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Vapor Recovery System. A system designed to capture and retain, without processing, vapors displaced during filling operations at service stations, bulk plants, or terminals. Examples are balanced-pressure vapor displacement systems and vacuum assist systems without vapor processing.

Ventilation. As specified in this code, ventilation is for the prevention of fire and explosion. It is considered adequate if it is sufficient to prevent accumulation of significant quantities of vapor-air mixtures in concentration over one-fourth of the lower flammable limit.

Warehouses.

General Purpose Warehouse. A separate, detached building or portion of a building used only for warehousing-type operations.

NOTE: Warehousing operations referred to above are those operations not accessible to the public and include general purpose, merchandise, distribution and industrial warehouse-type operations.

Liquid Warehouse. A separate, detached building or attached building used for warehousing-type operations for liquids.

1-3 Storage. Liquids shall be stored in tanks or in containers in accordance with Chapter 2 or Chapter 4.

1-4 Pressure Vessel. All new pressure vessels containing liquids shall comply with 1-4.1, 1-4.2 or 1-4.3, as applicable.

1-4.1 Fired pressure vessels shall be designed and constructed in accordance with Section I (Power Boilers) 1971, or Section VIII, Division 1 or Division 2 (Pressure Vessels) 1974, as applicable, of the ASME *Boiler and Pressure Vessel Code**.

1-4.2 Unfired pressure vessels shall be designed and constructed in accordance with Section VIII, Division 1 or Division 2, 1974 of the ASME *Boiler and Pressure Vessel Code**.

1-4.3 Fired and unfired pressure vessels which do not conform to 1-4.1 or 1-4.2 may be used provided approval has been obtained from the state or other governmental jurisdiction in which they are to be used. Such pressure vessels are generally referred to as "State Special."

1-5 Exits.

1-5.1 Egress from buildings and areas covered by this code shall be in accordance with NFPA *101®*, the *Life Safety Code®*.

*Available from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017.

Chapter 2 Tank Storage

2-1 Design and Construction of Tanks.

2-1.1 **Materials.** Tanks shall be designed and built in accordance with recognized good engineering standards for the material of construction being used, and shall be of steel with the following limitations and exceptions:

(a) The material of tank construction shall be compatible with the liquid to be stored. In case of doubt about the properties of the liquid to be stored, the supplier, producer of the liquid, or other competent authority shall be consulted.

(b) Tanks constructed of combustible materials shall be subject to the approval of the authority having jurisdiction and limited to:

1. Installation underground, or
2. Use where required by the properties of the liquid stored, or
3. Storage of Class IIIB liquids aboveground in areas not exposed to a spill or leak of Class I or Class II liquid, or
4. Storage of Class IIIB liquids inside a building protected by an approved automatic fire extinguishing system.

(c) Unlined concrete tanks may be used for storing liquids having a gravity of 40 degrees API or heavier. Concrete tanks with special linings may be used for other services provided the design is in accordance with sound engineering practice.

(d) Tanks may have combustible or noncombustible linings.

(e) Special engineering consideration shall be required if the specific gravity of the liquid to be stored exceeds that of water or if the tank is designed to contain liquids at a liquid temperature below 0°F (−17.8°C).

2-1.2 Fabrication.

2-1.2.1 Tanks may be of any shape or type consistent with sound engineering design.

2-1.2.2 Metal tanks shall be welded, riveted and caulked, or bolted, or constructed by use of a combination of these methods.

2-1.3 Atmospheric Tanks.

2-1.3.1 Atmospheric tanks shall be built in accordance with recognized standards of design. Atmospheric tanks may be built and used within the scopes of the following:

(a) Underwriters Laboratories Inc., *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, UL142 – 1972; *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*, UL58 – 1976; or *Standard for Steel Inside Tanks for Oil Burner Fuel*, UL80 – 1974.*

(b) American Petroleum Institute Standard No. 650, *Welded Steel Tanks for Oil Storage*, Sixth Edition, 1978.**

(c) American Petroleum Institute Specifications 12B, *Bolted Tanks for Storage of Production Liquids*, Twelfth Edition, January 1977**; 12D, *Field Welded Tanks for Storage of Production Liquids*, Eighth Edition, January 1977**; or 12F, *Shop Welded Tanks for Storage of Production Liquids*, Seventh Edition, January 1977**.

