BRITISH STANDARD

BS EN 14460:2006

Explosion resistant equipment

The European Standard EN 14460:2006 has the status of a British Standard

ICS 13.230

British Standards

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 14460:2006.

The UK participation in its preparation was entrusted to Technical Committee FSH/23, Fire precautions in industrial and chemical plant.

A list of organizations represented on FSH/23 can be obtained on request to its secretary.

Additional information

This harmonized European Standard gives requirements for the construction of process vessels or systems in which a potentially explosive atmosphere may occur, and which are subject to explosion protection techniques.

It does not give requirements for the design of explosion protection for either electrical or non-electrical (mechanical) equipment intended for use in explosive atmospheres and should not be used for such designs.

Requirements for the explosion protection of electrical equipment intended for use in explosive atmospheres are given in the BS EN 60079 series of standards. Techniques for the explosion protection of mechanical equipment intended for use in explosive atmospheres are given in the BS EN 13463 series of standards.

Explosion protection of process vessels or systems can be achieved by the application of:

1. Venting the requirements of which are given in:
   BS EN 14797, Explosion venting devices
   BS EN 14491, Dust explosion venting protective systems
   BS EN 14994, Gas explosion venting protective systems
2. Suppression the requirements of which are given in:
   BS EN 14373, Explosion suppression systems
3. Containment the requirements of which are given in this standard.

The requirements of this standard should be applied to the construction of a process vessel or system when any of the above explosion protection techniques are applied. The essential requirement is that the vessel or system should suffer no unintended rupture. When either venting or suppression is applied explosion pressures stay relatively low, but when the chosen protection technique is Containment, it is important to understand what containment means.

Explosion containment is a technique whereby the explosion is totally sealed inside the process plant or system. The process plant or system is therefore designed so that it does not rupture under the very highest explosion pressures generated; that is, there is no escape of either flame or pressure into the surroundings.

In the application of all explosion protection methods it may be necessary to take into account isolation techniques that prevent explosions from propagating between items of process plant. Requirements for explosion isolation techniques are given in harmonized standards currently being prepared by CEN TC 305 WG 3.

It may be necessary also to take into account pressure piling effects that may occur due to flame propagation either through connecting pipelines between process vessels or through structures inside a single vessel.

Other factors specific to an installation may also need to be considered.

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

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

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EUROPEAN STANDARD

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EN 14460

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English Version

Explosion resistant equipment

Appareil résistant à l'explosion

Explosionsfeste Geräte

This European Standard was approved by CEN on 23 March 2006.

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, 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.

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Foreword

This document (EN 14460:2006) has been prepared by Technical Committee CEN/TC 305 "Potentially explosive atmospheres – Explosion prevention and protection", 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 November 2006, and conflicting national standards shall be withdrawn at the latest by November 2006.

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 94/9/EC of 23 March 1994.

For relationship with EU Directive 94/9/EC, 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, 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.

Introduction

The principles of integrated explosion safety includes the following measures the manufacturer has to take:

a) prevention of formation of explosive atmospheres;

b) prevention of the ignition of the explosive atmospheres; and

c) if an explosion nevertheless occurs, to halt it immediately and/or to limit the range of explosion flames and explosion pressures to a sufficient level of safety.

It is essential that methods according to c) be used if the ignition hazard assessment of the equipment shows that the prevention of ignition sources, e.g. by using of types of ignition protection as defined in EN 13463 series, doesn't fulfil the requirements of the intended category which is necessary for the intended use of the equipment. This standard specifies requirements for equipment that shall be explosion resistant. Explosion resistance is the term applied to the construction of an enclosure so that it can withstand an expected explosion pressure without rupture. Giving equipment this property it limits the range of explosion flames and explosion pressures to a sufficient level of safety.

The equipment property "explosion resistance" can be used for equipment, protective systems and components.

1 Scope

This standard specifies requirements for explosion-pressure-resistant and explosion pressure shock-resistant equipment. This standard is applicable to process vessels and systems. It is not applicable to individual items of equipment such as motors and gearboxes that may be designed to withstand an internal explosion, which is the subject of EN 13463-3.

