



**APPENDIX C
CODE CHANGE PROPOSAL
NORTH CAROLINA
BUILDING CODE COUNCIL**

B-5

1429 Rock Quarry Road, Suite 105
Raleigh, North Carolina 27610
(919) 647-0008
david.rittlinger@ncdoi.gov

Petition for Rule Making

Item Number _____

Granted by BCC _____
Denied by BCC _____

Adopted by BCC _____
Disapproved by BCC _____

Approved by RRC _____
Objection by RRC _____

PROPONENT: Kate Whalen _____ PHONE: (919) 647-0033
REPRESENTING: _____
ADDRESS: 1429 Rock Quarry Rd, Suite 105 _____
CITY: Raleigh _____ STATE: NC _____ ZIP: 27610 _____
E-MAIL: kathryn.whalen@ncdoi.gov _____ FAX: () - _____

North Carolina State Building Code, Volume 2024 NC Mechanical Code - Section 1101, 1103, 1104, 1106, 1107, 1109, 1110

CHECK ONE: [x] Revise section to read as follows: [] Delete section and substitute the following:
[] Add new section to read as follows: [] Delete section without substitution:

~~LINE THROUGH MATERIAL TO BE DELETED~~ UNDERLINE MATERIAL TO BE ADDED

Please type. Continue proposal or reason on plain paper attached to this form. See reverse side for instructions.

See attached.

Will this proposal change the cost of construction? Decrease [] Increase [] No [x]
Will this proposal increase to the cost of a dwelling by \$80 or more? Yes [] No [x]
Will this proposal affect the Local or State funds? Local [] State [] No [x]
Will this proposal cause a substantial economic impact (≥\$1,000,000)? Yes [] No [x]

- Non-Substantial – Provide an economic analysis including benefit/cost estimates.
- Substantial – The economic analysis must also include 2-alternatives, time value of money and risk analysis.
- Pursuant to §143-138(a1)(2) a cost-benefit analysis is required for all proposed amendments to the NC Energy Conservation Code. The Building Code Council shall also require same for the NC Residential Code, Chapter 11.

REASON:

These changes will update the 2024 NCMC to reference the latest refrigerant standards and listings, and align Chapter 11 with those updated references. These changes include updating refrigerant classifications, allowed amounts per occupied space, required listings, and installation and testing requirements. The changes are expected to help smooth the transition to alternative refrigerants as HFC refrigerant production is phased-down.

Signature: Kate Whalen Date: 11/1/23 FORM 11/26/19 BCC CODE CHANGES

INSTRUCTIONS

Each proposed Code change request shall comply with the following policies:

Rule 1: The Original and twenty-two (22) copies of the proposed Petition for Rule-Making along with supporting documentation shall be filed with the Building Code Council Secretary. Submit one (1) electronic copy via email.

Rule 2: The filing shall be received by the first day of the month prior to the quarterly scheduled meeting date. Example: A December meeting date will require filing by November 1 prior to the meeting.

Rule 3: Each request shall be typewritten on this form and shall contain the following:

- (1) The proposed rule change must be set forth in full and contain explicit reference to the affected section or sections of the Code.
- (2) The request shall state the reasons for the proposed rule change with supporting documentation.
- (3) The proposed rule change shall comply with the standards set forth in GS 143-138(c) and reference to the particular standards shall be set forth in the request for the amendment.
- (4) The proposed rule change shall contain an economic impact analysis as required by GS 143-138(a).
- (5) A proposed rule change to the NC Energy Conservation Code shall have an accompanying cost-benefit analysis as required by GS 143-138(a1)(2).

Rule 4: When a request is improperly filed or not in accordance with all the rules listed above, the BCC Secretary shall reject the submittal and notify the applicant of the proper procedure to follow.

Rule 5: Upon the proper filing of a request, the BCC Secretary shall forward one copy of said request to each council member prior to the scheduled meeting date. Persons filing proposed petitions are hereby notified of the place and time of the scheduled hearings. The BCC Secretary shall cause to be published the notice of public hearing as specified in GS 143-138(a).

Rule 6: The Council shall either Grant or Deny the proposed Petition for Rulemaking at the meeting following receipt of the proposed rule change. The Council will take no further action on items that are Denied. Granted items may be referred to Committee for review.

Rule 7: The Council will hold a public hearing on Granted items at the next quarterly scheduled meeting. The Council will take final action on Granted items at the next quarterly scheduled meeting after the public hearing.

Timeline Example

| | |
|-------------------------------------|------------------------------|
| Petition received: | February 1 |
| Petition Granted: | March BCC meeting |
| Notice of Hearing published: | April NC Register |
| Committee review: | May - June |
| Hearing held: | June BCC meeting |
| Final Adoption: | September BCC meeting |
| Rules Review Meeting: | November RRC meeting |
| Approved: | December 1 |

1101.2.1 Group A2L, A2, A3 and B1 high-probability equipment. High-probability equipment using Group A2L, A2, A3, or B1 refrigerant shall comply with UL 484, UL/CSA 60335-2-40, or UL/CSA 60335-2-89.

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

| CHEMICAL REFRIGERANT | FORMULA | CHEMICAL NAME OF BLEND | REFRIGERANT SAFETY GROUP CLASSIFICATION | AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | | | | [F] DEGREES OF HAZARD ^a | |
|-----------------------|-------------------------------------|---|---|--|--------------|-----------------------|--------|---------|------------------|------------------------------------|----------------------|
| | | | | RCL | | | LFL | | OEL ^d | | |
| | | | | Pounds per 4,000 cubic feet lb/MCf | ppm | g/m ³ | lb/MCf | ppm | g/m ³ | | OEL ^e ppm |
| R-11 ^{d,e} | CCl ₃ F | trichlorofluoromethane | A1 | 0.39 | 1,100 | 6.2 6.1 | | | | 1,000 | 2-0-0 ^b |
| R-12 ^{d,e} | CCl ₂ F ₂ | dichlorodifluoromethane | A1 | 5.6 | 18,000 | 90 | | | | 1,000 | 2-0-0 ^b |
| R-13 ^{d,e} | CClF ₃ | chlorotrifluoromethane | A1 | — | — | — | | | | 1,000 | 2-0-0 ^b |
| R-13B1 ^{d,e} | CBrF ₃ | bromotrifluoromethane | A1 | — | — | — | | | | 1,000 | 2-0-0 ^b |
| <u>R-1311</u> | <u>CF₃I</u> | <u>trifluoroiodomethane</u> | <u>A1</u> | <u>1.0</u> | <u>2,000</u> | <u>16</u> | | | | <u>500</u> | |
| R-14 | CF ₄ | tetrafluoromethane (carbon tetrafluoride) | A1 | 25 | 110,000 | 400 | | | | 1,000 | 2-0-0 ^b |
| R-22 | CHClF ₂ | chlorodifluoromethane | A1 | 13 | 59,000 | 210 | | | | 1,000 | 2-0-0 ^b |
| R-23 | CHF ₃ | trifluoromethane (fluoroform) | A1 | 7.3 | 41,000 | 120 | | | | 1,000 | 2-0-0 ^b |
| R-30 | CH ₂ Cl ₂ | dichloromethane (methylene chloride) | B1 | — | — | — | | | | — | — |
| <u>R-31</u> | <u>CH₂ClF</u> | <u>Chlorofluoromethane</u> | <u>=</u> | <u>=</u> | <u>=</u> | <u>=</u> | | | | <u>=</u> | <u>=</u> |
| R-32 | CH ₂ F ₂ | difluoromethane (methylene fluoride) | A2 ^e A2L | 4.8 | 36,000 | 77 | 19.1 | 144,000 | 306 | 1,000 | 1-4-0 |
| R-40 | CH ₃ Cl | chloromethane (methyl chloride) | B2 | — | — | — | | | | — | — |
| <u>R-41</u> | <u>CH₃F</u> | <u>Fluoromethane (methyl fluoride)</u> | <u>=</u> | <u>=</u> | <u>=</u> | <u>=</u> | | | | <u>=</u> | <u>=</u> |
| R-50 | CH ₄ | methane | A3 | — | — | — | | 50,000 | | 1,000 | — |
| R-113 ^{d,e} | CCl ₂ FCClF ₂ | 1,1,2-trichloro-1,2,2-trifluoroethane | A1 | 1.2 | 2,600 | 20 | | | | 1,000 | 2-0-0 ^b |
| R-114 ^{d,e} | CClF ₂ CClF ₂ | 1,2-dichloro-1,1,2,2-tetrafluoroethane | A1 | 8.7 | 20,000 | 140 | | | | 1,000 | 2-0-0 ^b |
| R-115 | CClF ₂ CF ₃ | chloropentafluoroethane | A1 | 47 | 120,000 | 760 | | | | 1,000 | — |
| R-116 | CF ₃ CF ₃ | hexafluoroethane | A1 | 34 | 97,000 | 550 | | | | 1,000 | 1-0-0 |
| R-123 | CHCl ₂ CF ₃ | 2,2-dichloro-1,1,1-trifluoroethane | B1 | 3.5 | 9,100 | 57 | | | | 50 | 2-0-0 ^b |
| R-124 | CHClFCF ₃ | 2-chloro-1,1,1,2-tetrafluoroethane | A1 | 3.5 | 10,000 | 56 | | | | 1,000 | 2-0-0 ^b |
| R-125 | CHF ₂ CF ₃ | pentafluoroethane | A1 | 23 | 75,000 | 370 | | | | 1,000 | 2-0-0 ^b |
| R-134a | CH ₂ FCF ₃ | 1,1,1,2-tetrafluoroethane | A1 | 13 | 50,000 | 210 | | | | 1,000 | 2-0-0 ^b |
| R-141b | CH ₃ CCl ₂ F | 1,1-dichloro-1-fluoroethane | — | 0.78 | 2,600 | 12 | 17.8 | 60,000 | 287 | 500 | 2-1-0 |

