NFPA

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TANK VEHICLES FOR FLAMMABLE & COMBUSTIBLE LIQUIDS 1979

NATIONAL FIRE PROTECTION ASSOCIATION, INC.
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SC-FM-79

Standard for

Tank Vehicles for Flammable and Combustible Liquids

NFPA 385-1979

1979 Edition of NFPA 385

This 1979 edition of NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids*, was prepared by the Technical Committee on Transportation of Flammable Liquids and was adopted by the National Fire Protection Association, Inc., on November 13, 1979, at its Fall Meeting in Phoenix, Arizona. It was released by the Standards Council for publication on December 3, 1979.

This standard is recommended for use as the basis for legal regulations. It supersedes the edition of 1974 and prior editions and is under the jurisdiction of the NFPA Technical Committee on Transportation of Flammable Liquids and approved by the Flammable Liquids Correlating Committee.

Amendments, other than editorial, are indicated by lines in the margin of the pages in which they appear.

Origin and Development of NFPA 385

This standard was initiated in 1926, first officially adopted in 1929, and revised and issued in the following earlier editions: 1933, 1948, 1953, 1954, 1955, 1957, 1958, 1959, 1960, 1963, 1964, 1966, 1971 and 1974. Editions prior to 1948 had different titles.

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Standard for
Tank Vehicles for
Flammable and Combustible Liquids

NFPA 385-1979

Chapter 1 General Provisions

1-1 Scope.

1-1.1 This standard applies to tank vehicles to be used for the transportation of asphalt or normally stable flammable and combustible liquids with a flash point below 200°F (93.4°C). It is intended to provide minimum requirements for the design and construction of cargo tanks and their appurtenances and to set forth certain matters pertaining to tank vehicles.

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.

1-1.2 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, instability, corrosiveness, and toxicity.

1-1.3 Attention is directed to the fact that some cutback asphalts have flash points in the range of Class I liquids. Also, liquids having a flash point higher than 200°F (93.4°C), 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.

1-1.4 The requirements for aircraft fuel servicing tank vehicles are contained in *Aircraft Fuel Servicing*, NFPA 407.

1-1.5 A tank vehicle transporting a flammable or combustible liquid in interstate service shall be considered to be in conformity with this standard while it is in interstate service if it meets the requirements of the U. S. Department of Transportation Hazardous Materials Regulations.

1-2 Definitions.

Baffle. A nonliquidtight transverse partition in a cargo tank.

Bulkhead. A liquidtight transverse closure between compartments of a cargo tank.

Cargo Tank. Any tank having a liquid capacity in excess of 110 gal (418 L) used for carrying 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 liquidtight division in a cargo tank.

Flash Point. 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 viscosity less than 45 SUS at 100°F (37.8°C) and a flash point below 200°F (93.4°C) shall be determined in accordance with the *Standard Method of Test for Flash Point by the Tag Closed Tester*, ASTM D-56-73.*

The flash point of liquids having a viscosity of 45 SUS or more at 100°F (37.8°C) or a flash point of 200°F (93.4°C) or higher shall be determined in accordance with the *Standard Method of Test for Flash Point by the Pensky-Martens Closed Tester*, ASTM D-93-73.*

Head. A liquidtight transverse closure at the end of a cargo tank.

Liquid. For the purpose of this standard, liquid shall mean any material which has a fluidity greater than that of 300 penetration asphalt when tested in accordance with the *Test for Penetration for Bituminous Materials*, ASTM D-5-71.* When not otherwise identified, the term liquid shall include both flammable and combustible liquids.

Combustible Liquid. A liquid having a flash point at or above 100°F (37.8°C).

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Combustible liquids shall be subdivided as follows:

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

Class IIIA Liquids shall include those having flash points at or above 140°F (60°C) and below 200°F (93.4°C).

Class IIIB Liquids shall include those having flash points at or above 200°F (93.4°C).

This standard does not cover Class IIIB liquids (*see 1-1.1*). Where the term combustible liquids is used in this standard, it shall mean only Class II and Class IIIA 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 this limitation should not be construed as indicating that liquids with higher flash points are noncombustible.

Flammable Liquid. A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psi (275.8 kPa) (absolute) at 100°F (37.8°C) and shall be known as a Class I liquid.

Class I Liquids shall be subdivided as follows:

Class IA shall include those having flash points below 73°F (22.8°C) and having a boiling point below 100°F (37.8°C).

Class IB shall include those having flash points below 73°F (22.8°C) and having a boiling point at or above 100°F (37.8°C).

Class IC shall include those having flash points at or above 73°F (22.8°C) and below 100°F (37.8°C).

The volatility of liquids is increased when artificially heated to temperatures equal to or higher than their flash points. When so heated Class II and III liquids shall be subject to the applicable requirements for Class I or II liquids. This standard may also be applied to high flash point liquids when so heated even though these same liquids when not heated are outside of its scope.

NOTE: This classification does not apply to:
(a) Liquids without flash points that may be flammable under some conditions, such as certain halogenated hydrocarbons and mixtures containing petroleum fractions and halogenated hydrocarbons,
(b) Mists, sprays or foams.

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. The pressure measured in psi (kPa) absolute exerted by a liquid, as determined by the *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*, ASTM D-323-72.*

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Chapter 2 Tank Vehicle Design

2-1 General.

2-1.1 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 this chapter 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. The general design of the cargo tank and vehicle chassis shall be arranged to give the best combination of structural characteristics and vehicle performance. The design of the suspension system shall incorporate features to help assure lateral or tipping stability when turning corners.

