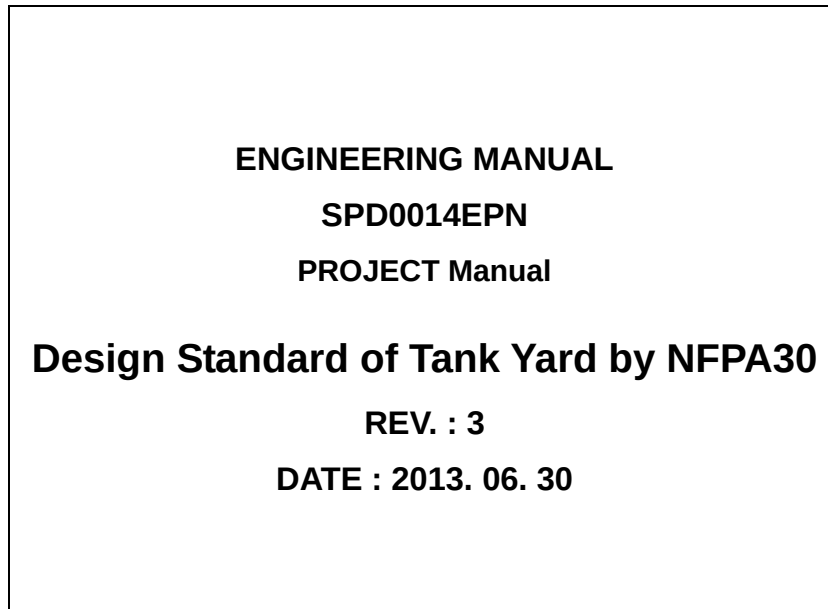


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REVISION HISTORY

개정번호	개정일자	개정 Page	개정 사유
0	1992.10.25	신규제정	- 가연성액체 위험물 (특히 제 4 석유류)을 저장 또는 취급하는 옥외저장탱크지역의 Plot Plan 을 NFPA Code 에 의해 작성하는 경우 일정한 기준미비로 인한 설계자마다의 각자 다른 해석 및 적용을 사전에 방지하고, 안전하며 합리적인 설계를 위해 Manual 을 작성하였다.
1	1993.11.30		- Manual 개정계획에 따라 NFPA Code 의 적용이 미비한 부분 및 오자를 1990 년 판에 준하여 개정·보완함.
2	2010.11.15		- 전사 조직 개편 이후 팀명, 문서번호 변경 - 작성부서 : ENG'G 기술팀 작 성 자 : 양 영 재 검 토 자 : 오 태 호 승 인 자 : 안 준 환
3	2013.06.30		- Manual 개정계획에 따라 NFPA Code 의 적용이 미비한 부분 및 오자를 2012 년 판에 준하여 개정·보완함.

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1. GENERAL

1.1 Purpose

This Manual is applicable for arranging Storage Tanks or Group of Tanks storing Flammable Liquids as per NFPA Code 30 in Refinery and Petrochemical Plant.

1.2 Scope

This Manual is applied to every Flammable Liquid. But, materials which are related to clause 1.2.1 and 1.2.2, others specified codes as referenced shall be used.

1.2.1 Following is beyond the scope of this manual

- (1) Solid Flammable Liquid at 37.8。 C (100。 F)
- (2) LNG, LPG based Tank Group (NFPA 58, 59, 59A)
- (3) Transportation of Flammable Liquid (NFPA 385)
- (4) Storing, Handling and Using (NFPA 31) of the Container which related to Fuel Oil Tanks and Fuel Burning Facilities (Boiler, etc)
- (5) Container or Group of Container (NAPA 395) which stores Flammable Liquid under 4.16 m³ (1,100 gal).
- (6) Liquid Halogenated Hydrocarbon which ignites regardless to Flash Point under the certain condition.(NFPA 321)
- (7) The thing that shape is unshaped or foamy out of Flammable Liquid : Mists, Sprays, Foams

1.2.2 Following NFPA codes shall be used as applicable with this manual

- (1) NFPA 32, Standard for Drycleaning Plants
- (2) NFPA 33, Standard for Spray Application Using Flammable and Combustible Materials
- (3) NFPA 34, Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids
- (4) NFPA 35, Standard for the Manufacture of Organic Coatings
- (5) NFPA 36, Standard for Solvent Extraction Plants
- (6) NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
- (7) NFPA 45, Standard for Fire Protection for Laboratories Using Chemicals
- (8) Chapter 10 of NFPA 99, Standard for Health Care Facilities

1.3 Terms and Definition

1.3.1 Aerosol : Material which has propulsive force under applying Pressure and sprayed as the condition of foam or spray.

1.3.2 Barrel : 42 U.S. gal (158.9 ℓ)

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1.3.3 Basement : Floor that more than ½ part of its relevant floor height is went down under horizon, so access which purposes to fire extinguishing is remarkably difficult.

1.3.4 Boiling Point
The temperature at which vapour pressure of liquid equals the surrounding atmospheric pressure. Atmospheric pressure shall be considered to be 14.7 psia (760 mm Hg)

1.3.5 Boil-Over
This is a phenomenon in which the strength of the fire is getting bigger suddenly by the gushing out of burning Liquid from the top of opened Tank after passing certain times by a Fire Occurrence from some Flammable Liquid which stored in the Tank. It can be explained as below.

Density of burning Liquid Surface(heat layer) is getting bigger than liquid side which is nonflammable under its surface by the heat of surface. The Heat layer sinks under below side of heat layer to constitute heat layer more and more if the density got bigger than over a certain amount. (by the difference of Density) so, it reaches to water on the bottom of Tank or emulsion because of the Sedimentation Velocity of this heat layer is much bigger than Recovery Speed of liquid surface, the water is overheated by heat of the heat layer and gushes out from lower part of the Tank to the upper part almost explosively.

This phenomenon is called the Boil-Over, the Liquid which is easy to boils-over is constituted with the elements which have the large scope of boiling points. Crude Oil and Compounded Liquid has the peculiarity of above.

1.3.6 Flash Point
The Minimum Temperature of the liquid that generates Vapor of enough concentration which constitutes flammable (Liquid Vapor + Air) Compound when compounding the Air that is near liquid surface and Liquid Vapor of surface on surface of the Liquid.

1.3.7 Crude Oil or Petroleum
The Hydrocarbon Compound that in which Flash Point is under 65.5。 C (150。 F)

1.3.8 Atmospheric Tank

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The storage tank that has been designed to operate at pressure from atmospheric through a gauge pressure of 1.0 psig i.e. 760 mmHg to 812 mmHg measured at top of the tank.

1.3.9 Low Pressure Tank

The Storage Tank which is designed to withstand Inside Pressure between 0.035 kg/cm²g to 1.054 kg/cm²g measured at top of the tank.

1.3.10 Pressure Vessel

Vessel which is applied ASME Boiler and Pressure Vessel Code.

1.3.11 Container

Under 60 U.S. gal (227 ℓ) of Container which aims for Transportation or Storing of the Liquid.

