FLAMMABLE & COMBUSTIBLE LIQUID TANK VEHICLES 1964

Sixty Cents

NATIONAL FIRE PROTECTION ASSOCIATION
International
60 Batterymarch Street, Boston, Mass. 02110

5M-6-64-FP
Printed in U.S.A.

National Fire Protection Association
International

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection. Anyone interested may become an Associate Member; the annual dues are $20.00. National and regional societies and associations are eligible to be Organization Members. Full membership information is available on request.

This is one of a large number of publications on fire safety issued by the Association. All NFPA codes, standards, and recommended practices are prepared by NFPA Technical Committees and adopted at an Annual Meeting of the Association. They are intended to prescribe reasonable measures for minimizing losses of life and property by fire.

This and other NFPA codes, standards, and recommended practices are published in the **National Fire Codes,** a compilation of NFPA's official technical material. Write the Association for full information.

Official NFPA Definitions

Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations or that which is advised but not required.

APPROVED means acceptable to the authority having jurisdiction. The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of nationally recognized testing laboratories,* i.e., laboratories qualified and equipped to conduct the necessary tests, in a position to determine compliance with appropriate standards for the current production of listed items, and the satisfactory performance of such equipment or materials in actual usage.

*Among the laboratories nationally recognized by the authorities having jurisdiction in the United States and Canada are the Underwriters' Laboratories, Inc., the Factory Mutual Engineering Division, the American Gas Association Laboratories, the Underwriters' Laboratories of Canada, the Canadian Standards Association Testing Laboratories, and the Canadian Gas Association Approvals Division.

LISTED: Equipment or materials included in a list published by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

LABELED: Equipment or materials to which has been attached a label of a nationally recognized testing laboratory that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling is indicated compliance with nationally recognized standards or the conduct of tests to determine suitable usage in a specified manner.

AUTHORITY HAVING JURISDICTION: The organization, office or individual responsible for "approving" equipment, an installation, or a procedure.

Multiple Copy Price Reduction For Six or More Copies Available on Request.

Recommended Regulatory Standard for

Tank Vehicles for Flammable and Combustible Liquids

NFPA No. 385 — 1964

1964 Edition of No. 385

This standard is prepared for issuance by enforcement authorities as a regulatory standard. It supersedes the edition of 1963 and prior editions. This standard was prepared by the NFPA Sectional Committee on Transportation of Flammable Liquids, approved by the Flammable Liquids Committee, and adopted by the National Fire Protection Association at its 1964 Annual Meeting. In this 1964 edition changes have to do with revising the standard to follow the new basic classification of flammable and combustible liquids. An exception for a specific design to prevent intermixing has been deleted since it had only applied retroactively prior to the inclusion of this material several years ago. Other changes are primarily editorial or a relocation within the standard of existing material.

Origin and Development of No. 385

This standard was initiated in 1926, first officially adopted in 1929, and later revised and issued in the following editions: 1933, 1948, 1953, 1954, 1955, 1957, 1958, 1959, 1960 and 1963. The edition prior to 1948 had different titles. The Committee has established an interpretations procedure which is printed on page 28.

Committee on Flammable Liquids

Paul C. Lamb, *Chairman,*
Lever Brothers Company, 390 Park Ave., New York, N. Y. 10022

Miles E. Woodworth,† *Secretary*
National Fire Protection Assn., 60 Batterymarch St., Boston, Mass. 02110

J. Robert Adams, Improved Risk Mutuals.
R. H. Albisser, Manufacturing Chemists' Assn., Inc.
W. J. Baker, Conference of Special Risk Underwriters.
C. V. Batley, Bethlehem Steel Co. (Personal)
W. C. Bluhm, American Petroleum Institute.
Herbert R. Bogardus, Fire Insurance Rating Organization of New Jersey.
W. S. Brooks, Oklahoma Inspection Bureau.
R. G. Brown, American Reciprocal Insurers.
G. E. Cain, National Paint, Varnish & Lacquer Assn.
Harold Crouch, Eastman Kodak Co. (Personal)
W. H. Doyle, Factory Insurance Assn.
James J. Duggan, Charleston, W. Va. (Personal)
A. F. Dyer, American Petroleum Institute.
D. M. Dymond, Canadian Standards Assn.
E. H. Fallin, National Petroleum Refiners Assn.
G. G. Fleming, Manufacturing Chemists' Assn., Inc.
Parker C. Folse, American Petroleum Institute.
Roger D. Frerikş, Federation of Societies for Paint Technology.
Ward A. Gill, National Automatic Laundry and Cleaning Council.
O. C. Haier, American Petroleum Institute.
S. L. Halac, National Soybean Processors Assn.
Raymond M. Hill, Fire Marshals Assn. of North America.
C. P. Hoffman, Jr., Truck Trailer Manufacturers Assn.
Charles H. Howe, Jr., Fire Marshals Assn. of North America.

Rodger R. Jackson, Laundry & Cleaners Allied Trades Assn.

O. W. Johnson, Palo Alto, Calif. (Personal)

Hugh V. Keepers, Fire Prevention and Engineering Bureau of Texas.

P. J. Keller, National Paint, Varnish & Lacquer Assn.

George F. Kennedy, Fire Marshals Assn. of North America.

Louis F. Langhurst, Vegetable Oil Extraction. (Personal)

Fred Loibl, National Institute of Drycleaning.

