

ATMOSPHERIC STORAGE TANKS**JGS 210-120-1-58E**

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1. SCOPE

This section covers the basic design for vertical, cylindrical tanks in various capacities for internal pressures approximately atmospheric pressure (the pressure lower than 2.5 pounds/square inches gauge) to store flammable liquids. API 650 shall be applied for those tanks.

For non-flammable liquid such as water and chemicals shall also be designed in accordance with this section, however, API 650 is not applicable.

Horizontal vessel, LPG storage tank, refrigeration tank, gas holders and underground tank are not included.

2. WORK PROCEDURE

2.1 Information for Detailed Design

A blank form "DESIGN INFORMATION FOR ATMOSPHERIC STORAGE TANKS" is attached in appendix-3. This blank form contains the process requirements and necessary information for the tank detailed design. Basic design group shall specify the data in accordance with the notes shown in the blank form.

The following sections describe the type selection and process requirements preparation procedure.

2.2 Work Flow

The tank design work flow is shown in attachment-4.

The basic designer shall review the following with the results of detailed design.

- (1) Minimum level and related pump NPSH
- (2) Nitrogen system design
- (3) Conformity to P & I Diagram

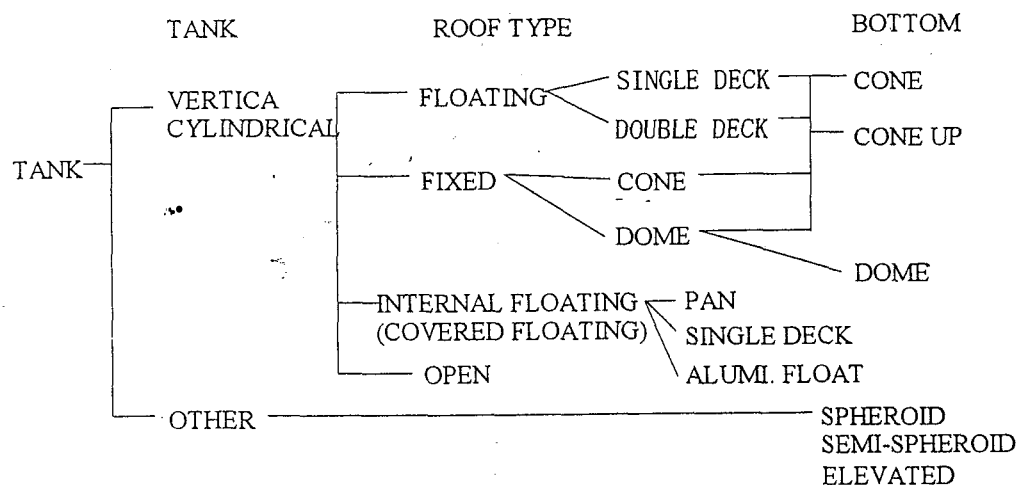
2.3 JOB Data

The tank lists of major projects are attached in Off-site manual (Sec. 2 storage facilities) for reference.

