



BSI Standards Publication

Testing methodologies for refrigerating devices for insulated means of transport

Part 2: Eutectic cooling devices

National foreword

This British Standard is the UK implementation of EN 16440-2:2023.

The UK participation in its preparation was entrusted to Technical Committee TW/1, Freight containers and swap bodies.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2023
Published by BSI Standards Limited 2023

ISBN 978 0 539 13017 1

ICS 27.200

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2023.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

English Version

Testing methodologies for refrigerating devices for insulated means of transport - Part 2: Eutectic cooling devices

Méthodes d'essai des dispositifs de réfrigération des moyens de transport isothermes - Partie 2 : Dispositifs de réfrigération eutectiques

Prüfung von Kühleinrichtungen für wärmegeämmte Transportmittel - Teil 2: Eutektische Kühleinrichtungen

This European Standard was approved by CEN on 10 April 2023.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents

Page

European foreword	4
1 Scope.....	5
2 Normative references.....	5
3 Terms and definitions	5
3.1 General terms and definitions	5
3.2 Terms and definitions for eutectic units with fans only	9
3.3 Typical setups for direct and indirect eutectic cooling devices.....	9
3.4 Symbols and uncertainties	11
4 Requirements.....	12
4.1 General.....	12
4.2 Description of the eutectic cooling devices and eutectic units	12
4.3 Test equipment.....	12
4.3.1 General requirements	12
4.3.2 Requirements for the calorimeter box	13
4.3.3 Requirements for the conditioned test room	16
4.4 Installation and connection of the eutectic cooling device.....	17
4.4.1 General.....	17
4.4.2 Installation of eutectic cooling device with locally separated components (split system)	17
5 Test conditions and methodology.....	17
5.1 General.....	17
5.2 Test conditions	17
5.2.1 Generality and rated conditions.....	17
5.2.2 Temperature measurements.....	18
5.3 Testing of dependent eutectic cooling device	19
5.3.1 General.....	19
5.3.2 Mandatory test 1: Testing of the charging time and the total energy consumption of the eutectic cooling device	21
5.3.3 Mandatory test 2: Testing of the maximum cooling time and the useful cooling energy	21
5.3.4 Optional test 3: Testing of the recharging time	22
5.3.5 Optional test 4: Testing of cooling time and energy after recharging	22
5.3.6 Measurements for performance testing.....	22
5.4 Time measurement	23
5.5 Functional tests - Defrosting device test	23
5.6 Air flow measurement.....	23
6 Test results.....	23
6.1 General.....	23
6.2 Useful cooling capacity	24
6.3 Total power.....	25
6.4 Determination of the cooling energy efficiency ratio EER_C	25
7 Test report.....	26
8 Marking	27

8.1	Marking, type plate	27
8.2	Information on total energy consumption	27
	Bibliography	28

European foreword

This document (EN 16440-2:2023) has been prepared by Technical Committee CEN/TC 413 “Insulated means of transport for temperature sensitive goods with or without cooling and/or heating device”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2023, and conflicting national standards shall be withdrawn at the latest by December 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

This document is applicable to eutectic cooling devices which are intended to be used with insulated transport equipment.

The following applications are covered:

- eutectic cooling devices with or without compressor/condenser unit intended to be installed into insulated means of transport (e.g. lorries, trailers, swap bodies, other transport equipment and wagons). Charging of the eutectic elements from the liquid to the solid phase can be performed either by a compressor/condenser unit mounted onto the vehicle or by a stationary direct or indirect system. The eutectic cooling devices are equipped, if relevant, with necessary components for the charging, transmission, cooling and/or with temperature control devices. The eutectic elements can be fitted with or without fans;
- eutectic cooling devices with independent eutectic elements are not covered by this document.

This document specifies the testing methodologies.

This document is only applicable for mono-temperature eutectic cooling devices. This document does not provide any safety requirements.

2 Normative references

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

EN ISO 5801, *Fans — Performance testing using standardized airways (ISO 5801)*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

ISO/IEC Guide 99, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

3.1 General terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC Guide 99 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

calorimeter box

thermally insulated room in which the eutectic unit of the eutectic cooling device is placed

Note 1 to entry: With eutectic cooling devices, usually the insulated transport equipment is used as the calorimeter box.

3.1.2

charging power

P_{ch}

power input needed to operate all necessary eutectic cooling components during charging

3.1.3

charging energy

E_{ch}

energy consumption for charging

3.1.4

charging time

t_{ch}

period of time required for the freezing of the eutectic mixture inside the eutectic elements which are submitted to the charging conditions defined by the manufacturer

3.1.5

compressor/condenser unit

part of the eutectic cooling device including compressor, condenser, condenser fans, housing, drives and the operating panel with the control devices

EXAMPLE A drive can be an electric motor, an internal combustion motor, a hydraulic engine and similar.

3.1.6

conditioned test room

room where the test conditions can be maintained at a constant level and in which the calorimeter box with the eutectic unit is mounted

Note 1 to entry: Eutectic unit is mounted inside the calorimeter box and its compressor condensing unit is mounted outside the calorimeter box, if applicable.

3.1.7

insulated means for transport

insulated vans, bodyworks for trucks and trailers, swap bodies, any kind of mobile containers and railway wagons

3.1.8

cooling device

system which lowers and/or maintains temperature

3.1.9

cooling energy efficiency ratio

EER_C

ratio of the useful cooling energy E_C to the total energy consumption E_T of the eutectic cooling device under rated conditions

3.1.10**energy supply**

devices not forming part of the eutectic cooling device but providing or generating the form of energy required for its operation

Note 1 to entry: This includes electric generators, hydraulic pumps, electric accumulators and fuel cells, among others.

3.1.11**dependent eutectic cooling device**

direct or indirect system with eutectic unit serving as a cooling device, intended to be installed into an insulated transport equipment with a compressor/condenser unit intended to be installed stationary or mobile onto the vehicle to charge the eutectic unit

3.1.12**eutectic element**

element containing eutectic mixtures intended for cold charging, optionally having evaporation tubes or heat exchangers

EXAMPLE tubes, plates, etc.

3.1.13**eutectic mixture**

liquid mixture of two or more components which at certain ratios inhibit the crystallisation process of one another resulting in a system having a lower melting point than either component

3.1.14**eutectic unit**

part of the eutectic cooling device consisting of one or more eutectic elements with or without forced air circulation and, if applicable, including the required expansion or refrigerant control valve and refrigerant distributor

3.1.15**heat load**

P_{HL}

heating power delivered into the calorimeter box by electric heating elements during the determination of the useful cooling capacity P_C

3.1.16**heat transmission**

P_{TR}

heat flow through the insulated limiting surfaces of the calorimeter box

3.1.17**heat transmission energy**

E_{TR}

thermal energy transmitted through the insulated limiting surfaces of the calorimeter box during the determination of the maximum cooling time t_{Cmax}

3.1.18

independent eutectic cooling unit

eutectic elements or eutectic units without any connection to a refrigerant circuit

Note 1 to entry: According to the scope independent cooling eutectic units are not covered by this document.

3.1.19

inlet air temperature at the compressor/condenser unit

$T_{\text{IN CON}}$

mean temperature of different measuring points located at air inlets of the compressor/condenser unit

3.1.20

inside temperature of the calorimeter box

T_i

arithmetic mean temperature measured at different locations inside the calorimeter box

3.1.21

load space

volume inside an insulated transport equipment or a compartment available for loading the goods (excluding eutectic unit)

3.1.22

maximum cooling time

t_{cmax}

period of time in cooling operation, starting after the charging of the eutectic elements has finished and stopping once the inside temperature T_i of the calorimeter box has reached the requested temperature of the class

3.1.23

rated conditions

constant values laid down for comparison and certification purposes

3.1.24

temperature of the conditioned test room

T_e

mean temperature of different measurement points located outside the calorimeter box (in the conditioned test room)

3.1.25

total energy consumption

E_T

energy consumption of all components necessary for the operation of the eutectic cooling device under rated conditions, over the total charging time and the maximum cooling time

Note 1 to entry: Example of energy: fuel or electricity.

3.1.26

total power

P_T

arithmetic mean of the power input of all eutectic cooling device components necessary for the operation during charging and/or cooling under rated conditions, including all means for operation