\text{C}} = D_{32^{\circ}\text{C}} = 365/2$ d = 182,5 days;

E_{aux} is the annual energy from ambient controlled anti-condensation heater(s) as described in Annex F. See I.5 for an example how to calculate this auxiliary.

The E_{total} shall be calculated in according the following equation:

$$E_{\text{total}} = 182,5 \times E_{\text{daily}16^{\circ}\text{C}} + 182,5 \times E_{\text{daily}32^{\circ}\text{C}} + E_{\text{aux}}$$

For **low noise refrigerating appliances**, the energy consumption shall be determined as provided for in Formula 4, but at an ambient temperature of 25 °C instead of at 16 °C and 32 °C. **[C]**

[A11] E_{daily} , expressed in kWh/24h and rounded to three decimal places for the calculation of the total annual energy consumption is then as follows:

$$E_{\text{daily}} = E_{25}$$

where E_{25} is the daily energy consumption at an ambient temperature of 25 °C and derived according 6.8.2 and 6.8.3. **[A11]**

NOTE 2 Energy associated with load processing arising from user interactions is not included in these calculations. See Annex G for measurements and associated energy calculations.

[A11] For the determination of $E_{\text{daily}16^{\circ}\text{C}}$ for mobile refrigerating appliances which are placed on the market with an AC/DC converter and having only a **pantry compartment** and which are not falling under the category **low noise refrigerating appliances**, the following cases have to be considered:

- If the appliance is equipped with a main switch which switches off the complete appliance, then $E_{\text{daily}16^{\circ}\text{C}} = 0$ kWh/d shall be used for further calculation
- If the appliance is equipped with a switch which switches off the cooling circuit, then $E_{\text{daily}16^{\circ}\text{C}} =$ stand-by energy consumption shall be used for further calculation
- If the appliance is equipped with no main switch, the appliance is disconnected from mains and $E_{\text{daily}16^{\circ}\text{C}} = 0$ kWh/d shall be used for further calculation. **[A11]**

7 Circumvention devices

A circumvention device is any control device, software, component or part that alters the refrigerating characteristics during any test procedure, resulting in measurements that are unrepresentative of the appliance's true characteristics that may occur during **normal use** under comparable conditions. Generally, circumvention devices save energy during an energy test but not during **normal use**. Examples of circumvention may include, without limitation, any variation to normal operation when the appliance is subjected to testing, and includes devices that

- a) alter **compartment** temperature set points during the test; or
- b) activate or de-activate heaters or other energy-consuming devices during the test; or
- c) manipulate compressor cycle time or other operating parameters during the test; or
- d) manipulate the **defrost interval**.

Devices that operate over a restricted range of conditions and which are:

- required for the maintenance of satisfactory food preservation temperatures within **compartments** (e.g. temperature compensation heaters in **fresh food compartments** that operate at low ambient conditions); or
- intended to reduce **energy consumption** during **normal use**

will generally not be treated as circumvention devices where the legitimate basis for their operation during **normal use** and under the test procedure for **energy consumption** is declared and can be demonstrated by the supplier.

Where the operation of a circumvention device is suspected, a laboratory should subject the appliance to measures such as door openings or other appropriate actions in an attempt to detect presence and operation of any such devices. Details of any such action and their effect shall be included in the test report. Where a circumvention device is suspected or detected during testing, a laboratory shall report that information to the client.

Circumvention devices, where present, may be subject to regional regulations and requirements. Such devices may be prohibited in some jurisdictions. Other jurisdictions may require the circumvention device to be defeated for energy tests or the product to be tested in such a way to obtain an assessment of the energy impact of the circumvention device operation. Any additional **energy consumption** associated with the circumvention device may be added to the measured **energy consumption** and there may be penalty factors associated with the additional energy associated with the circumvention device.

8 Uncertainty of measurement

For all energy measurements, the uncertainty of measurement of the measured value should be determined and stated with the measured result.

Where less stringent validity criteria have been applied to obtain an approximate result in a shorter time, the resulting increase in uncertainty shall be taken into account in any statement of uncertainty.

Verification tests should take into consideration the measurement uncertainty when assessing the energy result against any relevant validity criteria.

NOTE The calculation of uncertainty of measurement is not specified in this standard. Further guidance on this issue can be obtained from the ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*.

9 Test report

A test report that includes all of the relevant information listed in IEC 62552-3:2015 Annex F for tests undertaken in accordance with this standard should be prepared.

Annex A (normative)

Set up for energy testing

A.1 General

For the purposes of energy determination in accordance with this standard, the **refrigerating appliance** shall be set up as specified below.

The **refrigerating appliance** shall be installed in a test room and with instrumentation as specified in IEC 62552-1:2015, Annex A.

The **refrigerating appliance** shall be prepared and set up in accordance with the requirements of IEC 62552-1:2015, Annex B.

The **refrigerating appliance** shall have air temperature sensors installed at the positions specified in IEC 62552-1:2015, Annex D. The determination of **compartment** air temperature during energy testing shall be as specified in IEC 62552-1:2015, Annex D.

A.2 Additional set up requirements for energy testing

A.2.1 Ice making trays

Any **ice cube trays** with a dedicated position, as specified in the instructions, shall remain in place but shall be empty for energy tests (except as specified in Annex G).

A.2.2 User adjustable controls

User-adjustable temperature control(s) that are not used for energy interpolations in accordance with Annex E shall be set in a single position that meets the relevant **compartment** temperature requirements set out in Clause 5 (**target temperatures**) for all test runs. Where interpolation between the results of two or more test runs is to be performed in accordance with Annex E, the only setting(s) to be changed between test runs shall be the relevant **user-adjustable temperature control(s)** used for interpolation. The position of all baffles and **user-adjustable temperature control(s)** not used for interpolation shall be recorded in the test report.

Where a **wine storage compartment** has setting options for both uniform temperature and multiple temperature zones, the uniform temperature setting shall be selected for testing.

A.2.3 Ambient temperature

For **energy consumption** determination, the nominal test room temperatures are 16 °C and 32 °C. The operational requirements for test room **ambient temperatures** are specified in IEC 62552-1.

A.2.4 Accessories and shelves

Any accessories, loose trays, bins or containers that have no dedicated position or essential function during **normal use**, as specified in the instructions, shall be removed.