1.3.12 Portable Tank

Non-Fixing Type, Sealed Vessel with a capacity of over 60 U.S. gal (227 ℓ).

1.3.13 Storage Tank

Vessel with a capacity of over 60 gal (237 ℓ) which aims for Fixing Type installation.

1.3.14 Protection for Exposures

Fire Extinguishing Facility for protecting the Flammable Liquid Storage Tank or Structure of its neighboring Buildings, etc when fire is occurred at Flammable Liquid Storage or around it.: Water, Spray, Water Hydrant

1.3.15 Inerting System

The Installation to prevent the Gas inflow which causes the ignition by injection of inert Gas such as Nitrogen to the Flammable Liquid Storage Tank and creating the Inert Layer.

1.3.16 Separate Inside Storage Area

The Room or Building used as the Storage which stores the Liquid of Transportation Tank or Container, place that is parted with the room of other use.

(1) Inside Room

The Room that all sides is hermetic sealed, located in the Building and has no wall which is exposed to the outside.

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(2) Cut-Off Room

The Room that is located in the Building but at least one wall is contacted to the outside.

(3) Attached Building

As the projected out Room which is shared only one wall with other shape of room in the Building.

1.4 Reference

1.4.1 NFPA 30, Flammable and Combustible Liquids Code

1.4.2 NFPA 325M, Guide to Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids

2. Definition and Classification of Liquids

2.1 Definition of Liquids

2.1.1 Flammable Liquids (Class I)

The Liquid that Vapor Pressure is under 2.8 kg/cm^2 abs when Flash Point is under 37.8°C (100°F), Temperature is 37.8°C (100°F) (Refer to NFPA 325M and Reference Data.)

2.1.2 Combustible Liquids (Class II , Class IIIA, Class IIIB)

The Thing that Flash Point is over 37.8°C (100°F).
(Refer to NFPA 325M and Reference Data.)

2.1.3 Unstable Liquids

The Liquid which does Chemical Reaction like as Polymerization, Condensation, Decomposition intensely or does Spontaneous Reaction by Impact, Applying Pressure, Rising Temperature in the condition of Production, Transportation or the Atmospheric condition.. (The Thing except that Reactivity space is "0" from the Table of NFPA 325M.)

Example : Acetylene, Butadiene, Ethylene, Propylene, Styrene, Softened Vinyl (Vinyl Chloride)

2.1.4 Stable Liquids

Chemically Stabilized Liquid surely in case of Normal, even in case of Fire or the Liquid which do not cause chemical change even if coming in contact

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with the Water or Air. (The Thing except that Reactivity space is “0” from the Table of NFPA 325M.)

Example : Methanol, Ethanol, Methane, Ethane, Butane, Propane, Benzene, Toluene, Xylene, Ammonia, Hydrochloric Acid, Sulfuric Acid, etc.

2.2 Classifications of Liquids

Liquids can be classified as below.

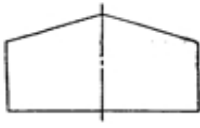
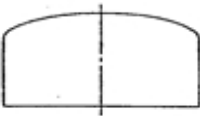
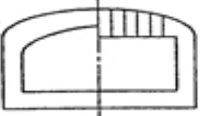
(Refer to NFPA 49 Hazardous Chemical Data.)

FLAMMABLE LIQUIDS			COMBUSTIBLE LIQUIDS		
I A	I B	I C	II	III A	III B
F.P < 73°F (22.8°C)	F.P < 73°F (22.8°C)	73°F ≤ F.P < 100°F(37.8°C)	100°F ≤ F.P < 140°F(60°C)	140° ≤ F.P < 200°F(93°C)	F.P ≥ 200°F (93°C)
B.P < 100°F (37.8°C)	B.P ≥ 100°F (37.8°C)	—	—	—	—

Note : F.P (Flash Point), B.P (Boiling Point)

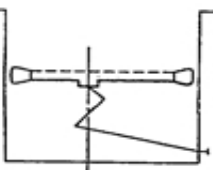
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2.3 Kinds of Liquid Storage Tank

Type	Restriction of Use	Applied Contents					
		GAS			Liquid		
		Atmospheric Pressure	High Pressure	Liquefied Material	Water, Volatile	Low Volatile	High Volatile
Cone Roof Tank (CRT) 	- Possible Internal pressure up to around 50~+100 mm H ₂ O. (But, Should be examined separately by API 650 Appendix F, etc.)	×	×	×	○	△	×
Dome Roof Tank (DRT) 	For case of impossible CRT or case of economical. (But, Maximum Internal Pressure is 1000 mm H ₂ O generally, at Small Type 3000 mm H ₂ O)	×	×	×	○	○	×
Double Wall Tank (DWT) 	Low temperature storage of Liquefied GAS, Liquefied Ethylene, Liquefied Propylene, Liquefied Ammonia, LNG, etc.	×	×	○	×	×	×

NOTE : ○ (Optimum) △ (Proper) × (Improper)

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Type	Restriction of Use	Applied Contents					
		GAS			Liquid		
		Atmospheric Pressure	High Pressure	Liquefied Material	Water, Volatile	Low Volatile	High Volatile
 Floating Roof Tank (FRT)	Do Not apply to Liquid in which Vapor Loss is small and rain water should not be mixed.	x	x	x	○	○	x
 Covered Float Tank (CFT)	Vapor Loss is small and maintained safely from rain, wind and snow. Specially, Good for snowy and cold area.	x	x	x	○	○	x
 Spherical Tank (SPT)	Storage of contents that has Pressure.	△	○	○	x	△	○

NOTE : ○ (Optimum) △ (Proper) × (Improper)

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3. Offsite Storage Tank Installation Standard

3.1 Safety Distance of Offsite Storage Tank

- 3.1.1 Refer to the Table below in case of Tank in which operating Pressure is under $0.17 \text{ kg/cm}^2\text{g}$ (2.5 psig) as the stable liquid Storing Tank and which is belong to Grade I, II, IIIA.

Table 3.1.1 Stable Liquid ($P \leq 0.17 \text{ kg/cm}^2\text{g}$)

Tank Shape	Kinds of Fire Extinguishing Facility	Maximum Distance (Over 1.5m) between Land Borderline or opposite side of Public Road	Maximum Distance (Over 1.5m) between Important Building in the land or Public Road
F·R·T	Exposure Danger Prevention	1/2 x Tank Diameter	1/6 x Tank Diameter
	None	Tank Diameter, under 52.5 m	1/6 x Tank Diameter
Vertical Tank With Weak Roof to Shell Seam	Under 45.7 m Diameter Foam or Inerting.	1/2 x Tank Diameter	"
	Exposure Danger Prevention	Tank Diameter	1/3 x Tank Diameter
	None	2 x Tank Diameter, under 105 m	"
Horizontal or Vertical Tank Emergency Safety Valve with a capacity of $W/0.17 \text{ kg/cm}^2\text{g}$	Foam or Inerting	1/2 x Table 3.1.3	1/2 x Table 3.1.3
	Exposure Danger Prevention	Table 3.1.3	Table 3.1.3
	None	2 x Table 3.1.3	Table 3.1.3

But, Above Table is applied in case of installing Grade I, II of Liquid Storage Tank at each different Dike or Drainage Way by Grades and case of combined installing Grade I, II, III A of Liquid Storage Tank at the same zone of Dike or Drainage Way only.