2-1.2 Any cargo tank designed for transporting materials at liquid temperatures above ambient temperatures shall have a metal warning plate not subject to corrosion located in a conspicuous place on the right side near the front. Such plate shall be permanently affixed to the tank or tank frame. Upon it shall be marked in characters at least ½ in. (1.2 cm) high by stamping, embossing, or other means of forming letters into or on the metal of the plate itself at least the following information:

"Maximum allowable cargo temperature is _°F (_°C)."

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

2-1.3 Cargo tanks used for transporting flammable and combustible liquids at temperatures equal to or above their boiling points shall be constructed in accordance with Section 2-2.

NOTE: Possible temperature rise during transfer as well as the loading temperature and altitude must be considered when determining if the flammable and combustible liquid will be transported at or above its boiling point. Where an accurate boiling point is unavailable for the material in question, or for mixtures which do not have a constant boiling point, the 10 percent point of a distillation performed in accordance with the *Standard Method of Test for Distillation of Petroleum Products*, ASTM D-86-67,* may be used as the boiling point of the liquid.

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2-1.4 Cargo tanks used for transporting flammable and combustible liquids at a temperature below their boiling points shall be constructed in accordance with the provisions of Section 2-2 or 2-3.

2-1.5 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.

2-1.6 A single cargo tank may be divided into compartments of different specification construction. Each such compartment shall conform to specification requirements concerned and be so identified with a permanent metal plate.

2-2 Cargo Tanks, Piping and Connections Designed for Transporting Flammable and Combustible Liquids at Temperatures at or Above Their Boiling Points. Cargo tanks, piping and connections designed for transporting flammable and combustible liquids above their boiling points shall be built in accordance with Specifications MC-307 or MC-331 of Part 178 of Title 49, *Code of Federal Regulations*, or in accordance with Chapter 6 of the *Standard for the Storage and Handling of Liquefied Petroleum Gases*, NFPA 58. Continued use of cargo tanks constructed on or before December 1, 1967, to Specifications MC-304 and MC-330 shall be permitted.

2-3 Cargo Tanks, Piping and Connections Designed for Transfer of Flammable and Combustible Liquids at Temperatures Below Their Boiling Points.

2-3.1 General. Cargo tanks constructed after the effective date of this standard shall be constructed in accordance with Section 2-3 as contained herein. Continued use of existing cargo tanks constructed in accordance with the 1966 edition of NFPA 385 and earlier editions shall be permitted, but new construction is not permitted.

2-3.2 Material. All sheet and plate material for shell, heads, bulkheads and baffles for cargo tanks which are not required to be constructed in accordance with the *American Society of Mechanical Engineers' Boiler and Pressure Vessel Code** shall meet the following minimum applicable requirements.

NOTE: Minimum requirements for materials listed below are duplicated from 49 CFR, Section 178.341, in effect as of January 1, 1974.

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(a) **Aluminum Alloys (AL).** Only aluminum alloy material suitable for fusion welding and in compliance with one of the following ASTM specifications shall be used:

ASTM B-209 Alloy 5052	ASTM B-209 Alloy 5254
ASTM B-209 Alloy 5086	ASTM B-209 Alloy 5454
ASTM B-209 Alloy 5154	ASTM B-209 Alloy 5652

All heads, bulkheads, baffles, and ring stiffeners may use 0 temper (annealed) or stronger tempers. All shells shall be made of materials with properties equivalent to H32 or H34 tempers, except that lower ultimate strength tempers may be used if the minimum shell thicknesses in Table 2-2 are increased in inverse proportion to the lesser ultimate strength.

(b) **Steel.**

	Mild steel (MS)	High strength low alloy steel (HSLA)	Austenitic stainless steel (SS)
Yield	25,000 psi	45,000 psi	25,000 psi
Ultimate strength	45,000 psi	60,000 psi	70,000 psi
Elongation, 2-in. samples	20%	25%	30%

2-3.3 Thickness of Sheets, Heads, Bulkheads, and Baffles.

2-3.3.1 Material Thickness. The minimum thicknesses of tank material authorized shall be predicated on not exceeding the maximum allowable stress level but in no case less than those indicated in Tables 2-1 and 2-2.

2-3.3.2 Product Density. The material thicknesses contained in Tables 2-1 and 2-2 are minimums based on a maximum 7.2 lb per gal (3.24 kg) product weight. If the tank is designed to haul products weighing more than 7.2 lb per gal (3.24 kg), the gallon per inch value used to determine the minimum thickness of heads, bulkheads, baffles or shell sheets shall be the actual section capacity required in gallons per inch multiplied by the actual product density in pounds per gallon divided by 7.2.

2-3.3.3 When aluminum is used for cargo tanks intended to transport cargoes at liquid temperatures above 250°F (121.1°C) the minimum thicknesses shall be increased by 1 percent for each 10°F (5.56°C) or portion thereof above 258°F (121.1°C). When the liquid temperatures are above 500°F (260°C) there shall be an additional 1 percent for each 10°F (5.56°C) or portion thereof above 500°F (260°C). Aluminum shall not be used for cargo tanks transporting cargoes at temperatures above 550°F (288°C).

Table 2-1 Minimum Thickness of Heads, Bulkheads and Baffles. Mild Steel (MS), High Strength Low Alloy Steel (HSLA), Austenitic Stainless Steel (SS), in U.S. Standard Gage; Aluminum Alloy (AL) — Expressed in Decimals of an Inch.