This standard is valid for atmospheres having pressures ranging from 800 hPa to 1100 hPa and temperatures ranging from - 20 °C to + 60 °C. This standard may also be helpful for the design, construction, testing and marking of equipment intended for use in atmospheres outside the validity range stated above, as far as this subject is not covered by specific standards.

This standard applies to equipment and combinations of equipment where deflagrations may occur and is not applicable to equipment and combination of equipment where detonation may occur. This standard should not be used for offshore applications.

It is essential that this standard be used for equipment made of metallic materials only.

2 Normative references

The following referenced documents are indispensable for the application 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 10002-1, *Metallic materials - Tensile testing - Part 1: Method of test at ambient temperature*

EN 10204, *Metallic products – Types of inspection documents*

EN 13237:2003, *Potentially explosive atmospheres - Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

EN 13445-1, *Unfired pressure vessels – Part 1: General*

EN 13445-2, *Unfired pressure vessels – Part 2: Materials*

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

EN 13445-4, *Unfired pressure vessels – Part 4: Fabrication*

EN 13980, *Potentially explosive atmospheres - Application of quality systems*

ISO 8421-1:1987, *Fire protection – Vocabulary - Part 1: General terms and phenomena of fire*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 13237:2003 and ISO 8421-1:1987 and the following apply.

3.1
deflagration
explosion propagating at subsonic velocity

[ISO 8421-1:1987, 1.11]

3.2
detonation
explosion propagating at supersonic velocity and characterized by a shock wave

[ISO 8421-1:1987, 1.12]

3.3
explosion
abrupt oxidation or decomposition reaction producing an increase in temperature, pressure, or in both simultaneously

[ISO 8421-1:1987, 1.13]

3.4
explosion resistant
property of vessels, and equipment designed to be either explosion-pressure-resistant or explosion-pressure-shock resistant

[EN 13237:2003, 3.34]

3.5
explosion-pressure-resistant
property of vessels, and equipment designed to withstand the expected explosion pressure without becoming permanently deformed

[EN 13237:2003, 3.31]

3.6
explosion-pressure-shock resistant
property of vessels, and equipment designed to withstand the expected explosion pressure without rupturing, but allowing permanent deformation

[EN 13237:2003, 3.32]

3.7
maximum explosion pressure
p_{max}
maximum pressure occurring in a closed vessel during the explosion of a specific explosive atmosphere determined under specified test conditions

[EN 13237:2003, 3.81]

3.8
maximum allowable explosion pressure
p_{exmax}
calculated maximum explosion pressure which the equipment will withstand

3.9
reduced explosion pressure
***p*red**
pressure generated by an explosion of an explosive atmosphere in a vessel, protected by either explosion relief or explosion suppression

[EN 13237:2003, 3.100]

4 Explosion resistant equipment

4.1 General

Explosion resistant equipment shall be so constructed that it can withstand an internal explosion without rupturing.

In general, a distinction is made between the following designs:

— design for the maximum explosion pressure;

— design for the reduced explosion pressure in conjunction with explosion pressure relief or explosion suppression.

Components of the system can be either explosion-pressure-resistant or explosion-pressure shock resistant.

