Storage Tanks

INTRODUCTION

A primary objective of the Production Department is to produce and deliver hydrocarbon products, safely at points of sale, to a specified quantity and quality

To achieve this objective, in an oil production system, the basic processes involved are:

- Producing reservoir fluids to surface facilities,
- Processing these fluids,
- Sending this product to a terminal for storage

An oil terminal acts as a buffer between the producing fields and the point of sale/ export.
It performs two basic functions:

Storage Facility

It is both practical and economically sensible to keep oil wells flowing at fairly constant rate, Hence the storage facilities is ultimately needed.

Treating Facility.

Most of the oil produced in the field requires some form of treatment to Bring it within specification as a merchantable product.
The treatment that takes place in the field varies considerably, from simple separation and/or chemical injection up to full scale dehydration.
This governs the treatment which needs to be carried out in the terminal

Cylindrical steel tanks are the most important elements of a terminal's equipment.

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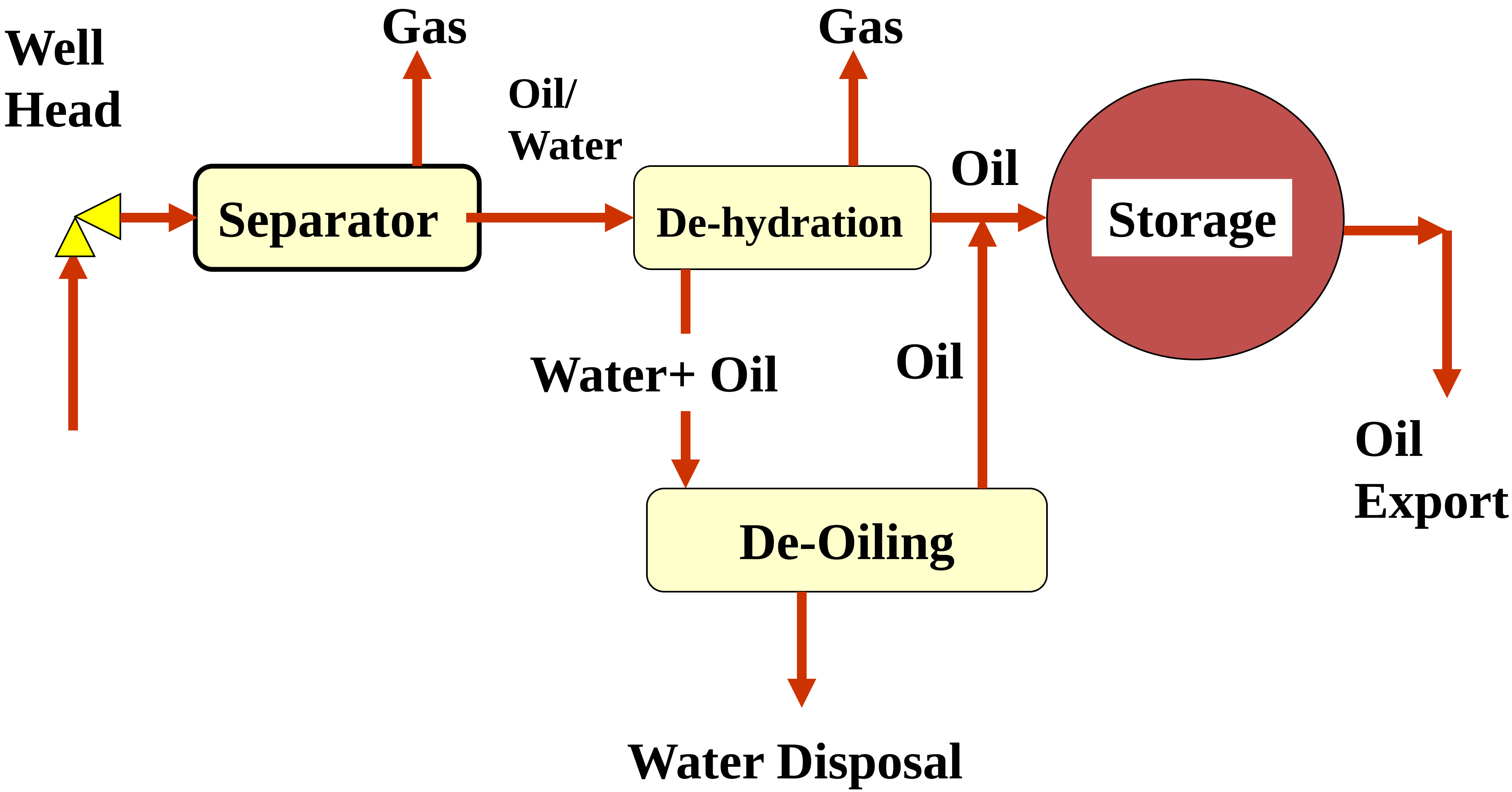
PROCESSING WELL STREAM FLUIDS



Tanks Classification

VESSELS CLASSSIFICATION

1. ATMOSPHERIC
2. LOW PRESSURE
3. HIGH PRESSURE

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STANDARDS OF ATMOSPHERIC TANKS

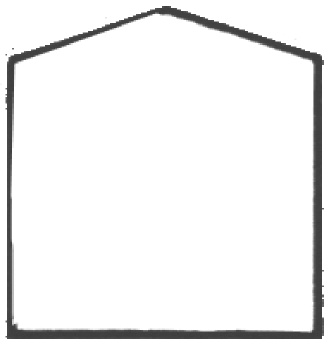
- API 650 Welded steel Tanks for oil storage
- API 653 Tanks Inspection, Repair and Reconstruction
  API 651 – Cathodic Protection of Petroleum Storage Tanks
  API 575 – Inspection of Atmospheric and Low-Pressure Storage Tanks.
- API 2517 Floating roof tanks
- API 2350 Overfill Protection for Storage Tanks
- API 2000 Venting
- ASME Section IX

STANDARDS OF LOW PRESSURE TANKS

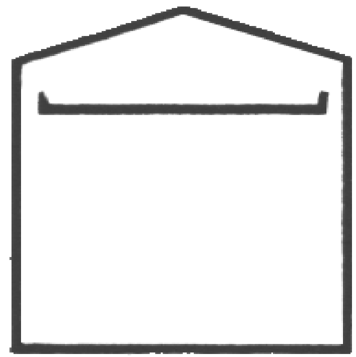
- **API 620 Low Pressure (< 15 psig)**
- **API 2350 Overfill Protection for Storage Tanks**
- **API 2552 Measurement& calibration of Spherical**

Storage Tanks Types

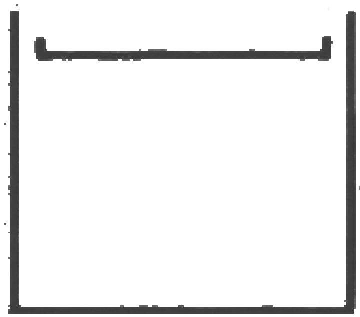
Atmospheric



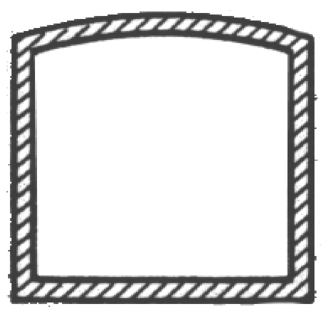
Cone roof



Internal floating roof



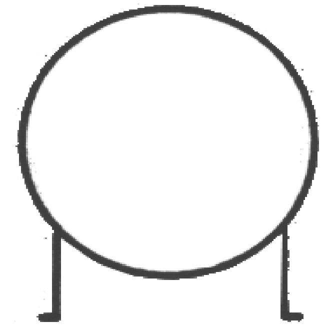
Floating roof



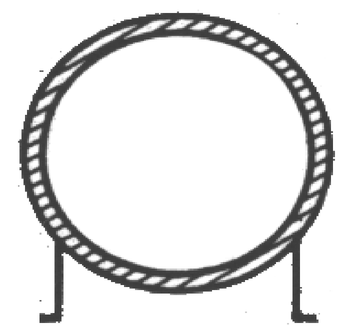
Low temperature

Pressure

Bullet



Sphere



Insulated sphere

Storage Tanks

FIXED ROOF

SPHERICAL

FLOATING ROOF

EXTERNAL

INTERNAL

PONTOON

DOUBLE DECK

OTHERS

Fixed-roof tanks

Fixed-roof tanks are relatively easy to construct and therefore cheaper to build than floating-roof tanks. Because of their closed construction, they are stiff and less sensitive to uneven soil settlements.

The main disadvantage of a fixed-roof tank is product losses due to the escape of vapour from the free space between the oil and the roof through vent openings in the roof.

These losses are either breathing losses, caused by the difference in day and night temperature, or filling losses, The slope of the roof shall be 1:16 or greater if specified by the Purchaser.

At least one fixed-roof manhole complying with this Standard, with a nominal opening of 600 mm (24 in.) or larger, shall be provided in the fixed roof for maintenance ventilation purposes.

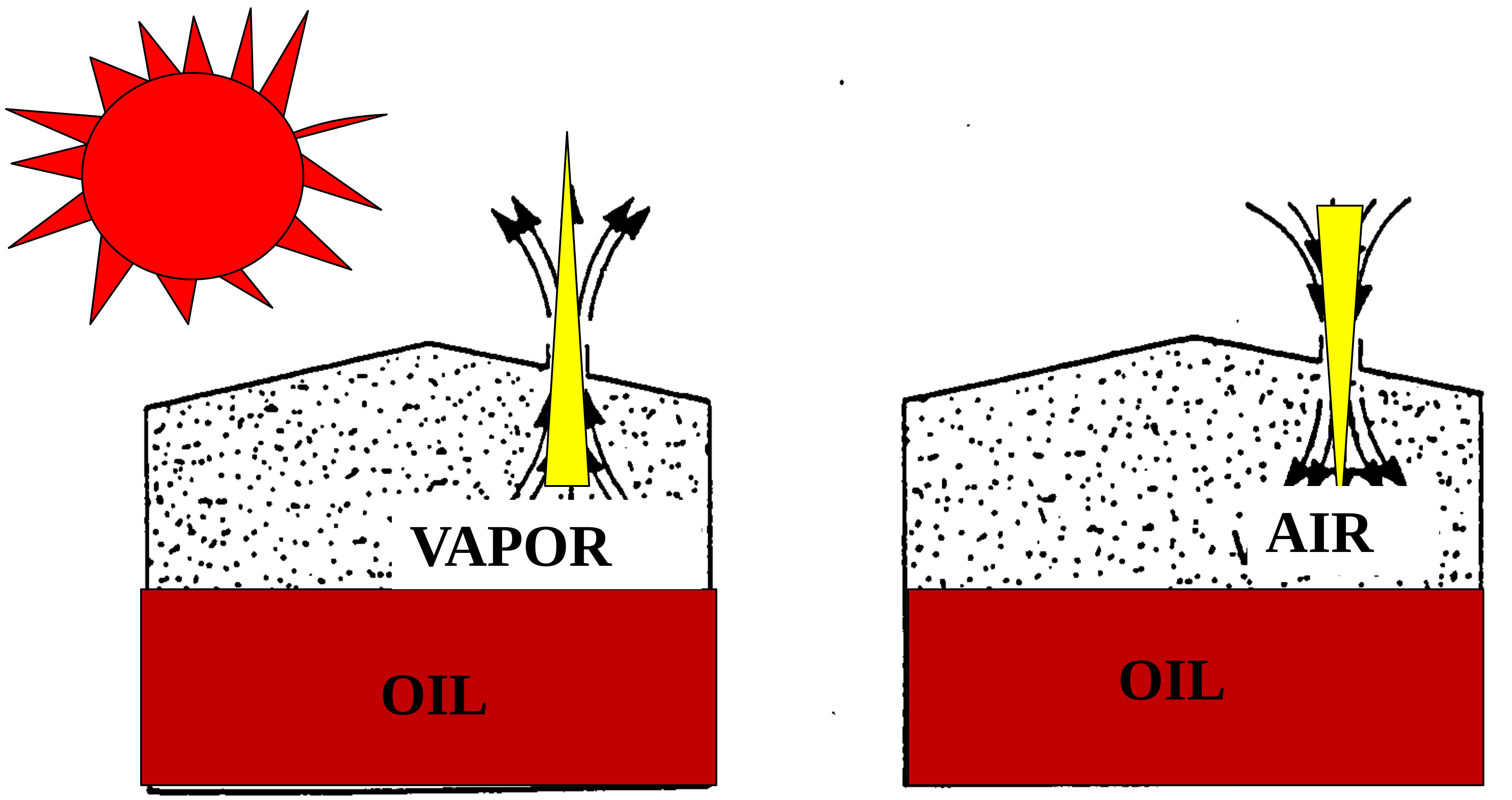
Design External Pressure : Shall not be less than 0.25 kPa (1 in. of water).

Design Internal Pressure : Shall not exceed 18 kPa (2.5 lbf/in.^{2}).

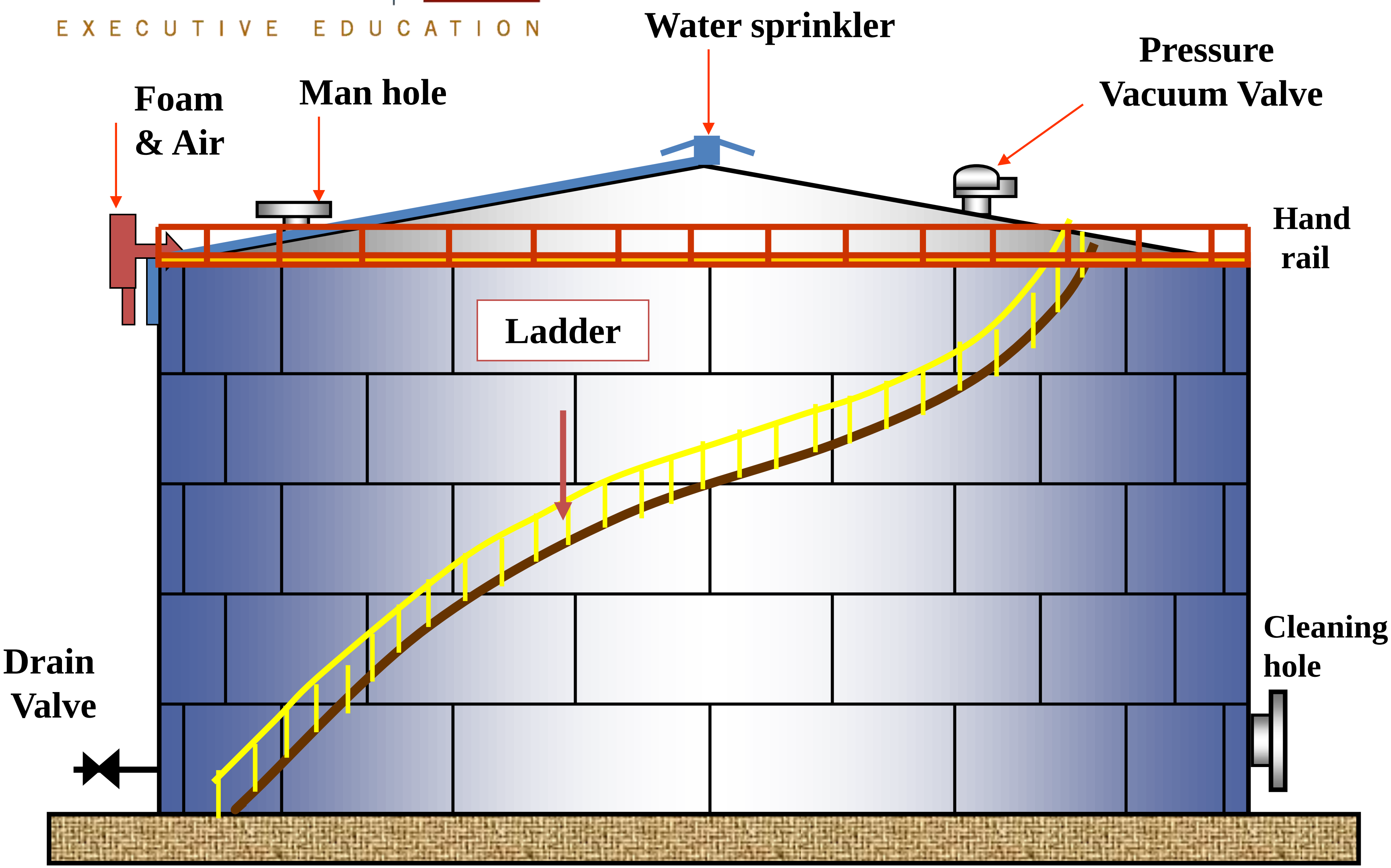
Hydrostatic Test : The load due to filling the tank with water to design liquid level.