	Volume capacity in gal per in.											
	10 or less			Over 10 to 14			14 to 18			18 and over		
	MS	HSLA, SS	AL	MS	HSLA, SS	AL	MS	HSLA, SS	AL	MS	HSLA, SS	AL
Thickness	14	15	0.096	13	14	0.109	12	13	0.130	11	12	0.151

Table 2-2 Minimum Thickness of Shell Sheets. Mild Steel (MS), High Strength Low Alloy Steel (HSLA), Austenitic Stainless Steel (SS), in U.S. Standard Gage; Aluminum Alloy (AL) — Expressed in Decimals of an Inch.

Maximum shell radius	Distance between bulkheads, baffles, or ring stiffeners		Volume capacity in gal per in.											
			10 or less			Over 10 to 14			14 to 18			18 and over		
			MS	HSLA, SS	AL	MS	HSLA, SS	AL	MS	HSLA, SS	AL	MS	HSLA, SS	AL
Less than 70 in.		36 in. or less	14	16	0.087	14	16	0.087	14	15	0.096	13	14	0.109
		Over 36 in. to 54 in.	14	16	.087	14	15	.096	13	14	.109	12	13	.130
		54 in. through 60 in.	14	15	.096	13	14	.109	12	13	.130	11	12	.151
70 in. or more, less than 90 in.		36 in. or less	14	16	.087	14	15	.096	13	14	.109	12	13	.130
		Over 36 in. to 54 in.	14	15	.096	13	14	.109	12	13	.130	11	12	.151
		54 in. through 60 in.	13	14	.109	12	13	.130	11	12	.151	10	11	.173
90 in. or more, less than 125 in.		36 in. or less	14	15	.096	13	14	.109	12	13	.130	11	12	.151
		Over 36 in. to 54 in.	13	14	.109	12	13	.130	11	12	.151	10	11	.173
		54 in. through 60 in.	12	13	.130	11	12	.151	10	11	.173	9	10	.194
125 in. or more		36 in. or less	13	14	.109	12	13	.130	11	12	.151	10	11	.173
		Over 36 in. to 54 in.	12	13	.130	11	12	.151	10	11	.173	9	10	.194
		54 in. through 60 in.	11	12	.151	10	11	.173	9	10	.194	8	9	.216

2-3.4 Structural Integrity.

2-3.4.1 Maximum Stress Values. The maximum calculated stress value shall not exceed 20 percent of the minimum ultimate strength of the material as authorized except when ASME pressure vessel design requirements apply (see Section VIII, American Society of Mechanical Engineers' *Boiler and Pressure Vessel Code*,* 1971 edition.

2-3.4.2 Loadings. Cargo tanks shall be provided with additional structural elements as necessary to prevent resulting stresses in excess of those permitted in 2-3.4.1. Consideration shall be given to forces imposed by each of the following loads individually, and where applicable a vector summation of any combination thereof:

(a) Dynamic loading under all product load configurations.

(b) Internal pressure.

(c) Superimposed loads such as operating equipment, insulation, linings, hose tubes, cabinets and piping.

(d) Reactions of supporting lugs and saddles or other supports.

(e) Effect of temperature gradients resulting from product and ambient temperature extremes. Thermal coefficients of dissimilar materials where used are to be accommodated.

2-3.5 Joints.

2-3.5.1 Method of Joining. All joints between tank shells, heads, baffles (or baffle attaching rings), and bulkheads shall be welded in accordance with the requirements contained in this section.

2-3.5.2 Strength of Joints [Aluminum Alloy (AL)]. All welded aluminum alloy joints shall be made in accordance with recognized good practice, and the efficiency of a joint shall be not less than 85 percent of the properties of the adjacent material. Aluminum alloys shall be joined by an inert gas arc welding process using aluminum-magnesium type of filler metals which are consistent with the material supplier's recommendations.

2-3.5.3 Strength of Joints [Mild Steel (MS), High Strength Low Alloy (HSLA), Austenitic Stainless Steel (SS)]. Joints shall be welded in accordance with recognized good practice, and the effi-

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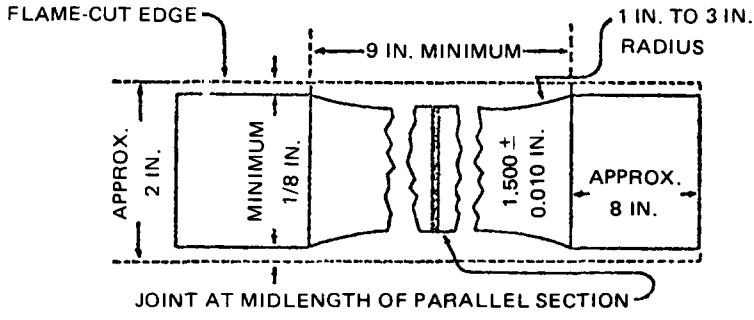
ciency of any joint shall be not less than 85 percent of the mechanical properties of the adjacent metal in the tank.

2-3.5.4 Combinations of mild steel (MS), high strength low alloy (HSLA) and/or austenitic stainless steel (SS) may be used in the construction of a single tank, provided that each material, where used, shall comply with the minimum requirements specified 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 and the stainless steel electrodes or filler rods used in the welding shall 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.

2-3.5.5 Compliance Test. Compliance with the requirements contained in 2-3.5.2 or 2-3.5.3 for the welded joints indicated in 2-3.5.1 shall be determined by preparing, from materials representative of those to be used in tanks subject to this specification and by the same technique of fabrication, two test specimens conforming to the figure as shown below and testing them to failure in tension. One pair of test specimens may represent all the tanks to be made of the same combination of materials by the same technique of fabrication, and in the same shop, within six months after the tests on such samples have been completed. The butt welded specimens tested shall be considered qualifying other types or combinations of types of weld using the same filler material and welding process as long as parent metals are of the same types of material.



TENSILE SPECIMEN

2-3.6 Supports and Anchoring.

2-3.6.1 Cargo tanks with frames not made integral with the tank as by welding shall be provided with restraining devices to eliminate any relative motion between the tank and frame which may result from the stopping, starting, or turning of the vehicle. Such restraining devices shall be readily accessible for inspection and maintenance, except that insulation and jacketing are permitted to cover the restraining devices.

2-3.6.2 Any cargo tank designed and constructed so that it constitutes in whole or in part the structural member used in lieu of a frame shall be supported in such a manner that the resulting stress levels in the cargo tank do not exceed those specified in 2-3.4.1. The design calculations of the support elements shall include loadings imposed by stopping, starting, and turning in addition to those imposed as indicated in 2-3.4.2 using 20 percent of the minimum ultimate strength of the support material.

2-3.7 Circumferential Reinforcement.

2-3.7.1 Tanks with shell thicknesses less than 3/8 of an in. (0.93 cm) shall, in addition to the reinforcement provided by the tank heads, be circumferentially reinforced with either bulkheads, baffles, or ring stiffeners. It is permissible to use any combination of the aforementioned reinforcements in a single cargo tank.

2-3.7.2 Location. Such reinforcement shall be located in such a manner that the maximum unreinforced portion of the shell be as specified in Table 2-2 and in no case more than 60 in. (150 cm). Additionally, such circumferential reinforcement shall be located within 1 in. (2.5 cm) of points where discontinuity in longitudinal shell sheet alignment exceeds 10 degrees unless otherwise reinforced with structural members capable of maintaining shell sheet stress levels permitted in 2-3.6.

2-3.7.3 Baffles. Baffles or baffle attaching rings if used as reinforcement members shall be circumferentially welded to the tank shell. The welding must not be less than 50 percent of the total circumference of the vessel, and the maximum unwelded space on this joint shall not exceed 40 times the shell thickness.

2-3.7.4 Double Bulkheads. Whenever double bulkheads are provided, they shall be separated by an air space. This air space shall be vented and be equipped with drainage facilities which shall be kept operative at all times (*see 6-1.7*).

2-3.7.5 Ring Stiffeners. Ring stiffeners when used to comply with this section shall be continuous around the circumference of the tank shell and shall have a section modulus about the neutral axis of the ring section parallel to the shell at least equal to that determined by the following formula:

$$\frac{I}{C} \text{ (Min)} = 0.00027 \text{ WL (MS, HSLA \& SS) Steel}$$

$$\frac{I}{C} \text{ (Min)} = 0.000467 \text{ WL (AL) Aluminum Alloy}$$

where

$\frac{I}{C}$ = section modulus $(\text{in.})^3$;

W = tank width or diameter (in.);

L = ring spacing (in.); i.e., the maximum distance from the midpoint of the unsupported shell on one side of the ring stiffener to the midpoint of the unsupported shell on the opposite side of the ring stiffener.

2-3.7.5.1 If a ring stiffener is welded to the tank shell (with each circumferential weld not less than 50 percent of the total circumference of the vessel and the maximum unwelded space on this joint not exceeding 40 times the shell thickness), a portion of the shell may be considered as part of the ring section for purposes of computing the ring section modulus. The maximum portion of the shell to be used in these calculations is as follows:

Circumferential ring stiffener to tank shell welds	Distance between parallel circumferential ring stiffener to shell welds	Shell section credit
1	. . . . .	20t
2	Less than 20t	20t + W
2	20t or more	40t

where

t = shell thickness;

W = distance between parallel circumferential ring stiffener to shell welds.

2-3.7.5.2 If configuration of internal or external ring stiffener encloses an air space, this air space shall be arranged for venting and be equipped with drainage facilities which shall be kept operative at all times.

2-3.8 Accident Damage Protection.

2-3.8.1 The design, construction, and installation of any appurtenance to the shell or head of the cargo tank must be such as to minimize the possibility of appurtenance damage or failure adversely affecting the product retention integrity of the tank.

2-3.8.2 Structural members, such as the suspension subframe, overturn protection and external rings, when practicable, shall be utilized as sites for attachment of appurtenances and any other accessories to a cargo tank.

2-3.8.3 Except as prescribed in 2-3.8.5, the welding of any appurtenance to a shell or head must be made by attachment to a mounting pad. The thickness of a mounting pad must not be less than that of the shell or head to which it is attached. A pad must extend at least 2 in. (5 cm) in each direction from any point of attachment of an appurtenance. Pads must have rounded corners or otherwise be shaped in a manner to preclude stress concentrations on the shell or head. The mounting pad must be attached by a continuous weld around the pad.

2-3.8.4 The appurtenance must be attached to the mounting pad so there will be no adverse affect upon the product-retention integrity of the tank if any force is applied to the appurtenance, in any direction, except normal to the tank, or within 45 degrees of normal.

