

Specification for

**Safety and
environmental aspects
in the design,
construction and
installation of
refrigerating
appliances and systems**

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Committees responsible for this British Standard

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- Association of Manufacturers of Domestic Electrical Appliances
- British Refrigeration Association
- Building Services Research and Information Association
- Cold Storage and Distribution Federation
- Department of the Environment (Building Research Establishment)
- Health and Safety Executive
- Heating and Ventilating Contractors' Association
- HEVAC Association
- Institute of Refrigeration
- LP Gas Association
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Foreword

This revision of BS 4434 has been prepared by Technical Committee RHE/18. It supersedes BS 4434:1989 which is withdrawn.

This revision is a thorough review of the requirements and content of BS 4434:1989 taking account of the need to specify safe methods of using environmentally friendly refrigerants which may present significantly greater local risks than the halocarbon refrigerants, some of which are considered to be causing environmental damage.

It is considered appropriate to publish this revised standard in 1995 because the fully halogenated chlorine-containing halocarbon refrigerants were withdrawn from production in Europe at the end of 1994. It is too early to predict future patterns of refrigerant usage though there is an obvious tendency to use increasing quantities of ammonia and hydrocarbons where these refrigerants are thought to be appropriate. Considerable work has been done to produce replacement halocarbon refrigerants which are more environmentally friendly than the CFCs and HCFCs which they are designed to replace. Unfortunately this has resulted in the marketing of a large number of alternative refrigerants, some of which may not remain in common use. The standard has been modified by the extension of Table 6, now Table 2, Classification of refrigerants, and the allocation of a practical limit of concentration for each refrigerant. This allocation, together with a statement of the basis of calculation, allows appropriate selections of all types of refrigerant including refrigerants not included in the table, provided their physical properties are known.

A European safety standard for refrigerants, prEN 378, is in preparation. After the proposed European standard is published the equivalent national standards will be withdrawn in accordance with an agreed timetable. During preparation of the European standard, it is not permissible to modify national standards. However, because of delays in producing the European standard and because of rapid changes in refrigeration procedures and practice resulting from environmental concerns, it has been agreed by resolution 111 of CEN/TC 182 that BS 4434:1989 may be revised to take account of the proposed content of EN 378. This resolution was subsequently accepted and confirmed by the CEN Technical Board.

It is hoped that this revision of BS 4434 will allow the adoption of new refrigerants and practices which were not considered in the preparation of BS 4434:1989.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 42, an inside back cover, and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

Introduction

This standard is intended to minimize possible hazards peculiar to refrigerating appliances, systems and ancillary equipment; it does not constitute a technical design manual. The standard is drawn up for the protection of the environment, of life and limb and the health of the individual and also for the prevention of damage to property in the sense of premises but not, for example, goods in storage.

In order to attain these objectives, good design, construction, installation, operation and maintenance are necessary.

It is intended that this standard be applied to all kinds of refrigerating systems in which the refrigerant is evaporated and condensed in a closed circuit, including heat pumps and absorption systems, but excluding systems using air as the working fluid.

Attention is drawn to relevant standards, refrigeration safety codes, pressure-vessel and piping codes, electrical codes and statutory regulations for health, safety and fire¹⁾. In many countries such documents exist and compliance with their provisions may be mandatory. In the absence of such rules a relevant document should be used that has received national or international recognition and has been accepted by agreement of all parties properly concerned in each transaction²⁾.

Attention is drawn to dangers common to all compression systems such as excessive temperature at discharge, erroneous operation (e.g. discharge valve closed while running) and reduction in mechanical strength caused by corrosion, erosion or vibration. Corrosion should be given special consideration as conditions peculiar to refrigerating systems arise due to alternate frosting and defrosting, the covering of apparatus by insulation, and the possibility of faulty vapour seals.

Special consideration should also be given to possible effects of low temperatures such as:

- a) brittleness of materials;
- b) freezing of ground beneath or adjacent to refrigerating equipment, with consequent danger to buildings;
- c) ruptures in associated equipment, caused for example by the freezing of products, water or heat-transferring liquids, and consequent release of refrigerant to atmosphere or into other apparatus unsuitable for the pressure resulting from, or excessive pressures exerted by, substances being processed and/or pumped.