| | | | | | | | | | | | |
|---------|--|----------------------------------|---------------------|-------------------------|--------|-----------------------|------|--------|-----|-------|--------------------|
| R-142b | CH ₃ CClF ₂ | 1-chloro-1,1-difluoroethane | A2 | 5.1 | 20,000 | 83 82 | 20.4 | 80,000 | 329 | 1,000 | 2-4-0 |
| R-143a | CH ₃ CF ₃ | 1,1,1-trifluoroethane | A2 ^e A2L | 4.5 4.4 | 21,000 | 70 | 17.5 | 82,000 | 282 | 1,000 | 2-0-0 ^b |
| R-152a | CH ₃ CHF ₂ | 1,1-difluoroethane | A2 | 2.0 | 12,000 | 32 | 8.1 | 48,000 | 130 | 1,000 | 1-4-0 |
| R-170 | CH ₃ CH ₃ | ethane | A3 | 0.54 | 7,000 | 8.7 8.6 | 2.4 | 31,000 | 38 | 1,000 | 2-4-0 |
| R-E170 | CH ₃ OCH ₃ | Methoxymethane (dimethyl ether) | A3 | 1.0 | 8,500 | 16 | 4.0 | 34,000 | 64 | 1,000 | — |
| R-218 | CF ₃ CF ₂ CF ₃ | octafluoropropane | A1 | 43 | 90,000 | 690 | | | | 1,000 | 2-0-0 ^b |
| R-227ea | CF ₃ CHFCF ₃ | 1,1,1,2,3,3,3-heptafluoropropane | A1 | 36 | 84,000 | 580 | | | | 1,000 | — |
| R-236fa | CF ₃ CH ₂ CF ₃ | 1,1,1,3,3,3-hexafluoropropane | A1 | 21 | 55,000 | 340 | | | | 1,000 | 2-0-0 ^b |
| R-245fa | CHF ₂ CH ₂ CF ₃ | 1,1,1,3,3-pentafluoropropane | B1 | 12 | 34,000 | 190 | | | | 300 | 2-0-0 ^b |
| R-290 | CH ₃ CH ₂ CH ₃ | propane | A3 | 0.56 0.59 | 5,300 | 9.5 | 2.4 | 21,000 | 38 | 1,000 | 2-4-0 |
| R-C318 | -(CF ₂) ₄ - | octafluorocyclobutane | A1 | 41 | 80,000 | 660 650 | | | | 1,000 | — |

(continued)

TABLE 1103.1—continued
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

| CHEMICAL REFRIGERANT | FORMULA | CHEMICAL NAME OF BLEND | REFRIGERANT SAFETY GROUP CLASSIFICATION | AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | | | | [F] DEGREES OF HAZARD ^a | |
|----------------------|----------|---|---|--|-----------------------------|------------------|--------|-----|------------------|------------------------------------|----------------------|
| | | | | RCL | | | LFL | | OEL ^d | | |
| | | | | Pounds per 1,000 cubic feet lb/Mcf | ppm | g/m ³ | lb/Mcf | ppm | g/m ³ | | OEL ^e ppm |
| R-400 ^{d,e} | zeotrope | R-12/114 (50.0/50.0) | A1 | 10 | 28,000 | 160 | | | | 1,000 | 2-0-0 ^b |
| R-400 ^{d,e} | 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 ^b |
| R-401B | zeotrope | R-22/152a/124 (61.0/11.0/28.0) | A1 | 7.2 | 30,000 | 120 | | | | 1,000 | 2-0-0 ^b |
| R-401C | zeotrope | R-22/152a/124 (33.0/15.0/52.0) | A1 | 5.2 | 20,000 | 84 | | | | 1,000 | 2-0-0 ^b |
| R-402A | zeotrope | R-125/290/22 (60.0/2.0/38.0) | A1 | 17 | 66,000 | 270 | | | | 1,000 | 2-0-0 ^b |
| R-402B | zeotrope | R-125/290/22 (38.0/2.0/60.0) | A1 | 15 | 63,000 | 240 | | | | 1,000 | 2-0-0 ^b |
| R-403A | zeotrope | R-290/22/218 (5.0/75.0/20.0) | A2 | 7.6 | 33,000 | 120 | | | | 1,000 | 2-0-0 ^b |
| R-403B | zeotrope | R-290/22/218 (5.0/56.0/39.0) | A1 | 18 | 70,000 68,000 | 290 | | | | 1,000 | 2-0-0 ^b |
| R-404A | zeotrope | R-125/143a/134a (44.0/52.0/4.0) | A1 | 31 | 130,000 | 500 | | | | 1,000 | 2-0-0 ^b |
| R-405A | zeotrope | R-22/152a/142b/C318 (45.0/7.0/5.5/42.5) | — | 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 75 | 18.8 | 82,000 | 301.9 | 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 ^b |
| R-407B | zeotrope | R-32/125/134a (10.0/70.0/20.0) | A1 | 21 | 79,000 | 330 | | | | 1,000 | 2-0-0 ^b |
| R-407C | zeotrope | R-32/125/134a (23.0/25.0/52.0) | A1 | 18 | 81,000 | 290 | | | | 1,000 | 2-0-0 ^b |
| R-407D | zeotrope | R-32/125/134a (15.0/15.0/70.0) | A1 | 16 | 68,000 | 250 | | | | 1,000 | 2-0-0 ^b |
| R-407E | zeotrope | R-32/125/134a (25.0/15.0/60.0) | A1 | 17 | 80,000 | 280 | | | | 1,000 | 2-0-0 ^b |
| R-407F | zeotrope | R-32/125/134a (30.0/30.0/40.0) | A1 | 20 | 95,000 | 320 | | | | 1,000 | — |
| R-407G | zeotrope | R-32/125/134a (2.5/2.5/95.0) | A1 | 13 | 52,000 | 210 | | | | 1,000 | — |
| R-407H | zeotrope | R-32/125/134a (32.5/15.0/52.5) | A1 | 19 | 92,000 | 300 | | | | 1,000 | — |
| <u>R-407I</u> | <u>zeotrope</u> | <u>R-32/125/134a (19.5/8.5/72.0)</u> | <u>A1</u> | <u>16</u> | <u>71,100</u> | <u>250</u> | | | | <u>1,000</u> | |
| R-408A | zeotrope | R-125/143a/22 (7.0/46.0/47.0) | A1 | 21 | 95,000 94,000 | 340 330 | | | | 1,000 | 2-0-0 ^b |
| R-409A | zeotrope | R-22/124/142b (60.0/25.0/15.0) | A1 | 7.1 | 29,000 | 110 | | | | 1,000 | 2-0-0 ^b |
| R-409B | zeotrope | R-22/124/142b (65.0/25.0/10.0) | A1 | 7.3 | 30,000 | 120 | | | | 1,000 | 2-0-0 ^b |
| R-410A | zeotrope | R-32/125 (50.0/50.0) | A1 | 26 | 140,000 | 420 | | | | 1,000 | 2-0-0 ^b |
| R-410B | zeotrope | R-32/125 (45.0/55.0) | A1 | 27 | 140,000 | 430 | | | | 1,000 | 2-0-0 ^b |
| R-411A | zeotrope | R-127/22/152a (1.5/87.5/11.0) | A2 | 2.9 | 14,000 | 46 | 11.6 | 55,000 | 185.6 | 990 970 | — |
| R-411B | zeotrope | R-1270/22/152a (3.0/94.0/3.0) | A2 | 2.8 | 13,000 | 45 | 14.8 | 70,000 | 238.3 | 980 940 | — |
| R-412A | zeotrope | R-22/218/142b (70.0/5.0/25.0) | A2 | 5.1 | 22,000 | 82 | 20.5 | 87,000 | 328.6 | 1,000 | — |
| R-413A | zeotrope | R-218/134a/600a (9.0/88.0/3.0) | A2 | 5.8 | 22,000 | 94 93 | 23.4 | 88,000 | 374.9 | 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 96 | | | | 1,000 | — |

