PETROLEUM STORAGE TANKS

Basic Training

PETROLEUM STORAGE TANKS - Basic Training

What we'll be covering

- The design of the tank.
- Which tank , which product.
- The structure & assembly of the tank.
- Tank inspection
- Measurement

Goals for Today

- To identify tank type & tank equipments
- To know the limitation of tank
- Calculation of tank volume
- Safe tank operation

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Course Content

1. **Background**
2. **Tank Design**
   - **Types of vertical tanks**
   - **Selection of vertical tanks**
3. **Tank Structure & Assembly of Tank**
4. **Tank Fittings**
   - **Operational fitting**
   - **Fittings common to all vertical tanks**
   - **Additional fitting for floating roof tanks**
   - **Special fittings and accessories for floating**
5. **Tank Inspection**
6. Tank Farm Safety

……...

7. **Measurement**
8. **Internal & external incident learning**
9. **Field trip**

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1.0 Background

Tanks have been around since the beginning of hydrocarbon production. *Tanks vary* considerably, in the *type* and *size* based on the *type of products* to be stored and the *volume involved*.

The failure of a tank can have several undesirable effects such as endangering personnel, affecting the environment and interrupting the Operator's business.

Companies therefore, require a consistent approach for assessing tank integrity and maintaining compliance with industry and regulatory standards, (that is community requirements). *Such an approach must;*

- ***Ensure tanks are not leaking and will not leak before next inspection***
- ***Reduce the potential for releases***
- ***Maintain tanks in safe operating conditions, and***
- ***Make repairs and determine when replacement is necessary.***

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TANK

The primary function of a storage tank is to store liquid substance.
This liquid substance may be:

- ***a) Feedstock***
- ***b) Finished products prior to shipping out to customers (Unit 75)***
- ***c) and Unfinished petroleum components awaiting for further***
  - ***processing (intermediate)***
  - ***blending***

While in the storage tanks, these products may settle out undesirable substances such as;

- ***a) Water***
- ***b) Emulsions***
- ***c) Dirt etc.***

This undesirable substances can then be removed through draw-off devices. Products may also be mixed, blended and treated in storage tanks effectively, using the large capacity available in these tanks.

TANK *(cont)*

Broadly, the storage tanks can be divided into two basic types:

Atmospheric storage

Atmospheric storage is a term applied to tanks operating at or near atmospheric pressure. This type of tank is used to hold liquid which will not vaporize at ambient temperature. Tanks used in this category are primarily the *open top, fixed roof (cone & dome)* and *floating roof.*

Pressurized storage

Pressurized storage applies to those vessels (mounded bullets) which are designed to withstand pressure sufficient to keep the liquid stored, from vaporizing. High vapor pressure hydrocarbons such as *propane*, *butane*, *iC5* are the types of products requiring pressurized storage vessels (Mounded Bullets).

Note: ***STORAGE TANK TRAINING for MG 3 Operators, will basically focus on aboveground vertical storage tanks of various types.***

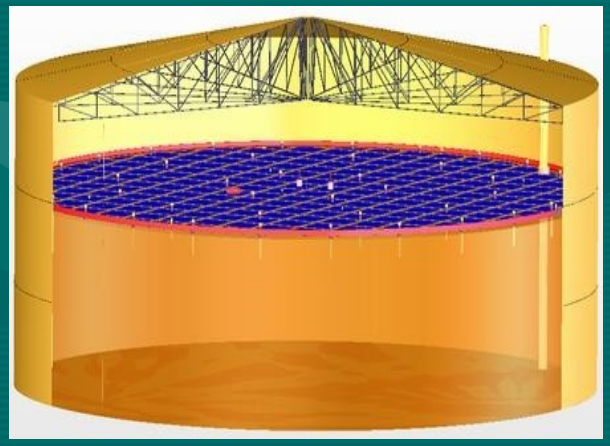
TANK

For safe storage of petroleum products, we have to consider the product properties such as volatility (RVP, pour point, flash point and others before we start designing and constructing the tank.

Cone Roof Tank

Dome Roof Tank

Internal Floating Roof Tank



Floating roof tank

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2.0 The design of the tank

Standard vertical tanks are available in several types, which differ in vapor-saving efficiency and in cost.

2.1 Vertical tanks

2.1.1 Open top tanks

This type of tank has no roof and shall be used for storing city water, fire water and cooling water (All water tanks in PPMSB are with roofs).

2.1.2 Fixed roof tanks

These types of tanks can be divided into:

- Cone roof
- Dome roof

Each type can be further subdivided into non-pressure and low-pressure fixed roof tanks.

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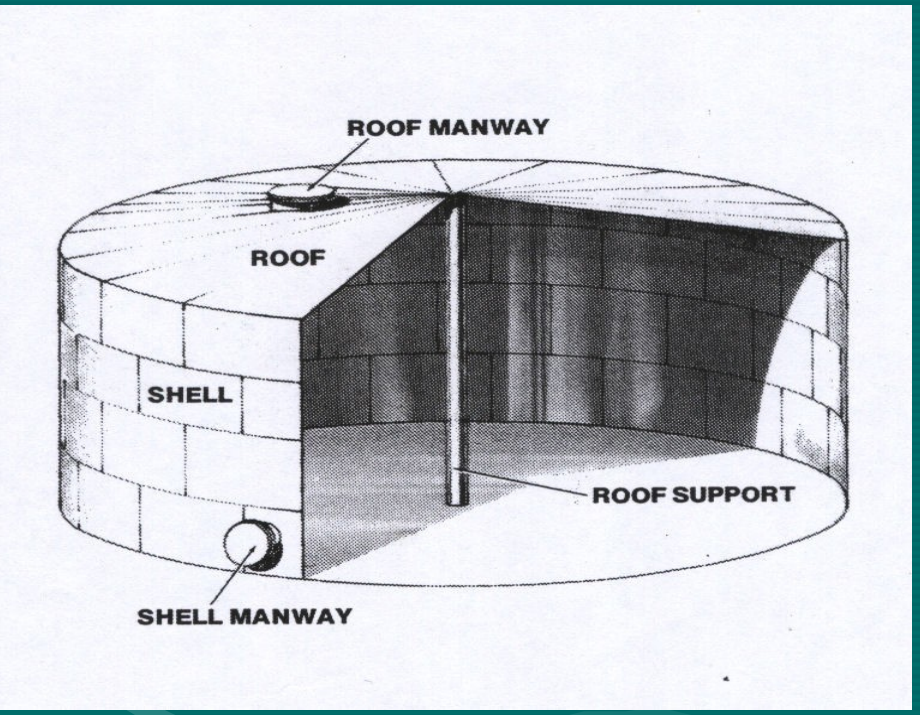
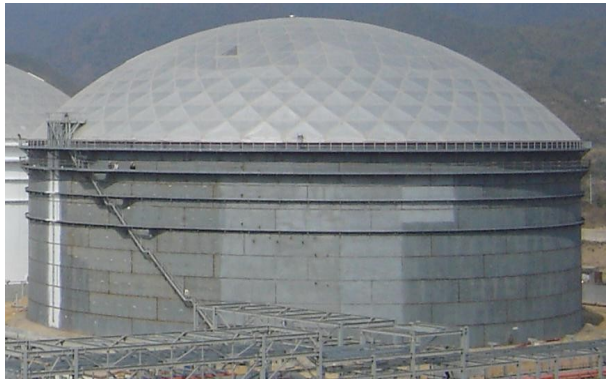


Cone roof tank



Dome roof tank

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2.1.3 Fixed roof tanks with floating covers (internal floating roof tanks)

In a fixed roof tank a floating cover can be installed to give a further reduction of vapor losses. These tanks are fitted with breather vents either at the top course of the shell plate or on the roof edge.

Typical feedstock/ products stored are: DPK (Kerosene, Jet A1)

2.1.4 Floating roof tank

This type of tanks are designed to work at atmospheric pressure. The diameter of a floating roof tanks shall at least be equal to its height to enable the use of a normal rolling ladder for access to the roof.

Typical Products stored are: Crude oil, Gasoline and Gasoline components, Solvents……

2.1.5 Bullets

The very volatility & high vapor pressure product such as Isopentane, LPG & Butane will be store in a vessel that will withstand product pressure and prevent any product vaporization. Due to high volatility & high vapor pressure the vessels are Mounded underground to prevent thermal radiation in case of any fire nearby.

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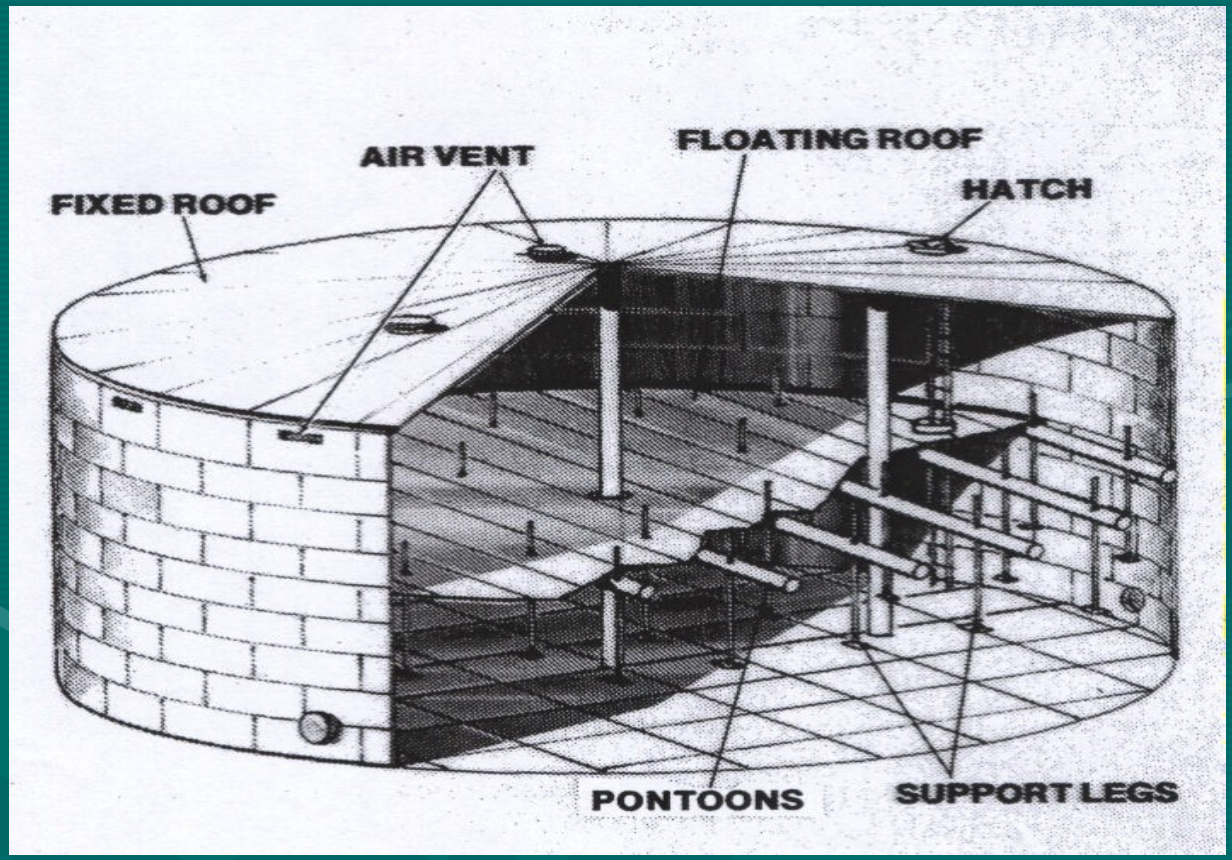
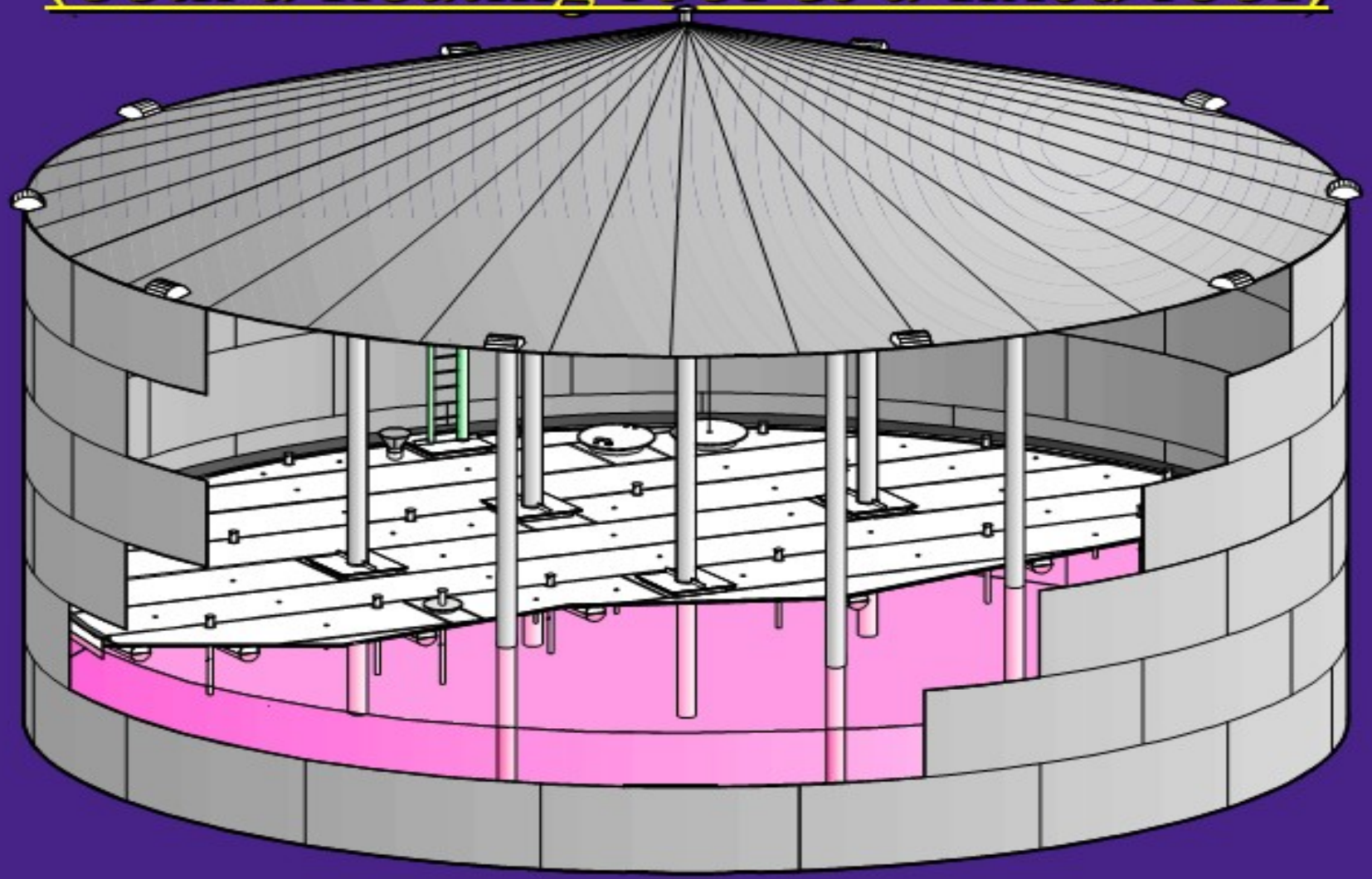


Internal Floating Roof Tank

Internal Floating-Roof Tank

(both a floating roof & a fixed roof)



