ants. Over the next 11 years, representatives from the American Gas Association, American Institute of Electrical Engineers, American Institute of Refrigeration, American Chemical Society, American Society of Heating and Ventilation Engineers, American Society of Mechanical Engineers, National Electrical Refrigerator Manufacturers Association, National Fire Protection Association, and ASRE met to expand the code to address all of the issues raised on the use of refrigeration equipment. The first Safety Code for Mechanical Refrigeration, recognized as American Standard B9 in October 1930, appeared in the first edition, 1932-1933, of the ASRE Refrigerating Handbook and Catalog. ASRE revisions designated ASA B9 appeared in 1933 and 1939. ASRE revisions designated ASA B9.1 appeared in 1950, 1953, and 1958. After the formation of ASHRAE, editions appeared as ASA B9.1-1964, ANSI B9.1-1971, ANSI/ASHRAE 15-1978, ANSI/ASHRAE 15-1989, ANSI/ASHRAE 15-1992, ANSI/ASHRAE 15-1994, and ANSI/ASHRAE 15-2001.

1. PURPOSE

This standard specifies safe design, construction, installation, and operation of refrigeration systems.

2. SCOPE

2.1 This standard establishes safeguards for life, limb, health, and property and prescribes safety requirements.

2.2 This standard applies

(a) to the design, construction, test, installation, operation, and inspection of mechanical and absorption refrigeration systems, including heat pump systems used in stationary applications,

(b) to modifications including replacement of parts or components if they are not identical in function and capacity, and

(c) to substitutions of refrigerant having a different designation.

3. DEFINITIONS

approved: acceptable to the authority having jurisdiction.

approved, nationally recognized laboratory: one that is acceptable to the authority having jurisdiction, which provides uniform testing and examination procedures and standards for meeting design, manufacturing, and factory testing requirements of this code; is organized, equipped, and qualified for testing; and has a follow-up inspection service of the current production of the listed products.

back pressure: the static pressure existing at the outlet of an operating pressure-relief device due to pressure in the discharge line.

balanced relief valve: a pressure-relief valve that incorporates means of minimizing the effect of back pressure on the operational characteristics of the valve (opening pressure, closing pressure, and relieving capacity).

blends: refrigerants consisting of mixtures of two or more different chemical compounds, often used individually as refrigerants for other applications.

brazed joint: a gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys that melt at temperatures above 1000°F (537.7°C) but less than the melting temperatures of the joined parts.

companion* or *block valves: pairs of mating stop valves that allow sections of a system to be joined before opening these valves or separated after closing them.

compressor: a machine used to compress refrigerant vapor.

compressor unit: a compressor with its prime mover and accessories.

condenser: that part of the refrigerating system where refrigerant is liquefied by the removal of heat.

condenser coil: a condenser constructed of pipe or tubing, not enclosed in a pressure vessel.

condensing unit: a combination of one or more power-driven compressors, condensers, liquid receivers (when required), and regularly furnished accessories.

containers, refrigerant: a cylinder for the transportation of refrigerant.

corridor: an enclosed passageway that limits travel to a single path.

critical pressure, critical temperature,* and *critical volume: a point on the saturation curve where the refrigerant liquid and vapor have identical volume, density, and enthalpy, and there is no latent heat.

design pressure: the maximum pressure for which a specific part of a refrigerating system is designed.

dual pressure-relief device: two pressure-relief devices mounted on a three-way valve that allows one device to remain active while the other is isolated.

duct: a tube or conduit used to convey or encase: (a) *air duct* is a tube or conduit used to convey air (air passages in self-contained systems are not air ducts); (b) *pipe duct* is a tube or conduit used to encase pipe or tubing.

evaporator: that part of the refrigerating system designed to vaporize liquid refrigerant to produce refrigeration.

evaporator coil: an evaporator constructed of pipe or tubing, not enclosed in a pressure vessel.

fusible plug: a plug containing an alloy that will melt at a specified temperature and relieve pressure.

header: a pipe or tube (extruded, cast, or fabricated) to which other pipes or tubes are connected.

heat pump: a refrigerating system used to transfer heat into a space or substance.

highside: those portions of the refrigerating system that are subject to approximate condensing pressure.

horsepower: the power delivered from the prime mover to the compressor of a refrigerating system.