- 3.1.2 Taking 1/2 distance of Table 3.1.1 distance is possible in case of Installing

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Grade III A of Liquid Storage Tank separately without letting it be existed together with Grade I, II Liquid Storage Tank at the same Dike or Drainage Way.

- 3.1.3 Safety Distance of Tank in which operating Pressure is more than 0.17 kg/cm²g (regardless of installing Safety Valve or not.) as the Tank which is belonged to Grade I , II , III A and stores Stable Liquid.

Table 3.1.2 Stable Liquid (P > 0.17 kg/cm²g)

Tank Shape	Kinds of Fire Extinguishing Facility	Maximum Distance between Land Borderline or opposite side of Public Road	Maximum Distance between Important Building in the land or Public Road
Every Shape of Tank	Exposure Danger Prevention	1 ½ x Table 3.1.3, Over 7.5 m	1 ½ x Table 3.1.3, Over 7.5 m
	None	3 x Table 3.1.3, Over 15 m	1 ½ x Table 3.1.3, Over 7.5 m

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Table 3.1.3 Safety Distance by Storage capacity of Tank

Tank Storage Capacity	Maximum Distance between Land Borderline or opposite side of Public Road	Maximum Distance between Important Building in the land or Public Road
Under 1,041ℓ (275 gal)	1.5 m	1.5 m
1,042 ~ 2,839ℓ (750 gal)	3.0 m	1.5 m
2,840 ~ 45,420ℓ (12,000 gal)	4.5 m	1.5 m
45,421 ~ 113,550ℓ (30,000 gal)	6.0 m	1.5 m
113,550 ~ 189,250ℓ (50,000 gal)	9.0 m	3.0 m
189,251 ~ 378,500ℓ (100,000 gal)	15.0 m	4.5 m
378,500 ~ 1,892,500ℓ (500,000 gal)	24.0 m	7.5 m
1,892,501 ~ 3,785,000ℓ (1,000,000 gal)	30.0 m	10.5 m
3,785,001 ~ 7,570,000ℓ (7,570,000 gal)	40.5 m	13.5 m
7,571,001 ~ 11,355,000ℓ (3,000,000 gal)	49.5 m	16.5 m
Over 11,355,001ℓ (3,000,001 gal)	52.5 m	18.0 m

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3.1.4 Refer to below Table in case of Storage Tank which has the peculiarity of the Boil-Over. But, Fixed Roof Tank which doesn't equipped with Inerting equipment at the Tank itself should be taken under 45.7m of diameter.

Table 3.1.4 Boil-Over Liquid

Tank Shape	Kinds of Fire Extinguishing Facility	Maximum Distance (Over 1.5m) between Land Borderline or opposite side of Public Road	Maximum Distance (Over 1.5m) between Important Building in the land or Public Road
F.R.T	Exposure Danger Prevention	$\frac{1}{2}$ x Tank Diameter	$\frac{1}{6}$ x Tank Diameter
	None	Tank Diameter	"
Fixed Roof	Foam or Inerting	Tank Diameter	$\frac{1}{3}$ x Tank Diameter
	Exposure Danger Prevention	2 x Tank Diameter	$\frac{2}{3}$ x Tank Diameter
	None	4 x Tank Diameter, under 105 m	$\frac{2}{3}$ x Tank Diameter

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3.1.5 Safety Distance between Unstable Liquid Storage Tanks refers to next Table.

Table 3.1.5 Unstable Liquid

Tank Shape	Kinds of Fire Extinguishing Facility	Maximum Distance (Over 1.5m) between Land Borderline or opposite side of Public Road	Maximum Distance (Over 1.5m) between Important Building in the land or Public Road
Horizontal and Vertical Tank W/Allowable Pressure Emergency Safety Valve of under 0.17 kg/cm ² g	Water Spray, inerting, Keeping Warm, Store Low Temperature and Measure	Table 3.1.3 Over 7.5 m	Over 7.5 m
	Exposure Danger Prevention	2 1/2 x Table 3.1.3 Over 15 m	Over 15 m
	None	5 x Table 3.1.3 Over 30 m	Over 30 m
Horizontal and Vertical Tank W/Allowable Pressure Emergency Safety Valve of under 0.17 kg/cm ² g	"	2 x Table 3.1.3 Over 15 m	Over 15 m
	Exposure Danger Prevention	4 x Table 3.1.3 Over 30 m	Over 30 m
	None	8 x Table 3.1.3 Over 45 m	Over 45 m

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3.1.6 Refer to next Table for Safety Distance of the Tank which is belonged to Grade III B and stores Stable Liquid. But, refer to Table 3.1.1 in case that installing by existed together with Grade I, II of Liquid Storage Tank at the same zone of Dike or Drainage Way.

Table 3.1.6 Grade III B Liquid

Tank Storage Capacity	Maximum Distance between Land Borderline or opposite side of Public Road	Maximum Distance between Important Building in the land or Public Road
Under 45,600ℓ (12,000 gal)	1.5 m	1.5 m
45,601~114,000ℓ (30,000 gal)	3.0 m	1.5 m
114,001~190,000ℓ (50,000 gal)	3.0 m	3.0 m
190,001~378,500ℓ (100,000 gal)	4.5 m	3.0 m
Over 378,501ℓ (100,001 gal)	4.5 m	4.5 m

3.2 Possessed open space between Outdoors Storage Tanks

3.2.1 Refer to next Table for Possessed Open Area between Tanks which is belonged to Grade I , II , III A and which stores Stable Liquid.

Table 3.2.1 Possessed Open Area (From Outside to Outside of Tank)

Tank Diameter	FRT	Fixed or Horizontal Tank	
		Class I , II	Class III A
Diameter under 45 m	1/6 x (Sum with Diameter of Neighboring Tank), Over 1.5 m	Same as Left	Same as Left
Diameter under 45 m Remote Impounding Type Dike Type	1/6 x (Sum with Diameter of Neighboring Tank), 1/4 x (")	1/4 X (Same as Left) 1/3 X (Same as Left)	1/6 X (Same as Left) 1/4 X (")

3.2.2 Possessed Open Area can be under 0.9 m in case of installing Crude Oil Tanks in which Storage Capacity of each Tank is under 126,000gal (3,000 barrel=477 m³) at the place except fabrication facility.

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3.2.3 Possessed Open Area of the Tank Group which is constituted with Grade III B of Liquid Storage Tanks only should be maintained over 0.9 m.
Refer to Table 3.2.1 in case that Grade III B of Liquid Storage Tank is installed together with Grade I, II of Liquid Storage Tank at the same Dike or Drainage Way.

