BRITISH STANDARD

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Refrigerating systems and heat pumps — Safety and environmental requirements

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

ICS 01.040.27; 13.020.01; 27.080; 27.200

British Standards

National foreword

This British Standard is the UK implementation of EN 378-1:2008. It supersedes BS EN 378-1:2000 which is withdrawn.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.

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

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

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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

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

This European Standard was approved by CEN on 13 October 2007.

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 378-1:2008) has been prepared by the CEN 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of an identical text or by endorsement, at the latest by August 2008, and conflicting national standards shall be withdrawn at the latest by August 2008.

This document supersedes EN 378-1:2000.

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, testing, marking and documentation*

— *Part 3: Installation site and personal protection*

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

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

Introduction

This European Standard relates to safety and environmental requirements in the design, manufacture, construction, installation, operation, maintenance, repair 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 European Standard includes heat pumps.

The extent to which hazards are covered is indicated below. In addition, machinery should comply as appropriate with EN ISO 12100-1 and EN ISO 12100-2 for hazards which are not covered by this European Standard.

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:

— component rupture or explosion, with risk of projectiles;

— escape of refrigerant with the risk of environmental damage or toxicity due to a fracture, a leakage caused by bad design, incorrect operation, and inadequate maintenance, repair, charging or disposal;

— burning or combustion of escaping refrigerant with consequent risk of fire including the risk of toxic products of combustion from non-flammable refrigerants.

(ODP,GWP) when escaping from the refrigerating system. Refrigerants shall be selected with due regard to their potential influence on the global environment as well as their possible effects on the local environment. Evaluation of the environmental performance however requires a life cycle approach. With regard to global climate change the **T**otal **E**quivalent **W**arming **I**mpact approach is generally used as the basis (see Annex B). Reference should be made to the EN ISO 14040 series to address other environmental aspects. Many factors influence environmental impacts such as:

— location of the system;

— energy efficiency of the system;

— type of refrigerant;

— service frequency;

— refrigerant leaks;

— sensitivity of charge on efficiency;

— minimisation of heat load;

— control methods.

The cost of the system will have an indirect influence on the environmental performance. Additional investments may be directed towards reducing leaks, increasing energy efficiency or modifying the design in order to use a different refrigerant. Only a life cycle approach is capable of identifying where additional investments will have the most beneficial effects.

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 on external factors.

The following hazards are worthy of note:

a) from the direct effect of extreme 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;
- touchable hot surfaces.

b) from excessive pressure due to, for example:

- increase in the pressure of condensation, caused by inadequate cooling or the partial pressure of non condensable 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 dilution of oil;
- condensation-induced shock.

d) from the escape of refrigerants, for example:

- fire;
- explosion;
- toxicity including products of combustion;
- 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 and 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

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;

c) location of these refrigerating systems.

NOTE 1 For secondary heating or cooling systems charged with any refrigerants listed in Annex E the charge limitations of part 1 (Annex C) apply.

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.

This European Standard is not applicable to refrigerating systems with air or water as refrigerant. Systems using refrigerants other than those listed in Annex E are not covered by this European Standard as long as a safety class is not assigned.

NOTE 2 For the safety classification of refrigerant fluids not included in Annex E, see Annex F.

This European Standard covers the hazards mentioned in the introduction.

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 94/9/EC.

2 Normative references

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

EN 378-2, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation*

3 Terms and definitions

For the purposes of this document, the following terms and 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

NOTE A unit system can include factory assembled companion or block valves.

3.1.4
limit charged 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 achieved 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 without compression and expansion of the fluid

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

NOTE A connection that is tightness tested for a leakage rate of less than 3 g refrigerant per year under a pressure of at least 0,25 × PS and where the mechanical joints are prevented from improper use by the need of a special tool, glue etc.) is considered as a similar permanent connection. This may include valves with seal cap and capped service ports.

3.1.9
high pressure side
part of a refrigerating system operating at approximately the condenser or gascooler 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..

3.1.12
cascade system
two or more independent refrigeration circuits where the condenser of one systems rejects heat directly to the evaporator of another

3.1.13
transcritical cycle
refrigerating cycle whose compressor discharges refrigerant at a condition (pressure) above the critical point

3.1.14
assembly
discrete unit with defined function (e.g. a condensing unit) made up from several components. Assemblies are often connected together on-site to make a complete system

3.1.15
component
individual functional item or sub-assembly of a refrigerating system

NOTE Does not include parts of sub-assemblies e.g. seals, fasteners.

3.2 Occupancies, localities

3.2.1
machinery room (location)
complete enclosed room or space, vented by mechanical ventilation and only accessible to authorised persons, which is intended for the installation of components of the refrigerating system or of the complete refrigerating system. Other equipment may also be installed provided it is compatible with the safety requirements for the refrigerating system

3.2.2
special machinery room (location)
machinery room intended only for the installation of the complete refrigerating system or components of the refrigerating system. It is accessible only to competent personnel for the purposes of maintenance and repair

3.2.3
occupied space (occupancy)
complete enclosed space which is occupied for a significant period by people. Where the spaces around the apparent occupied space are, by construction or design, not adequately tight, these are also considered as part of the occupied space. These can be for example voids above false ceilings, crawl ways, ducts and movable partitions. The occupied space may be accessible to the public (for example supermarket) or only to trained persons (for example cutting up of meat). In an occupied space, both parts of a refrigerating system or the complete refrigerating system may be located/installed

3.2.4
air lock
isolating chamber provided with separate entrance and exit doors allowing passage from one place to another whilst isolating one from the other

3.2.5
lobby
entrance hall or large hallway serving as a waiting room

3.2.6
hallway
corridor for the passage of people

3.2.7
exit
opening in the outer wall, with or without a door or gate

3.2.8
exit passageway
passageway immediately in the vicinity of the exit through which people leave the building

3.2.9
cold room
room or cabinet, maintained by a refrigerating system at a temperature lower than ambient temperature

3.2.10
direct connection
connection between rooms where the dividing wall contains an opening, including those which can optionally be shut by a door, window or hatch

3.2.11
open air
unenclosed space, whether roofed or not

3.2.12
escape duct
duct indicated as an emergency exit

3.2.13
crawl space
space that is in general accessed for maintenance only and where it is not possible to walk or access by walking

3.3 Pressures

3.3.1
gauge pressure
pressure for which the value is equal to the difference between the absolute pressure and atmospheric pressure

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.

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

NOTE 3 The subscript “max” is added to the symbol for maximum values.

3.3.3
design pressure
pressure chosen for the derivation of the calculation pressure of each component

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
tightness test pressure
pressure that is applied to test a system or any part of it for pressure tightness

3.3.6
surge limit
pressure at which the volume flow of a centrifugal compressor becomes unstable

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 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 parts of a refrigerating system other than:

- semihermetic and open type compressors;
- coils (including their headers) consisting of pipes with air as secondary fluid;
- piping and its valves, joints and fittings;
- control devices;
- pressure switches, gauges, liquid indicators;
- safety valves, fusible plugs, bursting discs;
- pumps

NOTE 1 This definition is in aligned to directive 97/23/EC.

NOTE 2 The semihermetic and open type compressors used in refrigerating systems may be subject to the exclusion article 1.3.10 of the directive 97/23/EC of M29/05/1997 by referring to the working party group guidelines WPG 1/11, 1/12 and 2/34.

3.4.9
condenser
heat exchanger in which vaporised refrigerant is liquefied by removal of heat

3.4.10
gas cooler
heat exchanger in a transcritical system in which supercritical refrigerant is cooled by removal of heat

3.4.11
liquid receiver
vessel permanently connected to a system by inlet and outlet pipes for accumulation of liquid refrigerant

3.4.12
accumulator
vessel capable of holding liquid refrigerant and permanently connected between the exit of the evaporator and suction of the compressor

3.4.13
evaporator
heat exchanger in which liquid refrigerant is vaporised by absorbing heat from the substance to be cooled

3.4.14
coil (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)

3.4.15
compressor unit
combination of one or more compressors and the regularly furnished accessories

3.4.16
condensing unit
combination of one or more compressors, condensers, liquid receivers (when required) and the regularly furnished accessories

3.4.17
surge drum
vessel 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, and excluding the volume of the permanent internal parts

3.4.20
type approved component
component for which examination is performed on one or more samples of this component in accordance with a recognised standard for type approval

3.5 Piping and joints

3.5.1
piping
all piping covered in the scope of EN 14276-2 such as pipes or tubes (including hoses, bellows, fittings, or flexible pipes) 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 less than 450 °C

3.5.6
soft soldered joint
joint obtained by joining of metal parts with metallic mixtures or alloys which melt below 200 °C

3.5.7
flanged joint
joint made by bolting together a pair of flanged ends

3.5.8
flared joint
metal-to-metal compression joint in which a conical spread is made on the end of the tube

3.5.9
compression joint
joints which achieve tightness by deforming a compressing ring

3.5.10
pipe thread end
pipe end with straight or tapered threads that achieves tightness with filling material or deformation of thread mount

3.5.11
header
pipe or tube component of a refrigerating system to which several other pipes or tubes are connected

3.5.12
shut-off device
device to shut off the flow of the fluid, e.g. refrigerant, brine

3.5.13
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

3.5.14
quick closing valve
shut-off device which closes automatically (e.g. by weight, spring force, quick closing ball) or has a closing angle of 130° or less

3.5.15
isolating valves
valves which prevent flow in either direction when closed

3.5.16
locked valve
valve sealed or in other ways constrained, so that it can only be operated by competent person

3.5.17
nominal size (DN)
numerical designation of size which is common to all components in a piping system other than components indicated by outside diameters or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions. The nominal size is designated by DN followed by a number

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 set pressure and re-closing after the pressure has fallen below the set 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 relieves the pressure

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

3.6.6
type approved temperature limiter
safety switching device for limiting the temperature which is type approved and designed to fail-safe so that in the event of a defect or malfunction of the device the power supply will be interrupted

3.6.7
safety switching device for limiting the pressure
pressure actuated device that is designed to stop the operation of the pressure generator

3.6.7.1
pressure limiter
device which automatically resets

NOTE It is called PSH for high pressure protection and PSL for low pressure protection.

3.6.7.2
type approved pressure limiter
safety switching device for limiting the pressure that is type approved according to EN 12263 which automatically resets

NOTE It is called PSH for high pressure protection and PSL for low pressure protection.

3.6.7.3
type approved pressure cut out
safety switching device for limiting the pressure that is type approved according to EN 12263 which manually resets without the aid of a tool

NOTE It is called PZH for high pressure protection and PZL for low pressure protection.

3.6.7.4
type approved safety pressure cut out
safety switching device for limiting the pressure that is type approved according to EN 12263 which manually resets only with the aid of a tool

NOTE It is called PZHH for high pressure protection and PZLL for low pressure protection.

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 concentration of refrigerant gas in the environment

3.6.10
overflow valve
pressure relief device discharging to a part of the refrigerating system with lower pressure

3.6.11
surge protection device
device which shuts down the compressor after a few surge pulses (e.g. by measuring pressure differences across the compressor or current input to the drive motor)

3.6.12
liquid level cut out
liquid level acutated device designed to prevent unsafe liquid levels

3.6.13
self closing valve
valve that closes automatically e.g. by weight or spring force

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 for the transmission of heat usually without any change in its phase (e.g. brine, water, air) or with a change in its phase at the same pressure (e.g. R744). When fluids listed in Annex E are used they need to comply with all requirements of refrigerants — even if they are used as a heat transfer medium

3.7.3
toxicity
ability of a fluid 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 (LFL)
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
outside air
air from outside the building

3.7.7
halocarbon and hydrocarbon
these are:

— CFC: fully-halogenated halocarbon containing only chlorine, fluorine and carbon;

— HCFC: halocarbon containing hydrogen, chlorine, fluorine and carbon;

— HFC: halocarbon containing only hydrogen, fluorine and carbon;

— PFC: fully fluorinated halocarbon containing only fluorine and carbon;

— HC: hydrocarbon containing only hydrogen and carbon

3.7.8
recover
removing refrigerant in any condition from a system and store it in an external container

3.7.9
recycle
reducing contaminants in used refrigerants by separating oil, removing non-condensables and using devices such as filters, driers or filter-driers to reduce moisture, acidity and particulate matter. The aim of recycling is to reuse the recovered refrigerant

3.7.10
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.

3.7.11
disposal
conveying a product to another party, usually for destruction

3.7.12
bubble point
liquid saturation temperature of a refrigerant at the specified pressure; the temperature at which a liquid refrigerant first begins to boil

NOTE The bubble point of a zeotropic refrigerant blend, at constant pressure, is lower than the dew point.

3.7.13
autoignition temperature of a substance
lowest temperature at or above which a chemical can spontaneously combust in a normal atmosphere without an external source of ignition, such as a flame or spark

3.8 Miscellaneous

3.8.1
competence
ability to perform satisfactorily the activities within an occupation

NOTE Levels of competence are defined in EN 13313.

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

NOTE Evacuation also removes moisture from a system.

3.8.5
factory made
manufactured at a dedicated production location under control of a recognised quality system

4 Classification

4.1 Refrigerating systems

4.1.1 General

Refrigerating systems are classified as described in 4.1.2 and 4.1.3 (see also Table C.1) according to the method of extracting heat from (cooling) or adding heat to (heating) the atmosphere or substance to be treated.

