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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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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.

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