2-3.8.5 Skirting structures, conduit clips, brakeline clips, and similar lightweight attachments, which are of a metal thickness, construction, or material, appreciably less strong but not more than 72 percent of the thickness of the tank shell or head to which such a device is attached, may be secured directly to the tank shell or head if each device is so designed and installed that damage to it will not affect the product retention integrity of the tank. These lightweight at-

tachments must be secured to the tank shell by continuous weld or in such manner as to preclude formation of pockets, which may become sites for incipient corrosion.

2-3.8.6 Rear Bumpers. Every cargo tank shall be provided with a rear bumper to protect the tank and piping in the event of a rear end collision and minimize the possibility of any part of the colliding vehicle striking the tank. The bumper shall be located at least 6 in. (15 cm) to the rear of any vehicle component which is used for loading or unloading purposes or may at any time contain lading while in transit. Dimensionally, the bumper shall conform to 49 C.F.R. & 393.86. Structurally, the bumper shall be designed to successfully absorb (no damage which will cause leakage of product) the impact of the vehicle with rated payload, with a deceleration of 2 "g" using a factor of safety of two based on the ultimate strength of the bumper material. For purposes of these regulations such impact shall be considered uniformly distributed and applied horizontally (parallel to the ground) from any direction at an angle not exceeding 30 degrees to the longitudinal axis of the vehicle.

2-3.8.7 Overturn Protection. All closures for filling, manhole, or inspection openings shall be protected from damage which will result in leakage of lading in the event of overturning of the vehicle by being enclosed within the body of the tank or dome attached to the tank or by guards.

2-3.8.7.1 When guards are required, they shall be designed and installed to withstand a vertical load of twice the weight of the loaded tank and a horizontal load in any direction equivalent to one-half the weight of the loaded tank. These design loads may be considered independently. Ultimate strength of the material shall be used as a calculation base. If more than one guard is used each shall carry its proportionate share of the load. If protection other than guards are considered, the same design load criteria are applicable.

2-3.8.7.2 Except for pressure actuated vents no overturn protection is required for nonoperating nozzles or fittings less than 5 in. (12.5 cm) in diameter (which do not contain product while in transit) that project a distance less than the inside diameter of the fitting. This projected distance may be measured either from the shell or the top of an adjacent ring stiffener provided such stiffener is within 30 in. (75 cm) of the center of the nozzle or fitting.

2-3.8.7.3 If the overturn protection is so constructed as to permit accumulation of liquid on the top of the tank, it shall be provided with drainage facilities directed to a safe point of discharge.

2-3.8.8 Piping.

2-3.8.8.1 Product discharge piping shall be provided with protection in such a manner as to reasonably assure against the accidental escape of contents. Such protection may be provided by:

(a) A shear section located outboard of each emergency valve seat and within 4 in. (10 cm) of the vessel which will break under strain and leave the emergency valve seat and its attachment to the vessel and the valve head intact and capable of retaining product. The shear section shall be machined in such a manner as to abruptly reduce the wall thickness of the adjacent piping (or valve) material by at least 20 percent; or

(b) By suitable guards capable of successfully absorbing a concentrated horizontal force of at least 8,000 lb (3600 kg) applied from any horizontal direction, without damage to the discharge piping which will adversely affect the product retention integrity of the discharge valve.

2-3.8.8.2 Minimum Road Clearance. The minimum allowable road clearance of any cargo tank component or protection device located between any two adjacent axles on a vehicle or vehicle combination shall be at least ½ in. (1.2 cm) for each ft separating such axles and in no case less than 12 in. (30 cm).

2-3.8.8.3 Strength of Piping, Fittings, Hose and Hose Couplings. Hose, piping, and fittings for tanks to be unloaded by pressure shall be designed for bursting pressure of at least 100 psig (689.5 kPa) and not less than four times the pressure to which, in any instance, it may be subjected in service by the action of any vehicle-mounted pump or other device (not including safety relief valves), the action of which may be subject to certain portions of the tank piping and hose to pressures greater than the design pressure of the tank. Any coupling used on hose to make connections shall be designed for a working pressure not less than 20 percent in excess of the design pressure of the hose and shall be so designed that there will be no leakage when connected.

2-3.8.8.4 Provision for Expansion and Vibration. Suitable provisions shall be made in every case to allow for and prevent damage due to expansion, contraction, jarring and vibration of all pipe. Slip joints shall not be used for this purpose.

2-3.8.8.5 Heater Coils. Heater coils, when installed, shall be so constructed that the breaking-off of their external connections will not cause leakage of contents of tank.

2-3.8.8.6 Gaging, Loading, and Air-Inlet Devices. Gaging, loading, and air-inlet devices, including their valves, shall be provided with adequate means for their secure closure, and means shall also be provided for the closing of pipe connection of valves.

2-3.9 Closures for Fill Openings and Manholes. Each compartment in excess of 2,500 gal (9500 L) capacity shall be accessible through a manhole of at least 11 in. x 15 in. (27.5 cm x 37.5 cm). Manhole and/or fill opening covers shall be designed to provide secure closure of the openings. They shall have structural capability of withstanding internal fluid pressures of 9 psig (62 kPa) without permanent deformation. Safety devices to prevent the manhole and/or fill cover from opening fully when internal pressure is present shall be provided.

2-3.10 Vents for Cargo Tanks in Other than Asphalt Service.

2-3.10.1 Each cargo tank compartment shall be provided with safety relief devices in accordance with the requirements contained in this section. All of such devices shall communicate with the vapor space. Shut-off valves shall not be installed between the tank opening and any safety device. Safety relief devices shall be so mounted, shielded, or drained as to eliminate the accumulation of water, the freezing of which could impair the operation or discharge capability of the device.