W. S. Marsh, Factory Mutual Engineering Division.

C. H. Mayhood, Manufacturing Chemists' Assn., Inc.

J. F. McKenna, American Petroleum Institute.

Dr. W. G. McKenna, Bureau of Explosives. (Personal)

L. S. Miller, Oil Insurance Assn.

N. H. Moore, The American Oil Chemists' Society.

J. W. Morris, Jr., South-Eastern Underwriters Assn.

J. H. Myers, American Petroleum Institute.

Dean Olds, Institute of Appliance Mfrs.

R. N. Patton, Joseph E. Seagram & Sons, Inc. (Personal)

George F. Prussing, Washington 7, D. C. (Personal)

George A. Quandee, Swift & Co. (Personal)

J. Sharp Queener, National Paint, Varnish & Lacquer Assn.

M. J. Reed, National Oil Fuel Institute.

Rudolph Schmidt, Jr., Assn. of Casualty & Surety Cos.

T. T. Singer, Western Actuarial Bureau.

Allan R. Smith, Steel Tank Institute.

Walton Smith, Hunt Foods and Industries, Inc.

E. C. Sommer, American Petroleum Institute.

S. F. Spence, Manufacturing Chemists' Assn., Inc.

R. I. Spencer, Factory Insurance Assn.

G. H. Steel, Ralston Purina Co. (Personal)

C. Austin Sutherland, National Tank Truck Carriers, Inc.

E. F. Tabisz, Underwriters' Laboratories of Canada.

Wm. H. Van Arnum, National Board of Fire Underwriters.

G. M. Walker, Fire Marshals Assn. of North America.

Wm. C. Whiting, New England Fire Insurance Rating Assn.

J. H. Witte, Underwriters' Laboratories, Inc.

T. H. Wright, Ohio Inspection Bureau.

Dr. M. G. Zabetakis, U.S. Bureau of Mines.

Alternates.

B. H. Battaglin, Western Actuarial Bureau. (Alternate to T. T. Singer.)

C. E. Blome, National Oil Fuel Institute. (Alternate to M. J. Reed.)

Paul R. Deschere, Laundry & Cleaners Allied Trades Assn. (Alternate to Rodger R. Jackson.)

B. H. Lord, Jr., American Petroleum Institute. (Alternate to A. F. Dyer.)

J. B. Mathis, Institute of Appliance Manufacturers. (Alternate to Dean Olds.)

H. S. Robinson, Oil Insurance Assn. (Alternate to L. S. Miller.)

A. T. Schrage, Factory Insurance Assn. (Alternate to R. I. Spencer.)

Clay B. Wade, South-Eastern Underwriters Assn. (Alternate to J. W. Morris, Jr.)

Wm. B. White, National Automatic Laundry and Cleaning Council. (Alternate to Ward A. Gill.)

Corresponding Members.†

Dr. Ing. Gert Magnus, Mannheim, Germany.

Ingvar Stromdahl, Stockholm, Sweden.

†Non-voting members.

Sectional Committee on Transportation of Flammable Liquids

J. H. Myers, *Chairman*

W. J. Baker
J. J. Duggan
A. F. Dyer
R. M. Hill
C. P. Hoffman, Jr.
O. W. Johnson
B. H. Lord, Jr.
(alternate to A. F. Dyer)
C. H. Mayhood
J. F. McKenna
W. G. McKenna
J. W. Morris, Jr.
Rudolph Schmidt, Jr.
A. R. Smith
E. C. Sommer
C. A. Sutherland
W. H. Van Arnum
C. B. Wade
(alternate to J. W. Morris, Jr.)
G. M. Walker

Recommended Regulatory Standard for

Tank Vehicles for Flammable and Combustible Liquids

NFPA No. 385 — 1964

CHAPTER 1. GENERAL PROVISIONS.

10. Scope.

1010. This standard applies to tank motor vehicles to be used for the transportation of asphalt or normally stable flammable and combustible liquids with a flash point below 200°F. It is intended to provide minimum requirements for the design, construction and operation of tank motor vehicles, their appurtenances, and certain features of tank motor vehicle chassis.

NOTE: Normally stable materials are those having the relative capacity to resist changes in their chemical composition which would produce violent reactions or detonations despite exposure to air, water, heat, including the normal range of conditions encountered in handling, storage, or transportation. Unstable (reactive) flammable and combustible liquid shall mean a liquid which in the pure state or as commercially produced or transported will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure, or temperature.

1020. Additional safeguards may be necessary for tank vehicles used for the transportation of flammable and combustible liquids having characteristics introducing additional factors such as high rates of expansion, in stability, corrosiveness and toxicity.

1030. Attention is directed to the fact that cutback asphalts can have flash points in the range of Class I liquids. Also liquids having a flash point higher than 200° F., such as asphalt, may assume the characteristics of lower flash point liquids when heated. Under such conditions it shall be appropriate to apply the provisions of this standard unless otherwise specifically exempted.

1040. The requirements for aircraft fuel servicing tank vehicles are contained in NFPA No. 407, Aircraft Fueling on the Ground.

11. Definitions.

ASPHALT. The term asphalt shall include other materials having similar characteristics when heated above ambient temperatures. (See Section 1030.)

AUTOMOTIVE SERVICE STATION. That portion of a property where flammable liquids used as motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles.

BAFFLE. A non-liquid-tight transverse partition in a cargo tank.

CARGO TANK. Any container having a liquid capacity in excess of 100 gallons used for carrying of flammable and combustible liquids or asphalt and mounted permanently or otherwise upon a tank vehicle. The term "cargo tank" does not apply to any container used solely for the purpose of supplying fuel for the propulsion of the tank vehicle upon which it is mounted.

COMPARTMENT. A liquid-tight division in a cargo tank.

FLASH POINT shall mean the minimum temperature of a liquid at which sufficient vapor is given off to form an ignitible mixture with the air near the surface of the liquid or within the vessel used as determined by appropriate test procedure and apparatus as specified.

