



FACTSHEET 1

Update on New Refrigerants Designations and Safety Classifications

February 2024

The purpose of this fact sheet is to provide an update on ASHRAE standards for refrigerants and to introduce the new refrigerants that have been awarded an «R» number over the last few years and introduced into the international market.

Standard 34

ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants*, establishes a simple means of referring to common refrigerants rather than by their chemical name, formula, or trade name. ASHRAE assigns numbers and safety classification to the refrigerants based on toxicity and flammability

data submitted by the refrigerant's producer. For pure compounds, the numbers are based on chemical formula. For blends, numbers are assigned sequentially based on the completion of a satisfactory review of data provided by the refrigerant's producer. Information is available in the current edition, ANSI/ASHRAE Standard 34-2022.

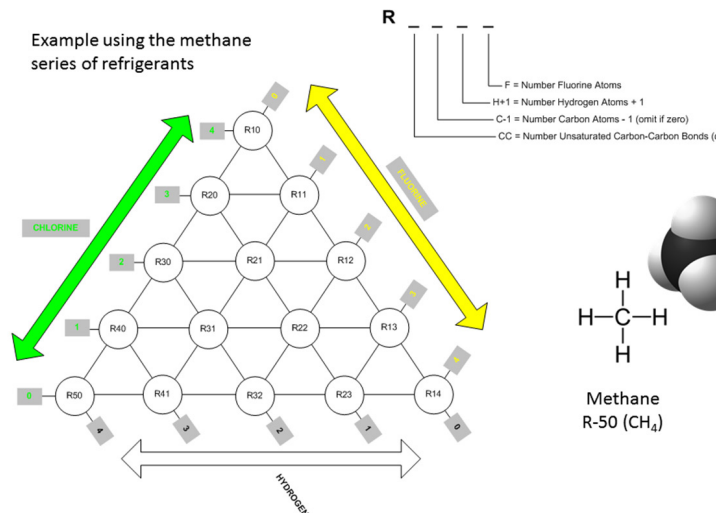
ASHRAE's Numbering System

Refrigerants are numbered with an R-, followed by the ASHRAE-assigned number.

Isomers (molecule with the same chemical formula as another molecule but with a different chemical structure) are identified with a lower case letter after the number (for example, R-134a). Refrigerant blends having the same pure components but with different compositions are identified with an upper case letter after the number (for example, R-401A and R-401B).

Refrigerants having the form R-4xxx are zeotropic (blends of two or more refrigerants whose liquid phase and vapor phase always have different composition), while those with the form R-5xxx are azeotropes (blends of refrigerants whose liquid phase and vapor phase have the same compositions at a specific pressure).

ASHRAE Standard 34



Hazard Classification

Standard 34 assigns an identifying reference letter and number to each refrigerant to classify it according to the hazard involved in its use.

The capital letter designates a toxicity class based on allowable exposure. The numeral denotes flammability.

For example, Standard 34 defines two safety classifications for toxicity. Class A denotes refrigerants of lower toxicity, and class B denotes refrigerants of higher toxicity.

For flammability, there are three classifications and one subclass. The three main flammability classifications are class 1, for refrigerants that do not propagate a flame when tested as per the standard; class 2, for refrigerants of lower flammability; and class 3, for highly flammable refrigerants such as the hydrocarbons.

Although there are classifications, there are extreme ambient conditions which, coupled with the refrigerant nature, can lead to higher toxicity.

Flammability subclass 2L designates flammability class 2 refrigerants that burn very slowly. Some HFOs, which have very low global warming potential, are mildly flammable, and are classified as A2L. This indicates that they are of lower toxicity and have low burning velocity.

ASHRAE Standard 34 – Basis of Standard

- Safety Group Classifications

| F L A M M A B I L I T Y | SAFETY GROUP | | |
|--|----------------------|-----------------|----|
| | Higher Flammability | A3 | B3 |
| | Lower Flammability | A2 | B2 |
| | No Flame Propagation | A1 | B1 |
| | Lower Toxicity | Higher Toxicity | |