(d) Steel Tank Institute Standard No. STI-P3, *Specification for STI-P3 System of Corrosion Protection of Underground Steel Storage Tanks*, 1980***.

2-1.3.2 Low pressure tanks and pressure vessels may be used as atmospheric tanks.

2-1.3.3 Atmospheric tanks shall not be used for the storage of a liquid at a temperature at or above its boiling point.

2-1.4 Low Pressure Tanks.

2-1.4.1 The normal operating pressure of the tank shall not exceed the design pressure of the tank.

2-1.4.2 Low pressure tanks shall be built in accordance with recognized standards of design. Low pressure tanks may be built in accordance with:

(a) American Petroleum Institute Standard No. 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, Fifth Edition, 1973.**

*Available from Underwriters Laboratories Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

**Available from America Petroleum Institute, 2101 L St., N.W., Washington, DC 20037.

***Available from Steel Tank Institute, 666 Dundee Rd, Northbrook, IL 60062.

(b) The principles of the *Code for Unfired Pressure Vessels*, Section VIII, Division I of the ASME *Boiler and Pressure Vessels Code*, 1974 Edition*.

2-1.4.3 Tanks built according to Underwriters Laboratories Inc. requirements in 2-1.3.1 may be used for operating pressures not exceeding 1 psig (6.895 kPa) and shall be limited to 2.5 psig (17.24 kPa) under emergency venting conditions.

2-1.4.4 Pressure vessels may be used as low pressure tanks.

2-1.5 Pressure Vessels.

2-1.5.1 The normal operating pressure of the vessel shall not exceed the design pressure of the vessel.

2-1.5.2 Storage tanks designed to withstand pressures above 15 psig shall meet the requirements of Section 1-4.

2-1.6 Provisions for Internal Corrosion.

2-1.6.1 When tanks are not designed in accordance with the American Petroleum Institute, American Society of Mechanical Engineers or the Underwriters Laboratories Inc. Standards, or if corrosion is anticipated beyond that provided for in the design formulas used, additional metal thickness or suitable protective coatings or linings shall be provided to compensate for the corrosion loss expected during the design life of the tank.

2-2 Installation of Outside Aboveground Tanks.

2-2.1 Location With Respect to Property Lines, Public Ways and Important Buildings on the Same Property.

2-2.1.1 Every aboveground tank for the storage of Class I, Class II or Class IIIA liquids, except as provided in 2-2.1.2 and those liquids with boil-over characteristics and unstable liquids, operating at pressures not in excess of 2.5 psig (17.24 kPa) and designed with a weak roof-to-shell seam or equipped with emergency venting devices which will not permit pressures to exceed 2.5 psig (17.24 kPa), shall be located in accordance with Table 2-1.

(a) For the purpose of Section 2-2, a floating roof tank is defined as one which incorporates either:

1. A pontoon or double deck metal floating roof in an open top tank in accordance with API Standard 650, or

*Available from the American Safety of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017.

2-2.4.7 Flame arresters or venting devices required in 2-2.4.6 may be omitted for IB and IC liquids where conditions are such that their use may, in case of obstruction, result in tank damage. Liquid properties justifying the omission of such devices include, but are not limited to, condensation, corrosiveness, crystallization, polymerization, freezing or plugging. When any of these conditions exist, consideration may be given to heating, use of devices employing special materials of construction, the use of liquid seals, or inerting (*see* NFPA 69, *Standard on Explosion Prevention Systems*).

2-2.5 Emergency Relief Venting for Fire Exposure for Aboveground Tanks.

2-2.5.1 Except as provided in 2-2.5.2, every aboveground storage tank shall have some form of construction or device that will relieve excessive internal pressure caused by exposure fires.

2-2.5.2 Tanks larger than 12,000 gal (45,420 L) capacity storing Class IIIB liquids and not within the diked area or the drainage path of Class I or Class II liquids do not require emergency relief venting.

