Designation: D6064 – 11

StandardSpecification for HFC-227ea, 1,1,1,2,3,3,3-Heptafluoropropane (CF_3CHFCF_3)[1]

This standard is issued under the fixed designation D6064; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers requirements for HFC-227ea as a fire-fighting medium.

1.2 This specification does not address the fire-fighting equipment or hardware that employs HFC-227ea or the conditions of employing such equipment (for example, handhelds, fixed installations, etc.).

1.3 This specification does not address the storage or transportation of HFC-227ea. Storage, handling, and transportation issues may be addressed in future ASTM specifications.

1.4 The values stated in both inch-pound and SI units are to be regarded separately as the standard. The values given in parentheses are for information only.

1.5 The following safety hazards caveat pertains only to the test methods portion, Section 5, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazards statements are given in Note 1.

2. Referenced Documents

2.1 *ISO Standards:*

ISO 3363 Fluorochlorinated Hydrocarbons for Industrial Use-Determination of Acidity-Titrimetric Method[2]

ISO 3427 Gaseous Halogenated Hydrocarbons (Liquefied Gases)–Taking of a Sample[2]

ISO 5789 Fluorinated Hydrocarbons for Industrial Use-Determination of Nonvolatile Residue[2]

2.2 *ASRE Standard:*

ASRE Standard 34[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *HFC*—hydrofluorocarbon; a chemical compound in which the compound molecule is comprised exclusively of hydrogen and fluorine and carbon atoms.

3.1.2 *HFC-227ea*—the compound 1,1,1,2,3,3,3-heptafluoropropane; CF_3CHFCF_3.

3.1.2.1 *Discussion*—The terminology system for fluorine-containing compounds (described in detail in ASRE Standard 34) provides a convenient means to reference the structure of individual compounds. By definition, the first digit of the numbering system represents one less than the number of carbon atoms in the compound molecule; the second digit, one more than the number of hydrogen atoms in the compound molecule; and the third digit, the number of fluorine atoms in the compound molecule. For molecules containing three carbon atoms, two appended letters are added to indicate the symmetry of the molecule. The first appended letter indicates the substitution on the central (C2) carbon; for example, the substitution CHF is assigned the designation "e." The second appended letter indicates the substitution at the C1 and C3 carbons; for example, identical substitution on the C1 and C3 carbons are assigned the designation "a." For example, the designation HFC-227ea indicates three carbon atoms (2 + 1), one hydrogen atom (2–1), and seven fluorine atoms; the designation "e" indicates that the central carbon is substituted as CHF, and the designation" a" indicates that the substitution on Carbons C1 and C3 is identical, that is, the structure is CF_3CHFCF_3.

4. Material Requirements

4.1 *Type I—Mixtures of HFC-227ea and Nitrogen:*

4.1.1 The nitrogen (N_2) partial pressure shall be such that the safe working pressure of the receiving vessel is not exceeded. To prevent excessive pressure, the fill density of HFC-227ea within a container should not exceed that needed to achieve complete filling of the container at the maximum envisaged storage temperature. For example, for the U.S. DOT 4BA500 cylinder, the nitrogen partial pressure shall not exceed 21.8 bar at 21°C (316 psig at 70°F) for a 1150-kg/m^3 (72-lb/ft^3) fill density (yielding a total pressure of 25.8 bar at 21°C (360 psig at 70°F). For this example, the safe working pressure of the 4BA500 cylinder is not exceeded for temperatures below 54°C (130°F).

[1] This specification is under the jurisdiction of ASTM Committee D26 on Halogenated Organic Solvents and Fire Extinguishing Agents and is the direct responsibility of Subcommittee D26.09 on Fire Extinguishing Agents.

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[2] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[3] American Society of Refrigeration Engineers, *Refrigeration Engineering 65*, 1957, p. 49.

4.1.2 HFC-227ea shall conform to the requirements prescribed in Table 1 when tested by the appropriate test method(s) listed in Section 6.

4.1.3 When a material analysis is required, by agreement between the purchaser and the supplier, the total pressure in the HFC-227ea container, partial pressure of the N_2, the fill density of HFC-227ea within the container, and the maximum safe storage temperature shall be part of the material analysis (certification). The pressure shall be reported in bar (preferred) or pound-force per square inch gage. The fill density shall be reported in kilograms per cubic metre at 21°C (preferred) or pounds per cubic foot at 70°F. The maximum safe storage temperature of the HFC-227ea container shall be reported in degrees Celsius (preferred) or in degrees Fahrenheit and shall conform to applicable regulations for the HFC-227ea container design and use.

