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Refrigerating systems and heat pumps — Safety and environmental requirements

Part 2: Design, construction, testing, marking and documentation

bsi.

National foreword

This British Standard is the UK implementation of EN 378-2:2016. It supersedes BS EN 378-2:2008+A2:2012 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/18, Refrigeration safety.

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

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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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European foreword

This document (EN 378-2:2016) has been prepared by Technical Committee CEN/TC 182 “Refrigerating systems, safety and environmental requirements”, 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of an identical text or by endorsement, at the latest by May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

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

This document supersedes EN 378-2:2008+A2:2012.

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 Annexes ZA and ZB, which are integral parts of this document.

EN 378 consists of the following parts under the general title “*Refrigerating systems and heat pumps — Safety and environmental requirements*”:

— *Part 1: Basic requirements, definitions, classification and selection criteria;*

— *Part 2: Design, construction, installing, testing, marking and documentation;*

— *Part 3: Installation site and personal protection;*

— *Part 4: Operation, maintenance, repair and recovery.*

The main changes in part 2 with respect to the previous edition are listed below:

— *Harmonization as far as possible with* ISO 5149:2014 *and* ISO 817:2014*;*

— *Harmonizing requirements with* DIRECTIVE 2014/68/EU (PED), related to pressure and DIRECTIVE 2006/42/EC (MD).

Following detailed changes are worth noting:

— *In 5.2.1, the application of harmonized standard for components has been clarified, by making the note normative;*

— *The content of the former Table 3 has been integrated in 6.2.6.2, with necessary modifications of the flow chart in Figure 1;*

— *Replacement of 6.2.2.3 with requirements related to pressure rise in case of external fire;*

— *Improvement 6.2.5.2.2, regarding electronic safety switching devices for limiting the pressure;*

— *Rearrangement of the transport and vibration tests formerly 6.2.12 and now 6.2.12 and 6.2.13;*

— *Modification of the explosion hazard requirements in 6.2.14 (formerly 6.2.13);*

— *Addition of Annex H on stress corrosion cracking, Annex I on leak simulation test, Annex J on commissioning procedure, Annex K on ignition sources;*

— *Modification of Annex ZA for harmonization with DIRECTIVE 2014/68/EU (PED);*

— *Deletion of Annex ZB and the update of Annex ZC (now new Annex ZB).*

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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The introduction of EN 378-1 is applicable.

This standard is a type C standard as stated in EN ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations and hazardous events are covered are indicated in the scope of this standard.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

1 Scope

This European Standard specifies the requirements for the safety of persons and property, provides guidance for the protection of the environment and establishes procedures for the operation, maintenance and repair of refrigerating systems and the recovery of refrigerants.

The term “refrigerating system” used in this European Standard includes heat pumps.

This Part 2 of this Standard is applicable to the design, construction and installation of refrigerating systems including piping, components and materials. It includes ancillary equipment not covered in EN 378-1, EN 378-3 or EN 378-4 which is directly associated with these systems. It also specifies requirements for testing, commissioning, marking and documentation. Requirements for secondary heat transfer circuits are excluded except for any protection requirements associated with the refrigerating system. Ancillary equipment includes, for example, fans, fan motors, electrical motors and transmission assemblies for open compressor systems.

This standard applies:

a) to refrigerating systems, stationary or mobile, of all sizes except to vehicle air conditioning systems covered by a specific product standard, e.g. ISO 13043;

b) to secondary cooling or heating systems;

c) to the location of the refrigerating systems;

d) to replaced parts and added components after adoption of this standard if they are not identical in function and in the capacity.

Systems using refrigerants other than those listed in EN 378-1:2016, Annex E are not covered by this standard.

This standard does not apply to goods in storage.

This standard is not applicable to refrigerating systems which were manufactured before the date of its publication as a European Standard except for extensions and modifications to the system which were implemented after publication.

This standard is applicable to new refrigerating systems, extensions or modifications of already existing systems, and for existing stationary systems, being transferred to and operated on another site.

This standard also applies in the case of the conversion of a system to another refrigerant type, in which case conformity to the relevant clauses of parts 1 to 4 of the standard shall be assessed.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 378-1:2016, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Basic requirements, definitions, classification and selection criteria*

EN 378-3:2016, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 3: Installation site and personal protection*

EN 378-4, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 4: Operation, maintenance, repair and recovery*

EN 809, *Pumps and pump units for liquids — Common safety requirements*

EN 837-1:1996, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

EN 837-2:1997, *Pressure gauges — Part 2: Selection and installation recommendations for pressure gauges*

EN 837-3:1996, *Pressure gauges — Part 3: Diaphragm and capsule pressure gauges — Dimensions, metrology, requirements and testing*

EN 1012-3, *Compressors and vacuum pumps — Safety requirements — Part 3: Process compressors*

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

EN 1092-3:2003, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 3: Copper alloy flanges*

EN 1736:2008, *Refrigerating systems and heat pumps — Flexible pipe elements, vibration isolators, expansion joints and non-metallic tubes — Requirements, design and installation*

EN 1861:1998, *Refrigerating systems and heat pumps — System flow diagrams and piping and instrument diagrams — Layout and symbols*

EN 12178:2003, *Refrigerating systems and heat pumps — Liquid level indicating devices — Requirements, testing and marking*

EN 12263:1998, *Refrigerating systems and heat pumps — Safety switching devices for limiting the pressure — Requirements and tests*

EN 12284:2003, *Refrigerating systems and heat pumps — Valves — Requirements, testing and marking*

EN 12693:2008, *Refrigerating systems and heat pumps — Safety and environmental requirements — Positive displacement refrigerant compressors*

EN 12735-1, *Copper and copper alloys — Seamless, round tubes for air conditioning and refrigeration — Part 1: Tubes for piping systems*

EN 12735-2, *Copper and copper alloys - Seamless, round tubes for air conditioning and refrigeration - Part 2: Tubes for equipment*

EN 12799:2000, *Brazing — Non-destructive examination of brazed joints*

EN 13136:2013, *Refrigerating systems and heat pumps — Pressure relief devices and their associated piping — Methods for calculation*

EN 13313:2010, *Refrigerating systems and heat pumps — Competence of personnel*

EN 13445-1:2014, *Unfired pressure vessels — Part 1: General*

EN 13445-2:2014, *Unfired pressure vessels — Part 2: Materials*

EN 13445-3:2014, *Unfired pressure vessels — Part 3: Design*

EN 13445-4:2014, *Unfired pressure vessels — Part 4: Fabrication*

EN 13445-5:2014, *Unfired pressure vessels — Part 5: Inspection and testing*

EN 13445-6:2014, *Unfired pressure vessels — Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron*

EN 13445-8:2014, *Unfired pressure vessels — Part 8: Additional requirements for pressure vessels of aluminium and aluminium alloys*

EN 13480-1:2012, *Metallic industrial piping — Part 1: General*

EN 13480-2:2012, *Metallic industrial piping — Part 2: Materials*

EN 13480-3:2012, *Metallic industrial piping — Part 3: Design and calculation*

EN 13480-4:2012, *Metallic industrial piping — Part 4: Fabrication and installation*

EN 13480-5:2012, *Metallic industrial piping — Part 5: Inspection and testing*

EN 13480-6:2012, *Metallic industrial piping — Part 6: Additional requirements for buried piping*

EN 13480-8:2012, *Metallic industrial piping — Part 8: Additional requirements for aluminium and aluminium alloy piping*

EN 14276-1:2006+A1:2011, *Pressure equipment for refrigerating systems and heat pumps — Part 1: Vessels — General requirements*

EN 14276-2:2007+A1:2011, *Pressure equipment for refrigerating systems and heat pumps — Part 2: Piping — General requirements*

EN 16084:2011, *Refrigerating systems and heat pumps — Qualification of tightness of components and joints*

EN 60079-15:2010, *Explosive atmospheres — Part 15: Equipment protection by type of protection "n" (IEC 60079-15:2010)*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified*)

EN 60335-1:2012, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1:2010, modified)*

EN 60335-2-24:2010, *Household and similar electrical appliances — Safety — Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice makers (IEC 60335-2-24:2010)*

EN 60335-2-34:2013, *Household and similar electrical appliances — Safety — Part 2-34: Particular requirements for motor-compressors (IEC 60335-2-34:2012)*

EN 60335-2-40:2003, *Household and similar electrical appliances — Safety — Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers (IEC 60335-2-40:2002)*

EN 60335-2-89:2010, *Household and similar electrical appliances — Safety — Part 2-89: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor (IEC 60335-2-89:2010)*

EN 61000-6-1:2007, *Electromagnetic compatibility (EMC) — Part 6-1: Generic standards — Immunity for residential, commercial and light-industrial environments (IEC 61000-6-1:2005)*

EN 61000-6-2:2005, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments (IEC 61000-6-2:2005)*

EN 61000-6-3:2007, *Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for residential, commercial and light-industrial environments (IEC 61000-6-3:2006)*

EN 61000-6-4:2007, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4:2006)*

EN ISO 3744:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010)*

EN ISO 3746:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane (ISO 3746:2010)*

EN ISO 4126-1:2013, *Safety devices for protection against excessive pressure — Part 1: Safety valves (ISO 4126-1:2013)*

EN ISO 4126-2:2003, *Safety devices for protection against excessive pressure — Part 2: Bursting disc safety devices (ISO 4126-2:2003)*

EN ISO 4871:2009, *Acoustics — Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*

EN ISO 6708:1995, *Pipework components — Definition and selection of DN (nominal size) (ISO 6708:1995)*

EN ISO 7010:2012, *Graphical symbols — Safety colours and safety signs — Registered safety signs (ISO 7010:2011)*

EN ISO 10675-1:2013, *Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 1: Steel, nickel, titanium and their alloys (ISO 10675-1:2008)*

EN ISO 10675-2:2013, *Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 2: Aluminium and its alloys (ISO 10675-2:2010)*

EN ISO 11202:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections (ISO 11202:2010)*

EN ISO 11688-1:2009, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning (ISO/TR 11688-1:1995)*

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13732-1:2008, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces (ISO 13732-1:2006)*

EN ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design (ISO 13850:2015)*

EN ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)*

EN ISO 14120:2015, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards (ISO 14120:2015)*

EN ISO 17636-1:2013, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film (ISO 17636-1:2013)*

EN ISO 17636-2:2013, *Non-destructive testing of welds — Radiographic testing — Part 2: X- and gamma-ray techniques with digital detectors (ISO 17636-2:2013)*

EN ISO 17638:2009, *Non-destructive testing of welds — Magnetic particle testing (ISO 17638:2003)*

EN ISO 17640:2010, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment (ISO 17640:2010)*

ISO 817:2014, *Refrigerants — Designation and safety classification*

ISO 13043:2011, *Road vehicles — Refrigerant systems used in mobile air conditioning systems (MAC) — Safety requirements*

ASTM D 4728:2006, *Standard Test Method for Random Vibration Testing of Shipping Containers*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in EN 378-1:2016 apply.

Designation, classification, and selected properties of the refrigerant such as:

— refrigerant number, e.g. R-717;

— safety classes A1, A2L, A2, A3, B1, B2L, B2, B3;

— lower flammability limits (LFL)

are specified in EN 378-1:2016, Annex E.

For the purposes of this document, abbreviated terms given in EN 378-1:2016 and the following apply.

DN Nominal size (see EN 378–1:2016, 3.5.14)

PS Maximum allowable pressure in bar (1 bar = 0,1 MPa) (see EN 378–1:2016, 3.3.2)

LFL Lower flammability limit in kg/m^3 (see EN 378–1:2016, 3.7.8)

4 Significant hazards

The list of significant hazards related to the Machinery Directive is given in Annex D.

5 Safety requirements

5.1 General safety and environmental requirements

5.1.1 General

Safety and environmental requirements are specified for components and piping in 5.2 and 5.3 and for assemblies in Clause 6.

Refrigerating appliances complying with product standards such as

— EN 60335-2-40 for electrical heat pumps, air-conditioners and dehumidifiers;

— EN 60335-2-24 for Particular requirements for refrigerating appliances, ice-cream appliances and ice makers;

— EN 60335-2-89 for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor

are in compliance with this European Standard up to and including category I as determined in Annex B, provided they are also compliant with the applicable safety requirements for machinery or low voltage. For refrigerating appliances of category II and higher, as determined in Annex B, the relevant requirements for pressure safety in Clauses 5 and 6 apply.

5.1.2 Hazards to persons, property and environment

Refrigerating systems and components shall be designed and constructed with the intention to eliminate possible hazards to persons, property and the environment. Deliberate discharge of refrigerants shall only be permitted in a manner which is not harmful to persons, property and the environment and in accordance with national laws.

5.2 Safety requirements for components and piping

5.2.1 General requirements

Components and piping shall comply with the related standards or requirements as indicated in Table 1. Requirements for components not included in Table 1 and which are below category II as defined in B.5 are indicated in 5.3.

Components that are declared to comply with the relevant directives using an alternative method also comply with the requirements of this standard.

Where the product standards for components or piping are not harmonized for the EC provisions in relation to pressure or if the essential requirements of such provisions are not covered, then the relevant requirements for pressure shall be confirmed by risk assessment.

Table 1 — Components and piping requirements

COMPONENT		related standard AND requirements
Heat exchangers: — pipe coil without air (tube in tube) — multi-tubular (shell and tubes)		EN 14276–1 or EN 13445 if applicable combined with 5.2.2 of this standard
Plate heat exchangers		EN 14276–1 or EN 13445 if applicable combined with 5.2.2 of this standard
Headers, coils and grids with air as secondary fluid		EN 14276–2 or EN 14276–1 if applicable combined with 5.2.2.2 of this standard
Receiver/accumulator/economizer		EN 14276–1 or EN 13445 if applicable combined with 5.2.2 of this standard
Oil separator		EN 14276–1 or EN 13445 if applicable combined with 5.2.2 of this standard
Drier		EN 14276–1 or EN 13445 if applicable combined with 5.2.2 of this standard
Filter		EN 14276–1 or EN 13445 if applicable combined with 5.2.2 of this standard
Muffler		EN 14276–1 or EN 13445 if applicable combined with 5.2.2 of this standard
Hermetic positive displacement motor-compressor		EN 14276–1, EN 60335–2-34 or EN 12693
Semi-hermetic positive displacement motor-compressor		EN 60335–2-34 or EN 12693
Open positive displacement compressor		EN 12693
Non positive displacement compressor		EN 14276–1, EN 1012–3 or EN 13445 if applicable combined with EN 60204–1
Pump	general requirements	EN 809 combined with EN 60204–1, and combined with 5.2.2.2 and 5.2.2.4 of this standard
	additional requirements for pumps in refrigerating systems and heat pumps with R-717	Annex A
Piping		EN 14276–2 or EN 13480
Piping joints: permanent joints		EN 14276–2
Piping joints: detachable joints		5.2.2.2 and 5.2.2.3 of this standard
Flexible piping		EN 1736
Valves	general	EN 12284
	isolating valves	EN 12284
	hand operated valves	EN 12284
	valves with seal cap	EN 12284
	pressure relief valve	EN 13136 and EN ISO 4126-1 combined with 5.2.2 of

COMPONENT		related standard AND requirements
		this standard
Safety switching devices for limiting the pressure		EN 12263 combined with 5.2.2.2 of this standard
Bursting disc		EN ISO 4126-2 and EN 13136 combined with 5.2.2.2 of this standard
Liquid level indicators		EN 12178 combined with 5.2.2.2 of this standard
Gauges		EN 837–1, EN 837–2 and EN 837–3 combined with 5.2.2.2 of this standard
Brazing and soldering materials		5.3.1.3 e), f) of this standard
Welding materials		EN 14276–2

If the component contains electrical components, and if the component standard does not cover electrical safety, then the component shall fulfil the electrical requirements of EN 60335-2-40, EN 60335-2-24, EN 60335-2-89 or EN 60204-1 as relevant.

5.2.2 Specific requirements

5.2.2.1 General

In addition to the requirements of 5.2.1, the following requirements are applicable for incorporation of specific components and piping into the refrigerating system.

5.2.2.2 Tightness

A tightness test shall be performed according to the type approval procedure as specified in EN 16084.

Unless otherwise agreed with the manufacturer of the assembly, components, not covered by the scope of EN 16084, shall be tested with detection equipment having a sensitivity equivalent to 3 g/year of refrigerant leakage or better, under a pressure of at least 0,25 × PS. The acceptance criterion is that no leak shall be detected.

NOTE This method may be specified in the components standard (see Table 1).

Clause 6 may require components incorporated in assemblies to conform to specified tightness control levels according to EN 16084.

When agreed by the manufacturer of the assembly, some or all component tests may be included in the assembly tests (refer to 6.3).

Tightness tests shall be conducted only after the component has passed a strength pressure test or has been verified by a type test for strength pressure.

For environmental and safety reasons, nitrogen, helium, carbon dioxide or mixtures of low level hydrogen are preferred test gases.

Radioactive tracers may be added to the test gases.

Air and gas mixtures should be avoided as certain mixtures can be dangerous. Air may be used if the hazard of ignition is eliminated and worker safety is ensured. Oxygen shall not be used for tightness tests.

5.2.2.3 Piping joints

Joints shall be designed so that they will not be damaged due to freezing of water on the outside. They shall be suitable for the pipe, the piping material and the pressure, temperature and fluid.

Coated (e.g. galvanized) pipes shall not be welded, unless all coating has been completely removed from the joint area. Welded joints shall be suitably protected.

5.2.2.4 Refrigerant liquid pumps

Refrigerant liquid pumps shall be provided with the following information as a minimum, which shall be durable and permanently affixed:

a) manufacturer;

b) type designation;

c) serial number;

d) year of manufacture;

e) maximum allowable pressure (PS).

5.3 Miscellaneous components

5.3.1 Materials

5.3.1.1 General

The material of the component shall be suitable for the intended temperature and pressure range and in combination with refrigerating systems as specified by the manufacturer of the refrigerating systems. The material of the component shall conform to relevant standards.

Restrictions for use of dangerous or hazardous substances and preparations shall be taken into account.

NOTE For example as required in EC/1907/2006 (REACH) and 2011/65/EU (RoHS).

5.3.1.2 Ferrous materials

a) Cast iron and malleable iron

Cast iron and malleable iron shall only be used, when suitable for the particular application in accordance with the requirements of this standard.

NOTE 1 Since some grades of cast iron are brittle, their application is dependent on temperature, stress and design considerations.

