SLOVENSKI STANDARD
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Hladilni sistemi in toplotne ļ rpalke ï Varnostnotehniļ ne in okoljevarstvene zahteve ï 1. del: Osnovne zahteve, definicije, razvrstitve in kriteriji za izbiro

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

Kälteanlagen und Wärmepumpen - Sicherheitstechnische und umweltrelevante Anforderungen - Teil 1: Grundlegende Anforderungen, Definitionen, Klassifikationen und Auswahlkriterien

Systemes de réfrigération et pompes a chaleur - Exigences de sécurité et d'environnement - Partie 1: Exigences de base, définitions, classification et criteres de choix

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ICS:

27.080	Toplotne ļ rpalke	Heat pumps
27.200	Hladilna tehnologija	Refrigerating technology

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

Systèmes de réfrigération et pompes à chaleur - Exigences de sécurité et d'environnement - Partie 1 : Exigences de base, définitions, classification et critères de choix

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This European Standard was approved by CEN on 11 November 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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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 supersedes EN 378:1994.

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 December 2000, and conflicting national standards shall be withdrawn at the latest by December 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.

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 378-1:1999 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, B, C, D, E, F, G and ZA of this European Standard are informative.

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

Introduction

This European Standard relates to safety and environmental requirements in the design, construction, manufacture, installation, operation, maintenance and disposal of refrigerating systems and appliances in respect to the local and global environments, but not to the final destruction of the refrigerants.

The term "refrigerating system" used in this standard includes heat pumps.

It is intended to minimize possible hazards to persons, property and the environment from refrigerating systems and refrigerants. These hazards are associated essentially with the physical and chemical characteristics of refrigerants as well as the pressures and temperatures occurring in refrigeration cycles.

Inadequate precautions may result in:

– rupture of a part or even an explosion, with risk from projected materials;

– escape of refrigerant due to a fracture, a leakage caused by bad design, incorrect operation, and inadequate maintenance, repair, charging or disposal;

– burning or explosion of escaping refrigerant with consequent risk of fire.

Refrigerants, their mixtures and combinations with oils, water or other materials, which are present in the refrigerating system, intended or unintended, affect the internal surrounding materials chemically and physically for example due to pressure and temperature. They can, if they have detrimental properties, endanger persons, property and the environment directly or indirectly due to global longterm effects (ODP,GWP) when escaping from the refrigerating system. The specifications of such refrigerants, mixtures and combinations are given in other standards and are not included in this standard.

Hazards due to the states of pressure and temperature in refrigerating systems are essentially due to the simultaneous presence of the liquid and vapour phases. Furthermore, the state of the refrigerant and the stresses that it exerts on the various components do not depend solely on the processes and functions inside the plant, but also from external causes.

The following hazards are worthy of note:

a) from the direct effect of low temperature, for example:

- brittleness of materials at low temperatures;
- freezing of enclosed liquid (water, brine or similar);
- thermal stresses;
- changes of volume due to temperature changes;
- injurious effects to persons caused by low temperatures;

b) from excessive pressure due to, for example:

- increase in the pressure of condensation, caused by inadequate cooling or the partial pressure of noncondensable gases or an accumulation of oil or liquid refrigerant;
- increase in the pressure of saturated vapour due to excessive external heating, for example of a liquid cooler, or when defrosting an air cooler or high ambient temperature when the plant is at a standstill;
- expansion of liquid refrigerant in a closed space without the presence of vapour, caused by a rise in external temperature;
- fire;

c) from the direct effect of the liquid phase, for example:

– excessive charge or flooding of equipment;
– presence of liquid in compressors, caused by syphoning, or condensation in the compressor;
– liquid hammer in piping;
– loss of lubrication due to emulsification of oil;

d) from the escape of refrigerants, for example:

– fire;
– explosion;
– toxicity;
– caustic effects;
– freezing of skin;
– asphyxiation;
– panic;
– depletion of the ozone layer;
– global warming;

e) from the moving parts of machinery, for example:

– injuries;
– hearing loss from excessive noise;
– damage due to vibration.

Attention is drawn to hazards common to all compression systems, such as excessive temperature at discharge, liquid slugging, erroneous operation or reduction in mechanical strength caused by corrosion, erosion, thermal stress, liquid hammer or vibration.

Corrosion, however, should have special consideration as conditions peculiar to refrigerating systems arise due to alternate frosting and defrosting or the covering of equipment by insulation.

The above analysis of the hazards applying to refrigerating systems explains the plan on which this European Standard has been based.