4.1.2 Direct system

The evaporator or condenser of the refrigerating system is in direct contact with the air or the substance to be cooled or heated. Systems in which a secondary coolant is in direct contact with the air or the goods to be cooled or heated (spray or ducted systems) shall be treated as direct systems.

4.1.3 Indirect systems

The evaporator cools or the condenser heats the heat-transfer medium which passes through a closed circuit containing heat exchangers that are in direct contact with the substance to be treated.

NOTE 4.4 is providing practical examples of direct and indirect systems.

4.2 Occupancies

4.2.1 General

Occupancies are classified in respect to the safety of the persons, who may be directly affected in case of abnormal operation of the refrigerating system. Considerations of safety in refrigerating systems take into account the site, the number of people occupying the site and the categories of occupancy. Machinery rooms (see 3.2.1 and 3.2.2) are regarded as unoccupied.

4.2.2 General occupancy — Class A

A location where people may sleep or where the number of people present is not controlled or to which any person has access without being personally acquainted with the personal safety precautions.

EXAMPLES hospitals, prisons, nursing homes, theatres, supermarkets, transport termini, hotels, lecture halls, dwellings, restaurants, ice rinks

4.2.3 Supervised occupancy — Class B

Rooms, parts of buildings or buildings, where only a limited number of people may be assembled, some of them being necessarily acquainted with the general safety precautions.

EXAMPLES laboratories, places for general manufacturing, office buildings

4.2.4 Occupancy with authorised access only — Class C

An occupancy which is not open to the public and where only authorised persons are granted access. Authorised persons shall be acquainted with general safety precautions of the establishment (e.g. industrial production facilities).

EXAMPLES cold stores, refineries, abattoirs, non-public areas in supermarkets, manufacturing facilities e.g. for chemicals, food, ice and ice cream

4.2.5 More than one category of occupancy

Where there is the possibility of more than one category of occupancy, the more stringent requirements apply. If occupancies are isolated, e.g. by sealed partitions, floors and ceilings, then the requirements of the individual category of occupancy apply.

NOTE Attention is drawn to the safety of adjacent premises and occupants in areas adjacent to a refrigerating system. Refrigerants heavier than air can cause oxygen deficient pockets at low level (see molar mass in the informative Annex F).

Table 1 — Category of occupancy

Categories	General characteristics	Examples [a]
General occupancy A	Rooms, parts of buildings, building where — people may sleep; — people are restricted in their movement; — an uncontrolled number of people are present or to which any person has access without being personally acquainted with the necessary safety precautions.	Hospitals, courts or prisons, theatres, supermarkets, schools, lecture halls, public transport termini, hotels, dwellings, restaurants.
Supervised occupancy B	Rooms, parts of buildings, buildings where only a limited number of people may be assembled, some being necessarily acquainted with the general safety precautions of the establishment.	Business or professional offices, laboratories, places for general manufacturing and where people work.
Authorised occupancy C	Rooms, parts of buildings, buildings where only authorized persons have access, who are acquainted with general and special safety precautions of the establishment and where manufacturing, processing or storage of material or products take place.	Manufacturing facilities, e.g. for chemicals, food, beverage, ice, ice-cream, refineries, cold stores, dairies, abattoirs, non-public areas in supermarkets.
[a] The list of examples is not exhaustive.		

4.3 Designation and Classification of refrigerants

Refrigerants are classified according to their flammability and toxicity as defined in Annex F.

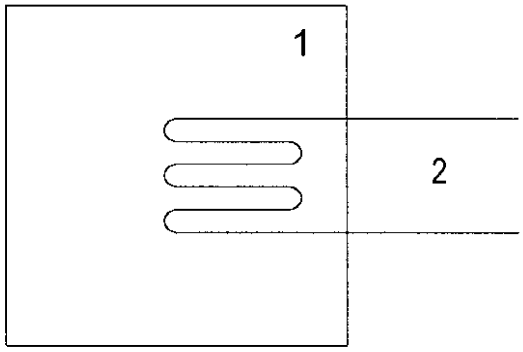
The designations and classifications of refrigerants are listed in Annex E which includes the fluid groups as defined in Directive 97/23/EC (Pressure Equipment Directive).

4.4 Examples of systems

4.4.1 Direct systems

4.4.1.1 Direct system

The refrigerant containing parts are located within the occupied space, into which the refrigerant could enter in the event, of a leak.

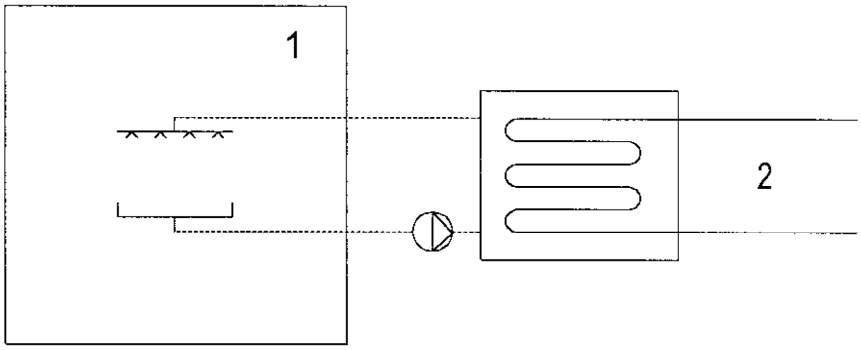


Key
1 occupied space
2 refrigerant containing part(s)

Figure 1 a — Direct system

4.4.1.2 Open spray system

Heat transfer medium in direct contact with refrigerant containing parts, where the indirect circuit is open to the occupied space. A refrigerant leak could enter the occupied space.

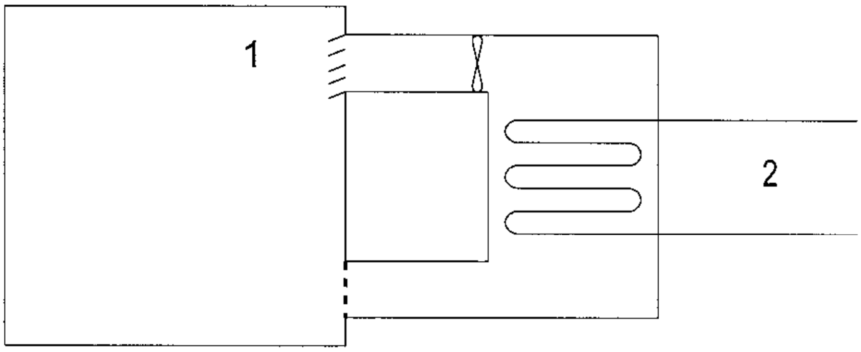


Key
1 occupied space
2 refrigerant containing part(s)

Figure 1 b — Open spray system

4.4.1.3 Direct ducted system

Ducted air in direct contact with refrigerant containing parts, where the conditioned air is supplied to the occupied space. A refrigerant leak could enter the occupied space.

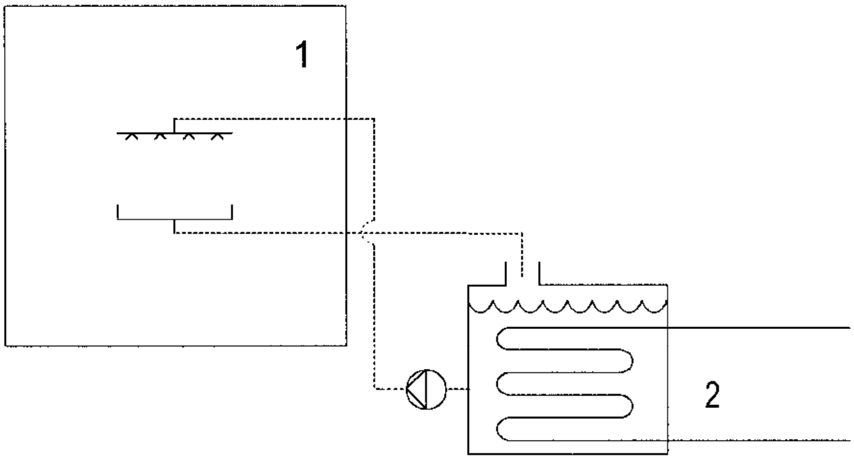


Key
1 occupied space
2 refrigerant containing part(s)

Figure 1 c — Direct ducted system

4.4.1.4 Open vented spray system

Heat transfer medium in direct contact with refrigerant containing parts, where the indirect circuit is open to the occupied space. A refrigerant leak could enter the occupied space.



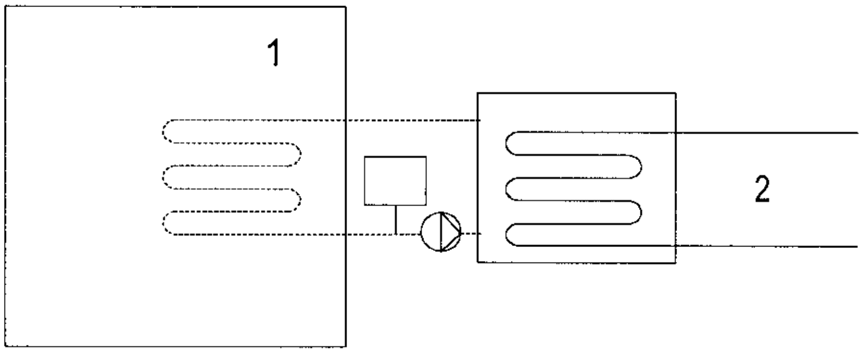
Key
1 occupied space
2 refrigerant containing part(s)

Figure 1 d — Open vented spray system

4.4.2 Indirect systems

4.4.2.1 Indirect closed system

Where a heat transfer medium is in direct communication with refrigerant containing parts, passing into the occupied space. A refrigerant leak into the indirect circuit could leak into the occupied space.

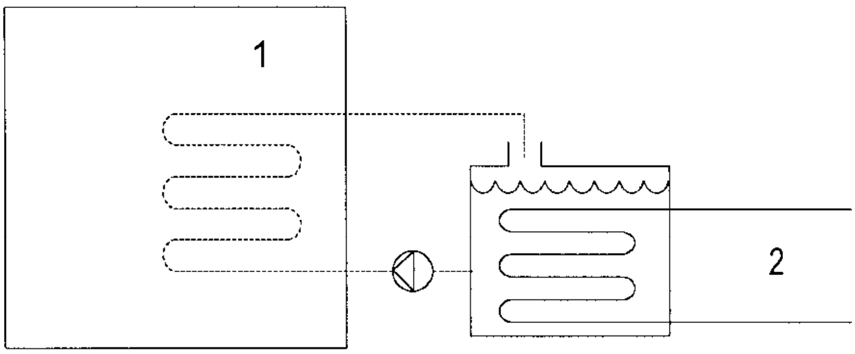


Key
1 occupied space
2 refrigerant containing part(s)

Figure 2 a — Indirect closed system

4.4.2.2 Indirect vented system

Where a heat transfer medium is in direct communication with refrigerant containing parts within a vented, or double-walled heat exchanger. A refrigerant leak will be vented out of the heat exchanger and not into the indirect circuit.

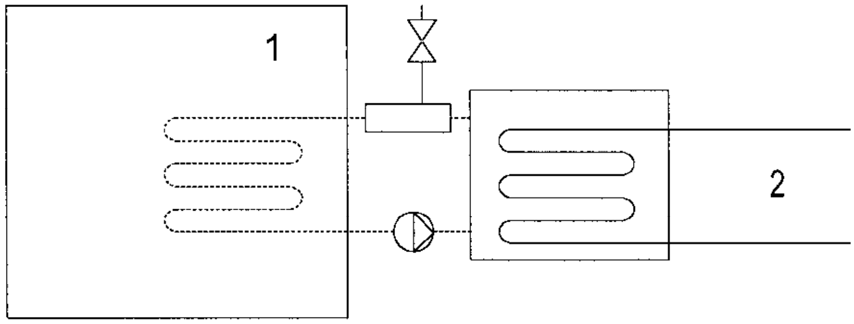


Key
1 occupied space
2 refrigerant containing part(s)

Figure 2 b — Indirect vented system

4.4.2.3 Indirect vented closed system

Where a heat transfer medium is in direct communication with refrigerant containing parts and the indirect circuit contains a refrigerant vent within the circuit. A refrigerant leak will be vented from the circuit.

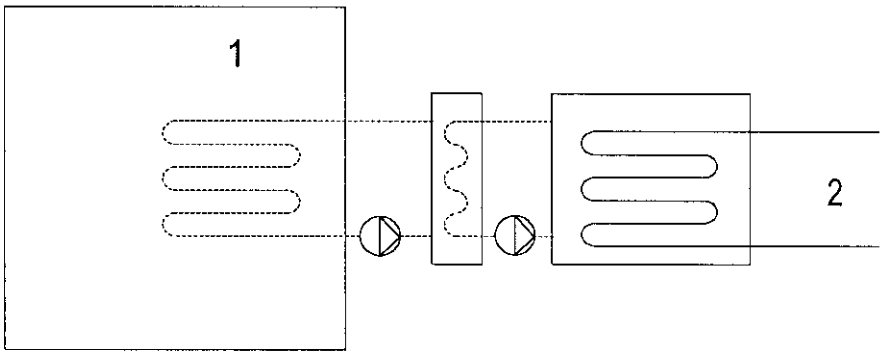


Key
1 occupied space
2 refrigerant containing part(s)

Figure 2 c — Indirect vented closed system

4.4.2.4 Double indirect system

Where a heat transfer medium is in direct communication with refrigerant containing parts and heat is exchanged with a second indirect circuit that passes into the occupied space. A refrigerant leak cannot enter the occupied space.