(1 bar = 100 kpa)

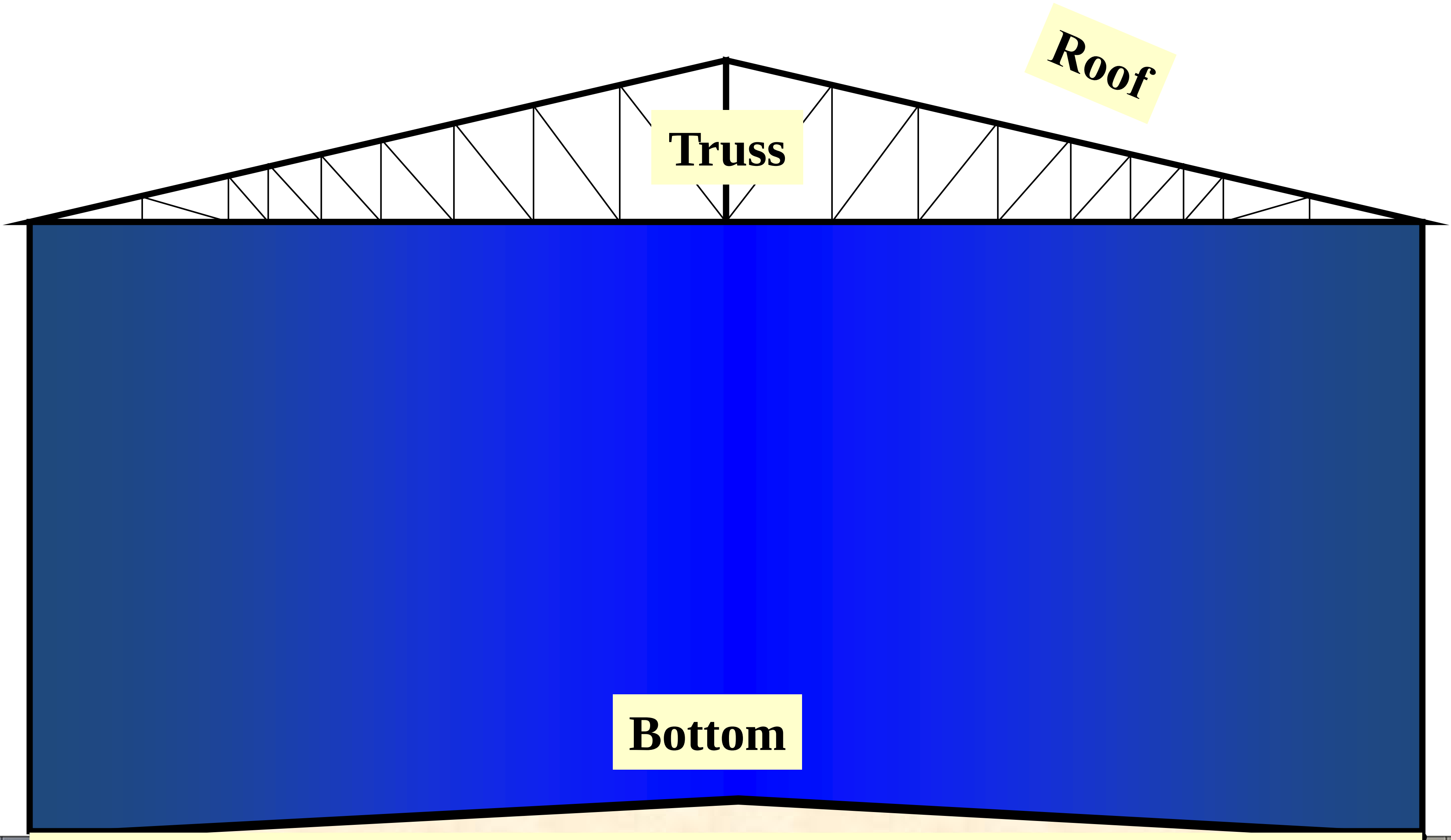
Fixed-roof tanks



FIXED ROOF


Water sprinkler
Pressure Vacuum Valve
Foam & Air
Man hole
Hand rail
Ladder
Drain Valve
Cleaning hole

FIXED ROOF



Floating Roofs

Floating-roofs are completely welded structures, fabricated on site.
The following types can be distinguished:

a. Pontoon roofs
b. Double deck roofs

a. Pontoon Roofs

The surface of the pontoon is 20-25% of the total roof surface. The pontoon is built of compartments which are separated from each other by liquid tight bulkheads. This ensures that a leakage in one of the compartments will be limited to that particular compartment.

A floating roof-tank is opened at the top.
The roof itself is a steel disc which floats on the surface of the oil and rises.

For a floating-roof tank, construction tolerances are rather small due to the fact that the roof must be free to move over most of the height of the tank.

For this reason the permitted ovality is limited by the necessary clearance between the roof and the shell and this narrow tolerance increases the construction costs .
The higher construction costs of a floating-roof tank are outweighed by the advantages, which are:

1- Reduced product loss due to minimized vapour loss
2- Reduced air pollution for the same reason
3- Reduce fire and explosion risk due to very small vapour space.

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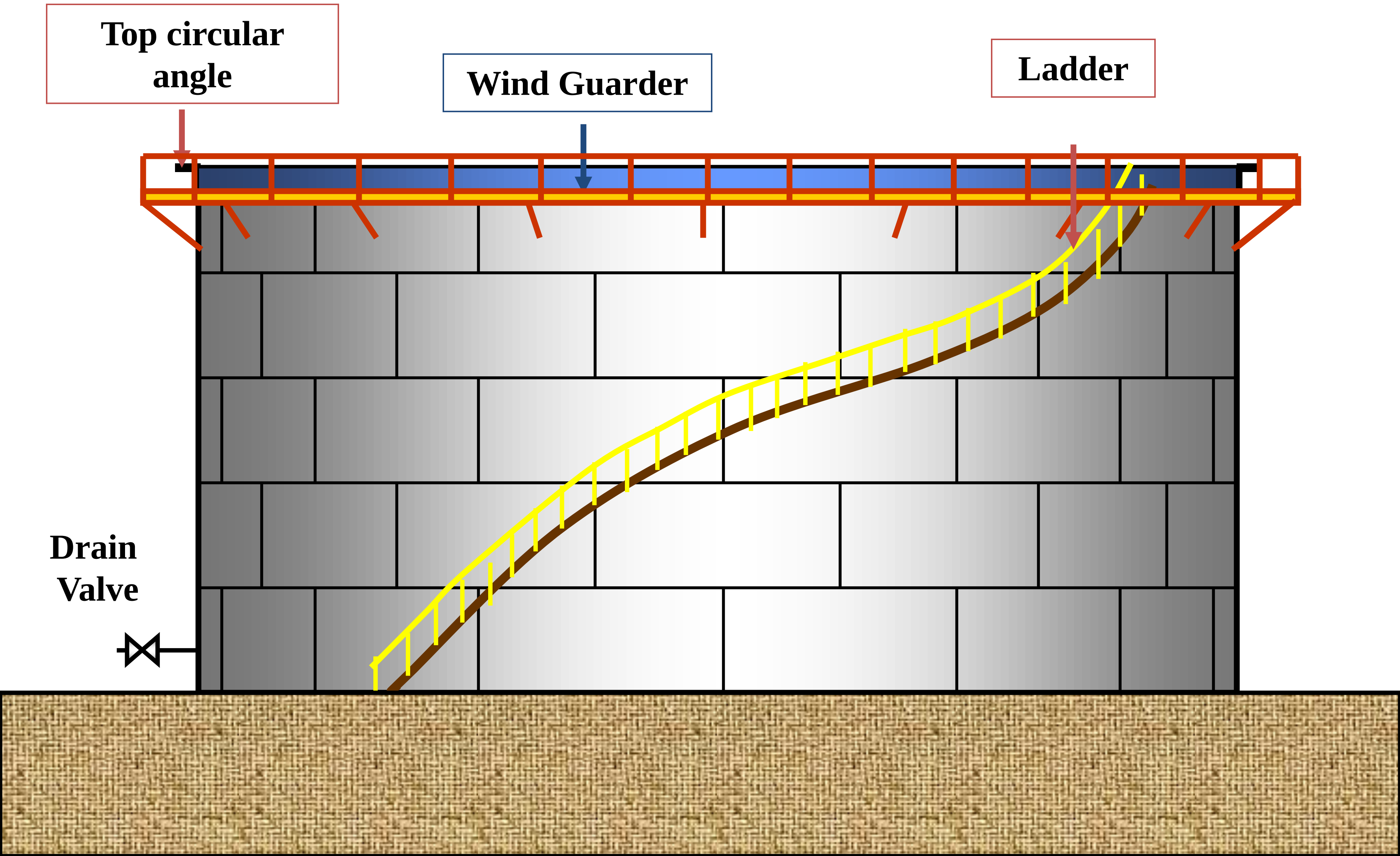
EXTERNAL FLOATING ROOF



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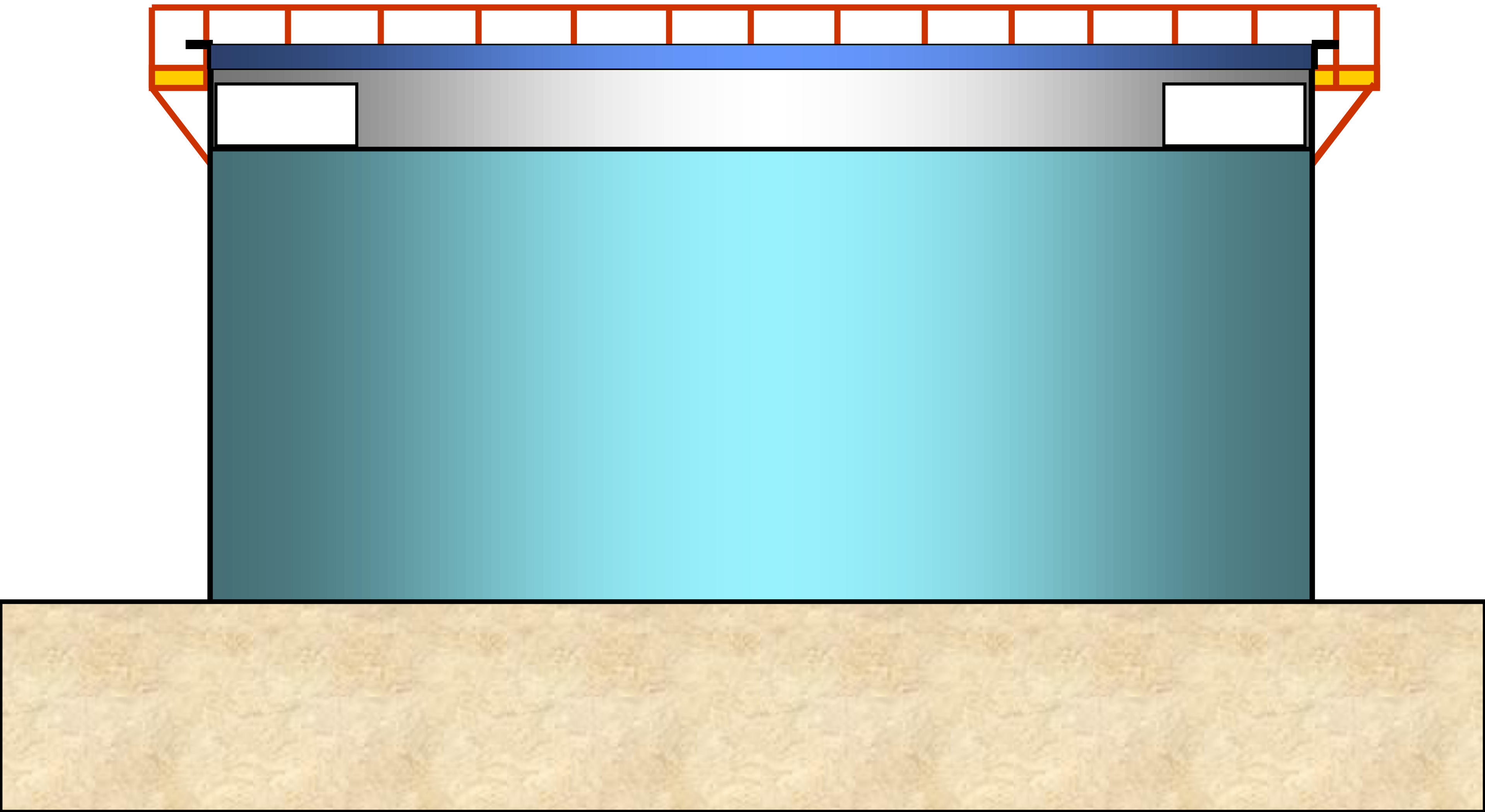
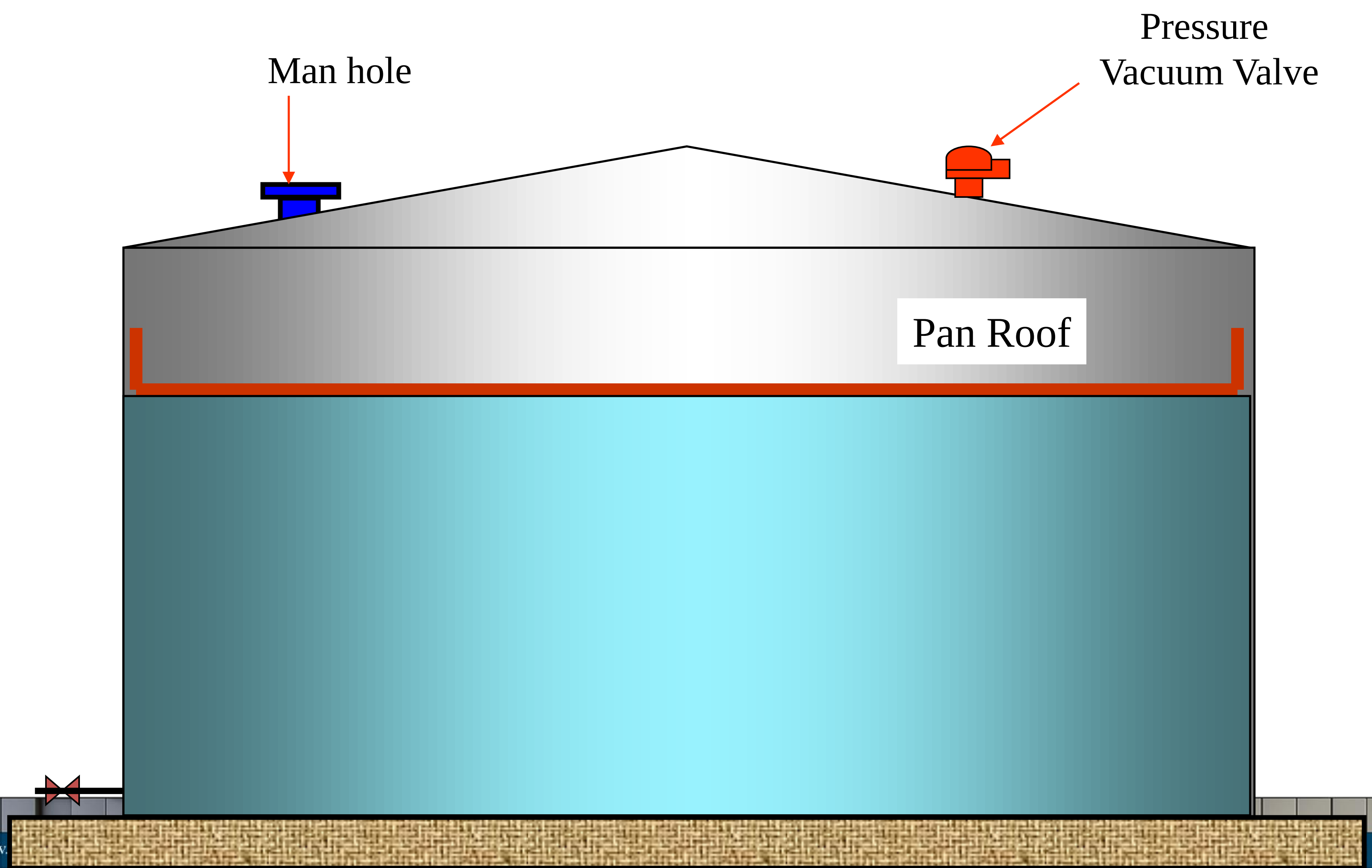
PONTOON