(continued)

TABLE 1103.1—continued
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

| CHEMICAL REFRIGERANT | FORMULA | CHEMICAL NAME OF BLEND | REFRIGERANT SAFETY GROUP CLASSIFICATION | AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | | | | | [F] DEGREES OF HAZARD ^a |
|----------------------|----------|------------------------|---|--|--------|------------------|--------|--------|------------------|----------------------|------------------------------------|
| | | | | RCL | | | LFL | | OEL ^d | | |
| | | | | Pounds per 1,000 cubic feet lb/Mcf | ppm | g/m ³ | lb/Mcf | ppm | g/m ³ | OEL ^e ppm | |
| R-415A | zeotrope | R-22/152a (82.0/18.0) | A2 | 2.9 | 14,000 | 47 | 11.7 | 56,000 | 187.9 | 1,000 | — |

| | | | | | | | | | | | |
|--------|------------------------------|---|----|--------------------------------|------------------------------------|------------------------------|-------------|---------------|--------------|------------------------------|--------------------|
| R-415B | zeotrope | R-22/152a (25.0/75.0) | A2 | 2.1 | 12,000 | 34 | <u>8.4</u> | <u>47.000</u> | <u>135.1</u> | 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 ^b |
| R-417A | zeotrope | R-125/134a/600 (46.6/50.0/3.4) | A1 | 3.5 | 13,000 | 56 <u>55</u> | | | | 1,000 | 2-0-0 ^b |
| R-417B | zeotrope | R-125/134a/600 (79.0/18.3/2.7) | A1 | 4.3 | 15,000 | 70 <u>69</u> | | | | 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 | <u>19.2</u> | <u>89.000</u> | <u>308.4</u> | 1,000 | — |
| R-419A | zeotrope | R-125/134a/E170 (77.0/19.0/4.0) | A2 | 4.2 | 15,000 | 67 | <u>16.7</u> | <u>60.000</u> | <u>268.6</u> | 1,000 | — |
| R-419B | zeotrope | R-125/134a/E170 (48.5/48.0/3.5) | A2 | 4.6 | 17,000 | 74 | <u>18.5</u> | <u>69.000</u> | <u>297.3</u> | 1,000 | — |
| R-420A | zeotrope | R-134a/142b (88.0/12.0) | A1 | 12 | 45.000 <u>44.000</u> | 190 <u>180</u> | | | | 1,000 | 2-0-0 ^b |
| R-421A | zeotrope | R-125/134a (58.0/42.0) | A1 | 17 | 61,000 | 280 | | | | 1,000 | 2-0-0 ^b |
| R-421B | zeotrope | R-125/134a (85.0/15.0) | A1 | 21 | 69,000 | 330 | | | | 1,000 | 2-0-0 ^b |
| R-422A | zeotrope | R-125/134a/600a (85.1/11.5/3.4) | A1 | 18 | 63,000 | 290 | | | | 1,000 | 2-0-0 ^b |
| R-422B | zeotrope | R-125/134a/600a (55.0/42.0/3.0) | A1 | 16 | 56,000 | 250 | | | | 1,000 | 2-0-0 ^b |
| R-422C | zeotrope | R-125/134a/600a (82.0/15.0/3.0) | A1 | 18 | 62,000 | 290 | | | | 1,000 | 2-0-0 ^b |
| R-422D | zeotrope | R-125/134a/600a (65.1/31.5/3.4) | A1 | 16 | 58,000 | 260 | | | | 1,000 | 2-0-0 ^b |
| 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 <u>300</u> | | | | 1,000 | 2-0-0 ^b |
| 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 <u>990</u> | 2-0-0 ^b |
| R-425A | zeotrope zeotrope | R-32/134a/227ea (18.5/69.5/12.0) | A1 | 16 | 72,000 | 260 | | | | 1,000 | 2-0-0 ^b |
| 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 <u>84.000</u> | 370 | | | | 1,000 | — |
| R-429A | zeotrope | R-E170/152a/600a (60.0/10.0/30.0) | A3 | 0.81 | 6,300 | 13 | <u>3.2</u> | <u>25.000</u> | <u>83.8</u> | 1,000 | — |
| R-430A | zeotrope | R-152a/600a (76.0/24.0) | A3 | 1.3 | 8,000 | 21 | <u>5.2</u> | <u>32.000</u> | <u>44.0</u> | 1,000 | — |
| R-431A | zeotrope | R-290/152a (71.0/29.0) | A3 | 0.69 <u>0.68</u> | 5,500 | 11 | <u>2.7</u> | <u>22.000</u> | <u>38.6</u> | 1,000 | — |
| R-432A | zeotrope | R-1270/E170 (80.0/20.0) | A3 | 0.13 | 1,200 | 2.1 | <u>2.4</u> | <u>22.000</u> | <u>39.2</u> | 700 <u>550</u> | — |
| R-433A | zeotrope | R-1270/290 (30.0/70.0) | A3 | 0.34 | 3,100 | 5.5 | <u>2.4</u> | <u>20.000</u> | <u>32.4</u> | 880 <u>760</u> | — |
| R-433B | zeotrope | R-1270/290 (5.0-95.0) | A3 | 0.51 <u>0.39</u> | 4,500 <u>3,500</u> | 8.1 <u>6.3</u> | <u>2.0</u> | <u>18.000</u> | <u>32.1</u> | 950 | — |
| R-433C | zeotrope | R-1270/290 (25.0-75.0) | A3 | 0.41 | 3,600 <u>3,700</u> | 6.6 <u>6.5</u> | <u>2.0</u> | <u>18.000</u> | <u>83.8</u> | 790 | — |

| | | | | | | | | | | | |
|--------|----------|---|----|----|--------|-----|--|--|--|-------|---|
| R-434A | zeotrope | R-125/143a/600a (63.2/18.0/16.0/2.8) | A1 | 20 | 73,000 | 320 | | | | 1,000 | — |
|--------|----------|---|----|----|--------|-----|--|--|--|-------|---|

(continued)