Any thermal storage devices (e.g. ice-bricks or similar) that are removable without the use of a tool shall be removed for all tests, irrespective of instructions.

A.2.5 Anti-condensation heaters

Anti-condensation heaters which are permanently on during **normal use** shall be tested with the heater(s) operating for all energy tests.

Anti-condensation heaters that can be switched 'on' or 'off' by the user shall be tested at both the 'on' and 'off' setting.

Anti-condensation heaters that have a number of possible settings that can be selected by the user shall be tested at both the 'highest energy' and the 'lowest energy' setting.

Sufficient data shall be collected so that the additional power consumption associated with the anti-condensation heater(s) at each specified setting can be estimated with the **compartment(s)** operating at the same temperature(s). The additional power consumed by the **refrigerating appliance** when the anti-condensation heater(s) are operating at each **ambient temperature** shall be determined. Energy test values shall be separately reported for each specified setting.

NOTE A number of possible approaches can be used to determine the incremental impact of manually switched anti-condensation heater(s) as set out in Annex F (for example, measure energy without heaters then add calculated energy, measure energy with heaters then subtract actual energy before adding calculated energy). If there is any doubt about the most expedient method, the optimum energy in accordance with Annex B (using interpolation where necessary) should be determined with and without the anti-condensation heater(s) operating in order to determine this value (noting that their operation may have a small impact on **compartment** temperatures).

Anti-condensation heaters which are automatically controlled and vary in response to ambient conditions (e.g. temperature and/or humidity) are classified as specified auxiliaries and shall be tested in accordance with Annex F.

Anti-condensation heaters which are automatically controlled and vary in response to ambient conditions but are configured so that the user can select the underlying or base level of heater power shall be tested at highest and lowest user setting in accordance with Annex F (refer F.2.8).

A.2.6 Automatic icemakers – ice storage bins

A.2.6.1 General

Where an appliance includes an automatic ice-making feature that produces, harvests and stores ice, the space that the ice storage bin occupies shall be specifically treated as a separate **sub-compartment** for the purposes of energy testing.

Any automatic ice-making bin shall be separately declared under '**Compartment** Details' in the test report.

For all energy tests, the ice delivery mechanism shall remain functional, i.e. all chutes and throats required for the delivery of ice shall be free of packing, covers or other blockages that may be fitted for shipping or when the ice-maker is not in use.

Where the ice storage space occupies a complete **compartment**, the temperature sensor placements shall be in accordance with IEC 62552-1:2015 Annex D (not A.2.6.5 of this part).

A.2.6.2 Intent and overview for energy testing

The intent is to make sure that during an **energy consumption** test to this standard the automatic ice-maker and its associated equipment behaves in a manner that is consistent with a value that would be obtained while the system is running but is not making new ice.

In order to achieve this condition during an energy test, automatic ice-makers shall function normally but shall not produce any new ice (but should be in a state that would allow it to).

produce new ice on demand without any user intervention if some ice were removed). Only devices or components directly associated with the production or harvesting of new ice shall be inoperative during the energy test. All components not explicitly associated with the production or harvesting of new ice shall operate normally during the energy test and shall be energized in a manner consistent with the duty cycle necessary to perform their respective functions. The cooling of the icemaker area(s) shall remain unchanged from normal ice-storage conditions.

Other than for verification tests as specified in A.2.6.4, connection to a water supply may be omitted if it can be demonstrated that the absence or presence of a connection to a water supply will make no difference to the measured **energy consumption**.

A.2.6.3 Ice storage bin configuration

The ice storage bin shall remain in place and empty for all energy testing, except where otherwise specified in A.2.6.4. The automatic ice-making bin shall be treated as a **sub-compartment** and shall be fitted with a temperature sensor as specified in A.2.6.5.

Any action taken by the test laboratory (including settings or configuration) during the energy test to make the automatic ice-maker operative but to cease production of ice due to an ice-bin-full condition in accordance with A.2.6 shall be included in the test report.

A.2.6.4 Verification of energy consumption with an automatic ice-maker

For the purposes of verification of **energy consumption** of an appliance, the setup of the automatic icemaker should be configured in accordance with the setup specified by the manufacturer.

In order to detect whether there are any undeclared circumvention devices in operation during an energy test, irrespective of instructions, a test laboratory may undertake tests, including the test as set out below to assess the normal operation of the automatic ice-maker and its associated controls against the requirements of Clause 7 and the intent of A.2.6.2.

The purpose of this test, where undertaken, is to assess the normal operation of the automatic ice-maker against the configuration used for energy testing as set out in A.2.6.4. The ice-maker is connected to a water supply, the ice-making function is operated until the bin is full and ice production has automatically stopped under its own control prior to commencing an energy test. To shorten the test time, pre-made ice cubes may be used to partially fill the ice storage bin before the start of the test, but only to a level that allows the icemaker to continue producing ice to fill the bin.

The automatic ice-making bin shall be fitted with a temperature sensor as specified in A.2.6.5.

The temperature in the ice-making storage bin should remain well below freezing during all stages of operation. As a guide, the **energy consumption** with the ice storage bin full of ice under this clause should not exceed by 2 % the **energy consumption** measured during energy testing for the same (or equivalent) **temperature control settings** and internal temperatures but with the ice storage bin empty.

A.2.6.5 Position of the temperature sensor in automatic ice-makers

☐ An automatic ice-maker bin shall have a single temperature sensor located in the position specified as follows for all energy tests: ☐

- a) Vertical placement: Approximately 50 mm below the top of the estimated maximum ice storage level while maintaining at least 20 mm clearance from the base of the bin.
- b) Horizontal placement: Approximately 20 mm clearance from the vertical centre line of the side of the bin that is closest to an external surface or warmer **sub-compartment** (e.g. door or wall or gasket or **sub-compartment**) or, where the bin is more than 50 mm from

an external surface, approximately 20 mm clearance from the vertical centre line of the largest side of the bin (i.e. where the bin is wholly within the **compartment**).

- c) Where the position specified in b) is affected by a direct air stream, it shall, as far as possible, be relocated to an alternative position that has 20 mm clearance from the side of the bin but away from a direct air stream that is colder than the bin contents.

