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Mechanical refrigerating systems used for cooling and heating — Safety requirements

Systèmes frigorifiques mécaniques utilisés pour le refroidissement et le chauffage — Prescriptions de sécurité

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Contents

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Annexes

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5149 was prepared by Technical Committee ISO/TC 86, *Refrigeration*, Sub-Committee SC 1, *Safety*.

This first edition cancels and replaces the first edition ISO/R 1662:1971, which has been technically revised.

Annexes A, B and C of this International Standard are for information only.

Introduction

The International Standard concerning the safety of refrigerating systems takes into account regulations already in force, or existing in draft form, in a number of countries. The provisions represent minimum requirements for the design, construction, installation, and operation of a refrigerating plant. However, in particular cases, more severe requirements may be necessary. Where national regulations are in force, full account should be taken of them.

Reference is made in this International Standard to pressure-vessel codes, electrical codes and the like, and in many countries such codes exist and are mandatory. In the absence of such mandatory rules in any particular country, an acceptable substitute becomes necessary. It is recommended therefore that a relevant document that has received national or international recognition should be used. However, such regulations must be acceptable to and be accepted by all the parties concerned in each transaction.[1)]

This International Standard is intended solely to minimize possible hazards to persons and property from refrigerating systems; it does not constitute a technical design manual. These hazards are associated essentially with the physical and chemical characteristics of refrigerants as well as the pressures and temperatures occurring in refrigeration cycles. Inadequate precautions may result in

— rupture of a part or even an explosion, with risk from flying pieces of metal;

— escape of refrigerant following a fracture or simply due to leakage, or to incorrect operation during running or repair, or during charging;

— burning or explosion of escaping refrigerant, with consequent risk of fire.

Refrigerants, on the one hand, affect a refrigerating system internally according to the nature of the materials used and the pressures and temperatures and, on the other hand, they may have external effects when they are toxic, flammable or explosive, and may present risks to personnel, goods or materials (from burns, poisoning, asphyxiation, deterioration and corrosion).

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

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1) See chapter 5 of the *Practical Guide to Refrigerating Storage*, International Institute of Refrigeration (IIR), Paris.

The following dangers are worth noting.

a) Danger from the direct effect of temperature:

— brittleness of metals at low temperatures;

— freezing of heat-transferring liquids (for example water, brine) in closed spaces;

— thermal stresses;

— damage to buildings resulting from freezing of the ground beneath them;

— injurious effects to persons caused by low temperatures.

b) Danger from excessive pressure due to:

— increase in the pressure of condensation, caused by inadequate cooling or the partial pressure of non-condensable gases or an accumulation of oil or liquid refrigerant;

— increase in the pressure of saturated vapour due to excessive external heating, for example of a liquid cooler, or when defrosting an air cooler, or high ambient temperature when the plant is at a standstill;

— expansion of liquid refrigerant in a closed space without the presence of vapour, caused by a rise in external temperature;

— fire.

c) Danger from the direct effect of the liquid phase:

— excessive charge or flooding of apparatus;

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

— loss of lubrication due to emulsification of oil.

d) Danger from the escape of refrigerants:

— fire;

— explosion;

— toxicity;

— panic;

— asphyxiation.

Attention is drawn to dangers common to all compression systems, such as excessive temperature at discharge, liquid slugging, erroneous operation (for example, discharge valve closed while running), or reduction in mechanical strength caused by corrosion, erosion, thermal stress, liquid hammer, or vibration. Corrosion, however, should have special consideration as conditions peculiar to refrigerating systems arise due to alternate frosting and defrosting or the covering of apparatus by insulation.

The above analysis of the risks applying to refrigerating installations explains the plan on which this International Standard has been based.

After general considerations (Section 1) and a classification of the occupancies, the cooling and heating systems and the refrigerants (Section 2), Section 3 defines the precautions to be considered at the design, construction and assembly stages, in the choice of working and test pressures, in the use of materials and in the disposition of safety devices in the various parts of the installation. Section 4 provides rules for the utilization of refrigerating equipment in the various types of occupancy with limits for refrigerant charge, requirements for machine rooms and also miscellaneous precautions. Finally, Section 5 describes instructions necessary to safeguard personnel, to secure correct operation of the plant and to prevent its deterioration.

Refrigerating systems with a relatively small amount of refrigerant charge, such as household refrigerators, commercial refrigerated cabinets, room air conditioners, heat pump units or small unitary refrigerating and air conditioning equipment, have specific safety aspects and need appropriate requirements. The appropriate safety requirements for these refrigerating systems are included in this International Standard. Additional requirements for the whole appliance may be found in other standards. Such special requirements are found in the references listed in subclause 1.2 and in annex C.

The next revision of this International Standard will incorporate data on ozone-depletion refrigerants.

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Mechanical refrigerating systems used for cooling and heating — Safety requirements

Section 1: General

1.1 Scope

This International Standard specifies the requirements relating to the safety of persons and property for the design, construction, installation and operation of refrigerating systems.

It applies to all types of refrigerating systems in which the refrigerant is evaporated and condensed in a closed circuit, including heat pumps and absorption systems, except for systems using water or air as the refrigerant.[2)]

Individual safety standards for identifiable types of refrigerating systems may deviate from requirements set forth in this International Standard to accommodate particular needs, provided that there is no reduction in the level of safety achieved.

This International Standard is applicable to new refrigerating systems, extensions and modifications of already existing systems, and for used systems on being transferred to and operated on another site. Deviations are permissible only if equivalent protection is ensured.

It also applies in the case of the conversion of a system for another refrigerant, for example R 40 to R 12, or ammonia to R 22.

1.2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 817:—[3)], *Refrigerants — Number designation.*

ISO 4126-1:1991, *Safety valves — Part 1: General requirements.*

IEC 335-2-24:1984, *Safety of household and similar electrical appliances — Part 2, Section 24 — Particular requirements for refrigerators and food freezers.*

IEC 335-2-34:1980, *Safety of household and similar electrical appliances — Part 2, Section 34 — Particular requirements for motor-compressors.*

IEC 335-2-40:1992, *Safety of household and similar electrical appliances — Part 2, Section 40 — Particular requirements for electric heat pumps, air-conditioners and dehumidifiers.*

1.3 Definitions

For the purposes of this International Standard, the following definitions apply.

1.3.1 abnormal fire risk: Fire risk that may arise from conflagration uncontrollable by the normal fire fighting facilities of a municipality.

1.3.2 absorption (or adsorption) refrigerating system: System in which refrigeration is effected by evaporation of a refrigerant, the vapour then being

2) More stringent regulations may exist, for example, for mines or transport (rail or road vehicles, ships and aeroplanes). Where such regulations exist, they take precedence.

3) To be published. (Revision of ISO 817:1974)

absorbed (or adsorbed) by an absorbent (or adsorbent) medium, from which it is subsequently expelled at a higher partial vapour pressure by heating and liquified by cooling.

1.3.3 authorized person: Person appointed to carry out specified duties in a safe manner, who has sufficient technical experience and knowledge to accomplish those duties safely.

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

1.3.5 bursting disc: Disc or foil which bursts at a pre-determined pressure.

1.3.6 changeover device: Valve controlling two protection devices and so arranged that only one can be rendered inoperative at any given moment.

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

1.3.8 companion valves; block valves: Pair of mating stop valves, valving off sections of systems and arranged so that these sections may be joined before opening these valves, or separated after closing them.

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

1.3.10 compressor unit: Condensing unit without the condenser and liquid receiver.

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

1.3.12 condensing unit: Specific refrigerating machine combination for a given refrigerant, consisting of one or more power-driven compressors, condensers, liquid receivers (when required) and the regularly furnished accessories.

1.3.13 critical density: Density at critical temperature and critical pressure.

1.3.14 design pressure: Design gauge pressure, used to determine the constructional characteristics of the apparatus. It shall not be less than the maximum working pressure.

1.3.15 evaporator: That part of the system in which liquid refrigerant is vaporized to produce refrigeration.

1.3.16 evaporating unit: A specific refrigerating machine combination for a given refrigerant, consisting of one or more power-driven compressors, evaporators, liquid receivers (when required) and regularly furnished accessories.

1.3.17 exit: Passage-way immediately in the vicinity of the door through which people leave a building.

1.3.18 fusible plug; fusible component: Device containing a material melting at a pre-determined temperature.

1.3.19 gauge pressure: Difference between the absolute pressure in the system and the atmosphere pressure at the site.

1.3.20 hallway: Corridor for the passage of people.

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

1.3.22 heat-transferring liquid: Any liquid which allows transmission of heat without any change in its liquid state.

1.3.23 hermetic refrigerant motor-compressor: Combination consisting of a compressor and motor, both of which are enclosed in the same housing, with no external shaft or shaft seals, the motor operating in the refrigerant.

1.3.24 high-pressure side: That part of a refrigerating system operating at approximately the condenser pressure.

1.3.25 human-occupied space: Space normally frequented or occupied by people, with the exception of machinery rooms and of cold rooms used for storage purposes.

1.3.26 internal gross volume: Volume calculated from the internal dimensions of the container, no account being taken of the volume of the internal parts.

1.3.27 internal net volume: Volume calculated from the internal dimensions of the container after the deduction of the volume of the internal parts.

1.3.28 intrinsic pressure safety: System that precludes the refrigerant pressure from exceeding the maximum working pressure of any component without safety devices by means of limiting the refrigerant charge at the maximum temperature relative to the internal volume of the components of the refrigerating system. (See requirements given in 3.7.2.3.)

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

1.3.30 low-pressure side: That part of a refrigerating system operating at approximately the evaporator pressure.

1.3.31 leakage test pressure: Gauge pressure which is applied to test the tightness of a refrigerating system and/or of any part of it.

1.3.32 limited-charge refrigerating system: System in which the internal volume and total refrigerant charge are such that, with the system idle, the maximum working pressure will not be exceeded if complete evaporation of the refrigerant charge occurs.

1.3.33 machinery: Refrigerating equipment forming a part of the refrigerating system including any or all of the following: compressor, condenser, generator, absorber (adsorber), liquid receiver, connecting pipe, evaporator.

1.3.34 machinery room: Room intended to contain, for reasons connected with safety, components of the refrigerating system, but not including rooms containing only evaporators, condensers or piping.

1.3.35 maximum working pressure (MWP): Gauge pressure which shall not be exceeded either in operation or at rest within the refrigerating system except within the operating range of the pressure-relief device (see table 3).

NOTE 1 It represents the basis of all other pressures in this International Standard.

1.3.36 non-positive-displacement compressor: Compressor in which an increase in vapour pressure is attained without changing the internal volume of the compression chamber.

1.3.37 piping: Pipes or tubes for interconnecting the various parts of a refrigerating system.