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

| CHEMICAL REFRIGERANT | FORMULA | CHEMICAL NAME OF BLEND | REFRIGERANT SAFETY GROUP CLASSIFICATION | AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | | | | | [F] DEGREES OF HAZARD ^a |
|----------------------|-----------------|---|---|--|------------------------------------|------------------------------|-------------|----------------------------|------------------|--------------------------------|------------------------------------|
| | | | | RCL | | | LFL | | | OEL ^d | |
| | | | | Pounds per 1,000 cubic feet lb/Mcf | ppm | g/m ³ | lb/Mcf | ppm | g/m ³ | OEL ^e ppm | |
| R-435A | zeotrope | R-E170/152a (80.0/20.0) | A3 | 1.1 | 8,500 | 17 | <u>4.3</u> | <u>34,000</u> | <u>68.2</u> | 1,000 | — |
| R-436A | zeotrope | R-290/600a (56.0/44.0) | A3 | 0.50 | 4,000 | 8.1 | <u>2.0</u> | <u>16,000</u> | <u>32.3</u> | 1,000 | — |
| R-436B | zeotrope | R-290/600a (52.0/48.0) | A3 | 0.51 | 4,000 | 8.1 <u>8.2</u> | <u>2.0</u> | <u>16,000</u> | <u>32.7</u> | 1,000 | — |
| <u>R-436C</u> | <u>zeotrope</u> | <u>R-290/600a (95.0/5.0)</u> | <u>A3</u> | <u>0.57</u> | <u>5,000</u> | <u>9.1</u> | <u>2.3</u> | <u>20,000</u> | <u>36.5</u> | <u>1,000</u> | |
| R-437A | zeotrope | R-125/134a/600/601 (19.5/78.5/1.4/0.6) | A1 | 5.0 <u>5.1</u> | 19,000 | 82 | | | | 990 | — |
| 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 | <u>18.9</u> | <u>104,000</u> <u>0</u> | <u>303.3</u> | 990 <u>1,000</u> | — |
| R-440A | zeotrope | R-290/134a/152a (0.6/1.6/97.8) | A2 | 1.9 | 12,000 | 31 | <u>7.8</u> | <u>46,000</u> | <u>124.7</u> | 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 | <u>2.0</u> | <u>16,000</u> | <u>31.7</u> | 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 | <u>2.2</u> | <u>20,000</u> | <u>35.6</u> | 580 <u>640</u> | — |
| R-444A | zeotrope | R-32/152a/1234ze(E) (12.0/5.0/83.0) | A2^e <u>A2L</u> | 5.1 | 21,000 | 81 | <u>19.9</u> | <u>82,000</u> | <u>324.8</u> | 850 | — |
| R-444B | zeotrope | R-32/152a/1234ze(E) (41.5/10.0/48.5) | A2^e <u>A2L</u> | 4.3 | 23,000 | 69 | <u>17.3</u> | <u>93,000</u> | <u>277.3</u> | 890 <u>930</u> | — |
| R-445A | zeotrope | R-744/134a/1234ze(E) (6.0/9.0/85.0) | A2^e <u>A2L</u> | 4.2 | 16,000 | 67 | <u>2.7</u> | <u>63,000</u> | <u>347.4</u> | 930 | — |
| R-446A | zeotrope | R-32/1234ze(E)/600 (68.0/29.0/3.0) | A2^e <u>A2L</u> | 2.5 | 16,000 | 39 | <u>13.5</u> | <u>62,000</u> | <u>217.4</u> | 960 | — |
| R-447A | zeotrope | R-32/125/1234ze(E) (68.0/3.5/28.5) | A2^e <u>A2L</u> | 2.6 | 16,000 | 42 | <u>18.9</u> | <u>65,000</u> | <u>303.5</u> | 900 <u>960</u> | — |
| R-447B | zeotrope | R-32/125/1234ze(E) (68.0/8.0/24.0) | A2^e <u>A2L</u> | 23 <u>2.6</u> | 30,000 <u>16,000</u> | 360 <u>42</u> | <u>20.6</u> | <u>121,000</u> <u>0</u> | <u>312.7</u> | 970 | — |
| 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 <u>860</u> | — |

| | | | | | | | | | | | | |
|--------|----------|---|---------------------|-----------------------|-----------------------------------|----------------------|------|--------------|-------|-----------------------|-----------------------|---|
| R-449A | zeotrope | R-32/125/1234yf/134a (24.3/24.7/25.3/25.7) | A1 | 23 | 100,000 | 370 | | | | | 830 840 | — |
| R-449B | zeotrope | R-32/125/1234yf/134a (25.2/24.3/23.2/27.3) | A1 | 23 | 100,000 | 370 | | | | | 850 | — |
| R-449C | zeotrope | R-32/125/1234yf/134a (20.0/20.0/31.0/29.0) | A1 | 23 | 98,000 | 360 | | | | | 800 | — |
| 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 ^e A2L | 5.3 5.0 | 18,000 | 81 | 20.3 | 70,000 | 326.6 | 520 530 | — | — |
| R-451B | zeotrope | R-1234yf/134a (88.8/11.2) | A2 ^e A2L | 5.3 5.0 | 18,000 | 81 | 20.3 | 70,000 | 326.6 | 530 | — | — |
| R-452A | zeotrope | R-32/125/1234yf (11.0/59.0/30.0) | A1 | 27 | 10,000 100,000 0 | 440 | | | | | 780 790 | — |
| R-452B | zeotrope | R-32/125/1234yf (67.0/7.0/26.0) | A2 ^e A2L | 23 4.8 | 30,000 | 360 77 | 19.3 | 119,000 0 | 310.5 | 870 | — | — |
| R-452C | zeotrope | R-32/125/1234yf (12.5/61.0/26.5) | A1 | 27 | 100,000 | 430 | | | | | 800 810 | — |
| R-453A | zeotrope | R-32/125/134a/227ea/600/601a (20.0/20.0/53.8/5.0/0.6/ 0.6) | A1 | 7.8 | 34,000 | 120 | | | | | 1,000 | — |
| R-454A | zeotrope | R-32/1234yf (35.0/65.0) | A2 ^e A2L | 28 3.2 | 16,000 | 450 52 | 18.3 | 63,000 | 293.9 | 690 | — | — |
| R-454B | zeotrope | R-32/1234yf (68.9/31.1) | A2 ^e A2L | 22 3.1 | 19,000 | 360 49 | 22.0 | 77,000 | 352.6 | 850 | — | — |

(continued)

TABLE 1103.1—continued
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

| CHEMICAL REFRIGERANT | FORMULA | CHEMICAL NAME OF BLEND | REFRIGERANT SAFETY GROUP CLASSIFICATION | AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | | | | [F] DEGREES OF HAZARD ^a | |
|----------------------|----------|---|---|--|-----------------------------|----------------------|--------|--------------|------------------|------------------------------------|----------------------|
| | | | | Pounds per 4,000 cubic feet lb/Mcf | RCL | | LFL | | OEL ^d | | |
| | | | | | ppm | g/m ³ | lb/Mcf | ppm | g/m ³ | | OEL ^e ppm |
| R-454C | zeotrope | R-32/1234yf (21.5/78.5) | A2 ^e A2L | 29 4.4 | 19,000 | 460 71 | 18.0 | 62,000 | 289.5 | 620 | — |
| R-455A | zeotrope | R-744/32/1234yf (3.0/21.5/75.5) | A2 ^e A2L | 23 4.9 | 30,000 22,000 | 380 79 | 26.9 | 118,000 0 | 432.1 | 650 | — |
| R-456A | zeotrope | R-32/134a/1234ze(E) (6.0/45.0/49.0) | A1 | 20 | 77,000 | 320 | | | | 900 | — |
| R-457A | zeotrope | R-32/1234yf/152a (18.0/70.0/12.0) | A2 ^e A2L | 25 3.4 | 15,000 | 400 54 | 13.5 | 60,000 | 216.3 | 650 | — |
| R-457B | zeotrope | <u>R-32/1234yf/152a</u> <u>(35.0/55.0/10.0)</u> | A2L | 3.7 | 19,000 | 59 | 14.9 | 76,000 | 239 | 730 | — |
| R-458A | zeotrope | R-32/125/134a/227ea/236fa (20.5/4.0/61.4/13.5/0.6) | A1 | 18 | 76,000 | 280 | | | | 1,000 | — |

