

Annex C **(normative)**

External Floating Roofs

• C.1 Scope

C.1.1 This Annex provides minimum requirements that, unless otherwise qualified in the text, apply to single-deck pontoon-type and double-deck-type floating roofs. See Section 3 for the definition of these roof types. This Annex is intended to limit only those factors that affect the safety and durability of the installation and that are considered to be consistent with the quality and safety requirements of this standard. Numerous alternative details and proprietary appurtenances are available; however, agreement between the Purchaser and the Manufacturer is required before they are used.

C.1.2 The type of roof and seal to be provided shall be as specified on the Data Sheet, Line 30. If the type is not specified, the Manufacturer shall provide a roof and seal that is cost-effective and suitable for the specified service. Pan-type floating roofs shall not be used.

C.1.3 The Purchaser is required to provide all applicable jurisdictional requirements that apply to external floating roofs (see 1.3).

C.1.4 See Annex W for bid requirements pertaining to external floating roofs.

C.2 Material

The material requirements of Section 4 shall apply unless otherwise stated in this Annex. Castings shall conform to any of the following specifications:

- a) ASTM A27M, grade 405-205 (ASTM A27, grade 60-30), fully annealed;
- b) ASTM A27M, grade 450-240 (ASTM A27, grade 65-35), fully annealed or normalized and tempered, or quenched and tempered;
- c) ASTM A216M (ASTM A216) WCA, WCB, or WCC grades annealed and normalized, or normalized and tempered.

C.3 Design

C.3.1 General

- **C.3.1.1** The roof and accessories shall be designed and constructed so that the roof is allowed to float to the maximum design liquid level and then return to a liquid level that floats the roof well below the top of the tank shell without damage to any part of the roof, tank, or appurtenances. During such an occurrence, no manual attention shall be required to protect the roof, tank, or appurtenances. If a windskirt or top-shell extension is used, it shall contain the roof seals at the highest point of travel. The Purchaser shall provide appropriate alarm devices to indicate a rise of the liquid in the tank to a level above the normal and overfill protection levels (see NFPA 30 and API 2350). Overflow slots shall not be used as a primary means of detecting an overfill incident. If specified by the Purchaser (Table 4 of the Data Sheet), emergency overflow openings may be provided to protect the tank and floating roof from damage.
- **C.3.1.2** The application of corrosion allowances shall be a matter of agreement between the Purchaser and the Manufacturer. Corrosion allowance shall be added to the required minimum thickness or, when no minimum thickness is required, added to the minimum thickness required for functionality.

- **C.3.1.3** Sleeves and fittings on the single deck or lower decks of annular pontoons or lower decks of double-deck roofs shall have a minimum wall thickness of 6 mm ($1/4$ in.) for all pipe and plate construction, unless otherwise specified on the Data Sheet, Table 5. Such penetrations, except for automatic bleeder vents and rim space vents, shall extend into the liquid.

C.3.1.4 The annular space between the roof outer rim of the floating roof and the product side of the tank shell shall be designed for proper clearance of the peripheral seal (see C.3.13). All appurtenances and internal components of the tank shall have adequate clearance for the proper operation of the completed roof assembly.

- **C.3.1.5** For tanks greater than 60 m (200 ft) in diameter, the deck portion of single-deck pontoon floating roofs shall be designed to avoid flexural fatigue failure caused by design wind loads. Such designs shall be a matter of agreement between the Purchaser and the Manufacturer, using techniques such as underside stitch welding.

C.3.1.6 All conductive parts of the external floating roof shall be electrically interconnected and bonded to the outer tank structure. Bonding (grounding) shunts shall be provided on the external floating roof and shall be located above the uppermost seal. Shunts shall be 50-mm (2-in.) wide by 28-gauge (0.4-mm [$1/64$ -in.] thick) austenitic stainless steel as a minimum, or shall provide equivalent corrosion resistance and current carrying capacity as stated in API 2003. Shunt spacing shall be no more than 3 m (10 ft). All movable cover accessories (hatches, manholes, pressure relief devices, and other openings) on the external floating roof shall be electrically bonded to the external floating roof to prevent static electricity sparking when they are opened.

