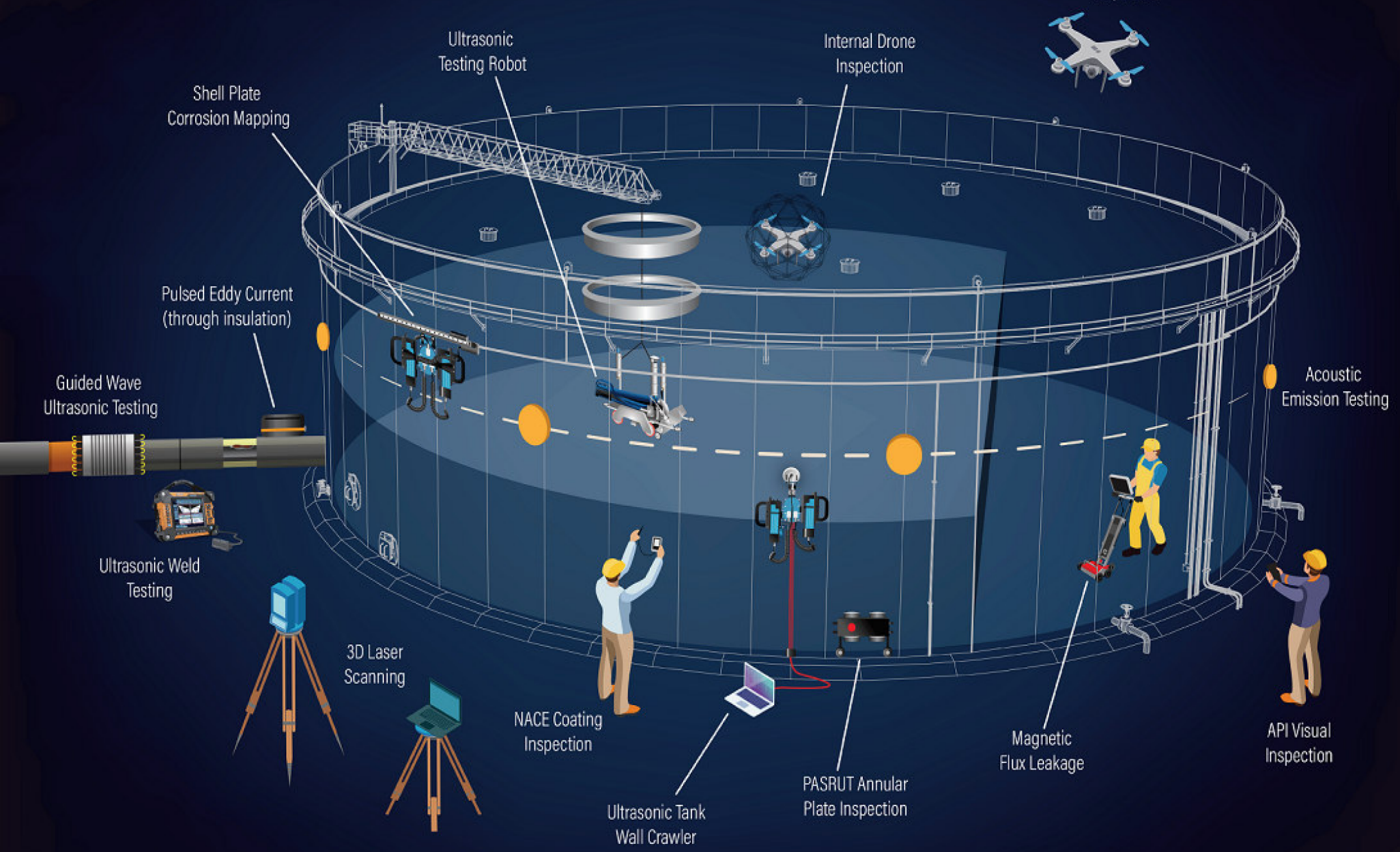
STORAGE TANKS



Prepared by: DSc Dževad Hadžihafizović (DEng)

Sarajevo 2024

Petroleum storage tanks - basic

Content

- The design of the tank.
- Which tank , which product.
- The structure & assembly of the tank.
- Tank inspection
- Measurement
- To identify tank type & tank equipments
- To know the limitation of tank
- Calculation of tank volume
- Safe tank operation

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

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.***

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
- 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.

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.*

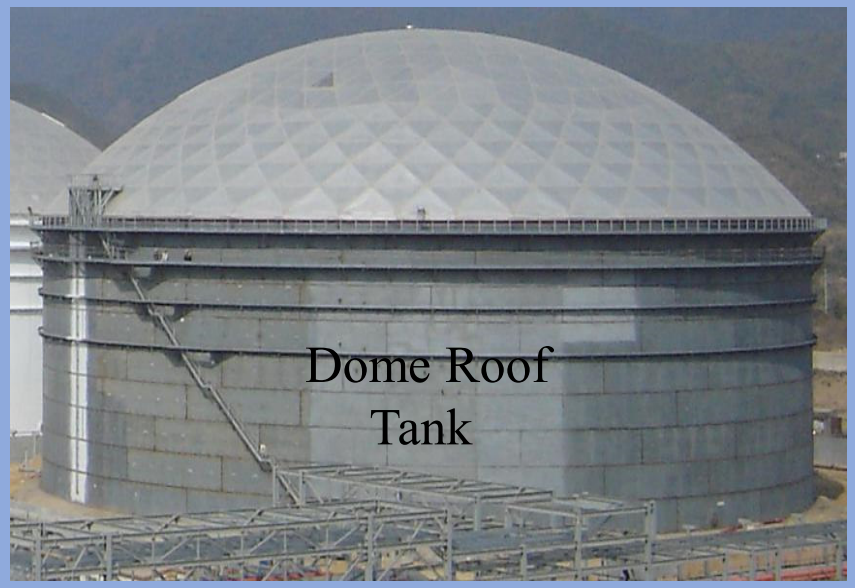
Pressurized storage

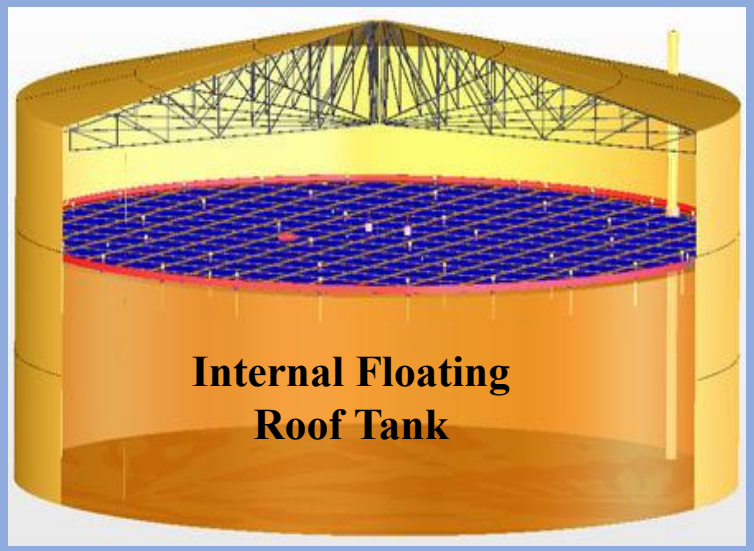
Pressurized storage applies to those vessels (mounded bullets) which are designed to withstand pressure sufficient to keep the liquid stored, from vaporizing. High vapor pressure hydrocarbons such as *propane*, *butane*, *iC5* are the types of products requiring pressurized storage vessels (Mounded Bullets).

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.





Floating
roof tank

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

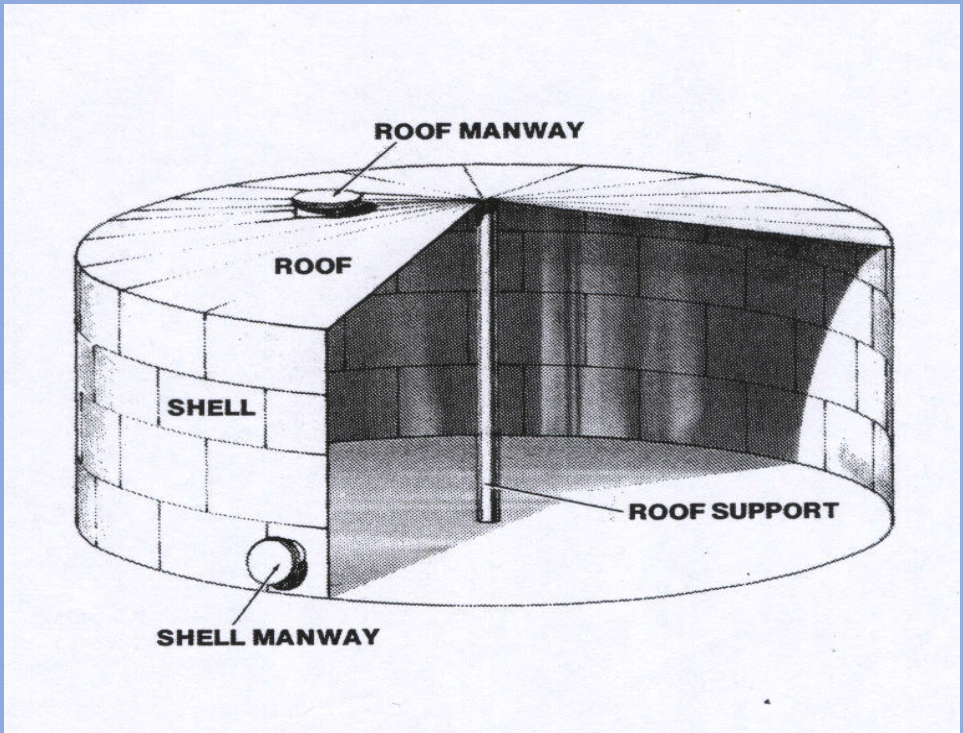
This type of tank has no roof and shall be used for storing city water, fire water and cooling water (All water tanks in PPMSB are with roofs).

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.



Cone roof tank

Dome roof tank

Fixed roof tanks

Fixed roof tanks are well known type of storage tanks, constructed over 100 years ago and provided mostly with self supporting roof structures either cone or dome type roofs. For large diameter fixed roof tanks column supported roof are used, for example in North America. Fixed roof tanks are designed as atmospheric , low , or high pressure tanks and may be used to store hydrocarbons as per product classification as given for example in the IP code.

These recommendations will include the type of tank, measures to obtain the best performance with regarding to emission reduction, use of P/V valves, floating suction, internal floating roofs, cost effective maintenance, etc.

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)

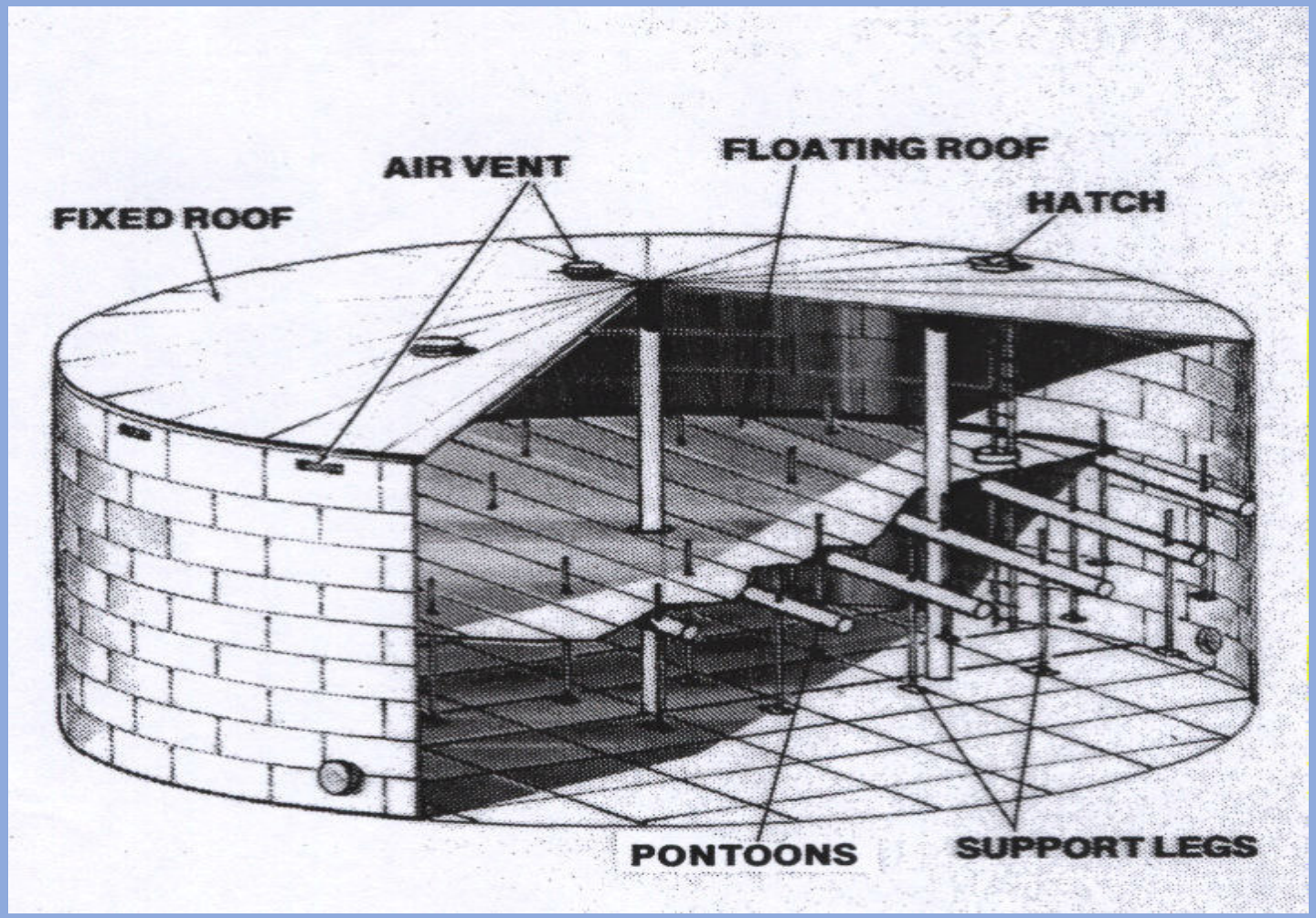
2.1.4 Floating roof tank

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.

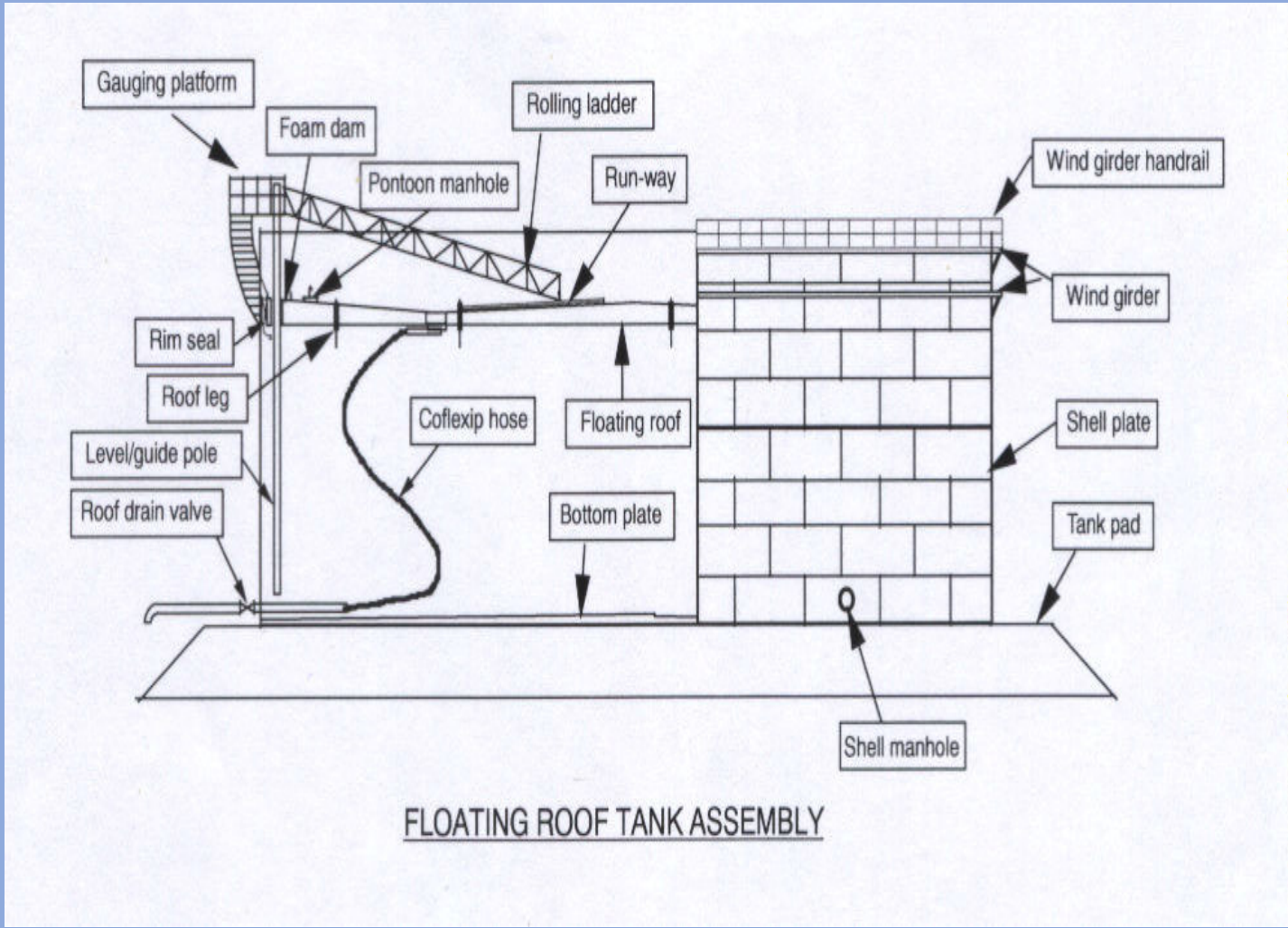
Typical Products stored are: Crude oil, Gasoline and Gasoline components, Solvents……

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.



