# SLOVENSKI STANDARD
# SIST EN 1252-2:2002

**01-maj-2002**

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**Kriogene posode - Materiali - 2. del: Zahtevana žilavost za temperature med –80 °C in –20 °C**

Cryogenic vessels - Materials - Part 2: Toughness requirements for temperatures between -80°C and -20°C

Kryo-Behälter - Werkstoffe - Teil 2: Anforderungen an die Fähigkeit bei Temperaturen zwischen -80°C und -20°C



Récipients cryogéniques - Matériaux - Partie 2: Exigences de ténacité pour les températures entre - 80°C et - 20°C



**Ta slovenski standard je istoveten z:** **EN 1252-2:2001**

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**ICS:**

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|---|---|---|
| 23.020.40 | Proti mrazu odporne posode (kriogenske posode) | Cryogenic vessels |

**SIST EN 1252-2:2002** **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

**EN 1252-2**

April 2001

ICS 23.020.40

English version

# Cryogenic vessels - Materials - Part 2: Toughness requirements for temperatures between -80 °C and -20 °C

This European Standard was approved by CEN on 19 January 2001.

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 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



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

**Management Centre: rue de Stassart, 36 B-1050 Brussels**

# Contents

# Foreword

This European Standard has been prepared by Technical Committee CEN/TC 268 "Cryogenic vessels", 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 2001, and conflicting national standards shall be withdrawn at the latest by October 2001.

For relationship with EC Directive(s), see informative Annex ZA, which is an integral part of this standard.

This document also supports the objectives of the framework Directives on Transport of Dangerous Goods. This standard has been submitted for reference into the RID and/or the technical annexes of the ADR.

Therefore, the standards listed in the normative references and covering basic requirements of the RID/ADR not addressed within the present document are normative only when the standards themselves are referred to in the RID and/or in the technical annexes of the ADR.

This European Standard is composed of the following parts :

EN 1252-1 Cryogenic vessels - Materials - Part 1: Toughness requirements for temperatures below - 80 °C

EN 1252-2 Cryogenic vessels - Materials - Part 2 : Toughness requirements for temperatures between - 80°C and - 20°C



According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

# Introduction

The use of materials at low temperatures entails special problems which have to be addressed. Consideration has to 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.

## 1 Scope

This European Standard specifies the toughness requirements of the metallic materials for use at a temperature between - 80 °C and - 20 °C ensuring suitability for use for the cryogenic vessels.

Fine grain and low alloyed steels with specified yield strength $\leq$ 460 N/mm², aluminium and aluminium alloys, copper and copper alloys and austenitic stainless steels are covered by this standard.

## 2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendements).



EN 10045-1, *Metallic materials - Charpy impact test - Part 1 : Test method*

EN 288-3 :1992, A1 :1997, *Specification and approval of welding procedures for metallic materials - Part 3 : Welding procedure tests for the arc welding of steels*



## 3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply :

**3.1**
**minimum metal temperature $T_M$**
the lowest temperature defined for each of the following conditions (see also 3.2 and 3.3) :

— temperature during normal operations ;

— 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.

**3.2**
**temperature adjustment term $T_S$**
term relevant to the calculation of the design reference temperature $T_R$ and dependent on the pressure induced principal membrane stress at the appropriate minimum metal temperature.

**3.3**
**design reference temperature $T_R$**
the temperature used for determining the impact energy requirements.

$T_R$ is determined by adding the adjustment $T_S$ to the minimum metal temperature $T_M$ :

$$T_R = T_M + T_S$$

All applicable combinations of the temperatures $T_M$ and $T_S$ shall be considered and the lowest possible $T_R$-value shall be used for the determination of the required material impact test temperature.

**3.4**
**impact test temperature $T_{KV}$**
the temperature at which the required impact energy has to be achieved (see clause 5).

**3.5**
**impact energy KV**
the energy determined from Charpy-V-notch tests performed in accordance with EN 10045-1.

**3.6**
**reference thickness $e_B$**
the thickness of a component to be used to relate the design reference temperature $T_R$ of the component with its required impact test temperature $T_{KV}$, (see Figures 1 to 5). The reference thickness $e_B$ is based on the nominal thickness (including corrosion allowance) and shall be as defined in Table 6. For butt welded components $e_B$ is the nominal wall thickness of the component at the edge of the weld preparation.



## 4 Requirements for steels with specified yield strength ≤ 460 N/mm²

### 4.1 General



This method, based on fracture mechanics can be used to determine the requirements to avoid brittle fracture in C, CMn, fine grain and low alloy steels with a specified minimum yield strength ≤ 460 N/mm².

In this procedure the impact test temperature $T_{KV}$ is not equal to the design reference temperature $T_R$.