3. DESIGN

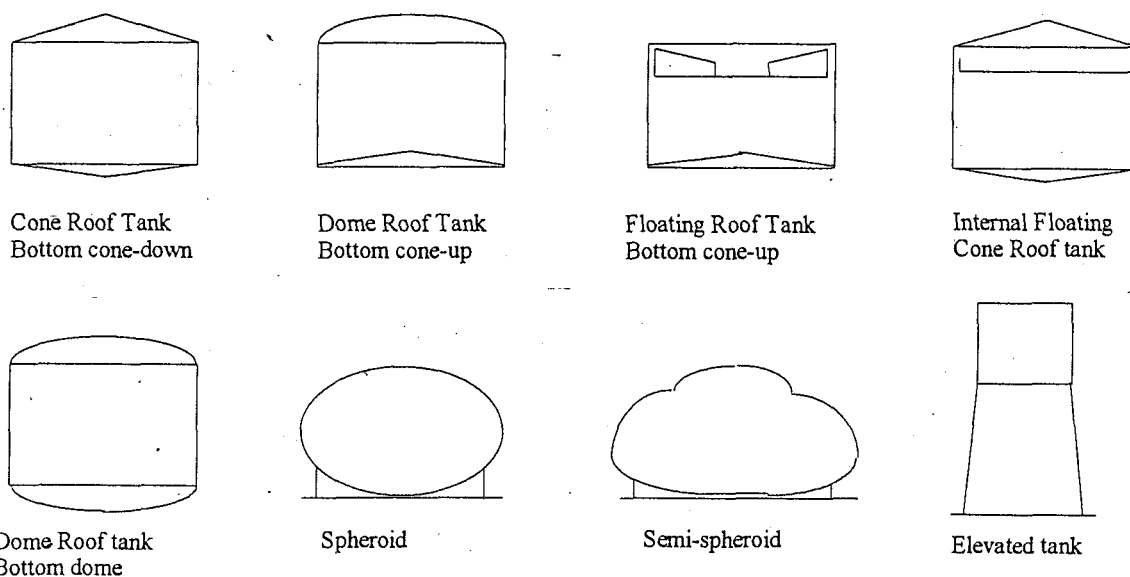
3.1 Tank Type

Storage tanks can be classified depending on the roof and bottom types as shown below. Refer to Figure 3.1-1.



Any combination of bottom type and roof type is applicable to the tank type selection, however a dome bottom type may be applied with a dome roof type for low pressure storage tanks.

Spheroid, Semi-spheroid and Elevated tanks will be mainly applied for water tanks, but not for flammable liquid storage.

Figure 3.1-1

3.2 Selection of Tank Type

The tank roof type is selected according to the vapor pressure, purity and harmfulness of components, operation requirements and the cost.

The following rank shows the tank cost in order, from the highest.

Internal floating > Double deck floating > Single deck floating > Dome > Cone > open

(1) Cone Roof tank (CRT)

This type is used for liquid whose vapor pressures are relatively low such as Gas oil and heavier, water, chemicals and lubricating oil.

Recommended limit of Reid Vapor Pressure (RVP) is shown in the attached figure (Fig. 3.2-1). The figure shows lean and rich area which are divided by Reid Vapor Pressure. Flammable vapor and air mixture is not existing in the lean area. Therefore, if the contents are stored in the lean area at the maximum expected storage temperature, this roof type can be applied.

If the contents are stored in the rich area, nitrogen/gas blanket or floating roof type shall be applied. If the nitrogen blanket is applied, vapor loss is unavoidable due to breathing of the tank. Therefore, the total cost shall compare the product loss with the tank cost difference of floating and cone roof tank. The blanket gas cost shall also be taken into account in the examination.

This tank type shall also be used for non-flammable liquid such as chemicals, water. However, the vapor pressure shall be checked by the same way of flammable liquid. If the contents are in the rich area, the total cost shall compare the loss of contents with the cost difference of roof type. This case nitrogen blanket is not necessary.

(2) Floating Roof tank (FRT)

This type is usually used for storing liquid having high vapor pressure such as Crude oil, Gasoline and naphtha. In a tropical atmosphere, Kerosene may be stored in this type.

This tank type has no vapor space, so vapor loss can be minimized, however small amount of rain water contamination through the roof seal is unavoidable.

(3) Internal Floating tank (IFRT)

Basically application of this type is the same as the floating roof type.

Floating roof tanks can not prevent contamination of rain water into the stored liquid. This type, therefore, is used for the liquid which is not allow water contamination.

(4) Dome Roof tank (DRT)

This type is used to store liquids having around 1 kg/cm² absolute vapor pressure, because it is applicable for higher design pressure up to 0.15 kg/cm² gauge (1500 mm of water column). Therefore, this type is mainly used for refrigerated liquid storage.