2-3.10.2 Normal Venting. Each cargo tank compartment shall be provided with pressure and vacuum vents having a minimum through area of 0.44 sq in. (2.86 cm^2). All pressure vents shall be set to open at no more than 1 psig (6.9 kPa) and all vacuum vents at no more than 6 oz (168 g). Pressure and vacuum vents shall be designed to prevent loss of liquid through the vent in case of vehicle overturn.

2-3.10.3 Loading and Unloading Venting Protection. If the tank is designed to be loaded or unloaded with the dome cover closed, the vent or vents as described in 2-3.10.2 above or additional vents shall limit the vacuum to 1 psi (6.9 kPa) and the tank pressure to 3 psig (20.7 kPa) based on maximum product transfer rate. Unless effective protection against overfilling is made, the pressure vent shall also have sufficient liquid capacity to prevent the pressure from exceeding 3 psig (20.7 kPa) in case of accidental overfilling. This pressure vent may be pressure operated or interlocked with the tank loading device and shall be designed to prevent loss of liquid through the vent under any condition of vehicle rollover attitude.

2-3.11 Emergency Venting for Fire Exposure.

2-3.11.1 Total Capacity. The total emergency venting capacity (cu ft/hr) (m^3/s) of each cargo tank compartment shall be not less than that determined from Table 2-3.

Table 2-3

Minimum Emergency Vent Capacity in Cubic Feet Free Air/Hr [14.7 Psia (101.3 kPa) and 60°F (15.6°C)]

Exposed Area Sq. Ft	Cu Ft Free Air per Hr	Exposed Area Sq Ft	Cu Ft Free Air per Hr
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

NOTE: Interpolate for intermediate sizes.

2-3.11.2 Pressure Actuated Venting. Each cargo tank compartment shall be equipped with pressure-actuated vent or vents set to open at not less than 3 psig (20.685 kPa) and close when pressure drops to 3 psig (20.685 kPa) or below. The minimum venting capacity for pressure-actuated vents shall be 6,000 cu ft (170 m^3) of free air per hr [14.7 psia (101.3 kPa) and 60°F (15.6°C)] from a tank pressure of 5 psig (34.475 kPa). Pressure-actuated devices shall be designed so as to prevent leakage of liquid past the device in case of surge or vehicle upset, except that they shall function in case of pressure rise under any condition of vehicle rollover attitude.

2-3.11.3 Fusible Venting. If the pressure-actuated venting required by 2-3.11.2 does not provide the total venting capacity required by 2-3.11.1 additional capacity shall be provided by adding fusible venting devices, each having a minimum area of 1.25 sq in. (8.1 cm^2); such fusible elements shall be so located as to not be in contact with the tank lading under normal operating conditions. The fusible vent or vents shall be actuated by elements which operate at a temperature not exceeding 250°F (121.1°C). The venting capacity of these devices shall be rated at not more than 5 psig (34.475 kPa). 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 gal (9500 L) in capacity, and at least one such device shall be located close to each end of the cargo tank or tank compartment.

2-3.11.4 Flow Testing and Marking of Vents. Each type and size of venting device shall be flow tested in the range 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 (34.475 kPa) differential.

2-3.11.5 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 Standard 2000 available from the American Petroleum Institute, 2101 L Street, NW, Washington, DC 20037.

2-4 Emergency-Discharge Control.

2-4.1 Liquids Having Viscosities Less than 45 SUS.

2-4.1.1 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 IIIA liquids having a viscosity less than 45 Saybolt Universal Seconds at 100°F (37.8°C), shall be equipped with a self-closing shut-off valve, designed, installed, and operated so as to ensure against the accidental escape of contents. These valves shall be located inside the tank or at a point outside the tank where the line enters or leaves the tank. The valve seat shall be located inside the tank or within the welded flange, its companion flange, nozzle, or coupling, 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 which may congeal and cause malfunctioning of the valve.

2-4.1.2 The operating mechanism for the valve shall be provided with a secondary control, remote from the fill openings and discharge connections, for use in the event of accidents or fire during delivery operations.

2-4.1.3 The control mechanism shall be provided with at least one fusible element which becomes effective at a temperature not over 250°F (121.1°C) permitting the valve to close automatically in case of fire. At least one fusible element shall be in the open where it would be exposed to the heat of a fire under the vehicle.

2-4.1.4 In every case there shall be provided a shear section located outboard of each emergency valve seat and within 4 in. (10 cm) of the vessel which will break under strain and leave the emergency valve seat and its attachment to the vessel and the valve head intact and capable of retaining product. The shear section shall be machined in such a manner as to abruptly reduce the wall thickness of the adjacent piping (or valve) material by at least 20 percent.

2-5 Liquids of Viscosities of 45 SUS or More. The outlets of each cargo tank used for the transportation of liquids having a viscosity equal to or greater than 45 Saybolt Universal Seconds at 100°F (37.8°C) shall be equipped with (1) a suitable shutoff valve, located internally, designed so that the valve will remain operable if the external connection is sheared off, or (2) a front- or rear-head mounted valve securely reinforced and protected against shock or road hazards.

2-6 Tests.