INTERNAL FLOATING COVER



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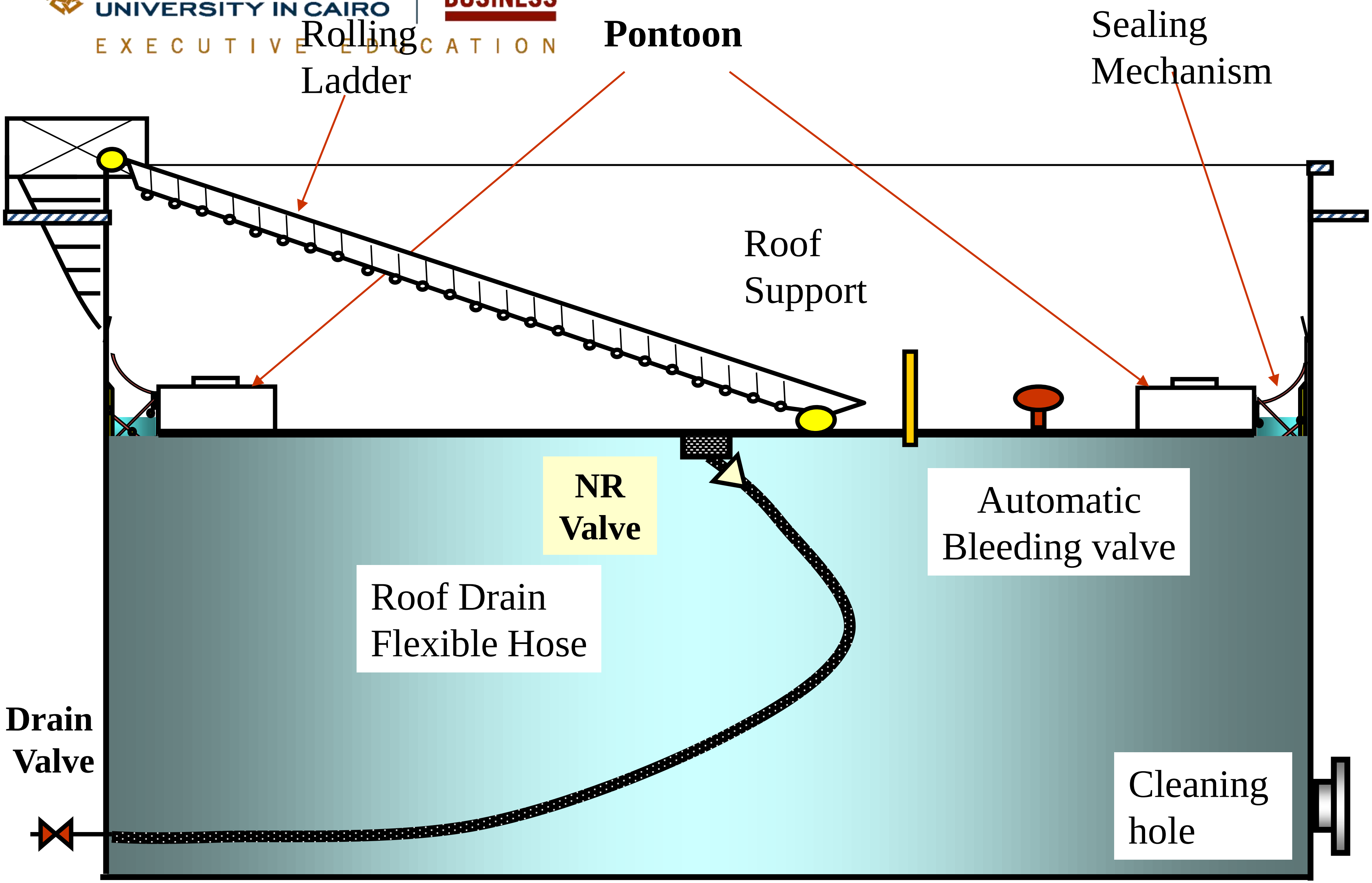
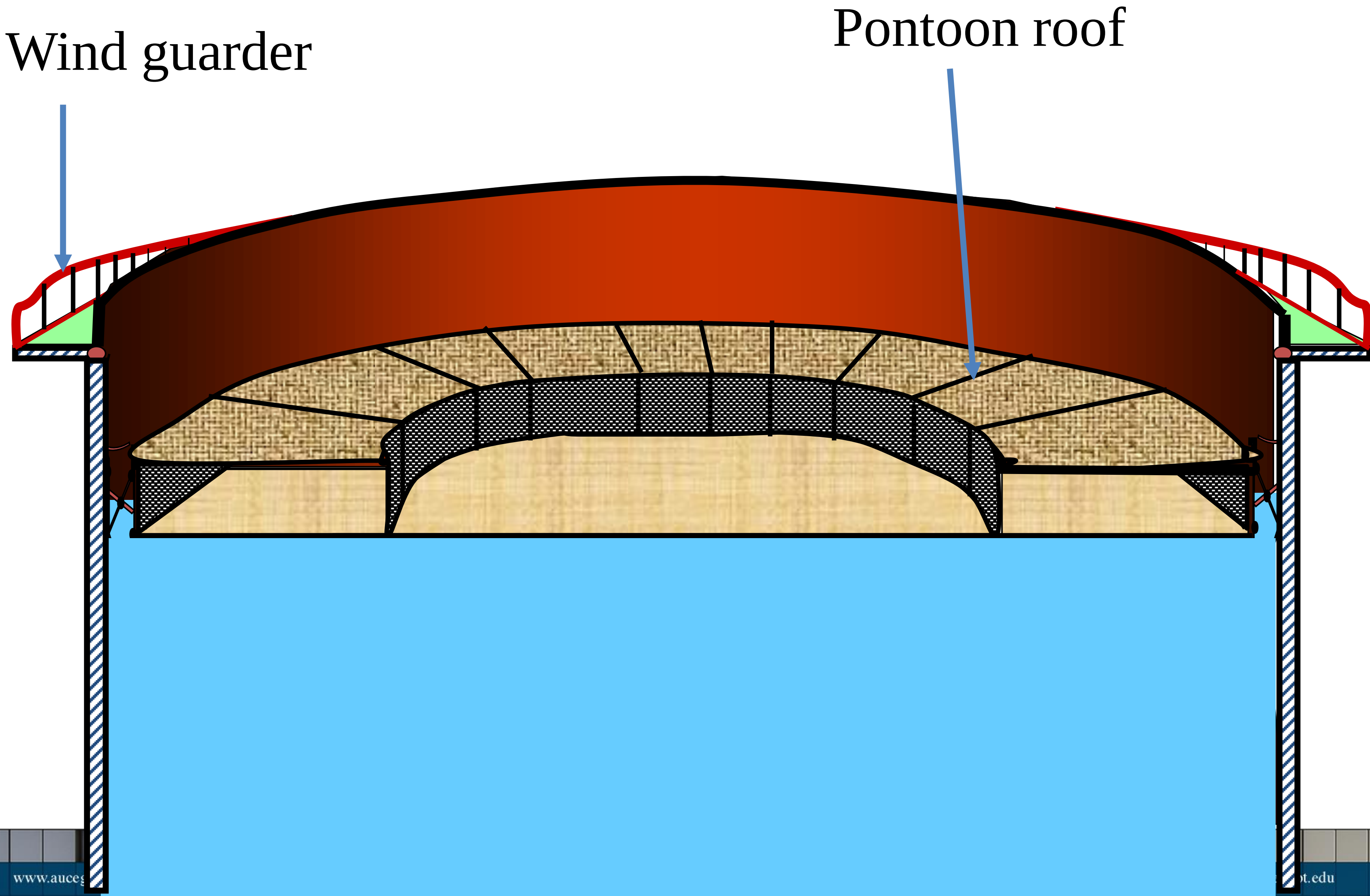


a. Pontoon Roofs

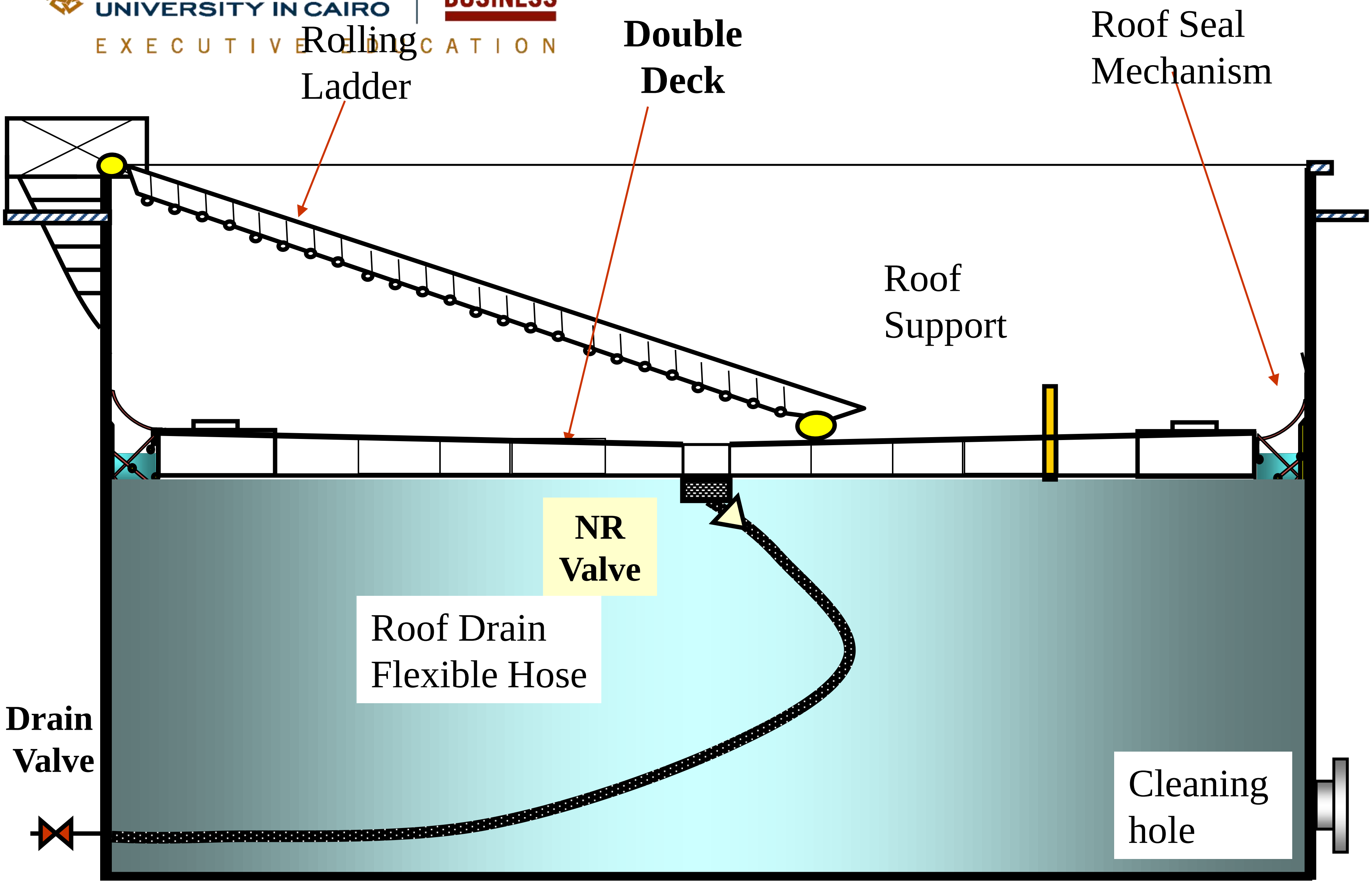


b- Double-Deck Roofs

This type of roof the lower deck rests on the liquid and some distance above this, the upper deck rests on the lower deck, supported by bulkheads and supporting, concentric rings.

The air space between the two decks provides an effective insulation against solar radiation.

Tanks greater than 85 m (280 ft) diameter shall have double deck floating roofs


Rolling Ladder
Double Deck
Roof Seal Mechanism
Roof Support
NR Valve
Roof Drain Flexible Hose
Drain Valve
Cleaning hole

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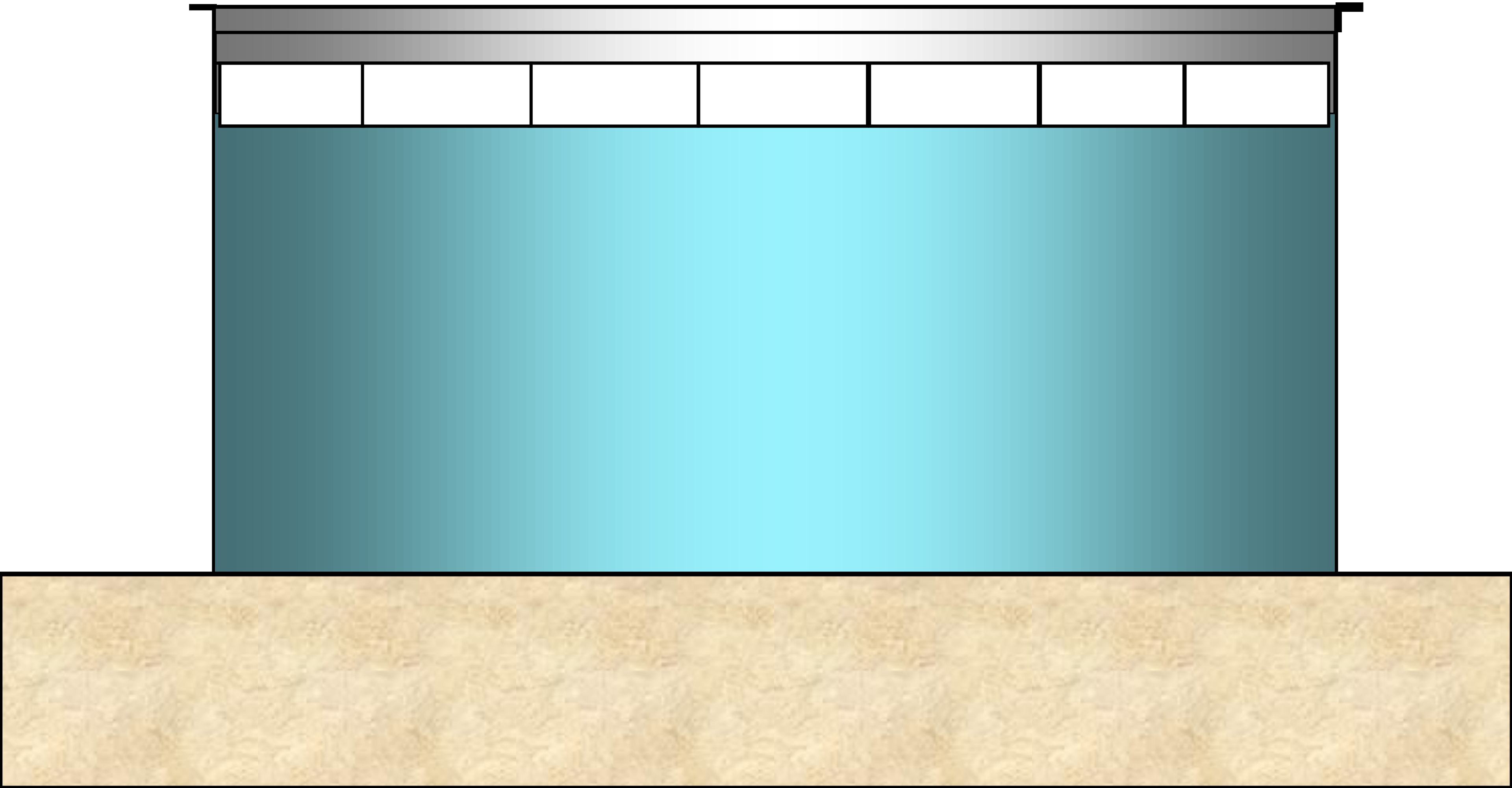
FLOATING ROOF TYPES