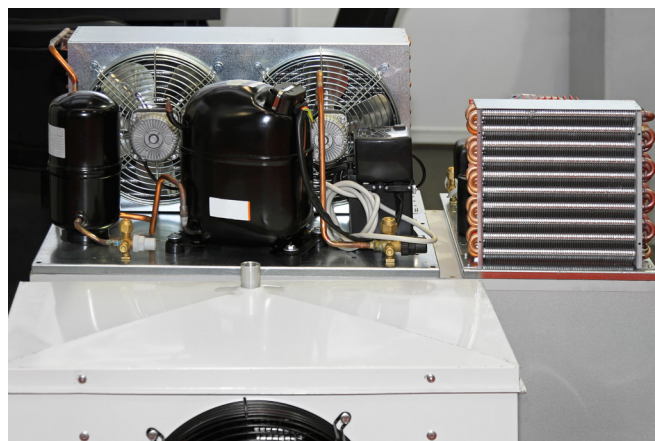
INCREASING TOXICITY →

* A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤ 3.9 in./s (10 cm/s).

Standard 15

ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*, sets forth requirements to help protect people and property where refrigeration facilities are located. Further information is available in the current edition, ANSI/ASHRAE Standard 15-2022.

Personal injury and property damage can result from a number of origins, such as rupture of a part with flying debris, release of refrigerant from a fracture or fire resulting from or intensified by burning, or deflagration of escaping refrigerant or lubricant. In addition, personal injury can result from the accidental release of refrigerants in inadequately ventilated spaces; narcotic and cardiac sensitization effects; toxic effects of vapor or the decomposition products due to vapor contact with flames or hot surfaces; corrosive attack on the eyes, skin, or other tissue; or freezing of tissue by contact with liquid.



New Refrigerants

The tables on the following pages list the approved refrigerant numbers from the latest edition of Standard 34 and addenda that were assigned from 2010 onward. Global Warming Potential data listed in the table are taken from Tables 3 and 4 of 2021 *ASHRAE Handbook—Fundamentals*, Chapter 29. Safety Group

classifications are taken from Tables 4-1 and 4-2 of Standard 34, and temperature data are taken from Tables D-1 and D2 of Standard 34.

| Refrigerants | | | | |
|-------------------------------|--|---------------------------|---|--|
| Number ^a | Chemical Name ^a | Safety Group ^a | Global Warming Potential (GWP ₁₀₀ ^b) | Normal Boiling Point, °F (°C) ^a |
| Unsaturated Organic Compounds | | | | |
| 1130(E) | trans-1,2-dichloroethene | B2 | N/A ^c | 117.9 (47.7) |
| 1132a | 1,1-difluoroethylene | A2 | N/A ^c | -122.5 (-86.7) |
| 1132(E) | trans-1,2-difluoroethene | B2 | N/A ^c | -62.5 (-52.5) |
| 1224yd(Z) | (Z)-1-chloro-2,3,3,3-tetrafluoropropene | A1 | N/A ^c | 58.1 (14.5) |
| 1233zd(E) | trans-1-chloro-3,3,3-trifluoro-1-propene | A1 | 1 | 64.6 (18.1) |
| 1234ze(E) | trans-1,3,3,3-tetrafluoro-1-propene | A2L | <1 | -2.2 (-19.0) |
| 1311 | trifluoroiodomethane | A1 | N/A ^c | -7.4 (-21.9) |
| 1336mzz(E) | trans-1,1,1,4,4,4-hexafluoro-2-butene | A1 | N/A ^c | 45.3 (7.4) |
| 1336mzz(Z) | cis-1,1,1,4,4,4-hexafluoro-2-butene | A1 | 2 | 91.4 (33.4) |