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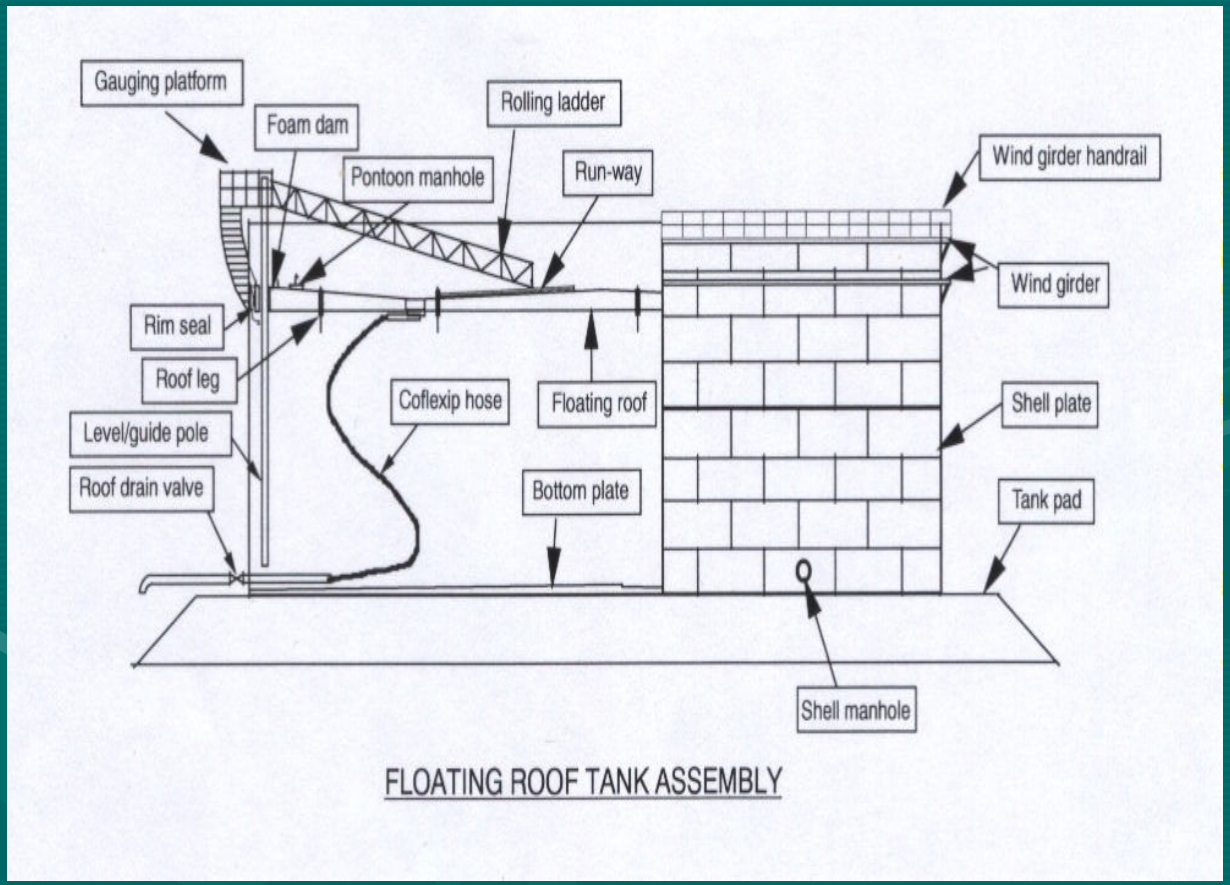
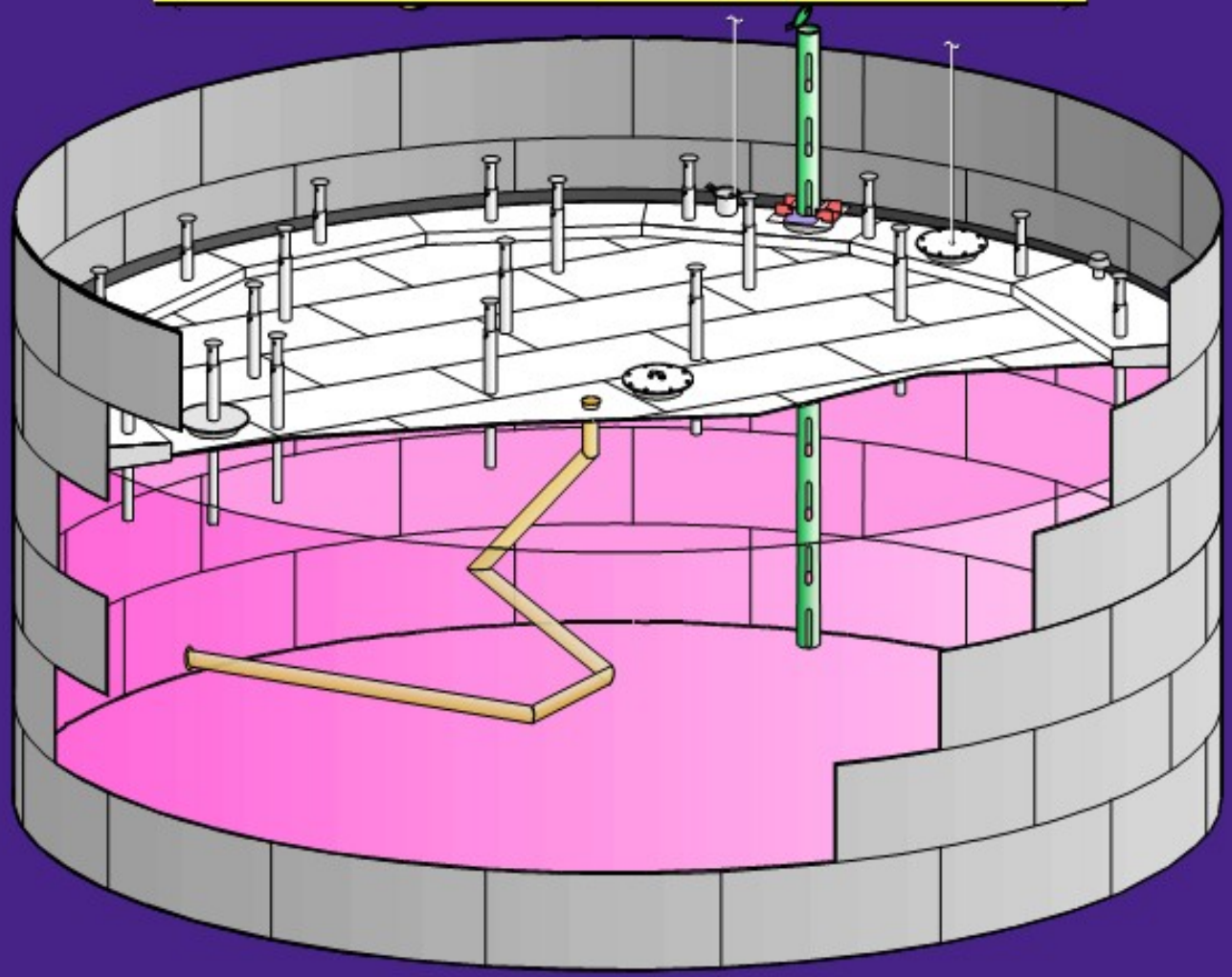


Floating Roof Tank

External Floating-Roof Tank

(floating roof, no fixed roof)



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2.2 Selection of Vertical Tanks – *which tank, which product*

2.2.1 General

The types and ranges of tanks recommended for storage of different classes of petroleum products.

2.3 Stability

For calculations of tank stability in strong winds, the velocities given in the local regulations should be used; if no local regulations exist, local experience should be considered.

Unstable tanks shall be provided with anchor bolts and concrete foundation rings. Uplifting is caused by the internal vapor pressure acting against the underside of the roof, in conjunction with wind load. A stability calculation shall be made to determine the number of anchor required.

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2.3 Stability

For calculations of tank stability in strong winds the following need to be done:

a) the velocities given in the local regulations should be used;

b) if no local regulations exist, local experience should be considered.

Unstable tanks shall be provided with anchor bolts and concrete foundation rings. Uplifting is caused by the internal vapor pressure acting against the underside of the roof, in conjunction with wind load. A stability calculation shall be made to determine the number of anchors required.

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2.4 Tank Foundation

2.4.1 Checking of foundation

Surface, subsurface and climatic conditions vary from place to place, so it is not practical to establish design data to cover all situations. The allowable soil loading and exact type of subsurface construction to be used must be decided for each individual case after careful consideration.

Some of the many conditions that require special engineering consideration are as follows:

- ***site on hillsides – undisturbed/ land filled***
- ***sites at swampy or filled ground***
- ***sites underlain by soils, such as organic clays that will settle over long period and can cause lateral ground stability problem***
- ***site adjacent to water courses or deep excavation***
- ***site exposed to flood water***
- ***site in regions of high seismicity***

2.4 Tank Foundation

2.4.2 Typical Foundation Types

2.4.2.1 Earth foundation without a ringwall

When subsurface conditions shows adequate bearing capacity and that settlements will be acceptable, satisfactory foundations may be constructed from earth material.

Design for satisfactory long-term performance are:

> ***For small tanks***, foundations can consist of compacted crushed stone, screenings, fine gravel, clean sand, or similar material placed directly on virgin soil.

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2.4 Tank Foundation

2.4.2 Typical Foundation Types

2.4.2.2 Earth foundations with a concrete ringwall large tanks, with heavy or tall shell and/or self-supported roofs impose a substantial load on the foundation under the shell. When there is some doubt whether a foundation will be able to carry the load directly, a concrete ringwall foundation should be used.

Advantages of concrete ringwall are:

- *It provides better distribution of the concentrated load of the shell to produce a more uniform soil loading under the tank*
- *It provides a level, solid starting plane for concentration of the shell*
- *It is capable of preserving its contour during construction*
- *It retains the fill under the tank bottom and prevents loss of material as a result of erosion*
- *It minimizes moisture under the tank*

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2.4 Tank Foundation

2.4.2 Typical Foundation Types

2.4.2.2 Earth foundations with a concrete ringwall

Other design requirements are:

> *The ringwall shall not be less than 300 mm (12 in) thick*
> *Depth of ringwall depends on the local conditions*

2.4.2.3 Earth foundations with a crushed stone and gravel ringwall

A crushed stone or gavel ringwall will provide adequate support for high load imposed by the shell.

Advantages are:

> *It provides better distribution of the concentrated load of the shell to produce a more uniform soil loading under the tank*
> *It provides a means of leveling the tank grade, and it is capable of preserving its contour during construction*
> *It retains the fill under the tank bottom and prevents loss of material as a result of erosion*
> *it can more smoothly accommodate differential settlement because of its flexibility*

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2.4 Tank Foundation

2.4.3 Tank foundations for leak detection

API supports a general position of installing a Release Prevention barrier (RPB) under new tanks during initial construction. An RPB includes steel bottoms, synthetic materials, clay liners, and all other barriers or combination of barriers placed in the bottom of or under an aboveground storage tank, which have the following functions:

- preventing the escape of contaminated material and
- containing or channeling released material for leak detection

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2.4 Tank Foundation

2.4.3 Tank foundations for leak detection

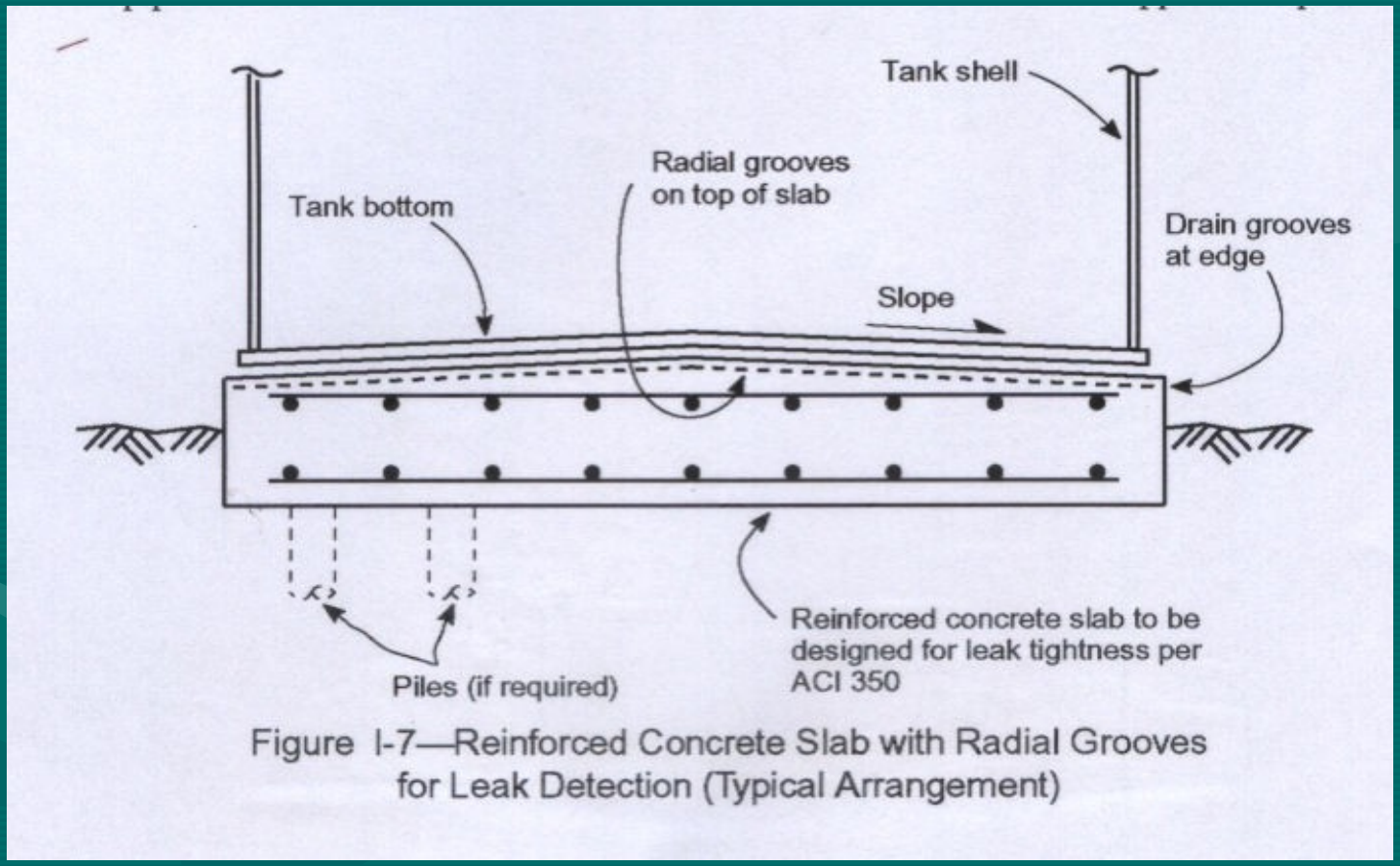

Figure I-7—Reinforced Concrete Slab with Radial Grooves for Leak Detection (Typical Arrangement)

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2.4 Tank Foundation

2.4.3 Tank foundations and leak detection

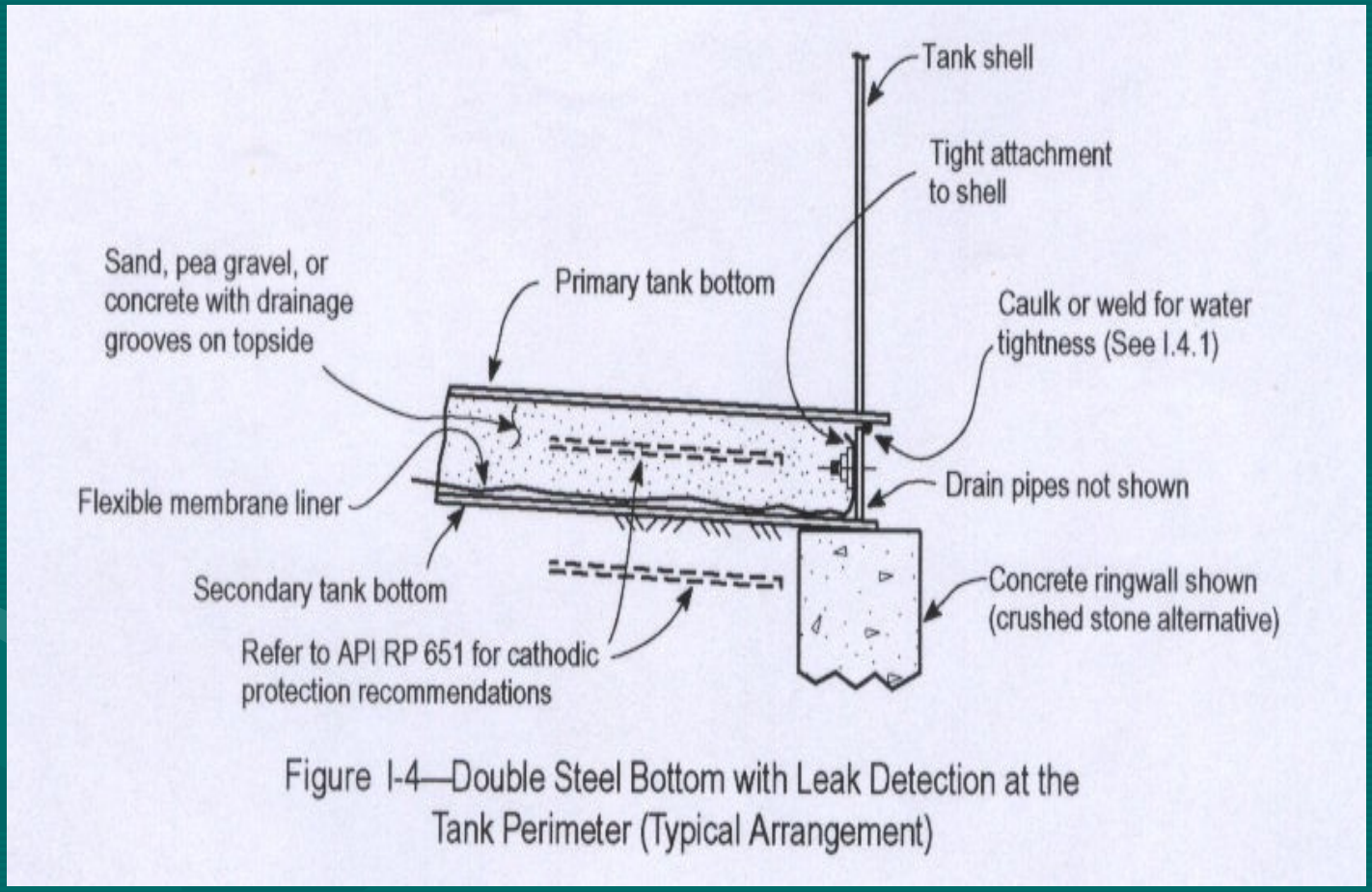

Figure I-4—Double Steel Bottom with Leak Detection at the Tank Perimeter (Typical Arrangement)

