

# CHAPTER 11

## REFRIGERATION

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**User note:**

**About this chapter:** Chapter 11 provides for the protection of life and property from the potential fire and health hazards associated with refrigerant chemicals and the machinery that contains such chemicals. Some refrigerants are toxic, some are flammable and some are both. This chapter refers to the International Fire Code<sup>®</sup>, ASHRAE 15 and IAR standards 2 through 5.

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### SECTION 1101 GENERAL

**[S] 1101.1 Scope.** This chapter shall govern the design, installation, construction and repair of refrigeration systems that vaporize and liquefy a fluid during the refrigerating cycle. Refrigerant piping design and installation, including pressure vessels and pressure relief devices, shall conform to this code and the Seattle Boiler and Pressure Vessel Code. Permanently installed refrigerant storage systems and other components shall be considered as part of the refrigeration system to which they are attached.

**1101.2 Factory-built equipment and appliances.** *Listed* and *labeled* self-contained, factory-built *equipment* and appliances shall be tested in accordance with UL 207, 412, 471 or 1995. Such *equipment* and appliances are deemed to meet the design, manufacture and factory test requirements of this code if installed in accordance with their listing and the manufacturer's instructions.

**1101.3 Protection.** Any portion of a refrigeration system that is subject to physical damage shall be protected in an *approved* manner.

**[S] 1101.4 Water connection.** Water supply and discharge connections associated with refrigeration systems shall be made in accordance with this code and the (~~International~~) Uniform Plumbing Code.

**1101.5 Fuel gas connection.** Fuel gas devices, *equipment* and appliances used with refrigeration systems shall be installed in accordance with the *International Fuel Gas Code*.

**1101.6 General.** Refrigeration systems shall comply with the requirements of this code and, except as modified by this code, ASHRAE 15. Ammonia-refrigerating systems shall comply with this code and, except as modified by this code, ASHRAE 15, IAR 2, IAR 3, IAR 4 and IAR 5.

**1101.7 Maintenance.** Mechanical refrigeration systems shall be maintained in proper operating condition, free from accumulations of oil, dirt, waste, excessive corrosion, other debris and leaks.

**1101.8 Change in refrigerant type.** The type of refrigerant in refrigeration systems having a refrigerant circuit containing more than 220 pounds (99.8 kg) of Group A1 or 30 pounds (13.6 kg) of any other group refrigerant shall not be changed without prior notification to the code official and compliance with the applicable code provisions for the new refrigerant type.

**[F] 1101.9 Refrigerant discharge.** Notification of refrigerant discharge shall be provided in accordance with the *International Fire Code*.

**1101.10 Locking access port caps.** Refrigerant circuit access ports located outdoors shall be fitted with locking-type tamper-resistant caps or shall be otherwise secured to prevent unauthorized access.

**Exception:** This section shall not apply to refrigerant circuit access ports on equipment installed in controlled areas such as on roofs with locked access hatches or doors.

### SECTION 1102 SYSTEM REQUIREMENTS

**1102.1 General.** The system classification, allowable refrigerants, maximum quantity, enclosure requirements, location limitations, and field pressure test requirements shall be determined as follows:

1. Determine the refrigeration system's classification, in accordance with Section 1103.3.
2. Determine the refrigerant classification in accordance with Section 1103.1.
3. Determine the maximum allowable quantity of refrigerant in accordance with Section 1104, based on type of refrigerant, system classification and *occupancy*.
4. Determine the system enclosure requirements in accordance with Section 1104.
5. Refrigeration *equipment* and *appliance* location and installation shall be subject to the limitations of Chapter 3.

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6. Nonfactory-tested, field-erected *equipment* and appliances shall be pressure tested in accordance with Section 1108.

**1102.2 Refrigerants.** The refrigerant shall be that which the *equipment* or *appliance* was designed to utilize or converted to utilize. Refrigerants not identified in Table 1103.1 shall be *approved* before use.

**1102.2.1 Mixing.** Refrigerants, including refrigerant blends, with different designations in ASHRAE 34 shall not be mixed in a system.

**Exception:** Addition of a second refrigerant is allowed where permitted by the *equipment* or *appliance* manufacturer to improve oil return at low temperatures. The refrigerant and amount added shall be in accordance with the manufacturer's instructions.

**1102.2.2 Purity.** Refrigerants used in refrigeration systems shall be new, recovered or *reclaimed refrigerants* in accordance with Section 1102.2.2.1, 1102.2.2.2 or 1102.2.2.3. Where required by the *equipment* or *appliance* owner or the code official, the installer shall furnish a signed declaration that the refrigerant used meets the requirements of Section 1102.2.2.1, 1102.2.2.2 or 1102.2.2.3.

**Exception:** The refrigerant used shall meet the purity specifications set by the manufacturer of the *equipment* or *appliance* in which such refrigerant is used where such specifications are different from that specified in Sections 1102.2.2.1, 1102.2.2.2 and 1102.2.2.3.

**1102.2.2.1 New refrigerants.** Refrigerants shall be of a purity level specified by the *equipment* or *appliance* manufacturer.

**1102.2.2.2 Recovered refrigerants.** Refrigerants that are recovered from refrigeration and air-conditioning systems shall not be reused in other than the system from which they were recovered and in other systems of the same owner. *Recovered refrigerants* shall be filtered and dried before reuse. *Recovered refrigerants* that show clear signs of contamination shall not be reused unless reclaimed in accordance with Section 1102.2.2.3.

**1102.2.2.3 Reclaimed refrigerants.** Used refrigerants shall not be reused in a different owner's *equipment* or appliances unless tested and found to meet the purity requirements of AHRI 700. Contaminated refrigerants shall not be used unless reclaimed and found to meet the purity requirements of AHRI 700.

**1102.3 Access port protection.** Refrigerant access ports shall be protected in accordance with Section 1101.10 whenever refrigerant is added to or recovered from refrigeration or air-conditioning systems.

### SECTION 1103 REFRIGERATION SYSTEM CLASSIFICATION

**1103.1 Refrigerant classification.** Refrigerants shall be classified in accordance with ASHRAE 34 as listed in Table 1103.1.

