SLOVENSKI STANDARD

SIST EN 14398-2:2004+A2:2008

01-junij-2008

Kriogene posode - Velike premiļne, vakuumsko neizolirane posode - 2. del: Konstruiranje, izdelava, kontrola in preskus

Cryogenic vessels - Large transportable non-vacuum insulated vessels - Part 2: Design, fabrication, inspection and testing

Kyo-Behälter - Große ortsbewegliche, nicht vakuum-isolierte Behälter - Teil 2: Bemessung, Herstellung und Prüfung

Récipients cryogéniques - Grands récipients transportables non isolés sous vide - Partie 2: Conception, fabrication, inspections et essais

Ta slovenski standard je istoveten z: **EN 14398-2:2003+A2:2008**

ICS:

23.020.40

SIST EN 14398-2:2004+A2:2008 **en,fr**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14398-2:2003+A2

March 2008

ICS 23.020.40

Supersedes EN 14398-2:2003

English Version

Cryogenic vessels - Large transportable non-vacuum insulated vessels - Part 2: Design, fabrication, inspection and testing

Récipients cryogéniques - Grands récipients transportables non isolés sous vide - Partie 2: Conception, fabrication, inspections et essais

Kyo-Behälter - Große ortsbewegliche, nicht vakuum-isolierte Behälter - Teil 2: Bemessung, Herstellung und Prüfung

This European Standard was approved by CEN on 10 July 2003 and includes Corrigendum 1 issued by CEN on 23 August 2006, Amendment 1 approved by CEN on 6 October 2006 and Amendment 2 approved by CEN on 7 February 2008.

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 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, 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

Ref. No. EN 14398-2:2003+A2:2008: E

Contents

page

Foreword

This document (EN 14398-2:2003+A2:2008) 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 September 2008 and conflicting national standards shall be withdrawn at the latest by September 2008.

This document includes Amendment 1, approved by CEN on 2006-10-06, Amendment 2, approved by CEN on 2008-02-07 and Corrigendum 1 issued by CEN on 2006-08-23.

This document supersedes EN 14398-2:2003.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1⟩ ⟨A1] and [A2⟩ ⟨A2].

The modifications of the related CEN Corrigendum have been implemented at the appropriate places in the text and are indicated by the tags [AC⟩ ⟨AC].

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports the objectives of the framework Directives on Transport of Dangerous Goods.

The standard has been submitted for reference into the RID and/or in the technical annexes of the ADR. [A2⟩ *deleted text* ⟨A2]

EN 14398 consists of the following parts under the general title, *Cryogenic vessels – Large transportable non-vacuum insulated vessels*:

– *Part 1: Fundamental requirements*

– *Part 2: Design, fabrication, inspection and testing*

– *Part 3: Operational requirements*

[A2⟩ Annexes B, C and E are normative. Annexes A and D are normative. ⟨A2]

This document includes a Bibliography.

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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies requirements for the design, fabrication, inspection and testing of large transportable non vacuum insulated cryogenic vessels of more than 1000 l volume, which are permanently (fixed tanks) or not permanently (demountable tanks) attached to a vehicle, for carriage by road. However, it can be used for other mode of transport providing the specific regulations/requirements are complied with.

This European Standard applies to large transportable non vacuum insulated cryogenic vessels for fluids specified in EN 14398-1 and does not apply to vessels designed for toxic fluids.

This European Standard does not include the general vehicle requirements e.g. running gear, brakes, lighting etc. that shall be in accordance with the relevant standards/regulations.

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 amendments).

EN 287-1, *Approval testing of welders - Fusion welding - Part 1: Steels*.

〚A2〛 *deleted text* 〚A2〛

EN 473, *Non destructive testing - Qualification and certification of NDT personnel - General principles*.

EN 875, *Destructive tests on welds in metallic materials - Impact tests - Test specimen location, notch orientation and examination*.

EN 895, *Destructive tests on welds in metallic materials - Transverse tensile test.*

EN 910, *Destructive tests on welds in metallic materials – Bend tests.*

EN 1252-1:1998, *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.*

EN 1418, *Welding personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanised and automatic welding of metallic materials.*

EN 1435, *Non-destructive examination of welds – Radiographic examination of welded joints.*

EN 1626, *Cryogenic vessels - Valves for cryogenic service.*

EN 1797, *Cryogenic vessels - Gas/material compatibility.*

EN 10028-4, *Flat products made of steels for pressure purposes – Part 4: Nickel alloy steels with specified low temperature properties*.