3.2.4 It is possible to receive requests of maintaining larger Possessed Open Area than Table 3.2.1 or separate equipment of the Tank for the purpose of Fire Extinguishing from the Fire Station in case of next matter.

- (1) Case that Grade I, II of Liquid Storage Tank is installed at the same Dike or Drainage Way.
- (2) Case of installing Tanks closely as over than 3 rows.
- (3) Case of installing Tanks irregularly.

3.2.5 Possessed Open Area of Unstable Liquid Storage Tank must be over than ½ of length that added diameter of neighboring tank.

3.2.6 Possessed Open Area between LPG Container and Grade I, II, IIIA of Liquid Storage Tank must be followed next matters.

- (1) Maximum Vertical Distance between LPG Container and Grade I, II, IIIA of Liquid Storage Tank should be 6m.
But, Possessed Open Area between LPG Container and Tank which installed Safety Valve that normal operation pressure is over 0.17 kg/cm²g or working pressure is over 0.17 kg/cm²g as the of Grade I, II, IIIA is referred to Table 3.2.1.
- (2) Install the Dike, middle Dike or make an incline on the floor side around the LPG Storage Tank to prevent filling of Grade I, II, III A Liquid under the LPG Container in case that Grade I, II, IIIA of Liquid Storage Tank is installed around the LPG Container.
- (3) Let LPG Container be separated as far over 0.9m for Safety distance from the outside of Dike in case of installing Grade I, II, IIIA of Liquid Storage Tank at the Dike.
But, there is no restriction in case of installing LPG Container Tank that capacity is lower than 0.48 m³ (125 gallons) around 2.5 m³ (660 gallons) of the Oil Tank for Fuel.

4. Outflow Accident Measure of Outdoors Storage Tank

4.1 Summary

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This is the thing which prevents spread of accident when an Outflow Accident occurs from Grade I, II and III A of Liquid Storage Tank by the Remote Impounding Method or Dike Method.

But, it is better not to install the Remote Impounding or Dike at Grade III B of Liquid Storage Tank.

4.2 Outflow Prevention Plan

4.2.1 Remote Impounding Method

The Inducing System of Flammable Liquid which flowed out from the Tank to the Drainage Catchment Pond which is at a certain distance away from the Group of Tank by using Drainage Way, etc is called the Remote Impounding, this System should be observed as below

- (1) The Distance from Tank to the Drainage Catchment Pond should be over 15m, Drainage slope between it should be over 1%.
- (2) Capacity of Drainage Catchment Pond should be more than the maximum Tank storage capacity.
- (3) Drainage Routing should not passed through the place which influence the other Tank or Neighboring Facility when the liquid of it was ignited.
- (4) Fence Line of Drainage Catchment Pond should be far away over 15m from the Every Facility or Tank

4.2.2 Dike Method

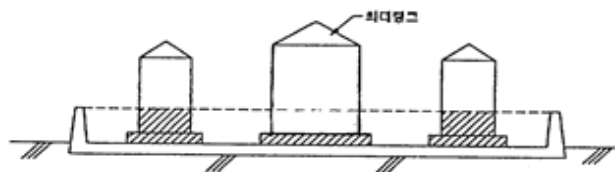
The prevention of accident expansion which caused by outflowing by storing the flowed out Liquid within Dike is called the Dike Method, this System should be observed as below.

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(1) Dike Capacity

The Capacity within the Dike should be bigger than the maximum amount of flowed out Liquid from that Tank in case of storing Flammable Liquid in the Maximum Tank within the Dike.

Capacity of the part under the height of Dike which is occupied by Tanks except the Maximum Tank should be considered in case of calculating Dike Capacity.

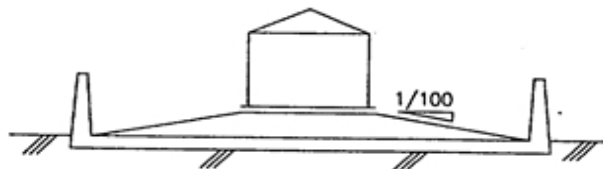


Dike Capacity $\geq$ Maximum Tank Outflow Amount + Capacity under the Dike Height of Tanks except the Maximum Tank

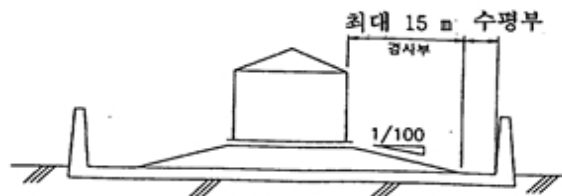
(2) Inclined Floor within Dike

Inclined Floor within Dike follows as below

- i. Case in which distance between outside wall of Tank and inside of Dike is less than 15m.



- ii. Case that distance between outside wall of Tank and inside of Dike is over 15m.

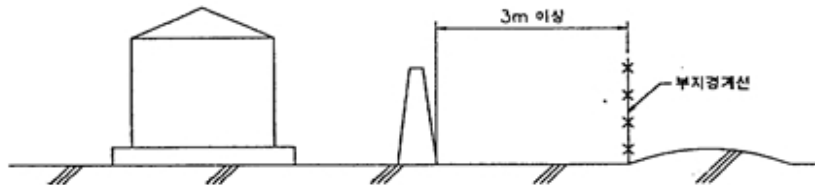


(3) Distance between Outside Wall of Dike and Other Buildings

Distance between outside wall of Dike (Contacted part to the surface of land)

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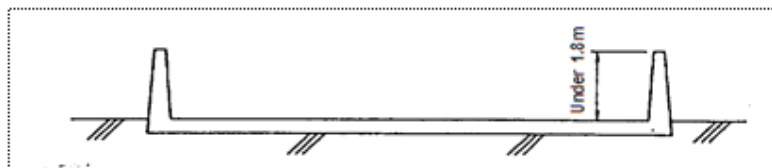
and other buildings should be followed below Drawing to make exit and entrance in the Dike easy.



- (4) Structure of Dike
The Wall of Dike must not let Liquid is leaked as the Structure of Soil, Concrete or Brick and it must stands against the Liquid Head in case of liquid flowing out.
Install over 0.6m (2ft) width of the Flat Side at the top part of wall for Dike Wall which is used the soil and over than 0.9m (3ft) height, also Inclination of wall should be maintained its degrees to not let that wall materials does fall.

Special measures must be taken such as floor concrete paving, etc for Dike of Grade I Flammable Liquid Storage Tank which is located on the porous soil to prevent the penetration of flowed out Liquid in more quantities to Lower Land or Drainage Way through the porous soil in case of flowing out Liquid.

