NORMA EUROPEA

Sistemi di refrigerazione e pompe di calore - Requisiti di sicurezza e ambientali - Parte 1: Requisiti di base, definizioni, criteri di classificazione e selezione

UNI EN 378-1

APRILE 2021

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

La norma specifica i requisiti per la sicurezza delle persone e dei beni, fornisce una guida per la tutela dell'ambiente e stabilisce procedure per il funzionamento, la manutenzione e la riparazione di impianti di refrigerazione e il recupero dei refrigeranti.
Il termine "sistema refrigerante" utilizzato nella presente norma europea comprende le pompe di calore.
La presente parte della EN 378 specifica i criteri di classificazione e di selezione applicabili ai sistemi di refrigerazione. Questi criteri di classificazione e di selezione sono utilizzati nelle parti 2, 3 e 4.
La presente norma si applica:

a) a sistemi di refrigerazione, fissi o mobili, di tutte le dimensioni salvo per i sistemi di climatizzazione per veicoli oggetto di specifiche norme di prodotto, per esempio la ISO 13043;
b) per sistemi di raffreddamento o riscaldamento secondari;
c) alla posizione dei sistemi di refrigerazione;
d) alle parti sostituite e alle componenti aggiunte dopo l'adozione di questa norma se non sono identiche nella funzione e nella capacità.

I sistemi che utilizzano refrigeranti diversi da quelli elencati nell'appendice E della presente norma europea non sono coperti dalla presente norma

TESTO INGLESE

La presente norma è la versione ufficiale in lingua inglese della norma europea EN 378-1:2016+A1 (edizione ottobre 2020).

La presente norma sostituisce la UNI EN 378-1:2017.

ICS 27.080; 27.200; 01.040.27

PREMESSA NAZIONALE

La presente norma costituisce il recepimento, in lingua inglese della norma europea EN 378-1:2016+A1 (edizione ottobre 2020), che assume così lo status di norma nazionale italiana.

La presente norma è stata elaborata sotto la competenza dell'ente federato all'UNI

CTI - Comitato Termotecnico Italiano

La presente norma è stata ratificata dal Presidente dell'UNI ed è entrata a far parte del corpo normativo nazionale il 22 aprile 2021.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 378-1:2016+A1

October 2020

ICS 01.040.27; 27.080; 27.200

Supersedes EN 378-1:2016

English Version

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

Systèmes frigorifiques 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 3 September 2016 and includes Amendment 1 approved by CEN on 17 August 2020.

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European foreword

This document (EN 378-1:2016+A1:2020) has been prepared by Technical Committee CEN/TC 182 "Refrigerating systems, safety and environmental requirements", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2021, and conflicting national standards shall be withdrawn at the latest by April 2021.

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

This document includes Amendment 1 approved by CEN on 17 August 2020.

This document supersedes A1) EN 378-1:2016 (A1.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1) (A1.

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.*

The main changes in part 1 with respect to the previous edition are listed below:

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

— adapt definitions for the purpose of harmonizing EN 378-2:2016 with PED.

Following detailed changes are worth noting:

— modification of the term "special machinery room" to "separate refrigeration machinery room" and adapt the definition in view of combustion equipment;

— modifications/inclusion of definitions for "part of the refrigerating system" (3.1.8), "pressure equipment" (3.1.20) and "pressure vessels" (3.4.8) in view of PED;

— movement of the location classification from Annex C to 5.3;

— rewording of the system examples in 5.3 to make the relation clear with location classification;

— replacement of Annex F (safety group) classifications by 5.2;

— modification of the approach to determine the refrigerant charge of a refrigeration system. The charge limit requirement is decided based on the most stringent refrigerant charge that results from the calculation based on toxicity and the calculation based on flammability. To this purpose, the tables in Annex C are modified. Table C.1 contains requirements based on toxicity classes, Table C.2 contains requirements based on flammability classes;

- addition of the refrigerant classes as determined in ISO 817 to toxicity classes A, B and flammability classes 1, 2L, 2, 3;
- modification of the charge limits for refrigerants of flammability class 3, for location classification III;
- addition of C.3, alternative risk management;
- addition of refrigerants in Annex E that have been approved for publication in ASHRAE 34 in January 2015 (not those approved for public review in January 2015);
- inclusion in Annex E of GWP values for refrigerants in view of REGULATION (EU) No 517/2014 (F-gas).

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the 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 regarding local and global environments. It does not related to the final destruction of the refrigerants.

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

Attention is drawn to hazards such as excessive temperature at compressor discharge, liquid slugging, erroneous operation and reduction in mechanical strength caused by corrosion, erosion, thermal stress, liquid hammer or vibration. Corrosion deserves special consideration as conditions peculiar to refrigerating systems arise due to alternate frosting and defrosting or the covering of equipment by insulation.

The extent to which hazards are covered is indicated in Annex G. In addition, machinery should comply as appropriate with EN ISO 12100 for hazards which are not covered by this European Standard.

Commonly used refrigerants except R-717 are heavier than air. Care should be taken to avoid stagnant pockets of heavy refrigerant vapours by proper location of ventilation inlet and exhaust openings. Refrigerants and their combinations with oils, water or other substances, can affect the system chemically and physically. They can, if they have detrimental properties, endanger persons, property and the environment when escaping from the refrigerating system. Refrigerants shall be selected with due regard to their potential influence on the global environment (ODP, GWP) as well as their possible effects on the local environment. Evaluation of the environmental performance 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;
- minimization of heat load;
- control methods.

Additional investments may be directed towards reducing leaks, increasing energy efficiency or modifying the design in order to use a different refrigerant. A life cycle approach is necessary to identify where additional investments will have the most beneficial effects.

1 Scope

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

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

This part of EN 378 specifies the classification and selection criteria applicable to refrigerating systems. These classification and selection criteria are used in parts 2, 3 and 4.

This standard applies:

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

b) to secondary cooling or heating systems;

c) to the location of the refrigerating systems;

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

Systems using refrigerants other than those listed in Annex E of this European Standard are not covered by this standard.

Annex C specifies how to determine the amount of refrigerant permitted in a given space, which when exceeded, requires additional protective measures to reduce the risk.

Annex E specifies criteria for safety and environmental considerations of different refrigerants used in refrigeration and air conditioning.

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

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

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

Product family standards dealing with the safety of refrigerating systems takes precedence over horizontal and generic standards covering the same subject.

2 Normative references

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

EN 378-2:2016, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation*

[A1) EN 378-3:2016+A1:2020, *Refrigerating systems and heat pumps - Safety and environmental requirements - Part 3: Installation site and personal protection* (A1]

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

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

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

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 circuit in which the refrigerant is circulated for the purpose of extracting and delivering heat (i.e. cooling and heating)

3.1.2
self-contained system
complete factory-made refrigerating system in a suitable frame and/or enclosure, that is fabricated and transported complete, or in two or more sections and in which no refrigerant-containing parts are connected on site other than by isolation valves, such as companion 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 the need for connecting any refrigerant-containing parts

Note 1 to entry: A unit system can include factory assembled companion 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 when complete evaporation of the refrigerant occurs

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

3.1.6
secondary cooling or heating system
system employing a fluid which transfers heat from the product or spaces to be cooled or heated or from another cooling or heating system to the refrigerating system without compression and expansion of the fluid

3.1.7
sealed system
refrigerating system in which all refrigerant containing parts are made tight by welding, brazing or a similar permanent connection which may include capped valves and capped service ports that allow proper repair or disposal and which have a tested leakage rate of less than 3 grams per year under a pressure of at least a quarter of the maximum allowable pressure

Note 1 to entry: Joints based on mechanical forces which are prevented from improper use by the need of a special tool (e.g. by glue) are considered as a similar permanent connection.

Note 2 to entry: Hermetically sealed systems in EN 16084 are equivalent to sealed systems in EN 378–2.

3.1.8
part of the refrigerating system
several components assembled together and exposed to the same pressure in operation or pressure source, respectively, as determined by the manufacturer

Note 1 to entry: The definitions 3.1.9 and 3.1.10 describe the most common situation.

3.1.9
high pressure side
part of a refrigerating system operating at approximately the condenser or gas cooler 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 usually in transit during operation

Note 1 to entry: Mobile systems includes refrigerated cargo systems in ships, refrigerating systems in fishing boats, air conditioning on board, and 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 circuit rejects heat directly to the evaporator of another

3.1.13
transcritical system
refrigerating system where the compressor discharges refrigerant at a pressure above the critical point

3.1.14
assembly
several components assembled to constitute an integrated and functional whole

Note 1 to entry: Assemblies are often connected together on-site to make a complete refrigerating system.

3.1.15
component
individual functional item of a refrigerating system

3.1.16
split system
A1) refrigerating system, comprising one or more factory-made indoor units in a space and one or more factory made units which are located outside the space and which are connected on site by refrigerant piping in accordance with the instructions of the manufacturers of the factory-made units

Note 1 to entry: Refrigerating systems include air conditioners and heat pumps. (A1

3.1.17
multisplit system
split system with more than one indoor unit

3.1.18
indoor unit
part of the split system that controls the temperature of the air inside the building or substances located in the building

3.1.19
fixed appliance
appliance that is intended to be used while fastened to a support or while secured in a specific location

3.1.20
pressure equipment
components of the refrigerating system, classified as pressure vessels according to definition 3.4.8, piping including its accessories (e.g. valves) according to definition 3.5, and safety accessories according to definition 3.6

3.2 Occupancies, locations

3.2.1
machinery room
enclosed room or space, with mechanical ventilation, sealed from public areas and not accessible to the public, which is intended to contain components of the refrigerating system

Note 1 to entry: A machinery room can contain other equipment provided design and its installation requirements are compatible with the requirements for the safety of the refrigerating system.

3.2.2
separate refrigeration machinery room
machinery room intended to contain only components of the refrigerating system, accessible only to competent personnel for the purposes of inspection, maintenance and repair

Note 1 to entry: Where the standard refers to the term machinery room, separate refrigeration machinery rooms are included.

3.2.3
occupied space
space in a building which is bounded by walls, floors and ceilings and which is occupied by persons for a significant period

Note 1 to entry: Where the spaces around the apparent occupied space are, by construction or design, not air tight with respect to the occupied space, these may be considered as part of the occupied space. above; e.g. false ceilings voids, crawl ways, ducts, movable partitions and doors with transfer grilles or undercut doors.

3.2.4
hallway
corridor for the passage of people

3.2.5
exit
opening in the outer wall, with or without a door or gate

3.2.6
exit passageway
passageway immediately in the vicinity of the exit through which people leave the building

3.2.7
cold room
room maintained by a refrigerating system at a temperature lower than ambient temperature

3.2.8
open air
any unenclosed space, possibly but not necessarily roofed

3.2.9
crawl space
space that is in general accessed for maintenance only and where it is not possible to walk or access by walking

Note 1 to entry: Usually, the height of crawl spaces is less than 1 m.

3.2.10
ventilated enclosure
enclosure containing the refrigerating system that does not enable air to flow from the enclosure to the surrounding space and has a ventilation system that produces airflow from the enclosures to the open air through a ventilation duct

3.3 Pressures

3.3.1
maximum allowable pressure
PS
maximum pressure for which the system or component is designed for, as specified by the manufacturer

Note 1 to entry: PS is the limit which should not be exceeded whether the system is working or not.

Note 2 to entry: The Pressure Equipment Directive 2014/68/EU designates the maximum allowable pressure as the symbol "PS".

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, receiver, evaporator, surge drum

3.4.3
compressor
device for mechanically increasing the pressure of a refrigerant vapour

3.4.4
motor-compressor
fixed combination of electrical motor and compressor in one unit

3.4.4.1
hermetic motor-compressor
combination of a compressor and electrical motor, both of which are enclosed in the same housing, with no external shaft or shaft seals

3.4.4.2
semi-hermetic (accessible hermetic) motor-compressor
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

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 component of a refrigerating system other than:

- 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;
- equipment comprising casings or machinery where the dimensioning, choice of material and manufacturing rules are based primarily on requirements for sufficient strength, rigidity and stability to meet the static and dynamic operational effects or other operational characteristics and for which pressure is not a significant design factor. Such equipment may include: pumps and compressors

Note 1 to entry: The semi-hermetic and open type compressors used in refrigerating systems may be subject to the exclusion article 1.2.j of the Directive 2014/68/EU by referring to the working party group guidelines WPG 1/11, 1/12 and 2/34. The compressor manufacturer needs to decide on the basis of a case by case assessment, if the exclusion article 1.2.j of the Directive 2014/68/EU is applicable.

Note 2 to entry: This definition is aligned to directive 2014/68 EU.

3.4.9
condenser
heat exchanger in which refrigerant vapour 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
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 or grid
component of the refrigerating system constructed from pipes or tubes suitably connected and serving as a heat exchanger (e.g. evaporator or condenser)

3.4.15
compressor unit
combination of one or more compressors and associated components

3.4.16
condensing unit
combination of one or more compressors, condensers, receivers (when required) and the associated components

3.4.17
surge drum
vessel containing refrigerant at low pressure and temperature and connected by liquid feed and vapour return pipes to one or more evaporators

3.4.18
internal net volume
volume calculated from the internal dimensions of a vessel, and excluding the volume of the permanent internal parts

3.4.19
type approved component
component for which examination is performed on one or more samples of this component in accordance with a recognized 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 components 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 higher than 450 °C but less than the melting temperatures of the joined parts

3.5.5
flanged joint
joint made by bolting together a pair of flanged ends

3.5.6
flared joint
metal-to-metal compression joint in which a conical spread is made on the end of the tube

3.5.7
compression joint
joints which achieve tightness by deforming a compressing ring

3.5.8
taper pipe thread joint
pipe joint with tapered threads that achieves tightness with filling material or deformation of thread mount

3.5.9
header
pipe or tube component of a refrigerating system to which several other pipes or tubes are connected

3.5.10
shut-off device
device to shut off the flow of the fluid, e.g. refrigerant, brine

3.5.11
companion 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

3.5.12
isolating valves
valves which prevent flow in either direction when closed

3.5.13
locked valve
valve sealed or in other ways constrained, so that it can only be operated by a competent person

3.5.14
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

Note 1 to entry: 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 fluid

3.6.5
temperature limiting device
temperature actuated device that is designed to prevent the generation of excessive temperatures

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

3.6.6.1
pressure limiter
safety switching device for limiting the pressure which automatically resets

Note 1 to entry: A pressure limiter is designated PSH for high pressure protection and PSL for low pressure protection.

3.6.6.2
type approved pressure limiter
safety switching device for limiting the pressure that is type approved according to EN 12263 with automatically reset

Note 1 to entry: A type approved pressure limiter is designated PSH for high pressure protection and PSL for low pressure protection.

3.6.6.3
type approved pressure cut out
safety switching device for limiting the pressure that is type approved according to EN 12263 which is reset manually without the aid of a tool

Note 1 to entry: A type approved pressure cut out is designated PZH for high pressure protection and PZL for low pressure protection.

3.6.6.4
type approved safety pressure cut out
safety switching device for limiting the pressure that is type approved according to EN 12263 which is reset manually only with the aid of a tool

Note 1 to entry: A type approved safety pressure cut out is designated PZH for high pressure protection and PZL for low pressure protection.