The flash point of liquids having a flash point at or below 175°F. (79.4°C), except for fuel oils and certain viscous materials, shall be determined in accordance with the Standard Method of Test for Flash Point by the Tag Closed Tester, ASTM D–56–61.

The flash point of liquids having a flash point above 175°F. (79.4°C), except for fuel oils, shall be determined in accordance with the Standard Method of Test for Flash Point by the Cleveland Open Cup Tester, ASTM D–92–57.

The flash point of fuel oil, and certain viscous materials having a flash point at or below 175°F. (79.4°C), shall be determined in accordance with the Standard Method of Test for Flash Point by the Pensky-Martens Closed Tester, ASTM D–93–62.

HEAD AND BULKHEAD. A liquid-tight transverse closure at the end of a cargo tank or between compartments of a cargo tank.

LIQUID shall mean, when not otherwise identified, to include both flammable and combustible liquids.

COMBUSTIBLE LIQUIDS shall mean any liquid having a flash point at or above 140°F. (60°C) and below 200°F. (93.4°C), and shall be known as Class III liquids.

NOTE: The upper limit of 200° F. (93.4° C.) is given because the application of this standard does not extend to liquids having flash points above 200° F. (93.4° C.) and should not be construed as indicating that liquids with higher flash points are noncombustible.

FLAMMABLE LIQUIDS shall mean any liquid having a flash point below 140°F. (60°C) and having a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100°F. (37.8°C).

Flammable liquids shall be divided into two classes of liquids as follows:

Class I liquids shall include those having flash points below 100°F. (37.8°C).

Class II liquids shall include those having flash points at or above 100°F. (37.8°C) and below 140°F. (60°C).

NOTE: This classification does not apply to:

(1) Materials that are solid at 100° F. (37.8° C.) or above,

(2) Liquids without flash points that may be flammable under some conditions, such as certain halogenated hydrocarbons and mixtures containing petroleum fractions and halogenated hydrocarbons,

(3) Mists, sprays or foams.

MARINE SERVICE STATION. That portion of a property where flammable liquids used as motor fuels are stored and dispensed from fixed equipment on shore, piers, wharves, or floating docks into the fuel tanks of motor craft, and shall include all facilities used in connection therewith.

TANK FULL TRAILER. Any vehicle with or without auxiliary motive power, equipped with a cargo tank mounted thereon or built as an integral part thereof and used for the transportation of flammable and combustible liquids or asphalt and so constructed that practically all of its weight and load rests on its own wheels.

TANK SEMI-TRAILER. Any vehicle with or without auxiliary motive power, equipped with a cargo tank mounted thereon or built as an integral part thereof, and used for the transportation of flammable and combustible liquids or asphalt, and so constructed that, when drawn by a tractor by means of a fifth wheel connection, some part of its load and weight rests upon the towing vehicle.

TANK TRUCK. Any single self-propelled motor vehicle equipped with a cargo tank mounted thereon, and used for the transportation of flammable and combustible liquids or asphalt.

TANK VEHICLE. Any tank truck, tank full trailer, or tractor and tank semi-trailer combination.

VAPOR PRESSURE shall mean the pressure, measured in pounds per square inch absolute exerted by a volatile liquid, as determined by the Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method), ASTM D–323–58.

CHAPTER 2. VEHICLE DESIGN.

20. Basic Design.

2010. Design of the tank vehicle shall give engineering consideration to the structural relationship between the cargo tank, the propulsion equipment and the supporting members if any, with due regard to the weight and temperature of the cargo, road performance, braking, and required ruggedness. The metal thicknesses specified in Chapter 2 are minimum thicknesses dictated by the structure of the tank itself, and it may be necessary that these thicknesses be increased where the tank shell is to be subjected to additional stress.

2020. Any tank vehicle designed or used for transporting materials at liquid temperatures above ambient temperature shall have a red warning sign permanently attached to the vehicle containing at least the following:

"Maximum allowable cargo temperature is ____° F."

This maximum allowable cargo temperature shall be specified by the manufacturer of the vehicle.

2030. Cargo tanks used for transporting flammable and combustible liquids with a vapor pressure of 18 psia or over at 100° F. shall be constructed in accordance with Article 21.

2040. Cargo tanks used for transporting flammable and combustible liquids with a vapor pressure under 18 psia at 100° F. shall be constructed in accordance with the provisions of Article 22 or Article 21.

2050. The material used in the construction of the cargo tanks shall be compatible with the chemical characteristics of the flammable and combustible liquid to be transported.

NOTE: In case of doubt, the supplier or producer of the flammable and combustible liquid or other competent authority should be consulted as to the suitability of the material of construction to be used.

21. Cargo Tanks, Piping and Connections Designed for Flammable Liquids Having a Vapor Pressure of 18 psia or Over at 100° F.

2110. Cargo tanks, piping and connections designed for flammable liquids having a vapor pressure of 18 psia or over at 100° F. shall be built in accordance with Specification MC 304 or MC 330 of Part 78 of Title 49, Code of Federal Regulations (Regulations of the Interstate Commerce Commission) or in accordance with Division III of the Standard for the Storage and Handling of Liquefied Petroleum Gases, NFPA No. 58.

22. Cargo Tanks, Piping and Connections Designed for Flammable and Combustible Liquids Having a Vapor Pressure Under 18 psia at 100° F.