NOTE 2 Malleable iron has two general classifications with several different grades in each. These grades can have very different mechanical properties.

b) Steel, cast steel, carbon steel and low alloy steel

Steel, cast steel, carbon steel and low alloy steel may be used for all components and piping in contact with refrigerant or heat-transfer fluid. Where there is a combination of low temperatures and high pressure, or where corrosion risks or thermal stresses are present, steel with adequate impact strength shall be used taking into account its thickness, its lowest operating temperature and its welding properties.

NOTE 3 Guidance on stress corrosion cracking in carbon steel is given in H.3.

c) High alloy steel

High alloy steel may be required where there is a combination of low temperatures and high pressure, or where corrosion risks or thermal stresses are present. The impact strength shall be adequate for the particular duty and the material suitable for welding, if required.

d) Stainless steel

When using stainless steel, care shall be taken to ensure that the grade of stainless steel is compatible with the process fluids and possible atmospheric impurities, such as for example sodium chloride (NaCl) or sulphuric acid (H_2SO_4).

5.3.1.3 Non-ferrous materials and their alloys (cast, forged, rolled and drawn)

a) Copper and copper alloys

Copper in contact with refrigerants shall be oxygen-free or de-oxidized, for example Cu-DHP as specified in EN 12735-1 and EN 12735-2.

Copper and alloys with a high percentage of copper shall not be used for parts carrying R-717 unless their compatibility has been proved by test or experience.

NOTE 1 Guidance on stress corrosion cracking in copper pipe is given in H.2.

b) Aluminium and aluminium alloys

Aluminium used for gaskets for use with R-717 shall be of at least 99,5 % purity. Aluminium alloys containing more than 2 % magnesium shall not be used with halogenated refrigerants unless their compatibility has been proved by test or experience.

Methyl chloride (CH_3Cl) shall not be used in contact with aluminium and its alloys.

NOTE 2 Aluminium and aluminium alloys may be used in any part of the refrigerant circuit provided that its strength is adequate and it is compatible with the refrigerants and the lubricants being used.

c) Magnesium and magnesium alloys

Magnesium and magnesium alloys shall not be used unless their compatibility with refrigerants has been proved by test or experience.

d) Zinc and zinc alloys

Zinc shall not be used in contact with R-717, except in electro zinc plated components.

Methyl chloride (CH_3Cl) shall not be used in contact with zinc.

e) Soldering alloys

Soldering alloys shall not be used for refrigerant containment purposes.

f) Brazing alloys

Brazing alloys shall not be used unless their compatibility with refrigerants and lubricants has been proved by test or experience.

g) Tin and lead tin alloys

Tin and lead tin alloys may be corroded by halogenated refrigerants and shall not be used unless their compatibility has been proved by test or experience.

NOTE 3 Copper free lead antimony or lead tin alloys may be used for valve seats.

5.3.1.4 Non-metallic materials

a) Gasket and packing materials

Gasket and packing materials for sealing joints and for sealing stuffing boxes on valves, etc. shall be resistant to the refrigerants, oils and lubricants used and shall be suitable for the expected range of pressures and temperatures.

NOTE See EN 16084.

b) Glass

Glass may be used in refrigerant circuits and for electrical terminal insulators, indicators and sight glasses, but it shall be resistant to the pressures, temperatures and chemical actions which may occur.

c) Asbestos

Asbestos shall not be used.

d) Plastics

When plastics are used, they shall be suitable for the mechanical, electrical, thermal, chemical and long term creep conditions to which they are subjected.

e) Elastomers

When elastomers are used, they shall be suitable for the mechanical, electrical, thermal and chemical conditions occurring, chemically and physically compatible with refrigerant or refrigerant-oil mixtures with which they are in contact, and they shall not create fire hazards.

5.3.2 Testing

5.3.2.1 Tests

All the components shall undergo the following tests:

a) strength pressure test (refer to 5.3.2.2);

b) tightness test (refer to 5.2.2.2);

c) functional test.

The results of these tests shall be recorded. When agreed by the manufacturer of the assembly, some or all tests may be conducted on the assembly (refer to 6.3).

5.3.2.2 Strength pressure test for miscellaneous components

5.3.2.2.1 General

The strength pressure test shall be one of the following methods:

— individual strength-pressure test according to 5.3.2.2.2, or

— strength-pressure type test according to 5.3.2.2.3, or

— fatigue test according to 5.3.2.2.4.

The test criteria specified in 5.3.2.2.5 shall apply.

5.3.2.2.2 Individual strength pressure test

Components shall be designed with a thickness according to standards of similar components of Table 1 and each component shall be strength pressure tested individually at a pressure which is no less than 1,43 × PS.

Preferably the strength pressure test shall be carried out by means of air or some other non-hazardous gas. Adequate precautions shall be taken to prevent danger to people and to minimize risk to property. A hydrostatic pressure test by means of water or some other liquid may be accepted under the condition that the refrigeration circuit shall not be contaminated when the test is complete.

5.3.2.2.3 Strength pressure type test

Components shall be type tested at a test pressure value which is no less than 3 × PS.

If the continuous operating temperature of the component is less than or equal to

— 125 °C for copper or aluminium, or

— 200 °C for steel,

the test temperature of the component part or assembly shall be at least 20 °C.

If the continuous operating temperature of the component exceeds

— 125 °C for copper or aluminium, or

— 200 °C for steel,

the test temperature of the parts or assemblies that are at these temperatures, and subjected to the pressure, shall be at least

— 150 °C for copper or aluminium and

— 260 °C for steel.

For other materials or higher temperatures, the effects of temperature on the material fatigue characteristics shall be evaluated.

5.3.2.2.4 Fatigue test

Three test samples shall be subjected to a strength pressure test at a test pressure value not less than 2 × PS.

Three test samples, other than the samples used for the strength pressure test, shall be filled with fluid, and shall be connected to a pressure-driving source. The pressure shall be raised and lowered between the upper and lower cyclic values at a rate specified by the component manufacturer for a total number of 250 000 cycles. The entire specified pressure excursion shall occur during each cycle. Pressure cycles shall be between 20 cycles per minute and 60 cycles per minute.

For safety purposes, it is suggested that a non-compressible fluid should be used.

The following test pressures shall be applied:

For components at the low pressure side, PS of the low pressure side shall be applied for the first cycle. For components at the high pressure side, PS of the high pressure side shall be applied for the first cycle. The pressure of the test cycles shall be as follows:

— the upper pressure value shall not be less than 0,7 × PS and the lower pressure value shall not be greater than 0,2 × PS. The upper pressure value shall not be less than 0,9 × PS for water heat exchangers in heat pumps,

— for the final test cycle, the test pressure shall be increased to a pressure value not less than 1,4 × PS (2 times 0,7 × PS). The pressure value shall not be less than 1,8 × PS (2 times 0,9 × PS) for water heat exchangers in heat pumps

If the continuous operating temperature is less than or equal to

— 125 °C for copper or aluminium, or

— 200 °C for steel,

the test temperature of the component part or assembly shall be at least 20 °C.

If the continuous operating temperature of the component exceeds

— 125 °C for copper or aluminium, or

— 200 °C for steel,

the fatigue test temperature of the parts or assemblies that are at these temperatures, shall be at least 10 K above the continuous operating temperature.

Static test pressure shall be increased by the ratio of allowable stress of material at room temperature to that at the highest continuous operating temperature.

For other materials, the effects of temperature on the fatigue characteristics shall be evaluated to determine the test conditions.

5.3.2.2.5 Acceptance criteria

In the case of individual strength pressure test at minimum 1,43 × PS, permanent deformation shall not result from this test.

In the case of strength pressure type test, the samples tested shall withstand a pressure not less than 3 × PS without rupture.

In the case of the fatigue test, the samples tested shall not rupture, burst, or leak after completion of this test.

5.3.3 Marking

For miscellaneous components no special marking is required.

5.3.4 Documentation

The following documents for components shall be provided:

a) results of tests;

b) material test certificates shall be provided by the manufacturer as required by the purchaser to enable him to ensure that the material used conforms with the required specification and that it is traceable from the final test through production up to receipt, preferably at the time of delivery and not later than the time of commissioning. Any required inspection certificate shall be prepared on behalf of and signed by the competent person who carried out the inspection, test, or checking;

NOTE Material certificates type 2.1 or type 2.2 in accordance with EN 10204 can be provided.

c) documentation shall include the following specifications:

- maximum allowable pressure;
- maximum allowable temperature;
- applicable refrigerant;
- applicable oil.

6 Requirements for assemblies

6.1 General

The design, construction, testing, installing, documentation and marking of the refrigerating system assembly shall comply with this clause.

Refrigerating system assemblies using R-717 as refrigerant shall also comply with the additional requirements as specified in Annex A.

Determination of the category of the assembly shall be done in accordance with Annex B.

Refrigerating systems shall be charged with refrigerant at the manufacturing location or charged on site as recommended by the manufacturer (see 6.4.3.2).

Constructional, welding and brazing materials shall be suitable to withstand foreseeable mechanical, thermal and chemical stresses. They shall be compatible with the refrigerants, refrigerant and oil mixtures (with possible impurities and contaminants) or the heat-transfer media.

Where components, joints or parts are described as hermetically sealed, they shall comply with the requirements "hermetically sealed" according to EN 16084.

For hermetically sealed systems the use of non-metallic flexible hoses shall be limited to the following:

- The hoses shall be of class 1 according to EN 1736
- The total maximum length of the non-metallic flexible hoses installed on the system shall fulfil the following formula:

$$\left[\sum l_i \times d_i \times \pi \times 10 g / m^2 year \; + \sum l_j \times d_j \times \pi \times 200 g / m^2 year \right] < 1{,}5 g / year$$

where

l_i is the length of the flexible hose in metres where the temperature of the refrigerant is lower than or equal to 32 °C;

l_j	is the length of the flexible hose in metres where the temperature of the refrigerant is higher than 32 °C;
d_i	is the internal diameter of the flexible hose in metres where the temperature of the refrigerant is lower than or equal to 32 °C;
d_j	is the internal diameter of the flexible hose in metres where the temperature of the refrigerant is higher than 32 °C;
10 g/m²year	is the allowable permeability at 32 °C for class 1 flexible hoses;
200 g/m²year	is the allowable permeability at 100 °C for class 1 flexible hoses.

6.2 Design and construction

6.2.1 General

All components selected for the assembly of the refrigerant circuit shall comply with Clause 5.

The supports and bases of refrigerating systems shall have sufficient strength to withstand external forces for example:

a) the mass of the vessels;

b) the mass of the contents and equipment, including the mass of hydrostatic test fluid and the mass of ice which may form under foreseeable abnormal operating circumstances;

c) the snow load;

d) the wind load;

e) the mass of stays, braces and interconnecting piping;

f) the thermal movement of the piping and components;

g) the forces arising from foreseeable misuse;

The supports and bases of refrigerating systems installed in areas with possible risk of earthquakes shall have sufficient strength to withstand the expected acceleration due to earthquakes.

The refrigerating system shall be equipped with sufficient service access ports as required for the application.

6.2.2 Determination of the maximum allowable pressure

6.2.2.1 Maximum allowable pressure (PS)

The maximum allowable pressure shall be determined by taking into account factors such as:

a) the maximum ambient temperature;

b) the possible accumulation of non-condensable gases;

c) the setting of any pressure relief device;

d) the method of defrosting;

e) the application (e.g. cooling or heating application);

f) solar radiation; (e.g. impact on ice rinks during standstill);

g) fouling;

h) transport conditions including those specified in 6.2.13.

Based on the relevant factors, the designer shall determine the maximum allowable pressures in the different parts of the refrigerating system taking into account a maximum ambient temperature as appropriate for the installation site.

One of the following methods shall be used to determine the maximum allowable pressure (PS) of the different parts of the refrigerating system.

— Method 1

  The designer shall document the calculation or testing method used for the determination of the maximum allowable pressure. Where temperature differences between ambient temperature and condensing temperature are calculated, the method shall be verified by testing.

  For the low temperature circuit of a cascade system, the maximum allowable pressure PS shall be determined by the designer. The designer shall make provision for standstill under all reasonably foreseeable conditions.

— Method 2

  Table 2 is an alternative to Method 1. The minimum value of the maximum allowable pressure shall be determined by the minimum specified temperatures given in Table 2 to determine the saturated refrigerant pressure. When the evaporators can be subject to high pressure e.g. during hot gas defrosting or reverse cycle operation, the high pressure side specified temperature shall be used.

  The use of specified temperatures does not always result in saturated refrigerant pressure within the system. In the case of a limit charged system at standstill condition the isochoric behaviour shall be regarded (refrigerant charge compared to free inner volume of the system). In case of pressure stages operating above the critical point Method 1 shall be used.

Table 2 — Specified design temperatures

Ambient conditions	≤ 32 °C	≤ 38 °C	≤ 43 °C	≤ 55 °C
High pressure side with air cooled condenser	55 °C	59 °C	63 °C	67 °C
High pressure side with water cooled condenser or water heat pump	Maximum leaving water temperature + 8 K but not less than the design temperature at low pressure side			
High pressure side with evaporative condenser	43 °C	43 °C	43 °C	55 °C
Low pressure side with heat exchanger exposed to the outdoor ambient temperature	32 °C	38 °C	43 °C	55 °C
Low pressure side with heat exchanger exposed to the indoor ambient temperature	27 °C	33 °C	38 °C	38 °C

NOTE 1 For the high pressure side, the specified temperatures are considered the maximum that will occur during operation. This temperature is higher than the temperature during compressor shut down (standstill). For the low pressure side and/or intermediate pressure side, it is sufficient to base the calculation of pressure on the expected temperature during compressor standstill period. These temperatures are minimum temperatures and thus determine that the system will not be designed for maximum allowable pressure lower than the saturated refrigerant pressure corresponding to these minimum temperatures.

NOTE 2 For zeotropic blends the maximum allowable pressure (PS) is the pressure at the bubble point.

NOTE 1 The pressure at which the system or part of the system usually operates is lower than the maximum allowable pressure PS.

NOTE 2 Excessive stress can result from gas pulsations.

NOTE 3 For determination of the ambient conditions EN 60721–2-1 can be used.

6.2.2.2 Component maximum allowable pressure

The maximum allowable pressure for each component shall not be less than the maximum allowable pressure of the system or part of the system.

The selection of materials for components shall take into account the impact strength at all temperatures to which they may be exposed.

NOTE The application of certain materials at low temperatures may request special consideration due to risk of brittle fracture.

6.2.2.3 Damage limitation requirements in the event of external fire

The pressure rise in case of external fire is not regarded as operational condition. However, the designer shall regard damage limitation requirements as appropriate for the refrigerating system. This may include measures as listed in Table 3. Other alternatives reaching the same level of safety may be applied.

Table 3 — Examples for measures to meet damage limitation requirements

Measures	Additional information
Application of suitable pressure relief devices	Calculation according to EN 13136
Place the refrigerating system in a separate refrigeration machinery room which complies with EN 378–3	
Allow migration of the refrigerant into other parts of the refrigerating system	The worst case condition shall be considered.

In case of application of pressure relief devices, the designer may choose a higher setting than 1 × PS provided the respective part of the refrigerating system is designed to meet damage limitation requirement for this higher setting. This is achieved if the manufacturer can demonstrate adequate level of protection by calculation or testing.

6.2.3 Piping

6.2.3.1 Foreseeable misuse of piping

For piping where misuse can be foreseen e.g. climbing, storage, hanging of tools or similar misuse, adequate countermeasures shall be taken.

NOTE Examples of countermeasures are sufficient strength, protection or warning labels.

6.2.3.2 Piping joints and fittings

6.2.3.2.1 General

Piping joints and fittings shall comply with the requirements of EN 14276-2.

Where joints are used on piping, damage caused by freezing or vibration shall be avoided.

NOTE Painting, coating, ice grooves are examples of countermeasures to avoid damage by freezing.

Joints other than brazed or welded shall be so made and located to minimize tension, compression, bending, or torsion of pipe. Pipe support shall be provided as necessary considering static and dynamic effects of the weight of the joint and joining components as well as possible displacement of the pipes due to flexible support of movable components. Operation, assembling, handling, transportation, and maintenance shall be taken into account.

6.2.3.2.2 Permanent joints

Welded or brazed joints shall comply with the requirements of EN 14276-2. Other permanent joints shall comply with the requirements of EN 16084.

6.2.3.2.3 Detachable joints

6.2.3.2.3.1 General

In general, detachable joints shall only be used where permanent joints are not appropriate for technical reasons.

It is recommended that in insulated piping the positions of detachable joints are permanently marked. At that position, it is recommended that insulation can be easily removed for inspection.

6.2.3.2.3.2 Flanged joints

Flanged joints shall be arranged so that the connected parts can be dismantled with minimum distortion stress of the piping.

It is preferable to use standardized flanges for steel piping according to EN 1092-1 and copper piping according to EN 1092-3.

The joints shall be solid and resistant enough to avoid any danger of the gasket being blown out. Flanges with a groove and tongue or projection and recess are preferred. Dismantling should be possible without forcing the jointed components. Care shall be taken not to overstress bolts due to cold operation by applying a defined pre-stress.

6.2.3.2.3.3 Flared joints

Flared joints shall be restricted to use with annealed pipe only, and to pipe sizes not exceeding a diameter of 20 mm outside diameter.

When copper piping is used, the material shall comply with the requirements of EN 12735-1 or EN 12735-2.

The pipe ends shall be cut at a right angle to the axes (perpendicular) and checked to be free of burrs.

For flare connections of copper pipes, the appropriate torque and conditions shall apply as indicated in Table 4. The flares shall be tightened with the designated torque by means of a torque wrench and appropriate spanner.

Table 4 — Standard tightening torque

Nominal outside diameter (according to EN 12735–1 and EN 12735–2)			Minimum wall Thickness (mm)	Tightening torque (Nm)
Metric series (mm)	Imperial series			
	(mm)	(in)		
6			0,80	14 — 18
	6,35	1/4	0,80	14 — 18
	7,94	5⁄16	0,80	33 — 42
8			0,80	33 — 42
	9,52	3/8	0,80	33 — 42
10			0,80	33 — 42
12			0,80	50 — 62
	12,7	1/2	0,80	50 — 62
15			0,80	63 — 77
	15,88	5/8	0,95	63 — 77
18			1,00	90 — 110
	19,06	3/4	1,00	90 — 110

A torque other than the value specified in Table 4 may be applied, provided it is recommended by the manufacturer.

When making flared joints, care should be taken to ensure that the flare is of the correct size and that the torque used to tighten the nut is not excessive. Care should be taken not to flare piping that has been work hardened.