2-2.5.3 In a vertical tank the construction referred to in 2-2.5.1 may take the form of a floating roof, lifter roof, a weak roof-to-shell seam, or other approved pressure relieving construction. The weak roof-to-shell seam shall be constructed to fail preferential to any other seam.

2-2.5.4 Where entire dependence for emergency relief is placed upon pressure relieving devices, the total venting capacity of both normal and emergency vents shall be enough to prevent rupture of the shell or bottom of the tank if vertical, or of the shell or heads if horizontal. If unstable liquids are stored, the effects of heat or gas resulting from polymerization, decomposition, condensation, or self-reactivity shall be taken into account. The total capacity of both normal and emergency venting devices shall be not less than that derived from Table 2-8 except as provided in 2-2.5.6 or 2-2.5.7. Such device may be a self-closing manhole cover, or one using long bolts that permit the cover to lift under internal pressure, or an additional or larger relief valve or valves. The wetted area of the tank shall be calculated on the basis of 55 percent of the total exposed area of a sphere or spheroid, 75 percent of the total exposed area of a horizontal tank and the first 30 ft (9.1 m) abovegrade of the exposed shell area of a vertical tank. (*See Appendix A for the square footage of typical tank sizes.*)

Table 2-8
Wetted Area Versus Cubic Feet Free Air per Hour*
(14.7 psia and 60° F) (101.3 kPa and 15.6° C)

Sq. Ft.	CFH	Sq. Ft.	CFH	Sq. Ft.	CFH
20	21,100	200	211,000	1,000	524,000
30	31,600	250	239,000	1,200	557,000
40	42,100	300	265,000	1,400	587,000
50	52,700	350	288,000	1,600	614,000
60	63,200	400	312,000	1,800	639,000
70	73,700	500	354,000	2,000	662,000
80	84,200	600	392,000	2,400	704,000
90	94,800	700	428,000	2,800	742,000
100	105,000	800	462,000	and over	
120	126,000	900	493,000		
140	147,000	1,000	524,000		
160	168,000				
180	190,000				
200	211,000				

SI Units: 1 sq ft = 0.0929 sq m; 1 cu ft = 0.02832 cu m.
*Interpolate for intermediate values.

Table 2-9
Wetted Area Over 2,800 sq ft and Pressures Over 1 psig

Sq. Ft.	CFH	Sq. Ft.	CFH
2,800	742,000	9,000	1,930,000
3,000	786,000	10,000	2,110,000
3,500	892,000	15,000	2,940,000
4,000	995,000	20,000	3,720,000
4,500	1,100,000	25,000	4,470,000
5,000	1,250,000	30,000	5,190,000
6,000	1,390,000	35,000	5,900,000
7,000	1,570,000	40,000	6,570,000
8,000	1,760,000		

SI Units: 1 sq ft = 0.0929 sq m; 1 cu ft = 0.02832 cu m.

2-2.5.5 For tanks and storage vessels designed for pressures over 1 psig (6.895 kPa), the total rate of venting shall be determined in accordance with Table 2-8, except that when the exposed wetted area of the surface is greater than 2,800 sq ft (260 m²), the total rate of venting shall be in accordance with Table 2-9 or calculated by the following formula:

$$CFH = 1{,}107\ A^{0.82}$$

Where:

CFH = venting requirement, in cubic feet of free air per hour

A = exposed wetted surface, in square feet

The foregoing formula is based on $Q = 21{,}000\ A^{0.82}$.

2-2.5.6 The total emergency relief venting capacity for any specific stable liquid can be determined by the following formula:

$$\text{Cubic feet of free air per hour} = V = \frac{1{,}337}{L\sqrt{M}}$$

V = cubic feet of free air per hour from Table 2-8

L = latent heat of vaporization of specific liquid in Btu per pound

M = molecular weight of specific liquids

2-2.5.7 For tanks containing stable liquids, the required airflow rate of 2-2.5.4 or 2-2.5.6 may be multiplied by the appropriate factor listed in the following schedule when protection is provided as indicated. Only one factor can be used for any one tank.