C.3.2 Joints

C.3.2.1 Joints shall be designed as described in 5.1.

C.3.2.2 If a lining is applied to the underside of the roof, all joints that will have a lining shall be seal-welded.

C.3.3 Decks

C.3.3.1 Roofs in corrosive service, such as covering sour crude oil, should be the contact type designed to eliminate the presence of any air-vapor mixture under the deck.

C.3.3.2 Unless otherwise specified by the Purchaser, all deck plates shall have a minimum nominal thickness of 4.8 mm ($3/16$ in.) with a permissible ordering basis of 6-gauge (0.1943 in.) sheet.

C.3.3.3 Deck plates shall be joined by continuous full-fillet welds on the top side. On the bottom side, where flexure can be anticipated adjacent to girders, support legs, or other relatively rigid members, full-fillet welds not less than 50 mm (2 in.) long on 250 mm (10 in.) centers shall be used on any plate laps that occur within 300 mm (12 in.) of any such members. A minimum of three fillet welds shall be made.

C.3.3.4 Top decks of double-deck roofs and of pontoon sections, which are designed with a permanent slope shall be designed, fabricated, and erected (with a minimum slope of 1 in 64) to minimize accumulation of standing water (e.g. pooling adjacent to a rolling ladder's track) when primary roof drains are open. This requirement is not intended to completely eliminate isolated puddles. When out of service, water shall flow freely to the primary roof drains. These decks shall preferably be lapped to provide the best drainage. Plate buckles shall be kept to a minimum.

C.3.3.5 The deck of single-deck pontoon floating roofs shall be designed to be in contact with the liquid during normal operation, regardless of service. The design shall accommodate deflection of the deck caused by trapped vapor.

C.3.3.6 All covers for roof openings, except roof drains and vents, shall have gaskets or other sealing surfaces and shall be provided with a liquid-tight cover.

C.3.4 Pontoon Design

C.3.4.1 Floating roofs shall have sufficient buoyancy to remain afloat on liquid with a specific gravity of the lower of the minimum design specific gravity or 0.7 and with primary drains inoperative for the following conditions.

- a) 250 mm (10 in.) of rainfall in a 24-hour period over the full horizontal tank area with the roofs intact. This condition does not apply to double-deck roofs provided with emergency drains designed to keep water to a lesser volume that the roofs will safely support. Such emergency drains shall not allow the product to flow onto the roof.

NOTE The rainfall rate for sizing the roof drains in C.3.8 may result in a larger accumulated rainfall.

- b) Single-deck and any two adjacent pontoon compartments punctured and flooded in single-deck pontoon roofs and any two adjacent compartments punctured and flooded in double-deck roofs, both roof types with no water or live load.

With agreement by the Purchaser, Item b may be replaced by the following for floating roofs 6 m (20 ft) in diameter or less: Any one compartment punctured and flooded in single-deck pontoon roofs or double-deck roofs, both roof types with no water or live load.

- c) Unbalanced snow load (S_u) when specified by the Purchaser. See Section 11 in Annex L.
- **C.3.4.2** The pontoon portions of single-deck pontoon-type roofs shall be designed to have adequate strength to prevent permanent distortion when the center deck is loaded by its design rainwater (C.3.4.1, Item a) or when the center deck and two adjacent pontoons are punctured (C.3.4.1, Item b). The allowable stress and stability criteria shall be jointly established by the Purchaser and the Manufacturer as part of the inquiry. Alternatively, a proof test simulating the conditions of C.3.4.1, with the roof floating on water, may be performed on the roof or on one of similar design that is of equal or greater diameter.

C.3.4.3 Any penetration of the floating roof shall not allow product to flow onto the roof under design conditions.

The sag of the roof deck under design conditions and the lower of the minimum design specific gravity of the stored liquid or 0.7 shall be considered in establishing the minimum elevations of all roof penetrations.