2210. Cargo Tank Construction.

2211. Cargo Tanks Constructed of Mild Steel.

(a) **Material.** All sheets for such cargo tanks shall be of mild steel to meet the following requirements:

Yield Point, minimum.....25,000 pounds per square inch
Ultimate Strength, minimum....45,000 pounds per square inch
Minimum Elongation, standard 2-inch sample.....20 per cent

(b) **Thickness of Sheets.** The minimum thicknesses of tank sheets shall be limited by the volume capacity of the tank expressed in terms of gallons per inch of length; and by the distance between bulkheads, baffles, or other shell stiffeners, as well as by the radius of shell curvature in case of shell sheets. Thickness of exterior head sheets shall never be less than the maximum requirements for shell sheets in any specific unit.

MINIMUM THICKNESS OF HEAD, BULKHEAD AND BAFFLE SHEETS

Mild Steel

Heads, Bulkheads, or Baffles (Dished, Corrugated, Reinforced or Rolled)				
Volume Capacity of Tank in Gallons per Inch of Length	10 or Less	Over 10 to 14	Over 14 to 18	Over 18
Manufacturers Std. Gage No.	14	13	12	11

MINIMUM THICKNESS OF SHELL SHEETS

Mild Steel

Volume Capacity of Tank in Gallons Per Inch of Length	Distance Between Attachments of Bulkheads, Baffles or Other Shell Stiffeners: 36 inches or less		Over 36 inches to 54 inches		Over 54 inches	
	Gage* No.	Approx. Thick. Decimals of in.	Gage* No.	Approx. Thick. Decimals of in.	Gage* No.	Approx. Thick. Decimals of in.
Maximum Shell Radius of less than 70 inches:						
10 gallons or less	14	0.0747	14	0.0747	14	0.0747
Over 10 to 14 gallons	14	0.0747	14	0.0747	13	0.0897
Over 14 to 18 gallons	14	0.0747	13	0.0897	12	0.1046
Over 18 gallons	13	0.0897	12	0.1046	11	0.1196
Maximum Shell Radius of 70 inches or more, but less than 90 inches:						
10 gallons or less	14	0.0747	14	0.0747	13	0.0897
Over 10 to 14 gallons	14	0.0747	13	0.0897	12	0.1046
Over 14 to 18 gallons	13	0.0897	12	0.1046	11	0.1196
Over 18 gallons	12	0.1046	11	0.1196	10	0.1345
Maximum Shell Radius of 90 inches or more, but less than 125 inches:						
10 gallons or less	14	0.0747	13	0.0897	12	0.1046
Over 10 to 14 gallons	13	0.0897	12	0.1046	11	0.1196
Over 14 to 18 gallons	12	0.1046	11	0.1196	10	0.1345
Over 18 gallons	11	0.1196	10	0.1345	9	0.1495
Maximum Shell Radius of 125 inches or more:						
10 gallons or less	13	0.0897	12	0.1046	11	0.1196
Over 10 to 14 gallons	12	0.1046	11	0.1196	10	0.1345
Over 14 to 18 gallons	11	0.1196	10	0.1345	9	0.1495
Over 18 gallons	10	0.1345	9	0.1495	8	0.1685

*Manufacturers Standard Gage and approximate equivalent thickness in decimals of inch.

2212. Cargo tanks constructed of low alloy low carbon (high tensile) steel and stainless steel.

(a) All low alloy low carbon (high tensile) steel sheets for such cargo tanks shall meet the following requirements:

Yield Point, *minimum*.....45,000 pounds per square inch
Ultimate Strength, minimum....60,000 pounds per square inch
Minimum Elongation, standard 2-inch sample.....25 per cent

(b) All stainless steel sheets for such cargo tanks shall meet the following minimum requirements:

Yield Point, minimum.....32,000 pounds per square inch
Ultimate Strength, minimum....75,000 pounds per square inch
Minimum Elongation, standard 2-inch sample.....20 per cent

(c) Thickness of high tensile and stainless steel sheets: The minimum thickness of high tensile and stainless steel tank sheets shall be limited by the volume capacity of the tank expressed in terms of gallons per inch of length; and by the distance between bulkheads, baffles, or other shell sheets; as follows:

Low Alloy Low Carbon (High Tensile) Steel and Stainless Steel Sheets

MINIMUM THICKNESS OF HEAD, BULKHEAD AND BAFFLE SHEETS

Heads, Bulkheads, or Baffles	**(Dished, Corrugated, Reinforced or Rolled)**			
Volume Capacity of Tank in	10 or	Over 10	Over 14	Over
Gallons per Inch of Length	Less	to 14	to 18	18
Manufacturers Std. Gage No.	15	14	13	12

MINIMUM THICKNESS OF SHELL SHEETS

Low Alloy Low Carbon (High Tensile) Steel and Stainless Steel

Volume Capacity of Tank in Gallons Per Inch of Length	Distance Between Attachments of Bulkheads, Baffles or Other Shell Stiffeners: 36 inches or less		Over 36 inches to 54 inches		Over 54 inches	
Maximum Shell Radius of less than 70 inches*:	Gage** No.	Approx. Thick. Decimals of in.	Gage** No.	Approx. Thick. Decimals of in.	Gage** No.	Approx. Thick. Decimals of in.
10 gallons or less	16	0.0588	16	0.0588	15	0.0673
Over 10 to 14 gallons	16	0.0588	15	0.0673	14	0.0747
Over 14 to 18 gallons	15	0.0673	14	0.0747	13	0.0897
Over 18 gallons	14	0.0747	13	0.0897	12	0.1046
Maximum Shell Radius of 70 inches or more, but less than 90 inches*:						
10 gallons or less	16	0.0588	15	0.0673	14	0.0747
Over 10 to 14 gallons	15	0.0673	14	0.0747	13	0.0897
Over 14 to 18 gallons	14	0.0747	13	0.0897	12	0.1046
Over 18 gallons	13	0.0897	12	0.1046	11	0.1196
Maximum Shell Radius o 190 inches or more, but less than 125 inches*:						
10 gallons or less	15	0.0673	14	0.0747	13	0.0897
Over 10 to 14 gallons	14	0.0747	13	0.0897	12	0.1046
Over 14 to 18 gallons	13	0.0897	12	0.1046	11	0.1196
Over 18 gallons	12	0.1046	11	0.1196	10	0.1345
Maximum Shell Radius of 125 inches or more*:						
10 gallons or less	14	0.0747	13	0.0897	12	0.1046
Over 10 to 14 gallons	13	0.0897	12	0.1046	11	0.1196
Over 14 to 18 gallons	12	0.1046	11	0.1196	10	0.1345
Over 18 gallons	11	0.1196	10	0.1345	9	0.1495