Parent material, welds and HAZ shall meet the impact energy KV and impact test temperature $T_{KV}$ requirements in Table 1 for design reference temperatures $T_R$ and reference thicknesses $e_B$. Values of $T_R$ shall be calculated from $T_M$ using the values of $T_S$ given in 4.2.

For materials with a specified minimum yield strength > 310 N/mm² the impact energy at $T_{KV}$ given in Figure 1 and Figure 2 shall be 40 J. Where 27 J is specified in the product standard, Figure 3 for the post-weld heat treated condition applies. For the as welded case with minimum yield strength in the range > 310 N/mm² and ≤ 360 N/mm² Figure 4 applies. For minimum yield strength > 360 N/mm² Figure 5 applies.

**Table 1 — Impact energy requirements**

| Specified minimum yield strength of base material N/mm² | Required impact energy KV (on 10 mm x 10 mm test pieces) J | Figure defining required *T*Kv | |
|---|---|---|---|
| | | Non welded and post-weld heat treated | As welded |
| ≤ 310 | 27 | 1 | 2 |
| > 310, ≤ 360 | 40 | 1 | 2 |
| | 27 | 3 | 4 |
| > 360 | 40 | 1 | 2 |
| | 27 | 3 | 5 |

## 4.2 Temperature adjustments

$T_S$ is a temperature adjustment which can be used if the pressure induced principal membrane stress does not exceed the percentage of the maximum allowable design stress or 50 N/mm² given in Table 2.

**Table 2 — Temperature adjustments**

| Condition | Percentage of maximum allowable design stress | | | Membrane stress [b] |
|---|---|---|---|---|
| | **> 75 %; ≤ 100 %** | **≤ 75 %** | **≤ 50 %** | **≤ 50 N/mm²** |
| Non welded or post-weld heat treated condition [a] | 0 °C | +10 °C | +25 °C | +50 °C |
| As welded condition and reference thickness < 30 mm | 0 °C | 0 °C | 0 °C | +40 °C |

[a] Also applicable for equipment where all nozzles and non-temporary welded attachments are first welded to vessel components and these sub-assemblies are post-weld heat treated before being assembled into the equipment by butt-welding, but the main seams are not subsequently post-weld heat treated.

[b] In this case the membrane stress should take account of internal and external pressure and dead weight.



## 4.3 Procedure for base material lower than 10 mm thick

Minimum $T_R$ values are given in Table 3 for use when the base material is less than 10 mm thick and the testing temperature $T_{KV}$ is 20 °C. The impact energy requirements are as specified in the relevant materials standards.



If these materials are to be used below the $T_R$ values given in Table 3 the testing shall be performed in accordance with the relevant curve for 10 mm in Figure 1 to Figure 5. The required energies for the sub-sized specimens are given in Table 4.

**Table 3 — Minimum $T_R$-values for base material less than 10 mm thick and $t_{KV}$ = 20 °C**

| Thickness mm | AW °C | PWHT °C |
|---|---|---|
| 8 | -20 | -35 |
| 6 | -25 | -40 |
| 4 | -40 | -55 |
| 2 | -55 | -70 |

# 5 General test requirements

Where impact tests are required they shall be Charpy V-notched tests in accordance with EN 10045-1. The impact energy requirements shall be met in the base material, heat affected zone and weld metal. The specimen position shall be in accordance with EN 288-3:1992/A1:1997, 7.4.4. From each sample three specimens shall be tested for each of the required positions and test temperatures. The mean value of the three specimens shall be at least equal to the impact energy requirement. Only one specimen may show a lower value, but this value shall not be less than 70 % of this requirement.

The required values for base material refer to the transverse direction. If transverse properties are not obtainable, the minimum impact energy requirements specified for transverse test pieces shall be multiplied by the factor 1,5 for C, CMn, fine grained and low alloyed steels with a minimum specified yield strength $\leq$ 460 N/mm². (For other materials refer to product standard).

## 5.1 Sub-sized specimens

If the base material is less than 10 mm thick the energy requirements are given in Table 4.

**Table 4 — Impact requirements for sub-sized Charpy V-notched specimen if the base material is less than 10 mm thick**

Dimensions in millimetres

| Specimen geometry mm x mm | | |
|---|---|---|
| 10 x 10 | 10 x 7,5 | 10 x 5 |
| 27 J | 22 J | 19 J |
| 40 J | 32 J | 28 J |



Alternatively, where proportional reduced energy requirements are preferred, Table 5 shall be applied.

## 5.2 Sub-sized specimens for components from which it is not possible to extract specimens of section size equal to the reference thickness

There are cases of unusually shaped components and/or weld procedure and production plates where the Charpy-V-notched-specimen extracted is either < 10 mm or not representative of the section thickness.

In these cases sub-sized specimens shall be tested at lower impact test temperature to model the behaviour for a full thickness specimen. The temperature shifts are given in Table 5.

Impact tests should be performed on the maximum thickness which can be extracted from the component under consideration.