3.6.7
changeover valve
valve serving two safety devices and so arranged that only one can be made inoperative at any one time

3.6.8
overflow valve
pressure relief valve discharging to a part of the refrigerating system with lower pressure

3.6.9
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)

3.6.10
liquid level cut out
switching device for limiting the liquid level

3.6.11
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 of the fluid and rejects heat at a higher temperature and a higher pressure usually involving changes of the state of the fluid

3.7.2
refrigerant type
specific nomenclature designation of a chemical compound or blend of compounds used as a refrigerant

3.7.3
heat-transfer fluid
fluid for the transmission of heat usually without any change in its phase (e.g. brine, water, air) or with evaporating and condensing at approximately the same pressure

Note 1 to entry: 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 fluid.

3.7.4
toxicity
ability of a fluid to be harmful, or lethal, or to impair a person's ability to escape due to acute or chronic exposure by contact, inhalation or ingestion

Note 1 to entry: Temporary discomfort that does not impair health is not considered to be harmful.

3.7.5
acute-toxicity exposure limit
ATEL
maximum recommended refrigerant concentration determined in accordance with this European Standard and intended to reduce the risks of acute toxicity hazards to humans in the event of a refrigerant release

3.7.6
oxygen deprivation limit
ODL
concentration of a refrigerant or other gas that results in insufficient oxygen for normal breathing

3.7.7
flammability
ability of a refrigerant or heat-transfer fluid to propagate a flame from an ignition source

3.7.8
lower flammability limit
LFL
minimum concentration of refrigerant that is capable of propagating a flame within a homogeneous mixture of refrigerant and air

3.7.9
practical limit
concentration used for simplified calculation to determine the maximum acceptable amount of refrigerant in an occupied space

Note 1 to entry: RCL is determined by toxicity and flammability tests, but practical limit is derived from RCL or historically established charge limit.

3.7.10
refrigerant concentration limit
RCL
maximum refrigerant concentration, in air, in accordance with and specified in C.3 of this European Standard and established to reduce the risks of acute toxicity, asphyxiation, and flammability hazards

Note 1 to entry: It is used to determine the maximum charge size for that refrigerant in a specific application.

3.7.11
quantity limit with additional ventilation
QLAV
charge density of refrigerant that when exceeded creates an instantaneous dangerous situation, if the total charge leaked within the occupied space

Note 1 to entry: See C.3 for the use of Quantity Limit with Additional Ventilation (QLAV) to manage risk for systems in occupied spaces where the level of ventilation is sufficient to disperse the leaked refrigerant within 15 min.

3.7.12
quantity limit with minimum ventilation
QLMV
charge density of refrigerant that would result in a concentration equal to the RCL in a room of non-air tight construction with a moderately severe refrigerant leak

Note 1 to entry: See C.3 for the use of Quantity Limit with Minimum Ventilation (QLMV) to manage risk for systems in occupied spaces not below ground level where the level of ventilation is not sufficient to disperse the leaked refrigerant within 15 min. The calculation is based on an opening of 0,003 2 m^2 and a leak rate of 2,78 g/s.

3.7.13
outside air
air from outside the building

3.7.14
halocarbon and hydrocarbon
either:

— 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

3.7.15
recover
removing refrigerant in any condition from a system and storing it in an external container

3.7.16
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

Note 1 to entry: The aim of recycling is to reuse the recovered refrigerant.

3.7.17
reclaim
processing used refrigerants to new product specifications

Note 1 to entry: 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.

3.7.18
disposal
to dispose or to convey a product usually for scrapping or destruction

3.7.19
bubble point
liquid saturation temperature of a refrigerant at a specified pressure at which a liquid refrigerant first begins to boil

Note 1 to entry: The bubble point of a zeotropic refrigerant blend, at constant pressure, is lower than the dew point.

3.7.20
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

3.7.21
response time
time elapsing from the moment a gas detection probe is placed into a concentration or exposed to a calibration gas or in front of a leak until an alarm is triggered

3.8 Miscellaneous

3.8.1
competence
ability to perform satisfactorily and safely the activities related to a given task

Note 1 to entry: Levels of competence are defined in EN 13313.

3.8.2
human 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

3.8.4
vacuum procedure
procedure to remove gases and moisture from inside a refrigerating system

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

3.8.6
operator
natural or legal person exercising actual power over the technical functioning of refrigerating systems

3.8.7
refrigerant detector
sensing device which responds to a pre-set concentration of refrigerant gas in the environment

4 Symbols and abbreviated terms

Table 1 — Quantities

Symbol	Quantity	Unit	Unit Symbol
α_i	Rate of gas recovered from the insulation at end of life, from 0 to 1	-	-
A	Area	square metre	m^2
$ATEL$	Acute toxicity exposure limit	kilogramme per cubic metre	kg/m^3
d	Diameter	metres	m
E_{annual}	Energy consumption	kilowatt-hour per year	kWh/year
GWP	Global warming potential, CO_2-related	-	-
GWP_i	The global warming potential of gas in the insulation	-	

Symbol	Quantity	Unit	Unit Symbol
h	Height	metre	m
L	Leakage	kilogramme per year	kg/year
l	Length	metres	m
LFL	Lower flammability limit	kilogramme per cubic metre	kg/m^3
m	Refrigerant charge	kilogramme	kg
m_i	Gas charge in the insulation system	kilogramme	kg
$\dot{m}$	Leak rate	Kilogramme per second	kg/s
n	System operating time	year	year
ODL	Oxygen deprivation limit	kilogramme per cubic metre	kg/m^3
P	Pressure	Pascal	Pa
Q	Air flow	Cubic metres per hour	m^3/h
$QLAV$	Quantity limit with additional ventilation	kilogramme per cubic metre	kg/m^3
$QLMV$	Quantity limit with minimum ventilation	kilogramme per cubic metre	kg/m^3
RCL	Refrigerant concentration limit	kilogramme per cubic metre	kg/m^3
s	Time since leak starts	Seconds per cubic metre	s/m^3
t	Time	second hour year	s h year
T	Temperature	degrees centigrade Kelvin	°C K
$TEWI$	Total equivalent warming impact	kilogramme (of CO_2)	kg
V	Volume	cubic metre	m^3
$\dot{V}$	Air flow	Cubic metres per second	m^3/s
x	Refrigerant concentration in the room	kilogramme per cubic metre	kg/m^3
α *recovery*	Recovery/recycling factor	0 to 1	-
β	CO_2-emission	kilogramme per kilowatt-hour	kg/kWh
ρ	Density of the fluid	kilogramme per cubic metre	kg/m^3

Table 2 — Constants

Symbol	Description	Value
c	Flow coefficient	1,0 for orifice
$\dot{m}$	Leak rate	0,00278 kg/s

Table 3 — Abbreviated terms

Abbreviation	Term
DN	Nominal size
GWP	Global warming potential, CO_2-related
GWP_i	The global warming potential of gas in the insulation
ODP	Ozone depleting potential
PED	Pressure equipment directive
PS	Maximum allowable pressure

5 Classification

5.1 Access categories

5.1.1 General

Occupancies are categorised with respect to the safety of the persons, who may be directly affected in the event 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 access categories. Machinery rooms (see 3.2.1 and 3.2.2) shall not be considered occupied space except as defined in [A1⟩ EN 378-3:2016+A1:2020 ⟨A1], 5.1. The access categories are defined in Table 4.

Table 4 — Access categories

Categories	General characteristics	Examples [a]
General access **a**	Rooms, parts of buildings, building where — sleeping facilities are provided — people are restricted in their movement — an uncontrolled number of people are present — 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 access **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

Categories	General characteristics	Examples [a]
Authorized access 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.		

NOTE Occupancies can be categorised by national requirements.

5.1.2 More than one access category

Where there is the possibility of more than one access category, the more stringent requirements apply. If occupied spaces are isolated, e.g. by sealed partitions, floors and ceilings, then the requirements of the individual access category 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 molecular mass in Annex E).

5.2 Designation and classification of refrigerants

Refrigerants listed in Annex E use the designation and safety class specified in ISO 817. Practical limits values shall be those assigned in Annex E.

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 or create a risk of ignition of the refrigerant. It is used to determine the maximum charge size for that refrigerant in a specific application.

For refrigerants including blends that were commercialised by 2003, the practical limits existing at that time (as set in previous international or national standards) shall be maintained unless, for non flammable refrigerants, the ATEL/ODL values exceed the practical limit, in which case the ATEL/ODL values shall be used.

5.3 Location classification of refrigerating systems

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

The four classes of location are:

a) Class IV - Ventilated enclosure

If all refrigerant-containing parts are located in a ventilated enclosure then the requirements for a class IV location shall apply. The ventilated enclosure shall fulfil the requirements of EN 378-2 and EN 378-3.

b) Class III – Machinery room or open air

If all refrigerant-containing parts are located in a machinery room or open air then the requirements for a class III location shall apply. The machinery room shall fulfil the requirements of EN 378-3.

c) Class II – Compressors in machinery room or open air

If all compressors and pressure vessels are either located in a machinery room or in the open air then the requirements for a class II location shall apply unless the system complies with the requirements of class III. Coils and pipework including valves may be located in an occupied space.

d) Class I – Mechanical equipment located within the occupied space

If the refrigerating system or refrigerant-containing parts are located in the occupied space, then the system is considered to be of class I unless the system complies with the requirements of class II.

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.

If a secondary system serving an occupied space 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 releasable systems according to C.1.

NOTE 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.

5.4 Refrigerating system classification

5.4.1 General

Refrigerating systems are classified as described in 5.4.2 and 5.4.3 (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.

NOTE 5.5 provides practical examples of direct and indirect systems.

5.4.2 Direct releasable systems

The evaporator, condenser or gas cooler of the refrigerating system is in direct contact with the air or the substance to be cooled or heated. Systems in which a heat-transfer fluid is in direct contact with the air or the goods to be cooled or heated (spray or ducted systems) shall be treated as direct releasable systems.

5.4.3 Indirect systems

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

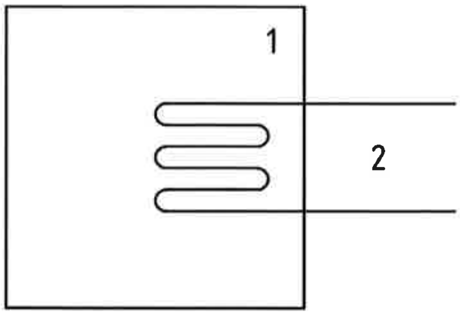
5.5 Examples of systems

5.5.1 Direct releasable systems

5.5.1.1 Direct system

A direct system shall be classified as a direct releasable system if a single rupture of the refrigerant-containing circuit results in refrigerant release in the occupied space, irrespectively of the location of the refrigerant circuit (see Figure 1).

Direct systems are considered to be located in location class I (5.3 d) or II (5.3 c).



Key

1 occupied space

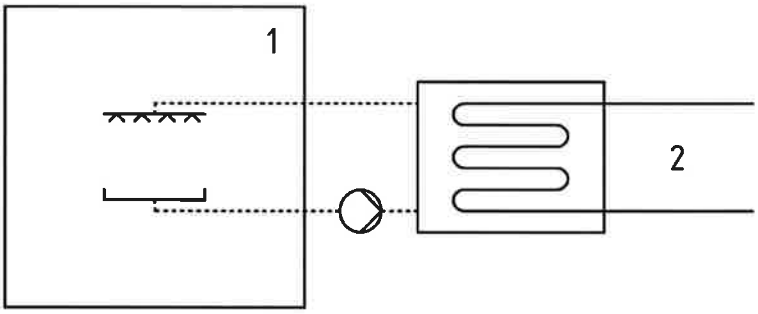
2 refrigerant-containing part(s)

Figure 1 — Direct releasable system

5.5.1.2 Open spray system

An open spray system shall be classified as a direct releasable system if the heat-transfer fluid is in direct contact with refrigerant-containing parts and the indirect circuit is open to an occupied space (see Figure 2).

Open spray systems are considered to be located in location class I (5.3 d) or II (5.3 c).



Key

1 occupied space

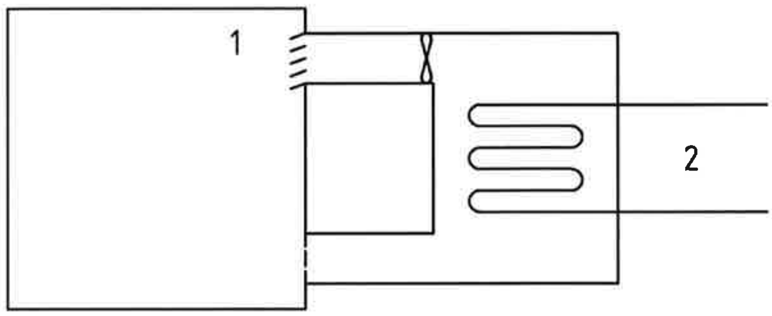
2 refrigerant-containing part(s)

Figure 2 — Open spray system

5.5.1.3 Direct ducted system

A ducted system is classified as a direct releasable system if the conditioned air is in direct contact with refrigerant-containing parts of the circuit and the conditioned air is supplied to an occupied space (see Figure 3).

Direct ducted systems are considered to be located in location class I (5.3 d) or II (5.3 c).



Key

1 occupied space

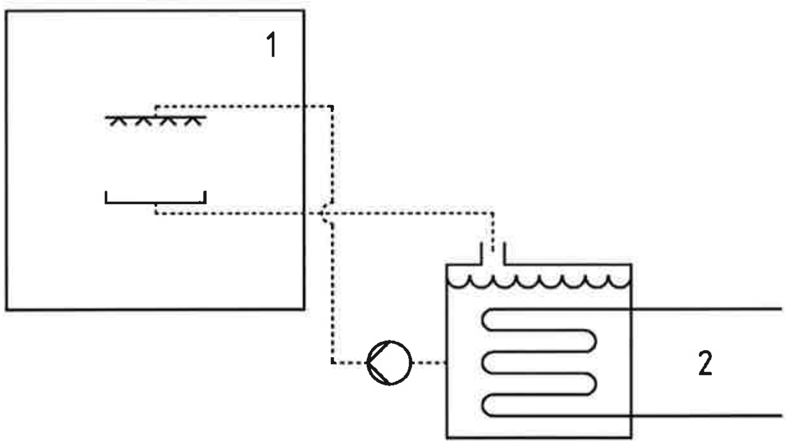
2 refrigerant-containing part(s)

Figure 3 — Direct ducted system

5.5.1.4 Open vented spray system

An open vented spray system is classified as a direct releasable system if the heat-transfer fluid is in direct contact with refrigerant-containing parts of the circuit and the indirect circuit is open to an occupied space. The heat-transfer fluid shall be vented to the atmosphere outside the occupied space but the possibility remains that a single rupture of the refrigerant circuit could result in refrigerant release to the occupied space (see Figure 4).

Open vented spray systems are considered to be located in location class I (5.3 d) or II (5.3 c).