Internal Floating Roof Tank



Floating Roof Tank

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

2.2.1General

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

Class of product	TANK DIAMETER IN METERS																						
	3	4	6	8	10	12.5	15	17.5	20	22.5	25	27.5	30	33	36	39	42	45	48	54	60	66	72	78
Class 1 Flash point less than 21 ^{0}C	BHC,BLC						BHC BLC BHD BLD BOF			Preferably BOF,BLC,BLD							BOF			BOF				
Class 11 Flash point 21 ^{0}C and higher but less than 55 ^{0}C	BLC						BLC BLD BOF			Preferably BOF,BLC,BLD							BOF (on poor subsoil or other special conditionBNC may be preferred)			BOF				
Class 111 + unclassified Flash point 55 ^{0}C and higher	BNC						BNC BND			BNC BND							BNC			BNC Special cases				

Note: Tanks up to 39 m incl., storing certain class 1 and 11 products, may be connected to a vapor recovery system, or a fixed roof with floating cover may be used (especially as an alternative to the BOF type) where rain water penetrating between shell and seal may have an adverse effect on the quality of the product stored).

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.

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.

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*

2.4.2 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.

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*

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*

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

2.4.3 Tank foundations for leak detection

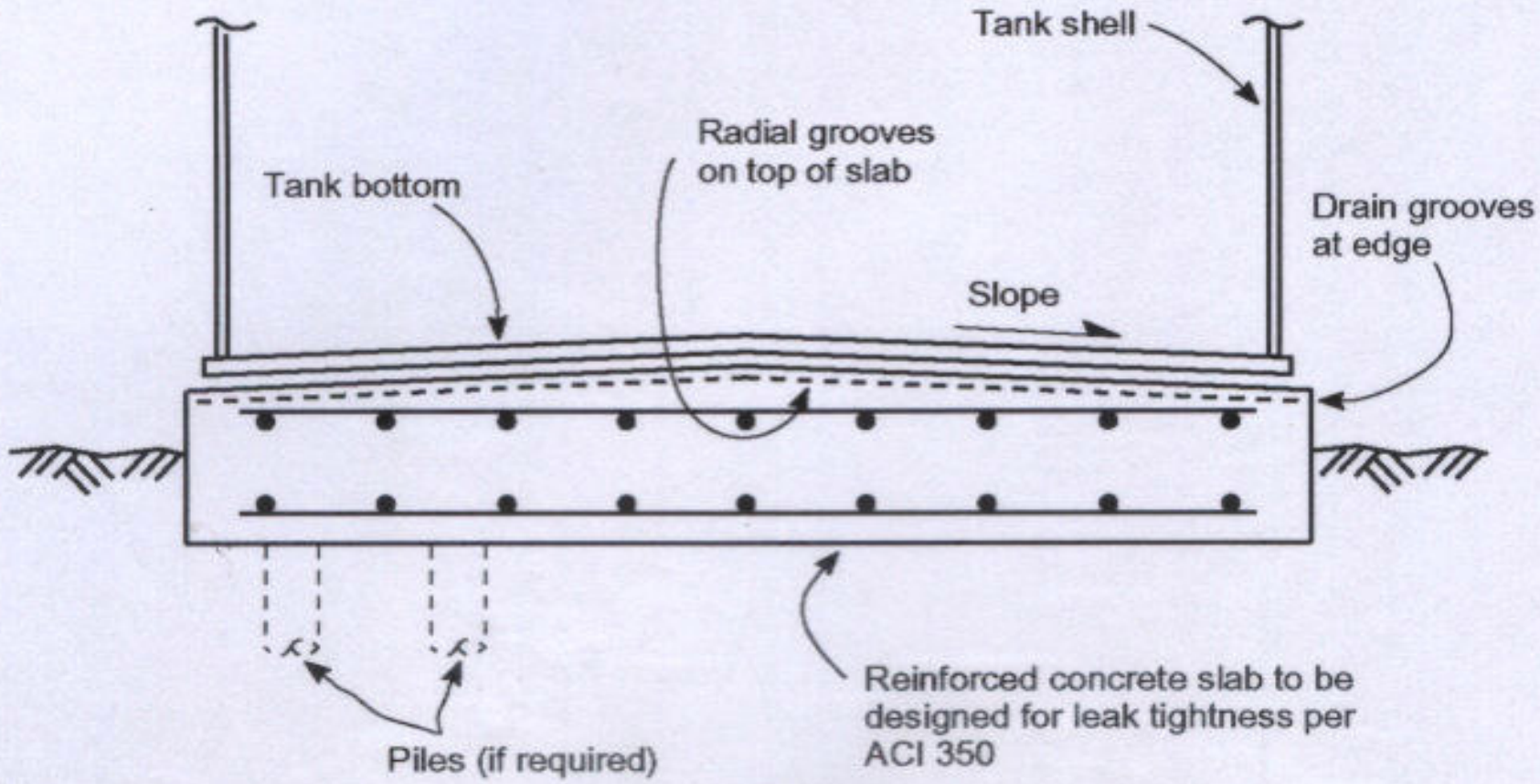


Figure I-7—Reinforced Concrete Slab with Radial Grooves for Leak Detection (Typical Arrangement)

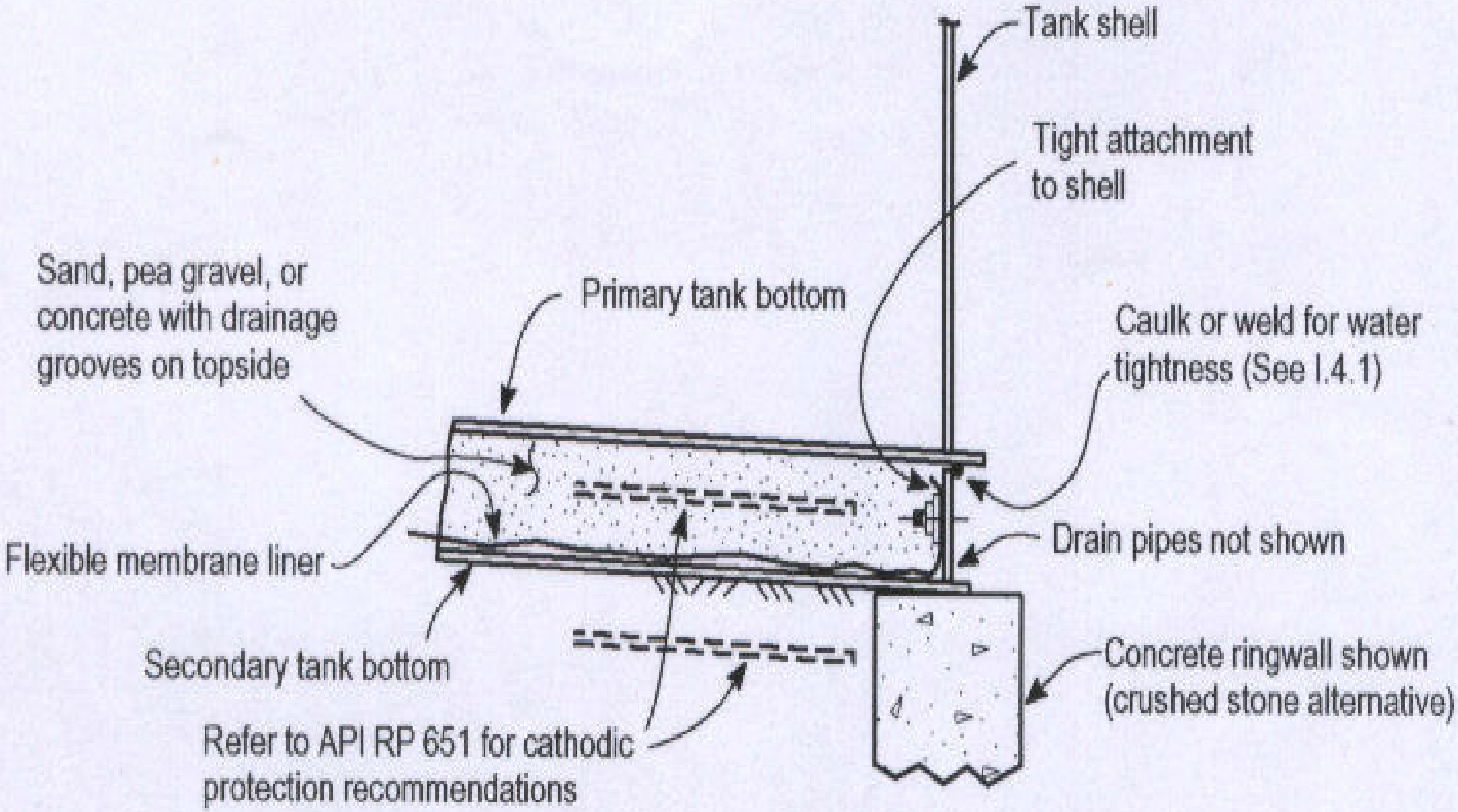


Figure I-4—Double Steel Bottom with Leak Detection at the Tank Perimeter (Typical Arrangement)

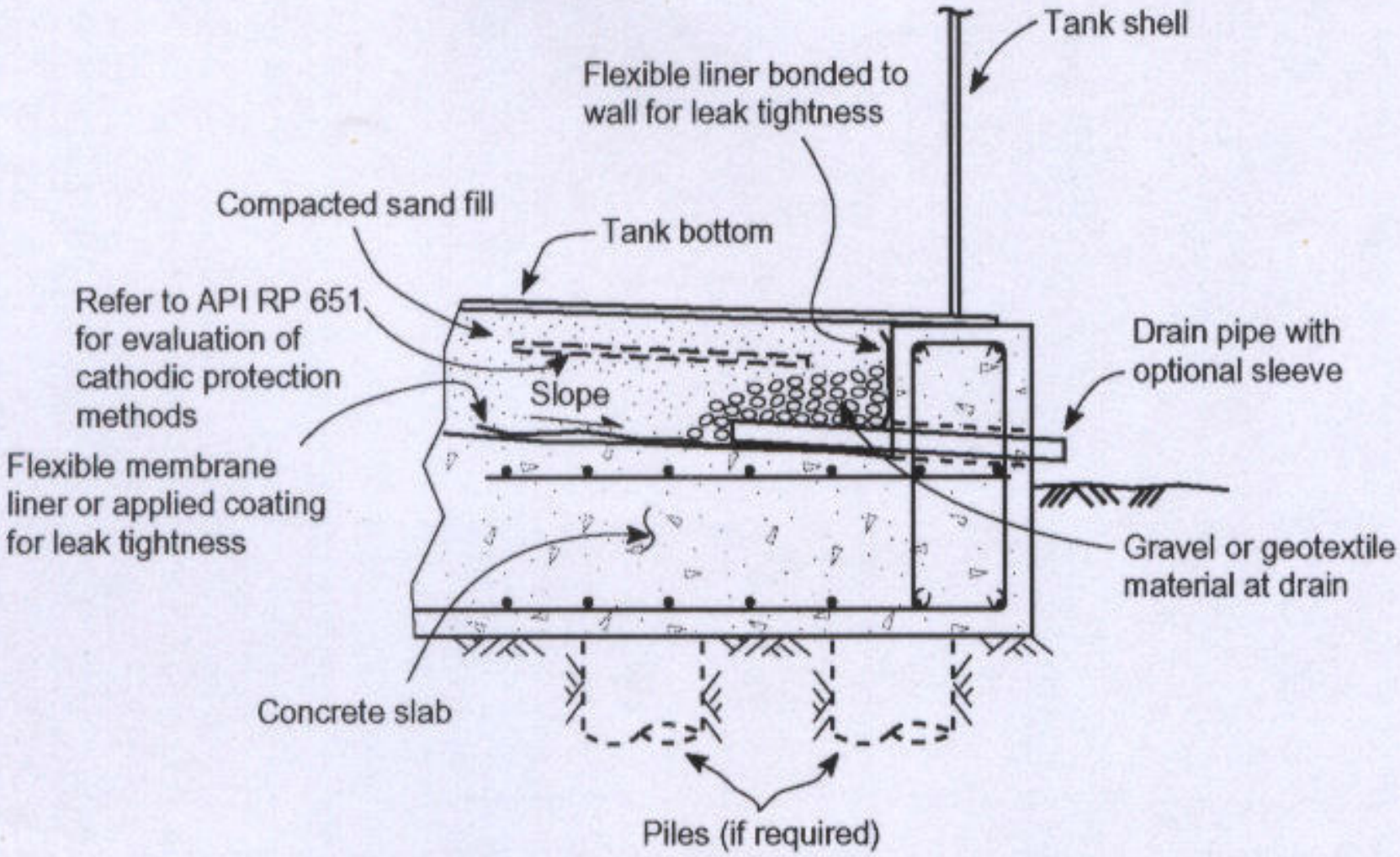


Figure I-6—Reinforced Concrete Slab with Leak Detection at the Perimeter (Typical Arrangement)