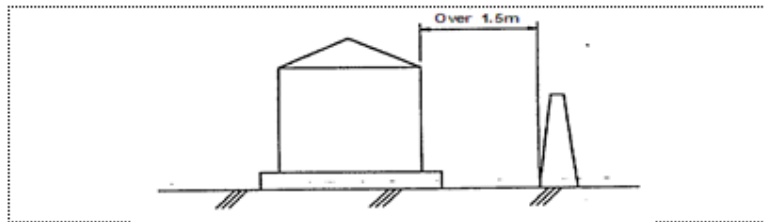
- (5) Height of Dike
Height of Dike should be less than 1.8 m.
But, Height of Dike can be over than 1.8 m in case that satisfied next matters as the case of installing Safe Exit within the Dike from its inside to the outside and case of installing required Emergency Access Road and Normal Access Road of valve and tank attached to equipments from outside of Dike to the inside.
(The Check of Owner is required in case that Height of Dike is more than 1.8 m because NFPA does not regulate about this by method in detail.)



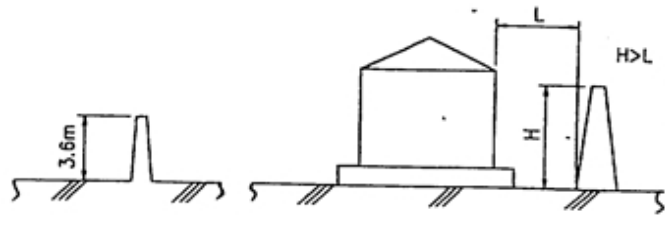
- i. The distance between Tank and inside lower end of the Dike must be the Minimum Distance which can resist Jet flow of the Liquid in case of flowing out Liquid which caused by corrosion, breaking, etc of the Tank surface. The distance in this case should be over 0.6 times than the Maximum storage

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height of Tank or over $\frac{1}{3}$ than up to the tangent height of Tank. (Maintain a distance of 1.5 m minimum.)



- ii. Pipe of the pierced part of Dike should be design carefully for being applied the excessive Stress by Fire and Settlement of land base.
- iii. Dike which stores Grade I Liquid should be equipped with the equipment which makes accesses to the Tank roof or normal Valve operation possible without going down under the upper end of Dike in case that inside height of Dike exceeds 3.6 m (12 ft) or case that distance between Tank and inside upper end is shorter than height of Dike. For example, must be equipped Overhead Bridge or similar equipment with this, or must use the Remote operated Valve.



- (6) Other
 - i. Must be equipped with facility for draining the rain water or sprinkled water from Dike that facility should has the control equipment which prevents that flammable liquid flows into the rain water line or drainage line. Also, Drainage facility should be controlled from outside of Dike in case of fire occurrence.
 - ii. Drum, Can, etc which stores dangerous material must not be stored within the Dike.
 - iii. LPG Storage Tank must not be installed within the same Dike with Grade I , II , III of Liquid Storage Tank.

4.3 Tank Installation Standard within Dike

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4.3.1 Recommended Practice of Storage Tank Area that separated with Plant Area

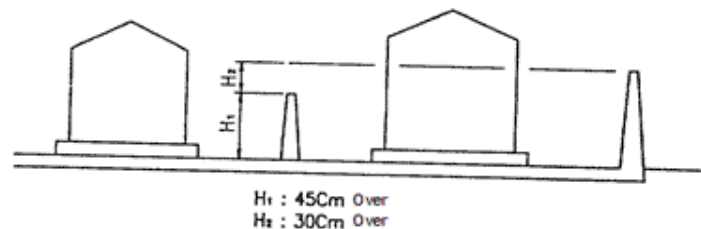
- (1) Dike Should be installed for FRT group per every store capacity of 120,000 m³ (750,000 bbls).
But, a separate Dike Should be installed for FRT that store capacity during cold season is over 120,000 m³.
- (2) Dike should be installed per every store capacity of 60,000 m³ (400,000 bbls) for CRT group or mixed Tank group of FRT and CRT.
But, a separate Dike Should be installed for CRT that store capacity during cold season is over 60,000 m³.
- (3) Installation of the Middle Dike within the one of Dike is followed as below.
 - i. Dike is installed per every Tank in case of Petroleum Storage Tank.
 - ii. Middle Dike is installed per each Tanks in case of Tank that store capacity during cold season is over 15,900 m³ (100,000 bbls) as the Grade I, II Liquid Storage Tank.
 - iii. Middle Dike is installed per every case that capacity of Tank group within one Dike is 24,000 m³ (150,000 bbls).
 - iv. Height of Middle Dike should be over 45cm and lower about 30cm than Dike height.
 - v. Height of Middle Dike should be more than as listed below
 - ① Petroleum Storage Tank : 25 % of relevant capacity
 - ② Other Flammable Liquid : 15 % of the maximum capacity Storage
 Capacity of the Middle Dike in this case should be more than the value which includes Tank capacity under the part of Middle Dike's upper end.

4.3.2 Dike installation standard of Storage Tank Area which is installed within the Plant Area

- (1) Capacity of Storage Tank that installed within the Plant is mainly smaller than the Storage Tank of clause 4.3.1 because it is decided by considering productivity.
The Maximum Capacity is decided by the designer after figuring out about it through a discussion with Owner because NFPA Code 30 does not defined the maximum capacity which can be stored in one Dike.
Tank that stored Unstable Liquid should be installed by separating with individual Dikes.
But, Tank can be installed within the same Dike on the basis of NFPA CODE 15 (Standard for Spray Fixed System for Fire Protection)

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- (2) Next is the Installation Standard of Middle Dike(or Drainage Way) within the same Dike.
- i. Tank in which storage capacity is over $1,589 \text{ m}^3$ (10,000 bbls) as Cone Roof Tank which stores chemically Stable Liquid or Floating Roof Tank and other Tank which stores petroleum in the manufacturing facility is separated by Middle Dike.
Each Tank Group should be separated by Middle Dike even if the capacity of each Tanks is under $1,589 \text{ m}^3$ and also the total capacity of Dike does not exceeds $2,385 \text{ m}^3$ (15,000 bbls).
 - ii. Tank in which storage capacity exceeds 378.5 m^3 (2,380 bbls) is separated individually by Middle Dike even in case of storing Stable Liquid as the Tank which is not relevant to clause 1) (Ex : Dome Roof Tank,etc). Also, each Tank Group is separated by Middle Dike so that storage capacity within the Middle Dike does not exceeds 567.7 m^3 (3570 bbls) even if each Tanks capacity is under 378.5 m^3 .
 - iii. Middle Dike is installed between relevant tank and neighboring Tank to secure over 10% of relevant Tank capacity in case that there are more than two(2) groups of Tank which stores Grade I liquid within the same Dike, and Diameter of one(1) group of them is exceeded 45.0 m (150 ft). But, Tank Capacity for Middle Dike should be considered.
 - iv. Drainage Way or Dike should be installed between Tanks to use the space between Tanks in maximum by considering storage capacity of individual Tanks, and in case of installing Middle Dike, its height should be more than 45cm and lower about 30cm than the Dike height.



