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R 1662

REFRIGERATING PLANTS

SAFETY REQUIREMENTS

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BRIEF HISTORY

The ISO Recommendation R 1662, *Refrigerating plants – Safety requirements*, was drawn up by Technical Committee ISO/TC 86, *Refrigeration*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of Draft ISO Recommendation No. 1662, which was circulated to all the ISO Member Bodies for enquiry in October 1968. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Greece	South Africa, Rep. of
Austria	Hungary	Spain
Belgium	India	Sweden
Chile	Israel	Switzerland
Czechoslovakia	Italy	Thailand
Denmark	Japan	Turkey
France	Netherlands	U.A.R.
Germany	Poland	U.S.S.R.

The following Member Bodies opposed the approval of the Draft :

New Zealand
United Kingdom
U.S.A.

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

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REFRIGERATING PLANTS

SAFETY REQUIREMENTS

INTRODUCTION

This ISO Recommendation concerning the safety of refrigerating plants has been made taking 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.

In accordance with ISO regulations, the present document is restricted to recommendations. It is evident, however, that amongst these are some which could not be neglected without grave danger, and others which only illustrate good practice. It is therefore recommended that, when using the present document as a basis for a standard or a national regulation, a distinction should be made between these two categories of recommendations as only the first could be considered to have an obligatory character.*

Reference is made in the document 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.**

These recommendations are intended solely to minimize possible hazards in refrigerating plants; they do 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.

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* A proposed basis for this distinction is given in Annex A.

** See Chapter 5 of *Practical guide to refrigerating storage*, published by the International Institute of Refrigeration (IIR), Paris XVII^{ème}, 117 Boulevard Malesherbes.

Refrigerants, on the one hand, affect a refrigerating plant 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.

The following are dangers worthy of noting :

(*a*) *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*) *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*) *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*) *from the escape of refrigerants*

- fire;
- explosion;
- toxicity;
- panic.

No reference is made to dangers common to all compression plants, such as : excessive temperature at discharge, erroneous operation (for example, discharge valve closed while running) or reduction in mechanical strength caused by corrosion, erosion or vibration. Corrosion, however, should have special consideration as conditions peculiar to refrigerating plants 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 the present ISO Recommendation has been based.

After general considerations (Part I), definitions (Part II) and a classification of the occupancies, the cooling systems and the refrigerants (Part III), Part IV 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. Part V provides rules for the application of refrigerating equipment in the various types of occupancy for exits and ventilation in terms of the number of persons involved and also miscellaneous precautions. Finally, Part VI describes instructions necessary to safeguard personnel, to secure correct operation of the plant and to prevent its deterioration.

Small refrigerating equipment, such as refrigerators, commercial refrigerated cabinets and unit air conditioners, having specific safety aspects may require appropriate additional recommendations. Taking into account, however, that, on the one hand, such special recommendations are not yet available and that, on the other hand, a number of general requirements included in this ISO Recommendation also apply to small equipment, the clauses including requirements of the latter nature are accordingly given (see clause 2.2).

PART I

GENERAL

1. SCOPE

1.1 This ISO Recommendation is drawn up for the protection of life and limb and the health of the individual and also for the prevention of damage to property.

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

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

1.4 This ISO Recommendation also applies in the case of the conversion of a plant for another refrigerant, for example R 40 to R 12 or ammonia to R 22.

1.5 Conversions of and changes to existing plant should be carried out only by the manufacturer or a competent installer.

2. FIELD OF APPLICATION

2.1 This ISO Recommendation, when pertinent, applies to all kinds of refrigerating systems in which the refrigerant is evaporated and condensed in a closed circuit, including heat pumps and absorption systems but excluding systems using water or air as the refrigerant. If special regulations exist as, for example, for mines or transport (rail or road vehicles, ships and aeroplanes), they will supersede this ISO Recommendation insofar as they are more stringent.

2.2 In the case of small refrigerating equipment and factory assembled units, such as household refrigerators, commercial refrigerated cabinets, unit air conditioners, etc., with only a small charge of refrigerant, only some of the clauses are in general applicable. To facilitate the use of this ISO Recommendation, the clauses involved are listed separately in Annex B. Due consideration should also be given to any Recommendation issued by ISO or IEC relating to these small equipments.

PART II

DEFINITIONS

For the purpose of this ISO Recommendation, the following definitions apply.

3. **Refrigerating system**. A 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.

4. **Refrigerating plant or installation**. An assembly of components of a refrigerating system and all the apparatus necessary for its utilization.

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

6. **Limited charge refrigerating system**. A 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.

7. **Refrigerating unit**. See *Condensing unit*, *Compressor unit* and *Unit system*, below.

8. **Condensing unit**. A 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.

9. **Compressor unit**. A condensing unit less the condenser and liquid receiver.

10. **Unit system**. A complete factory-assembled, factory-charged and factory-tested system with a suitable frame or enclosure requiring no refrigerant-containing parts to be connected on site.

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

12. **Refrigerant compressor**. A mechanical component of a refrigerating system that withdraws refrigerant vapour – generally from the evaporator – and discharges it at a higher pressure.

13. **Positive displacement compressor**. A compressor in which increase in vapour pressure is attained by changing the internal volume of the compression chamber.

14. **Non-positive displacement compressor**. A compressor in which increase in vapour pressure is attained without changing the internal volume of the compression chamber.