**TABLE 1103.1  
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL**

CHEMICAL REFRIGERANT	FORMULA	CHEMICAL NAME OF BLEND	REFRIGERANT CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE				[F] DEGREES OF HAZARD <sup>a</sup>
				Pounds per 1,000 cubic feet	ppm	g/m <sup>3</sup>	OEL <sup>e</sup>	
R-11 <sup>d</sup>	CCl <sub>3</sub> F	trichlorofluoromethane	A1	0.39	1,100	6.2	C1,000	2-0-0 <sup>b</sup>
R-12 <sup>d</sup>	CCl <sub>2</sub> F <sub>2</sub>	dichlorodifluoromethane	A1	5.6	18,000	90	1,000	2-0-0 <sup>b</sup>
R-13 <sup>d</sup>	CClF <sub>3</sub>	chlorotrifluoromethane	A1	—	—	—	1,000	2-0-0 <sup>b</sup>
R-13B1 <sup>d</sup>	CBrF <sub>3</sub>	bromotrifluoromethane	A1	—	—	—	1,000	2-0-0 <sup>b</sup>
R-14	CF <sub>4</sub>	tetrafluoromethane (carbon tetrafluoride)	A1	25	110,000	400	1,000	2-0-0 <sup>b</sup>
R-22	CHClF <sub>2</sub>	chlorodifluoromethane	A1	13	59,000	210	1,000	2-0-0 <sup>b</sup>
R-23	CHF <sub>3</sub>	trifluoromethane (fluoroform)	A1	7.3	41,000	120	1,000	2-0-0 <sup>b</sup>
R-30	CH <sub>2</sub> Cl <sub>2</sub>	dichloromethane (methylene chloride)	B1	—	—	—	—	—
R-32	CH <sub>2</sub> F <sub>2</sub>	difluoromethane (methylene fluoride)	A2 <sup>f</sup>	4.8	36,000	77	1,000	1-4-0
R-40	CH <sub>3</sub> Cl	chloromethane (methyl chloride)	B2	—	—	—	—	—
R-50	CH <sub>4</sub>	methane	A3	—	—	—	1,000	—
R-113 <sup>d</sup>	CCl <sub>2</sub> FCClF <sub>2</sub>	1,1,2-trichloro-1,1,2,2-trifluoroethane	A1	1.2	2,600	20	1,000	2-0-0 <sup>b</sup>
R-114 <sup>d</sup>	CClF <sub>2</sub> CClF <sub>2</sub>	1,2-dichloro-1,1,2,2-tetrafluoroethane	A1	8.7	20,000	140	1,000	2-0-0 <sup>b</sup>
R-115	CClF <sub>2</sub> CF <sub>3</sub>	chloropentafluoroethane	A1	47	120,000	760	1,000	—
R-116	CF <sub>3</sub> CF <sub>3</sub>	hexafluoroethane	A1	34	97,000	550	1,000	1-0-0
R-123	CHCl <sub>2</sub> CF <sub>3</sub>	2,2-dichloro-1,1,1-trifluoroethane	B1	3.5	9,100	57	50	2-0-0 <sup>b</sup>
R-124	CHClFCF <sub>3</sub>	2-chloro-1,1,1,2-tetrafluoroethane	A1	3.5	10,000	56	1,000	2-0-0 <sup>b</sup>
R-125	CHF <sub>2</sub> CF <sub>3</sub>	pentafluoroethane	A1	23	75,000	370	1,000	2-0-0 <sup>b</sup>
R-134a	CH <sub>2</sub> FCF <sub>3</sub>	1,1,1,2-tetrafluoroethane	A1	13	50,000	210	1,000	2-0-0 <sup>b</sup>
R-141b	CH <sub>3</sub> CCl <sub>2</sub> F	1,1-dichloro-1-fluoroethane	—	0.78	2,600	12	500	2-1-0
R-142b	CH <sub>3</sub> CClF <sub>2</sub>	1-chloro-1,1-difluoroethane	A2	5.1	20,000	83	1,000	2-4-0
R-143a	CH <sub>3</sub> CF <sub>3</sub>	1,1,1-trifluoroethane	A2 <sup>f</sup>	4.5	21,000	70	1,000	2-0-0 <sup>b</sup>
R-152a	CH <sub>3</sub> CHF <sub>2</sub>	1,1-difluoroethane	A2	2.0	12,000	32	1,000	1-4-0
R-170	CH <sub>3</sub> CH <sub>3</sub>	ethane	A3	0.54	7,000	8.7	1,000	2-4-0
R-E170	CH <sub>3</sub> OCH <sub>3</sub>	Methoxymethane (dimethyl ether)	A3	1.0	8,500	16	1,000	—
R-218	CF <sub>3</sub> CF <sub>2</sub> CF <sub>3</sub>	octafluoropropane	A1	43	90,000	690	1,000	2-0-0 <sup>b</sup>
R-227ea	CF <sub>3</sub> CHF <sub>2</sub> CF <sub>3</sub>	1,1,1,2,3,3,3-heptafluoropropane	A1	36	84,000	580	1,000	—
R-236fa	CF <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub>	1,1,1,3,3,3-hexafluoropropane	A1	21	55,000	340	1,000	2-0-0 <sup>b</sup>
R-245fa	CHF <sub>2</sub> CH <sub>2</sub> CF <sub>3</sub>	1,1,1,3,3-pentafluoropropane	B1	12	34,000	190	300	2-0-0 <sup>b</sup>
R-290	CH <sub>3</sub> CH <sub>2</sub> CH <sub>3</sub>	propane	A3	0.56	5,300	9.5	1,000	2-4-0
R-C318	-(CF <sub>2</sub> ) <sub>4</sub> -	octafluorocyclobutane	A1	41	80,000	660	1,000	—
R-400 <sup>d</sup>	zeotrope	R-12/114 (50.0/50.0)	A1	10	28,000	160	1,000	2-0-0 <sup>b</sup>
R-400 <sup>d</sup>	zeotrope	R-12/114 (60.0/40.0)	A1	11	30,000	170	1,000	—
R-401A	zeotrope	R-22/152a/124 (53.0/13.0/34.0)	A1	6.6	27,000	110	1,000	2-0-0 <sup>b</sup>
R-401B	zeotrope	R-22/152a/124 (61.0/11.0/28.0)	A1	7.2	30,000	120	1,000	2-0-0 <sup>b</sup>

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TABLE 1103.1—continued  
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

CHEMICAL REFRIGERANT	FORMULA	CHEMICAL NAME OF BLEND	REFRIGERANT CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE				[F] DEGREES OF HAZARD <sup>b</sup>
				Pounds per 1,000 cubic feet	ppm	g/m <sup>3</sup>	OEL <sup>e</sup>	
R-401C	zeotrope	R-22/152a/124 (33.0/15.0/52.0)	A1	5.2	20,000	84	1,000	2-0-0 <sup>b</sup>
R-402A	zeotrope	R-125/290/22 (60.0/2.0/38.0)	A1	17	66,000	270	1,000	2-0-0 <sup>b</sup>
R-402B	zeotrope	R-125/290/22 (38.0/2.0/60.0)	A1	15	63,000	240	1,000	2-0-0 <sup>b</sup>
R-403A	zeotrope	R-290/22/218 (5.0/75.0/20.0)	A2	7.6	33,000	120	1,000	2-0-0 <sup>b</sup>
R-403B	zeotrope	R-290/22/218 (5.0/56.0/39.0)	A1	18	70,000	290	1,000	2-0-0 <sup>b</sup>
R-404A	zeotrope	R-125/143a/134a (44.0/52.0/4.0)	A1	31	130,000	500	1,000	2-0-0 <sup>b</sup>
R-405A	zeotrope	R-22/152a/142b/C318 (45.0/7.0/5.5/2.5)	—	16	57,000	260	1,000	—
R-406A	zeotrope	R-22/600a/142b (55.0/4.0/41.0)	A2	4.7	21,000	25	1,000	—
R-407A	zeotrope	R-32/125/134a (20.0/40.0/40.0)	A1	19	83,000	300	1,000	2-0-0 <sup>b</sup>
R-407B	zeotrope	R-32/125/134a (10.0/70.0/20.0)	A1	21	79,000	330	1,000	2-0-0 <sup>b</sup>
R-407C	zeotrope	R-32/125/134a (23.0/25.0/52.0)	A1	18	81,000	290	1,000	2-0-0 <sup>b</sup>
R-407D	zeotrope	R-32/125/134a (15.0/15.0/70.0)	A1	16	68,000	250	1,000	2-0-0 <sup>b</sup>
R-407E	zeotrope	R-32/125/134a (25.0/15.0/60.0)	A1	17	80,000	280	1,000	2-0-0 <sup>b</sup>
R-407F	zeotrope	R-32/125/134a (30.0/30.0/40.0)	A1	20	95,000	320	1,000	—
R-408A	zeotrope	R-125/143a/22 (7.0/46.0/47.0)	A1	21	95,000	340	1,000	2-0-0 <sup>b</sup>
R-409A	zeotrope	R-22/124/142b (60.0/25.0/15.0)	A1	7.1	29,000	110	1,000	2-0-0 <sup>b</sup>
R-409B	zeotrope	R-22/124/142b (65.0/25.0/10.0)	A1	7.3	30,000	120	1,000	2-0-0 <sup>b</sup>
R-410A	zeotrope	R-32/125 (50.0/50.0)	A1	26	140,000	420	1,000	2-0-0 <sup>b</sup>
R-410B	zeotrope	R-32/125 (45.0/55.0)	A1	27	140,000	430	1,000	2-0-0 <sup>b</sup>
R-411A	zeotrope	R-127/22/152a (1.5/87.5/11.0)	A2	2.9	14,000	46	990	—
R-411B	zeotrope	R-1270/22/152a (3.0/94.0/3.0)	A2	2.8	13,000	45	980	—
R-412A	zeotrope	R-22/218/142b (70.0/5.0/25.0)	A2	5.1	22,000	82	1,000	—
R-413A	zeotrope	R-218/134a/600a (9.0/88.0/3.0)	A2	5.8	22,000	94	1,000	—
R-414A	zeotrope	R-22/124/600a/142b (51.0/28.5/4.0/16.5)	A1	6.4	26,000	100	1,000	—
R-414B	zeotrope	R-22/124/600a/142b (50.0/39.0/1.5/9.5)	A1	6.0	23,000	95	1,000	—
R-415A	zeotrope	R-22/152a (82.0/18.0)	A2	2.9	14,000	47	1,000	—
R-415B	zeotrope	R-22/152a (25.0/75.0)	A2	2.1	12,000	34	1,000	—
R-416A	zeotrope	R-134a/124/600 (59.0/39.5/1.5)	A1	3.9	14,000	62	1,000	2-0-0 <sup>b</sup>