1.3.38 positive-displacement compressor: Compressor in which an increase in vapour pressure is attained by changing the internal volume of the compression chamber.

1.3.39 pressure-limiting device: Pressure-actuated adjustable instrument (for example, a high-pressure switch) which is designed to stop the operation of the pressure-imposing element and may also operate an alarm. This device cannot prevent a change in pressure when the machine is at a standstill.

1.3.40 pressure-relief device: Valve (1.3.41) or disc (1.3.5) designed to relieve excessive pressure automatically.

1.3.41 pressure-relief valve: Pressure-actuated valve held shut by a spring or other means and designed automatically to relieve pressure in excess of its setting. It is designed to reclose and prevent further flow of fluid after the pressure has dropped below its setting.

1.3.42 pressure vessels: Any refrigerant containing part of a refrigerating system other than:

— compressors,
— pumps,
— component parts of sealed absorption systems,
— evaporators, each separate section of which does not exceed 15 litres of refrigerant-containing volume,
— coils and grids,
— piping and its valves, joints and fittings,
— control devices,
— headers and other components having not more than 152 mm internal diameter and internal net volume not more than 100 litres.

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

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

1.3.45 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 of the fluid, usually involving changes of state of the fluid.

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

1.3.47 refrigerating system: Combination of interconnected, refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting and rejecting heat.

1.3.48 sealed absorption system: Unit system for Group 2 refrigerants only in which all refrigerant-containing parts, except for a fusible component, are made permanently tight by welding or brazing against refrigerant loss.

NOTE 2 This is a restrictive definition for the purposes of this International Standard only.

1.3.49 self-contained system: Complete factory-made and factory-charged and tested system in a suitable frame and/or enclosure, which 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.

1.3.50 shut-off device: Device to shut off the flow of refrigerant.

1.3.51 soldered joint: Gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys which melt at temperatures in general from 200 °C to 450 °C. This does not apply to fusible plugs or components used for relief purposes.

1.3.52 strength-test pressure: Gauge pressure which is applied to test the strength of a refrigerating system and/or of any part of it.

1.3.53 type-tested pressure-limiting device: Pressure-limiting device which is designed to stop the operation of the pressure-imposing element even in the case of internal defects of the device.

Such pressure limiting devices are available with:

— automatic reset,

— manual reset,

— safety manual reset by means of tools.

1.3.53.1 pressure-limiting device with automatic reset: Device which opens the electric circuit when the system pressure rises to the preset cut-out level. It resets automatically when the pressure has decreased to the preset cut-in value.

1.3.53.2 pressure-limiting device with manual reset: Device which opens and locks out the electric circuit when the pressure rises to the preset cut-out level. Reset is possible by hand, only after a predetermined decrease in pressure has occurred.

1.3.53.3 pressure-limiting device with safety manual reset: Device which opens and locks out the electric circuit when the system pressure rises to the preset cut-out level. Resetting of the device is possible only by means of tools after a pre-determined decrease in pressure has occurred.

1.3.54 unit system: Self-contained system which has been assembled and tested prior to its installation and which is installed without connecting any refrigerant-containing parts. A unit system may include factory-assembled companion or block valves.

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

1.3.56 welded joint: Gas-tight joint obtained by joining of the metal parts in the plastic or molten state.

Section 2: Classification

2.1 Occupancies

Considerations of safety in refrigerating systems take into account the site, the number of people occupying the site, and the categories of occupancy.

The categories are listed in table 1. They refer to all those areas where an installation would affect safety.

2.1.1 Where there is more than one category of occupancy, the most stringent requirements apply, unless occupancies are isolated, for example by tightly sealed partitions, floors and ceilings. In this case, the requirements of the individual category of occupancy apply.

2.1.2 Due regard shall be paid to the safety of adjacent premises and occupants in areas adjacent to a refrigerating installation.

2.2 Refrigerating systems

Refrigerating systems shall be classified, as shown in table 2, according to the method of extracting heat from, or adding heat to, the air or substance to be treated.

2.2.1 Direct system

The evaporator or condenser of the refrigerating system is in direct communication with the air or the substance to be cooled or heated.

2.2.2 Indirect systems

The evaporator of the refrigerating system, located externally to the space where the heat is extracted from, or delivered to, the air or substance to be treated, cools or heats a heat-transferring liquid (see 1.3.22) which is circulated to cool or heat the substance concerned.

2.2.2.1 Indirect open system

The evaporator cools or the condenser heats the heat-transferring liquid which is brought into direct communication with the substance concerned by sprays or similar means.

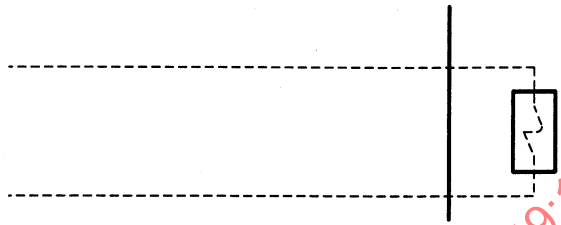
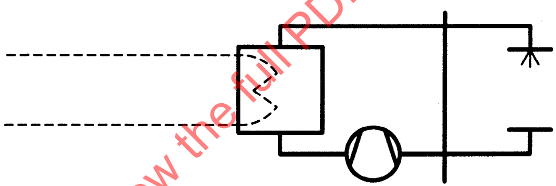
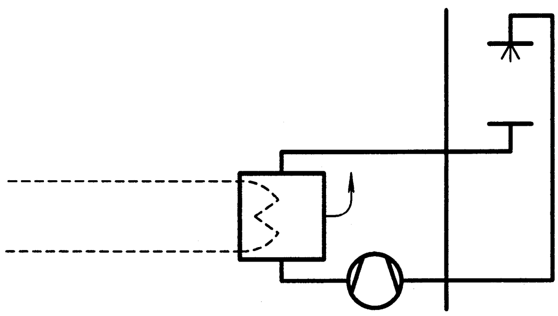
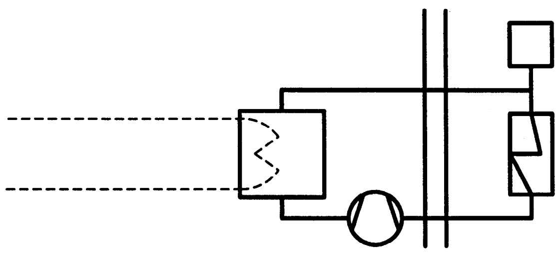
2.2.2.2 Indirect vented open system

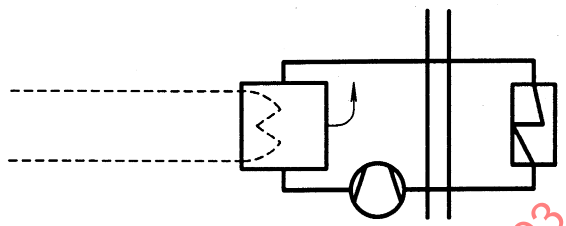
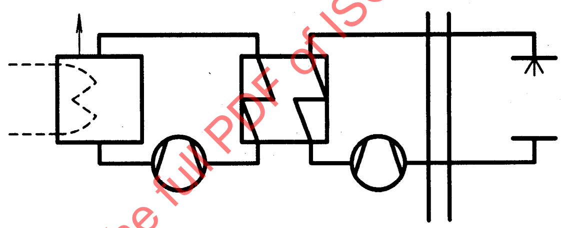
This system is similar to that described in 2.2.2.1, except that the evaporator or condenser is placed in an open tank or is appropriately vented with a comparable effect.

Table 1 — Categories of occupancy

Category	General characteristics	Examples
A Institutional	People may be restricted in their movements	Hospitals, court houses, prisons with cells
B Public assembly	People may assemble freely	Theatres, dance rooms, department stores, passenger stations, schools, churches, lecture halls, restaurants
C Residential	Sleeping accommodation is provided	Homes, hotels, residential apartments, clubs, colleges
D Commercial	Any number of people may be assembled, some being necessarily acquainted with the general safety precautions of the establishment	Business or professional offices, small shops, small restaurants, laboratories, places for general manufacturing and the performance of work, markets with unrestricted entry
E Industrial	Only authorized persons have access and where manufacturing, processing or storage of materials or products takes place	Manufacturing facilities for chemicals, food, beverages, ice cream and ice; refineries, cold stores, dairies, abattoirs

Table 2 — Classification of refrigerating systems

Subclause	Designation	Refrigerating system	Air or substance to be treated
2.2.1	Direct system		
2.2.2.1	Indirect open system		
2.2.2.2	Indirect vented open system		
2.2.2.3	Indirect closed system		

Subclause	Designation	Refrigerating system	Air or substance to be treated
2.2.2.4	Indirect vented closed system		
2.2.2.5	Double indirect system		

Pipework containing refrigerant - - - - - - - - - -
Pipework containing heat-transferring liquid ————————

2.2.2.3 Indirect closed system

The evaporator cools or the condenser heats the heat-transferring liquid which passes through a closed circuit in direct communication with the air or substance to be cooled.

2.2.2.4 Indirect vented closed system

This system is similar to that of 2.2.2.3, except that the evaporator or condenser is placed in an open tank or is appropriately vented with a comparable effect.

2.2.2.5 Double indirect system

This system is similar to that of 2.2.2.1, except that the heat-transferring liquid passes through a second heat-exchanger located externally to the space, as mentioned in 2.2.2 and cools or heats a second heat-transferring liquid, which is brought into direct communication with the air or substance concerned by sprays or similar means.

2.3 Refrigerants

Refrigerants are classified according to their characteristics as follows (see annex A).

Group 1: Non-flammable refrigerants which are not substantially injurious to the health of persons.

Group 2: Toxic or corrosive refrigerants whose lower ignition limit (explosion limit) is not less than 3,5 % by volume when they form a mixture with air.

Group 3: Refrigerants whose lower ignition limit (explosion limit) is less than 3,5 % by volume when they form a mixture with air.

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

2.3.1 Refrigerant groups

2.3.1.1 Group 1

Refrigerants in this group are non-flammable and may be used in systems where the total charge, adequate in quantity for the refrigeration requirements of the spaces concerned, could escape into the human-occupied spaces without exceeding the practical limits given in table 4.

The application of direct cooling to human-occupied space is a major safety matter. Direct systems are restricted by the requirements of 4.3 to specified quantities of refrigerant, limited by considerations of toxicity or asphyxiation risks.

Toxic decomposition products may result from contact with flames or hot surfaces under certain conditions. Major decomposition products of Group 1 refrigerants, with the exception of carbon dioxide, are hydrochloric acid and hydrofluoric acid. Although toxic, they provide an automatic and definite warning by their exceedingly irritating smell even at low concentrations.

