SLOVENSKI STANDARD

SIST EN 378-2:2000

01-december-2000

Refrigerating systems and heat pumps - Safety and environmental requirements - Part 2: Design, construction, testing, marking and documentation

Refrigerating systems and heat pumps - Safety and environmental requirements - Part 2: Design, construction, testing, marking and documentation

Kälteanlagen und Wärmepumpen - Sicherheitstechnische und umweltrelevante Anforderungen - Teil 2: Konstruktion, Herstellung, Prüfung, Kennzeichnung und Dokumentation

Systemes de réfrigération et pompes a chaleur - Exigences de sécurité et d'environnement - Partie 2: Conception, construction, essais, marquage et documentation

Ta slovenski standard je istoveten z: **EN 378-2:2000**

ICS:

27.080

27.200

SIST EN 378-2:2000 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 378-2

January 2000

ICS 27.080; 27.200

English version

Refrigerating systems and heat pumps - Safety and environmental requirements - Part 2: Design, construction, testing, marking and documentation

Systèmes de réfrigération et pompes à chaleur - Exigences de sécurité et d'environnement - Partie 2: Conception, construction, essais, marquage et documentation

Kälteanlagen und Wärmepumpen - Sicherheitstechnische und umweltrelevante Anforderungen - Teil 2: Konstruktion, Herstellung, Prüfung, Kennzeichnung und Dokumentation

This European Standard was approved by CEN on 10 October 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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

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

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Ref. No. EN 378-2:2000 E

Contents

Foreword

This European Standard 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 July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

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

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

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

NOTE 1: It should be noted that this standard at the time of publication does not satisfy all essential safety requirements of the Directive 97/23/EC.

NOTE 2: This European Standard had also been proposed for inclusion in the mandate under the EU Directive 89/392/EEC (Machinery Directive). As the mandate has been given after the Standard had been accepted by the Technical Committee for submission to formal vote and in order not to further delay its publication, it will be reviewed within the context of the latest version of the Machinery Directive directly after the publication.

This EN 378-2 is part of a standard consisting of a series of the following parts:

Part 1: Basic requirements, definitions, classification and selection criteria

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

Part 3: Installation site and personal protection

Part 4: Operation, maintenance, repair and recovery

For the 6-month enquiry, the draft standard was issued in 13 parts. After the discussion of the comments received during the enquiry it was decided to rearrange the content of 12 parts and to publish the final standard in the above 4 parts. The remaining part 13 will be published as a separate standard.

The annexes A and B of this European Standard are normative and the annexes C, D, E and ZA are informative.

Introduction

The introduction of EN 378-1 is applicable.

1 Scope

1.1 The scope of EN 378-1 is applicable.

1.2 This Part 2 of the European Standard is applicable to the design and construction of refrigerating systems and the components and materials used including piping. It also specifies requirements for testing, commissioning, marking and documentation.

> NOTE: The classification of refrigerants as defined in Directive 97/23/EC and the associated technical requirements of pressure equipment are listed in the European standard on "Pressure equipment for refrigerating systems and heat pumps – Part 1: Vessels – General requirements" which is in preparation, see informative annex E.

1.3 Certain clauses and subclauses of this Part 2 are not applicable to unit systems and self-contained systems which operate with charges of refrigerant up to

10,0 kg of group L1 refrigerant,
2,5 kg of group L2 refrigerant, and
1,0 kg of group L3 refrigerant.

These clauses and subclauses are:

5.2;
clause 6;
7.4.3.1; 7.4.3.3; 7.5;
9.1.1; 9.1.2; 9.2; 9.3; 9.4.3.3; 9.4.3.4; 9.4.3.5; 9.5.1; 9.5.2; 9.5.3; 9.5.6;
10.1.2; 10.3; 10.5; 10.6.

> NOTE: Other clauses and subclauses may or may not apply, but in each case consideration of the system details in conjunction with the text will make it clear whether they apply or not.

1.4 Some clauses and subclauses are not applicable to systems built on site with refrigerant charges up to

2,5 kg of group L1 refrigerant,
1,5 kg of group L2 refrigerant, and
1,0 kg of group L3 refrigerant.

These clauses are:

6.5.2.2 and clause 11.