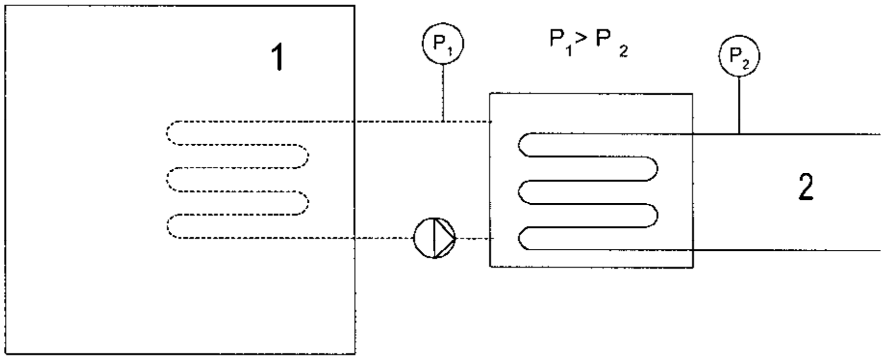


Key
1 occupied space
2 refrigerant containing part(s)

Figure 2 d — Double indirect system

4.4.2.5 High pressure indirect system

Where the heat transfer medium is at a higher pressure than the refrigerant containing parts. The refrigerant cannot leak into the indirect circuit.



Key
1 occupied space
2 refrigerant containing part(s)
P_1 Pressure 1
P_2 Pressure 2

Figure 2 e — High pressure indirect system

4.5 Special requirements for skating rinks

Skating rinks are classified as general occupancy class A. There shall be adequate means of escape in an emergency. For detailed requirements with respect refrigerating systems for ice rinks refer to normative Annex G.

Annex A
(informative)

Equivalent terms in English, French and German

Index of the terms defined in the standard	Répertoire des termes définis dans la norme	Verzeichnis der in der Norm definierten Benennungen	Clause number
absorption or adsorption system	système à absorption ou à adsorption	Absorptions- oder Adsorptions-anlage	3.1.5
accumulator	accumulateur	Speicher	3.4.12
air lock	sas	Luftschleuse	3.2.4
assembly	Assemblage	Baugruppe	3.1.14
autoignition temperature of a substance	température d'inflammation spontanée d'une matière	Selbstentzündungstemperatur	3.7.13
brazed joint	joint brasé fort	Hartlötverbindung	3.5.4
bubble point	point d'ébullition	Siedepunkt	3.7.12
bursting disc	disque de rupture	Berstscheibe	3.6.3
canned rotor motorcompressor	motocompresseur à rotor chemisé	Spaltrohr-Motorverdichter	3.4.4.3
cascade system	système en cascade	Kaskadenanlage	3.1.12
changeover device	inverseur	Wechselventil	3.6.8
closed system	système fermé	geschlossene Anlage	3.1.7
coil (grid)	serpentin	Rohrschlange	3.4.14
cold room	enceinte réfrigérée	Kühlraum	3.2.9
comfort air conditioning	conditionnement de l'air de confort	Behaglichkeitsluft-konditionierung	3.8.2
companion [block] valves	contre-robinets [ou robinets-vannes] de sectionnement	Verbindungs-[Trenn-]armatur	3.5.13
competence	compétence	Sachkunde	3.8.1
component	composant	Bauteil	3.1.15
compressor	compresseur	Verdichter	3.4.3
compressor unit	groupe compresseur	Verdichtersatz	3.4.15
compression joint	joint par compression	Druckverbindung	3.5.9
condenser	condenseur	Verflüssiger	3.4.9
condensing unit	groupe de condensation	Verflüssigungssatz	3.4.16
crawl spaces	vide sanitaire	Hohlraum	3.2.13
design pressure	pression de conception	Konstruktionsdruck	3.3.3
direct communication	communication directe	Direkte Verbindung	3.2.10
disposal	mise à disposition	Entsorgung	3.7.11
escape duct	passage de fuite	Flucht-/Rettungsweg	3.2.12
evaporator	évaporateur	Verdampfer	3.4.13
exit	sortie	Ausgang	3.2.7
exit passageway	passage de sortie	Ausgangskorridor	3.2.8
factory made	fabiqué en usine	fabrikmäßig zusammengebaut	3.8.5
flanged joint	joint à bride	Flanschverbindung	3.5.7
flared joint	joint évasé	Bördelverbindung	3.5.8
fractionation	fractionnement	Fraktionierung	3.7.5

(*continued*)

Index of the terms defined in the standard	Répertoire des termes définis dans la norme	Verzeichnis der in der Norm definierten Benennungen	Clause number
fusible plug	bouchon fusible	Schmelzpropfen	3.6.4
gas cooler	repodisseu de gaz	Gaskühler	3.4.10
gauge pressure	pression effective	Überdruck	3.3.1
hallway	corridor	Durchgang	3.2.6
header	collecteur	Sammel- und Verteilstück	3.5.11
heat pump (refrigerating system)	pompe à chaleur [système de réfrigération]	Wärmepumpe [Kälteanlage]	3.1.1
heat-transfer medium	fluide caloporteur	Wärmeträger	3.7.2
hermetic motorcompressor	motocompresseur hermétique	Hermetischer Motorverdichter	3.4.4.1
high pressure side	côté haute pression	Hochdruckseite	3.1.9
halocarbon and hydrocarbon	hydrocarbure/halocarbure	Kohlenwasserstoff und Halogenkohlenwasserstoff	3.7.7
internal gross volume	volume interne brut	Bruttoinhalt	3.4.18
internal net volume	volume interne net	Nettoinhalt	3.4.1.9
isolating valves	robinet, de sectionnement	Absperrventil	3.5.15
joint	joint	Verbindung	3.5.2
limited charge system	système à charge limitée	Anlage mit begrenzter Füll-menge	3.1.4
liquid receiver	réservoir de liquide	Flüssigkeitssammler	3.4.11
liquid level cut out	limiteur de niveau de liquides	Flüssigkeitsstandsbegrenzer	3.6.12
lobby	hall d'entrée	Vorhalle	3.2.5
locked valve	soupape verrouillée	geschlossenes Ventil	3.5.16
low pressure side	côté basse pression	Niederdruckseite	3.1.10
lower flammability limit	limite inférieure d'inflammabilité	untere Explosionsgrenze	3.7.4
machinery room	salle des machines	Maschinenraum	3.2.1
maximum allowable pressure	pression maximale admissible	max. zulässiger Druck	3.3.2
mobile system	système mobile	Ortsveränderliche Anlage; Kälteanlage	3.1.11
motorcompressor	motocompresseur	Motorverdichter	3.4.4
non-positive displacement compressor	compresseur non volumétrique	Strömungsverdichter	3.4.7
occupied space	espace occupé par des per-sonnes	Personen-Aufenthaltsbereich	3.2.3
open air	air libre	im Freien	3.2.11
open compressor	compresseur ouvert	offener Verdichter	3.4.5
outside air	air extérieur	Außenluft	3.7.6
overflow valve	supape de décharger	Überströmventil	3.6.10

(*continued*)

Index of the terms defined in the standard	Répertoiredes termes définis-dans la norme	Verzeichnis der in der Normdefinierten Benennungen	Clause number
piping	tuyauterie	Rohrleitung	3.5.1
pipe thread end	joint fileté conique	Rohrende mit konischem Gewinde	3.5.10
positive displacement compressor	compresseur volumétrique	Verdrängerverdichter	3.4.6
pressure limiter	limiteur de pression	Druckwächter	3.6.7.1
pressure relief device	dispositif de surpression	Druckentlastungseinrichtung	3.6.1
pressure relief valve	soupape de sécurité	Druckentlastungsventil	3.6.2
pressure vessel	réservoir à pression	Druckbehälter	3.4.8
quick closing valve	robinet à fermeture rapide	Schnellschlußventil	3.5.14
reclaim	régénérer	Wiederaufbereitung	3.7.10
recover	récupérer	Rückgewinnung	3.7.8
recycle	recycler	Recycling	3.7.9
refrigerant	fluide frigorigène	Kältemittel	3.7.1
refrigerant detector	détecteur de fluide frigorigène	Kältemitteldetektor	3.6.9
refrigerating equipment	composants frigorifiques	kältetechnische Komponenten	3.4.2
refrigerating installation	installation de réfrigération	kältetechnische Einrichtung	3.4.1
refrigerating system (heat pump)	système de réfrigération [pompe à chaleur]	Kälteanlage [Wärmepumpe]	3.1.1
special machinery room	salle des machines de réfrigération	besonderer Maschinenraum	3.2.2
safety switching device for limiting the pressure	dispositif de sécurité de limitation de la pression	Sicherheitsschalteinrichtung zur Druckbegrenzung	3.6.7
sealed system	système scellé	dauerhaft geschlossene Anlage	3.1.8
secondary cooling or heating system	système secondaire de refroidissement ou de chauffage	indirektes Kühl- oder Heizsystem	3.1.6
self-contained breathing apparatus	appareil respiratoire	unabhängiges Atemschutzgerät (Isoliergerät)	3.8.3
self-contained system	système autonome	Kältesatz	3.1.2
self closing valve	robinet à autofermeture	Selbstschlussventil	3.6.13

(*continued*)

Index of the terms defined in the standard	Répertoiredes termes définis-dans la norme	Verzeichnis der in der Normdefinierten Benennungen	Clause number
semihermetic (accessible hermetic) motor compressor	motocompresseur hermétique accessible	Halbhermetischer Motorverdichter	3.4.4.2
shut-off device	dispositif d'arrêt	Absperreinrichtung	3.5.12
soldered joint	joint brasé tendre	Weichlötverbindung	3.5.5
soft soldered joint	joint brasé	Weichlötnaht	3.5.6
strength test pressure	pression de l'essai de résistance	Festigkeits-Prüfdruck	3.3.4
surge drum	réservoir-tampon	Abscheider	3.4.17
surge protection device	dispositif de limitation des surtensions	Schutzeinrichtung gegen Druckstöße (Druckspitzen)	3.6.11
surge limit	pression de crête	Saugdruck-Grenzwert	3.3.6
temperature limiting device	dispositif de limitation de la température	Temperaturbegrenzungseinrichtung	3.6.5
tightness test pressure	pression de l’essai de d’étanchéité	Dichtheits-Prüfdruck	3.3.5
toxicity	toxicité	Giftigkeit	3.7.3
transcritcle cycle	cycle transcritique	transkritischer Kreislauf	3.1.13
type approved component	ayant subi un essai de type component	baumustergeprüftes Bauteil	3.4.20
type approved temperature limiter	ayant subi un essai de type limiteur de température	baumustergeprüfter Temperaturbegrenzer	3.6.6
type approved pressure limiter	ayant subi un essai de type limiteur de pression	baumustergeprüfter Druckwächter	3.6.7.2
type approved pressure cut out	ayant subi un essai de type pressostat	baumustergeprüfter Druckbegrenzer	3.6.7.3
type approved safety pressure cut out	ayant subi un essai de type pressostat de sécurité	baumustergeprüfter Sicherheitsdruckbegrenzer	3.6.7.4
unit system	système monobloc	Betriebsfertiger Kältesatz	3.1.3
vacuum procedure	tirage au vide	Vakuumverfahren	3.8.4
welded joint	joint soudé	Schweißverbindung	3.5.3

Annex B
(informative)

Total equivalent warming impact (TEWI)

The TEWI (en: total equivalent warming impact) is a way of assessing global warming by combining the direct contribution of refrigerant emissions into the atmosphere with the indirect contribution of the carbon dioxide and other gas emissions resulting from the energy required to operate the refrigerating system over its operational life.

TEWI is designed to calculate the total global warming contribution of the refrigeration process in use. It measures both the direct global warming effect of the refrigerant, if emitted, and the indirect contribution of the energy required to power the unit over its normal operational life. It is only valid for comparing alternative systems or refrigerant options for one application in one location.

For a given system TEWI includes:

— direct global warming effect under certain conditions of refrigerant loss;

— direct global warming effect of greenhouse gases emitted from insulation or other components, if applicable;

— indirect global warming effect from the CO_2 and other gases emitted during generation of the power to run the system and to cover the power losses between energy producer and energy consumer.

It is possible to identify the most effective means to reduce the actual global warming impact of a refrigerating system by using TEWI. The main options are:

— minimise refrigerant load requirements;

— design/selection of the most suitable refrigerating system and refrigerant — to meet the demand of a specific cooling application;

— optimisation of the system for best energy efficiency (the best combination and arrangement of components and system use to reduce energy consumption);

— proper maintenance to sustain optimum energy performance and to avoid refrigerant leaks (e.g. all systems will be further improved with correct maintenance and operation);

— recovery and recycling/reclaim of used refrigerant;

— recovery and recycling/reclaim of used insulation.