TABLE 1103.1—continued  
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

CHEMICAL REFRIGERANT	FORMULA	CHEMICAL NAME OF BLEND	REFRIGERANT CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE				[F] DEGREES OF HAZARD <sup>a</sup>
				Pounds per 1,000 cubic feet	ppm	g/m <sup>3</sup>	OEL <sup>e</sup>	
R-417A	zeotrope	R-125/134a/600 (46.6/50.0/3.4)	A1	3.5	13,000	56	1,000	2-0-0 <sup>b</sup>
R-417B	zeotrope	R-125/134a/600 (79.0/18.3/2.7)	A1	4.3	15,000	70	1,000	—
R-417C	zeotrope	R-125/134a/600 (19.5/78.8/1.7)	A1	5.4	21,000	87	1,000	—
R-418A	zeotrope	R-290/22/152a (1.5/96.0/2.5)	A2	4.8	22,000	77	1,000	—
R-419A	zeotrope	R-125/134a/E170 (77.0/19.0/4.0)	A2	4.2	15,000	67	1,000	—
R-419B	zeotrope	R-125/134a/E170 (48.5/48.0/3.5)	A2	4.6	17,000	74	1,000	—
R-420A	zeotrope	R-134a/142b (88.0/12.0)	A1	12	45,000	190	1,000	2-0-0 <sup>b</sup>
R-421A	zeotrope	R-125/134a (58.0/42.0)	A1	17	61,000	280	1,000	2-0-0 <sup>b</sup>
R-421B	zeotrope	R-125/134a (85.0/15.0)	A1	21	69,000	330	1,000	2-0-0 <sup>b</sup>
R-422A	zeotrope	R-125/134a/600a (85.1/11.5/3.4)	A1	18	63,000	290	1,000	2-0-0 <sup>b</sup>
R-422B	zeotrope	R-125/134a/600a (55.0/42.0/3.0)	A1	16	56,000	250	1,000	2-0-0 <sup>b</sup>
R-422C	zeotrope	R-125/134a/600a (82.0/15.0/3.0)	A1	18	62,000	290	1,000	2-0-0 <sup>b</sup>
R-422D	zeotrope	R-125/134a/600a (65.1/31.5/3.4)	A1	16	58,000	260	1,000	2-0-0 <sup>b</sup>
R-422E	zeotrope	R-125/134a/600a (58.0/39.3/2.7)	A1	16	57,000	260	1,000	—
R-423A	zeotrope	R-134a/227ea (52.5/47.5)	A1	19	59,000	310	1,000	2-0-0 <sup>b</sup>
R-424A	zeotrope	R-125/134a/600a/600/601a (50.5/47.0/0.9/1.0/0.6)	A1	6.2	23,000	100	970	2-0-0 <sup>b</sup>
R-425A	zoetrope	R-32/134a/227ea (18.5/69.5/12.0)	A1	16	72,000	260	1,000	2-0-0 <sup>b</sup>
R-426A	zeotrope	R-125/134a/600a/601a (5.1/93.0/1.3/0.6)	A1	5.2	20,000	83	990	—
R-427A	zeotrope	R-32/125/143a/134a (15.0/25.0/10.0/50.0)	A1	18	79,000	290	1,000	2-1-0
R-428A	zeotrope	R-125/143a/290/600a (77.5/20.0/0.6/1.9)	A1	23	83,000	370	1,000	—
R-429A	zeotrope	R-E170/152a/600a (60.0/10.0/30.0)	A3	0.81	6,300	13	1,000	—
R-430A	zeotrope	R-152a/600a (76.0/24.0)	A3	1.3	8,000	21	1,000	—
R-431A	zeotrope	R-290/152a (71.0/29.0)	A3	0.69	5,500	11	1,000	—
R-432A	zeotrope	R-1270/E170 (80.0/20.0)	A3	0.13	1,200	2.1	700	—
R-433A	zeotrope	R-1270/290 (30.0/70.0)	A3	0.34	3,100	5.5	880	—
R-433B	zeotrope	R-1270/290 (5.0-95.0)	A3	0.51	4,500	8.1	950	—
R-433C	zeotrope	R-1270/290 (25.0-75.0)	A3	0.41	3,600	6.6	790	—
R-434A	zeotrope	R-125/143a/600a (63.2/18.0/16.0/2.8)	A1	20	73,000	320	1,000	—
R-435A	zeotrope	R-E170/152a (80.0/20.0)	A3	1.1	8,500	17	1,000	—
R-436A	zeotrope	R-290/600a (56.0/44.0)	A3	0.50	4,000	8.1	1,000	—
R-436B	zeotrope	R-290/600a (52.0/48.0)	A3	0.51	4,000	8.1	1,000	—
R-437A	zeotrope	R-125/134a/600/601 (19.5/78.5/1.4/0.6)	A1	5.0	19,000	82	990	—

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TABLE 1103.1—continued  
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