C.3.5 Pontoon Openings

- Each compartment shall be provided with a liquid-tight manhole with a minimum nominal size of NPS 20. Manhole covers shall be provided with suitable hold-down fixtures (which may be of the quick-opening type) or with other means of preventing wind or fire-fighting hose streams from removing the covers. The top edge of the manhole necks shall be at an elevation that prevents liquid from entering the compartments under the conditions of C.3.4. With agreement by the Purchaser, floating roofs 6 m (20 ft) in diameter or less may be designed using a pontoon inspection port in place of a pontoon manhole.

Each compartment shall be vented to protect against internal or external pressure. Vents may be in the manhole cover, inspection port cover, or the top deck of the compartment. The vents shall be at an elevation that prevents liquid from entering the compartment under the conditions of C.3.4 and shall terminate in a manner that prevents entry of rain and fire-fighting liquids.

C.3.6 Compartments

Compartment plates are radial or circumferential dividers forming compartments that provide flotation for the roof (see C.3.4). All internal compartment plates (or sheets) shall be single-fillet welded along all of their edges, and other welding shall be performed at junctions as required to make each compartment leak tight. Each compartment weld shall be tested for leak tightness using internal pressure or a vacuum box and a soap solution or penetrating oil.

C.3.7 Ladders

- Unless otherwise specified by the Purchaser, the floating roof shall be supplied with a ladder that automatically adjusts to any roof position so that access to the roof is always provided. The ladder shall be designed for full-roof travel, regardless of the normal setting of the roof-leg supports. The ladder shall have full-length handrails on both sides and shall be designed for a 4450 N (1000 lbf) midpoint load with the ladder in any operating position. Step assemblies shall be of open type and have non-slip walking surfaces and self-leveling treads with a minimum width of 510 mm (20 in.) and a 860 mm (34 in.) minimum high handrail at the nose of the tread with the floating roof at any position. When the roof is in its extreme low position, the slope of the rolling ladder shall not be less than 35 degrees to vertical, unless specified otherwise by the Purchaser. Wheels shall be provided at the lower end of the ladder, sized to prevent binding of the ladder, and provided with maintenance-free bearings. Ladders shall be grounded to both the roof and the gauger's platform with at least an AWG (American Wire Gage) 2/0 (67 sq. mm [0.104 sq. in.]), non-tangling cable. Cable shall be configured so that it will not freeze to adjacent surfaces in cold weather. Ladder and track design shall minimize ponding by using trussed runways or other details considering fatigue and stiffening effects resulting from supports. The Purchaser may elect to add requirements such as a wider stair width, lateral roof loading, and alternate runway designs that reduce ponding under the ladder.

C.3.8 Roof Drains

C.3.8.1 Primary Roof Drains

- 1) Primary roof drains shall be sized and positioned to accommodate the rainfall rates specified on the Data Sheet, Line 33, while preventing the roof from accumulating a water level greater than design, without allowing the roof to tilt excessively or interfere with its operation. Roof drains shall be furnished attached to low-type nozzles on the tank shell with valves to be supplied by the Purchaser. The roof drain shall have an interior flange connection to allow installation and removal of the drain system. A swing-type check valve shall be provided at the inlet of drains on single-deck roofs to prevent backflow of stored product if leakage occurs, unless otherwise specified on the Data Sheet, Line 32. Swing-type check valves are not required on double-deck roofs because the geometry would prevent backflow of stored product if leakage occurs, unless otherwise specified on the Data Sheet, Line 32. The drains shall be removable, if required by the Purchaser. Primary roof drains shall not be smaller than NPS 3 for roofs with a diameter less than or equal 36 m (120 ft) or smaller than NPS 4 for roofs with a diameter greater than 36 m (120 ft).
- 2) Primary roof drains shall be resistant to the tank's contents, or suitably coated, and shall be free from floating, kinking, or catching on any internal appurtenance or obstruction during operation, and from being crushed by landing legs on the bottom.
- 3) The Purchaser shall specify, on the Data Sheet, Line 32, the required primary roof drain. Acceptable types of primary roof drains are:
 - a) manufacturer's standard drain;
 - b) steel swing or pivot-jointed pipe drains, designed and packed for external pressure;
 - c) stainless steel armored hose.
- 4) If supplied, rigid segments of drain piping attached to the bottom or the roof shall be guided, not rigidly attached, to allow for differential thermal expansion and plate flexing. The design shall avoid being damaged by the roof support legs or other obstructions.
- 5) Siphon-type and non-armored hose-type drains are not acceptable as primary roof drains.
- 6) Double-deck floating roofs up to 60 m (200 ft) in diameter shall have either a single center sump or a reversed-slope, top-center deck with multiple sumps connected to a single drain line, depending on the design rainfall

quantity and the roof configuration. Double-deck floating roofs larger than 60 m (200 ft) in diameter shall have a reversed-slope, top-center deck with multiple roof sumps having individual drain lines.

- 7) Inlets to single-deck primary roof drains shall have guarded trash stops or screens to stop debris from entering and obstructing the drain system. The Manufacturer shall provide isolation valves to stop product flow onto the roof when the check valve fails, unless specified otherwise on the Data Sheet, Line 32. Cut-off valves for this purpose shall have extension handles to permit actuation when puddles obstruct access to the valve.
- 8) When specified on the Data Sheet, Line 32, drains, sumps, check valves, and cut-off valves shall be protected from freeze damage by using special equipment designs. Any mechanically actuated cut-off valve shall permit actuation when the drain pipe is partially obstructed by chunk ice or slush (e.g., a ram valve or a metal-seated ball valve).

• C.3.8.2 Emergency Roof Drains

Double-deck roofs shall have a minimum of three open-ended emergency roof drains designed to provide drainage to prevent sinking the roof during severe rainfall events. Emergency drains are prohibited on single-deck floating roofs. Elevation of the emergency overflow drains shall be such that the outer rim cannot be completely submerged. These drains shall discharge at least 300 mm (1 ft) below the bottom of the roof and shall consist of open-ended pipes, braced as necessary to the roof structure. The drains shall be sized to handle the rainfall specified by the Purchaser, with a minimum diameter of NPS 4. The drains shall be sealed with a slit fabric seal or similar device that covers at least 90 % of the opening that will reduce the product-exposed surfaces while permitting rainwater passage. The drains shall be fabricated from Schedule 80 pipe, or heavier, and fittings with 6 mm (1/4-in.) thick roof deck reinforcing plates.

C.3.8.3 Out-of-Service Supplementary Drains

- Unless specified otherwise by the Purchaser, threaded pipe couplings and plugs with a 600-mm (24-in.) extension “T-bar” handle shall be provided on single-deck pontoon floating roofs, for use as supplementary drains when the roof is resting on its legs and when the primary drains are inoperative. The number of drains shall be based on the specified rainfall rate (see Line 33 of the Data Sheet) and tank size. Fittings shall be at least NPS 4. Plugs shall have threads coated with a non-stick coating or anti-seize paste such as tetrafluoroethylene. One supplementary drain shall be located adjacent to the ladder track.

C.3.9 Vents

To prevent overstressing of the roof deck or seal membrane, automatic bleeder vents (vacuum breakers) shall be furnished for venting air to or from the underside of the deck when filling or emptying the tank. The Manufacturer shall determine and recommend the number and sizes of bleeder vents to be provided based on maximum filling and emptying rates specified. Each automatic bleeder vent (vacuum breaker vent) shall be closed at all times, except when required to be open to relieve excess pressure or vacuum, in accordance with the Manufacturer's design. Each automatic bleeder vent (vacuum breaker vent) shall be equipped with a gasketed lid, pallet, flapper, or other closure device.

C.3.10 Supporting Legs

- **C.3.10.1** Floating roofs shall be provided with either removable or non-removable legs. If removable legs are specified on the Data Sheet, Line 32, the legs shall be adjustable from the top side of the roof, and designed to be inserted through either fixed low legs or leg sleeves. Both low and high legs shall have cutouts (minimum of 19 mm [3/4 in.] wide) at the bottom to permit drainage of trapped product. Removable covers shall be provided for leg sleeves or fixed low legs when the adjustable legs are removed. Adjustable legs shall be capped on top. If specified on the Data Sheet, Line 32, removable legs shall be provided with storage rack(s) on the top of the pontoon or deck appropriate for leg storage during normal operation or during maintenance. Rack quantity and location shall be determined by the Manufacturer to balance the roof live load and shall take into account the weight of the rolling

ladder. The materials of construction shall be tabulated on the Data Sheet, Table 5. Removable legs shall be no smaller than NPS 2. High legs shall have a stop to prevent their dropping through the low legs during installation. See C.1.3 regarding Purchaser specification of jurisdictional requirements.

