Chapter Ind 45

MECHANICAL REFRIGERATION

History: Chapter Ind 45 as it existed on March 31, 1963 was repealed and a new chapter Ind 45 was created effective April 1, 1963.

Ind 45.01 Scope; purpose; application. (1) The application of this code is intended to insure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which is vaporized and is normally liquefied in its refrigerating cycle, when employed under the occupancy classifications listed in Wis. Adm. Code section Ind 45.03. The provisions of this code are not intended to apply to the use of water or air as a refrigerant nor to refrigerating systems installed on railroad cars, motor vehicles, motor drawn vehicles or on shipboard.

(2) This code is intended to provide reasonable safeguards to life, limb, health, and property; to correct certain practices which are inconsistent with safety; and to prescribe standards of safety which will properly influence future progress and developments in refrigerating systems. Equipment listed by an approved, nationally recognized testing laboratory, as defined in Wis. Adm. Code section Ind 45.02 is deemed to meet the design, manufacture, and factory test requirements of this code or equivalent, for the refrigerant or refrigerants for which such equipment is designed.

(3) The provisions of this code shall apply to refrigerating systems installed subsequent to its adoption and to parts replaced or added to systems installed prior or subsequent to its adoption. In cases of practical difficulty or unnecessary hardship, the commission may grant exceptions from the literal requirements of this code or permit the use of other devices or methods, but only when it is clearly evident that equivalent protection is thereby secured.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63.

Ind 45.02 Definitions. (1) ABSORBER *(adsorber)* is that part of the low side of an absorption system used for absorbing (adsorbing) vapor refrigerant.

(2) ABSORPTION SYSTEM. See *Refrigeration system (43) (a).*

(3) APPROVED means acceptable to the Wisconsin industrial commission.

(4) An APPROVED NATIONALLY RECOGNIZED TESTING LABORATORY is one acceptable to the Wisconsin industrial commission that provides uniform testing and examination procedures under established standards, is properly organized, equipped, and qualified for testing, and has a follow-up inspection service of the current production of the listed products.

(5) BRAZED JOINT, for the purpose of this code, is a gas-tight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 1,000 F. but less than the melting temperatures of the joined parts.

(6) BRINE is any liquid, used for the transmission of heat without a change in its state, having no flash point or a flash point above 150 F.

(7) CHECK VALVE is a valve that permits a fluid flow in only one direction.

(8) COMPANION or BLOCK VALVES are pairs 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.

(9) COMPRESSOR is a specific machine, with or without accessories, for compressing a given refrigerant vapor.

(10) COMPRESSOR UNIT is a condensing unit less the condenser and liquid receiver.

(11) CONDENSER is a vessel or arrangement of pipe or tubing in which vaporized refrigerant is liquefied by the removal of heat.

(12) CONDENSING UNIT is 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.

(13) CONTAINER is a vessel for the transportation of refrigerant.

(14) DESIGN WORKING PRESSURE is the maximum allowable working pressure for which a specific part of a system is designed.

(15) DUCT is a tube or conduit used for conveying or encasing purposes as specifically defined below:

(a) *Air duct* is a tube or conduit used for conveying air. (The air passages of self-contained systems are not to be construed as air ducts.)

(b) *Pipe duct* is a tube or conduit used for encasing pipe.

(c) *Wire duct* is a tube or conduit used for encasing either moving or stationary wire, rope, etc.

(16) ENTRANCE is a confined passageway immediately adjacent to the door through which people enter a building.

(17) EVAPORATOR is that part of the system in which liquid refrigerant is vaporized to produce refrigeration.

(18) EXIT is a confined passageway immediately adjacent to the door through which people leave a building.

(19) EXPANSION COIL is an evaporator constructed of pipe or tubing.

(20) FUSIBLE PLUG is a device having a predetermined-temperature fusible member for the relief of pressure.

(21) GENERATOR is any device equipped with a heating element used in the refrigerating system to increase the pressure of refrigerant in its gas or vapor state for the purpose of liquefying the refrigerant.

(22) HALLWAY is a corridor for the passage of people.

(23) HIGH SIDE means the parts of a refrigerating system under condenser pressure.

(24) HUMANLY OCCUPIED SPACE is a space normally frequented or occupied by people but excluding machinery rooms and walk-in coolers used primarily for refrigerated storage.

(25) INTERNAL GROSS VOLUME is the volume as determined from internal dimensions of the container with no allowance for volume of internal parts.

(26) LIMITED CHARGED SYSTEM is a system in which, with the compressor idle, the internal volume and total refrigerant charge are such that the allowable working pressure will not be exceeded by complete evaporation of the refrigerant charge.

(27) LIQUID RECEIVER is a vessel permanently connected to a system by inlet and outlet pipes for storage of a liquid refrigerant.

(28) LOW SIDE means the parts of a refrigerating system under evaporator pressure.

(29) MACHINERY is the 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, or evaporator.

(30) MACHINERY ROOMS. (a) *Machinery room* as required by Wis. Adm. Code section Ind 45.062 is a room in which a refrigerating system is permanently installed and operated but not including evaporators located in a cold storage room, refrigerator box, air cooled space, or other enclosed space. Closets solely contained within, and opening only into, a room shall not be considered machinery rooms but shall be considered a part of the machinery room in which they are contained or open into. It is not the intent of this definition to cause the space in which a self-contained system is located to be classified as a machinery room.

(b) *Machinery room, class T*, as required by Wis. Adm. Code section Ind 45.062 is a room having machinery but no flame-producing apparatus permanently installed and operated and also conforming to the following:

1. Any doors, communicating with the building, shall be approved self-closing, tight-fitting fire doors.

2. Walls, floor, and ceiling shall be tight and of not less than one-hour fire-resistive construction.

3. It shall have an exit door which opens directly to the outer air or through a vestibule-type exit equipped with self-closing, tight-fitting doors.

4. Exterior openings, if present, shall not be under any fire escape or any open stairway.

5. All pipes piercing the interior walls, ceiling, or floor of such room shall be tightly sealed to the walls, ceiling, or floor through which they pass.

6. Emergency remote controls to stop the action of the refrigerant compressor shall be provided and located immediately outside the machinery room.

7. Mechanical means shall be provided for ventilation. (See Wis. Adm. Code section Ind 45.08 (11) (c)).

8. Emergency remote controls for the mechanical means of ventilation shall be provided and located outside the machinery room.

(31) MECHANICAL JOINT, for the purpose of this code, is a gas-tight joint, obtained by the joining of metal parts through a positive-holding mechanical construction.

(32) NON-POSITIVE DISPLACEMENT COMPRESSOR is a compressor in which increase in vapor pressure is attained without changing the internal volume of the compression chamber.

(33) PIPING means the pipe or tube mains for interconnecting the various parts of a refrigerating system.

(34) POSITIVE DISPLACEMENT COMPRESSOR is a compressor in which increase in vapor pressure is attained by changing the internal volume of the compression chamber.

(35) PREMISES are the buildings and that part of the grounds of one property, where an installation would affect the safety of those buildings or adjacent property.

(36) PRESSURE GAUGE. A dial instrument for registering the pressure of a fluid confined within a pipe or chamber.

(37) PRESSURE-IMPOSING ELEMENT is any device or portion of the equipment used for the purpose of increasing the refrigerant vapor pressure.

(38) PRESSURE-LIMITING DEVICE is a pressure-responsible mechanism designed to automatically stop the operation of the pressure-imposing element at a predetermined pressure.

(39) PRESSURE-RELIEF DEVICE is a pressure-actuated valve or rupture member designed to automatically relieve excessive pressure.

(40) PRESSURE-RELIEF VALVE is a pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure in excess of its setting.

(41) PRESSURE VESSEL. Any refrigerant-containing receptacle of a refrigerating system, other than evaporator (each separate section of which does not exceed ½ cu. ft. of refrigerant-containing volume), expansion coils, compressors, controls, headers, pipe and pipe fittings.

(42) REFRIGERANT is a substance used to produce refrigeration by its expansion or vaporization.

(43) REFRIGERATING SYSTEM is a combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat.

(a) *Absorption system* is a refrigerating system in which the gas evolved in the evaporator is taken up by an absorber or adsorber.

(b) *Sealed absorption system* is a unit system for group 2 refrigerants only in which all refrigerant-containing parts are made permanently tight by welding or brazing against refrigerant loss.

Note. This is a restrictive definition for the purposes of this code as used in Wis. Adm. Code section Ind 45.06 (2) and (3).

(c) *Self-contained system* is a complete factory-made and factory tested system in a suitable frame or enclosure which is fabricated and shipped in one or more sections and in which no refrigerant-containing parts are connected in the field other than by companion or block valves.

(d) *Unit system* is a 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.

(44) RUPTURE MEMBER is a device that will rupture at a predetermined pressure.

(45) SOLDERED JOINT, for the purpose of this code, is a gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys which melt at temperatures below 1000 F. and above 400 F.

(46) STOP VALVE is a shut-off for controlling the flow of refrigerant.

(47) WELDED JOINT, for the purpose of this code, is a gas-tight joint, obtained by the joining of metal parts in the plastic or molten state.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63; renum. (35) to (46) to be (36) to (47), cr. (35), Register, December, 1965, No. 120, eff. 1–1–66.

Ind 45.03 Occupancy classification. (1) Locations governed by this code are public buildings and places of employment.

(a) *Institutional occupancy*, as used in this code, shall apply to that portion of the premises in which persons are confined to receive medical, charitable, educational, or other care or treatment, or in which persons are held or detained by reason of public or civic duty, including among others, hospitals, asylums, sanitariums, police stations, jails, courthouses with cells, and similar occupancies.

(b) *Public assembly occupancy*, as used in this code, shall apply to that portion of the premises in which persons congregate for civic, political, educational, religious, social, or recreational purposes; including among others, armories, assembly rooms, auditoriums, ballrooms, bath houses, bus terminals, broadcasting studios, churches, colleges, courthouses without cells, dance halls, department stores, exhibition halls, fraternity halls, libraries, lodge rooms, mortuary chapels, museums, passenger depots, schools, skating rinks, subway stations, theaters, and similar occupancies.