CHEMICAL REFRIGERANT	FORMULA	CHEMICAL NAME OF BLEND	REFRIGERANT CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE				[F] DEGREES OF HAZARD <sup>a</sup>
				Pounds per 1,000 cubic feet	ppm	g/m <sup>3</sup>	OEL <sup>e</sup>	
R-438A	zeotrope	R-32/125/134a/600/601a (8.5/45.0/44.2/1.7/0.6)	A1	4.9	20,000	79	990	—
R-439A	zeotrope	R-32/125/600a (50.0/47.0/3.0)	A2	4.7	26,000	76	990	—
R-440A	zeotrope	R-290/134a/152a (0.6/1.6/97.8)	A2	1.9	12,000	31	1,000	—
R-441A	zeotrope	R-170/290/600a/600 (3.1/54.8/6.0/36.1)	A3	0.39	3,200	6.3	1,000	—
R-442A	zeotrope	R-32/125/134a/152a/227ea (31.0/31.0/30.0/3.0/5.0)	A1	21	100,000	330	1,000	—
R-443A	zeotrope	R-1270/290/600a (55.0/40.0/5.0)	A3	0.19	1,700	3.1	580	—
R-444A	zeotrope	R-32/152a/1234ze(E) (12.0/5.0/83.0)	A2 <sup>f</sup>	5.1	21,000	81	850	—
R-444B	zeotrope	R-32/152a/1234ze(E) (41.5/10.0/48.5)	A2 <sup>f</sup>	4.3	23,000	69	890	—
R-445A	zeotrope	R-744/134a/1234ze(E) (6.0/9.0/85.0)	A2 <sup>f</sup>	4.2	16,000	67	930	—
R-446A	zeotrope	R-32/1234ze(E)/600 (68.0/29.0/3.0)	A2 <sup>f</sup>	2.5	16,000	39	960	—
R-447A	zeotrope	R-32/125/1234ze(E) (68.0/3.5/28.5)	A2 <sup>f</sup>	2.6	16,000	42	900	—
R-448A	zeotrope	R-32/125/1234yf/134a/1234ze(E) (26.0/26.0/20.0/21.0/7.0)	A1	24	110,000	390	890	—
R-449A	zeotrope	R-32/125/1234yf/134a (24.3/24.7/25.3/25.7)	A1	23	100,000	370	830	—
R-450A	zeotrope	R-134a/1234ze(E) (42.0/58.0)	A1	20	72,000	320	880	—
R-451A	zeotrope	R-1234yf/134a (89.8/10.2)	A2 <sup>f</sup>	5.3	18,000	81	520	—
R-451B	zeotrope	R-1234yf/134a (88.8/11.2)	A2 <sup>f</sup>	5.3	18,000	81	530	—
R-452A	zeotrope	R-32/125/1234yf (11.0/59.0/30.0)	A1	27	100,000	440	780	—
R-500 <sup>e</sup>	azeotrope	R-12/152a (73.8/26.2)	A1	7.6	30,000	120	1,000	2-0-0 <sup>b</sup>
R-501 <sup>d</sup>	azeotrope	R-22/12 (75.0/25.0)	A1	13	54,000	210	1,000	—
R-502 <sup>e</sup>	azeotrope	R-22/115 (48.8/51.2)	A1	21	73,000	330	1,000	2-0-0 <sup>b</sup>
R-503 <sup>e</sup>	azeotrope	R-23/13 (40.1/59.9)	—	—	—	—	1,000	2-0-0 <sup>b</sup>
R-504 <sup>d</sup>	azeotrope	R-32/115 (48.2/51.8)	—	28	140,000	450	1,000	—
R-507A	azeotrope	R-125/143a (50.0/50.0)	A1	32	130,000	520	1,000	2-0-0 <sup>b</sup>
R-508A	azeotrope	R-23/116 (39.0/61.0)	A1	14	55,000	220	1,000	2-0-0 <sup>b</sup>
R-508B	azeotrope	R-23/116 (46.0/54.0)	A1	13	52,000	200	1,000	2-0-0 <sup>b</sup>
R-509A	azeotrope	R-22/218 (44.0/56.0)	A1	24	75,000	390	1,000	2-0-0 <sup>b</sup>
R-510A	azeotrope	R-E170/600a (88.0/12.0)	A3	0.87	7,300	14	1,000	—
R-511A	azeotrope	R-290/E170 (95.0/5.0)	A3	0.59	5,300	9.5	1,000	—
R-512A	azeotrope	R-134a/152a (5.0/95.0)	A2	1.9	11,000	31	1,000	—
R-513A	azeotrope	R-1234yf/134a (56.0/44.0)	A1	20	72,000	320	650	—
R-600	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	butane	A3	0.15	1,000	2.4	1,000	1-4-0
R-600a	CH(CH <sub>3</sub> ) <sub>2</sub> CH <sub>3</sub>	2-methylpropane (isobutane)	A3	0.59	4,000	9.6	1,000	2-4-0
R-601	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	pentane	A3	0.18	1,000	2.9	600	—
R-601a	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> CH <sub>3</sub>	2-methylbutane (isopentane)	A3	0.18	1,000	2.9	600	—
R-610	ethoxyethane (ethyl ether)	CH <sub>3</sub> CH <sub>2</sub> OCH <sub>2</sub> CH <sub>3</sub>	—	—	—	—	400	—

TABLE 1103.1—continued  
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

CHEMICAL REFRIGERANT	FORMULA	CHEMICAL NAME OF BLEND	REFRIGERANT CLASSIFICATION	AMOUNT OF REFRIGERANT PER OCCUPIED SPACE				[F] DEGREES OF HAZARD <sup>a</sup>
				Pounds per 1,000 cubic feet	ppm	g/m <sup>3</sup>	OEL <sup>e</sup>	
R-611	methyl formate	HCOOCH <sub>3</sub>	B2	—	—	—	100	—
R-717	NH <sub>3</sub>	ammonia	B2 <sup>f</sup>	0.014	320	0.22	25	3-3-0 <sup>c</sup>
R-718	H <sub>2</sub> O	water	A1	—	—	—	—	0-0-0
R-744	CO <sub>2</sub>	carbon dioxide	A1	4.5	40,000	72	5,000	2-0-0 <sup>b</sup>
R-1150	CH <sub>2</sub> =CH <sub>2</sub>	ethene (ethylene)	A3	—	—	—	200	1-4-2
R-1233zd(E)	CF <sub>3</sub> CH=CHCl	trans-1-chloro-3,3,3-trifluoro-1-propene	A1	5.3	16,000	85	800	—
R-1234yf	CF <sub>3</sub> CF=CH <sub>2</sub>	2,3,3,3-tetrafluoro-1 propene	A2 <sup>f</sup>	4.7	16,000	75	500	—
R-1234ze(E)	CF <sub>3</sub> CH=CHF	trans-1,3,3,3-tetrafluoro-1-propene	A2 <sup>f</sup>	4.7	16,000	75	800	—
R-1270	CH <sub>3</sub> CH=CH <sub>2</sub>	Propene (propylene)	A3	0.1	1,000	1.7	500	1-4-1

For SI: 1 pound = 0.454 kg, 1 cubic foot = 0.0283m<sup>3</sup>

a. Degrees of hazard are for health, fire, and reactivity, respectively, in accordance with NFPA 704.

b. Reduction to 1-0-0 is allowed if analysis satisfactory to the code official shows that the maximum concentration for a rupture or full loss of refrigerant charge would not exceed the IDLH, considering both the refrigerant quantity and room volume.

c. For installations that are entirely outdoors, use 3-1-0.

d. Class I ozone depleting substance; prohibited for new installations.

e. Occupational Exposure Limit based on the OSHA PEL, ACGIH TLV-TWA, the TERA WEEL or consistent value on a time-weighted average (TWA) basis (unless noted C for ceiling) for an 8 hr/d and 40 hr/wk.

f. The ASHRAE Standard 34 flammability classification for this refrigerant is 2L, which is a subclass of Class 2.

**1103.2 Occupancy classification.** Locations of refrigerating systems are described by *occupancy* classifications that consider the ability of people to respond to potential exposure to refrigerants. Where *equipment* or appliances, other than piping, are located outside a building and within 20 feet (6096 mm) of any building opening, such *equipment* or appliances shall be governed by the *occupancy* classification of the building. *Occupancy* classifications shall be defined as follows:

1. Institutional *occupancy* is that portion of premises from which occupants cannot readily leave without the assistance of others because they are disabled, debilitated or confined. Institutional occupancies include, among others, hospitals, nursing homes, asylums and spaces containing locked cells.
2. Public assembly *occupancy* is that portion of premises 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.
3. Residential *occupancy* is that portion of premises 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, multiunit apartments and private residences.
4. Commercial *occupancy* is that portion of premises 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.
5. Large mercantile *occupancy* is that portion of premises where more than 100 persons congregate on levels above or below street level to purchase personal merchandise.
6. Industrial *occupancy* is that portion of premises 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.
7. Mixed *occupancy* occurs where two or more occupancies are located within the same building. Where 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. Where the various occupancies are not so isolated, the *occupancy* having the most stringent requirements shall be the governing *occupancy*.