DOBLE DICK



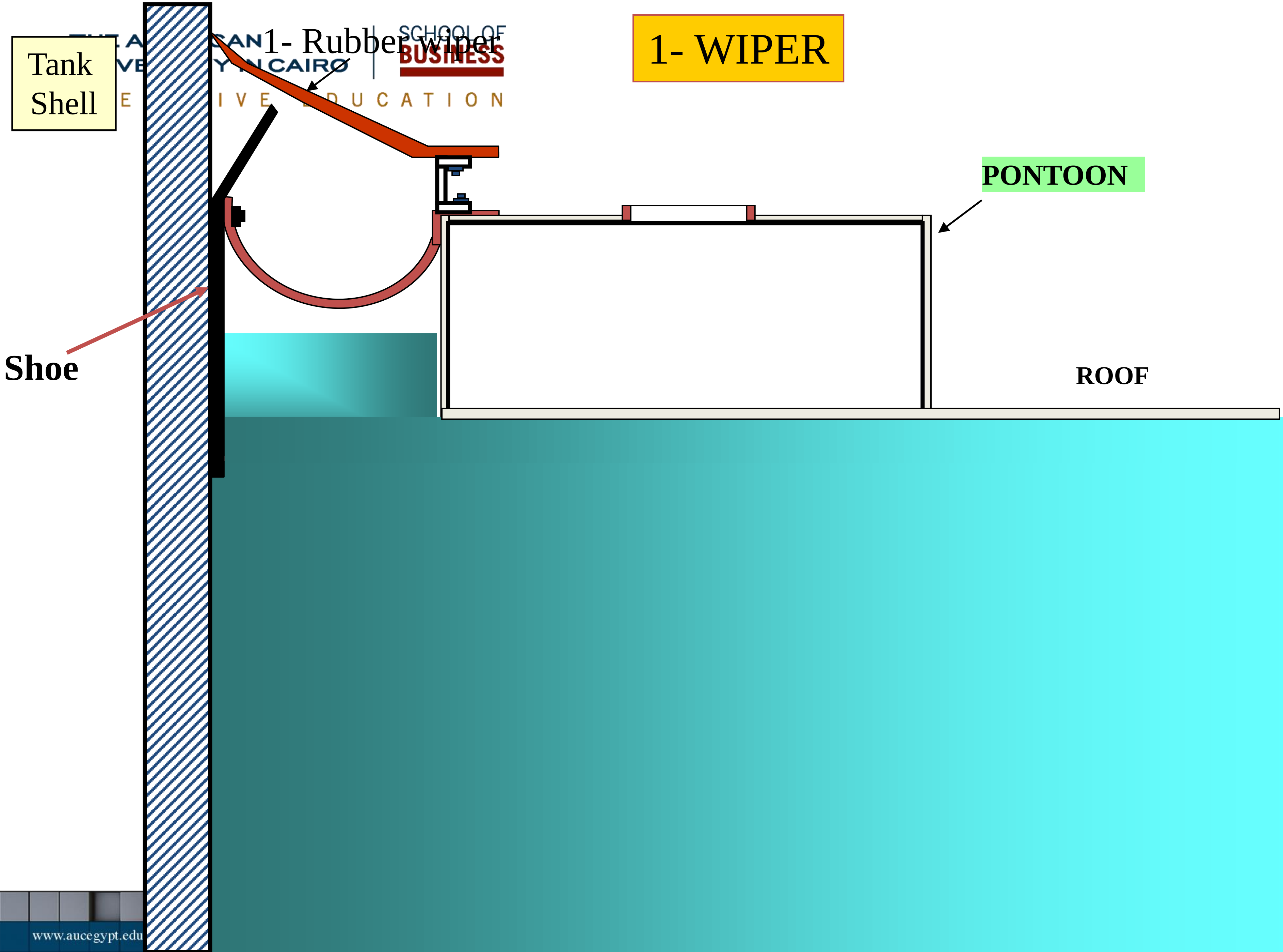
Floating roof Construction Details

Roof Seals

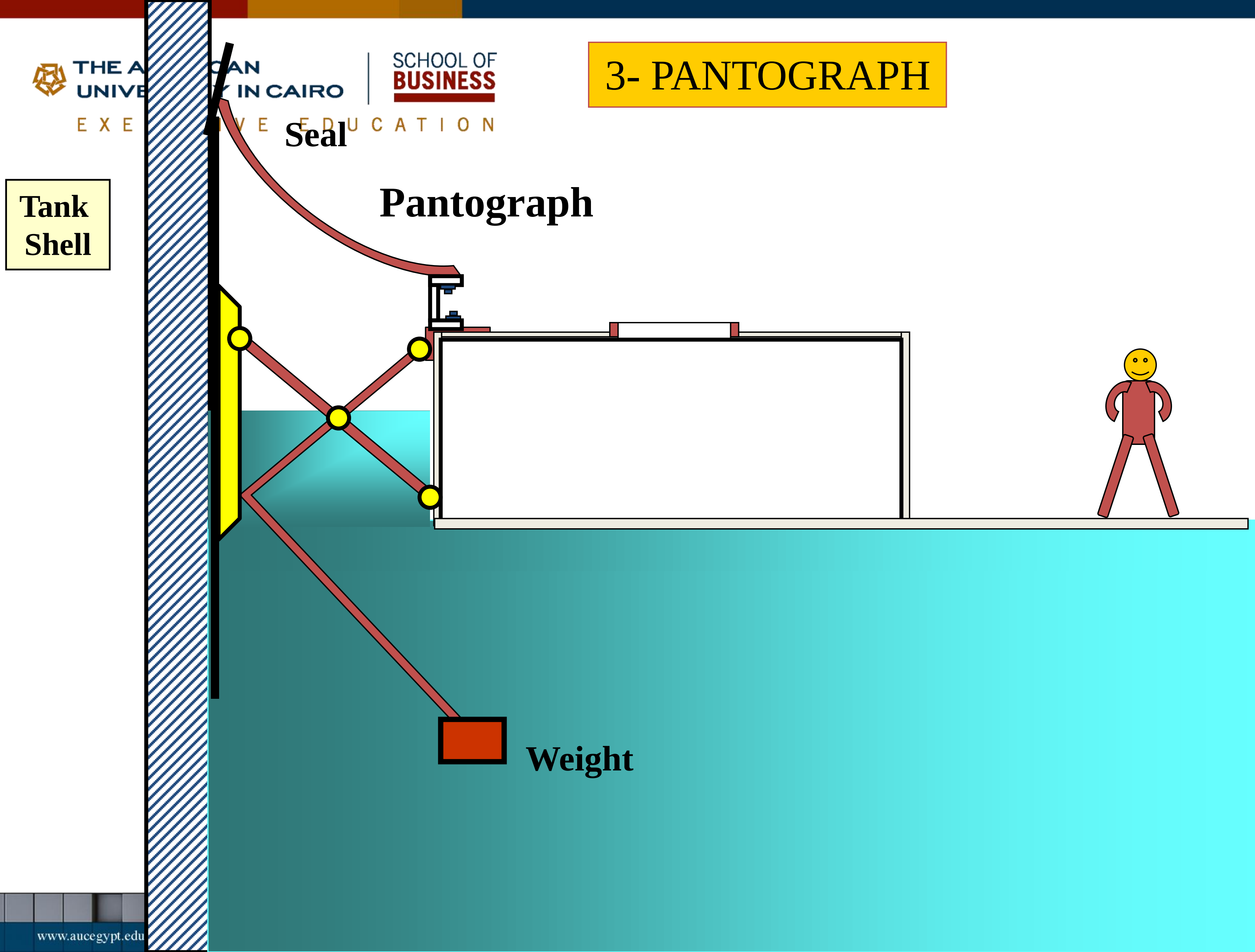
The up and down movement of a floating roof must be smooth and therefore a rim seal is installed between the tank shell and the outside of the floating roof.

This rim seal can move inwards and outwards approximately 100 to 150 mm to compensate for possible non-circularity of the tank shell.

1- WIPER



3- PANTOGRAPH



Roof Drains

Drainage of rainwater is important for the trouble-free operation of a floating-roof tank.

Any rain falling on the roof is collected in a sump at the lowest point of the roof. It is discharged via an articulated steel drain pipe (sometimes through a flexible hose drain) installed between the sump and a nozzle in the lowest course of the shell.

A check valve is installed near the roof end of the pipe to prevent back-flow of stored product in case of leakage of the pipe drain or its swing joints.

Roof Access Ladders

For inspection and maintenance purposes an access ladder is provided from the top of the shell to the roof, running over a rail track on the roof.

Often these ladders are provided with self-levelling stair treads, which are always in a horizontal position. As a consequence the height of small-diameter tanks must always be less than the diameter.

This problem is overcome by installing the rails on which the ladder rolls on an elevated structure on the centre deck.

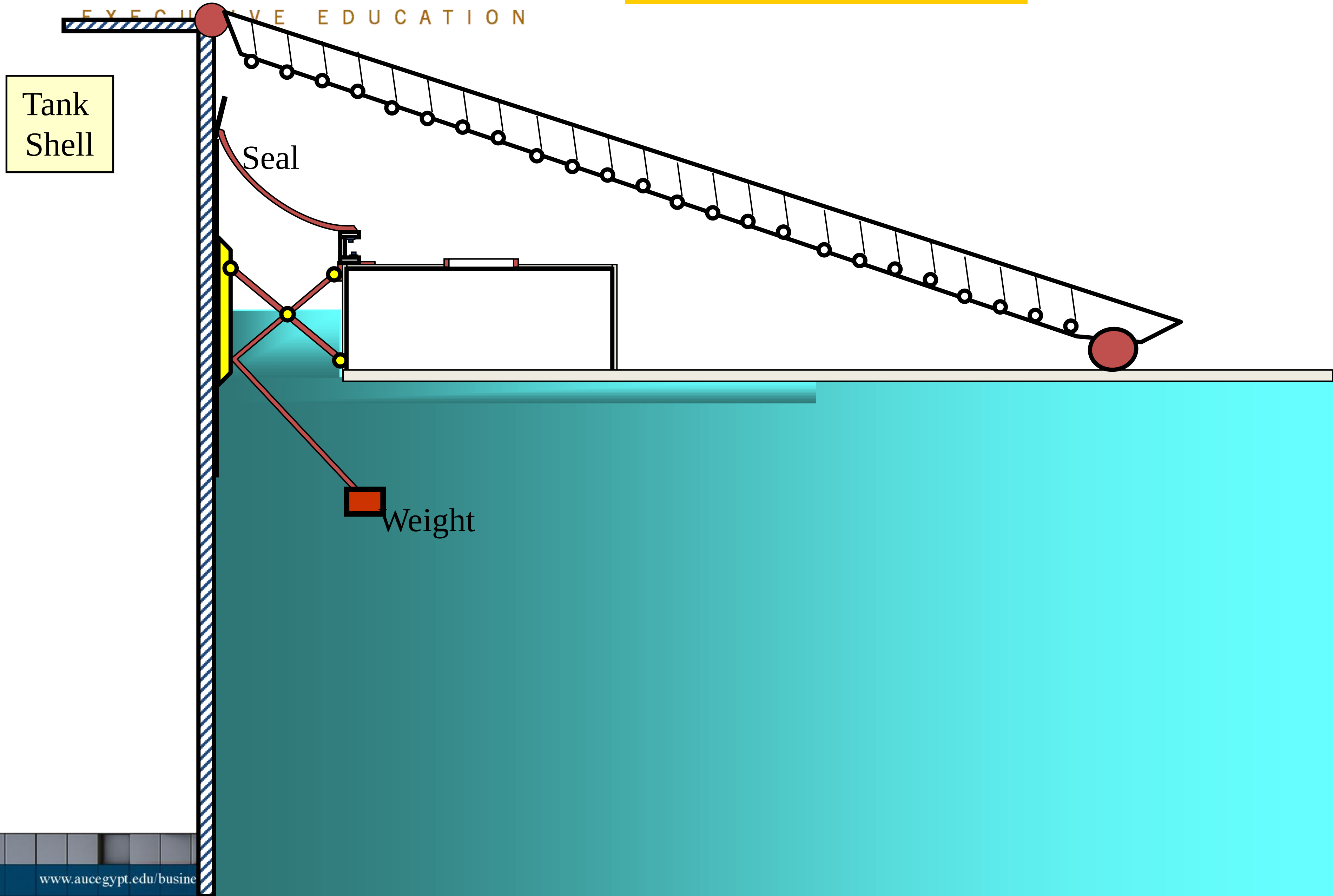
Roof Supports

The floating roof is provided with roof supports, which can be adjusted to two positions.

The first position is approximately 0.9 m above the tank bottom to keep the roof free from all accessories on the tank bottom.

The second position is approximately 1.8 m above the tank bottom for access under the roof during maintenance.

Access Ladder



Access Ladder

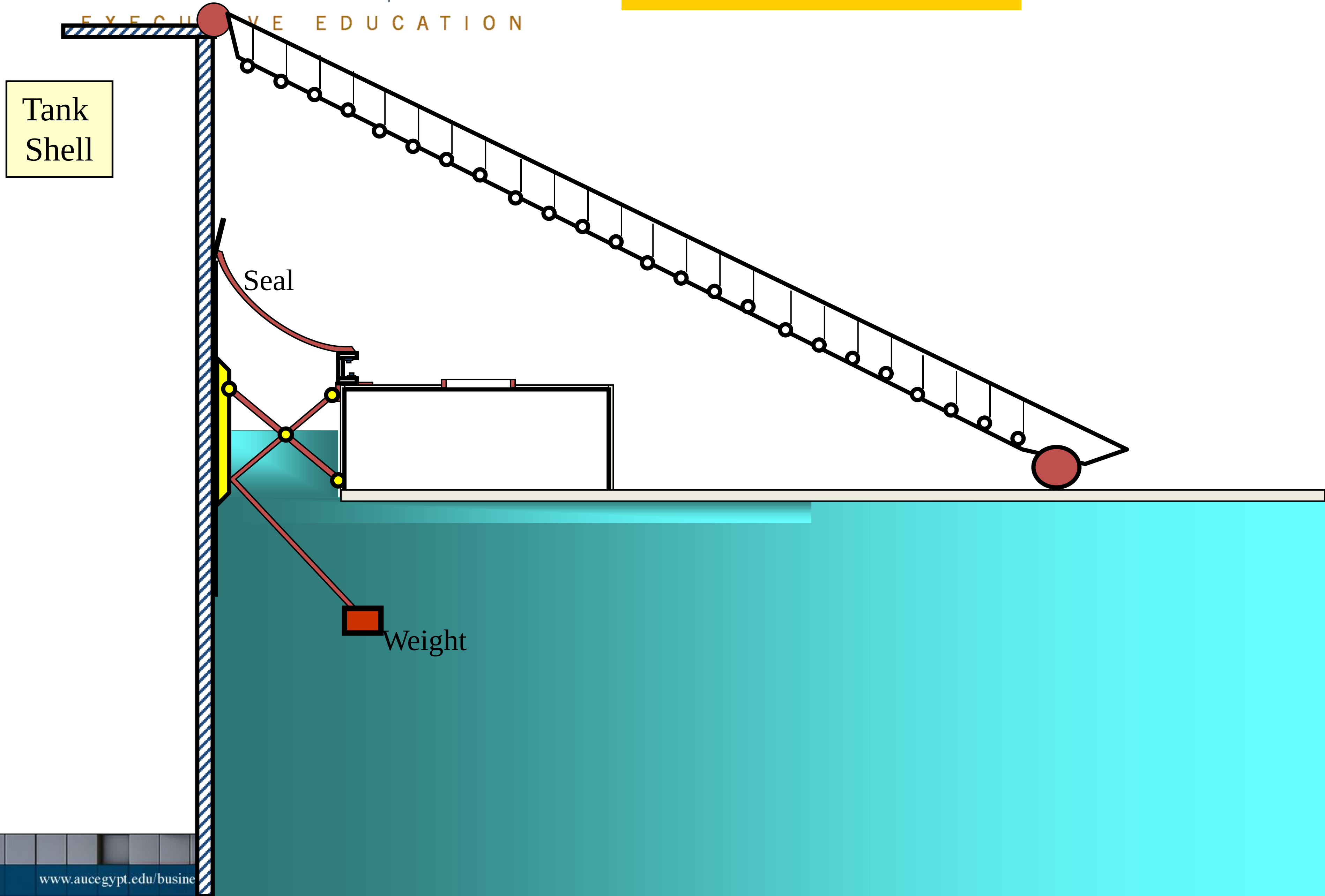


Table 1

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Tank Diameter in meter

Height meter	3	4	6	8	10	12.5	15	17	20	22.5	25	27.5	30	33	36
	Tank Capacity in meter ^{3}														
1	7	12	28	50	78	127	176	240	314	397	490	593	706	855	1117
2	14	24	56	100	156	254	352	480	628	794	980	1186	1412	1710	2234
3	21	36	84	150	234	381	528	720	942	1191	1470	1779	2118	2565	3351
4	28	48	112	200	312	508	704	960	1256	1588	1960	2372	2824	3420	4468
5	35	60	140	250	390	635	880	250	1570	1985	2450	2965	3530	4275	5585
6	42	72	168	300	468	762	1056	1200	1884	2382	2940	3558	4236	5130	6702
7		84	196	350	546	889	1232	1440	2198	2779	3430	4151	4942	5985	7819
8		96	224	400	624	1016	1408	1680	2512	3176	3920	4744	5648	6840	8936
9			252	450	702	1143	1584	1920	2826	3573	4410	5337	6354	7695	10053
10			280	500	780	1270	1760	2400	3140	3970	4900	5930	7060	8550	11170
11				550	858	1397	1936	2680	3454	4367	5390	550	7766	9405	12287

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Guide line to help in Petroleum products Tanks choice

	FIXED ROOF	FLOATING ROOF	PRESSURE STORAGE	VAPOR RECOVERY
VAPOR PRESSURE LESS THAN 1.5 PSIA	X			
VAPOR PRESSURE FROM 1.5 PSIA TO 11.1 PSIA		X		
VAPOR PRESSURE >11.1 PSIA			X	X

Reference: ETP Environmental Protection Agency

STORAGE BASED ON (ETP)

	FIXED ROOF	FLOATING ROOF	PRESSURE STORAGE
CRUDE		X	
KEROSENE, JET FUEL GASOLINE NAPHTHA		X	
DIESEL GAS OIL FUEL OIL ASPHALT	X		
HYDROCARBON ABOVE V.P 11.1 PSIA			X

Refrigerated Storage

Refrigerated Storage

The decision to use refrigerated storage in lieu of pressurized storage is generally a function of the volume of the liquid to be stored, the fill rate, the physical and thermodynamic properties of the liquid to be stored, and the capital investment and operating expenses of each type of system.