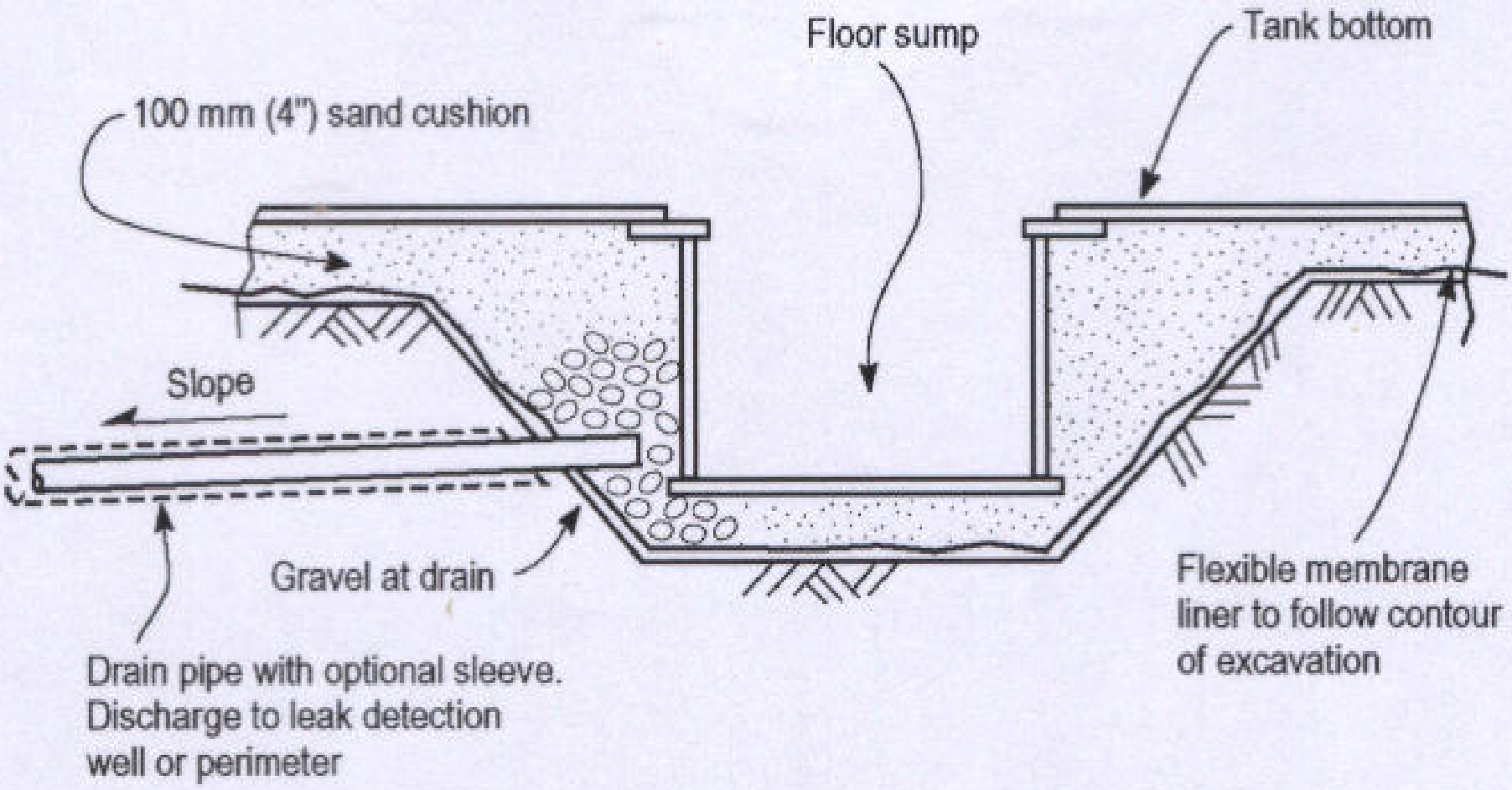


Figure I-8—Typical Drawoff Sump

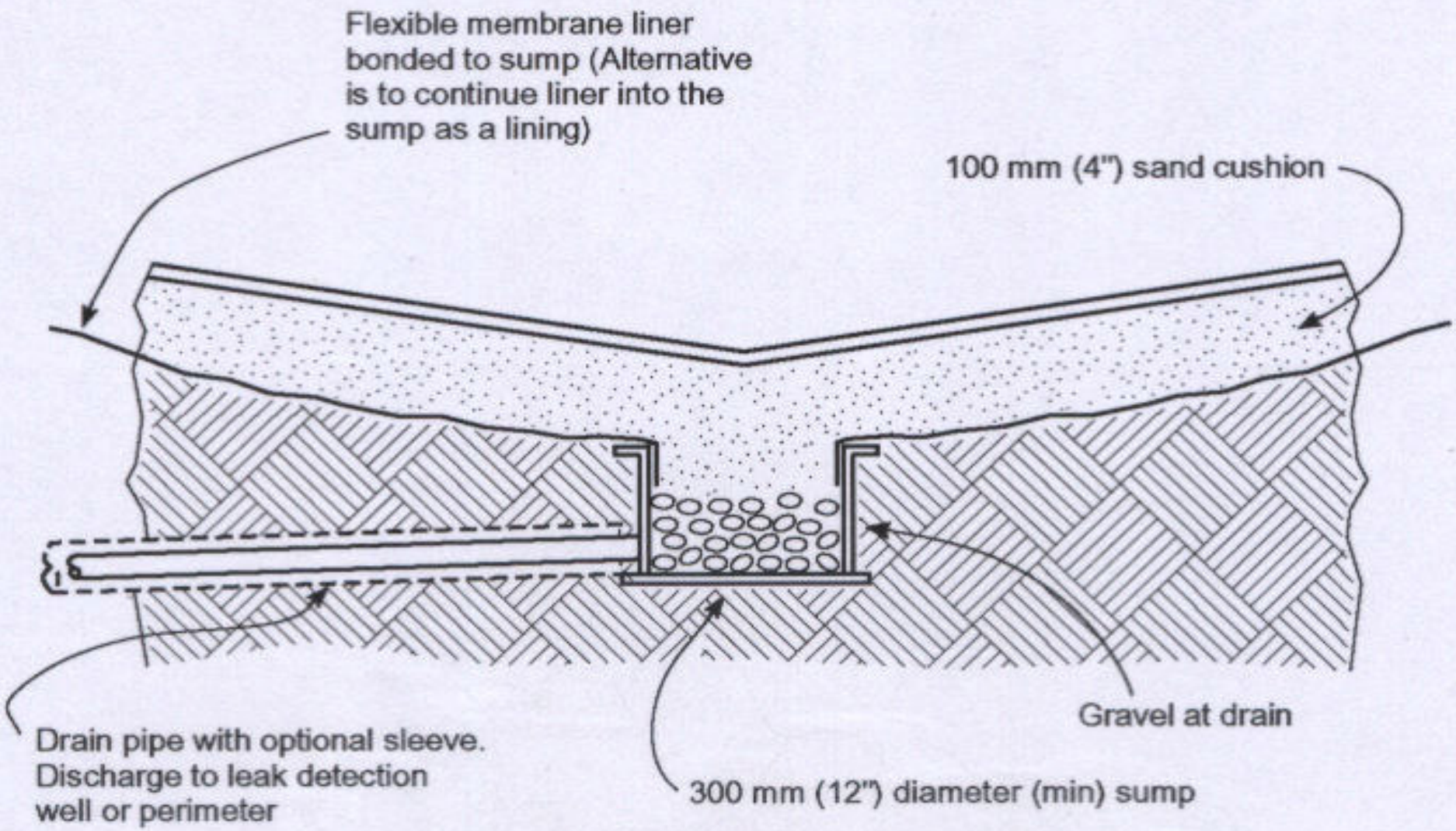
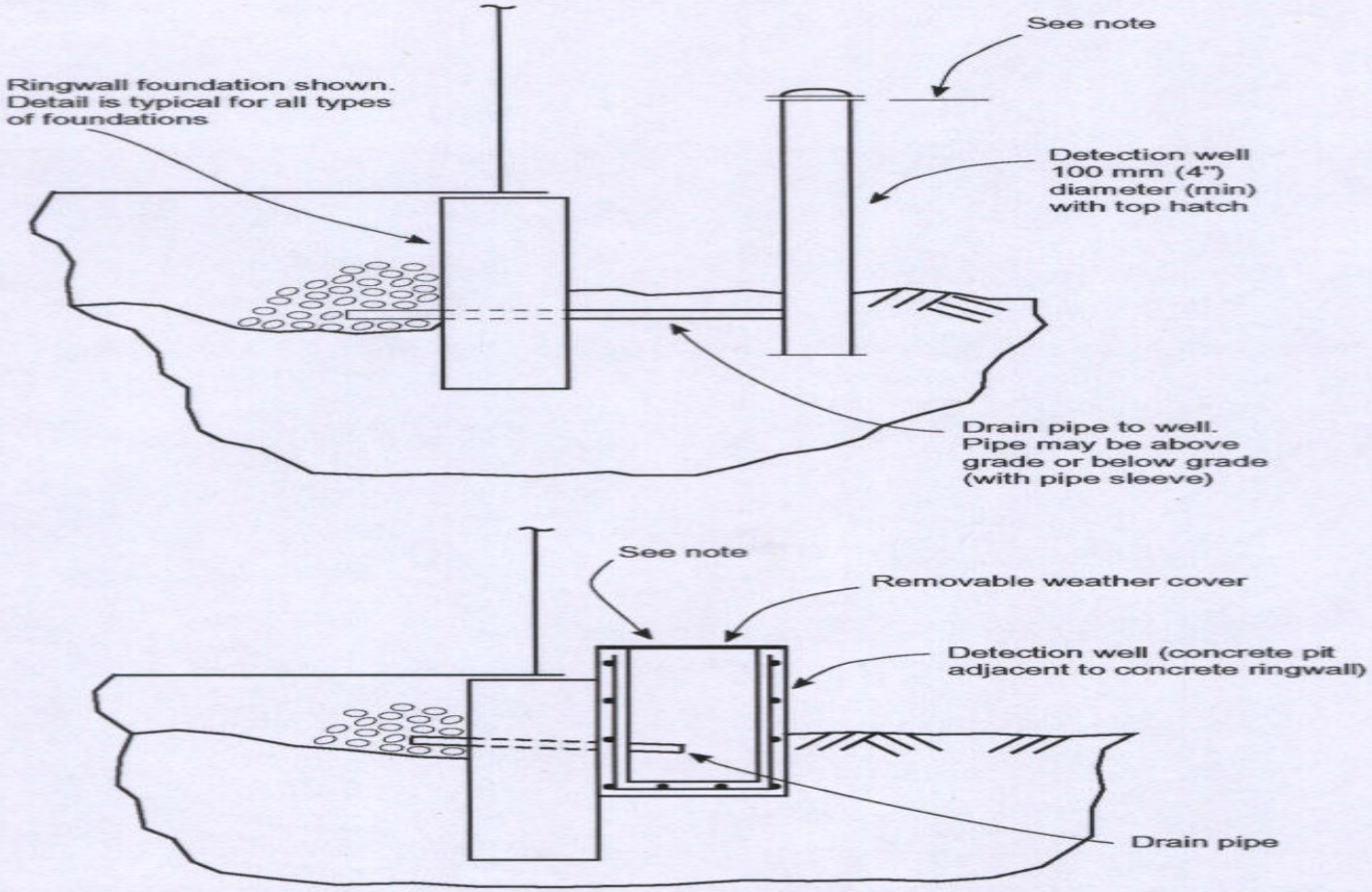


Figure I-9—Center Sump for Downward-Sloped Bottom



Note: Top of well shall be above maximum high water level within dike.

Figure I-10—Typical Leak Detection Wells

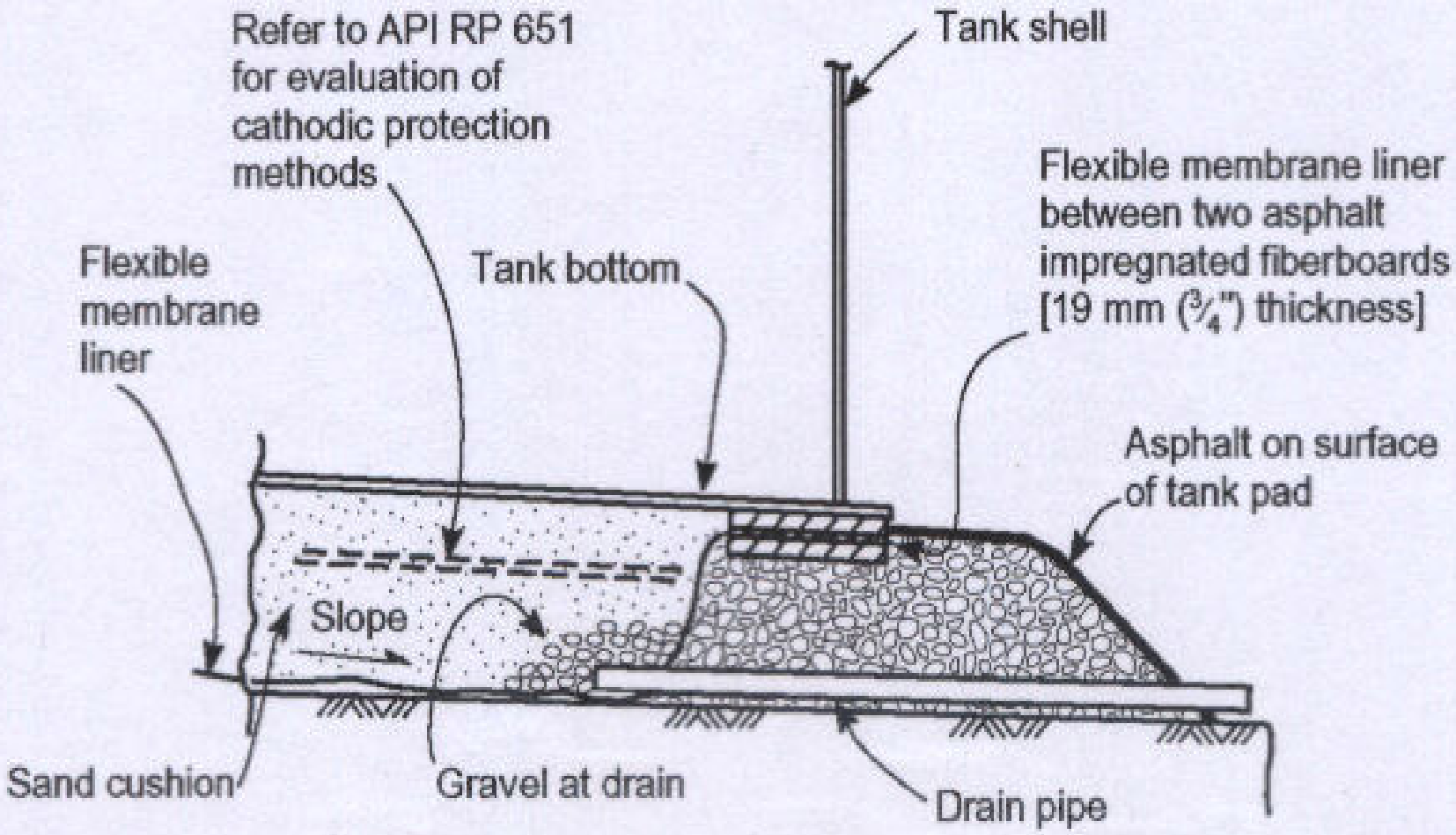


Figure I-3—Earthen Foundation with Undertank Leak Detection at the Tank Perimeter (Typical Arrangement)

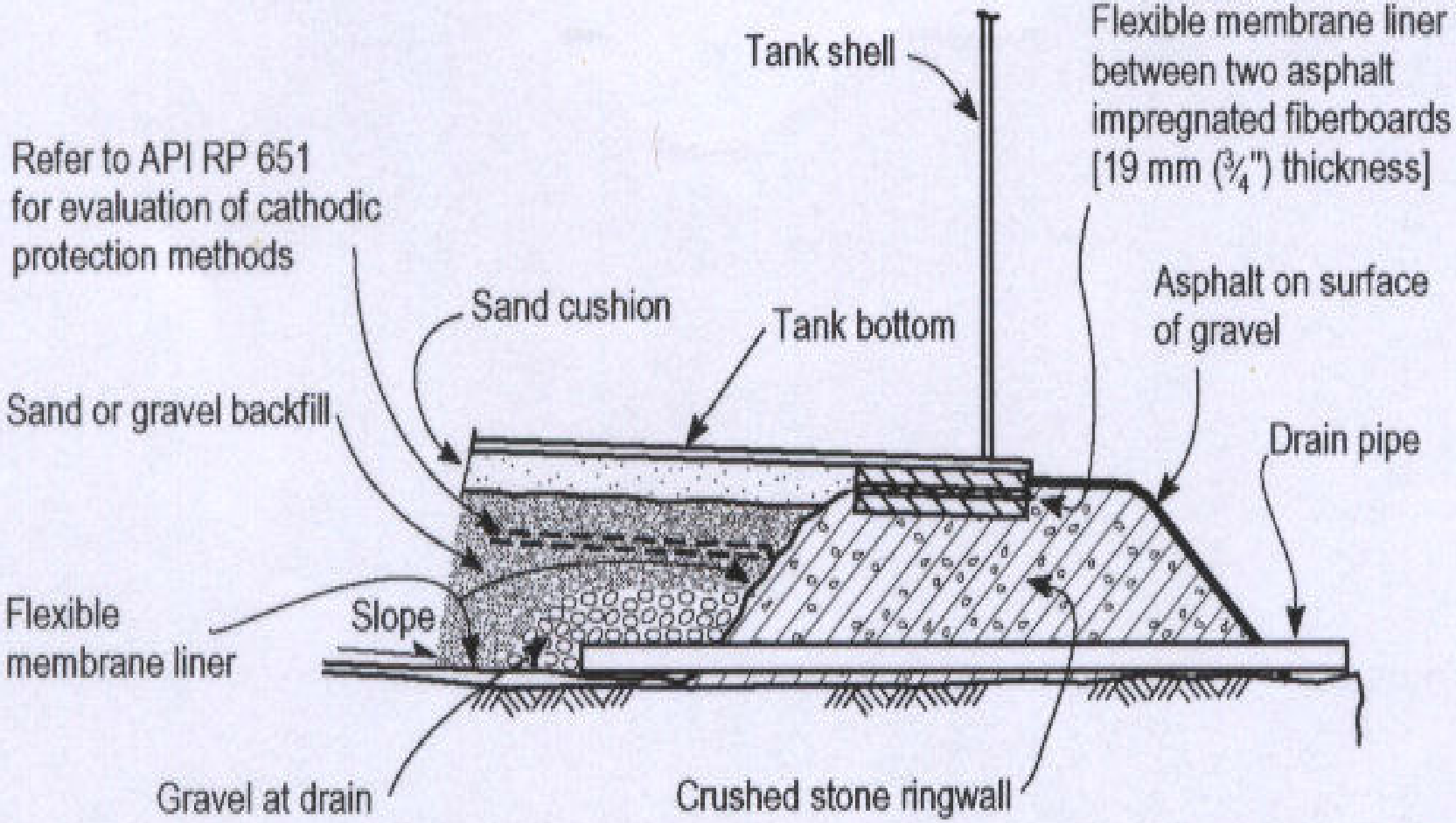


Figure I-2—Crushed Stone Ringwall with Undertank Leak Detection at the Tank Perimeter (Typical Arrangement)

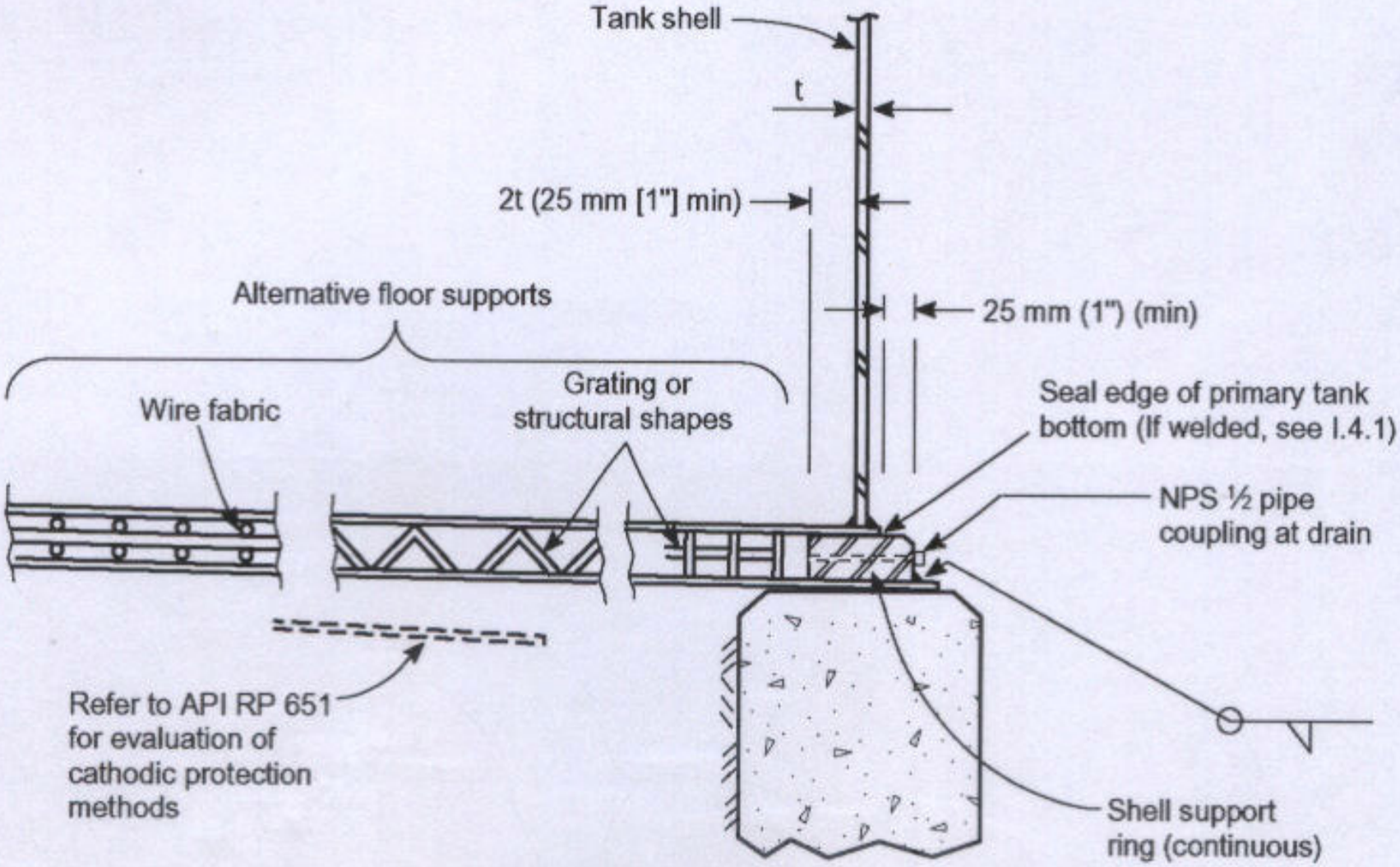
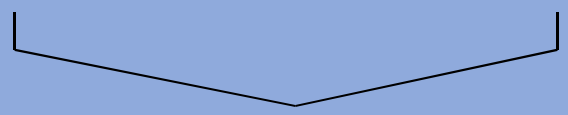


Figure I-5—Double Steel Bottom with Leak Detection at the Tank Perimeter (Typical Arrangement)

3.0 Tank Structure

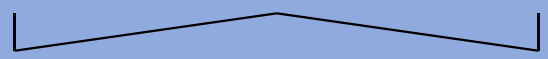
3.1 Bottom/ Floor design – Designed to, permit complete draw- off, minimize product contact and to ulitilize maximum tank capacity and prevention of corrosion of bottom plate.