| Refrigerant Blends | | | | | | | |
|--------------------|---|---------------------------|---|-------------------------------|----------------------------|-------------------------------|----------------------------|
| Num. ^a | Composition (Mass %) ^a | Safety Group ^a | Global Warming Potential (GWP100 ^b) | Bubble Point, °F ^a | Dew Point, °F ^a | Bubble Point, °C ^a | Dew Point, °C ^a |
| Zeotropes | | | | | | | |
| 407F | R-32/125/134a (30.0/30.0/40.0) | A1 | 1670 | -51.0 | -39.5 | -46.1 | -39.7 |
| 407G | R-32/125/134a (2.5/2.5/95.0) | A1 | N/A ^c | -20.6 | -17.0 | -29.2 | -27.2 |
| 407H | R-32/125/134a (32.5/15.0/52.5) | A1 | N/A ^c | -48.5 | -35.7 | -44.7 | -37.6 |
| 407I | R-32/125/134a (19.5/8.5/72.0) | A1 | N/A ^c | -39.6 | -27.4 | -39.8 | -33.0 |
| 417B | R-125/134a/600 (79.0/18.3/2.7) | A1 | 2740 | -48.8 | -42.7 | -44.9 | -41.5 |
| 417C | R-125/134a/600 (19.5/78.8/1.7) | A1 | N/A ^c | -26.9 | -20.6 | -32.7 | -29.2 |
| 419B | R-125/134a/E170 (48.5/48.0/3.5) | A2 | N/A ^c | -35.3 | -24.7 | -37.4 | -31.5 |
| 422E | R-125/134a/600a (58.0/39.3/2.7) | A1 | N/A ^c | -43.2 | -33.5 | -41.8 | -36.4 |
| 427C | R-32/125/143a/134a (25.0/25.0/10.0/40.0) | A1 | N/A ^c | -50.6 | -38.9 | -45.9 | -39.4 |
| 436C | R-290/600a (95.0/5.0) | A3 | N/A ^c | -42.7 | -39.1 | -41.5 | -39.5 |
| 439A | R-32/125/600a (50.0/47.0/3.0) | A2 | 1830 | -61.6 | -61.2 | -52.0 | -51.8 |
| 440A | R-290/134a/152a (0.6/1.6/97.8) | A2 | 156 | -13.9 | -11.7 | -25.5 | -24.3 |
| 441A | R-170/290/600a/600 (3.1/54.8/6.0/36.1) | A3 | 5 | -43.4 | -4.7 | -41.9 | -20.4 |
| 442A | R-32/125/134a/152a/227ea (31.0/31.0/30.0/3.0/5.0) | A1 | 1750 | -51.7 | -39.8 | -46.5 | -39.9 |
| 443A | R-1270/290v/600a (55.0/40.0/5.0) | A3 | 4 | -48.6 | -42.2 | -44.8 | -41.2 |
| 444A | R-32/152a/1234ze(E) (12.0/5.0/83.0) | A2L | 89 | -29.7 | -11.7 | -34.3 | -24.3 |
| 444B | R-32/152a/1234ze(E) (41.5/10.0/48.5) | A2L | 295 | -48.3 | -30.8 | -44.6 | -34.9 |
| 445A | R-744/134a/1234ze(E) (6.0/9.0/85.0) | A2L | 118 | -58.5 | -10.3 | -50.3 | -23.5 |
| 446A | R-32/1234ze(E)/600 (68.0/29.0/3.0) | A2L | 461 | -56.9 | -47.2 | -49.4 | -44.0 |
| 447A | R-32/125/1234ze(E) (68.0/3.5/28.5) | A2L | 572 | -56.7 | -47.6 | -49.3 | -44.2 |
| 447B | R-32/125/1234ze(E) (68.0/8.0/24.0) | A2L | N/A ^c | -58.2 | -50.8 | -50.1 | -46.0 |
| 448A | R-32/125/1234yf/134a/1234ze(E) (26.0/26.0/20.0/21.0/7.0) | A1 | 1360 | -50.6 | -39.6 | -45.9 | -39.8 |
| 448B | R-32/125/1234yf/134a/1234ze(E) (21.0/21.0/20.0/31.0/7.0) | A1 | N/A ^c | -47.3 | -35.1 | -44.1 | -37.4 |
| 449A | R-32 /125 /1234yf /134a (24.3/24.7/25.3/25.7) | A1 | 1280 | -50.8 | -39.8 | -46.0 | -39.9 |
| 449B | R-32/125/1234yf/134a (25.2/24.3/23.2/27.3) | A1 | 1300 | -51.0 | -40.4 | -46.1 | -40.2 |
| 449C | R-32/125/1234yf/134a (20.0/20.0/31.0/29.0) | A1 | N/A ^c | -48.3 | -36.6 | -44.6 | -38.1 |
| 450A | R-134a/1234ze(E) (42.0/58.0) | A1 | 547 | -10.1 | -9.0 | -23.4 | -22.8 |
| 451A | R-1234yf/134a (89.8/10.2) | A2L | 133 | -23.4 | -22.9 | -30.8 | -30.5 |
| 451B | R-1234yf/134a (88.8/11.2) | A2L | 146 | -23.8 | -23.1 | -31.0 | -31.0 |
| 452A | R-32/125/1234yf (11.0/59.0/30.0) | A1 | 1952 | -52.6 | -45.8 | -47.0 | -43.2 |
| 452B | R-32/125/1234yf (67.0/7.0/26.0) | A2L | N/A ^c | -59.8 | -58.5 | -51.0 | -50.3 |
| 452C | R-32/125/1234yf (12.5/61.0/26.5) | A1 | N/A ^c | -53.5 | -47.6 | -47.5 | -44.2 |
| 453A | R-32/125/134a/227ea/600/601a (20.0/20.0/53.8/5.0/0.6/0.6) | A1 | 1640 | -44.0 | -31.0 | -42.2 | -35.0 |
| 454A | R-32/1234yf (35.0/65.0) | A2L | 238 | -55.1 | -42.9 | -48.4 | -41.6 |
| 454B | R-32/1234yf (68.9/31.1) | A2L | 467 | -59.6 | -58.0 | -50.9 | -50.0 |
| 454C | R-32/1234yf (21.5/78.5) | A2L | N/A ^c | -50.8 | -36.0 | -46.0 | -37.8 |
| 454D | R-32/1234yf (43.0/57.0) | A2L | N/A ^c | -55.8 | -48.1 | -48.8 | -44.5 |
| 455A | R-744/32/1234yf (3.0/21.5/75.5) | A2L | N/A ^c | -60.9 | -38.4 | -51.6 | -39.1 |
| 455B | R-744/32/1234yf (6.0/42.0/52.0) | A2L | N/A ^c | -72.4 | -52.1 | -58.0 | -46.7 |
| 455C | R-744/32/1234yf (3.0/43.0/54.0) | A2L | N/A ^c | -64.2 | -50.4 | -53.4 | -45.8 |
| 456A | R-32/134a/1234ze(E) (6.0/45.0/49.0) | A1 | N/A ^c | -22.7 | -14.1 | -30.4 | -25.6 |
| 457A | R-32/1234yf/152a (18.0/70.0/12.0) | A2L | N/A ^c | -44.9 | -31.9 | -42.7 | -35.5 |