IDLH (immediately dangerous to life or health): the maximum concentration from which unprotected persons are able to escape within 30 minutes without escape-impairing symptoms or irreversible health effects.[1]

informative appendix: an appendix that is not part of the standard but is included for information only.

inside dimension: inside diameter, width, height, or cross-sectional diagonal.

internal gross volume: the volume as determined from internal dimensions of the container with no allowance for the volume of internal parts.

limited charge system: a system in which, with the compressor idle, the design pressure will not be exceeded when the refrigerant charge has completely evaporated.

liquid receiver: a vessel, permanently connected to a refrigerating system by inlet and outlet pipes, for storage of liquid refrigerant.

listed: equipment or materials included in a list published by an approved, nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

lithium bromide/water absorption system: an absorption system where water (R-718) is the refrigerant and lithium bromide (LiBr) is the absorbent.

lobby: a waiting room or large hallway serving as a waiting room.

lower flammability limit (LFL): the minimum concentration of the refrigerant that propagates a flame through a homogeneous mixture of refrigerant and air.

lowside: the portion of a refrigerating system that is subjected to approximate evaporator pressure.

machinery: the refrigerating equipment forming a part of the refrigerating system including, but not limited to, any or all of the following: compressor, condenser, liquid receiver, evaporator, and connecting piping.

machinery room: a space, meeting the requirements of 8.11 and 8.12, that is designed to house compressors and pressure vessels.

manufacturer: the company or organization that evidences its responsibility by affixing its name, trademark, or trade name to refrigerating equipment.

means of egress: a continuous and unobstructed path of travel from any point in a building or structure to a public way.

mechanical joint: a gas-tight joint obtained by joining metal parts with a positive-holding mechanical construction such as flanged, screwed, or flared joints or compression fittings.

nonpositive displacement compressor: a compressor in which the increase in vapor pressure is attained without changing the internal volume of the compression chamber.

normative appendix: integral parts of the mandatory requirements of the standard, which, for reasons of convenience, are placed after all other normative elements.

occupancy: for class of occupancy, see Section 4.

occupied space: that portion of the premises accessible to or occupied by people, excluding machinery rooms.

pilot operated relief valve: a pressure-relief valve in which the major relieving device is combined with and is controlled by a self-actuated auxiliary pressure-relief valve.

piping: the pipe or tube used to convey fluid from one part of a refrigeration system to another. Piping includes pipe, flanges, bolting, gaskets, valves, fittings, pipe-supporting fixtures, structural attachments, and the pressure-containing parts of other components, such as expansion joints, strainers, filters, and devices that serve such purposes as mixing, separating, muffling, snubbing, distributing, metering, or controlling flow.

positive displacement compressor: a compressor in which the increase in pressure is attained by changing the internal volume of the compression chamber.

premises: a tract of land and the buildings thereon.

pressure-imposing element: any device or portion of the equipment used to increase refrigerant pressure.

pressure-limiting device: a pressure-responsive electronic or mechanical control designed to automatically stop the operation of the pressure-imposing element at a predetermined pressure.

pressure-relief device: a pressure-, not temperature-, actuated valve or rupture member designed to automatically relieve pressure in excess of its setting.

pressure-relief valve: a pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure in excess of its setting.

pressure vessel: any refrigerant-containing receptacle in a refrigerating system. This does not include evaporators where each separate evaporator section does not exceed 0.5 ft^3 (0.014 m^3) of refrigerant-containing volume regardless of the maximum inside dimension. This also does not include evaporator coils, compressors, condenser coils, controls, headers, pumps, and piping.

pumpdown charge: the quantity of refrigerant stored at some point in the refrigeration system for operational, service, or standby purposes.

reclaimed refrigerants: refrigerants reprocessed to the same specifications as new refrigerants by any means, including distillation. Such refrigerants have been chemically analyzed to verify that those specifications have been met.

recovered refrigerants: refrigerants removed from a system in any condition without necessarily testing or processing them.

recycled refrigerants: refrigerants for which contaminants have been reduced by oil separation, removal of noncondensible gases, and single or multiple passes through filter driers or other devices that reduce moisture, acidity, and particulate matter.