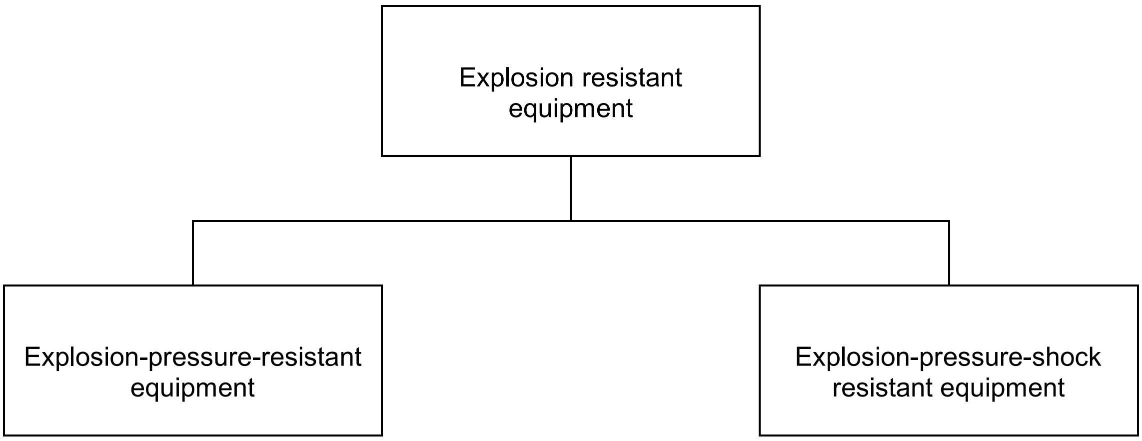


Figure 1 — Explosion resistant equipment

4.2 Design pressure

The design pressure shall not be less than the maximum gauge pressure occurring in the equipment, when subjected to explosion or reduced explosion conditions. The design pressure shall be used as the calculation pressure as detailed in EN 13445-3.

NOTE 1 If the inside of the equipment is divided into sections (e.g. tanks connected by a pipeline or containing baffles or surge plates), during an explosion in one of the sections the pressure in the other sections of the equipment will be increased. As a result, an explosion in these sections will occur at an elevated initial pressure. Further, pressure peaks occur which are higher than the value expected under atmospheric conditions. In the case of such arrangements, appropriate measures should be taken, either explosion de-coupling techniques or explosion resistant design derived from representative explosion trials.

NOTE 2 Pressures quoted are gauge pressures unless otherwise stated.

For guidance on the derivation of design pressure see Annex A.

4.3 Design temperature

For wall temperatures governed by the weather or by the vessel charge of less than – 10 °C EN 13445-2 shall be consulted for material requirements.

In case of an explosion there is only a marginal heat up of the vessel walls. Therefore, the anticipated operating temperature at the initial pressure shall be used as the design temperature.

4.4 Additional loads

Loads which are due to an activation of a venting device, due to product load and/or to hydrostatic load shall be considered. In addition any other load that may occur at the same time as an explosion e.g. windload, snowload, shall be considered, corresponding to EN 13445-3.

If brittle material is used for pressure shock-resistant apparatus and components, then care shall be taken to avoid excessive or uneven stressing during assembly.

4.5 Wall thickness allowance

If a corrosion and/or erosion allowance is requested by the customer this shall be deducted from the design wall thicknesses before design calculations are carried out (see Clause 8).

5 Explosion-pressure-resistant design

Explosion-pressure-resistant equipment shall withstand the maximum or reduced explosion pressure without becoming permanently deformed. EN 13445-3 which covers the design of and calculations for unfired pressure vessels shall be used when dimensioning and manufacturing these equipments. The maximum or reduced explosion pressure shall be used as the basis for the calculation pressure. Explosion pressure-resistant design fulfils the requirements of explosion-pressure-shock resistant design.

6 Explosion-pressure-shock resistant design

6.1 General

Explosion-pressure-shock resistant equipment shall be so constructed that they can withstand the maximum or reduced explosion pressure without rupturing, but may become permanently deformed (see 8.2 g)). Explosion-pressure-resistant equipment according to Clause 5 is considered to be explosion-pressure-shock resistant for a 50 % higher gauge pressure, if the requirements according to 6.2.1 are fulfilled.

Explosion pressure-shock resistant equipment shall be designed or tested either by

a) design according to 6.2 and pressure test according to 6.3.3, Table 1, column A for each device;

b) pressure test as a type test according to 6.3.3, Table 1, column B (with permanent deformation) and pressure test of all devices according to 6.3.3, Table 1, column A; or

c) explosion test as a type test according to 6.3.3, Table 1, column C and pressure test of all devices according to 6.3.3, Table 1, column A.

In case the pressure test of all devices according to 6.3.3, Table 1, column A is impossible because of technical and/or safety reasons the manufacturer has to demonstrate the quality of all devices by:

1) material certificates according to EN 10204;

2) non-destructive examination of welding, at least ultra sonic;

3) check of the measurements compared with the design drawings.