The parameters involved in selecting the optimum refrigerated storage facility are:

- Quantity and quality of product to be stored.
- Fill rate, temperature, and pressure of incoming stream.
- Shipping conditions for the product.
- Composition of the product.
- Cooling media (air, water, etc.) available.
- Availability and cost of utilities.
- Load bearing value of soil.

	Boiling point ^0C	Specific gravity
Ammonia NH_3	- 33	0.68
Methane CH_4	- 162	0.43
Ethane C_2H_6	- 88	0.38
Propane C_3H_8	- 42	0.51
Butane C_4H_{10}	- 0.5	0.58
Oxygen O_2	- 183	1.14
Nitrogen N_2	- 196	0.81

When using refrigerated storage, the liquid to be stored is normally chilled to its bubble point temperature at atmospheric pressure. Refrigerated storage tanks normally operate at an internal pressure between 3 and 15 kPa (ga).

In some cases, pressurized-refrigerated storage is attractive. In this type of refrigerated storage, the product to be stored is chilled to a temperature that allows it to be stored at a pressure somewhere between atmospheric pressure and its vapor pressure at ambient temperature.

Refrigeration requirements normally include the following basic functions:

- Cooling the filling stream to storage temperature.
- Re-liquefying product vaporized by heat leak into the system.
- Liquefying vapors displaced by the incoming liquid.

Other factors which should be considered are:

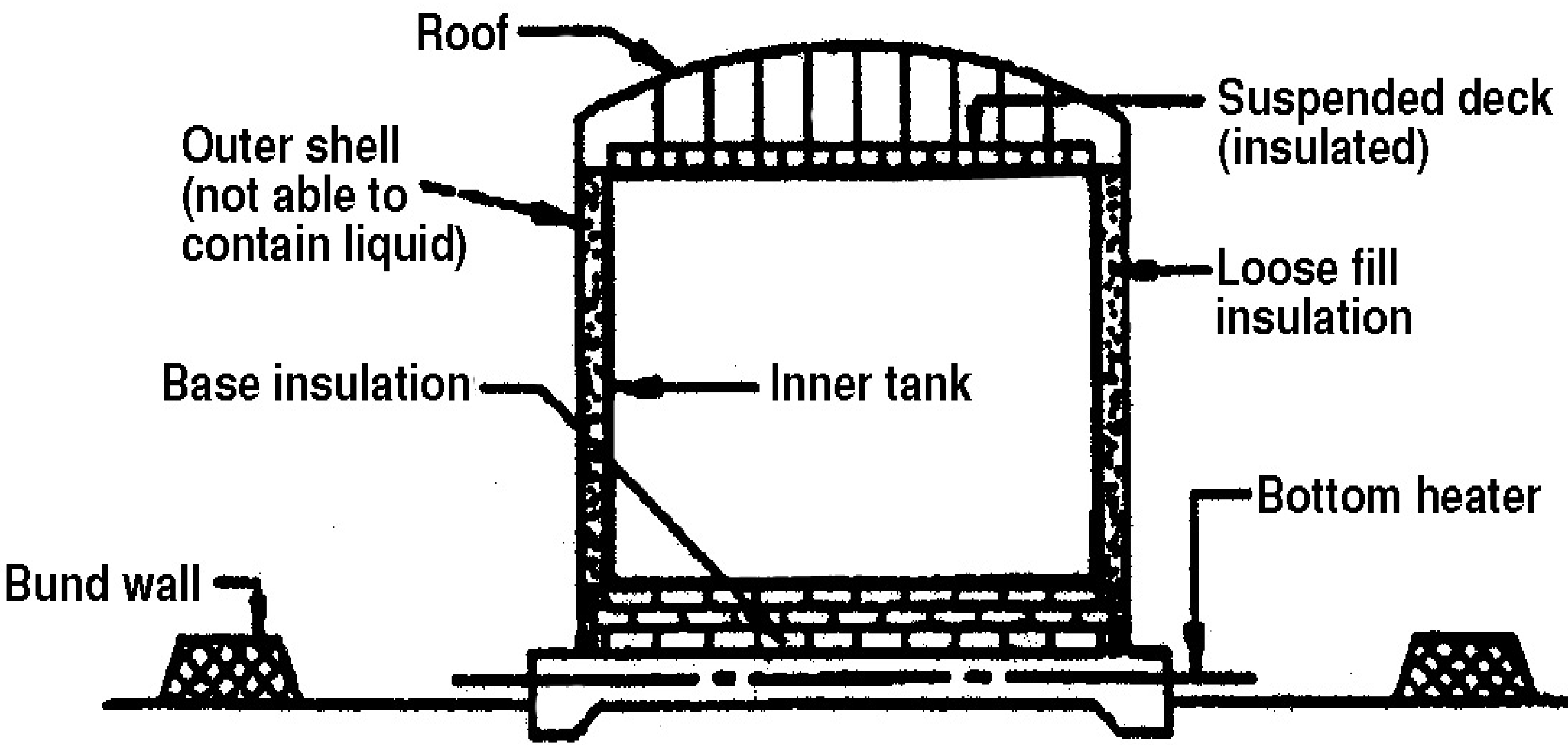
- Pump energy requirements
- Barometric pressure variations
- Product compositions
- Solar radiation effects
- Superheated products

Single Containment Tank

Either a single tank or a tank comprising an inner tank and an outer container designed and constructed so that only the inner tank is required to meet the low temperature ductility requirements for storage of the product.

Spherical Pressure Vessel

Single Containment Tank

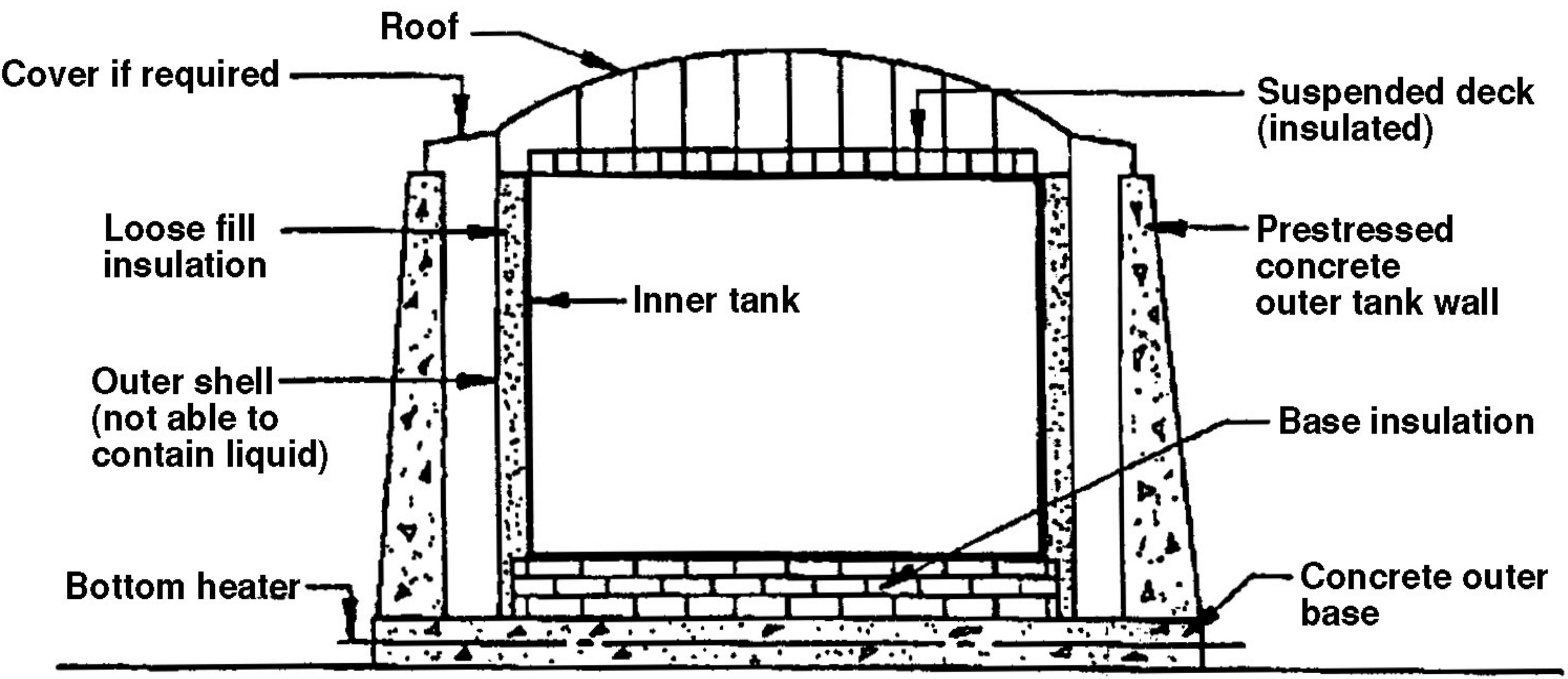


Double Containment Tank

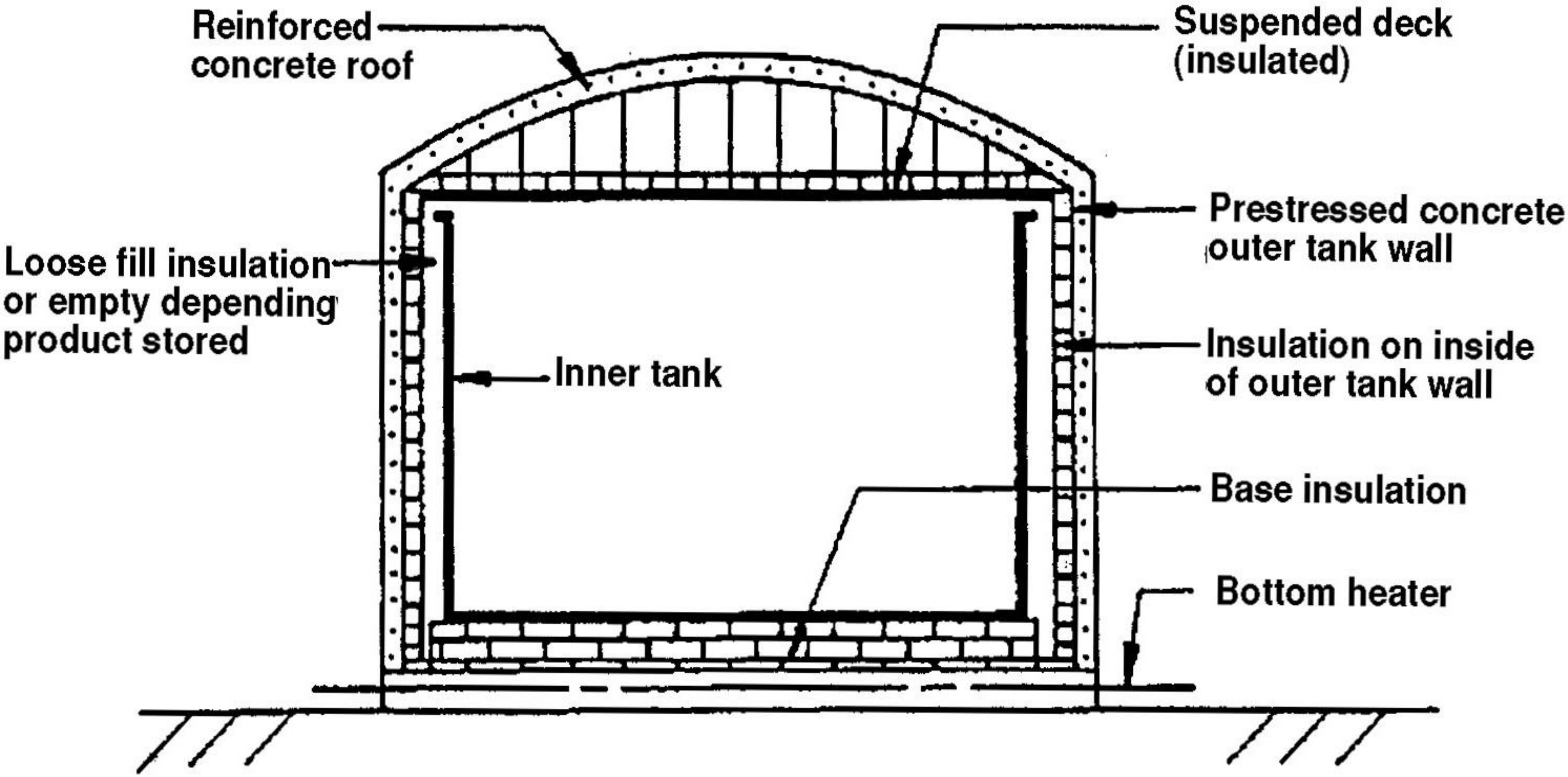
A double tank designed and constructed so that both the inner tank and the outer tank are capable of independently containing the refrigerated liquid stored.
To minimize the pool of escaping liquid, the outer tank or wall is located at a distance not exceeding 6 m from the inner tank.

The inner tank contains the refrigerated liquid under normal operating conditions.
The outer tank or wall is intended to contain the refrigerated liquid product leakage from the inner tank, but it is not intended to contain any vapor resulting from product leakage from the inner tank.