NOTE 1 Energy efficiency is therefore usually a more significant target for reducing global warming than reduction of system charge. In many cases a more efficient refrigerating system with a refrigerant charge which has a higher GWP potential may be better for the environment than a less efficient refrigerating system with a lower GWP potential refrigerant charge. All the more so if emissions are minimised: no leaks mean no direct global warming.

TEWI is calculated relative to a particular refrigerating system and not only to the refrigerant itself. It varies from one system to another and depends on assumptions made relative to important factors like operating time, service life, conversion factor and efficiency. For a given system or application, the most effective use of TEWI is made by determining the relative importance of the direct and indirect effects.

For instance, where the refrigerating system is only an element of a larger system, such as in a secondary circuit/system (e.g. central station air conditioning) then the total energy consumption in use (including the standing and distribution losses of the air conditioning system) has to be taken into account in arriving at a satisfactory comparison of the total equivalent warming impact.

The TEWI factor can be calculated by the following equation where the various areas of impact are correspondingly separated.

$$\text{TEWI} = \text{GWP} \times L \times n + [\text{GWP} \times m \times (1-\alpha_{\text{recovery}})] + n \times E_{\text{annual}} \times \beta$$

where

$\text{GWP} \times L \times n$ is the impact of leakage losses;

$\text{GWP} \times m \times (1-\alpha_{\text{recovery}})$ is the impact of recovery losses;

$n \times E_{\text{annual}} \times \beta$ is the impact of energy consumption.

where

TEWI is the total equivalent warming impact, in kilogrammes of CO_2;

GWP is the global warming potential, CO_2-related;

L is the leakage, in kilogrammes per year;

n is the system operating time, in years;

m is the refrigerant charge, in kilogrammes;

α_{recovery} is the recovery/recycling factor, 0 to 1;

E_{annual} is the energy consumption, in kilowatt-hour per year;

β is the CO_2-emission, in kilogrammes per kilowatt-hour.

NOTE 2 The GWP (en: **g**lobal **w**arming **p**otential) is an index describing the radioactive characteristics of well-mixed greenhouse gases, that represents the combined effects of the differing times these gases remain in the atmosphere and their relative effectiveness in adsorbing outgoing infrared radiation. This index approximates the time integrated warming effect of a given greenhouse gas in today's atmosphere, relative to CO_2

NOTE 3 The conversion factor β gives the quantity of CO_2 produced by the generation of 1 kWh. It can vary considerably geographically and in terms of time.

When greenhouse gases may be emitted by insulation or other components in the cooling or heating system the global warming potential of such gases is to be added.:

$$\text{GWP}_i \times m_i (1 - \alpha_i)$$

where

GWP_i is the global warming potential of gas in the insulation, CO_2-related;

m_i is the gas charge in the insulation system, in kilogrammes;

α_i is the rate of gas recovered from the insulation at the end of life, from 0 to 1.

When calculating TEWI it is very important to update GWP CO_2 related and CO_2-emission per kilowatt hour from the latest figures.

Many of the assumptions and factors in this calculation method are usually specific to an application in a particular location.

Comparisons (of results from) between different applications or different locations are therefore unlikely to have much validity.

This calculation is of particular importance at the design stage or when a retrofit decision is to be made.

Annex C
(normative)

Refrigerant charge limitations

C.1 General

There are three types of location for refrigerating systems. The appropriate location shall be selected in accordance with this European Standard which takes account of possible hazards.

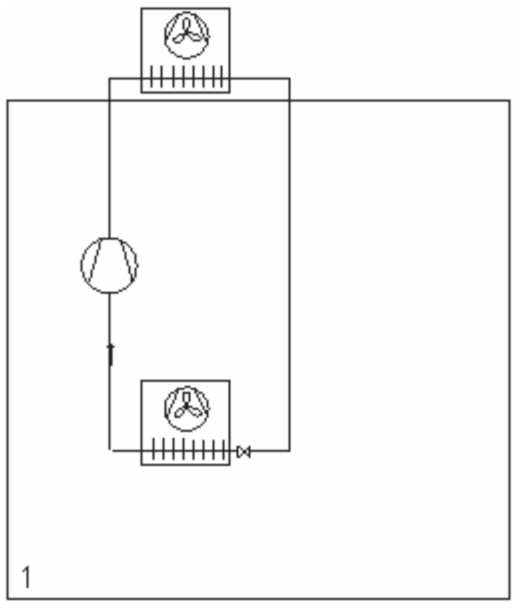
The three types of location are:

a) refrigerating system located in an occupied space;

b) refrigerating system with the compressors, liquid receivers and condensors located in an unoccupied machinery room (see EN 378-3:2008, 5.2) or in the open air;

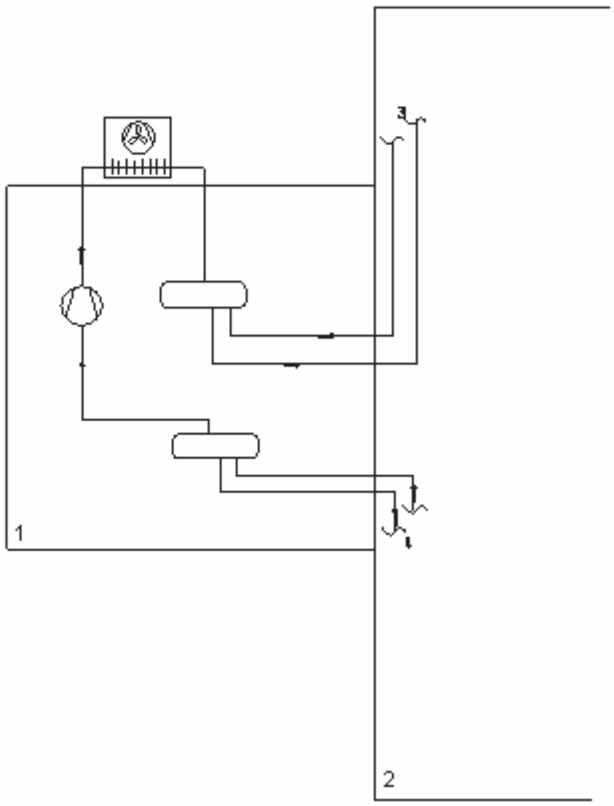
c) refrigerating system with all refrigerant containing parts located in an unoccupied machinery room (see EN 378-3:2008, 5.2) or in the open air.

Figures 1 to 3 provide examples for location types.



Key
1 occupied space

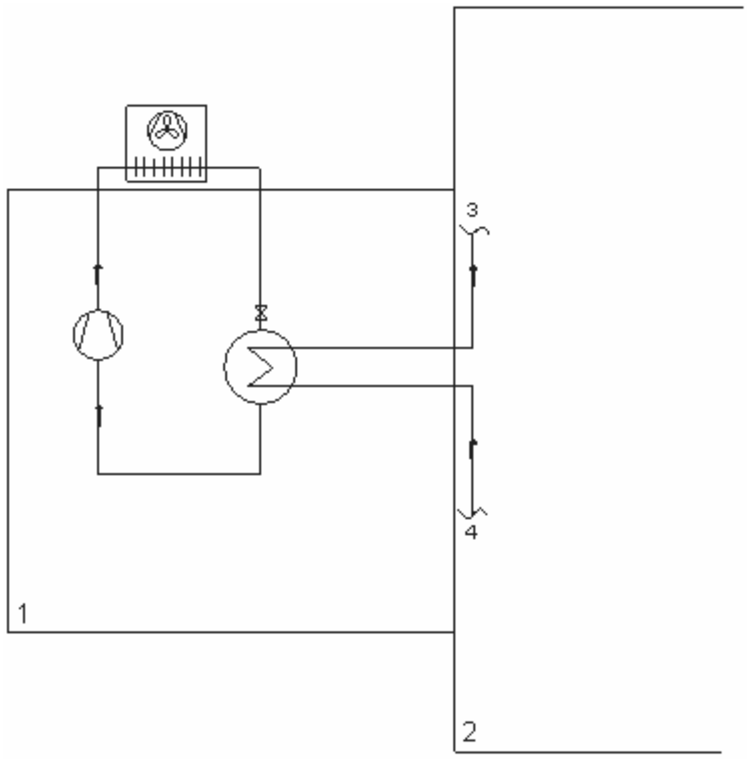
Figure C.1 — System located in an occupied space



Key

1 machinery or special machinery room
2 occupied space
3 liquid lines to evaporators
4 suction lines from evaporators

Figure C.2 — Refrigerating systems with compressors, liquid receivers and condensers located in a machinery room, special machinery room or in the open air



Key

1 machinery or special machinery room
2 occupied space
3 heat transfer fluid supply line
4 heat transfer fluid return line

Figure C.3 — Refrigerating system with all refrigerant containing parts located in a machinery or special machinery room or in the open air

NOTE 1 Some heat pumps/air conditioners operate for either heating or cooling by reversing the flow from the compressor to the heat exchangers by means of a special reversing valve. In these cases the high and low pressure sides of the system can change depending on the mode of the unit.

Refrigerating systems or parts of systems shall not be installed in or on stairways, landings, entrances or exits used by the public, if free passage is thereby limited.

NOTE 2 Table C.1 shows whether combinations are permitted or not. Combinations which are permitted but subject to restrictions are indicated with specific requirements and/or refrigerant charge limits. The charge limit can be an absolute value or calculated from characteristic refrigerant data and room volumes.

NOTE 3 Requirements for B3 refrigerants are not included in Table C.1. Annex E does not list a B3 refrigerant. Experiences and theoretical risk evaluations for the use of B3 refrigerants respectively are insufficient to justify those requirements.

If a secondary system employs a substance that is listed as a refrigerant under Annex E, the charge of that heat transfer fluid shall be calculated by using the requirements for direct systems within Table C.1.

For sealed refrigerating systems using flammable refrigerants (A2, A3, B2, B3), but excluding R717, no sources of ignition shall be associated with parts of the equipment that could come into contact with leaked refrigerant. All potential sources of ignition shall be sealed according to the methods detailed in EN 378-2.

A factory sealed refrigerating system with less than 0,15 kg of A2 or A3 refrigerant can be located in an occupied space which is not a special machinery room without restriction.

C.2 Guidelines on using Table C.1

Table C.1 determines refrigerant charge limitations for a given system. In order to determine the charge limit the system has to be classified according to the four categories:

— safety group of the refrigerant (see Annex E);

— occupancy (see 4.2);

— system category (direct or indirect — see 4.1);

— location of the refrigerating system (see C.1).

Assignment of all categories leads to one distinct box in Table C.1 with a charge limitation and potentially additional requirements. For easier reference these boxes are numbered. Each refrigerant safety group has a separate table segment within Table C.1 resulting in six segments.

Some of the combinations for the different categories appear to be in conflict or unnecessary. One example is: “direct systems with all refrigerant containing parts in a machinery room”. This is however a valid and important combination and would apply for ducted and for open type spray systems where the refrigerant containing parts might be located in an unoccupied machinery room or in the outside but where refrigerant could directly leak into the occupied space.

Indirect systems that are not located in a machinery room are another combination that may seem unnecessary. Residential water to water heat pumps however, clearly fall into this category.

Example 1: Split A/C system

A split Air-conditioner with R410A as refrigerant is to be installed in a bedroom of a private residence (room-size: 16 m², -height: 2,7 m).

The system category is direct (the evaporator is located in the occupied space), the occupancy is category A — General occupancy and the location of the system is type b) — Compressor and liquid receiver in an unoccupied machinery room or in the open air. The resulting requirement is BOX Nr. 3 of the table with refrigerant A1. It requires aligning the charge size to practical limit and room volume. The practical limits for all refrigerants are tabled in Annex E. The max charge size is practical limit (0,44 kg/m³) times room volume (16 m² × 2,7 m) 19,0 kg.

Example 2: Refrigerating system for display cabinets in a petrol station

An R290 system is to be installed in a petrol station to refrigerate display cabinets.

Except for a condenser all refrigerant containing parts are inside the store (55 m² floor size; 3,5m floor height). The refrigerant safety group is category A3, The occupancy is category A — General occupancy and the system type is direct. The location of the refrigerating system is a) human occupied space which is not a machinery room. The system type is direct. The resulting requirement is in box 1 of the table for A3 refrigerants and requires that the maximum charge is to be calculated by practical limit (0,008 kg/m³) times room volume (55 × 3,5) (→ 1,54 kg) and it shall not exceed 1,5 kg. The system has to be a sealed system. The maximum charge is therefore 1,5 kg and the system shall be a sealed system.

Example 3: Refrigerating system for the production of frozen foods

An R717 system is to be installed in a factory that manufactures frozen food.

Condenser, compressor, and receiver of the water cooled system are installed in a special machinery room. The system feeds a series of evaporators in the factory. The refrigerant safety group is B2 and the system is direct. The occupancy is category C — Occupancy with authorised access only and the location of the refrigerating system is type b) — Compressor and liquid receiver in an unoccupied machinery room or in the open air. The resulting requirement is in box 15 of the table segment for B2 refrigerants: If the density of personnel is less than 1 per 10 m² there is no restriction of the charge size. For all other cases the maximum charge is 25 kg.