C.3.10.2 The legs and attachments shall be designed to support the roof and a uniform live load of at least 1.2 kPa (25 lbf/ft²). Where possible, the roof load shall be transmitted to the legs through bulkheads or diaphragms. Leg attachments to single decks shall be given particular attention to prevent failures at the points of attachment.

C.3.10.3 Legs shall have settings for at least two levels:

- a) a minimum setting determined by the Manufacturer to support the roof in the low-roof position while clearing mixers, nozzles, shell manholes, seals, and other components inside the tank by at least 75 mm (3 in.); and
- b) the elevation of the roof in the high-roof position shall provide a 2 m (78 in.) minimum clearance throughout the bottom, between the roof and the tank bottom, unless specified otherwise on the Data Sheet, Line 32.

When specified on the Data Sheet, Line 33, the two settings shall be field-adaptable to allow for uneven tank bottom settlement (i.e. constructed to permit small variations from the required positions for each leg).

- **C.3.10.4** Legs shall be Schedule 80 minimum and sleeves shall be Schedule 40 minimum unless specified otherwise on the Data Sheet, Table 5.

C.3.10.5 Roof legs shall have matching steel landing pads continuous full-fillet welded to the tank bottom with minimum dimensions of 10-mm (³/₈-in.) thickness by 350-mm (14-in.) diameter. The centerline of the legs shall coincide with the centerline of the landing pads.

C.3.10.6 Roof support legs sleeves shall be installed plumb. Fixed legs or leg sleeves through single decks shall be reinforced.

C.3.10.7 All fixed leg or leg sleeve penetrations through the deck plate (top and bottom for pontoon and double-deck roofs) shall be attached to the deck plate(s) with continuous fillet welds made from the top side, as a minimum.

- **C.3.10.8** If specified (see C.1.3 regarding Purchaser specification of jurisdictional requirements), covers and seals shall be provided at all openings.
- **C.3.10.9** When side entry mixers are specified and there is inadequate clearance between the roof and mixer components, rather than increasing the leg lengths, the pontoon (or double deck) shall be notched with a recessed pocket providing at least 75 mm (3 in.) mixer component clearance at the low-roof position.

C.3.11 Roof Manholes

Roof manholes shall be provided for access to the tank interior and for ventilation when the tank is empty.

Manholes shall be located around the roof to provide an effective pattern for access, lighting, and ventilation of the product storage interior. Each manhole shall have a minimum nominal diameter of 600 mm (24 in.) and shall have a liquid-tight gasketed, bolted cover equivalent to the cover shown in Figure 5.16.

The minimum number of manholes shall be as follows:

Nominal Tank Diameter D , m (ft)	Minimum Number
$D \leq 61$ (200)	2
61 (200) $< D \leq 91$ (300)	3
91 (300) $< D$	4

C.3.12 Centering and Anti-rotation Devices

C.3.12.1 A guide pole shall be provided as an anti-rotation device for the floating roof. Locate the guide pole near the gauger's platform. The guide pole shall be capable of resisting the lateral forces imposed by the roof ladder, unequal snow loads, and wind loads.

C.3.12.2 Guide pole sections shall be welded with full penetration butt welds. Backing strips are not permitted. Provision must be made for draining and venting of unslotted pipe. See 7.5.2 for guide pole erection tolerance requirements.

- **C.3.12.3** The guide pole shall have all required emission control devices around the well opening where it penetrates the roof, such as those described in C.3.14.1, Item (1) and specified on the Data Sheet, Line 32. (See C.1.3 regarding Purchaser specification of jurisdictional requirement.)