Double Containment Tank



Full Containment Tank



SPHERICAL TANKS

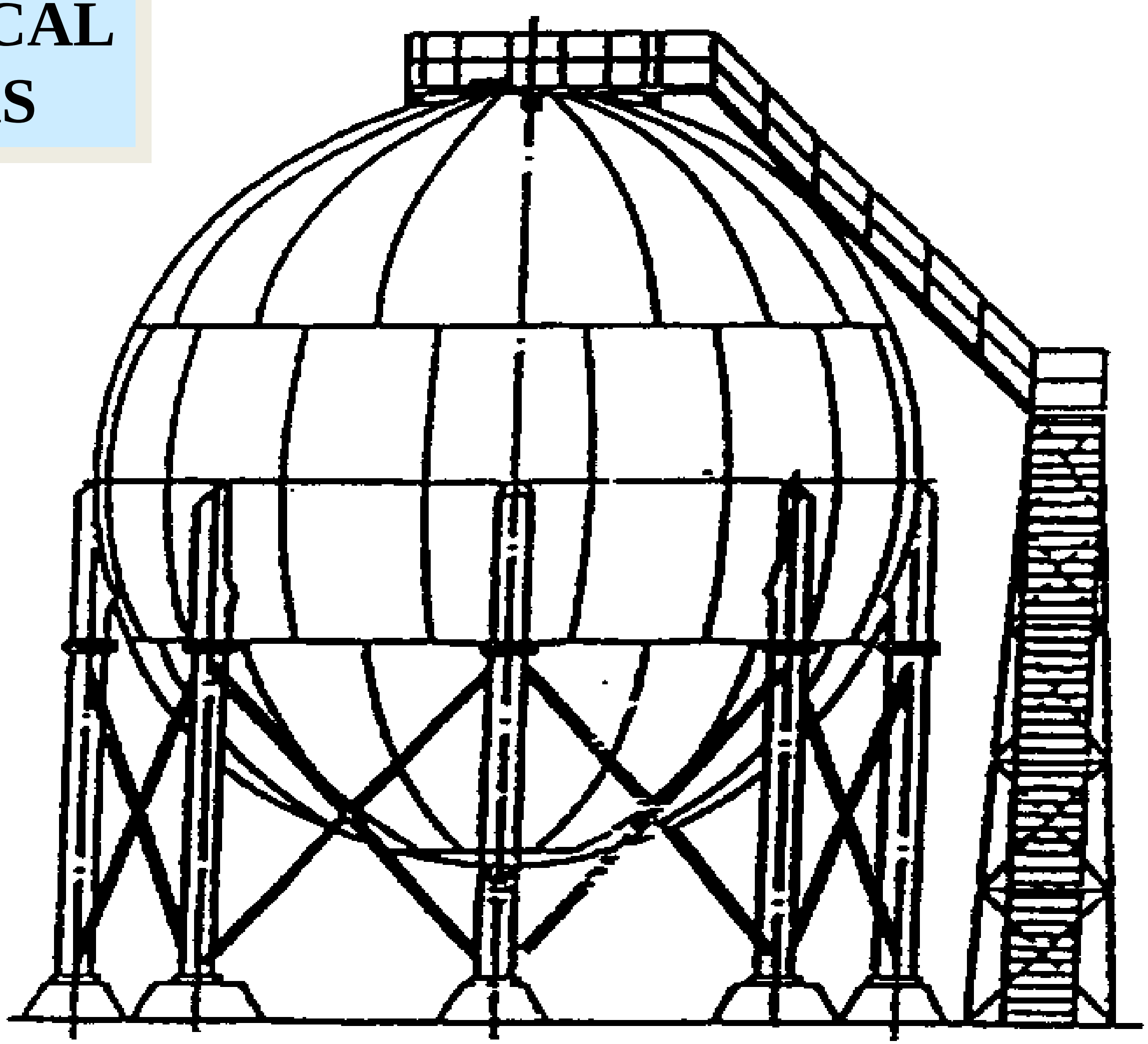
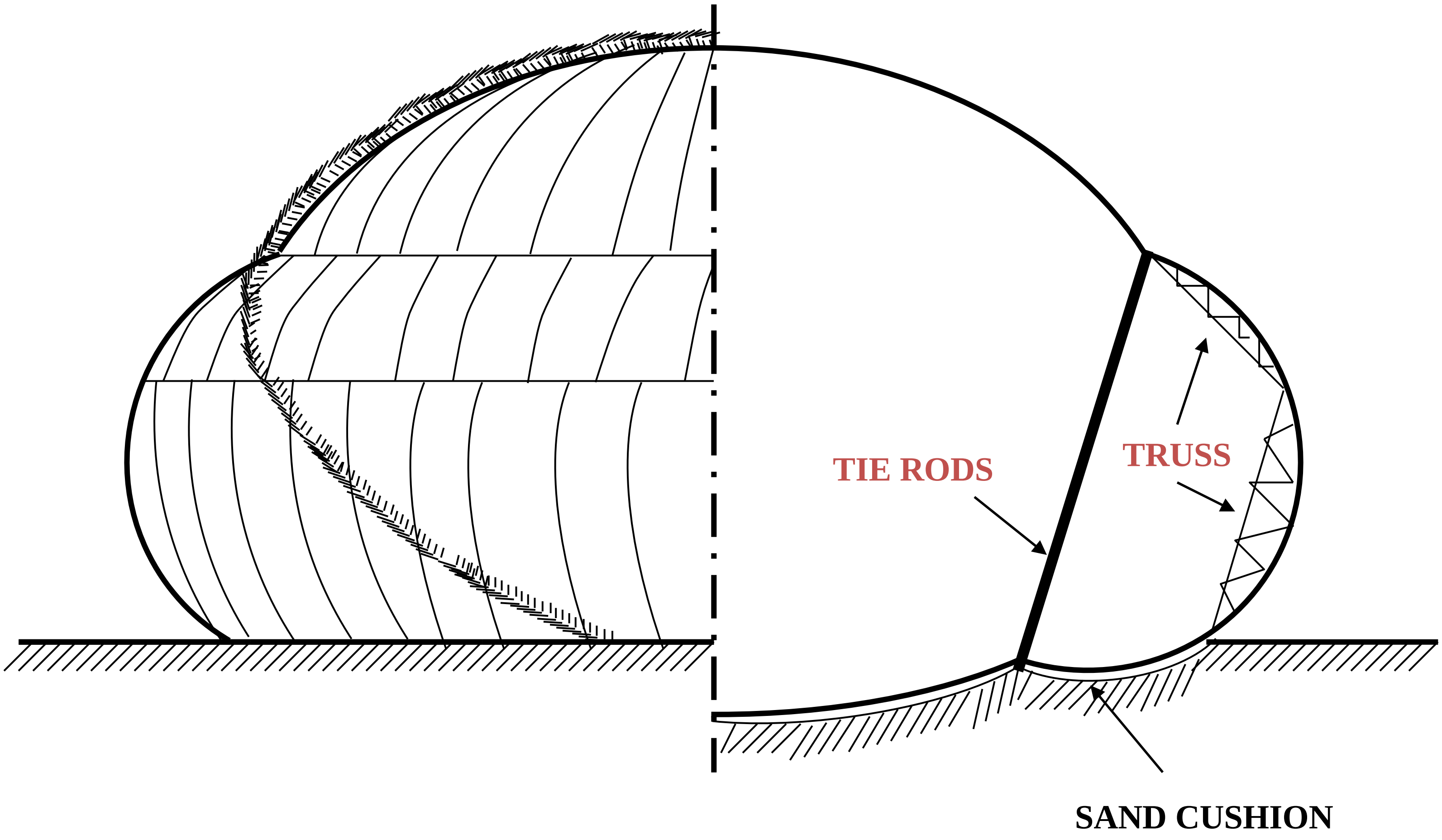


Fig.4

LOW PRESSURE STORAGE NODED SPHEROID TYPE



40,000 BARREL CAPACITY

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Domed Roof Design Pressure

- API 620 – Low Pressure (0.5 < 15 psig)

STORAGE TANKS FITTINGS

• PIPING FITTINGS

- VALVES
- FLANGES
- GASKETS
- ELBOWS
- REDUCERS
- TEES
- BLENDS
- OTHERS

TANKS PIPING FITTING CLASSIFICATION

- AND CLASSIFIED BY RATED PRESSURE(LB)

150 300 , 400 , 600 , 900 , 1500 , 2500

OR

A , B , C , D , E , F , G (clean)

AA , BB , CC , DD , EE , FF , GG (sour)

RATED PRESSURE(LB)

150 , 300 , 400 , 600 , 900 , 1500 , 2500

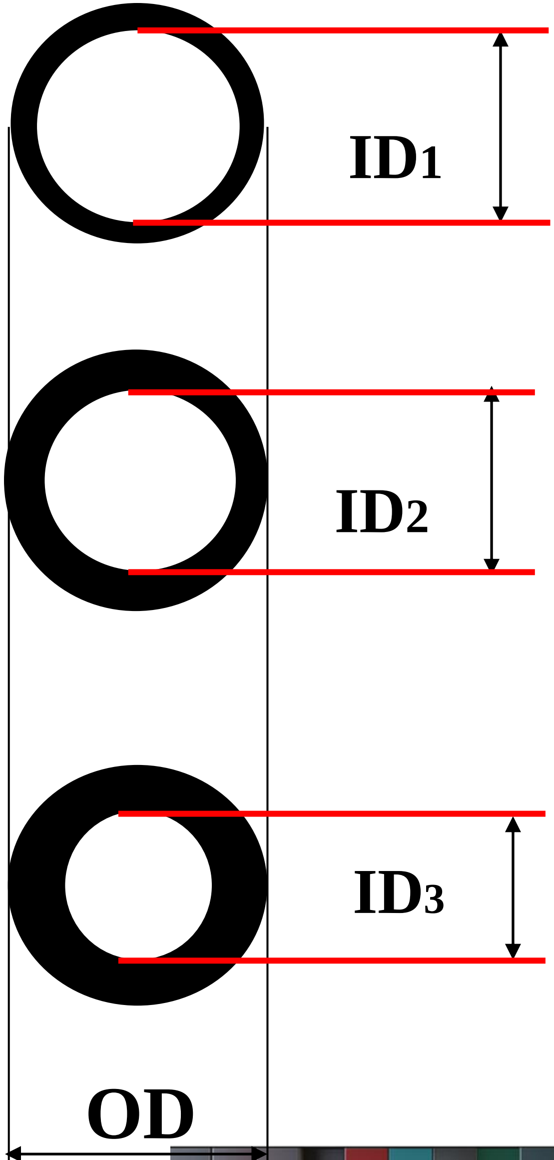
- THIS PRESSURE VALUES ARE NOT THE PIPING WORKING PRESSURES

- PIPING WORKING PRESSURES CAN BE OBTAIED FROM TABLES AGAINST TEMPERATURE

TABLE D1 RATING CEILING VALUES

TEMPERATURE F	WORKING PRESSURES psig						
	150	300	400	600	900	1500	2500
-20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000

PIPING SCHEDULE



PIPE SCH. 40#   (STD PIPE)

PIPE SCH. 80#   (X STRONG)

PIPE SCH. 160#   (XX STRONG)

FLANGED FITTINGS STANDARDS

	ASME B16.5	ASME B16.47
SIZE	½" UP TO 24 "	26 " UP TO 60 "
RATE	150 # UP TO 2500 #	75 # UP TO 900#

- **ALL PIPES WITH THE SAME NOMINAL PIPE SIZE HAVE THE SAME <u>O.D</u>**

- **NOMINAL PIPE SIZE IS NOT EQUAL TO <u>OD.</u> OR <u>ID.</u>**

- **NOMINAL PIPE SIZE IS EQUAL TO <u>O.D.</u>**

FOR PIPES SIZE 14 INCHS AND LARGER

(This Annex is not part of ASME/ANSI B16.5-1988 and is included for information only.)

TABLE C1 DIMENSIONS OF WELDED AND SEAMLESS STEEL PIPE (ANSI/ASME B36.10M)

Listed by Schedule Numbers

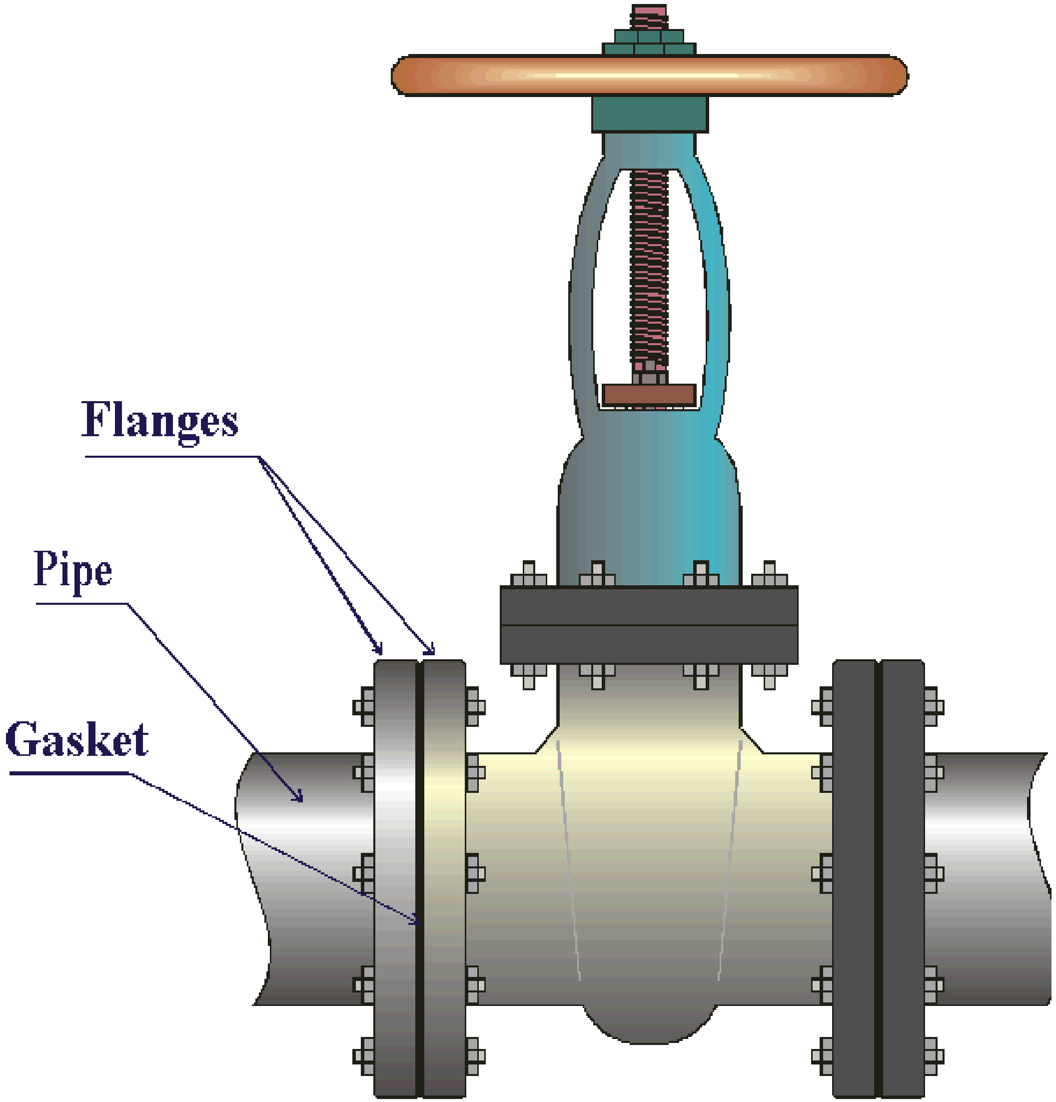
Nominal Pipe Size	Outside Diameter, in.	Schedule 10 in.	Schedule 20 in.	Schedule 30 in.	Schedule 40 in.	Schedule 60 in.	Schedule 80 in.	Schedule 100 in.	Schedule 120 in.	Schedule 140 in.	Schedule 160 in.
1/8	0.405	...	...	...	0.068	...	0.095	...	...	...	...
1/4	0.540	...	...	...	0.088	...	0.119	...	...	...	...
3/8	0.675	...	...	...	0.091	...	0.126	...	...	...	...
1/2	0.840	...	...	...	0.109	...	0.147	...	...	...	0.188
3/4	1.050	...	...	...	0.113	...	0.154	...	...	...	0.219
1	1.315	...	...	...	0.133	...	0.179	...	...	...	0.250
1 1/4	1.660	...	...	...	0.140	...	0.191	...	...	...	0.250
1 1/2	1.900	...	...	...	0.145	...	0.200	...	...	...	0.281
2	2.375	...	...	...	0.154	...	0.218	...	...	...	0.344
2 1/2	2.875	...	...	...	0.203	...	0.276	...	...	...	0.375
3	3.500	...	...	...	0.216	...	0.300	...	...	...	0.438
3 1/2	4.000	...	...	...	0.226	...	0.318	...	...	...	...
4	4.500	...	...	...	0.237	...	0.337	...	0.438	...	0.531
5	5.563	...	...	...	0.258	...	0.375	...	0.500	...	0.625
6	6.625	...	...	...	0.280	...	0.432	...	0.562	...	0.719
8	8.625	...	0.250	0.277	0.322	0.406	0.500	0.594	0.719	0.812	0.906
10	10.750	...	0.250	0.307	0.365	0.500	0.594	0.719	0.844	1.000	1.125
12	12.750	...	0.250	0.330	0.406	0.562	0.688	0.844	1.000	1.125	1.312
14	14.000	0.250	0.312	0.375	0.438	0.594	0.750	0.938	1.094	1.250	1.406
16	16.000	0.250	0.312	0.375	0.500	0.656	0.844	1.031	1.219	1.438	1.594
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