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).



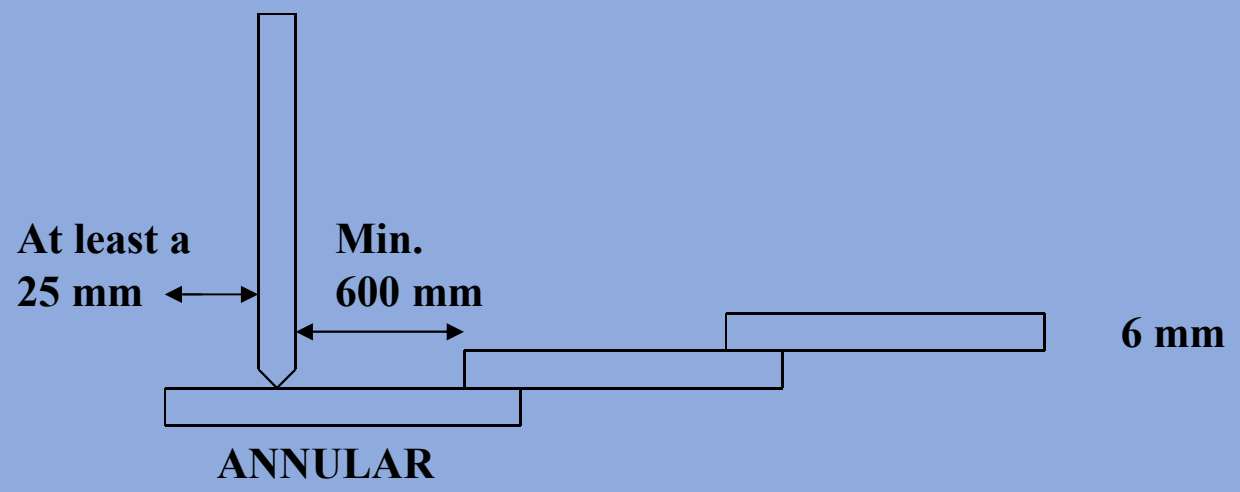
- Cone up bottom (bottom up)

  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.*

3.0 Tank Structure

3.2 Bottom plates

- All bottom plates shall have a minimum nominal thickness of 6 mm exclusive of any corrosion allowance specified by the owner for the bottom plates.
- Annular plates shall be at least 8 mm thick.
- Bottom shell plate shall have a minimum nominal width of 1800 mm



3.0 Tank Structure

3.3 Attachment to shell

The connection between the bottom edge of the lowest course of the shell plates and the bottom annular plates shall be continuous fillet weld on both side of the shell plates.

3.4 Joints in tank bottom plates

All joint in bottom plates shall be lapped. The minimum lap shall be five times the thickness of the plate.

There shall be a minimum lap of 65 mm between the bottom plates and the bottom annular plates.

3.0 Tank Structure

3.5 Pad Plates

Pad plates fixed to the tank bottom shall be used at all supports. Pad plates should be of circular shape; if square or rectangular plates are used, they shall have their corners rounded (radius at least 5 times the plate thickness) and continuously welded.

3.6 Shell Design

The bottom course shall have a minimum height of 1800 mm and a minimum thickness of 8 mm.

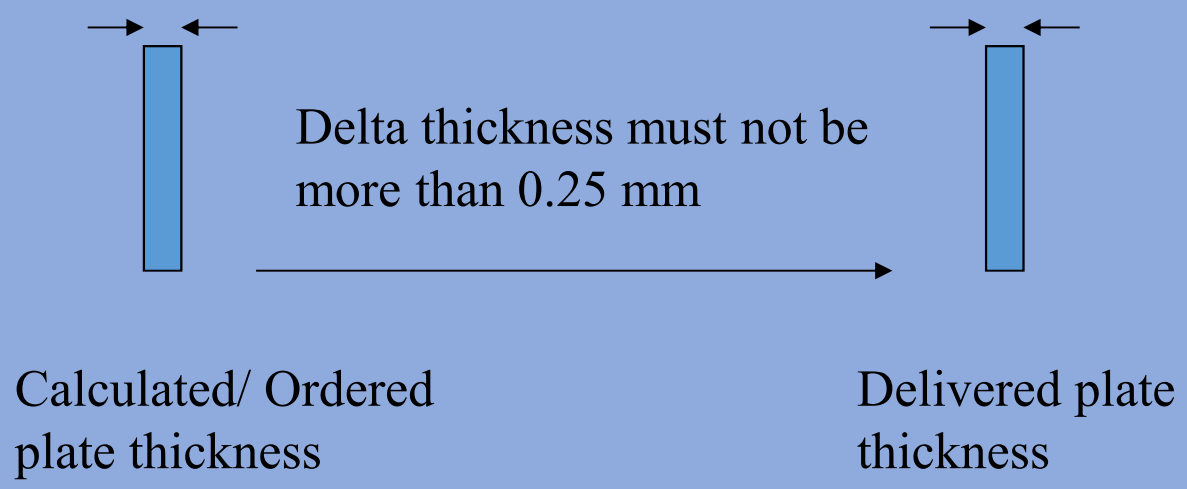
The nominal thickness of the shell plates shall not exceed 40 mm. The minimum shell thickness shall be:

- *6 mm for tanks of less than 33 m in diameter*
- *8 mm for tanks of 33 m up to and including 60 m in diameter,*
- *10 mm for tanks over 60 m in diameter.*

3.6 Internal Loading

No course shall have a thickness less than that of the course above, regardless of the material of construction.

The shell plates for which a minimum thickness has been calculated and ordered shall not under run (furnished by mill) the computed thickness by more than 0.25 mm at any place.



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.

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.

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.

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.

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.***

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.

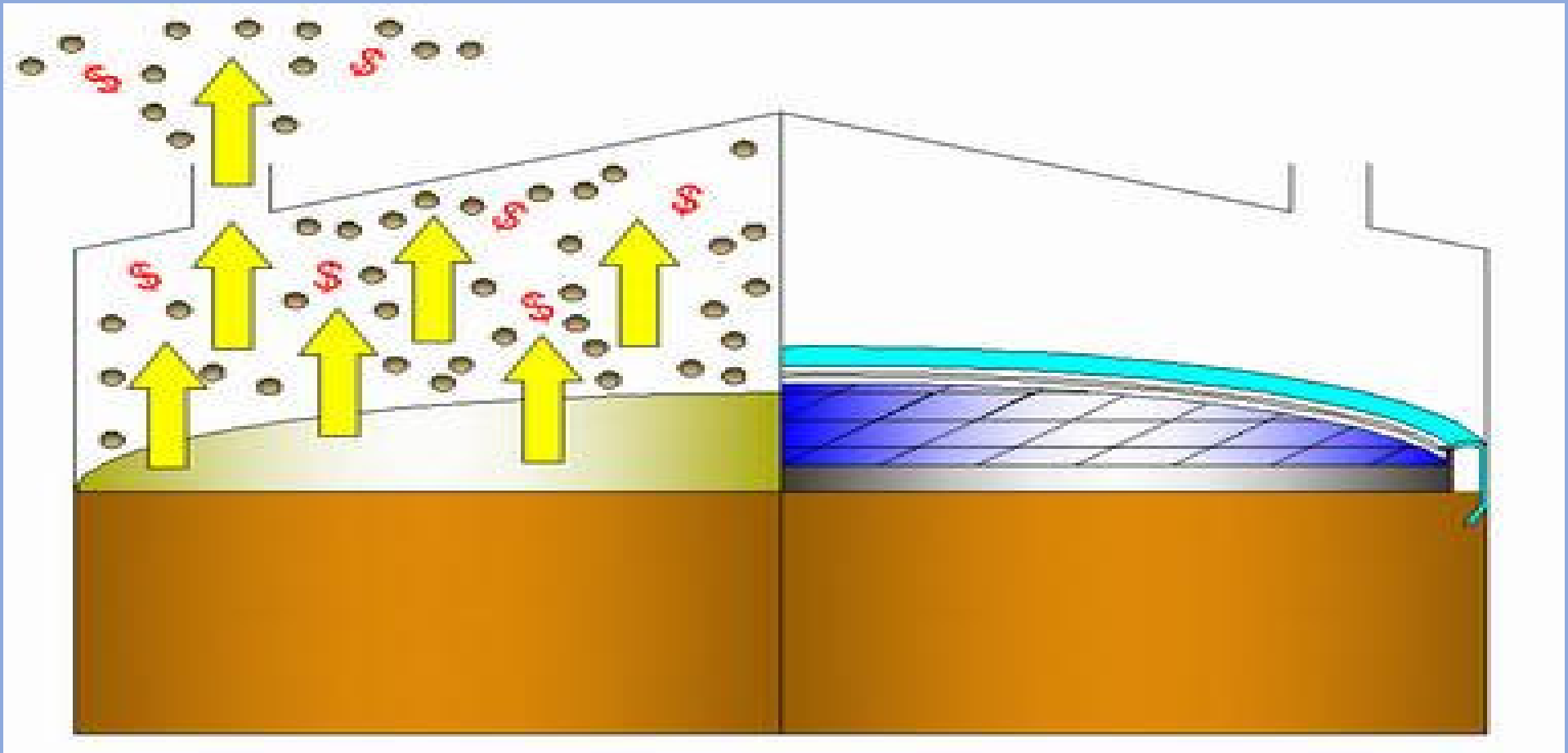
3.10 Internal floating roof tank

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)

3.9 Fixed roof design

3.10 Internal floating roof tank

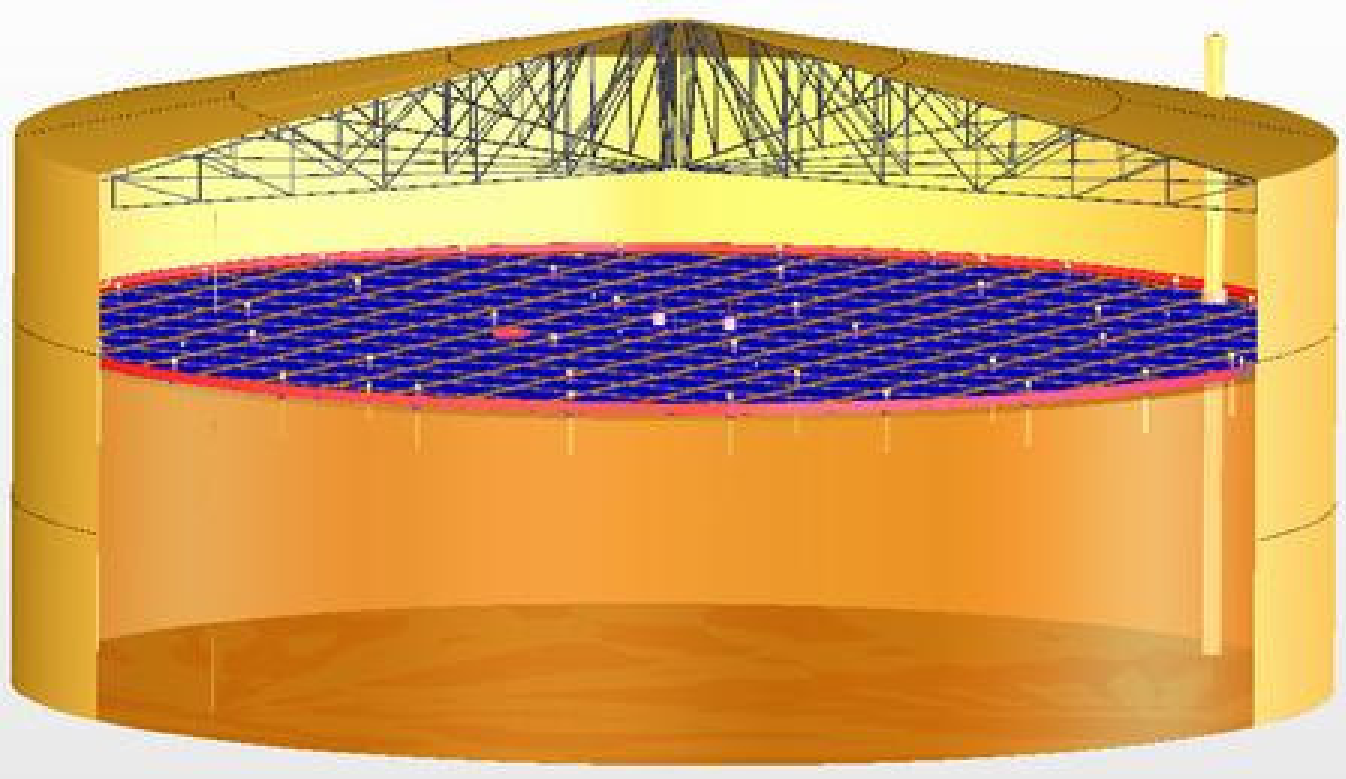


Internal Floating Roof (IFR)

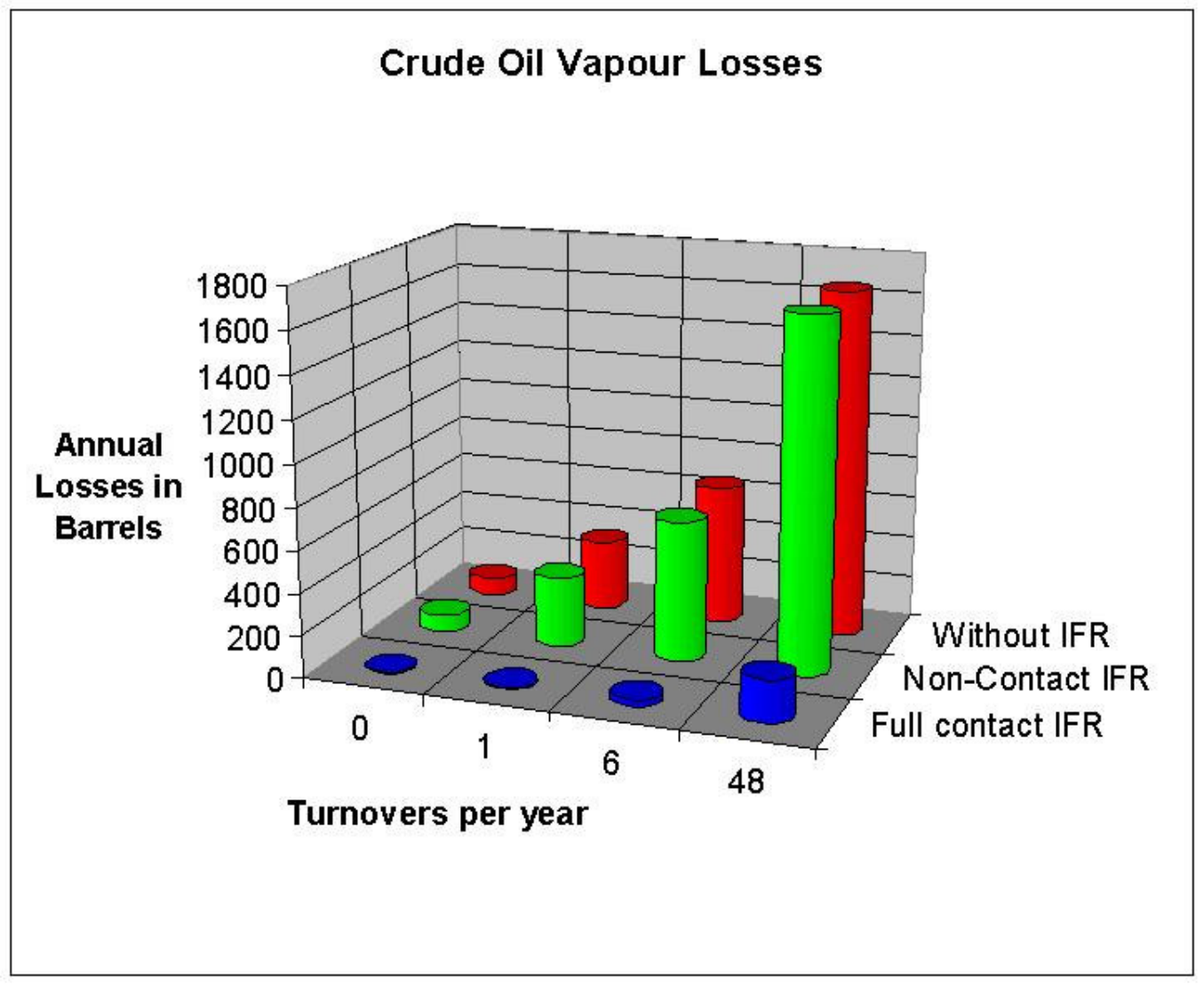
An internal floating roof tank has both a permanent fixed roof and a floating desk inside. The term "deck" or "floating roof" is used in reference to the structure floating on the liquid stored within the tank. The deck of an internal floating roof tank rises and falls with the liquid level whilst in 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