**1103.3 System classification.** Refrigeration systems shall be classified according to the degree of probability that refrigerant leaked 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.

**1103.3.1 Low-probability systems.** Double-indirect open-spray systems, indirect closed systems and indirect-vented closed systems shall be classified as low-probability systems, provided that all refrigerant-containing piping and fittings are isolated where the quantities in Table 1103.1 are exceeded.

**1103.3.2 High-probability systems.** Direct systems and indirect open-spray systems shall be classified as high-probability systems.

**Exception:** An indirect open-spray system shall not be required to be classified as a high-probability system if the pressure of the secondary coolant is at all times (operating and standby) greater than the pressure of the refrigerant.

## SECTION 1104 SYSTEM APPLICATION REQUIREMENTS

**1104.1 General.** The refrigerant, occupancy and system classification cited in this section shall be determined in accordance with Sections 1103.1, 1103.2 and 1103.3, respectively.

**1104.2 Machinery room.** Except as provided in Sections 1104.2.1 and 1104.2.2, all components containing the refrigerant shall be located either outdoors or in a *machinery room* where the quantity of refrigerant in an independent circuit of a system exceeds the amounts shown in Table 1103.1. For refrigerant blends not listed in Table 1103.1, the same requirement shall apply where the amount for any blend component exceeds that indicated in Table 1103.1 for that component. This requirement shall also apply where the combined amount of the blend components exceeds a limit of 69,100 parts per million (ppm) by volume. Machinery rooms required by this section shall be constructed and maintained in accordance with Section 1105 for Group A1 and B1 refrigerants and in accordance with Sections 1105 and 1106 for Group A2, B2, A3 and B3 refrigerants.

### Exceptions:

1. Machinery rooms are not required for *listed equipment* and appliances containing not more than 6.6 pounds (3 kg) of refrigerant, regardless of the refrigerant's safety classification, where installed in accordance with the equipment's or appliance's listing and the *equipment or appliance* manufacturer's installation instructions.
2. Piping in conformance with Section 1107 is allowed in other locations to connect components installed in a *machinery room* with those installed outdoors.

**1104.2.1 Institutional occupancies.** The amounts shown in Table 1103.1 shall be reduced by 50 percent for all areas of institutional occupancies except kitchens, laboratories and mortuaries. The total of all Group A2, B2, A3 and B3 refrigerants shall not exceed 550 pounds (250 kg) in occupied areas or machinery rooms.

**[S] 1104.2.2 Industrial occupancies and refrigerated rooms.** This section applies only to rooms and spaces that: are within industrial occupancies; contain a refrigerant evaporator; are maintained at temperatures below 68°F (20°C); and are used for manufacturing, food and beverage preparation, meat cutting, other processes and storage. Where a machinery room would otherwise be required by Section 1104.2, a machinery room shall not be required where all of the following conditions are met:

1. The space containing the machinery is separated from other occupancies by tight construction with tight-fitting doors.
2. Access is restricted to authorized personnel.
3. Refrigerant detectors are installed as required for machinery rooms in accordance with Section 1105.3.

### Exceptions:

1. Refrigerant detectors are not required in unoccupied areas that contain only continuous piping that does not include valves, valve assemblies, equipment, or equipment connections.
2. Where approved alternatives are provided, refrigerant detectors for ammonia refrigeration are not required for rooms or areas that are always occupied, and for rooms or areas that have high humidity or other harsh environmental conditions that are incompatible with detection devices.
4. Surfaces having temperatures exceeding 800°F (427°C) and open flames are not present where any Group A2, B2, A3 or B3 refrigerant is used (see Section 1104.3.4).
5. All electrical *equipment* and appliances conform to Class 1, Division 2, hazardous location classification requirements of ((NFPA-70)) *the Seattle Electrical Code* where the quantity of any Group A2, B2, A3 or B3 refrigerant, other than ammonia, in a single independent circuit would exceed 25 percent of the lower flammability limit (LFL) upon release to the space.
6. All refrigerant-containing parts in systems with a total connected compressor power exceeding 100 horsepower (hp) (74.6 kW)—except evaporators used for refrigeration or dehumidification, condensers used for heating, control and pressure relief valves for either, low-probability pumps and connecting piping—are located either outdoors or in a *machinery room*.

**1104.3 Refrigerant restrictions.** Refrigerant applications, maximum quantities and use shall be restricted in accordance with Sections 1104.3.1 through 1104.3.4.

**1104.3.1 Air-conditioning for human comfort.** In other than industrial occupancies where the quantity in a single independent circuit does not exceed the amount in Table 1103.1, Group B1, B2 and B3 refrigerants shall not be used in high-probability systems for air-conditioning for human comfort.



**1104.3.2 Nonindustrial occupancies.** Group A2 and B2 refrigerants shall not be used in high-probability systems where the quantity of refrigerant in any independent refrigerant circuit exceeds the amount shown in Table 1104.3.2. Group A3 and B3 refrigerants shall not be used except where *approved*.

**Exception:** This section does not apply to laboratories where the floor area per occupant is not less than 100 square feet (9.3 m<sup>2</sup>).

**TABLE 1104.3.2  
MAXIMUM PERMISSIBLE QUANTITIES OF REFRIGERANTS**

TYPE OF REFRIGERATION SYSTEM	MAXIMUM POUNDS FOR VARIOUS OCCUPANCIES			
	Institutional	Assembly	Residential	All other occupancies
<b>Sealed absorption system</b>				
In exit access	0	0	3.3	3.3
In adjacent outdoor locations	0	0	22	22
In other than exit access	0	6.6	6.6	6.6
<b>Unit systems</b>				
In other than exit access	0	0	6.6	6.6

For SI: 1 pound = 0.454 kg.

**1104.3.3 All occupancies.** The total of all Group A2, B2, A3 and B3 refrigerants other than R-717, ammonia, shall not exceed 1,100 pounds (499 kg) except where *approved*.

**1104.3.4 Protection from refrigerant decomposition.** Where any device having an open flame or surface temperature greater than 800°F (427°C) is used in a room containing more than 6.6 pounds (3 kg) of refrigerant in a single independent circuit, a hood and exhaust system shall be provided in accordance with Section 510. Such exhaust system shall exhaust *combustion* products to the outdoors.

**Exception:** A hood and exhaust system shall not be required where any of the following apply:

1. The refrigerant is R-717, R-718 or R-744.
2. The *combustion* air is ducted from the outdoors in a manner that prevents leaked refrigerant from being combusted.
3. A refrigerant detector is used to stop the *combustion* in the event of a refrigerant leak (see Sections 1105.3 and 1105.5).

**1104.4 Volume calculations.** Volume calculations shall be in accordance with Sections 1104.4.1 through 1104.4.3.

**1104.4.1 Noncommunicating spaces.** Where the refrigerant-containing parts of a system are located in one or more spaces that do not communicate through permanent openings or HVAC ducts, the volume of the smallest, enclosed occupied space shall be used to determine the permissible quantity of refrigerant in the system.