EN 10028-7:2000, *Flat products made of steels for pressure purposes - Part 7: Stainless steels.*

EN 13068-3, *Non-destructive testing – Radioscopic testing – Part 3: General principles of radioscopic testing of metallic materials by X – and gamma rays.*

EN 13445-3, *Unfired pressure vessels – Part 3: Design.*

EN 13648-3, *Cryogenic vessels - Safety devices for protection against excessive pressure - Part 3: Determination of required discharge - Capacity and sizing*.

EN 14398-1:2003, *Cryogenic vessels - Large transportable non-vacuum insulated vessels - Part 1: Fundamental requirements*.

EN 14398-3, *Cryogenic vessels – Large Transportable non-vacuum insulated vessels – Part 3: Operational requirements.*

EN ISO 6520-1, *Welding and allied processes - Classification of geometric imperfections in metallic materials - Part 1: Fusion welding* [A1] *(ISO 6520-1:2007)* [A1].

[A2] EN ISO 9606-2, *Qualification test of welders - Fusion welding - Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004).*

EN ISO 15613, *Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test (ISO 15613:2004).*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004).*

EN ISO 15614-2, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 2: Arc welding of aluminium and its alloys (ISO 15614-2:2005).* [A2]

ISO 1106-1, *Recommended practice for radiographic examination of fusion welded joints - Part 1: Fusion welded butt joints in steel plates up to 50 mm thick.*

3 Terms, definitions and symbols

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

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 14398-1:2003 and the following apply.

3.1.1
large transportable non vacuum insulated vessel
vessel of more than 1000 l volume intended for one or more cryogenic fluids, consisting of an inner vessel, an insulation, all of the valves and accessories and additional framework

3.1.2
fixed tank (tank vehicle)
large transportable vessel permanently attached to a vehicle or to units of running gear used in its stead

3.1.3
demountable tank
large transportable vessel non permanently attached to a vehicle. When attached to the carrier vehicle, the demountable tank meets the requirements prescribed for a fixed tank. It is designed to be lifted only when empty

3.1.4
inner vessel
pressure vessel proper intended to contain the cryogenic fluid

3.1.5
insulation
to protect the vessel against heat transfer from the outside atmospheric temperature

3.1.6
automatic welding
welding in which the parameters are automatically controlled. Some of these parameters can be adjusted to a limited extent, either manually or automatically, during welding to maintain the specified welding conditions

3.1.7
maximum allowable pressure, p_s
maximum pressure for which the equipment is designed, as specified by the manufacturer, defined at a location specified by the manufacturer, being the location of connection of protecting or limited devices or the top of the equipment

3.1.8
relief plate/plug
plate or plug retained by atmospheric pressure only which allows relief of excess internal pressure

3.1.9
bursting disc device
non-reclosing pressure relief device ruptured by differential pressure. It is the complete assembly of installed components including where appropriate the bursting disc holder

3.2 Symbols

For the purposes of this European Standard, the following symbols apply.

c	allowance for corrosion	mm
d_i	diameter of opening	mm
d_a	outside diameter of tube or nozzle	mm
f	narrow side of rectangular or elliptical plate	mm
l_b, l'_b	buckling length	mm
n	number of lobes	-
p	design pressure as defined in 4.3.2.2	bar
p_e	allowable external pressure limited by elastic buckling	bar
p_k	strengthening pressure	bar
p_p	allowable external pressure limited by plastic deformation	bar
p_T	pressure test (see 4.2.3.2)	bar
r	radius e.g. inside knuckle radius of dished end and cones	mm
s	minimum thickness	mm
s_e	actual wall thickness	mm
v	factor indicative of the utilisation of the permissible design stress in joints or factor allowing for weakenings	-
x	(decay-length zone) distance over which governing stress is assumed to act	mm
A	cross sectional area of reinforcing element	mm^2

C, β	design factors	-
D	shell diameter	mm
D_a	outside diameter e.g. of a cylindrical shell	mm
D_i	internal diameter e.g. of a cylindrical shell	mm
E	Young's modulus	N/mm^2
I	moment of inertia of reinforcing element	mm^4
R_e	apparent yield stress or 0,2 % proof stress (1 % proof stress for austenitic steel)	N/mm^2
R_m	minimum tensile strength (actual or guaranteed)	N/mm^2
K	material property used for design	N/mm^2
R	radius of curvature e.g. inside crown radius of dished end	mm
S	safety factor at design pressure, in relation with Re	-
S_k	safety factor against elastic buckling at design pressure	-
S_p	safety factor against plastic deformation	-
Z	auxiliary value	-
v	Poisson's ratio	-
u	out of roundness	-

4 Design

4.1 Design options

4.1.1 General

The design shall be carried out in accordance with one of the options given in 4.1.2, 4.1.3 or 4.1.4.

