

EXHIBIT 3



Standard Specification for Liquefied Petroleum (LP) Gases¹

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1. Scope

1.1 This specification covers those products commonly referred to as liquefied petroleum gases.

1.2 This specification is applicable to products intended for use as domestic, commercial, industrial, and engine fuels.

1.3 This specification is for use in formulating specifications for required properties of liquefied petroleum gases at the time of delivery in bulk.

2. Referenced Documents

2.1 ASTM Standards:

- D 1265 Practice for Sampling Liquefied Petroleum (LP) Gases (Manual Method)²
- D 1267 Test Method for Gage Vapor Pressure of Liquefied Petroleum (LP) Gases (LP-Gas Method)²
- D 1657 Test Method for Density or Relative Density of Light Hydrocarbons by Pressure Thermohydrometer²
- D 1837 Test Method for Volatility of Liquefied Petroleum (LP) Gases²
- D 1838 Test Method for Copper Strip Corrosion by Liquefied Petroleum (LP) Gases²
- D 2158 Test Method for Residues in Liquefied Petroleum (LP) Gases²
- D 2163 Test Method for Analysis of Liquefied Petroleum (LP) Gases and Propene Concentrates by Gas Chromatography²
- D 2420 Test Method for Hydrogen Sulfide in Liquefied Petroleum (LP) Gases (Lead Acetate Method)²
- D 2598 Practice for Calculation of Certain Physical Properties of Liquefied Petroleum (LP) Gases from Compositional Analysis²
- D 2713 Test Method for Dryness of Propane (Valve Freeze Method)²

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² Annual Book of ASTM Standards, Vol 05.01.

D 2784 Test Method for Sulfur in Liquefied Petroleum Gases (Oxy-Hydrogen Burner or Lamp)²

D 3700 Practice for Containing Hydrocarbon Fluid Samples Using a Floating Piston Cylinder³

2.2 Other Document:

GPA Standard 2140⁴

3. Types

3.1 Four basic types of liquefied petroleum gases are provided to cover the common use applications, as follows:

3.1.1 *Commercial Propane*—A hydrocarbon product for use where high volatility is required. Commercial propane is suitable for certain low severity internal combustion engine applications.

3.1.2 *Commercial Butane*—A hydrocarbon product for use where low volatility is required.

3.1.3 *Commercial PB Mixtures*—Mixtures of propane and butane for use where intermediate volatility is required.

3.1.4 *Special-Duty Propane*—A high-quality product composed chiefly of propane, which exhibits superior antiknock characteristics when used as an internal combustion engine fuel.

4. Detail Requirements

4.1 The four types of liquefied petroleum gases shall conform to the requirements prescribed in Table 1.

5. Sampling

5.1 Proper sampling of liquefied gases is extremely important if the tests are to be significant. Obtain samples for compositional analysis in accordance with Practice D 3700D 3700. Samples for other required tests should be obtained in accordance with Practice D 1265D 1265.

6. Keywords

6.1 butane; liquefied petroleum (LP) gases specifications; propane

³ Annual Book of ASTM Standards, Vol 05.02.

⁴ Available from Gas Processors Assn., 6526 E. 60th St., Tulsa, OK 74145.



TABLE 1 Detail Requirements for Liquefied Petroleum Gases

	Product Designation				
	Commercial Propane	Commercial Butane	Commercial PB Mixtures	Special-Duty Propane ^A	ASTM Test Methods (see Section 2)
Vapor pressure at 100°F (37.8°C), max, psig	208	70	^B	208	D 1267 or
kPa	1434	483		1434	D 2598 ^C
Volatile residue:					
evaporated temperature, 95 %, max, °F	-37	36	36	-37	
°C	-38.3	2.2	2.2	-38.3	D 1837
or					
butane and heavier, max, vol %	2.5	...	...	2.5	D 2163
pentane and heavier, max, vol %	...	2.0	2.0	...	D 2163
Propylene content, max, vol %	...	...	...	5.0	D 2163
Residual matter:					
residue on evaporation 100 mL, max, mL	0.05	0.05	0.05	0.05	D 2158
oil stain observation	pass ^D	pass ^D	pass ^D	pass ^D	D 2158
Relative density at 60/60°F (15.6/15.6°C)	^E	^E	^E	...	D 1657 or
Corrosion, copper, strip	No. 1	No. 1	No. 1	No. 1	D 2598
Sulfur, ppmw	185 ^G	140 ^G	140 ^G	123 ^G	D 1838 ^F
Hydrogen sulfide	pass	pass	pass	pass	D 2784
Moisture content	pass	...	...	pass	D 2420
Free water content	...	none ^H	none ^H	...	D 2713

^AEquivalent to Propane HD-5 of GPA Standard 2140.