5. Venting of offsite Storage Tank

5.1 Normal Venting

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- 5.1.1 Atmospheric Storage Tanks should be equipped with the Ventilation Equipment which can control the factors properly like as below.
 - (1) Inbreathing by flowing out of Liquid within the Tank.
 - (2) Inbreathing by Vapor Condensation which is due to Atmosphere Temperature dropping.
 - (3) Outbreathing by inflow of Liquid within to the Tank.
 - (4) Outbreathing by Vapor Extraction and Evaporation which is due to Atmosphere Temperature rising.
- 5.1.2 Size of Normal Venting Pipe should be followed as next
 - (1) API 2000 Venting Atmospheric and Low Pressure Storage Tanks
 - (2) Other Official Standard
 - (3) Over than 1¼ in. (32 mm) of minimum inside diameter as the over than sum of required amount by Temperature change and minimum liquid flow.
- 5.1.3 Exit Direction of Vent, Drain or Every Vent Pipe of Tanks in which operating pressure is more than 0.17 kg/cm²g should be selected to prevent heating Tank by fire heat or inflow of flame in case of fire occurrence at the Vented Vapor.
- 5.1.4 Ventilation Equipment which is hermetic always should be installed to the Grade I A Liquid Storage Tank and Pressure Vessel except the case of vacuum.
- 5.1.5 Ventilation Equipment which is hermetic always should be installed to the Grade I B, I C Liquid Storage Tank and Pressure Vessel except the case of Boost, Vacuum or Flame Arrestor installed case
- 5.1.6 Open Vent can be installed for the Petroleum Storage Tank of under 476.9m³ (3,000 bbls) storage capacity which is installed at Oil Field Area or the Atmospheric Tank of under 3.785m³ (23.8 bbls) storage capacity which stores the Liquid except Grade I A.
- 5.1.7 Caution is needed in case of Grade I B, I C of Liquid storage Tank because Tank can be collapsed if Flame Arrestor and Ventilation Equipment is blocked by condensation, corrosion, crystallization, polymerization, freezing and filling.

5.2 Emergency Relief Venting for Exposure

- 5.2.1 Emergency Relief Venting cannot be installed in case of Grade I or II Storage Tank, Tank which is not installed in the same Dike or Drainage Way and Tank in which storage capacity is more than 45.306m³ (285 bbls) in case of

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liquid of Grade III B.

- 5.2.2 Emergency Relief Venting that considered the boost of Tank inside pressure by exposure to the surrounding fire should be installed in case of every Outdoor Storage Tank which stores flammable liquid except clause 5.2.1.
- 5.2.3 Structure of Outdoor Storage Tank at clause 5.2.2 should be Floating Roof, Lifter Roof, Weak Roof-to-shell Seam or official Pressure Discharging Style Structure in case of Vertical Tank.
- 5.2.4 In case of installing Emergency Relief Venting as the Pressure Discharging equipment of Tank, its capacity should be over than the sum of normal venting capacity and emergency venting capacity to prevent from damaged of Tank Wall, Floor (Vertical Type), Head (Horizontal Type) by pressure boost.
Emergency Venting Equipment Capacity of Unstable Liquid Storage Tank should be considered the influence of Heat or Gas which occurs by polymerization, decomposition, condensation and spontaneous reaction in this case additionally.
Capacity of normal and emergency venting equipment should be more than Table 5.2.4, there are Self-Closing Manhole Cover or (But, case of clause 5.2.6 and 5.2.7 is excepted.) Lifting Cover With Long Bolt or Relief Valve as the example of equipments.
Wetted Area of Tank shows the exposed area of 55 % of whole surface area in case of Sphere Type or Oval Type, or 77% in case of Horizontal Type and up to 9 m from on the ground in case of Vertical Type.
- 5.2.5 Total venting rate is followed as per Table 5.2.4 in case of Tank having Storing Pressure is over $0.07 \text{ kg/cm}^2\text{g}$ (1 psig) or in case of Vessel, followed Table 5.2.5 in case of Tank that exposed surface area is over 260 m^2 (2,800 ft²)

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Table 5.2.4 Exposed Area vs Required Venting Amount (1 kg/cm²g, 15.6。C)

Exposed Area (m ²)	Required Venting Amount (m ³ /hr)	Exposed Area (m ²)	Required Venting Amount (m ³ /hr)	Exposed Area (m ²)	Required Venting Amount (m ³ /hr)
1.9	586.1	13.0	4083.3	65	11888.9
2.8	877.8	14.9	4666.7	74.3	12834.3
3.7	1169.4	16.7	5277.8	83.6	13694.4
4.6	1463.9	18.6	5861.1	92.9	14555.5
5.6	1755.5	23.2	6638.9	111.5	15472.2
6.5	2019.4	27.9	7361.1	130	16305.5
7.4	2348.9	32.5	8000	148.6	17055.5
8.4	2634.3	37.1	8666.7	167.2	17750.0
9.3	2916.7	46.4	9834.3	185.5	18388.9
11.1	3500.0	55.7	10888.9	223	19555.5

Table 5.2.5 Exposed Area vs Required Venting Amount

Exposed Area (m ²)	Required Venting Amount (m ³ /hr)	Exposed Area (m ²)	Required Venting Amount (m ³ /hr)	Exposed Area (m ²)	Required Venting Amount (m ³ /hr)
260.1	20611.1	557.4	38611.1	1858.0	103434.3
278.7	21834.3	650.3	43611.1	2322.5	124166.7
325.1	24777.8	743.2	48888.9	2787.0	144166.7
371.6	27638.9	836.1	53611.1	3251.5	163888.9
418.0	30555.5	929.0	58611.1	3716.0	182500.0
464.5	34722.2	1393.5	81666.7		

5.2.6 Total emergency venting amount about some particular Stable Liquid Storage Tank is followed next formula.

$$CMH = V \times \frac{2.4087}{L \sqrt{M}}$$

CMH = Emergency Venting Amount, m³/hr

V = Required requested Amount of Table 5.2.4, m³/hr

L = Latent heat of vaporization of Particular Liquid, cal/kg·mole

M = Mole weight of Particular Liquid, kg/mole

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- 5.2.7 Venting Amount can be calculated by applying a certain Factor to the calculated value of Table 5.2.4, 5.2.6 in case of satisfying next condition as the Stable Liquid Tank.

Factor	Condition
0.5	Equipped Drainage Way
0.3	Equipped Water Spray and Drainage Way or Tank keeping warm is equipped condition of Note.
0.15	Equipped Water Spray and Drainage Way or Tank keeping warm is equipped condition of Note.