.5 for drainage in accordance with 2-2.3.2 for tanks over 200 sq ft (18.6 m²) of wetted area

.3 for water spray in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, and drainage in accordance with 2-2.3.2

.3 for insulation in accordance with 2-2.5.7(a)

.15 for water spray with insulation in accordance with 2-2.5.7(a) and drainage in accordance with 2-2.3.2 (*see Appendix A*)

(a) Insulation systems for which credit is taken shall meet the following performance criteria:

1. Remain in place under fire exposure conditions.

2. Withstand dislodgment when subjected to hose stream impingement during fire exposure. This requirement may be waived where use of solid hose streams is not contemplated or would not be practical.

3. Maintain a maximum conductance value of 4.0 Btu's per hour per square foot per degree F (Btu/hr/sq ft/°F) when the outer insulation jacket or cover is at a temperature of 1,660°F (904.4°C) and when the mean temperature of the insulation is 1,000°F (537.8°C).

2-2.5.8 The outlet of all vents and vent drains on tanks equipped with emergency venting to permit pressures exceeding 2.5 psig (17.2 kPa) shall be arranged to discharge in such a way as to prevent localized overheating of or flame impingement on any part of the tank, in the event vapors from such vents are ignited.

2-2.5.9 Each commercial tank venting device shall have stamped on it the opening pressure, the pressure at which the valve reaches the full open position and the flow capacity at the latter pressure. If the start to open pressure is less than 2.5 psig (17.2 kPa) and the pressure at full open position is greater than 2.5 psig (17.2 kPa), the flow capacity at 2.5 psig (17.2 kPa) shall also be stamped on the venting device. The flow capacity shall be expressed in cubic feet per hour of air at 60°F (15.6°C) and 14.7 psia (101.3 kPa).

(a) The flow capacity of tank venting devices under 8 in. (203.2 mm) in nominal pipe size shall be determined by actual test of each type and size of vent. These flow tests may be conducted by the manufacturer if certified by a qualified impartial observer, or may be conducted by a qualified, impartial outside agency. The flow capacity of tank venting devices 8 in. (203.2 mm) nominal pipe size and larger, including manhole covers with long bolts or equivalent, may be calculated provided that the opening pressure is actually measured, the rating pressure and corresponding free orifice area are stated, the word "calculated" appears on the nameplate, and the computation is based on a flow coefficient of 0.5 applied to the rated orifice area.

(b) A suitable formula for this calculation is:

$$CFH = 1{,}667\ C_f\ A\ \sqrt{P_t - P_a}$$

where CFH = venting requirement in cubic feet of free air per hour

C_f = 0.5 [the flow coefficient]

A = the orifice area in sq in.

P_t = the absolute pressure inside the tank in inches of water

P_a = the absolute atmospheric pressure outside the tank in inches of water

2-2.6 Vent Piping for Aboveground Tanks.

2-2.6.1 Vent piping shall be constructed in accordance with Chapter 3.

2-2.6.2 Where vent pipe outlets for tanks storing Class I liquids are adjacent to buildings or public ways, they shall be located so that the vapors are released at a safe point outside of buildings and not less than 12 ft (3.7 m) above the adjacent ground level. In order to aid their dispersion, vapors shall be discharged upward or horizontally away from closely adjacent walls. Vent outlets shall be located so that flammable vapors will not be trapped by eaves or other obstructions and shall be at least 5 ft (1.5 m) from building openings.

2-2.6.3 The manifolding of tank vent piping shall be avoided except where required for special purposes such as vapor recovery, vapor conservation or air pollution control. When tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they may be required to handle when manifolded tanks are subject to the same fire exposure.

2-2.6.4 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the vapors from Class I liquids from entering tanks storing Class II or Class III liquids, to prevent contamination (*see 1-1.2*) and possible change in classification of the less volatile liquid.

2-2.7 Tank Openings Other Than Vents for Aboveground Tanks.

2-2.7.1 Each connection to an aboveground tank through which liquid can normally flow shall be provided with an internal or an external valve located as close as practical to the shell of the tank.

2-2.7.2 Each connection below the liquid level through which liquid does not normally flow shall be provided with a liquidtight closure. This may be a valve, plug or blind, or a combination of these.