In standards for particular classes or types of appliance, certain tests included in this standard should be specified as type tests only.

1.1 Scope

This British Standard specifies requirements for the safety aspects of the design, construction, installation and inspection of refrigerating appliances, systems and ancillary equipment intended for use or installation in institutional, public assembly, residential, commercial and industrial premises.

It is applicable to new refrigerating systems, to extensions and modifications of existing systems and to used systems on being re-installed and operated on another site.

It is also applicable to the conversion of a system for use with a different refrigerant, e.g. R-12 to R-134a or R-22 to R-717 (see Table 2).

It is not applicable to systems which use air or water as a refrigerant, or to liquefied gas storage tanks.

Requirements for safety aspects in the design of appliances, systems and ancillary equipment are given in section 2.

Requirements for safety aspects in the location and installation of appliances, systems and ancillary equipment are given in section 3.

Requirements for testing, inspection, documentation and marking are given in section 4.

¹⁾ For example:

For pressure vessels: BS 5500, BS 7005, and the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII, *Rules for construction of pressure vessels* [1]

For pressure systems: The Pressure Systems and Transportable Gas Containers Regulations 1989 [2] apply unless the compressor drive motors have a total installed capacity not exceeding 25 kW

For piping: BS 2871, ANSI B.31.5 [3]

For electrical equipment: BS EN 60335-1:1995 and BS 7671

For occupational exposure limits of refrigerants: the current edition of Health and Safety Executive Environmental Hygiene Guidance Note EH 40 *Occupational exposure limits* [4] published annually by HMSO.

For more detailed consideration of certain refrigerants reference may also be made to the Institute of Refrigeration Codes of practice for ammonia and chlorofluorocarbons, Parts 1 and 2, [5]

²⁾ For example, chapter 5 of the *Guide to refrigerated storage* [6] published by the International Institute of Refrigeration (Paris).

Requirements for the instruction manual or leaflet are given in section 5.

1.2 References

1.2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 41. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by updating or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on page 41, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this British Standard the following definitions apply.

1.3.1

adsorption refrigerating system (adsorption refrigerating system)

a 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 liquefied by cooling

1.3.2

allowable pressure

the maximum pressure permitted in any part of a system, irrespective of whether the system is or is not operating, except within the range of any pressure relief device

NOTE 1 It may be differently specified for the high and low pressure sides of a system.

NOTE 2 Allowable pressure is the European Union (EU) standard term for maximum working pressure.

1.3.3

azeotrope

a mixture of volatile substances which is characterized by remaining in the same proportions and boiling at a constant temperature as the mixture evaporates

NOTE 1 The azeotropic proportions for a particular azeotrope apply strictly at a specific pressure, but in practice azeotropic mixtures appear to evaporate and condense as if they were a single fluid, with properties different from their components, over a range of pressures.

NOTE 2 See also 1.3.41 near azeotrope, and 1.3.79 zeotrope.

1.3.4

brazed joint

a gas-tight joint obtained by the joining of metal parts with non-ferrous filler metal alloys that melt at less than the melting temperatures of the joined parts. The parent metal does not participate by fusion in making the joint

NOTE 1 Non-ferrous metal alloys used for brazed joints generally have a melting point higher than 450 °C.

NOTE 2 The term brazing includes the process otherwise known as silver soldering.

1.3.5

bursting disc

a safety device that ruptures at a predetermined pressure

1.3.6

changeover device

a valve controlling two protection devices and so arranged that only one can be made inoperative at any one time

1.3.7

coil

a heat-exchanging battery made of tubing formed into a compact shape by spiral or serpentine configuration

1.3.8

comfort air conditioning

a method of air treatment designed to satisfy the comfort requirements of the occupants of a building

1.3.9

competence

ability to perform satisfactorily the activities within an occupation

1.3.10

compressor

a mechanically operated component for compressing a refrigerant vapour

1.3.11

condenser

a heat exchanger in the form of a vessel or arrangement of tubing in which vapour is liquefied by the removal of heat

1.3.12

cooling coil

a heat exchanger of coil form intended to reduce the temperature of fluid passing in or around or through it

1.3.13**cooling system**

the part of a refrigerating system that includes the evaporator and any secondary system for the purpose of cooling air or other substances

NOTE For the purposes of this standard, cooling systems are classified into six types (see 1.6 and Table 4).