6.2 Design and manufacture according to EN 13445 with modified design criteria

6.2.1 General

EN 13445 for unfired pressure vessels shall be used with the following modifications:

— The nominal design stress for design conditions as defined in EN 13445-3 may be multiplied by 1,5 in the case of materials with sufficient ductility. These materials are:

  — steel, cast steel and spheroidal graphite castings with

    — rupture elongation A5 ≥ 14 %, test temperature 20 °C; and

    — notch impact energy ≥ 27 J, ISO V.
    The test temperature shall not be higher than the lowest intended operating temperature and shall not exceed 20°C.

  — aluminium with

    — rupture elongation A5 ≥ 20 %, test temperature 20 °C; and

    — notch impact energy not defined.

6.2.2 Materials

Only materials permitted by EN 13445-2 shall be used which fulfil the mechanical, thermal and chemical requirements of the design and operation of the equipment.

6.2.3 Design and manufacture

Manufacture shall be in accordance with EN 13445-4.

Detailed design features which can lead to cracking shall be avoided. This requires limitation of stress concentrations (For examples see Annex B).

6.2.4 Openings

Openings shall preferably be reinforced by increasing the wall thickness of the nozzle up to a maximum value $s_s \leq 1{,}5\ s_e$ (see Figure 2).

The wall thickness of the nozzle which contributes to the compensation of the weakening shall have an extended length, l, of at least:

$$l \geq \sqrt{(d_i + s_s - c_1 - c_2)(s_s - c_1 - c_2)} \qquad (1)$$

where

l is the extended length of the nozzle with thickness s_s, in mm;

d_i is the inside diameter of the nozzle, in mm.

Disc-shaped reinforcement shall be avoided if possible; but if used, then the width b and the thickness h of the disc shall be designed to conform to:

$$b \geq \sqrt{(D_\mathrm{i} + s_\mathrm{A} - c_1 - c_2)(s_\mathrm{A} - c_1 - c_2)} \quad (2)$$

$$h = s_\mathrm{A} - s_\mathrm{e} \leq s_\mathrm{e} \quad (3)$$

where

s_s is the nozzle wall thickness, in mm;

s_e is the actual vessel wall thickness, in mm;

b is the width of a disc-shaped reinforcement, in mm;

D_i is the inside diameter of the cylinder or spherically dished and formed head, in mm;

s_A is the required wall thickness at the opening, in mm;

c_1 is the amount by which the actual thickness may be less than the nominal thickness, if any, in mm;

c_2 is the wear or corrosion allowance, in mm;

h is the thickness of the disc-shaped reinforcement, in mm.

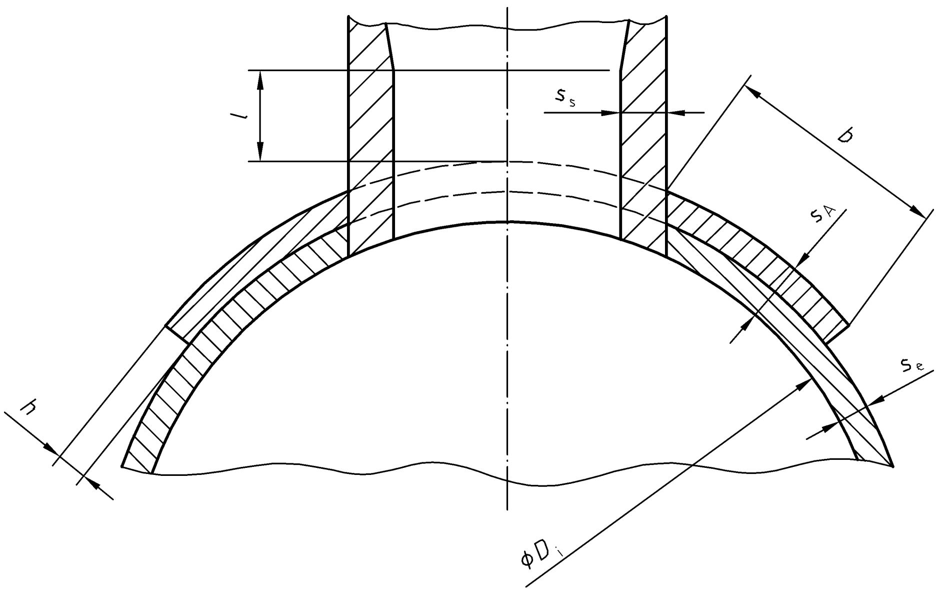


Figure 2 — Measures at openings

6.2.5 Weld efficiency and testing

The following tests shall be performed depending on the weld joint factor drawn upon:

— Weld joint factor 1,0:

All welds undergo non-destructive testing and, as far as possible, visual inspection on both sides.