(c) *Residential occupancy,* as used in this code, shall apply to that portion of the premises in which sleeping accommodations are provided, including among others, club houses, convents, dormitories, hotels, lodging houses, multiple story apartments, residences, studios, tenements, and similar occupancies.

(d) *Commercial occupancy,* as used in this code, shall apply to that portion of the premises used for the transaction of business; for the rendering of professional services; for the supplying of food, drink or other bodily needs and comforts; for manufacturing purposes or for the performance of work or labor (except as included under subsection (e)—Industrial Occupancy) including among others, bake shops, fur storage, laboratories, loft buildings, markets, office buildings, professional buildings, restaurants, stores other than department stores, and similar occupancies.

(e) *Industrial occupancy,* as used in this code, shall apply to an entire building or to that portion of the premises used for manufacturing, processing, or storage of materials or products, including among others, chemical, food, candy and ice cream factories, ice making plants, meat packing plants, refineries, perishable food warehouses and similar occupancies, provided the entire building is occupied by a single tenant.

(f) *Mixed occupancy,* as used in this code, shall apply to a building occupied or used for different purposes in different parts. When the occupancies are cut off from the rest of the building by tight partitions, floors, and ceilings and protected by self-closing doors, the requirements for each type of occupancy shall apply for its portion of the building or premises. For example, the cold storage spaces in retail frozen food lockers, hotels, and department stores in buildings occupied by a single tenant might be classified under *Industrial occupancy,* whereas other portions of the building would be classified under other occupancies. When the occupancies are not so separated, the occupancy carrying the more stringent requirements shall govern.

(2) ADJACENT LOCATIONS. Equipment installed in locations adjacent to areas outlined in subsection (1), including outdoor installations, shall be governed by the applicable requirements of this code.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63; am. Register, December, 1965, No. 120 eff. 1–1–66.

REFRIGERATING SYSTEM

Ind 45.04 Classification by type. (1) Refrigerating systems shall be classified as follows:

(a) *Direct system* is one in which the evaporator is in direct contact with the material or space refrigerated or is located in air-circulating passages communicating with such spaces.

(b) *Indirect system* is one in which a liquid, such as brine or water, cooled by the refrigerant, is circulated to the material or space refrigerated or is used to cool air so circulated. Indirect systems which are distinguished by the type or method of application are as given in the following paragraphs:

1. Indirect open-spray system is one in which a liquid, such as brine or water, cooled by an evaporator located in an enclosure external to a cooling chamber, is circulated to such cooling chamber and is sprayed therein.

2. Indirect closed-surface system is one in which a liquid such as brine or water, cooled by an evaporator located in an enclosure external to a cooling chamber, is circulated to and through such a cooling chamber in pipes or other closed circuits.

3. Indirect vented closed-surface system is one in which a liquid, such as brine or water, cooled by an evaporator located in a vented enclosure external to a cooling chamber, is circulated to and through such cooling chamber in pipes or other closed circuits.

4. Double indirect vented open-spray system is one in which a liquid, such as brine or water, cooled by an evaporator located in a vented enclosure, is circulated through a closed circuit to a second enclosure where it cools another supply of a liquid, such as brine or water, and this liquid in turn is circulated to a cooling chamber and is sprayed therein.

5. Double (or secondary) refrigerant system is one in which an evaporative refrigerant is used in a secondary circuit. For the purpose of this code, each system enclosing a separate body of an evaporative refrigerant shall be considered as a separate direct system.

Note. The direct and various indirect systems referred to are illustrated in figure 1.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.05 Refrigerant classification. (1) GENERAL. Refrigerants shall be classified as follows:

(a) *Group 1.*

Carbon dioxide (Refrigerant 744)	CO_2
Dichlorodifluoromethane (Refrigerant 12)	CCl_2F_2
Dichlorodifluoromethane, 73.8%	CCl_2F_2
and Ethylidene Fluoride, 26.2% (Refrigerant 500)	CH_2-CHF_2
Dichloromethane (Methylene chloride) (Refrigerant 30)	CH_2Cl_2
Dichloromonofluoromethane (Refrigerant 21)	$CHCl_2F$
Dichlorotetrafluoroethane (Refrigerant 114)	$C_2Cl_2F_4$
Monobromotrifluoromethane (Refrigerant 13B1)	$CBrF_3$
Monochlorodifluoromethane (Refrigerant 22)	$CHClF_2$
Monochlorodifluoromethance, 48.8%	$CHClF_2$
and Monochloropenta-fluoroethane, 51.2% (Refrigerant 502)	$CClF_2CF_3$
Monochlorotrifluoromethane (Refrigerant 13)	$CClF_3$
Octafluorocyclobutane (Refrigerant C318)	C_4F_8
Trichloromonofluoromethane (Refrigerant 11)	CCl_3F
Trichlorotrifluoroethane (Refrigerant 113)	$C_2Cl_3F_3$

(b) *Group 2.*

Ammonia	NH_3
Dichloroethylene	$C_2H_2Cl_2$
Ethyl chloride	C_2H_5Cl
Methyl chloride	CH_3Cl
Methyl formate	$HCOOCH_3$
Sulphur dioxide	SO_2

(c) *Group 3.*

Butane	C_4H_{10}
Ethane	C_2H_6
Ethylene	C_2H_4
Isobutane	$(CH_3)_3CH$
Propane	C_3H_8

(2) OTHER REFRIGERANTS. Refrigerants, other than water and air, not listed in Wis. Adm. Code section Ind 45.05 shall not be used until approved by the industrial commission and assigned a group classification.

History: Cr. Register March, 1963, No. 87, eff. 4–1–63; am. (1) (a), and Figure 1, Register, December, 1965, No. 120, eff. 1–1–66.

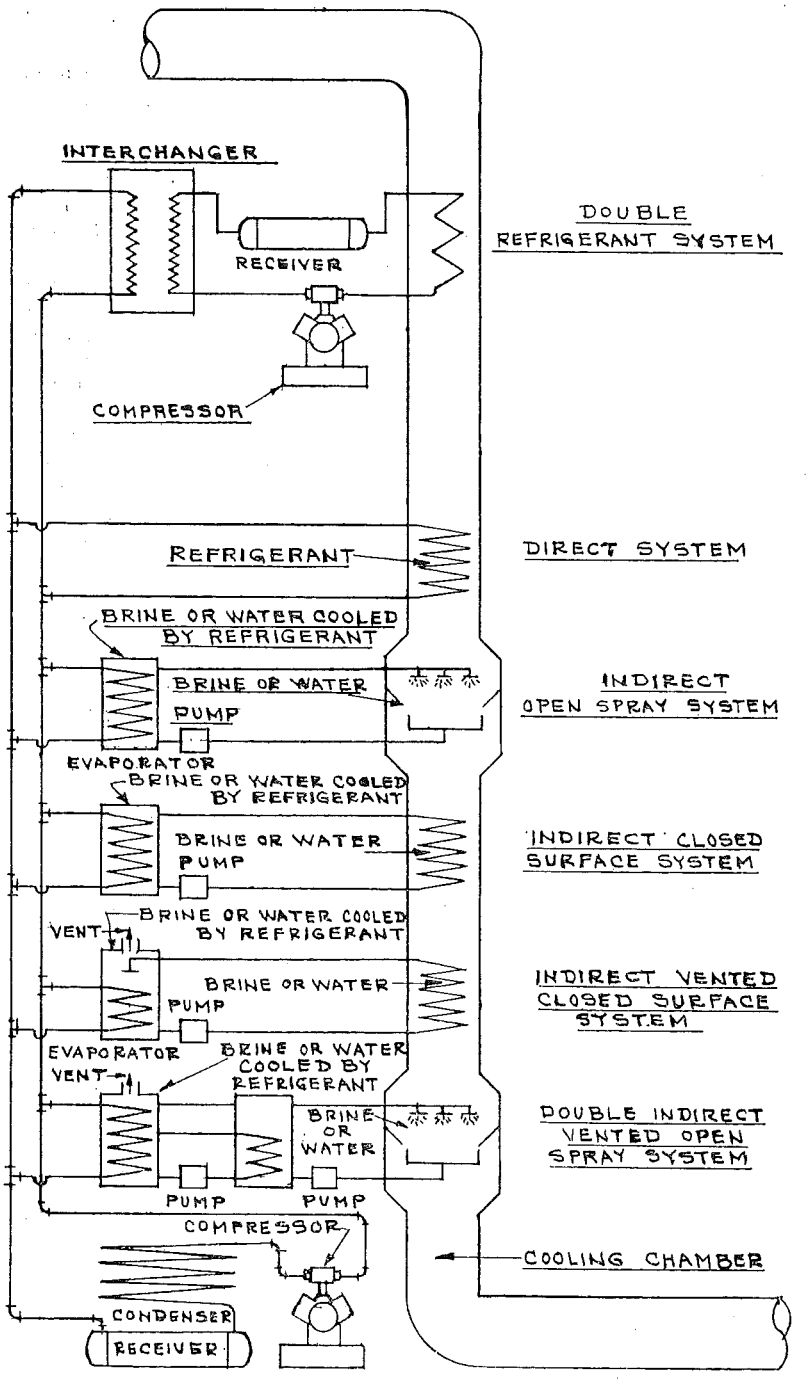

Figure 1

Register, May, 1972, No. 197
Mechanical Refrigeration

Ind 45.06 Requirements for institutional, public assembly, residential, and commercial occupancies. (1) PUBLIC STAIRWAY, STAIR LANDING, ENTRANCE, OR EXIT. No refrigerating system shall be installed in or on a public stairway, stair landing, entrance, or exit.