*If other than circular cross section, the radius used shall be the maximum for that portion of the cross section under consideration.

**Manufacturers Standard Gage and approximate equivalent thickness in decimals of inch.

2213. Cargo Tanks Constructed of Aluminum Alloys for High Strength Welded Construction.

(a) **Material.** All sheets for shell, heads and bulkheads of such cargo tanks shall be of aluminum alloys GR20A (5052 commercial designation), GM31A (5454 commercial designation), GR40A (5154 commercial designation) or GM40A (5086 commercial designation), conforming to American Society for Testing and Materials Specification B209–62.

All heads, bulkheads, baffles and other shell stiffeners may use O temper (annealed) or stronger tempers. All shells shall be of H32 temper or H34 temper, except that when shell thicknesses of 0.250 inch or thicker are used, the H112 temper is additionally permitted.

(b) **Thickness of Sheets.** The minimum nominal thicknesses of tank sheets shall be limited by the volume capacity of the tank, expressed in terms of gallons per inch of length; and by the distance between bulkheads, baffles, or other shell stiffeners, as well as by the radius of shell curvature in the case of shell sheets. Thickness of exterior head sheets shall never be less than the maximum requirements for shell sheets.

(c). When aluminum is used for cargo tanks intended to transport cargoes at liquid temperatures above 250° F. the minimum thicknesses in the following tables shall be increased by one per cent for each 10° F. or portion thereof above 250° F. When the liquid temperatures are above 500° F. there shall be an additional one per cent for each 10° F. or portion thereof above 500° F. Aluminum shall not be used for cargo tanks transporting cargoes at temperatures above 550° F.

MINIMUM THICKNESS OF HEAD, BULKHEAD AND BAFFLE SHEETS

Aluminum Alloys GR20A, GM 31A, GR40A, and GM40A

Heads, Bulkheads, or Baffles	*(Dished, Corrugated, Reinforced or Rolled)*			
Volume Capacity of Tank in Gallons per Inch of Length	10 or Less	Over 10 to 14	Over 14 to 18	Over 18
Thickness in decimals of inch	.096	.109	.130	.151

MINIMUM THICKNESS OF SHELL SHEETS
Aluminum Alloys GR20A, GM31A, GR40A and GM40A

Volume Capacity of Tank in Gallons Per Inch of Length	Distance Between Attachments of Bulkheads, Baffles or Other Shell Stiffeners: 36 inches or less	Over 36 inches to 54 inches	Over 54 inches
Inch Decimal Thickness for Maximum Shell Radius of less than 70 inches:			
10 gallons or less	.087	.087	.096
Over 10 to 14 gallons	.087	.096	.109
Over 14 to 18 gallons	.096	.109	.130
Over 18 gallons	.109	.130	.151
Inch Decimal Thickness for Maximum Shell Radius of 70 inches or more, but less than 90 inches:			
10 gallons or less	.087	.096	.109
Over 10 to 14 gallons	.096	.109	.130
Over 14 to 18 gallons	.109	.130	.151
Over 18 gallons	.130	.151	.173
Inch Decimal Thickness for Maximum Shell Radius of 90 inches or more, but less than 125 inches:			
10 gallons or less	.096	.109	.130
Over 10 to 14 gallons	.109	.130	.151
Over 14 to 18 gallons	.130	.151	.173
Over 18 gallons	.151	.173	.194
Inch Decimal Thickness for Maximum Shell Radius of 125 inches or more:			
10 gallons or less	.109	.130	.151
Over 10 to 14 gallons	.130	.151	.173
Over 14 to 18 gallons	.151	.173	.194
Over 18 gallons	.173	.194	.216

2220. Joints.

2221. Joints shall be welded in accordance with recognized good practice and the efficiency of any joint shall be not less than 85 per cent of that of the adjacent metal in the tank.

2222. Mild steel sheets as specified in paragraph 2211 may be used in combination with high tensile steel sheets or stainless steel sheets as specified in paragraph 2212 in the construction

of a single tank, provided each material, where used, shall comply with the minimum requirements for the material used in the construction of that section of the tank. Whenever stainless steel sheets are used in combination with sheets of other types of steel, joints made by welding shall be formed by the use of stainless steel electrodes or filler rods on condition that the stainless steel electrodes or filler rods used in the welding be suitable for use with the grade of stainless steel concerned, according to the recommendations of the manufacturer of the stainless steel electrodes or filler rods.

2223. In cargo tanks constructed of aluminum alloys, all joints in and to tank shells, heads and bulkheads shall be welded. All welded aluminum joints shall be made in accordance with recognized good practice, and the efficiency of a joint shall not be less than 85 per cent of the annealed properties of the material in question. Aluminum alloys for high strength welded construction shall be joined by an inert gas arc welding process using filler metals R–GR40A, E–GR40A (5154 alloy) and R–GM50A, E–GM50A (5356 alloy) as conforming to American Society for Testing and Materials Specification No. B285–61 (American Welding Society Specification No. A5.10–61).