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2.4 Tank Foundation

2.4.3 Tank foundations for leak detection

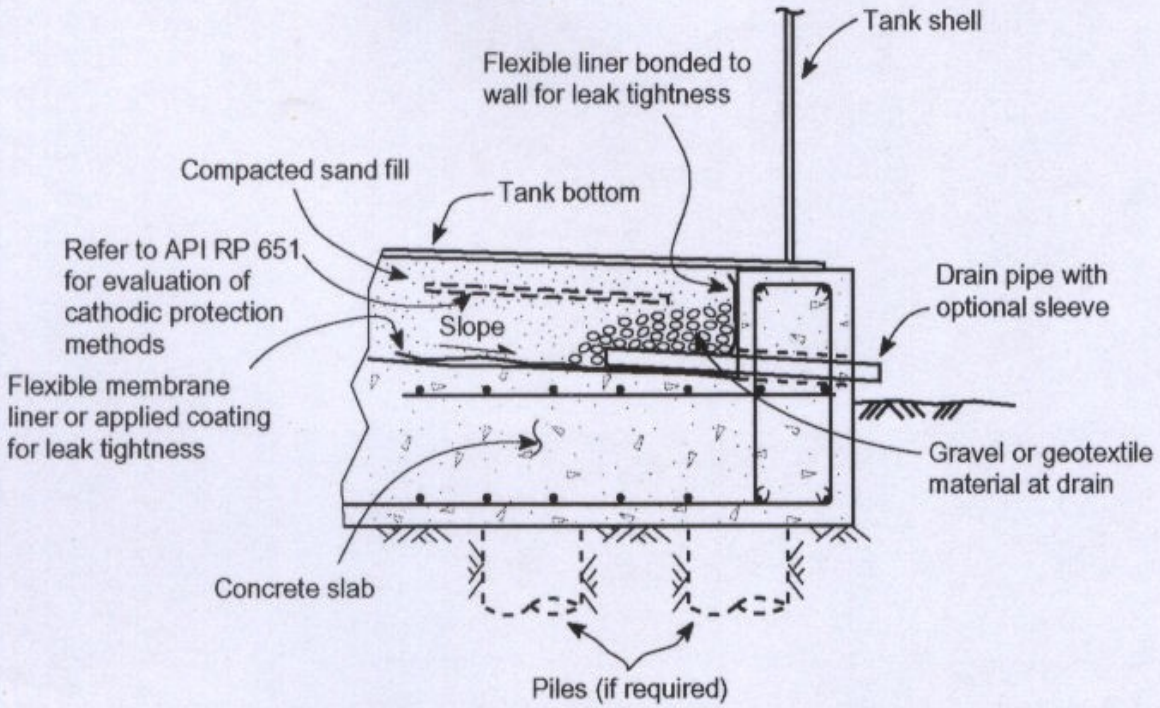

Figure I-6—Reinforced Concrete Slab with Leak Detection at the Perimeter (Typical Arrangement)

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2.4 Tank Foundation

2.4.3 Tank foundations for leak detection

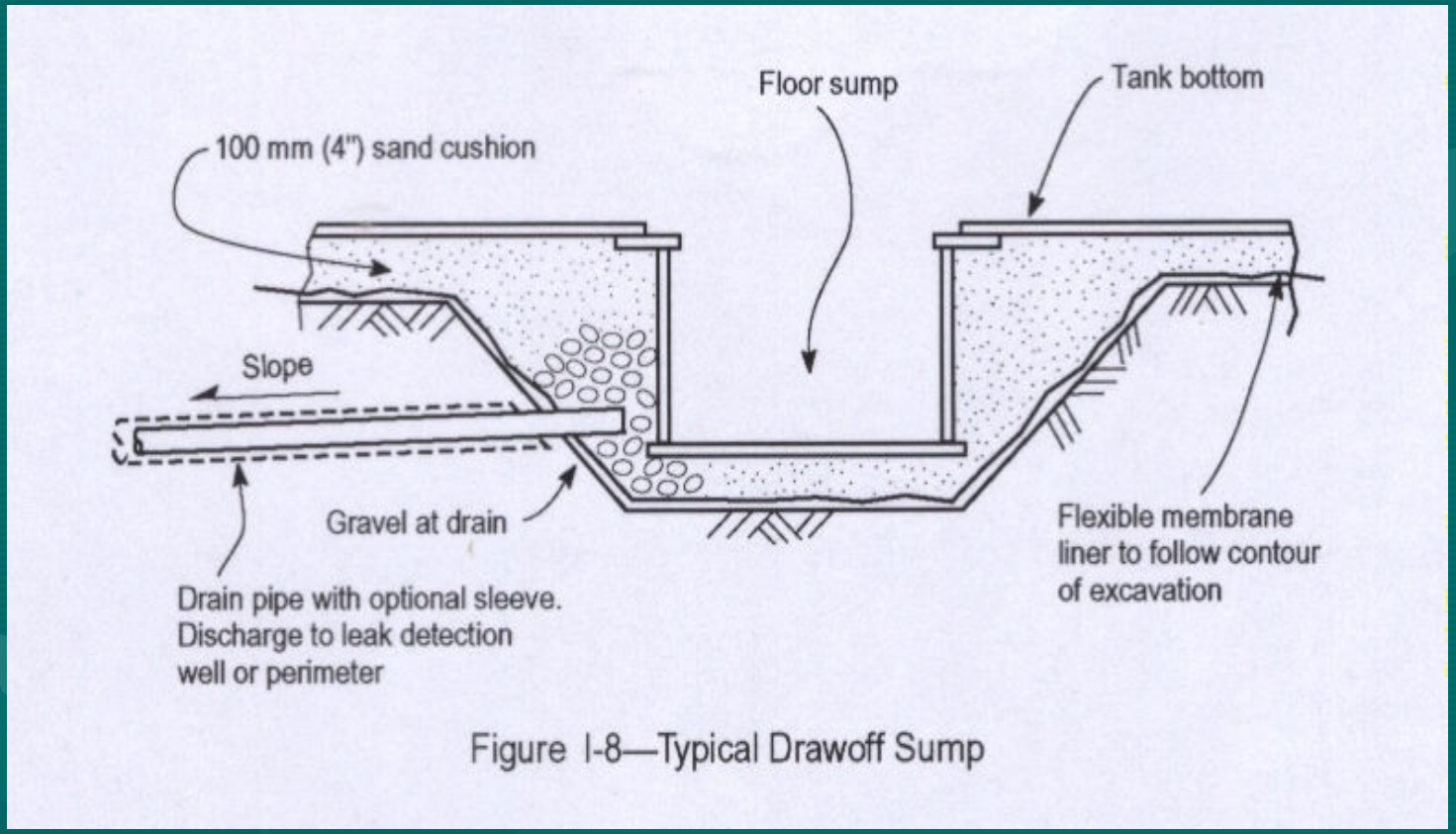

Figure I-8—Typical Drawoff Sump

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2.4 Tank Foundation

2.4.3 Tank foundations for leak detection

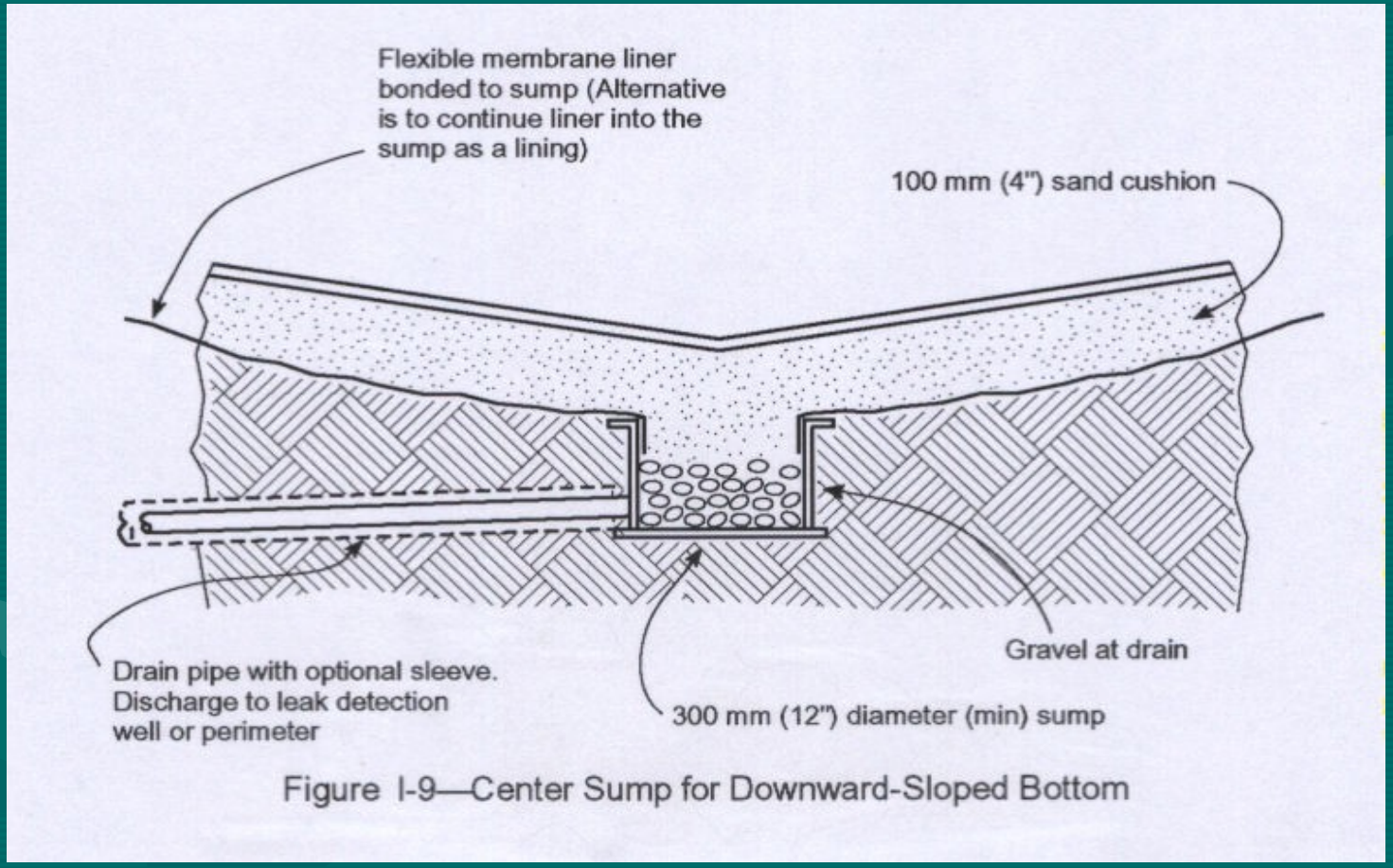

Figure I-9—Center Sump for Downward-Sloped Bottom

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2.4 Tank Foundation

2.4.3 Tank foundations for leak detection

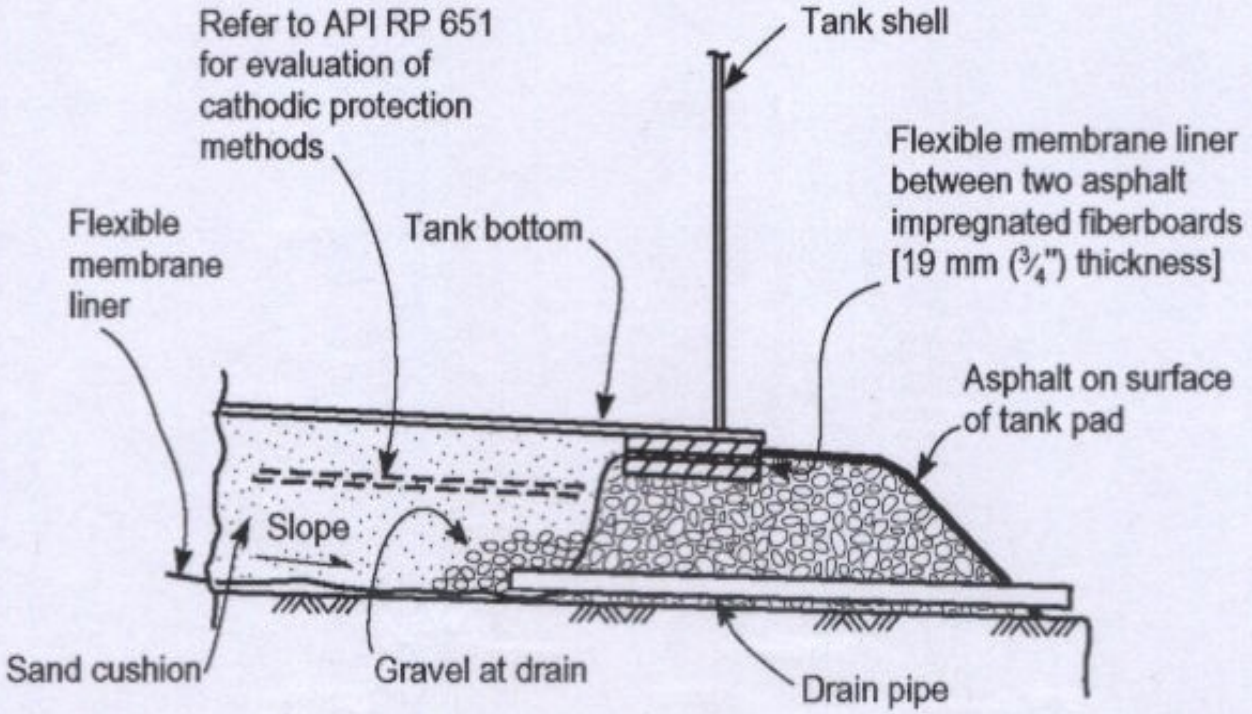

Figure I-3—Earthen Foundation with Undertank Leak Detection at the Tank Perimeter (Typical Arrangement)

