



BSI Standards Publication

## **Cryogenic vessels - Toughness requirements for materials at cryogenic temperature**

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Part 2: Temperatures between -80 degrees C and -20 degrees C

## National foreword

This British Standard is the UK implementation of EN ISO 21028-2:2018. It is identical to ISO 21028-2:2018. It supersedes BS EN 1252-2:2001, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PVE/18, Cryogenic vessels.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

**Cryogenic vessels - Toughness requirements for materials  
at cryogenic temperature - Part 2: Temperatures between  
-80 degrees C and -20 degrees C (ISO 21028-2:2018)**

Réipients cryogéniques - Exigences de ténacité  
pour les matériaux à température cryogénique  
- Partie 2: Températures comprises entre -80  
degrés C et -20 degrés C (ISO 21028-2:2018)

Kryo-Behälter - Zähigkeitsanforderungen  
an Werkstoffe bei kryogenen Temperaturen  
- Teil 2: Temperaturen zwischen -80 °C  
und -20 °C (ISO 21028-2:2018)

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

**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword](http://www.iso.org/iso/foreword).

This document was prepared by Technical Committee ISO/TC 220, *Cryogenic vessels*.

This second edition cancels and replaces the first edition (ISO 21028-2:2004), which has been technically revised.

The main changes compared to the previous edition are as follows:

- tables and figures on impact test temperatures and design reference have been modified;
- [Annex B](#) has been added to present an example of calculation of the lowest temperature authorized during operation.

A list of all parts in the ISO 21028 series can be found on the ISO website.

## **Introduction**

The use of materials at low temperatures entails special problems which should be addressed. Consideration should be given, in particular, to changes in mechanical characteristics, expansion and contraction phenomena and the thermal conduction of the various materials. The most important property to be considered is the material toughness at low temperature.

## European foreword

This document (EN ISO 21028-2:2018) has been prepared by Technical Committee ISO/TC 220 "Cryogenic vessels" in collaboration with Technical Committee CEN/TC 268 "Cryogenic vessels and specific hydrogen technologies applications", the secretariat of which is held by AFNOR.

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 October 2018, and conflicting national standards shall be withdrawn at the latest by October 2018.

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.

This document supersedes EN 1252-2:2001.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative [Annex ZA](#), which is an integral part of this document.

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

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# Cryogenic vessels - Toughness requirements for materials at cryogenic temperature —

## Part 2: Temperatures between -80 degrees C and -20 degrees C

### 1 Scope

This document specifies the toughness requirements of metallic materials for use at temperatures between  $-20\text{ }^{\circ}\text{C}$  and  $-80\text{ }^{\circ}\text{C}$  to ensure their suitability for cryogenic vessels. This document is applicable to fine-grain and low-alloyed steels with specified yield strength  $\leq 460\text{ N/mm}^2$ , aluminium and aluminium alloys, copper and copper alloys and austenitic stainless steels.

**NOTE** For steel materials listed in EN 13445-2 or EN 13480-2 or for steel materials and weldings complying with the same fundamental safety requirements, the requirements for prevention of brittle fracture at low temperatures according to EN 13445-2:2014, Annex B, method 2, or EN 13480-2:2012, Annex B, method 2 can be applied.

### 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.

ISO 148 (all parts), *Metallic materials — Charpy pendulum impact test*

ISO 9016, *Destructive tests on welds in metallic materials — Impact tests — Test specimen location, notch orientation and examination*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

#### 3.1

##### minimum metal temperature

$T_M$   
lowest temperature defined for each of the conditions:

- temperature during normal operation;
- temperature during start-up and shut down procedures;
- temperature which may occur during possible process upsets;
- temperature which may occur during pressure or leak testing;
- ambient conditions.

Note 1 to entry: See also *temperature adjustment term* [\(3.2\)](#) and *design reference temperature* [\(3.3\)](#).

### 3.2 temperature adjustment term

$T_S$   
term relevant to the calculation of the *design reference temperature*,  $T_R$  [\(3.3\)](#) and dependent on the pressure-induced principal membrane stress at the appropriate minimum metal temperature

### 3.3 design reference temperature

$T_R$   
temperature used for determining the impact energy requirements themselves, determined by adding the *temperature adjustment term*,  $T_S$  [\(3.2\)](#) to the *minimum metal temperature*,  $T_M$  [\(3.1\)](#):

$$T_R = T_M + T_S$$

Note 1 to entry: All applicable combinations of the temperatures  $T_M$  and  $T_S$  are to be considered and the lowest possible  $T_R$  value used for the determination of the required material *impact test temperature* [\(3.4\)](#).

### 3.4 impact test temperature

$T_{KV}$   
temperature at which the required impact energy has to be achieved

Note 1 to entry: See [Clause 5](#).

### 3.5 impact energy

KV  
energy determined from Charpy V-notch tests

Note 1 to entry: These tests are performed in accordance with ISO 148 (all parts).

### 3.6 reference thickness

$e_B$   
thickness of a component used to relate the *design reference temperature*,  $T_R$  [\(3.3\)](#) of the component with its required *impact test temperature*,  $T_{KV}$  [\(3.4\)](#)

Note 1 to entry: The reference thickness is based on the nominal thickness (including corrosion allowance) and can be as defined in [Table 6](#). For butt-welded components, it is the nominal wall thickness of the component at the edge of the weld preparation.

Note 2 to entry: See [Figures 1](#) to [5](#).

## 4 Symbols

| Symbol | Definition          | Unit |
|--------|---------------------|------|
| A-W    | as-welded           |      |
| $a$    | depth of the defect | mm   |
| $e$    | wall thickness      | mm   |
| $e_B$  | reference thickness | mm   |
| KV     | impact energy       | J    |