Flared joints shall be subjected only to forces arising from the system pressure and those exerted by the flare nut in making the joint. Flexible section(s) in the connected pipe, support of it and associated components shall be provided as necessary to prevent extraneous tension, bending or torsion forces acting on the joint. Consider static (weight or tensile/compressive forces) and dynamic (mass × acceleration, including vibration) forces that may arise during assembly, handling, transport, operation or maintenance. Appropriate clamping of the flared pipe connections shall be used to avoid breaking caused by excessive vibrations.

6.2.3.2.3.4 Taper pipe thread joints

Taper pipe thread joints that are part of the boundary of the refrigerating system shall be restricted to maximum DN 40 and only be used for connecting control-, safety- and indicating devices to components. Taper pipe fittings and sealing medium shall be type approved by the manufacturer with regard to tightness.

6.2.3.2.3.5 Compression joints

Compression joints shall be restricted to piping with maximum DN 32.

6.2.3.3 Requirements for piping installed at site

6.2.3.3.1 General

For proper arrangement of piping the physical layout, in particular the position of each pipe, the flow conditions (two-phase flow, oil supply operation on partial load), condensation processes, thermal expansion, vibration and good accessibility shall be taken into account.

NOTE Routing and supporting of piping have an important effect on the operational reliability and serviceability of a refrigerating system.

As a general rule, piping shall be installed so as to avoid damage from any generally expected activity.

The following considerations shall apply to the installation of piping for safety and environmental protection:

a) there shall be no hazard for persons and free passage in escape and access routes shall not be restricted;

b) no valves and detachable joints shall be located in areas accessible to the general public except when they comply with EN 16084;

c) valves and detachable joints shall not be accessible to the general public unless protected against an unauthorized operation or disconnection;

d) piping shall be protected against heat by segregation from hot pipes and heat sources;

e) connecting pipes (e.g. in the case of split systems) shall be made before opening the valves to permit refrigerant to flow between the refrigerating system parts. A valve shall be provided to evacuate the interconnecting pipe and/or any uncharged refrigerating system part;

f) refrigerant piping shall be protected or enclosed to avoid damage;

g) flexible refrigerant connectors (such as connecting lines between the indoor and outdoor units) that may be displaced during normal operations shall be protected against mechanical damage;

h) during brazing or welding, refrigerant shall be removed from parts of the system affected by the heat from brazing or welding. It is recommended that such components are shipped without refrigerant charge;

i) see 6.2.3.3.7 for requirements regarding accessibility of piping and joints.

6.2.3.3.2 Specific requirements for installation of piping for equipment intended to use A2, A3, B2 or B3 refrigerants

Piping and joints of a split system shall be made with permanent joints when inside an occupied space except joints directly connecting the piping to indoor units.

6.2.3.3.3 Spacing for pipe supports

Piping shall be suitably supported according to its size and service weight. The recommended maximum spacing for pipe supports is shown in Table 5 and Table 6.

Table 5 — Recommended maximum spacing for supports for copper pipe

Outside diameter (mm)	Spacing (m)
15 to 22 soft	2
22 to < 54 half hard	3
54 to 67 half hard	4
NOTE Information on soft and half hard is given in EN 12735–1 and EN 12735–2.	

Table 6 — Recommended maximum spacing for supports for steel pipe

Nominal bore DN (according to EN ISO 6708)	Spacing (m)
15 to 25	2
32 to 50	3
65 to 80	4,5
100 to 175	5
200 to 350	6
400 to 450	7

6.2.3.3.4 Protection of piping

Precautions shall be taken to avoid excessive vibration or pulsation. Particular attention shall be paid to preventing direct transmission of noise or vibration to or through the supporting structure.

The assessment of vibrations or pulsations should be carried out on the system in service, at conditions which give the worst effect on piping.

Protection devices, piping and fittings shall be protected as far as possible against adverse environmental effects, for example, the danger of water collecting and freezing in relief pipes or the accumulation of dirt and debris.

Provision shall be made for expansion and contraction of long runs of piping.

Piping in refrigerating systems shall be so designed and installed to minimize the likelihood of liquid hammer (hydraulic shock) damaging the system.

Steel pipes and components shall be protected against corrosion with a rustproof coating before applying any insulation; Adhesive used for the insulation shall not react with or dissolve the applied rustproof coating.

NOTE Guidance on corrosion protection is given in EN ISO 12944-1 (steel piping).

Flexible pipe elements shall be protected against mechanical damage, excessive stress by torsion or other forces. Provisions for regular checks (visual inspection) shall be made.

6.2.3.3.5 Piping in ducts or shafts

Where refrigerant piping shares a duct with other services, provision shall be made to avoid damage due to interaction between them.

There shall be no refrigerant pipes in ventilation or air conditioning ducts where these are also used as escape routes.

Piping shall not be located in lift shafts.

6.2.3.3.6 Location

Sufficient space for insulation of the piping shall be provided where it is required.

Piping outside a machinery room or enclosure shall be protected against possible accidental damage.

Piping with detachable joints not protected against disconnection shall not be located in public hallways, lobbies, stairways, stairway landings, entrances, exits or in any duct or shaft which has unprotected openings to these locations.

Piping which has no detachable joints, valves or controls, and is protected against accidental damage may be installed in public hallways, stairways or lobbies, provided it is not less than 2,2 m above the floor.

Piping passing through fire resistant walls and ceilings shall be sealed in such a way as to be consistent with the fire rating of the partition.

6.2.3.3.7 Accessibility of piping and joints

The clearance around the piping shall be sufficient to allow routine maintenance of insulation and components, checking of pipe joints and repairing of leaks.

All detachable joints shall be readily accessible for inspection.

6.2.3.4 Piping for accessories and measurements

Piping, including flexible pipes as specified in EN 1736, for the connection of measuring, control and safety devices shall be of sufficient strength in relation to the maximum allowable pressure and shall be installed so as to minimize vibration and corrosion.

Tubes for the connection of measuring, control and safety devices should be connected and routed so that the collection of liquid, oil or dirt is avoided as far as possible.

A minimum nominal internal diameter of 4 mm is required for the connection pipes of safety switching devices, except for safety switching devices requiring a connection pipe with a smaller bore in order to damp pulsations. If this damping is required to ensure the correct function of the device, then the connection pipe shall be fitted as high as practical on the vessel or piping to prevent the entry of liquid phase or oil into the pipe.

6.2.3.5 Drain

6.2.3.5.1 General

Shut-off devices in drains which should not be opened when the system is operating as intended shall be safeguarded against unauthorized actuation. Installation in a separate refrigeration machinery room provides sufficient protection against unauthorized actuation.

6.2.3.5.2 Special requirements

Where service instructions require regular changes of the oil, the manufacturer shall provide instructions how to drain off oil with minimum refrigerant emission to the environment.

When a self closing valve is used in the oil drain line, a shut-off valve shall be installed on the inlet side of it, or a valve combining these two functions shall be fitted.

NOTE The risk of dirt on the seat can be minimized by installing the valve with the spindle in the horizontal position.

Refrigerating systems other than sealed systems shall have the necessary shut-off devices and/or connection facilities in order to enable the compressor of the system or external evacuation devices to transfer refrigerant and oil from the system to internal or external receivers.

Drain-off valves shall be provided to facilitate removal of the refrigerant from the system with minimum refrigerant emission.

Piping which is not used during normal operation shall be fitted with a permanent or removable cap or equivalent.

6.2.4 Shut off devices

6.2.4.1 Isolating valves

Refrigerating systems shall be provided with sufficient isolating valves so as to minimize danger and loss of refrigerant particularly during repair and/or maintenance.

6.2.4.2 Hand operated valves

Hand operated valves required for use during essential operational conditions shall be fitted with a hand wheel or operating handle.

6.2.4.3 Change of gland packing/seal

If it is not possible to tighten or change the gland packing/seal(s) while the valve is exposed to system pressure, it shall be possible to isolate the valve from the system, or provisions shall be made to evacuate refrigerant from the part of the system where the valve is located.

6.2.4.4 Oil drain that can be actuated during normal operation

Self closing valves shall be installed at oil draining points which are intended to be actuated during normal operation.

6.2.4.5 Arrangement of shut-off devices

Shut-off devices shall not be mounted in crawl spaces or in piping shafts designed for human entry.

6.2.5 Protection devices

6.2.5.1 General

In refrigerating systems the pressure during operation and standstill shall not exceed the maximum allowable pressure of any part of the refrigerating system, as determined by the designer according to 6.2.2.1.

Excessive internal pressure from foreseeable causes shall be prevented or relieved with minimum practicable risk for persons, property and the environment. If a pressure relief device is discharging, the pressure in a part of the system shall not exceed the maximum allowable pressure of that part by more than 10 %. The restriction of 10 % does not apply for pressure rise caused by external fire.

6.2.5.2 Safety switching devices for limiting the pressure

6.2.5.2.1 Electro-mechanical safety switching devices for limiting the pressure

Electro-mechanical switching devices shall be in accordance with EN 12263:1998. If used for protection of the refrigerating system against excessive pressure, they shall not be used for control purposes.

6.2.5.2.2 Electronic safety switching devices for limiting the pressure

Electronic safety switching devices for limiting the pressure shall be type tested and shall fulfil the requirements for safety accessories, for example safety functions shall not be affected by control functions.

The devices shall comply with the requirements according to EN 12263, Clause 4.

NOTE Some of these requirements may be not relevant for certain types of electronic safety switching devices limiting the pressure.

Regarding the applicable requirements for included electronics, those devices shall comply with the relevant standard as appropriate for the application of the refrigerating system and as demanded by the legal provisions for pressure safety and machinery.

EXAMPLE Examples for such standards are:

- Harmonized product standards of EN 60335 series;
- Annex H of standard EN 60730–2-6, with additional requirements;
  - control function shall be class C; and
  - deviation and drift shall not exceed +0 %.
- EN 62061 for SIL class 2;
- EN ISO 13849 for PL = d.

6.2.6 Application of protection devices

6.2.6.1 General

Protection devices shall be provided for both the refrigerating system and the secondary heat transfer circuit.

Wherever practicable, a safety switching device for limiting the pressure shall be used to stop the pressure source before any pressure relief device starts to operate. For relieving excessive pressure a pressure relief valve shall be used in accordance with 6.2.6.2. Wherever practicable, pressure relief valves venting to a lower pressure stage or to an expansion vessel are preferred instead of pressure relief devices relieving to atmosphere.

6.2.6.2 Protection of the refrigerating system against excessive pressure except in the event of external fire

For refrigerating systems protection devices shall be provided according to the flow chart as indicated in Figure 1 and the following text. The application of protection devices shall be considered for all parts of the refrigerating system, as they were determined by the designer according to 6.2.2.1, and only if the relevant pressure source may cause excessive internal pressure. This clause does not describe damage limitation requirements in the event of external fire, please refer to 6.2.2.3.

Figure 1 consists of parts A, B, C, and D, each of which has to be considered in relation to one another in order to determine the protective devices.

All protection devices shall be type tested and certified according to the legal requirements, except the pressure relief device which protects only the compressor.

Devices used for protection of parts of the refrigerating system shall be set according to the following rules:

1) Where the pressure is limited by a safety switching device limiting the pressure:

   The safety switching device(s) for limiting the pressure shall be set at a pressure ≤ 1 × PS.

2) Where the pressure is limited by a pressure relief device:

   The pressure relief device(s) shall be set at a pressure ≤ 1 × PS,

   The pressure relief device(s) shall be fully open at ≤ 1,1 × PS.

3) Where pressure relief device(s) and safety switching device(s) for limiting the pressure are used for protection of the same part of the refrigerating system, the setting of the safety switching device limiting the pressure shall be ≤ 0,9 times the setting of the pressure relief device.

   If the manufacturer can ensure a sufficient precision of the setting, it is allowed to reduce the difference of 10 % between the setting of the safety switching device limiting the pressure and the pressure relieve device accordingly, provided that the intended response order is maintained.

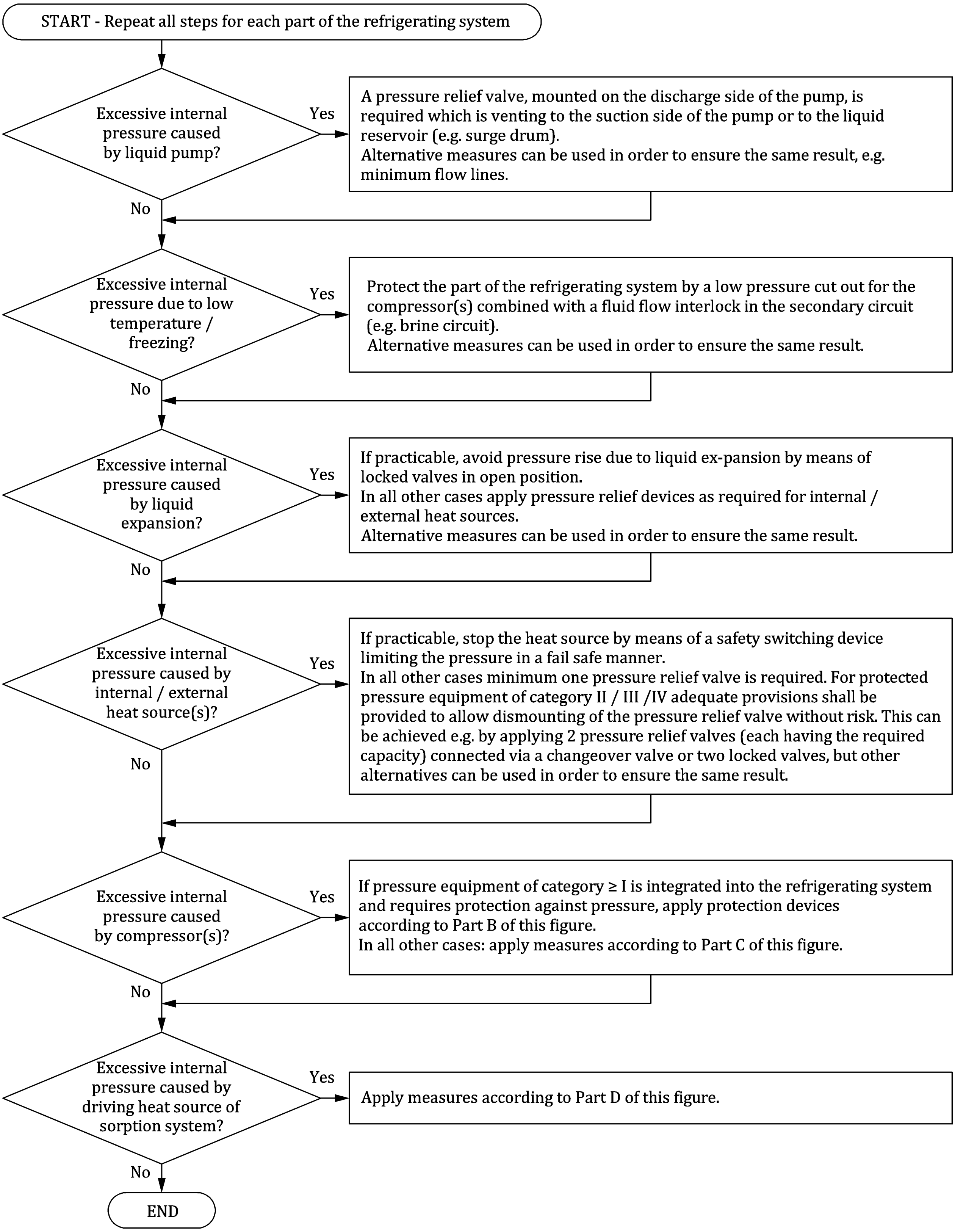
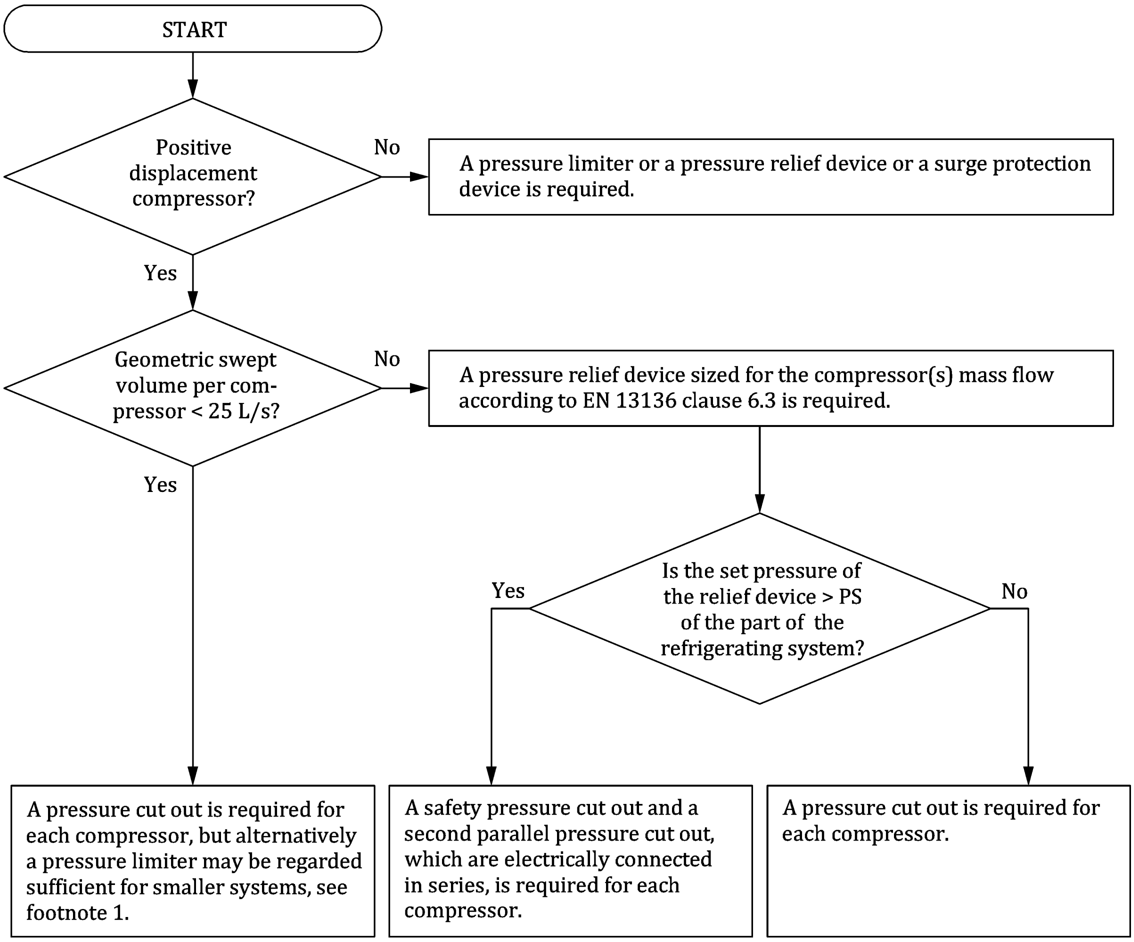


Figure 1 — Protection of the refrigerating system against excessive pressure — Part A



FOOTNOTE 1 For smaller systems with refrigerant charge less than 100 kg safety class A1 or 30 kg safety class A2L or 5 kg safety class A2 / A3, a pressure limiter is regarded sufficient provided the automatic reset does not lead to an increased safety risk.