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2.4 Tank Foundation

2.4.3 Tank foundations for leak detection

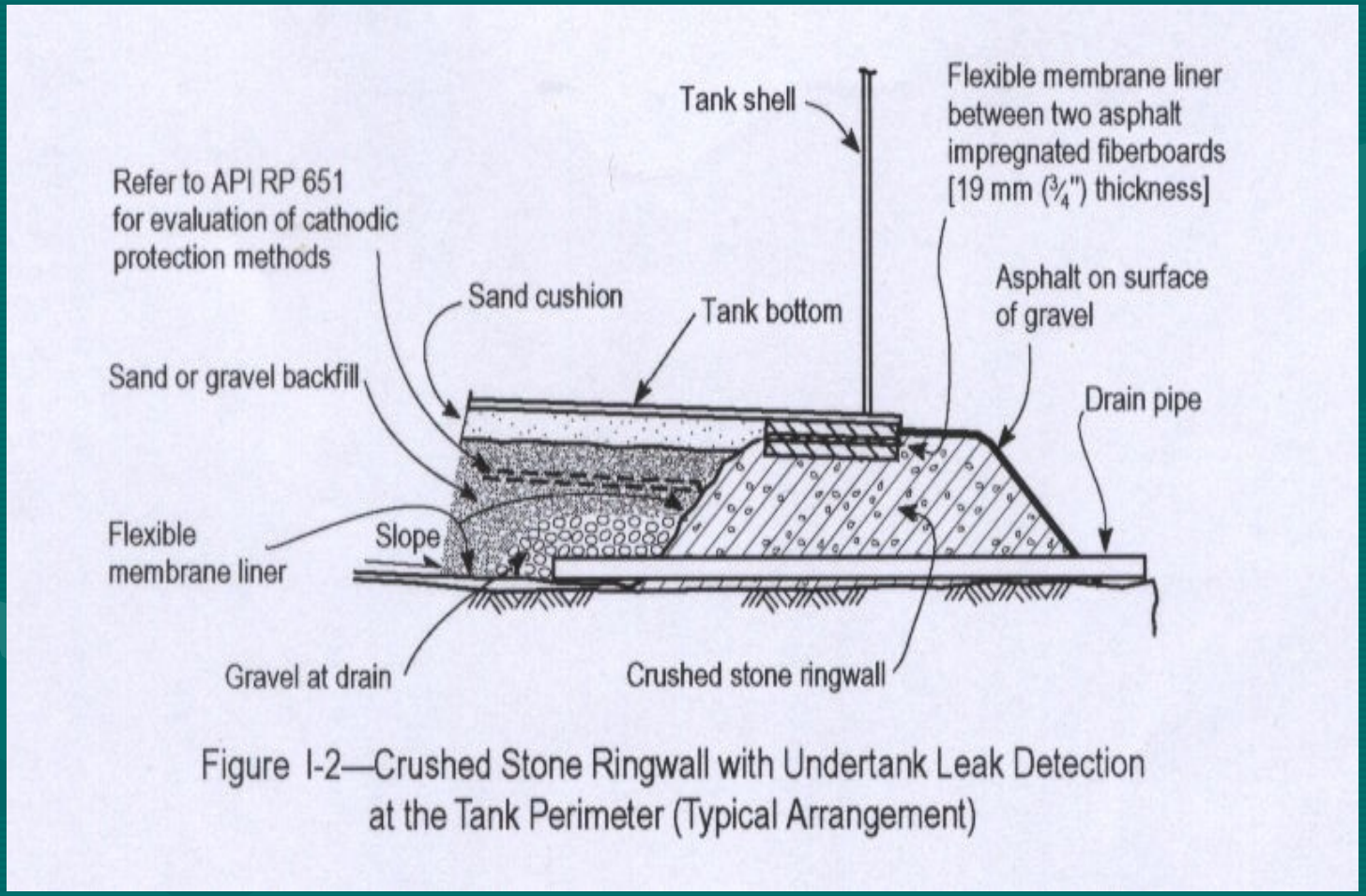

Figure I-2—Crushed Stone Ringwall with Undertank Leak Detection at the Tank Perimeter (Typical Arrangement)

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3.0 Tank Structure

3.1 Bottom/ Floor design – Designed to, permit complete draw-off, minimize product contact and to ulitilize maximum tank capacity and prevention of corrosion of bottom plate.

3.1.1 Two types of tank flooring are:

> Cone down bottom (Bottom down)

Generally, bottom down is design for cone roof tanks. Centre of the flooring is installed with drain pit. Water in the tank is accumulated in the pit (lowest point of the bottom plate/ floor).

> Cone up bottom (bottom up)

Generally, this type of design is used for floating-roof tanks, 3 to 4 collector pits are installed, close to the shell plate. Each of the pit is provided with a water draw-off line. *However, only one is connected to the closed water draw system in PPMSB.*

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3.7 External Loading

3.7.1 Primary wind girders

3.7.1.1 Open top and floating roof tanks

Open top and floating roof tanks shall be provided with a primary wind girder to maintain roundness when the tank is subjected to wind loads.

The wind girder shall be in the form of a ring located on the outside of the tank shell, approximately 1 m below the top of the uppermost shell course. The top of the uppermost shell course shall be provided with a top curb angle.

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3.7 External Loading

3.7.1 Primary wind girders

3.7.1.2 Construction of primary wind girders

Wind girders may be constructed from formed plate sections, by welding. The outer periphery of the wind girder may be circular or polygonal.

Drain holes to be provided for trapped rain water.

Support shall be provided for all wind girders when the width of the horizontal leg or web exceeds 16 times the thickness of the leg or web.

Continuous welds shall be used for all joints in wind girders.

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3.7.2 Secondary wind girders

3.7.2.1 General

Tank may require secondary rings to maintain roundness over the full height of the tank shell under wind and/or vacuum conditions (BS 2654).

3.7.2.2 Design of secondary wind girders

There are basically, additional stiffening rings. Continuous welding (full penetration butt welds) shall be used for all connections of the secondary wind girders.

3.7.3 Isolated radial loads

Isolated radial loads (heavy platforms or elevated walkways) shall be distributed along the shell by rolled structural section, plate ribs or build-up members, preferably in a horizontal position.

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3.8 Shell openings

3.8.1 Reinforcement of shell openings

All openings larger than 80 mm in diameter shall be reinforce.

3.8.2 Pipe connections

Pipes connected to the nozzles of tanks shells designed in such a way that no significant bending moments or loads act on the nozzle. For bigger lines, use of bellows and balanced supports should be considered.

3.8.3 Clean-out doors

If required for tanks made of carbon steel, clean out doors shall be designed and fabricated. This is more for sludge removal and to allow entry of a conveyor belt, if required.

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3.9 Fixed roof design

3.9.1 Type of roof

As mentioned earlier: - Cone roof

- Dome roof

3.9.2 Design of supporting structure

A supported cone roof is roof formed to approximately the surface of a right cone that is supported principally either by rafters on girders and columns or by rafters on trusses with or without column.

3.9.3 General

> ***Minimum thickness of roof plate – 5mm (3/16 in)***
> ***Thicker roof plates may be required for self-supporting roofs.***
> ***The roof thickness also determined by the type of product stored. more corrosive product require thicker plate.***

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3.9 Fixed roof design

3.9.3 General *(cont)*

> roof plates of supported cone roofs shall not be attached to the support members.

> Roof plate shall be attached to the top angle of the tank with a continuous fillet weld on the top side only. The roof-to-shell joint may be considered frangible and in the event of excessive internal pressure may fail before failure occurs in the tank shell joints or the shell-to-bottom joint.

3.10 Internal floating roof tank

An internal floating roof and its accessories shall be designed and constructed to allow the roof to operate throughout its normal travel with manual attention .

3.10.1 The IFR shall be designed and built to float and rest in a uniform horizontal plane (no drainage slope required)

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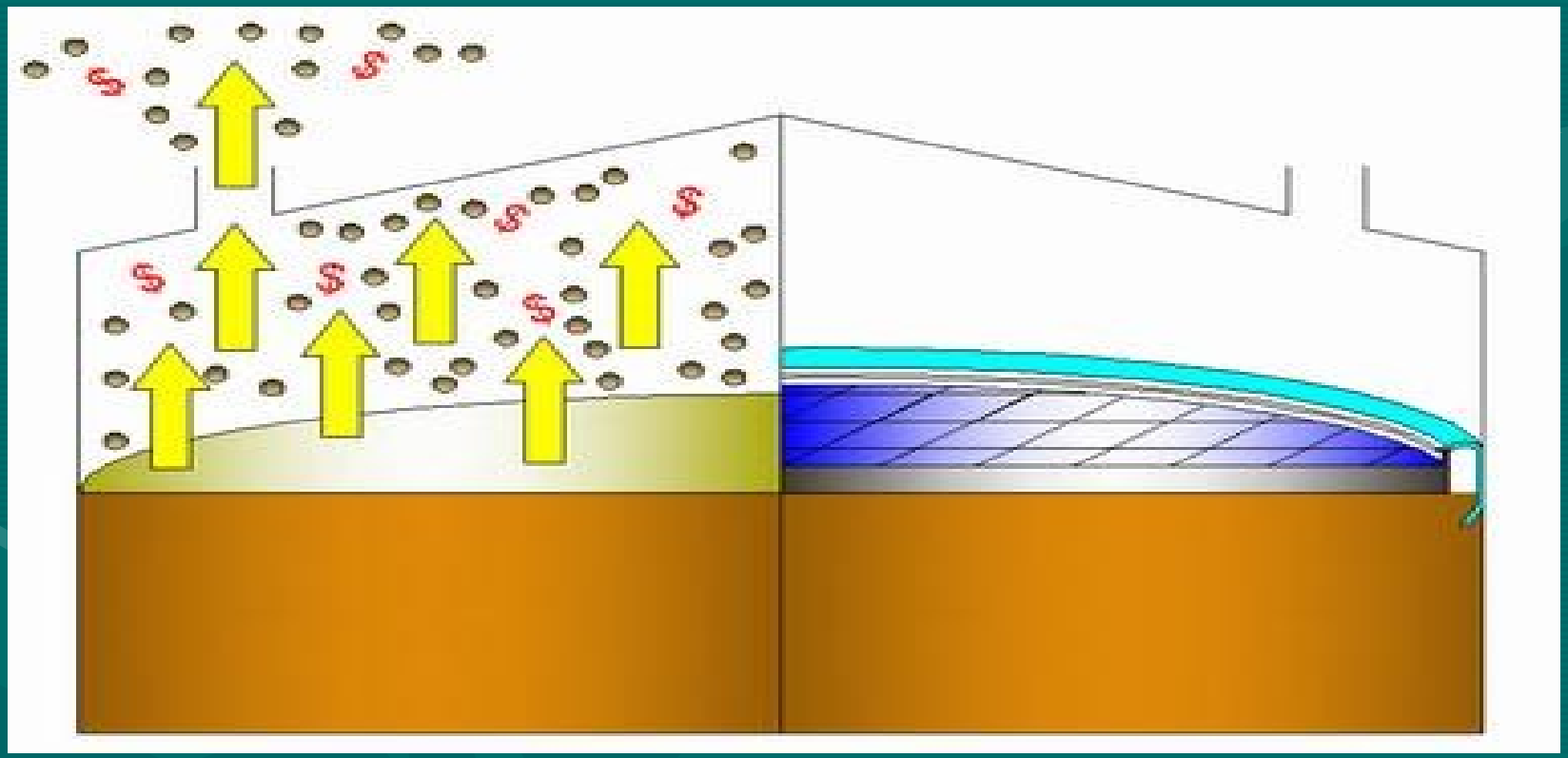
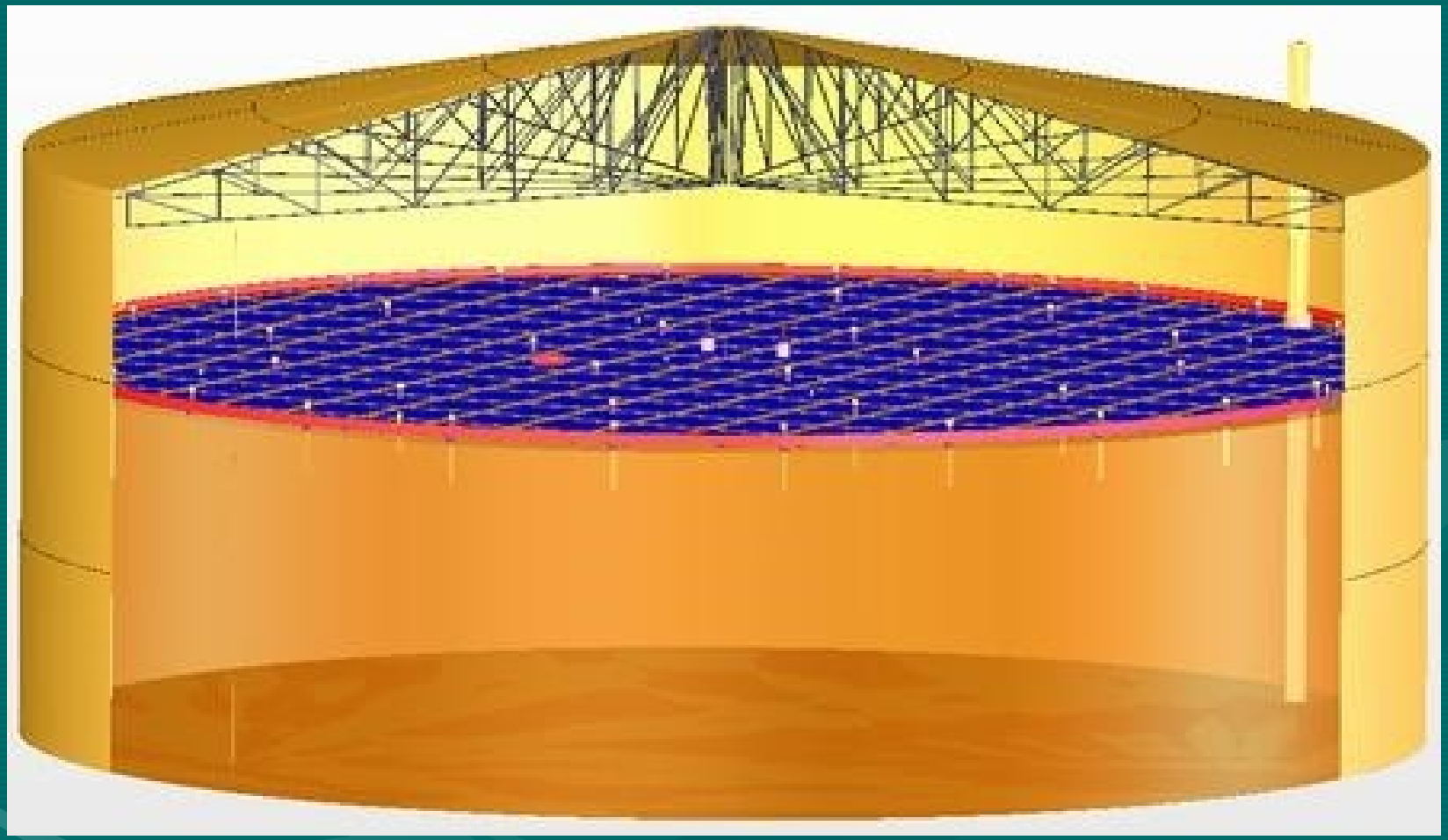
3.9 Fixed roof design

3.10 Internal floating roof tank



Internal Floating Roof (IFR)

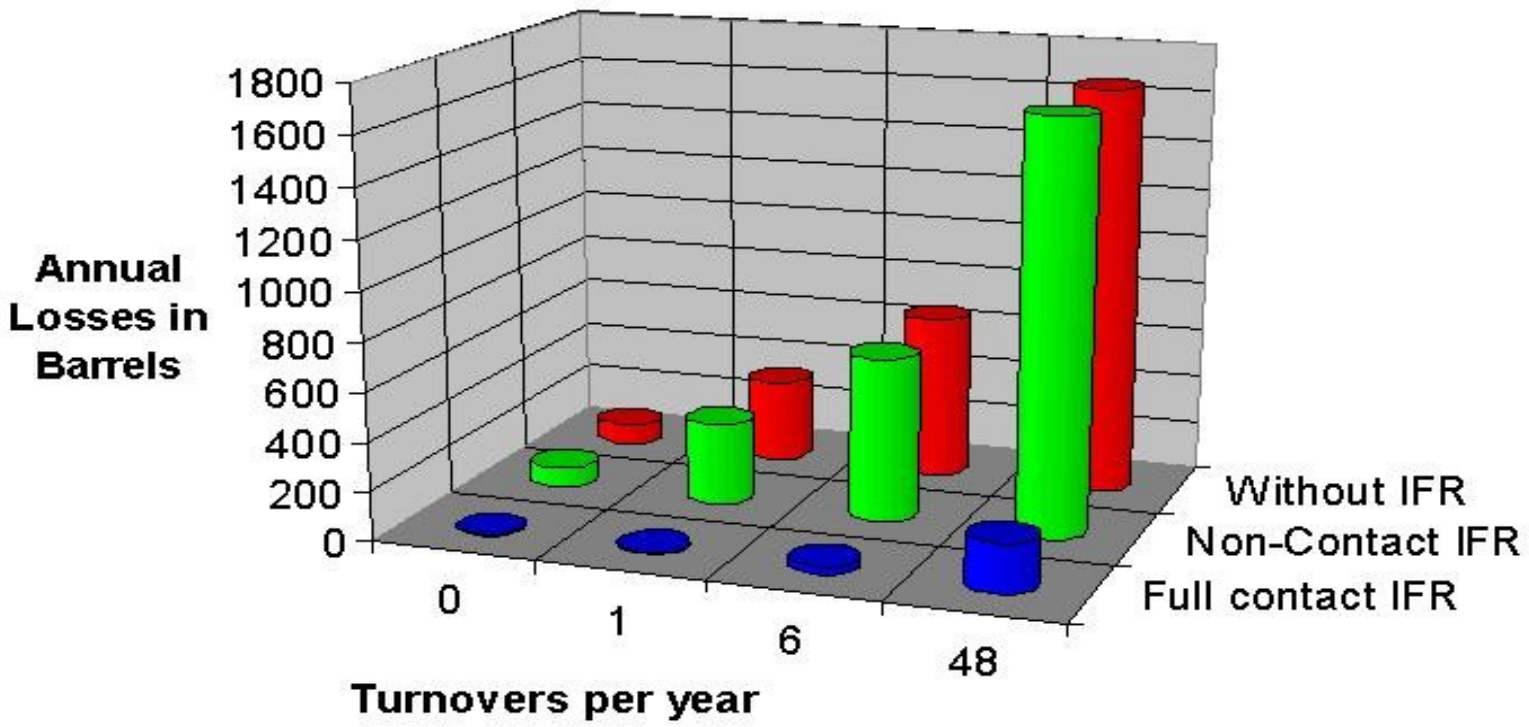
An internal floating roof tank has both a permanent fixed roof and a floating desk inside. The term "deck" or "floating roof" is used in reference to the structure floating on the liquid stored within the tank. The deck of an internal floating roof tank rises and falls with the liquid level whilst in full contact on the underside thus achieving no vapor zone.