Metallic materials used at cryogenic temperatures shall meet the requirements of the relevant sections of EN 1252-1 or EN 1252-2.

In the case of 9 % Ni steel, the additional requirements of annex B shall be satisfied.

For carbon and low alloy steels the requirements of EN 1252-2 shall be satisfied.

4.1.2 Design by calculation

Calculation of all pressure and load bearing components shall be carried out. The pressure part thicknesses of the vessel shall not be less than required by 4.3. Additional calculations may be required to ensure the design is satisfactory for the operating conditions including an allowance for dynamic loads.

4.1.3 Design by calculation and pressure strengthening

The pressure retaining capability of vessels manufactured from austenitic stainless steel, strengthened by pressure, shall be calculated in accordance with annex C.

4.1.4 Design by calculation supplemented with experimental methods

Where it is not possible to design by calculation alone planned and controlled experimental means may be used providing that the results confirm the safety factors required in 4.3. An example would be the application of strain gauges to assess stress levels.

4.2 Common design requirements

4.2.1 General

The requirements of 4.2.2 to 4.2.7 are applicable to all vessels irrespective of the design option used.

In the event of an increase in at least one of the following parameters :

— maximum allowable pressure ;

— specific mass (density) of the densest gas for which the vessel is designed ;

— maximum tare weight of the inner vessel ;

— nominal length and/or diameter of the inner shell ;

or, in the event of any change relative :

— to the type of material or grade (e.g. stainless steel to aluminium) ;

— to the fundamental shape ;

— to the decrease in the minimum mechanical properties of the material being used ;

— to the modification of the design of an assembly method concerning any part under stress, particularly as far as the support systems between the inner vessel and the insulation or the vessel itself or the protective frame, if any, are concerned ;

the initial design programme shall be repeated to take account of these modifications.

4.2.2 Design specification

To enable the design to be prepared the following information which defines a vessel type shall be available :

— maximum allowable pressure ;

— fluids intended to be used ;

— liquid capacity ;

— dimensions and allowable weight, taking characteristics of the vehicle into account ;

— location of fastening points and loads allowable on these points ;

— filling and emptying rate ;

— range of ambient temperature, if differing from 7.2 of EN 14398-1:2003.

A design document in the form of drawings with text if any shall be prepared, it shall contain the information given above plus the following where applicable :

— definition of which components are designed by calculation, by pressure strengthening, by experiment and by satisfactory in service experience ;

— drawings with dimensions and thicknesses of load bearing components ;

— specification of all load bearing materials including grade, class, temper, testing etc. as relevant ;

— type of material test certificates ;

— location and details of welds and other joints, welding and other joining procedures, filler, joining materials etc. as relevant ;

— calculations to verify compliance with this standard ;

— design test programme ;

— non destructive testing requirements ;

— pressure test requirements ;

— piping configuration including type, size and location of all valves and relief devices ;

— details of fastenings.

4.2.3 Design loads

4.2.3.1 General

The large transportable cryogenic vessel shall be able to withstand safely the mechanical and thermal loads encountered during pressure test and normal operation.

In considering design loads during transport, static loads shall be substituted for static plus dynamic loads. The static loads used shall be as follows :

— in the direction of travel : twice the total mass ;

— at right angles to the direction of travel : the total mass ;

— vertically upwards: the total mass ;

— vertically downwards: twice the total mass.

Each of these loads is considered to act in isolation and includes the mass of the component under consideration.

4.2.3.2 Vessel

With the exception of a) the following loads shall be considered to act in combination where relevant :

a) test pressure : the value used for validation purposes shall be :

$$p_T \geq 1{,}3\, p_s \text{ bar} \qquad (1)$$

considered for each element of the vessel e.g. shell, courses, head, etc..

p_s is the maximum allowable pressure, in bar.

The vessel shall be capable of holding the pressure test fluid without plastic deformation.

b) pressure during operation, p_C, where :

$$p_C = p_s + p_L \qquad (2)$$

p_L is the pressure, in bars, exerted by the mass of the liquid contents when the vessel is filled to capacity and subject to each load defined in 4.2.3.1, with either :

1) boiling liquid at minimum allowable temperature

2) cryogenic fluid at its equilibrium triple point or melting point temperature;

c) reaction at the support points of the vessel due to the mass of the vessel and its contents when subject to each of the loads defined in 4.2.3.1 ;

d) load imposed by the piping due to the differential thermal movement of the vessel, the piping and the insulation.