(2) PUBLIC HALLWAY OR LOBBY. No refrigerating system shall interfere with free passage. No group 2 refrigerant shall be permitted in public hallways or lobbies of institution or public assembly occupancies. Refrigerating systems installed in a public hallway or lobby shall be limited to:

(a) *Unit systems* containing not more than the quantities of group 1 refrigerant specified in table 1, or

(b) *Sealed absorption systems* containing not more than 3 pounds of group 2 refrigerant when in residential and commercial occupancies.

TABLE 1.—MAXIMUM PERMISSIBLE QUANTITIES OF GROUP 1 REFRIGERANTS FOR DIRECT SYSTEMS

Refrigerant Name and Number	Chemical Formula	Maximum quantity in lb. per 1000 cu. ft. of humanly occupied space
Carbon dioxide (Refrigerant 744)	CO_2	11
Dichlorodifluoromethane (Refrigerant 12)	CCl_2F_2	31
Dichlorodifluoromethane, 73.8% and Ethylidene Fluoride, 26.2% (Refrigerant 500)	CCl_2F_2 / CH_3-CHF_2	26
Dichloromethane (Methylene chloride) (Refrigerant 30)	CH_2Cl_2	6
Dichloromonofluoromethane (Refrigerant 21)	$CHCl_2F$	13
Dichlorotetrafluoromethane (Refrigerant 114)	$C_2Cl_2F_4$	44
Monobromotrifluoromethane (Refrigerant 13B1)	$CBrF_3$	38
Monochlorodifluoromethane (Refrigerant 22)	$CHClF_2$	22
Monochlorodifluoromethane, 48.8% and Monochloropentafluoroethane, 51.2% (Refrigerant 502)	$CHClF_2$ / $CClF_2CF_3$	30
Monochlorotrifluoromethane (Refrigerant 13)	$CClF_3$	27
Octafluorocyclobutane (Refrigerant C318)	C_4F_8	50
Trichloromonofluoromethane (Refrigerant 11)	CCl_3F	35
Trichlorotrifluoroethane (Refrigerant 113)	$C_2Cl_3F_3$	24

(3) REFRIGERANT PIPING THROUGH FLOORS. Refrigerant piping shall not be carried through floors except as follows:

(a) It may be carried from the basement to the first floor or from the top floor to a refrigerating machinery penthouse or to the roof.

(b) For the purpose of connecting to a condenser on the roof, it may be carried through an approved, rigid and tight continuous fire-resisting pipe duct or shaft having no openings on intermediate floors, or it may be carried on the outer wall of the building provided it is not located in an air shaft, closed court, or in other similar open spaces enclosed within the outer walls of the building.

(c) In systems containing group 1 refrigerants, the refrigerant piping may also be carried through floors, intermediate between the first floor and the top floor, provided it is enclosed in an approved, rigid and tight continuous fire-resistive pipe duct or shaft where it passes through intermediate spaces not served by the system. Piping of direct systems, as governed by Wis. Adm. Code section Ind 45.062 (1), need not be enclosed where it passes through space served by that system. The pipe duct or shaft shall be vented to the outside or to a space served by the system.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63; am. Table 1, Register, December, 1965, No. 120, eff. 1–1–66.

Ind 45.062 Group 1 refrigerants. (1) DIRECT SYSTEMS. The maximum permissible quantity of a group 1 refrigerant in a direct system is specified in table 1 except institutional occupancies where further limited by (a).

(a) Direct systems in institutional occupancies shall be limited to unit systems each containing not more than 20 pounds of group 1 refrigerants, except in kitchens, laboratories, and mortuaries. (See subsection (4)).

(b) When the refrigerant-containing parts of a system are located in one or more enclosed spaces, the cubical content of the smallest enclosed humanly occupied space other than the machinery room, shall be used to determine the permissible quantity of refrigerant in the system. Where a refrigerating system has evaporator coils serving individual stories of a building, the story having the smallest volume shall be used to determine the maximum quantity of refrigerant in the entire system.

(c) When the evaporator is located in an air duct system, cubical content of the smallest humanly occupied enclosed space served by the air duct system shall be used to determine the permissible quantity of refrigerant in the system; however, if the air flow to any enclosed space served by the air duct system cannot be shut off or reduced below one-quarter of its maximum, the cubical content of the entire space served by the air duct system may be used to determine the permissible quantity of refrigerant in the system.

(d) In institutional and public assembly occupancies, direct expansion coils or evaporators used for air conditioning and located downstream from, and in proximity to, a heating coil, or located upstream within 18 inches of a heating coil, shall be fitted with a pressure relief device discharging to the outside of the building in an approved manner; except that such a relief device shall not be required on unit or self-contained systems if the internal volume of the low side of the system which may be shut off by valves, divided by the total weight of refrigerant in the system less the weight of refrigerant vapor contained in the other parts of the system at 110 F. exceeds the specific volume of the refrigerant at critical conditions of temperature and pressure.

Note. The exemption in (d) is also stated in formula form below.

$$\frac{V_1}{W_1 - W_2} \text{ shall be more than } V_{sp}$$

where V_1 = low side volume, cu. ft.

V_{sp} = specific volume at critical conditions of temperature and pressure, cu. ft. per lb.

W_1 = total weight of refrigerant in system, lb.

W_2 = weight of refrigerant vapor (lb.) at 110 F. in V_2, or

$= \frac{V_2}{\text{specific volume}}$ of refrigerant in cu. ft. per lb., at 110 F., where V_2 = total volume of system less V_1 cu. ft.

(2) INDIRECT SYSTEMS. A system containing more than the quantity of a group 1 refrigerant allowed in table 1 shall be of the indirect type with all refrigerant-containing parts, excepting parts mounted

outside the building and piping installed in accordance with Wis. Adm. Code section Ind 45.06 (3), installed in a machinery room used for no other purpose than for mechanical equipment.

(3) OPEN FLAMES IN MACHINERY ROOMS. No open flame or apparatus to produce an open flame shall be installed in a machinery room where any refrigerant other than carbon dioxide is used unless the flame is enclosed and vented to the open air. The use of matches, cigarette lighters, halide leak detectors, and similar devices shall not be considered a violation of this paragraph or of subsection (4).

(4) OPEN FLAMES IN INSTITUTIONAL OCCUPANCIES. In institutional occupancies, where more than 1 pound of a group 1 refrigerant, other than carbon dioxide, is used in a system, any portion of which is in a room where there is an apparatus for producing an open flame, then such refrigerant shall be classed in group 2, unless the flame-producing apparatus is provided with a hood and flue capable of removing the products of combustion to the open air.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63; am. (1) (a), Register, December, 1965, No. 120, eff. 1–1–66.

Ind 45.063 Group 2 refrigerants. (1) DIRECT SYSTEMS. Direct systems containing group 2 refrigerants shall not be used for air conditioning for human comfort. For other applications, the maximum permissible quantity of group 2 refrigerants in a direct system is shown in table 2.

(2) INDIRECT SYSTEMS. The maximum permissible quantity of group 2 refrigerant in any indirect system is shown in table 3. Such systems shall be of the following type:

(a) *Institutional and public assembly occupancies.* Indirect vented closed-surface, or double indirect vented open-spray.

TABLE 2.—MAXIMUM PERMISSIBLE QUANTITIES OF GROUP 2 REFRIGERANTS FOR DIRECT SYSTEMS

Type of refrigerating system	Maximum pounds for various occupancies			
	Institutional	Public Assembly	Residential	Commercial
Sealed Absorption Systems:				
(a) In public hallways or lobbies	0	0	3	3
(b) In other than public hallways or lobbies	0*	6	6	20
Self-Contained or Unit Systems:				
(a) In public hallways or lobbies	0	0	0	0
(b) In other than public hallways or lobbies	0	0*	6	20

*6 pounds allowed when installed in kitchens, laboratories, and mortuaries.

(b) *Residential and commercial occupancies.* Indirect vented closed-surface, or double indirect vented open-spray, or primary circuit of double-refrigerant type.

(3) MACHINERY ROOMS FOR INDIRECT SYSTEMS, GROUP 2 REFRIGERANTS. (a) Indirect systems using group 2 refrigerants not in excess of the quantities shown in column 1 of table 3 shall have all refrigerant-containing parts, excepting parts mounted outside the building and piping installed in accordance with Wis. Adm. Code section Ind 45.062 (4) installed in a machinery room used for no other purpose than for mechanical equipment.

TABLE 3.—MAXIMUM PERMISSIBLE QUANTITIES OF GROUP 2 REFRIGERANTS FOR INDIRECT SYSTEMS

Occupancy	Column 1 Machinery Rooms (See Section Ind 45.02) max. lb.	Column 2 Class T Machinery Rooms (See Section Ind 45.02) max. lb.
Institutional	0	Not more than 500 lb.
Public Assembly	0	Not more than 1000 lb.
Residential	Not more than 300 lb.	No limit
Commercial	Not more than 600 lb.	No limit

(b) Indirect systems using group 2 refrigerants not in excess of the quantities shown in column 2 of table 3 shall have all refrigerant-containing parts installed in a class T machinery room.

(c) Flame-producing devices, hot surfaces, and electrical equipment in machinery rooms. Where a machinery room is required by this code to house a refrigerating system containing any group 2 refrigerant other than sulphur dioxide, no flame-producing device or hot surface above 800 F. shall be permitted in such room and all electrical equipment in the room shall conform to the requirements of hazardous locations, class 1, of the latest edition of the Wisconsin state electrical code. The use of matches, cigarette lighters, halide leak detectors, and similar devices shall not be considered a violation of this paragraph.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.064 Group 3 refrigerants. (1) Group 3 refrigerants shall not be used in institutional, public assembly, residential, or commercial occupancies except in laboratories for commercial occupancies. In such laboratory installations only unit systems containing not more than 6 pounds shall be used unless the number of persons does not exceed one person per 100 square feet of laboratory floor area, in which case the requirements for industrial occupancy shall apply.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.07 Requirements for industrial occupancies. (1) GENERAL. There shall be no restriction on the quantity or kind of refrigerant used in an industrial occupancy, except as specified in subsection (2) and Wis. Adm. Code section Ind 45.08 (10).