2-2.7.3 Openings for gaging on tanks storing Class I liquids shall be provided with a vaportight cap or cover. Such covers shall be closed when not gaging.

2-2.7.4 For Class IB and Class IC liquids other than crude oils, gasolines and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity. A fill pipe entering the top of a tank shall terminate within 6 in. (152.4 mm) of the bottom of the tank and shall be installed to avoid excessive vibration.

2-2.7.5 Filling and emptying connections for Class I, Class II and Class IIIA liquids which are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 ft (1.5 m) away from any building opening. Such connections for any liquid shall be closed and liquidtight when not in use and shall be properly identified.

2-3 Installation of Underground Tanks.

2-3.1 Location. Excavation for underground storage tanks shall be made with due care to avoid undermining of foundations of existing structures. Underground tanks or tanks under buildings shall be so located with respect to existing building foundations and supports that the loads carried by the latter cannot be transmitted to the tank. The distance from any part of a tank storing Class I liquids to the nearest wall of any basement or pit shall be not less than 1 ft (0.3048 m), and to any property line that can be built upon, not less than 3 ft (0.91 m). The distance from any part of a tank storing Class II or Class III liquids to the nearest wall of any basement, pit or property line shall be not less than 1 ft (0.3048 m).

2-3.1 Burial Depth and Cover.

2-3.2.1 Steel underground tanks shall be set on firm foundations and surrounded with at least 6 in. (152.4 mm) of noncorrosive inert material such as clean sand or gravel well-tamped in place. The tank shall be placed in the hole with care, since dropping or rolling the tank into the hole can break a weld, puncture or damage the tank, or scrape off the protective coating of coated tanks.

2-3.2.2 Steel underground tanks shall be covered with a minimum of 2 ft (.6096 m) of earth, or shall be covered with not less than 1 ft (0.3048 m) of earth, on top of which shall be placed a slab of reinforced concrete not less than 4 in. (101.6 mm) thick. When they are, or are likely to be, subjected to traffic, they shall be protected against damage from vehicles passing over them by at least 3 ft (0.91 m) of earth cover, or 18 in. (457.2 mm) of well-tamped earth plus either 6 in. (152.4 mm) of reinforced concrete or 8 in. (203.2 mm) of asphaltic concrete. When asphaltic or reinforced concrete paving is used as part of the protection, it shall extend at least 1 ft (0.3048 m) horizontally beyond the outline of the tank in all directions.

2-3.2.3 Nonmetallic underground tanks shall be installed in accordance with the manufacturer's instructions. The minimum depth of cover shall be as specified in 2-3.2.2 for steel tanks.

2-3.5.5 When tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they can be required to handle when manifolded tanks are filled simultaneously. Float-type check valves installed in tank openings connected to manifolded vent piping to prevent product contamination may be used provided that the tank pressure will not exceed that permitted by 2-3.2.4 when the valves close.

Exception: For service stations, the capacity of manifolded vent piping shall be sufficient to discharge vapors generated when two manifolded tanks are simultaneously filled.

2-3.5.6 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the vapors from Class I liquids from entering tanks storing Class II or Class III liquids, to prevent contamination (*see 1-1.2*) and possible change in classification of the less volatile liquid.

2-3.6 Tank Openings Other Than Vents for Underground Tanks.

2-3.6.1 Connections for all tank openings shall be liquidtight.

2-3.6.2 Openings for manual gaging, if independent of the fill pipe, shall be provided with a liquidtight cap or cover. Covers shall be kept closed when not gaging. If inside a building, each such opening shall be protected against liquid overflow and possible vapor release by means of a spring loaded check valve or other approved device.

2-3.6.3 Fill and discharge lines shall enter tanks only through the top. Fill lines shall be sloped toward the tank. Underground tanks for Class I liquids having a capacity of more than 1,000 gal (3,785 L) shall be equipped with a tight fill device for connecting the fill hose to the tank.

2-3.6.4 For Class IB and Class IC liquids other than crude oils, gasolines and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity by terminating within 6 in. (152.4 mm) of the bottom of the tank.

2-3.6.5 Filling and emptying and vapor recovery connections for Class I, Class II or Class IIIA liquids which are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 ft (1.5 m) away from any building opening. Such connections shall be closed and liquidtight when not in use and shall be properly identified.