1.5 Some unit systems and self-contained systems have maximum allowable pressures separately specified for the high and low pressure sides. In such cases, if it is not possible to separate the high and low pressure sides after the unit has been assembled, any further testing of the system can be carried out at pressures not more than the allowable pressure of the low pressure side. For particular classes or types of appliances in quantity production certain tests included in this Part 2 of the European Standard can be specified as type tests only.

2 Normative references

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

EN 287-1
Approval testing of welders – Fusion welding – Part 1: Steels

EN 60204-1
Safety of machinery – Electrical equipment of machines – Part 1: General requirements
(IEC 60204-1 : 1997)

EN 60335-1
Safety of household and similar electrical appliances – Part 1: General requirements
(IEC 60335-1 : 1991, modified)

EN 60335-2-34
Safety of household and similar electrical appliances – Part 2: Particular requirements for motor-compressors
(IEC 60335-2-234 : 1996)

ISO 817
Organic refrigerants – Number designation

prEN 378-1 : 1999
Refrigerating systems and heat pumps – Safety and environmental requirements – Part 1: Basic requirements, definitions, classification and selection criteria

EN 378-4 : 1999
Refrigerating systems and heat pumps – Safety and environmental requirements – Part 4: Operation, maintenance, repair and recovery

EN 1290
Non-destructive examination of welds – Magnetic particle examination of welds

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

EN 1714
Non-destructive testing of welds – Ultrasonic examination of welded joints

prEN 1736:1994
Refrigerating systems and heat pumps – Flexible pipe elements – Requirements, design and installation

prEN ISO 4126-2
Safety devices for protection against excessive pressure – Part 2: Bursting disc safety devices
(ISO/DIS 4126-2 : 1996)

prEN 12178:1995
Refrigerating systems and heat pumps – Liquid level indicating devices – Requirements, testing and marking

EN 12263
Refrigerating systems and heat pumps – Safety switching devices for limiting the pressure – Requirements and tests

prEN 12284:1996
Refrigerating systems and heat pumps – Valves – Requirements, testing and marking

prEN 12693:1996
Refrigerating systems and heat pumps – Safety and environmental requirements – Refrigerant compressors

3 Definitions

For the purposes of this European Standard the definitions given in EN 378-1 apply.

4 General

4.1 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.

4.2 Refrigerant charge

Refrigerating systems shall be designed in such a way that the refrigerant charge is kept as small as reasonably practicable.

4.3 Energy consumption

Refrigerating systems shall be so designed and constructed that under the foreseeable operating conditions the energy consumption is kept as low as reasonably practicable.

4.4 Maintenance, servicing and testing

Refrigerating systems shall be constructed and equipped with any necessary devices for maintenance, adequate servicing and testing, also see EN 378-4.

4.5 Materials

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

4.6 Compressors

Compressors shall comply with prEN 12693:1996 or EN 60335-2-34.

5 Pressure requirements and pressure vessels

5.1 Pressure requirements

5.1.1 General

All parts of the refrigerant circuit shall be designed and manufactured to remain leakproof and withstand the pressure which can occur during operation, standstill and transportation taking into account the thermal, physical and chemical stresses to be expected.

5.1.2 Maximum allowable pressure (p_s) (also see NOTE 7)

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

a) the ambient temperature;

b) the possible build-up 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;

g) fouling.

However, the minimum value of allowable pressure shall be determined by the minimum specified design temperatures given in table 1 to determine the saturated refrigerant pressure.

Table 1: Specified design temperatures

Ambient condition	≤ 32 °C	≤ 43 °C
High pressure side with air-cooled condenser	55 °C	63 °C
High pressure side with water-cooled or evaporative condenser	43 °C	43 °C
Low pressure side	32 °C	43 °C

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.

NOTE 1: For the high pressure side, the specified temperatures are considered the maximum which 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: The use of specified temperatures does not always result in saturated refrigerant pressure within the system, e.g. a limited charge system or a system working at or above critical temperature.

NOTE 3: The system can be subdivided into several parts (e.g. low and high pressure sides) for each of which there might be a different maximum allowable pressure.