Crude Oil Vapour Losses
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

3.9 Fixed roof design

3.9.3 General

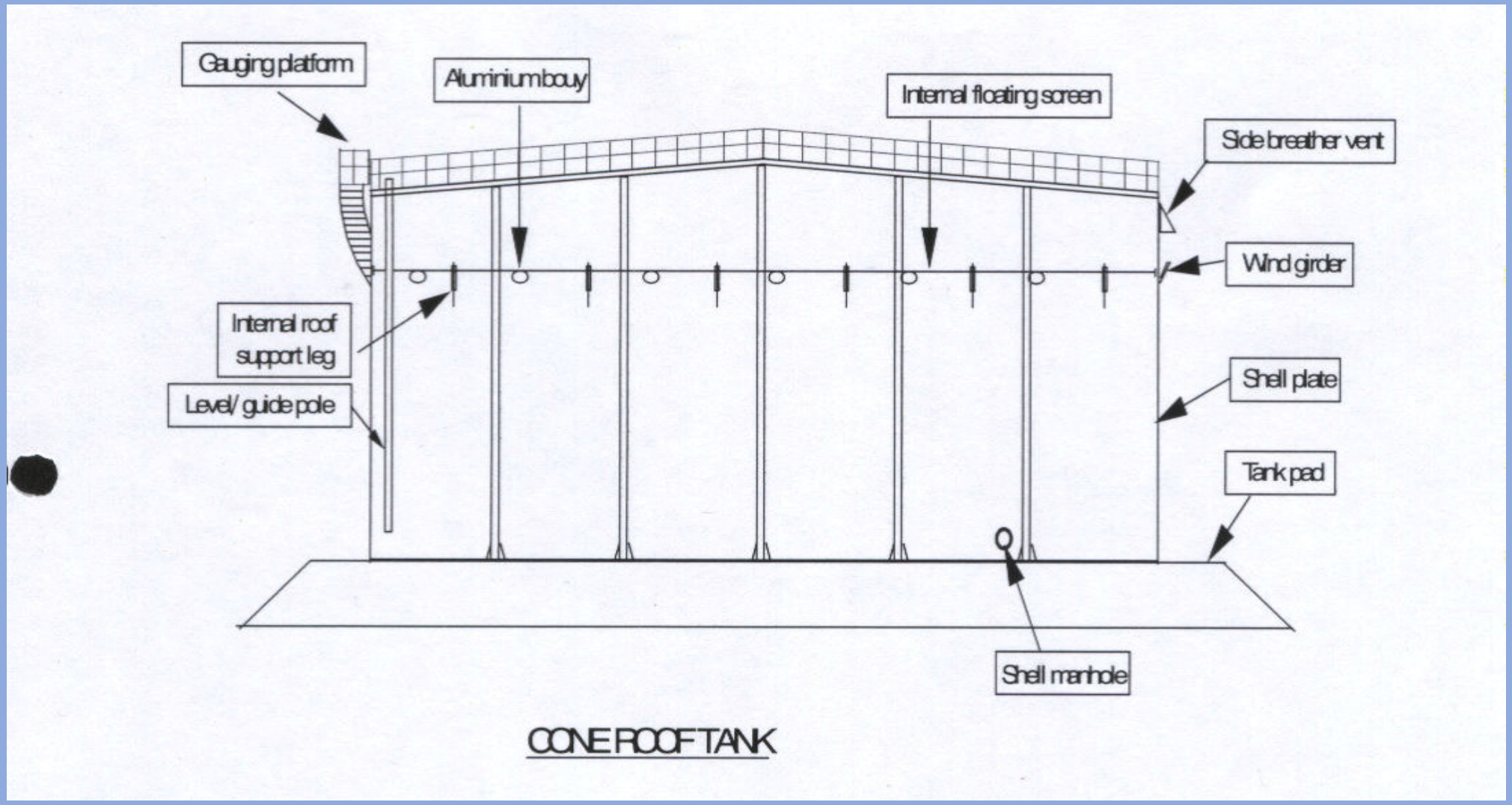
- roof plates of supported cone roofs shall not be attached to the support members.
- Roof plate shall be attached to the top angle of the tank with a continuous fillet weld on the top side only. The roof-to-shell joint may be considered frangible and in the event of excessive internal pressure may fail 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)

Internal floating roof tank



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

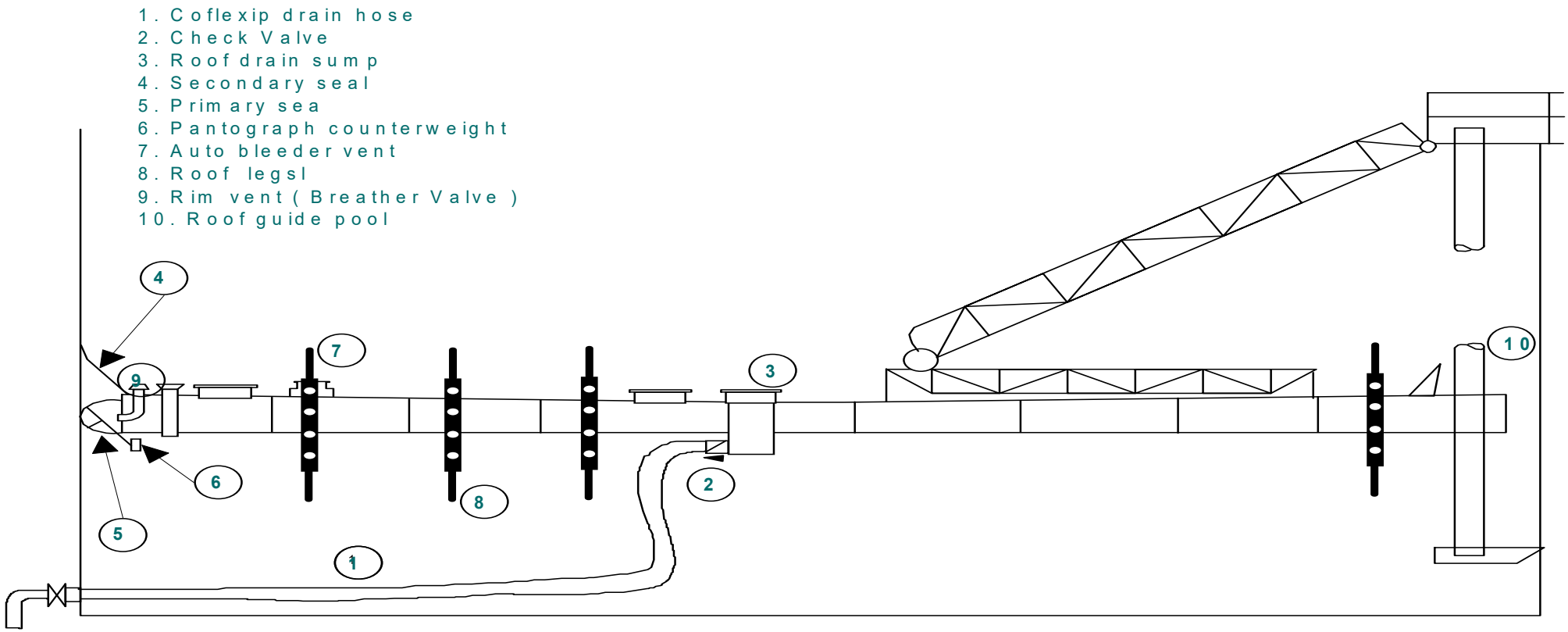
- A vapor tight rim seal (or skirt) is provided:

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

3.11 External floating roof tank

3.11.1 Types of EFRT

- Single deck pontoon roof
- Double deck roof



3.11.2 Manholes/ vents are provided for:

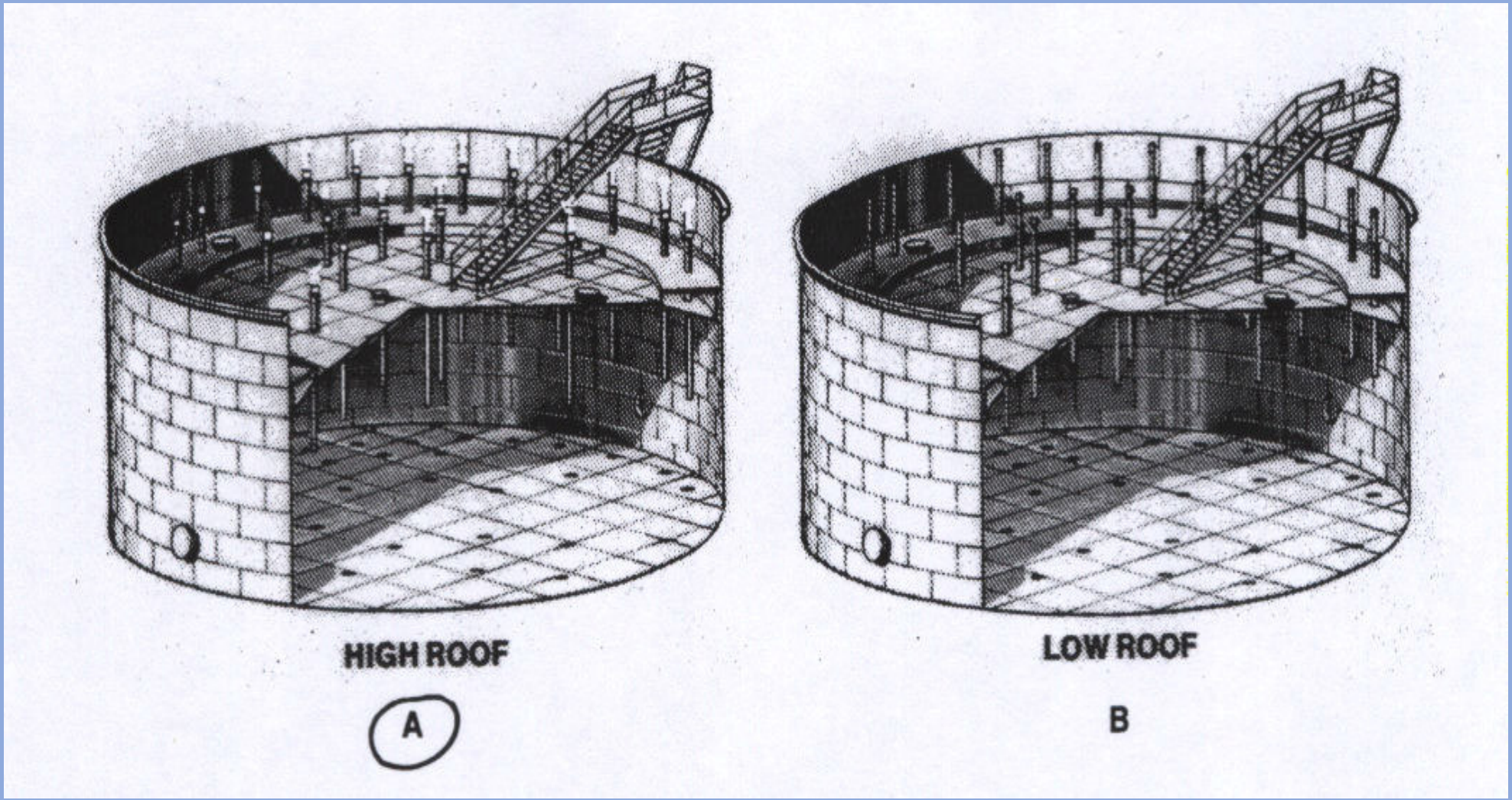
- Pontoon with liquid tight covers
- Deck manholes with are used only during tank shutdown
- Each compartment shall be provided with elevated vents
- Suitable vents shall be provided to prevent overstressing of the roof deck or seal membrane

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)

3.11 External floating roof tank

3.11.3 Support legs



3.11 External floating roof tank

3.11.4 Seals/ Types

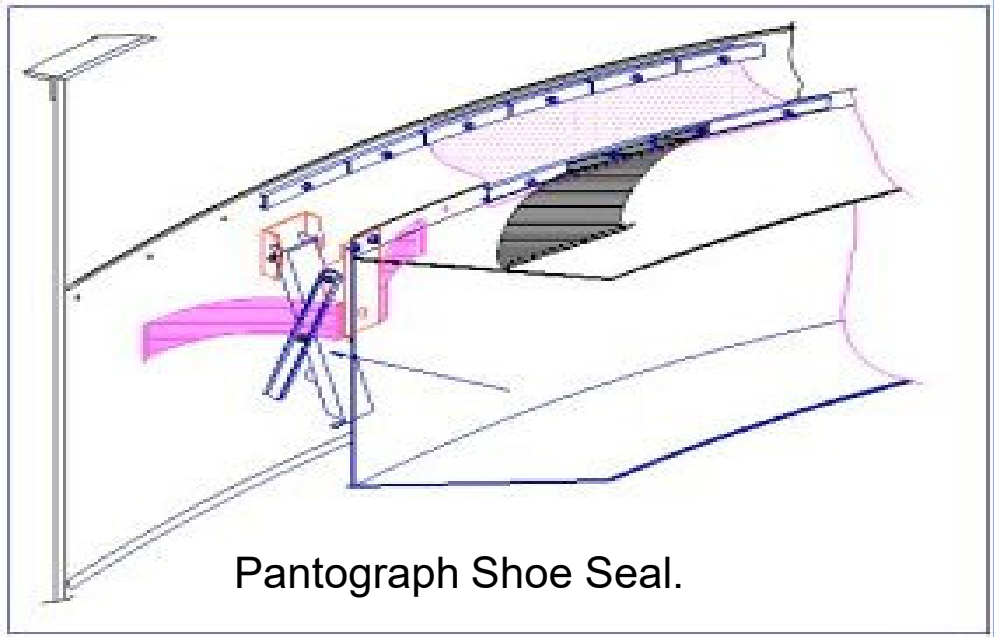
- The space between the outer periphery of the roof and the tank shell shall be sealed by a flexible device that provides a reasonable close fit to shell surface
- Steel shoes with fabric or nonmetallic material used as seal or seal components Material shall be durable and shall not discolor or contaminate the product stored.

3.11 External floating roof tank

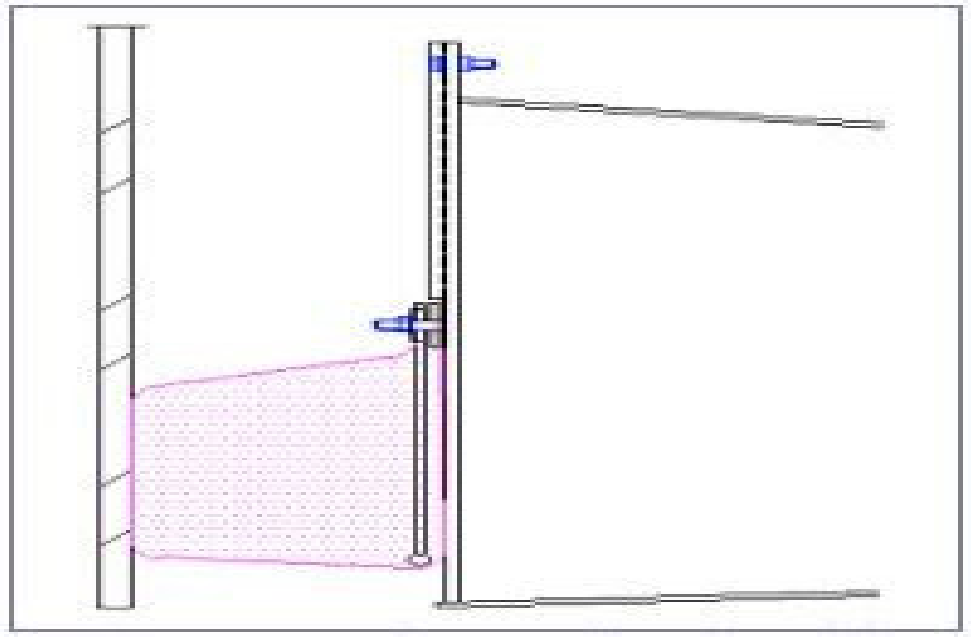
3.11.4 Seals/ Types

Pictures/ drawings of seals follows:

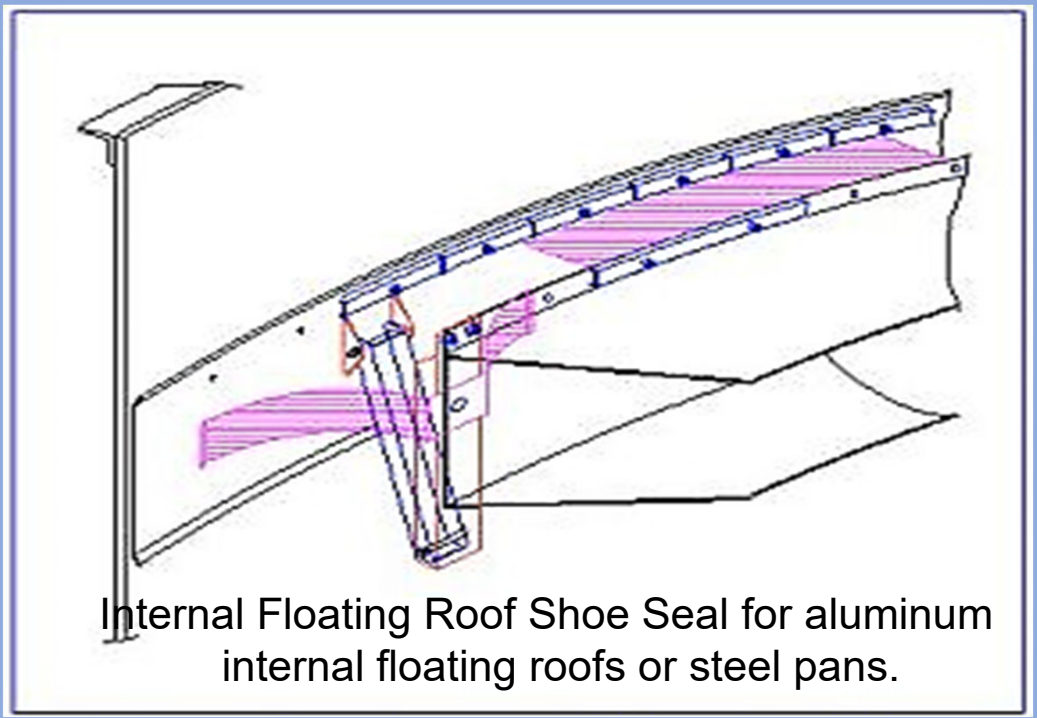
Primary and Secondary Seals for Floating Roof Tanks



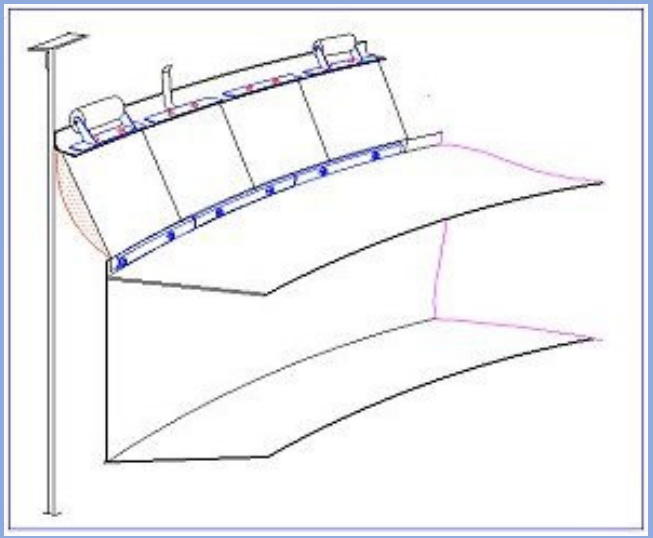
Pantograph Shoe Seal.



