INTERNATIONAL

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Standard Specification for HFC-125 (Pentafluoroethane, C_2HF_5)[1]

This standard is issued under the fixed designation D 6231; 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 the requirements for HFC-125 as a fire–fighting medium.

1.2 This specification does not address the fire–fighting equipment or hardware that employs HFC-125 or the conditions of employing such equipment, for example, hand helds, fixed installations, etc.

1.3 This specification does not address the storage or transportation of HFC-125. Storage, handling, and transportation issues are addressed in Practice D 6268.

1.4 The following safety hazards caveat pertains to the test methods portion, Section 6, 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 *ASTM Standards:*

D 6268 Practice for Handling, Transportation, and Storage of HFC-125, Pentafluoroethane (C_2HF_5)[2]

2.2 *ISO Standards:*

ISO 3363 Fluorinated Hydrocarbons for Industrial Use – Determination of Acidity – Titration Method[3]

ISO 3427 Gaseous Halogenated Hydrocarbons (Liquefied Gases) – Taking a Sample[3]

ISO 5789 Fluorinated Hydrocarbons for Industrial Use – Determination of Nonvolatile Residue[3]

2.3 *CGA Standards:*

No. C-4 American National Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained[4]

No. P-1 Safe Handling of Compressed Gases in Containers[4]

2.4 *U.S. Governmental Standards:*

Code of Federal Regulations (CFR) Title 49, Part 172.101, Tables of Hazardous Materials and Special Provisions[5]

Code of Federal Regulations (CFR) Title 49, Parts 173.302 and 173.304, Preparation and Packaging of Gases[5]

Code of Federal Regulations (CFR) Title 49, Part 172 Subpart D, Marking Requirements of Packaging for Transportation[5]

2.5 *American Society of Refrigeration Engineers:*

ASRE Standard 34, Designation of Refrigerants[6]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *halogenated hydrocarbon, n*—the halogenated compound coding terminology system provides a convenient means to reference halogenated hydrocarbons (see ASRE 34). Halogenated hydrocarbons are saturated hydrocarbons in which one or more of the hydrogen atoms have been replaced by atoms of the halogen series: fluorine, chlorine, bromine, and iodine. It is convention to prefix the number with an abbreviation of the compound:

CFC	=	chlorofluorocarbon
HCFC	=	hydrochlorofluorocarbon
HFC	=	hydrofluorocarbon
FC	=	fluorocarbon
R	=	refrigerant

3.1.1.1 *Discussion*—By definition, the right–most digit of the numbering system is the number of fluorine atoms. The second digit from the right is the number of hydrogen atoms plus one (+1). The third digit from the right is one less (-1) than number of carbon atoms in the compound (when this number is zero (0) it is omitted from the number). Unaccounted for valance requirements are assumed to be chlorine atoms. When the compound contains bromine or iodine, the same rules apply except the letter “B” for bromine or “I” for iodine follows the parent compound designated number and the number of the atoms is placed after the letter.

$$\text{Example: } C_2HF_5 = R-125 = HFC-125 \quad (1)$$

3.1.2 *HFC-125, n*—the compound pentafluoroethane; C_2HF_5.

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

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[2] *Annual Book of ASTM Standards*, Vol. 15.05.

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

[4] Available from the Compressed Gas Association.

[5] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20036.

[6] Available from American Society of Refrigeration Engineers, *Refrigeration Engineering 65*, 49 (1957).

4. Material Requirements

4.1 *Type I*:

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 the HFC-125/nitrogen within the container should not exceed that needed to achieve complete filling of the container at the maximum expected storage temperature. For example, the U.S. DOT 4BA500 cylinder partial pressure shall not exceed 24.8 bar at 21° C (360 psig at 70 °F) for a 833 kg/m^3(52 lb/ft^3) fill density. For this example, the safe working pressure of the 4BA500 cylinder is not exceeded for temperatures below 54 °C (130 °F).