Key

1 occupied space

2 refrigerant-containing part(s)

Figure 4 — Open vented spray system

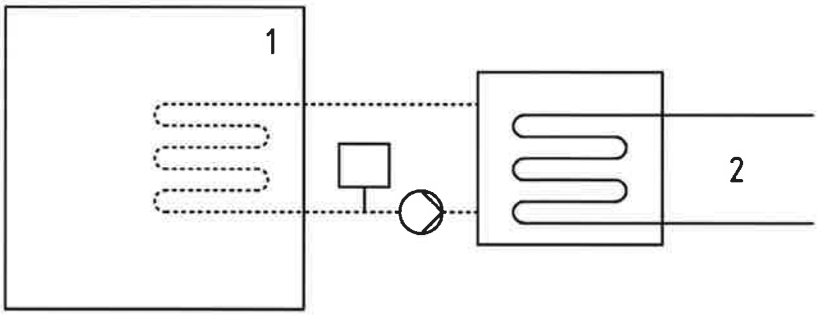
5.5.2 Indirect systems

5.5.2.1 Indirect closed system

An indirect system shall be classified as an indirect closed system if the heat-transfer fluid is in direct communication with an occupied space and a refrigerant leak into the indirect circuit can enter into the occupied space if the indirect circuit also leaks or is purged (see Figure 5).

Indirect closed systems are considered to be located in location class I (5.3 d) or II (5.3 c).

NOTE A pressure relief device (or purger) on a secondary circuit is an appropriate method to prevent refrigerant leaking into the occupied space. Such a system is not considered as an indirect closed system, see 5.5.2.3.



Key

1 occupied space

2 refrigerant-containing part(s)

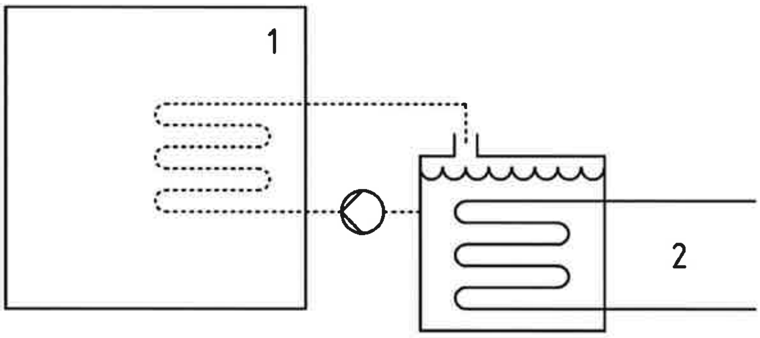
Figure 5 — Indirect closed system

5.5.2.2 Indirect vented system

An indirect system shall be classified as an indirect vented system if the heat-transfer fluid is in direct communication with an occupied space and a refrigerant leak into the indirect circuit can vent to the atmosphere outside the occupied space (see Figure 6).

NOTE This can be achieved by using a double-walled heat exchanger.

Indirect vented systems are considered to be located in location class III (5.3 b).



Key

1 occupied space

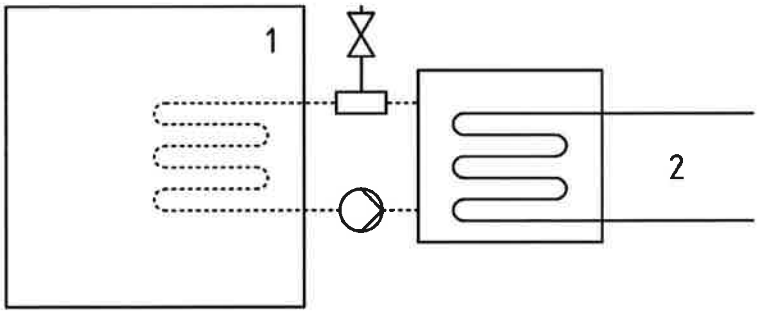
2 refrigerant-containing part(s)

Figure 6 — Indirect vented system

5.5.2.3 Indirect vented closed system

An indirect system shall be classified as an indirect vented closed system if the heat-transfer fluid is in direct communication with an occupied space and a refrigerant leak into the indirect circuit can vent to the atmosphere through a mechanical vent, outside the occupied space (see Figure 7).

Indirect vented systems are considered to be located in location class III (5.3 b).



Key

1 occupied space

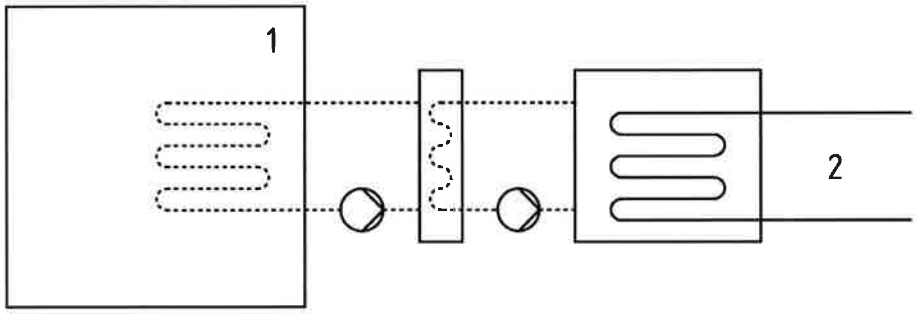
2 refrigerant-containing part(s)

Figure 7 — Indirect vented closed system

5.5.2.4 Double indirect system

An indirect system shall be classified as a double indirect system if the heat-transfer fluid is in direct communication with refrigerant-containing parts and the heat can be exchanged with a second indirect circuit that passes into an occupied space (see Figure 8). A refrigerant leak cannot enter the occupied space.

Double indirect systems are considered to be located in location class III (5.3 b).



Key

1 occupied space

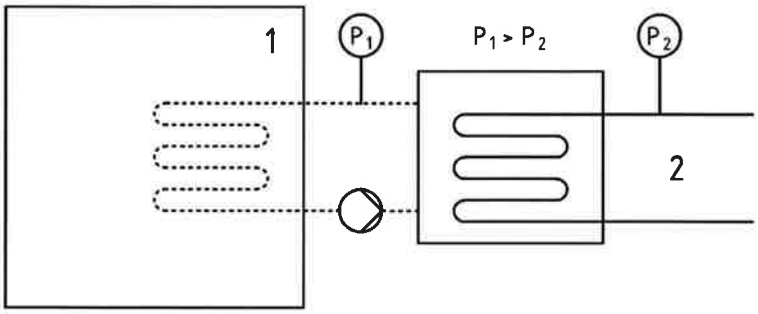
2 refrigerant-containing part(s)

Figure 8 — Double indirect system

5.5.2.5 High pressure indirect system

An indirect system shall be classified as a high pressure indirect system if the heat-transfer fluid is in direct communication with an occupied space and the indirect circuit is maintained at a higher pressure than the refrigerant circuit at all times so that a rupture of the refrigerant circuit cannot result in a refrigerant release to the occupied space (see Figure 9). The refrigerant cannot leak into the indirect circuit.

High pressure indirect systems are considered to be located in location class III (5.3 b).



Key

1 occupied space

2 refrigerant-containing part(s)

P_1 Pressure 1

P_2 Pressure 2

Figure 9 — High pressure indirect system

5.6 Special requirements for ice rinks

For detailed requirements with respect to refrigerating systems for ice rinks refer to Annex F.

6 Quantity of refrigerant

The maximum refrigerant charge that can be permitted in a system is determined by the access categories of any space into which refrigerant could leak, either directly or in some circumstances through a heat-transfer fluid.

NOTE The space which determines the charge limits might not be the space that is served by the refrigerating or air-conditioning system.

The quantity of refrigerant that could enter into a space shall be determined as follows:

— the refrigerant quantity shall not exceed the amounts specified in C.1;

— the refrigerant quantity is the quantity that can be released into the space where the refrigerant quantity shall be the largest charge of any single refrigerating system unless otherwise specified in this standard.

Where product standards exist for particular types of systems and where these product standards refer to refrigerant quantities limits, such quantities shall overrule the requirements of this standard.

7 Space volume calculations

The space considered shall be any space which contains refrigerant-containing parts or into which refrigerant could be released.

The volume (V) of the smallest, enclosed, occupied space shall be used in the determination of the refrigerant quantity limits.

Multiple spaces that have appropriate openings (which cannot be closed) between the individual spaces or are connected with a common ventilation supply, return or exhaust system not containing the evaporator or the condenser shall be treated as a single space.

Where the evaporator or condenser is located in an air supply duct system serving multiple spaces, the volume of the smallest single space shall be used.

If the air flow to a space cannot be reduced to less than 10 % of the maximum air flow by the use of an air flow reducer, then that space shall be included in the volume of the smallest human occupied space.

For refrigerants of safety class A1 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. For refrigerants of safety class A1 the effect of the air changes may be considered in calculating the volume if the space has a mechanical ventilation system which will be operating during the occupation of the space.

Where the evaporator or condenser is located in an air supply duct system and the system serves an un-partitioned multi-storey building, the occupied volume of the smallest occupied storey of the building shall be used.

The space above a false ceiling or partition shall be included in the volume calculation unless the false ceiling is airtight.

Where an indoor unit, or any related refrigerant-containing pipework, is located in a space such that the total charge exceeds the allowable charge, special provisions shall be made to ensure at least an equivalent level of safety. See C.3.

Annex A
(informative)

Equivalent terms in English, French and German

Table A.1 — 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 numbe r
absorption or adsorption system	système à absorption ou à adsorption	Absorptions- oder Adsorptionsanlage	3.1.5
acute toxicity exposure limit	limite d'exposition de toxicité aiguë	Grenzwert für die Belastung durch akute Toxizität	3.7.5
accumulator	accumulateur	Speicher	3.4.12
assembly	assemblage	Baugruppe	3.1.14
autoignition temperature of a substance	température d'inflammation spontanée d'une matière	Selbstentzündungstemper a-tur	3.7.20
brazed joint	joint brasé fort	Hartlötverbindung	3.5.4
bubble point	point d'ébullition	Siedepunkt	3.7.19
bursting disc	disque de rupture	Berstscheibe	3.6.3
cascade system	système en cascade	Kaskadenanlage	3.1.12
changeover valve	inverseur	Wechselventil	3.6.7
coil or grid	serpentin	Rohrschlange	3.4.14
cold room	enceinte réfrigérée	Kühlraum	3.2.7
human comfort air conditioning	conditionnement de l'air de confort	Behaglichkeitsluft-konditionierung	3.8.2
companion valves	contre-robinets de sectionnement	Verbindungsarmatur	3.5.11
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	3.5.7
condenser	condenseur	Verflüssiger	3.4.9
condensing unit	groupe de condensation	Verflüssigungssatz	3.4.16
crawl space	vide sanitaire	Hohlraum	3.2.9
disposal	mise à disposition	Entsorgung	3.7.18
evaporator	évaporateur	Verdampfer	3.4.13

Index of the terms defined in the standard	Répertoire des termes définis dans la norme	Verzeichnis der in der Norm definierten Benennungen	Clause numbe r
exit	sortie	Ausgang	3.2.5
exit passageway	passage de sortie	Ausgangskorridor	3.2.6
factory made	fabriqué en usine	fabrikmäßig zusammengebaut	3.8.5
fixed appliance	appareil fixe	fest installiertes Gerät	3.1.19
flammability	inflammabilité	Brennbarkeit	3.7.7
flanged joint	joint à bride	Flanschverbindung	3.5.5
flared joint	joint évasé	Bördelverbindung	3.5.6
fusible plug	bouchon fusible	Schmelzpropfen	3.6.4
gas cooler	refroidisseur de gaz	Gaskühler	3.4.10
hallway	corridor	Durchgang	3.2.4
halocarbon and hydrocarbon	halocarbure/hydrocarbure	Halogenkohlenwasserstoff und Kohlenwasserstoff	3.7.14
header	collecteur	Sammel- und Verteilstück	3.5.9
heat pump (refrigerating system)	pompe à chaleur [système de réfrigération]	Wärmepumpe [Kälteanlage]	3.1.1
heat-transfer fluid	fluide caloporteur	Wärmeträger	3.7.3
hermetic motor-compressor	motocompresseur hermétique	Hermetischer Motorverdichter	3.4.4.1
high pressure side	côté haute pression	Hochdruckseite	3.1.9
indoor unit	unité intérieure	Innengerät	3.1.18
internal net volume	volume interne net	Nettoinhalt	3.4.18
isolating valves	robinet, de sectionnement	Absperrventil	3.5.12
joint	joint	Verbindung	3.5.2
limit charged system	système à charge limitée	Anlage mit begrenzter Füllmenge	3.1.4
receiver	réservoir	Sammler	3.4.11
liquid level cut out	limiteur de niveau de liquides	Flüssigkeitsstandsbegrenz er	3.6.10
locked valve	soupape verrouillée	gesichertes Ventil	3.5.13
low pressure side	côté basse pression	Niederdruckseite	3.1.10
lower flammability limit	limite inférieure d'inflammabilité	untere Explosionsgrenze	3.7.8
machinery room	salle des machines	Maschinenraum	3.2.1
maximum allowable pressure	pression maximale admissible	max. zulässiger Druck	3.3.1
mobile system	système mobile	Ortsveränderliche Anlage;	3.1.11

Index of the terms defined in the standard	Répertoire des termes définis dans la norme	Verzeichnis der in der Norm definierten Benennungen	Clause numbe r
		Kälteanlage	
motor-compressor	motocompresseur	Motorverdichter	3.4.4
multisplit system	système multisplit	Multi-Split Anlage	3.1.17
nominal size (DN)	diamètre nominal	Nennweite	3.5.14
non-positive displacement compressor	compresseur non volumétrique	Strömungsverdichter	3.4.7
occupied space	espace occupé par des personnes	Personen-Aufenthaltsbereich	3.2.3
open air	air libre	im Freien	3.2.8
open compressor	compresseur ouvert	offener Verdichter	3.4.5
outside air	air extérieur	Außenluft	3.7.13
overflow valve	soupape de décharger	Überströmventil	3.6.8
oxygen depriviation limit	limite de privation d'oxygène	Grenzwert für Sauerstoffmangel	3.7.6
part of the refrigeration system	partie du système frigorifique	Abschnitt der Kälteanlage	3.1.8
piping	tuyauterie	Rohrleitung	3.5.1
positive displacement compressor	compresseur volumétrique	Verdrängerverdichter	3.4.6
practical limit	limite pratique	Praktischer Grenzwert	3.7.9
pressure equipment	équipement sous pression	Druckgeräte	3.1.20
pressure limiter	limiteur de pression	Druckwächter	3.6.6.1
pressure relief device	dispositif de surpression	Druckentlastungseinrichtu ng	3.6.1
pressure relief valve	soupape de sécurité	Druckentlastungsventil	3.6.2
pressure vessel	réservoir à pression	Druckbehälter	3.4.8
quantity limit with additional ventilation	quantité limite avec ventilation supplémentaire	Grenzmenge mit zusätzlicher Belüftung	3.7.11
quantity limit with minimum ventilation	quantité limite avec ventilation minimale	Grenzmenge mit minimaler Belüftung	3.7.12
reclaim	régénérer	Wiederaufbereitung	3.7.17
recover	récupérer	Rückgewinnung	3.7.15
recycle	recycler	Recycling	3.7.16
refrigerant	fluide frigorigène	Kältemittel	3.7.1
refrigerant concentration limit	limite de concentration du fluide frigorigène	Kältemittelkonzentrations - grenze	3.7.10