2-6.1 At the time of manufacture, every cargo tank shall be tested by a minimum air or hydrostatic pressure of 3 psig (20.685 kPa) or at least equal to the tank design pressure, whichever is greater. If compartmented, each individual compartment shall be similarly tested with adjacent compartments empty and at atmospheric pressure. Air pressure, if used, shall be held for a period of at least 5 minutes during which the entire surface of all joints under pressure shall be coated with a solution of soap and water, heavy oil, or other material suitable for the purpose, foaming or bubbling of which indicates the presence of leaks. Hydrostatic pressure, if used, shall be done by using water or other liquid having a similar viscosity, the temperature

of which shall not exceed 100°F (37.8°C) during the test, and applying pressure as prescribed above, gaged at the top of the tank, at which time all joints under pressure shall be inspected for the issuance of liquid to indicate leaks. All closures shall be in place while test by either method is made. During these tests, operative relief devices shall be clamped, plugged, or otherwise rendered inoperative; such clamps, plugs, and similar devices shall be removed immediately after the test is finished.

2-6.2 The test in 2-6.1 shall be repeated following alteration or repairs which involve tank integrity. If there is any leakage, undue distortion, or if failure impends or occurs, the cargo tank shall not be placed in service unless an adequate repair is made. The adequacy of the repair shall be determined by the same method of test.

2-7 Separation to Prevent Intermixing. Tank vehicles designed to transport Class I liquid in one or more compartments and Class II or Class III liquid in other compartment or compartments, or to transport chemically noncompatible liquids, shall be provided with double bulkheads and shall be equipped with separate piping, pumps, meters and hoses for such classes of product.

2-8 Lighting. 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.

Chapter 3 Asphalt Tank Vehicles

3-1 General. Cargo tanks shall be free of water or volatile liquids before they are loaded with hot asphalt.

3-2 Vents for Cargo Tanks in Asphalt Service.

3-2.1 Each cargo tank used in asphalt service shall be provided with a vent having an effective opening at least equivalent to a nominal 2-in. pipe.

3-2.2 Each cargo tank for asphalt service shall be provided with a manhole having a free opening of at least 15 in. (381 mm) in diameter designed to relieve internal pressure at between 2 and 3 psig (.095 and .143 kPa) or an equivalent relief device.

3-3 Overflows and Drains for Asphalt Tank Vehicles. 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.

3-4 Burner and Burner Tubes for Asphalt Tank Vehicles.

3-4.1 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.

3-4.2 Burner tubes shall be properly installed and maintained.

3-4.3 The bottom of internal burner tubes shall be located as low in the tank as proper design and functioning will permit.

3-4.4 Instructions for the proper method of operating the burner equipment and the pumping equipment, if so equipped, shall be provided. These instructions shall accompany the vehicle at all times.

3-4.5 A legible red warning sign shall be permanently attached near the burners on any tank vehicle equipped with burners and shall contain at last the following information:

"WARNING"

This burner equipment must not be operated while the vehicle is being loaded or is in transit, or when the burner tubes are not completely submerged.

Chapter 4 Marking on Tank Vehicles

4-1 Marking.

4-1.1 Every tank vehicle used for the transportation of any flammable or combustible liquids, regardless of the quantity being transported, or whether loaded or empty, shall be conspicuously and legibly marked in accordance with the requirements of the U.S. Department of Transportation Hazardous Materials Regulations.

4-1.2 Manufacturer's Certificate. A certificate signed by a responsible official of the manufacturer of the cargo tank, or from a competent testing agency, certifying that each such cargo tank is designed, constructed, and tested in compliance with this standard shall be procured, and such certificate shall be retained in the files of the carrier during the time that such cargo tank is employed by him, plus one year.

4-1.3 In addition to this certificate, there shall be on every cargo tank (or tank compartment if constructed to different specification) a metal plate not subject to corrosion located on the right side, near the front, in a place readily accessible for inspection. Such plate shall be permanently affixed to the tank by means of soldering, brazing, welding, or other equally suitable means; and upon it shall be marked in characters at least 3/16 in. (0.47 cm) high by stamping, embossing, or other means of forming letters into or on the metal of the plate itself at least the information indicated below. The plate shall not be so painted as to obscure the markings thereon.

4-1.4 If a cargo tank is to be physically altered to meet another specification (or to accommodate a commodity not requiring a specification tank) such combinations shall be indicated beside specification identification.

Vehicle manufacturer.....
Manufacturer's serial no.....
Specification identification DOT MC 306; or MC 307; or MC 312 .....
Date of manufacture.....
Original test date.....
Certificate date.....
Design pressure.....psig

Test pressure.....psig
Head material.....
Shell material.....
Weld material.....
Lining material.....
Nominal tank capacity by compartment (front to rear .....U.S. gal)
Maximum product load.....lbs
Loading limits.....gpm and/or psig
Unloading limits.....gpm and/or psig

4-1.5 If the cargo tank has a metal certification plate for MC 306 specification, the characters "NFPA 385" may be added to the Specification Identification line on the metal plate.

Chapter 5 Auxiliary Equipment

5-1 Auxiliary Internal Combustion Engines.

5-1.1 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.

5-1.2 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.

5-1.3 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.

5-1.4 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.

5-1.5 When the engine is located in a position where spillage from the cargo tank or its appurtenances or from side racks might consitute 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 viciniy of the engine.

5-1.6 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.

5-1.7 The exhaust system shall be substantially constructed and installed and free from leaks. The exhaust line and muffler shall have adequate clearance from combustible materials, and the exhaust

gases shall be discharged at a location which will not constitute a hazard. When engines are carried as in 5-1.6, the exhaust gases shall be discharged outside of each such closed space.