4.1.2 HFC-125 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 material analysis is required, by agreement between the purchaser and the supplier, the total pressure in the HFC-125 container, partial pressure of the nitrogen, the fill density of the HFC-125 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/in.^{2} gage (psig). The fill density shall be reported in kg/m^3 at 21°C (preferred) or lb/ft^3 at 70 °F. The maximum safe storage temperature of the HFC-125 shall be reported in °C (preferred) or in °F and shall conform to the applicable regulations for the HFC-125 container design and use.

4.2 *Type II*—HFC-125 shall conform to the requirements of Type I as listed in 4.1 and shall contain no more than 1.5 % by volume fixed gases in the 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.

NOTE 1—**Warning:** Exposure to concentrations of HFC-125 in excess of 7.5 % by volume in air during periods of elevated adrenaline could produce cardiac arrhythmia in some personnel.

4.4 Unless otherwise specified, Type I is assumed.

5. Sampling

5.1 Samples of HFC-125 taken from the liquid phase, shall be taken from filled containers in accordance with the method specified in ISO 3427. The sampling bottle shall be capable of safely resisting the vapor pressure of the sample at the highest temperature that could be encountered.

5.2 The HFC-125 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.

TABLE 1 Requirements

Property	Requirement
HFC-125 purity, mol/mol, min, %	99.0
Acidity, ppm by mass, as HCl, max	3.0
Water content, ppm by mass, max	10
Nonvolatile residue, max, % by weight	0.08
Suspended matter or sediment	none visible

6. Test Methods

6.1 *Purity*:

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

6.1.2 *Apparatus*—The following special apparatus is required to determine the percent HFC-125.

6.1.2.1 *Gas Chromatograph*, equipped with a thermal conductivity detector (TCD) and an integrator, 1-mV recorder, or other output device.

6.1.2.2 *Chromatographic Column*, 6 ft length by ⅛-in. outside diameter (OD) stainless steel tubing, packed with 80 to 100 mesh PORAPAK Q or equivalent.

NOTE 2—Column is available prepacked from any chromatographic supply vendor.

6.1.2.3 *Gas Sampling Valve*, 1-mL volume or a volume sufficient to achieve proper separation and peak area for the specified column.

6.1.3 *Reagents*—The carrier gas shall be a chromatographic grade of helium. The column packing shall be 80 to 100 mesh PORAPAK Q or equivalent.

6.1.4 *Procedure*:

6.1.4.1 Install the column in the gas chromatograph and set the oven temperature to 45 °C, injection port to 175 °C, detector clock to 200 °C. The oven temperature is programmed to hold at 45 °C for 2 min, then to rise 10 °C/min, to a maximum of 150 °C.

6.1.4.2 Adjust the column helium flow to 20 mL/min.

6.1.4.3 Adjust the detector voltage to the mid-range of the thermal conductivity detector (TCD) and allow the instrument to equilibrate.

6.1.4.4 Take a vapor sample from the liquid phase (inverted cylinder). Flush the sample loop and valve for approximately 30 s.

6.1.4.5 Rotate the sample valve to transfer the sample into the chromatograph and note the time.

6.1.4.6 Close the sample cylinder valve.

6.1.4.7 Allow the sample to elute for approximately 15 min, attenuating as necessary to make the peak height a convenient size. Under proper instrument settings, air (N_2, O_2) should elute after about 0.4 min and HFC-125 should elute after approximately 5.7 min.

6.1.5 *Calculation*:

6.1.5.1 Calculate percent HFC-125 as follows:

$$\%\ \mathrm{HFC-125} = A_H(100)/A_T \tag{2}$$

where:

A_H = area of the HFC-125 peak (peak area *x* attenuation), and

A_T = sum all of the relevant peak areas excluding the nitrogen (air) peak (peak area *x* attenuation).

Percent HFC-125 below that specified in Table 1 shall constitute failure by this test method.

6.1.5.2 Calculate the percent nitrogen (air):

$$\%\ N_2\ (\mathrm{air}) = A_N(100)/(A_T+A_N) \tag{3}$$

where: