



Sandborn Roofs Inc.

Environmental & Investment Protection

SANDBORN INTERNAL FLOATING ROOF SPECIFICATION

1. GENERAL

This specification defines the minimum requirements for the design, materials, fabrication, inspection, testing and documentation of a Sandborn Internal Floating Roof as applied to steel oil storage tanks operating at low pressure.

2. CODES AND STANDARDS

- API Standard 650 Welded Steel Tanks for Oil Storage, Appendix H
- API Standard 653 Tank Inspection, Repair, Alteration, and Reconstruction
- API Standard 2000 Venting Atmospheric and Low-Pressure Storage Tanks (Non-refrigerated and Refrigerated)
- NFPA 11 Low Expansion Foam
- NFPA 30 Flammable and Combustible Liquids Code
- National Building Code of Canada (NBC)
- Provincial Building Codes (PBC)
- CCME Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks

All codes, standards and specifications shall be the latest editions in effect at the time of design and fabrication.

3. ROOF DESIGN

3.1 General

The design of the internal floating roof shall consider the design of the storage tank for the determination of size and the effects of operating and environmental conditions.

The design temperature shall be based on the lowest one-day mean ambient temperature at the tank location plus 8°C (15°F). Values for the lowest one-day mean temperatures are provided in the API 650 Standard.

The specific fluid vapor pressure stored shall follow the CCME Guidelines recommendations and shall not exceed 76 kPa (11 psi) at 21°C (69.8°F).

The internal floating roof shall be constructed of composite material panel modules in full contact with the product, designed for internal, covered service. The roof shall be supported by either stainless steel cables or aluminum legs with nylon inserts to protect the tank floor. Floating roof supports must be able to accommodate multiple positioning for operating and servicing of the tank. Alternately, the floating roof can be supported by a grid structure attached to the tank shell and fixed roof support columns if excessive levels of tank bottoms may build up in the tank.

The design shall guarantee that the floating roof can safely support a load of 2.2 kN (500lbf) over an area of 0.1 m² (1 ft²). This load may be applied while the roof is floating on the product or when it is landed on its supports. This design for loading must comply with the API 650 Standard Appendix H.4.2.

3.2 Minimum Thickness

The floating roof shall be built using panels constructed of a closed cell polyurethane foam core with a metallic skin to give the strength properties of a composite panel.

- The minimum thickness for the panel skin shall be 0.41 mm (0.016 in)
- The nominal thickness for deck panels shall be 63 mm (2.50 in)

3.3 Panels

The following requirements shall be applicable to the floating roof panels:

- Panels shall be in direct contact with the product surface.
- Panels must be inherently buoyant not relying on hollow buoyancy compartments.
- All panel edges shall be sealed to prevent liquid entry.
- Panel thickness of small diameter floating roofs may be increased to maintain deck buoyancy.
- Core material shall be impervious to the stored product.

3.4 Roof Ladder

The floating roof should allow the installation of a fixed ladder from the roof hatch to the tank floor without reducing the operation levels of the tank.

3.5 Anti-Rotation Devices

The roof manufacturer shall supply anti-rotational and centering devices with the internal floating roof. Vertical cables running from the fixed roof of the tank to the tank bottom at the preferred anti-rotation device. If anti-rotation cables are used, a spring or alternate means of relief must be included between the floor and the fixed roof of the tank.

Minimum quantities for anti-rotation cables shall be as follows:

| Tank Diameter | Quantity |
|----------------------|-----------------|
| < 20'Ø | 1 |
| > 20'Ø < 80'Ø | 2 |
| > 80'Ø < 150'Ø | 4 |
| > 150'Ø < 210'Ø | 6 |
| > 210'Ø | 8 |

3.6 Venting

The filling and suction rates for the tank service shall be specified by the owner. The roof manufacturer shall design proper venting devices accordingly to prevent overstressing the roof deck.