Index of the terms defined in the standard	Répertoire des termes définis dans la norme	Verzeichnis der in der Norm definierten Benennungen	Clause numbe r
refrigerant detector	détecteur de fluide frigorigène	Kältemitteldetektor	3.8.7
refrigerant type	type de fluide frigorigène	Art des Kältemittels	3.7.2
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
response time	temps de réponse	Reaktionszeit	3.7.21
safety switching device for limiting the pressure	dispositif de sécurité de limitation de la pression	Sicherheitsschalteinrichtu ng zur Druckbegrenzung	3.6.6
sealed system	système scellé	dauerhaft geschlossene Anlage	3.1.7
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	3.6.11
semi-hermetic (accessible sermetic) motor-compressor	motocompresseur hermétique accessible	Halbhermetischer Motorverdichter	3.4.4.2
separate refrigeration machinery room	salle des machines de réfrigération	separater Kältemaschinenraum	3.2.2
shut-off device	dispositif d'arrêt	Absperreinrichtung	3.5.10
split system	système split	Splitanlage	3.1.16
surge drum	réservoir-tampon	Abscheider	3.4.17
surge protection device	dispositif de limitation des surtensions	Schutzeinrichtung gegen Druckstöße (Druckspitzen)	3.6.9
taper pipe thread joint	joint fileté conique	Rohrverbindung mit konischem Gewinde	3.5.8
temperature limiting device	dispositif de limitation de la température	Temperaturbegrenzungsei nrichtung	3.6.5
toxicity	toxicité	Giftigkeit	3.7.4
transcritical cycle	cycle transcritique	transkritischer Kreislauf	3.1.13
type approved component	ayant subi un essai de type	baumustergeprüfte	3.4.19

Index of the terms defined in the standard	Répertoire des termes définis dans la norme	Verzeichnis der in der Norm definierten Benennungen	Clause numbe r
	component	Komponente	
type approved pressure cut out	ayant subi un essai de type pressostat	baumustergeprüfter Druckbegrenzer	3.6.6.3
type approved pressure limiter	limiteur de pression ayant subi un essai de type	baumustergeprüfter Druckwächter	3.6.6.2
type approved safety pressure cut out	ayant subi un essai de type pressostat de sécurité	baumustergeprüfter Sicherheitsdruckbegrenze r	3.6.6.4
unit system	système monobloc	Betriebsfertiger Kältesatz	3.1.3
vacuum procedure	tirage au vide	Evakuieren	3.8.4
ventilated enclosure	gaine ventilée	belüftetes Gehäuse	3.2.10
welded joint	joint soudé	Schweißverbindung	3.5.3

Annex B
(informative)

Total equivalent warming impact (TEWI)

The total equivalent warming impact (TEWI) 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 use of a refrigerating system. 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 intended 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:

— minimize heat load requirements;

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

— optimization 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) shall 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 formula 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 kg of CO_2;
GWP	is the global warming potential, CO_2-related;
L	is the leakage, in kg/y;
n	is the system operating time, in y;
m	is the refrigerant charge, in kg;
α_{recovery}	is the recovery/recycling factor, 0 to 1;
E_{annual}	is the energy consumption, in kW/y;
β	is the CO_2-emission, in kg/kWh.

NOTE 2 The GWP (en: **g**lobal **w**arming **p**otential) is an index describing the radiative 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:

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

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 kg;
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 limit requirements

C.1 Charge limits requirements for refrigerating systems

Refrigerant charge limits shall be calculated according to Table C.1 and Table C.2 depending on the toxicity and/or the flammability of the refrigerant.

Where more restrictive national or regional regulations exist, they take precedence over the charge limit requirements of this standard.

The following method shall be applied to determine the charge limit of a refrigerating system:

a) determine the appropriate access category a, b or c according to Table 4 and location I, II, III, or IV according to 5.3 for the system;

b) determine the toxicity class of the refrigerant used in the refrigerating system which will be A or B, being the first character in the safety class specified in Annex E. The toxicity limit equals ATEL/ODL values (see Annex E) or the practical limit (see Annex E) whichever is higher;

c) determine the charge limit for the refrigerating system based on toxicity as the greater of:

   1) Charge limit from Table C.1;

   2) 20 m^3 multiplied by the toxicity limit for sealed refrigerating systems;

   3) 150 g for sealed refrigerating system using toxicity class A refrigerant;

d) determine the flammability class of the refrigerant used in the refrigerating system which will be 1, 2L, 2 or 3, being the characters following A or B in the safety class specified in Annex E. Determine the corresponding LFL according to Annex E;

e) determine the charge limit for the refrigerating system based on flammability as the greater of:

   1) Charge limit from Table C.2;

   2) m_1 x 1,5 for sealed refrigerating systems using flammability class 2L;

   3) m_1 for sealed refrigerating systems using flammability class 2 or 3;

   4) 150 g for sealed refrigerating systems;

f) apply the lowest refrigerant charge obtained according to c) and e). For determination of charge limits for refrigerants of flammability class 1, e) is not applicable.

The charge limits in Table C.2 are capped to a limit based upon the LFL of the refrigerant. In case of flammability class 2 or 3 refrigerants, the basic cap factor is m_1, m_2 and m_3. For flammability class 2L refrigerants the basic cap factor is increased by a factor of 1,5 in recognition of the lower burning velocities of these refrigerants, which lead to a reduced probability and consequence of ignition.

The cap factors shown in Table C.2 are:

- $m_1 = 4\ m^3 \times LFL$
- $m_2 = 26\ m^3 \times LFL$
- $m_3 = 130\ m^3 \times LFL$

where LFL equals the lower flammable limit in kg/m^3 according to Annex E.

NOTE The multiplier of 4, 26 and 130 are based on a charge of 150 g, 1 kg, and 5 kg respectively of R-290.

Table C.1 — Charge limit requirements for refrigerating systems based on toxicity

<table>
<tr><th rowspan="2">Toxicity class</th><th rowspan="2" colspan="2">Access category</th><th colspan="4">Location classification</th></tr>
<tr><th>I</th><th>II</th><th>III</th><th>IV</th></tr>
<tr><td rowspan="5">A</td><td colspan="2">a</td><td colspan="2">Toxicity limit × Room volume or see C.3</td><td rowspan="5">No charge restriction [a]</td><td rowspan="7">The charge requirements based on toxicity shall be assessed according to location I, II or III, depending on the location of the ventilated enclosure</td></tr>
<tr><td rowspan="2">b</td><td>Upper floors without emergency exits or Below ground floor level</td><td>Toxicity limit × Room volume
or see C.3</td><td rowspan="4">No charge restriction [a]</td></tr>
<tr><td>Other</td><td>No charge restriction [a]</td></tr>
<tr><td rowspan="2">c</td><td>Upper floors without emergency exits or Below ground floor level</td><td>Toxicity limit × Room volume
or see C.3</td></tr>
<tr><td>Other</td><td>No charge restriction [a]</td></tr>
<tr><td rowspan="2">B</td><td colspan="2">a</td><td colspan="2">For sealed sorption systems, toxicity limit × Room volume and not more than 2,5 kg,

all other systems, toxicity limit × Room volume</td><td rowspan="2">No charge restriction[a]</td></tr>
<tr><td>b</td><td>Upper floors without emergency exits or Below ground</td><td>Toxicity limit × Room volume</td><td>Charge not more than 25 kg[a]</td></tr>
</table>

		floor level				
		Density of personnel <1 person per 10 m^2	Charge not more than 10 kg[a]	No charge restriction[a]		
		Other		Charge not more than 25 kg[a]		
	c	Density of personnel <1 person per 10 m^2	Charge not more than 50 kg[a] and emergency exits are available	No charge restriction[a]		
		Other	Charge not more than 10 kg[a]	Charge not more than 25 kg[a]		

[a] For open air, [A1⟩ EN 378-3:2016+A1:2020 ⟨A1], 4.2 applies and, for machinery rooms, [A1⟩ EN 378-3:2016+A1:2020 ⟨A1], 4.3 applies.

Table C.2 — Charge limit requirements for refrigerating systems based on flammability

Flammability class	Access category		Location classification I	II	III	IV
			I	II	III	IV
2L	a	Human comfort	According to C.2 and not more than m_2 [a] × 1,5 or According to C.3 and not more than m_3 [b] × 1,5		No charge restriction [c]	Refrigerant charge not more than m_3[b] × 1,5
		Other applications	20 % x LFL × Room volume and not more than m_2 [a] × 1,5 or According to C.3 and not more than m_3 [b] × 1,5			
	b	Human comfort	According to C.2 and not more than m_2 [a] × 1,5 or According to C.3 and not more than m_3 [b] × 1,5			
		Other applications	20 % × LFL × Room volume and not more than m_2 [a] × 1,5 or according to C.3 and not more than m_3 [b] × 1,5	20 % × LFL × Room volume and not more than 25 kg[c] or according to C.3 and not more than m_3 [b] × 1,5		
	c	Human comfort	According to C.2 and not more than m_2[a] × 1,5 or According to C.3 and not more than m_3[b] × 1,5			
		Other applications	20 % × LFL × Room volume and not more than m_2 [a] × 1,5 or according to C.3 and not	20 % × LFL × Room volume and not more than 25 kg [c] or according to C.3 and not		

Flammability class	Access category	Location classification I	Location classification II	Location classification III	Location classification IV
		more than m_3 [b] × 1,5	more than m_3 [b] × 1,5		
	<1 person per 10 m^2	20 % × LFL × Room volume and not more than 50 kg [a] or according to C.3 and not more than m_3 [b] × 1,5	No charge restriction [c]		

[a] $m_2 = 26\ m^3 \times$ LFL.

[b] $m_3 = 130\ m^3 \times$ LFL.

[c] For open air, [A1] EN 378-3:2016+A1:2020 [/A1], 4.2 applies and, for machinery rooms, [A1] EN 378-3:2016+A1:2020 [/A1], 4.3 applies.

<table>
<tr><th rowspan="2">Flammability class</th><th rowspan="2" colspan="3">Access category</th><th colspan="4">Location classification</th></tr>
<tr><th>I</th><th>II</th><th>III</th><th>IV</th></tr>
<tr><td rowspan="7">2</td><td rowspan="2">a</td><td colspan="2">Human comfort</td><td colspan="2">According to C.2 and not more than m_2 [a]</td><td rowspan="7">No charge restriction [c]</td><td rowspan="7">Refrigerant charge not more
than m_3 [b]</td></tr>
<tr><td colspan="2">Other applications</td><td colspan="2">20 % × LFL × Room volume and not more than m_2 [a]</td></tr>
<tr><td rowspan="2">b</td><td colspan="2">Human comfort</td><td colspan="2">According to C.2 and not more than m_2 [a]</td></tr>
<tr><td colspan="2">Other applications</td><td colspan="2">20 % × LFL × Room volume and not more than m_2 [a]</td></tr>
<tr><td rowspan="3">c</td><td colspan="2">Human comfort</td><td colspan="2">According to C.2 and not more than m_2 [a]</td></tr>
<tr><td rowspan="2">Other applications</td><td>Below ground</td><td colspan="2">20 % × LFL × Room volume and not more than m_2 [a]</td></tr>
<tr><td>Above ground</td><td>20 % × LFL × Room volume and not more than 10 kg [c]</td><td>20 % × LFL × Room volume and not more than 25 kg [c]</td></tr>
<tr><td colspan="8">[a] $m_2 = 26\ m^3 \times LFL$.
[b] $m_3 = 130\ m^3 \times LFL$.
[c] For open air, [A1] EN 378-3:2016+A1:2020 [A1], 4.2 applies and, for machinery rooms, [A1] EN 378-3:2016+A1:2020 [A1], 4.3 applies.</td></tr>
</table>

Flammability class	Access category			Location classification I	II	III	IV
3	a	Human comfort		According to C.2 and not more than the greater of m_2 or 1,5 kg		Not more than 5 kg [c]	Refrigerant charge not more than m_3 [b]
		Other applications	Below ground	Only sealed systems: 20 % × LFL × Room volume and not more than 1 kg			
			Above ground	Only sealed systems: 20 % × LFL × Room volume and not more than 1,5 kg			
	b	Human comfort		According to C.2. and not more than the greater of m_2 or 1,5 kg		Not more than 10 kg [c]	
		Other applications	Below ground	20 % × LFL × Room volume and not more than 1 kg [a]			
			Above ground	20 % × LFL × Room volume and not more than 2,5 kg			
	c	Human comfort		According to C.2. and not more than the greater of m_2 or 1,5 kg.		No charge restriction [c]	
		Other applications	Below ground	20 % × LFL × Room volume and not more than 1 kg [c]			
			Above ground	20 % × LFL × Room volume and not more than 10 kg [c]	20 % × LFL × Room volume and not more than 25 kg [c]		

Flammabi lity class	Access category	Location classification			
		I	II	III	IV

a $m_2 = 26\ m^3 \times LFL$.

b $m_3 = 130\ m^3 \times LFL$.

c For open air, [A1] EN 378-3:2016+A1:2020 [A1], 4.2 applies and, for machinery rooms, [A1] EN 378-3:2016+A1:2020 [A1], 4.3 applies.

C.2 Charge limitations due to flammability for air conditioning systems or heat pumps for human comfort

C.2.1 Refrigerant-containing parts in a occupied space

When the charge of refrigerants with flammability class 2L is greater than m_1 x 1,5, the maximum charge in the room shall be in accordance with Formula (C.1). When the charge of refrigerants with flammability class 2 and 3 is greater than m_1, the maximum charge in the room shall be in accordance with Formula (C.1) or the required minimum floor area A_{min} to install a system with refrigerant charge m (kg) shall be in accordance with Formula (C.2).

$$m_{max} = 2{,}5 \times \text{LFL}^{5/4} \times h_0 \times A^{1/2} \quad \text{(C.1)}$$

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

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 in kg/m^3, as defined in Annex E;

h_0 is the height factor of the appliance:

— 0,6 for floor location;

— 1,8 for wall mounted;

— 1,0 for window mounted;

— 2,2 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 g/mol.

NOTE Calculation examples are provided in Annex H.

C.2.2 Special requirements for non fixed factory sealed single package air conditioning 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 in accordance with Formula (C.3), the maximum charge in a room shall be in accordance with Formula (C.4), or the required minimum floor area, A_{min} to install an appliance with refrigerant charge m (kg) shall be in accordance with Formula (C.5):

$$4 \times \text{LFL} < m \leq 8 \times \text{LFL} \quad \text{(C.3)}$$

$$m_{max} = 0{,}25 \times A \times \text{LFL} \times 2{,}2 \quad \text{(C.4)}$$

$$A_{min} = m/(0,25 \times LFL \times 2,2) \quad (C.5)$$

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 in kg/m^3, as defined 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 at least the minimum airflow required under normal steady-state conditions, even when the compressor is switched off by the thermostat.

C.3 Alternative for risk management of refrigerating systems in occupied spaces

C.3.1 General

Where the combination of location classification and access categories shown in Table C.1 and Table C.2 allow the use of the alternative provisions then the designer can choose (for some or all of the occupied spaces served by the equipment) to calculate the allowable refrigerant charge using the RCL, QLMV or QLAV values in C.3.2. All occupied spaces where refrigerant-containing parts of the system are located shall be considered in calculating the allowable refrigerant charge.