Note:

1. Lagging Material should not be away from Tank wall by pressure of draining water of Outdoor fire hydrant.
2. Thermal Conductivity should be $0.051 \text{ cal/hr/m}^2/\text{ }^\circ\text{C}$ when outside temperature of lagging material is $904.4\text{ }^\circ\text{C}$, algebraic average temperature is $537.8\text{ }^\circ\text{C}$

- 5.2.8 Tank Venting Equipment should be attached with Name Board which is expressed clearly for opening pressure, pressure at the maximum opening and passing flow rate.
Also, Venting Equipment that initial opening pressure is $0.17 \text{ kg/cm}^2\text{g}$ (2.5 psig) and pressure of maximum opening is $0.17 \text{ kg/cm}^2\text{g}$ should be attached to Name Board which is expressed clearly for passing flow rate at pressure $0.17 \text{ kg/cm}^2\text{g}$.
- 5.2.9 Passing Flow Rate of Pressure Venting Equipment should be the one finished the examination of official institute and the Simple Formula is same as next in case that Venting Equipment's diameter of orifice is over than 8 in. (20cm).

$$\text{CFH} = 1,667 \times \text{Cf} \times \text{A} \times \sqrt{\text{Pt} - \text{Pa}}$$

Cf = 0.5 (Flow Coefficient)

A = Area of Orifice (in²)

Pt = Absolute Pressure of Tank Inside (in H₂O)

Pa = Tank Outside Atmospheric Pressure (in H₂O)

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5.3 Vent Piping

- 5.3.1 Vent Piping Exit should be over 3.6m Height from the ground and should let the Vapor be discharged toward upper direction.
Also, let discharged vapor does not blocked by obstacle such as Eave, etc in case of neighboring buildings, and the Exit must be secured at a Safety Distance of over 1.5m from the opening part of the building.
- 5.3.2 Vent Piping should not being Manifolding except the special purpose such as re-vaporizing, storing, air pollution of the vaporized Vapor.
Vent Piping must be able to be converted to individual venting system out of Manifolded Tank in case of fire occurrence.
- 5.3.3 Vent Piping of Grade I Liquid Tank and Grade II, III Liquid Tank must not be Manifolded.
But, it is possible in case of equipped the equipment which prevents that Grade I Vapor being intake to the other Tanks by maintaining inside of individual Tanks as positive pressure.

6. Liquid Processing Operations

6.1 Scope

This chapter regulates the matters about restriction of fire which is related to the flammable liquid and it is applied to the facility which uses or treats dangerous material.

6.2 General Matters

Facility which treats Flammable Liquid should be installed·operated safely to protect Human Life, Important Building or Facility from the danger of fire or explosion.
Temperature, Pressure, Discharging of Flammable Liquid or Vapor, Fire that can be broken out should be considered in case of preparing Plot Plan of Flammable Liquid Treating Facility.

6.3 Safety Distance

- 6.3.1 Refer Table 6.3.1 for Safety Distance of Flammable Treating Facility

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Table 6.3.1 Safety Distance of Treating Facility

The Minimum Distance to the Site Border Line (Opposite side of public road) (m)				
Maximum Operation Capacity of Vessel (m ³)	Stable Liquid (Emergency Venting)		Unstable Liquid (Emergency Venting)	
	Under 0.17 kg/cm ² g	Over 0.17 kg/cm ² g	Under 0.17 kg/cm ² g	Over 0.17 kg/cm ² g
Under 1.04	1.5	3.0	4.5	6.0
1.05 ~ 2.83	3.0	4.5	7.5	12.0
2.84 ~ 45.42	4.5	7.5	12.0	18.0
45.43 ~113.55	6.0	9.0	15.0	24.0
113.56 ~ 189.25	9.0	13.5	22.5	36.0
189.26 ~ 378.4	15.0	22.5	37.5	60.0
Over 378.5	24.0	36.0	60.0	90.0

Note: Multiply Safety Distance of above by double in case there is no installation for Fire Extinguishing Facility around Flammable Treating Facility.

Table 6.2.1 Safety Distance of Treating Facility (Continued from previous page)

The Minimum Distance to the Site Border Line (Opposite side of public road) (m)				
Maximum Operation Capacity of Vessel (m ³)	Stable Liquid (Emergency Venting)		Unstable Liquid (Emergency Venting)	
	Under 0.17 kg/cm ² g	Over 0.17 kg/cm ² g	Under 0.17 kg/cm ² g	Over 0.17 kg/cm ² g
Under 1.04	1.5	3.0	4.5	6.0
1.05 ~ 2.83	1.5	3.0	4.5	6.0
2.84 ~ 45.42	1.5	3.0	4.5	6.0
45.43 ~113.55	1.5	3.0	4.5	6.0
113.56 ~ 189.25	3.0	4.5	7.5	12.0
189.26 ~ 378.4	4.5	7.5	12.0	18.0
Over 378.5	7.5	12.0	19.5	30.0

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6.3.2 Safety Distance can be ignored in case that Stable Liquid Treating Facility is located within the Building, case of the Wall which has Safety Distance over 7.6m from Facility, case that surrounded by Fireproof Wall which is able to stand for more than 2 hours under the fire.

And Safety Distance can be ignored in case that surrounded by Fireproof Wall which is able to stand for more than 4 hours under the fire.

6.3.3 In case of Facility of Pump, Heater, Heat Exchanger, etc should be secured Safety Distance of Table 6.3.1 between the Building except that facility used process.

But it can be under Table 6.3.1 in case of satisfy the condition of provision 6.3.2

6.3.4 Unstable Liquid Treating Facility should be secured Safety Distance over 7.6m from the other facilities or should be installed the Fireproof Wall which stands for more than 2 hours under the fire. The Fireproof Wall should stand for explosion also.

6.4 Building and Structure

6.4.1 Structure and Building that related with process should be Incombustible Material and Fireproof Construction. But, it can be Non-Fireproof Construction in case it is equipped with the sprinkler or the fire extinguishing equipment. The Consultation is required in this case.

6.4.2 Grade I Flammable Liquid must not be treated, used on Underground Floor. In case of installing Grade I Flammable Liquid Treating Facility on Underground Floor that has possibility of accumulation by flowing of Flammable Vapor or on Over ground Floor within Building which has the Pit, a Compulsory Venting Facility should be installed on the underground Floor.

6.4.3 Venting Facility for Heat, Smoke should be installed around Flammable Liquid Treating Facility for easy access in case of fire fighting. Exit must be installed for easy escape of person's life in case of fire. Also, Exit must not be exposed to Drainage Way.

6.4.4 The Structure same as next should be installed around Grade I A or Unstable Flammable Liquid Treating Facility by considering Explosive Venting in case of explosion.

- (1) Open Air Construction
- (2) Lightweight Walls and/or Roof
- (3) Lightweight Wall Panels and Roof Hatches

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(4) Windows of Explosion - Venting Type

6.5 Drainage

6.5.1 Emergency Drainage System should be equipped with Drainage Way that flowed out flammable liquid or Water for fire fighting and can be discharged to the safe location.

6.5.2 Oil Trap or Separator should be installed in case that Emergency Drainage System is connected to Dirty Water Line or General Drainage Line.

6.6 Venting

6.6.1 Air of 0.3 m³/min should be vented per floor area in case that Treating Facility of Grade I Flammable Liquid or Grade I, II Flammable Liquid which is maintained over flashing point is installed at hermetic space. This kind of venting should be discharged to the outside by using natural, compulsory venting style. Discharged Air must not be circulated in the room in this time.

Exception: It is alright for the structure that some of discharged air can be circulated in case of installing the equipment which rang the alarm automatically and stopping Circulator when the density of circulated air is shown as over 1/4 than value of the Lowest Limit of Inflammability by sensing circulated air continuously.