If the position of the temperature sensor is moved so that it is away from the preferred positions specified in a) and b) above, the position of the sensor shall be noted in the test report.

NOTE In a verification test in accordance with A.2.6.4, ice will usually touch the temperature sensor in the storage bin. See A.2.6.1 regarding the placement of temperature sensors in separate **compartments** that are dedicated to ice storage.

Annex B (normative)

Determination of steady state power and temperature

B.1 General

This Annex specifies the method to be used to determine the power consumption and temperature for a **refrigerating appliance** during stable operation that is tested in accordance with this standard.

B.2 Setup for testing and data collection

The objective is to select a representative period of operation in order to determine the average power and average internal temperatures (for all relevant **compartments**) for the selected **temperature control setting** and test **ambient temperature**.

The **refrigerating appliance** under test shall be set up and operated in accordance with Annex A.

There are two possible cases with respect to the determination of **steady state** power consumption:

- Case SS1 (see Clause B.3) applies to products without a **defrost control cycle** and products with a defrost system (with its own **defrost control cycle**) where the **defrost control cycle** is long and the **steady state** test period of interest may not be bounded by **defrost and recovery periods**. Quite stringent internal validity criteria are applied to the data to ensure that a representative period of operation is selected.
- Case SS2 (see Clause B.4) applies to products with a defrost system (with its own **defrost control cycle**) where the **steady state** test period of interest commences with a valid **defrost and recovery period**. Case SS2 shall be used where stability between defrosts cannot be established using Case SS1. In Case SS2 the whole period from defrost to defrost is used to determine the **steady state** power consumption by deduction of initial incremental **defrost and recovery** energy (see DF1 in Annex C). In Case SS2, the **steady state** operation before the initial defrost and before the following defrost are compared and they shall meet the relevant stability criteria. The initial defrost shall also meet the validity requirement of DF1 as specified in Annex C.

B.3 Case SS1: no defrost control cycle or where stability is established for a period between defrosts

B.3.1 Case SS1 approach

Case SS1 applies to all products without a **defrost control cycle**. It also can apply to products with a defrost system (with its own **defrost control cycle**) where the **defrost control cycle** is long and the **steady state** test period of interest is not bounded by **defrost and recovery periods**. In this case, no **defrost and recovery period** (or part thereof) shall occur during the selected test period under Case SS1.

Where the **steady state** power is determined under Case SS1, a **steady state** test period that is made up of 3 internal blocks of test data is selected that are adjacent but not overlapping. Each block of test data shall contain an equal number (n) of whole **temperature control cycles**. The minimum number of **temperature control cycles** per block is 1. A test period is selected where all relevant criteria for internal spread and slope for temperature and power can be established.

A block size of 1 **temperature control cycle** will have a total test period of 3 **temperature control cycles**, a block size of 2 **temperature control cycles** will have a test period of 6 **temperature control cycles**, and so on. The definition of **temperature control cycle** in IEC 62552-1:2015 should be considered carefully. It is generally recommended that for more complex refrigeration systems alternative **temperature control cycles** based on temperature maxima in each **compartment** be examined in addition to compressor cycles (where present) to see which one provides the most stable estimate of power over time. Selecting the most stable **temperature control cycle** can shorten the required testing time to achieve a valid result.

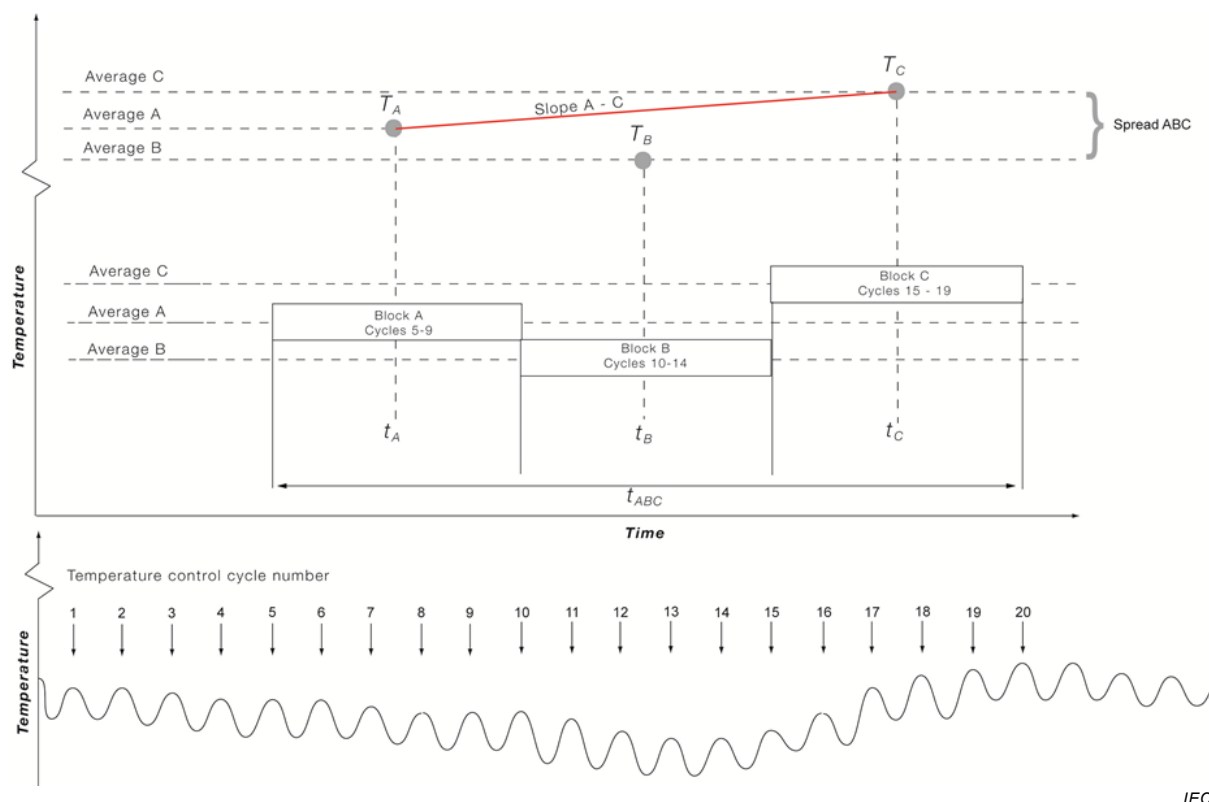
Where there are no discernable changes in temperature or power consumption over time, a test period that is made up of 3 internal blocks of test data is selected. Each block of test data shall be equal in length, adjacent and no less than 4 h in duration.