— Weld efficiency factor 0,85:

The welds undergo, as far as possible, visual inspection on both sides. All welded joints with a total weld length of no less than 10 % of the length of all welds in sum undergo non-destructive testing.

— Up to weld joint factor 0,7:

All welds undergo visual inspection.

6.2.6 Bolts

For gases and vapours the same gasket factor shall be used as for fluids.

Bolts shall be designed in accordance to EN 13445-3. The safety factor used for design pressure may be multiplied by 0,7 and for assembly by 0,85.

For C-clamps the allowable load may be increased by a factor of 1,5.

6.2.7 Flanges

The calculation shall be for assembly (initial deformation of the gasket) and for the load given by the explosion pressure.

For pipe flanges manufactured as per EN 1092-1, the allowed pressure rating given in the standards may be multiplied by a factor of 1,5 without checking.

NOTE Until a European Standard about product flanges is prepared this applies also for product flanges according to the German Standards DIN 28030-1 and DIN 28030-2.

Flanges used in conjunction with C-clamps shall be designed without the reduction in safety factors permitted in 6.2.

6.3 Testing

6.3.1 General

The test can take place as a hydrostatic or a pneumatic pressure test or alternatively as an explosion test. Equipment shall be tested to a pressure defined by Equation (4), using any one of the values for *F* from Table 1.

The test pressure is defined by:

$$p_\mathrm{t} = F \times \frac{R_{\mathrm{p}0,2}\left(20\ °C\right)}{R_{\mathrm{p}0,2}\left(\vartheta\right)} \times p \qquad (4)$$

where

ϑ is the design temperature, in °C;

p_t is the test pressure, in hPa;

F is the factor defined in the following clauses;

$R_{p0,2}$ is the minimum guaranteed yield strength, in N/mm^2; according to EN 10002-1.

p is the design pressure, in hPa.

The ratio $R_{p0,2}$ (20 °C) to $R_{p0,2}$ (ϑ) may be considered 1 unless the difference between the test temperature and the design temperature exceeds 100 K for steels or 50 K for aluminium.

If the explosion test is used the reached explosion pressure shall be at least equal the required test pressure.

6.3.2 Pressure test

Pressure testing of explosion-pressure-shock resistant equipment shall be carried out at a test pressure defined in 6.3.3, Table 1 column A or B depending on the selected test procedure for not less than 3 min. No permanent deformation shall occur during the test with a test pressure defined in column A and permanent deformation but no rupturing may occur during the test with a test pressure defined in column B. The test temperature and test pressure shall be given in the test report.

6.3.3 Explosion test

Explosion test shall be carried out with the explosive atmosphere the equipment is intended to use for or with a test atmosphere with similar safety related properties (maximum explosion pressure, maximum rate of explosion pressure rise). The explosion pressure shall be recorded by a pressure recording system (limiting frequency ≥ 100 kHz) fitted to the equipment. The resulted maximum explosion pressure shall reach the values defined in Table 1, column C at least. Permanent deformation but no rupturing may occur as result of the test. The used test mixture, test temperature, the pressure record and maximum explosion pressure shall be given in the test report.

Table 1 — Values of factor *F* in accordance to Equation (4)

	A **Pressure test** **(Routine test)** **No permanent deformation allowed**	**B** **Pressure test** **(Type test)** **Permanent deformation allowed**	**C** **Explosion test** **(alternatively to the pressure test)** **(Type test)**
Materials according to 6.2.1	0,9	1,1	1,1 (Deformation allowed)
Brittle material/Flake Graphite/Cast aluminium G-Al Mg 5 and G-Al Si Mg wa	2,0	not applicable	2,0 (Deformation not allowed)
Cast Steel and cast iron GGG 35.3 and 40.3	1,3	not applicable	1,3 (Deformation not allowed)
NOTE Dished ends should be checked for buckling at the knuckle zone at the test pressure.			