The following cases shall be considered :

— cooldown (vessel warm - piping cold) ;

— filling and withdrawal (vessel cold - piping cold) ; and

— transport and storage (vessel cold - piping warm) ;

e) load imposed on the vessel at its support points when cooling from ambient to operating temperature and during operation.

4.2.3.3 Self supporting vessels

In the case of vehicles in which the vessel constitute stressed self-supporting members of the vehicle, these shall be designed to withstand the stresses thus imposed in addition to stresses from other sources, (see 4.2.3.2 c).

4.2.3.4 Vessel supports

The vessel supports shall be suitable for each load defined in 4.2.3.2 c) plus loads due to differential thermal movements.

4.2.3.5 Surge plates

The vessel shall be divided by surge plates to provide stability and limit dynamic loads to the requirements of 4.2.3, unless it is to be filled equal to or more than 80 % of its capacity or nominally empty. The cross sectional area of the surge plate shall be at least 70 % of that of the vessel.

Current experience with surge plates limiting the capacity to 7 500 l has been shown to meet these requirements.

Surge plates and their attachments to the shell shall be designed to resist the stresses caused by a pressure evenly distributed across the area of the surge plate. The pressure is calculated by considering the mass of liquid between the plates decelerating at 2 g (4.2.3).

4.2.3.6 Fastening points

Fastening points shall be suitable for fastening the large transportable cryogenic vessel to the vehicle when filled to capacity and subject to each of the loads defined in 4.2.3.

4.2.3.7 Protection of upper fittings

The fittings and accessories mounted on the upper part of the vessel shall be protected in such a way that damage caused by overturning cannot impair operational integrity. This protection may take the form of strengthening rings, protective canopies or transverse or longitudinal members so shaped that effective protection is given.

4.2.3.8 Stability

The overall width of the ground-level bearing surface (distance between the outer points of contact with the ground of the right-hand tyre and the left-hand tyre of the same axle) shall be at least equal to 90 % of the height of the centre of gravity of the fully laden tank-vehicle. In an articulated vehicle the mass on the axles of the load-carrying unit of the laden semi-trailer shall not exceed 60 % of the nominal total laden mass of the complete articulated vehicle.

4.2.3.9 Piping and valves

Piping including valves, fittings and supports shall withstand the following loads. With the exception of a) the loads shall be considered to act in combination where relevant.

a) pneumatic pressure test : not less than the allowable working pressure p_s;

b) pressure during operation : not less than the set pressure of the system pressure relief device ;

c) thermal loads defined in 4.2.3.2 d) ;

d) dynamic loads ;

e) set pressure of thermal relief devices where applicable ;

f) loads generated during pressure relief discharge.

This equipment shall be protected or positioned so as to be protected against the risk of being wrenched off or damaged during transport.

The leakproofness of this equipment shall be ensured in the event of overturning of the vehicle. The gaskets shall be made of a material compatible with the fluid carried, in accordance with EN 1797.

Each bottom-filling or bottom-discharge opening shall be provided with at least two independent shut-off devices in series, the first being a stop valve provided with protection against mechanical damage.

In order to prevent leaks of flammable fluids the first stop valve shall be an instant-closing safety device which closes automatically in the event of an unintended movement of the vehicle or of fire during the filling/emptying operation. It shall also be possible to operate the closing device by remote control. All vent pipes including pressure relief devices and purge valves shall be connected to a vent pipe allowing safe discharge. The control cabinet shall be vented so that flammable gas cannot accumulate therein.

4.2.4 Fatigue

The design shall take into account the effect of cyclic stress on the inner vessel, outer jacket and their attachments during normal conditions of operation.

When considering the case of fatigue, the common requirement of dimensioning with loads according to 4.2.3 will be such as to accommodate the effects of fatigue. Particular attention may be necessary to specific details in the supports and piping systems to avoid stress raisers.

4.2.5 Corrosion allowance

Corrosion allowance is not required on surfaces in contact with the operating fluid. Corrosion allowance is not required on other surfaces if they are adequately protected against corrosion.

4.2.6 Inspection openings

Inspection openings are not required in the vessel, providing the requirements of EN 14398-3 are followed.

NOTE Due to the combination of materials of construction and operating fluids, internal corrosion cannot occur.