1.3.14**design pressure**

the pressure used in determining the necessary materials, thickness and construction for components with regard to their ability to contain pressure

1.3.15**evaporator**

a heat exchanger in which liquid refrigerant is vaporized by absorbing heat from the substance to be cooled

1.3.16**exit**

an opening in the outer wall of a room or building, with or without a door or gate

NOTE Emergency exits are covered by the Building Regulations 1991, including Amendment 1995 [7].

1.3.17**exit passageway**

a passageway immediately in the vicinity of the door through which people leave a building

1.3.18**flanged joint**

joint made by bolting together a pair of flanged ends

1.3.19**flared joint**

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

1.3.20**fusible plug or fusible component**

a safety device having a low temperature melting point element to release pressure at a predetermined temperature

1.3.21**gauge pressure**

the difference between the absolute pressure in a system and the atmospheric pressure at the site

NOTE The atmospheric pressure is generally assumed to be 1.013 bar³⁾.

1.3.22**global warming**

the effect whereby heat loss from the earth is reduced by the insulating effect of the atmosphere

NOTE Strictly speaking the term should be "increased global warming" because concern is with man-made increases in global warming above the natural global warming produced by water vapour and natural concentrations of other atmospheric constituents.

1.3.23**global warming potential (GWP)**

the time integrated commitment to climate forcing from the instantaneous release of 1 kg of refrigerant expressed relative to that from 1 kg of carbon dioxide. Carbon dioxide is taken as having a GWP of 1. In this standard GWP, which depends on the absorption spectrum of the substance and on its atmospheric life, is measured on the basis of a 100 year time horizon

1.3.24**hallway**

a corridor for the passage of people

1.3.25**header**

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

1.3.26**heat pump system**

a refrigerating system designed to make use of the heat rejected by the system, e.g. for space heating

1.3.27**heat-transferring liquid**

any liquid used for the transmission of heat without any change in its liquid state

NOTE See 2.2.4 for requirements regarding temperature limitations.

1.3.28**high pressure side**

that portion of a refrigerating system which is subjected to the higher or condensing pressure

1.3.29**human-occupied space**

the complete space which is occupied for a significant period by humans

NOTE Where spaces around the apparent human-occupied space are, by construction or design, not air tight, these are considered as part of the human-occupied space, e.g. false ceiling voids, crawl ways, ducts, and spaces behind moveable partitions and doors with transfer grilles.

³⁾ 1 bar = 10⁵ N/m² = 100 kPa.

1.3.30**internal gross volume**

the volume of a pressure vessel calculated from the internal dimensions of the vessel, no account being taken of the volume of any internal parts

1.3.31**isolating valve**

a valve used to shut off flow completely

NOTE Valves may be arranged to isolate sections of systems for the purposes of assembly or maintenance while other sections remain charged with refrigerant.

1.3.32**leakage test pressure**

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

1.3.33**limited charge system**

a refrigerating system in which the internal volume and total refrigerant charge are such that, with the system idle, the allowable pressure would not be exceeded if complete evaporation of the refrigerant charge were to occur

1.3.34**liquid receiver**

a vessel permanently installed in the high pressure side of a refrigerating system to provide a reserve of liquid refrigerant, or to facilitate storage of the refrigerant charge during repairs or maintenance

1.3.35**lobby**

an entrance hall or large hallway serving as a waiting room

1.3.36**low pressure side**

that portion of a refrigerating system which is subjected to the lower or evaporating pressure

1.3.37**lower explosive limit (LEL)**

minimum concentration of a refrigerant that is capable of propagating a flame through a homogeneous mixture of the refrigerant and air

NOTE 1 Also sometimes referred to as lower flammability limit (LFL).

NOTE 2 The classification of refrigerants according to flammability is given in Table 1.

1.3.38**machinery**

the refrigerating equipment forming a part of a refrigerating system

NOTE This includes the compressor, condenser, generator, absorber, (or adsorber), liquid receiver, connecting piping, evaporator, pump and surge drum.

1.3.39**machinery room**

an enclosure in which machinery is housed

NOTE For a refrigerating system this does not include the coldroom in which evaporators are located, the refrigerator box, air cooled space or any other enclosed space.