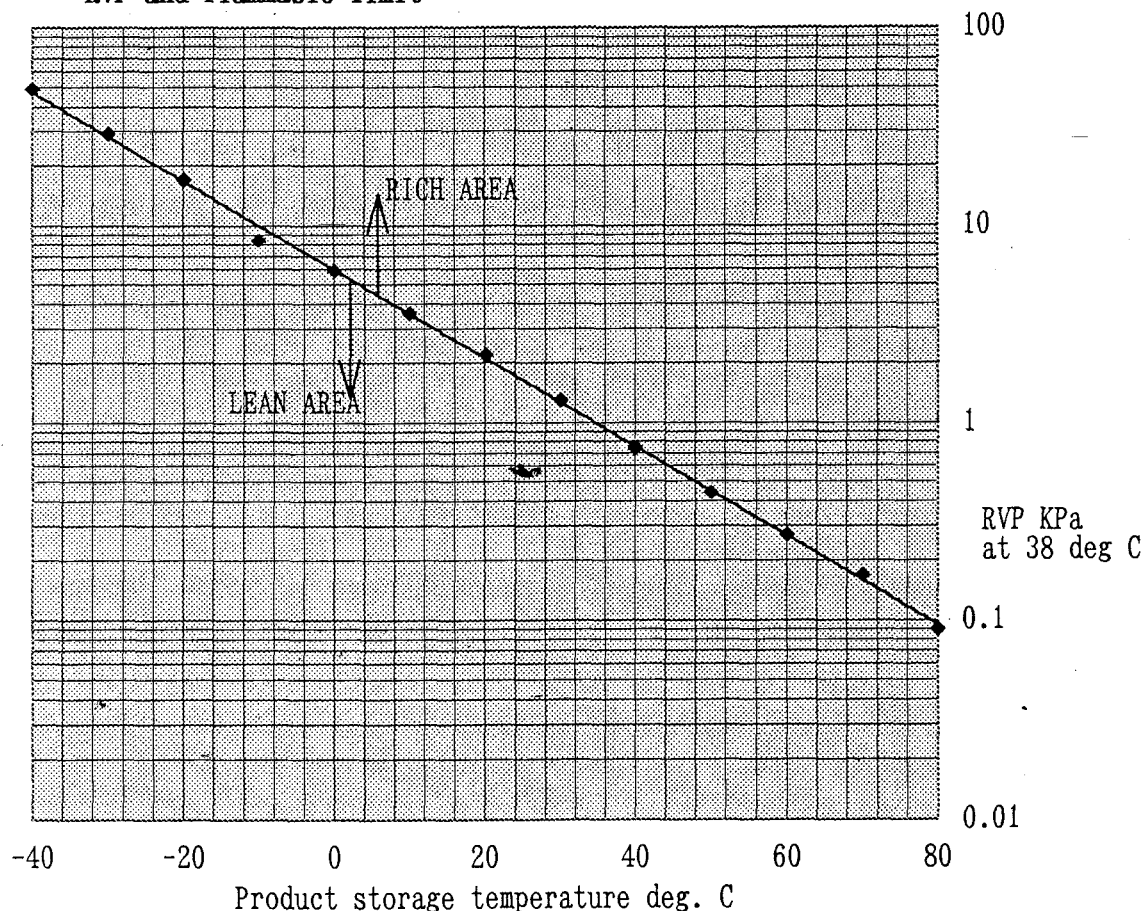
This type may also be used for liquids having low vapor pressure instead of cone roof type, if the tank cost is lower than the cone roof type.

(5) Others

(a) Open top tank may be used for water storage. But it is not recommended for the tank which has long holding time (longer than 12 hours), because clogging troubles may occur in the down stream of the tank resulting from algae growing and peel off in the tank.

(b) Elevated tank is only used for drinking water storage. The shape of the tank will be cone roof tank type. However, other shapes such as cubic, sphere will also be used considering the aesthetics.

Fig 3.2-1 Relationship between storage temperature, RVP and flammable limit



3.3 Storage Capacity

3.3.1 Liquid Level

Refer to Figure 3.3-1

Caution ; This philosophy can not be applied for the tank designed by the Japanese regulations, because the sizing of tanks conforming to Japanese regulations is more complicated than the International standard.

(1) Cone Roof Tank (including Dome Roof Tank)

H1 ; Normally zero (0 mm) or fixed air foam chamber (if the chamber is provided) inlet nozzle bottom. (note 3)

H2 ; 150 mm or 30 minutes from the maximum filling volume (note 2)

H3 ; Greater of 300 mm for 12" and larger nozzle sizes and 150 mm for 10" and smaller nozzle sizes or NPSH requirement

H4 ; Top of largest nozzle (note 3)

(2) Floating Roof Tank (including Internal Floating Tank)

H1 ; Free board for floating roof.