Table C.1 — Refrigerant safety groups [a]

Refrigerant safety group — A1		
Location of the refrigerating system	**Occupancy** **General occupancy – Class A**	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***1*** Max. charge = practical limit x room volume [b c d]	***2*** Considered as direct system; see box nr ***1***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***3*** Max. charge = practical limit x room volume	***4*** No restriction
All refrigerant containing parts in an unoccupied machinery room or in the open air	***5*** No restriction	***6*** No restriction
	Supervised occupancy — Class B	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***7*** Below ground floor level or on upper floors without adequate emergency exits: treated as general occupancy — Class B; otherwise no restrictions of charge	***8*** Considered as direct system; see box nr. ***7***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***9*** No restriction	***10*** No restriction
All refrigerant containing parts in an unoccupied machinery room or in the open air	***11*** No restriction	***12*** No restriction
	Occupancy with authorised access only — Class C	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***13*** Below ground floor level or on upper floors without adequate emergency exits: treated as general occupancy — Class B; otherwise no restrictions of charge	***14*** Considered as direct system; see box nr. ***13***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***15*** No restriction	***16*** No restriction
All refrigerant containing parts in an unoccupied machinery room or in the open air	***17*** No restriction	***18*** No restriction

Table C.1 (*continued*)

Refrigerant safety group — A2		
Location of the refrigerating system	**Occupancy** **General occupancy — Class A**	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***1*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: max. charge = practical limit x room vol. and not exceeding 38 x LFL	***2*** Considered as direct system; see box nr. ***1***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***3*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: max. charge = practical limit x room vol. and not exceeding 38 x LFL	***4*** A/C systems and heat pumps for human comfort (see C.3) Max charge = practical limit x room vol.
All refrigerant containing parts in an unoccupied machinery room or in the open air	***5*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: max. charge = practical limit x room vol. and not exceeding 132 x LFL .	***6*** No restriction if exit to the open air and no direct communication with rooms for categories A and B
	Supervised occupancy — Class B	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***7*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Max. charge = 10 kg	***8*** Considered as direct system; see box nr. ***7***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***9*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: max. charge = 25 kg	***10*** No Restriction, if machinery room has no direct communication to occupied space
All refrigerant containing parts in an unoccupied machinery room or in the open air	***11*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: no Restriction, if machinery room has no direct communication to occupied space	***12*** No Restriction, if machinery room has no direct communication to occupied space
	Occupancy with authorised access only — Class C	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***13*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: max. charge = 10 kg or 50 kg if density of personel is < 1 per 10m² and sufficient mergency exits are available	***14*** Considered as direct system; see box nr. ***13***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***15*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: max. charge = 25 kg or no Restriction if density of personel is < 1/10 m^2	***16*** No restriction
All refrigerant containing parts in an unoccupied machinery room or in the open air	***17*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: no restriction	***18*** No restriction

Table C.1 (*continued*)

Refrigerant safety group— B1		
Location of the refrigerating system	**Occupancy** **General occupancy — ClassA**	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***1*** Max. charge = practical limit x room vol.	***2*** Considered as direct system; see box nr. ***1***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***3*** Max. charge = practical limit x room vol.	***4*** Max charge = 2,5 kg for sealed absorption systems; all other systems: max charge = practical limit x room vol.
All refrigerant containing parts in an unoccupied machinery room or in the open air	***5*** Max. charge = 2,5 kg	***6*** No restriction if exit to the open air and no direct communication with rooms of categories A and B
	Supervised occupancy — Class B	
	Direct systems	Indirect systems
Not in a machinery room	***7*** Max. charge = 10 kg	***8*** Considered as direct system; see box nr. ***7***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***9*** Max. charge = 25 kg	***10*** No restriction, if machinery room has no direct communication to occupied space
All refrigerant containing parts in an unoccupied machinery room or in the open air	***11*** No restriction, if machinery room has no direct communication to occupied space	***12*** No restriction, if machinery room has no direct communication to occupied space
	Occupancy with authorised access only — Class C	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***13*** Max. charge = 10 kg or 50 kg if density of personnel is < 1/10m² and sufficient emergency exits are available	***14*** Considered as direct system; see box nr. ***13***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***15*** Max. charge = 25 kg or no Restriction if density of personnel is < 1/10 m^2	***16*** No restriction
All refrigerant containing parts in an unoccupied machinery room or in the open air	***17*** No restriction	***18*** No restriction

Table C.1 (*continued*)

Refrigerant safety group— B2		
Location of the refrigerating system	**Occupancy** **General occupancy — Class A**	
	Direct Systems	Indirect Systems
Human occupied space which is not a machinery room	***1*** Max. charge = 2,5 kg for sealed absorption systems; all other systems: max .charge = practical limit x room vol.	***2*** Considered as direct system; see box nr. ***1***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***3*** Max. charge = 2,5 kg for sealed absorption systems; all other systems: max. charge = practical limit x room vol.	***4*** Max. charge = 2,5 kg for sealed absorption systems; all other systems: max charge = practical limit x room vol.
All refrigerant containing parts in an unoccupied machinery room or in the open air	***5*** Max. charge = 2,5 kg	***6*** No restriction if exit to the open air and no direct communication with rooms to categories A and B
	Supervised occupancy — Class B	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***7*** Max. charge = 10 kg	***8*** Considered as direct system; see box nr. ***7***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***9*** Max. charge = 25 kg	***10*** No restriction, if machinery room has no direct communication to occupied space
All refrigerant containing parts in an unoccupied machinery room or in the open air	***11*** No restriction, if machinery room has no direct communication to occupied space	***12*** No restriction, if machinery room has no direct communication to occupied space
	Occupancy with authorised access only — Class C	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***13*** Max. charge = 10 kg or 50 kg if density of personnel is < 1/10m² and sufficient emergency exits are available	***14*** Considered as direct system; see box nr. ***13***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***15*** max charge = 25 kg or No Restriction if density of person nel is < $1/10m^2$	***16*** No restriction
All refrigerant containing parts in an unoccupied machinery room or in the open air	***17*** No restriction	***18*** No restriction

Table C.1 (*continued*)

Refrigerant safety group — A3		
Location of the refrigerating system	**Occupancy** **General occupancy — Class A**	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***1*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Only sealed systems with Max. charge = practical limit x room volume and not exceeding 1,5 kg	***2*** Considered as direct system see box nr. ***1***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***3*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Only sealed systems with Max. charge = practical limit x room volume and not exceeding 1,5 kg;	***4*** AIC Systems and heat pumps for human comfort: see C.3 Max. charge = practical limit x room volume and not exceeding 1,5 kg
All refrigerant containing parts in an unoccupied machinery room or in the open air	***5*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Only sealed systems with max charge = practical limit x room volume and not exceeding 1 kg below or 5 kg above ground floor level	***6*** AIC Systems and heat pumps for human comfort: see C.3 Max. charge = practical limit x room volume and not exceeding 1 kg Below ground floor level or 5 kg above ground floor level
	Supervised occupancy — Class B	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	7 A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Max charge = practical limit x room volume and not exceeding 1 kg Below ground floor level and 2,5 kg above ground floor level	***8*** Considered as direct system; see box nr. ***7***
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***9*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Max charge = practical limit x room volume and not exceeding 1 kg Below ground floor level and 2,5 kg above ground floor level	***10*** AIC Systems and heat pumps for human comfort: see C.3 max charge = practical limit x room volume and not exceeding 1 kg Belowground floor level and 2,5 kg above ground floor level
All refrigerant containing parts in an unoccupied machinery room or in the open air	***11*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Max charge = practical limit x room volume and not exceeding 1 kg below or 10 kg above ground floor level	***12*** AIC Systems and heat pumps for human comfort: see C.3 max Charge = 1 kg Below ground floor or 10 kg above ground floor level
	Occupancy with authorised access only — Class C	
	Direct systems	Indirect systems
Human occupied space which is not a machinery room	***13*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Max charge = 1 kg below ground floor and 10 kg above ground floor level	***14*** Considered as direct system; see box nr. ***13***

Table C.1 (*continued*)

Refrigerant safety group — A3		
Location of the refrigerating system	**Occupancy** **Occupancy with authorised access only — Class C**	
	Direct systems	Indirect systems
Compressor and liquid receiver in an unoccupied machinery room or in the open air	***15*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Max charge = 1 kg below ground floor and 25 kg above ground floor level	***16*** AIC Systems and heat pumps for human comfort: see C.3 max charge = 1 kg Below ground floor and 25 kg above ground floor level
All refrigerant containing parts in an unoccupied machinery room or in the open air	***17*** A/C systems and heat pumps for human comfort (see C.3) All other refrigerating systems: Max charge = 1 kg below ground floor level. No restriction above ground floor level	***18*** AIC Systems and heat pumps for human comfort: see C.3 Max. charge = 1 kg Below ground floor and no restriction above ground floor level

[a] The numbering system in Table C.1 is for convenience and easier reference only. The numbers do not represent references to other parts of this standard.

[b] The total volume of all the rooms cooled or heated by air from one system is used as the volume for calculation, if the air supply to each room cannot be restricted below 25 % of its full supply.

[c] If the space has a mechanical ventilation system which will be operating during the occupation of the space, the effect of the air change may be considered in calculating the volume.

[d] Other methods of ensuring safety in the event of a sudden major release of refrigerant are permitted. Such methods should ensure that the concentrations will not rise above the practical limits given in the normative Annex E or to give adequate warning to occupant(s) in the space of such a rise so that they may avoid excess exposure time. The alternative method should demonstrate a level of safety at least equivalent to the method described in box 1.

NOTE Units throughout Table C.1 are:

charge [kg];

practical limit [kg/m³];

volume [m³];

unless otherwise stated.

C.3 Charge limitations due to flammability for A/C systems or heat pumps for human comfort

C.3.1 General

A factory sealed refrigerating systems with less than 150 g of A2 or A3 refrigerant can be located in an occupied space which is not a machinery or special machinery room without restriction.

C.3.2 Refrigerant containing parts in a occupied space

The maximum charge in a room shall be in accordance with the following:

If the charge size is greater than 4 m³ × LFL the maximum charge in a room shall be in accordance with the following:

$$m_{max} = 2{,}5 \times LFL^{5/4} \times h_0 \times A^{1/2}$$

or the required minimum floor area A_{min} to install a system with refrigerant charge m (kg) shall be in accordance with following;

$$A_{min} = (m/(2{,}5 \times LFL^{5/4} \times h_0))^2$$

where

m_{max} is the allowable maximum charge in a room in kg;

m is the refrigerant charge amount in the system in kg;

A_{min} is the required minimum room area in m^2;

A is the room area in m^2;

LFL is the Lower Flammable Limit (LFL) in kg/m^3;

h_0 is the installation height of the appliance in m:

— 0,6, m for floor location;

— 1,8 m for wall mounted;

— 1,0 m for window mounted;

— 2,2 m for ceiling mounted,

where the LFL is in kg/m^3 from Annex E and the molecular mass of the refrigerant is greater than 42.

EXAMPLE 1:

— A/C system with a charge of 300 g R290.

— $LFL_{R290} = 0{,}038\ kg/m^3$.

The charge size is > 152 g (4 m^3 × LFL), so the minimum room size has to be calculated dependent on the installation location.

Table C.2 — Installation location — Minimum room volume

installation location	installation height [m]	minimum floor area [m²]	minimum room volume (height 2,2 m) [m³]
floor	0,6	142,1	312,6
wall mounted	1,8	15,8	34,7
window mounted	1,0	51,2	112,5
ceiling mounted	2,2	10,6	23,3

EXAMPLE 2:

For a room with 30 m^3 the maximum allowable charge of a window mounted A/C appliance is 230 g R290.

C.3.3 Special requirements for non fixed factory sealed A/C systems or heat pumps with a limited charge

For non fixed factory sealed single package units (i.e. one functional unit in one enclosure) with a charge amount of

$(4\ m^3) \times LFL < m \leq 8\ m^3 \times LFL$,

the maximum charge in a room shall be in accordance with the following:

$m_{max} = 0{,}25 \times A \times LFL \times 2{,}2$

or the required minimum floor area, A_{min} to install an appliance with refrigerant charge m (kg) shall be in accordance with following:

$A_{min} = m/(0{,}25 \times LFL \times 2{,}2)$

where

m_{max} is the allowable maximum charge in kg;

m is the refrigerant charge amount in the appliance in kg;

A_{min} is the required minimum area in m^2;

A is the room area in m^2;

LFL is the Lower Flammable Limit (LFL) in kg/m^3, as referred in Annex E.

NOTE The appliance can be placed at any height above the floor.

When the appliance is switched on, a fan shall operate continuously supplying a minimum airflow as under normal steady state conditions, even when the compressor is switched off by the thermostat.

Compliance is checked by inspection.

C.3.4 Special requirements for mechanically ventilated enclosures in an occupied space

The refrigerating circuit is provided with a separate enclosure that does not communicate with the room. The system enclosure shall have a ventilation system that produces airflow from the system interior to the outside through a ventilation shaft. Systems with mechanically ventilated enclosures can be operated with refrigerants of categories A2 or A3. The maximum charge for those systems shall not exceed:

$m_{max} = 130 \times LFL$,

where

m_{max} is the allowable maximum charge in kg;

LFL is the Lower Flammable Limit (LFL) in kg/m^3, as referred in Annex E.