Historical Application of FRP

In 1971 Dynaglass introduced FRP to the industry to help solve the many corrosion problems suffered from the use of metals. For over 31 years, FRP equipment intalled by dynaglass in various applications have proven to have met every expectations. Internal Floating roof was first constructed out of steel. As steel begins to rust costs in maintenance continue to rise. Aluminum thought to be better was introduced, but for some applications these also suffered corrosion. Eventually Steel or Aluminum IFR will need to be replaced at a cost. In search of better materials to solve the corrosion and rust problems, FRP was used to produce fuel storage tanks since 1958 and continues to be commonly seen in use for underground storage tanks amongst many other successful applications. Many tanks have existed underground beyond their 30-year manufacturer's warranty term. Some have even been dug out and re-buried with a re-certified 2nd term 30-year warranty.

Vapor Loss


Annual Losses in Barrels
1800
1600
1400
1200
1000
800
600
400
200
0
0
1
6
48
Turnovers per year
Without IFR
Non-Contact IFR
Full contact IFR

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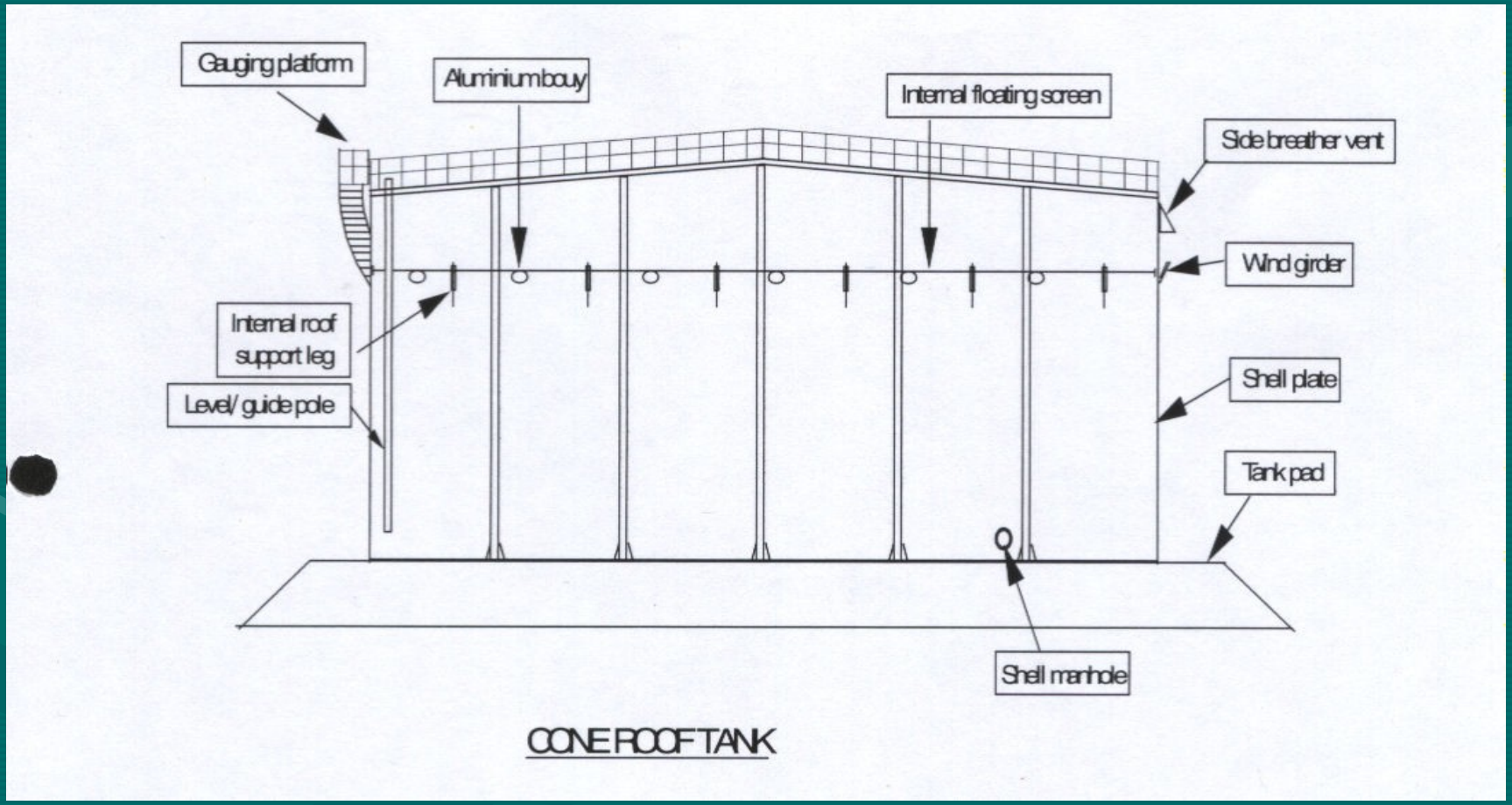
Internal floating roof tank



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3.10 Internal floating roof tank *(internal floating roof picture)*

3.10.2 Buoyancy

> Metallic pontoon internal floating roofs have peripheral closed top bulk-headed compartments for buoyancy.
> Double deck internal floating roofs are also available.
> Sandwich-panel internal floating roofs have metallic panel modules for buoyancy compartments.

3.10.3 Floating screen material

> Steel
> Stainless steel
> Aluminum (commonly used)

3.10.4 Roof seal/ types

> A vapor tight rim seal (or skirt) is provided

- *Liquid filled, gas-filled or foam-filled fabric seal*
- *Flexible wiper seal*
- *Mech. shoe - combination of light gauge metallic band and fabric seal.*

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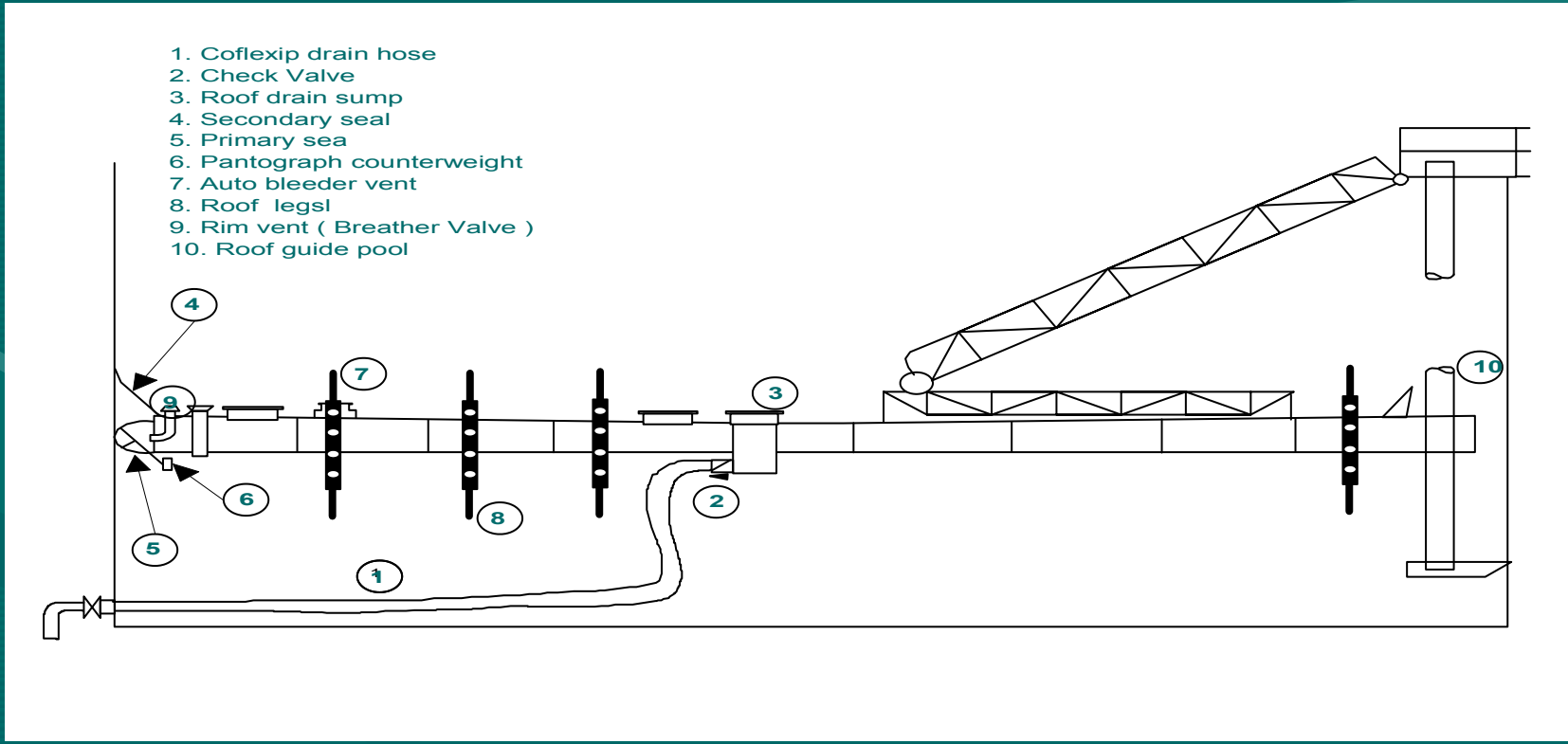
3.11 External floating roof tank

3.11.1 Types of EFRT

- > Single deck pontoon roof
- > Double deck roof



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3.11 External floating roof tank

3.11.2 Manholes/ vents are provided for:

> Pontoon with liquid tight covers
> Deck manholes with are used only during tank shutdown

> Each compartment shall be provided with elevated vents
> Suitable vents shall be provided to prevent overstressing of the roof deck or seal membrane

3.11.3 Support legs

> Floating roof shall be provided with support legs
> Legs pipes shall be perforated at the bottom to provide drainage
> The length of the legs are adjustable from the top
> Operating position (low leg) and cleaning or maintenance position (high leg)

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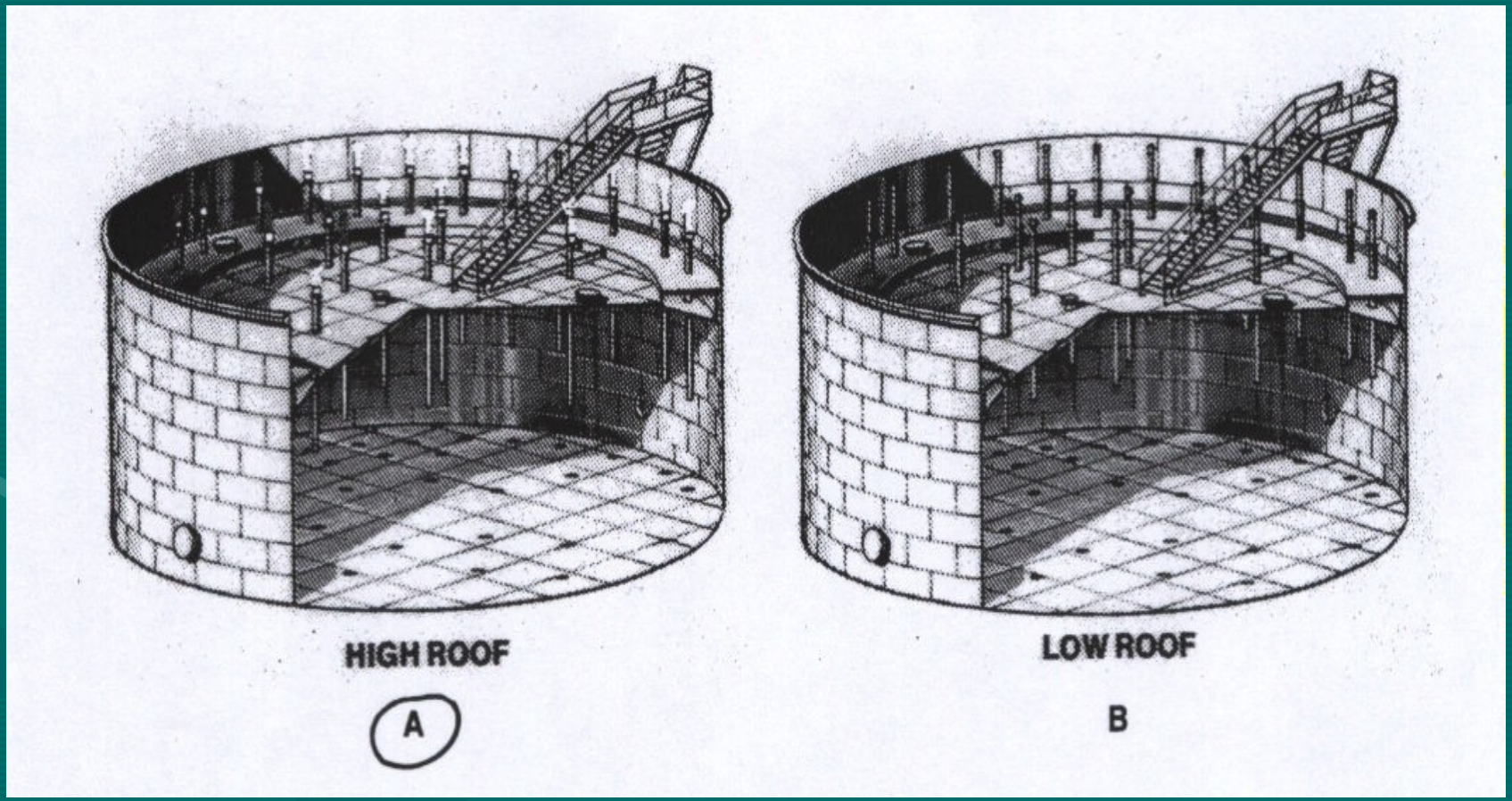
3.11 External floating roof tank

3.11.3 Support legs



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3.11 External floating roof tank

3.11.4 Seals/ Types

> The space between the outer periphery of the roof and the tank shell shall be sealed by a flexible device that provides a reasonable close fit to shell surface

- Steel shoes with fabric or nonmetallic material used as seal or seal components
- Material shall be durable and shall not discolor or contaminate the product stored.