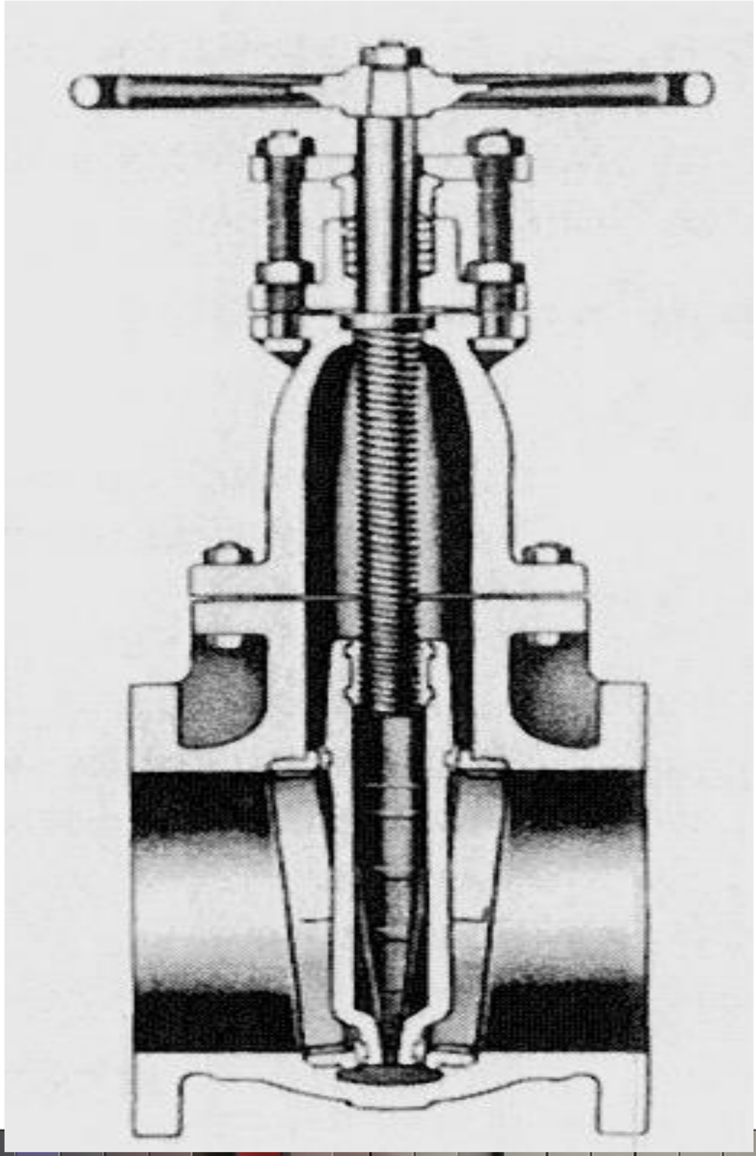
TABLE B1 DIMENSIONS OF WELDED AND SEAMLESS STEEL PIPE (ANSI/ASME B36.10M)

Listed as Standard Wall, Extra Strong, and Double Extra Strong Wall

		Wall Thickness, in.		
NOMINAL SIZE	OD"	STANDARD WALL	EXTRA STRONG	DOUBLE EXTRA STRONG
1/8	0.405	0.068	0.095	. . .
1/4	0.540	0.088	0.119	. . .
3/8	0.675	0.091	0.126	. . .
1/2	0.840	0.109	0.147	0.294
3/4	1.050	0.113	0.154	0.308
1	1.315	0.133	0.179	0.358
1 1/4	1.660	0.140	0.191	0.382
1 1/2	1.900	0.145	0.200	0.400
2	2.375	0.154	0.218	0.436
2 1/2	2.875	0.203	0.276	0.552
3	3.500	0.216	0.300	0.600
3 1/2	4.000	0.226	0.318	. . .
4	4.500	0.237	0.337	0.674
5	5.563	0.258	0.375	0.750
6	6.625	0.280	0.432	0.864
8	8.625	0.322	0.500	0.875
10	10.750	0.365	0.500	1.000
12	12.750	0.375	0.500	1.000
14	14.000	0.375	0.500	. . .
16	16.000	0.375	0.500	. . .
18	18.000	0.375	0.500	. . .

* GATE VALVES



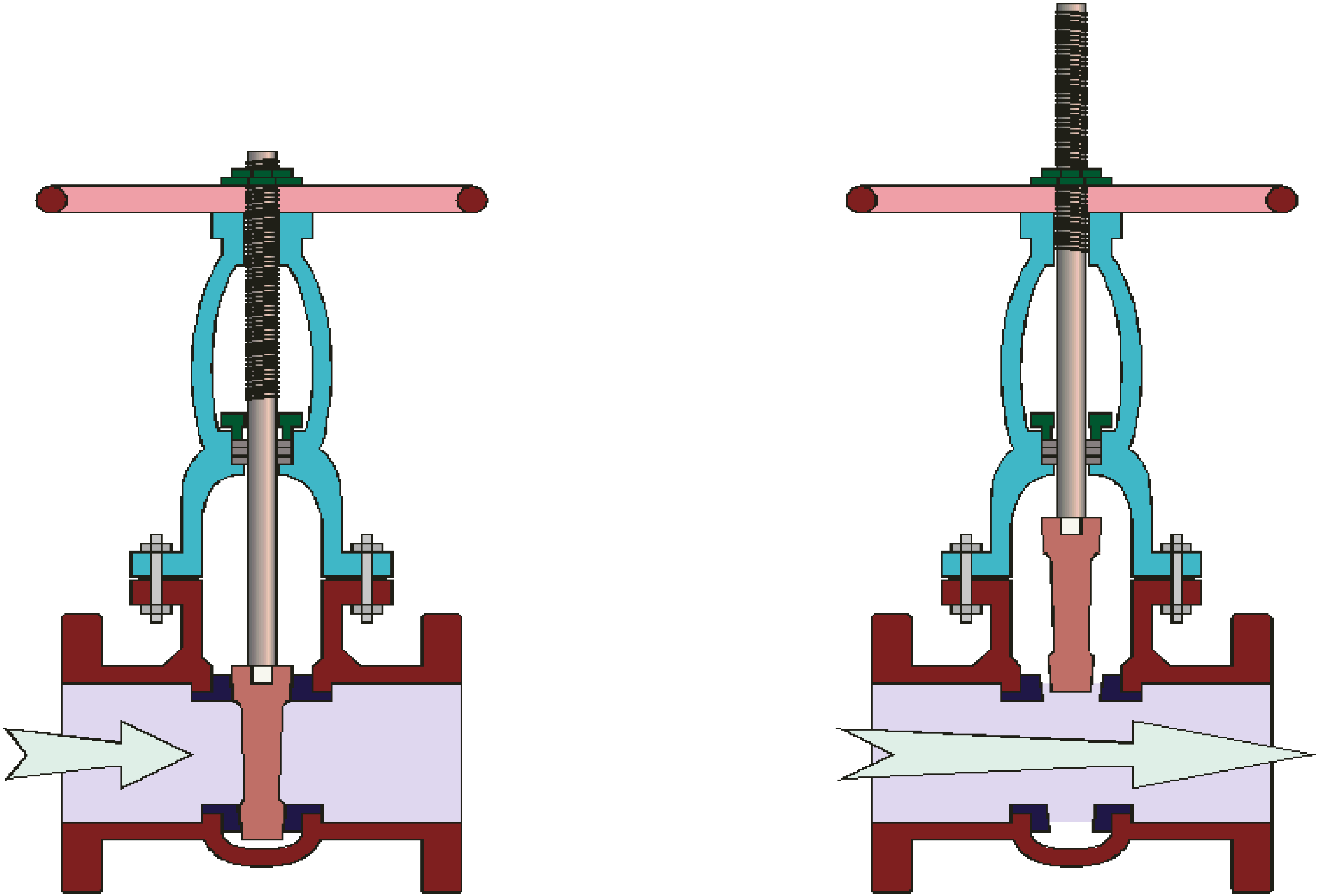


Rising Stem Gate Valve

Large gate valves normally have a rising stem,
which rises over the hand-wheel.

The valve stem shows if the valve is open or closed.

Rising stem gate valve



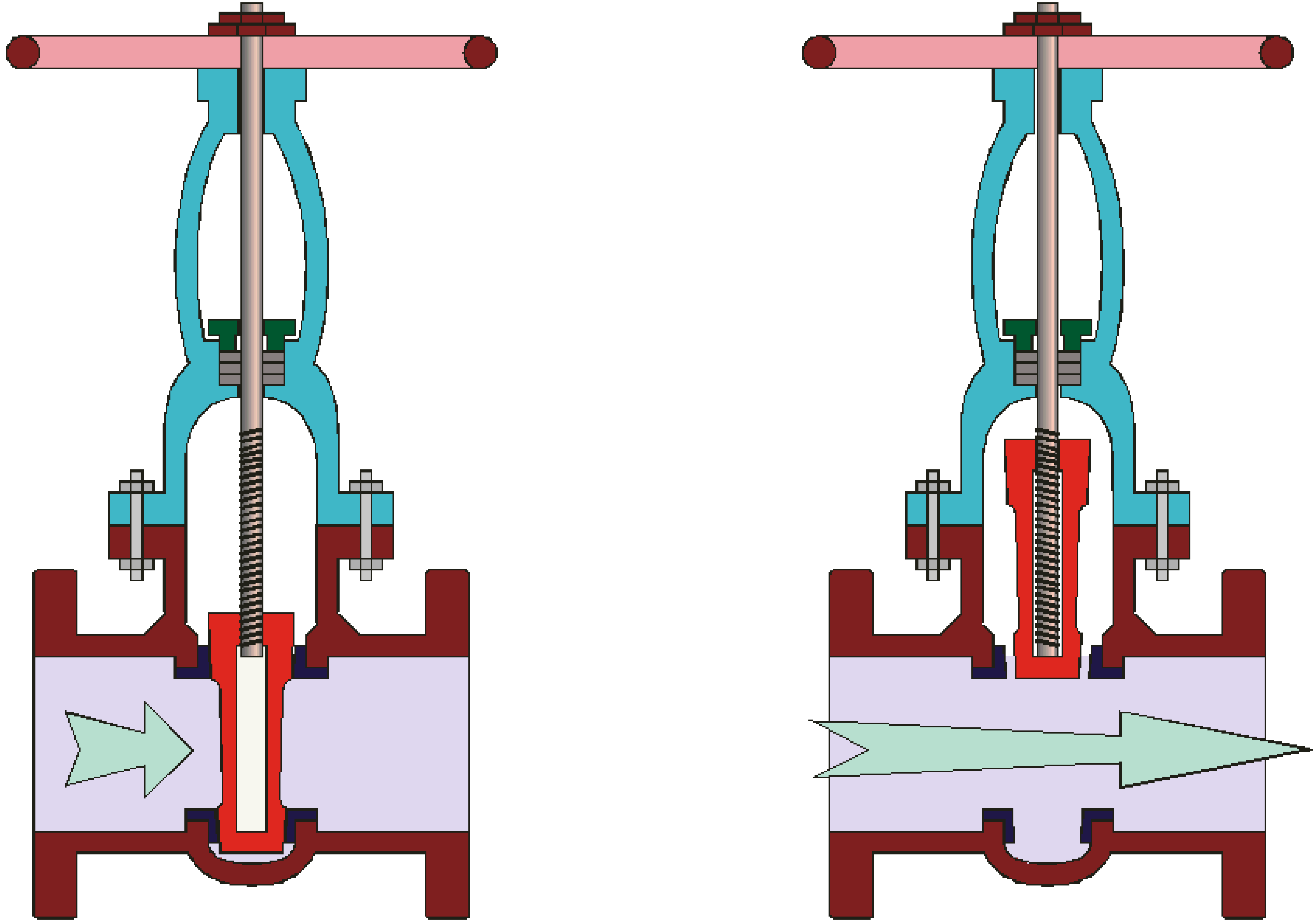
Closed

Open

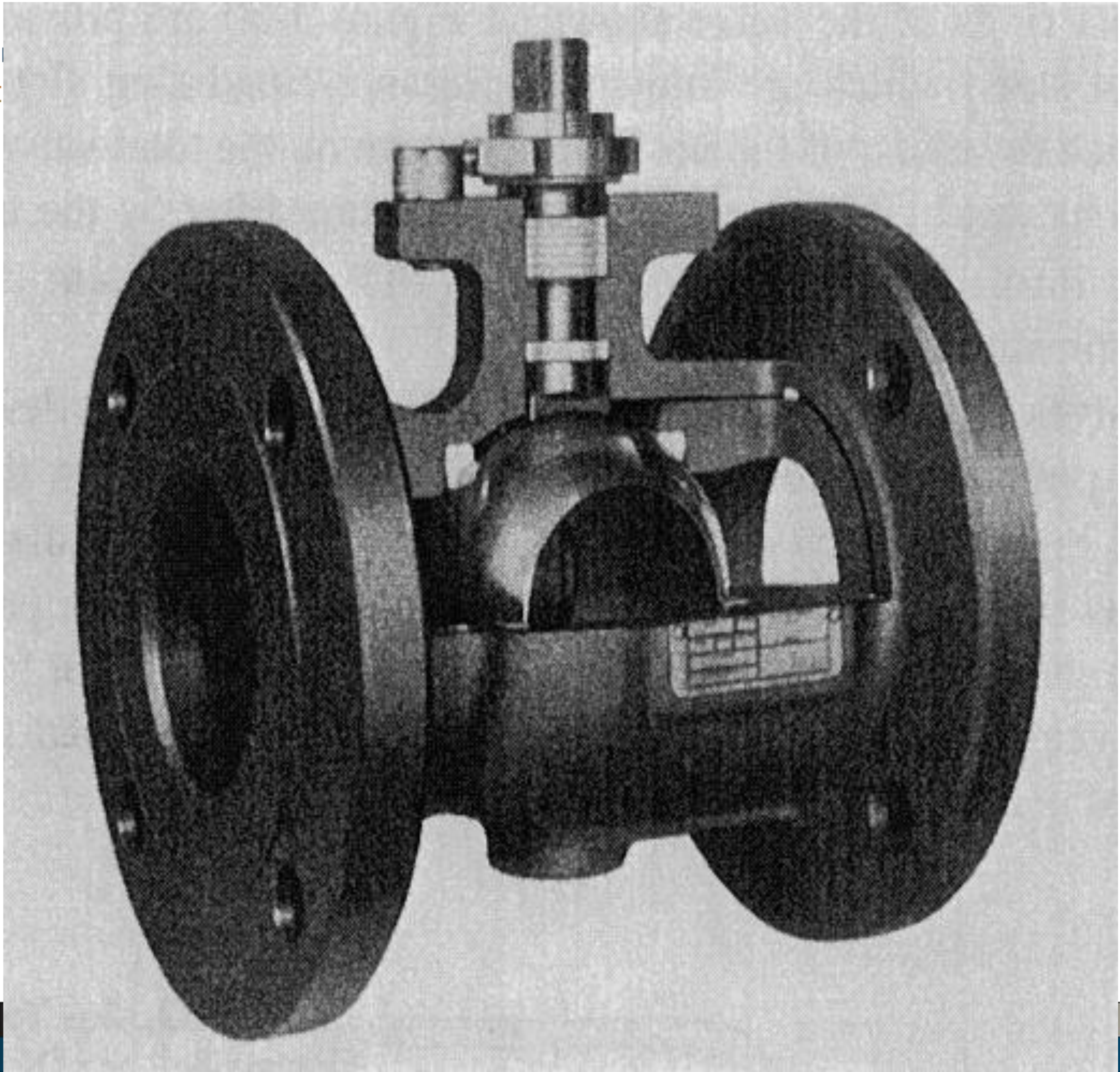
Non-Rising Stem Gate Valve

Some gate valves have a non-rising stem.
The stem does not come out of the hand-wheel.
The wedge moves up on the stem thread.
These types of valves are used where there is not enough space above the valve stem.