Foam Seals can be liquid or vapor mounted.



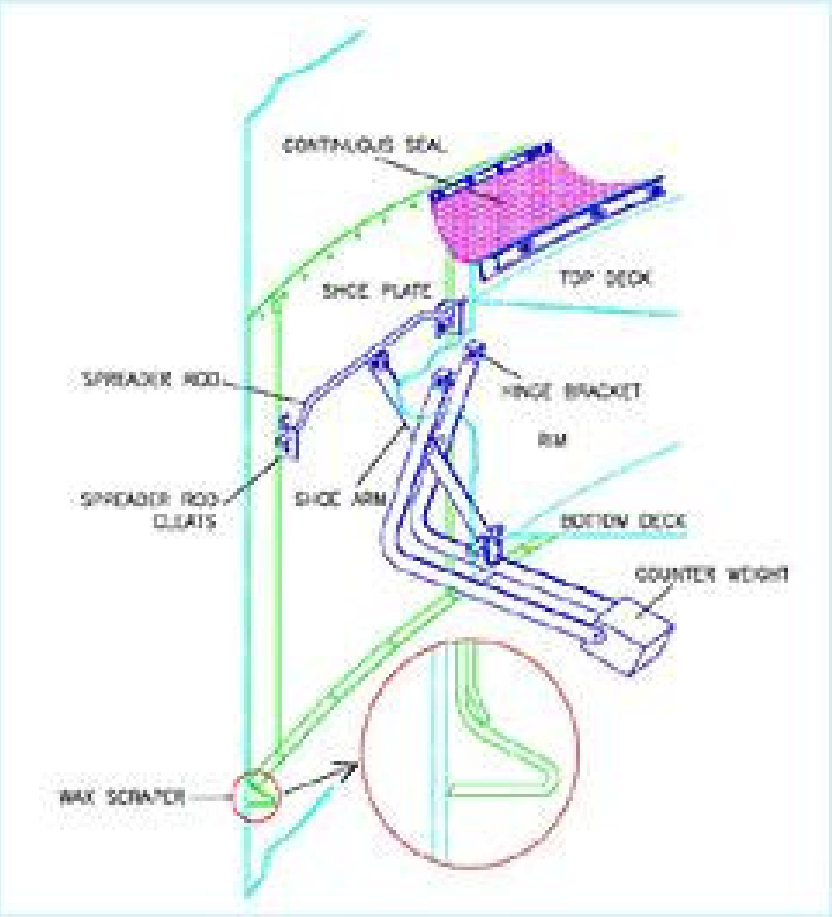
Internal Floating Roof Shoe Seal for aluminum internal floating roofs or steel pans.



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

3.11 External floating roof tank

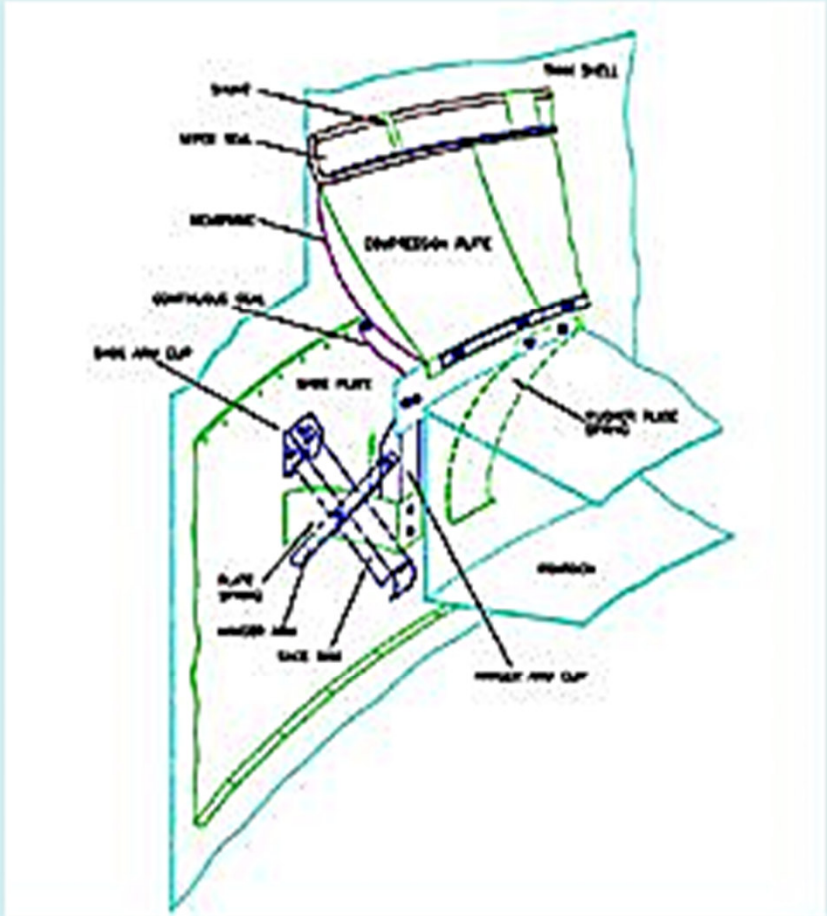
3.11.4 Seals/ Types



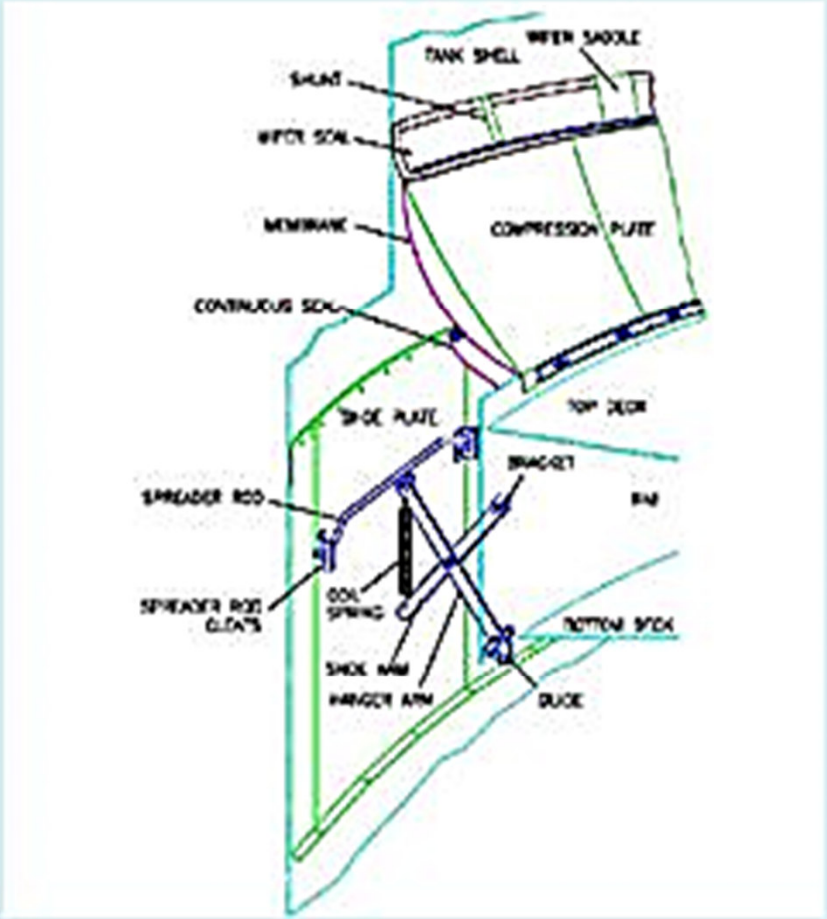
(WB-1 Pantograph Type Mechanical Shoe Seal)

3.11 External floating roof tank

3.11.4 Seals/ Types



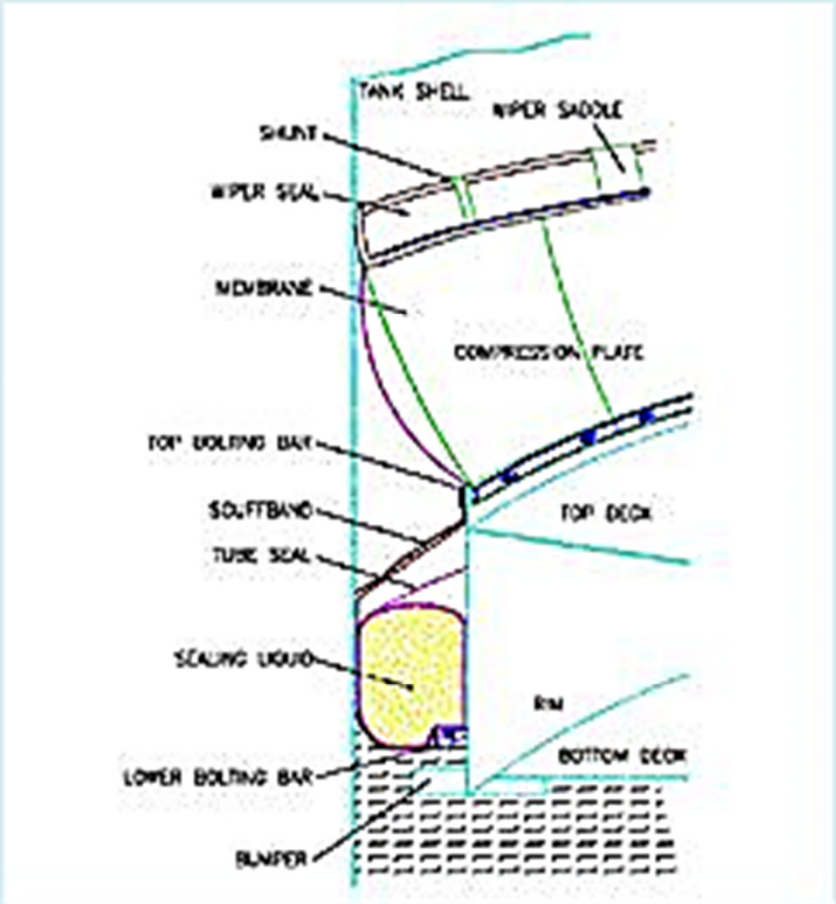
(WB-2 Plate Spring Type Mechanical Shoe Seal)



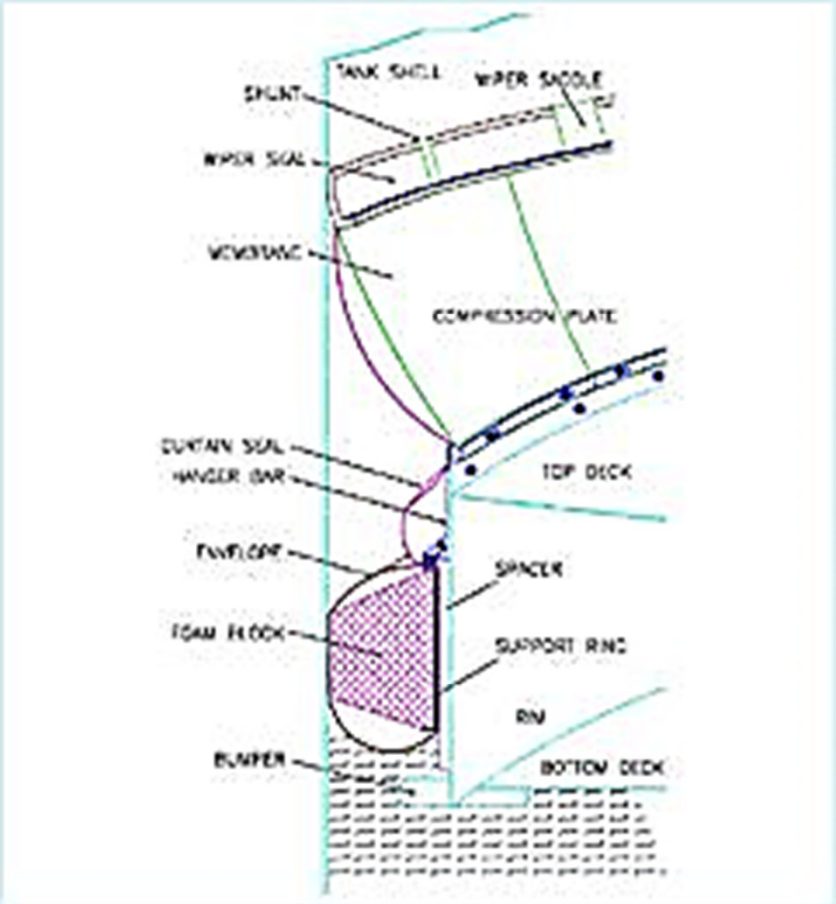
(WB-3 Coil Spring Type Mechanical Shoe Seal)

3.11 External floating roof tank

3.11.4 Seals/ Types



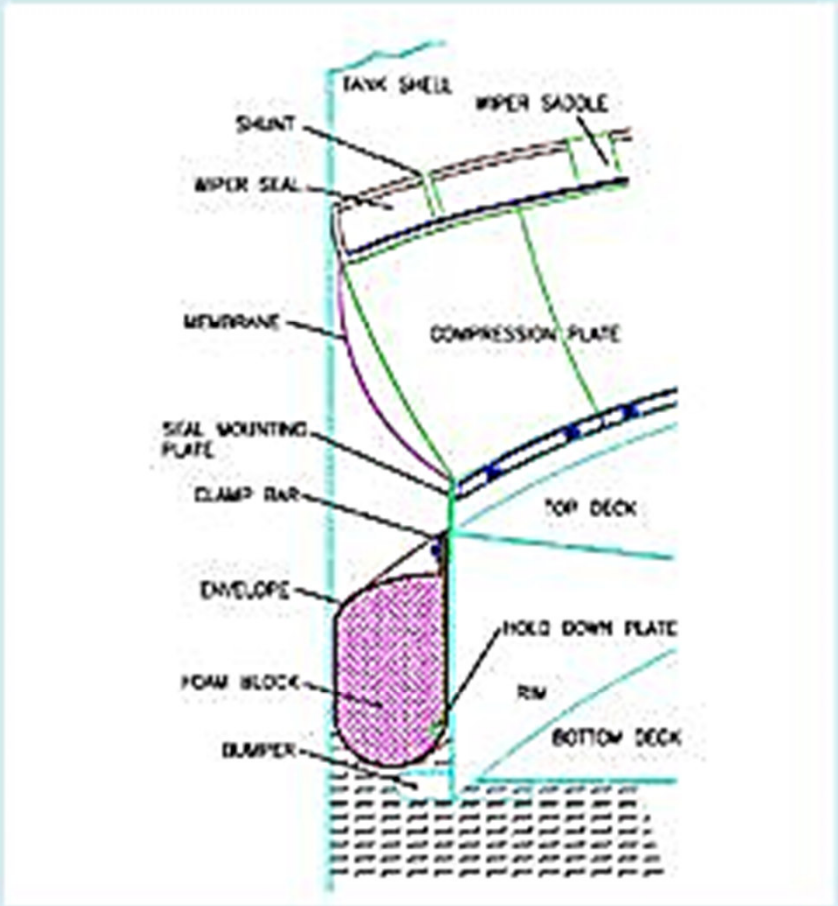
(Tubeseal Liquid Filled Seal)



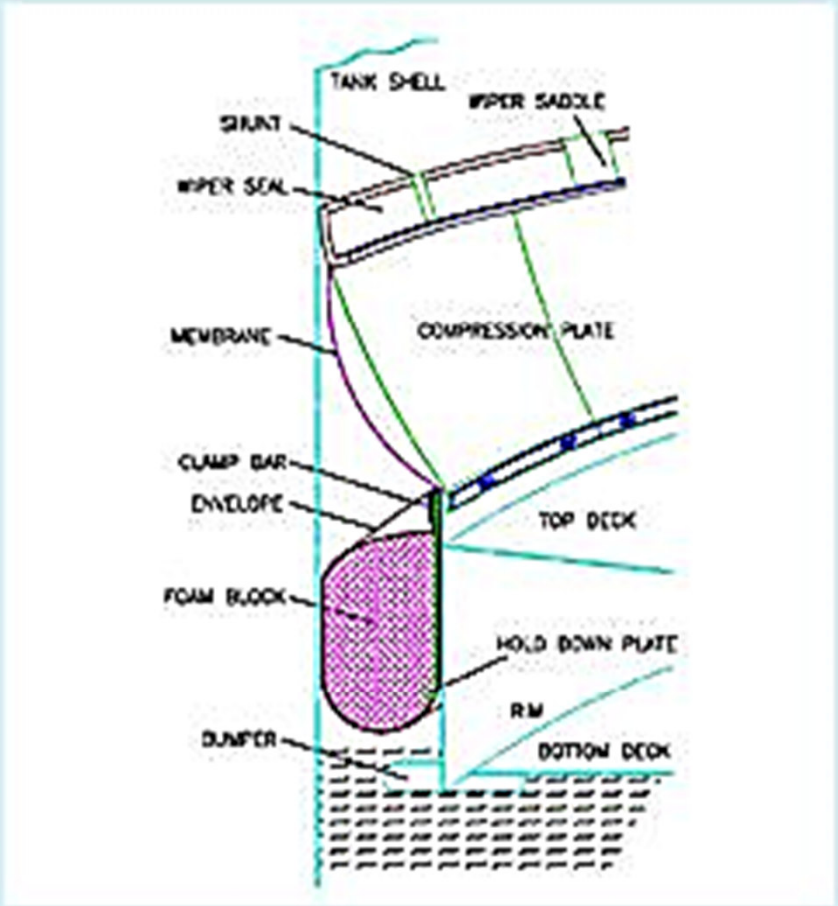
(WB-7 Foam Seal)