These alternative provisions can only be used for an occupied space which fulfils all of following conditions:

— systems where the refrigerant is classified as A1 or A2L according to Annex E;

— systems where the refrigerant charge does not exceed 150 kg and does not exceed 1,5 × m_3 for A2L refrigerants;

— [A1) systems where all branches (e.g. headers or Tees) and all changes in diameter (e.g. reducers) in refrigerant-containing piping in the occupied space in question are manufactured from factory-made fittings or manifolds;

— systems which are split systems and where design, sizing, and selection of materials and of components of field installed refrigerant-containing piping in the occupied space in question are in accordance with the instructions of the manufacturers of the factory-made units;

— systems where no valves (e.g. expansion valves, switch-over valves, service valves) or service ports are installed in the in the occupied space in question, with the exception of valves or service ports which are part of the factory-made units; (A1]

— system location is class II in accordance with 5.3;

— systems where the heat exchanger in the indoor unit and the control of the system are designed to prevent damage due to ice formation;

— systems where the refrigerant-containing parts of the indoor unit are protected against fan breakage or the fan is designed to prevent breakage;

— systems where only permanent joints are used in the occupied space in question except for site-made joints directly connecting the indoor unit to the piping;

— systems where the refrigerant-containing pipes in the occupied space in question are installed in such way that it is protected against accidental damage in accordance with EN 378-2:2016, 6.2.3.3.4 and A1) EN 378-3:2016+A1:2020 (A1, 6.2;

— alternative provisions to ensure safety are provided in accordance with C.3.2.2 and C.3.2.3;

— doors of the occupied space are not tight-fitting;

— effect of flow down is mitigated in accordance with C.3.2.4.

NOTE Provided all of the above conditions are fulfilled, the maximum leakage in the occupied space is assumed to be not greater than that resulting from a pinhole leak, and the maximum charge is calculated on that basis.

C.3.2 Allowable charge

C.3.2.1 General

For occupied spaces exceeding 250 m^2, the charge limits calculation shall use 250 m^2 as the room floor area for determination of the room volume

The total charge of the system divided by the room volume shall not exceed the QLMV value in Table C.3 (or if the lowest floor is underground, the RCL value in Table C.3) unless appropriate measures are taken. If the value exceeds the QLMV or RCL, appropriate measures shall be taken in accordance with C.3.2.2 or C.3.2.3. The appropriate measure shall be ventilation (natural or mechanical), safety shut-off valves and safety alarm, in conjunction with a gas detection device, see in A1) EN 378-3:2016+A1:2020 (A1, Clauses 6, 8, 9 and 10. A safety alarm alone shall not be considered as an appropriate measure where occupants are restricted in their movement (see A1) EN 378-3:2016+A1:2020 (A1, 8.1).

NOTE 1 For systems that are installed and operated within the constraints of C.3.1 the risk of rapid release of refrigerant through a major leak has been minimized. The calculation of ventilation rate in this annex has therefore been based on a maximum leakage rate of 10 kg/h.

NOTE 2 QLMV is based on a room height of 2,2 m and an opening of 0,003 2 m^2 (calculated from a 0,8 m width door and 4 mm gap typical of rooms without designed ventilation).

NOTE 3 QLAV is based on an oxygen concentration of 18,5 vol % assuming perfect mixing.

NOTE 4 Calculation examples are provided in Annex H.

Table C.3 — Allowable refrigerant charge

Refrigerant	Allowable concentration (kg/m^3) RCL	QLMV (kg/m^3)	QLAV (kg/m^3)
R-22	0,21	0,28	0,50 [a]
R-134a	0,21	0,28	0,58 [a]
R-407C	0,27	0,44	0,49 [a]
R-410A	0,39	0,42	0,42 [a]
R-744	0,072	0,074	0,18 [b]
R-32	0,061	0,063	0,15 [c]
R-1234yf	0,058	0,060	0,14 [c]
R-1234ze	0,061	0,063	0,15 [c]

[a] Based on ODL

[b] Based on a volume fraction of 10 %

[c] Based on 50 % LFL

For refrigerants not listed in Table C.3, QLAV shall be the lower of:

- For R-744 a volume fraction of 10 % (due to acute anaesthetic effect);
- ODL;
- 50 % of LFL for class 2L refrigerants.

For refrigerants not listed in Table C.3, Formula (C.6) shall be used for the calculation of QLMV:

$$\text{QLMV} = s\big|_{\text{x=RCL}} \times \dot{m} \qquad \text{(C.6)}$$

where

$s\big|_{\text{x=RCL}}$ is the point in normalized time *s*, when the concentration x = *RCL*, and is found by solving

$$\frac{dx}{ds} = \dot{m} - x \times A \times c \times \sqrt{2 \times \left(1 - \frac{\rho_a}{\rho}\right) \times h \times g}$$

x is the refrigerant concentration in the room (kg/m^3);

s is the time since the leak started divided by the room volume (s/m^3);

$\dot{m}$ is the leak rate from refrigerating system (0,002 78 kg/s);

A is the opening area (m^2) to give the minimum ventilation rate typical of rooms without designed ventilation, 0,004 m × 0,8 m = 0,003 2 m^2;

c is the flow coefficient equal to 1;

ρ is the density of refrigerant air mixture (kg/m^3) where $\rho = x + \rho_a - x\frac{\rho_a}{\rho_r}$;

ρ_a is the air density (kg/m^3) (calculated based on molar mass of air = 29 and ISO 817);

ρ_r is the refrigerant density (kg/m^3) (calculated based on molar mass and ISO 817);

h is the height of ceiling (m).

The QLMV of refrigerants with molecular mass between 50 g/mol and 125 g/mol can be determined by linear interpolation of the values given in Table C.4.

Where the above gives an undefined QLMV or QLMV above QLAV, QLMV equal to QLAV shall be used.

Table C.4 — Interpolation table for calculating QLMV

RCL	Molecular mass			
	50	75	100	125
0,05	0,051	0,051	0,051	0,051
0,10	0,106	0,108	0,108	0,109
0,15	0,168	0,173	0,175	0,176
0,20	0,242	0,254	0,260	0,264
0,25	0,336	0,367	0,383	0,394
0,30	0,470	0,564	0,633	0,689
0,35	0,724	-	-	-

C.3.2.2 Occupancies except those on the lowest underground floor of the building

Where the refrigerant charge divided by the room volume does not exceed the QLMV, no additional measures are required.

Where the value is more than the QLMV but less than or equal to QLAV value, at least one of the measures described in [A1) EN 378-3:2016+A1:2020 (A1], Clauses 6 and 8 shall be applied. Where the value exceeds the QLAV, at least two of the specified measures shall be applied.

C.3.2.3 Occupancies on the lowest underground floor of the building

Where the refrigerant charge divided by the room volume is more than the RCL value in Table C.3 but less than or equal to QLMV value, at least one of the measures described in [A1) EN 378-3:2016+A1:2020 (A1], Clauses 6, 8 and 9 shall be applied. Where the value exceeds the QLMV, at least two of the specified measures shall be applied. The value shall not exceed QLAV value.

C.3.2.4 Effect of flow down

Even if there is no refrigerating system on the lowest floor, where the largest system charge in the building divided by the total volume of the lowest floor exceeds QLMV value, mechanical ventilation shall be provided in accordance with [A1) EN 378-3:2016+A1:2020 (A1], 6.3.

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 (which may be cooled by 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. This annex is limited to cold rooms operating at below 0 °C.

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

Depending on the operating conditions the following devices should be provided in cold rooms with a volume of more than 10 m^3 if required:

a) alarm switch 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 without attending to the alarm. The alarm switch should be fitted with an illuminated sign or fluorescent label and should be able to be activated from the floor by means of e.g. a robust wire pull cord or chain. In large cold stores with multiple exits additional alarm switches may be necessary;

b) signal devices connected to an electric circuit with a voltage of at least 12 V. Batteries for this purpose should 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. Light switches should have permanently illuminated buttons;

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) permanent emergency lighting system, which is illuminated whenever the cold room lights are switched off.

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.

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 is less than 18 % and/or the concentration of carbon dioxide is greater than 4 %) 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 needs 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

In Tables E.1, E.2, E.3 the vapour density, molecular mass, normal boiling point (with bubble point and dew point), azeotropic temperatures, ODP and GWP (AR5) are not part of this European Standard and are provided for information purposes only.

A1⟩

Table E.1 — Refrigerant designations

Refrigerant number	Chemical name [b]	Chemical formula	Safety class	PED [m] fluid group	Practical limit [d] kg/m³	ATEL/ ODL [g] kg/m³	LFL [h] kg/m³	Vapour density 25 °C, 101,3 kPa [a] kg/m³	Molecular mass [a]	Normal boiling point [a] °C	ODP [a e]	GWP [l] 100 yr ITH	GWP [a f] (AR5) 100 yr ITH	Auto ignition temperature °C
Methane series														
11	Trichlorofluoromethane	CCl_3F	A1	2	0,3 [i]	0,0062[j]	NF	5,62	137,4	24	1	4 750	4 660	ND
12	Dichlorodifluoromethane	CCl_2F_2	A1	2	0,5 [i]	0,088 [j]	NF	4,94	120,9	−29	1	10 900	10 200	ND
12B1	Bromochlorodifluoromethane	$CBrClF_2$	ND	ND	0,2	ND	NF	6,76	165,4	−4	3	1 890	1 750	N.D
13	Chlorotrifluoromethane	$CClF_3$	A1	2	0,5 [i]	ND	NF	4,27	104,5	−81	1	14 400	13 900	ND
13B1	Bromotrifluoromethane	$CBrF_3$	A1	2	0,6 [i]	ND	NF	6,09	148,9	−58	10	7 140	6 290	ND
14	Carbon tetrafluoride	CF_4	A1	2	0,4	0,40 [j]	NF	3,60	88,0	−128	0	7 390	6 630	ND
22	Chlorodifluoromethane	$CHClF_2$	A1	2	0,3 [i]	0,21 [j]	NF	3,54	86,5	−41	0,055	1 810	1 760	635
23	Trifluoromethane	CHF_3	A1	2	0,68 [i]	0,15	NF	2,86	70,0	−82	0	14 800	12 400	765
30	Dichloromethane (methylene chloride)	CH_2Cl_2	B2	2	0,017	ND	0,417	NA	84,9	40	ND	9	9	662

Refrigerant number	Chemical name [b]	Chemical formula	Safety class	PED [m] fluid group	Practical limit [d] kg/m^3	ATEL/ ODL [g] kg/m^3	LFL [h] kg/m^3	Vapour density 25 °C, 101,3 kPa [a] kg/m^3	Molecular mass [a]	Normal boiling point [a] °C	ODP [a e]	GWP [l] 100 yr ITH	GWP [a f] (AR5) 100 yr ITH	Auto ignition temperature °C
32	Difluoromethane (methylene fluoride)	CH_2F_2	A2L	1	0,061	0,30 [j]	0,307	2,13	52,0	−52	0	675	677	648
50	Methane	CH_4	A3	1	0,006	ND	0,032	0,654	16,0	−161	0	25	30	645
Ethane series														
113	1,1,2-trichloro-1,2,2-trifluoroethane	CCl_2FCClF_2	A1	2	0,4 [i]	0,02 [j]	NF	NA	187,4	48	0,8	6 130	5 820	ND
114	1,2-dichloro-1,1,2,2-tetrafluoroethane	$CClF_2CClF_2$	A1	2	0,7 [i]	0,14 [j]	NF	6,99	170,9	4	1	10 000	8 590	ND
115	Chloropentafluoroethane	$CClF_2CF_3$	A1	2	0,76 [i]	0,76 [j]	NF	6,32	154,5	−39	0,6	7 370	7 670	ND
116	Hexafluoroethane	CF_3CF_3	A1	2	0,68	0,68	NF	5,64	138,0	−78	0	12 200	11 100	ND
123	2,2-dichloro-1,1,1-trifluoroethane	$CHCl_2CF_3$	B1	2	0,1 [i]	0,057 [j]	NF	NA	153,0	27	0,02	77	79	730
124	2-chloro-1,1,1,2-tetrafluoroethane	$CHClFCF_3$	A1	2	0,11 [i]	0,056 [j]	NF	5,58	136,5	−12	0,022	609	527	ND
125	Pentafluoroethane	CHF_2CF_3	A1	2	0,39 [i]	0,37 [j]	NF	4,91	120,0	−49	0	3 500	3 170	733
134a	1,1,1,2-tetrafluoroethane	CH_2FCF_3	A1	2	0,25 [i]	0,21 [j]	NF	4,17	102,0	−26	0	1 430	1 300	743
141b	1,1-dichloro-1-fluoroethane	CH_3CCl_2F	ND	2	0,053	0,012 [j]	NA	NA	117,0	32	0,11	725	782	532
142b	1-chloro-1,1-difluoroethane	CH_3CClF_2	A2	1	0,066	0,10 [j]	0,329	4,11	100,5	−10	0,065	2 310	1 980	750
143a	1,1,1-trifluoroethane	CH_3CF_3	A2L	1	0,056	0,58 [j]	0,282	3,44	84,0	−47	0	4 470	4 800	750
152a	1,1-difluoroethane	CH_3CHF_2	A2	1	0,027 [i]	0,14	0,130	2,70	66,0	−25	0	124	138	455
170	Ethane	CH_3CH_3	A3	1	0,008 6	0,008 6 [j]	0,038	1,23	30,0	−89	0	6	6	515
1150	Ethene (ethylene)	$CH_2 = CH_2$	A3	1	0,006	ND	0,036	1,15	28,1	−104	0	4	4	ND