(2) NUMBER OF PERSONS. When the number of persons in a refrigerated space, served by a direct system, on any floor above the first floor (ground level or deck level) exceeds one person per 100 square feet of floor area, the requirements of commercial occupancy shall apply unless that refrigerated space containing more than one person per 100 square feet of floor area above the first floor is provided with the required number of doors opening directly into approved building exits. Such refrigerated space shall be cut off from the rest of the building by tight construction with tight-fitting doors.

Note. The above does not prohibit openings for the passage of products from one refrigerated space to another refrigerated space.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.08 Installation requirements. (1) Foundations and supports for condensing units or compressor units shall be of substantial construction. (See subsection (3).)

(2) Moving machinery shall be guarded in accordance with accepted safety standards.

(3) Clear space adequate for inspection and servicing of condensing units or compressor units shall be provided.

(4) Condensing units or compressor units with enclosures shall be readily accessible for servicing and inspection.

(5) Water supply and discharge connections shall be made in accordance with applicable plumbing codes.

(a) Discharge water lines shall not be directly connected to the waste or sewer system. The waste or discharge from such equipment shall be over and above a trapped and vented plumbing fixture.

(6) Illumination adequate for inspection and servicing of condensing units or compressor units shall be provided.

(7) Electrical equipment and wiring shall be installed in accordance with the provisions of the Wisconsin state electrical code.

(8) Gas fuel devices and equipment used with refrigerating systems shall be installed in accordance with provisions of applicable state code.

(9) When the quantity of flammable refrigerant in any one refrigerating system exceeds the amount given in table 4 for each 1000 cubic feet of room volume in which the system or any part thereof is installed, then no flame-producing device or hot surface above 800 F. shall be permitted in such room and all electrical equipment in the room shall conform to the requirements of hazardous locations, class 1, of the latest edition of the Wisconsin state electrical code.

TABLE 4.—MAXIMUM PERMISSIBLE QUANTITIES OF FLAMMABLE REFRIGERANTS

Name	Chemical formula	Maximum quantity in lb. per 1000 cu. ft. of room volume
Butane	C_4H_{10}	2½
Ethane	C_2H_6	2½
Ethyl Chloride	C_2H_5Cl	6
Ethylene	C_2H_4	2
Isobutane	$(CH_3)_3CH$	2½
Methyl Chloride	CH_3Cl	10
Methyl formate	$HCOOCH_3$	7
Propane	C_3H_8	2½

(10) Flammable refrigerants as listed in table 4 shall not be used in a refrigerating system in excess of 1000 pounds unless approved by the Wisconsin industrial commission.

(11) Machinery room requirements. (See definitions, Wis. Adm. Code section Ind 45.02.)

(a) Each refrigerating machinery room shall be provided with tight-fitting door or doors and have no partitions or openings that will permit the passage of escaping refrigerant to other parts of the building.

(b) Each refrigerating machinery room shall be provided with means for ventilation to the outer air. The ventilation shall consist of windows or doors opening to the outer air, of the size shown in table

5, or of mechanical means capable of removing the air from the room in accordance with table 5. The amount of ventilation for refrigerant removal purposes shall be determined by the refrigerant content of the largest system in the machinery room.

(c) Mechanical ventilation, when used, shall consist of one or more power-driven exhaust fans, which shall be capable of removing from the refrigerating machinery room the amount of air specified in table 5. The inlet to the fan, or fans, of air duct connection shall be located near the refrigerating equipment. The outlet from the fan, or fans, or air duct connections shall terminate outside of the building in an approved manner. When air ducts are used either on the inlet or discharge side of the fan, or fans, they shall have an area not less than specified in table 5. Provision shall be made for the inlet of air to replace that being exhausted.

(d) Class T machinery rooms in basements or sub-basements (see definitions, Wis. Adm. Code section Ind 45.02) shall have, as specified in table 5, mechanical ventilation operating continuously.

(12) Air duct systems of air conditioning equipment for human comfort using mechanical refrigeration should be installed in accordance with the applicable provisions of the Wisconsin heating, ventilating and air conditioning code, chapter Ind 59.

TABLE 5.—MINIMUM AIR DUCT AREAS AND OPENINGS

Weight of refrigerant in system, lb.	Mechanical discharge of air, CFM	Duct area, sq. ft.	Open areas of windows and doors, sq. ft.
up to 20	150	¼	4
50	250	⅓	6
100	400	½	10
150	550	⅔	12½
200	680	⅔	14
250	800	1	15
300	900	1	17
400	1,100	1¼	20
500	1,275	1¼	22
600	1,450	1½	24
700	1,630	1½	26
800	1,800	2	28
900	1,950	2	30
1,000	2,050	2	31
1,250	2,250	2¼	33
1,500	2,500	2¼	37
1,750	2,700	2¼	38
2,000	2,900	2¼	40
2,500	3,300	2½	43
3,000	3,700	3	48
4,000	4,600	3¾	55
5,000	5,500	4½	62
6,000	6,300	5	68
7,000	7,200	5½	74
8,000	8,000	5¾	80
9,000	8,700	6¼	85
10,000	9,500	6½	90
12,000	10,900	7	100
14,000	12,200	7½	109
16,000	13,300	7¾	118
18,000	14,300	8	125
20,000	15,200	8¼	130
25,000	17,000	8¾	140
30,000	18,200	9	145
35,000	19,400	9¼	150
40,000	20,500	9½	155
45,000	21,500	9¾	160

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.09 Refrigerant piping, valves, fittings, and related parts; general. (1) STANDARDS. Refrigerating piping, valves, fittings, and related parts used in the construction and installation of refrigerating systems shall conform to standards accepted by the Wisconsin industrial commission.

Note: The Wisconsin Industrial Commission will recognize the provisions of American Standard Code for Pressure Piping (B 31.5—1962) and American Standard Wrought-Steel Wrought-Iron Pipe (B 36.10—1959), Specifications for Seamless Copper Pipe, Standard Sizes, (ASTM B 42–62), American Standard Specifications for Seamless Copper Water Tube (ASTM B 88–62) (ASA H 23.1–63), Standard Specifications for Seamless Copper Tubing, Bright Annealed (ASTM B 20–62), Specifications for Seamless Red Brass Pipe, Standard Sizes (ASTM B 43–62).

(2) METAL ENCLOSURES OR PIPE DUCTS FOR SOFT COPPER TUBING. Rigid or flexible metal enclosures shall be provided for soft, annealed copper tubing used for refrigerant piping erected on the premises and containing other than group 1 refrigerants. No enclosures shall be required for connections between condensing unit and the nearest riser box, provided such connections do not exceed 6 feet in length.

(3) SPECIFIC MINIMUM REQUIREMENTS FOR REFRIGERANT PIPE AND TUBING. (a) No less than schedule 80 wall thickness carbon steel or wrought iron pipe shall be used for group 2 and group 3 refrigerant liquid lines for sizes 1½ inches and smaller. No less than Schedule 40 wall thickness carbon steel or wrought iron pipe shall be used for group 1 refrigerant liquid lines sizes 6 inches and smaller, group 2 and group 3 refrigerant liquid lines sizes 2 inches through 6 inches and group 1, group 2, and group 3 refrigerant vapor lines 6 inches and smaller. Butt-welded carbon steel and butt-welded wrought iron pipe shall not be used for refrigerant liquid lines. Cast iron pipe shall not be used for group 1, group 2, or group 3 refrigerant lines.

(b) Standard iron pipe size copper and red brass (not less than 80% copper) pipe and tubing may be used and shall conform to standards accepted by the Wisconsin industrial commission.

(c) Water tube size hard copper tubing used for refrigerant piping erected on the premises shall conform to standards accepted by the Wisconsin industrial commission for dimensions and specifications, except that copper tubing with outside diameters of ¼" and ⅜" shall have a minimum nominal wall thickness of not less than 0.030" and 0.032", respectively.

(d) Soft annealed copper tubing used for refrigerant piping erected on the premises shall not be used in sizes larger than 1⅜" outside

Outside diameter, in.	Wall thickness, in.
¼	0.030
⅜	0.032
½	0.032
⅝	0.035
¾	0.042
⅞	0.045
1	0.050
1⅛	0.050
1¼	0.055
1⅜	0.055

diameter (1¼" nominal). Mechanical joints shall not be used on soft annealed copper tubing on sizes larger than ⅞" outside diameter. Minimum nominal wall thicknesses of soft annealed copper tubing shall be as follows:

(e) Sweat joints on copper tubing used in refrigerating systems containing group 2 or group 3 refrigerants shall be brazed joints. Soldered joints shall not be used in such refrigerating systems.

(4) JOINTS AND REFRIGERANT-CONTAINING PARTS IN AIR DUCTS. Joints and all refrigerant-containing parts of a refrigerating system located in an air duct of an air conditioning system carrying conditioned air to and from a humanly occupied space shall be constructed to withstand, without leakage, a temperature of 1000 F.

(5) STOP VALVES. (a) *General requirements.* All systems containing more than 50 pounds of a group 1 refrigerant or 6 pounds of a group 2 or 3 refrigerant, other than systems utilizing non-positive displacement compressors, shall have stop valves installed as follows:

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.

(b) *Systems containing 100 pounds or more of refrigerant.* All systems containing 100 pounds or more of a refrigerant, other than systems utilizing nonpositive displacement compressors, shall have stop valves, in addition to those in subsection (6) (a), on each inlet of each liquid receiver except that none shall be required on the inlet of a receiver in a condensing unit nor on the inlet of a receiver which is an integral part of a condenser.

(c) Stop valves used with soft annealed copper tubing or hard drawn copper tubing ¾" nominal size or smaller shall be securely mounted, independent of tubing fastenings or supports.