1 Scope

1.1 This European Standard specifies the requirements relating to safety of persons and property, but not goods in storage, and the local and global environment for:

a) stationary and mobile refrigerating systems of all sizes, including heat pumps;

b) secondary cooling or heating systems; and

c) the location of these refrigerating systems.

1.2 For refrigerating systems with a limited mass of refrigerant only some of the parts and clauses are applicable. The exceptions are defined in the scope and the clauses of each Part of EN 378.

1.3 This European Standard is not applicable to refrigerating systems with air or water as refrigerant.

1.4 This European Standard covers the hazards mentioned in the introduction.

1.5 This European Standard is applicable to new refrigerating systems. The part dealing with maintenance, repair, operation, recovery, reuse and disposal also applies to existing systems. Parties responsible for existing refrigerating systems should consider the safety and environmental aspects of this European Standard and implement the more stringent requirements so far as they are reasonably practicable.

The extent to which hazards are covered is indicated in the introduction. In addition, machinery should comply as appropriate with EN 292-1 and EN 292-2 for hazards which are not covered by this standard.

NOTE Directive 94/9/EC concerning equipment and protective systems intended for use in potentially explosive atmospheres can be applicable to the type of machine or equipment covered by this European standard. The present standard is not intended to provide means of complying with the essential health and safety requirements of Directive 94/4/EC.

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 292-1
Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology

EN 292-2
Safety of machinery – Basic concepts, general prinicples for design – Part 2: Technical principles and specifications

EN 294
Safety of machinery – Safety distances to prevent danger zones being reached by the upper limbs

3 Definitions

For the purposes of this European Standard the following definitions apply:

NOTE: See informative annex A for equivalent terms in English, French and German.

3.1 Refrigerating systems

3.1.1 refrigerating system [heat pump]: Combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which the refrigerant is circulated for the purpose of extracting and rejecting heat (i.e. cooling, heating).

3.1.2 self-contained system: Complete factory-made refrigerating system in a suitable frame and/or enclosure, that is fabricated and transported in one or more sections and in which no refrigerant containing parts are connected on site other than by companion or block valves.

3.1.3 unit system: Self-contained system that has been assembled, filled ready for use and tested prior to its installation and is installed without need for connecting any refrigerant containing parts; a unit system can include factory assembled companion or block valves.

3.1.4 limited charge system: Refrigerating system in which the internal volume and total refrigerant charge are such that, with the system idle, the allowable pressure will not be exceeded if complete evaporation of the refrigerant charge occurs.

3.1.5 absorption or adsorption system: Refrigerating system in which refrigeration is effected by evaporation of a refrigerant, the vapour then being absorbed or adsorbed by an absorbent or adsorbent medium respectively, from which it is subsequently expelled at a higher partial vapour pressure by heating and then liquefied by cooling.

3.1.6 secondary cooling or heating system: System employing a fluid which transfers heat from the product or spaces to be cooled or heated or from another cooling or heating system to the refrigerating system.

3.1.7 closed system: Refrigerating system in which all refrigerant-containing parts are made tight by flanges, screwed fittings or similar connections.

3.1.8 sealed system: Refrigerating system in which all refrigerant containing parts are made tight by welding, brazing or a similar permanent connection.

3.1.9 high pressure side: Part of a refrigerating system operating at approximately the condenser pressure.

3.1.10 low pressure side: Part of a refrigerating system operating at approximately the evaporator pressure.

3.1.11 mobile system: Refrigerating system which is normally in transit during operation.

NOTE: Mobile systems include the following:

– refrigerating systems in vessels, e.g. refrigerated cargo systems in ships, refrigerating systems in fishing boats, air conditioning on board, refrigerating systems for provisions;

– transport refrigerating systems, e.g. transport of refrigerated cargo by road, train and containers;

– refrigerating systems for air conditioning in vehicles, e.g. cars, lorries, buses, excavators and cranes.

3.2 Occupancies, localities

3.2.1 special machinery room: Room or enclosure specially intended to contain, for reasons connected with safety and environmental protection, components of the refrigerating system not accessible to the public but not including rooms or enclosures containing only evaporators, condensers or piping.

3.2.2 human occupied space: Complete space which is occupied for a significant period by humans. Where the spaces around the apparent human occupied space are, by construction or design, not air tight, these are considered as part of the human occupied space, e.g. false ceiling voids, crawl ways, ducts, movable partitions and doors with transfer grilles.

3.2.3 air lock: Isolating chamber provided with separate entrance and exit doors allowing passage from one place to another whilst isolating one from the other.

3.2.4 lobby: Entrance hall or large hallway serving as a waiting room.