^BThe permissible vapor pressures of products classified as PB mixtures must not exceed 208 psig (1430 kPa) and additionally must not exceed that calculated from the following relationship between the observed vapor pressure and the observed relative density:

$$\text{Vapor pressure, max} = 1167 - 1880 (\text{relative density } 60/60^\circ\text{F}) \text{ or } 1167 - 1880 (\text{density at } 15^\circ\text{C})$$

A specific mixture shall be designated by the vapor pressure at 100°F in pounds per square inch gage. To comply with the designation, the vapor pressure of the mixture shall be within + 0 to - 10 psi of the vapor pressure specified.

^CIn case of dispute about the vapor pressure of a product, the value actually determined by Test Method D 1267D 1267 shall prevail over the value calculated by Practice D 2598D 2598.

^DAn acceptable product shall not yield a persistent oil ring when 0.3 mL of solvent residue mixture is added to a filter paper, in 0.1-mL increments and examined in daylight after 2 min as described in Test Method D 2158D 2158.

^EAlthough not a specific requirement, the relative density must be determined for other purposes and should be reported. Additionally, the relative density of PB mixture is needed to establish the permissible maximum vapor pressure (see Footnote B).

^FThis method may not accurately determine the presence of reactive materials (for example, H₂S, S^G) in liquefied petroleum gas if the product contains corrosion inhibitors or other chemicals which diminish the reaction with the copper strip.

^GThe total sulfur limits in these specifications do include sulfur compounds used for stenching purposes.

^HThe presence or absence of water shall be determined by visual inspection of the samples on which the relative density is determined.

APPENDIX

(Nonmandatory Information)

X1. SIGNIFICANCE OF ASTM SPECIFICATIONS FOR LIQUEFIED PETROLEUM (LP) GASES

X1.1 General

X1.1.1 Liquefied petroleum gas products are composed of those readily liquefiable hydrocarbon compounds which are produced in the course of processing natural gas and also in the course of the conventional refining of crude oil. The composition of liquefied gases can vary widely depending upon the source and the nature of the treatment to which the products have been subjected.

X1.1.2 There are many uses for liquefied petroleum gases. Important uses are, (1) as domestic, commercial, and industrial fuels, (2) as a carbon source material in metal treating operations, (3) as refinery raw materials for synthetic gasoline production, and (4) as petrochemical raw materials. The nature of the needs dictates the required composition characteristics in these various applications. Since the last three uses of those listed are in the category of specialty applications which

involve special requirements, they are excluded from consideration in the specifications.

X1.1.3 In substance, the ASTM Specifications for Liquefied Petroleum Gases are designed to properly define acceptable products for domestic, commercial, and industrial uses. In many cases it will be found that products meeting the specifications will also be usable in applications other than the ones for which they were designed. The following can be accepted as a general guide in the more common use applications of the three types of fuels:

X1.1.3.1 *Commercial Propane*—This fuel type is adequate for domestic, commercial, and industrial use, particularly in geographical areas and in seasons where low ambient temperatures are common, and where uniformity of fuel is an important consideration. Commercial propane is suitable for certain low severity internal combustion engine applications.



X1.1.3.2 *Commercial PB Mixtures*—This fuel type, since it covers a broad range of mixtures, permits the tailoring of fuels to specific needs. The various mixtures find application as domestic, commercial, and industrial fuel in areas and at times when low ambient temperature conditions are less frequently encountered.

X1.1.3.3 *Commercial Butane*—This fuel type finds limited application as a domestic fuel in areas of warmer climates. It is similarly used in industrial applications where problems of fuel vaporization are not present.