C.3.13 Peripheral Seals

C.3.13.1 See H.4.4 for descriptions of peripheral seal types, selection guidelines, and additional requirements. Peripheral seals are also referred to as rim seals.

- **C.3.13.2** The Purchaser shall specify the seal materials in the Data Sheet, Table 5.
- **C.3.13.3** See C.1.3 regarding Purchaser specification of jurisdictional requirements. All seals shall be installed such that gaps between the seal and the shell of the tank meet the gap requirements of the jurisdiction for new construction, if any, and the Purchaser's gap requirements.

C.3.13.4 Installation and removal of peripheral seals shall not require draining the tank.

C.3.13.5 The specific requirements for external floating roof peripheral seals are:

- **a) Primary Seal**

The type of primary seal may be controlled by jurisdiction regulations. Types generally used are mechanical shoe seals and liquid-mounted (envelope) seals. Unless specified otherwise on the Data Sheet, Line 31, primary seals shall be the mechanical shoe type and shall be supplied and installed by the roof Manufacturer.

- **b) Secondary Seal**

The type of secondary seal may be controlled by jurisdiction regulations. If required by the Purchaser, a secondary seal shall be provided by the roof Manufacturer as specified on the Data Sheet, Line 31. Unless specified otherwise, secondary seals shall be the wiper type and shall be supplied and installed by the roof Manufacturer. The design of the secondary seal shall permit inspection of the primary seal without removal.

c) Mechanical Shoe Seals

The following additional requirements apply to mechanical shoe seals, if used, and which may be used as primary or secondary seals.

- The metal band (shoe) is typically formed as a series of sheets that are overlapped or joined together to form a ring that is held against the shell by a series of mechanical devices. For external floating roofs only, the mechanical shoe seal shoes shall extend at least 610 mm (24 in.) above and at least 100 mm (4 in.) into the liquid at the design flotation level, except when this type of seal is the secondary seal, installed above a primary seal. The “design flotation level” is defined as the roof position (under dead load conditions) for the specific gravity range from 0.7 to the design specific gravity on the Data Sheet.

C.3.14 Gauging Device

- **C.3.14.1** Each roof shall be provided with gauging ports with caps (gauging wells or hatches) as indicated on the Data Sheet, Line 32 (see C.1.3 regarding Purchaser specification of jurisdictional requirement), with one port located adjacent to the gauger's platform and remote from regions of turbulent flow. These ports may be as follows.
 - 1) Slotted guide pole gauge wells: These are vertical anti-rotation pipes that can be used for gauging. Unless specified otherwise by the Purchaser, the pipe shall have two rows of 25-mm by 300-mm (1-in. by 12-in.) vertical slots on staggered 280-mm (11-in.) centers located 180 degrees apart. Slots shall range from the maximum fill height to near the tank bottom. Holes may be provided in lieu of slots if holes are required by the Purchaser. Well and pole shall be equipped with all required emission control devices, which may include items such as a gasketed sliding well cover, and a pole wiper, as well as either a pole sleeve or a pole float and float wiper (see API *MPMS* Ch. 19.2 for requirements and illustrations of some of these devices). If there are no slots or holes located so as to allow the stored liquid to flow into the pole at liquid levels above the lowest operating level, then the pole is not considered slotted for purposes of air regulation compliance (even if there are slots or holes located below the lowest operating level).
 - 2) Non-guide pole gauge wells: These shall be NPS 8 pipes projecting at least 150 mm (6 in.) above the roof's outer rim. For sample hatches without gauging apparatus, see C.3.16.3.
- **C.3.14.2** Each gauge well shall have a B16.5 Class 150 bolt pattern, flat-face pipe flange with a full-face gasket at its top, and shall be attached to a non-sparking cap. See C.1.3 regarding Purchaser specification of jurisdictional requirements.
- **C.3.14.3** Each gauge well shall have a permanent gauge mark or tab just inside the cap on the pipe wall called a “reference point” or “knife edge.”
- **C.3.14.4** When specified on the Data Sheet, Line 32, a datum plate shall be attached to the bottom of the slotted guide pole at the distance designated by the Purchaser.
- **C.3.14.5** If striking plates are specified on the Data Sheet, Line 32, they shall be provided on the tank bottom beneath the guide pole or under the gauge well if no guide pole is specified.
- **C.3.14.6** A gauger's platform shall be located at an elevation that remains above and clear of the roof, its sealing system, and foam dam even during an overflow event. The Purchaser shall specify the platform location on the Data Sheet Plan. The direction is typically upwind of the direction of the prevailing wind.