refrigerant: the fluid used for heat transfer in a refrigerating system; the refrigerant absorbs heat and transfers it at a higher temperature and a higher pressure, usually with a change of state.

refrigerant detector: a device that is capable of sensing the presence of refrigerant vapor.

refrigerating system: a combination of interconnected parts forming a closed circuit in which refrigerant is circulated for the purpose of extracting, then rejecting, heat. (See Section 5 for classification of refrigerating systems by type.)

refrigerating system classification: refrigerating systems are classified according to the degree of probability, low or high, that leaked refrigerant from a failed connection, seal, or component could enter an occupied area. The distinction is based on the basic design or location of the components.

refrigerating system, direct: (see 5.1.1).

refrigerating system, indirect: (see 5.1.2).

rupture member: a device that will rupture and release refrigerant to relieve pressure.

saturation pressure: the pressure at which vapor and liquid exist in equilibrium at a given temperature.

sealed ammonia/water absorption system: an absorption system where ammonia (R-717) is the refrigerant and water is the absorbent and all refrigerant-containing parts are made permanently tight by welding or brazing.

secondary coolant: any liquid used for the transmission of heat, without vaporization.

self-contained system: a complete, factory-assembled and factory-tested system that is shipped in one or more sections and has no refrigerant-containing parts that are joined in the field by other than companion or block valves.

set pressure: the pressure at which a pressure-relief device or pressure control is set to operate.

shall (shall not): used when a provision is or is not mandatory.

soldered joint: a gas-tight joint formed by joining metal parts with alloys that melt at temperatures not exceeding 800°F (426.5°C) and above 400°F (204.5°C).

specified: explicitly stated in detail. Specified limits or prescriptions are mandatory.

stop valve: a device used to shut off the flow of refrigerant.

tenant: a person or organization having the legal right to occupy a premises.

three-way valve: a service valve for dual pressure-relief devices that allows using one device while isolating the other from the system, maintaining one valve in operation at all times.

TLV-TWA (threshold limit value-time weighted average): the refrigerant concentration in air for a normal 8-hour workday and a 40-hour workweek to which repeated exposure, day after day, will not cause an adverse effect in most persons.

ultimate strength: the stress at which rupture occurs.

unit system: (see *self-contained system*).

unprotected tubing: tubing that is unenclosed and therefore exposed to crushing, abrasion, puncture, or similar damage after installation.

zeotropic: refers to blends comprising multiple components of different volatility that, when used in refrigeration cycles, change volumetric composition and saturation temperatures as they evaporate (boil) or condense at constant pressure. The word is derived from the Greek words *zein* (to boil) and *tropos* (to change).

4. OCCUPANCY CLASSIFICATION

4.1 Locations of refrigerating systems are described by occupancy classifications that consider the ability of people to respond to potential exposure to refrigerant as follows:

4.1.1 *Institutional occupancy* is a premise or that portion of a premise from which, because they are disabled, debilitated, or confined, occupants cannot readily leave without the assistance of others. Institutional occupancies include, among others, hospitals, nursing homes, asylums, and spaces containing locked cells.

4.1.2 *Public assembly occupancy* is a premise or that portion of a premise where large numbers of people congregate and from which occupants cannot quickly vacate the space. Public assembly occupancies include, among others, auditoriums, ballrooms, classrooms, passenger depots, restaurants, and theaters.

4.1.3 *Residential occupancy* is a premise or that portion of a premise that provides the occupants with complete independent living facilities including permanent provisions for living, sleeping, eating, cooking, and sanitation. Residential occupancies include, among others, dormitories, hotels, multi-unit apartments, and private residences.

4.1.4 *Commercial occupancy* is a premise or that portion of a premise where people transact business, receive personal service, or purchase food and other goods. Commercial occupancies include, among others, office and professional buildings, markets (but not large mercantile occupancies), and work or storage areas that do not qualify as industrial occupancies.

4.1.5 *Large mercantile occupancy* is a premise or that portion of a premise where more than 100 persons congregate on levels above or below street level to purchase personal merchandise.