These vents shall be adequate to evacuate air and gasses from underneath the roof when it is landed during filling operations.

The vents shall also be adequate to release any vacuum generated underneath the roof after it settles completely suspended on its supports, during emptying operations.

The roof manufacturer may recommend ideal operating rates and possibly the installation of an inlet diffuser.

3.7 Manholes and Inspection Hatches

The manufacturer shall specify the appropriate number of manholes according to the application. However, at least one (1) manhole shall be provided with the floating roof to allow for access to and ventilation of the tank when the floating roof is suspended on its supports and the tank is empty.

Minimum floating roof manhole sizes shall be as follows:

- For tanks with 24"Ø shell manways – 18" x 22"
- For tanks with 20"Ø shell manways – 14" x 19"

Note: Larger manways can be provided as required by the end user.

3.8 Floating Roof Penetrations

The floating roof shall allow for all tank gauge poles, hatches and internal ladders, according with the tank design.

Columns and other rigid vertical appurtenances that penetrate the deck shall be provided with a vapor seal that permits a local deviation of $\pm 125\text{mm}$ (5 in). Appurtenances shall be plumb within a tolerance of $\pm 75\text{ mm}$ (3 in).

3.9 Roof Supports

Roof supports shall be designed to withstand a minimum live load of 0.24 kPa (5 lb/ft^2). The floating roof shall be equipped with operating drains or other means of automatically preventing an accumulation of liquid on the top side of the floating roof. Deck drains shall facilitate the return of spillage or condensate to the stored product.

Supports must be able to adjust for high and low positions of the floating roof.

If the floating roof is to be supported by stainless steel support cables attached to the fixed roof, the tank owner must confirm that the fixed roof is able to carry the extra load imposed by the floating roof.

3.10 Anti-Static / Grounding Devices

Antistatic protection shall be provided with electrical bonding to the tank shell or floating roof, all conductive parts shall be electrically connected and bonded to the outer tank structure. This may be accomplished by electric drains in the seal area or flexible cables from the external tank roof to the internal floating roof. Flexible cables are preferred.

Minimum quantities for grounding cables shall be:

| Tank Diameter | Quantity |
|---------------------------------|----------|
| $< 80'\text{Ø}$ | 2 |
| $> 80'\text{Ø} < 150'\text{Ø}$ | 4 |
| $> 150'\text{Ø} < 210'\text{Ø}$ | 6 |
| $> 210'\text{Ø}$ | 8 |

3.11 Seals

A peripheral seal that spans the annular space between the internal floating roof deck and the tank shell shall be provided. Any vertical appurtenances that penetrate the deck are required to have a seal.

3.11.1 Peripheral Seals

The design of internal floating roof peripheral seals shall be as follows:

- A peripheral seal shall be designed to accommodate $\pm 100\text{ mm}$ (4 in) of local deviation between the floating roof and the tank shell.

- Primary seals may be either: liquid mounted shoe seals, liquid mounted foam log seals or vapor mounted wiper seals.
- Secondary seals, if required shall be wiper types.
- The design of shoe seals and wiper type seals shall allow for complete in-service access and repair from the top of the floating roof.
- The roof and seal must meet the requirements of CCME-EPC-87E “Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks”
- When determining the maximum fill height for an internal floating roof tank, consideration shall be given to ensure that adequate space is maintained in the top of the tank for the floating roof. As a minimum the following vertical clearances shall be maintained between the maximum fill levels and the lowest obstruction at the top of the tank shell (such as rafter clips or foam deflectors):

| Type of Rim Seal | Minimum Clearances |
|---|--------------------|
| Single Vapor Mounted Wiper | 15” |
| Double Vapor Mounted Wiper | 21” |
| Liquid Mounted Shoe Seal | 15” |
| Liquid Mounted Shoe Seal w/ Secondary Wiper | 21” |
| Any Seal with Optional 24” Foam Dam | 26” |

Note:

- Liquid mounted rim seals can interfere with the function of overflow slots. Should overflow slots be used in conjunction with liquid mounted primary seals the design and position of the overflow slots must account for potential obstruction of the overflow by the primary seal. Typical shoe seal projection below the liquid level is 8”. It is recommended that alternate means of fill control be considered.