C.3.15 Inlet Diffuser

Supply inlet diffusers if required on the Data Sheet. (also see 5.8.11.2)

C.3.16 Other Roof Accessories

C.3.16.1 Wax Scrapers

If wax scrapers are specified on the Data Sheet, Line 31, they shall be located such that the scraping action occurs below the liquid surface. Design of wax scrapers shall not interfere with bottom shell course accessories.

• C.3.16.2 Foam Dams

A foam dam, if specified on the Data Sheet, Line 32, shall be designed to retain foam at the seal area, at a depth to cover the seal area while causing the foam to flow laterally to the point of seal rupture. The top of the foam dam shall be at least 300 mm (12 in.) but no more than 600 mm (24 in.) from the tank shell. The foam dam shall be a minimum of 300 mm (12 in.) high and extend at least 50 mm (2 in.) above the secondary seal, a combustible secondary seal using a plastic-foam log, or any burnout panel, measured at its highest contact point with the shell.

The foam dam shall be fabricated from minimum sheet metal thickness of 10-gauge (0.134 in.) carbon steel, 18-gauge (0.050 in.) stainless steel, or other sufficiently fire resistant material.

A bolted foam dam shall be attached to the outer rim, the rim angle, or to an angle that has been welded to the deck or pontoons. During design and construction, steps should be taken to prevent seal separation and associated compliance issues. A welded foam dam shall be installed on the top plates of the pontoon or roof deck. Welded foam dams and support angles used for bolted foam dams shall be continuously welded on the foam side.

Support braces, if required, shall be installed on the side of the foam dam closest to the center of the tank at a circumferential spacing of approximately 1.5 m (5 ft) on center, but need not be welded or permanently affixed to the floating roof.

To allow drainage of rainwater, the foam dam bottom or attachment angle shall be slotted on the basis of 278 mm² of slot area per m² of dammed area (0.04 in.² of slot area per ft² of dammed area), with a maximum drain slot height of 9.5 mm (³/₈ in.). Bolts should not penetrate the deck or pontoons.

• C.3.16.3 Sample Hatches

If specified on the Data Sheet, Line 32, the Manufacturer shall install an NPS 8 sample hatch with funnel on the roof deck with remote access from the gauging platform. Manufacturer shall install a recoil reel on the gauging platform. The hatch shall be equipped with a self-closing liquid-tight cover that can be opened and closed from the gauger's platform.

C.3.16.4 Side Entry Mixers

- a) Mixers shall conform to the Data Sheet, Line 26.
- b) Each mixer shall be installed in cover plates in dedicated shell nozzles or manholes.

C.4 Fabrication, Erection, Welding, Inspection, and Testing

C.4.1 The applicable fabrication, erection, welding, examination, and testing requirements of this standard shall apply.

C.4.2 Deck seams and other joints that are required to be liquid- or vapor-tight shall be examined for leaks by means of penetrating oil or any other method consistent with the methods described in this standard for testing cone-roof seams and tank-bottom seams.

C.4.3 The roof shall be given a flotation test while the tank is being filled with water and emptied. During this test, the upper side of the lower deck shall be examined for leaks. The appearance of a damp spot on the upper side of the lower deck shall be considered evidence of leakage.

C.4.4 The upper side of the upper decks of pontoon and double-deck roofs shall be visually examined for pinholes and defective welding.

C.4.5 Drainpipe and hose systems of primary drains shall be tested with water at a pressure of 350 kPa (50 lbf/in.²) gauge. During the flotation test, the roof drain valves shall be kept open and observed for leakage of the tank contents into the drain lines.