| Refrigerant Blends (continued) | | | | | | | |
|--------------------------------|--|---------------------------|---|-------------------------------|----------------------------|-------------------------------|----------------------------|
| Num. ^a | Composition (Mass %) ^a | Safety Group ^a | Global Warming Potential (GWP100 ^b) | Bubble Point, °F ^a | Dew Point, °F ^a | Bubble Point, °C ^a | Dew Point, °C ^a |
| Zeotropes | | | | | | | |
| 457B | R-32/1234yf/152a (35.0/55.0/10.0) | A2L | N/A ^c | -51.5 | -40.7 | -46.4 | -40.4 |
| 457C | R-32/1234yf/152a (7.5/78.0/14.5) | A2L | N/A ^c | -35.1 | -25.7 | -37.3 | -32.1 |
| 457D | R-32/1234yf/152a (4.0/82.0/14.0) | A2L | N/A ^c | -30.1 | -23.8 | -34.5 | -31.0 |
| 458A | R-32/125/134a/227ea/236fa (20.5/4.0/61.4/13.5/0.6) | A1 | N/A ^c | -39.6 | -26.3 | -39.8 | -32.4 |
| 459A | R-32/1234yf/1234ze(E) (68.0/26.0/6.0) | A2L | N/A ^c | -58.6 | -55.5 | -50.3 | -48.6 |
| 459B | R-32/1234yf/1234ze(E) (21.0/69.0/10.0) | A2L | N/A ^c | -47.2 | -33.0 | -44.0 | -36.1 |
| 460A | R-32/125/134a/1234ze(E) (12.0/52.0/14.0/22.0) | A1 | N/A ^c | -48.3 | -35.0 | -44.6 | -37.2 |
| 460B | R-32/125/134a/1234ze(E) (28.0/25.0/20.0/27.0) | A1 | N/A ^c | -49.4 | -34.8 | -45.2 | -37.1 |
| 460C | R-32/125/134a/1234ze(E) (2.5/2.5/46.0/49.0) | A1 | N/A ^c | -20.6 | -14.8 | -29.2 | -26.0 |
| 461A | R-125/143a/134a/227ea/600a (55.0/5.0/32.0/5.0/3.0) | A1 | N/A ^c | -44.0 | -38.0 | -42.0 | -37.0 |
| 462A | R-32/125/143a/134a/600 (9.0/42.0/2.0/44.0/3.0) | A2 | N/A ^c | -44.7 | -33.9 | -42.6 | -36.6 |
| 463A | R-744/32/125/1234yf/134a (6.0/36.0/30.0/14.0/14.0) | A1 | N/A ^c | -73.1 | -52.4 | -58.4 | -46.9 |
| 464A | R-32/125/1234ze(E)/227ea (27.0/27.0/40.0/6.0) | A1 | N/A ^c | -51.7 | -34.4 | -46.5 | -36.9 |
| 465A | R-32/290/1234yf (21.0/7.9/71.1) | A2 | N/A ^c | -61.2 | -40.0 | -51.8 | -40.0 |
| 466A | R-32/125/131i (49.0/11.5/39.5) | A1 | N/A ^c | -61.1 | -51.7 | -59.8 | -51.0 |
| 467A | R-32/125/134a/600a (22.0/5.0/72.4/0.6) | A2L | N/A ^c | -40.9 | -27.9 | -40.5 | -33.3 |
| 468A | R-1132a/32/1234yf (3.5/21.5/75.0) | A2L | N/A ^c | -60.3 | -38.2 | -51.3 | -39.0 |
| 468B | R-1132a/32/1234yf (6.0/13.0/81.0) | A2L | N/A ^c | -62.3 | -34.2 | -52.4 | -36.8 |