(6) LOCATION OF REFRIGERANT PIPING. (a) Refrigerant piping crossing an open space which affords passageway in any building shall be not less than 7½ feet above the floor unless against the ceiling of such space.

(b) Free passageway shall not be obstructed by refrigerant piping. 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. 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 1 inch nominal diameter (1⅛" outside diameter) and smaller be contained in a rigid metal pipe.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63; am. Note, am. (3) (a), (4) and (5) (b), Register, December, 1965, No. 120, eff. 1–1–66.

Ind 45.10 Design and construction of equipment; general. (Also, see Wis. Adm. Code section Ind 45.11 for pressure vessels) (1) TEST PRESSURE. (a) Every part of a refrigerating system, with the exception of pressure gauges, control mechanisms and limited charged systems, shall be designed, constructed, and assembled to be capable of withstanding a test pressure not less than the minimum refriger-

ant leak field test pressure specified in table 6 without being stressed beyond ⅓ of its ultimate strength. (See subsection (2).) Limited charged systems equipped with a pressure relief device, shall be designed, constructed, and assembled to be capable of withstanding a test pressure not less than 1.5 times the setting of the pressure relief devices without being stressed beyond ⅓ of its ultimate strength.

Note. This paragraph establishes a minimum design working pressure in terms of the field test pressure so that the minimum refrigerant leak field test pressure, specified in table 6, can be safely applied. Rules governing pressure-relief devices, pressure-limiting devices, etc., shall be based on the design working pressure selected.

(b) All materials used in the construction and installation of refrigerating systems shall be suitable for conveying the refrigerant used. No material shall be used that will deteriorate because of the refrigerant, or the oil, or the combination of both.

Note. Many refrigerants are corrosive to the usual materials when moisture or air, or both, are present and it is assumed in approving these materials that the system will be charged and operated in accordance with accepted practice, to prevent or minimize this corrosion. Some synthetic materials react dangerously with Refrigerant 22.

(c) Aluminum, zinc, or magnesium shall not be used in contact with methyl chloride in a refrigerating system. Magnesium alloys shall not be used in contact with any hologenated refrigerant.

(2) MINIMUM TEST PRESSURES. Every refrigerant-containing part of every system, including pressure gauges and control mechanisms, shall be tested and proved tight by the manufacturer at not less than the minimum refrigerant leak field test pressure specified in Table 6 except limited charged systems. (See subsection (3) and Wis. Adm. Code section Ind 45.14 (1) (b).)

(a) The test pressure applied to either the high or low side of each refrigerating system shall be at least equal to the design working pressure of the pressure vessels in the high or low side of the system, respectively, or to the setting of the pressure relief device protecting the respective pressure vessels, whichever is lower, but not less than the minimum refrigerant leak field test pressures specified in table 6. Any components connected to said pressure vessels shall be of sufficient strength to conform to the design requirements of subsection (1) (a).

(b) Limited charged unit systems shall be tested in accordance with subsection (2) except that limited charged unit systems equipped with a pressure relief device may be tested and proved tight at a pressure not less than 1½ times the setting of the pressure relief device.

(3) ACCEPTABLE EQUIPMENT. Equipment listed by an approved nationally recognized testing laboratory having a follow-up inspection service shall be deemed as meeting the intent of the requirements of subsections (1) and (2).

(4) PRESSURE LIMITING DEVICES. (a) Pressure-limiting devices shall be provided on all systems containing more than 20 pounds of refrigerant and operating above atmospheric pressure, and on all water cooled systems so constructed that the compressor or generator is capable of producing a pressure in excess of the test pressure; except water cooled unit systems containing not more than 3 pounds of a group 1 refrigerant providing the operating pressure developed in the

system with the water supply shut off does not exceed one-fifth the ultimate strength of the system, or providing an overload device will stop the action of the compressor before the pressure exceeds one-fifth the ultimate strength of the system.

(b) The maximum setting to which a pressure limiting device may readily be set by use of the adjusting means provided shall not exceed 90% of the setting of the pressure-relief device installed on the high side of a system, 90% of the refrigerant leak field test pressure actually applied, or 90% of the design working pressure of the high side of the system, whichever is smallest. The pressure limiting device shall stop the action of the pressure-imposing element at a pressure no higher than this maximum setting. In determining this maximum setting for systems erected on the premises and field leak tested in accordance with Wis. Adm. Code section Ind 45.14 (1) (a), 90% of the leak test pressures in table 6 may be utilized in lieu of the field test pressure actually applied. (See Wis. Adm. Code section Ind 45.14 (1) for minimum refrigerant leak field test pressures.)

(c) On systems using nonpositive displacement compressors, the pressure-limiting device may be set at the pressure setting of the relief device, the refrigerant leak field test pressure actually applied or the design working pressure of the high side of the system, whichever is smallest, provided the pressure relief device is subject to low side pressure and there are no stop valves on the system as exempted by Wis. Adm. Code section Ind 45.09 (5) for nonpositive displacement compressors.

(d) Pressure-limiting devices shall be connected, with no intervening stop valves, between the pressure-imposing element and any stop valve on the discharge side.

(5) GAUGE PROTECTION. Liquid level gauge glasses, except those of bull's eye type or indirect level indicator, shall have automatic and manual closing shut-off devices and all glasses shall be protected against injury by sturdy metal guards.

(6) GAUGE LOCATION. A pressure gauge shall be attached to the high pressure side of refrigeration systems having a capacity of:

(a) 5 tons, or 5 H.P., or 5 Kva, and over using a group 2 or group 3 refrigerant.

(b) 25 tons, or 25 H.P., or 25 Kva, and over using a group 1 refrigerant.

(7) DIAL. The dial of a pressure gauge shall be graduated up to approximately double the operating pressure and to no less than 1.2 times the design working pressure.

(a) An effective stop shall be provided for the indicating pointer to indicate an over or under pressure condition.

(8) NAMEPLATE. Each separately sold condensing unit and each compressor or compressor unit sold for field assembly in a refrigerating system shall carry a nameplate marked with the manufacturer's name, nationally registered trademark or trade name, identification

number, the test pressure applied by the manufacturer, and the refrigerant for which it is designed. The refrigerant shall be designated according to tables in Wis. Adm. Code section Ind 45.20.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63; am. (1) (c), (2) intro. par.; r. and recr. (4) (c); cr. (4) (d) and am. (8), Register, December, 1965, No. 120, eff. 1-1-66.

REFRIGERANT-CONTAINING PRESSURE VESSELS

Ind 45.11 Construction, inspection, and stamping of pressure vessels. (1) Refrigerant-containing vessels shall be constructed, inspected, and stamped in accordance with the provisions of the current Wisconsin boiler and unfired pressure vessel code.

(2) All pressure vessels, regardless of size or pressure, shall be equipped with relief devices in accordance with the provision of Wis. Adm. Code section Ind 45.13.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63.

Ind 45.12 Relief devices in general. (1) GENERAL. Every refrigerating system shall be protected by a pressure-relief device unless so constructed that pressure due to fire conditions will be safely relieved by some part of the system.

(a) No stop valve shall be located between any automatic pressure-relief device or fusible plug and the part or parts of the system protected thereby, except when the parallel relief devices are so arranged that only one can be rendered inoperative at a time for testing or repair purposes.

(b) All pressure-relief devices shall be connected as nearly as practicable directly to the pressure vessel or other parts of the system protected thereby, above the liquid refrigerant level, and installed so that they are readily accessible for inspection and repair and so that they cannot be readily rendered inoperative. Fusible plugs may be located above or below the liquid refrigerant level.

(c) The seats and discs of pressure-relief devices shall be constructed of suitable material to resist refrigerant corrosion or other chemical action caused by the refrigerant. Seats or discs of cast iron shall not be used.

(d) The rated discharge capacity of a pressure-relief valve for a refrigerant-containing vessel, expressed in pounds of air per minute, shall be determined at a pressure at the inlet of the relief valve equal to 110% of the valve setting in accordance with applicable provisions of the Wisconsin boiler and unfired pressure vessel code.

(e) The rated discharge capacity of a rupture member or fusible plug discharging to atmosphere under critical flow conditions in pounds of air per minute shall be determined by the following formulas:

$$C = 0.8\ P_1 d^2$$

$$d = 1.12 \sqrt{\frac{C}{P_1}}$$

Where C = minimum required discharge capacity, in lb. of air per min.

d = minimum diameter of bore of fusible plug or internal diameter of inlet pipe to rupture member in inches

Where for rupture members:

P_1 = (set pressure $\times$ 1.10) + 14.7

For fusible plugs:

P_1 = absolute saturation pressure, corresponding to the stamped temperature melting point of the fusible plug or the critical pressure of the refrigerant used, whichever is smaller, psia

(f) All pressure-relief devices (not fusible plugs) shall be directly pressure-actuated.

(g) The size of the discharge pipe from the pressure-relief device shall be not less than the size of the relief device outlet. The discharge from more than one relief device may be run into a common header, the area of which shall be not less than the sum of the combined net areas of the 3 largest relief devices discharging into it. An open drain leg shall be provided at the lowest point for testing and for the removal of moisture.

(h) The length of discharge piping permitted to be installed on the outlet of a relief valve, rupture member, or fusible plug shall be determined as follows:

$$C = \frac{3\ P\ d^{5/2}}{L^{1/2}}$$

or

$$d = \sqrt[5]{\frac{C^2 L}{9P^2}}$$

where C = minimum required discharge capacity, in lb. of air per min.

d = internal diameter of pipe in in.

L = length of discharge in ft.

P = $0.25P_1$ (P_1 is defined under equation 1.)

(See table 7 for computations derived from the preceding formula.)