| | | | | | | | | | | | |
|----------------------|-----------------|---|---------------------------|------------------------------|------------------------------------|------------------------------|-------------|---------------------------|--------------|------------------------------|--------------------|
| R-459A | zeotrope | R-32/1234yf/1234ze(E) (68.0/26.0/6.0) | A2* <u>A2L</u> | 23 <u>4.3</u> | 27,000 | 360 <u>69</u> | 17.4 | <u>107.00</u> <u>0</u> | <u>278.7</u> | 870 | — |
| R-459B | zeotrope | R-32/1234yf/1234ze(E) (21.0/69.0/10.0) | A2* <u>A2L</u> | 30 | 16,000 <u>25,000</u> | 470 <u>92</u> | 23.3 | <u>99.000</u> | <u>373.5</u> | 640 | — |
| R-460A | zeotrope | R-32/125/134a/1234ze(E) (12.0/52.0/14.0/22.0) | A1 | 24 | 92,000 | 380 | | | | 650 <u>950</u> | — |
| R-460B | zeotrope | R-32/125/134a/1234ze(E) (28.0/25.0/20.0/27.0) | A1 | 25 | 120,000 | 400 | | | | 950 | — |
| <u>R-460C</u> | <u>zeotrope</u> | <u>R-32/125/134a/1234ze(E)</u> <u>(2.5/2.5/46.0/49.0)</u> | <u>A1</u> | <u>20</u> | <u>73,000</u> | <u>310</u> | | | | <u>900</u> | |
| R-461A | zeotrope | R-125/143a/134a/227ea/600a (55.0/5.0/32.0/5.0/3.0) | A1 | 17 | 61,000 | 270 | | | | 1,000 | — |
| R-462A | zeotrope | R-32/125/143a/134a/600 (9.0/42.0/2.0/44.0/3.0) | A2 | 3.9 | 16,000 | 62 | 16.6 | <u>105.00</u> <u>0</u> | <u>265.8</u> | 1,000 | — |
| R-463A | zeotrope | R-744/32/125/1234yf/134a (6.0/36.0/30.0/14.0/14.0) | A1 | 19 | 98,000 | 300 | | | | 990 | — |
| <u>R-464A</u> | <u>zeotrope</u> | <u>R-32/125/1234ze(E)/227ea</u> <u>(27.0/27.0/40.0/6.0)</u> | <u>A1</u> | <u>27</u> | <u>120.00</u> <u>0</u> | <u>430</u> | | | | <u>930</u> | |
| <u>R-465A</u> | <u>zeotrope</u> | <u>R-32/290/1234yf (21.0/7.9/71.1)</u> | <u>A2</u> | <u>2.5</u> | <u>12,000</u> | <u>40</u> | <u>10.0</u> | <u>98.000</u> | <u>160.9</u> | <u>660</u> | |
| <u>R-466A</u> | <u>zeotrope</u> | <u>R-32/125/1311 (49.0/11.5/39.5)</u> | <u>A1</u> | <u>6.2</u> | <u>30,000</u> | <u>99</u> | | | | <u>860</u> | |
| <u>R-467A</u> | <u>zeotrope</u> | <u>R-32/125/134a/600a</u> <u>(22.0/5.0/72.4/0.6)</u> | <u>A2L</u> | <u>6.7</u> | <u>31,000</u> | <u>110</u> | | | | <u>1,000</u> | |
| <u>R-468A</u> | <u>zeotrope</u> | <u>R-1132a/32/1234yf</u> <u>(3.5/21.5/75.0)</u> | <u>A2L</u> | <u>4.1</u> | <u>18,000</u> | <u>66</u> | | | | <u>610</u> | |
| <u>R-469A</u> | <u>zeotrope</u> | <u>R-744/R-32/R-125</u> <u>(35.0/32.5/32.5)</u> | <u>A1</u> | <u>8</u> | <u>53,000</u> | <u>130</u> | | | | <u>1,600</u> | |
| <u>R-470A</u> | <u>zeotrope</u> | <u>R-744/32/125/134a/1234ze(E)/</u> <u>227ea</u> <u>(10.0/17.0/19.0/7.0/44.0/3.0)</u> | <u>A1</u> | <u>17</u> | <u>77,000</u> | <u>270</u> | | | | <u>1,100</u> | |
| <u>R-470B</u> | <u>zeotrope</u> | <u>R-744/32/125/134a/1234ze(E)/</u> <u>227ea</u> <u>(10.0/11.5/11.5/3.0/57.0/7.0)</u> | <u>A1</u> | <u>16</u> | <u>72,000</u> | <u>260</u> | | | | <u>1,100</u> | |
| <u>R-471A</u> | <u>zeotrope</u> | <u>R-1234ze(E)/227ea/1336mzz(E)</u> <u>(78.7/4.3/17.0)</u> | <u>A1</u> | <u>9.7</u> | <u>31,000</u> | <u>160</u> | | | | <u>710</u> | |
| <u>R-472A</u> | <u>zeotrope</u> | <u>R-744/32/134a (69.0/12.0/19.0)</u> | <u>A1</u> | <u>4.5</u> | <u>35,000</u> | <u>72</u> | | | | <u>2,700</u> | |
| R-500 ^{e,d} | azeotrope | R-12/152a (73.8/26.2) | A1 | 7.6 <u>7.4</u> | 30,000 <u>29,000</u> | 120 | | | | 1,000 | 2-0-0 ^b |
| R-501 ^{d,c} | azeotrope | R-22/12 (75.0/25.0) | A1 | 13 | 54,000 | 210 | | | | 1,000 | — |
| R-502 ^{e,d} | azeotrope | R-22/115 (48.8/51.2) | A1 | 21 | 73,000 | 330 | | | | 1,000 | 2-0-0 ^b |
| R-503 ^{e,d} | azeotrope | R-23/13 (40.1/59.9) | — | — | — | — | | | | 1,000 | 2-0-0 ^b |
| R-504 ^{d,c} | 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 <u>510</u> | | | | 1,000 | 2-0-0 ^b |
| R-508A | azeotrope | R-23/116 (39.0/61.0) | A1 | 14 | 55,000 | 220 | | | | 1,000 | 2-0-0 ^b |
| R-508B | azeotrope | R-23/116 (46.0/54.0) | A1 | 13 | 52,000 | 200 | | | | 1,000 | 2-0-0 ^b |

| | | | | | | | | | | | |
|---------------|------------------|---------------------------------------|-----------|------------------------------|------------------------------------|-----------------------------|-------------|---------------|--------------|------------|--------------------|
| R-509A | azeotrope | R-22/218 (44.0/56.0) | A1 | 24 | 75,000 | 390 380 | | | | 1,000 | 2-0-0 ^b |
| R-510A | azeotrope | R-E170/600a (88.0/12.0) | A3 | 0.87 | 7,300 | 14 | <u>3.5</u> | <u>29,000</u> | <u>56.1</u> | 1,000 | — |
| R-511A | azeotrope | R-290/E170 (95.0/5.0) | A3 | 0.59 | 5,300 | 9.5 | <u>2.4</u> | <u>21,000</u> | <u>38.0</u> | 1,000 | — |
| R-512A | azeotrope | R-134a/152a (5.0/95.0) | A2 | 1.9 | 11,000 | 31 | <u>7.7</u> | <u>45,000</u> | <u>123.9</u> | 1,000 | — |
| R-513A | azeotrope | R-1234yf/134a (56.0/44.0) | A1 | 20 | 72,000 | 320 | | | | 650 | — |
| R-513B | azeotrope | R-1234yf/134a (58.5/41.5) | A1 | 21 | 74,000 | 330 | | | | 640 | — |
| R-514A | azeotrope | R-1336mzz(S)/1130(E) (74.7/25.3) | B1 | 0.86 | 2,400 | 14 | | | | 320 | — |
| R-515A | azeotrope | R-1234ze(E)/227ea (88.0/12.0) | A1 | 19 | 62,000 <u>63,000</u> | 300 | | | | 810 | — |
| <u>R-515B</u> | <u>azeotrope</u> | <u>R-1234ze(E)/227ea (91.1/8.9)</u> | <u>A1</u> | <u>18</u> | <u>61,000</u> | <u>290</u> | | | | <u>810</u> | |
| R-516A | azeotrope | R-1234yf/134a/152a (77.5/8.5/14.0) | A2 | 7.0 <u>3.2</u> | 27,000 <u>13,000</u> | 110 <u>52</u> | <u>13.1</u> | <u>50,000</u> | <u>210.1</u> | 590 | — |

(continued)