H2 ; 150 mm or 30 minutes from the maximum filling volume (note 2)

H3 ; 300 mm or NPSH requirement

H4 ; Greater of top of largest nozzle or low position of floating roof (note 3)

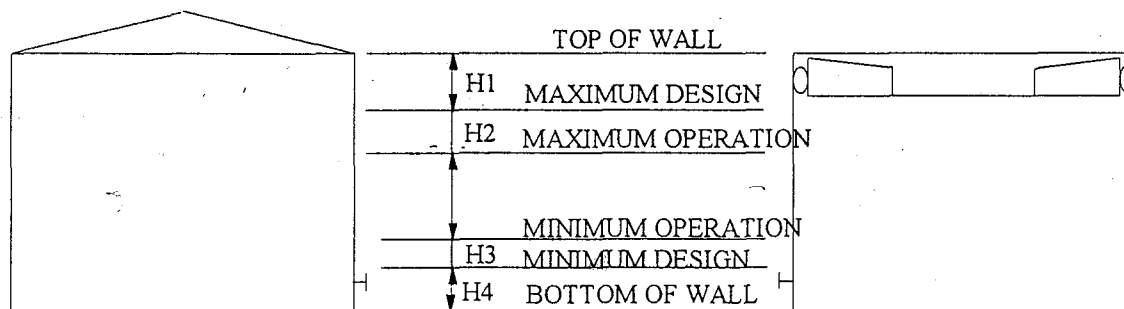
Note 1 ; High and low level (HLL and LLL) alarm will be set in the area of H2 and H3 respectively. If high high and low low level (HHLL and LLLL) for an emergency shutdown or an automatic diversion system are provided, the set points will also be selected in the area of H2 and H3 respectively, but, of course, out side the set point of HLL or LLL.

Note 2 ; It is assumed that filling flow rate from an export tanker (Crude or product receiving case) is very high, so the recommended time of 30 minutes shall be calculated using the slow unloading rate (approx. 30 % of the maximum unloading rate).

Note 3 ; Assumption of H4 and H1 for CRT based on API 650 are shown in Appendix-2.

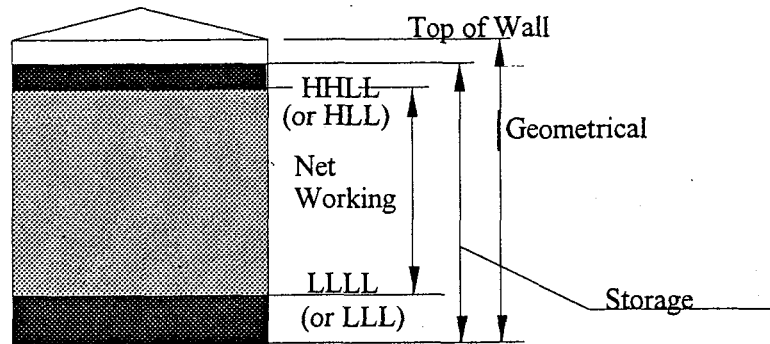
Actual height for the nozzles may be changed due to detailed design such as plate and welding line arrangement, so it shall be confirmed with detailed engineering group, if necessary.

Figure 3.3-1 LIQUID LEVELS



3.3.2 Definition of Capacity

- Nominal capacity ; All this capacity can be used, defined as below. This capacity is usually used as tank name.
- Geometrical capacity ; The volume of vertical cylindrical section
- Storage capacity ; The volume from the tank bottom to the maximum design level.
- Net working capacity ; The volume between HLL and LLL or HHLL and LLLL



3.4 Operating and Design Conditions

3.4.1 Operating Conditions

(1) Operating temperature

The selection of operating temperature is very important, because the density of the contents in a tank is defined by the Operating temperature and is used as the base for tank sizing and the tank wall thickness calculation.

The Operating temperature shall be selected from the following items.

- Run-down temperature from process units
- Ambient air temperature (annual mean or annual highest mean temperature)
- Receiving temperature from a tanker (if the contents receives from a tanker)

The density at the highest operating temperatures shall be used for the tank sizing and the density at the lowest operating temperature shall be used for the tank wall thickness calculation. However, the following cases, the density at the highest temperature shall be used for both purpose.

- The tank has a heater to maintain the storage temperature.
- The tank only receives run-down fluid from process units.
- The tank has a temperature compensating level indicator.

The maximum and the minimum storage temperatures shall Clearly be mentioned in the offsite design basis.

(2) Operating pressure

Operating pressure is approximately atmospheric pressure. The detail is described in the Design Pressure, para. 3.4.2-(2).

3.4.2 Design Conditions

(1) Design temperature

The design temperature shall be the maximum operating temperature plus 10°C when the maximum temperature during normal operation can not be estimated. This temperature is used only for the tank mechanical design nor tank sizing.

If hot run-down is expected due to mal-operation in process plants, the maximum temperature shall be assumed based on the tank dead stock volume and expected operating time of the abnormal situation. This temperature is not usually used for the tank design.