3.11.2 Penetration Seals

Penetration seals are required. The column and vertical ladder negotiator seals shall be fabricated of material that must be suitable for the product service and operating temperature. All penetration seals shall be designed to provide a close fit, taking into account horizontal and vertical movement of the floating roof deck. Penetration seals shall be designed to accommodate ± 125 mm (5 in) of deviation.

Guide wheels and a hold down device shall be installed on penetration seals to reduce wear on seal material and increase the effectiveness of the seal

4. MATERIALS

All materials used in oil storage tank roofs shall comply with API 650 Standard, Appendix H.

All material shall meet the dimensional tolerance specified in either CAN/CSA-G40.20 or API 650 Standard: Welded Steel Tanks for Oil Storage.

Composite panel type roofs consist of modules constructed of a rigid foam core wrapped in a metallic envelope.

The core materials shall be rigid, closed cell polyurethane foam conforming to ASTM-D2341 with the following minimum properties:

| Description | Requirements | ASTM Method |
|-----------------------------|--|-------------|
| Density (in-place) | 48 kg/m ³ (3.0 lb/ft ³) | D 1622 |
| Compressive Yield Strength | 150 kPa (22 psi) | D 1621 |
| Shear Strength | 140 kPa (20 psi) | C 273 |
| Water Absorption (% Volume) | 1.27 | D 2842 |
| Closed Cell Content | >95% | D 2856 |
| Flame Spread | 46 | E 84 |

5. INSPECTING AND TESTING

The manufacturer has the responsibility for compliance with all design and material requirements according with applicable codes, standards and well sound engineering practices. However, the company may at its own discretion have sufficient independent inspection to ensure all design, materials and methods comply with API 650 and other relevant standards. This may involve monitoring of design calculations, shop fabrication, field erection and testing. The company inspector shall reject any aspect that does not comply with the standards.

The company inspection may be carried out at the manufacture's shop to verify the conformance of materials to the specifications indicated in the manufacturer's proposal and the condition of the materials. Shop inspection shall also cover quality and accuracy of the fabrication activities.

Inspection may also be provided for all aspects of field erection and for the full erection period.

An independent third party can be retained for these inspections, or the manufacturer can undertake the inspections.

If specified by the tank owner the floating shall be given a flotation test in water or product to check that it travels freely to its full height and that the peripheral seal operates throughout the entire travel of the floating roof.

The fit of the peripheral seal shall be checked to ensure that an acceptable contact with the tank shell is maintained.

6. CONTRACTOR QUALIFICATIONS

The internal roof contractor must have at least ten (10) years experience furnishing and installing full-surface contact floating roofs as described in this specification and provide an extensive list of installations, including owner, location, size, tank service and year of completion.

The internal floating roof shall be manufactured and installed by Sandborn Roofs Inc. of Nisku, Alberta, (780) 955-8761 or an approved equal.

7. WARRANTY

The manufacturer shall guarantee all material and workmanship to be of first class quality, in accordance with the best-approved methods of manufacturing and to be free from all defects for a period of two (1) year.

A ten (10) year anti sinking warranty shall be issued upon completion of installation.

| REV # | DATE | REVISION | BY | APPR. |
|--------------|-------------|---------------------------------------|-----------|--------------|
| 0 | 03-06-2003 | Issued for Implementation | RC | LP |
| 1 | 26-03-2004 | General Formatting Changes | RC | LP |
| 2 | 24-10-2005 | Update Material Data | RC | LP |
| 3 | 14-02-2007 | Update for Foam Dam Height Deductions | IG | MV |
| 4 | 01-01-2011 | Update Warranty Statement | MV | MV |