As an alternative to using **temperature control cycles**, fixed length periods may be used (referred to as fixed time slices) to make up each block.

A trial test period shall be made up of 3 blocks of data called A, B and C.

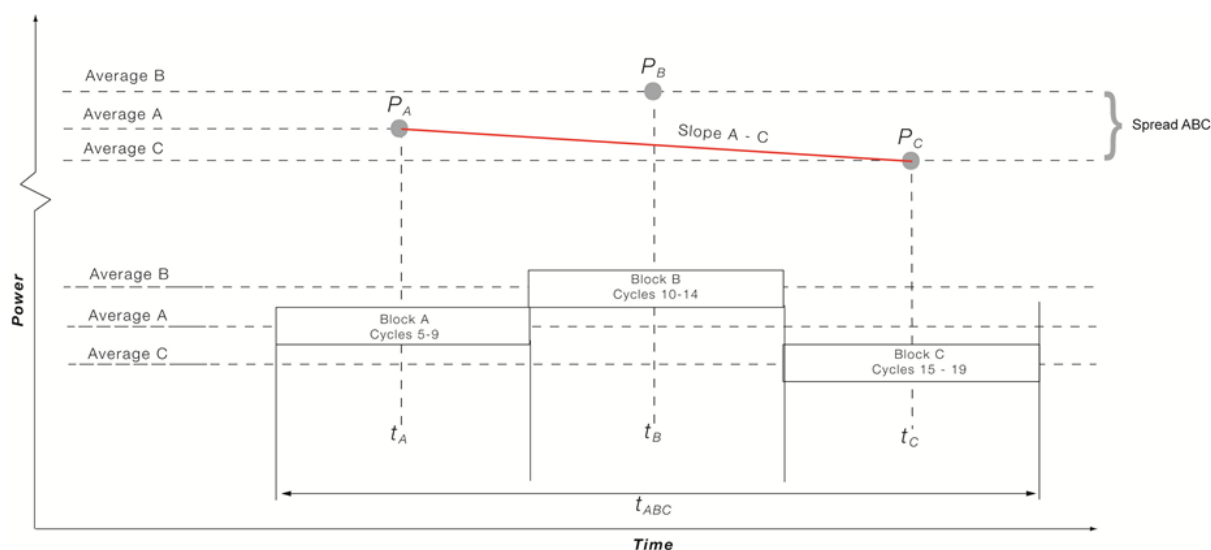
NOTE There is no maximum number of **temperature control cycles** per block, but a value of 10 is considered to be unusually long.

An example test period made up of blocks of 5 **temperature control cycles** is illustrated in Figure B.1.



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Figure B.1 – Illustration of a test period made of blocks of 5 temperature control cycles – temperatures for Case SS1



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Figure B.2 – Illustration of a test period made of blocks of 5 temperature control cycles – power for Case SS1

For each block of data (A, B and C), calculate the average power and the average temperature in each relevant **compartment**.

Calculate the following characteristics across the test Blocks A, B and C:

- Spread of temperature for each **compartment**: calculated as the difference between the average temperature of the warmest Block (A, B or C) and the average temperature of the coldest Block (A, B or C). All temperature differences (spread) are in K. Refer to Equation (5).
- Slope of temperatures from Block A to Block C: calculated as [the absolute value of the difference between the average temperature of Block A and the average temperature of Block C] divided by [the test time at the middle of Block C minus the test time at the middle of Block A]. All temperature slopes are in K/h. Refer to Equation (6).
- Spread of power (watt): calculated as the difference between the average power of the highest power Block (A, B or C) and the average power of the lowest power Block (A, B or C) divided by [the average power for the whole test period (A, B and C)], expressed as a percentage. Refer to Equation (7).
- Slope of power from Block A to Block C: calculated as [the absolute value of the difference between the average power of Block C and the average power of Block A] divided by [the test time at the middle of Block C minus the test time at the middle of Block A] and divided by [the average power for the whole test period (A, B and C)]. All power slopes are expressed as a percentage per hour (%/h). Refer to Equation (8).

$$\text{Spread of temperature} = T_{\max(A,B,C)} - T_{\min(A,B,C)} \text{ (K)} \quad (5)$$

$$\text{Slope of temperature} = \frac{ABS[T_C - T_A]}{[t_C - t_A]} \text{ (K/h)} \quad (6)$$

$$\text{Spread of power} = \frac{P_{\max(A,B,C)} - P_{\min(A,B,C)}}{P_{av(A,B,C)}} \text{ (%) } \quad (7)$$

$$\text{Slope of power} = \frac{ABS[P_C - P_A]}{[t_C - t_A] \times P_{av(A,B,C)}} \quad (\%/h) \quad (8)$$

Where for each block A, B and C:

T is the temperature

t is the test time (the centre point of the block)

P is the power

% is the result of the quotient (expressed as a percentage, where 1,0 = 100 %)

B.3.2 Case SS1 acceptance criteria

Based on the characteristics calculated in B.3.1, assess the validity of the whole test period (made up of 3 blocks, each consisting of n **temperature control cycles**). The test period shall be valid if all of the following criteria are met:

- Total test period t_{ABC} (sum of length of Blocks A, B and C) is no less than 6 h where there are **temperature control cycles** and no less than 12 h where there are no **temperature control cycles** (or where fixed time slices are used);
- Spread of temperature (across Blocks A, B, C) is less than 0,25 K for each **compartment**;
- Slope of temperature (from Block A to Block C) is less than 0,025 K/h for each **compartment**;
- Spread of power (across Blocks A, B, C) where **temperature control cycles** are present is less than: for a total test period t_{ABC} of 12 h or less, a spread of not more than 1 %; for a total test period t_{ABC} from 12 to 36 h, a spread of not more than 1 % + $(t_{ABC} - 12) / 1\,200$; for a total test period t_{ABC} of 36 h or more, a spread of not more than 3 %;
- Spread of power (across Blocks A, B, C) where no **temperature control cycles** are present or where fixed time periods are selected is less than 1 %, irrespective of the total test period;
- Slope of power (from Block A to Block C) is less than 0,25 %/h;
- Where **temperature control cycles** are present, the two comparable test periods that start one and two **temperature control cycles** earlier than the period selected also meet all of the above criteria (i.e. the selected test period is the third possible period that meets all other validity criteria);
- Where **temperature control cycles** are not present (or where fixed time slices are used), the two comparable test periods that start one hour and two hours earlier than the period selected also meet all of the above criteria.