**1104.4.2 Communicating spaces.** Where an evaporator or condenser is located in an air duct system, the volume of the smallest, enclosed occupied space served by the duct system shall be used to determine the maximum allowable quantity of refrigerant in the system.

**Exception:** If airflow to any enclosed space cannot be reduced below one-quarter of its maximum, the entire space served by the air duct system shall be used to determine the maximum allowable quantity of refrigerant in the system.

**[S] 1104.4.3 Plenums.** Where the space above a suspended ceiling is continuous and part of the supply or return air *plenum* system, this space shall be included in calculating the volume of the enclosed space.

**Interpretation:** For variable refrigerant flow systems, the total allowable quantity of refrigerant in the system includes the refrigerant in the condensing unit, refrigerant controller, fan coil, and all associated piping.

## SECTION 1105 MACHINERY ROOM, GENERAL REQUIREMENTS

**[BF] 1105.1 Design and construction.** Machinery rooms shall be designed and constructed in accordance with the *International Building Code* and this section.

**1105.2 Openings.** Ducts and air handlers in the *machinery room* that operate at a lower pressure than the room shall be sealed to prevent any refrigerant leakage from entering the airstream.

**[S][F] 1105.3 Refrigerant ((~~detector~~)) detection system.** ~~((Refrigerant detectors in machinery rooms shall be provided as required by Sections 605.8 and 605.17 of the *International Fire Code*.)~~ Refrigeration machinery rooms shall contain a refrigerant detection system with an audible and visual alarm. The detector, or a sampling tube that draws air to the detector, shall be located in an area where refrigerant from a leak will concentrate. The alarm shall be actuated at a value not greater than the corresponding TLV-TWA values shown in this code for the refrigerant classification. Detectors and alarms shall be placed in *approved* locations. The detectors shall transmit a signal to an *approved* location.

## REFRIGERATION

**1105.4 Tests.** Periodic tests of the mechanical ventilating system shall be performed in accordance with manufacturer's specifications and as required by the code official.

**1105.5 Fuel-burning appliances.** Fuel-burning appliances and *equipment* having open flames and that use *combustion* air from the *machinery room* shall not be installed in a *machinery room*.

**Exceptions:**

1. Where the refrigerant is carbon dioxide or water.
2. Fuel-burning appliances shall not be prohibited in the same *machinery room* with refrigerant-containing *equipment* or appliances where *combustion* air is ducted from outside the *machinery room* and sealed in such a manner as to prevent any refrigerant leakage from entering the *combustion* chamber, or where a refrigerant vapor detector is employed to automatically shut off the *combustion* process in the event of refrigerant leakage.

[S] **1105.6 Ventilation.** Machinery rooms shall ~~((be mechanically ventilated))~~ have continuous mechanical ventilation to the outdoors.

**Informative Note:** The requirement for continuous mechanical ventilation to the outdoors means that fire dampers are not allowed on *machinery room* ventilation ducts.

**Exception:** Where a refrigerating system is located outdoors more than 20 feet (6096 mm) from any building opening and is enclosed by a penthouse, lean-to or other open structure, natural ~~((or mechanical))~~ ventilation shall be ~~((provided))~~ permitted. There shall be no openings to the building. Location of the openings shall be based on the relative density of the refrigerant to air. The free-aperture cross section for the ventilation of the *machinery room* shall be not less than:

$$F = \sqrt{G} \quad \text{(Equation 11-1)}$$

For SI:  $F = 0.138\sqrt{G}$

where:

$F$  = The free opening area in square feet ( $m^2$ ).

$G$  = The mass of refrigerant in pounds (kg) in the largest system, any part of which is located in the *machinery room*.

**1105.6.1 Discharge location.** The discharge of the air shall be to the outdoors in accordance with Chapter 5. Exhaust from mechanical ventilation systems shall be discharged not less than 20 feet (6096 mm) from a property line or openings into buildings.

**1105.6.1.1 Indoor exhaust opening location.** Indoor mechanical exhaust intake openings shall be located where refrigerant leakage is likely to concentrate based on the refrigerant's relative density to air, and the locations of the air current paths and refrigerating machinery.

**1105.6.2 Makeup air.** Provisions shall be made for *makeup air* to replace that being exhausted. Openings for *makeup air* shall be located to avoid intake of *exhaust air*. Supply and exhaust ducts to the *machinery room* shall not serve any other area, shall be constructed in accordance with Chapter 5 and shall be covered with corrosion-resistant screen of not less than 1/4-inch (6.4 mm) mesh.

[W][S] **1105.6.3 Ventilation rate other than ammonia systems.** For other than ammonia systems, the mechanical ventilation systems shall be capable of exhausting the minimum quantity of air both at normal operating and emergency conditions, as required by Sections 1105.6.3.1 and 1105.6.3.2. ~~((The minimum required emergency ventilation rate for ammonia shall be 30 air changes per hour in accordance with IAR2.))~~ Multiple fans or multispeed fans shall be allowed to produce the emergency ventilation rate and to obtain a reduced airflow for normal ventilation.

[S] **1105.6.3.1 Quantity—normal ventilation.** During occupied conditions, the mechanical ventilation system shall exhaust the larger of the following:

1. Not less than 0.5 cfm per square foot ( $0.0025 \text{ m}^3/\text{s} \cdot \text{m}^2$ ) of *machinery room* area, ~~((or 20 cfm (0.009  $\text{m}^3/\text{s}$ ) per person.))~~
2. A volume required to limit the room temperature rise to 18°F (10°C) taking into account the ambient heating effect of all machinery in the room.
3. Not less than 20 cfm (0.009  $\text{m}^3/\text{s}$ ) per person.

[S] **1105.6.3.1.1 Quantity—unoccupied condition.** During unoccupied conditions, the mechanical ventilation system is permitted to exhaust the larger of the following:

1. Not less than 0.25 cfm per square foot ( $0.00125 \text{ m}^3/\text{s} \cdot \text{m}^2$ ) of *machinery room* area; or
2. A volume required to limit the room temperature rise to 18°F (10°C) taking into account the ambient heating effect of all machinery in the room.

The system shall be provided with controls that increase the ventilation to the rate required for occupied spaces when the space is illuminated.

**1105.6.3.2 Quantity—emergency conditions.** Upon actuation of the refrigerant detector required in Section 1105.3, the mechanical ventilation system shall *exhaust air* from the *machinery room* in the following quantity:

$$Q = 100 \times \sqrt{G} \quad \text{(Equation 11-2)}$$

For SI:  $Q = 0.07 \times \sqrt{G}$

where:

$Q$  = The airflow in cubic feet per minute ( $\text{m}^3/\text{s}$ ).

$G$  = The design mass of refrigerant in pounds (kg) in the largest system, any part of which is located in the *machinery room*.

**[S] 1105.6.4 Ventilation rate—ammonia.** The minimum required normal and emergency ventilation rates for ammonia shall be in accordance with IAR2 and Sections 1105.6.4.1 and 1105.6.4.2.

**[S] 1105.6.4.1 Quantity—normal ventilation.** During normal conditions, the mechanical ventilation system shall exhaust the larger of the following:

1. Not less than 2 cfm per square foot ( $0.01 \text{ m}^3/\text{s} \cdot \text{m}^2$ ) of *machinery room* area; or
2. A volume required to limit the room temperature rise to 18°F (10°C) taking into account the ambient heating effect of all machinery in the room; or
3. Not less than 5 air changes per hour.

**[S] 1105.6.4.2 Quantity—emergency conditions.** Upon actuation of the refrigerant detector required in Section 1105.3, the mechanical ventilation system shall exhaust air from the *machinery room* at a rate of not less than 30 air changes per hour or in accordance with IAR 2.