1.3.40**maximum charge**

the maximum allowable mass of the refrigerant in a refrigerating system

1.3.41**near azeotrope**

a mixture of volatile substances, not in their azeotropic proportions, which boils at a more or less constant temperature as the mixture evaporates

NOTE 1 For a near azeotropic mixture the temperature glide during evaporation is normally of the order of 1 °C or less.

NOTE 2 See also 1.3.3 azeotrope, and 1.3.79 zeotrope.

1.3.42**non-positive displacement compressor**

a compressor in which an increase in vapour pressure is attained without changing the internal volume of the compression chamber

1.3.43**occupational exposure limit (OEL)**

the airborne concentration of a substance to which it is believed that nearly all workers may be repeatedly exposed on a daily basis without adverse health effects

NOTE 1 Also sometimes called the threshold limit value (TLV).

NOTE 2 Attention is drawn to Regulation 2 of the Control of Substances Hazardous to Health Regulations 1994 [8] and the Health and Safety Executive Environmental Hygiene Guidance Note EH40 [4]

1.3.44**oil drain**

an arrangement on a refrigerating system whereby lubricating oil carried from the compressor may be drained from the system

1.3.45**ozone depletion potential (ODP)**

the capacity of one molecule of a substance to destroy stratospheric ozone relative to that of one molecule of R11 (CCl₃F). R11 is taken as having an ODP of 1

1.3.46**piping**

the pipes or tubes (including any hose, bellows or flexible pipe) for interconnecting the various parts of a refrigerating system

1.3.47**positive displacement compressor**

a compressor in which an increase in vapour pressure is attained by changing the internal volume of the compression chamber

NOTE See also 1.3.42 non-positive displacement compressor.

1.3.48**pressure limiting device**

a pressure actuated adjustable or factory pre-set non-adjustable instrument (e.g. a high pressure switch) which is designed to stop the operation of the pressure imposing element and which may also operate an alarm

1.3.49**pressure relief device**

a valve (see 1.3.50) or bursting disc (see 1.3.5) designed to relieve excessive pressure automatically

1.3.50**pressure relief valve**

a pressure actuated valve held shut by a spring or other means and designed to relieve excessive pressure automatically by starting to open at a pressure not exceeding the allowable pressure and reclosing, to prevent further flow of fluid, after normal conditions of service have been restored

1.3.51**pressure system**

a refrigerating system comprising a pressure vessel or connected group of pressure vessels, any associated piping and any associated compressor

1.3.52**pressure vessel**

a closed vessel containing fluid at a pressure differing from atmospheric pressure

1.3.53**process valve**

a valve used on a regular basis for process operations

1.3.54**receiver**

a vessel that stores refrigerant, located in the refrigerating system

NOTE These vessels are sometimes called suction accumulators.

1.3.55**reclamation**

the reprocessing of a used refrigerant to a new product specification

NOTE Chemical analysis of the refrigerant is necessary to determine whether it conforms to the appropriate specification

1.3.56**recovery**

the removal of refrigerant in any condition from a system and its storage in an external container

1.3.57**recycling**

reducing contaminants in used refrigerants by separating oil, removing noncondensibles and using devices such as filters/driers to reduce moisture, acidity and particulate matter

1.3.58**refrigerant**

a substance used to produce refrigeration by its vaporization

NOTE A list of typical refrigerants and their physical properties is given in Table 2.

1.3.59**refrigerant detector**

sensing device which responds to a pre-set proportion of refrigerant vapour in the environment

1.3.60**refrigerated space**

a refrigerated room used for operations or service purposes

NOTE Examples include cold stores, freezing tunnels and low temperature environmental areas.

1.3.61**refrigerating system**

a combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purposes of extracting heat

1.3.62**sealed system**

a unit system in which all refrigerant-containing parts, except for a fusible component, are sealed, for example by welding or brazing, against refrigerant loss

1.3.63**self-contained breathing apparatus**

breathing apparatus which has a portable supply of compressed air, independent of the ambient atmosphere, and from which exhaust air passes without recirculation to the ambient atmosphere

1.3.64**self-contained system**

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

1.3.65**short exposure time**

the maximum permissible exposure time of humans to a major release of refrigerant

NOTE This time is usually of the order of 10 min.