4.1.6 *Industrial occupancy* is a premise or that portion of a premise that is not open to the public, where access by authorized persons is controlled, and that is used to manufacture, process, or store goods such as chemicals, food, ice, meat, or petroleum.

4.1.7 *Mixed occupancy* occurs when two or more occupancies are located within the same building. When each occupancy is isolated from the rest of the building by tight walls, floors, and ceilings and by self-closing doors, the requirements for each occupancy shall apply to its portion of the building. When the various occupancies are not so isolated, the occupancy having the most stringent requirements shall be the governing occupancy.

4.2 Equipment, other than piping, located outside a building and within 20 ft (6.1 m) of any building opening shall be governed by the occupancy classification of the building.

Exception: Equipment located within 20 ft (6.1 m) of the building opening for the machinery room.

5. REFRIGERATING SYSTEM CLASSIFICATION

5.1 Refrigerating Systems. These systems are defined by the method employed for extracting or delivering heat as follows (see Figure 1):

5.1.1 *A direct system* is one in which the evaporator or condenser of the refrigerating system is in direct contact with the air or other substances to be cooled or heated.

5.1.2 *An indirect system* is one in which a secondary coolant cooled or heated by the refrigerating system is circulated to the air or other substance to be cooled or heated. Indirect systems are distinguished by the method of application given below.

5.1.2.1 *An indirect open spray system* is one in which a secondary coolant is in direct contact with the air or other substance to be cooled or heated.

5.1.2.2 *A double indirect open spray system* is one in which the secondary substance for an indirect open spray system (5.1.2.1) is heated or cooled by the secondary coolant circulated from a second enclosure.

5.1.2.3 *An indirect closed system* is one in which a secondary coolant passes through a closed circuit in the air or other substance to be cooled or heated.

5.1.2.4 *An indirect, vented closed system* is one in which a secondary coolant passes through a closed circuit in the air or other substance to be cooled or heated, except that the evaporator or condenser is placed in an open or appropriately vented tank.

Paragraph	Designation	Cooling or heating source	Air or substance to be cooled or heated
5.1.1	Direct system		
5.1.2.1	Indirect open spray system		
5.1.2.2	Double indirect open spray system		
5.1.2.3	Indirect closed system		
5.1.2.4	Indirect vented closed system		

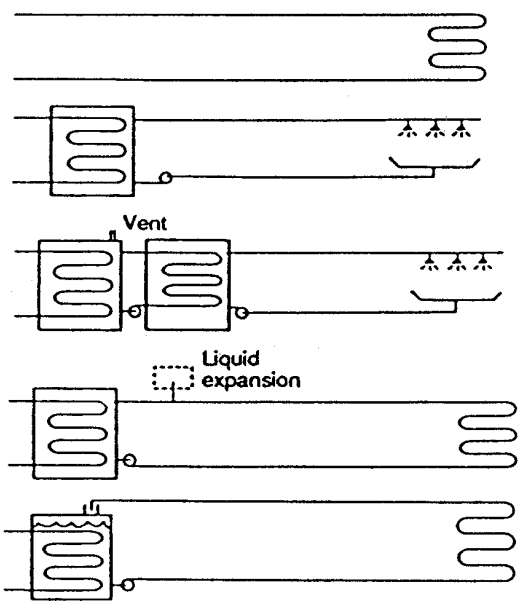

Figure 1 *Refrigerating system designation.*

5.2 Refrigeration System Classification. For the purpose of applying Tables 1 and 2, a refrigerating system shall be classified according to the degree of probability that a leakage of refrigerant will enter an occupancy-classified area as follows.

5.2.1 High-Probability System. A high-probability system is any system in which the basic design, or the location of components, is such that a leakage of refrigerant from a failed connection, seal, or component will enter the occupied space. Typical high-probability systems are (a) direct systems or (b) indirect open spray systems in which the refrigerant is capable of producing pressure greater than the secondary coolant.

5.2.2 Low-Probability System. A low-probability system is any system in which the basic design, or location of the components, is such that leakage of refrigerant from a failed connection, seal, or component cannot enter the occupied space. Typical low-probability systems are (a) indirect closed systems or (b) double indirect systems and (c) indirect open spray systems if the following condition is met:

> In a low-probability indirect open spray system, the secondary coolant pressure shall remain greater than refrigerant pressure in all conditions of operation and standby. Operation conditions are defined in 9.2.1 and standby conditions are defined in 9.2.2.