TABLE 1103.1—continued
REFRIGERANT CLASSIFICATION, AMOUNT AND OEL

| CHEMICAL REFRIGERANT | FORMULA | CHEMICAL NAME OF BLEND | REFRIGERANT SAFETY GROUP CLASSIFICATION | AMOUNT OF REFRIGERANT PER OCCUPIED SPACE | | | | | | | [F] DEGREES OF HAZARD ^a |
|----------------------|---|--|---|--|--------|------------------------------|------------|---------------|------------------|----------------------|------------------------------------|
| | | | | RCL | | | LFL | | OEL ^d | | |
| | | | | Pounds per 1,000 cubic feet lb/Mcf | ppm | g/m ³ | lb/Mcf | ppm | g/m ³ | OEL ^e ppm | |
| R-600 | CH ₃ CH ₂ CH ₂ CH ₃ | butane | A3 | 0.15 | 1,000 | 2.4 | <u>3.0</u> | <u>20,000</u> | <u>48</u> | 1,000 | 1-4-0 |
| R-600a | CH(CH ₃) ₂ CH ₃ | 2-methylpropane (isobutane) | A3 | 0.59 | 4,000 | 9.6 <u>9.5</u> | <u>2.4</u> | <u>16,000</u> | <u>38</u> | 1,000 | 2-4-0 |
| R-601 | CH ₃ CH ₂ CH ₂ CH ₂ CH ₃ | pentane | A3 | 0.18 | 1,000 | 2.9 | <u>2.2</u> | <u>12,000</u> | <u>35</u> | 600 | — |
| R-601a | (CH ₃) ₂ CHCH ₂ CH ₃ | 2-methylbutane (isopentane) | A3 | 0.18 | 1,000 | 2.9 | <u>2.4</u> | <u>13,000</u> | <u>38</u> | 600 | — |
| R-610 | CH ₃ CH ₂ OCH ₂ CH ₃ | ethoxyethane (ethyl ether) | — | — | — | — | | | | 400 | — |
| R-611 | HCOOCH ₃ | methyl formate | B2 | — | — | — | | | | 100 | — |
| R-718 | H ₂ O | water | A1 | — | — | — | | | | — | 0-0-0 |
| R-744 | CO ₂ | carbon dioxide | A1 | 4.5 | 40,000 | 72 | | | | 5,000 | 2-0-0 ^b |
| R-1130(E) | CHCl=CHCl | trans-1,2-dichloroethene | B1 <u>B2</u> | 0.25 | 1,000 | 4 | <u>16</u> | <u>65,000</u> | <u>258</u> | 200 | — |
| R-1132a | CF ₂ =CH ₂ | 1,1-difluoroethylene | A2 | 2.0 | 13,000 | 33 | <u>8.1</u> | <u>50,000</u> | <u>131</u> | 500 | — |
| R-1150 | CH ₂ =CH ₂ | ethene (ethylene) | A3 | — | — | — | <u>2.2</u> | <u>31,000</u> | <u>36</u> | 200 | 1-4-2 |
| R-1224yd(Z) | CF ₃ CF=CHCl | (Z)-1-chloro-2,3,3,3-tetrafluoroethylene | A1 | 23 | 60,000 | 360 <u>370</u> | | | | 1,000 | — |

| | | | | | | | | | | | |
|-------------------------|---|--|---------------------|------------------------------|------------------|----------------------------|------|---------------|------------|----------------|-------|
| R-1233zd(E) | CF ₃ CH=CHCl | trans-1-chloro-3,3,3-trifluoro-1-propene | A1 | 5.3 | 16,000 | 85 | | | | 800 | — |
| R-1234yf | CF ₃ CF=CH ₂ | 2,3,3,3-tetrafluoro-1-propene | A2 ^e A2L | <u>4.7</u> <u>4.5</u> | 16,000 | 75 | 18.0 | <u>62,000</u> | <u>289</u> | 500 | — |
| R-1234ze(E) | CF₃CH=CHF CF ₃ CH=CFH | trans-1,3,3,3-tetrafluoro-1-propene | A2 ^e A2L | 4.7 | 16,000 | 75 <u>76</u> | 18.8 | <u>65,000</u> | <u>303</u> | 800 | — |
| R-1270 | CH ₃ CH=CH ₂ | Propene (propylene) | A3 | 0.1 | 1,000 | 1.7 | | | | 500 | 1-4-1 |
| R-1336mzz(E) | CF₃CH=CHCF₃ | trans-1,1,1,4,4,4-hexafluoro-2-butene | A1 | 3.0 | 7,200 | 48 | | | | 400 | |
| R-1336mzz(Z) | CF ₃ CHCHCF ₃ | cis-1,1,1,4,4,4-hexafluoro-2-butene | A1 | 5.4 <u>5.2</u> | 13,000 | 87 <u>84</u> | | | | 500 | — |

For SI: 1 pound = 0.454 kg, 1 cubic foot = 0.0283m³

- Degrees of hazard are for health, fire, and reactivity, respectively, in accordance with NFPA 704.
- 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.
- ~~The ASHRAE Standard 34 flammability classification for this refrigerant is 2L, which is a subclass of Class 2.~~
- ~~c.~~ Class I ozone depleting substance; prohibited for new installations.
- ~~d.~~ 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.

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. High-probability systems used for human comfort shall use Group A1 or A2L refrigerant.~~

Exceptions:

- Equipment listed for and used in residential occupancies containing a maximum of 6.6 pounds (3 kg) of refrigerant.
- Equipment listed for and used in commercial occupancies containing a maximum of 22 pounds (10 kg) of refrigerant.
- Industrial occupancies.

1104.3.2 Nonindustrial occupancies Group A2, A3, B2 and B3 refrigerants. ~~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 A2 and B2 refrigerants shall not be used in high-probability systems. Group A3 and B3 refrigerants shall not be used except where approved.~~

~~Exception~~**Exceptions:** This section does not apply to: ~~laboratories where the floor area per occupant is not less than 100 square feet (9.3 m²).~~

- Laboratories where the floor area per occupant is not less than 100 square feet (9.3 m²).
- Listed self-contained systems having a maximum of 0.331 pounds (150 g) of Group A3 refrigerant.
- Industrial occupancies.
- Equipment listed for and used in residential occupancies containing a maximum of 6.6 pounds (3 kg) of Group A2 or B2 refrigerant.
- Equipment listed for and used in commercial occupancies containing a maximum of 22 pounds (10 kg) of Group A2 or B2 refrigerant.

**TABLE 1104.3.2
MAXIMUM PERMISSIBLE QUANTITIES OF REFRIGERANTS**

| TYPE OF REFRIGERATION SYSTEM | MAXIMUM POUNDS FOR VARIOUS OCCUPANCIES | | | |
|------------------------------|--|-----------------|-------------|-----------------------|
| | Institutional | Public assembly | Residential | All other occupancies |

| | | | | |
|---------------------------------|---|-----|-----|-----|
| Scaled absorption system | | | | |
| —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 |
| Unit systems | | | | |
| —In other than exit access | 0 | 0 | 6.6 | 6.6 |

For SI: 1 pound = 0.454 kg.

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1106.3 Flammable Class 2 and 3 refrigerants. Where refrigerants of Groups A2, A3, B2 and B3 are used, the *machinery room* shall conform to the Class I, Division 2, *hazardous location* classification requirements of NFPA 70.

Exception: *Machinery rooms* for systems containing Group A2L refrigerants that are provided with ventilation in accordance with Section 1106.4.

1106.4 Special requirements for Group A2L refrigerant machinery rooms. *Machinery rooms* with systems containing Group A2L refrigerants that do not conform to the Class I, Division 2, *hazardous location* electrical requirements of NFPA 70, as permitted by the exception to Section 1106.3, shall comply with Sections 1106.4.1 through 1106.4.3.

Exception: *Machinery rooms* conforming to the Class I, Division 2, *hazardous location* classification requirements of NFPA 70 are not required to comply with Sections 1106.4.1 and 1106.4.2.

1106.4 Group A2L and B2L refrigerant. *Machinery rooms* for Group A2L and B2L refrigerant shall comply with Sections 1106.4.1 through Section 1106.4.3.

[F] 1106.4.1 Ventilation system activation. Ventilation shall be activated by the refrigerant detection system in the *machinery room*. Refrigerant detection systems shall be in accordance with Section 608.9 of the *International Fire Code* and all of the following:

1. The detectors shall activate at or below a refrigerant concentration of 25 percent of the LFL.
2. Upon activation, the detection system shall activate the emergency ventilation system required by Section 1106.4.2.
3. The detection, signaling and control circuits shall be supervised.

1106.4.1 Elevated temperatures. Open flame-producing devices or continuously operating hot surfaces over 1290°F (700°C) shall not be permanently installed in the room.