6.6.2 Outside Air as much as vented amount should be flowed into the room to let the natural venting or compulsory venting is not be controlled.

6.6.3 Flammable Compounded Air (Vapor+Air) should not be flowed into the facility under the condition of normal operation in case of venting for building and facility which is installed at building. And the Facility should be secured the safety distance over than 1.5m from the facility which let Grade I Flammable Liquid exposed to the air as filling station, open type centrifuge, board structure vacuum filter, open type vacuum filter and the surface opened facility.

6.7 Electric Equipment

6.7.1 This is applied to the place that stores or treats Grade I Flammable Liquid or the place that stores or treats Grade II , III Flammable Liquid over flashing point.

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6.7.2 Every Electric Equipments and electric wire should be followed the regulation of NFPA 70, National Electrical Code.

6.7.3 Table 6.7.3 is the Electrical Area Classification which aims to installing the Electric Equipments in normal condition.

Table 6.7.3 Classification of Dangerous Place

Equipment Installing Place		NEC Class I Division	Scope of Classification Area
Facility installed in the room as the condition of 6.4.4 that Flammable Vapor+Air can be existed under the normal operation.		1	Space within 1.5m from each end parts of facility to every direction.
		2	Space from the over ground or floor up to 3m height as space between 1.5m ~ 2.4m from each end parts of facility to every direction.
Facility installed in the room as the condition of 6.4.4 that Flammable Vapor+Air can be existed under the normal operation.		1	Space within 1.5m from each end parts of facility to every direction.
		2	Space from the over ground or floor up to 3m height as space between 1.5m ~ 2.4m from each end parts of facility to every direction and space between 1.5m ~ 7.5m from each end parts of facility to every direction.
Over Ground Tank	Outdoor Tank	1	Inner space of Dike that height of Dike is bigger than the distance between outer wall of Tank and Dike.
	Outer Wall, Ending, Roof, In Dike Area	2	Space within 3m from Tank outer wall, ending, roof and Dike inside up to upper end.
	Venting Piping	1	Space within 1.5m from Vent opening part space to every direction.
		2	Space between 1.5m ~ 3m from Vent opening part space to every direction.
	Floating Roof	1	Roof Upper Part and Inner Wall Inside

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Table 6.7.3 Classification of Dangerous Place

Equipment Installing Place		NEC Class I Division	Scope of Classification Area
Under Ground Tank	Petrol Cap	1	Petrol Cap Pit, Box or space under the ground side is in the area of Division 1 or 2.
		2	Space within 3m radius in center of Loose Fill Conn. to over ground 30cm or Space within 1.5m radius in center of Tight Fill Conn. to over ground 30cm .
	Venting Piping	1 2	Space within 0.9m from every direction of venting pipe. Space between 0.9m ~ 1.5m from every direction of venting pipe.
Venting works suitably, Oil filling to Drum or Container inside or outside.		1	Space within 0.9m from every direction of petrol Cap or venting pipe.
		2	Space within 0.9m ~ 1.5m of petrol Cap or venting pipe and Space up to 4.5m height within 3m radius in center of venting pipe or petrol cap from over ground or floor.
Inside Installed Pump, Bleeder, Collecting Hole, Gauge, etc		2	space within 1.5m from ending of facility to every direction. Space up to 0.9m height from over ground or floor as the space within 7.5m of horizontal distance from ending of facility.
Outside Installed Pump, Bleeder, Collecting Hole, Gauge, etc		2	Space within 0.9m from ending of facility to every direction and Space up to 45cm height from over ground or floor as the space within 3.0m of horizontal distance from ending of facility.

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Table 6.7.3 Classification of Dangerous Place

Equipment Installing Place		NEC Class I Division	Scope of Classification Area
Pits	Has no Compulsory Venting	1	Every Pit Area within Division 1 or 2 Area
	Has Compulsory Venting	2	Every Pit Area within Division 1 or 2 Area
	Valve, Fitting or Piping, Fit which is not within Division 1 or 2 area.	2	Every Pit Area
Drainage Ditch, Separator, Impounding Basin in outside Drainage Ditch, Separator, Impounding Basin in inside		2	Space up to 45cm over Ditch, Seperator, Basin and same with space pit up to 45cm as within 3.5m from end of facility to every horizontal direction.
Tank Vehicle and Car that stores or fills through the Open Dome.		1	Space within 1.5m from end of Dome to each directions.
		2	Space within 1.5m ~4.5m from end of Dome.
Stores or fills through connecting hole on the floor which has Atmospheric Venting		1	Space within 0.9m from venting pipe to every direction.
		2	Space within 0.9m ~ 4.5m from venting pipe to every direction and space up to 45cm over ground as within 3m radius in center of connecting hole for storing.
Office and Lounge		Ordinary	Case that has Opening as Office and Lounge in the scope of Indoor classified Area.
Stores or fills through Hermetic Dome which has Atmospheric Venting		1	Space within 0.9m from venting pipe to every direction.
Stores or fills through Hermetic Dome which has Atmospheric Venting		2	Space within 0.9m ~ 4.5m from venting pipe and space within 1.5m from end of Dome to every direction.

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Table 6.7.3 Classification of Dangerous Place

Equipment Installing Place	NEC Class I Division	Scope of Classification Area
Stores or fills through Hermetic Dome which has Vapor controller	2	Space within 0.9m from connecting hole of Vapor controller, storage or filling hole to every direction
Place which has Vapor controller and storing or sending on the filling floor	2	Space within 0.9m from connecting hole of Vapor controller, storage or filling hole to every direction or space up to 45cm over ground as within 3m radius in center of connecting hole.
Garage and repair shop of Tank Vehicle	1	Space of every fit or under the ground side.
	2	Space up to 45cm on the ground side or floor within garage and repair shop.
Garage except Tank Vehicle	Ordinary	Case which has opening as warehouse in the scope of Outdoor classified area.
Outdoor Drum Storage	Ordinary	
Warehouse inside without moving of flammable liquid	Ordinary	Case which has opening as warehouse in the scope of Indoor classified area.
Stores or fills through Hermetic Dome which has Atmospheric Venting	2	Space within 0.9m ~ 4.5m from venting pipe to every direction and Space within 1.5m from end of Dome to each directions.
Stores or fills through Hermetic Dome which has Vapor Controller	2	Space within 0.9m from connecting hole of Vapor controller, Storing or filling hole to every direction.
Place which has Vapor Controller and Storing or sending on the filling floor	2	Space within 0.9m from connecting hole of Vapor controller, Storing or filling hole to every direction. Space up to 45cm as within 3m radius in center of connecting hole.
Garage and repair shop of Tank Vehicle	1	Space of every fit or under the ground side.
	2	Space up to 45cm height on the ground side or floor within garage or repair shop.
Garage except Tank Vehicle	Ordinary	Case which has opening as warehouse in the scope of Outdoor classified area.
Outdoor Drum Storage	Ordinary	
Warehouse inside without moving of flammable liquid	Ordinary	Case which has opening as warehouse in the scope of Indoor classified area.