5-1.8 The ignition wiring shall be substantially installed with firm connections, and spark plug and all other terminals shall be suitably insulated to prevent sparking in event of contact with conductive materials. The ignition switch shall be of the enclosed type.

5-2 Auxiliary Electric Generators and Motors.

5-2.1 Electrical equipment installed or carried upon a tank vehicle transporting Class I liquids for the operation of pumps or other devices used for the handling of product and operating product handling accessories shall meet the following requirements.

5-2.2 Generators which are mounted on the engine providing propulsive power for the vehicle or an auxiliary engine, or located in the immediate vicinity of such engine or its exhaust system, may have general purpose enclosure. Generators located elsewhere shall be provided with explosionproof enclosures.

5-2.3 Motors having sparking contacts shall be provided with explosionproof enclosures.

5-2.4 Wiring shall be adequate for maximum loads to be carried and shall be installed so as to be protected from physical damage and contact with possible product spill either by location or by being enclosed in metal conduit or other oil-resistant protective covering. Junction boxes shall be sealed.

5-2.5 Switches, overload protection devices and other sparking equipment shall be located and enclosed as provided for generators in 5-2.2.

5-2.6 Where the generator or motor is located within an enclosed space, adequate provision shall be made for air circulation to prevent overheating and possible accumulation of explosive vapor.

5-3 Pumps and Hose.

5-3.1 When a pump is used to deliver products, automatic means shall be provided to prevent pressure in excess of the design working pressures of the accessories, piping, and hose.

5-3.2 Each length of hose used for delivery of product by pump shall be marked to indicate the manufacturer's recommended working pressure.

5-3.3 All pressure hoses and couplings shall be inspected at intervals appropriate to the service. With the hose extended, apply pressure to the hose and couplings to the maximum operating pressure. Any hose showing material deteriorations, signs of leakage, or weakness in its carcass or at the couplings shall be withdrawn from service and repaired or discarded.

Chapter 6 Operation of Tank Vehicles

6-1 General Operating Conditions.

6-1.1 Drivers shall be thoroughly trained in the proper method of operating tank vehicles and in the proper procedures for loading and unloading tank vehicles. Tank vehicles shall not be operated unless they are in proper repair, devoid of accumulation of grease, oil, or other flammables, and free of leaks.

6-1.2 Dome covers shall be closed and latched while the tank vehicle is in transit.

6-1.3 No tank vehicle shall be operated with a cargo temperature above the maximum allowable cargo temperature specified on the warning sign required by 2-1.2.

6-1.4 No material shall be loaded into or transported in a cargo tank at a temperature above its ignition temperature, unless properly safeguarded in a manner approved by the authority having jurisdiction.

6-1.5 Flammable and combustible liquids, which are loaded at or above their boiling points or may reach their boiling point temperature during transit, shall be loaded only into cargo tanks constructed in accordance with Section 2-2.

6-1.6 Flammable and combustible liquids shall be loaded only into cargo tanks whose material used in construction shall be compatible with the chemical characteristics of the liquid. The flammable and combustible liquid being loaded shall also be chemically compatible with the liquid hauled on the previous load unless the cargo tank has been cleaned.

NOTE: In case of doubt, the supplier or producer of the flammable or combustible liquid or other competent authority should be consulted.

6-1.7 Class II or Class III liquids shall not be loaded into an adjacent compartment to Class I liquids unless double bulkheads are provided, nor shall chemically noncompatible chemicals be loaded into adjacent compartments unless separated by double bulkheads.

6-1.8 To prevent a hazard from a change in flash point of liquids, no cargo tank, or any compartment thereof, which has been utilized for Class I liquid, shall be loaded with Class II or Class III liquid until such tank or compartment and all piping, pumps, meters, and hose connected thereto have been completely drained. A tank, compartment, piping, pump, meter, or hose which does not drain completely shall be flushed at the loading point with a quantity of Class II or Class III liquid equal to twice the capacity of piping, pump, meter, and hose, to clear any residue of Class I liquid from the system.

NOTE: To reduce the danger of static ignition when changing from Class I to Class II or Class III (switch loading), other precautions may be necessary. (*See Appendix for further information.*)

6-1.9 No repairs shall be made to any tank vehicle unless the repairs can be made without hazard, nor shall any loaded motor vehicle be repaired in a closed garage.

6-1.10 No cargo tank shall be repaired by any method employing a flame, arc, or other source of ignition, unless the tank is maintained gas free or otherwise made safe in an approved manner.

6-2 Loading and Unloading Tank Vehicles.

6-2.1 Loading and unloading of tank vehicles shall only be done in approved locations.

6-2.2 The driver, operator, or attendant of any tank vehicle shall not remain in the vehicle but shall not leave the vehicle unattended during the loading or unloading process. Delivery hose, when attached to a tank vehicle, shall be considered to be a part of the tank vehicle.

6-2.3 When transferring Class I liquids, motors of tank vehicles or motors of auxiliary or portable pumps shall be shut down during making and breaking hose connections. If loading or unloading is done without requiring the use of the motor of the tank vehicle, the motor shall be shut down throughout the transfer operations of Class I liquids.

6-2.4 If portable pumps are used for transferring Class I liquids, the portable pumps shall comply with the applicable provisions of Section 5-1 or 5-2.

6-2.5 No cargo tank or compartment thereof used for the transportation of any flammable or combustible liquid or asphalt shall be loaded liquid full. Sufficient space (outage) shall be provided in