The requirement for the test period to remain valid when moved along for 3 consecutive **temperature control cycles** ensures that compliance with all criteria for the selected period is not a chance or random occurrence. In the example illustrated in Figure B.1, if the test period starting at **temperature control cycle** 5 and ending at **temperature control cycle** 20 was the first period to meet the above criteria 1 to 5, the test period from 6 to 21 and 7 to 22 would also have to meet all criteria. In this case the test period from 7 to 22 is the first valid test period.

NOTE 1 The full set of criteria above were developed on the basis of extensive testing and review of data for more than 100 **refrigerating appliances**.

The **temperature control setting(s)** shall remain unchanged for all the test period used to determine the value for SS1 (Blocks A, B and C).

Where there are more than two **compartments**, assessment of temperature stability as set out above is required for:

- The largest **unfrozen compartment** and largest **frozen compartment** (where applicable), or
- The largest two **compartments** (where all **compartments** are **frozen** or **unfrozen**).

In addition, temperature stability shall be achieved as specified above for all **compartments** that are used for interpolation for **energy consumption** in accordance with Annex E.

If the above criteria cannot be met, the size of n is increased (and therefore the length of the test period is increased) and/or more test data is collected until all criteria can be met simultaneously.

The recommended approach during the collection of test data is to continually look (backwards) at all of the data collected to that moment in order to assess all possible test periods for all possible block sizes (n) to establish the earliest possible point in the test data that can meet the above validity criteria. While it is not generally recommended that data from a warm start (pull down when the power is first connected) be included in these assessments, these criteria should ensure that any pull down prior to the establishment of stable operation is automatically excluded from a valid test period.

Where there are a number of possible test periods that meet the above criteria, the test period with the minimum spread of power from the available test data should be selected.

Where the criteria of power spread cannot be met by extending the total test period (with or without **temperature control cycles**), a valid result may be obtained by using 3 blocks of data with each block no less than 36 h in length (total test period no less than 108 h).

NOTE 2 A worked example to select the optimum test period characteristics is included in Annex I.

B.3.3 Case SS1 calculation of values

Where a test period, made up of Blocks A, B and C, meets the relevant acceptance criteria in B.3.2, then the temperature T_i for each **compartment** i and the average power P_{SS1} is determined as the average of all measured values included in the time period covered by Blocks A, B and C.

The **steady state** power used for subsequent energy calculations P_{SS} is determined by modifying the value of P_{SS1} using Formula (15) in Clause B.5 where the measured **ambient temperature** is not equal to the nominal **ambient temperature** during the test.

The total test time for Blocks A, B and C shall be reported.

The **steady state** compressor run time CRt_{SS} is calculated as the percentage of time that the compressor is on during the total time for all **temperature control cycles** in Blocks A, B and C.

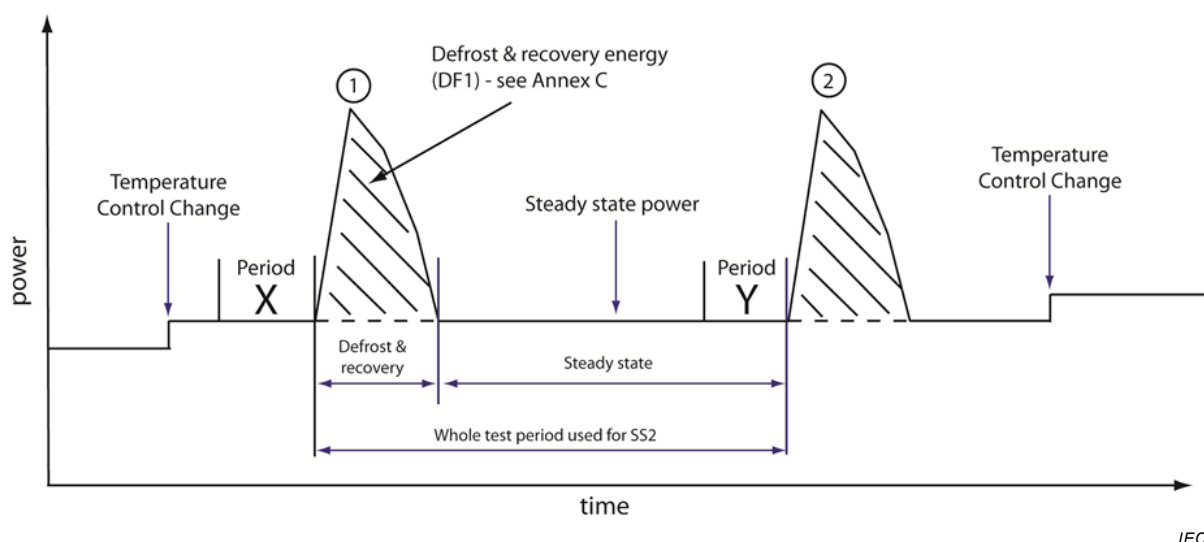
B.4 Case SS2: steady state determined between defrosts

B.4.1 Case SS2 approach

Case SS2 applies to products with one or more defrost systems (each with its own **defrost control cycle**) where the **steady state** test period of interest is bounded by **defrost and recovery periods**. While it may be used for all products with one or more defrost systems, Case SS2 shall be used if stability cannot be established using Case SS1.

For products with long **defrost intervals**, the use of Case SS1 may considerably shorten the required test time.

Case SS2 uses all data between the start of two **defrost and recovery periods** to calculate the **steady state** power (see Formula (12)). Checks are undertaken to compare the characteristics of the **steady state** operation prior to each **defrost and recovery period** (Periods X and Y in Figure B.3) to ensure that they meet the relevant stability requirements before undertaking any further analysis. The initial **defrost and recovery period** within the test period SS2 shall comply with the validity requirements of Annex C and the incremental energy associated with this **defrost and recovery period** shall be determined in accordance with Annex C (DF1) in order to determine the value for P_{SS2} (which is the whole test period less the value for DF1).