2-3.6.6 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connection, or other approved device, unless the opening is pipe-connected to a vapor processing system. Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. All connections shall be vaportight.

2-4 Installation of Tanks Inside of Buildings.

2-4.1 Location. Tanks shall not be permitted inside of buildings except as provided in Chapters 5, 6, 7, 8 or 9.

2-4.2 Vents. Vents for tanks inside of buildings shall be as required in 2-2.4, 2-2.5, 2-2.6.2 and 2-3.5, except that emergency venting by the use of weak roof seams on tanks shall not be permitted. Automatic sprinkler systems designed in accordance with the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, may be accepted by the authority having jurisdiction as equivalent to water spray systems for purposes of calculating the required air flow rates for emergency vents in 2-2.5.7. Except for tanks containing Class IIIB liquids, vents shall terminate outside the buildings.

Basically equal to the Greater of Fill Rate or Exit Rate unless both performed at same time the = to Both.

2-4.3 Vent Piping. Vent piping shall be constructed in accordance with Chapter 3.

2-4.4 Tank Openings Other Than Vents for Tanks Inside Buildings.

2-4.4.1 Connections for all tank openings shall be liquidtight.

2-4.4.2 Each connection to a tank inside of buildings through which liquid can normally flow shall be provided with an internal or an external valve located as close as practical to the shell of the tank.

2-4.4.3 Tanks for storage of Class I or Class II liquids inside buildings shall be provided with either:

(a) a normally closed remotely activated valve,

(b) an automatic-closing heat-activated valve, or

(c) another approved device on each liquid transfer connection below the liquid level, except for connections used for emergency disposal, to provide for quick cut-off of flow in the event of fire in the vicinity of the tank.

This function can be incorporated in the valve required in 2-4.4.2, and if a separate valve, shall be located adjacent to the valve required in 2-4.4.2.

2-4.4.4 Openings for manual gaging of Class I or Class II liquids, if independent of the fill pipe, shall be provided with a vaportight cap or cover. Openings shall be kept closed when not gaging. Each such opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring loaded check valve or other approved device. Substitutes for manual gaging include, but are not limited to, heavy-duty flat gage glasses, magnetic, hydraulic or hydrostatic remote reading devices and sealed float gages.

2-4.4.5 For Class IB and Class IC liquids other than crude oils, gasolines and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity by terminating within 6 in. (152.4 mm) of the bottom of the tank.

2-4.4.6 The fill pipe inside of the tank shall be installed to avoid excessive vibration of the pipe.

2-4.4.7 The inlet of the fill pipe and the outlet of a vapor recovery line for which connections are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 ft (1.5 m) away from any building opening. Such connections shall be closed and tight when not in use and shall be properly identified.

2-4.4.8 Tanks storing Class I, Class II and Class IIIA liquids inside buildings shall be equipped with a device, or other means shall be provided, to prevent overflow into the building. Suitable devices include, but are not limited to, a float valve, a preset meter on the fill line, a valve actuated by the weight of the tank contents, a low head pump which is incapable of producing overflow, or a liquidtight overflow pipe at least one pipe size larger than the fill pipe discharging by gravity back to the outside source of liquid or to an approved location.

2-4.4.9 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connections, or other approved device, unless the opening is pipe-connected to a vapor processing system. Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. All connections shall be vaportight.

2-5 Supports, Foundations and Anchorage for All Tank Locations.

2-5.1 Tanks shall rest on the ground or on foundations made of concrete, masonry, piling or steel. Tank foundations shall be designed to minimize the possibility of uneven settling of the tank and to minimize corrosion in any part of the tank resting on the foundation. Appendix E of API Standard 650, *Specification for Welded Steel Tanks for Oil Storage*, and Appendix B of API Standard 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*,* provide information on tank foundations.

2-5.2 When tanks are supported above the foundations, tank supports shall be installed on firm foundations. Supports for tanks storing Class I, Class II or Class IIIA liquids shall be of concrete, masonry or protected steel. Single wood timber supports (not cribbing) laid horizontally may be used for outside aboveground tanks if not more than 12 in. (304.8 mm) high at their lowest point.