7 Documentation of quality of explosion resistant equipment

7.1 Pressure vessels

Equipment which meet the requirements of EN 13445 are considered to be explosion-pressure resistant for the same gauge pressure and explosion-pressure-shock resistant for 50 % higher gauge pressure and the same documentation may be used.

7.2 Materials

For major parts of equipment manufactured in accordance with Clause 5 or 6.2.1 material certification shall be as specified in EN 13445-2.

7.3 Welding

Documentary evidence shall be provided that the weld procedures and the welder qualifications satisfy the requirements of the design method employed (see EN 13980).

7.4 Examination and test

Documentary evidence shall be provided for any non destructive testing and/or pressure or explosion test carried out.

8 Information for use

8.1 Marking

All explosion resistant equipment shall be marked on the main part in a visible place. This marking shall be legible and durable taking into account possible chemical corrosion.

Marking shall include:

a) name and address of the manufacturer;

b) manufacturer's type identification;

c) year of construction;

d) serial number;

e) maximum operational pressure and temperature.

8.2 Accompanying documents

The manufacturer shall provide the following minimum written instructions:

a) the information marked on the equipment;

b) all details of the operational requirements;

c) specification of the allowance of wear or corrosion;

d) documentation about the tests described in 6.3 and the maximum explosion pressure;

e) documentation according to Clause 7;

f) a full description of installation and maintenance procedures and periodic inspection. Periodic inspection checks for corrosion or wear are only necessary in cases where corrosion or wear of the equipment can occur;

g) a full description of procedures to be followed after an explosion.

Annex A
(normative)

Calculation of design pressure

The design pressure p in the vessel or apparatus is calculated from the anticipated maximum explosion pressure p_{max} or the reduced explosion pressure p_{red}.

$$p = p_{max} - 1000 \text{ hPa} \quad \text{(A.1)}$$

or

$$p = p_{red} - 1000 \text{ hPa} \quad \text{(A.2)}$$

In determining the design pressure p the initial pressure p_v shall be considered only if it is less than 900 hPa or more than 1100 hPa absolute:

$$p = \frac{p_{max0} \times p_V}{p_0} - 1000 \text{ hPa} \quad \text{(A.3)}$$

$$p = \frac{p_{red0} \times p_V}{p_0} - 1000 \text{ hPa} \quad \text{(A.4)}$$

where:

p_0 corresponds to atmospheric pressure, always p_0 = 1000 hPa absolute;

p_{max0} corresponds to p_{max} when the initial pressure is 1000 hPa absolute;

p_{red0} corresponds to p_{red} for 1000 hPa initial absolute pressure;

p_v is the initial absolute pressure which exists when the ignition source is being activated.

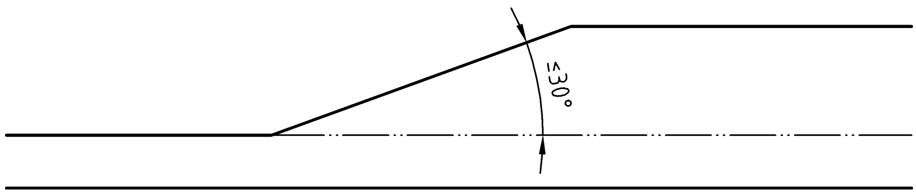
Pressures p_{max}, p_{red}, p_{max0}, p_{red0}, p_0 *and* p_v are absolute pressures. The design pressure p is stated as gauge pressure.