(2) PRESSURE-RELIEF DEVICES FOR POSITIVE DISPLACEMENT COMPRESSORS. Positive displacement compressors operating above 15 pounds per square inch gauge and having a displacement exceeding 50 cubic feet per minute, shall be equipped by the manufacturer with a pressure-relief device of adequate size and pressure setting to prevent rupture of the compressor, located between the compressor and stop valve on the discharge side. The location of an internal valve shall be permanently indicated by stamping or casting the words "relief valve". The discharge from such relief device may be vented to the atmosphere or into the low pressure side of the system.

(3) OUTSIDE DISCHARGE. Discharge of pressure-relief devices and fusible plugs on all systems containing more than 6 pounds of group 2 or group 3 refrigerants shall be to the outside of the building in an approved manner. Discharge of pressure-relief devices and fusible plugs on all systems containing more than 100 pounds of group 1 refrigerants, unless installed in a machinery room used for no purpose other than to house mechanical equipment and complying with the provisions as specified in Wis. Adm. Code section Ind 45.08 (11) shall be vented to the outside of the building in an approved manner. (See subsection (6).)

(a) Pressure-relief devices may discharge into the low side of the system, provided the pressure-relief devices are of a type not appreciably affected by back pressures and provided the low side of the sys-

tem is equipped with pressure-relief devices. The relief devices on the low side of the system shall have sufficient capacity to protect the pressure vessels that are relieved into the low side of the system, or to protect all pressure vessels on the low side of the system, whichever relieving capacity is the largest, as computed by the formula in Wis. Adm. Code section Ind 45.13 (5). Such low side pressure-relief devices shall be set in accordance with Wis. Adm. Code section Ind 45.13 (6) and vented to the outside of the building in an approved manner. (See subsection (6).)

(4) AMMONIA DISCHARGE. Where ammonia is used, the discharge may be into a tank of water which shall be used for no purpose except ammonia absorption. At least one gallon of fresh water shall be provided for each pound of ammonia in the system. The water used shall be prevented from freezing without the use of salt or chemicals. The tank shall be substantially constructed of not less than ⅛" or No. 11 U.S. gauge iron or steel. No horizontal dimension of the tank shall be greater than one-half the height. The tank shall have hinged cover, or, if of the enclosed type, shall have a vent hole at the top. All pipe connections shall be through the top of the tank only. The discharge pipe from the pressure-relief valves shall discharge the ammonia in the center of the tank near the bottom.

(5) SULPHUR DIOXIDE DISCHARGE. Where sulphur dioxide is used, the discharge may be into a tank of absorptive brine which shall be used for no purpose except sulphur dioxide absorption. There shall be one gallon of standard dichromate brine (2½ pounds sodium dichromate per gallon of water) for each pound of sulphur dioxide in the system. Brines made with caustic soda or soda ash may be used in place of sodium dichromate, provided the quantity and strength give the equivalent sulphur dioxide absorbing power. The tank shall be substantially constructed of not less than ⅛" or No. 11 U.S. gauge iron or steel. The tank shall have a hinged cover, or if of the enclosed type, shall have a vent hole at the top. All pipe connections shall be through the top of the tank only. The discharge pipe from the pressure-relief valve shall discharge the sulphur dioxide in the center of the tank near the bottom.

(6) DISCHARGE. Discharge piping shall be by unobstructed continuous piping to the outside atmosphere not less than 12 feet above the ground and not closer than 20 feet to any fire escape, doorway, ventilator, or other opening. The pipe shall be provided with a diffuser and so positioned that water cannot enter the line.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.13 Relief devices for pressure vessels. (1) GENERAL. The rules of this section are based upon the rules as stated in the Wisconsin boiler and unfired pressure vessel code with such additional modifications as are necessary for control of refrigerants.

(2) PRESSURE VESSELS OVER 3 CUBIC FEET. Each pressure vessel containing liquid refrigerant with internal gross volume exceeding 3 cubic feet, except as specified in subsection (4), and which may be shut off by valves from all other parts of a refrigerating system, shall be protected by a pressure-relief device, having sufficient

capacity to prevent the pressure in the pressure vessel from rising more than 10% above the setting of the pressure-relief device. (See subsection (5).)

(a) *Pressure vessels over 3 cubic feet, but less than 10 cubic feet.* Under conditions specified in subsection (2), a single relief device (relief valve or rupture member) may be used on pressure vessels having less than 10 cubic feet internal gross volume.

(b) *Pressure vessels of 10 cubic feet internal gross volume or over.* Under conditions specified in subsection (2), a relief device system consisting of a pressure-relief device in parallel with a second pressure-relief device as described in Wis. Adm. Code section Ind 45.12 (1) (a) shall be provided on pressure vessels having internal gross volume of 10 cubic feet or over. Each relief valve or rupture member shall have sufficient capacity to prevent the pressure in the pressure vessel from rising more than 10% above the setting of the pressure-relief device. (See subsection (8).)

1. Relief valves discharging into low side of the system. Under conditions permitted in Wis. Adm. Code section Ind 45.12 (3) (a), a single relief valve (not rupture member) of the required relieving capacity may be used on vessels of 10 cubic feet or over.

(c) *Relief devices in parallel on large vessels.* In cases where large pressure vessels containing liquid refrigerant except as specified in subsection (4), require the use of 2 or more pressure-relief devices in parallel to obtain the capacity required by Wis. Adm. Code subsection (5), the battery of pressure-relief devices shall be considered as a unit, and therefore as one pressure-relief device.

(3) PRESSURE VESSELS WITH INTERNAL GROSS VOLUME OF 3 CUBIC FEET OR LESS. Each pressure vessel having an internal gross volume of 3 cubic feet or less, containing liquid refrigerant, except as specified in subsection (4), and which may be shut off by valves from all other parts of a refrigerating system, shall be protected by a pressure-relief device, or fusible plug. A fusible plug is permitted only on the high side of a refrigerating system. Pressure vessels of less than 3" I.D. are exempt from these requirements.

(a) Relief valves on pressure vessels with gross volume of 3 cubic feet or less. If a relief valve or rupture member is used to protect a pressure vessel, the ultimate bursting pressure of the pressure vessel so protected shall be at least 2½ times the pressure setting of the pressure relief valve or rupture member.

(b) Fusible plugs and pressure vessels with gross volume of 3 cubic feet or less. If a fusible plug is used, the ultimate bursting pressure of the pressure vessel so protected shall be at least 2½ times the refrigerant saturation pressure, psig, corresponding to the stamped temperature on the fusible plug, or at least 2½ times the critical pressure of the refrigerant used, whichever is smaller.

(4) RELIEF DEVICE FOR PRESSURE VESSELS USED AS, OR AS PART OF EVAPORATOR. Pressure vessels having internal diameters greater than 6 inches used as, or as part of, evaporators insulated or installed in insulated space, and which may be shut off by valves from all other parts of a refrigerating system shall be protected by a pressure-re-

lief device in accordance with the provisions of subsections (2) and (3) except that the provisions of subsection (2) (b), requiring a second parallel relief device, shall not apply. Pressure vessels used as evaporators, having internal diameters of 6 inches or less, are exempt from pressure relief valve requirements.

(5) REQUIRED CAPACITY. The minimum required rated discharge capacity of the pressure-relief device or fusible plug for a refrigerant-containing vessel shall be determined by the following:

$$C = fDL$$

where C = minimum required discharge capacity of the relief device in lb. of air per min.
D = outside diameter of the vessel in ft.
L = length of the vessel in ft.
f = factor dependent upon kind of refrigerant, as follows:

Kind of Refrigerant	Value of f
Ammonia (Refrigerant 717)	0.5
Refrigerants 12, 22 and 500	1.6
Refrigerant 502 and Refrigerants 13, 13B1, and 14 when on cascaded systems	2.5
All other refrigerants	1.0

(6) PRESSURE-RELIEF DEVICE SETTING. Except as permitted in subsection (3) (a) all pressure-relief devices shall be set to start to function at a pressure not to exceed the design working pressure of the pressure vessel as determined and stamped on the pressure vessel or system by the manufacturer.

(7) RUPTURE MEMBER SETTING. All rupture members used in lieu of, or in series with, a relief valve shall function at a pressure not to exceed the design working pressure of the vessel and the conditions of application shall conform to the requirements of the Wisconsin boiler and unfired pressure vessel code.

(a) Rupture members installed ahead of relief valves need not be larger, but shall not be smaller, than the relief valve inlet. (See Wis. Adm. Code section Ind 45.12 (1) (e).)

(8) MARKING OF RELIEF DEVICES. (a) All pressure-relief valves for refrigerant-containing vessels shall be set and sealed by the manufacturer. Each relief valve shall be marked by the manufacturer with the data required in the Wisconsin boiler and unfired pressure vessel code.

(b) Each rupture member for refrigerant-containing pressure vessels shall be marked with the information required in the Wisconsin boiler and unfired pressure vessel code.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63; am. table in (5), Register, December, 1965, No. 120, eff. 1–1–66.

Ind 45.14 Field tests. (1) GENERAL. Every refrigerant-containing part of every system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gauges, and control mechanisms that are factory tested shall be tested and proved tight after complete installation, and before operation, at not less than the minimum refrigerant leak field test pressures shown in table 6, or in accordance with subsections (1) (a) and (b).

(a) Systems erected on the premises using group 1 refrigerant and with copper tubing not exceeding ⅝" O.D. with wall thickness as required by Wis. Adm. Code sections Ind 45.09 (3) (c) and (d) may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 70 F. or higher.

(b) Limited charged systems equipped with a pressure-relief device, erected on the premises, shall be tested at a pressure not less than 1½ times the pressure setting of the relief device.

(2) TEST MEDIUM. No oxygen or any combustible gas or combustible mixture of gases shall be used within the system for testing.