Non-rising stem gate valve

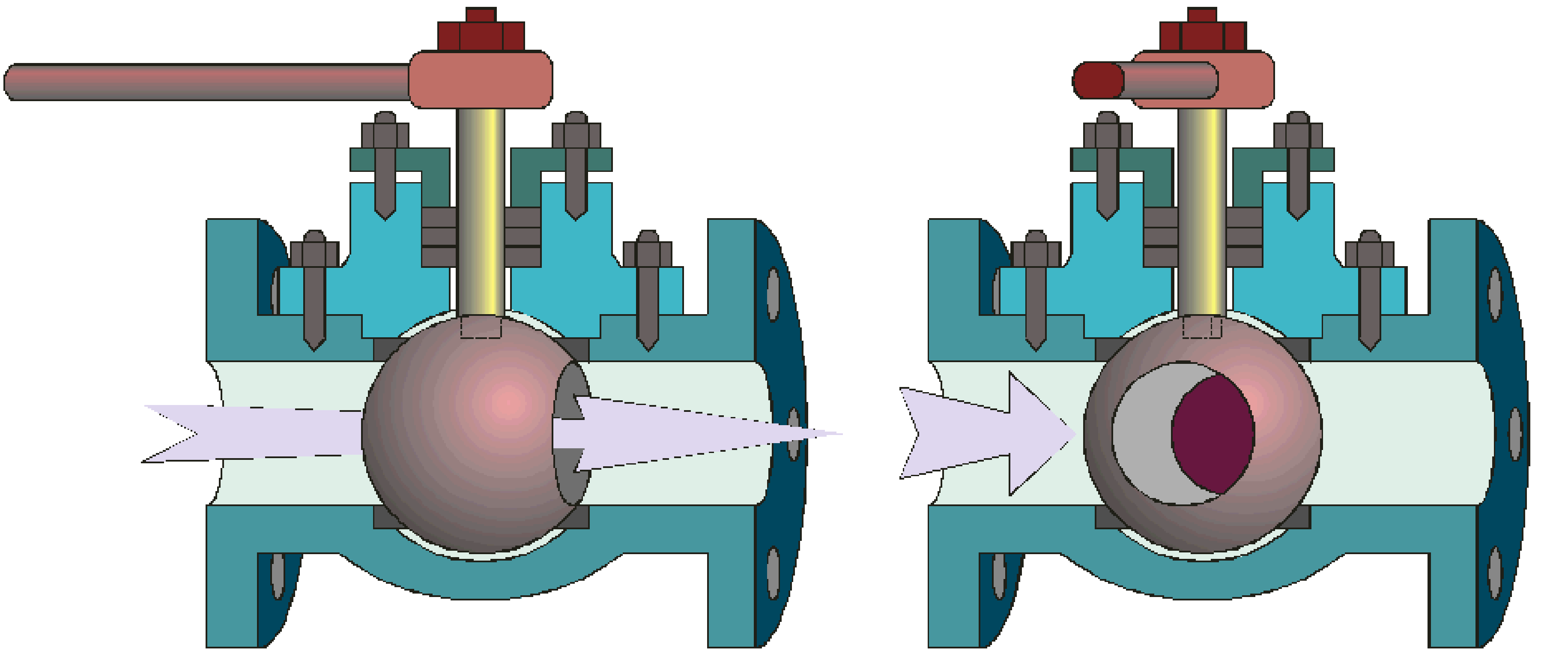


•BALL
•VALVES



BALL VALVES

Ball valves are usually used in pipe systems for fully open or fully closed status. *The ball valve also can be used*
for throttling (i.e. partially open)



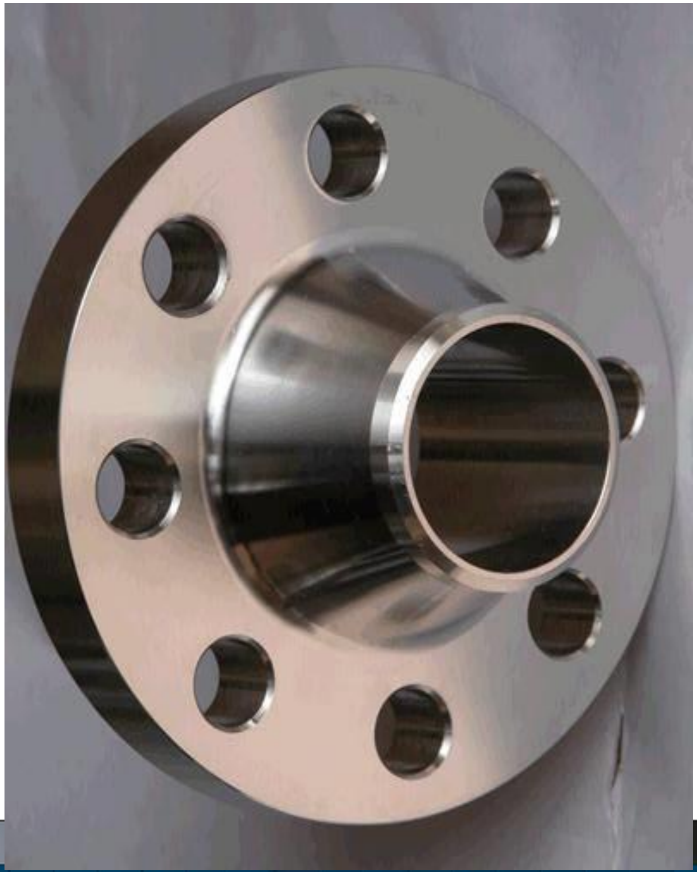
In ball valves, the isolating element is a ball with a hole through the centre.
The size of the hole is the same as the size of the pipe, so there is no restriction to the flow A one-quarter turn of the valve stem will rotate the ball by 90o
This is enough to move the ball from the fully-open to the fully-closed position.
The part names and functions are similar to those of the gate valve.

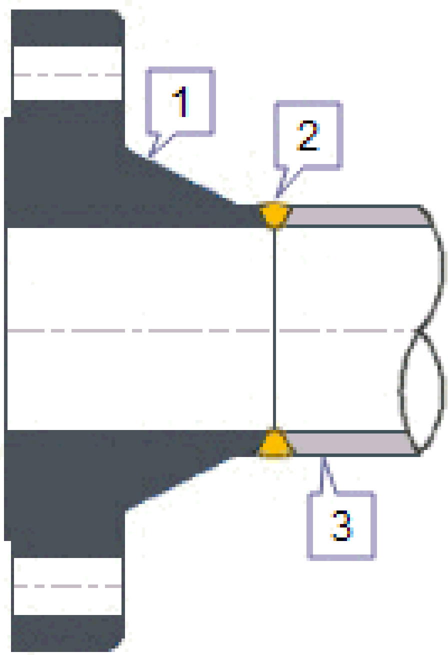
Ball Valve Advantages

= Ball valves have the advantage that they can be opened and closed quickly.
= They can be used as bypass valves.
Bypass valves are used to allow fluid to bypass a piece of equipment in case of abnormal conditions.

Gaskets, Packing and Mechanical Seals

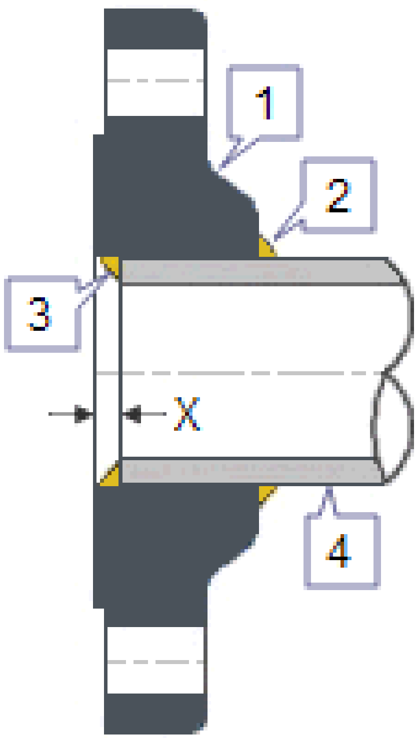
Welding-neck flange (WN)





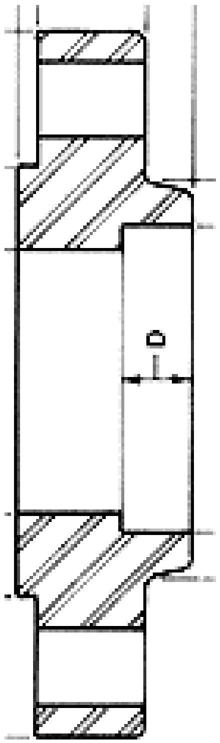
1. Welding Neck flange 2. Buttweld
3. Pipe or Fitting

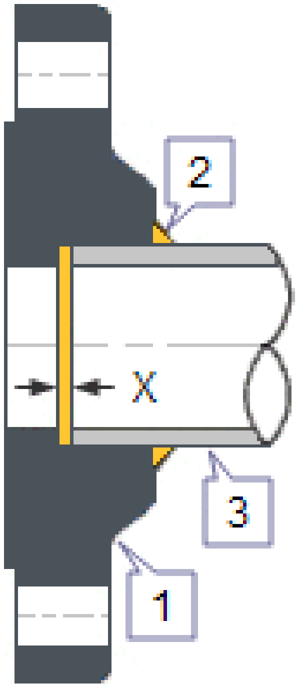
Slip-on Flanges (SO)



1. Slip On Flange 2. Fillet Weld (outside)
3. Fillet Weld (inside) 4. Pipe

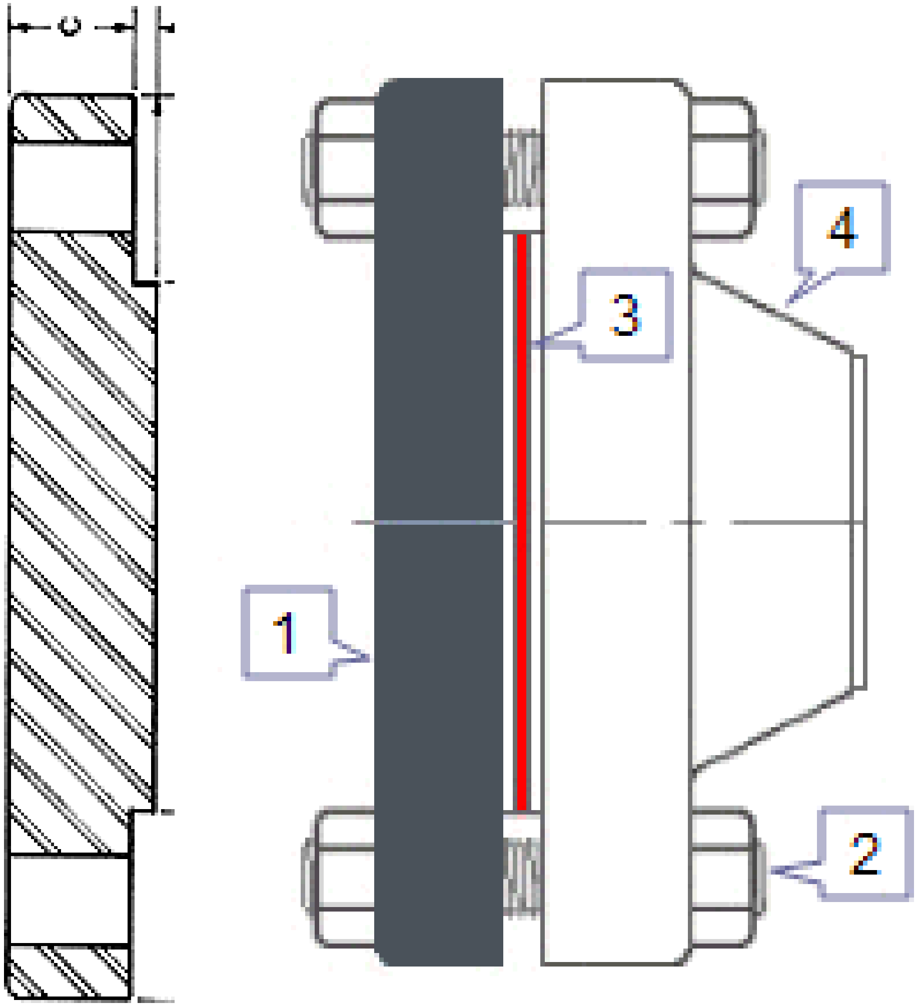
Socket-type flanges (SW)





1. Socket Weld Flange **2.** Fillet Weld
3. Pipe **X** = Expansion gap

Blind Flanges (B)

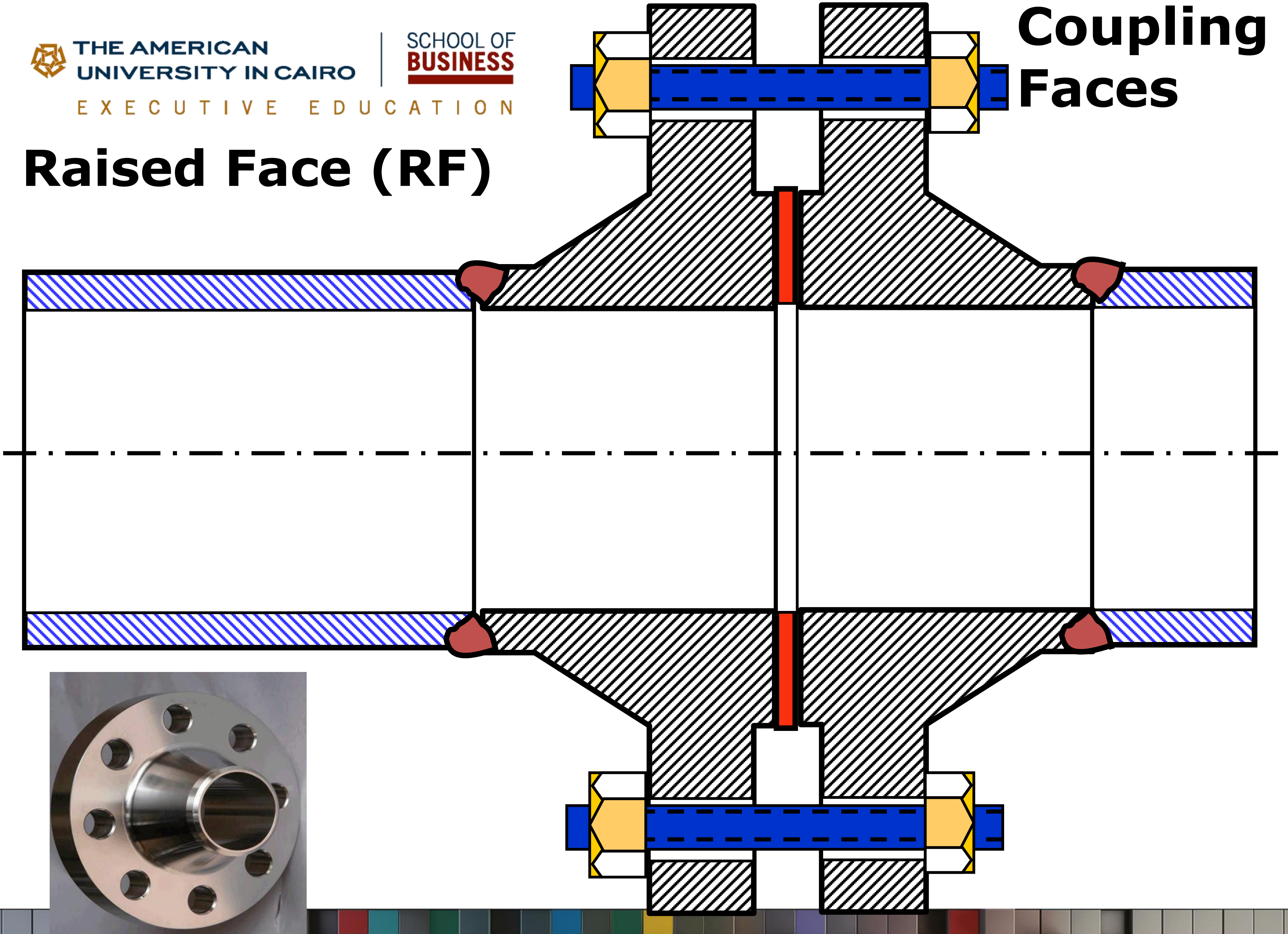


1. Blind flange 2. Studbolt
3. Gasket 4. Other Flange

Spectacle blind

Coupling Faces

Raised Face (RF)



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Spiral Wound Gaskets