1.3.66**solder joint**

a gastight joint, obtained by the joining of metal parts with metallic mixtures or alloys that melt at temperatures in general from 200 °C to 450 °C.

the parent metal does not participate by fusion in making the joint

NOTE This definition does not include fusible plugs (see 1.3.20) or components used for pressure relief purposes.

1.3.67**special machinery room**

a machinery room (see 1.3.39) for which special requirements have been specified (see 3.2.2)

1.3.68**strength test pressure**

the gauge pressure that is applied to test the strength of a refrigerating system or any part of it

1.3.69**sudden major release**

the release of the majority of the total refrigerant charge into the human-occupied space in a short time, usually less than 5 min

1.3.70**surge drum**

a vessel containing refrigerant liquid and vapour at low pressure and temperature and connected by liquid feed and vapour return pipes to an evaporator

1.3.71**temperature glide**

the change of temperature which occurs during the evaporation or condensation of a zeotropic mixture at a constant pressure

1.3.72**toxicity**

potential of a refrigerant to be harmful or lethal on acute or chronic exposure by contact, inhalation or ingestion

NOTE 1 The effects of concern include but are not limited to those of carcinogens, poisons, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, neurotoxins, agents that act on the haemopoietic system and agents that damage the lungs, skin, eyes or mucous membranes.

NOTE 2 Temporary discomfort at a level that is not impairing is excluded.

1.3.73**total equivalent warming impact (TEWI)**

the overall warming effect of operating a refrigerating system for its entire life. This effect is made up of a “direct” contribution due to emissions of refrigerant during and after the life of the system and an “indirect” contribution caused by the emission of carbon dioxide during the generation of power to drive the refrigerating system

the total equivalent warming impact (TEWI) can be calculated from the following equation

$$\text{TEWI} = (\text{GWP} \times L \times n) + \{\text{GWP} \times m(1 - \alpha)\} + (n \times E \times \beta)$$

where

GWP is global warming potential as defined in 1.3.23;

L is the leakage rate of refrigerant (in kg/year);

n is the operating life (in years);

m is the working refrigerant charge (in kg);

α is the efficiency of refrigerant recovery (as a proportion);

E is the energy consumption (in kWh/year);

β is the CO₂ emitted during generation of the power to run the system (in kg/kWh).

NOTE 1 The value of β depends on the type of electricity generating system in use. The value of β is low for hydroelectric and nuclear power generation.

NOTE 2 Where power is generated using fossil fuels the indirect warming contribution ($n \times E \times \beta$) is usually predominant.

1.3.74**ultimate strength of a system**

pressure at which a part of a system ruptures or bursts

1.3.75**unit system**

a self-contained system that has been assembled and tested prior to its installation and is installed without connecting any refrigerant-containing parts

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

1.3.76**vent**

a device permitting fluid flow in order to maintain the balance of pressure between the atmosphere and a system

1.3.77**vestibule**

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

NOTE Also known as an air lock.

1.3.78**welded joint**

a gastight joint obtained by the joining of the metal parts in the plastic or molten state

1.3.79**zeotrope**

a mixture of volatile substances which changes in composition as it evaporates. As a consequence the evaporating temperature changes as the more volatile component distils out of the less volatile component(s)

NOTE 1 Also sometimes called a non-azeotrope.

NOTE 2 See also 1.3.3 azeotrope and 1.3.41 near azeotrope.

1.4 Refrigerant groups

1.4.1 Refrigerants are classified according to their chemical composition as follows:

a) Halocarbons:

1) *CFCs (chlorofluorocarbons):*

Fully-halogenated (no hydrogen remaining) halocarbons containing chlorine, fluorine and carbon;

2) *HCFCs (hydrochlorofluorocarbons):*

Halocarbons containing hydrogen, chlorine, fluorine and carbon;

3) *HFCs (hydrofluorocarbons):* Halocarbons containing only hydrogen, fluorine and carbon;

4) *PFCs (perfluorocarbons):* Halocarbons containing only fluorine and carbon;

b) Hydrocarbons: Compounds containing only hydrogen and carbon.