2-5.3 Steel supports or exposed piling for tanks storing Class I, Class II or Class IIIA liquids shall be protected by materials having a fire resistance rating of not less than 2 hrs, except that steel saddles need not be protected if less than 12 in. (304.8 mm) high at their lowest point. At the discretion of the authority having jurisdiction, water spray protection in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, or NFPA 13, *Standard for the Installation of Sprinkler Systems*, or equivalent may be used.

2-5.4 The design of the supporting structure for tanks such as spheres shall require special engineering consideration. Appendix N of the API Standard 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*,* contains information regarding supporting structures.

2-5.5 Every tank shall be so supported as to prevent the excessive concentration of loads on the supporting portion of the shell.

2-5.6 Where a tank is located in an area subject to flooding, provisions shall be taken to prevent tanks, either full or empty, from floating during a rise in water level up to the established maximum flood stage.

2-5.6.1 Aboveground Tanks.

2-5.6.1.1 Each vertical tank shall be located so that its top extends above the maximum flood stage by at least 30 percent of its allowable storage capacity.

*Available from American Petroleum Institute, 2101 L St., N.W., Washington, DC 20037.

2-5.6.1.2 Horizontal tanks located so that more than 70 percent of the tank's storage capacity will be submerged at the established flood stage shall be anchored; attached to a foundation of concrete or of steel and concrete of sufficient weight to provide adequate load for the tank when filled with flammable or combustible liquid and submerged by flood water to the established flood stage; or adequately secured from floating by other means. Tank vents or other openings which are not liquidtight shall be extended above maximum flood stage water level.

2-5.6.1.3 A dependable water supply shall be available for filling an empty or partially filled tank, except that where filling the tank with water is impractical or hazardous because of the tank's contents, tanks shall be protected by other means against movement or collapse.

2-5.6.1.4 Spherical or spheroid tanks shall be protected by applicable methods as specified for either vertical or horizontal tanks.

2-5.6.2 Underground Tanks.

2-5.6.2.1 At locations where there is an ample and dependable water supply available, underground tanks containing flammable or combustible liquids, so placed that more than 70 percent of their storage capacity will be submerged at the maximum flood stage, shall be so anchored, weighted or secured as to prevent movement when filled or loaded with water and submerged by flood water to the established flood stage. Tank vents or other openings which are not liquidtight shall be extended above maximum flood stage water level.

2-5.6.2.2 At locations where there is no ample and dependable water supply or where filling of underground tanks with water is impractical because of the contents, each tank shall be safeguarded against movement when empty, and submerged by high ground water or flood water by anchoring or by securing by other means. Each such tank shall be so constructed and installed that it will safely resist external pressures if submerged.

2-5.6.3 Water Loading. The filling of a tank to be protected by water loading shall be started as soon as flood waters are predicted to reach a dangerous flood stage. Where independently fueled water pumps are relied upon, sufficient fuel shall be available at all times to permit continuing operations until all tanks are filled. Tank valves shall be closed and locked in closed position when water loading has been completed.

2-5.6.4 Operating Instructions.

2-5.6.4.1 Operating instructions or procedures to be followed in a flood emergency shall be readily available.

2-5.6.4.2 Personnel relied upon to carry out flood emergency procedures shall be informed of the location and operation of valves and other equipment necessary to effect the intent of these requirements.

2-5.7 In areas subject to earthquakes, the tank supports and connections shall be designed to resist damage as a result of such shocks.

2-6 Sources of Ignition.

2-6.1 In locations where flammable vapors may be present, precautions shall be taken to prevent ignition by eliminating or controlling sources of ignition. Sources of ignition may include open flames, lightning, smoking, cutting and welding, hot surfaces, frictional heat, sparks (static, electrical and mechanical), spontaneous ignition, chemical and physical-chemical reactions and radiant heat. NFPA 77, *Recommended Practice on Static Electricity*, and NFPA 78, *Lightning Protection Code*, provide information on such protection.

2-7 Testing.