Figure 1 — Protection of the refrigerating system against excessive pressure — Part B

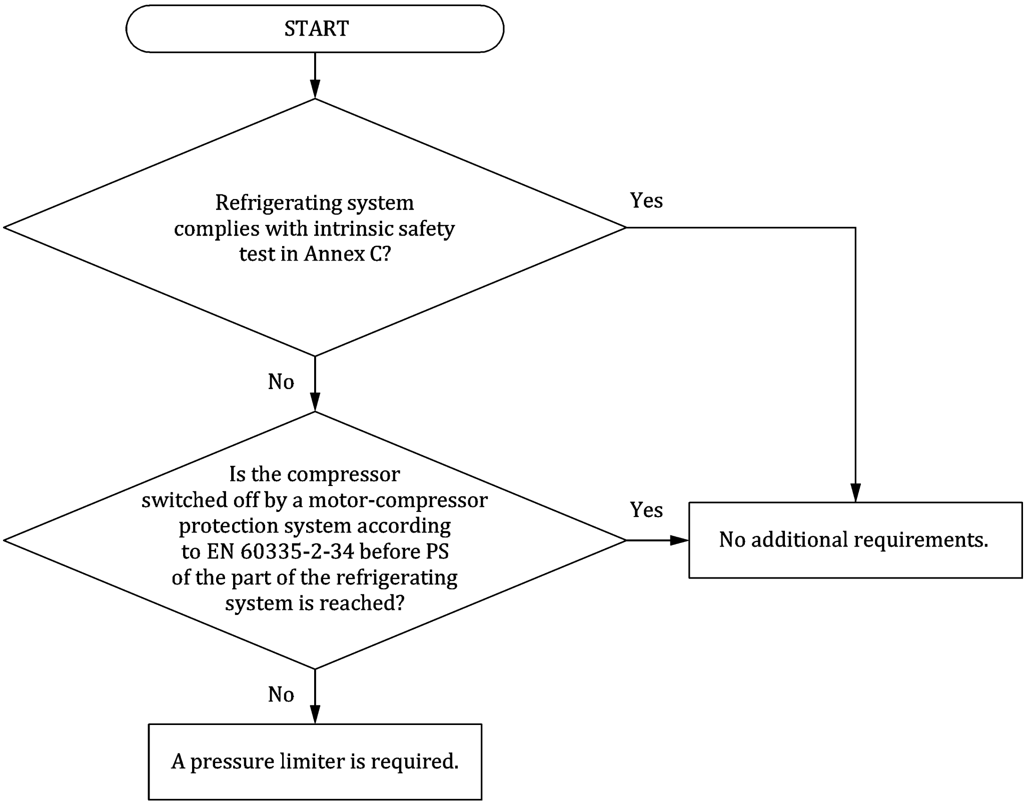


Figure 1 — Protection of the refrigerating system against excessive pressure — Part C

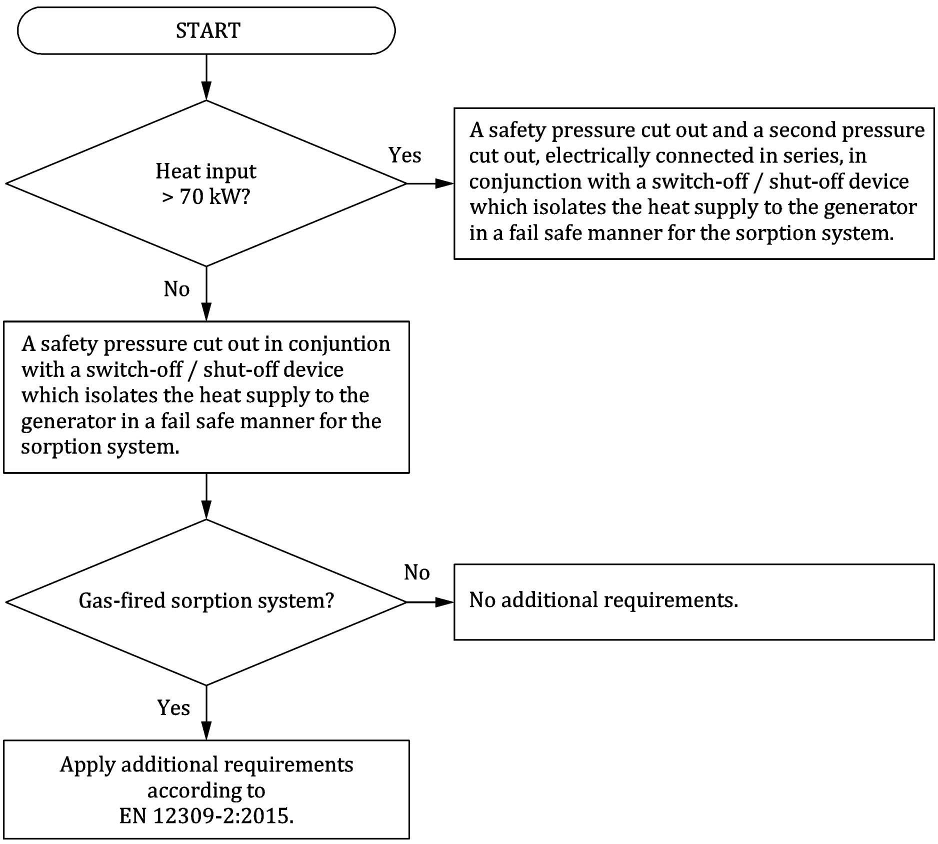


Figure 1 — Protection of the refrigerating system against excessive pressure — Part D

6.2.6.3 Overflow valves

Where a pressure relief device, except compressor relief devices, discharges from a higher to a lower pressure stage of the system a pressure relief valve of the back-pressure compensating type shall be used.

The back pressure compensation characteristics of the valve shall be such that the pressure created during relief is not higher than the pressure created by a pressure relief device relieving to the atmosphere.

The relieving capacity of the pressure relief devices on the low pressure side of the system shall protect all connected vessels, compressors and pumps which might be subjected to excess pressure simultaneously. Calculation shall be in accordance with EN 13136.

6.2.6.4 Isolation of pressure relief devices

There shall be no isolating valves in the inlet or outlet line of a pressure relief device except as specified in 6.2.6.6.

6.2.6.5 Indication device for pressure relief devices

For systems with a charge of at least 300 kg of refrigerant, an indicating device shall be provided to check whether the relief valve has discharged to atmosphere.

EXAMPLE Examples of indication devices:

— u-trap filled with oil;

— maximum indicating pressure gauge between relief valve and bursting disc;

— upstream installation of bursting discs with inter-space monitoring and pressure alarm device (pressure limiter). The actual relieving pressure of the type-tested pressure limiter monitoring the inter-space shall be set to a pressure of less than or equal to 0,5 bar (0,05 MPa);

— gas sensor in the discharge line;

— use of pressure relief valves with a soft seal, with pressure monitoring of the protected section and alarming at a permanently attended station when a level of 2 bar (0,2 MPa) below the actual relieving pressure of the pressure relief valve is reached.

6.2.6.6 Arrangement of pressure relief devices for refrigerating systems

6.2.6.6.1 General

Where this standard requires the provision of a pressure relief device then the pressure relief device shall be set not higher than the PS of the component it protects provided that other parts of the system are protected by another device. If other parts of the system are not protected by another device, then the pressure relief device shall not be set higher than the PS of any other component in the part of the system.

Pressure relief devices shall be mounted on or in proximity to the pressure vessel or other part of the refrigerating system which they protect. Pressure relief devices shall be easily accessible and shall be connected above the level of liquid refrigerant, except for devices which protect against the effect of liquid expansion.

When an externally mounted single pressure relief device is used to discharge to the low pressure side of the system, means shall be provided by which the device may be removed without losing a significant quantity of refrigerant.

NOTE Relief devices which are contained within a compressor package which can be isolated from the rest of the system are deemed to comply with this requirement.

Overflow lines of overflow valves shall lead into the low pressure side of the system (e.g. the return line to the separator) via the shortest practical path and shall preferably lead into the gas phase (see Figures F.2 and F.3).

Locked valves are permitted:

— between the compressor and its relief device in open position;

— between pressure relief devices and the pressure vessel or other part of the refrigerating system which they protect (see Figure F.1 and F.4), provided they are secured in the open position by means of a lead seal or equivalent;

— upstream and downstream of an overflow valve, for systems containing more than 100 kg refrigerant, provided they are secured in the open position by means of a lead seal or equivalent.

Where locked valves are required to be secured by means of a lead seal or equivalent, this seal shall be clearly marked with the identification of a competent person in accordance with EN 13313.

Where a release to atmosphere would bring the refrigerant condition to or below the triple point, the refrigerant may solidify. The arrangement of pressure relief devices and associated pipes shall be designed to prevent any blockage of the refrigerant flow. The relief valve may be mounted remote from the vessel or other equipment which it is protecting to ensure that it can relieve to atmosphere without any risk of the outlet pipe blocking provided the inlet piping to the relief valve is adequately sized according to EN 13136.

Pressure relief devices discharging into the atmosphere may be installed in parallel to the overflow pressure relief devices to protect the system against excessive pressure arising from external heat sources.

6.2.6.6.2 Calculations

Sizing of pressure relief devices, up and downstream piping and change over valves, if any, shall be calculated according to EN 13136.

6.2.6.6.3 Fusible plugs

Fusible plugs shall not be used.

6.2.6.6.4 Bursting disc

A bursting disc relieving to the atmosphere shall only be used in series with a pressure relief valve and located on the inlet side of the pressure relief valve. In order to check that the bursting disc is intact, a sensor operating an indicator shall be located in the pipe between the bursting disc and the pressure relief valve. The bursting disc installed ahead of a pressure relief valve shall not be smaller than the inlet of the pressure relief valve. The bursting disc shall be constructed so that no piece of the broken disc obstructs the pressure relief valve or hinders the flow of refrigerant.

NOTE A pressure gauge connected between the bursting disc and the pressure relief device incorporating maximum pressure indication is considered to be a suitable indicator.

6.2.6.6.5 Discharge piping from pressure relief devices

Discharge from pressure relief devices shall take place so that persons and property are not endangered by the released refrigerant.

NOTE The refrigerant can be diffused into the air by adequate means but away from any air intake to the building or discharged into an adequate quantity of a suitable absorbing substance.

Adverse effects shall be considered e.g. the danger of water collecting and freezing in relief discharge pipes or the accumulation of dirt or debris, or, in the case of R-744 systems, blockage of the discharge by solid CO_2.

Discharge lines for pressure relief devices shall be calculated according to EN 13136.

The connection of discharge lines to discharge devices shall be arranged so that individual tightness testing (e.g. access for leak refrigerant detection) of the discharge devices is possible.

6.2.6.7 Arrangement of safety switching devices for limiting the pressure

No shut-off valve shall be positioned between the safety switching device for limiting the pressure and the pressure imposing element unless either:

— a second safety switching device for limiting the pressure of equal type is fitted and the shut-off valve is a changeover valve, or

— a pressure relief valve or bursting disc is fitted to the relevant part of the system.

Examples of practical arrangement of safety devices can be found in Annex F.

Safety switching devices for limiting the pressure mounted on the high pressure side shall be protected against pulsations that may occur. This can be achieved by applying appropriate construction methods, by application of a damping device or by using reduced connection tubes. Refer also to 6.2.3.4 for installation of piping.

NOTE Type approved safety pressure cut out, type approved pressure cut out and type approved pressure limiters are safety switching devices for limiting the pressure as defined in EN 378–1.

One safety switching device for limiting the pressure may be used to stop more than one pressure imposing element if the arrangement of the safety switching device complies with above requirements.

Safety switching devices for limiting the pressure shall be arranged so that a change of setting can only be carried out by the use of a tool.

In case of an automatic restart after failure of the power supply means shall be provided to prevent hazardous situations. Failure of electrical power to the safety switching devices for limiting the pressure or to the microprocessor/computer, if it is used in the safety circuit, shall stop the compressor. Refer also to 6.2.5.2.2 for the use of electronic safety switching devices for limiting the pressure.

6.2.6.8 Protection of the secondary cooling and heating system

If the heat exchanger between the refrigerating system and the secondary cooling and heating system can be shut off so that an increase in pressure could occur, then the heat exchanger shall be protected on the secondary side by means of a pressure relief device set at a pressure not higher than PS of the secondary side.

For a refrigerating system with a refrigerant charge of more than 500 kg, measures shall be taken to detect (e.g. by refrigerant detectors) and report (e.g. by a warning detector) the presence of refrigerant in any associated circuit containing water or other liquids.

When B1, A2L, A2, B2, B2L, A3 or B3 refrigerant of more than 500 kg is used in an indirect system (refer to EN 378-1:2016, 5.4) the heat exchanger shall not allow the release of the refrigerant into the areas served by the secondary heat-transfer fluid due to a failure of the wall of the evaporator or condenser.

The following examples comply with this requirement.

EXAMPLE 1 An automatic air/refrigerant separator, mounted on the secondary circuit on the outlet pipe from the evaporator or the condenser and at a higher level than the heat exchanger. The air/refrigerant separator shall have a sufficient flow rating to discharge the refrigerant that can be released through the heat exchanger. The air separator shall discharge the refrigerant into the vented unit housing or the outside.

EXAMPLE 2 A double wall heat exchanger, between the primary and the secondary circuit, in order to avoid, in case of leakage, that the refrigerant leaks into the secondary circuit.

EXAMPLE 3 The pressure of the secondary circuit is always greater than the pressure of the primary circuit in the area of contact.

Protection against freezing shall be in accordance with the principles given in 6.2.6.2.

6.2.7 Indicating and measuring instruments (monitoring)

6.2.7.1 General

Refrigerating systems shall be equipped with the indicating and measuring instruments necessary for testing, operating and servicing as specified in this European Standard.

“Monitoring devices” as described in this part of EN 378 are not considered to be protection devices.

6.2.7.2 Arrangement of refrigerant pressure indicators

For systems containing more than 10,0 kg of refrigerant, pressure indicator connections for each pressure side or distinct pressure stage shall be provided (the fitting of permanent pressure indicators being optional).

When a pressure gauge is permanently installed on the high side of a refrigerating system, its dial shall indicate the pressure to a range of at least 1,2 × PS of the system.

If a replaceable oil strainer is provided in the lubricating system of the open type compressor, an oil pressure indicator shall be provided to detect insufficient lubrication pressure.

Pressure vessels with an internal net volume of 100 l or larger, provided with shut-off devices on the inlet and outlet and which may contain liquid refrigerant, shall be provided with a pressure indicator connection.

Refrigerant-containing components which are cleaned or defrosted in the warm or hot state and under manual control shall be equipped with one or more pressure indicators. When a pressure gauge is used, its dial shall indicate the pressure to a range of at least 1,2 times the saturation pressure of the refrigerant at the maximum temperature achieved during the cleaning or defrosting process.

6.2.7.3 Liquid level indicators

Refrigerant receivers in systems containing more than:

— 100 kg of group A1 refrigerant;

— 25 kg of group A2L, B2L, A2, B1 or B2 refrigerant;

— 2,5 kg of group A3 or B3 refrigerant;

and which may be isolated shall be provided with a liquid level indicator to show at least the maximum refrigerant level.

Liquid level indicators constructed of glass tubes shall not be used (see EN 12178).

Liquid level sight glasses comprising a flat or ridged glass disc sealed to a casing are not considered to be tubes.

Liquid level indicators with long glass plates shall be fitted with a non-return safety mechanism in the lower and upper connection pipe.

6.2.8 Liquid slugging in compressors

Refrigerating systems shall be designed and installed so that, under reasonably foreseeable operating conditions, liquid refrigerant, oil or mixture of it cannot lead to a dangerous situation such as rupture of the compressor.

To avoid damage of the compressors by slugging because of the charge of refrigerant and the volume of the vessel at the suction side, the vessel may be fitted with a maximum liquid level cut out that stops the compressors before any damage occurs.

6.2.9 Electrical requirements

The design of the electrical equipment shall comply with:

a) product standard of the EN 60335 series, or

b) EN 60204-1 and for electronically controlled systems that are safety related with EN ISO 13849-1 requirements for PL = d or EN 62061 requirements for SIL2

as relevant.

6.2.10 Protection against hot surfaces

Where the risk of contact with hot surfaces is possible equipment shall comply with the EN 60335 series where applicable or provisions shall be made for protection considering the criteria as defined in EN ISO 13732-1.

The temperature of surfaces that may be exposed to leakage of A2, A2L, B2L, A3, B2, or B3 refrigerants shall comply with the requirements in 6.2.14.

6.2.11 Protection against moving parts

Where the risk of contact with moving parts is possible (e.g. fans, rotors and shafts of open compressors), the equipment shall comply with EN ISO 13857, EN ISO 14120:2015, EN ISO 12100 or EN 60335 series when applicable.

6.2.12 Vibration and drop test

6.2.12.1 General

Factory sealed single package units (i.e. one functional unit in one enclosure) which are not fixed appliances, shall withstand the effects of dropping and vibration during transport and intended use without leaking refrigerant.

A sample shall be subjected to the tests of 6.2.12.2 to 6.2.12.6.

There shall be no refrigerant leakage.

Compliance is checked by the following:

— power input of the sample measured after at least 1 h shall not differ by more than 10 % from the value measured under the same conditions before the tests; or

— use of detection equipment having an equivalent sensitivity of 3 g/year of refrigerant shall reveal no leaks.

The tests of 6.2.12.2, 6.2.12.3 and 6.2.12.4 may be carried out on the sample charged with a non-flammable refrigerant or a non-hazardous gas.

During the test damage of parts other than the refrigerating circuit is allowed.