**[S][F] 1105.6.5 Standby source of power required.** Where *mechanical ventilation*, treatment systems, temperature control, alarm, detection or other electrically operated systems are required, such systems shall be provided with a legally required standby source of power. See the *International Building Code* Chapter 27 and *Seattle Electrical Code* Article 701.

**Exception:** Legally required standby power is not required where an *approved* fail-safe engineered system is installed.

**[S] 1105.7 Termination of relief devices.** Pressure relief devices, fusible plugs and purge systems located within the *machinery room* shall terminate outside of the structure at a location not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, ventilation opening or exit.

For additional requirements regarding termination of relief devices for flammable refrigerants, toxic and highly toxic refrigerants, ammonia refrigerant, treatment systems, flaring systems, and ammonia diffusion systems, see Section 606 of the *International Fire Code*.

**1105.8 Ammonia discharge.** Pressure relief valves for ammonia systems shall discharge in accordance with ASHRAE 15.

**[F] 1105.9 Emergency pressure control system.** Permanently installed refrigeration systems containing more than 6.6 pounds (3 kg) of flammable, toxic or highly toxic refrigerant or ammonia shall be provided with an emergency pressure control system in accordance with Section 605.10 of the *International Fire Code*.

## SECTION 1106 MACHINERY ROOM, SPECIAL REQUIREMENTS

**1106.1 General.** Where required by Section 1104.2, the *machinery room* shall meet the requirements of this section in addition to the requirements of Section 1105.

**1106.2 Elevated temperature.** There shall not be an open flame-producing device or continuously operating hot surface over 800°F (427°C) permanently installed in the room.

**[S] 1106.3 Ammonia room ventilation.** Ventilation systems in ammonia machinery rooms shall be operated continuously at the ventilation rate specified in Section 1105.6.3.

**Exceptions:**

1. Machinery rooms equipped with a vapor detector that will automatically start the ventilation system at the ventilation rate specified in Section 1105.6.3, and that will actuate an alarm at a detection level not to exceed 1,000 ppm.
2. Machinery rooms conforming to the Class 1, Division 2, *hazardous location* classification requirements of ((NFPA 70)) the *Seattle Electrical Code* are permitted to be ventilated in accordance with Section 1105.

**1106.4 Flammable refrigerants.** Where refrigerants of Groups A2, A3, B2 and B3 are used, the *machinery room* shall conform to the Class 1, Division 2, *hazardous location* classification requirements of NFPA 70.

**Exceptions:**

1. Ammonia *machinery rooms* that are provided with *ventilation* in accordance with Section 1106.3.
2. *Machinery rooms* for systems containing Group A2L *refrigerants* that are in accordance with Section 1106.5.

**1106.5 Special requirements for Group A2L refrigerant machinery rooms.** *Machinery rooms* for systems containing Group A2L refrigerants shall comply with Sections 1106.5.1 through 1106.5.3.

**Exception:** *Machinery rooms* conforming to the Class I, Division 2, hazardous location classification requirements of NFPA 70 are not required to comply with Sections 1106.5.1 and 1106.5.2.

**[F] 1106.5.1 Refrigerant detection system.** The *machinery room* shall be provided with a *refrigerant* detection system. The *refrigerant* detection system shall be in accordance with Section 605.8 of the *International Fire Code* and all of the following:

1. The detectors shall activate at or below a *refrigerant* concentration of 25% of the *LFL*.
2. Upon activation, the detection system shall activate the emergency ventilation system required by Section 1106.5.2.
3. The detection, signaling and control circuits shall be supervised.

**1106.5.2 Emergency ventilation system.** An emergency ventilation system shall be provided at the minimum exhaust rate specified in ASHRAE 15 or Table 1106.5.2. Shutdown of the emergency ventilation system shall be by manual means.

**TABLE 1106.5.2  
MINIMUM EXHAUST RATES**

REFRIGERANT	Q(m/sec)	Q(cfm)
R32	15.4	32,600
R143	13.6	28,700
R444A	6.46	13,700
R444B	10.6	22,400
R445A	7.83	16,600
R446A	23.9	50,700
R447A	23.8	50,400
R451A	7.04	15,000
R451B	7.05	15,000
R1234yf	7.80	16,600
R1234ze(E)	5.92	12,600

**1106.5.3 Emergency ventilation system discharge.** The emergency ventilation system point of discharge to the atmosphere shall be located outside of the structure at not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, *ventilation* opening or *exit*.

**[F] 1106.6 Remote controls.** Remote control of the mechanical equipment and appliances located in the machinery room shall comply with Sections 1106.6.1 and 1106.6.2.

**[F] 1106.6.1 Refrigeration system emergency shutoff.** A clearly identified switch of the break-glass type or with an approved tamper-resistant cover shall provide off-only control of refrigerant compressors, refrigerant pumps, and normally closed, automatic refrigerant valves located in the machinery room. Additionally, this equipment shall be automatically shut off whenever the refrigerant vapor concentration in the machinery room exceeds the vapor detector's upper detection limit or 25 percent of the LEL, whichever is lower.

**[F] 1106.6.2 Ventilation system.** A clearly identified switch of the break-glass type or with an approved tamper-resistant cover shall provide on-only control of the *machinery room* ventilation fans.

**[F] 1106.7 Emergency signs and labels.** Refrigeration units and systems shall be provided with *approved* emergency signs, charts, and labels in accordance with the *International Fire Code*.

**[S][F] 1106.8 Alarm activation.** Where continuous ventilation is provided, failure of the ventilation system shall automatically activate an audible and visual alarm.

## SECTION 1107 REFRIGERANT PIPING

**1107.1 General.** The design of refrigerant piping shall be in accordance with ASME B31.5. Refrigerant piping shall be installed, tested and placed in operation in accordance with this chapter.

**1107.2 Piping location.** Refrigerant piping that crosses an open space that affords passageway in any building shall be not less than 7 feet 3 inches (2210 mm) above the floor unless the piping is located against the ceiling of such space. Refrigerant piping shall not be placed in any of the following:

1. A fire-resistance-rated exit access corridor.
2. An interior exit stairway.

3. An interior exit ramp.
4. An exit passageway.
5. An elevator, dumbwaiter or other shaft containing a moving object.
6. A shaft that has one or more openings into a fire-resistance-rated exit access corridor, interior exit stairway or ramp or exit passageway.

**[S] Exceptions:**

1. Refrigerant piping and equipment is permitted to be separated from the corridor, stair, passageway by construction equal to the rated construction of the space and located so that all required clearances are maintained.
2. Refrigerant piping is permitted to pass through corridors if located above a ceiling and the piping has no joints in the corridor.
3. Refrigerant piping is permitted to pass through lobbies that are part of an exit system if the refrigeration system contains not more than the amount of refrigerant allowed by Section 1104.3.

**1107.2.1 Piping in concrete floors.** Refrigerant piping installed in concrete floors shall be encased in pipe ducts. The piping shall be isolated and supported to prevent damaging vibration, stress and corrosion.

**1107.2.2 Refrigerant penetrations.** Refrigerant piping shall not penetrate floors, ceilings or roofs.

**Exceptions:**

1. Penetrations connecting the basement and the first floor.
2. Penetrations connecting the top floor and a machinery penthouse or roof installation.
3. Penetrations connecting adjacent floors served by the refrigeration system.
4. Penetrations by piping in a direct system where the refrigerant quantity does not exceed Table 1103.1 for the smallest occupied space through which the piping passes.
5. In other than industrial occupancies and where the refrigerant quantity exceeds Table 1103.1 for the smallest space, penetrations for piping that connects separate pieces of *equipment* that are either:
  - 5.1. Enclosed by an *approved* gas-tight, fire-resistive duct or shaft with openings to those floors served by the refrigeration system.
  - 5.2. Located on the exterior of the building where vented to the outdoors or to the space served by the system and not used as an air shaft, closed court or similar space.