1106.4.2 Emergency ventilation system. An emergency ventilation system shall be provided at the minimum exhaust rate specified in ASHRAE 15 or Table 1106.4.2. Shutdown of the emergency ventilation system shall be by manual means.

1106.4.2 Refrigerant detector. In addition to the requirements of Section 1105.3, refrigerant detectors shall signal an alarm and activate the ventilation system in accordance with the response time specified in Table 1106.4.2.

**TABLE 1106.4.2
MINIMUM EXHAUST RATES**

| REFRIGERANT | Q(m/sec) | Q(efm) |
|-------------|----------|--------|
| 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 |
|------------|------|--------|

TABLE 1106.4.2 GROUP A2L and B2L DETECTOR ACTIVATION

| Activation Level | Maximum Response Time (seconds) | ASHRAE 15 Ventilation Level | Alarm Reset | Alarm Type |
|---|---------------------------------|-----------------------------|-------------|------------|
| Less than or equal to the OEL in Table 1103.1 | 300 | 1 | Automatic | Trouble |
| Less than or equal to the refrigerant concentration level in Table 1103.1 | 15 | 2 | Manual | Emergency |

1106.4.3 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.

1106.4.3 Mechanical ventilation. The machinery room shall have a mechanical ventilation system complying with ASHRAE 15.

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**TABLE 1107.4
REFRIGERANT PIPE**

| PIPING MATERIAL | STANDARD |
|---------------------------|--|
| Aluminum tube | ASTM B210/ASTM B210M, ASTM B491/B491M |
| Brass (copper alloy) pipe | ASTM B43 |
| Copper linesets | ASTM B280, ASTM B1003 |
| Copper pipe | ASTM B42, ASTM B302 |
| Copper tube ^a | ASTM B68, ASTM B75, ASTM B88, ASTM B280, ASTM B819 |
| Steel pipe ^b | ASTM A53, ASTM A106, ASTM A333 |
| Steel tube | ASTM A254, ASTM A334 |

- a. Soft annealed copper tubing larger than 1³/₈ inch (35 mm) O.D. shall not be used for field-assembled refrigerant piping unless it is protected from mechanical damage.
- b. ASTM A53, Type F steel pipe shall not be used for refrigerant lines having an operating temperature less than -20°F (-29°C). only be permitted for discharge lines in pressure relief systems.

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**TABLE 1107.5
REFRIGERANT PIPE FITTINGS**

| FITTING MATERIAL | STANDARD |
|---------------------------------|--|
| Aluminum | ASTM B361 |
| Brass (copper alloy) | ASME B16.15, ASME B16.24 |
| Copper and Copper Alloy (Brass) | ASME B16.15, ASME B16.18, ASME B16.22, ASME B16.24, ASME B16.26, ASME B16.50 |

| | |
|-------|--|
| Steel | ASTM A105, ASTM A181, ASTM A193, ASTM A234, ASTM A420, ASTM A707 |
|-------|--|

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1107.7 Flexible connectors, expansion and vibration compensators. Flexible connectors and expansion and vibration control devices shall be *listed* and *labeled* for use in refrigerant systems and pressures for which the components are installed.

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1109.2.2 Refrigerant pipe enclosure. Refrigerant piping shall be protected by locating it within the building elements or within protective enclosures.

Exception: Piping protection within the building elements or protective enclosure shall not be required in any of the following locations:

1. Where installed without ready access or located more than 7 feet 3 inches (2210 mm) above the finished floor.
2. Where located within 6 feet (1829 mm) of the refrigerant unit or *appliance*.
3. Where located in a *machinery room* complying with Section 1105.
4. Outside the building:
 - 4.1 Protected from damage from the weather, including, but not limited to, hail, ice, and snow loads and
 - 4.2 Protected from damage within the expected foot or traffic path or
 - 4.3 Outside, underground, installed not less than 8 inches (200 mm) below finished grade and protected against corrosion.

1109.2.3 Prohibited locations. Refrigerant piping shall not be installed in any of the following locations:

1. Exposed within a fire-resistance-rated exit access corridor.
2. ~~Exposed within~~ ~~Within~~ an interior exit stairway.
3. Within an interior exit ramp.
4. Within an exit passageway.
5. Within an elevator, dumbwaiter or other shaft containing a moving object.

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1109.2.6 Exposed piping surface temperature. Exposed piping with ready access to nonauthorized personnel having surface temperatures greater than 120°F (49°C) or less than 5°F (-15°C) shall be protected from contact or shall have thermal insulation that limits the exposed insulation surface temperature to a range of 5°F (-15°C) to 120°F (49°C).

1109.2.7 Pipe identification. Refrigerant pipe located in areas other than the room or space where the refrigerating *equipment* is located shall be identified. The pipe identification shall be located at intervals not exceeding 20 feet (6096 mm) on the refrigerant piping or pipe insulation. The minimum height of lettering of the identification label shall be 1/2 inch (12.7 mm). The identification shall indicate the refrigerant designation and safety group classification of refrigerant used in the piping system. For Group A2L and B2L refrigerants, the identification shall also include the following statement: “WARNING – Risk of Fire. Flammable Refrigerant.” For Group A2, A3, B2 and B3 refrigerants, the identification shall also include the following statement: “DANGER—Risk of Fire or Explosion. Flammable Refrigerant.” For any Group B refrigerant, the identification shall also include the following statement: “DANGER—Toxic Refrigerant.”

1109.3 Installation requirements for Group A2L, A2, A3, ~~or~~ B2L, B2, or B3 refrigerant. Piping systems using Group A2L, A2, A3 ~~or~~ B2L, B2, or B3 refrigerant shall comply with the requirements of Sections 1109.3.1 and 1109.3.2.

1109.3.1 Pipe protection. In addition to the requirements of Section 305.5, aluminum, copper and steel tube used for Group A2L, A2, A3, ~~and~~ B2L, B2, and B3 refrigerants and located in concealed locations where tubing is installed in studs, joists, rafters or similar member spaces, and located less than 1 1/2 inches (38 mm) from the nearest edge of the member, shall be continuously protected by shield plates. Protective steel shield plates having a minimum thickness of 0.0575 inch (1.46 mm) (No. 16 gage) shall cover the area of the tube plus the area extending not less than 2 inches (51 mm) beyond both sides of the tube.

1109.3.2 Shaft ventilation. Refrigerant pipe shafts with systems using Group A2L or B2L refrigerant shall be naturally or mechanically ventilated. Refrigerant pipe shafts with one or more systems using any Group A2, A3, B2, or B3 refrigerant shall be continuously mechanically ventilated and shall include a refrigerant detector. The shaft ventilation exhaust outlet shall comply with Section 501.3.1. Naturally ventilated shafts shall have a pipe, duct or conduit not less

than 4 inches (102 mm) in diameter that connects to the lowest point of the shaft and extends to the outdoors. The pipe, duct or conduit shall be level or pitched downward to the outdoors. Mechanically ventilated shafts shall have a minimum airflow velocity in accordance with Table 1109.3.2. The mechanical ventilation shall be continuously operated or activated by a refrigerant detector. Systems utilizing a refrigerant detector shall activate the mechanical ventilation at a maximum refrigerant concentration of 25 percent of the lower flammable limit of the refrigerant. 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 shaft shall not be required to be ventilated for double-wall refrigerant pipe where the interstitial space of the double-wall pipe is vented to the outdoors.

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~~1109.4~~ Installation requirements for Group A2, A3, B2 or B3 refrigerant. Piping systems using Group A2, A3, B2 or B3 refrigerant shall comply with the requirements of Sections ~~1109.4.1~~ and ~~1109.4.2~~.

~~1109.4.1~~ Piping material. Piping material for Group A2, A3, B2 or B3 refrigerant located inside the building, except for *machinery rooms*, shall be copper pipe, brass pipe or steel pipe. Pipe joints located in areas other than the *machinery room* shall be welded. Self-contained *listed* and *labeled equipment* or *appliances* shall have piping material based on the listing requirements.

~~1109.4.2~~ Shaft ventilation. Refrigerant pipe shafts with systems using Group A2, A3, B2 or B3 refrigerant shall be continuously mechanically ventilated. The shaft ventilation exhaust outlet shall comply with Section ~~501.3.1~~. Mechanically ventilated shafts shall have a minimum airflow velocity as specified in Table 1109.3.2. The shaft shall not be required to be ventilated for double-wall refrigerant pipe where the interstitial space of the double-wall pipe is vented to the outdoors.