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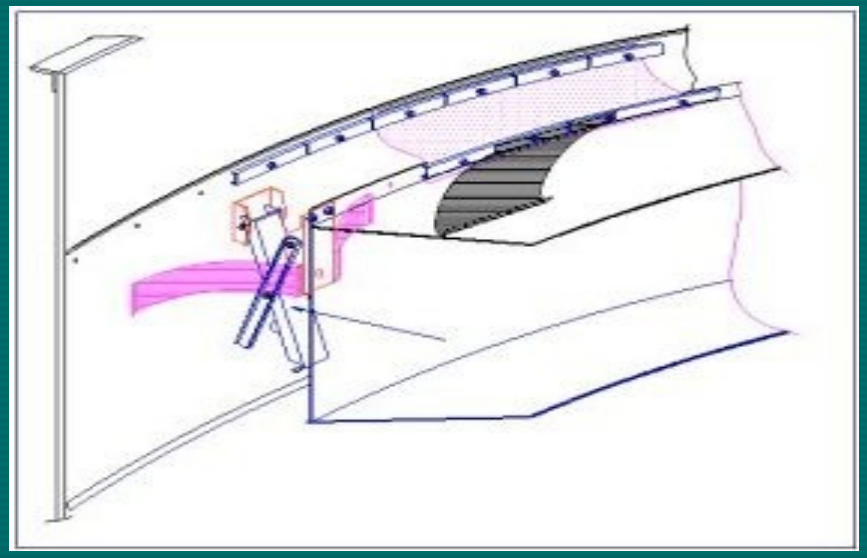
3.11 External floating roof tank

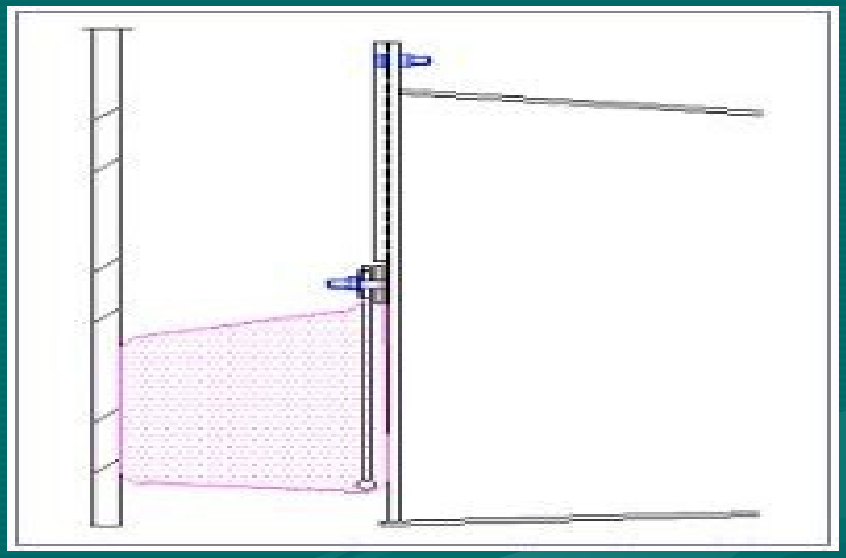
3.11.4 Seals/ Types

Pictures/ drawings of seals follows:

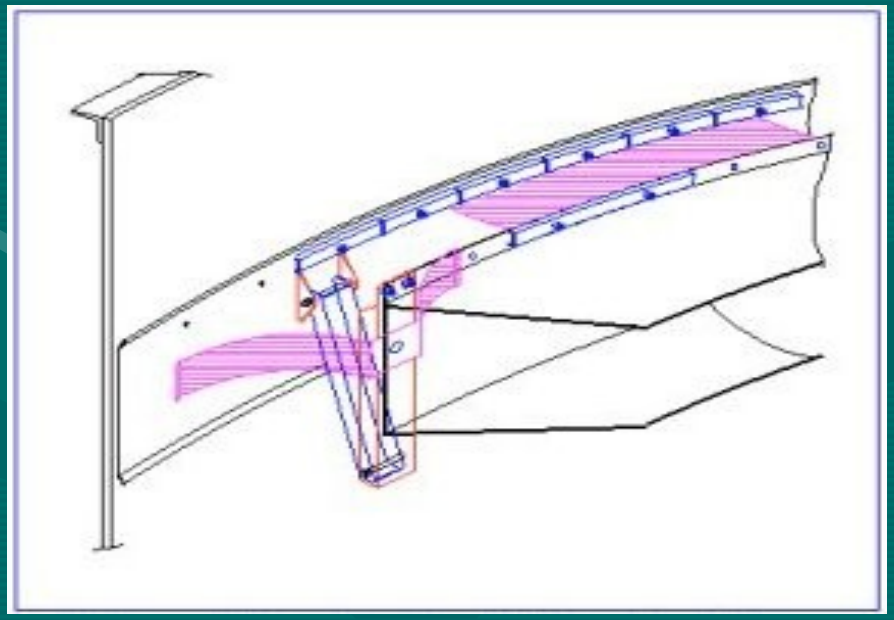
Primary and Secondary Seals for Floating Roof Tanks



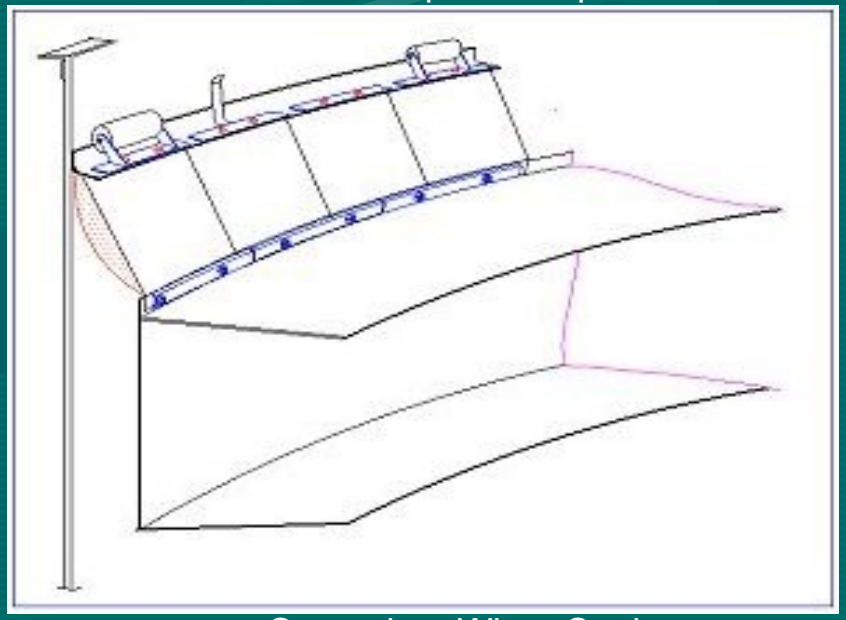
Pantograph Shoe Seal.



Foam Seals can be liquid or vapor mounted.



Internal Floating Roof Shoe Seal for aluminum internal floating roofs or steel pans.



Secondary Wiper Seal
(with roller for out of round tanks)

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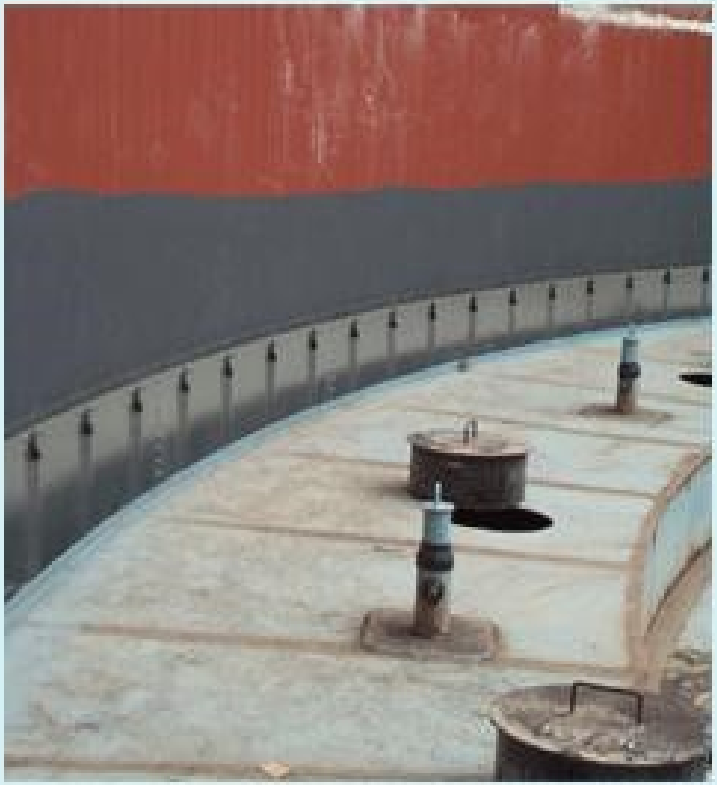
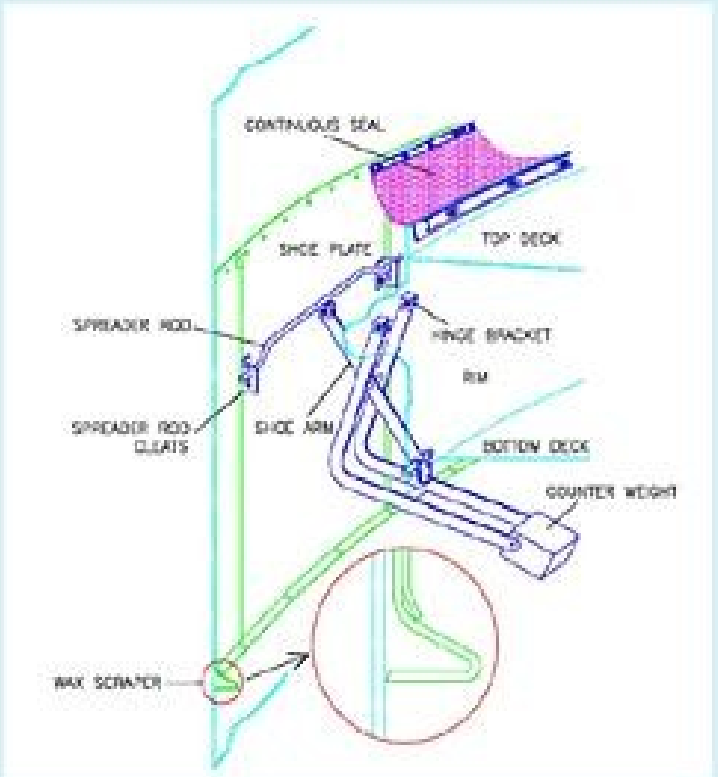
3.11 External floating roof tank

3.11.4 Seals/ Types





(WB-1 Pantograph Type Mechanical Shoe Seal)

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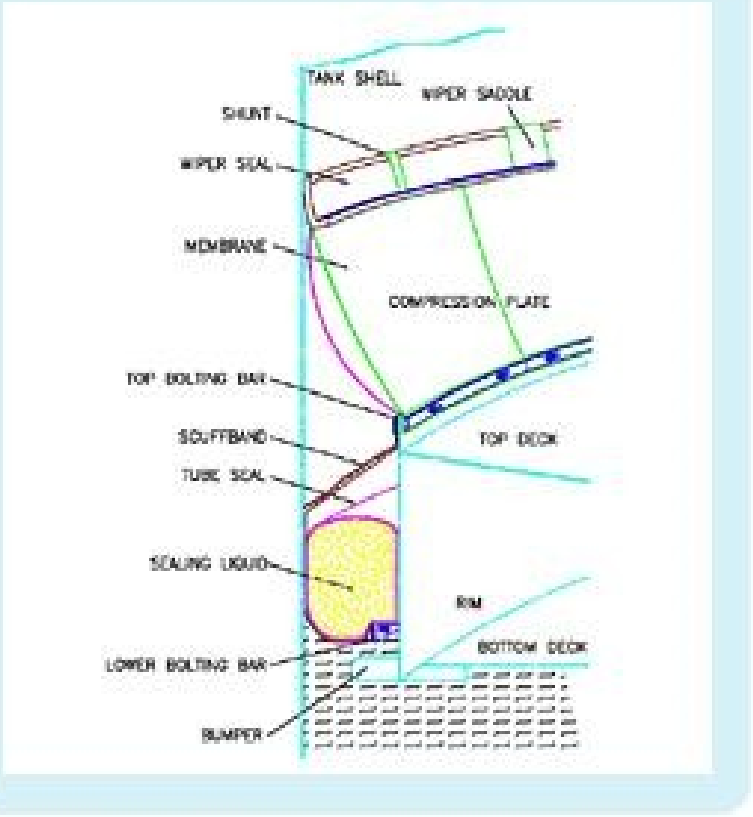
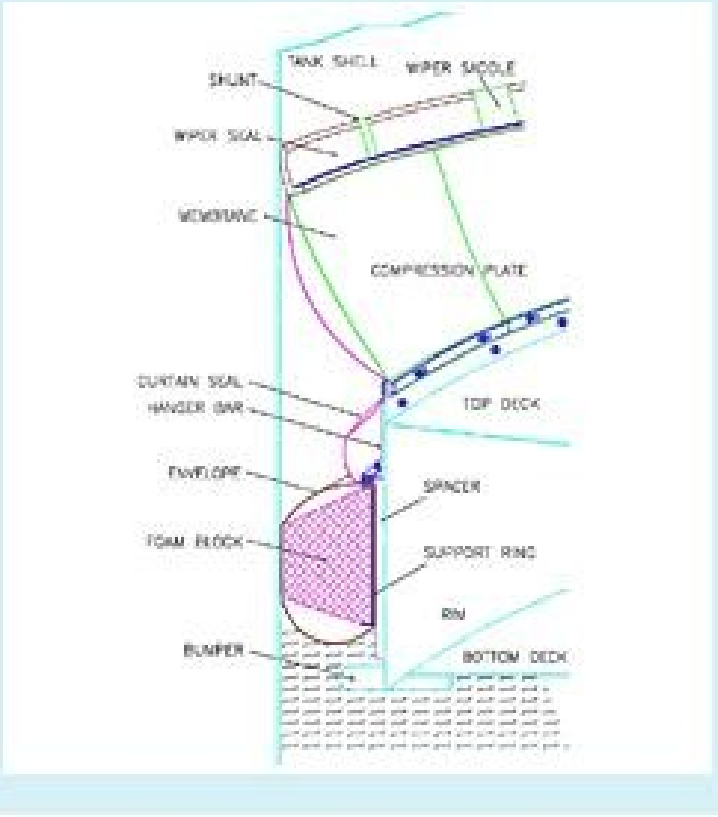
3.11 External floating roof tank

3.11.4 Seals/ Types



(Tubeseal Liquid Filled Seal)



(WB-7 Foam Seal)

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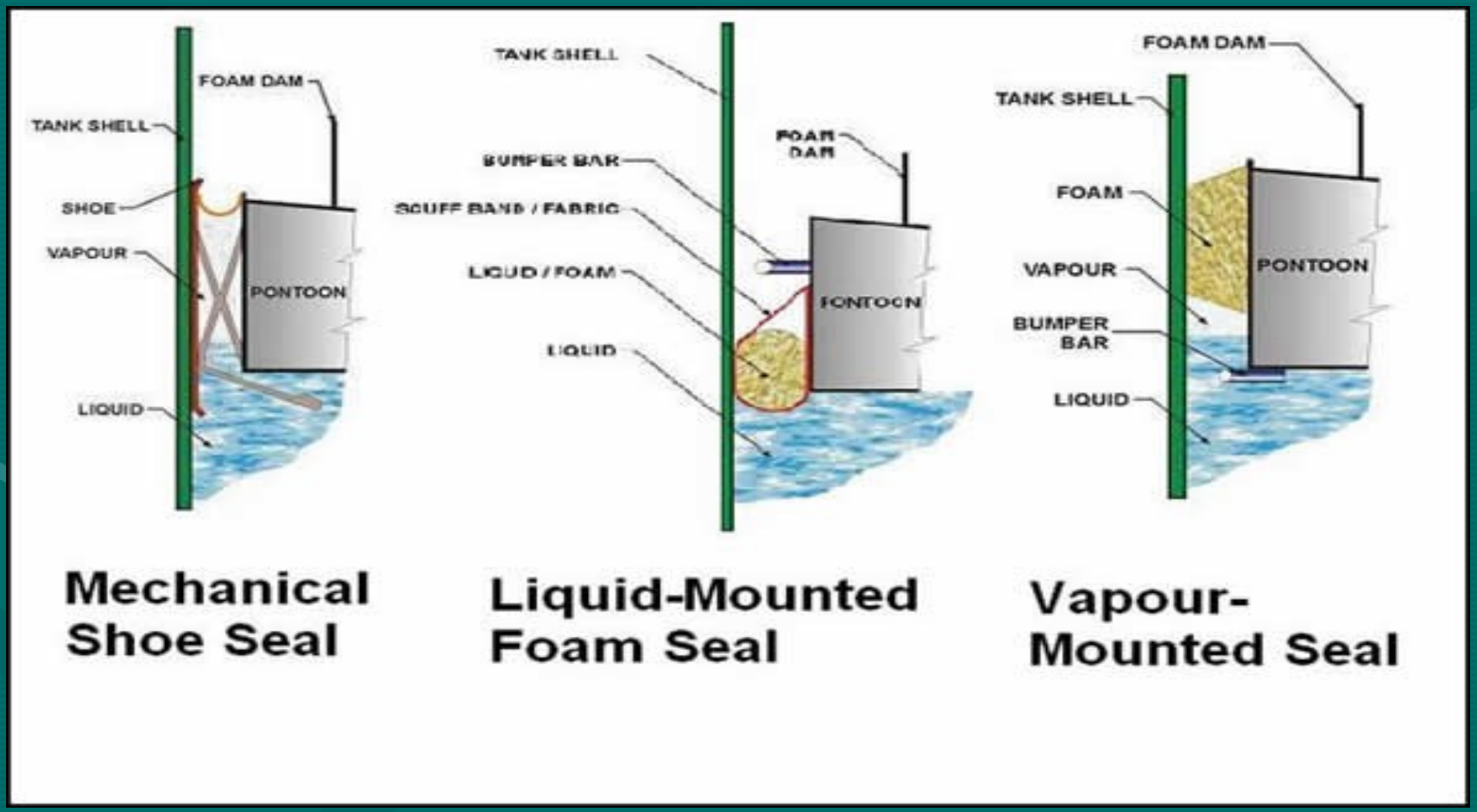
3.11 External floating roof tank