**1107.3 Pipe enclosures.** Rigid or flexible metal enclosures or pipe ducts shall be provided for soft, annealed copper tubing and used for refrigerant piping erected on the premises and containing other than Group A1 or B1 refrigerants. Enclosures shall not be required for connections between condensing units and the nearest riser box(es), provided such connections do not exceed 6 feet (1829 mm) in length.

**1107.4 Condensation.** Refrigerating piping and fittings, brine piping and fittings that, during normal operation, will reach a surface temperature below the dew point of the surrounding air, and are located in spaces or areas where condensation will cause a safety hazard to the building occupants, structure, electrical *equipment* or any other *equipment* or appliances, shall be protected in an *approved* manner to prevent such damage.

**1107.5 Materials for refrigerant pipe and tubing.** Piping materials shall be as set forth in Sections 1107.5.1 through 1107.5.5.

**[S] 1107.5.1 Steel pipe.** Carbon steel pipe with a wall thickness not less than Schedule 80 shall be used for Group A2, A3, B2 or B3 refrigerant liquid lines for sizes 1.5 inches (38 mm) and smaller. Carbon steel pipe with a wall thickness not less than Schedule 40 shall be used for Group A1 or B1 refrigerant liquid lines 6 inches (152 mm) and smaller, Group A2, A3, B2 or B3 refrigerant liquid lines sizes 2 inches (51 mm) through 6 inches (152 mm) and all refrigerant suction and discharge lines 6 inches (152 mm) and smaller. (~~Type F steel pipe shall not be used for refrigerant~~) Refrigerant lines having an operating temperature less than -20°F (-29°C) shall be designed to meet the requirements of ASME B31.5, *Refrigeration Piping and Heat Transfer Components*.

**1107.5.2 Copper and copper-alloy pipe.** Standard iron-pipe size, copper and copper-alloy (not less than 80-percent copper) pipe shall conform to ASTM B42 and ASTM B43.

**1107.5.3 Copper tube.** Copper tube used for refrigerant piping erected on the premises shall be seamless copper tube of Type ACR (hard or annealed) complying with ASTM B280 or ASTM B819. Annealed temper copper tube shall not be used in sizes larger than a 2-inch (51 mm) nominal size. Mechanical joints other than press-connect joints listed for refrigerant piping shall not be used on annealed temper copper tube in sizes larger than 7/8-inch (22.2 mm) OD size.

**1107.5.4 Copper tubing joints.** Copper tubing joints used in refrigerating systems containing Group A2, A3, B2 or B3 refrigerants shall be brazed. Soldered joints shall not be used in such refrigerating systems.

**1107.5.5 Aluminum tube.** Type 3003-0 aluminum tubing with high-pressure fittings shall not be used with methyl chloride and other refrigerants known to attack aluminum.

## REFRIGERATION

**1107.6 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 human-occupied space shall be constructed to withstand, without leakage, a pressure of 150 percent of the higher of the design pressure or pressure relief device setting.

**1107.7 Exposure of refrigerant pipe joints.** Refrigerant pipe joints erected on the premises shall be exposed for visual inspection prior to being covered or enclosed.

**1107.8 Stop valves.** Systems containing more than 6.6 pounds (3 kg) of a refrigerant in systems using positive-displacement compressors shall have stop valves installed as follows:

1. At the inlet of each compressor, compressor unit or condensing unit.
2. At the discharge outlet of each compressor, compressor unit or condensing unit and of each liquid receiver.

**Exceptions:**

1. Systems that have a refrigerant pumpout function capable of storing the entire refrigerant charge in a receiver or heat exchanger.
2. Systems that are equipped with provisions for pumpout of the refrigerant using either portable or permanently installed recovery *equipment*.
3. Self-contained systems.

[S] **1107.8.1 Liquid receivers.** Systems containing 100 pounds (45 kg) or more of a refrigerant, other than systems utilizing nonpositive displacement compressors, shall have stop valves, in addition to those required by Section 1107.8, on each inlet of each liquid receiver. Stop valves shall not be required on the inlet of a receiver in a condensing unit, nor on the inlet of a receiver that is an integral part of the condenser.

Ammonia systems shall be provided with liquid receivers designed for pumpdown that have sufficient capacity to assure that the liquid does not occupy more than 90 percent of the volume of the receiver at 90°F.

**1107.8.2 Copper tubing.** Stop valves used with soft annealed copper tubing or hard-drawn copper tubing 7/8-inch (22.2 mm) OD standard size or smaller shall be securely mounted, independent of tubing fastenings or supports.

**1107.8.3 Identification.** Stop valves shall be identified where their intended purpose is not obvious. Numbers shall not be used to label the valves, unless a key to the numbers is located near the valves.

## SECTION 1108 FIELD TEST

**1108.1 General.** Every refrigerant-containing part of every system that is erected on the premises, except compressors, condensers, vessels, evaporators, safety devices, pressure gauges and control mechanisms that are *listed* and factory tested, shall be tested and proved tight after complete installation, and before operation. Tests shall include both the high- and low-pressure sides of each system at not less than the lower of the design pressures or the setting of the pressure relief device(s). The design pressures for testing shall be those listed on the condensing unit, compressor or compressor unit nameplate, as required by ASHRAE 15.

**Exceptions:**

1. Gas bulk storage tanks that are not permanently connected to a refrigeration system.
2. Systems erected on the premises with copper tubing not exceeding 5/8-inch (15.8 mm) OD, with wall thickness as required by ASHRAE 15, shall be tested in accordance with Section 1108.1, or by means of refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 70°F (21°C) or higher.
3. Limited-charge systems equipped with a pressure relief device, erected on the premises, shall be tested at a pressure not less than one and one-half times the pressure setting of the relief device. If the *equipment* or *appliance* has been tested by the manufacturer at one and one-half times the design pressure, the test after erection on the premises shall be conducted at the design pressure.

**1108.1.1 Booster compressor.** Where a compressor is used as a booster to obtain an intermediate pressure and discharges into the suction side of another compressor, the booster compressor shall be considered to be a part of the low side, provided that it is protected by a pressure relief device.

**1108.1.2 Centrifugal/nonpositive displacement compressors.** In field-testing systems using centrifugal or other nonpositive displacement compressors, the entire system shall be considered as the low-side pressure for field test purposes.

**1108.2 Test gases.** Tests shall be performed with an inert dried gas including, but not limited to, nitrogen and carbon dioxide. Oxygen, air, combustible gases and mixtures containing such gases shall not be used.

**Exception:** The use of air is allowed to test R-717, ammonia, systems provided that they are subsequently evacuated before charging with refrigerant.

**1108.3 Test apparatus.** 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.

**1108.4 Declaration.** A certificate of test shall be provided for all systems containing 55 pounds (25 kg) or more of refrigerant. The certificate shall give the name of the refrigerant and the field test pressure applied to the high side and the low side of the system. The certification of test shall be signed by the installer and shall be made part of the public record.

#### [F] SECTION 1109 PERIODIC TESTING

**[F] 1109.1 Testing required.** The following emergency devices and systems shall be periodically tested in accordance with the manufacturer's instructions and as required by the code official:

1. Treatment and flaring systems.
2. Valves and appurtenances necessary to the operation of emergency refrigeration control boxes.
3. Fans and associated *equipment* intended to operate emergency ventilation systems.
4. Detection and alarm systems.