TABLE 6.—MINIMUM REFRIGERANT LEAK FIELD TEST PRESSURES

Refrigerant Name and Number*	Chemical Formula	Minimum Field Refrigerant Leak Test Pressures, psig	
		High Side	Low Side
Ammonia (717)	NH_3	300	150
Butane (600)	C_4H_{10}	95	50
Carbon dioxide (744)	CO_2	1500	1000
Dichlorodifluoromethane (12)	CCl_2F_2	235	140
Dichlorodifluoromethane 73.8% / Ethylidene fluoride 26.2% (500)	CCl_2F_2 / CH_3CHF_2	285	150
Dichloroethylene (1130)	C_2H_2Cl	30	30
Dichloromethane (Methylene chloride) (30)	CH_2Cl_2	30	30
Dichloromonofluoromethane (21)		70	40
Dichlorotetrafluoroethane (114)	$C_2Cl_2F_4$	50	50
Ethane (170)	C_2H_6	1200	700
Ethyl chloride (160)	C_2H_6Cl	60	50
Ethylene (1150)	C_2H_4	1600	1200
Isobutane (601)	$(CH_3)_3CH$	130	70
Methyl chloride (40)	CH_3Cl	210	120
Methyl formate (611)	$HCOOCH_3$	50	50
Monobromotrifluoromethane (13B1)	$CBrF_3$	435	245
Monochlorodifluoromethane (22)	$CHClF_2$	300	150

Refrigerant Name and Number*	Chemical Formula	High Side	Low Side
Monochlorodifluoromethane 48.8% and Monochloropentafluoroethane 51.2% (502)	$CHClF_2$ / $CClF_2CF_3$	300	150
Monochlorotrifluoromethane (13)	$CClF_3$	685*	685*
Octafluorocyclobutane (C318)	C_4F_8	130	70
Propane (290)	C_3H_8	300	150
Sulphur dioxide (764)	SO_2	170	85
Trichloromonofluoromethane (11)	CCl_3F	20	20
Trichlorotrifluoroethane (113)	$C_2Cl_3F_3$	20	20

*Critical pressure is 561 psia at critical temp of 83.9 F. (See Note (1) above).

Notes: (1) For refrigerants not listed in table 6, the test pressure for the high pressure side shall be not less than the saturated vapor pressure of the refrigerant at 150 F. The test pressure for the low pressure side shall be not less than the saturated vapor pressure of the refrigerant at 110 F. However, the test pressure for either the high or low side need not exceed 125% of the critical pressure of the refrigerant. In no case shall the test pressure be less than 30 psig.

(2) When a compressor is used as a booster to obtain a low pressure and discharges into the suction line of another system, the booster compressor is considered a part of the low side, and values listed under the low side column in table 6 shall be used for both high and low side of the booster compressor provided that a low pressure stage compressor of the positive displacement type shall have a pressure-relief valve.

(3) In field testing systems using non-positive displacement compressors, the entire system shall be considered for field test purposes as the low side pressure.

(a) The means used to build up the test pressure shall have either a pressure limiting device or a pressure reducing device and a gauge on the outlet side.

* Critical pressure is 561 psia at critical temperature of 83.9 F. (See note (1) above)

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63; am. Table 6, Register, December, 1965, No. 120, eff. 1-1-66.

SIGNS—SAFETY MASKS—AND SPECIAL RULES

Ind 45.151 Signs. (1) Systems containing more than 100 pounds of refrigerant other than self-contained or unit type having a capacity of 100 H.P., 100 tons, or 100 Kva or more shall be provided with metal signs having letters not less than ½" in height designating the main shutoff valves to each vessel, main steam or electrical control, remote control switch, and pressure-limiting device. On all exposed high pressure and low pressure piping in each room where installed outside the machinery room, shall be signs, as specified above, with the name of the refrigerant and the letters "HP" or "LP".

(a) Each refrigerating system shall be provided with a legible metal sign indicating thereon the kind of refrigerant in use. The sign shall be permanently attached to the compressor, or at the liquid receiver or charging valve. If these locations are not within sight of each other, such a sign shall be attached at each location.

(b) When the kind of refrigerant is changed as provided in Wis. Adm. Code section Ind 45.157 there shall be a new sign, of the same type as specified in subsection (1), indicating clearly that a substitution has been made, and stating the same information for the new refrigerant as was stated in the original.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63; am. (1) (b), Register, December, 1965, No. 120, eff. 1-1-66.

Ind 45.154 Charging and discharging refrigerants. (1) When refrigerant is added to a system, except a unit system requiring less than 6 pounds of refrigerant it shall be charged into the low pressure side of the system. Any point on the downstream side of the main liquid line stop valve shall be considered as part of the low pressure side when operating with said stop valve in the closed position. No service container shall be left connected to a system except while charging or withdrawing refrigerant.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63.

Ind 45.155 Refrigerants withdrawn from refrigerating systems. Refrigerants withdrawn from refrigerating systems shall be transferred to approved containers only. No refrigerant shall be discharged to a sewer.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63.

Ind 45.156 Containers used for refrigerants withdrawn from a refrigerating system. Containers used for refrigerants withdrawn from a refrigerating system shall be carefully weighed each time they are used for this purpose, and the containers shall not be filled in excess of the permissible filling weight for such containers and such refrigerants as are prescribed in pertinent regulations.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63.

Ind 45.157 Substitution of kind of refrigerant. Substitution of kind of refrigerant in a system shall not be made without the permission of the approving authority, the user, and the makers of the original equipment, and due observance of safety requirements, including:

(a) The effects of the substituted refrigerant on materials in the system;

(b) The possibility of overloading the liquid receiver which should not be more than 80% full of liquid;

(c) The liability of exceeding motor horsepower, design working pressure, or any other element that would violate any of the provisions of this code;

(d) The proper size of refrigerant controls;

(e) The effect on the operation and setting of safety devices;

(f) The possible hazards created by mixture of the original and the substituted refrigerant;

(g) Effect of the classification of the refrigerant as provided in this standard.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.158 Refrigerant stored in a machinery room. Refrigerant stored in a machinery room shall be not more than 20% of the normal refrigerant charged nor more than 300 pounds of the refrigerant, in addition to the charge in the system and the refrigerant stored in a permanently attached receiver, and then only in approved storage containers.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.159 Masks or helmets. (1) One mask or helmet shall be provided at a location convenient to the machinery room when an amount of a group 2 refrigerant between 100 and 1000 pounds, inclusive, is employed. If more than 1000 pounds of group 2 refrigerant are employed, at least 2 masks or helmets shall be provided.

(2) Masks or helmets shall be a type acceptable to the industrial commission for the refrigerant employed. They shall be kept in a suitable cabinet immediately outside the machinery room or other approved accessible location. They shall be maintained in a usable condition.

(3) For each safety mask there shall be available a spare canister or cartridge. Canisters and cartridges shall be renewed immediately after having been used.

(4) Canisters and cartridges shall be marked indelibly by the manufacturer with an expiration date and shall not be kept in use or used after that date.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

MAINTENANCE—RESPONSIBILITY

Ind 45.16 Maintenance. All refrigerating systems shall be maintained by the user in a clean condition, free from accumulations of oily dirt, waste, and other debris, and shall be kept readily accessible at all times.

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63.

Ind 45.17 Responsibility as to operation of the system. (1) It shall be the duty of the person in charge of the premises on which a refrigerating system containing more than 50 pounds of refrigerant is installed, to place a card conspicuously as near as practicable to the

refrigerant compressor giving directions for the operation of the system, including precautions to be observed in case of a breakdown or leak as follows:

(a) Instruction for shutting down the system in case of emergency;

(b) The name, address, and day and night telephone numbers for obtaining services.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63.

Ind 45.18 Pressure gauges. Pressure gauges shall be checked for accuracy prior to test and immediately after every occasion of unusually high pressure, equal to full scale reading either by comparison with master gauges or by setting the pointer as determined by a dead weight pressure gauge tester.

History: Cr. Register, March, 1963, No. 87, eff. 4-1-63.

REGISTRATION

Ind 45.20 Registration. (1) Mechanical refrigeration systems of the following classifications shall be *registered* with the industrial commission *within a 60-day period following completion:*

(a) Any system using a group 1 refrigerant and having an aggregate capacity rated at or greater than 25 tons, 25 Kva, or 25 H.P.

(b) Any system using group 2 or group 3 refrigerants and having an aggregate capacity rated at, or greater than 10 H.P., 10 tons, or 10 Kva.

(2) Registration information shall be submitted on form SB-34 obtainable from the industrial commission, or on an 8½ x 11 facsimile of that form reproduced below.

(3) Registration forms (SB-34) shall be completed according to the instructions appearing on the form and shall be filed by the installing contractor in behalf of the owner.

SB-34

MECHANICAL REFRIGERATION INSTALLATION REGISTRATION
Prepare in triplicate.

State of Wisconsin
Industrial Commission
Industrial Safety and Buildings Division

Send original to Industrial Commission, Hill Farms State Office Building, P.O. Box 2209, Madison 53702. Send copy to owner. Keep one copy. POST it conspicuously.

User or Owner	Location of Installation
Address of User or Owner	
Type of System ☐ Remote ☐ Self-Contained ☐ Direct Expansion ☐ Indirect ☐ Other (Specify)	
Use ☐ Air Conditioning ☐ Manufacturing or Storage ☐ Recreational	
Description Capacity Tons_____ KVA_____ HP_____	Refrigerant _____
Installing Contractor	
Date Installation Completed	
By (Signature)	Title

Wis. Adm. Code, section Ind 45.20 (Mechanical Refrigeration) provides that:

1. Mechanical Refrigeration Systems of the following classification shall be registered with the Industrial Commission within a 60-day period following completion:

(a) Any system using a group 1 refrigerant and having an aggregate capacity rated at, or greater than 25 tons, 25 KVA, or 25 HP.

(b) Any system using group 2 or group 3 refrigerants and having an aggregate capacity rated at or greater than 10 HP, 10 tons, or 10 KVA.