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Figure B.3 – Case SS2 – typical operation of a refrigerating appliance with a defrost control cycle

A period of **steady state operation** (called Period X), ending at the start of a **defrost and recovery period** and made up of no less than 4 whole **temperature control cycles** (where **temperature control cycles** are present) and no less than 4 h in length, is selected. A second period of **steady state** operation (called Period Y), ending at the start of the next **defrost and recovery period** and made up of no less than 4 whole **temperature control cycles** (where **temperature control cycles** are present) and no less than 4 h in length, is selected. Periods X and Y shall always consist of the same number of **temperature control cycles** (where **temperature control cycles** are present) and should be approximately the same length. Periods X and Y shall be exactly the same length where no **temperature control cycles** are present.

Where no subsequent **defrost and recovery period** has been initiated within 48 h, Period Y may be selected at a point during **steady state** operation where the elapsed time from the end of Period X to the end of Period Y exceeds 48 h but where Period Y is not adjacent to a subsequent **defrost and recovery period**. Where Period Y is selected in this manner, it shall be noted in the test report.

The temperature in each **compartment** and power for Period X are then compared to the temperature in each **compartment** and power for Period Y.

Calculate the following characteristics across the Periods X and Y:

- Spread of temperature for each **compartment**: calculated as the difference between the average temperature of the warmer period (X or Y) minus the average temperature of the colder period (X or Y). All temperature differences (spread) are in degrees K. Refer to Equation (9).
- Spread of power: calculated as the difference between the average power of the higher power period (X or Y) minus the average power of the lower power period (X or Y) divided

by the average power for the Periods X and Y. The spread of power is expressed as both a percentage and as an absolute spread (W). Refer to Equations (10) and (11).

$$\text{Spread of temperature} = T_{\max(X,Y)} - T_{\min(X,Y)} \text{ (K)} \quad (9)$$

$$\text{Spread of power} = \frac{P_{\max(X,Y)} - P_{\min(X,Y)}}{P_{av(X,Y)}} \text{ (%) } \quad (10)$$

$$\text{Spread of power} = P_{\max(X,Y)} - P_{\min(X,Y)} \text{ (W)} \quad (11)$$

Where for each period X and Y:

T is the temperature

P is the power in W

% is the result of the quotient (expressed as a percentage, where 1,0 = 100 %)

B.4.2 Case SS2 acceptance criteria

For the period selected for determination of P_{SS2} **steady state** power to be valid, the following criteria shall be met:

- Period X and Y shall be made up of no less than 4 whole **temperature control cycles** (where **temperature control cycles** are present) and shall have the same number of **temperature control cycles**. Where no **temperature control cycles** are present (or where fixed time slices are used), X & Y shall be the same length.
- Period X and Y shall not be less than 4 h in length.
- The ratio of the total length of Period X (in hours) to the total length of Period Y (in hours) shall be in the range 0,8 to 1,25 where **temperature control cycles** are present.
- The spread of temperature of the two selected Periods X and Y shall be less than 0,5 K for each **compartment**;
- The spread of power of the two selected Periods X and Y shall be less than 2 % or less than 1 W, whichever is the greater value.
- The initial **defrost and recovery period** which is included in period SS2 shall qualify as a valid **defrost and recovery period** in accordance with Annex C.
- The value of ΔE_{df} for the initial **defrost and recovery period** which is included in period SS2 shall be determined in accordance with Annex C.

The **temperature control setting** shall remain unchanged for all the test period used to determine the value for SS2, including the period used to determine the incremental **defrost and recovery** energy (ΔE_{df} for DF1) specified in Annex C (including all of Periods X and Y).

Where the initially selected Period X and Period Y do not comply with the acceptance criteria specified above, the minimum length of time for Period X and Y shall both be increased in steps of 1 **temperature control cycle** (in 1 h steps where there are no **temperature control cycles** or where fixed time slices are used) to see if there are any possible complying periods. Where the size of X and Y are increased, the first valid value using the sequence specified above shall be used. The length of X and Y shall not exceed 50 % of the defrost interval or 8 h, whichever is the longer.

Where there are more than two **compartments**, assessment of temperature stability as set out above is required for:

- The largest **unfrozen compartment** and largest **frozen compartment** (where applicable), or
- The largest two **compartments** (where all **compartments** are **frozen** or **unfrozen**).

In addition, temperature stability shall be achieved as specified above for all **compartments** that are used for interpolation for **energy consumption** in accordance with Annex E.

In rare cases where there is no **steady state** operation between defrosts, it may not be possible to ever confirm the validity of the initial **defrost and recovery period** at the start of SS2 in accordance with Annex C. An alternative approach to deal with such cases is outlined in Annex K, but this should only be used if compliance with Annex C can never normally be achieved.

B.4.3 Case SS2 calculation of values

Where the acceptance criteria in B.4.2 have been met, the determination of **steady state** power and **steady state** temperature in each **compartment** are calculated from the whole test period used for SS2 (including the initial **defrost and recovery period**) as set out in Formula (12) and Formula (13) below. The calculation determines the **energy consumption** over whole **defrost control cycle** and subtracts the incremental defrost and recovery energy in accordance with Annex C in order to determine the **steady state** power consumption P_{SS2} . Similarly, each **compartment** temperature is determined over the whole **defrost control cycle** and the accumulated temperature difference during the **defrost and recovery period** in each **compartment** (in accordance with Annex C) is subtracted in order to determine the **steady state** temperature in each **compartment** T_{SS2-i} .

The average power during the **steady state** period shall be calculated from the whole test period used for SS2 as follows:

$$P_{SS2} = \frac{(E_{end-Y} - E_{end-X}) - \Delta E_{df}}{(t_{end-Y} - t_{end-X})} \quad (12)$$

Where

P_{SS2} is the **steady state** power for the selected **defrost control cycle** in W

E_{end-X} is the accumulated energy reading at the end of Period X in Wh

E_{end-Y} is the accumulated energy reading at the end of Period Y in Wh

t_{end-X} is the test time at the end of Period X in h

t_{end-Y} is the test time at the end of Period Y in h

ΔE_{df} is the incremental **defrost and recovery** energy in Wh in accordance with Annex C for the **defrost and recovery period** commencing at the end of Period X.