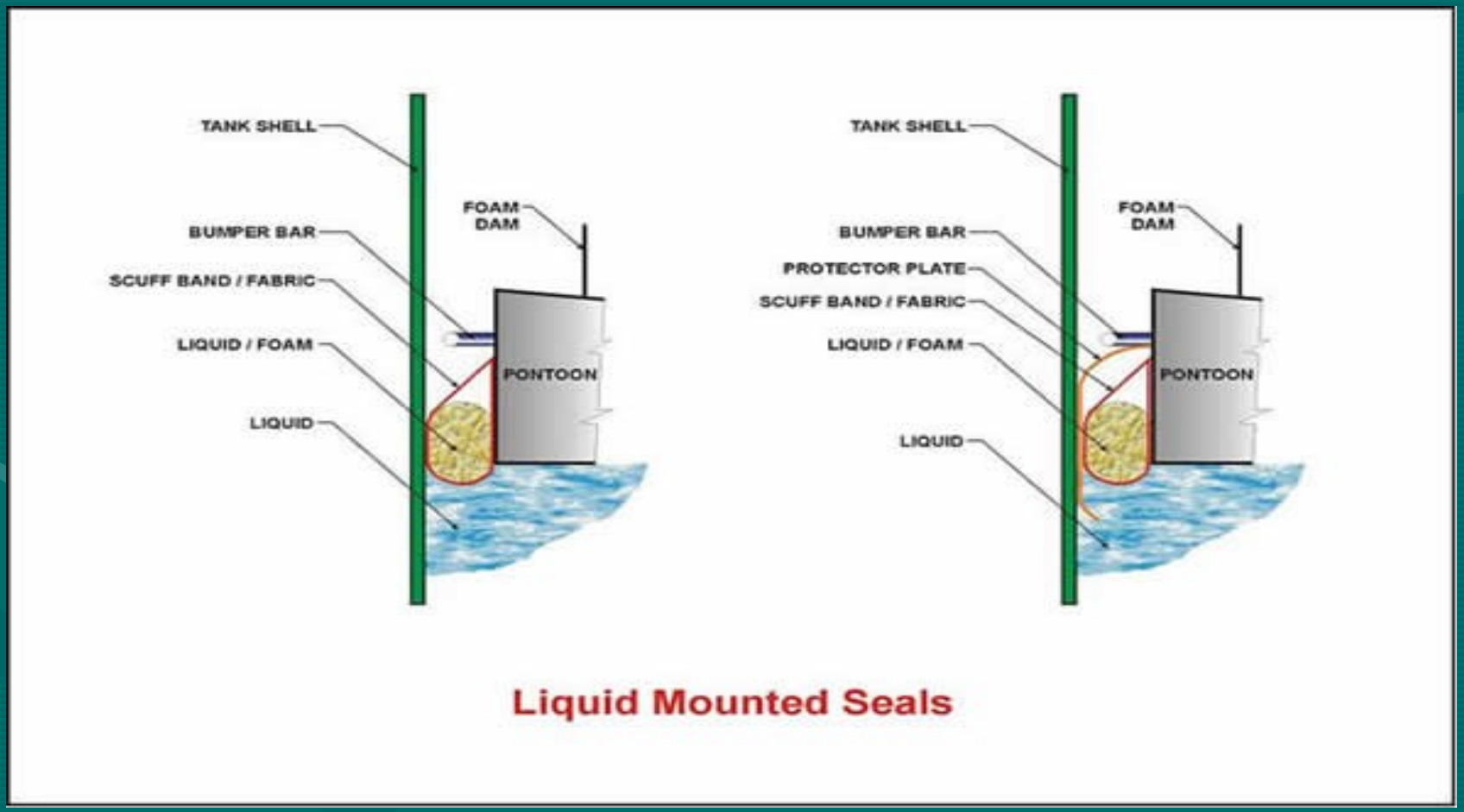
3.11.4 Seals/ Types



STORAGE TANKS – Basic Training

3.11 External floating roof tank

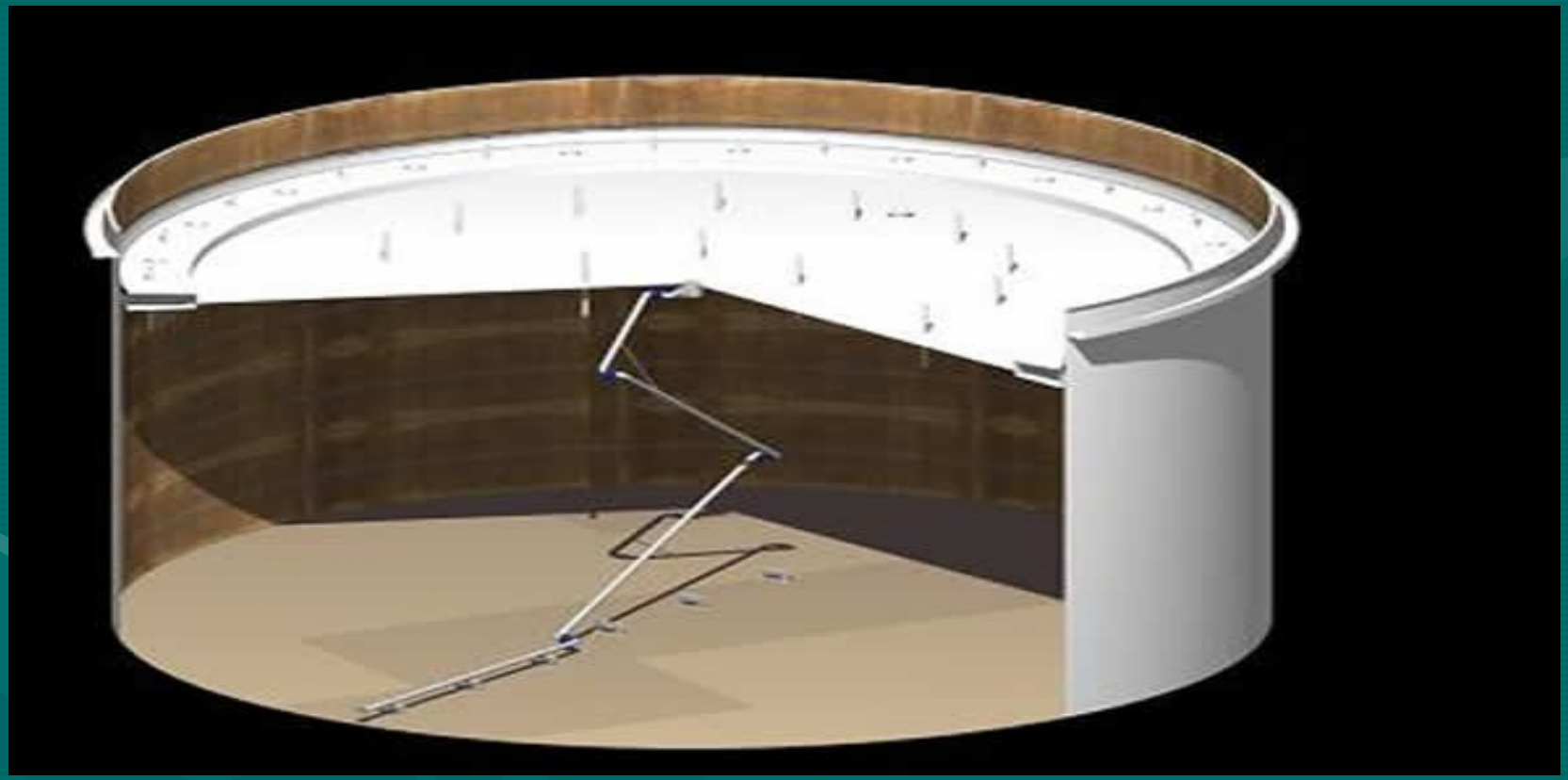
3.11.4 Seals/ Types



STORAGE TANKS – Basic Training

3.11 External floating roof tank

3.11.5 Drains > Roof drain



We could select the most suitable floating roof drains type and size (capacity), also on the application of the roof sump with the non return valve and with the types of discharge drain valves at the tank shell. Emergency type drains for double deck and single deck roof structures are part of the engineering package.

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3.11 External floating roof tank

3.11.6 Foam Dams

> Foam dams collect debris and therefore retain water causing excessive corrosion of dam/ deck joint, roof annulars and seal connections. The dam drain holes should always unplugged.`

STORAGE TANKS- Basic Training

4.0 Tank Fittings

4.1 Operational Fittings for vertical Tanks

Standard range of fittings and accessories

Tanks shall be provided with the standard range of fittings and accessories. Optional fittings shall be supplied only when specified by the owner.

4.1.1 Breather valves *(pic)* and free vents

The number and sizes of breather valves and free vents required should be specified separately due to large variations is pumping rates, etc.

When deciding on the number of free vents required, their capacity shall be taken into account.

Note: If the storage capacity of an existing tank is increased by fitting additional courses of shell plates, the venting capacity of the enlarged tank shall be checked, and increase if necessary.

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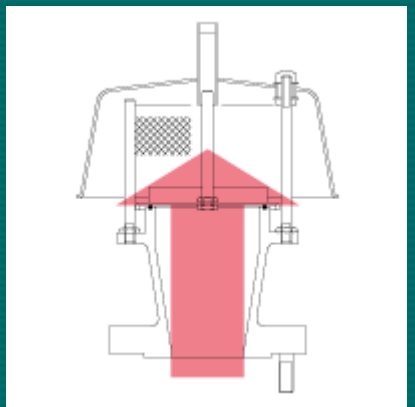
(WBBA - End Line Type)

(WBBA - In Line Type)

Tank Breather valves

- These are special types of relief valves which are specifically designed for tank protection.
- This valve only allows pressure to relief to atmosphere.
- Breather valves are used extensively on bulk storage tank to minimize evaporation losses.
- It prevents the excessive pressure which can unbalance or damage the tank.



4.1 Operational Fittings for vertical Tanks *(cont)*

4.1.3 Required venting capacity

The venting requirements shall include the following conditions:

- Inbreathing resulting from a maximum outflow from the tank
- Inbreathing resulting from contraction of vapors caused by a maximum decrease in atmospheric temperature
- Outbreathing resulting from a maximum inflow of product into the tank and maximum evaporation caused by such inflow
- Outbreathing resulting from expansion and evaporation due to a maximum in atmospheric temperature (thermal breathing)
- Outbreathing resulting from the fire exposure

Note: Both cone and dome shaped fixed roof tanks shall be designed to fail at the roof-to-shell connection when subjected to an internal explosion or sudden increase in pressure.

4.1 Operational Fittings for vertical Tanks *(cont)*

4.1.4 Thermal venting

Special attention is required to the influence of a sudden drop in temperature (e.g. due to rainfall) on the venting requirements of tanks containing warm product and for tanks in tropical areas.

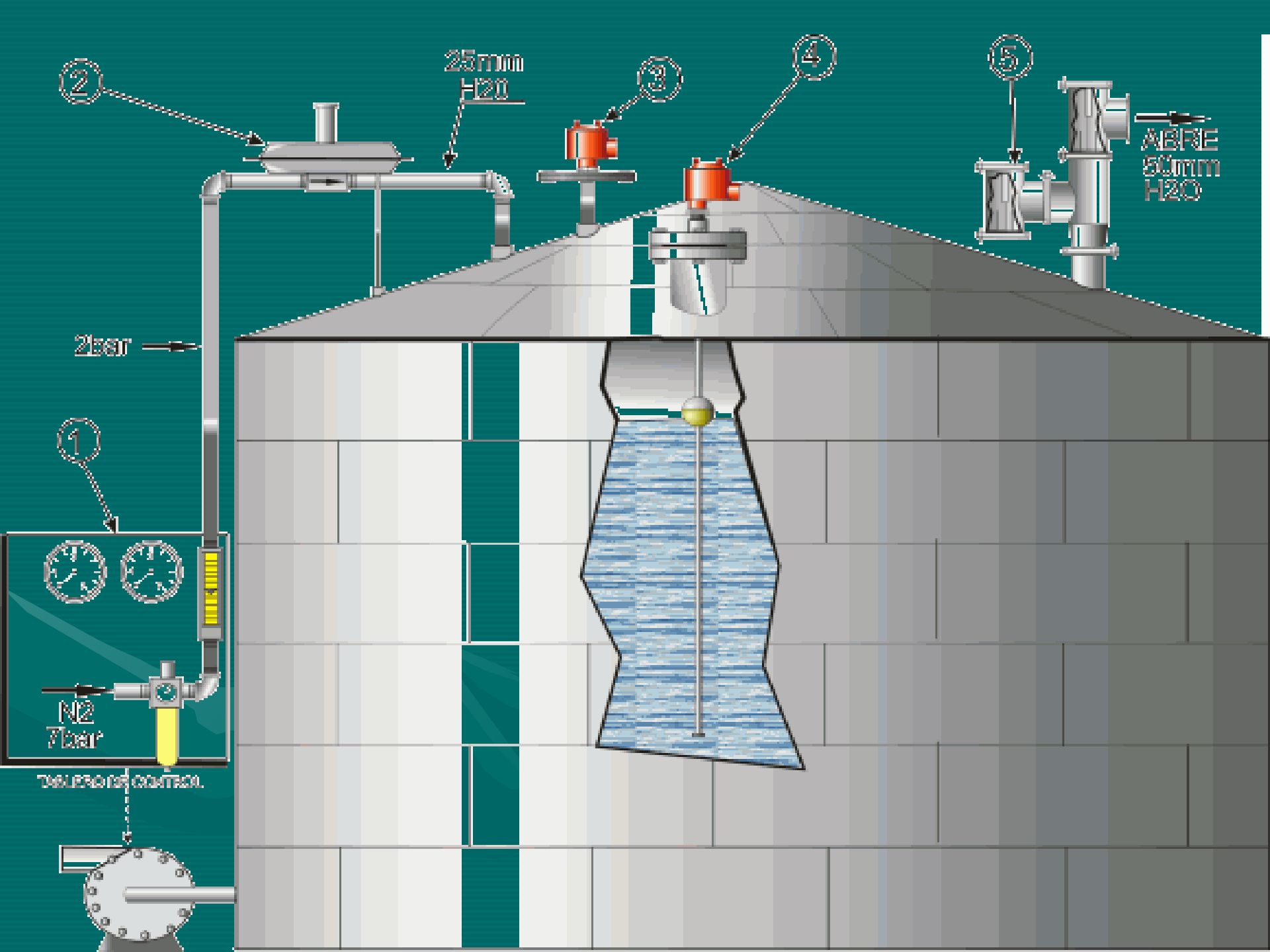
A drop of 20 oC or more in 15 minutes may be experienced. Where these conditions apply the venting shall be increased by at least 20% of the thermal venting capacity requirements.