15. **Condenser**. A heat exchanger in which the refrigerant, after compression to a suitable pressure, is condensed by rejection of heat to an appropriate external cooling medium.

16. **Receiver**. A vessel permanently connected to a system by inlet and outlet pipes for storage of a liquid refrigerant.

17. **Evaporator**. A heat exchanger in which liquid refrigerant, after reduction of its pressure (expansion), is evaporated by absorption of heat from the medium to be cooled.

18. **Coil or Grid**. A part of the refrigerating system constructed from bent or straight pipes or tubes suitably connected and serving as a heat exchanger (evaporator or condenser).

19. **Pressure relief valve**. A pressure-actuated valve held shut by a spring or other means and designed to relieve automatically pressure in excess of its setting.

20. **Bursting disc**. A disc or foil which bursts at a pre-determined pressure.

21. **Fusible plug**. A device containing a material melting at a pre-determined temperature.

22. **High pressure limiting device**. A pressure-actuated adjustable instrument (for example, a high pressure switch) designed to stop the operation of the pressure-imposing element and which may also operate an alarm.

23. **Piping**. The pipes or tubes for interconnecting the various parts of a refrigerating system.

24. **Header**. A pipe or tube component of a refrigerating circuit to which several other pipes or tubes are connected.

25. **Refrigerant**. A 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.

26. **Heat-transferring liquid (brine, water)**. Any liquid for the transmission of heat without any change in its liquid state and having no flash point or a flash point above 65 °C.

27. **Gauge pressure**. That part of the pressure exceeding the atmospheric pressure. Generally it is assumed to be 1 bar less than the absolute pressure.

28. **High pressure side**. That part of a refrigerating system subject to the pressure of condensation.

29. **Low pressure side**. That part of a refrigerating system subject to the pressure of evaporation.

30. **Internal gross volume**. Volume calculated from the internal dimensions of the container, no account being taken of the volume of the internal parts.

31. **Internal net volume**. Volume calculated from the internal dimensions of the container, after deduction of the volume of the internal parts.

32. **Critical density**. Density at critical temperature and critical pressure.

33. **Machinery room**. A room specially intended to contain components of the refrigerating system for reasons connected with safety.

34. **Humanly occupied space**. Space normally frequented or occupied by people with the exception of machinery rooms and of cold rooms used for storage purposes.

35. **Hallway**. A corridor for the passage of people.

36. **Lobby**. An entrance hall or large hallway serving as a waiting room.

37. **Exit**. A passage-way immediately in the vicinity of the door through which people leave a building.

38. **Vestibule with doors (air lock).** An isolating chamber provided with separate entrance and exit doors allowing passage from one place to another whilst isolating one from the other.

39. **Changeover device.** A valve controlling two protection devices and so arranged that only one can be rendered inoperative at any given moment.

40. **Abnormal fire risk.** Danger arising from fires which cannot be controlled by the usual methods of protection against fire.

PART III

CLASSIFICATION

41. OCCUPANCIES

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

The categories are listed in Table 1. They refer to that part of a property and adjoining property where an installation would affect safety.

TABLE 1 – List of categories

Category	General characteristics	Examples
A	where persons are restricted in their movement	hospitals, court houses, prisons with cells
B	where people may freely assemble	theatres, dance rooms, department stores, passenger stations, schools, churches, lecture halls, restaurants
C	where sleeping accommodation is provided	homes, hotels, residential apartments, clubs, colleges
D	where any number of people may be assembled, a limited number being necessarily acquainted with the general safety precautions of the establishment	business or professional offices, small shops and small restaurants, laboratories, places for general manufacturing and the performance of work, markets with unrestricted entry
E	where only authorized persons have access and where manufacturing, processing or storage of materials or products takes place	plants manufacturing chemicals, food, beverages, ice cream and ice, refineries, cold stores, dairies, abattoirs

41.1 In establishments with more than one category of occupancy, the most stringent requirements apply, unless the different occupancies are separated and cut off from the rest of the building by tightly sealed partitions, floors and ceilings, in which case the requirements of the individual occupancies apply.

41.2 When installing plants in locations adjacent to property classified in categories defined in this section, due regard should be paid to the safety of adjacent property.

42. COOLING SYSTEMS

Cooling systems can be classified, as shown in Table 2, according to the method of extracting heat from the air or substance to be cooled.

42.1 Direct cooling system

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

42.2 Indirect cooling systems

The evaporator of the refrigerating system, located externally to the space where the heat is extracted from the air or substance to be cooled, cools a heat-transferring liquid (see Part II – Definitions) which is circulated to cool the air or substance concerned.

42.2.1 *Indirect open system*. The evaporator cools the heat-transferring liquid which is brought into direct communication with the air or substance to be cooled by sprays or similar means.

42.2.2 *Indirect vented open system*. This system is similar to that of clause 42.2.1, except that the evaporator is placed in an open tank or appropriately vented with comparable effet.

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

42.2.4 *Indirect vented closed system*. This system is similar to that of clause 42.2.3, except that the evaporator is placed in an open tank or appropriately vented with comparable effect.

42.2.5 *Double indirect system*. This system is similar to that of clause 42.2.4, except that the cooled heat-transferring liquid passes through a second heat exchanger located externally to the space as mentioned in clause 42.2 and cools a second heat-transferring liquid which is brought into direct communication with the air or substance to be cooled by sprays or similar means.