3.2.5 hallway: Corridor for the passage of people.

3.2.6 exit: Opening in the outer wall, with or without a door or gate.

3.2.7 exit passageway: Passageway immediately in the vicinity of the door through which people leave the building.

3.2.8 cold room: Room or cabinet, maintained by a refrigerating system at a temperature lower than ambient temperature.

3.2.9 direct communication: Communication where the partition wall between rooms contains an opening which can optionally be shut by a door, window or hatch.

3.2.10 open air: Any unenclosed space, which may be roofed.

3.3 Pressures

3.3.1 gauge pressure: Pressure for which the value is equal to the algebraic difference between the absolute pressure and atmospheric pressure [see EN 764].

NOTE: All pressures are gauge pressures, unless otherwise indicated.

3.3.2 maximum allowable pressure: Maximum pressure for which the equipment is designed, as specified by the manufacturer.

NOTE 1: Limit to the operating pressure which should not be exceeded either when the system is working or not, see EN 764.

NOTE 2: The Pressure Equipment Directive 97/23/EC identifies the maximum allowable pressure by the symbol "PS".

3.3.3 design pressure: Pressure chosen for the derivation of the calculation pressure of each component, see EN 764.

NOTE: It is used for determining the necessary materials, thickness and construction for components with regard to their ability to withstand pressure.

3.3.4 strength test pressure: Pressure that is applied to test the strength of a refrigerating system or any part of it.

3.3.5 leakage test pressure: Pressure that is applied to test a system or any part of it for pressure tightness.

3.3.6 maximum declared pressure: Pressure declared by the manufacturer of the component or device to which it may be subjected without reducing its performance.

3.3.7 ultimate strength of a system: Pressure at which a part of the system ruptures or bursts.

3.4 Components of refrigerating systems

3.4.1 refrigerating installation: Assembly of components of a refrigerating system and all the apparatus necessary for its operation.

3.4.2 refrigerating equipment: Components forming a part of the refrigerating system, e.g. compressor, condenser, generator, absorber, adsorber, liquid receiver, evaporator, surge drum.

3.4.3 compressor: Device for mechanically increasing the pressure of a refrigerant vapour.

3.4.4 motorcompressor: Fixed combination of electrical motor and compressor in one unit.

3.4.4.1 hermetic motorcompressor: Combination consisting of a compressor and electrical motor, both of which are enclosed in the same housing, with no external shaft or shaft seals, the electrical motor operating in a mixture of oil and refrigerant vapour.

3.4.4.2 semihermetic (accessible hermetic) motorcompressor: Combination consisting of a compressor and electrical motor, both of which are enclosed in the same housing, having removable covers for access, but having no external shaft or shaft seals, the electrical motor operating in a mixture of oil and refrigerant vapour.

3.4.4.3 canned rotor motorcompressor: Motorcompressor within a sealed housing not enclosing the motor windings and having no external shaft.

3.4.5 open compressor: Compressor having a drive shaft penetrating the refrigerant-tight housing.

3.4.6 positive displacement compressor: Compressor in which compression is obtained by changing the internal volume of the compression chamber.

3.4.7 non-positive displacement compressor: Compressor in which compression is obtained without changing the internal volume of the compression chamber.

3.4.8 pressure vessel: Any refrigerant-containing part of a refrigerating system other than:

– compressors;

– pumps;

– component parts of sealed absorption systems;

– evaporators, each separate section of which does not exceed 15 l of refrigerant containing volume;

– coils and grids;

– piping and its valves, joints and fittings;

– control devices;

– headers and other components having an internal diameter of not greater than 152 mm and an internal net volume of not greater than 100 l.

3.4.9 condenser: Heat exchanger in which vaporized refrigerant is liquified by removal of heat.

3.4.10 liquid receiver: Vessel permanently connected to a system by inlet and outlet pipes for accumulation of liquid refrigerant.

3.4.11 evaporator: Heat exchanger in which liquid refrigerant is vaporized by absorbing heat from the substance to be cooled.

3.4.12 coil: Part of the refrigerating system constructed from bent or straight pipes or tubes suitably connected and serving as a heat exchanger (evaporator or condenser).

3.4.13 grid: Part of the refrigerating system constructed from bent or straight pipes or tubes suitably connected and serving as a heat exchanger (evaporator or condenser).

3.4.14 compressor unit: Combination of one or more compressors and the regularly furnished accessories.

3.4.15 condensing unit: Combination of one or more compressors, condensers or liquid receivers (when required) and the regularly furnished accessories.