5.3 Changing Refrigerant. A change in the type of refrigerant in a system shall not be made without the notification of the authority having jurisdiction, the user, and due observance of safety requirements. The refrigerant being considered shall be evaluated for suitability.

6. REFRIGERANT SAFETY CLASSIFICATION

6.1 Single-Compound Refrigerants. Single-compound refrigerants shall be classified into safety groups, based on toxicity and flammability, in accordance with *ANSI/ASHRAE Standard 34*. The classifications indicated in *ANSI/ASHRAE Standard 34* shall be used for refrigerants that have them assigned. Other refrigerants shall be classified in accordance with the criteria in Standard 34; such classifications shall be submitted for approval to the authority having jurisdiction.

6.2 Blends. Refrigerant blends shall be classified following the worst-case of fractionation composition, determined in accordance with *ANSI/ASHRAE Standard 34*. For blends assigned only a single safety group in *ANSI/ASHRAE Standard 34*, that classification shall be used.

7. RESTRICTIONS ON REFRIGERANT USE

7.1 General. The occupancy, refrigerating system, and refrigerant safety classifications cited in this section shall be determined in accordance with Sections 4, 5, and 6, respectively.

7.2 Refrigerant Quantity Limits. The quantity of refrigerant in each independent circuit of high probability systems shall not exceed the amounts shown in Table 1, except as provided in 7.2.1 and 7.2.2, based on volumes determined in accordance with 7.3. For refrigerant blends not listed in Table 1, the amount of each component shall be limited in the same manner and the total of all components in each circuit shall not exceed the quantity that would equal 69,100 ppm by volume upon release to the volume determined by 7.3.

Exception:

(a) Listed equipment containing not more than 6.6 lb (3 kg) of refrigerant, regardless of its refrigerant safety classification, is exempt from 7.2 provided the equipment is installed in accordance with the listing and with the manufacturer's installation instructions.

(b) Listed equipment for use in laboratories with more than 100 ft^2 (9.3 m^2) of space per person, regardless of the refrigerant safety classification, is exempt from 7.2 provided that the equipment is installed in accordance with the listing and the manufacturer's installation instructions.

7.2.1 Institutional Occupancies. The amounts shown in Table 1 shall be reduced by 50% for all areas of institutional occupancies. Also, the total of all Group A2, B2, A3, and B3 refrigerants shall not exceed 550 lb (250 kg) in the occupied areas and machinery rooms of institutional occupancies.

7.2.2 Industrial Occupancies and Refrigerated Rooms. Subsection 7.3 does not apply in industrial occupancies and refrigerated rooms where the following seven conditions are met:

1. The space(s) containing the machinery is separated from other occupancies by tight construction with tight-fitting doors.
2. Access is restricted to authorized personnel.
3. The floor area per occupant is not less than 100 ft^2 (9.3 m^2).

   Exception: The minimum floor area shall not apply where the space is provided with egress directly to the outdoors or into approved building exits.
4. Refrigerant detectors are installed with the sensing location and alarm level as required in refrigerating machinery rooms in accordance with 8.11.2.1.
5. Open flames and surfaces exceeding 800°F (426.7°C) are not permitted where any Group A2, B2, A3, or B3 refrigerant other than R-717, ammonia, is used.
6. All electrical equipment conforms to Class 1, Division 2, of NFPA 70 where the quantity of any Group A2, B2, A3, or B3 refrigerant other than R-717, ammonia, in an independent circuit would exceed 25% of the lower flammability limit (LFL) upon release to the space based on the volume determined by 7.3.
7. All refrigerant-containing parts in systems exceeding 100 HP (74.6 kW) compressor drive power, except evaporators used for refrigeration or dehumidification, condensers used for heating, control and pressure-relief valves for either, and connecting piping, are located either in a machinery room or outdoors.

7.3 Volume Calculations. The volume used to determine the refrigerant quantity limits for refrigerants in 7.2 shall be based on the volume of space to which refrigerant disperses in the event of a refrigerant leak.