2230. Bulkheads and Baffles.

2231. Every cargo tank having a total capacity in excess of 3000 gallons and used for the distribution of Class I liquids to automotive and marine service stations to which the public is invited shall be divided into compartments, no one of which shall exceed 2500 gallons. A design tolerance of ten per cent shall be allowed for capacities of individual compartments or tanks.

2232. Bulkheads or compartments shall not be required in any cargo tank used for transportation service, regardless of total capacity, provided such cargo tank is not used for the delivery of flammable liquids to service stations or other premises to which the public is invited. Bulkheads or compartments shall not be required in any cargo tank used for asphalt service.

2233. Every cargo tank, and every compartment over 90 inches in length, except those used in asphalt service, shall be provided with baffles, the number of which shall be such that the linear distance between any two adjacent baffles, or between any tank head or bulkhead and the baffles nearest it, shall in no case exceed 60 inches.

2234. The cross sectional area of each baffle shall be not less than 80 per cent of the cross sectional area of the tank and the thickness of such baffle shall be not less than that required for heads and bulkheads of the cargo tank in which installed.

2235. Cargo tanks with compartments carrying Class II or Class III liquids adjacent to compartments carrying Class I liquids shall be provided with an air space between compartments. This air space shall be equipped and maintained with drainage facilities operative at all times.

2240. Test.

2241. At the time of manufacture every cargo tank shall be tested by a minimum air or hydrostatic pressure of three pounds per square inch applied to each compartment, or to the whole tank if it be not divided into compartments. Such pressure shall be maintained for a period of at least five minutes, during which, if the test is by air pressure, the entire exterior surface of all the joints shall be coated with a solution of soap and water, heavy oil or other material suitable for the purpose, foaming or bubbling of which will indicate the presence of leaks. Hydrostatic pressure, if used, shall be gaged at the top of the tank; and the tank shall be inspected at the joints for the issuance of liquid to indicate leaks. Any leakage discovered by either of the methods above described, or by any other method shall be deemed as evidence of failure to meet the requirements of this specification.

2250. Outlet Valve and Faucet Connections.

2251. Outlets shall be substantially made and so attached to the tank.

2252. Drawoff valves and faucets shall have discharge ends threaded, or they shall be designed so as to permit being tightly connected to hose extending to fill pipe.

2260. Vents for Tank Vehicles in Other Than Asphalt Services.

2261. **Normal Venting.** Each cargo tank or tank compartment, except those used in asphalt service, shall be provided with a normal vent or vents having a minimum through area of 0.44 square inches. The pressure vent shall be set to open at no more than 1 psig. Pressure and vacuum vents shall be designed to prevent loss of liquid through the vent in case of vehicle upset. If the tank is designed to be loaded or unloaded with the dome cover closed, the vent or vents shall be designed to limit the vacuum to one pound per square inch and the tank pressure to 3 psig on the basis of the maximum product transfer rate.

2262. **Emergency Venting for Fire Exposure.**

(a) **Total Capacity.** Each cargo tank or tank compartment, except those used in asphalt service, shall be provided with one or more devices with sufficient capacity to limit the tank internal pressure to 5 psig. This total emergency venting capacity shall be not less than that determined from Table 1, using the external surface of the cargo tank or tank compartment as the exposed area.

(b) **Pressure-Actuated Venting.** Each cargo tank or tank compartment shall be equipped with pressure-actuated vent or vents set to open at not less than 3 psig. The minimum venting capacity for pressure-actuated vents shall be 6,000 cubic feet of free air per hour (14.7 psia and 60°F.) at 5 psig. Pressure-actuated devices shall be designed so as to prevent leakage of liquid past the device in case of surge or vehicle upset but shall function in case of pressure rise when in upset position.

(c) **Fusible Venting.** If the pressure-actuated venting required by (b) does not provide the total venting capacity re-

TABLE 1

MINIMUM EMERGENCY VENT CAPACITY IN CUBIC FEET FREE AIR/HOUR (14.7 PSIA AND 60°F.)

Exposed Area Square Feet	Cubic Feet Free Air per Hour	Exposed Area Square Feet	Cubic Feet Free Air per Hour
20	15,800	275	214,300
30	23,700	300	225,100
40	31,600	350	245,700
50	39,500	400	265,000
60	47,400	450	283,200
70	55,300	500	300,600
80	63,300	550	317,300
90	71,200	600	333,300
100	79,100	650	348,800
120	94,900	700	363,700
140	110,700	750	378,200
160	126,500	800	392,200
180	142,300	850	405,900
200	158,100	900	419,300
225	191,300	950	432,300
250	203,100	1,000	445,000

NOTES: Interpolate for intermediate sizes.

The venting capacities have been calculated on the basis of 75% of the square feet of the total exposed area of the cargo tank, using the formulas for heat input contained in NFPA No. 30. The derivation of these formulas is also explained in this standard.

quired by (a), additional capacity shall be provided by adding fusible venting devices each having a minimum area of 1.25 square inches. The fusible vent or vents shall be actuated by elements which operate at a temperature not exceeding 250°F. when the tank pressure is between 3 and 5 psig. When fusible venting devices are used no less than two such devices shall be used on any cargo tank or tank compartment over 2,500 gallons in capacity, and at least one such device shall be located close to each end of the cargo tank or tank compartment.