Refrigerant number	Chemical name [b]	Chemical formula	Safety class	PED [m] fluid group	Practical limit [d] kg/m³	ATEL/ ODL [g] kg/m³	LFL [h] kg/m³	Vapour density 25 °C, 101,3 kPa [a] kg/m³	Molecular mass [a]	Normal boiling point [a] °C	ODP [a e]	GWP [l] 100 yr ITH	GWP [a f] (AR5) 100 yr ITH	Auto ignition temperature °C
Propane series														
218	Octafluoropropane	$CF_3CF_2CF_3$	A1	2	1,84	0,85 [j]	NF	7,69	188,0	-37	0	8 830	8 900	ND
227ea	1,1,1,2,3,3,3-heptafluoropropane	CF_3CHFCF_3	A1	2	0,63	0,63 [j]	NF	6,95	170,0	-15	0	3 220	3 350	ND
236fa	1,1,1,3,3,3-hexafluoropropane	$CF_3CH_2CF_3$	A1	2	0,59 [i]	0,34 [j]	NF	6,22	152,0	-1	0	9 810	8 060	ND
245fa	1,1,1,3,3-pentafluoropropane	$CF_3CH_2CHF_2$	B1	2	0,19	0,19	NF	5,48	134,0	15	0	1 030	858	ND
290	Propane	$CH_3CH_2CH_3$	A3	1	0,008	0,09	0,038	1,80	44,0	-42	0	3	3	470
1233zd(E)	Trans-1-chloro-3,3,3-trifluoroprop-1-ene	CF3CH = CHCl	A1	2	0,086	0,086	NF	5,34	130,5	18,1	~0	4,5	1	ND
1234yf	2,3,3,3-tetrafluoroprop-1-ene	$CF_3CF = CH_2$	A2L	1	0,058	0,47 [j]	0,289	4,66	114,0	-29,5	0	4	< 1	405
1234ze(E)	Trans-1,3,3,3-tetrafuoroprop-1-ene	$CF_3CF = CHF$	A2L	2 [n]	0,061	0,28	0,303	4,66	114,0	-19	0	7	< 1	368
1270	Propene (propylene)	$CH_3CH = CH_2$	A3	1	0,008 [i]	0,001 7 [j k]	0,046	1,72	42,1	-48	0	2	2	455
Ethene series														
1130 (E)	Trans-1,2-dichloroethene	CHCl = CHCl	B2	1	0,004	0,004	0,257	NA	96,9	47,7	~0	0	ND	ND
Butene series														
1336mzz(E)	trans-1,1,1,4,4,4-hexafluoro-2-butene	CF3CH = CHCF3	A1	2	0,048	0,048	NF	6,93	164,1	7,4	0	9	9	ND
1336mzz(Z)	cis-1,1,1,4,4,4-hexafluoro-2-butene	CF3CH = CHCF3	A1	2	0,087	0,087	NF	NA	164,1	33,4	0	9	2	ND
Cyclic organic compounds														
C318	Octafluorocyclobutane	C_4F_8	A1	2	0,81	0,65	NF	8,18	200,0	-6	0	10 300	9 540	ND

Refrigerant number	Chemical name [b]	Chemical formula	Safety class	PED [m] fluid group	Practical limit [d] kg/m³	ATEL/ ODL [g] kg/m³	LFL [h] kg/m³	Vapour density 25 °C, 101,3 kPa [a] kg/m³	Molecular mass [a]	Normal boiling point [a] °C	ODP [a e]	GWP [l] 100 yr ITH	GWP [a f] (AR5) 100 yr ITH	Auto ignition temperature °C
Hydrocarbons														
600	Butane	$CH_3CH_2CH_2CH_3$	A3	1	0,008 9 [i]	0,002 4 [jk]	0,038	2,38	58,1	0	0	4	4	365
600a	2-methyl propane (isobutane)	$CH(CH_3)_3$	A3	1	0,011 [i]	0,059	0,043	2,38	58,1	−12	0	3	3	460
601	Pentane	$CH_3CH_2CH_2CH_2CH_3$	A3	1	0,008 [i]	0,002 9 [jk]	0,035	NA	72,1	36	0	5	5	ND
601a	2methyl butane (isopentane)	$(CH_3)_2CHCH_2CH_3$	A3	1	0,008 [i]	0,002 9 [jk]	0,038	NA	72,1	27	0	5	5	ND
Other organic compounds														
E170	Dimethyl ether	(CH3)2O	A3	1	0,013 [i]	0,079	0,064	1,88	46	−25	0	1	1	235
Inorganic compounds														
717	Ammonia	NH_3	B2L	1	0,000 35 [i]	0,000 22 [j]	0,116	0,70	17,0	−33	0	0	0	630
744	Carbon dioxide	CO_2	A1	2	0,1 [i]	0,072 [j]	NF	1,80	44,0	−78 [c]	0	1	1	ND

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

NA signifies not applicable.

ND signifies not determined.

NF signifies non-flammable.

Refrigerant number	Chemical name [b]	Chemical formula	Safety class	PED [m] fluid group	Practical limit [d]	ATEL/ ODL [g]	LFL [h]	Vapour density 25 °C, 101,3 kPa [a]	Molecular mass [a]	Normal boiling point [a]	ODP [a e]	GWP [l]	GWP [a f] (AR5)	Auto ignition temperature
					kg/m^3	kg/m^3	kg/m^3	kg/m^3		°C		100 yr ITH	100 yr ITH	°C

a The vapour density, molecular mass, normal boiling point, ODP and GWP (AR5) are not part of this European Standard and are provided for information purposes only.

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

c Sublimation temperature. Triple point is −56,6 °C at 5,2 bar.

d Determined according to 5.2 of this standard.

e Adopted under the Montreal Protocol.

f Data from IPCC Assessment Report V (AR5); for HCs which are not included in AR5, data from F-Gas regulation N° 517/2014.

g Acute-Toxicity Exposure Limit (ATEL) or Oxygen Deprivation Limit (ODL), whichever is lower values taken from ISO 817.

h Lower Flammability Limit.

i Practical limit values are grandfathered according to 5.2.

j ATEL/ODL values are changed in comparison to EN 378-1:2008+A2:2012 according to data from ISO 817.

k No cardiac NOEL value available, value determined according to ISO 817.

l Data from European F-Gas regulation N° 517/2014; for CFCs and for HCFCs which are not included in F-Gas regulation N° 517/2014, data from IPCC assessment report IV.

m PED = Pressure Equipment Directive 2014/68/EU.

n According to the test conditions in ISO 817, the refrigerant is classed as 2L, however the PED fluid group is 2, based on CLP Regulation (EC) 1272/2008.

Table E.2 — Refrigerant designations of R400 blends

Refrigerant number	Composition [c] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m³	ATEL/ ODL [g] kg/m³	LFL [h] kg/m³	Vapour density 25 °C, 101,3 kPa [a] kg/m³	Molecular mass [a]	Normal boiling point [a] °C	ODP [a] [e]	GWP [a] [f] [k] 100 yr ITH	GWP [a] [f] [m] (AR5) 100 yr ITH	Auto-ignition temperature °C
401A	R-22/152a/124 (53/13/34)	±2/+0,5 – 1,5/ ± 1	A1	2	0,30 [i]	0,10 [j]	NF	3,86	94,4	– 33,4 to – 27,8	0,037	1 182	1 130	681
401B	R-22/152a/124 (61/11/28)	±2/+0,5 – 1,5/ ± 1	A1	2	0,34 [i]	0,11	NF	3,80	92,8	– 34,9 to – 29,6	0,04	1 288	1 240	685
401C	R-22/152a/124 (33/15/52)	±2/+0,5 – 1,5/ ± 1	A1	2	0,24 [i]	0,083 [j]	NF	4,13	101	– 28,9 to – 23,3	0,03	932,6	876	ND
402A	R-125/290/22 (60/2/38)	±2/+0,1 – 1,0/ ± 2	A1	2	0,33 [i]	0,27 [j]	NF	4,16	101,5	– 49,2 to – 47,0	0,021	2 788	2 570	723
402B	R-125/290/22 (38/2/60)	±2/+0,1 – 1,0/ ± 2	A1	2	0,32 [i]	0,24 [j]	NF	3,87	94,7	– 47,2 to – 44,8	0,033	2 416	2 260	641
403A	R-290/22/218 (5/75/20)	+0,2 – 2,0/ ± 2/ ± 2	A1	2	0,33 [i]	0,24 [j]	0,480	3,76	92	–43,8 to –42,3	0,041	3 124	3 100	ND
403B	R-290/22/218 (5/56/39)	+0,2 – 2,0/ ± 2/ ± 2	A1	2	0,41 [i]	0,29	NF	4,22	103,3	– 49,1 to – 46,84	0,031	4 457	4 460	ND
404A	R-125/143a/134a (44/52/4)	±2/ ± 1/ ± 2	A1	2	0,52	0,52 [j]	NF	3,99	97,6	– 46,5 to – 45,7	0	3 922	3 940	728
405A	R-22/152a/142b/C318 (45/7/5,5/42,5)	±2/ ± 1/ ± 1/ ± 2 [b]	A1	2	ND	0,26	ND	4,58	111,9	– 32,8 to – 24,4	0,028	5 328	4 970	ND
406A	R-22/600a/142b (55/4/41)	±2/ ± 1/ ± 1	A2	1	0,13	0,14	0,302	3,68	89,9	– 32,7 to – 23,5	0,057	1 943	1 780	ND
407A	R-32/125/134a (20/40/40)	±2/ ± 2/ ± 2	A1	2	0,33 [i]	0,31 [j]	NF	3,68	90,1	– 45,2 to – 38,7	0	2 107	1 920	685
407B	R-32/125/134a (10/70/20)	±2/ ± 2/ ± 2	A1	2	0,35 [i]	0,33 [j]	NF	4,21	102,9	– 46,8 to – 42,4	0	2 804	2 550	703
407C	R-32/125/134a (23/25/52)	±2/ ± 2/ ± 2	A1	2	0,31 [i]	0,29 [j]	NF	3,53	86,2	– 43,8 to – 36,7	0	1 774	1 620	704
407D	R-32/125/134a (15/15/70)	±2/ ± 2/ ± 2	A1	2	0,41 [i]	0,25 [j]	NF	3,72	90,9	– 39,4 to – 32,7	0	1 627	1 490	ND
407E	R-32/125/134a (25/15/60)	±2/ ± 2/ ± 2	A1	2	0,40 [i]	0,27 [j]	NF	3,43	83,8	– 42,8 to – 35,6	0	1 552	1 420	ND
407F	R-32/125/134a (30/30/40)	±2/ ± 2/ ± 2	A1	2	0,32	0,32	NF	3,36	82,1	– 46,1 to – 39,7	0	1 825	1 670	ND
407G	R-32/125/134a (2,5/2,5/95,0)	±0,5/ ± 0,5/ ± 1,0	A1	2	0,21	0,21	NF	4,2	100,0	– 29,2 to – 27,2	0	1 463	1 330	ND

Refrigerant number	Composition [c] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m^3	ATEL/ ODL [g] kg/m^3	LFL [h] kg/m^3	Vapour density 25 °C, 101,3 kPa [a] kg/m^3	Molecular mass [a]	Normal boiling point [a] °C	ODP [a] [e]	GWP [a f k] 100 yr ITH	GWP [a f m] (AR5) 100 yr ITH	Auto-ignition temperature °C
407H	R-32/125/134a (32,5/15/52,5)	±1,0/ ± 1,0/ ± 2,0	A1	2	0,38	0,38	NF	3,28	79,1	– 44,7 to – 37,6	0	1 495	1 380	ND
407I	R-32/125/134a (19,5/8,5/72)	1,0 –2,0/+2,0 –1,0/ ± 2,0	A1	2	0,25	0,25	NF	3,61	86,9	–39,8 to –33,0	0	1 459	1 340	ND
408A	R-125/143a/22 (7/46/47)	±2/ ± 1/ ± 2	A1	2	0,41 [i]	0,33 [j]	NF	3,56	87,0	– 44,6 to – 44,1	0,026	3 152	3 260	ND
409A	R-22/124/142b (60/25/15)	±2/ ± 2/ ± 1	A1	2	0,16 [i]	0,12 [j]	NF	3,98	97,5	– 34,7 to – 26,3	0,048	1 585	1 480	ND
409B	R-22/124/142b (65/25/10)	±2/ ± 2/ ± 1	A1	2	0,17 [i]	0,12 [j]	NF	3,95	96,7	– 35,8 to – 28,2	0,048	1 560	1 470	ND
410A	R-32/125 (50/50)	+0,5 – 1,5/+1,5 – 0,5	A1	2	0,44 [i]	0,42 [j]	NF	2,97	72,6	– 51,6 to – 51,5	0	2 088	1 920	ND
410B	R-32/125 (45/55)	±1/ ± 1	A1	2	0,43 [i]	0,43 [j]	NF	3,09	75,5	– 51,5 to – 51,4	0	2 229	2 050	ND
411A	R-1270/22/152a (1,5/87,5/11,0)	+0 – 1/+2 – 0/+0 – 1	A2	1	0,04 [i]	0,074 [j]	0,186	3,37	82,4	– 39,6 to – 37,1	0,048	1 597	1 560	ND
411B	R-1270/22/152a (3/94/3)	+0 – 1/+2 – 0/+0 – 1	A2	1	0,05	0,044 [j]	0,239	3,40	83,1	– 41,6 to – 40,2	0,052	1 705	1 660	ND
412A	R-22/218/142b (70/5/25)	±2/ ± 2/ ± 1	A2	1	0,07	0,17 [j]	0,329	3,77	92,2	– 36,5 to – 28,9	0,055	2 286	2 170	ND
413A	R-218/134a/600a (9/88/3)	±1/ ± 2/+0 – 1	A2	1	0,08	0,21	0,375	4,25	103,9	– 29,4 to – 27,4	0	2 053	1 950	ND
414A	R-22/124/600a/142b (51,0/28,5/4,0/16,5)	±2/ ± 2/ ± 0,5/+0,5 – 1,0	A1	2	0,10 [i]	0,10 [j]	NF	3,96	97,0	– 33,2 to – 24,7	0,045	1 478	1 370	ND
414B	R-22/124/600a/142b (50,0/39,0/1,5/9,5)	±2/ ± 2/ ± 0,5/+0,5 – 1,0	A1	2	0,096 [i]	0,096 [j]	NF	4,16	101,6	– 33,1 to – 24,7	0,042	1 362	1 270	ND
415A	R-22/152a (82,0/18,0)	±0,1/ ± 0,1	A2	1	0,04	0,19 [j]	0,188	3,35	81,9	– 37,5 to – 34,7	0,028	1 507	1 470	ND
415B	R-22/152a (25,0/75,0)	±0,1/ ± 0,1	A2	1	0,03	0,15 [j]	0,13	2,87	70,2	– 23,4 to – 21,8	0,009	545,5	544	ND
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	0,064	0,064 [j]	NF	4,58	111,9	– 23,9 to – 22,1	0,009	1 084	975	ND