Annex D
(informative)

Protection for people who are inside cold rooms

D.1 General

In order to minimize the hazard for people who get locked in cold rooms, sometimes along with strong currents of air, measures as described in the following clauses should be taken. Care should be taken to ensure that no personnel are locked in cold rooms at the end of the working day. The annex is limited to cold rooms operating at sub zero level.

D.2 Operation of doors and emergency exit doors

It should be possible to leave a cold room at all times. Therefore it should be possible to open doors both from the inside and the outside.

D.3 Emergency switch or signal

According to the operating conditions, the following devices should be provided in cold rooms with a volume of more than 10 m^3:

a) alarm switch operated by illuminated push buttons near the floor or by chains hanging near the floor, installed in a suitable place in the cold room, the operation of which initiates an audible signal and a visual signal, in a place where the permanent presence of a person is guaranteed. It should not be possible to stop this signal except by means of a specific operation;

b) signal devices connected to an electric circuit with a voltage of at least 12 V. Batteries for this purpose shall have an operating time of at least 10 h and be connected to a mains supplied automatic charging device. If a transformer is used, it should be supplied with current from a different circuit to the one used for other equipment in the cold room. Furthermore, the device should be of such design that it does not cease to function due to corrosion, frost or the formation of ice on contact surfaces;

c) light switch in the cold room in parallel with light switches located outside this room so that the lighting turned on by means of the inside switch cannot be turned off by means of the outside switch;

d) plug switch or other systems giving the same result for the fans located in the cold room in series with the switches located on the outside so that the fans turned off by means of the inside switch cannot be turned on by means of the outside switch;

e) light switches should have permanently illuminated buttons;

f) in the event of failure of the lighting, the routes towards the emergency exit (and/or alarm switch) should be indicated by independent lighting or by other approved means;

g) permanent emergency lighting system.

D.4 Cold rooms with a controlled atmosphere

In cold rooms with a controlled atmosphere (rooms with an atmosphere in which the concentration of oxygen, carbon dioxide and nitrogen are different from those in normal air) the following additional requirements apply:

a) self-contained breathing apparatus should be worn when entering these cold rooms;

b) if a cold room with a controlled atmosphere is entered, another person should remain outside the room and in visual contact with those inside through an inspection port. The person outside should also have a self-contained breathing apparatus at his disposal in case he should have to enter the room in order to rescue the person inside in an emergency;

c) doors, hatches and other appliances giving access to the cold room should be provided with a written warning notice against low oxygen level in the cold room.

Annex E
(normative)

Safety classification and information about refrigerants

Table E.1 — Refrigerant designations

	Refrigerant number	Chemical name [b]	Chemical formula	Safety group [d]	PED fluid group	Practical limit [e] (kg/m^3)	ATEL/ODL [j] (kg/m^3)	Flammability LFL [k] (kg/m^3)	Vapour density 25 °C, 101,3 kPa [a] (kg/m^3)	Molecular mass [a]	Normal boiling point [a] (°C)	ODP [a f]	GWP [a g] (100 yr ITH)	Auto-ignition tempe-rature (°C)
Methane series														
	11	Trichlorofluoromethane	CCl_3F	A1	2	0,3	0,3	—	5,824	137,4	23,8	1	3 800	—
	12	Dichlorodifluoromethane	CCl_2F_2	A1	2	0,5	0,5	—	5,039	120,9	– 29,0	1	8 100	—
	12B1	Bromochlorodifluoromethane	$CBrClF_2$		2	0,2	0,2	—		165,4	– 4,0	3	13 00[h]	—
	13	Chlorotrifluoromethane	$CClF_3$	A1	2	0,5	0,5	—	4,309	104,5	– 81,4	1	14 000[h]	—
	13B1	Bromotrifluoromethane	$CBrF_3$	A1	2	0,6	0,6	—	6,169	148,9	– 58,0	10	5 400	—
	14	Carbon tetrafluoride	CF_4	A1	2	n/a	n/a	—	3,611	88,0	– 128,0	0	6 500	—
	22	Chlorodifluoromethane	$CHClF_2$	A1	2	0,3	0,3	—	3,587	86,5	– 40,8	0,055	1 500	635
	23	Trifluoromethane	CHF_3	A1	2	0,68	0,68	—	2,884	70,0	– 82,1	0	11 700	765
	30	Dichloromethane (methylene chloride)	CH_2Cl_2	B2	2	0,017		0,417		84,9	40,0		9	662
	32	Difluoromethane (methylene fluoride)	CH_2F_2	A2	1	0,061	0,085	0,306	2,153	52,0	– 51,7	0	650	648
	50	Methane	CH_4	A3	1	0,006		0,032	0,657	16,0	– 161,0	0	21	645
Ethane series														
	113	1,1,2-trichloro-1,2,2-trifluoroethane	CCl_2FCClF_2	A1	2	0,4	0,4	—	3,467	187,4	47,6	0,8	4 800	—
	114	1,2-dichloro-1,1,2,2-tetrafluoroethane	$CClF_2CClF_2$	A1	2	0,7	0,7	—	7,207	170,9	3,8	1	9 800[h]	—
	115	Chloropentafluoroethane	$CClF_2CF_3$	A1	2	0,6	0,6	—	6,438	154,5	– 39,0	0,6	7 200[h]	—
	116	Hexafluoroethane	CF_3CF_3	A1	2	0,55	0,55	—	5,696	138,0	– 79,0	0	9 200	—
	123	2,2-dichloro-1,1,1-trifluoroethane	$CHCl_2CF_3$	B1	2	0,1	0,1	—	5,872	153,0	27,9	0,02	90	730
	124	2-chloro-1,1,1,2-tetrafluoroethane	$CHClFCF_3$	A1	2	0,11	0,11	—	5,728	136,5	– 12,1	0,022	470	—
	125	Pentafluoroethane	CHF_2CF_3	A1	2	0,39	0,39	—	4,982	120,0	– 48,1	0	2 800	733
	134a	1,1,1,2-tetrafluoroethane	CH_2FCF_3	A1	2	0,25	0,25	—	4,258	102,0	– 26,2	0	1 300	743
	141b	1,1-dichloro-1-fluoroethane	CH_3CCl_2F	A2	2	0,013	0,013	0,43	3,826	117,0	32,0	0,11	600	532
	142b	1-chloro-1,1-difluoroethane	CH_3CClF_2	A2	1	0,066	0,10	0,329	4,223	100,5	– 10,0	0,065	1 800	750
	143a	1,1,1-trifluoroethane	CH_3CF_3	A2	1	0,056	0,53	0,282	3,495	84,0	– 47,0	0	3 800	750
	152a	1,1-difluoroethane	CH_3CHF_2	A2	1	0,026	0,14	0,13	2,759	66,0	– 25,0	0	140	455
	170	Ethane	CH_3CH_3	A3	1	0,008	0,01	0,038	1,239	30,0	– 89,0	0	3[i]	515
	1150	Ethene (ethylene)	$CH_2{=}CH_2$	A3	1	0,007		0,036	1,153	28,1	– 104,0	0	3[i]	—

Table E.1 (*continued*)

	Refrigerant number	Chemical name [b]	Chemical formula	Safety group [d]	PED fluid group	Practical limit [e] (kg/m³)	ATEL/ODL [j] (kg/m³)	Flammability LFL[k] (kg/m³)	Vapour density 25 °C, 101,3 kPa[a] (kg/m³)	Molecular mass [a]	Normal boiling point [a] (°C)	ODP [a f]	GWP [a g] (100 yr ITH)	Auto-ignition tempe-rature (°C)
Propane series														
	218	Octafluoropropane	$CF_3CF_2CF_3$	A1	2	0,44	0,44	—	7,853	188,0	– 37	0	7000	—
	227ea	1,1,1,2,3,3,3-heptafluoropropane	CF_3CHFCF_3	A1	2	0,49	0,49	—	7,137	170,0	– 15,6	0	2 900	—
	236fa	1,1,1,3,3,3-hexafluoropropane	$CF_3CH_2CF_3$	A1	2	0,59	0,59	—	6,418	152,0	– 1,4	0	6 300	—
	245fa	1,1,1,3,3-pentafluoropropane	$CF_3CH2CHF_2$	B1	2	0,19	0,19	—	5,689	134,0	14,9	0	950[h]	—
	290	Propane	$CH_3CH_2CH_3$	A3	1	0,008	0,09	0,038	1,832	44,0	– 42	0	3[i]	470
	1270	Propene (propylene)	$CH_3CH{=}CH_2$	A3	1	0,008	0,010	0,040	1,745	42,1	– 48	0	3[i]	455
Butane (and higher) series														
	365mfc	1,1,1,3,3-pentafluorobutane	$CF_3CH_2CF_2CH_3$						n.a.	148,0	40,1	0	890[h]	—
	43-10mee	1,1,1,2,2,3,4,5,5,5-decafluoropentane	$CF_3CF_2CHFCHFCF_3$	A1	2			—	n.a.	252,0	54,6	0	1 500[h]	—
Cyclic organic compounds														
	C318	Octafluorocyclobutane	C_4F_8		2	0,81	0,81	—	8,429	200,0	– 6	0	8 700	—
Hydrocarbons														
	600	Butane	$CH_3CH_2CH_2CH_3$	A3	1	0,008 6	0,19	0,043	2,450	58,1	0	0	3[i]	365
	600a	2-methyl propane (isobutane)	$CH(CH_3)_3$	A3	1	0,008 6	0,06	0,043	2,440	58,1	– 12	0	3[i]	460
	601	Pentane	$CH_3CH_2CH_2CH_2CH_3$	A3	1	0,008	N/A	0,041	2,058	72,1	36,1	0	3[i]	—
	601a	2methyl butane (isopentane)	$(CH_3)_2CHCH_2CH_3$	A3	1	0,008	N/A	0,041	2,786	72,1	27,8	0	3[i]	—
Other organic compounds														
	E170	Dimethyl Ether	$(CH_3)_2O$	A3	1	0,013	N/A	0,064	1,914	46	– 24, 8	0		235

Table E.1 (*continued*)

Refrigerant number	Chemical name[b]	Chemical formula	Safety group[d]	PED fluid group	Practical limit[e] (kg/m³)	ATEL/ODL[j] (kg/m³)	Flammability LFL[k] (kg/m³)	Vapour density 25 °C, 101,3 kPa[a] (kg/m³)	Molecular mass[a]	Normal boiling point[a] (°C)	ODP[a f]	GWP[a g] (100 yr ITH)	Auto-ignition tempe-rature (°C)
Inorganic compounds													
717	Ammonia	NH_3	B2	1	0,000 35	0,000 35	0,104	0,704	17,0	– 33	0	0	630
744	Carbon dioxide	CO_2	A1	2	0,1	0,036	—	1,808	44,0	– 78[c]	0	1	—

See Tables E.2 and E.3 for R-400 and R-500 blends.

[a] The vapour density, molecular mass, normal boiling point, ODP and GWP are not part of this standard and are provided for information purposes only.

[b] The preferred chemical name is followed by the popular name in parentheses.

[c] Sublimes. Triple point is -56,6 °C at 5,2 bar absolute.

[d] See Annex F. Unclassified refrigerants indicate either insufficient data to classify or no formal request for classification.

[e] See Annex F.

[f] Adopted under the Montreal Protocol.

[g] IPCC , Second Assessment Report (adopted in Kyoto Protocol).

[h] IPCC, Third Assessment Report 2001.

[i] 1998 Ozone Assessment Report.

[j] Acute-Toxicity Exposure Limit or Oxygen Deprivation Limit, whichever is lower.

[k] Lower Flammability Limit.