**Table 5 — Equivalent impact energy requirements when sub-sized specimens are extracted from thicker sections**

Dimensions in millimetres

| Required impact energy KV J | Specimen geometry mm x mm | Sub-sized specimen requirement | | |
|---|---|---|---|---|
| | | KV J | Specimen geometry mm x mm | Shift of impact test temperature |
| 27 | 10 x 10 | 20<br>14 | 7,5 x 10<br>5,0 x 10 | $T_{KV}$ - 5 °C<br>$T_{KV}$ -20 °C |
| 40 | 10 x 10 | 30<br>20 | 7,5 x 10<br>5,0 x 10 | $T_{KV}$ - 5 °C<br>$T_{KV}$ -20 °C |
| 20 | 7,5 x 10 | 14 | 5,0 x 10 | $T_{KV}$ -15 °C |
| 30 | 7,5 x 10 | 20 | 5,0 x 10 | $T_{KV}$ -15 °C |

## 6 Welds

When materials are to be joined by welding, the choice of consumables and procedures (see EN 288 standards) shall ensure that the required impact energy properties are achieved in weld and heat affected zone regions, when tested in accordance with clause 5.



The required impact energy shall be at least equal to the specified impact energy for the base metal.

## 7 Requirements for aluminium and aluminium alloys, copper and copper alloys and austenitic stainless steels



Toughness of aluminium and aluminium alloys, copper and copper alloys and austenitic stainless steels is inherently high enough at low temperature to render impact test unnecessary.

Welds of austenitic stainless steels shall be impact tested if the material certificate for the weld consumable shows that it has a ferrite content exceeding 10 %.

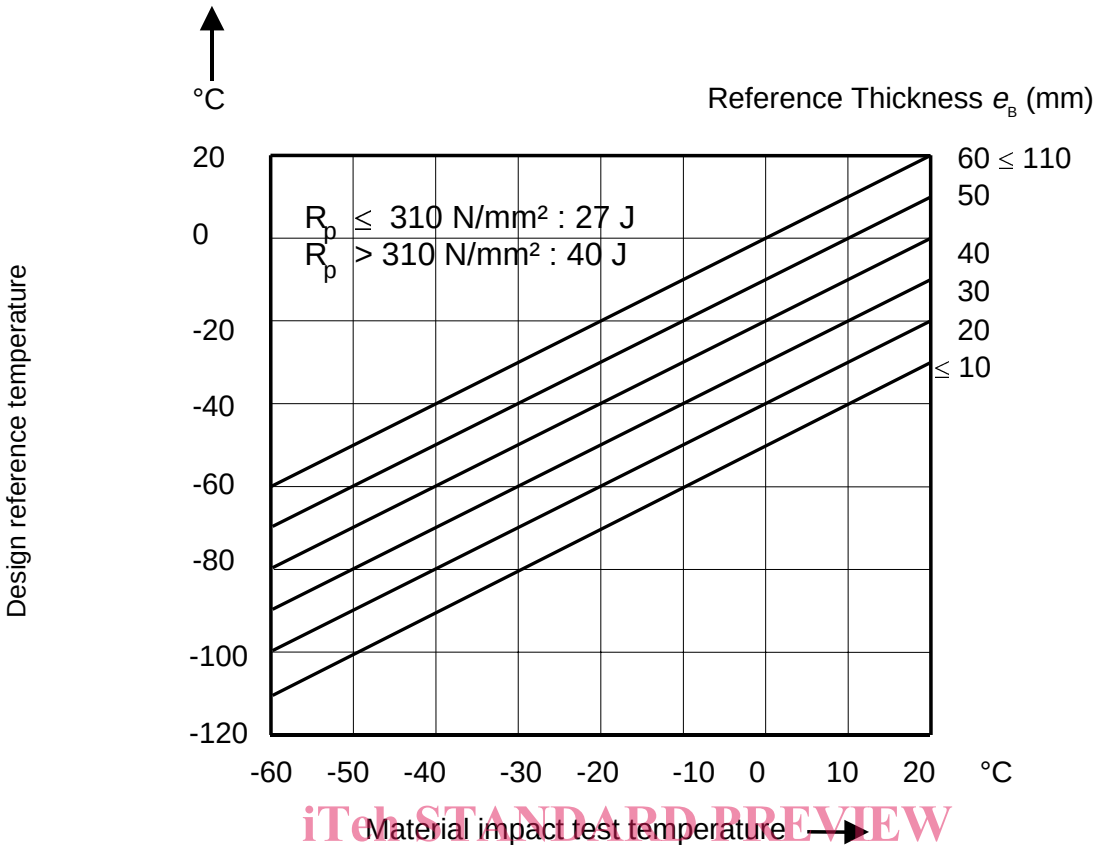




**Figure 1 - Design reference temperature and impact test temperature post weld heat treated condition**