Refrigerant number	Composition [c] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m³	ATEL/ ODL [g] kg/m³	LFL [h] kg/m³	Vapour density 25 °C, 101,3 kPa [a] kg/m³	Molecular mass [a]	Normal boiling point [a] °C	ODP [a] [e]	GWP [a f k] 100 yr ITH	GWP [a f m] (AR5) 100 yr ITH	Auto-ignition temperature °C
417A	R-125/134a/600 (46,6/50,0/3,4)	±1,1/ ± 1,0/+0,1 – 0,4	A1	2	0,15 [i]	0,057 [j]	NF	4,36	106,7	−38,0 to – 32,9	0	2 346	2 130	ND
417B	R-125/134a/600 (79,0/18,3/2,7)	±1,1/ ± 1,0/+0,1 – 0,5	A1	2	0,069	0,069	NF	4,63	113,1	−44,9 to – 41,5	0	3 027	2 740	ND
417C	R-125/134a/600 (19,5/78,8/1,7)	±1,0/ ± 1,0/+0,1 −0,5	A1	2	0,087	0,087	NF	4,24	103,7	−32,7 to −29,2	0	1 809	1 640	ND
418A	R-290/22/152a (1,5/96,0/2,5)	±0,5/ ± 1,0/ ± 0,5	A2	1	0,06	0,20 [j]	0,31	3,46	84,6	– 41,7 to – 40,0	0,033	1 741	1 690	ND
419A	R-125/134a/E170 (77,0/19,0/4,0)	±1,0/ ± 1,0/ ± 1,0	A2	1	0,05	0,31 [j]	0,25	4,47	109,3	– 42,6 to – 35,9	0	2 967	2 690	ND
419B	R-125/134a/E170 (48,5/48,0/3,5)	±1,0/ ± 1,0/ ± 0,5	A2	1	0,06	0,26	0,29	4,3	105,2	−37,4 to −31,5	0	2 384	2 160	ND
420A	R-134a/142b (88,0/12,0)	+1,0 −1,0/+0,0 – 1,0	A1	2	0,18	0,18 [j]	NF	4,16	101,9	– 24,9 to – 24,2	0,005	1 536	1 380	ND
421A	R-125/134a (58,0/42,0)	±1,0/ ± 1,0	A1	2	0,28	0,28 [j]	NF	4,57	111,8	– 40,8 to – 35,5	0	2 631	2 380	ND
421B	R-125/134a (85,0/15,0)	±1,0/ ± 1,0	A1	2	0,33	0,330 [j]	NF	4,78	116,9	– 45,7 to – 42,6	0	3 190	2 890	ND
422A	R-125/134a/600a (85,1/11,5/3,4)	±1,0/ ± 1,0/+0,1 – 0,4	A1	2	0,29	0,29 [j]	NF	4,65	113,6	– 46,5 to – 44,1	0	3 143	2 850	ND
422B	R-125/134a/600a (55,0/42,0/3,0)	±1,0/ ± 1,0/+ 0,1 – 0,5	A1	2	0,25	0,25 [j]	NF	4,44	108,5	– 40,5 to – 35,6	0	2 526	2 290	ND
422C	R-125/134a/600a (82,0/15,0/3,0)	±1,0/ ± 1,0/+ 0,1 – 0,5	A1	2	0,29	0,29 [j]	NF	4,64	113,4	– 45,3 to – 42,3	0	3 085	2 790	ND
422D	R-125/134a/600a (65,1/31,5/3,4)	+0,9 – 1,1/ ± 1,0/+ 0,1 – 0,4	A1	2	0,26	0,26 [j]	NF	4,49	109,9	– 43,2 to – 38,4	0	2 729	2 470	ND
422E	R-125/134a/600a (58,0/39,3/2,7)	±1,0/+1,7 −1,3/+0,3 −0,2	A1	2	0,26	0,26	NF	4,47	109,3	−41,8 to - 36,4	0	2 592	2 350	ND
423A	R-134a/227ea (52,5/47,5)	±1,0/ ± 1,0	A1	2	0,30	0,30 [j]	NF	5,15	126,0	– 24,2 to – 23,5	0	2 280	2 270	ND

Refrigerant number	Composition [c]	Composition tolerances	Safety class	PED [l] fluid group	Practical limit [d]	ATEL/ ODL [g]	LFL [h]	Vapour density 25 °C, 101,3 kPa [a]	Molecular mass [a]	Normal boiling point [a]	ODP [a e]	GWP [a f k]	GWP [a f m] (AR5)	Auto-ignition temperature
	weight %	%			kg/m³	kg/m³	kg/m³	kg/m³		°C		100 yr ITH	100 yr ITH	°C
424A	R-125/134a/600a/600/601a (50,5/47,0/0,9/1,0/0,6)	±1,0/ ± 1,0/+0,1 – 0,2/ +0,1 – 0,2/+0,1 – 0,2	A1	2	0,10	0,10 [j]	NF	4,43	108,4	– 39,1 to – 33,3	0	2 440	2 210	ND
425A	R-32/134a/227ea (18,5/69,5/12,0)	±0,5/ ± 0,5/ ± 0,5	A1	2	0,27	0,27 [j]	NF	3,69	90,3	– 38,1 to – 31,3	0	1 505	1 430	ND
426A	R-125/134a/600/601a (5,1/93,0/1,3/0,6)	±1,0/ ± 1,0/+0,1 – 0,2/ +0,1 – 0,2	A1	2	0,083	0,083 [j]	NF	4,16	101,6	– 28,5 to – 26,7	0	1 508	1 370	ND
427A	R-32/125/143a/134a (15,0/25,0/10,0/50,0)	±2,0/ ± 2,0/ ± 2,0/ ± 2,0	A1	2	0,29	0,29 [j]	NF	3,70	90,4	– 43,0 to – 36,3	0	2 138	2 020	ND
427B	R-32/125/143a/134a (20,6/25,6/19,0/34,8)	+1,0 –2,0/+2,0 –1,0/ ± 2,0/ ± 2,0	A1	2	0,35	0,35	NF	3,53	85,0	–46,2 to –40,1	0	2 382	2 320	ND
428A	R-125/143a/290/600a (77,5/20,0/0,6/1,9)	±1,0/ ± 1,0/+0,1 – 0,2/ +0,1 – 0,2	A1	2	0,37	0,37 [j]	NF	4,40	107,5	– 48,3 to – 47,5	0	3 607	3 420	ND
429A	R-E170/152a/600a (60,0/10,0/30,0)	±1,0/ ± 1,0/ ± 1,0	A3	1	0,01	0,098 [j]	0,052	2,08	50,8	– 26,0 to – 25,6	0	19	15,3	ND
430A	R-152a/600a (76,0/24,0)	±1,0/ ± 1,0	A3	1	0,017	0,10 [j]	0,084	2,61	64,0	– 27,6 to – 27,6	0	95	106	ND
431A	R-290/152a (71,0/29,0)	±1,0/ ± 1,0	A3	1	0,009	0,10 [j]	0,044	2,00	48,8	– 43,1 to – 43,1	0	38,1	42,2	ND
432A	R-1270/E170 (80,0/20,0)	±1,0/ ± 1,0	A3	1	0,008	0,0021 [j]	0,039	1,75	42,8	– 46,6 to – 45,6	0	1,8	1,8	ND
433A	R-1270/290 (30,0/70,0)	±1,0/ ± 1,0	A3	1	0,007	0,0055 [j]	0,036	1,78	43,5	– 44,6 to – 44,2	0	2,7	2,7	ND
433B	R-1270/290 (5,0/95,0)	±1,0/ ± 1,0	A3	1	0,005	0,025	0,025	1,8	44,0	–42,7 to –42,5	0	3	3	ND
433C	R-1270/290 (25,0/75,0)	±1,0/ ± 1,0	A3	1	0,006	0,0066 [j]	0,032	1,78	43,6	– 44,3 to – 43,9	0	2,8	2,8	ND
434A	R-125/143a/134a/600a (63,2/18,0/16,0/2,8)	±1,0/ ± 1,0/ ± 1,0/+ 0,1 – 0,2	A1	2	0,32	0,32 [j]	NF	4,32	105,7	– 45,0 to – 42,3	0	3 245	3 080	ND
435A	R-E170/152a (80,0/20,0)	±1,0/ ± 1,0	A3	1	0,014	0,09 [j]	0,069	2,00	49,0	– 26,1 to – 25,9	0	25,6	28,4	ND

Refrigerant number	Composition [c] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m^3	ATEL/ ODL [g] kg/m^3	LFL [h] kg/m^3	Vapour density 25 °C, 101,3 kPa [a] kg/m^3	Molecular mass [a]	Normal boiling point [a] °C	ODP [a] [e]	GWP [a f k] 100 yr ITH	GWP [a f m] (AR5) 100 yr ITH	Auto-ignition temperature °C
436A	R-290/600a (56,0/44,0)	±1,0/ ± 1,0	A3	1	0,006	0,073 [j]	0,032	2,02	49,3	−34,3 to −26,2	0	3	3	ND
436B	R-290/600a (52,0/48,0)	±1,0/ ± 1,0	A3	1	0,007	0,071 [j]	0,033	2,00	49,9	−33,4 to −25,0	0	3	3	ND
436C	R-290/600a (95,0/5,0)	±2,0/ ± 2,0	A3	1	0,007	0,087	0,032	1,85	44,6	−41,5 to -39,5	0	4	3	ND
437A	R-125/134a/600/601 (19,5/78,5/1,4/0,6)	+0,5 – 1,8/+1,5 – 0,7/ +0,1 – 0,2/+0,1 – 0,2	A1	2	0,081	0,081 [j]	NF	4,24	103,71	− 32,9 to − 29,2	0	1 805	1 640	ND
438A	R-32/125/134a/600/601a (8,5/45,0/44,2/1,7/0,6)	+0,5 – 1,5/ ± 1,5/ ± 1,5/ +0,1 – 0,2/+0,1 – 0,2	A1	2	0,079	0,079 [j]	NF	4,05	99,1	− 43,0 to − 36,4	0	2 265	2 060	ND
439A	R-32/125/600a (50,0/47,0/3,0)	±1,0/ ± 1,0/ ± 0,5	A2	1	0,061	0,34	0,304	2,91	71,2	− 52,0 to − 51,8	0	1 983	1 830	ND
440A	R-290/134a/152a (0,6/1,6/97,8)	±0,1/ ± 0,6/ ± 0,5	A2	1	0,025	0,14	0,124	2,71	66,2	− 25,5 to − 24,3	0	144,2	156	ND
441A	R-170/290/600a/600 (3,1/54,8/6,0/36,1)	±0,3/ ± 2,0/ ± 0,6/ ± 2,0	A3	1	0,006 3	0,006 3	0,032	1,98	48,3	− 41,9 to − 20,4	0	3,5	3,5	ND
442A	R-32/125/134a/152a/227ea (31,0/31,0/30,0/3,0/5,0)	±1,0/ ± 1,0/ ± 1,0/ ± 0,5/ ± 1,0	A1	2	0,33	0,33	NF	3,35	81,8	− 46,5 to − 52,7	0	1 888	1 750	ND
443A	R-1270/290/600a (55/40/5)	±2,0 / ± 2,0 / ± 1,2	A3	1	0,003	0,003	0,036	1,8	43,5	−44,8 to −41,2	0	2,5	2,5	ND
444A	R-32/152a/1234ze(E) (12/5/83)	±1,0 / ± 1,0 / ± 2,0	A2L	1	0,065	0,289	0,323	4,03	96,7	−34,3 to −24,3	0	93	89	ND
444B	R-32/152a/1234ze(E) (41,5/10/48,5)	±1,0/ ± 1,0/ ± 1,0	A2L	1	0,055	0,33	0,276	3,02	72,8	−44,6 to −34,9	0	295,9	295	ND
445A	R-744/134a/1234ze(E) (6/9/85)	±1,0 / ± 1,0 / ± 2,0	A2L	1	0,069	0,228	0,347	4,29	103,1	−50,3 to −23,5	0	134,7	118	ND
446A	R-32/1234ze(E)/600 (68/29/3)	+0,5 – 1,0/ +2,0 – 0,6/ +1,0 – 1,0	A2L	1	0,047	0,068	0,237	2,6	62,0	−49,4 to −44,0	0	461,2	461	ND

Refrigerant number	Composition [c] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m³	ATEL/ ODL [g] kg/m³	LFL [h] kg/m³	Vapour density 25 °C, 101,3 kPa [a] kg/m³	Molecular mass [a]	Normal boiling point [a] °C	ODP [a] [e]	GWP [a f k] 100 yr ITH	GWP [a f m] (AR5) 100 yr ITH	Auto-ignition temperature °C
447A	R-32/125/1234ze(E) (68/3,5/28,5)	+1,5 – 0,5/+1,5 – 0,5/ +1,0 –1,0	A2L	1	0,066	0,36	0,330	2,61	63,0	−49,3 to −44,2	0	583,5	572	ND
447B	R-32/125/1234ze(E) (68/8/24)	+1,0 - 2,0/+2,0 - 1,0/ +1,0 - 2,0	A2L	1	0,062	0,36	0,312	2,6	63,1	−50,1 to −46,0	0	740,7	714	ND
448A	R-32/125/1234yf/134a/1234ze(E) (26/26/20/21/7)	+0,5 – 2,0/+2,0 – 0,5/ +0,5 - 2,0/+2,0 – 1,0/+0,5 – 2,0	A1	2	0,388	0,388	NF	3,58	86,3	−45,9 to −39,8	0	1 387	1 270	ND
449A	R-32/125/1234yf/134a (24,3/24,7/25,3/25,7)	+2,0 – 1,0/ +1,0 – 0,2/ +0,2 - 1,0/+1,0 – 0,2	A1	2	0,357	0,357	NF	3,62	87,2	−46,0 to −39,9	0	1 397	1 280	ND
449B	R-32/125/1234yf/134a (25,2/24,3/23,2/27,3)	+0,3 - 1,5/+1,5 - 0,3/+0,3 - 1,5/+1,5 - 0,3	A1	2	0,353	0,353	NF	3,59	86,4	−46,1 to −40,2	0	1 412	1 300	ND
449C	R-32/125/1234yf/134a (20/20/31/29)	+0,5 - 1,5/+1,5 - 0,5/+0,5 - 1,5/+1,5 - 0,5	A1	2	0,362	0,362	NF	3,76	90,3	−44,6 to −38,2	0	1 251	1 150	ND
450A	R-134a/1234ze(E) (42/58)	±2,0/ ± 2,0	A1	2	0,320	0,320	NF	4,54	108,7	−23,4 to −22,8	0	604,7	547	ND
451A	R-1234yf/134a (89,8/10,2)	±0,2/ ± 0,2	A2L	1	0,068	0,462	0,346	4,71	112,7	−30,8 to −30,5	0	149,5	133	ND
451B	R-1234yf/134a (88,8/11,2)	±0,2/ ± 0,2	A2L	1	0,068	0,461	0,341	4,70	112,6	−31,0 to −30,6	0	163,7	146	ND
452A	R-32/125/1234yf (11/59/30)	±1,7/ ± 1,8	A1	2	0,423	0,423	NF	4,30	103,5	−47 to −43,2	0	2 140	1 950	ND
452B	R-32/125/1234yf (67/7/26)	±2,0/ ± 1,5/ ± 2,0	A2L	1	0,062	0,364	0,310	2,63	63,5	−51,0 to −50,3	0	698,3	676	ND
452C	R-32/125/1234yf (12,5/61/26,5)	+0,5–1,5/ ± 1,0/+0,5 - 1,5	A1	2	0,417	0,417	NF	4,23	101,9	−47,5 to −44,2	0	2 220	2 020	ND
453A	R-32/125/134a/227ea/600/601a (20/20/53,8/5/0,6/0,6)	±1,0/ ± 1,0/ ± 1,0/ ± 0,5/+0,1 - 0,2/+0,1 - 0,2	A1	2	0,123	0,123	NF	3,69	88,8	−42,2 to −35,0	0	1 765	1 640	ND
454A	R-32/1234yf (35/65)	±2,0/ ± 2,0	A2L	1	0,056	0,461	0,278	3,34	80,5	−48,4 to −41,6	0	238,9	238	ND