4.2 *Type II—HFC-227ea*—HFC-227ea shall conform to the requirements of Type I, as listed in 3.1, and shall contain no more than 1.5 % by volume fixed gases in vapor phase, expressed as air when tested by the appropriate test method(s) listed in Section 6.

4.3 By agreement between the purchaser and the supplier, analysis may be required and limits established for elements or compounds not specified in Table 1.

4.4 Unless otherwise specified, Type II is assumed.

NOTE 1—Prolonged exposure to concentrations of HFC-227ea in excess of 10.5 % by volume in air during periods of elevated adrenaline could produce cardiac arrhythmia in some personnel.

5. Sampling

5.1 Samples of HFC-227ea, taken from the liquid phase, shall be taken from filled containers in accordance with the method specified in ISO 3427. The sampling cylinder shall be capable of safely resisting the vapor pressure of the sample at the highest temperature that could be encountered.

5.2 The HFC-227ea selected in accordance with 5.1 shall be tested for quality conformance in accordance with Section 6. The presence of one or more defects shall be cause for rejection.

6. Test Methods

6.1 *Purity:*

6.1.1 Determine the purity by gas-liquid chromatography in accordance with the technique described in 6.1.2-6.1.5 or another acceptable laboratory technique providing equivalent results.

TABLE 1 Requirements

Property	Requirement
HFC-227ea purity	99.0 %, mol/mol, min
Acidity	(exclusive of any N_2 present)
	2.0 ppm by mass, as HCL, max
Water content ppm by mass, max	10 ppm by mass, max
Nonvolatile residue	0.05 g/100 mL, max
Halogen ion	passes test
Suspended matter or sediment	none visible

6.1.2 *Apparatus*—The following special apparatus is required to determine the percent of HFC-227ea:

6.1.2.1 *Gas Chromatograph,* capable of programmed temperature operation and equipped with a thermal conductivity detector.

6.1.2.2 *Column,* 3.1-m by 5-mm outside diameter (2.6-mm inner diameter) glass tubing, packed with 80 to 120 mesh Carbopack B[4] or equivalent.

6.1.2.3 *Gas Sampling Valve,* 10-mL volume or a volume sufficient to achieve proper separation in the specified column.

6.1.2.4 *Glass Syringe,* 20-mL Hamilton B-D,[5] or equivalent.

6.1.2.5 *Three-Way Purge/Isolation Valve,* Hamilton 86727 miniature inert valve with Luer Lock fittings,[5] or equivalent.

6.1.3 *Reagents*—The carrier gas shall be a chromatographic grade of helium. The column packing shall consist of a standard solution, for example 3 % (weight/weight) methyl silicone,[5] on 80 to 120-mesh Carbopack B[5] (or equivalent).

6.1.4 *Procedure:*

6.1.4.1 Install the column and adjust the temperature of the column oven to 30°C, injection port to 100°C, and detector block to 150°C. The temperature should be programmed to rise 10 to 15°C/min (from an initial temperature of 30°C), to a maximum of 100°C.

6.1.4.2 Adjust the helium flow to 25 mL/min.

6.1.4.3 Adjust the detector voltage to 8 V or to the mid-range of the thermal conductivity detector (TCD) instrument being used and allow the instrument to stabilize.

6.1.4.4 Take the sample from the vapor phase; collect approximately 20 mL in the glass syringe.

6.1.4.5 Purge the sample loop with approximately 10 mL of sample from the syringe and transfer the sample into the chromatographic system.

6.1.4.6 Allow the sample to elute, for approximately 18 min, attenuating as necessary to make the peak heights a convenient size. Under proper instrument settings, the HFC-227ea should elute after approximately 5 min.

6.1.5 *Calculation:*

6.1.5.1 Calculate percent HFC-227ea as follows:

$$\%HFC-227ea = \frac{A(CF_3CHFCF_3) \times 100}{As} \quad (1)$$

where:

$A(CF_3CHFCF_3)$ = area of the HFC-227ea peak, and
As = sum of the area of all peaks, excluding the nitrogen peak.

Percent HFC-227ea below that specified in Table 1 shall constitute failure of this test method.

6.1.5.2 Calculate percent nitrogen as follows:

$$\%N_2 = \frac{An \times 100}{As} \quad (2)$$

where:

An = area of nitrogen peak, and
As = sum of the area of all other peaks, including the nitrogen peak.

[4] Available from Alltech, 2051 Waukegan Road, Deerfield, IL 60015.
[5] Available from Hamilton Co., P.O. Box 10030, Reno, NV 89520-0012.