3.11 External floating roof tank

3.11.4 Seals/ Types



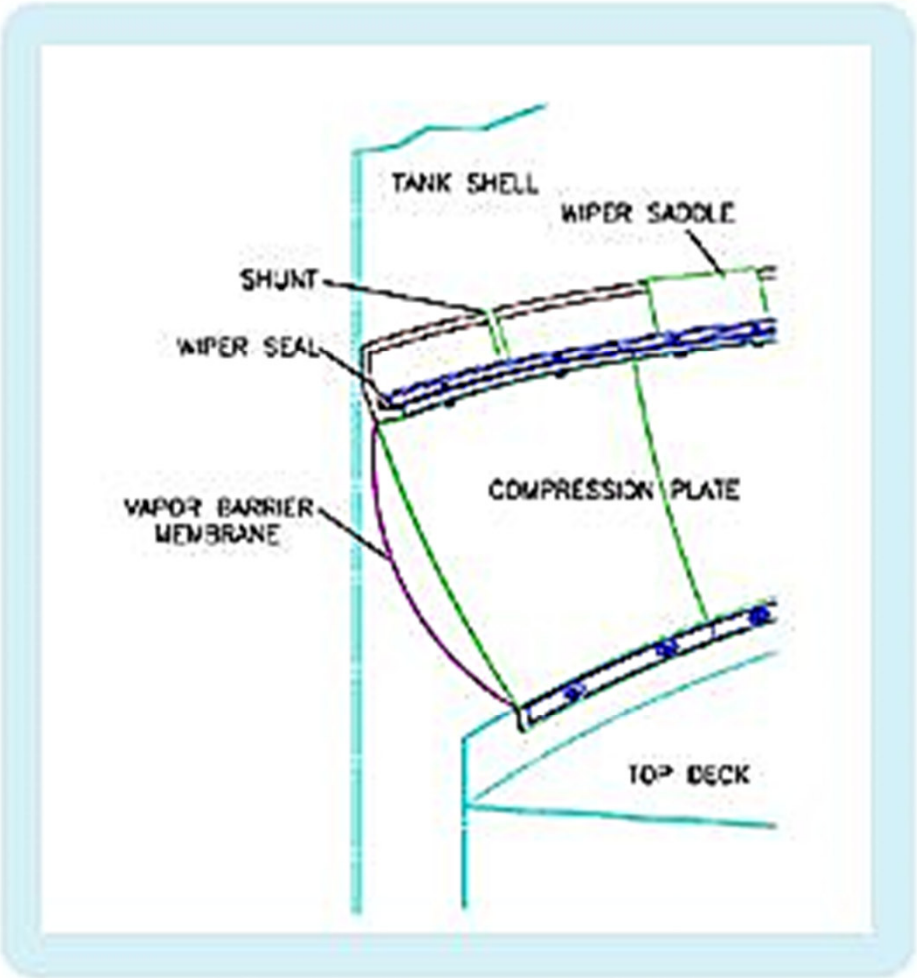
(Liquid Mounted-Contacted-Type)



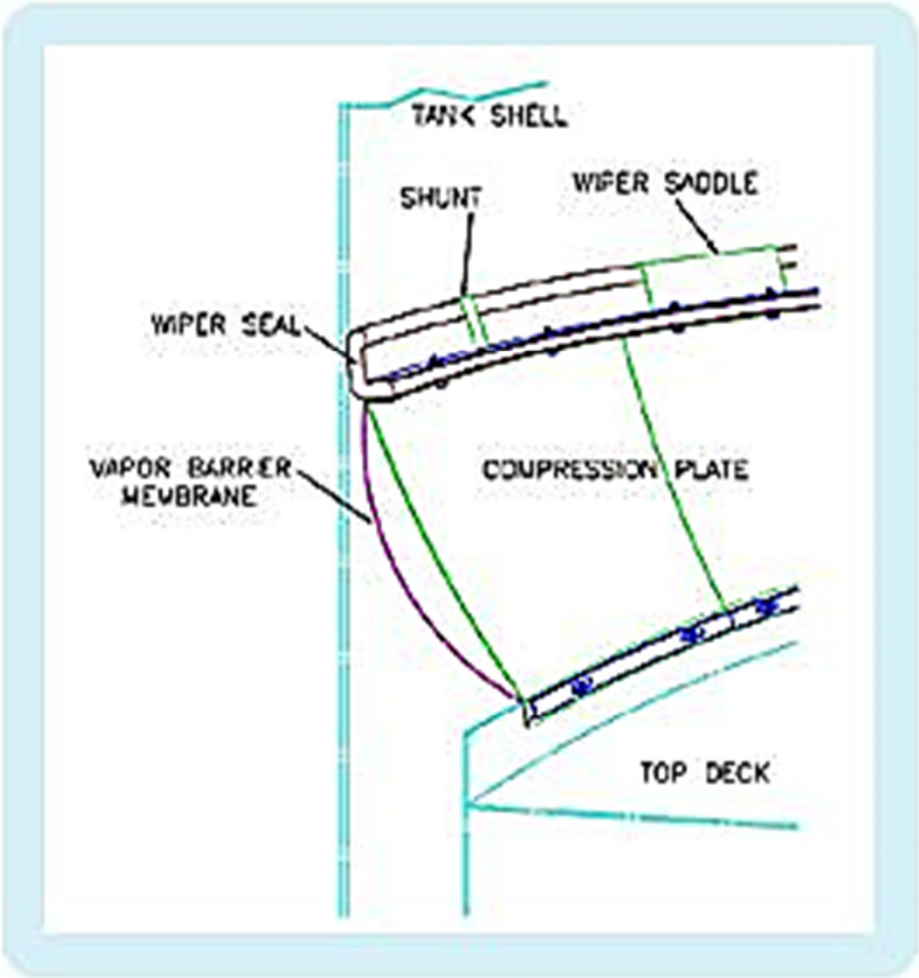
(Vapor Mounted-Contacted-Type)

3.11 External floating roof tank

3.11.4 Seals/ Types



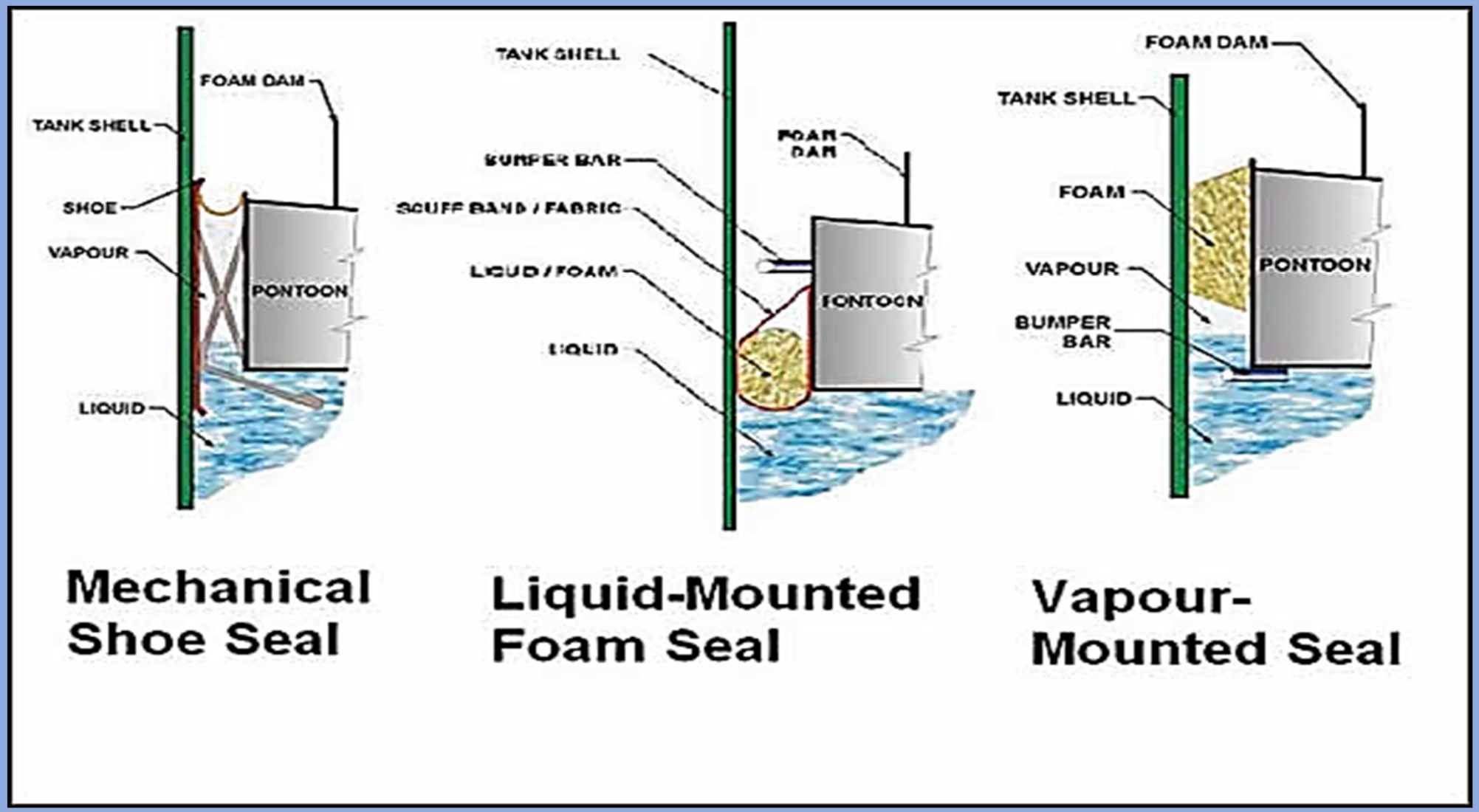
(WB-50 Secondary Seal)



(WB-50E Secondary Seal)