~~1109.5~~1109.4 Refrigerant pipe penetrations. The annular space between the outside of a refrigerant pipe and the inside of a pipe sleeve or opening in a building envelope wall, floor or ceiling assembly penetrated by a refrigerant pipe shall be sealed in an manner with caulking material or foam sealant or closed with a gasketing system. The caulking material, foam sealant or gasketing system shall be designed for the conditions at the penetration location and shall be compatible with the pipe, sleeve and building materials in contact with the sealing materials. Refrigerant pipes penetrating fire-resistance-rated assemblies or membranes of fire-resistance-rated assemblies shall be sealed or closed in accordance with Section 714 of the *International Building Code*.

~~1109.6~~1109.5 Stress and strain. Refrigerant piping shall be installed so as to prevent strains and stresses that exceed the structural strength of the pipe. Where necessary, provisions shall be made to protect piping from damage resulting from vibration, expansion, contraction and structural settlement.

~~1109.7~~ Condensate control. Refrigerating 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 has the potential to cause a safety hazard to the building occupants, structure, electrical *equipment* or any other *equipment* or *appliances*, shall be insulated or protected in an *approved* manner to prevent damage from condensation.

~~1109.8~~1109.6 Stop valves. Stop valves shall be installed in specified locations in accordance with Sections ~~1109.8.1~~1109.6.1 and ~~1109.8.2~~1109.6.2. Stop valves shall be supported in accordance with Section ~~1109.8.3~~1109.6.3 and identified in accordance with Section ~~1109.8.4~~1109.6.4.

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 pumping out the refrigerant using either portable or permanently installed refrigerant recovery *equipment*.
3. Self-contained *listed* and *labeled* systems.

~~1109.8.1~~1109.6.1 Refrigerating systems containing more than 6.6 pounds (3.0 kg) of refrigerant. Stop valves shall be installed in the following locations on refrigerating systems containing more than 6.6 pounds (3.0 kg) of refrigerant:

1. The suction inlet of each compressor, compressor unit or condensing unit.
2. The discharge outlet of each compressor, compressor unit or condensing unit.
3. The outlet of each liquid receiver.

~~1109.8.2~~1109.6.2 Refrigerating systems containing more than 100 pounds (45 kg) of refrigerant. In addition to stop valves required by Section ~~1109.8.1~~1109.6.1, systems containing more than 100 pounds (45 kg) of refrigerant shall have stop valves installed in the following locations:

1. Each inlet of each liquid receiver.

2. Each inlet and each outlet of each condenser where more than one condenser is used in parallel.

Exceptions:

1. Stop valves shall not be required at the inlet of a receiver in a condensing unit nor at the inlet of a receiver that is an integral part of the condenser.
2. Systems utilizing nonpositive displacement compressors.

~~1109.8.3~~**1109.6.3 Stop valve support.** Stop valves shall be supported to prevent detrimental stress and strain on the refrigerant piping system. The piping system shall not be utilized to support stop valves on copper tubing or aluminum tubing 1 inch (25.4 mm) outside diameter or larger.

~~1109.8.4~~**1109.6.4 Identification.** Stop valves shall be identified where their intended purpose is not obvious. Where valves are identified by a numbering or lettering system, legend(s) or key(s) for the valve identification shall be located in the room containing the indoor refrigeration *equipment*. The minimum height of lettering of the identification label shall be 1/2 inch (12.7 mm).

~~1109.9~~**1109.7 Pipe Supports.** Pipe supports shall be in accordance with Section 305.

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1110.3 Test gases. The medium used for pressure testing the refrigerant system shall be one of the following inert gases: oxygen-free nitrogen, helium, ~~or~~ argon or premixed nonflammable oxygen-free nitrogen with a tracer gas of hydrogen or helium. For R-744 refrigerant systems, carbon dioxide shall be allowed as the test medium. For R-718 refrigerant systems, water shall be allowed as the test medium. ~~Oxygen, air, combustible gases and mixtures containing such gases shall not be used as a test medium. Systems erected on the premises with tubing not exceeding 5/8 inch (15.9 mm) outside diameter shall be allowed to use the refrigerant identified on the nameplate label or marking as the test medium.~~

1110.3.1 Test gases not permitted. Oxygen, air, refrigerants other than those identified in Section 1110.3, combustible gases and mixtures containing such gases shall not be used as the pressure test medium.

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1110.5 Piping system strength test pressure test and leak test. Refrigerating system components and refrigerant piping shall be tested in accordance with ASME B31.5 or this section. Separate tests for isolated portions of the system are permitted provided that all required portions are tested at least once. Pressurize with test gas for a minimum of 10 minutes to not less than the lower of (a) the lowest design pressure for any system component, or (b) the lowest value of set pressure for any pressure relief devices in the system. The design pressures for determination of test pressure shall be the pressure identified on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel, or other system component with a nameplate. A passing test result shall have no rupture or structural failure of any system component or refrigerant piping. Refrigerant piping and tubing greater than 3/4 inch (19 mm) in diameter shall be tested in accordance with ASHRAE 15. The refrigerant piping system shall be tested as a whole or separate tests shall be conducted for the low pressure side and high pressure side of the piping system. The refrigerant piping system shall be tested in accordance with both of the following methods:

- ~~1. The system shall be pressurized for a period of not less than 60 minutes to 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 the pressure *listed* on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. Additional test gas shall not be added to the system after the start of the pressure test. The system shall not show loss of pressure on the test pressure measuring device during the pressure test. Where using refrigerant as a test medium in accordance with Section 1110.3, the test pressure shall be not less than the saturation dew point pressure at 77°F (25°C).~~
2. A vacuum of 500 microns shall be achieved. After achieving a vacuum, the system shall be isolated from the vacuum pump. The system pressure shall not rise above 1,500 microns for a period of not less than 10 minutes.

~~**1110.5.1 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 that conveys conditioned air to and from human-occupied spaces shall be tested at a pressure of 150 percent of the higher of the design pressure or pressure relief device setting.~~

~~**1110.5.2 Limited charge systems.** Limited charge systems 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. *Listed* and *labeled* limited charge systems shall be tested at the *equipment* or *appliance* design pressure.~~

~~1110.6 Booster compressor.~~ Where a compressor protected by a pressure relief device is used as a booster to obtain an intermediate pressure, and such compressor discharges into the suction side of another compressor, the booster compressor shall be considered to be a part of the low pressure side of the system.

~~1110.7 Centrifugal/nonpositive displacement compressors.~~ Where testing systems using centrifugal or other nonpositive displacement compressors, the entire system shall be considered to be the low pressure side for test purposes.

~~1110.8~~**1110.6 Contractor or engineer declaration.** The installing contractor or *registered design professional* of record shall issue a certificate of test to the code official for all systems containing 55 pounds (25 kg) or more of refrigerant. The certificate shall give the test date, name of the refrigerant, test medium and the field test pressure applied to the high-pressure side and the low-pressure side of the system. The certification of test shall be signed by the installing contractor or *registered design professional* and shall be made part of the public record.

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CHAPTER 15

REFERENCED STANDARDS

....

ASHRAE

ASHRAE
1791 Tullie Circle NE
Atlanta, GA 30329

15—~~2019~~2022

Safety Standard for Refrigeration Systems

1101.1.1, Table 1106.4.2, 1106.4.3, 1110.5

34—~~2019~~2022

Designation and Safety Classification of Refrigerants

1102.2.1, 1103.1, ~~Table 1103.1~~

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ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428

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A333-18

Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and other Applications with required Notch Toughness

Table 1107.4

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UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

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UL/CSA 60335-2-40—~~2019~~2022

Household and Similar Electrical Appliances—Safety—Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers – 3rd Edition

908.1, 916.1, 918.1, 918.2, Table 1101.2, 1101.2.1

UL/CSA 60335-2-89—~~172021~~

Household and Similar Electrical Appliances—Safety—Part 2-89: Particular Requirements for Commercial Refrigerating Appliances with an Incorporated or Remote Refrigerant Unit or Compressor

Table 1101.2, 1101.2.1