Table E.2 — Refrigerant designations of R400 blends

Refrigerant Number	Composition c (weight %)	Composition tolerances (%)	Safety group d	PED fluid group	Practical limit e (kg/m^3)	ATEL/ODL h (kg/m^3)	Flammability LFL i (kg/m^3)	Vapour density 25 °C, 101,3 kPa a (kg/m^3)	Molecular mass a	Bubble Point/dew point at 1,0 at. (°C) a	ODP f	GWP g (100 yr ITH)	Auto-ignition tempe-rature (°C)
401A	R-22/152a/124 (53/13/34)	± 2/+ 0,5 – 1,5/± 1	A1	2	0,3	0,3	n/a	3,929	94,4	– 33,4 to – 27,8	0,037	970	681
401B	R-22/152a/124 (61/11/28)	± 2/+ 0,5 – 1,5/± 1	A1	2	0,34	0,34	n/a	3,860	92,8	– 34,9 to – 29,6	0,04	1 060	685
401C	R-22/152a/124 (33/15/52)	± 2/+ 0,5 – 1,5/± 1	A1	2	0,24	0,24	n/a	4,211	101	– 28,9 to – 23,3	0,03	760	—
402A	R-125/290/22 (60/2/38)	± 2/+ 0.1, – 1.0/± 2	A1	2	0,33	0,33	n/a	4,214	101,5	– 49,2 to – 47,0	0,021	2 250	723
402B	R-125/290/22 (38/2/60)	± 2/+ 0.1, – 1.0/± 2	A1	2	0,32	0,32	n/a	3,929	94,7	– 47,2 to – 44,8	0,033	1 960	641
403A	R-290/22/218 (5/75/20)	+ 0,2 – 2,0/± 2/± 2	A1	2	0,33	0,33	n/a	3,817	92	– 44,0 to – 42,4	0,041	2 520	—
403B	R-290/22/218 (5/56/39)	+ 0,2 – 2,0/± 2/± 2	A1	2	0,41	0,41	n/a	4,289	103,2	– 43,9 to – 42,4	0,031	3 570	—
404A	R-125/143a/134a (44/52/4)	± 2/± 1/± 2	A1	2	0,48	0,48	n/a	4,057	97,6	– 46,5 to – 45,7	0	3 260	728
405A	R-225/152a/142b/C318 (45/7/5,5/42,5)	± 2/± 1/± 1/± 2 b	A1	2	0,26	0,26	N/a	4,665	111,9	– 32,8 to – 24,4	0,028	4 480	—
406A	R-22/600a/142b (55/4/41)	± 2/± 1/± 1	A2	1	0,13	0,13	0.302	3,744	89,9	– 32,7 to – 23,5	0,057	1 560	—
407A	R-32/125/134a (20/40/40)	± 2/± 2/± 2	A1	2	0,33	0,33	n/a	3,743	90,1	– 45,2 to – 38,7	0	1 770	685
407B	R-32/125/134a (10/70/20)	± 2/± 2/± 2	A1	2	0,35	0,35	n/a	4,274	102,9	– 46,8 to – 42,4	0	2 280	703
407C	R-32/125/134a (23/25/52)	± 2/± 2/± 2	A1	2	0,31	0,31	n/a	3,582	86,2	– 43,8 to – 36,7	0	1 520	704
407D	R-32/125/134a (15/15/70)	± 2/± 2/± 2	A1	2	0,41	0,41	n/a	3,784	90,9	– 39,4 to – 32,7	0	1 420	—
407E	R-32/125/134a (25/15/60)	± 2/± 2/± 2	A1	2	0,40	0,40	n/a	3,482	83,8	– 42,8 to – 35,6	0	1 360	—
408A	R-125/143a/22 (7/46/47)	± 2/± 1/± 2	A1	2	0,41	0,41	n/a	3,614	87,0	– 44,6 to – 44,1	0,026	2 650	—
409A	R-22/124/142b (60/25/15)	± 2/± 2/± 1	A1	2	0,16	0,16	n/a	4,055	97,5	– 34,7 to – 26,3	0,048	1 290	—
409B	R-22/124/142b (65/25/10)	± 2/± 2/± 1	A1	2	0,17	0,17	n/a	4,021	96,7	– 35,8 to – 28,2	0,048	1 270	—
410A	R-32/125 (50/50)	+ 0,5 – 1,5/+ 1,5 – 0,5	A1	2	0,44	0,44	n/a	3,007	72,6	– 51,6 to – 51,5	0	1 720	—
410B	R-32/125 (45/55)	± 1/± 1	A1	2	0,43	0,43	n/a	3,131	75,5	– 51,5 to – 51,4	0	1 830	—
411A	R-1270/22/152a (1,5/87,5/11,0)	+ 0 – 1/+ 2 – 0/+ 0 – 1	A2	1	0,04	0,09	0,186	3,420	82,5	– 39,6 to – 37,1	0,048	1 330	—
411B	R-1270/22/152a (3,94/3)	+ 0 – 1/+ 2 – 0/+ 0 – 1	A2	1	0,05	0,09	0,239	3,446	83,3	– 41,6 to – 40,2	0,052	1 410	—
412A	R-22/218/142b (70/5/25)	± 2/± 2/± 1	A2	1	0,07	0,18	0,329	3,883	92,2	– 36,5 to – 28,9	0,055	1 850	—
413A	R-218/134a/600a (9/88/3)	± 1/± 2/+ 0, – 1	A2	1	0,08	0,21	0,375	4,334	103,9	– 29,4 to – 27,4	0	1 770	—
414A	R-22/124/600a/142b (51.0/28.5/4.0/16.5)	± 2/± 2/± 0,5/+ 0,5, – 1.0	A1	2	0,08	0,08	n/a	4,040	97,0	– 33,2 to – 24,7	0,045	1 200	—
414B	R-22/124/600a/142b (50.0/39.0/1.5/9.5)	± 2/± 2/± 0,5/+ 0,5, – 1.0	A1	2	0,07	0,07	n/a	4,232	101,6	– 33,1 to – 24,7	0,042	1 100	—

Table E.2 (*continued*)

Refrigerant Number	Composition c (weight %)	Composition Tolerances (%)	Safety Group d	PED fluid Group	Practical Limit e (kg/m³)	ATEL/ODL h (kg/m³)	Flammability LFL i (kg/m³)	Vapour density 25 °C, 101,3 kPa a (kg/m³)	Molecular Mass a	Bubble Point/dew point at 1,0 at. (°C) a	ODP f	GWP g (100 yr ITH)	Auto-ignition tempe-rature (°C)
416A	R-134a/124/600 (59.0/39.5/1.5)	+ 0,5 – 1,0/+ 1,0, – 0,5/+ 0,1, – 0,2	A1	2			n/a	4,678	111,9	– 23,4 to – 21,8	0,009	950	—
417A	R-125/134a/600 (46.6/50.0/3.4)	± 1,1/± 1,0/+ 0,1, – 0,4	A1	2	0,15	0,15	n/a	4,443	106,7	– 38,0 to – 32,9	0	1 950	—

a The vapour density, molecular mass, “bubble point” and “dew point” temperatures are not part of this standard; they are provided for information only.

The “bubble point temperature” is defined as the liquid saturation temperature of a refrigerant at the specified pressure; the temperature at which a liquid refrigerant first begins to boil.

The bubble point of a zeotropic refrigerant blend, at constant pressure, is lower than the dew point.

The “dew point temperature” is defined as the vapour saturation temperature of a refrigerant at the specified pressure; the temperature at which the last drop of liquid refrigerant boils.

The dew point of a zeotropic refrigerant blend, at constant pressure, is higher than the bubble point.

b The sum of the composition tolerances for R152a and R142b shall be between + 0 and - 2 %.

c Blend components are conventionally listed in order of increasing normal boiling point.

d See Annex F. Unclassified refrigerants indicate either insufficient data to classify or no formal request for classification.

e Practical Limit. Calculated from the values for the individual components as listed in Table E.1.

f Calculated from the values for the individual components as listed in Table E.1.

g Calculated from the values for the individual components as listed in Table E.1.

h Acute-Toxicity Exposure Limit or Oxygen Deprivation Limit, whichever is lower.

i Lower Flammability Limit.

Table E.3 — Refrigerant designations of R500 blends [a]

Refrigerant number	Azeotropic composition [e] (weight %)	Safety Group [f]	PED fluid group	Practical limit [g] (kg/m^3)		Vapour density 25 °C, 101,3 kPa[b] (kg/m^3)	Molecular mass [b]	Normal boiling point (°C) [b]	Azeotropic temperature (°C) [d]	ODP [h]	GWP [i] (100 yr ITH)	Auto-ignition tempe-rature (°C)
500	R-12/152a (73,8/26,2)	A1	2	0,4		4,137	99,3	– 33,5	0	0,74	6 000	—
501	R-22/12 (75,0/25,0)[c]	A1	2	0,38		3,863	93,1	– 41,0	– 41	0,29	3 150	—
502	R-22/115 (48,8/51,2)	A1	2	0,45		4,635	112,0	– 45,4	19	0,33	4 400	—
503	R-23/13 (40,1/59,9)		2	0,35		3,594	87,5	– 88,7	88	0,6	13 100	—
504	R-32/115 (48,2/51,8)					3,282	79,2	– 57,0	17	0,31	4 040	—
505	R-12/31 (78,0/22,0)[c]						103,5	– 30,0	115	0,78	n/a	—
506	R-31/114 (55,1/44,9)						93,7	– 12,0	18	0,45	n/a	—
507A	R-125/143a (50/50)	A1	2	0,49		4,108	98,9	– 46,7	– 40	0	3 300	—
508A	R-23/116 (39,61)	A1	2	0,22		4,124	100,1	– 86,0	– 86	0	11 860	—
508B	R-23/116 (46/54)	A1	2	0,2		3,930	95,4	– 88,3	– 45,6	0	11 850	—
509A	R-22/218 (44/56)	A1	2	0,56		5,155	124,0	– 47,0	0	0,024	4 580	—

[a] Azeotropic refrigerants exhibit some segregation of components at conditions of temperature and pressure other than those at which they are formulated. The extent of segregation depends on the particular azeotrope and hardware system configuration.

[b] The vapour density, molecular mass and normal boiling point are not part of this standard, but are provided for informative purposes only.

[c] The exact composition of this azeotrope is in question, and additional experimental studies are needed.

[d] Under vapour-liquid equilibrium (VLE) conditions.

[e] Blend components are conventionally listed in order of increasing normal boiling point.

[f] See Annex F. Unclassified refrigerants indicate either insufficient data to classify or no formal request for classification.

[g] See Annex F.

[h] Calculated from the values for the individual components as listed in Table E.1.

[i] Calculated from the values for the individual components as listed in Table E.1.

Annex F
(informative)

Safety group classifications

F.1 Acronyms used in this annex:

ALC	Approximate Lethal Concentration
ATEL	Acute Toxicity Exposure Limit
ETFL	Elevated Temperature Flammability Limit — LFL tested at 60 °C
FCL	Flammable Concentration Limit
LC_{50}	Concentration at which Lethality is observed for at least 50 % of the test population
LFL	Lower Flammability Limit
LOEL	Lowest Observed Effect (concentration) Level
NOEL	No observed effect (concentration) level
ODL	Oxygen Deprivation Limit
ppm	Parts per million ($\times 10^{-6}$)
RCL	Refrigerant Concentration Level
TCF	Toxic Concentration Factor
TLV-TWA	Time Weighted Average Threshold Limit Value[1)]
UFL	Upper Flammability Limit
WCF	Worst Case Formulation — The allowed composition for a 400 or 500 series refrigerant (within the standard tolerance range given in Annex E) which results in the highest concentration of flammable component(s) or the lowest calculated ATEL
WCFF — Flammability	Worst Case Fractionated Formulation — The Composition during fractionation which results in the highest concentration of flammable component(s) in the liquid or in the vapour phase
WCFF — Toxicity	Worst Case Fractionated Formulation — The Composition during fractionation which results in the highest concentration of component(s) in the liquid or in the vapour phase for which the TLV-TWA is less than 400 ppm

F.2 Classification

F.2.1 General

The safety classification should consist of two alphanumeric characters (e.g. A2 or B1). The upper case letter indicates the toxicity level as defined in F.2.2; the Arabic numeral denotes the flammability as defined in F.2.3.

1) See American Conference of Governmental and Industrial Hygienists — ACGIH.

F.2.2 Toxicity classification

Refrigerants should be assigned to one of two classes — A or B — based on allowable chronic exposure concentration levels:

Class A, (Lower Toxicity): refrigerants with a time weighted average concentration not having an adverse effect on nearly all workers who may be exposed to it day after day for a normal 8-hour workday and a 40-hour workweek whose value is equal to or above 400 ml/m^3 (400 ppm by volume);

Class B, (Higher Toxicity): refrigerants with a time weighted average concentration not having an adverse effect on nearly all workers who may be exposed to it day after day for a normal 8-hour workday and a 40-hour workweek whose value is below 400 ml/m^3 (400 ppm by volume).

F.2.3 Flammability classification

F.2.3.1 General

Refrigerants should be assigned to one of three classes — 1, 2, or 3 — based on flammability testing conducted in accordance with section F.2.3.2, F.2.3.3, F.2.3.4. Refrigerant blends should be assigned flammability classifications based on their Worst-Case Fractionated Formulation (WCFF), as determined from a fractionation analysis (see F.2.5). A WCF and WCFF are not required if none of the components of the blend are either Class 2 or Class 3. In this case, a fractionation analysis is not required and the blend should be Class 1.

F.2.3.2 Class 1 (No Flame Propagation)

A single compound refrigerant should be classified as Class 1, if the refrigerant does not show flame propagation when tested in air at 60 °C and 101,3 kPa.

A refrigerant blend should be classified Class 1, if the WCFF of the blend, as determined from a fractionation analysis, does not show flame propagation when tested at 60,0 °C and 101,3 kPa.

F.2.3.3 Class 2 (Lower Flammability)

A single compound refrigerant should be classified as Class 2 if the refrigerant meets all three of the following conditions:

— exhibits flame propagation when tested at 60 °C and 101,3 kPa;

— has a LFL ≥ 3,5 Vol%;

— has a heat of combustion < 19 000 kJ/kg.

A blend should be classified as Class 2, if it meets all three of the following conditions:

— WCFF exhibits flame propagation when tested at 60 °C and 101,3 kPa;

— WCFF has a LFL ≥ 3,5 Vol%;

— nominal formulation has a heat of combustion < 19 000 kJ/kg.