6.2.12.2 Vibration test in the final transport packaging

The sample is tested in its final packaging for transport and shall withstand a random vibration test for 180 min according to ASTM D 4728 with the power spectral densities according to Table 7:

Table 7 — Power spectral densities

Frequency (Hz)	**Power spectral density level** (g^2/Hz)
1	0,000 05
4	0,01
16	0,01
40	0,001
80	0,001
200	0,000 01
Overall, g_{rms} [a]	0,52

[a] g_{rms} represents the root mean square acceleration

6.2.12.3 Drop test in the final transport packaging

The sample is tested in its final packaging for transport and shall withstand the following number of drops on a horizontal hardwood board 20 mm thick placed on a concrete or similar hard surface:

— one with the sample held upright;

— one for each of the four edges of the bottom side, with the bottom side forming an angle of about 30° to the horizontal.

The drop height depends on the weight of the sample according to Table 8:

Table 8 — Drop height

Appliance weight (kg)	**Drop height** (mm)
< 10	800
≥ 10 and < 20	600
≥ 20 and < 30	500
≥ 30 and < 40	400
≥ 40 and < 50	300
≥ 50	200

6.2.12.4 Drop test without transport packaging

The tests of 6.2.12.3 are repeated on the sample without its packaging and with the drop height according to Table 9:

Table 9 — Drop height

Appliance weight (kg)	**Drop height** (mm)
< 10	200
≥ 10 and < 20	170
≥ 20 and < 30	150
≥ 30 and < 40	120
≥ 40	100

6.2.12.5 Operation after drop test

The sample is installed in accordance with the installation instructions. It is supplied at rated voltage or at the upper limit of the rated voltage range and operated at ambient temperature.

The sample is operated in cycles for 10 days (240 h), each cycle consisting of the compressor running for 10 min followed by a rest period of 5 min.

This test may be made on a separate sample.

6.2.12.6 Resonance test

The appliance shall be constructed so that its operation does not cause resonance points in the piping connected to the compressor.

Compliance is checked by the following test:

The sample is installed in accordance with the installation instructions. It is supplied at rated voltage or at the upper limit of the rated voltage range and operated at ambient temperature.

The supply frequency is increased in steps of 1 Hz between 0,8 times and 1,2 times the rated frequency.

The vibration amplitude is measured at critical points in the piping. There shall be no sudden increase of the amplitude when increasing the supply frequency within the specified range.

NOTE 1 The vibration amplitude can be measured, for example, by sliding an arrow gauge along the piping. The arrow gauge is an isosceles triangle with a height equal to 10 times the base (see Figure 2) and is held against the piping with the arrow axis perpendicular to the direction of the vibration to be measured. The amplitude is the value of A (see Figure 3) divided by 10.

Dimensions in millimetres

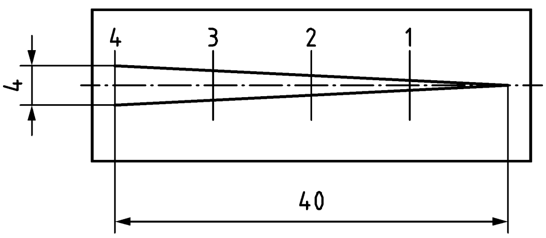


Figure 2 — Isosceles triangle arrow test gauge

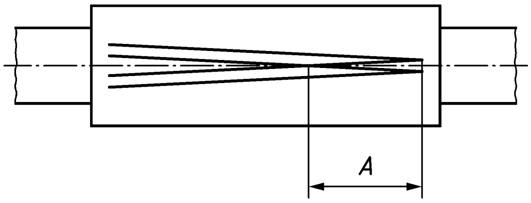


Figure 3 — Measurement of vibration amplitude

NOTE 2 Critical points are those with a bigger vibration amplitude.

This test may be made on a separate sample.

6.2.13 Transport test

To ensure the safety during transport the following requirements shall apply:

Based on the fact that repetitive pressure peaks seldom occur during transport, that all systems are strength pressure tested beforehand and taking into account the characteristic of the refrigerant, there are no additional pressure requirements related to transport of equipment without pressure relief devices.

For equipment containing liquid refrigerant and having a pressure relief device on the section containing liquid refrigerant, the following shall apply:

— pressure in parts protected by a pressure relief device shall not exceed 0,9 times the setting of that device during transport;

— pressure shall be calculated or tested assuming that the system might be subjected to the highest transport temperature for a period of twelve hours;

— for transport 55 °C shall be used as highest transport temperature except for transport under tropical conditions;

— for transport under tropical conditions 70 °C shall be used as highest transport temperature;

— if however, the design of the equipment is as such that it cannot withstand certain temperatures during transport, then this shall be clearly marked on the packaging of the unit.

6.2.14 Protection against fire and explosion hazards

For systems using flammable refrigerants, refrigerating systems shall be constructed so that any leaked refrigerant will not flow or stagnate so as to cause a fire or explosion hazard in areas within the equipment where components and apparatus which could be a source of ignition and which could function under normal conditions or in the event of a leak, are fitted.

Refrigerating systems in the scope of and complying with EN 60335 series are deemed to comply with this clause.

NOTE 1 Sources of ignition include hot surfaces that exceed specified temperature limits, flames and hot gases that are not suitably enclosed and electrical apparatus that could arc or spark. For other types of potential sources of ignition refer to EN 1127–1. Annex K gives guidance on the potential ignition sources.

To determine whether a source of ignition is in a position where leaked refrigerant could flow or stagnate, EN 60079-10-1:2009 shall be used to estimate the size and extent of a potentially flammable zone.

NOTE 2 EN 60079–10–1:2009, B.5.2 (estimation of hypothetical volume) or other forms of assessment may be used, e.g. computational modelling may be appropriate in some situations.

Annex I provides a method of assessment that meets the requirements of EN 60079-10-1.

Components and apparatus are not considered to be a source of ignition provided they comply with at least one of the following:

— Positioned such that it is out of the potentially flammable zone where any leaked refrigerant could flow or stagnate, or

— Ventilated with a sufficiently high airflow that is either permanent or initiated prior to energizing the components and apparatus. Sufficiently high airflow is such that the concentration of refrigerant at the potential source of ignition does not exceed 50 % of the LFL, or

— Requirements for protected equipment suitable for zone 2, zone 1 or zone 0 areas as defined in EN 60079-10-1, or

— For electrical equipment, the maximum possible energy of a spark or arc within its circuit will not ignite the most flammable concentration of the refrigerant used.

NOTE 3 EN 60079–11:2012, Clause 10 provides a test method.

NOTE 4 General requirements for types of protection are given in EN 60079–0. The types of protection within the EN 60079 series are based on specific gas groups, which may not represent class 2 and 2L refrigerants due to different flammability characteristics. The testing of the protection method may be carried out with the applicable refrigerant (EN 60079–0:2012, 4.4).

EN 60079-15:2010, 19.3 and for limiting volume of sealed or encapsulated apparatus to 100 cm^3 does not apply.

Where the components are protected from impact by an enclosure which complies with the impact test in EN 60079-0:2012, 26.4.2, the impact test on the components is not required.

Consideration shall be given to the availability of the airflow for the duration of the equipment lifetime and appropriate controls put in place to prevent energizing the components or apparatus in the event that the airflow is diminished to a value that would result in a concentration exceeding the 50 % of the LFL.

The temperature of surfaces that may be exposed to leakage of A2, A2L, B2L, A3, B2, or B3 refrigerants shall not exceed the autoignition temperature of the refrigerant reduced by 100 K. Autoignition temperatures are given in EN 378-1:2016, Annex E.

The disconnection and connection of electrical connectors on components is not considered to be normal operation. Where there is a plug and socket outlet they shall be considered part of the equipment. Disconnecting or connecting the plug from/to the socket outlet is considered to be part of normal operation unless the use of a special tool is required.

For equipment having enclosures with doors and other movable panels, etc., the assessment shall also consider the extent of flammable zones when doors or panels are opened before or following a leak, if it is expected that they can be opened in normal operation. If the assessment demonstrates that a potentially flammable zone may extend beyond the boundary of the equipment, this information shall be provided in the documentation for the equipment.

NOTE 5 Systems may require conformity to the essential safety requirements of the Directive 94/9/EC March 1994 on the approximation of the laws of the member states concerning equipment and protective systems intended for use in potentially explosive atmospheres. Conformity to this standard does not demonstrate conformity to Directive 94/9/EC.

NOTE 6 Separate components, such as thermostats, which are charged with less than 0,5 g of a flammable gas are not considered to cause a fire or explosion hazard in the event of leakage of the gas within the component itself.

6.2.15 Requirements for ventilated enclosures

Where ventilated enclosures are applied for A2L, B2L, A2, B2, A3 and B3 refrigerants as defined in EN 378-1:2016, Annex C, following requirements apply.

The enclosure shall provide airflow between the space and the interior of the enclosure. The manufacturer shall specify the ventilation duct by size and number of bends, in addition the maximum pressure drop in Pascal (Pa) may be given. The negative pressure measurement in the interior of the enclosure shall be 20 Pa or more and the flow rate to the exterior shall be at least $Q_{\min}$, with a minimum ventilation flow of 2 m^3/h. The ventilation duct flow area shall not be restricted by any components. There shall be no ignition sources located in the duct.

$Q_{\min}$ shall be calculated as follows:

$$Q_{\min} = 15 \times s \times (m_c/\rho) \geq 2\ m^3/h$$

where

$Q_{\min}$	is the volume flow of the ventilation (m^3/h);
15	is the constant converting the 4 min leak rate to an heavy leak rate ($1/h$);
s	is 4 (safety factor);
m_c	is refrigerant charge mass (kg);
ρ	is density of the refrigerant at atmospheric pressure at 25 °C (kg/m^3).

The ventilation system shall operate as follows:

— it shall run at all times, the airflow shall be monitored continuously and the refrigerating system is switched into a safe mode within 10 s in the event that the airflow is reduced below $Q_{\min}$. The safe mode shall be maintained until the airflow is restored, or

— it shall be switched on by a refrigerant gas sensor before 25 % of the LFL is reached (see EN 378-1:2016, Annex E). The sensor shall be suitably located considering the density of the refrigerant. The sensor and ventilation function shall be checked at regular intervals according to the manufacturer's instructions. A failure shall be indicated and the system shall be switched in a safe mode with the fan switched on until the failure has been resolved.

A type test or individual test shall be performed to assess compliance with the requirements for the ventilation system.

6.2.16 Electromagnetic compatibility and fields (EMC, EMF)

Equipment shall be designed and constructed so that

— emission of radiation is limited to the extent necessary for its operation and that the effects on exposed persons are not existing or reduced to non-dangerous proportions by complying with, EN 61000-6-3 or EN 61000-6-4 as applicable, and

— external radiation does not interfere with its operation by complying with EN 61000-6-1 or EN 61000-6-2 as applicable.

Where harmonized product standards are used for compliance in this particular field, then these are deemed adequate.

6.2.17 Noise

Where refrigerating systems or heat pumps require operators, the location of the operator shall be indicated in the instruction manual according to 6.4.3.1.

Where the noise emission at the location of the operator is considered a hazard e.g. where the emission sound pressure level exceeds 70 dB(A) the effect of the emissions shall be reduced to an acceptable level by means of acoustic insulation or isolation taking into account the technical measures to reduce noise at source given in EN ISO 11688-1.

The A-weighted emission sound pressure level at the operator position shall be measured in accordance with EN ISO 11202. The operating conditions during the noise test shall be at full load.

Where data on sound power levels are required the A-weighted sound power level shall be determined according to EN ISO 3744 (or EN ISO 3746); the operating conditions during the noise test shall be at full load.

Refrigeration systems complying with EN 60335-2-40 are considered to comply with the requirements for noise in this clause.

6.3 Testing

6.3.1 Tests

Before putting into service any refrigerating installation, all the components or the whole refrigerating system, shall undergo the following tests:

a) strength pressure test according to 6.3.2;

b) tightness test according to 6.3.3;

c) functional test of safety switching devices for limiting the pressure;

d) conformity test of the complete installation according to 6.3.4.

Joints shall be accessible for inspection while strength pressure tests and tightness tests are in progress. After strength pressure tests and tightness tests and before the system is started up for the first time, functional tests of all the electrical safety circuits shall be carried out.

The results of these tests shall be recorded.

6.3.2 Strength pressure test

Components shall be tested according to their product standard as indicated in Table 1. If the product standards in Table 1 are not applicable, then, the strength pressure tests as indicated in 5.3.2.2 shall be performed on these components.

If all components, piping and joints are tested or type approved beforehand according to Clause 5, then a tightness test on the complete assembly, as described in 6.3.3 is sufficient.

If components are not tested beforehand as indicated above, then the assembly of these components has to be tested as specified in Clause 6 at the test pressure derived from the maximum allowable pressure (PS) of the system.

For piping and piping joints not tested beforehand the following requirements apply:

a) For the remaining piping and piping joints of category II or higher (as defined in Annex B) one of the following tests shall be applied:

   — perform the tests as described in EN 14276-2, or

— individual proof test at minimum 1,43 × PS, or

— remaining piping and piping joints have to be strength pressure tested at minimum 1,1 × PS. In addition, 10 % of the permanent joints of category II or higher have to be submitted to a non-destructive test in accordance with EN ISO 17638 or EN ISO 17640. For brazed joints, EN 12799 applies, for welds EN ISO 10675-1:2013 and EN ISO 10675-2:2013.

NOTE 1 Strength pressure tests at 1,1 × PS are considered where strength pressure tests at 1,43 × PS may be harmful to the system. This procedure is only applied where the other procedures are harmful for the system.

b) If the category of the remaining piping and piping joints is less than or equal to category I (as defined in Annex B) then one of the following tests shall be applied:

— carry out one of the tests required for piping and piping joints of category II or higher, or

— test the remaining piping and piping joints at minimum 1,1 × PS, or

— type approve the remaining piping and piping joints as described in 5.2.2.3 in combination with the tightness test as described in 6.3.3.

c) If the category of the remaining piping and piping joints is less than or equal to category I (as defined in Annex B) and the unit fulfils the requirements of Annex C then a tightness test as described in 6.3.3 is sufficient.

For the strength pressure test, the pressure relief devices and control devices may be removed if necessary.

NOTE 2 For the connection of these components, a tightness test is necessary if the components are reconnected to the equipment after the strength pressure test.

The maximum allowable pressure can be separately specified for each part of the refrigerating system. In this case, the test pressure can be different for each part of the refrigerating system.

During this test, the low pressure side of the compressors complying with EN 60335-2-34 should not be subjected to test pressures in excess of PS on the low pressure side as defined by the manufacturer.

The test on the assembly should be carried out by means of a non-hazardous gas. Oxygen should not be used. Oxygen free nitrogen is preferred for this test.

6.3.3 Tightness test

6.3.3.1 General

The system shall be tested for tightness of the whole or in parts in accordance with this clause either before leaving the factory if it is factory assembled or on site if it is assembled or charged on site, in stages, if necessary, as the system is completed.

Leak testing should be carried out prior to painting.

Several techniques are used for testing for leaks depending on the production conditions, e.g. pressure with inert gas, radioactive gas traces. In order to avoid the emission of any hazardous substance, tightness testing should be done using inert gas such as nitrogen, helium or carbon dioxide. Air, oxygen, acetylene or hydrocarbons shall not be used for reasons of safety. Air and gas mixtures shall be avoided as certain mixtures can be dangerous.

NOTE A vacuum procedure can be used to get a rough indication of tightness.

A test method shall be applied reaching equivalent results to the requirements of 6.3.3.2 or 6.3.3.3.

6.3.3.2 For self-contained systems with refrigerant charge less than 5 kg which are tested with refrigerant in the system

No leaks shall be detected in following cases.

a) For factory made joints:

   — Joints in sealed systems shall be tested under a pressure of at least 0,25 × PS with detection equipment with a capability of 3 g/year of refrigerant or better;

   — Joints in other systems shall be tested under a pressure of at least 0,25 × PS with detection equipment with a capability of 5 g/year of refrigerant or better.

b) For joints made at the installation site:

   — Joints shall be tested with detection equipment with a capability of 5 g/year of refrigerant or better, with the equipment in standstill and under operation or under a pressure of at least these standstill or operation conditions.

The leak detection procedure shall take into account following:

— the response time of the equipment;

— the maximum distance between the leak and the leak testing equipment.

The corresponding instructions have to be given by the manufacturer of the leak testing equipment. Where the system is not tested at the above required pressures or not tested with pure refrigerant, the constructor shall demonstrate the applied test method to be equivalent to the above requirements.

The detection equipment shall be regularly calibrated according to the instructions of its manufacturer.

Every detected leak shall be repaired and re-tested for tightness.

6.3.3.3 For systems not covered by 6.3.3.2

Tests shall not be conducted using refrigerant as the test fluid.

a) Factory test:

   All refrigerant-containing parts or unit systems shall be tested and proved tight by the manufacturer at not less than PS for which they are rated. Tests shall be performed with dry nitrogen or another non-flammable, non-reactive, dried gas. Oxygen, air, or mixtures containing them shall not be used. The means used to build up the test pressure shall have either a pressure limiting device or a pressure-reducing device and a gauge on the outlet side. The pressure limiting device shall be set above the test pressure but low enough to prevent permanent deformation of the system's components.

   There are two exceptions to test fluids mentioned in the above requirement:

   — Mixtures of dry nitrogen and inert gases in combination with flammable gas in concentrations not exceeding the lesser of a weight fraction (mass fraction) of 5 % or 25 % of the LFL are allowed for factory tests;

   — Compressed air without added refrigerant is allowed for factory tests provided the system is subsequently evacuated to less than 132 Pa absolute pressure before charging with refrigerant.

b) Acceptance criteria:

For refrigerants with GWP ≥ 150, the acceptance criterion for this test is that no leaks shall be detected when using detection equipment with a capability of 10^{-6} Pa m³/s or better, for example a helium sniffer.

For refrigerants with GWP < 150, the acceptance criterion for this test is that no leaks shall be detected when using detection equipment with a capability of 10^{-3} Pa m³/s or better, for example application of water with a foaming agent to the outer surface or a leak test spray.

NOTE 1 For refrigerants with GWP < 150 alternative test methods can be found in EN 1779.

NOTE 2 Lower test pressures can be applied provided that equal sensitivity can be shown.

Any leak detected at this level of sensitivity shall be repaired and retested.

c) Site tests:

All sections of the refrigerating system constructed on site shall be tightness tested before the plant is charged with refrigerant. The site test procedure and acceptance criteria shall conform to the requirements of 6.3.3.3 a) and 6.3.3.3 b). Elements that have already been tightness tested and that can be safely isolated from the site test need not be retested.