The maximum charge is determined by means of table 4 relating to the smallest human-occupied space concerned, except that the total volume of all rooms cooled by air from one air circulation system may be used as the criterion, provided that the air supply to each room cannot be restricted below 25 % of the full supply to that room. This limits the concentration that could occur if the charge leaked out of the system.

A system containing more than the quantity of Group 1 refrigerant allowed in table 4 shall be of the indirect type, and all refrigerant-containing parts except piping shall be installed in a machinery room or installed outside the building.

Care should be taken to avoid stagnant pockets of heavier-than-air refrigerant at low levels.

At all times, care should be taken to minimize the discharge of refrigerant to the atmosphere.

2.3.1.2 Group 2

Refrigerants in this group have toxicity as a dominant characteristic. A few refrigerants in this group are flammable, but with a lower ignition limit of 3,5 % or more by volume, and for these appropriate additional restrictions are required.

Ammonia is the unique refrigerant in this group which is in widespread use. It has the advantage of automatically warning of leaks by its characteristic odour, even at concentrations far below any risks. Ammonia is only flammable in a very narrow and high range of concentration with a high ignition temperature. (For ammonia systems, see 3.8.2.3.)

All other refrigerants of this group are rarely used and are to be considered obsolete. They are, therefore, only of theoretical interest.

2.3.1.3 Group 3

Refrigerants in this group have their explosive or flammable characteristics dominant, with a lower ignition limit below 3,5 % by volume. They are, in general, of low toxicity.

2.3.2 Physical properties

For information on physical properties of refrigerants, see annex A.

Table 3 — Relationship between the various pressures and the maximum working pressure (MWP)

Pressure	Limit
Design pressure	Not less than 1,0 × MWP
Strength-test pressure for components made of castings	Not less than 1,5 × MWP
Strength-test pressure for components made of rolled or drawn materials	Not less than 1,3 × MWP
Test pressure for complete system assembled on site	Not less than 1,0 × MWP
Leakage-test pressure	Not more than 1,0 × MWP
Pressure-limiting device setting	Less than 1,0 × MWP [1)]
Pressure-relief device setting	1,0 × MWP
Relief-valve rated discharge	Not more than 1,1 × MWP

1) It is recommended that the pressure-limiting device setting be lower than that of the relief device.

Table 4 — Practical limits of concentration for Group 1 refrigerants

Refrigerant number R	Chemical name	Chemical formula	Practical limits[1)] (see 2.3.1.1) kg/m^3
11	Trichlorofluoromethane	CCl_3F	0,3
12	Dichlorodifluoromethane	CCl_2F_2	0,5
12B1	Bromochlorodifluoromethane	$CBrClF_2$	0,2
13	Chlorotrifluoromethane	$CClF_3$	0,5
13B1	Bromotrifluoromethane	$CBrF_3$	0,6
22	Chlorodifluoromethane	$CHClF_2$	0,3
23	Trifluoromethane	CHF_3	0,3
113	Trichlorotrifluoroethane	CCl_2FCClF_2	0,4
114	Dichlorotetrafluoroethane	$CClF_2CClF_2$	0,7
500	R 12 (73,8 %) + R 152a (26,2 %)	CCl_2F_2/CH_3CHF_2	0,4
502	R 22 (48,8 %) + R 115 (51,2 %)	$CHClF_2/CClF_2CF_3$	0,4
503	R 23 (40,1 %) + R 13 (59,9 %)	R 23 (40,1 %) + R 13 (59,9 %)	0,4
744	Carbon dioxide	CO_2	0,1

1) Practical limits for Group 1 refrigerants are less than half of the normal narcotic effect limits.

These values shall be reduced to 2/3 of the listed value for altitudes higher than 2 000 m above sea level, and to 1/3 of the listed value for altitudes above 3 500 m above sea level.

Section 3: Design and construction of equipment

3.1 Pressure requirements

NOTE 3 In this International Standard, the word "pressure", is meant to be "gauge pressure" except in 3.7.7.

Refrigerating systems shall be capable of withstanding the following pressure requirements, taking into account the temperatures to be expected, mechanical stress and stress due to chemical action.

3.1.1 Testing of refrigerating systems or components

3.1.1.1 Strength-pressure testing

3.1.1.1.1 Components of refrigerating systems shall be pressure-strength tested individually or in groups according to their location in the system and in accordance with table 3 by the manufacturer or on site, if not previously tested, e.g. by a type test.

3.1.1.1.2 For miscellaneous pressure-containing parts not covered by accepted codes or standards, the test pressure shall not cause permanent deformation, except that where deformation is necessary to the manufacture of the component, it shall be deemed adequate if the components are designed to withstand without rupture a pressure not less than three times the MWP.

3.1.1.1.3 The strength-pressure test shall be carried out as a hydrostatic pressure test by means of water or some other liquid, except where a component cannot be pressure tested with liquid for technical reasons. In that case, it shall be tested by means of air or some other non-hazardous gas. Adequate precautions shall be taken to prevent danger to people and to minimize risk to property.

3.1.1.1.4 Lower test pressures may be used for pressure gauges and control devices, provided that the housing of the device is treated in accordance with 3.1.1.1.1.

3.1.1.2 Complete-system test

3.1.1.2.1 After assembly and before putting into service, each system shall be subjected to a pressure test in accordance with table 3, by means of air or some suitable gas, provided that all component parts of the system have previously been pressure-tested in accordance with 3.1.1.1.

3.1.1.2.2 For testing systems containing not more than 10 kg of Group 1 refrigerants or not more than 2,5 kg of Group 2 refrigerants, and with pipelines not exceeding 16 mm inside diameter, the refrigerant intended for operation may be used at a pressure not lower than the pressure corresponding to 20 °C.

3.1.1.2.3 For factory-assembled refrigerating systems, a leakage test in accordance with 3.1.1.3 is sufficient, provided that all components have previously been tested in accordance with 3.1.1.1.

3.1.1.2.4 Such testing may be carried out in stages as the system is completed.

3.1.1.3 Leakage test

The whole system shall be leak tested in accordance with table 3, by the manufacturer if it is factory-assembled, or on site if it is assembled or charged on site. Such testing may be carried out in stages as the system is completed.

3.2 Materials

In selecting constructional, welding and brazing materials for refrigerating systems, care shall be taken that they will be able to withstand the chemical, mechanical and thermal stresses. They shall be resistant to the refrigerants to be used, to the refrigerant and oil mixtures with possible impurities and contaminants, and to the heat-transferring liquids. For pressure vessels, the special requirements given in 3.3 shall be followed.

3.2.1 Ferrous materials

3.2.1.1 Cast iron and malleable iron may be used for machines and fittings of the refrigerant circuit, as well as for heat-transferring liquid circuits.

3.2.1.2 Steel and cast steel, carbon steel and low-alloy steel may be used for all parts carrying refrigerant and also for heat-transferring liquid circuits. In low-temperature installations, steel shall be used with an adequate impact strength for the particular duty, taking into consideration the material thickness and its welding properties.

3.2.1.3 High-alloyed steel materials may be required at lower temperatures, higher pressures and where corrosion risks are present. The impact strength shall be adequate for the particular duty, and the material shall be suitable for welding.

3.2.2 Non-ferrous metals and their alloys
(cast, forged, rolled and drawn)

3.2.2.1 Copper and copper alloys

3.2.2.1.1 If copper is used in contact with refrigerants, it shall be oxygen-free or deoxidized.

3.2.2.1.2 Copper and alloys with a high percentage of copper shall not be used for parts carrying the refrigerants ammonia and methyl formate, unless their compatibility with the materials coming into contact with them has been established.

3.2.2.2 Aluminium and its alloys

These shall not be used in contact with the refrigerant methyl chloride. If used in connection with other refrigerants, the compatibility of aluminium or its alloys shall be previously established.

3.2.2.3 Magnesium

Magnesium shall not be used, except for special cases where alloys with a low percentage of magnesium may be used after carefully testing their compatibility with the materials coming into contact with them.

3.2.2.4 Zinc

Zinc shall not be used for the refrigerants ammonia and methyl chloride.

3.2.2.5 Lead

Lead should not be used for fluorinated refrigerants, except for packing purposes.

3.2.2.6 Tin and lead/tin alloys

These are corroded by fluorinated hydrocarbons. Their use at working temperatures under – 10 °C is not recommended.

3.2.2.7 Soldering and brazing alloys

3.2.2.7.1 Due to the development of new materials and methods, in particular for joining aluminium parts, recommendations are not given. Materials containing zinc or other metals normally not compatible with certain refrigerants shall, however, only be allowed after the manufacturer of the refrigerating equipment has proved conclusively that such materials may be safely used.

3.2.2.7.2 Soft-soldering alloys with tin as their base may be used where mechanical stresses are low, but for working temperatures below – 10 °C their use is not recommended. The effect of the alloy components, for example lead and tin, should not be disregarded.

3.2.2.7.3 Brazing alloys may be used for higher stresses and for lower working temperatures. The alloy components shall be examined for their compatibility with refrigerants.

3.2.3 Non-metallic materials

3.2.3.1 Packing materials for sealing joints and for sealing stuffing-boxes on fittings, etc. shall be resistant to the refrigerants and refrigerating machine oils used. They shall also be suitable for the pressures and temperatures occurring. No erosion shall occur which might cause leakages and risks.

3.2.3.2 Glass may be used in the refrigerant circuits and in the heat-transferring-liquid circuits of machines, apparatus and pipes for fluid gauges and for observation ports.

3.2.3.3 Plastics may be used provided they are adequate for the mechanical, thermal, chemical and long-term creep stresses occurring and provided they do not create fire hazards.

3.3 Pressure vessels

3.3.1 Testing of pressure vessels

Pressure vessels shall be tested in accordance with provisions of national and/or international codes by a competent person acceptable to the jurisdictional authority.

3.3.2 Pressure-relief devices for pressure vessels

Pressure-relief devices, as defined in 3.7.1.1, shall be arranged according to 3.7.6.

3.3.3 Requirements for marking

3.3.3.1 Pressure vessels whose maximum working pressure exceeds 100 kPa, and in which the product of the internal gross volume of the vessels, in litres, and the maximum working pressure, in kilopascals, exceeds the value of 20 000 kPa × volume, shall be marked in accordance with 3.3.4.1 and 3.3.4.3.

3.3.3.2 Other pressure vessels with an internal net volume larger than 0,1 litre, or where the product of the internal net volume, in litres, and the maximum working pressure, in kilopascals, exceeds the value of 1 200 kPa × volume, shall be marked in accordance with 3.3.4.2.

3.3.4 Marking

3.3.4.1 All pressure vessels which require marking in accordance with 3.3.3.1 shall be provided with an identification plate bearing at least the following information:

— manufacturer's or supplier's name;

— serial number;

— year of manufacture;

— maximum working pressure;

— maximum working temperature.