3.4.16 evaporating unit: Combination of one or more compressors, evaporators, liquid receivers (when required) and the regularly fumished accessories.

3.4.17 surge drum: Vessels containing refrigerant at low pressure and temperature and connected by liquid feed and vapour return pipes to (an) evaporator(s).

3.4.18 internal gross volume: Volume calculated from the internal dimensions of a vessel, no account being taken of the volume of any internal parts.

3.4.19 internal net volume: Volume calculated from the internal dimensions of a vessel, after the subtraction of the volume of the intemal parts.

3.5 Piping, joints and fittings

3.5.1 piping: Pipes or tubes (including any hose, bellows or flexible pipe) for interconnecting the various parts of a refrigerating system.

3.5.2 joint: Connection made between two parts.

3.5.3 welded joint: Joint obtained by the joining of metal parts in the plastic or molten state.

3.5.4 brazed joint: Joint obtained by the joining of metal parts with alloys which melt at temperatures in general higher than 450 °C but less than the melting temperatures of the joined parts.

3.5.5 soldered joint: Joint obtained by the joining of metal parts with metallic mixtures or alloys which melt at temperatures in general from 200 °C to 450 °C.

3.5.6 flanged joint: Joint made by bolting together a pair of flanged ends.

3.5.7 flared joint: Metal-to-metal compression joint in which a conical spread is made on the end of the tube.

3.5.8 screwed joint: Threaded pipe joint not requiring any sealing material e.g. compression joint with deformable metal ring.

3.5.9 taper pipe thread end: Threaded pipe joint requiring filler materials in order to block the spiral leakage path.

3.5.10 header: Pipe or tube component of a refrigerating system to which several other pipes or tubes are connected.

3.5.11 shut-off device: Device to shut off the flow of the fluid, e. g. refrigerant, brine.

3.5.12 companion [block] valves: Pairs of mating stop valves, isolating sections of systems and arranged so that these sections may be joined before opening these valves or separated after closing them.

3.5.13 quick closing valve: Shut-off device which closes automatically (e.g. by weight, spring force, quick closing ball) or has a very small closing angle.

3.6 Safety accessories

3.6.1 pressure relief device: Pressure relief valve or bursting disc device designed to relieve excessive pressure automatically.

3.6.2 pressure relief valve: Pressure actuated valve held shut by a spring or other means and designed to relieve excessive pressure automatically by starting to open at a pressure not exceeding the allowable pressure and reclosing after the pressure has fallen below the allowable pressure.

3.6.3 bursting disc: Disc or foil which bursts at a predetermined differential pressure.

3.6.4 fusible plug: Device containing a material which melts at a predetermined temperature and thereby relieving the pressure.

3.6.5 temperature limiting device: Temperature actuated device that is designed to prevent unsafe temperatures.

3.6.6 safety switching device for limiting the pressure: Pressure actuated device that is designed to stop the operation of the pressure generator.

3.6.6.1 pressure limiter: Device which automatically resets and is called PSH for high pressure protection and PSL for low pressure protection.

3.6.6.2 pressure cut out: Device which is manually reset without the aid of a tool and is called PZH for high pressure protection and PZL for low pressure protection.

3.6.6.3 safety pressure cut out: Device which is manually reset only with the aid of a tool and is called PZHH for high pressure protection and PZLL for low pressure protection.

3.6.7 type tested safety switching device for limiting the pressure: Device which is type tested and designed to fail safe so that in the event of a defect or malfunction of the device the power supply will be interrupted.

3.6.8 changeover device: Valve controlling two safety devices and so arranged that only one can be made inoperative at any one time.

3.6.9 refrigerant detector: Sensing device which responds to a pre-set quantity of refrigerant gas in the environment.

3.7 Fluids

3.7.1 refrigerant: Fluid used for heat transfer in a refrigerating system, which absorbs heat at a low temperature and a low pressure and rejects heat at a higher temperature and a higher pressure usually involving changes of the state of the fluid.

3.7.2 heat-transfer medium: Fluid (e.g. brine, water, air) for the transmission of heat without any change in its state.

3.7.3 toxicity: Ability of a refrigerant to be harmful or lethal due to acute or chronic exposure by contact, inhalation or ingestion.

NOTE: Temporary discomfort that does not impair health is not considered to be harmful.

3.7.4 lower flammability limit: Minimum concentration of refrigerant that is capable of propagating a flame within a homogeneous mixture of refrigerant and air.

3.7.5 fractionation: Change in composition of a refrigerant mixture by e.g. evaporation of the more volatile component(s) or condensation of the less volatile component(s).