6.3.4 Test of the complete refrigerating system before putting it into operation

6.3.4.1 General

Before the refrigerating system is put into operation the complete installation including the complete refrigerating system shall be checked for compliance with design drawings, flow-, pipe-, instrumentation- and electrical diagrams of the system.

For assemblies having the appropriate declaration of conformity, this requirement is considered to be fulfilled.

Guidelines regarding the procedure for commissioning are listed in Annex J.

6.3.4.2 Inspection of refrigerating system

The inspection of a refrigerating system shall be performed by a competent person (according to EN 13313) and shall include the following items:

a) checking of documentation relating to pressure equipment;

b) checking of safety devices and equipment according to 6.3.4.3;

c) checking that selected welds on piping are in accordance with EN 14276-2:

NOTE This may include examination with ultrasonic or X-ray.

d) checking that selected brazed joints on piping are in accordance with EN 14276-2;

e) checking of refrigerant piping according to 6.3.4.4;

f) checking and documentation of the alignment of the drive couplings of open compressors, pumps, fans, etc.;

g) checking the record of the tightness test of the refrigerating system;

h) visual inspection of the refrigerating system according to 6.3.4.5;

i) checking the marking according to 6.4.2.

This inspection shall be documented, see 6.4.3. No refrigerating system shall be put into operation, unless it is documented.

6.3.4.3 Checking of safety devices

6.3.4.3.1 Fitting

A check shall be made to ensure that the required safety devices for the refrigerating system are fitted and in working order and that the pressure at which those devices operate has been chosen so that the safety of the system is ensured.

6.3.4.3.2 Compliance with appropriate standards

A check shall be made that safety devices comply with appropriate standards.

6.3.4.3.3 Safety switching devices for limiting the pressure

A check shall be made, where appropriate, that the safety switching devices for limiting the pressure are functional and are fitted correctly.

6.3.4.3.4 Externally mounted pressure relief valves

Externally mounted pressure relief valves shall be checked to ensure that the correct set pressure is as stamped on the valve or is specified on a data plate.

6.3.4.3.5 Bursting discs

The marking of the correct nominal bursting pressure of bursting discs (excluding internal discs) shall be checked.

6.3.4.4 Checking of refrigerant piping

A check shall be made, where appropriate, that the refrigerating system piping has been installed in accordance with the drawings, specifications and appropriate standards.

6.3.4.5 Visual inspection of the complete installation

Visual inspection of the complete installation shall be carried out.

NOTE Informative Annex G proposes a list with specific check items.

6.4 Marking and documentation

6.4.1 General

Equipment shall comply with the requirements for marking in 6.4.2 and documentation 6.4.3.

Equipment which is under the scope of and complies with EN 60335-2-24 or EN 60335-2-40 is considered to comply with the requirements for marking in 6.4.2 and documentation in 6.4.3.

6.4.2 Marking

6.4.2.1 General

Every refrigerating system and its main components shall be identifiable by marking. This marking shall always be visible.

Shut-off devices and main control devices shall be clearly labelled, if it is not obvious what they control.

Service access points to refrigerating systems with A2L, A2, A3, B2L, B2 and B3 refrigerants shall be marked with the flame symbol according to EN ISO 7010-W021. For refrigerating systems in machinery rooms or open air, the warning notice in EN 378-3:2016,10.2 is deemed sufficient.

6.4.2.2 Refrigerating systems

A clearly readable identification plate shall be located on the refrigerating system.

The identification plate shall contain at least the following data:

a) name and address of manufacturer and where applicable the name and address of the authorized representative;

b) model, serial number or reference number;

c) year in which the manufacturing process is completed;

NOTE 1 The year of manufacture may also be part of the serial number, and all information may be part of the identification plate of the equipment and may be coded.

d) number designation of the refrigerant in accordance with ISO 817 (also see EN 378-1:2016, Annex E);

e) refrigerant charge;

f) maximum allowable pressure(s) (PS)

g) mandatory marking. When A2L, A2, A3, B2L, B2 and B3 refrigerants are used, the flame symbol according to EN ISO 7010-W021 shall be displayed with a minimum height of 30 mm, and the symbol need not be in colour.

The identification plate shall also contain details of electrical data as required by EN 60204-1, EN 60335-2-40, EN 60335-2-24 or EN 60335-2-89.

NOTE 2 For machines and their related products intended to be put on the market in the EEA, CE marking is defined in the applicable European Directive(s), e.g. 2006/42/EC (Machinery, MD), 2014/35/EU (Low Voltage, LVD), 2014/30/EU (Electromagnetic compatibility, EMC), 2014/34/EU (Explosive Atmospheres, ATEX) or 2014/68/EU (Pressure Equipment, PED).

NOTE 3 For refrigerating systems using fluorinated greenhouse gases, regulation (EU) No 517/2014 sets labelling requirements which are different from the requirements given in this standard and additional marking is required e.g. GWP, tonne(s) of CO_2 equivalent.

6.4.2.3 Piping and valves

Piping assembled and installed on site shall be marked by colour coding. This is not required if the piping flow is obvious by appearance.

As a European Standard is not available, colour coding should be according to national codes.

When the safety of persons or property can be affected by the release of the piping contents, labels identifying the contents shall be attached to the pipe near valves and where walls are penetrated.

The discharge piping from pressure relief valves shall be marked. Collecting lines for overflow valves shall be marked if the piping flow is not obvious from appearance.

Valves which permit parts of the refrigerating system to be isolated shall be marked.

Shut-off devices and main control devices shall be clearly labelled, if it is not obvious what they control.

The function of main shut-off devices, and controls for refrigerant and services (gas, air, water and electricity) shall be clearly marked.

NOTE Codes can be used to identify the devices provided a key to the codes is located near the devices.

Devices to be operated only by authorized persons should be marked.

6.4.3 Documentation

6.4.3.1 Installation documentation

Any documentation required by 6.3.4.2 shall be prepared on behalf of and signed by the competent person responsible for carrying out the inspection, test or checking.

The installer shall document that the system has been installed in accordance with the design requirements and shall state the setting of safety and control devices, if adjustable, as left after commissioning.

6.4.3.2 Instruction manual

The manufacturer and/or installer shall supply an adequate number of instruction manuals according EN ISO 12100 or leaflets and shall also provide safety instructions.

Instruction manuals for the equipment shall be provided in following languages:

— one of the official community languages, as drawn up by the manufacturer;

— translation of the manual in the language or languages of the country where the equipment is to be used.

The instruction manual shall at least contain the following information, if relevant:

a) the purpose of the system;

b) the description of the machinery and equipment;

c) refrigerating system schematic diagram and electrical circuit diagram, see 6.4.3.4;

d) instructions concerning starting, stopping and standstill of the system and parts thereof;

e) instructions concerning the disposal of operating fluid and equipment;

f) causes of the most common defects and measures to be taken, e.g. instructions concerning leakage detecting by authorized personnel and the need to contact competent maintenance technicians in the event of leakage or breakdown;

g) precautions to be taken to prevent the freezing of water in condensers, coolers, etc. at low ambient temperatures or by reduction of the system pressure/temperature;

h) precautions to be taken when lifting or transporting systems or parts of systems;

i) the on site information according to 6.4.3.3, as applicable, in its entirety;

j) reference to protective measures, first aid provisions and procedures to be followed in the event of emergencies, e.g. leakage, fire, explosion; refer to EN 378-3;

k) maintenance instructions for the entire system with a time schedule for preventive maintenance with respect to leakage, refer to EN 378-4;

l) instructions concerning charging and discharging of refrigerant;

m) instructions concerning the handling of refrigerant and the hazards associated with it;

n) instructions concerning function and maintenance of safety, protective and first aid equipment, alarm devices and pilot lamps;

o) guidance for the drafting of the logbook according to 6.4.3.5;

p) instructions to avoid overpressure during use, maintenance and servicing;

q) information concerning noise emission: Specify the workstation if required (see 6.2.16) and indicate for these locations the A-weighted emission sound pressure levels. Additionally information concerning the sound power level shall be given if the equivalent A-weighted sound pressure level at these locations exceeds 80 dB(A);

r) The noise data shall be accompanied by a statement of the measuring method used and the value of the associated uncertainty, K, using the dual-number form of declaration in accordance with EN ISO 4871;

s) whether personal protection equipment (PPE) is required according to EN 378-3;

t) where regular draining of oil is required, instructions for draining oil to minimize the risk for emission of refrigerant to the atmosphere;

u) where applicable data according to EN 378-3:2016, 6.4.1.

The installer shall outline the emergency procedures, relevant to the refrigerating system, to be taken in the event of disturbances and accidents of other kinds.

NOTE Information concerning hand-arm and whole body vibration are not relevant.

6.4.3.3 On site information

The installer shall also provide adequately protected documentation that shall be situated near the operating site of the refrigerating system and be clearly readable.

NOTE In the case of split or multisplit systems, the operating site may be considered as the outdoor unit.

This on site information shall at least contain the following information:

a) name, address and telephone number of the installer, his service department, the service department of the operator of the refrigerating system and the addresses and telephone numbers of fire department, police, hospitals and burn centres;

b) nature of the refrigerant by indicating its chemical formula and its number designation (see EN 378-1:2016, Annex E);

c) instructions for shutting down the refrigerating system in case of emergency;

d) maximum allowable pressures;

e) details of the flammability if a flammable refrigerant is used (group A2L, A2, A3, B2L, B2, B3 refrigerant);

f) details of the toxicity if a toxic refrigerant is used (group B1, B2L, B2, B3 refrigerant).

6.4.3.4 Drawings

For complex systems for which it is difficult to see the function of each component a piping and instrument diagram of the refrigerating system shall be displayed on or near the machine card identifying the shut-off and control devices. This diagram shall be made according to EN 1861.

6.4.3.5 Logbook

When the refrigerant charge exceeds 3 kg, a logbook shall be prepared upon installation of the system by the installer. This logbook is to be regularly updated as specified in EN 378-4.

In the logbook, at least the following information shall be recorded:

a) the details of the maintenance and repair works;

b) the quantities, kind of (new, reused, recycled, reclaimed) refrigerant which have been charged on each occasion, the quantities of refrigerant which have been transferred from the system on each occasion (see also EN 378-4);

c) the results of any analysis of a reused refrigerant;

d) the source of the reused refrigerant;

e) changes and replacements of components of the system;

f) the result of all periodic routine tests;

g) significant periods of non-use.

NOTE For refrigerating systems using fluorinated greenhouse gases, requirements for log book are specified in regulation (EU) No 517/2014.

Annex A
(normative)

Additional requirements for refrigerating systems containing R-717

A.1 Systems with a refrigerant charge above 50 kg

Refrigerating systems with a refrigerant charge above 50 kg shall have shut-off devices in order to isolate components of the system where liquid refrigerant is usually present such as receivers, accumulators, surge drum and flooded type heat exchangers.

NOTE For an installation where earthquakes are anticipated, a seismoscope that triggers the emergency stop system may be required. This system resets manually.

When pressure relief valves which blow off into the atmosphere are used as protection devices against excessive pressure, two pressure relief valves each of them having the total required relief capacity and connected by a changeover valve shall be used.

A.2 Systems with a refrigerant charge above 3 000 kg

Groups of components with a maximum possible total refrigerant charge above 3 000 kg of R-717 shall be equipped with a functionally remote-controlled shut-off device in the liquid line. This device shall close in the case of control power failure, detection of a leak or emergency stop (e.g. according to EN ISO 13850). It shall be integrated into the emergency system with the means to re-open the device manually. If the shut-off device only operates in one direction (e.g. solenoid valve), back-flow shall be prevented, e.g. by means of a pump down circuit.

Pumps shall be mounted directly between valves of which one shall be a remote controlled valve. To be able to carry out repairs on remote-controlled valves, it is recommended that a shut-off valve, which cannot be actuated during operation, be installed upstream.

Consideration shall be given to hydrostatic expansion due to temperature rise of liquid refrigerant trapped in or between closed valves when the emergency stop system is activated. A hydrostatic relief device or other means shall be provided to prevent over-pressurization; this relief shall be into a lower pressure portion of the system. When the emergency stop system is triggered, it shall be possible to shut off the pipes between components such that no additional risks, such as the inclusion of liquid, can occur due to the emergency stop system.

NOTE An emergency stop system consists of operations that are triggered manually or by means of leak detection devices and puts the refrigerating system in a safe operating mode.

A.3 Pumps

Pumps for R-717 shall either be a centrifugal pump with hermetic motor, or be equipped with a double seal system. In addition, a dry run protection device for the pumps shall be installed in accordance with the manufacturer's operating instructions (e.g. differential pressure monitoring, minimum level safety switch). If a remote-controlled shut-off valve is installed upstream of the pumps (potential danger of cavitation is increased) it shall be fitted with a limit switch to indicate that the valve is closed and the pump shall be interlocked with the limit switch (closed circuit principle).

Annex B
(normative)

Determination of category for components and refrigerating system assemblies

B.1 General

For determination of category for components and refrigerating system assemblies, as required in Clauses 5 and 6 of this standard, the necessary steps shall be taken as indicated hereafter.

B.2 Classification of the refrigerant

For classification of the refrigerant, refer to EN 378-1:2016, Annex E.

B.3 Determine the maximum allowable pressure of the assembly

The maximum allowable pressure(s) shall be determined according to 6.2.2.1.

B.4 Determine the state (liquid or gas) of the refrigerant

If the vapour pressure at the maximum allowable temperature (at bubble point) is greater than 0,5 bar (0,05 MPa) above normal atmospheric pressure, then this fluid is considered to be a gas, otherwise the fluid is to be considered a liquid.

B.5 Determination of category of components

B.5.1 General

Before determination of the category of the assembly, the categories of the different components within the refrigerating systems shall be determined.

It is possible that the PS of the component is larger than the PS of the assembly that it has to fit into. Usually, for determination of category, the PS value of the assembly shall be used. In this case, the PS of the safety accessory to be used for the protection of this component shall be set at the PS value of the assembly. In case protection for the component is provided at the PS of this component, then the PS value of the component shall be used for determination of the category of this component.

B.5.2 Pressure vessels and piping

— Category determination for pressure vessels is given in Table B.1.

— Category determination for piping is given in Table B.2.

Table B.1 — Category determination for pressure vessels

Fluid	Nature	PS (bar) [a]	V (l)	PS × V (bar × l)	Category/Article
if	**and**	**and**	**and**	**and**	**then**
GROUP 1	GAS	≤ 0,5	—	—	Not submitted to PED [b]
		> 0,5 and ≤ 200	≤ 1	—	Art. 4.3 [c]
			> 1	≤ 25	Art. 4.3 [c]
				> 25 and ≤ 50	I
				> 50 and ≤ 200	II
		> 200 and ≤ 1 000	≤ 1	—	III
		> 0,5 and ≤ 1 000	> 1	> 200 and ≤ 1 000	III
				> 1 000	IV
		> 1 000	—	—	IV
	LIQUID [d]	≤ 0,5	—	—	Not submitted to PED [b]
		> 0,5 and ≤ 500	≤ 1	—	Art. 4.3 [c]
		> 0,5 and ≤ 200	> 1	≤ 200	Art. 4.3 [c]
		> 0,5 and ≤ 10		> 200	I
		> 10 and ≤ 500			II
		> 500	< 1	—	II
			> 1	—	III
GROUP 2	GAS	≤ 0,5	—	—	Not submitted to PED [b]
		> 0,5 and ≤ 1 000	≤ 1	—	Art. 4.3 [c]
		> 1 000 and ≤ 3 000		—	III
		> 0,5 and ≤ 1 000	> 1	≤ 50	Art. 4.3 [c]
				> 50 and ≤ 200	I
				> 200 and ≤ 1 000	II
		> 0,5 and ≤ 3 000		> 1 000 and ≤ 3 000	III
		> 0,5 and ≤ 4	> 750	> 3 000	III
		> 4	> 1	> 3 000	IV
		> 3 000	—	—	IV

Fluid	Nature	PS (bar) [a]	V (l)	PS × V (bar × l)	Category/Article
if	**and**	**and**	**and**	**and**	**then**
	LIQUID [d]	≤ 0,5	—	—	Not submitted to PED [b]
		> 0,5 and ≤ 10	—	—	Art. 4.3 [c]
		> 10 and ≤ 1 000	—	≤ 10 000	Art. 4.3 [c]
		> 10 and ≤ 500	> 20	> 10 000	I
		> 1 000	< 10	—	I
		> 500	> 10	> 10 000	II

NOTE The categories in this table are equivalent to the categories in the Pressure Equipment Directive 2014/68/EU. For reference:

— PED = Pressure Equipment Directive 2014/68/EU

— Art. 4.3 = reference to Article 4.3 of the Pressure Equipment Directive 2014/68/EU

[a] 1 bar = 0,1 MPa

[b] For the purpose of this standard this category is considered to be less than Category I

[c] For the purpose of this standard this category is considered to be less than Category I

[d] Liquids are all fluids having a vapour pressure (at maximum allowable temperature) of not more than 0,5 bar above normal atmospheric pressure (1 013 mbar)

Table B.2 —Category determination for piping

Fluid	Nature	PS (bar) [a]	DN	PS × DN (bar) [a]	Category/Article
if	**and**	**and**	**and**	**and**	**then**
Group 1	GAS	≤ 0,5	—	—	Not submitted to PED [b]
		> 0,5	≤ 25	—	Art. 4.3[c]
			> 25 and ≤ 100	≤ 1 000	I
				> 1 000	II
			> 100 and ≤ 350	≤ 3 500	II
				> 3 500	III
			> 350		III
	LIQUID [d]	≤ 0,5	—	—	Not submitted to PED [b]
		> 0,5	≤ 25	—	Art. 4.3 [c]
			> 25	≤ 2 000	Art. 4.3 [c]
		> 0,5 and ≤ 10	> 200	> 2 000	I
		> 10 and ≤ 500	> 25		II
		> 500	> 25	—	III
GROUP 2	GAS	≤ 0,5	—	—	Not submitted to PED [b]
		> 0,5	≤ 32	—	Art. 4.3 [c]
			> 32	≤ 1 000	Art. 4.3 [c]
			> 32 and ≤ 100	> 1 000	I
			> 100	> 1 000 and ≤ 3500	I
			> 100 and ≤ 250	> 3 500	II
			> 250	> 3 500 and ≤ 5 000	II
				> 5 000	III
	LIQUID [d]	≤ 0,5	—	—	Not submitted to PED [b]
		> 0,5 and ≤ 10	—	—	Art. 4.3 [c]
		> 10	≤ 200	—	Art. 4.3 [c]
			> 200	≤ 5 000	Art. 4.3 [c]
		> 10 and ≤ 500	> 200	> 5 000	I
		> 500		—	II

Fluid	Nature	PS (bar) [a]	DN	PS × DN (bar) [a]	Category/Article
if	and	and	and	and	then

NOTE The categories in this table are equivalent to the categories in the Pressure Equipment Directive 2014/68/EU. For reference:

— PED = Pressure Equipment Directive 2014/68/EU

— Art. 4.3 = reference to Article 4.3 of the Pressure Equipment Directive 2014/68/EU

[a] 1 bar = 0,1 MPa

[b] For the purpose of this standard this category is considered to be less than Category I

[c] For the purpose of this standard this category is considered to be less than Category I

[d] Liquids are all fluids having a vapour pressure (at maximum allowable temperature) of not more than 0,5 bar above normal atmospheric pressure(1 013 mbar)

B.5.3 Safety accessories

The category determination of safety accessories shall be based upon the category of the components they have to protect. The category of safety accessories, which are used for the protection of pressure equipment of category I or higher, shall be generally determined to category IV. By way of exception, safety accessories manufactured for specific pressure equipment / specific other components may be classified in the same category as the pressure equipment / other components they protect.