X1.1.3.4 *Special-Duty Propane*—This fuel type is a special liquefied petroleum gas product tailored to meet the restrictive needs of internal combustion engines operating under moderate to high engine severity. Fuel products of this type will be less variable in composition and combustion characteristics than the other products covered by this specification.

X1.2 Significance and Use

X1.2.1 This specification addresses commercial liquefied petroleum gases consisting of either propane or butane or mixtures thereof. Consequently, the important characteristics of these products can be defined and controlled by a relatively few simple measurements. The specification test methods provided achieve the desired results. The significance of the various tests as they can apply to consumer problems is summarized here.

X1.2.1.1 Vapor Pressure, Volatility, and Relative Density:

(a) *Vapor Pressure* is an indirect measure of the most extreme low-temperature conditions under which initial vaporization can be expected to take place. It can be considered as a semiquantitative measure of the amount of the most volatile material present in the product. It can also be used as a means for predicting the maximum pressures which may be experienced at fuel tank temperatures. Vapor pressure becomes more significant when it is related to volatility.

(b) *Volatility*, expressed in terms of the 95 % evaporated temperature of the product, is a measure of the amount of least volatile fuel component present in the product. Coupled with a vapor pressure limit, it serves to assure essentially single-component products in the cases of commercial propane and commercial butane fuel types. When volatility is coupled with a vapor pressure limit which has been related to gravity, as in the case of the commercial PB-mixture type of fuels, the combination serves to assure essentially two component mixtures for such fuels. When coupled with a proper vapor pressure limit, this measurement serves to assure that special-duty propane products will be composed chiefly of propane and propylene and that propane will be the major constituent.

(c) *Relative Density*, by itself, has little significance. It becomes of value only when related to vapor pressure and volatility. Since relative density is of importance in meeting transportation and storage requirements it is always determined for all liquefied petroleum gas products.

X1.2.1.2 *Other Product Characteristics*—While the vaporization and combustion characteristics of commercial liquefied gas products are completely defined for the normal use applications by vapor pressure, volatility, and relative density, as given in X1.2.1.1, there are other items which either affect or might affect the results obtained in some specific use applications. For that reason, limits are specified for residue content, copper corrosion, sulfur content, moisture content, and free water content to provide assurance of product dependability under the more extreme conditions of use.

(a) *Residue* is a measure of the concentration of soluble hydrocarbon materials present in the product which are substantially less volatile than the liquefied petroleum gas product being sampled. Control of residue content is of importance in applications where the fuel is used in liquid or vapor feed systems (where fuel vapors are withdrawn from the top of the LPG storage container). In either case, failure to limit the permissible concentration of residue materials may result in troublesome deposits or regulating equipment may become fouled, or both.

(b) *Copper Corrosion* limits are for the purpose of providing assurance that difficulties will not be experienced in the deterioration of the copper and copper-alloy fittings and connections which are commonly used in many types of utilization, storage, and transportation equipment. The copper corrosion test will detect the presence of hydrogen sulfide, which is highly toxic. The copper corrosion limits also provide assurance that the LP-Gas will not contain H₂S in such quantities as to present a health and safety hazard if it is known that the product does not contain corrosion inhibitors or other chemicals which diminish the reaction with the copper strip. In addition, Test Method D 2420D 2420 is recommended as a field test and added safeguard to ensure that LP-Gas does not contain detectable amounts of hydrogen sulfide.

(c) *Sulfur Content* limits are provided to more completely define liquefied petroleum gas products because these products are generally lower in sulfur content than most other petroleum-derived fuels. The limit on sulfur content minimizes sulfur oxide emissions and limits potential corrosion by exhaust gases from combustion of LPG.

(d) *Moisture Content* is a measure of the approximate percentage saturation of the product with water. This measurement is a requirement only on the commercial and special duty propane types of liquefied petroleum gas. The purpose of moisture content control is to provide assurance that pressure reducing regulators and similar equipment will operate consistently without troublesome freeze-ups caused by the separation of dissolved water from the product.

(e) *Free Water Content* is of importance only on the commercial PB-mixtures and commercial butane type products. These two types of products are normally used under ambient conditions which are mild and, as a consequence, the only requirement is vigilance to assure that no free water is present.

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