Low-temperature vessels shall also be marked with

— minimum permissible temperature, if out of the range – 10 °C to + 50 °C.

3.3.4.2 On batch-produced vessels other than those mentioned in 3.3.3.1, the following information shall be provided:

— manufacturer's name or logo;

— model and/or serial number;

— maximum working pressure;

— allowable temperature, if out of the range – 10 °C to + 50 °C.

The marking of each pressure vessel is not necessary if the system of which it is a part is marked in accordance with 4.2.7.1.

3.3.4.3 The identification plate shall be permanently connected to the vessel. If the plate is not readily visible, a facsimile shall be fixed in the most convenient adjacent position.

3.3.5 Strength-test certificate

Any necessary strength-test certificates and any necessary copies shall be prepared on behalf of and signed by the person(s) witnessing and responsible for the test.

3.3.6 Repeat strength test

A repeat strength test shall be carried out on pressure vessels following repair work or other work likely to affect the strength, or when a change in use subjects the vessels to higher stress. Any necessary strength-test certificate and any necessary copies shall be prepared on behalf of and be signed by the person(s) witnessing and responsible for the repeat test.

3.4 Refrigerant piping, valves and fittings

3.4.1 Pipes and tubes

The material, wall thickness, tensile strength, ductility, corrosion resistance, and forming and testing method for tubes shall be suitable for the refrigerant used. They shall satisfy the pressure, mechanical and thermal stress conditions of the application.

3.4.2 Joints

With the following exceptions, any flared, compression, flanged, screwed, welded, brazed or soldered joint suitable for the pipe or tube, the piping material and the refrigerant, and the pressure, mechanical and thermal stress of the application may be used.

Exceptions:

a) Solder: not for discharge lines or R 717.

b) Brazing: not for R 717.

c) Pipe thread: not for liquid lines larger than 25 mm nominal inside diameter; not for vapour lines larger than 40 mm nominal inside diameter.

3.4.3 Welding and brazing methods

Where welders' qualifications and welding and brazing procedures are defined in applicable standards acceptable to the governing authority, they shall be used to control the fabrication, repair and enlargement of piping systems.

3.4.4 Piping installed on site (see also 4.3)

3.4.4.1 Refrigerant piping shall be suitably supported. The distance between the supports depends on the size and service weight of the piping.

3.4.4.2 The clearance around the piping shall be sufficient to allow routine maintenance of components. Free passage shall not be obstructed.

3.4.4.3 Pipes passing through fire-resistant walls and ceilings shall be sealed so as not to allow the spreading of fire to neighbouring rooms. Pipe ducts and shafts shall be shut off from other rooms in such a way as to resist the spread of fire. Ducts containing piping for flammable or toxic refrigerants shall be vented to a safe place to prevent a dangerous accumulation of vapour in the event of a leak.

3.4.4.4 In the case of long runs of piping, provisions shall be made for expansion and contraction.

3.4.4.5 Flexible hoses shall be well protected against mechanical damage and shall be examined periodically.

3.4.4.6 Adequate precautions shall be taken to avoid excessive vibration.

3.4.4.7 Piping, valves and fittings in areas of free passage shall be installed not less than 2,20 m above the floor or against the ceiling. Overhead piping shall be positioned clear of the zone of activities which may cause damage to the piping.

3.4.4.8 In channels or ducts for refrigerant piping, there shall be no other piping or electric wires unless adequate protection for both is provided.

Refrigerant piping shall not be placed in any elevator, dumbwaiter or other shaft containing a moving object, or in any shaft which has openings to living quarters or to main exit hallways, unless the mass of Group 1 refrigerant is below the practical limit (see table 4).

3.4.4.9 Refrigerant piping shall not be placed in public hallways, lobbies or stairways, except that such refrigerant piping may pass across a public hallway if there are no joints in the section in the public hallway, and provided non-ferrous tubing of 29-mm nominal outside diameter and smaller is contained in a rigid metal pipe.

3.4.5 Identification of piping content

When the safety of persons or property may be affected by the release of the piping content, labels identifying the contents shall be applied to the pipe near valves and penetrated walls.

3.4.6 Shut-off devices

3.4.6.1 The ultimate strength of the housing of a shut-off device of up to 150-mm nominal inside diameter, or made of ductile steel, shall be able to withstand at least five times the MWP of the system portion to which it is applied.

Shut-off devices with nominal inside diameters greater than 150 mm, made of non-ductile steel, shall be able to withstand at least 6,5 times the MWP of the system portion to which they are applied.

3.4.6.2 The shut-off device shall be constructed so that operating stems and/or covers cannot be removed by rotation and, when closed, prevent flow in both directions. With the exception of shut-off devices with packing on the atmospheric side, it shall be possible to tighten or to remove gland packing while under pressure.

3.4.6.3 The arrangement of shut-off devices shall be as follows.

a) Systems containing more than 2,5 kg of a Group 2 or 1 kg of a Group 3 refrigerant, other than systems utilizing non-positive displacement compressors, shall have shut-off devices installed in:

   1) each inlet of each compressor, compressor unit, or condensing unit;

   2) each discharge outlet of each compressor, compressor unit, or condensing unit, and of each liquid receiver.

   3) each discharge of a liquid receiver.

b) All systems containing 50 kg or more of refrigerant, other than systems utilizing non-positive-displacement compressors, shall have shut-off devices at the locations specified in a) and on each inlet of each liquid receiver, except on the inlet of a receiver in a condensing unit or on the inlet of a receiver which is an integral part of a condenser.

3.4.6.4 Shut-off devices used with soft annealed copper tubing or hard drawn copper tubing of 23-mm nominal outside diameter or smaller shall be securely mounted, independent of tubing fastenings or supports.

3.4.6.5 Shut-off devices shall be suitably labelled if it is not obvious what they control. Numbers may be used to label the devices provided a key to the numbers is located near the devices.

3.4.6.6 On all oil drain lines, two shut-off devices shall be installed in series. The second device may be a quick-closing valve.

3.4.6.7 Shut-off devices which should not be closed when the system is operating shall be safeguarded against actuation by unauthorized persons.

3.5 Other refrigerant-containing components

Parts of refrigerating systems other than control mechanisms or pressure gauges and which are not governed by other parts of this International Standard shall be designed, constructed and assembled so as to be capable of withstanding the pressure tests, without permanent distortion or damage (see table 3).

3.6 Indicating and measuring instruments

Refrigerating systems shall be equipped with the indicating and measuring instruments necessary for adequate service and operation as set forth in this subclause.

3.6.1 Refrigerant pressure gauges

The term gauge as used in 3.6 includes instruments utilizing either analog or digital displays.

3.6.1.1 Calibration and marking

The requirements of 3.6 only apply to permanently mounted gauges. High-pressure-side gauges shall be calibrated to a pressure not less than the MWP. If the dials or displays of pressure gauges are calibrated in pressures and the corresponding saturation vapour temperatures, the gauges shall be marked to show the refrigerants for which they are suitable.

3.6.1.2 Arrangement

3.6.1.2.1 Each pressure side or pressure stage of a refrigerant system shall be equipped with pressure gauges when the mass of refrigerant exceeds

100 kg for Group 1 refrigerants,

25 kg for Group 2 refrigerants, or

1 kg for Group 3 refrigerants.

For systems containing more than 10 kg of Group 1 refrigerants or containing more than 2,5 kg of Group 2 refrigerants, pressure-gauge connections shall be provided (the fitting of permanent pressure gauges being optional).

3.6.1.2.2 Pressure vessels with an internal net volume of 100 litres or larger, provided with shut-off devices and which may contain liquid refrigerant, shall be provided with a pressure-gauge connection.

3.6.1.2.3 Heating or cooling jackets of pressure vessels shall be equipped with a pressure gauge and a thermometer.

3.6.1.2.4 Apparatus which is cleaned or defrosted in the warm or hot state, and is under manual control, shall be equipped with pressure gauges.

3.6.1.2.5 Gauges or gauge connections may be omitted in systems containing of up to

10 kg of Group 1 refrigerants,

2,5 kg of Group 2 refrigerants, or

1 kg of Group 3 refrigerants.

3.6.2 Liquid-level indicators

3.6.2.1 The test pressure of liquid-level indicators shall be at least equal to the test pressure applied to those parts of the system to which they are fitted. Bull's-eye or bolted flat glass liquid-level indicators do not require automatic shut-off devices. Top and bottom connections of external glass tube type indicators shall have automatic shut-off devices. Such glass tube indicators shall have adequate guards against wanton or accidental damage and to prevent injury to observers in the event of glass breakage.

3.6.2.2 Refrigerant receivers in systems containing more than

10 kg of Group 1 refrigerants,

2,5 kg of Group 2 refrigerants, or

1 kg of Group 3 refrigerants,

and which may be isolated, shall be provided with a liquid-level indicator.

3.7 Protection against excessive pressure

Excessive pressures may be generated by the operation of the compressor or by exposure of the system or parts of the system to excessive temperatures during transport, storage, installation and operation. This subclause is directed toward the prevention of excessive pressure from these causes.

All parts of the refrigerant circuit shall be designed and manufactured to withstand the pressure which may occur during operation, standstill and transportation, taking the expected temperatures into account.

In each refrigerating system, the pressure during operation, standstill and transportation shall not exceed the maximum working pressure of any component by more than 10 %.

3.7.1 Protection devices

3.7.1.1 Pressure-relief valves

The adjustment of the valve shall be sealed after testing and setting, the seal having the identifying mark of the valve manufacturer or other competent organization or person. The set pressure and rated discharge capacity, or the set pressure, coefficient of discharge for the particular refrigerant and the flow area (in square millimetres), shall be marked on the seal or on the valve body.

3.7.1.2 Bursting discs and holders

The disc shall be firmly clamped in its holder. The inner circular cross-section of the holder serves as the free aperture cross-section for the disc. Not less than this free aperture cross-section shall be maintained throughout the body of the device.

Each disc or foil shall have the name of the manufacturer and the nominal bursting pressure marked on it in such a manner that the operation is not affected.

3.7.1.3 Fusible plugs

The melting temperature of the fusible material shall be stamped on the non-fusible portion of the plug.

3.7.1.4 Pressure-limiting device

A pressure-limiting device having a means of adjustment shall have a stop or be sealed to limit adjustment to the pressure indicated in table 3.

3.7.2 Application of protection devices

3.7.2.1 Protection of the system — General

3.7.2.1.1 Every refrigerating system shall be protected, in accordance with the second and third paragraphs of 3.7, by at least one pressure-relief device, fusible plug, or some other means designed to relieve safely excessive pressure, unless it is intrinsically safe or protected against excessive pressure in accordance with 3.7.2.2.

3.7.2.1.2 A pressure-limiting device designed to stop the pressure-imposing elements shall be provided on every refrigerating system unless the system is intrinsically safe.

A high-pressure limiting device, when required, shall be set so that it stops the pressure-imposing element at a pressure not higher than the pressure shown in table 3.

No shut-off device shall be imposed between a required pressure-limiting device and the pressure-imposing element (see 3.7.3.1.3).

3.7.2.2 Protection of system by pressure-limiting devices

If a system is protected only by pressure-limiting devices, all components of the refrigerant circuit shall withstand the pressure of the refrigerant having at least the following temperatures:

Ambient conditions

Up to 32 °C	**Up to 43 °C**	
55 °C	63 °C	High-pressure side with air-cooled condenser
43 °C	43 °C	High-pressure side with water-cooled or evaporative condenser
32 °C	43 °C	Low-pressure side

NOTE 4 For the high-pressure side, the operating temperature is considered as the maximum. This temperature is higher than the temperature during compressor shutdown (standstill). For the low-pressure side, it is sufficient to base the calculation of pressure on the expected temperature during the compressor standstill period. These temperatures are minimum temperatures and thus determine the minimum pressures which refrigerant lines, instruments and pressure vessels have to withstand.

The following type-tested devices are required.

a) One pressure-limiting device may be the only device required if the mass of Group 1 refrigerant is less than 100 kg and the compressor swept volume is less than 15 l/s.

b) One pressure-limiting device with manual reset and a second parallel device with reset by means of a tool are required, in combination with a pressure-relief device, discharging to the low-pressure side, to a special container, or to the atmosphere.

c) One temperature- or pressure-limiting device is required for an absorption system with a heating input of up to 5 kW.

d) One pressure-limiting device with reset by means of a tool, together with a pressure- or temperature-limiting device as a second type-tested device for use with an absorption system.

3.7.2.3 Protection by intrinsic pressure safety

Refrigerating systems with charges of up to 10 kg of Group 1 refrigerants or up to 2,5 kg of Group 2 refrigerants are defined as being intrinsically safe from excessive pressure if it has been confirmed that the maximum working pressure is not exceeded under adverse or fault conditions, as specified in 3.7.2.3.1 and 3.7.2.3.2.

Intrinsic pressure safety is considered to be evident if the following conditions exist.

3.7.2.3.1 During standstill

The maximum working pressure is higher than

a) the saturated vapour pressure of the refrigerant at the temperature of 63 °C, or

b) the measured pressure at a temperature of 63 °C.

3.7.2.3.2 During operation

The maximum working pressure is higher than the pressure obtained under the following test conditions applied simultaneously:

a) ambient temperature of 32 °C or higher depending on application conditions;

b) inlet temperature of liquid chillers shall be not less than 32 °C, in accordance with the maximum temperatures provided;

c) operating voltage shall be the most unfavourable value between 0,94 and 1,06 times the rated voltage or voltage range;

d) doors or lids open with no product load;

e) expansion device(s) is(are) closed or opened, whichever produces the higher pressure;

f) evaporator is

1) air-fed evaporator with

— natural convection [maximum ambient temperature as specified under a) and undisturbed air convection], or

— forced-feed convection [maximum ambient temperature as specified under a) and highest mass flow], or

2) liquid-chiller evaporator [maximum liquid temperature as specified under b) and highest mass flow];

g) condenser is

1) air-fed condenser with

— natural convection [maximum ambient temperature as specified in a) installed to manufacturer's instructions (for appliances intended to be built in], or

— forced-feed convection [maximum ambient temperature as specified under a) with the fan not operating; in the case of a system with more than one fan, the fan with the strongest cooling effect shall not operate], or

2) liquid-fed condenser [maximum permissible liquid temperature as specified under b) with liquid inlet open or closed, whichever produces the higher pressure];

h) external electrical shut-off devices [e.g. thermal or electrical overload safety devices of the pressure-imposing element (compressor or boiler)], as well as coolant or air-flow controls, are shunted unless their reliability is proved by a special type test with respect to the pressure increase;

i) in absorption-type refrigeration systems, all possible kinds of heating are employed at the same time if there is no locking device to prevent heating from more than one source; if there is a locking device, the heating which produces the highest pressure shall be applied;

j) if applicable, defrost heating is switched on at the same time unless it is prevented by a locking device.

3.7.2.4 Criteria for intrinsic pressure safety

The condition of intrinsic pressure safety is considered to be fulfilled if one of the following conditions is obtained before reaching the maximum working pressure and without releasing refrigerant from the refrigerant circuit:

a) the motor-compressor runs continuously until a steady-state pressure is reached;

b) the motor-compressor blocks due to overload;

c) the energy supply to the pressure-imposing element is switched off by a type-tested overload safety device;

d) a part within the refrigerant circuit breaks, e.g. the valve plate or the gasket of the cylinder head in the hermetically sealed motor compressor;

e) an internal pressure-relief valve opens the high-pressure side to the low-pressure side.

If a fusible plug alone is used for protection, the ultimate strength of the parts so protected shall be sufficient to withstand at least two and a half times the refrigerant saturation pressure corresponding to the temperature stamped on the fusible plug, or at least two and a half times the critical pressure of the refrigerant used, whichever is the smaller.

3.7.3 Protection of machinery components

3.7.3.1 Positive-displacement compressors

3.7.3.1.1 Such compressors absorbing more than 10 kW power or having a displacement of more than 25 l/s shall be equipped with a pressure-relief device from the compressor discharge adequate to prevent a rise in pressure which could endanger the compressor. The discharge from the device shall be vented to the atmosphere or into the low-pressure side of the refrigerating system.

3.7.3.1.2 It is recommended that the compressor discharge-relief device discharges to the atmosphere since pressure-relief devices relieving to the low side may be affected by the low-side pressure, and compressor operation with relief to the compressor suction may cause destructive compressor overheating.

3.7.3.1.3 Compressors with a discharge shut-off device and compressors absorbing more than 10 kW power shall be protected by means of a pressure-limiting device set in accordance with table 3.

3.7.3.2 Non-positive displacement compressors

These need not have a pressure-relief device provided that it is not possible to exceed the maximum working pressure.

3.7.3.3 Positive-displacement pumps

In any circuit of a refrigerating system, positive-displacement pumps shall be protected by a pressure-relief device on the discharge side. The discharge from the device may be vented to the atmosphere or into the refrigerating system connected to the low-pressure side of the pump.

3.7.4 Pressure vessels (see 3.3)

3.7.4.1 Pressure vessels which may contain liquid refrigerant and which may be shut off from other parts of the refrigerating system shall be protected by a pressure-relief device or fusible plug of adequate capacity and in a manner defined as follows.

a) Pressure vessels with an internal gross volume of 300 litres or more shall be equipped with two relief devices connected by a changeover valve, each relief device having the required capacity discharging to the atmosphere. Under the conditions given in 3.7.6.5, a single pressure-relief device may be used, discharging to the low-pressure side of the system.

b) Pressure vessels having an internal gross volume of less than 300 litres and more than 100 litres shall have a single relief device either discharging to the atmosphere, or to the low-pressure side under the conditions given in 3.7.6.5.

c) Pressure vessels having an internal gross volume of less than 100 litres shall be protected by means of a pressure-relief device, except as follows:

   — a vessel having a nominal internal diameter less than 152 mm may be protected by a fusible plug;

   — a vessel having a nominal internal diameter less than 76 mm does not require a pressure-relief device or fusible plug.

3.7.4.2 The minimum required discharge capacity of the pressure-relief device or fusible plug for each pressure vessel shall be determined by equation (3.1):

$$Q_R = \frac{qA}{r} \qquad \ldots (3.1)$$

where

Q_R is the minimum required discharge capacity of the relief device, in kilograms per second of refrigerant;

q is the density of heat flow (= 10 kW/m^2);

A is the external surface of the vessel, in square metres;

r is the latent heat of vaporization, in kilojoules per kilogram.

3.7.5 Liquid expansion

Portions of the system which are capable of being completely filled with liquid refrigerant and capable of being shut off from the rest of the system present a danger from rupture due to liquid expansion. Protection against this danger shall be provided.

3.7.6 Arrangement of protection devices

3.7.6.1 A pressure-relief device shall be mounted on, or be in proximity to, a pressure vessel or other part of the refrigerating system which it protects. It should be easily accessible and shall be connected, except for a hydrostatic-relief device, above the level of the liquid refrigerant.

3.7.6.2 A fusible plug shall be mounted on, or be in close proximity to, a pressure vessel or other part which it protects. The fusible plug shall not be insulated.

3.7.6.3 No shut-off device shall be inserted between the refrigerant circuit portion of the system to be protected and the pressure-relief device. A changeover device may, however, be used in order to facilitate testing and repairs.

3.7.6.4 A bursting disc shall not be used as the sole pressure-relief device, since the operation of the device will result in the loss of the entire refrigerant charge. In order to minimize loss of refrigerant, under normal operating conditions, a bursting disc may be used in series with a relief valve and be located on the inlet side of the relief valve. A pressure tap shall be located in the pipe between the disc and the relief valve in order to check the pressure. The bursting disc installed ahead of a relief valve need not be larger than, but shall not be smaller than, the inlet of the relief valve. The bursting disc shall be so constructed that no piece of the broken disc can obstruct the pressure-relief valve or hinder the flow of refrigerant.

3.7.6.5 Pressure-relief devices on the high-pressure side may discharge into the low-pressure side of the system, provided that they are of a type not appreciably affected by back pressure and provided that the low-pressure side of the system is equipped with protection devices of sufficient capacity to protect simultaneously all connected vessels subjected to excess pressure, calculated in accordance with equation (3.1) which applies to protection devices for pressure vessels.

3.7.7 Discharge capacity

The discharge capacity or the coefficient of discharge of a pressure-relief device shall be established based on tests in accordance with ISO 4126, giving preference to the coefficient of discharge method.

3.7.7.1 Discharge capacity of pressure-relief valves

In the refrigeration industry, the use of tables with thermodynamic data is common and considering that the Group 1 refrigerants are highly compressible, preference is given to the method using equation (3.2) for the calculation of the valve size, assuming that critical flow pressure will normally occur:

$$A_0 = \frac{Q}{\psi K_d \sqrt{2p/v}} = \frac{Q}{\psi K_d \sqrt{2p\varrho}} \qquad \ldots (3.2)$$

where

- A_0 is the minimum cross-section of flow before the valve seat, in square metres;
- Q is the flow-through capacity, in kilograms per second;
- ψ is an outflow function:

$$\psi = \left(\frac{2}{\kappa+1}\right)^{1/(\kappa-1)} \sqrt{\frac{\kappa}{\kappa+1}} = \frac{1}{\sqrt{2}} \sqrt{\kappa \left(\frac{2}{\kappa+1}\right)^{(\kappa+1)/(\kappa-1)}} \qquad \ldots (3.3)$$

- K_d is the coefficient of discharge of the valve[4)];
- p is the absolute pressure in the pressure chamber (corresponding to the MWP), in pascals;
- v is the specific volume of the medium in the pressure chamber, in cubic metres per kilogram;
- ϱ is the density of the medium in the pressure chamber, in kilograms per cubic metre;
- κ is the isentropic exponent of the medium in the pressure chamber, i.e. before the valve.

In accordance with table 3, the rated capacity shall be rated at a pressure not higher than 1,1 times the MWP.

For the common refrigerants, values of κ and ψ are given in figure 1.

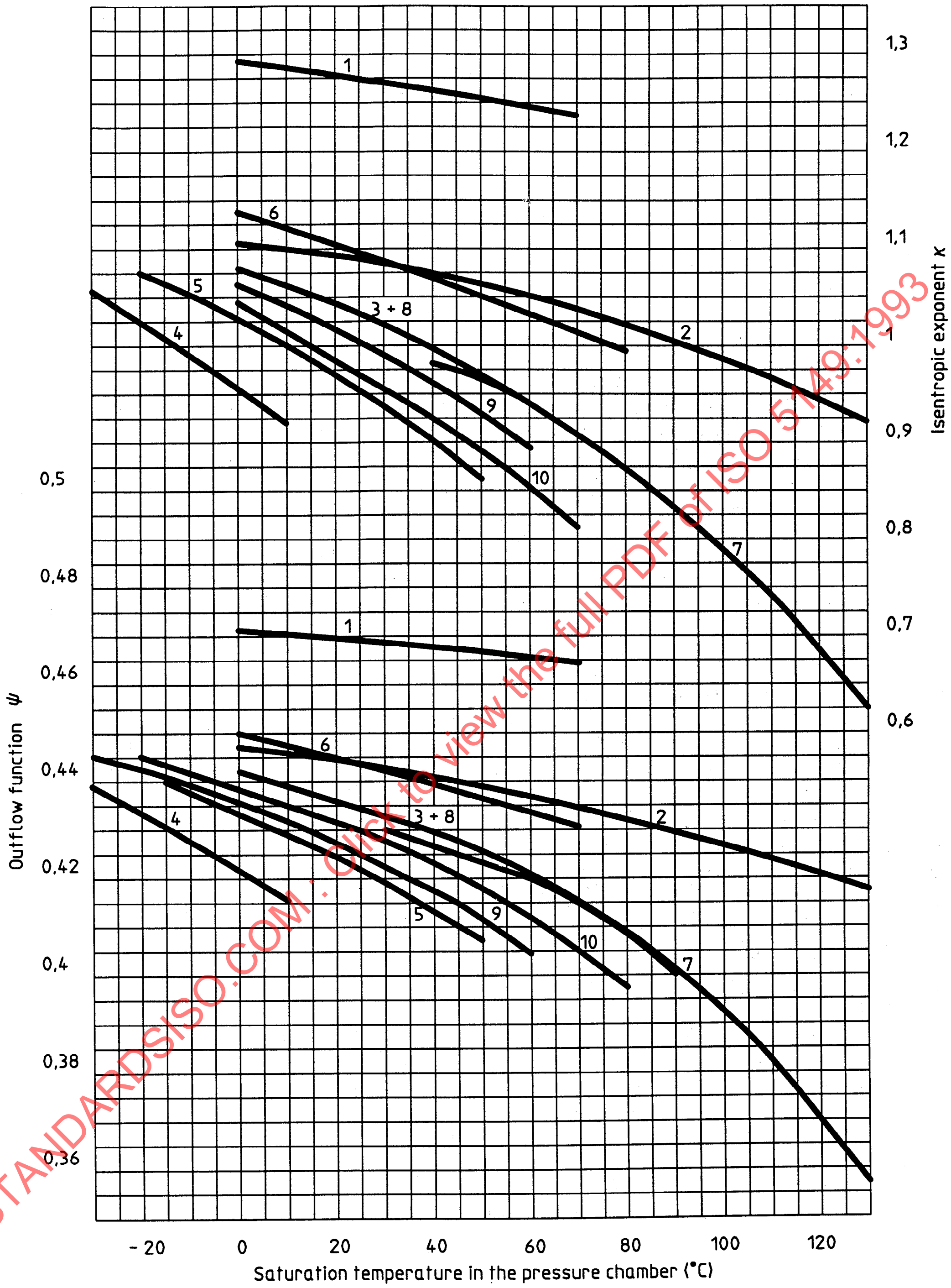
Using the more common units, equation (3.2) becomes:

$$A_0 = \frac{Q}{CK_d p} \cdot \sqrt{RTZ} \qquad \ldots (3.4)$$

where

- A_0 is the minimum cross-section of flow before the valve seat, in square millimetres;
- Q is the flow-through capacity, in kilograms per hour;
- R is the gas constant, in joules per kilogram Kelvin (annex A);
- T is the absolute temperature in the pressure chamber, i.e. before the valve seat, in kelvins;
- Z is the compressibility factor;
- C is an outflow function;
- K_d is the coefficient of discharge of the valve[4)];
- p is the absolute pressure in the pressure chamber, in kilopascals.

4) In accordance with ISO 4126, the certified or allotted coefficient of discharge corresponds to a capacity of 90 % of the capacity determined by test.



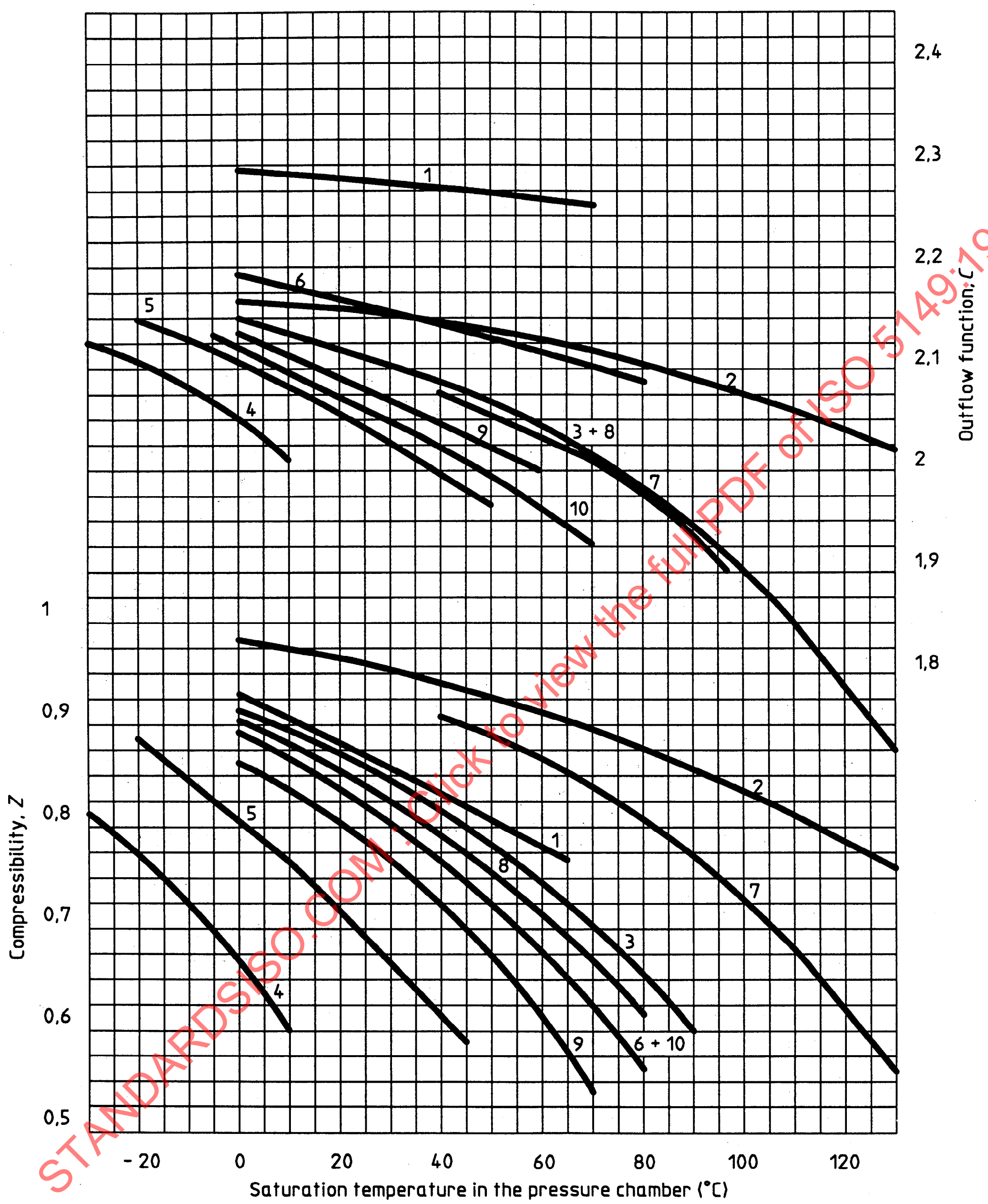
Key

1	R 717/NH_3	6	R 22
2	R 11	7	R 114
3	R 12	8	R 500
4	R 13	9	R 502
5	R 13B1	10	Propane

Figure 1 — Isentropic exponent κ and outflow function ψ for the most important refrigerants

In accordance with table 3, the rated capacity shall be rated at a pressure not higher than 1,1 times the MWP.

For the common refrigerants, values of Z and C are given in figure 2.



Key

1	R 717/NH_3	6	R 22
2	R 11	7	R 114
3	R 12	8	R 500
4	R 13	9	R 502
5	R 13B1	10	Propane

Figure 2 — Outflow function C and compressibility Z for the most important refrigerants

3.7.7.2 Discharge capacity of a bursting disc or fusible plug

This is calculated according to equation (3.2) or (3.4), using one of the following values for K_d, depending on how the pipe between the vessel and the device is mounted on the vessel:

through wall mounting: $K_d = 0{,}55$

inside flush mounting: $K_d = 0{,}70$

If the K_d value of the device itself is lower than the above applicable value, then this smaller value shall be used in the calculation.

3.7.7.3 Two or more devices

Two or more devices in parallel may be considered as a single device.

Two pressure-relief devices controlled by a changeover device shall each be of the size required for the protection of the apparatus.

3.7.7.4 Pressure loss in the supply line

Pressure loss in the supply line (including the changeover device) shall not exceed 3 % of the MWP, i.e. set pressure (gauge) of the device, considering that the maximum mass flow is discharged.