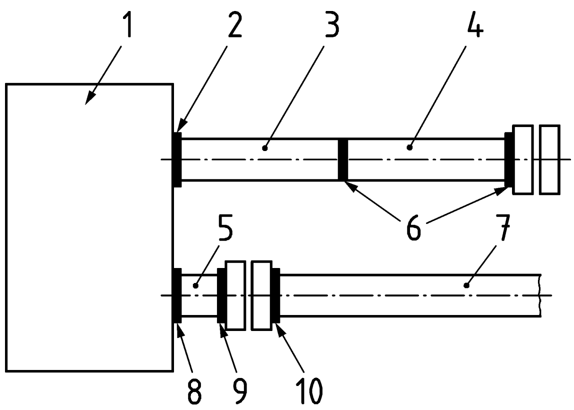
B.5.4 Joining of pressure equipment

For practical determination of category, some examples are given here below:

a) permanent connections between two parts shall comply with the highest category of the two parts;

b) assemblies may be considered as an assembly components in a sequence so that the permanent joint falls in the lowest possible category.

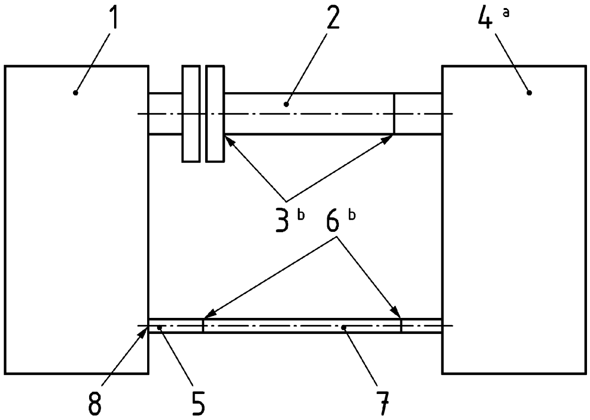
For parts equipped with extension pipes, the category of the extension pipe shall determine the category of the connection. The connections to an extension pipe should not have any influence on the strength of a higher category vessel.



Key

1	vessel category III
2	permanent connection category III
3	extension pipe category I
4	pipe category I
5	pipe category II
6	permanent connection category I
7	pipe category I
8	permanent connection category III
9	permanent connection category II
10	permanent connection category I

Figure B.1 — Joining of pressure equipment



Key

1 condensing unit category II

2 pipe category I

3 permanent joint category I

4 evaporator category I with electric fan included

5 extension pipe Art. 4.3

6 permanent connection Art. 4.3

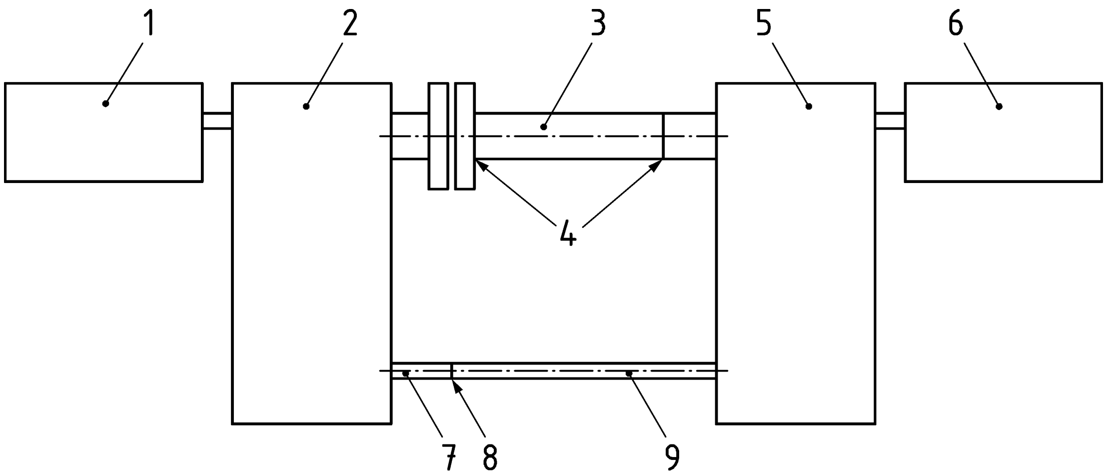
7 pipe Art. 4.3

8 permanent joint category II

[a] These are out of the scope of the Pressure Equipment Directive as they have to comply with the Low Voltage Directive or Machinery Directive.

[b] These permanent joints are out of the scope of the Pressure Equipment Directive as they are a part of a new assembly that has to comply with the Low Voltage Directive or Machine Directive.

Figure B.2 — Example 1: Category II assembly



Key

1 safety accessory (category III or higher)

2 condensing unit category III

3 pipe category II

4 permanent joint category II

5 vessel category II

6 safety accessory (category II or higher)

7 extension pipe category I

8 permanent joint category I

9 pipe category I

Figure B.3 — Example 2: Category III assembly

B.6 Determination of category of the assembly

The category of the refrigerating system assembly shall be determined based on the highest category of the pressure equipment it consists of (as determined in previous points) without taking into account the category of the safety accessories.

Annex C
(normative)

Requirements for intrinsic safety test

C.1 General

Requirements for intrinsic safety test are only applicable for equipment which, according to the flow chart in 6.2.6.2, results in the option which requires the intrinsic safety test to be performed.

C.2 Determination of the maximum pressure during abnormal operation

C.2.1 Determination of the pressure at the high pressure side (PHIS)

The heat exchanger at the high pressure side of the refrigerating system shall be subjected to following test in order to determine PHIS:

The refrigerating system shall be installed taking into account the clearances to adjacent surfaces as specified by the manufacturer.

The refrigerating system shall be operated at rated voltage or at the upper limit of the rated voltage range, at an ambient temperature of 23 °C ± 5 °C.

When steady-state conditions are attained, the heat-transfer fluid flow of the heat exchanger at the high pressure side shall be restricted or shut off, whichever is the most unfavourable with the refrigerating system operating.

Where the refrigerating system is equipped with external heaters, they shall be operated. The highest pressure that occurred during this test is considered to be PHIS.

C.2.2 Determination of the pressure at the low pressure side (PLIS)

The heat exchanger at the low pressure side of the refrigerating system shall be subjected to following test in order to determine PLIS:

The refrigerating system shall be installed taking into account the clearances to adjacent surfaces as specified by the manufacturer.

The refrigerating system shall not be operated in order to simulate standstill conditions.

The temperature of the heat-transfer fluid at the low pressure side heat exchanger shall be maintained at the maximum temperature specified by the manufacturer.

If the heat-transfer fluid is water, then this condition shall be maintained during 30 min. If the heat-transfer fluid is air, this condition shall be maintained for 1 h.

For refrigerating systems or parts carrying liquid refrigerant during transport under tropical climate, the refrigerating system or the charged part of it shall be maintained at a temperature of 70 °C for 1 h.

The highest pressure that occurred at the low pressure side is considered to be PLIS.

NOTE The temperature of 70 °C is the maximum temperature expected during transport in a container under tropical climate conditions.

C.2.3 Determination of PHIS and PLIS for reversible heat pumps

For reversible heat pumps the test shall be executed in both cooling and heating mode as described in C.2.1 and C.2.2. The highest values obtained in each section shall be taken into account to decide PHIS and PLIS for that section.

C.3 Strength pressure test

A pressure test shall be carried out on 3 samples of each component and joints, or on the assembly as a total.

One of the following test methods shall be applied:

— Method 1

The test shall be conducted at 3 times PHIS on the high pressure side and at 3 times PLIS on the low pressure side.

— Method 2

Test according to 5.3.2.2 where for the burst test and the first cycle PS is considered to be PHIS when the test is performed on the high pressure side and PLIS when the test is performed on the low pressure side.

For both methods the strength pressure test shall be carried out as a hydrostatic pressure test by means of water or some other liquid. Adequate precautions shall be taken to prevent danger to people and to minimize risk to property.

Acceptance criteria: the part under test shall not rupture.

C.4 Test results

The test report shall indicate:

— accepted ambient temperature see 6.2.2.1 and C.2.2;

— method of strength pressure test.

Annex D
(normative)

List of significant hazards

This annex contains all significant hazards, hazardous situations and events, as for as they are dealt with in this standard, identified by risk assessment as significant for type of machinery and which requires action to eliminate or reduce the risk. The risk assessment shall be made according to EN ISO 12100:2010. The refrigerating systems and their equipment shall be manufactured in accordance with the principle listed in EN ISO 12100:2010 to eliminate or reduce the foreseeable risk.

Table D.1 — List of significant hazards

No according to EN ISO 12100	Hazards, hazardous situations and hazardous events	Relevant clause of EN 378–2:2016
1	**Mechanical hazards** due to:	
	Cutting or severing hazard	6.2.11
	High pressure fluid injection or ejection hazard	5.2.1, 5.2.2, 5.3.2, 6.2.3
2	**Electrical hazards** due to:	
	Contact of persons with live parts (direct contact)	6.2.9
	Contact of persons with parts which have become live under faulty conditions (indirect contact)	6.2.6.7, 6.2.9
	Electrostatic phenomena	6.2.9
	Thermal radiation or other phenomena such as the projection of molten particles and chemical effects from short circuits, overloads, etc.	6.2.9, 6.2.10
3	**Thermal hazards,** resulting in:	
	Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by the radiation of heat sources	6.2.6, 6.2.10, 6.2.14
	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts	5.1.2, 5.3.1.4, 6.2.3.5, 6.2.4
7	**Material / substance hazards** resulting in:	
	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts	5.1.2, 5.1.3.4, 6.2.3.5, 6.2.4
	Fire or explosion hazard	6.2.5.1, 6.2.6, 6.2.14
10	**Hazards associated with the environment in which the machine is used** due to:	
	Pollution and lack of oxygen	5.1.2, 5.3.1.4, 6.2.4

Annex E
(informative)

Assessment of assemblies for compliance with directive 2014/68/EU

Assessment of the assembly for compliance with DIRECTIVE 2014/68/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 May 2014 on the harmonization of the laws of the Member States relating to the making available on the market of pressure equipment

The category of the assembly should be determined as indicated in Annex B.

NOTE This annex only explains the assessment requirements of the Pressure Equipment Directive, not the requirement for CE-marking in a total.

Depending on the category of the assembly it is required to assess the assembly together with a notified body and to add a declaration of conformity as such as indicated in Table E.1.

Table E.1 — Assessment of the assembly for PED

category	Declaration of conformity is required?	Notified body?
< I	No	No
≥ II	Yes	Yes
= I	Yes	No

Components should be assessed according to the component category if there is no CE-mark.

For components already CE-marked, documents according to Table E.2 should be provided.

Table E.2 — Assessment of components

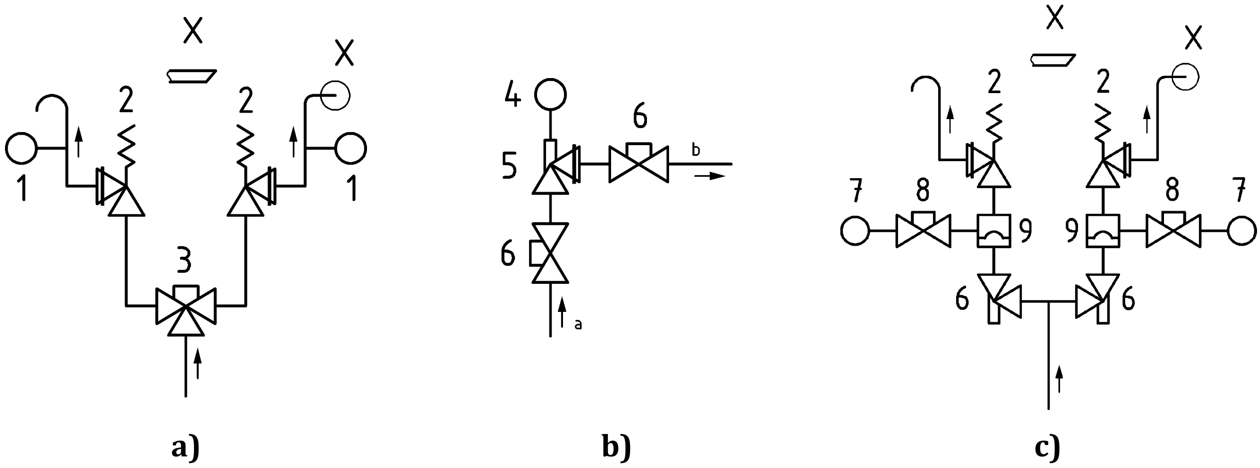
category	Required declaration of conformity
< I	—
I	PED and/or other directives
≥ II	PED
NOTE As a pressure vessel of category I used in refrigerating systems is always submitted to LVD [a] and/or MD [b], the exclusion of art 1.2 (f) of the PED applies. As such, conformity with PED is only to be assessed for category II, III and IV.	
[a] LVD: DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits [b] MD: Directive 2006/42/EC of the European parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EU (recast)”	

Annex F
(informative)

Examples for arrangement of pressure relief devices in refrigerating systems

Certain systems containing large amount of refrigerant may require specific arrangements for pressure relief valves to allow adequate tightness and monitoring of the correct set-up of the pressure relief device and their periodic maintenance.

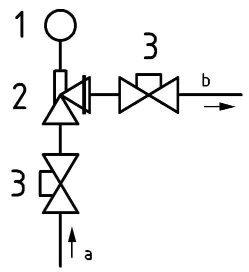
Such specific arrangements are given in Figure F.1 as examples.



Key

1 detection of refrigerant concentration
2 pressure relief valve relieving to the atmosphere
3 changeover valve secured with a cap
4 bellows monitoring device
5 pressure relief valve in the form of a backpressure compensating overflow valve with bellow vent relieving to LPS
6 locked valve as in 6.2.6.6
7 pressure limiter (adjusted to 0,5 bar (0,05 MPa))
8 locked valve with vent and cap
9 bursting disc with monitoring device
a from vessel of high pressure side or piping section
b to low pressure side of system

Figure F.1 — Arrangements of pressure relief valves equipped with monitoring devices for their tightness



Key

1 bellows monitoring device

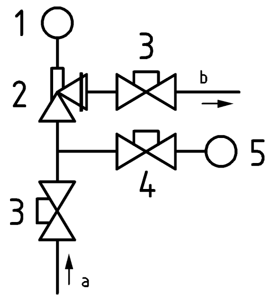
2 pressure relief valve in the form of a backpressure compensating overflow valve with bellow vent relieving to LPS

3 locked valve as in 6.2.6.6

a from vessel of high pressure side or piping section

b to low pressure side of system

Figure F.2 — Backpressure compensating overflow valve for protection of a pressure vessel of the high-pressure side or piping section against liquid expansion



Key

1 bellows monitoring device

2 pressure relief valve in the form of a backpressure compensating overflow valve with bellow vent relieving to LPS

3 locked valve as in 6.2.6.6

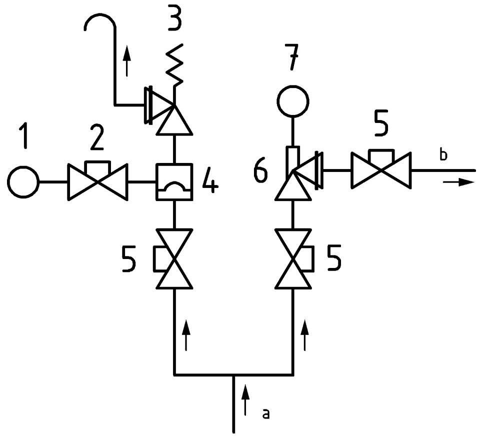
4 locked valve with vent and cap (recommended)

5 pressure limiter (adjusted 2 bar (0,2 MPa) lower than PS)

a from externally heated components of low pressure side

b to low pressure side of system

Figure F.3 — Backpressure compensating overflow valve for protection of a pressure vessel of the low pressure side against liquid expansion and/or external heat



Key

1 pressure limiter (adjusted 0,5 bar (0,05 MPa) lower than PS)

2 locked valve with vent and cap (recommended)

3 pressure relief valve relieving to the atmosphere

4 bursting disc with monitoring device

5 locked valve as in 6.2.6.6

6 pressure relief valve in the form of a backpressure compensating overflow valve with bellow vent relieving to LPS

7 bellows monitor

a common piping from pressure vessel

b to low pressure side of system

Figure F.4 — Pressure relief device consisting of a backpressure compensating overflow valve relieving to the low pressure side of the system and a pressure relief valve discharging to the atmosphere for protection against liquid expansion and/or external heat

Annex G
(informative)

Checklist for external visual inspection of the installation

For external visual inspection of the refrigerating system, the checklist covers the following items:

a) check for transit or storage damage to the equipment;

b) check that all components are as specified;

c) check that all safety devices, documents and equipment required by this European Standard are present;

d) check that all devices and arrangements for safety and environmental protection are present and in compliance with this European Standard;

e) check that pressure vessel documents, certificates, identification plates, instruction manual and documentation required in this European Standard are present;

f) check that volume of receivers is sufficient;

g) check instructions and directions to prevent deliberate discharge of refrigerants to the environment;

h) check that, where piping is accessible to the general public, the surface temperatures shall not endanger this general public;

i) compare the complete installation with the refrigerating and electrical system drawings; check whether electrical supply is adequate for the power to be drawn;

j) check documentation relating to pressure vessels if vessels are changed, modified or used for another refrigerant;

k) check vibrations and movements caused by temperature and pressure under operation conditions;

l) check installation of fittings and valves;

m) check supports and fixing (materials, routing, connection);

n) check quality of welding and other joints;

o) check protection against mechanical damage;

p) check protection against heat;

q) check protection of moving parts;

r) check accessibility for maintenance or repair and for inspection of piping;

s) check valve arrangement;

t) check quality of thermal insulation and vapour barriers;

u) check fouling of heat exchange surfaces.