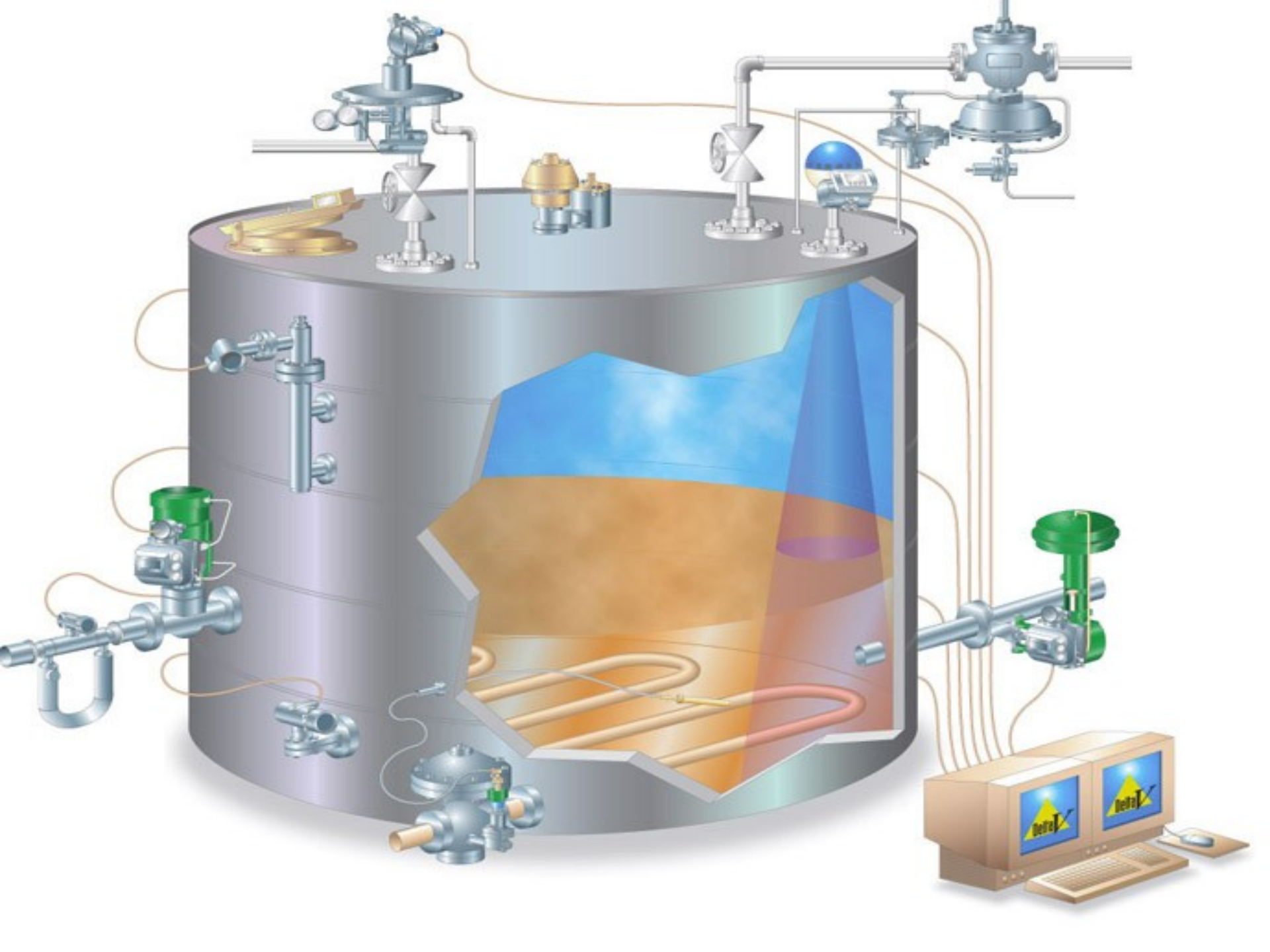
Tank N_2 blanketing/Inerting

- N2 Blanketing System is a insert gas control system to maintain the positive(+) interior pressure of vessel.

Objectives:

- It removes the explosive factor by controlling hazardous gas such as oxygen from the vapor space of tank
- It prevents the damage of product by blocking the inflow of useless moisture and gas.
- It protects the tank from explosion by restricting spark.


2
25mm
H20
3
4
5
ABRE
50mm
H20
2bar
1
N2
7bar


DeltaV
DeltaV

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4.2 Fittings Common to All Vertical Tanks

4.2.1 Stairways, handrails, etc.

Vertical tanks should be provided with spiral stairways. An exception may be made for groups of tanks of less than 12.5 m diameter sited close together and connected by walkways at roof level. In such groups, two tanks at opposite ends of each group shall be provided with stairways, so that each tank in that group will then have at least two escape routes from the roof.

Handrails shall be provided at the edge of the roof for full circumference of all fixed roof tanks and to the centre of the roof on all tanks exceeding 12.5 m diameter. Handrails shall be provided on the outside of all spiral stairways. For open top tanks, the inside of the staircases shall also be provided with a handrail in the immediate vicinity of the top landing.

Caution: Always have one hand free to hold the railing while using the tank stairways.

STORAGE TANKS- Basic Training

4.2 Fittings Common to All Vertical Tanks

4.2.1 Stairways, handrails, etc. *(cont)*

Handrails shall be provided on both sides of all walkways between tanks.

Note: The Owner shall specify on the requisition if it is required that all stairways and walkways are to be provided with galvanized, open grating (25 mm deep with main bearing strips of 5 mm thickness).

Stairways shall be provided with the specified lighting facilities.

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4.2.2 Roof nozzles for breather valves, free vents, dip hatch and slot dipping devices

> Fixed roof tanks shall be fitted with roof nozzles suitable for cone or dome roofs, to enable these fittings to be mounted vertically and to provide clearance when roof insulation is fitted.

4.2.3 Manholes

> Fixed roof tanks are usually equipped with the following manholes:

- Screws-down, gas tight hinged-cover roof manholes
- Bolted-cover shell manholes
- Sliding/tight fitting cover for pontoon manholes in floating roof tanks

STORAGE TANKS – Basic Training

4.2 Fittings Common to All Vertical Tanks

4.2.4 Shell nozzles for inlet and outlet

The sizes of shell inlet and outlet nozzles shall be specified by the Owner. Bottom outlets may be installed only in hard foundation (e.g. rock) where soil settlement are considered negligible.

4.2.5 Drainage arrangement – water draw (centre drains or side drains)

In operation, tank bottoms should normally slope down towards the centre and be fitted with centre sumps;

> large tanks (>50 m diameter) may also be provided with additional side drain sumps, the nozzles of which may be blinded off after the water test.

However, for products with temperature exceeding 100 oC, the tank bottom slope up towards the centre in order to prevent corrosion caused by rain water penetrating under the bottom.

STORAGE TANKS - Basic Training

4.2 Fittings Common to All Vertical Tanks

4.2.6 Water spray system

If specified by the Owner, a water spray system shall be supplied.

4.2.7 Foam connection

If specified by the Owner, floating roof tanks shall be equipped with a foam system.

Floating roof tanks shall be provided with a foam dam.

If specified by the Owner, fixed roof tanks shall be equipped with a semi-fixed subsurface type or semi-fixed top pourer type foam extinguishing system.

4.2.8 Fire protection for floating roof tanks *(sketches below)*

If specified by the Owner, a detection system shall be installed.

STORAGE TANKS – Basic Training

4.2. Fittings Common to All Vertical Tanks

4.2.9 Earth ing/ **Lightning Arrestors**

All tanks shall be fitted with earthing bosses and lightening arrestors

STORAGE TANKS – Basic Training

4.2. Fittings Common to All Vertical Tanks

4.2.9 Earth ing/ Lightning Arrestors

All tanks shall be fitted with earthing bosses and lightening arrestors

4.2.10 Liquid level indicators

Liquid indicators or automatic liquid-level gauges shall be fitted to all tanks.

The construction of the gauge poles depends on the operational conditions and the required measurement accuracy of the level gauges.

4.2.11 Dip plate or datum plate

A 6 mm thick dip plate shall be provided for welding to the tank bottom or lowest shell course directly under the dip fittings (i.e. dip hatch, slot dipping devices and combined vent and dip hatches).

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4.3 Additional fittings for fixed roof tanks

4.3.3 Level alarms/ indication system

At least two independent level alarm systems shall be provided:

- Low, high and high/high level alarms (ATG)
- Independent high level alarm

The Hi/Hi level shall be set such that the maximum filling height is limited to 200 mm below the top of the shell.

STORAGE TANKS – Basic Training

4.3 Additional fittings for fixed roof tanks

4.3.3 Level alarms/ indication system (Examples)

	Low Low Level	Low Level	High Level	High-High Level	Independent High Level
	mm	mm	mm	mm	mm
T-7101	1,650	1,800	14,000	14,200	14,300
T-7102	1,650	1,800	14,000	14,200	14,300
T-7103	1,650	1,800	14,000	14,200	14,300
T-7104	1,650	1,800	14,000	14,200	14,300
T-7105	1,650	1,800	14,000	14,200	14,300
T-7106	1,650	1,800	14,000	14,200	14,300
T-7107	1,650	1,800	14,000	14,200	14,300
T-7108	1,650	1,800	14,000	14,200	14,300

	Low Low Level	Low Level	High Level	High-High Level	Independent High Level
	mm	mm	mm	mm	mm
T-7301	1,700	1,800	**17,370**	18,200	18,338
T-7302	1,700	1,800	**17,370**	18,200	18,338
T-7303	1,700	1,800	**17,370**	18,200	18,338
T-7304	1,700	1,800	**17,370**	18,200	18,338
T-7305	1,650	1,800	16,600	17,400	17,536
T-7306	1,650	1,800	16,600	17,400	17,536
T-7307	1,650	1,800	14,200	14,900	15,008
T-7308	1,650	1,800	14,200	14,900	15,008
T-7309	1,650	1,800	17,300	18,200	18,250
T-7310	1,650	1,800	17,300	18,200	18,250
T-7311	640	1,000	16,600	17,400	17,566
T-7312	640	1,000	16,600	17,400	17,566
T-7313	530	1,000	13,300	14,000	14,108
T-7314	530	1,000	13,300	14,000	14,108
T-7315	1,650	1,800	12,900	13,600	13,650
T-7316	1,650	1,800	12,900	13,600	13,650

4.3 Additional fittings for fixed roof tanks

4.3.4 Level alarms/ indication system *(cont)*

Tanks with an internal floating cover (IFC):

- The Hi/Hi level shall be set such that at least 200 mm clearance remains between any moving part of the IFC and any obstruction fixed to the shell, including the roof supporting structure.
- The low level alarm shall be set such that the IFC still remains floating with its supports at least 100 mm above the tank bottom.

STORAGE TANKS – Basic Training

4.4 Additional fittings for fixed roof tanks

4.4.1 Dip hatches

Tank shall be supplied with one dip hatch, unless additional hatches are specified.

(Guage Hatch)

(Emergecy Vent & Hatch Cover)

STORAGE TANKS - Basic Training

4.4 Additional fittings for fixed roof tanks

4.4.3 Heating coils

If specified, heating coils shall be fitted to tanks when products are required to be maintained at above-ambient temperatures to facilitate pumping (e.g. on lubricating oil, bitumen and sulfur storage tanks).

4.4.4 Suction heaters

If specified, suction heaters shall be provided for tanks fitted with coils when additional localized heat is required at the outlet connection. These heaters are usually of the nested tube type, and are suitable for steam or heat transfer fluid systems.

4.4.5 Angle ring for tank roof insulation

When tank roofs are to be insulated an additional circumferential angle ring and various small fittings shall be provided to retain the insulation material, which is terminated below the top curb angle.

4.4 Additional fittings for fixed roof tanks

4.2.6 Side-entry mixers

Side-entry mixers may be required to improve mixing of the product or to reduce the formation of sludge. If side-entry mixers are to be installed, the required shell connections shall be specified. Side-entry mixers shall be placed on manholes-type shell nozzles to allow easy removal for maintenance without entering the tank.

4.2.7 Sample connections and thermo-indicators

If specified, sample connections and thermo-indicators shall be provided adjacent to the spiral stairway. Such connections shall be flanged.

STORAGE TANKS – Basic Training

4.5 Special fittings and accessories for floating roof

4.5.1 Primary roof seals

The circumferential primary roof seal may comprise metallic shoes having flexible seals with a weight or spring-operated pusher mechanism, or be a compression plate type seal, or a fabric foam filled seal.

- *the lower part of the metallic shoe shall be submerged in the product;*
- *compression plate types shall be provided with a continuous weighted skirt which is partly submerged in the product.*
- *foam filled envelope seal shall be of the liquid mounted type.*

Rim mounted secondary roof seals shall be used in all primary roof seal systems. Both primary and secondary seals shall have a minimum inward and outward flexibility of 125 mm.

STORAGE TANKS – Basic Training

4.5 Special fittings and accessories for floating roof

4.5.2 Fittings

All floating roof shall be equipped with a complete set of accessories required for the proper functioning of the floating roof.

> Support legs

Adjustable supporting legs are provided on which the roof rests in its lowest position during operation and in its highest position during maintenance operations.

Pad plates shall be located on the bottom for each supporting leg.

STORAGE TANKS – Basic Training

4.5 Special fittings and accessories for floating roof

4.5.3 Fittings *(cont)*

> Roof drains

Floating roofs shall be fitted with roof drains. Roof drains could be articulated pipe and coflexip hose. A check valve shall be provided near the roof end of the articulated pipe or hose, to prevent backflow of stored product onto the roof in case of leakage in the pipe joints or hose/ hose fittings.

Depending on the size of the tank and amount of rainfall, two or more roof drains should be installed.

STORAGE TANKS – Basic Training

4.5 Special fittings and accessories for floating roof

4.5.3 Fittings *(cont)*

> Access ladder to the roof

The access ladder to the roof shall be equipped with self-leveling stair treads. The rails shall be placed at such a height above the centre deck that rain water on the deck cannot affect movement of the ladder. The ladder shall be provided with an anti-derailing device to prevent uplift of the ladder during strong winds.

> Earthing

In addition to the earthing bosses on the tank shell, electrical earthing facilities (spring stainless steel shunts) shall be fitted for the earthing of the floating roof across the rim space at a maximum interval of 2.5 meter. Their sliding contact with the shell, shall be in the open air above the secondary seal. An earthing cable be along the access ladder to the roof.

4.5 Special fittings and accessories for floating roof

4.5.3 Fittings *(cont)*

> Automatic bleeder vents

Automatic bleeder vents shall be provided to vent the air from under the floating roof when the tank is being filled initially. They shall also open automatically just before the roof lands on its supports, thereby preventing the development of a vacuum under the roof. The capacity of the vents shall be based on the maximum pumping rates.

> Rim vents for metallic shoe type seals

Rim vent shall be provided to prevent any excess pressure in the rim space, as this might press the shoe ring too tightly against the tank shell. Settling shall be plus and minus 2.5 mbar.

4.5 Special fittings and accessories for floating roof

4.5.3 Fittings *(cont)*

> Guide and level pole

All floating roof tanks shall be equipped with a guide pole or combined guide and level gauge pole.

> Shell fittings

The shell fittings are identical to those supplied for fix roof tanks. However, the main inlet shall be provided with an extension pipe to direct the product towards the centre of the tank. The nominal length inside the tank shell be D/4 (where D is the tank diameter) but shall not exceed 10 meters.

Insulated Tank for Fuel Oil Storage

LPG SPHERES

- The spheres are very strong structures.
- The even distribution of stresses internally & externally makes sure that there are no weal points.
- They have small surface area per unit volume than cylindrical tanks due to which less heat transfers from surroundings and hence less pressurization due to heat.

- LPG tanks. jpg

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Tank Dyke wall

This is a wall always built around bulk storage tanks for following purposes :

- To prevent spreading of oil if tank is leaked
- To prevent Flood water to become close to tank which can destroy the tank foundation

STORAGE TANKS – Basic Training

5.0 Tank Inspection

5.1 Inspection Frequencies

5.1.1 General

> It is important for the inspection of tank to be based upon a long term program particularly where plant operator is dealing with extensive tank farm installation involving numerous tanks in a variety of service.

> If deferred for long then there is a risk of tank deteriorating and developing defects which could lead to major leakage, fires and pollution incidents.

> In-service inspection can give a good indication of integrity and operability. However, there is no substitute in most operations for out-of-service inspection.

STORAGE TANKS – Basic Training

5.0 Tank Inspection

5.1 Inspection Frequencies

5.1.2 External Inspection

> External inspection should take two forms.

Firstly, field operators should check for any abnormal situations during the daily work or during scheduled checks

> Secondly a detailed on-stream inspection should be undertaken by the inspection department

> It is important for inspectors to thoroughly evaluate the results of on-stream inspections to revalidate the scope, extent and frequency of such inspections and to further justify the interval of thorough internal examination.

STORAGE TANKS – Basic Training

5.0 Tank Inspection

5.1 Inspection Frequencies

5.1.3 Internal Inspection

> The tables in the notes provides guidance on the frequency of out-of-service interval inspections. The intervals are based on tanks exhibiting no undue abnormalities or deterioration during operations and on-stream inspections.

> External or internal corrosion, excessive foundation settlement etc., should be thoroughly investigated and the inspection interval reduced accordingly.

Refer to the notes provided on INSPECTION where Inspection checklists are attached.