Annex B
(informative)

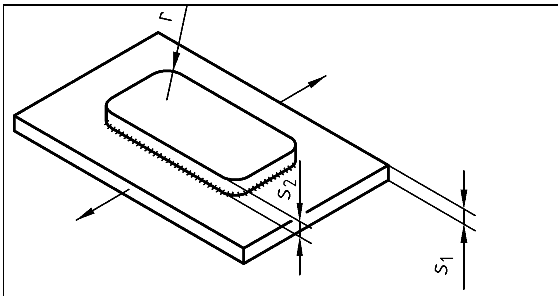
Examples for limitation of stress concentration

Examples for limitation of stress concentration

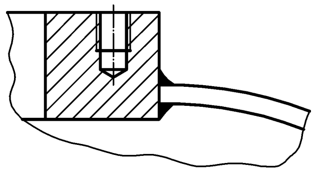
— Abrupt change in wall-thicknesses



— The wall-thickness of welded parts should not be greater than the thickness of the shell. Reinforcing plates and parts should be radiused

	Fillet welded reinforcing plates and pads. Not subjected to cyclic loading	$s_2 \leq s_1$ $r \geq 2 \times s_2$

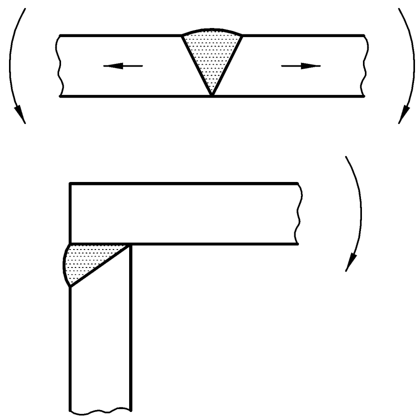
— Avoidance of details giving severe localised restraint



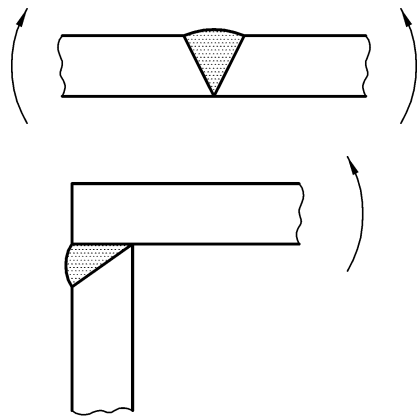
— Single-sided welding should be avoided. If this is not possible, normal tensile stress (membrane stress) and compressive stress may be allowed in the case of bending. In the case of bending where tensile stress in the root of the weld will occur, it will be necessary to increase the safety factors from 6.2 by 50%.

EXAMPLE

allowed:



not allowed (or allowed with a safety factor 50% higher than specified in 6.2):



Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 94/9/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 94/9/EC of 23. March 1994 concerning products and protective systems intended for use in potentially explosive atmospheres.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 94/9/EC

Essential Requirements (ERs) of Directive 94/9/EC		Clauses/sub-clauses of this European Standard
1.0	General requirements	whole document
1.01	Principles of integrated explosion safety	4.1, 4.2, 5, 6
1.04	Surrounding area conditions	4.3, 4.4
1.05	Marking	8.1
1.06	Instructions	8.2
1.1	Selection of materials	4.5, 6.2.2, 6.2.5, 7.2, 7.3
1.2	Design conditions	5, 6
1.2.1	Technological knwowledge of explosion protection for safe operation	6.1, 6.2
1.2.5	Additional means of protection	4.4
1.4	Hazards arising from external effects	4.3, 4.4, 4.5, 6.3
3.1	Planning and design	4.2, 4.4, 5, 6.1

WARNING: Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.

Bibliography

[1] EN 1092-1, *Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1: Steel flanges*

[2] EN 1127-1, *Explosive atmospheres - Explosion prevention and protection – Part 1: Basic concepts and methodology*

[3] EN 1591-1, *Flanges and their joints - Design rules for gasketed circular flange connections – Part 1: Calculation method*

[4] EN 13445-5, *Unfired pressure vessels – Part 5: Inspection and testing*

[5] EN 13445-6, *Unfired pressure vessels – Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron*

[6] EN 13463-3, *Non-electrical equipment for use in potentially explosive atmospheres - Part 3: Protection by flameproof enclosure 'd'*

[7] DIN 28030-1, *Flanged joints for vessels and process apparatus – Part 1: Apparatus flanged vessels*

[8] DIN 28030-2, *Flanged joints for vessels and process apparatus – Part 2: Tolerances on flange dimensions*

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BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

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