3.7.6 sudden major release: Release and vapourization of the majority of the total refrigerant charge in a short time, e.g. under 5 min.

3.7.7 short exposure time: Maximum time that humans can be exposed to a major release of refrigerant e.g. no more than 10 min.

3.7.8 outside air: Air from outside the building.

3.7.9 halocarbon and hydrocarbon:

These are:

CFC: Fully-halogenated (no hydrogen remaining) halocarbon containing chlorine, fluorine and carbon;

HCFC: Halocarbon containing hydrogen, chlorine, fluorine and carbon;

HFC: Halocarbon containing only hydrogen, fluorine and carbon;

PFC: Halocarbon containing only fluorine and carbon;

HC: Hydrocarbon containing only hydrogen and carbon.

3.7.10 recover: Removing refrigerant in any condition from a system and store it in an external container.

3.7.11 recycle: Reducing contaminants in used refrigerants by separating oil, removing noncondensibles and using devices such as filters, driers or filter-driers to reduce moisture, acidity and particulate matter.

3.7.12 reclaim: Processing used refrigerants to new product specifications.

NOTE: Chemical analysis of the refrigerant determines that appropriate specifications are met. The identification of contaminants and required chemical analysis both are specified in national and international standards for new product specifications.

3.7.13 disposal: Conveying a product to another party, usually for destruction.

3.8 Miscellaneous

3.8.1 competence: Ability to perform satisfactorily the activities within an occupation.

3.8.2 comfort air conditioning: Method of air treatment designed to satisfy the comfort requirements of the occupants.

3.8.3 self-contained breathing apparatus: Breathing apparatus which has a portable supply of compressed air, independent of the ambient atmosphere, where exhaust air passes without recirculation to the ambient atmosphere.

3.8.4 vacuum procedure: Procedure to check the gas tightness of an uncharged system by drawing a vacuum.

4 Basic requirements

4.1 General

4.1.1 Refrigerating systems

Refrigerating systems shall be designed, constructed, installed, operated, maintained and disposed of according to this European Standard.

4.1.2 Refrigerants

Where refrigerants of different groups are used in a refrigerating system the requirements of each individual group shall apply.

4.1.3 Discharge of refrigerants

Deliberate discharge of environmentally harmful refrigerants shall be avoided.

4.1.4 Selection of refrigerants

When selecting a refrigerant the potential influence on global warming and the depletion of ozone in the stratosphere shall be taken into account.

NOTE 1: A way of assessing global warming is using the concept of total equivalent warming impact (TEWI) that combines the direct contribution of refrigerant emissions into the atmosphere with the indirect contribution of the carbon dioxide emissions resulting from the energy required to operate the refrigerating system over its operational life, also see informative annex B.

NOTE 2: Emitted refrigerant can have global impact due to:

- global warming potential (GWP);
- ozone depletion potential (ODP).

4.2 Design, construction, materials

4.2.1 Components under pressure

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

4.2.2 Protection against excessive pressure

In refrigerating systems the pressure during normal operation, standstill and transportation shall not exceed the maximum allowable pressure of any component. Excessive internal pressure from foreseeable causes shall be prevented or relieved with minimum practicable risk for persons, property and the environment, and if a pressure relief device is discharging, the pressure on any component shall not exceed the allowable pressure by more than 10 %.

4.2.3 Indicating and measuring instruments (monitoring)

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

4.2.4 Safeguarding against unauthorized actuation

Control and safety devices which should not be operated by unauthorized persons shall be safeguarded against deliberate or accidental actuation.

4.2.5 Refrigerant charge

Refrigerating systems shall be designed with due care for their local and global environment in such a way that each refrigerant charge is kept as small as reasonably practicable in a system which is as tight as reasonably practicable.

4.2.6 Loss of refrigerant

Refrigerating systems shall be so equipped with devices necessary for testing, servicing, maintenance and recovery of refrigerant and so constructed that even in the case of fire or leakage the loss or refrigerant is minimized.

4.2.7 Liquid slugging in compressors

Refrigerating systems shall be so designed and installed that liquid refrigerant or oil cannot return in excessive quantity to damage the compressor(s).

4.2.8 Liquid hammer in systems

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

4.2.9 Moving parts of machinery

Moving parts of machinery shall be guarded according to EN 292-1, EN 292-2 and EN 294.

4.2.10 Noise

Compressors, fans, valves, equipment and ducts of refrigerating systems shall be so designed and constructed that risks resulting from the emission of airborne noise are reduced to the lowest practical level taking account of technical progress and the availability of means of reducing noise in particular at source.