NOTE 4: The pressure at which the system (or part of the system) normally operates will be lower than the maximum allowable pressure.

NOTE 5: Excessive stress can result from gas pulsations.

NOTE 6: For zeotropic blends the design pressure is the pressure at the dew point.

NOTE 7: The Pressure Equipment Directive 97/23/EC identifies the maximum allowable pressure by the symbol "PS".

5.1.3 Component design pressure

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

5.1.4 Pressure relationships to maximum allowable pressure

5.1.4.1 General

Systems and components shall be designed to meet the pressure relationship given in table 2.

Table 2: Relationship between the various pressures and the maximum allowable pressure (p_s)

Design pressure	$\geq 1{,}0 \times p_s$
Strength test pressure	In accordance with existing standards, see note.
Leakage test pressure	$\leq 1{,}0 \times p_s$
Pressure limiting device (with relief device), setting	$\leq 0{,}9 \times p_s$
Pressure limiting device (without relief device), setting	$\leq 1{,}0 \times p_s$
Pressure relief device, setting	$1{,}0 \times p_s$
Pressure relief valve, rated discharge at	$\leq 1{,}1 \times p_s$
NOTE: A European standard on "Pressure equipment for refrigerating systems and heat pumps – Part 1: Vessels-General requirements" is in preparation, see informative annex E.	

5.1.4.2 Unit systems and self-contained systems

For unit systems and self-contained systems containing not more than 2,5 kg of group L1 refrigerant, not more than 1,5 kg of group L2 refrigerant or not more than 1,0 kg of group L3 refrigerant, where the low pressure side cannot be isolated from the high pressure side, the test pressure of the whole system may be the maximum allowable pressure of the low pressure side, provided the components of the high pressure side have been pre-tested (see 9.3 and EN 12263).

5.2 Pressure vessels

5.2.1 General

Pressure vessels shall comply with relevant European standards.

NOTE: The technical requirements for pressure equipment as defined in Directive 97/23/EC are listed in the European standard on "Pressure equipment for refrigerating systems and heat pumps – Part 1: Vessels – General requirements" which is in preparation, see informative annex E.

5.2.2 Supports

Supports and bases for pressure vessels shall be so designed and arranged as to be capable of withstanding the static and dynamic forces that occur.

NOTE: Such forces may stem from the mass of the vessels, the mass of the contents and equipment, snow load, wind load, the mass of stays, braces and interconnecting piping and the thermal movement of the piping and components.

6 Piping

6.1 General

6.1.1 Refrigerant circuit

All piping of the refrigerant circuit shall comply with appropriate existing standards and be designed, manufactured and installed to remain leak-tight and to withstand the pressures and temperatures which can occur during operation, standstill and transportation taking into account the thermal, physical and chemical stresses to be expected. The material, wall thickness, tensile strength, ductility, corrosion resistance, forming and testing methods shall be suitable for the refrigerant used and withstand the pressures and stresses which may occur.

NOTE: European standards are in preparation.

6.1.2 Liquid hammer in systems

Piping in refrigerating systems shall be so designed and installed that liquid hammer (hydraulic shock) cannot damage the system.

6.1.3 Protection devices, piping and fittings

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

6.1.4 Long runs

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

6.1.5 Flexible pipe elements

Flexible pipe elements shall comply with EN 1736. They shall be protected against mechanical damage, torsional and other stresses.

NOTE: They should be checked regularly.

6.1.6 Misuse

Consideration shall be given to the misuse of piping as a means of access, e.g. climbing, storage etc.

6.2 Piping joints

6.2.1 General

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

Pipes with varying diameters shall only be connected using factory made diameter reducing couplings.

Snap-on or push-on connections shall only be used for connection of the parts of self-contained systems.

NOTE 1: Non-detachable joints are preferred to detachable joints.

NOTE 2: Flanged joints are preferred to flared, screwed or compression type joints, particularly where vibration is expected.

NOTE 3: Snap-on or push-on connections are not recommended.

NOTE 4: It is recommended that in insulated piping the positions of detachable joints are permanently marked.

6.2.2 Non-detachable joints

6.2.2.1 General

For non-detachable joints soldering, welding or brazing shall be used.

During any welding or brazing, impurity caused by oxide formation shall be avoided, for example by using inert gas, or removed.

NOTE: Other non-detachable joints can be used considering that their suitability has been proved.

6.2.2.2 Soldering

Soft soldering shall not be used for piping joints, the assembly of piping and where fittings are to be incorporated in the piping.

NOTE: For such situations brazing or welding is preferable.

6.2.2.3 Welding

Welding shall comply with the appropriate European standards. When selecting the welding process, operating temperatures, materials to be jointed and composition of filler metal shall be considered.

Fittings for butt welding shall be compatible with the piping material.

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.

Welders shall be in possession of a valid approval certificate for the work in accordance with EN 287-1.

6.2.2.4 Brazing

The compatibility of all materials including filler and flux with the refrigerant shall be thoroughly established by investigation. The possibility of corrosion shall be taken into account.

Brazing shall not be used for ammonia piping, unless the material has been proved to be compatible.

Brazing shall only be carried out by persons competent in this field.

NOTE: Other non-detachable joints can be used considering that their suitability has been proved.

6.2.3 Detachable joints

6.2.3.1 Flanged joints

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

NOTE 1: It is preferable to use standardized flanges for steel piping and standardized loose flanges with upturned welding neck for copper piping.

NOTE 2: The joints should 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 should be taken not to overstress bolts due to cold operation by applying a defined prestress.

6.2.3.2 Flared joints

Flared joints shall not be used for connection to expansion valves.

Flared joints shall be avoided where reasonably practicable.

Flared fittings shall be restricted to use with annealed pipe only, to pipe sizes not exceeding a diameter of 19 mm outside diameter and shall not be used for copper and aluminium pipe of less than 9 mm outside diameter.

NOTE 1: 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. It is essential that thread and sliding surfaces are lubricated before they are jointed. Care should be taken not to flare piping which has been work hardened.

NOTE 2: Screwed compression fittings are a preferred alternative to flared joints.

6.2.3.3 Taper pipe threads

Taper pipe threads shall only be used for connecting control and indicating devices to components. Taper pipe fittings shall be of solid and proven construction.

Unproven packing material shall not be used for sealing threads.

6.2.3.4 Screwed compression fittings

Screwed fittings with joints shall be restricted to:

a) liquid lines: 32 mm maximum inside diameter;

b) vapour lines: 40 mm maximum inside diameter.

Screwed compression joints with a deformable metallic ring shall be restricted to 88 mm outside diameter pipe.

6.3 Layout of piping

6.3.1 General

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.

Piping shall be suitably supported according to its size and service weight. The recommended maximum spacing for pipe supports is shown in tables 3 and 4.

Table 3: Recommended maximum spacing for supports for copper pipe

Outside diameter mm	Spacing m
15 to 22 soft	1
22 to < 54 half hard	2
54 to 67 half hard	3

Table 4: Recommended maximum spacing for supports for steel pipe

Nominal bore DN	Spacing m
15 to 25	1
32 to 50	3
65 to 80	3,5
100 to 175	4
200 to 350	6
400 to 450	7,5

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

6.3.2 Liquid hammer in systems

Piping in refrigerating systems shall be so designed and installed that liquid hammer (hydraulic shock) cannot damage the system.

NOTE: Liquid hammer due to a sudden deceleration of liquid refrigerants in piping with subsequent shock wave can be prevented by e.g.:

a) mounting the solenoid valve as close as possible to the expansion valve;

b) mounting the solenoid valve in hot gas piping for defrosting as close as possible to the evaporator;

c) prefilling the piping through a by-pass line to the solenoid valve;

d) installing a slower operating valve.

6.3.3 Location

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

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

6.3.4 Corrosion protection

Steel pipes and components shall be protected against corrosion with a rustproof coating, especially before applying any insulation.

NOTE: Corrosion protection can comply with the appropriate existing standard.

6.4 Routing

6.4.1 General

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

a) there shall be no hazard for persons i. e. free passage in escape and access routes shall not be restricted, no detachable joints and valves shall be located in areas accessible to unauthorized persons where group L2 or L3 refrigerants are used;

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

c) pipe runs shall be designed to be as practicable as possible to minimize refrigerant charge and pressure losses.