DESIGNATION OF REFRIGERANTS

ASHRAE Standard Refrigerant Designation	Chemical Name	Chemical Formula
Halocarbon Compounds		
10	Carbontetrachloride	CCl_4
11	Trichloromonofluoromethane	CCl_3F
12	Dichlorodifluoromethane	CCl_2F_2
13	Monochlorotrifluoromethane	$CClF_3$
13B1	Monobromotrifluoromethane	$CBrF_3$
14	Carbontetrafluoride	CF_4
20	Chloroform	$CHCl_3$
21	Dichloromonofluoromethane	$CHCl_2F$
22	Monochlorodifluoromethane	$CHClF_2$
23	Trifluoromethane	CHF_3
30	Methylene Chloride	CH_2Cl_2
31	Monochloromonofluoromethane	CH_2ClF
32	Methylene fluoride	CH_2F_2
40	Methyl chloride	CH_3Cl
41	Methyl fluoride	CH_3F
50	Methane	CH_4
110	Hexachloroethane	CCl_3CCl_3
111	Pentachloromonofluoroethane	CCl_3CCl_2F
112	Tetrachlorodifluoroethane	CCl_2FCCl_2F
112a	Tetrachlorodifluoroethane	CCl_3CClF_2
113	Trichlorotrifluoroethane	CCl_2FCClF_2
113a	Trichlorotrifluoroethane	CCl_3CF_3
114	Dichlorotetrafluoroethane	$CClF_2CClF_2$
114a	Dichlorotetrafluoroethane	CCl_2FCF_3
114B2	Dibromotetrafluoroethane	$CBrF_2CBrF_2$
115	Monochloropentafluoroethane	$CClF_2CF_3$
116	Hexafluoroethane	CF_3CF_3
120	Pentachloroethane	$CHCl_2CCl_3$
123	Dichlorotrifluoroethane	$CHCl_2CF_3$
124	Monochlorotetrafluoroethane	$CHClFCF_3$
124a	Monochlorotetrafluoroethane	CHF_2CClF_2
125	Pentafluoroethane	CHF_2CF_3
133a	Monochlorotrifluoroethane	CH_2ClCF_3
140a	Trichloroethane	CH_3CCl_3
142b	Monochlorodifluoroethane	CH_3CClF_2
143a	Trifluoroethane	CH_3CF_3
150a	Dichloroethane	CH_3CHCl_2
152a	Difluoroethane	CH_3CHF_2
160	Ethyl chloride	CH_3CH_2Cl
170	Ethane	CH_3CH_3
218	Octafluoropropane	$CF_3CF_2CF_3$
290	Propane	$CH_3CH_2CH_3$
Cyclic Organic Compounds		
C316	Dichlorohexafluorocyclobutane	$C_4Cl_2F_6$
C317	Monochloroheptafluorocyclobutane	C_4ClF_7
C318	Octafluorocyclobutane	C_4F_8
Azeotropes		
500	Refrigerants 12/152a73.8/26.2 wt%*	CCl_2F_2/CH_3CHF_2
501	Refrigerants 22/1273/25 wt%	$CHClF_2/CCl_2F_2$
502	Refrigerants 22/115 48.8/51.2 wt%	$CHClF_2/CClF_2CF_3$

ASHRAE Standard Refrigerant Designation	Chemical Name	Chemical Formula
Miscellaneous Organic Compounds		
Hydrocarbons		
50	Methane	CH_4
170	Ethane	CH_2CH_3
290	Propane	$CH_3CH_2CH_3$
600	Butane	$CH_3CH_2CH_2CH_3$
601	Isobutane	$CH(CH_3)_3$
{1150	Ethylene	$CH_2=CH_2$
{1270	Propylene	$CH_3CH=CH_2$
Oxygen Compounds		
610	Ethyl ether	$C_2H_5OC_2H_5$
611	Methyl formate	$HCOOCH_3$
Sulphur Compounds		
620		
Nitrogen Compounds		
630	Methyl amine	CH_3NH_2
631	Ethyl amine	$C_2H_5NH_2$
Inorganic Compounds		
717	Ammonia	NH_3
718	Water	H_2O
729	Water	
744	Carbon dioxide	CO_2
744A	Nitrous oxide	N_2O
764	Sulphur dioxide	SO_2
Unsaturated Organic Compounds		
112a	Dichlorodifluoroethylene	$CCl_2=CF_2$
1113	Monochlorotrifluoroethylene	$CClF=CF_2$
1114	Tetrafluoroethylene	$CF_2=CF_2$
1120	Trichloroethylene	$CHCl=CCl_2$
1130	Dichloroethylene	$CHCl=CHCl$
1132a	Vinylidene fluoride	$CH_2=CF_2$
1140	Vinyl chloride	$CH_2=CHCl$
1141	Vinyl fluoride	$CH_2=CHF$
1150	Ethylene	$CH_2=CH_2$
1270	Propylene	$CH_3CH=CH_2$

*Carrier Corp. Document 2-D-127, p. 1.

TABLE 7.—LENGTH OF DISCHARGE PIPING FOR RELIEF VALVES OR RUPTURE MEMBERS OF VARIOUS DISCHARGE CAPACITIES

Equiv. length of discharge pipe, ft. (L)	Discharge capacity in lb. of air per min. (C) Standard wall iron pipe sizes, in.							
	½	¾	1	1¼	1½	2	2½	3
	RELIEF DEVICE SET AT 25 PSIA (P_1)							
50	0.81	1.6	2.9	5.9	8.7	16.3	25.3	43.8
75	0.67	1.4	2.4	4.9	7.2	13.3	20.9	35.8
100	0.58	1.2	2.1	4.2	6.2	11.5	18.0	30.9
150	0.47	0.95	1.7	3.4	5.0	9.4	14.6	25.3
200	0.41	0.8	1.5	2.9	4.4	8.1	12.6	21.8
300	0.33	0.67	1.2	2.4	3.6	6.6	10.5	17.9
	RELIEF DEVICE SET AT 50 PSIA (P_1)							
50	1.6	3.3	5.9	11.9	17.4	32.5	50.6	87.6
75	1.3	2.7	4.9	9.7	14.3	26.5	41.8	71.5
100	1.2	2.3	4.2	8.4	12.3	23.0	36.0	61.7
150	0.94	1.9	3.5	6.9	10.0	18.7	29.2	50.6
200	0.81	1.6	2.9	5.9	8.7	16.3	25.3	43.7
300	0.66	1.3	2.5	4.9	7.1	13.3	21.0	35.7
	RELIEF DEVICE SET AT 75 PSIA (P_1)							
50	2.4	4.9	8.9	17.9	26.1	48.7	75.9	131.5
75	2.0	4.1	7.3	14.6	21.4	39.8	62.6	107.0
100	1.7	3.5	6.4	12.6	18.5	34.4	54.0	92.6
150	1.4	2.8	5.2	10.3	15.0	28.0	43.8	75.9
200	1.2	2.5	4.4	8.9	13.1	24.4	37.9	65.6
300	0.9	2.0	3.7	7.3	10.7	19.9	31.5	53.5
	RELIEF DEVICE SET AT 100 PSIA (P_1)							
50	3.2	6.6	11.9	23.8	34.8	65.0	101.2	175.2
75	2.7	5.4	9.7	19.4	28.6	53.0	83.6	143.0
100	2.3	4.6	8.5	16.8	24.6	45.9	72.0	123.6
150	1.9	3.8	6.9	13.7	20.0	37.4	58.4	101.2
200	1.6	3.3	5.9	11.9	17.5	32.5	50.6	87.6
300	1.3	2.7	4.9	9.7	14.2	26.5	42.0	71.4
	RELIEF DEVICE SET AT 150 PSIA (P_1)							
50	4.9	9.9	17.9	35.7	52.3	97.5	151.8	262.8
75	4.0	8.1	14.6	29.2	42.9	79.5	125.4	214.5
100	3.5	6.9	12.7	25.2	36.9	68.9	108.0	185.4
150	2.8	5.7	10.4	20.6	30.0	56.1	87.6	151.8
200	2.4	4.9	8.9	17.8	26.2	48.7	75.9	131.4
300	1.9	4.0	7.4	14.6	21.1	39.7	63.0	107.1
	RELIEF DEVICE SET AT 200 PSIA (P_1)							
50	6.5	13.2	23.8	47.6	69.7	130.0	202.4	350.4
75	5.3	10.8	19.4	38.9	57.2	106.0	167.2	286.0
100	4.6	9.2	16.9	33.6	49.2	91.8	144.0	247.2
150	3.8	7.6	13.8	27.4	40.0	74.8	116.8	202.4
200	3.2	6.5	11.8	23.8	34.9	64.9	101.2	175.2
300	2.6	5.3	9.8	19.4	28.4	52.9	84.0	142.8
	RELIEF DEVICE SET AT 250 PSIA (P_1)							
50	8.1	16.5	29.8	59.5	87.1	162.5	253.0	437.0
75	6.7	13.5	24.3	48.6	71.5	132.5	209.0	357.5
100	5.8	11.6	21.2	42.0	61.6	114.8	180.0	309.0
150	4.7	9.5	17.3	34.3	50.0	93.5	146.0	253.0
200	4.1	8.2	14.8	29.7	43.7	81.2	126.5	219.0
300	3.3	6.7	12.3	24.3	35.5	66.2	105.0	178.5
	RELIEF DEVICE SET AT 300 PSIA (P_1)							
50	9.7	19.8	35.7	71.4	104.5	195.0	303.6	525.6
75	7.9	16.2	29.1	58.3	85.8	159.0	250.8	429.0
100	6.9	13.9	25.4	50.4	73.9	137.7	216.0	370.8
150	5.6	11.3	20.7	41.1	60.0	112.2	175.2	303.6
200	4.9	9.8	17.8	35.6	52.4	97.4	151.8	262.8
300	3.9	7.9	14.7	29.1	42.6	79.4	126.0	214.2

History: Cr. Register, March, 1963, No. 87, eff. 4–1–63; am. table, Designation of Refrigerants, Register, December, 1965, No. 120, eff. 1–1–66.

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