2263. **Flow Testing and Marking of Vents.**

(**a**) Each venting device shall be flow tested in the ranges specified in the applicable preceding paragraphs. The actual rated flow capacity of the vent in cubic feet of free air per hour at the pressure in psig at which the flow capacity is determined shall be stamped on the device. The fusible vent or vents shall have their flow rating determined at 5 psig differential.

NOTE: For purposes of calibration, the venting devices may be tested with water or other media. When water is used, the cubic feet of air per hour may be considered to be 27 times the cubic feet of water per hour.

(**b**) These flow tests may be conducted by the manufacturer, if certified by a qualified impartial observer, or may be delegated to an outside agency.

NOTE: Information on suitable methods for conducting such tests is provided in API RP — 2000 available from the American Petroleum Institute, 1271 Avenue of the Americas, New York 20, New York.

2264. **Installation of Vents.**

(**a**) All vents shall be arranged to provide direct flow from the vapor space of the tank. Shutoff valves shall not be installed between the tank opening and the vent.

2270. Vents for Tank Vehicles in Asphalt Service.

2271. Each cargo tank used in asphalt service shall be provided with a vent having an effective opening at least equivalent to a nominal two-inch pipe.

2272. Each cargo tank for asphalt service shall be provided with a manhole having a free opening of at least 15 inches in diameter designed to relieve internal pressure at between two and three pounds per square inch gage or an equivalent relief device.

2280. Emergency-Discharge Control.

Liquids Having Viscosities Less Than 45 SSU.

2281. The outlets of each cargo tank or compartment used for transportation of Class I liquids, and trucks constructed hereafter for transportation of Class II and Class III flammable liquids having a viscosity less than 45 seconds Saybolt Universal at 100° F., shall be equipped with a reliable and efficient shutoff valve located inside the shell; or in the sump when it is an integral part of the shell; and designed so that the valve must be kept closed except during loading and unloading operations.

NOTE: The 45 second viscosity limit is included for the purposes of requiring internal valves when transporting free-flowing distillate oils, such as kerosene, diesel oil and domestic heating oil, and of excluding this requirement when transporting viscous oils such as residual fuel oil, bunker fuel oil, and asphalt products.

2282. The operating mechanism for the valve shall be provided with a secondary control, remote from the fill openings and discharge faucets, for use in the event of accidents or fire during delivery operations.

2283. The control mechanism shall be provided with a fusible section which will permit valves to close automatically in case of fire.

2284. In every case there shall be provided, between the shutoff valve seat and discharge faucet, a shear section which will break under strain unless the discharge piping is so arranged as to afford the same protection and leave the shutoff valve seat intact.

Liquids of Viscosities of 45 SSU or More.

2285. The outlets of each cargo tank used for the transportation of liquids having a viscosity equal to or greater than 45 seconds Saybolt Universal at 100° F. shall be equipped with a suitable shutoff valve, located internally, designed so that the valve will remain operable if the external connection is sheared off or a front or rear-head mounted valve securely reinforced and protected against shock or road hazards.

2290. Overflows and Drains for Asphalt Tank Vehicles.

2291. Overflow protection for asphalt tank vehicles shall be provided in the form of reservoirs or flashing around fill and vent pipes. Overflow and drain pipes shall have thicknesses heavier than the tank shell and shall be designed so that hot asphalt will not spill onto tires, brakes, burner equipment or vehicle's exhaust system.

23. Separation to Prevent Intermixing.

2310. Tank vehicles transporting Class I liquid in one or more compartments and Class II or Class III liquid in other compartment or compartments shall be equipped with separate piping, pumps, meters and hoses for such classes of product.

CHAPTER 3. TANK-VEHICLE CHASSIS, ASSEMBLY AND APPURTENANCES.

30. Tires.

3010. All tank motor vehicles shall be equipped with rubber tires on all wheels.

31. Anchoring of Cargo Tanks.

3110. Adequate hold-down devices shall be provided to anchor each cargo tank in a suitable manner that will not introduce undue concentration of stresses and shall be built to withstand loadings in any direction equal to the weight of the tank and attachments when filled with water. These devices on vehicles with frames shall all incorporate turnbuckles or similar positive action devices for drawing the tank down tight on the frame of the tank vehicle.

3120. Suitable stops and anchors shall be attached to the tank vehicle and the tank to prevent movement between them due to starting, stopping and turning. These stops or anchors shall be installed so as to be readily accessible for inspection and maintenance except that insulation for insulated tanks is permitted to cover such stops and anchors.

3130. Whenever any cargo tank is so designed and constructed that the cargo tank constitutes, in whole or in part, the stress member used in lieu of a frame, then such cargo tanks shall be designed so as to successfully and adequately withstand the stresses thereby imposed in addition to those otherwise imposed on the tank.

3140. Sections 3110, 3120 and 3130 shall not be so construed as to prohibit the installation between the tank and the chassis or undercarriage, devices, such as wood or rubber blocks, intended to provide for expansion or cushioning of the tank; provided, however, that such devices shall be reliable and be securely installed so as not to result in non-compliance with the other provisions of Article 31.

32. Static Protection.*

3210. Cargo tanks, and vehicle chassis, shall be electrically bonded.

3220. Provisions shall be made in the tank structure of the vehicle for the bonding of vehicle to the fill pipe during truck loading operations.

33. Protection Against Collision or Overturn.

3310. Drawoff valves or faucets projecting beyond the frame at the rear of a tank vehicle shall be adequately protected against collision by bumpers or similar means.

3320. On tank vehicles constructed hereafter, all closures for filling openings shall be protected from damage in the event of overturning of the tank vehicle by being enclosed within the body of the tank or a dome attached thereto, or by the use of suitable metal guards securely attached to the tank or the frame of the tank vehicle.