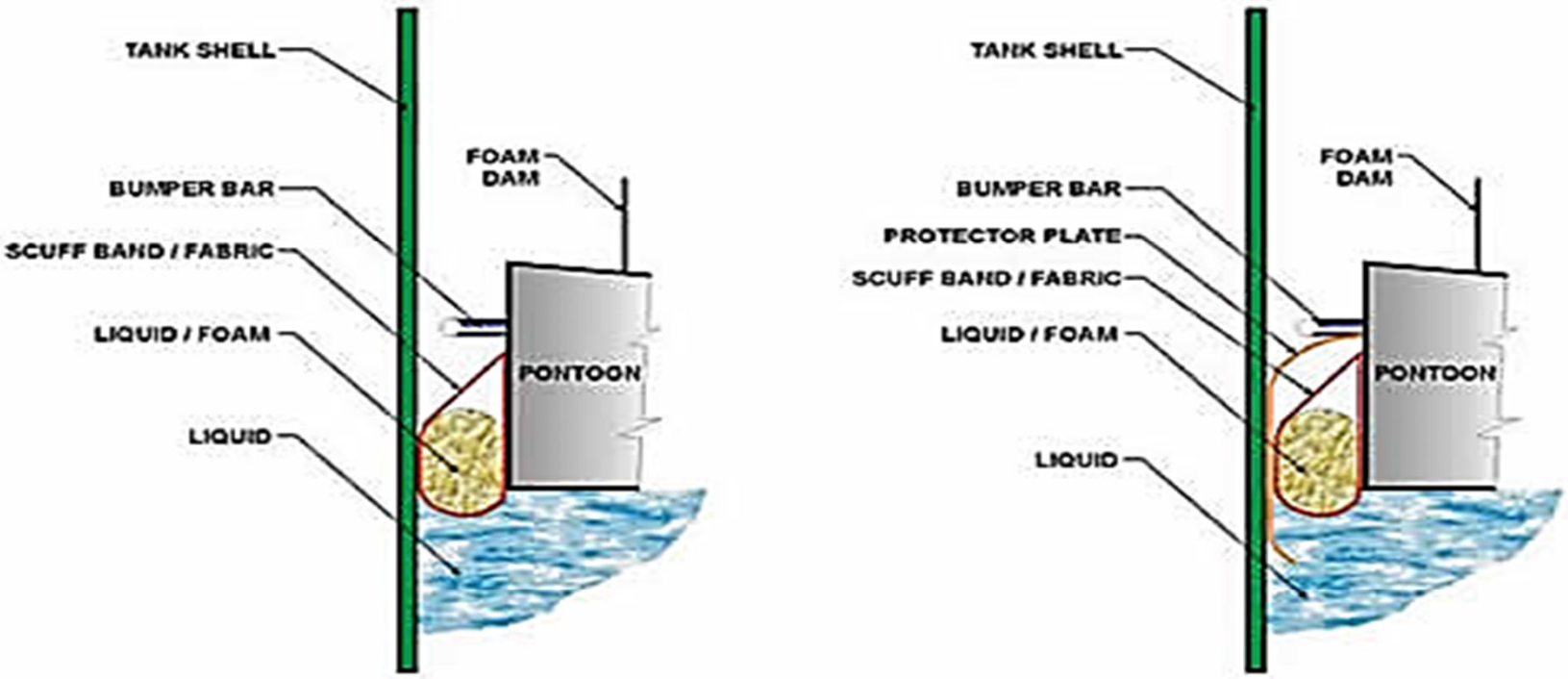
3.11 External floating roof tank

3.11.4 Seals/ Types



3.11 External floating roof tank

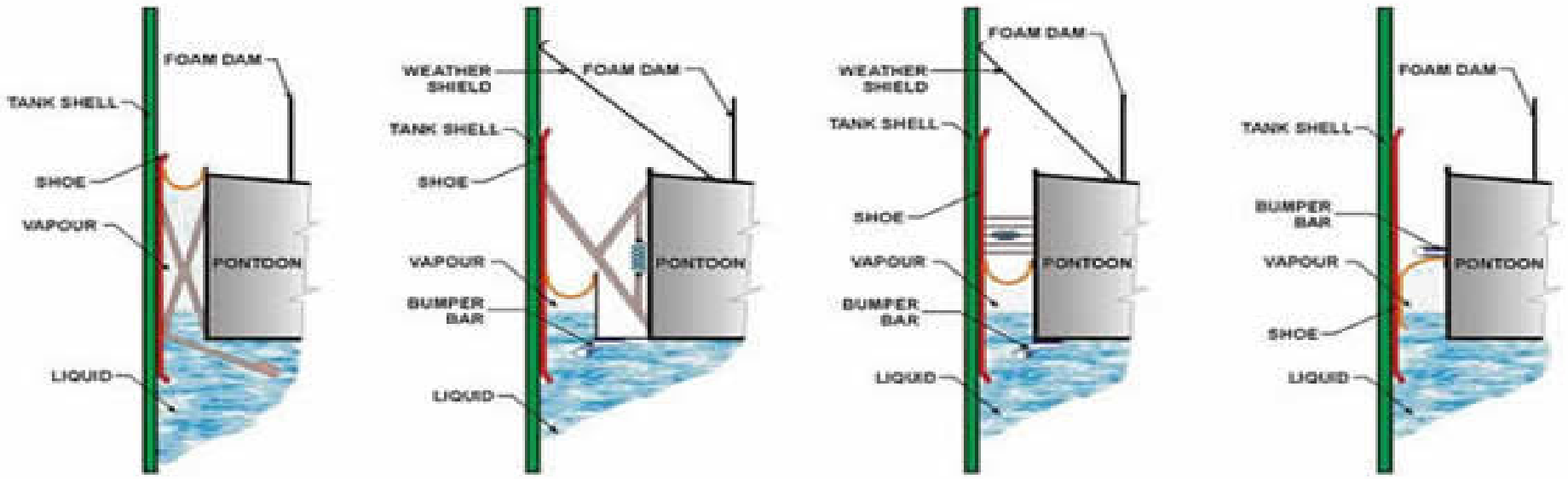
3.11.4 Seals/ Types



Liquid Mounted Seals

3.11 External floating roof tank

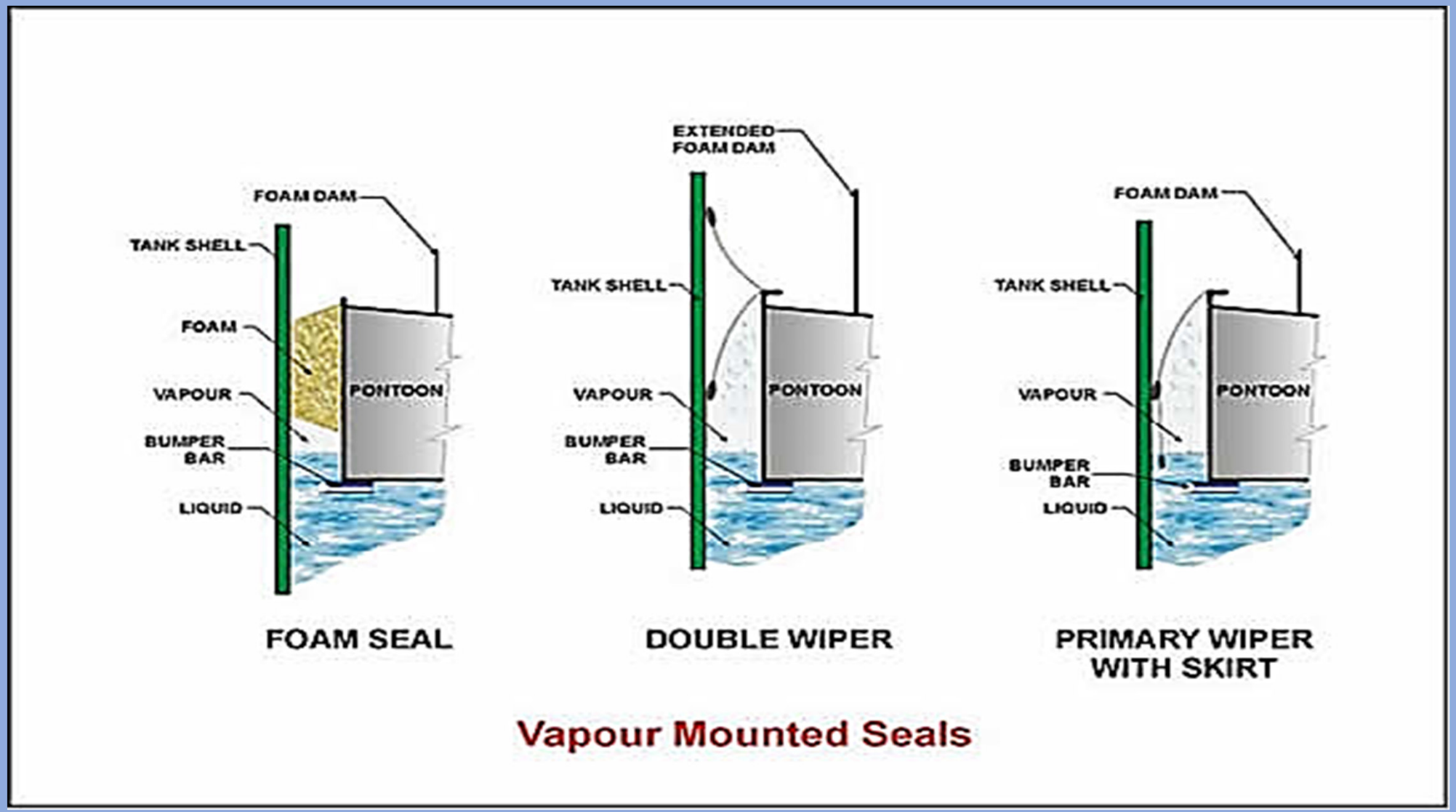
3.11.4 Seals/ Types



Mechanical Shoe Seals

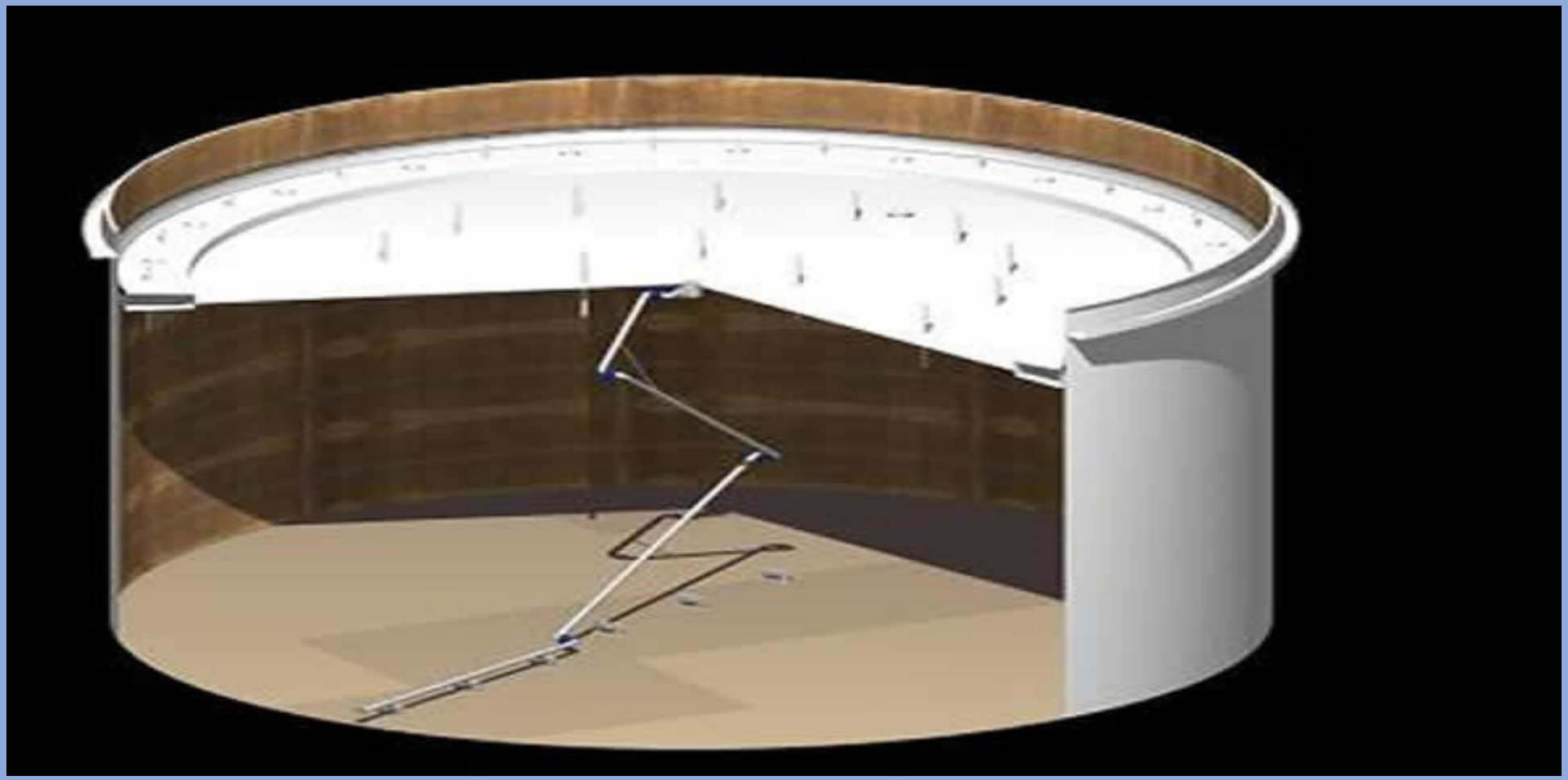
3.11 External floating roof tank

3.11.4 Seals/ Types



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.

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.`

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.

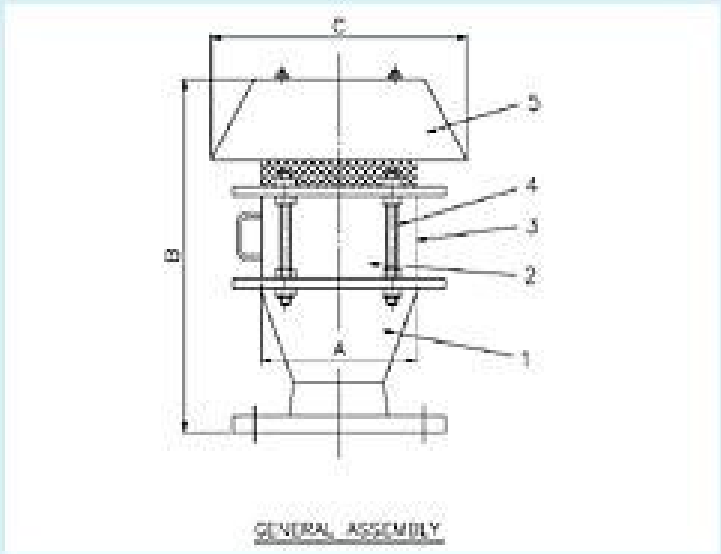
When deciding on the number of free vents required, their capacity shall be taken into account.

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.

(WBBA - End Line Type)

(WBBA - In Line Type)

(WBBA - End Line Type)



(WBBA - In Line Type)

Flame Arrestor

Introduction

Flame arrestor is designed to stop the propagation of flame from ignited flammable liquid vapors with low flash points. They prevent flame propagation by absorbing and dispatching heat thereby reducing the temperature of the flame front preventing ignition behind the cell element. Flame Arrestor can be installed either vertically or horizontally and is available in aluminum, carbon steel or stainless steel. The cell element is available in stainless steel and special materials are available on request.

Design Features

Because of the safety critical nature of the progress, designing and specifying flame arrestors requires great care and consideration. There is a wide range of volatile gaseous compounds and mixtures, each having its own unique combustion characteristics.

Careful consideration also needs to be given to the corrosive nature of these compounds, as the element and housing of any arrestors will needs to be constructed of materials resistant to this corrosion.

The World Bridge manufacture elements from stainless steel 304, 316 or 316L as standard.

The World Bridge Flame Arrestor is passive device with no moving parts.

They prevent the propagation of flame from the exposed side of the unit to the protected side by the use of wound crimped metal ribbon type flame cell element. This construction produces a matrix of uniform openings that are carefully construct to quench the flame by absorbing the heat of the flame. This provides an extinguishing barrier to the ignited vapor mixture.

4.1 Operational Fittings for vertical Tanks *(cont)*

4.1.2 Roof nozzles

The flow characteristics of breather valves and free vents are influenced by the profile and length of the roof nozzle.

Wire netting in the opening of free vents and breather valves (e.g. as used to prevent nesting of birds) shall have openings of at least 6 mm square.

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.

4.1.4 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 °C 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.

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.*

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.

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

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 °C, the tank bottom slope up towards the centre in order to prevent corrosion caused by rain water penetrating under the bottom.

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.

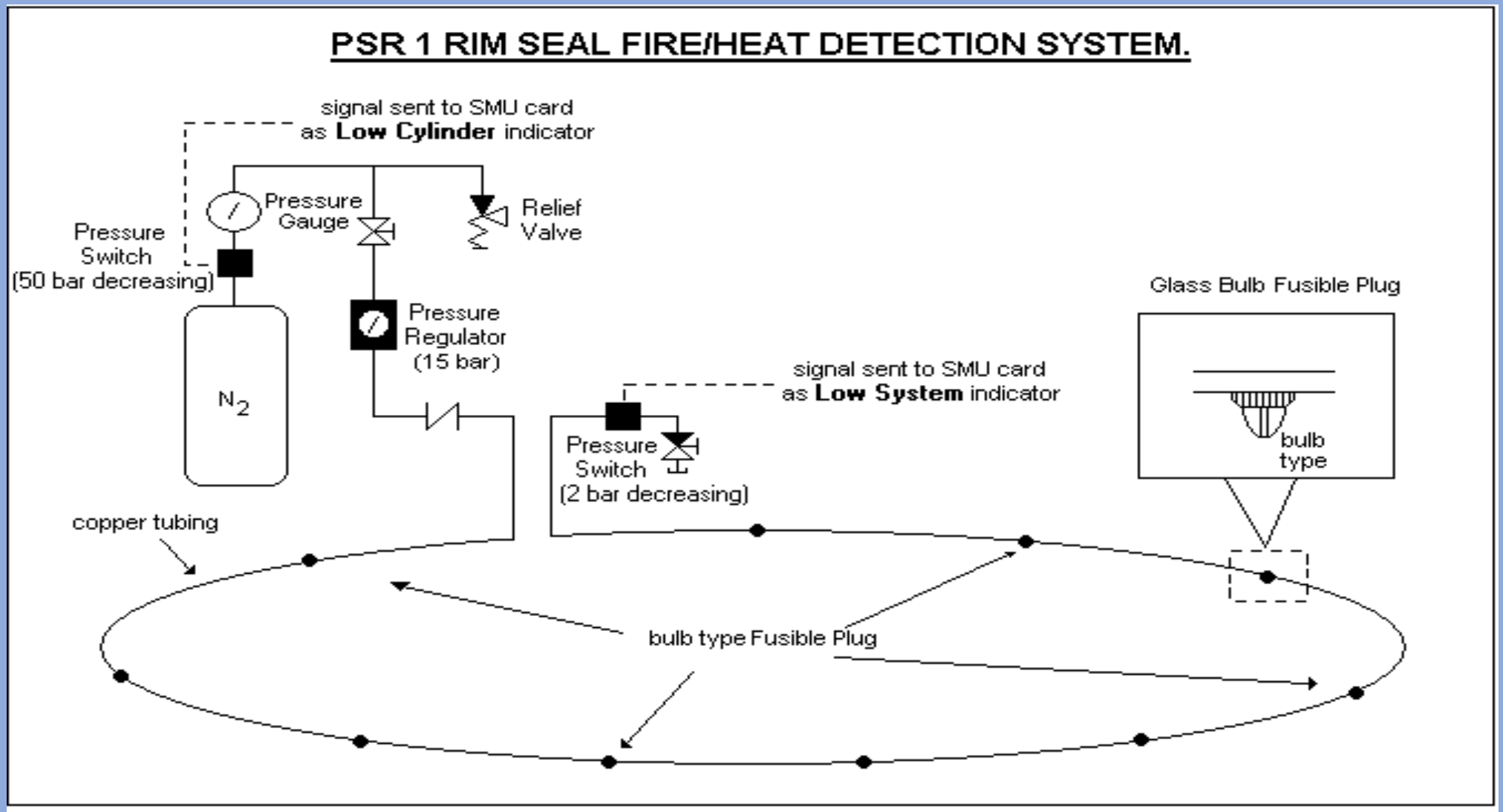
4.2.7 Foam connection

- 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.

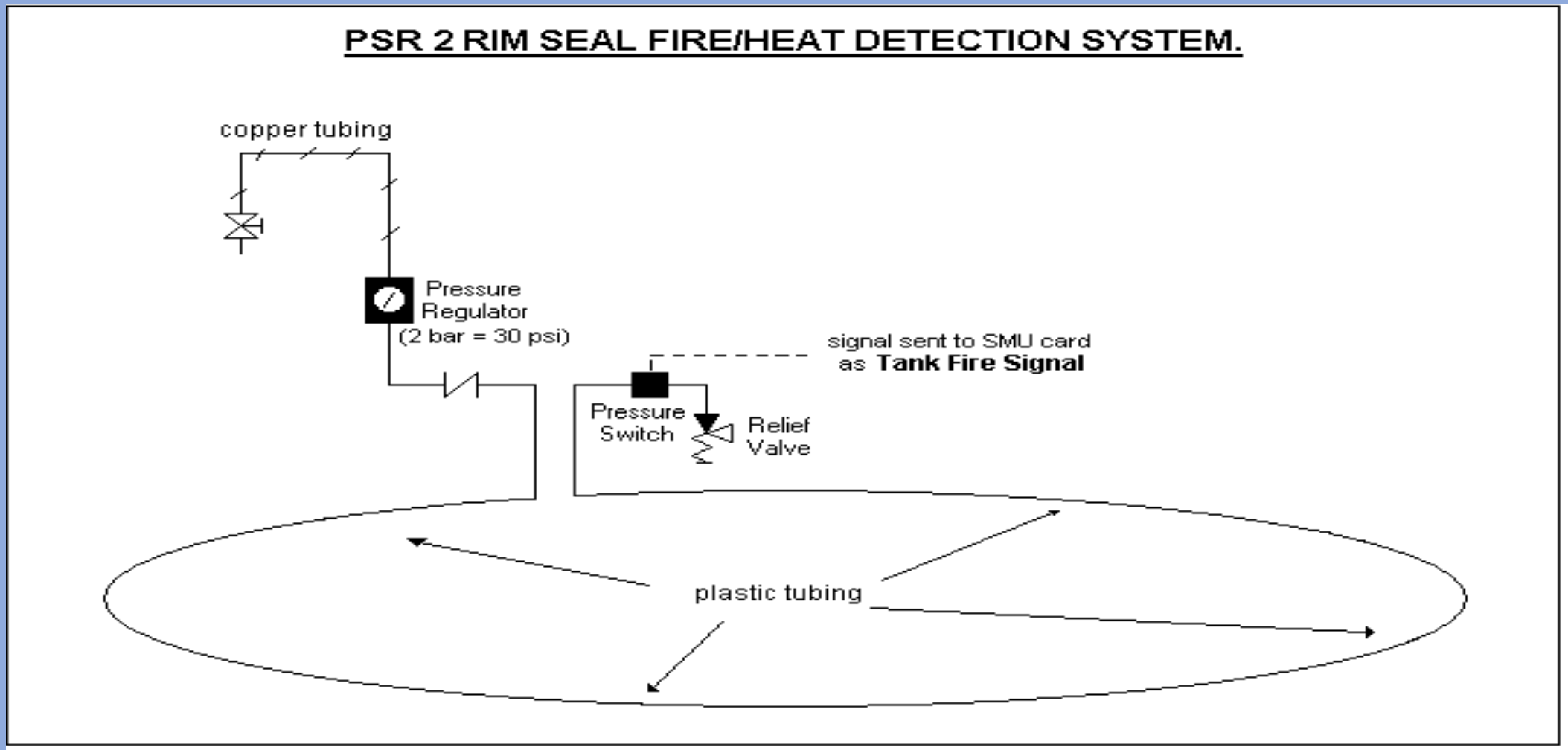
4.2.8 Fire protection for floating roof tanks *(sketches below)*

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

4.2 Fittings Common to All Vertical Tanks



4.2 Fittings Common to All Vertical Tanks



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. 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).

4.3 Additional fittings for fixed roof tanks

4.3.1 Slot dipping devices

- Slot dipping devices are required for all tanks operating under pressure, so that dips and samples may be taken without excessive pressure loss.

4.3.2 Manometer or pressure/ vacuum gauges

- If specified, manometers shall be supplied for pressurized tanks in order that the working of the breather valves may be checked. The manometers are normally mounted at ground level for easy reading.

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.

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.

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)

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.

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.

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.

4.5 Special fittings and accessories for floating roof

4.5.3 Fittings

- 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.

➢ 4.5.3 Fittings

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

- 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.

4.5.3 Fittings

- 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.

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.

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.

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.

MONTHLY ABOVEGROUND STORAGE TANK INSPECTION CHECKLIST

Location: _____ Date: _____ Completed by: _____

	Tank:	Tank:	Tank:
Is there any deterioration on the tank, tank coating, piping, foundation, drainage, supports, ladder, platform, or safety equipment? For molded plastic tanks, check for evidence of cracked and worn areas and delamination. If yes, specify below.	Yes No	Yes No	Yes No
Is there any water at the lowest possible point within the primary tank (fuel tanks only)? Remove any water found. For tanks containing other products, is there any evidence of chemical degradation?	Yes No N/A	Yes No N/A	Yes No N/A
Is there any evidence of liquid (product or water) in the interstitial space (double-walled tanks) or containment area?	Yes No N/A	Yes No N/A	Yes No N/A
Are all drain valves secured in the closed position when not in use and all tank openings properly sealed? Are the piping connections tight and aligned?	Yes No N/A	Yes No N/A	Yes No N/A
Is the spill basket clean and functional?	Yes No N/A	Yes No N/A	Yes No N/A
Is the liquid level gauge readable and in good condition?	Yes No	Yes No	Yes No
Are there any obstructions or restrictions to the normal and emergency vents that prevent normal function? Ensure that the emergency vent moves freely.	Yes No	Yes No	Yes No
Are there any operational malfunctions of ancillary equipment (pumps, gauges, etc.)?	Yes No	Yes No	Yes No
Is there any evidence of a release from the tank – this includes visible signs of leakage around the tank, concrete pad, containment area, ringwall, or ground?	Yes No	Yes No	Yes No
Is there a clear path to the tank and containment area, and are gates/doors to the containment area operable and in good condition?	Yes No	Yes No	Yes No
Is a complete spill kit available?	Yes No	Yes No	Yes No
Are there any conditions that may be a fire or safety hazard, or pose an environmental hazard? If yes, specify below.	Yes No	Yes No	Yes No

Any deficiencies noted during the inspection must be corrected as soon as possible. **Facility personnel must contact EHS to review all tank maintenance and needed repairs with the exception of replacing hoses and fuel filters.** If there are any questions, call the Department of Environmental Health and Safety at 814/865-6391. Comments/Clarifications and Corrections: _____

_____

_____