3.7.7.5 Capacity correction for the effect of back pressure

If the back pressure on a pressure-relief device exceeds the critical flow pressure, p_{CF}, calculated from the following equation:

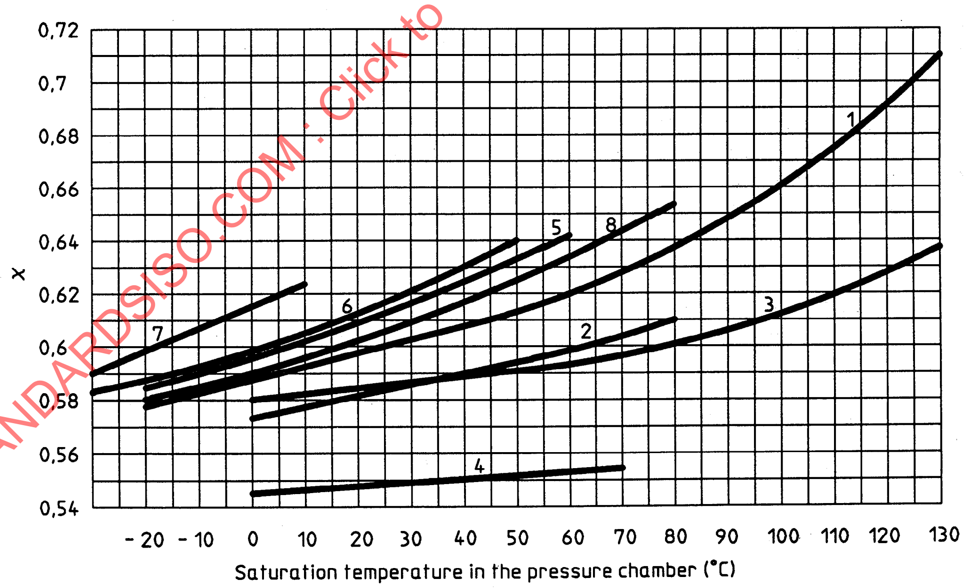
$$p_{CF} = p\left(\frac{2}{\kappa + 1}\right)^{\kappa/(\kappa - 1)} \qquad \dots (3.5)$$

or the capacity of the device ceases to be independent of the back pressure even if the lift remains constant, a capacity correction factor, χ, shall be applied to allow for the decrease in capacity. The factor χ is calculated as follows:

$$\chi = \frac{p_{CF}}{p} = \left(\frac{2}{\kappa + 1}\right)^{\kappa/(\kappa - 1)} \qquad \dots (3.6)$$

Figure 3 gives values of χ in relation to the saturation temperature in the pression chamber.

For devices where the lift is a function of the back pressure, the manufacturer shall be required to supply specific information, where applicable.



Key

1	R 12, R 114, R 500	5	R 502
2	R 22	6	R 13B1
3	R 11	7	R 13
4	R 717/NH_3	8	Propane

Figure 3 — Value of the factor χ for critical flow pressure

3.7.8 Arrangement of discharge

3.7.8.1 Discharge from pressure-relief devices and fusible plugs shall take place so that persons are not endangered by the escaping refrigerant. It may be diffused into the air away from the air intake to the building by adequate means, or discharged into an adequate quantity of a suitable absorbing liquid.

If the charge of a Group 1 refrigerant is less than the limits specified in 4.3.1.1.1 for occupancies A, B, C and D, it may be diffused into the room, provided that persons are not directly hit by liquid refrigerant.

3.7.8.2 All protection devices and pipelines shall be protected against adverse climatic effects.

3.7.8.3 Separate vent stacks shall be provided for high-side and low-side reliefs unless the vent stack is sized for the total volume of vapour relieved as if it were relieved at the lowest pressure-relief device setting.

3.7.9 Emergency manual pressure relief

Where emergency manual pressure relief is provided to enable manually controlled refrigerant release under fire or other emergency conditions, the rules given in 3.7.9.1 to 3.7.9.3 shall apply.

3.7.9.1 The point of connection of the discharge piping shall be above the liquid level.

3.7.9.2 The shut-off devices shall be protected against improper use by means such as enclosure in a locked box with "Break Glass" access to its key. Clear labelling shall be provided as to the intended emergency use.

3.7.9.3 The discharge lines and valves shall be selected and installed to achieve the desired discharge rate.

The arrangement of the discharge lines shall conform to the requirements of 3.7.8.

3.8 Electrical installations

The design, construction, installation, testing and use of electrical equipment shall be in accordance with IEC 335-2-24, IEC 335-2-34 and IEC 335-2-40.

3.8.1 General arrangements

3.8.1.1 Main power supply

The electrical power supply to refrigerating systems shall be arranged so that it can be switched off independently of the electricity supply to other equipment in general and, in particular, to any lighting system and ventilation unit.

3.8.1.2 Auxiliary electrical supply

3.8.1.2.1 Mechanical ventilation

Fans required by these safety requirements for the ventilation of spaces containing refrigerating machinery shall be so arranged that they can be controlled by switching arrangements both inside and outside the space.

3.8.1.2.2 Normal lighting

Permanent lighting appliances shall be selected and positioned in spaces containing refrigerating machinery to provide adequate illumination for safe operation.

3.8.1.2.3 Emergency lighting

An emergency fixed or portable lighting system shall be provided, adequate to allow operation of controls and evacuation of personnel when the normal lighting fails.

3.8.1.2.4 Alarm system

A refrigerant-leak alarm system (see 3.8.3.3) shall be powered by an independent emergency system (for instance, a battery) installed in accordance with IEC 335-2-24.

3.8.2 Special arrangements

3.8.2.1 Condensation

Where moisture from condensation may be in contact with electrical equipment, such equipment shall be suitable for use in a wet location.

3.8.2.2 Flammable refrigerants

Some of the refrigerants in Group 2 and all the refrigerants in Group 3 are flammable. Where the quantity of flammable refrigerants in any refrigerating system exceeds the amount of 2,5 kg of Group 3 refrigerant or 25 kg of flammable Group 2 refrigerant (for ammonia, see 3.8.2.3), all electrical equipment in any room in which any part of the refrigerating system is installed shall comply with the requirements for hazardous areas.

3.8.2.3 Ammonia (R 717)

Machinery rooms housing ammonia-containing refrigerating systems shall conform to the requirements for flammable refrigerants specified in 3.8.2.3.1 to 3.8.2.3.3.

3.8.2.3.1 Switches shall be provided to disconnect all electrical circuits entering the room (except low-voltage alarm circuits). These switches shall be of the totally enclosed type or shall be located outside the machinery room.

Automatic switches shall be activated to disconnect their circuits by detector devices complying with 3.8.3.

A manual switch may be used, provided that it is located outside the machinery room. Where a manual switch is used, an operator shall be in constant attendance.

3.8.2.3.2 The machinery room shall be provided with a mechanical ventilation system used exclusively for the machinery room. The system shall have an air-moving capacity not less than that specified in 4.1.3.2. This ventilating system shall be activated by a detector device complying with 3.8.3. The fan motor and associated electrical equipment shall be of the totally enclosed type or shall be located outside the machinery room and the ventilation air stream. In machinery rooms having an operator in constant attendance, it is permissible to replace the detector with a manual switch for the mechanical ventilation system, provided that the switch is located outside the room.

3.8.2.3.3 The machinery room shall be provided with a continuously operated mechanical ventilation system used exclusively for the machinery room, having an air-moving capacity of not less than that specified in 4.1.3.2.

Failure of this mechanical ventilation system shall initiate a supervised alarm so that corrective action can be initiated.

3.8.2.4 Group 1 refrigerants and non-flammable Group 2 refrigerants

These refrigerants do not require other special arrangements. Ammonia does not require other special arrangements outside of the machinery room.

3.8.3 Refrigerant detectors

3.8.3.1 The detector devices specified in 3.8.2.3 shall function at a concentration not exceeding 25 % of the lower limit of concentration of the explosive range in air for the refrigerant. (See annex A.)

3.8.3.2 The refrigerant concentration in each machinery room shall be monitored at one or more points within the room.

3.8.3.3 When sensing a refrigerant concentration exceeding its preset limit, the detector device shall, in addition to its other functions, initiate a supervised alarm so that emergency action can be initiated.

Section 4: Requirements for utilization

4.1 Machinery rooms

Machinery rooms serve to accommodate refrigerating machinery, but need not be reserved exclusively for this machinery.

A machinery room shall be so dimensioned that all parts are easily accessible, with adequate space for proper service, maintenance and operation.

There shall be clear headroom of not less than 2 m below equipment situated over gangways.

4.1.1 General requirements

Refrigerating machinery rooms shall have well-fitting doors opening outwards (self-closing if they issue into the building) and which are adequate in number to ensure freedom for persons to escape in an emergency. There shall be no openings that permit passage of escaping refrigerant to other parts of the building.

Machinery rooms shall be ventilated to the outdoors. Unless mechanical ventilation is otherwise required by this International Standard, natural ventilation such as that obtained through permanent openings or grilles may be used. However, natural ventilation shall not be used where the openings for such ventilation cannot be located with due regard to the density of the refrigerant vapour.

The sum of the opening areas for such ventilation shall have an area related to the mass of refrigerant in the largest refrigerating system, any part of which is in the machinery room, and in accordance with equation (4.1) given in 4.1.3.1.

The flow area for natural ventilation shall not be obstructed by area walls, shaft walls, surrounding buildings or similar obstructions.

The mechanical ventilation referred to shall be by power-driven fans capable of exhausting from the machinery room at least the amount of air given by equation (4.2) in 4.1.3.2. To obtain a reduced air flow under non-emergency conditions, multispeed fans may be used.

The air inlet to fans or inlet ducts shall be near the machinery and shall be suitably guarded. The discharge of the air shall be to the outside of the building in such a manner as not to cause inconvenience or danger. Openings for fresh air shall be positioned to avoid short circuiting. Ducts may be required to accomplish this.

In machinery rooms without natural ventilation, such as those in basements or sub-basements, a sufficient proportion of the mechanical ventilation specified in equation (4.2) shall be in continuous operation for the normal health and comfort of persons concerned.

4.1.2 Special requirements

4.1.2.1 In certain cases, as specified in 4.3 and table 5, the machinery room shall meet the following additional requirements besides those given in 4.1.1.

a) Communication with adjacent rooms, permanently occupied or for general use, shall only be by means of tight-fitting, self-closing doors capable of resisting fire for at least 1 h.

b) Walls, floors and ceilings shall be tightly sealed and be capable of resisting fire for at least 1 h.

c) All piping and ducting through walls, ceilings and floors shall be tightly sealed to these.

d) Exterior openings shall not be under emergency exits or staircases.

e) At least one emergency exit shall be provided which opens directly to the outer air or through a vestibule-type exit equipped with a self-closing, tight-fitting door.

f) A remote switch for stopping machinery shall be provided outside and near the machinery room door.

g) Independent mechanical ventilation with an independent emergency control shall be located outside and near the machinery room.

h) There shall be no flame-producing equipment permanently installed and operated.