Annex H
(informative)

Stress corrosion cracking

H.1 Introduction

Stress corrosion is a chemo-physical phenomenon which affects a range of metals including copper, titanium, carbon steel and stainless steel. It is most likely to occur when certain metallic components are subjected to moderate stresses while exposed to a specific environment, and it is characterized by the appearance of microcracks which run perpendicular to the major stress axis and may be intergranular or transgranular (i.e. may run between grains in the metal structure or through them). The crack tip is typically feathered (contains many fine branches) indicating that this is not a simple yield or fatigue fracture.

Stress corrosion failures have been reported in the copper pipework of fluorocarbon refrigerating systems and in steel pressure vessels and pipework in ammonia systems. The majority of stress corrosion failure cases in ammonia equipment are in high pressure receivers, although stress corrosion is known to have affected the shell of water chiller evaporators, oil recovery pots and suction header pipework. There are no reported cases of stress corrosion failures of steel vessels in fluorocarbon plants, although it is possible that conditions conducive to the formation of stress corrosion cracks could arise in the event of acidification of the refrigerant. There are no known cases of stress corrosion cracking of stainless steel or titanium in refrigerating systems.

H.2 Stress corrosion in copper

Stress corrosion has been reported in copper pipes for fluorocarbon refrigerant systems, typically progressing from the outside of the pipe inward and usually triggered by chemicals in insulation adhesive compounds when exposed to a wet environment, for example where insulated pipes have been submerged during installation. The stress arises from the pressure loading of the pipe and so the resultant cracks are longitudinal. After stress corrosion failure, the inside of the pipe will show a characteristic copper-blue pattern.

Once the stress corrosion has been established it often results in multiple pinhole leaks necessitating replacement of the affected pipework. The stress corrosion will not spread to sections of the pipe that were not subjected to the corrosive environmental conditions.

H.3 Stress corrosion in steel

Stress corrosion has also been associated with non-catastrophic failure of carbon steel pressure vessels in ammonia systems. It has been established that microcracks in the inner surface of the pressure vessel are not uncommon. Provided these cracks do not progress beyond the vessel's corrosion allowance and do not affect the mechanical strength of the pressure envelope, they should not pose a problem. Usually the microcracks penetrate to a depth of about 1 mm but do not progress beyond. Occasionally however a stress corrosion crack will continue to propagate.

H.4 Factors that influence stress corrosion cracking

H.4.1 General

The sections that follow are focused on ammonia refrigerating systems using carbon steel pressure containing equipment. Recommendations for preventing stress corrosion cracking are given.

H.4.2 Yield strength

Stress corrosion cracking is more likely in steels with a high yield strength because the surface is more brittle. It has been established that cracking is unlikely if the parent material has a yield strength less than 350 MN/m^2. It is recommended that material with a minimum yield strength of 265 MN/m^{2}is specified for pressure vessel shell and end caps, but it shall be noted that the actual material yield strength may be higher than the specified minimum.

NOTE “Minimum yield strength” is a term commonly used in the steel industry referring to the lowest allowable yield strength for material. The yield strength of the actual materials used in the fabrication of a vessel might exceed the minimum by as much as 50 %.

H.4.3 Temperature

Stress corrosion cracking is more likely to occur at elevated temperatures. If the normal operating temperature of the vessel is above – 5 °C, or if the vessel temperature during system shutdown is expected to be above - 5 °C then the vessel should be post-weld stress relieved. Traditionally this has been applied to high pressure receivers, but water cooled shell and tube condensers, economisers and intercoolers may operate in this temperature range, as do evaporators for water chillers. Oil recovery pots may also be subject to higher temperatures for long periods and should be stress relieved.

H.4.4 Oxygen content

Stress corrosion cracking is more likely to occur where there are increased oxygen levels within the system. High pressure receivers, where non-condensable gases, including oxygen, can accumulate are particularly at risk. The majority of reported cases of stress corrosion cracking are in high pressure receivers, although instances in intermediate pressure and low pressure vessels are not unknown.

Stress corrosion cracking may be initiated if the oxygen level exceeds 5×10^{-7} (0,5 ppm). Maintaining the oxygen content below 0,5 ppm in a system on a continuous basis is not feasible, but care should be taken to ensure that the system is purged of non-condensable gases at commissioning and routinely during operation.

H.4.5 Water content

It is reported that stress corrosion cracking is less likely to occur if there are moderate levels of water in the ammonia. As the water content in the ammonia increases, the amount of oxygen required to initiate stress corrosion also increases, up to a limit of 2×10^{-3} (2 000 ppm) water which will inhibit the onset of stress corrosion cracking provided the oxygen levels are below 1×10^{-4} (100 ppm).

NOTE This finding was the result of research into failures of ammonia holding tanks in the fertiliser industry and has been widely reported as a preventative measure for ammonia vessels including refrigeration receivers. However it is less useful in a refrigerating system, where oxygen will accumulate as a non-condensable gas upstream of the expansion valve at the vapour/liquid interface (usually in the high pressure receiver) but water will accumulate as a non-volatile liquid (or ice) downstream of the expansion valve (usually in the surge drum or accumulator).

H.4.6 Age of equipment

Leakage due to stress corrosion cracking is most likely to occur in the first few months of operation, suggesting that the microcracks form almost immediately when all the prerequisite conditions are present and it is only the time taken for the crack to propagate through the material that is variable. This is a function of the thickness of the material, the stress applied to the material and the material properties.

H.4.7 Avoiding stress corrosion cracking

Ensuring that the parent metal yield strength is sufficiently low is the most effective measure for avoiding SCC, as the initial surface cracking is associated with high yield strength material. All fittings such as end caps should be hot formed, or stress relieved after cold forming. The shell material should be specified with a minimum yield strength of 265 MN/m^2. Vessels should be stress relieved after manufacture if possible. If the vessel contains delicate internal components such as rubber bushes then post-weld heat treatment may not be possible.

For low temperature vessels (for example accumulators, surge drums and suction traps) post-weld heat treatment is less critical, but is recommended if possible. For high temperature vessels such as high pressure receivers, water chillers, intercoolers and economisers post weld heat treatment is strongly recommended.

The literature based on the ammonia production and fertiliser industries recommends a minimum water content of 2×10^{-3} (2 000 ppm) in ammonia systems in order to prevent stress corrosion with oxygen content up to 1×10^{-4} (100 ppm). In refrigerating systems this might be beneficial for evaporators, for example water chillers, but it is unlikely to have much effect on high pressure receivers and intercoolers.

H.4.8 Conclusions

Attention to detail in the material specification, production, testing and installation of the system will ensure that stress corrosion is avoided. Where stress corrosion cracking has caused a leak, the damaged component shall be replaced whether it is copper pipe in a fluorocarbon system or a steel pressure vessel in an ammonia system. Where stress corrosion cracks are identified, but are not propagating, then the vessel should be monitored as the basis for determining when its replacement might be warranted.

Annex I
(informative)

Leak simulation test for A2L, A2, A3, B2L, B2, B3 refrigerants

A leak simulation test according to 6.2.14 should comply with following method.

A leak simulation test is carried out by introducing a release of refrigerant from a suitable container at a position on the refrigeration system. Refrigerant is released at the critical failure point. A critical failure point is any refrigerant containing part (pipework or component) that will result in the highest concentration of refrigerant at the potential source of ignition.

A suitable container is separate from the refrigeration system and may be a refrigerant cylinder, hose and suitable release point.

The equipment/system shall be arranged as intended for its installation and according to the installation manual. Where there are various possibilities for the installation, the arrangement that gives the most unfavourable result shall be used.

For joints and components within the scope of EN 16084 the mass flow shall not be less than 1 g/s ± 5 %. For all other cases the mass flow rates shall not be less than 3 g/s ± 5 %.

The refrigerant shall be released in vapour phase.

The refrigerant is released in the direction that results in the highest concentration at the source of ignition being tested.

The refrigerant shall be released at a pressure of at least 0,25 × PS of the applicable part of the system and not less than 2 bar.

The total mass of the released refrigerant shall not be less than the charge of the refrigeration system or until the concentrations have not increased or changed by more than ± 10 % of the mean value within three minutes.

NOTE Identify possible channels, ducts and cable sheathing that the refrigerant could possible pass through, e.g. leaks from within pipe insulation where the refrigerant may travel to other locations from where the leak originally occurs.

During the test the system is switched off or operated under normal operation at rated voltage, whichever gives the most unfavourable result unless ventilation is activated prior to energizing any loads, in which case the test shall be conducted with the appliance operating. During a test where the appliance is operating, the refrigerant release is started at the same time as the appliance is switched on.

If a part of the system has a minimum room size associated with it according to Part 1, the test is carried out in a room of that size within ± 20 %. The test is conducted in a room that has a residual airspeed of not more than 0,1 m/s.

The gas concentration is measured at intervals of no more than 5 s.

The measured concentration of refrigerant gas surrounding the component shall not exceed 50 % of the refrigerant LFL for the duration of the test.

The test is performed twice and is repeated a third time if one of the tests gives more than 40 % of the LFL.

The instrument used for monitoring the refrigerant gas concentration shall have a fast response to the gas concentration, typically 2 s to 3 s and shall be located so as to not unduly influence the results of the test.

The duration of test shall be at least two times the duration of the leak for the refrigerant charge to be released or until the concentrations have not increased or changed by more than ± 10 % of the mean value within three minutes.

Annex J
(informative)

Commissioning procedure

During commissioning the following checks have to be executed:

— checking the tightness of the assembly, according to a) to d);

— vacuuming and filling of the assembly according to e);

— checking for leakages according to f);

— certification according to g).

a) During the commissioning of the assembly required in 6.3.4.2 the tightness of the assembly has to be checked according to 6.3.3.

b) If during pressure testing or tightness testing a leak is detected, the leak shall be repaired and the pressure test and tightness test shall be repeated where appropriate. If any component is permanently deformed by the pressure test, it shall be replaced.

c) During tightness testing connections shall be accessible for inspection.

d) A certificate of tightness shall be provided with the installation documentation as required in 6.4.3.1. This certificate shall indicate the method used to check tightness including test pressures where appropriate.

e) The vacuum procedure shall be applied after the tightness test has been completed. A stationary vacuum pump shall be connected to the assembly or relevant part of an assembly and an absolute pressure of less than 270 Pa shall be achieved. The achieved pressure should be maintained at this level for sufficient time after the pump has been isolated from the assembly to ensure that the moisture has been removed and the system is not leaking. For smaller systems a lower vacuum pressure may be necessary.

   The competent person (according to EN 13313) that executes this operation, shall decide when the vacuum can be broken and whether the vacuum procedure should be repeated.

   At the end of the vacuum procedure, the assembly can be filled with the appropriate refrigerant.

f) During the commissioning of the assembly, a leak check has to be executed after the assembly has been put into operation. The assembly should also be checked for correct operation during this procedure.

g) A certificate for the vacuum and filling procedure shall be provided. This certificate indicates the method used, the results of the procedure, the pressures applied and the duration of the test.

Annex K
(informative)

Information on effective ignition sources

Types of ignition sources are described in EN 1127, and when evaluating whether ignition sources exists all relevant types should be evaluated. Table K.1 indicates which types of ignition sources are usually relevant to evaluate for refrigeration systems.

Special aspects of the specific system being evaluated may lead to more ignition types being relevant. For example if a refrigeration system cools an infrared laser, then the possible ignition by "Electromagnetic waves from 3 × 1 011 Hz to 3 × 1 015 Hz" should be evaluated.

Table K.1 — Relevance of ignition sources from EN 1127

Clause in EN 1127–1	Ignition sources listed in EN 1127–1	Usually relevant to evaluate for refrigeration systems under normal operation	Examples
5.1	Hot surfaces	Yes	Electrical heaters
5.2	Flames and hot gases	Yes	Gas heaters
5.3	Mechanically generated sparks	Yes	During service
5.4	Electrical apparatus	Yes	Electrical sparks from opening circuits.
5.5	Stray electric currents and cathodic corrosion protection	No	-
5.6	Static electricity	Yes	Large plastic surfaces
5.7	Lightning	No	It is highly unlikely that lightning will hit at the same time as a leak is occurring
5.8	Radio frequency (RF) electromagnetic waves from 104 Hz to 3 × 1 011 Hz	No	-
5.9	Electromagnetic waves from 3 × 1 011 Hz to 3 × 1 015 Hz	No	-
5.10	Ionizing radiation	No	-
5.11	Ultrasonics	No	-
5.12	Adiabatic compression and shock waves	No	An air compressors taking air from the vicinity of a leak

Clause in EN 1127–1	Ignition sources listed in EN 1127–1	Usually relevant to evaluate for refrigeration systems under normal operation	Examples
5.13	Exothermic reactions, including self-ignition of dusts	No	

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EU

This European Standard has been prepared under a mandate given to CEN by the European Commission to provide a means of conforming to Essential Requirements of the New Approach Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive, 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 2014/68/EU

Clauses/subclauses of this European Standard	Essential requirements (ERs) of Directive 2014/68/EU	Qualifying remarks/Notes
6.2.2	2.2.1	Adequate strength
6.2.6.6.1, 6.2.6.6.3, 6.2.6.6.5, 6.2.10, Annex A	2.3	Safe handling and operation
6.2.1, 6.2.3.5, 6.2.4.4, 6.2.6.6.1, 6.2.6.6.5	2.5	Draining and venting
6.2.3.3.4, 6.2.3.4	2.6	Corrosion
6.2.1, 6.2.2.1, 6.2.2.2, 6.2.3	2.8	Assemblies
6.2.7	2.9 (a)	Filling and discharge
6.2.4	2.9 (b)	Filling and discharge
6.2.4	2.9 (c)	Filling and discharge
6.2.5, 6.2.6	2.10 (a)	Protection against excessive pressure
6.2.5, 6.2.6.1, 6.2.6.2, 6.2.6.3, 6.2.6.4, 6.2.6.6, 6.2.6.7	2.11.1	Safety accessories
6.2.5.2, 6.2.6.1, 6.2.6.2, 6.2.6.7	2.11.2	Safety accessories
6.2.2.3, 6.2.5.1	2.12	External fire
6.3.1, 6.3.4	3.2.1	Final inspection
6.3.2	3.2.2	Proof test
6.3.4.3	3.2.3	Inspection of safety devices
6.4.2	3.3	Marking and labelling
6.4.3.1, 6.4.3.2, 6.4.3.3, 6.4.3.4	3.4	Operating instructions
6.2.3.3.3	6 (a)	Piping
6.2.3.3.1, 6.2.3.3.4, 6.2.3.4	6 (d)	Piping

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

Annex ZB
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/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 Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery, and amended Directive 95/16/EC (recast).

Once this standard is cited in the Official Journal of the European Union 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 ZB.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 ZB.1 — Correspondence between this European Standard and Directive 2006/42/EC

Clauses/subclauses of this European Standard	Essential requirements (ERs) of Directive 2006/42/EC	Qualifying remarks/Notes
Clause 4, 5.1	1.1.2	General
5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1, 6.2, 6.3, 6.2.3	1.1.3	Materials and products
6.2.2, 6.2.3, 6.2.12, 6.2.13	1.1.5	Handling and transportation
6.2.1, 6.2.5, 6.2.6, 6.2.8, 6.2.9	1.2.1	Control systems
6.2.7	1.2.2	Control devices
6.2.9	1.2.3	Starting
6.2.9	1.2.4	Stopping device
6.2.6.7	1.2.6	Failure of power supply
5.3, 6.2.3	1.3.2	Break up during operation
6.2.11	1.3.7	Moving parts
6.2.11	1.3.8	Moving parts
6.2.11	1.4.1	Guards and protection devices
6.2.9	1.5.1	Electricity supply
6.2.9	1.5.2	Static electricity
6.2.3, 6.4.2.3, 6.4.3.2	1.5.4	Errors of fitting
6.2.10	1.5.5	Extreme temperatures
6.2.3, 6.2.5.1, 6.2.14	1.5.6	Fire
6.2.14	1.5.7	Explosion
6.2.3.3.4, 6.2.17	1.5.8	Noise
6.2.3.3, 6.2.12	1.5.9	Vibration

Clauses/subclauses of this European Standard	Essential requirements (ERs) of Directive 2006/42/EC	Qualifying remarks/Notes
6.2.16	1.5.10	Radiation
6.2.16	1.5.11	External radiation
6.2.3, 6.2.4	1.6.1	Maintenance
6.2.3.3.7	1.6.2	Access
6.2.9	1.6.3	Isolation of energy sources
6.2.7, 6.2.5.2, 6.2.3.1	1.7.1.1	Information devices
6.2.6	1.7.1.2	Warning devices
6.4.3.3	1.7.2	Warning of residual risks
6.4.2.2	1.7.3	Marking
6.4.3.2	1.7.4	Instructions

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

Bibliography

[1] EN 1779:1999, *Non-destructive testing — Leak testing — Criteria for method and technique selection*

[2] EN 10204:2004, *Metallic products — Types of inspection documents*

[3] EN 12952-2:2011, *Water-tube boilers and auxiliary installations — Part 2: Materials for pressure parts of boilers and accessories*

[4] EN 12953-1:2012, *Shell boilers — Part 1: General*

[5] EN ISO 12944-1:1998, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 1: General introduction (ISO 12944-1:1998)*

[6] EN ISO 17638:2009, *Non-destructive testing of welds — Magnetic particle testing (ISO 17638:2003)*

[7] EN 60721-2-1, *Classification of environmental conditions — Part 2-1: Environmental conditions appearing in nature — Temperature and Humidity (IEC 60721-2-1)*

[8] European Agreement concerning the International Carriage of Dangerous Goods by Road ADR applicable as from 1 January (ADR 2015)

[9] Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on the approximation of the laws of the Member States relating to machinery

[10] DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment

[11] DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility

[12] DIRECTIVE 2014/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast)

[13] DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits

[14] DIRECTIVE 2014/68/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment

[15] REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation

(EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (REACH)

[16] REGULATION (EC) No 1272/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006

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