1.4.2 Refrigerants are classified into groups according to the risks they pose to health and safety as shown in Table 1.

Table 1 — Safety group classification of refrigerants as determined by flammability and toxicity

Flammability group	Toxicity group	
	A (OEL > 400 p.p.m. V/V)	B (OEL < 400 p.p.m. V/V)
1 (non flammable)	A1	B1
2 (LEL > 3.5 % V/V)	A2	B2
3 (LEL < 3.5 % V/V)	A3	—

NOTE 1 Although ozone depleting and global warming effects are not included in the classification, these effects are important and need to be considered when selecting the refrigerant for a particular application.

NOTE 2 In general, for a well designed and maintained refrigerating system, the indirect global warming effect caused by release of CO₂ during the generation of power to drive the refrigerating system is significantly greater than the direct global warming effect. It is therefore important to select refrigerants and design systems for maximum efficiency.

A more detailed classification of some refrigerants in the groups shown in Table 1 is given in Table 2.

NOTE 3 Where there is doubt under which group a refrigerant not listed in Table 2 should be classified, it should be classified in the group requiring the more stringent precautions.

NOTE 4 Refrigerants should be selected to minimize local and environmental hazards taking account of the category of occupancy and the type of cooling system. (See Table 3 and Table 4 and section 2.)

NOTE 5 Selection of a refrigerant usually involves a compromise between requirements of low environmental impact on the one hand, and efficiency and safety on the other.

Table 2 — Classification of refrigerants

Refrigerant group	Refrigerant number ^e	Description	Formula	Molar mass ^d	Practical limit ^{ab}	Flammability				Global warming potential ^c (GWP) 100 year time horizon	Ozone depletion potential ^c (ODP)
						Auto-ignition temperature °C	Flammability limits Concentration in air				
				lower limit			upper limit				
				kg/m ³	% V/V		kg/m ³	% V/V			
A1	R-11	Trichlorofluoromethane	CCl ₃ F	137.4	0.3	—	—	—	—	4 000	1
A1	R-12	Dichlorodifluoromethane	CCl ₂ F ₂	120.9	0.5	—	—	—	—	8 500	0.9
A1	R-12B1	Bromochlorodifluoromethane	CBrClF ₂	165.4	0.2	—	—	—	—		3
A1	R-13	Chlorotrifluoromethane	CClF ₃	104.5	0.5	—	—	—	—	13 000	1
A1	R-13B1	Bromotrifluoromethane	CBrF ₃	148.9	0.6	—	—	—	—	4 900	10 to 16
A1	R-22	Chlorodifluoromethane	CHClF ₂	86.5	0.14	635	—	—	—	1 700	0.055
A1	R-23	Trifluoromethane	CHF ₃	70.0	0.68	765	—	—	—	12 000	0
A1	R-113	1,1,2-Trichloro-1,2,2-trifluoroethane	CCl ₂ FCClF ₂	187.4	0.4	—	—	—	—	5 000	0.9
A1	R-114	1,2-Dichloro-1,1,2,2-tetrafluoroethane	CClF ₂ CClF ₂	170.9	0.7	—	—	—	—	9 300	0.8
A1	R-115	2-Chloro-1,1,1,2,2-pentafluoroethane	CF ₃ CClF ₂	154.5	0.6	—	—	—	—	9 300	0.5
A1	R-124	2-Chloro-1,1,1,2-tetrafluoroethane	CF ₃ CHClF	136.5	0.11	—	—	—	—	480	0.023
A1	R-125	Pentafluoroethane	CF ₃ CHF ₂	120.0	0.39	733	—	—	—	3 200	0
A1	R-134a	1,1,1,2-Tetrafluoroethane	CF ₃ CH ₂ F	102.0	0.25	743	—	—	—	1 300	0
A1	R-218	Octafluoropropane	C ₃ F ₈	188.0	1.84	—	—	—	—	7 000	0
A1	R-C318	Octafluorocyclobutane	C ₄ F ₈	200.0	0.81	—	—	—	—	5 279	0
A1	R-500	R-12 (73.8 %) + R-152a (26.2 %)	CCl ₂ F ₂ + CF ₂ HCH ₃	99.3	0.4	—	—	—	—	6 310	0.66
A1	R-501	R-12 (25 %) + R-22 (75 %)	CCl ₂ F ₂ + CHClF ₂	93.1	0.38	—	—	—	—	3 400	0.26
A1	R-502	R-22 (48.8 %) + R-115 (51.2 %)	CHClF ₂ + CF ₃ CClF ₂	111.6	0.45	—	—	—	—	5 591	0.283
A1	R-503	R-13 (59.9 %) + R-23 (40.1 %)	CClF ₃ + CHF ₃	87.3	0.35	—	—	—	—	12 639	0.6
A1	R-507	R-125 (50 %) + R-143a (50 %)	CF ₃ CHF ₂ + CF ₃ CH ₃	98.8	0.49	—	—	—	—	3 800	0
A1	R-718	Water	H ₂ O	18.0	—	—	—	—	—	0	0
A1	R-744	Carbon dioxide	CO ₂	44.0	0.1	—	—	—	—	1	0