| 468C | R-1132a/32/1234yf (6.0/42.0/52.0) | A2L | N/A ^c | -69.9 | -51.2 | -56.6 | -46.2 |
| 469A | R-744/R-32/R-125 (35.0/32.5/32.5) | A1 | N/A ^c | -109.3 | -78.7 | -78.5 | -61.5 |
| 470A | R-744/32/125/134a/1234ze(E)/227ea (10.0/17.0/19.0/7.0/44.0/3.0) | A1 | N/A ^c | -80.7 | -32.1 | -62.7 | -35.6 |
| 470B | R-744/32/125/134a/1234ze(E)/227ea (10.0/11.5/11.5/3.0/57.0/7.0) | A1 | N/A ^c | -79.1 | -24.5 | -61.7 | -31.4 |
| 471A | R-1234ze(E)/227ea/1336mzz(E) (78.7/4.3/17.0) | A1 | N/A ^c | 1.5 | 7.2 | -16.9 | -13.8 |
| 472A | R-744/32/134a (69.0/12.0/19.0) | A1 | N/A ^c | -119.7 | -78.7 | -84.3 | -61.5 |
| 472B | R-744/32/134a (58.0/10.0/32.0) | A1 | N/A ^c | -117.2 | -66.6 | -82.9 | -54.8 |
| 473A | R-1132a/23/744/125 (20.0/10.0/60.0/10.0) | A1 | N/A ^c | -126.0 | -117.0 | -87.6 | -83.0 |
| 474A | R-1132(E)/1234yf (23.0/77.0) | A2L | N/A ^c | -45.5 | -33.6 | -43.1 | -36.4 |
| 474B | R-1132(E)/1234yf (31.5/68.5) | A2L | N/A ^c | -50.4 | -37.1 | -45.8 | -38.4 |
| 475A | R-1234yf/134a/1234ze(E) (45.0/43.0/12.0) | A1 | N/A ^c | -19.8 | -19.0 | -28.8 | -28.3 |
| 475B | R-1234yf/134a/1234ze(E) (35.4/10.1/54.5) | A2L | N/A ^c | -15.3 | -13.9 | -26.3 | -25.5 |
| 476A | R-134a/1234ze(E)/1336mzz(E) (10.0/78.0/12.0) | A1 | N/A ^c | -2.4 | 2.9 | -19.1 | -16.1 |
| 477A | R-1270/600a (84.0/16.0) | A3 | N/A ^c | -48.3 | -35.0 | -44.6 | -37.2 |
| 477B | R-1270/600a (38.0/62.0) | A3 | N/A ^c | -24.7 | -9.6 | -31.5 | -23.1 |
| 478A | R-744/32/125/134a/152a/1234ze(E)/227ea (7.0/26.0/15.0/15.0/3.0/30.0/4.0) | A2L | N/A ^c | -73.1 | -35.3 | -58.4 | -37.4 |
| 479A | R-1132(E)/32/1234yf (28.0/21.5/50.5) | A2L | N/A ^c | -58.8 | -48.5 | -50.4 | -44.7 |
| 480A | R-744/1234ze(E)/227ea (5.0/86.0/9.0) | A1 | N/A ^c | -51.7 | -7.1 | -46.5 | -21.7 |
| 481A | R-32/125/134a/1233zd(E)/601a (16.9/6.3/74.4/1.8/0.6) | A1 | N/A ^c | -36.9 | -22.9 | -38.3 | -30.5 |
| 482A | R-134a/1234ze(E)/1224yd(Z) (10.0/83.5/6.5) | A1 | N/A ^c | -3.3 | 1.4 | -19.6 | -17.0 |
| 483A | R-290/600 (15.0/85.0) | A3 | N/A ^c | 6.1 | 23.4 | -14.4 | -4.8 |
| 484A | R-1270/600 (12.0/88.0) | A3 | N/A ^c | 7.7 | 24.6 | -13.5 | -4.1 |
| 486A | R-1234yf/134a/131i/1234ze(E) (21.9/6.3/38.0/33.8) | A1 | N/A ^c | -14.3 | -12.8 | -25.7 | -24.9 |
| 487A | R-170/1270 (20.0/80.0) | A3 | N/A ^c | -91.3 | -63.8 | -68.5 | -53.2 |