F.2.3.4 Class 3 (Higher Flammability)

A single compound refrigerant should be classified as Class 3, if the refrigerant meets both of the following conditions:

— exhibits flame propagation when tested at 60 °C and 101,3 kPa;

— has a LFL ≤ 3.5 Vol%; or it has a heat of combustion that is ≥ 19 000 kJ/kg.

A blend should be classified as Class 3, if it meets both of the following conditions:

— WCFF exhibits flame propagation when tested at 60,0 °C and 101,3 kPa;

— WCFF has a LFL ≤ 3.5 Vol%; or the WCFF has a heat of combustion that is ≥ 19 000 kJ/kg.

F.2.3.5 For Class 2 or Class 3 refrigerants or refrigerant blends the LFL should be determined. For those Class 2 or Class 3 refrigerants or refrigerant blends that show no flame propagation when tested at 23,0 °C and 101,3 kPa (i.e. no LFL) the elevated temperature flame limit (ETFL) should be used in lieu of the LFL for determining their flammability classifications, as follows.

For a single compound refrigerant, the ETFL should be used in lieu of the LFL.

For a refrigerant blend, the ETFL of the WCFF should be used in lieu of the LFL.

F.2.3.6 The heat of combustion should be calculated at 25 °C and 101,3 kPa.

For single component refrigerants, the heat of combustion can be calculated, if the heat of formation (enthalpy of formation) of the refrigerant and its products of reaction are known. Values for heats of formation are tabulated in several chemical and physical properties handbooks and databases. The heat of combustion is the enthalpy of formation of the reactants (refrigerant and oxygen) minus the enthalpy of formation of the products of reaction. Calculated values should be based on the complete combustion of one mole of refrigerant with enough oxygen for a stoichiometric reaction. The reactants and the combustion products should be assumed to be in the gas phase. The combustion products should be CO_2, (N_2, SO_2 if nitrogen or sulfur are part of the refrigerants molecular structure) HF and HCl, if there is enough hydrogen in the molecule. If there is insufficient hydrogen available for the formation of both HF and HCl, then the formation of HF takes preference over the formation of HCl. The remaining F and Cl produce F_2 and Cl_2. Excess H should be assumed to be converted to H_2O.

For refrigerant blends, the heat of combustion of the nominal formulation should be measured or calculated from a balanced stoichiometric equation of all component refrigerants.

Heats of formation and heats of combustion are normally expressed as energy per mole (kJ/mole). For purposes of flammability classification under this standard, convert the heat of combustion for a refrigerant from an energy per mole value to an energy per mass value (kJ/kg).

F.2.4 Matrix diagram of safety group classification system

The toxicity and flammability classifications described in F.2.2 and F.2.3 yield six separate safety group classifications (A1, A2, A3, B1, B2, and B3) for refrigerants.

Table F.1 — Safety group classification system

		TOXICITY	
		Lower	Higher
FLAMMABILITY	No Flame Propagation	A1	B1
	Lower Flammability	A2	B2
	Higher Flammability	A3	B3

F.2.5 Safety classification of refrigerant blends

Refrigerant Blends, whether zeotropic or azeotropic, whose flammability and/or toxicity characteristics may change as the composition changes during fractionation, should be assigned a safety group classification based on the worst case of fractionation. This classification should be determined according to the same criteria as a single-component refrigerant.

For flammability, "worst case of fractionation" is defined as (the composition during fractionation that results in the highest concentration of the flammable component(s) in the vapour or liquid phase). For toxicity, "worst case of fractionation" is defined as the composition during fractionation that results in the highest concentration of the component(s) in the vapour or liquid phase for which the TLV-TWA is less than 400 ppm by volume. The TLV-TWA for a specific blend composition should be calculated from the TLV-TWA of the individual components.

F.3 Refrigerant practical (concentration) limit

F.3.1 General

The practical limit for a refrigerant represents the highest concentration level in an occupied space which will not result in any escape impairing (i.e. acute) effects. It is used to determine the maximum charge size for that refrigerant in a specific application.

The practical limit for refrigerant fluids that have been in commercial use for 5 years before the introduction of this revised European Standard should have their existing practical limit (as set in previous international or national standards) maintained. These values are used, where applicable, in this European Standard.

F.3.2 Determination of practical limits for new refrigerant fluids (those for which F.3.1 is not applicable)

F.3.2.1 General

The practical limit should be calculated from the Refrigerant Concentration Limit (RCL).

Determination of the RCL should assume full vaporization; no removal by dissolution, reaction, or decomposition in the space to which it is released. Safety factors are included for consideration of temporary local concentrations or uncertainties in the test data. Other standards for application of refrigerants, which take into consideration temporary local concentrations, may use the individual ATEL, ODL and LFL values to determine the practical refrigerant quantity limit.

The RCL for each refrigerant should be the lowest of the quantities calculated in accordance with F.3.2.2, F.3.2.4 and F.3.2.5, using data as indicated in F.3.2.6.1 and adjusted in accordance with F.3.3.

F.3.2.2 Acute-Toxicity Exposure Limit (ATEL)

The ATEL should be the lowest of the toxic concentration factors (TCF) (a)-(d) as follows:

a) Mortality

28,3 % of the 4-hour LC_{50} for rats. If not determined, 28,3 % of the 4-hour ALC for rats provided that it did not result in mortality for more than half the exposed animals. The following equations should be used to adjust LC_{50} or ALC values that were determined with 15-minute to 8-hour tests, for refrigerants for which 4-hour data are not available:

$\alpha = \beta \times (t/T)^{1/2}$

where

α is the LC_{50} for time T and

β is the LC_{50} for time t

or

$\chi = \delta \times (t/T)^{1/2}$

where

χ is the ALC for time T and

δ is the ALC for time t.

For the purpose of this European Standard

T is 4 h and t is the test duration expressed in hours, applicable for 0,25 h to 8 h.

NOTE 28,3 % is based on the recalculation of LC_{50} for T = 30 min with a safety factor of 10. The time of 30 min is meant to represent the time required for escape from an area where a refrigerant leak has occurred.

b) Cardiac sensitization

100 % of NOEL for cardiac sensitization in un-anesthetized dogs. If not available then 80 % of the LOEL for cardiac sensitization in dogs provided that the LOEL induced sensitization in more than one animal and did not induce sensitization in more than half the exposed animals. The cardiac sensitization term is omitted from ATEL determination if the LC_{50} or ALC in (a) is less than 10 000 ppm by volume, or if the refrigerant is found, by toxicological review, to not cause cardiac sensitization.

c) Anesthetic effect

50 % of the 10-minute EC_{50} for anesthesia in mice or rats. If not determined, 50 % of the LOEL for signs of anesthesia in rats during acute toxicity studies, provided that the LOEL did not induce an anesthetic effect for more than half the exposed animals. If neither has been determined, 80 % of the NOEL for signs of anesthesia in rats during an acute, subchronic, or chronic toxicity study in which clinical signs are documented.

d) Other escape-impairing symptoms and permanent injury

The lowest concentration, for human exposures of 30 min, that is likely to impair an individual's ability to escape or to cause irreversible, adverse health effects. The source of the value should be documented.

F.3.2.3 Blends

The individual parameter values in F.3.2.2 (a) through (d) should be calculated according to the following formula: 1/TCF of the Blend = $MF_1/C_1 + MF_2/C_2 + MF_n/C_n$. (Where MF_n is the mole fraction of component n of the blend and C_n is the TCF for component n.) in accordance with ISO 10298, 4.2, unless synergistic effects have been identified. Exceptions will be noted in the table.

F.3.2.4 Oxygen Deprivation Limit (ODL)

The ODL should be 140 000 ppm (18,0 % O_2) by volume refrigerant in air.

F.3.2.5 Flammable Concentration Limit (FCL)

The FCL should be expressed in ppm and calculated as 20 % of the LFL expressed in ppm. This safety factor is intended to prevent local temporary concentrations from exceeding the LFL. Other standards for application of flammable refrigerants, which take into consideration stratification and leak patterns of the refrigerant, may use the LFL as part of the calculation of the refrigerant concentration limit (RCL).

F.3.2.6 Data for calculations

F.3.2.6.1 Acceptable data sources

The data used to calculate the ATEL should be taken from scientific and engineering studies or published or unpublished safety assessments by governmental agencies or expert panels. Source studies for toxicity data should indicate the extent of compliance with Good Laboratory Practices (GLP). Data from peer-reviewed publications, including journal articles and reports, also are allowed. The information should be supplied in one of the official languages of ISO. Submissions should include an evaluation of the experimental and analytical methods used and summarize the qualifications of the person or persons providing the evaluation.

F.3.2.6.2 Toxicity data for other species

Toxicity data for species of test animals other than those indicated in F.3.2.2 (a)-(d) may be considered and are subject to the same requirements as stated in F.3.2.6.1.

F.3.2.6.3 Consistent measures

Use of data that are determined in manner consistent with those used deriving the data in F.3.2.2.(a)-(d), or by methods that consistently yield a lower RCL for the same effects, is permitted, for the parameters identified in 2.3.1.

F.3.2.6.4 No-effect data

Where no treatment-related effect was observed in animal tests for items F.3.2.2 (a) to (d), the ATEL calculation required by F.3.2.2 should use the highest concentration tested in lieu of the specified effect or no-effect level.

F.3.2.6.5 Conservative data

Where multiple data values have been published, the values used should be those resulting in the lowest RCL. (Exceptions: 1. Where peer-reviewed studies explicitly document flaws in or refinements to published data, the flawed data shall be rejected. 2. For the cardiac sensitization and anesthetic effect NOEL in F.3.2.2 (b) and (c), respectively, the highest-published NOEL not exceeding a published LOEL, for any fraction of tested animals, should be used. Both the NOEL and LOEL should conform to F.3.2.6.1 for this exception.

F.3.3 Units conversion

Mass per unit volume

The following equation should be used to convert the RCL from a volumetric ratio, ppm by volume, to mass per unit volume, g/m^3:

$$\phi = \gamma \text{ a } M$$

where

ϕ is the RCL expressed as g/m^3;

γ is the RCL expressed as ppm by volume;

a = $4{,}096 \times 10^{-5}$ mol/m^3;

M is the molecular mass of the refrigerant in g/mol.

Adjustment for altitude

The RCL should be adjusted for altitude, when expressed as mass per unit volume, kg/m^3, for locations above seal level. The RCL should not be adjusted when expresses as a ratio, ppm.

RCL_a = RCL × (l- (b × h))

b = $7{,}94 \times 10^{-5}$m^{-1}

h = altitude above seal level in m

F.3.4 Classification of new refrigerant fluids

When required, the identification and safety classification of fluids which are not included in this European Standard (Annex E) will be assigned by ISO/TC 86 and published in ISO 817. Practical limits values will be those assigned in ISO 5149.

Annex G
(normative)

Special requirements for ice rinks

G.1 Indoor skating rinks

Systems may be classified as indirect systems, if refrigerant containing parts are separated from general occupancy by an adequate, reinforced, tightly sealed concrete floor (applicable for A1, B1 and B2 refrigerants only). In this case the following requirements shall be fulfilled:

— refrigerant receivers shall be provided which can hold the total refrigerant charge;

— pipes and headers shall be welded or brazed without flanges and encased in the concrete floor;

— flow and return pipes are arranged in a dedicated pipe trench which is gas tight to the public and vented to the machinery room.

G.2 Outdoor skating rinks and installations for similar sporting activities

All refrigerating equipment, piping and fittings shall be fully protected against unauthorized interference and so arranged that they are accessible for inspection. For group B2 refrigerant systems requirements as in G.1 apply.

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[4] EN 736-1, *Valves — Terminology — Part 1: Definition of types of valves*

[5] EN 764-1, *Pressure equipment — Part 1: Terminology — Pressure, temperature, volume, nominal size*

[6] EN 12263, *Refrigerating systems and heat pumps — Safety switching devices for limiting the pressure — Requirements and tests*

[7] EN 13313, *Refrigerating systems and heat pumps — Competence of personnel*

[8] EN 14276-1, *Pressure equipment for refrigerating systems and heat pumps — Part 1: Vessels — General requirements*

[9] EN 14276-2:2007, *Pressure equipment for refrigerating systems and heat pumps — Part 2: Piping — General requirements*

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

[11] EN 60335-1, *Safety of household and similar electrical appliances — Part 1: General requirements (IEC 60335-1:1991, modified)*

[12] EN 60335-2-24, *Household and similar electrical appliances — Safety — Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice-makers (IEC 60335-2-24:2002)*

[13] EN 60335-2-34, *Household and similar electrical appliances — Safety — Part 2-34: Particular requirements for motor-compressors (IEC 60335-2-34:2002)*

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[15] EN 60335-2-89, *Household and similar appliances — Safety — Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor (IEC 60335-2-89:2002)*

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[19] ISO 817, *Refrigerants —Designation system*

[20] ISO 5149, *Mechanical refrigerating systems used for cooling and heating — Safety requirements*

[21] ISO 10298, *Determination of toxicity of a gas or gas mixture*

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Headquarters 389
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London, W4 4AL, UK
Tel +44 (0)20 8996 9001
Fax +44 (0)20 8996 7001
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