The length of the test period used ($t_{end-Y} - t_{end-X}$) shall be separately reported. Where applicable, it shall be noted whether Period Y was adjacent to a subsequent defrost.

The **steady state** power used for subsequent energy calculations P_{SS} is determined by modifying the value of P_{SS2} using the formula in B.5 where the measured **ambient temperature** is not equal to the nominal **ambient temperature** during the test.

The average temperature during the **steady state** period shall be calculated from the whole test period used for SS2 as follows:

$$\text{C)} \quad T_{SS2-i} = (T_{av-endX-endY-i}) - \left[\frac{\Delta Th_{df-i}}{(t_{end-Y} - t_{end-X})} \right] \quad (13) \text{C)}$$

Where

- T_{SS2-i} is the **steady state** temperature in **compartment** i that occurs in the whole test period used for SS2 in degrees C
- $T_{av-endX-endY-i}$ is the average temperature in **compartment** i over the period from the end of Period X to the end of Period Y in degrees C
- $\text{C} \Delta Th_{dfj-i}$ is the accumulated temperature difference over time in each **compartment** i in Kh as determined in accordance with C.3.3 for the **defrost and recovery period** j commencing at the end of Period X C
- t_{end-X} is the test time at the end of Period X in h
- t_{end-Y} is the test time at the end of Period Y in h

For products with a compressor run time defrost controller, the **steady state** compressor run time CRt_{SS} is calculated as the percentage of time that the compressor is on for the whole **defrost control cycle** less the value for Δt_{dr} determined in Annex C as set out in Equation (14).

$$\text{C} \quad CRt_{SS2} = \frac{Rt_{end-Y} - Rt_{end-X} - \Delta t_{drj}}{(t_{end-Y} - t_{end-X})} \quad (14) \text{C}$$

Where

- CRt_{SS2} is the average percentage compressor run time that occurs in **steady state** in %
- Rt_{end-X} is the total accumulated compressor run time (on period) at the end of period X in h
- Rt_{end-Y} is the total accumulated compressor run time (on period) at the end of period Y in h
- $\text{C} \Delta t_{drj}$ is the additional compressor run time in h as determined in accordance with C.3.3 for the **defrost and recovery period** j commencing at the end of period X C
- t_{end-X} is the test time at the end of the Period X in h
- t_{end-Y} is the test time at the end of the Period Y in h

Care is required not to count defrost heater on time as compressor on time in these calculations (although it is possible that some controllers include the defrost heater operation as run time – each product should be checked to see how it is configured).

B.5 Correction of steady state power

The **steady state** power used for subsequent energy calculations P_{ss} is based on the measured **steady state** power (B.3 or B.4 as applicable) after adjustment using Formula (15) below. This adjustment takes into account the difference between the measured **ambient temperature** during the test and the nominal ambient test temperature.

$$P_{SS} = P_{SSM} \times \left(1 + [T_{at} - T_{am}] \times \frac{\sum_{i=1}^n \left[\frac{V_i}{(c_l \times (18 + T_{it}) + c_2)} \right]}{\sum_{i=1}^n \left[\frac{V_i \times (T_{am} - T_{im})}{(c_l \times (18 + T_{it}) + c_2)} \right]} \right) \times \frac{1}{[1 + (T_{at} - T_{am}) \times \Delta COP]} \quad (15)$$

Where

- P_{SSM} is the measured **steady state** power for the period in W as specified in B.3 (P_{SS1}) or B.4 (P_{SS2}) as applicable
- T_{at} is the target test room **ambient temperature**
- T_{am} is the measured test room **ambient temperature** during the test period
- V_i is **rated volume** of **compartment** i (for **compartments** 1 to n)

- T_{im} is the measured temperature in **compartment** i to n during the test period
- T_{it} is the **target temperature** for **energy consumption** in **compartment** i to n (refer Table 1)
- c_1 is a constant given as 0,011 364
- c_2 is a constant given as 1,25
- ΔCOP is the adjustment given in Table B.1 for the product type and test condition.

All temperatures are in degrees Celsius (°C).

[A11] NOTE Z1 For a refrigerating appliance that consists only of a pantry compartment and which is equipped with a main switch which switches off the complete appliance (see 6.8.5, “Total energy consumption”), $P_{ss} = P_{SSM}$

For a **compartment** the target temperature of which is above ambient temperature, Formula (15) shall not be applied. **[A11]**

Table B.1 – Assumed ΔCOP adjustment

[A11] Product type	ΔCOP adjustment at 16 °C	ΔCOP adjustment at 25 °C	ΔCOP adjustment at 32 °C
Two or more compartments	0,000 per K increase	–0.007 per K increase	–0,014 per K increase
One compartment	–0,004 per K increase	–0,012 per K increase	–0,019 per K increase [A11]

This formula is not valid for corrections that are outside the permitted ambient test temperature range specified in IEC 62552-1:2015 (nominally $\pm 0,5$ K). This correction is only applied to the **steady state** power. No correction is applied to measured temperatures or any **defrost and recovery** calculations in Annex C. The value(s) of **volume** that are used in the correction equation are the **rated** values in accordance with this standard as specified in the instructions or other product literature. More information on the derivation of this equation is included in Annex L.

Annex C (normative)

Defrost and recovery energy and temperature change

C.1 General

This Annex specifies the method to be used to determine the additional energy associated with **defrost and recovery periods** that occur in **refrigerating appliances** with one or more **defrost control cycles**. It also specifies the determination of the temperature change by **compartment** that is associated with those **defrost and recovery periods**. Normally, test data for these calculations is collected as part of the testing for **steady state** power consumption in Annex B. Individual **defrost and recovery periods** that occur at any time during the normal testing program can be used as long as these meet the relevant validity criteria. Where there is more than one defrost system (with its own **defrost control cycle**), the characteristics of each shall be separately determined (or in combination, where appropriate).

NOTE As **cyclic defrost** systems do not have a **defrost control cycle**, Annex C is only applicable to **compartments** or **refrigerating appliances** with **automatic defrost** systems other than **cyclic defrost**.