Table 2 — Classification of refrigerants

Refrigerant group	Refrigerant number ^e	Description	Formula	Molar mass ^d kg/kmol	Practical limit ^{ab} kg/m ³	Flammability				Global warming potential ^c (GWP) 100 year time horizon	Ozone depletion potential ^c (ODP)	
						Auto-ignition temperature °C	Flammability limits Concentration in air					
							lower limit		upper limit			
							kg/m ³	% V/V	kg/m ³			% V/V
A1/A1	R-401A	R-22 (53 %) + R152a (13 %) + R-124 (34 %)	CHClF ₂ + CHF ₂ CH ₃ + CF ₃ CHClF	94.4	0.13	681	—	—	—	—	1 082	0.04
A1/A1	R-401B	R-22 (61 %) + R152a (11 %) + R-124 (28 %)	CHClF ₂ + CHF ₂ CH ₃ + CF ₃ CHClF	92.8	0.13	685	—	—	—	—	1 187	0.04
A1/A1	R-401C	R-22 (33 %) + R152a (15 %) + R-124 (52 %)	CHClF ₂ + CHF ₂ CH ₃ + CF ₃ CHClF	101.0	0.12	—	—	—	—	—	832	0.03
A1/A1	R-402A	R-125 (60 %) + R-290 (2 %) + R-22 (38 %)	CF ₃ CHF ₂ + CH ₃ CH ₂ CH ₃ + CHClF ₂	101.5	0.22	723	—	—	—	—	2 566	0.02
A1/A1	R-402B	R-125 (38 %) + R-290 (2 %) + R-22 (60 %)	CF ₃ CHF ₂ + CH ₃ CH ₂ CH ₃ + CHClF ₂	94.7	0.18	641	—	—	—	—	2 236	0.03
A1/A1	R-403A	R-22 (75 %) + R-218 (20 %) + R-290 (5 %)	CHClF ₂ + C ₃ F ₈ + C ₃ H ₈	92	0.17	—	—	—	—	—	2 675	0.04
A1/A1	R-403B	R-22 (56 %) + R-218 (39 %) + R-290 (5 %)	CHClF ₂ + C ₃ F ₈ + C ₃ H ₈	103.2	0.21	—	—	—	—	—	3 682	0.03
A1/A1	R-404A	R-125 (44 %) + R-143a (52 %) + R-134a (40 %)	CF ₃ CHF ₂ + CF ₃ CH ₃ + CF ₃ CH ₂ F	97.6	0.48	728	—	—	—	—	3 748	0
A1/A1	R-407A	R-32 (20 %) + R-125 (40 %) + R-134a (40 %)	CH ₂ F ₂ + CF ₃ CHF ₂ + CF ₃ CH ₂ F	90.1	0.33	685	—	—	—	—	1 916	0
A1/A1	R-407B	R-32 (10 %) + R-125 (70 %) + R-134a (20 %)	CH ₂ F ₂ + CF ₃ CH ₂ F + CF ₃ CHF ₂	102.9	0.35	723	—	—	—	—	2 560	0
A1/A1	R-407C	R-32 (23 %) + R-125 (25 %) + R-134a (52 %)	CH ₂ F ₂ + CF ₃ CHF ₂ + CF ₃ CH ₂ F	86.2	0.35	704	—	—	—	—	1 610	0