| Refrigerant Blends (continued) | | | | | | | |
|--------------------------------|--|---------------------------|---|-------------------------------|----------------------------|-------------------------------|----------------------------|
| Num. ^a | Composition (Mass %) ^a | Safety Group ^a | Global Warming Potential (GWP100 ^b) | Bubble Point, °F ^a | Dew Point, °F ^a | Bubble Point, °C ^a | Dew Point, °C ^a |
| Zeotropes | | | | | | | |
| 488A | R-32/1234yf/152a/1234ze(E) (6.0/50.0/3.0/41.0) | A2L | N/A ^c | -31.1 | -18.4 | -35.1 | -28.0 |
| 489A | R-50/1150/600 (1.5/22.0/76.5) | A3 | N/A ^c | -192.5 | 8.1 | -124.7 | -13.3 |

| Refrigerant Blends | | | | |
|--------------------|------------------------------------|---------------------------|---|--|
| Num. ^a | Composition (Mass %) ^a | Safety Group ^a | Global Warming Potential (GWP100 ^b) | Normal Boiling Point, °F (°C) ^a |
| Azeotropes | | | | |
| 511A | R-290/E170 (HC-290) | A3 | 5 | -43.7 (-42.1) |
| 512A | R-134a/152a (5.0/95.0) | A2 | 196 | -11.2 (-24.0) |
| 513A | R-1234yf/134a (56.0/44.0) | A1 | 573 | -20.6 (-29.2) |
| 513B | R-1234yf/134a (58.5/41.5) | A1 | N/A ^c | -20.6 (-29.2) |
| 514A | R-1336mzz(Z)/1130(E) (74.7/25.3) | B1 | N/A ^c | 84.2 (29.0) |
| 515A | R-1234ze(E)/227ea (88.0/12.0) | A1 | N/A ^c | -2.0 (-18.9) |
| 515B | R-1234ze(E)/227ea (91.1/8.9) | A1 | N/A ^c | -2.3 (-19.0) |
| 516A | R-1234yf/134a/152a (77.5/8.5/14.0) | A2L | N/A ^c | -20.9 (-29.4) |

a. Source: ASHRAE Standard 34

b. Source: 2021 *ASHRAE Handbook—Fundamentals*

c. "N/A" indicates a refrigerant for which no GWP information is currently available in *ASHRAE Handbook—Fundamentals*. Data on some of these refrigerants may be found in reports of the Refrigeration Technical Options Committee, or, for blends, the GWP may be calculated from the GWP of the pure compounds.

Shaded cells indicate refrigerants added since the previous version of the Factsheet.

This list is not intended to be complete or definitive. Please refer to the latest edition of ASHRAE Standard 34 and all published addenda for complete information on refrigerant designations and safety classifications.

ASHRAE and UNEP Cooperation

United Nations Environment Programme (UNEP), represented by the OzonAction-Law Division, and ASHRAE have a Memorandum of Understanding to establish technical cooperation and mutual coordination toward providing professional technical services to the refrigeration and air-conditioning stakeholders

(governmental, private, and public). The organizations work to ensure that up-to-date related technical information and standards are properly introduced and promoted. ASHRAE is a worldwide technical society of more than 57,000 individual members.

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