4.1.2.2 When using refrigerants of Group 3, the machinery room shall comply with national and/or international codes, as referred to in the "Introduction".

4.1.3 Ventilation

4.1.3.1 Natural ventilation

The free aperture cross-section for the ventilation of the machinery room shall amount to at least the following value:

$$F = 0{,}14\, G^{1/2} \qquad \ldots (4.1)$$

where

F is the free opening area, in square metres;

G is the mass of the refrigerant charge, in kilograms, in the largest system of which any part is located in the machinery room.

4.1.3.2 Mechanical ventilation

The output of the mechanical ventilation system for the machinery room shall be at least the following value:

$$Q = 13{,}88\, G^{2/3} \qquad \ldots (4.2)$$

where

Q is the air flow, in litres per second;

G is the mass of the refrigerant charge, in kilograms, in the largest system of which any part is located in the machinery room.

However, a ventilation system greater than that required to produce 15 air changes per hour is not required.

4.2 Miscellaneous special precautions

4.2.1 Protection of fans and other moving machinery

Fans and all moving machinery shall be guarded.

4.2.2 Refrigerant stored in a machinery room

The quantity of refrigerant which may be stored in a machinery room, apart from the charge in the system, shall not exceed 150 kg.

Hazardous refrigerants shall not be stored in machinery rooms, apart from the charge in the system. Specially designed storage areas shall be provided for this purpose.

Refrigerants withdrawn from refrigerating systems shall be transferred to approved containers only. No refrigerant shall be discharged to a sewer, river or lake.

Containers used for refrigerants withdrawn from a refrigerating system shall be carefully weighed each time they are used for this purpose. The containers shall not be filled in excess of the permissible filling mass for such containers.

4.2.3 Influence of heating elements near evaporators

Where a direct expansion coil or evaporator is in an air duct in an occupancy of class A or B (see table 1), and it can be valved-off, and the temperature/volume relationship in the valved-off section is such that the design pressure can be exceeded, then a pressure-relief valve or bursting disc discharging to the outside atmosphere shall be fitted.

4.2.4 Unauthorized entry

Cold rooms, rooms with a dangerous atmosphere, machinery rooms, etc. shall be clearly marked as such on the doors, together with warning notices that unauthorized persons must not enter.

Additionally, warning notices shall be displayed prohibiting unauthorized operation of the plant.

4.2.5 Safety of personnel in cold rooms

Attention is drawn to the danger of persons being unable to move due to an accident, or falling asleep or being inadvertently locked in cold rooms, especially in those having temperatures below 0 °C. Some measures to increase safety are given in annex B.

4.2.6 Sprinklers for use on ammonia leakage

Due to the high absorption capacity of ammonia in water, the use of water-sprinkler devices and/or a water screen may be considered according to the circumstances, for example as protection in case of leakages in ammonia-plate freezers with flexible connections, or from evaporators serving cold-storage rooms containing goods, etc.

4.2.7 Marking for refrigerating systems assembled and installed on site

4.2.7.1 The refrigerating system

A clearly visible, permanent sign near or on the machines shall give at least the following information:

a) installer's or manufacturer's name and address;

b) model and/or serial number;

c) year of installation or manufacture;

d) ISO refrigerant number (see ISO 817);

e) mass of refrigerant charge;

f) maximum working pressure(s): high side, low side.

If the mass of refrigerant in a refrigerating system is not more than 10 kg of a Group 1 refrigerant, or 2,5 kg of a Group 2 refrigerant, or 1 kg of a Group 3 refrigerant, the year of manufacture may be part of the serial number, and all the above information may be coded or be part of the nameplate of the appliance.

4.2.7.2 Marking of compressors, compressor units, condensing units, evaporating units, and liquid refrigerant pumps

Each compressor (or each unit, where the compressor forms part of a compressor unit, a condensing unit or an evaporating unit) and each liquid-refrigerant pump shall be provided with an attached plate giving at least the following information:

a) manufacturer's name or the name of the responsible vendor;

b) model or type;

c) serial number;

d) ISO refrigerant number(s) (see ISO 817);

e) maximum working pressures;

f) maximum speed, in revolutions per minute;

g) electrical characteristics as required by IEC 335-2-34.

For compressors with a power consumption of up to 3 kW, e) and f) may be omitted.

4.2.7.3 Main shut-off devices and controls for services (gas, air, water, electricity), remote-control devices and pressure devices

These should be clearly marked as to their function.

4.2.7.4 Exposed refrigerant piping outside machinery rooms

These should be marked with the ISO refrigerant number in accordance with ISO 817.

4.2.8 Water lines

Connection of water lines to a water supply or drain shall be governed by applicable national or international codes.

4.2.9 Air-duct systems

When installed for air conditioning, especially for human-occupied space, air-duct systems shall comply with fire department regulations and national and/or international codes, as referred to in the "Introduction".

4.2.10 Heat-transfer liquids

These liquids, when used in any indirect system in any occupancy classified as A, B, C or D (see table 1), shall only be used below the boiling point at atmospheric pressure. They shall either have no flash-point or shall have a flash-point higher than 55 °C. They shall have no serious toxic effects.

4.2.11 Release of refrigerants

At all times, care shall be taken to minimize the discharge of refrigerant to the atmosphere. Special care shall be taken to avoid stagnant pockets of heavier-than-air refrigerants at low levels.

4.3 Use of cooling or heating systems and refrigerants in relation to occupancy

When installing a cooling or heating system, the refrigerant and the type of refrigerating system shall be selected with due attention paid to the occupancy relevant to the premises for which the refrigerant is utilized.

For each category of occupancy, certain cooling or heating systems and certain locations of machinery and pipelines in combination with certain refrigerants are prohibited or subject to restrictions, or are permitted free of restrictions.

Table 5 shows whether combinations are permitted or not. Combinations which are permitted but which are subject to restrictions are indicated by the number(s) of the subclause(s) specifying the restrictions.

4.3.1 Group 1 refrigerants

4.3.1.1 Requirements for the use of refrigerating systems containing Group 1 refrigerants

4.3.1.1.1 Direct and indirect open systems (see 2.2.1 and 2.2.2.1)

Occupancy categories A, B, C and D: The use of these systems is permitted under the following conditions. The refrigerant charge, in kilograms, contained in the system shall not exceed the product of

a) the concentration allowed for the refrigerant, in kilograms per cubic metre (see table 4), and

b) the volume, in cubic metres, of the smallest human-occupied space of the occupancy in which the refrigerant-containing equipment is located.

The total volume of all the rooms cooled or heated by air from one system may be used as the criterion if the air supply to each room cannot be restricted below 25 % of the full supply to each.

Occupancy category E: For upper floors or floors below ground which do not have adequate emergency exits, taking into account the number of persons normally present, the restrictions of occupancy categories A, B, C and D shall apply. Otherwise, there are no restrictions.

Table 5 — Requirements for the use of refrigerating systems in relation to occupancy

<table>
<tr><th rowspan="3">Refrigerant group</th><th rowspan="3">Refrigerating system[1]</th><th colspan="6">Location of refrigerating machine</th></tr>
<tr><th colspan="4">Occupancies A, B, C and D[2]</th><th colspan="2">Occupancy E</th></tr>
<tr><th colspan="2">In a machinery room[3]</th><th colspan="2">In a human-occupied space</th><th>In a machinery room[3]</th><th>In a human-occupied space</th></tr>
<tr><td rowspan="2">1</td><td>Direct
Indirect open</td><td colspan="2">4.3.1.1.1
4.3.1.2.2 } 4.3.1.2</td><td colspan="2">4.3.1.1.1
4.3.1.2.1 } 4.3.1.2</td><td>4.3.1.1.1</td><td>4.3.1.1.1</td></tr>
<tr><td>Indirect vented open
Indirect closed
Indirect vented closed
Double indirect</td><td colspan="2">4.3.1.1.2
4.3.1.2.2</td><td colspan="2">4.3.1.1.2
4.3.1.2.1</td><td colspan="2">No restrictions</td></tr>
<tr><td rowspan="5">2</td><td rowspan="2"></td><td colspan="2">Occupancies A, B and C</td><td colspan="2">Occupancy D</td><td colspan="2">Occupancy E</td></tr>
<tr><td>In a machinery room[3]</td><td>In a human-occupied space</td><td>In a machinery room[3]</td><td>In a human-occupied space</td><td>In a machinery room[3]</td><td>In a human-occupied space</td></tr>
<tr><td>Direct</td><td>3.8.2.2
3.8.2.3
4.3.2.1.1
4.3.2.2.1
4.3.2.2.3</td><td>3.8.2.2
3.8.2.3
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3.8.2.3
4.3.2.1.2
4.3.2.2.2</td></tr>
<tr><td>Indirect open
Indirect vented open
Indirect closed</td><td colspan="2">Not permitted</td><td>3.8.2.2
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4.3.2.1.2
4.3.2.2.1
4.3.2.2.3</td><td>3.8.2.2
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<tr><td>Indirect vented closed
Double indirect</td><td>3.8.2.2
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4.3.2.1.3
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4.3.2.2.3</td><td>3.8.2.2
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3.8.2.3</td><td>3.8.2.2
3.8.2.3
4.3.2.2.2</td></tr>
<tr><td>3</td><td>All</td><td colspan="6">3.8.2.2
4.3.3</td></tr>
<tr><td colspan="8">1) See table 2.
2) See table 1.
3) See 4.1.</td></tr>
</table>

4.3.1.1.2 Indirect vented open system, indirect closed system, indirect vented closed system and double indirect system (see 2.2.2.2 to 2.2.2.5)

Occupancy categories A, B, C and D: There are no restrictions if all the machinery is located in a machinery room in accordance with 4.1.1; otherwise the charge of refrigerant shall be restricted in accordance with 4.3.1.1.1.

Occupancy category E: There are no restrictions.

4.3.1.2 Location of refrigerating systems containing Group 1 refrigerants

4.3.1.2.1 Refrigerating systems or parts thereof not in a machinery room

Occupancy categories A, B, C and D: In hallways, lobbies and sundry rooms of category A and in hallways and lobbies of categories B, C and D, only unit systems may be installed, containing no more refrigerant than that allowed by the restrictions given in 4.3.1.1.1. The free movement of persons shall not be obstructed. No refrigerating system or part thereof