34. Lighting.

3410. No lighting device other than electric lights shall be used on tank vehicles. Lighting circuits shall have suitable overcurrent protection (fuses or automatic circuit breakers). The wiring shall have sufficient carrying capacity and mechanical strength, and shall be secured, insulated, and protected against physical damage, in keeping with recognized good practice.

35. Fuel System.

3510. Liquid fuel tanks shall be so designed, constructed and installed as to present no unusual hazard, and shall be so arranged as to vent during filling operations and permit drainage without removal from their mountings. Liquefied Petroleum Gas fuel containers shall be designed, constructed and installed in accordance with the requirements of the Standard for the Storage and Handling of Liquefied Petroleum Gases, NFPA No. 58.

---

*Drag chains and straps, formerly specified for the purpose of eliminating static charges, have been shown to be ineffective and their elimination is recommended.

3520. All portions of the fuel-feed system, including carburetor, pumps, and all auxiliary mechanisms and connections shall be constructed and installed in a workmanlike manner, and so constructed and located as to minimize the fire hazard, with no readily combustible materials used therein, and shall, except for Diesel fuel connections, be well separated from the engine exhaust system. A pressure-release device shall be provided where necessary. The fuel-feed lines shall be made of materials not adversely affected by the fuel to be used or by other materials likely to be encountered, of adequate strength for their purpose, well secured to avoid chafing or undue vibration, having a readily accessible and reliable shutoff valve or stopcock. Joints depending upon solder for mechanical strength and liquid tightness shall not be used in the fuel system at or near the engine, or its accessories, unless the solder has a melting point of not less than 340° F., or unless a self-closing, thermally controlled valve set to operate at not exceeding 300° F., or other equivalent automatic device, shall be installed in the fuel line on the fuel-tank side of such joint.

3530. Fuel tanks for the vehicle engine and fuel tanks for the burners on asphalt trucks shall be located remotely from the burner or protected by a noncombustible shield from the burner to prevent flashback.

36. Exhaust System.

3610. The exhaust system, including muffler (or silencer) and exhaust line shall have ample clearance from the fuel system and combustible materials, and shall not be exposed to leakage or spillage of product or accumulations of grease, oil or gasoline.

3620. The exhaust system, including all units, shall be constructed and installed in a workmanlike manner. A muffler (or silencer) cutout shall not be used.

37. Full Trailers and Semi-Trailers.

3710. Trailers shall be firmly and securely attached to the vehicle drawing them, in a manner conforming with recognized good practice.

3720. Each full trailer, and semi-trailer, shall be equipped with reliable brakes on all wheels, and adequate provision shall be made for their efficient operation from the driver's seat of the vehicle drawing the trailer, or semi-trailer.

3730. Trailer connections shall be such as to prevent the towed vehicle from whipping or swerving from side to side

dangerously or unreasonably and shall cause the trailer to follow substantially in the path of the towing vehicle.

38. Marking.

3810. Every tank vehicle used for the transportation of any flammable liquid, regardless of the quantity being transported, or whether loaded or empty, shall be conspicuously and legibly marked on each side and the rear thereof, in letters at least 3 inches high on a background of sharply contrasting color, optionally as follows:

(1) With a sign or lettering on the motor vehicle with the word "Flammable."

(2) With the common name of the flammable liquid being transported.

(3) With the name of the carrier or his trademark, when and only when such name or mark plainly indicates the flammable nature of the cargo.

39. Fire Extinguishers.

3910. Each tank vehicle shall be provided with at least one portable fire extinguisher having at least a 12-B, C rating or when more than one is provided, each extinguisher shall have at least a 6-B rating. Ratings shall be in accordance with the Standard for Installation, Maintenance and Use of Portable Fire Extinguishers, No. 10.

3920. Fire extinguishers shall be kept in good operating condition at all times, and they shall be located in an accessible place on each tank vehicle.

CHAPTER 4. AUXILIARY EQUIPMENT.

40. Auxiliary Internal Combustion Engines.

4010. Internal combustion engines, other than those providing propulsive power, installed or carried upon a tank vehicle transporting Class I liquids for the purpose of providing power for the operation of pumps or other devices, shall meet the following requirements:

4011. The engine air intake shall be equipped with an effective flame arrester, or an air cleaner having effective flame arrester characteristics, substantially installed and capable of preventing emission of flame from the intake side of the engine in event of backfiring.

4012. The fuel system shall be so located or constructed as to minimize the fire hazard. If the fuel tank is located above or immediately adjacent to the engine, suitable shielding shall be provided to prevent spillage during the filling operation, or leakage from the tank or fuel system, from coming in contact with the engine or any parts of the ignition and exhaust systems. All parts of the fuel system shall be constructed and installed in a workmanlike manner.

4013. Pumps and other appurtenances shall be so located in relation to the engine that spillage or leakage from such parts shall be prevented from coming in contact with the engine or any parts of the ignition and exhaust system, or adequate shielding shall be provided to attain the same purpose. The engine cooling fan shall be so positioned, rotated or shielded as to minimize the possibility of drawing flammable vapors toward the engine.

4014. When the engine is located in a position where spillage from the cargo tank or its appurtenances or from side racks might constitute a hazard, suitable shielding shall be provided to prevent such spillage from contacting the engine or engine exhaust system and for draining such spillage away from the vicinity of the engine.

4015. Where the engine is carried within an enclosed space adequate provision shall be made for air circulation at all times, to prevent accumulation of explosive vapors and to avoid overheating.

4016. The exhaust system shall be substantially constructed and installed and free from leaks. The exhaust line and muffler