2-7.1 All tanks, whether shop-built or field-erected, shall be tested before they are placed in service in accordance with the applicable paragraphs of the Code under which they were built. The ASME Code stamp, API monogram, or the Listing Mark of Underwriters Laboratories Inc. on a tank shall be evidence of compliance with this test. Tanks not marked in accordance with the above Codes shall be tested before they are placed in service in accordance with good engineering principles and reference shall be made to the sections on testing in the Codes listed in 2-1.3.1, 2-1.4.2, or 2-1.5.2.

2-7.2 When the vertical length of the fill and vent pipes is such that when filled with liquid the static head imposed upon the bottom of the tank exceeds 10 lbs per sq in. (68.95 kPa), the tank and related piping shall be tested hydrostatically to a pressure equal to the static head thus imposed. In special cases where the height of the vent above the top of the tank is excessive, the hydrostatic test pressure shall be determined by using recognized engineering practice.

2-7.3 In addition to the test called for in 2-7.1 and 2-7.2, all tanks and connections shall be tested for tightness. Except for underground tanks, this tightness shall be made at operating pressure with air, inert gas or water prior to placing the tank in service. In the case of field-erected tanks the test called for in 2-7.1 or 2-7.2 may be considered to be the test for tank tightness.

Underground tanks and piping, before being covered, enclosed, or placed in use, shall be tested for tightness hydrostatically, or with air pressure at not less than 3 lbs per sq in. (20.68 kPa) and not more than 5 lbs per sq in. (34.4 kPa). (*See 3-7.1 for testing pressure piping.*)

2-7.4 Before the tank is initially placed in service, all leaks or deformations shall be corrected in an acceptable manner. Mechanical caulking is not permitted for correcting leaks in welded tanks except pin hole leaks in the roof.

2-7.5 Tanks to be operated at pressures below their design pressure may be tested by the applicable provisions of 2-7.1 or 2-7.2 based upon the pressure developed under full emergency venting of the tank.

2-8 Fire Protection and Identification.

2-8.1 A fire extinguishing system in accordance with an applicable NFPA standard shall be provided or be available for vertical atmospheric fixed roof storage tanks larger than 50,000 gal (189,250 L) capacity storing Class I liquids if located in a congested area where there is an unusual exposure hazard to the tank from adjacent property or to adjacent property from the tank. Fixed roof tanks storing Class II or III liquids at temperatures below their flash points and floating roof tanks storing any liquid generally do not require protection when installed in compliance with Section 2-2.

2-8.2 The application of NFPA 704, *Identification of the Fire Hazards of Materials*, to storage tanks containing liquids shall not be required except when the contents have a health or reactivity degree of hazard of 2 or more or a flammability rating of 4. The marking need not be applied directly to the tank but located where it can readily be seen, such as on the shoulder of an accessway or walkway to the tank or tanks or on the piping outside of the diked area. If more than one tank is involved, the markings shall be so located that each tank can readily be identified.

2-9 Prevention of Overfilling of Tanks.

2-9.1 Tanks receiving transfer of Class I liquids from mainline pipelines or marine vessels and located in an area where overfilling may endanger a place of habitation or public assembly shall be either:

(a) Gaged at frequent intervals while receiving transfer of product, and communications maintained with mainline pipeline or marine personnel so that flow can be promptly shut down or diverted, or

(b) Equipped with an independent high level alarm located where personnel are on duty during the transfer and can promptly arrange for flow stoppage or diversion, or

(c) Equipped with an independent high level alarm system that will automatically shut down or divert flow.

2-10 Leakage Detection and Inventory Records for Underground Tanks.

2-10.1 Accurate inventory records or a leak detection program shall be maintained on all Class I Liquid Storage Tanks for indication of possible leakage from the tanks or associated piping. (*See NFPA 329, Underground Leakage of Flammable and Combustible Liquids.*)

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10/17/84
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NUCLEAR REGULATORY COMMISSION

Docket No. 50-400 Official Exh. No. 5

In the matter of Theron Harris

Staff	IDENTIFIED ✓
Applicant	RECEIVED ✓
Intervenor ✓	REJECTED
Cont'g Off'r	
Contractor	DATE 10-17-84
Other	Witness
Reporter URB	