Refrigerant number	Composition [c] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m3	ATEL/ ODL [g] kg/m3	LFL [h] kg/m3	Vapour density 25 °C, 101,3 kPa [a] kg/m3	Molecular mass [a]	Normal boiling point [a] °C	ODP [a] [e]	GWP [a] [f] [k] 100 yr ITH	GWP [a] [f] [m] (AR5) 100 yr ITH	Auto-ignition temperature °C
454B	R-32/1234yf (68,9/31,1)	±1,0/ ± 1,0	A2L	1	0,059	0,358	0,297	2,60	62,6	−50,9 to −50,0	0	466,3	467	ND
454C	R-32/1234yf (21,5/78,5)	±2,0/ ± 2,0	A2L	1	0,059	0,445	0,293	3,78	90,8	−46,0 to −37,8	0	148,3	146	ND
455A	R-744/32/1234yf (3/21,5/75,5)	+2,0−1,0/+1,0−2,0/ ± 2,0	A2L	1	0,086	0,429	0,431	3,64	87,5	−51,6 to −39,1	0	148,2	146	ND
456A	R-32/134a/1234ze(E) (6/45/49)	±1,0/ ± 1,0/ ± 1,0	A1	2	0,319	0,319	NF	4,23	101,4	−30,4 to −25,6	0	687,4	626	ND
457A	R-32/1234yf/152a (18/70/12)	+0,5−1,5/+0,5−1,5/+0,1 - 1,9	A2L	1	0,043	0,394	0,216	3,65	87,6	−42,7 to −35,5	0	139,2	139	ND
458A	R-32/125/134a/227ea/236fa (20,5/4/61,4/13,5/0,6)	±0,5/ ± 0,5/ ± 0,5/ ± 0,5/ ± 0,1	A1	2	0,276	0,279	NF	3,74	89,9	−39,8 to −32,4	0	1 650	1 560	ND
459A	R-32/1234yf/1234ze(E) (68,0/26,0/6,0)	+0,5 - 1,5/ ± 2,0/+1,5 - 0,5	A2L	1	0,056	0,468	0,278	2,61	63,0	−50,3 to −48,6	0	460,5	461	ND
459B	R-32/1234yf/1234ze(E) (21,0/69,0/10,0)	+0,5−1,0/ ± 2,0/ ± 1,0	A2L	1	0,068	0,490	0,342	3,79	91,2	−44,0 to −36,1	0	145,2	143	ND
460A	R-32/125/134a/1234ze(E) (12,0/52,0/14,0/22,0)	±1,0/ ± 1,0/ ± 1,0/ ± 1,0	A1	2	0,382	0,382	NF	4,18	100,6	−44,6 to −37,7	0	2 103	1 910	ND
460B	R-32/125/134a/1234ze(E) (28,0/25,0/20,0/27,0)	±1,0/ ± 1,0/ ± 1,0/ ± 1,0	A1	2	0,420	0,420	NF	3,52	84,8	−45,2 to −37,1	0	1 352	1 240	ND
460C	R-32/125/134a/1234ze(E) (2,5 / 2,5/ 46,0 / 49,0)	±0,5/ ± 0,5/ ± 1,0/ ± 1,0	A1	2	0,314	0,314	NF	4,40	105,3	−27,8 to −24,5	0	765,6	695	ND
461A	R-125/R-143a/134a/R-227ea/600a (55,0/5,0/32,0/5,0/3,0)	±1,0/ ± 0,5/ ± 1,0/ ± 0,5/+0,1 −0,4	A1	2	0,274	0,274	NF	4,56	109,6	−29,2 to −26,0	0	2 767	2 570	ND
462A	R-32/125/143a/134a/600 (9,0/42,0/2,0/44,0/3,0)	+1,5 −1,0/ ± 2,0/ ± 1,0/ ± 2,0/ ± 1,0	A2	1	0,044	0,044	0,291	4,04	67,8	−42,0 to −37,0	0	2 249	2 060	ND

Refrigerant number	Composition [c] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m^3	ATEL/ ODL [g] kg/m^3	LFL [h] kg/m^3	Vapour density 25 °C, 101,3 kPa [a] kg/m^3	Molecular mass [a]	Normal boiling point [a] °C	ODP [a e]	GWP [a f k] 100 yr ITH	GWP [a f m] (AR5) 100 yr ITH	Auto-ignition temperature °C
463A	R-744/32/125/1234yf/134a (6,0/36,0/30,0/14,0/14,0)	+2,0 −1,0 / ± 2,0/ ± 2,0/ ± 2,0/ ± 2,0	A1	2	0,3	0,3	NF	4,04	74,7	−42,6 to −36,2	0	1 494	1 380	ND
464A	R-32/125/1234ze(E)/227ea (27,0/27,0/40,0/6,0)	±1,0/ ± 1,0/ ± 1,0/ ± 0,5	A1	2	0,435	0,435	NF	3,68	88,5	−58,4 to −46,9	0	1 323	1 240	ND
465A	R-32/290/1234yf (21,0/7,9/71,1)	+0,5 −1,5/+0,1 −0,9/ ± 1,0	A2	1	0,032	0,407	0,161	3,45	83,6	−46,5 to −36,9	0	144,8	143	ND

ND signifies not determined.

NF non-flammable.

Refrigerant number	Composition [c]	Composition tolerances	Safety class	PED [l] fluid group	Practical limit [d]	ATEL/ ODL [g]	LFL [h]	Vapour density 25 °C, 101,3 kPa [a]	Molecular mass [a]	Normal boiling point [a]	ODP [a] [e]	GWP [a f k]	GWP [a f m] (AR5)	Auto-ignition temperature
	weight %	%			kg/m³	kg/m³	kg/m³	kg/m³		°C		100 yr ITH	100 yr ITH	°C

[a] ODP, GWP (AR5), 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 R-152a and R-142b shall be between + 0 and – 2 %.

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

[d] Practical Limit. Calculated from the values for the individual components.

[e] Ozone depleting potential: Calculated from the values for the individual components as listed in Table E.1.

[f] Global Warming Potential: Calculated from the values for the individual components as listed in Table E.1. For GWP (AR5) values are rounded to 3 significant figures.

[g] Acute-Toxicity Exposure Limit (ATEL) or Oxygen Deprivation Limit (ODL), whichever is lower.

[h] Lower Flammability Limit, based on WCF for 2L classified blends.

[i] Practical limit values are grandfathered according to 5.2.

[j] ATEL/ODL values are changed in comparison to EN 378-1:2008+A2:2012 according to data from ISO 817.

[k] Data from European F-Gas regulation N° 517/2014; for CFCs and for HCFCs which are not included in F-Gas regulation N° 517/2014, data from IPCC assessment report IV.

[l] PED = Pressure Equipment Directive 2014/68/EU.

[m] Data from IPCC Assessment Report V (AR5); for HCs which are not included in AR5, data from F-Gas regulation N° 517/2014.

Table E.3 — Refrigerant designations of R 500 blends [a]

Refrigerant number	Composition [e] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m³	ATEL/ ODL [g] kg/m³	LFL [h] kg/m³	Vapour density 25 °C, 101,3 kPa [a] kg/m³	Molecular mass [b]	Normal boiling point [b] °C	Azeotropic Temperature [d] °C	ODP bf	GWP b k 100yr ITH	GWP bm (AR5) 100 yr ITH	Auto-ignition tempe-rature °C
500	R-12/152a (73,8/26,2)	+1,0 – 0,0/+0,0 – 1,0	A1	2	0,4 [i]	0,12 [j]	NF	4,06	99,3	– 33,5	0	0,74	8 077	7 560	ND
501	R-22/12 (75,0/25,0) [c]		A1	2	0,38 [i]	0,21 [j]	NF	3,81	93,1	– 41,0	– 41	0,29	4 083	3 870	ND
502	R-22/115 (48,8/51,2)		A1	2	0,45 [i]	0,33 [j]	NF	4,56	112,0	– 45,4	19	0,33	4 657	4 790	ND
503	R-23/13 (40,1/59,9)		A1	2	0,35 [i]	ND	NF	3,58	87,5	– 88,7	88	0,6	14 560	13 300	ND
504	R-32/115 (48,2/51,8)		A1	2	0,45	0,45	NF	3,24	79,2	– 57	17	0,31	4 143	4 300	ND
507A	R-125/143a (50/50)	+1,5 – 0,5/+0,5 – 1,5	A1	2	0,53	0,53 [j]	NF	4,04	98,9	– 46,7	– 40	0	3 985	3 990	ND
508A	R-23/116 (39,0/61,0)	±2,0/ ± 2,0	A1	2	0,23	0,23	NF	4,09	100,1	– 86,0	– 86	0	13 210	11 600	ND
508B	R-23/116 (46,0/54,0)	±2,0/ ± 2,0	A1	2	0,25	0,2	NF	3,90	95,4	– 88,3	– 45,6	0	13 400	11 700	ND
509A	R-22/218 (44,0/56,0)	±2,0/ ± 2,0	A1	2	0,56 [i]	0,38	NF	5,07	124,0	– 47,0	0	0,024	5 741	5 760	ND
510A	R-E170/600a (88,0/12,0)	±0,5/ ± 0,5	A3	1	0,011	0,087 [j]	0,056	1,93	47,2	–25,1	–25,2	0	1,2	1,2	ND
511A	R-290/E170 (95,0/5,0)	±1,0/ ± 1,0	A3	1	0,008	0,092	0,038	1,81	44,2	– 42	– 20 to +40	0	2,9	2,9	ND
512A	R-134a/152a (5,0/95,0)	±1,0/ ± 1,0	A2	1	0,025	0,14	0,124	2,75	67,2	– 24	– 20 to +40	0	189,3	196	ND
513A	1234yf/134a (56/44)	+1,0/-1,0, +1,0/-1,0	A1	2	0,329	0,329	NF	4,52	108,4	–29,1	27	0	631,4	573	ND
513B	R-1234yf/134a (58,5/41,5)	±0,5/ ± 0,5	A1	2	0,329	0,329	NF	4,54	108,7	–29,2	27,2	0	595,8	540	ND

Refrigerant number	Composition [e] weight %	Composition tolerances %	Safety class	PED [l] fluid group	Practical limit [d] kg/m³	ATEL/ ODL [g] kg/m³	LFL [h] kg/m³	Vapour density 25 °C, 101,3 kPa [a] kg/m³	Molecular mass [b]	Normal boiling point [b] °C	Azeotropic Temperature [d] °C	ODP bf	GWP b k 100yr ITH	GWP bm (AR5) 100 yr ITH	Auto-ignition tempe-rature °C
514A	R-1336mzz(Z)/1130(E) (74,7/25,3)	+1,5–0,5/+0,5 – 1,5	B1	2	0,013	0,013	NF	NA	139,6	29,0	50,0	~0	7	ND	ND
515A	R-1234ze(E)/227ea (88,0/12,0)	+1,0–2,0/+2,0 -1,0	A1	2	0,306	0,306	NF	4,97	118,7	−18,9	60,0	0	392,6	403	ND

NA signifies not applicable.

ND signifies not determined.

NF signifies non-flammable.

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 the size and the position of system components.

b ODP, GWP (AR5), vapour density, molecular mass, azeotropic temperature 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 Ozone depleting potential: Calculated from the values for the individual components as listed in Table E.1.

g Acute-Toxicity Exposure Limit (ATEL) or Oxygen Deprivation Limit (ODL), whichever is lower.

h Lower Flammability Limit, based on WCF for 2L classified blends.

i Practical limit values are grandfathered according to 5.2.

j ATEL/ODL values are changed in comparison to EN 378-1:2008+A2:2012 according to data from ISO 817.

k Global Warming Potential: Calculated from the values for the individual components as listed in Table E.1. For GWP (AR5) values are rounded to 3 significant figures.

l PED = Pressure Equipment Directive 2014/68/EU

m Values calculated based on from IPCC Assessment Report V (AR5); For HCs which are not included in AR5, values are taken from F-Gas regulation N° 517/2014

A1

Annex F
(normative)

Special requirements for ice rinks

F.1 Indoor ice rinks

Systems containing A1, A2L, B1 and B2L refrigerants may be classified as indirect systems, if refrigerant-containing parts are separated from a space which is categorised as general access according to Table 4 by an adequate, reinforced, tightly sealed concrete floor. 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 shall be arranged in a dedicated pipe trench which is configured so that leaking refrigerant cannot flow to any occupied space and which is vented to the machinery room.

F.2 Outdoor ice rinks and installations for similar sporting activities

All refrigerating equipment, piping and fittings shall be fully protected against tampering and accidental damage and arranged so that they are accessible for inspection. For systems containing B2L refrigerants 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 shall be arranged in a dedicated pipe trench which is configured so that leaking refrigerant cannot flow to any occupied space and which is vented to the machinery room.

Annex G
(informative)

Potential hazards for refrigerating systems

Refrigerating system pressure and temperature hazards can be caused by refrigerant in the vapour, liquid or combined 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 equipment, but also on external causes.

The following hazards are noteworthy:

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

   1) brittleness of materials at low temperatures;

   2) freezing of enclosed liquid;

   3) thermal stresses;

   4) changes of volume due to temperature changes;

   5) injurious effects caused by low temperatures;

   6) touchable hot surfaces.

b) from excessive pressure due to, for example:

   1) increase in the condensing pressure, caused by inadequate cooling of the condenser or the partial pressure of non-condensable gases or an accumulation of oil or liquid refrigerant in the condenser;

   2) increase of 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 system is at a standstill;

   3) hydrostatic thermal expansion of liquid refrigerant in a closed space, caused by a rise in external temperature;

   4) fire;

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

   1) excessive refrigerant charge or refrigerant flooding of equipment;

   2) presence of liquid in compressors, caused by siphoning, or condensation in the compressor;

   3) liquid hammer in piping;

   4) loss of lubrication due to the emulsification oil;

d) from the escape of refrigerants, for example:

1) fire;
2) explosion;
3) toxicity;
4) caustic effects;
5) freezing of skin;
6) asphyxiation;
7) panic;
8) environmental issues such as depletion of the ozone layer and global warming;

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

1) injury;
2) hearing loss from excessive noise;
3) damage due to vibration.

Annex H
(informative)

Calculation examples related to C.2 and C.3

H.1 Example 1 for C.2.1

For an air conditioning system which has:

— a charge of 300 g of R-290;

— LFL of R-290 equals 0,038 kg/m^3;

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

Table H.1 — Installation location — Minimum room volume

Installation location	Height factor	Minimum floor area [m^2]	Minimum room volume (for a height of 2,2 m) [m^3]
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

H.2 Example 2 for C.2.1

For a room with a floor area of 30 m^2 the maximum allowable charge of R-290 for a window mounted air conditioning appliance is 230 g.

H.3 Example 3 for C.3

A system with 90 kg R-134a is installed in a space of 300 m^3

90 kg in 300 m^3 equals 0,3 kg/m^3

0,3 kg/m^3 exceeds the QLMV of 0,28 kg/m^3

0,3 kg/m^3 is below the QLAV of 0,58 kg/m^3

The system installation is permitted provided at least one of the safety measures described in [A1) EN 378-3:2016+A1:2020 (A1], Clause 6, 8, 9 or 10.

H.4 Example 4 for C.3

A system with refrigerant R-410A is installed in room volumes as specified in Table H.2.

The system is a direct system, in location class II.

Table H.2 — Determination of maximum charge

Example	Room Volume	Maximum charge limit According to C.3.1	Maximum charge based on QLMV Room volume multiplied with QLMV	Maximum charge based on QLAV Room volume multiplied with QLAV	Conclusion
1	1 000 m^3	150 kg	420 kg	420 kg	The maximum charge is 150 kg
2	100 m^3	150 kg	42 kg	42 kg	The maximum charge is Option 1: 42 kg Option 2: 150 kg provided two additional measures are applied according to C.3.2

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