C.2 Setup for testing and data collection

The objective is to measure and select a number of representative **defrost and recovery periods** in order to determine a representative value for the additional (incremental) energy associated with **defrost and recovery** (over and above the **steady state power** consumption) and the change in average internal temperatures (for each relevant **compartment**) associated with **defrost and recovery** (relative to the **steady state** temperature) for each test **ambient temperature**.

The **refrigerating appliance** under test shall be set up and operated in accordance with Annex A. Where the cumulative time that the **refrigerating appliance** under test has been disconnected from power exceeds 6 h during the 24 h prior to the occurrence of a **defrost and recovery period**, then data from that **defrost and recovery period** shall be deemed invalid and shall not be used to determine representative values for incremental **defrost and recovery** energy and temperature change in accordance with Annex C.

To characterise the additional energy required, and the average temperature change, during a **defrost and recovery period** (relative to **steady state** conditions) at each test **ambient temperature**, a specified number of representative **defrost and recovery periods** need to be measured. In order to be considered representative, the **steady state power** and temperature before and after the **defrost and recovery period** shall meet the relevant stability or acceptance criteria. The number of **defrost and recovery periods** to be measured at each **ambient temperature** is specified in this Annex. A minimum of one **defrost and recovery period** is required for each test point used for energy determination for each **ambient temperature** condition. Alternatively, at least four **defrost and recovery periods** are required and at least half of all **defrost and recovery periods** have to have the coldest **compartment** at or below **target temperature** for each **ambient temperature**.

Conceptually, the additional energy associated with **defrost and recovery**, over and above the underlying **steady state** power consumption, is determined as illustrated in Figure C.1.

The main case considered is called Case DF1, where the **refrigerating appliance** can demonstrate **steady state** operation before and after the **defrost and recovery period**.

In rare cases (called DF2) it may not be possible to reliably demonstrate **steady state** operation before and after the **defrost and recovery period** for any defrost. Only in this case may the methodology set out in Annex K be used.

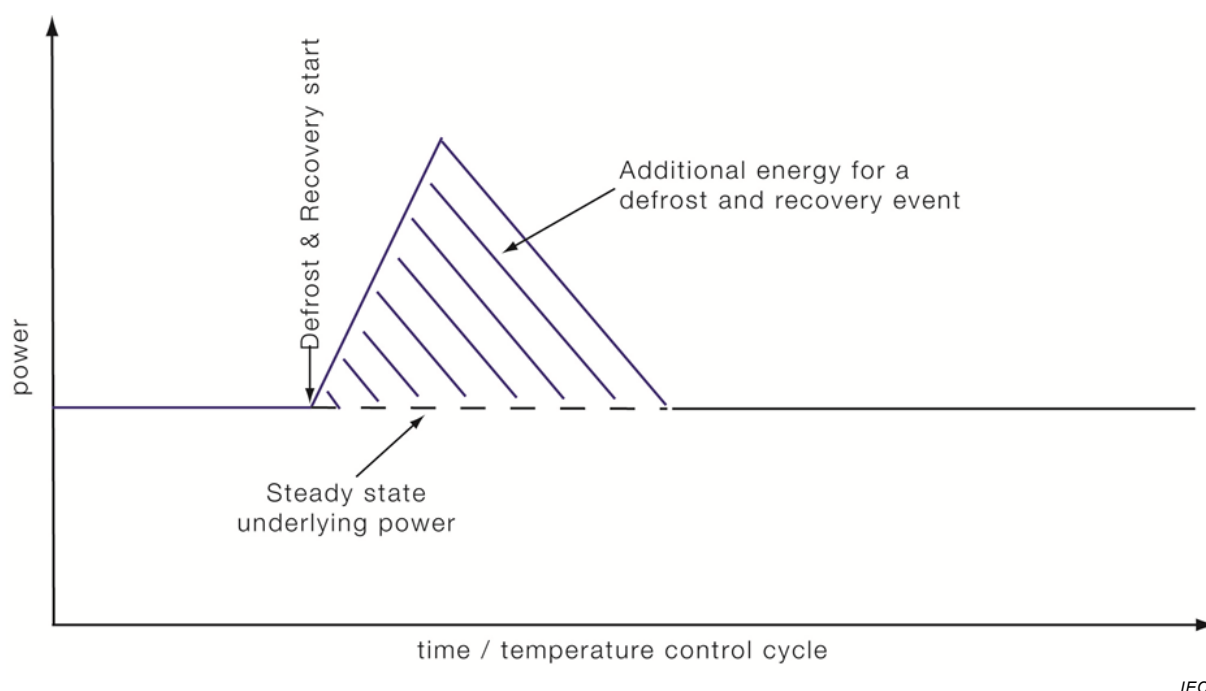


Figure C.1 – Conceptual illustration of the additional energy associated with a defrost and recovery period

C.3 Case DF1: where steady state operation can normally be established before and after defrosts

C.3.1 Case DF1 approach

Case DF1 is where the **refrigerating appliance** normally operates in a **steady state** condition prior to defrost and returns to **steady state** operation some time after the defrost. Effectively, **steady state** operation occurs on either side of a **defrost and recovery period**. Each **defrost and recovery period** is examined in isolation. This approach is used for all types of **refrigerating appliances** that have one or more **compartments** with a defrost system (with its own **defrost control cycle**).

A period of **steady state** operation (called Period D), ending well before the start of a **defrost and recovery period** is selected to be the minimum possible size that meets the criteria set out in C.3.2. A period of **steady state** operation (called Period F), starting well after the end of the same **defrost and recovery period** is selected to be the minimum possible size that meets the criteria set out in C.3.2.

For the purposes of validity assessment in C.3.2, the nominal centre of the **defrost and recovery period** is defined as 2 h after the initiation of the defrost heater or, in the case where there is no defrost heater, after the interruption of the refrigeration system related to the **automatic defrost**. This is illustrated in Figure C.2 – time interval Δt_{DI} and time interval Δt_{FI} shall be approximately the same, but will vary depending on the exact time of the selected **temperature control cycle** (where applicable) at the end of Period D and the start of Period F.

NOTE C.3.2 sets out cases where the length of Periods D and F and time for Δt_{DI} and Δt_{FI} can be adjusted in order to find complying values.