DRAFT EAST AFRICAN STANDARD

The petroleum industry — Storage and distribution of petroleum products in above-ground bulk installations

EAST AFRICAN COMMUNITY
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Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in the East African Community. It is envisaged that through harmonized standardization, trade barriers that are encountered when goods and services are exchanged within the Community will be removed.

In order to achieve this objective, the Community established an East African Standards Committee mandated to develop and issue East African Standards.

The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

DEAS 1:2019 was prepared by Technical Committee EASC/TC 038, Petroleum and petroleum products industry and handling equipment.
The petroleum industry — Storage and distribution of petroleum products in above-ground bulk installations

1 Scope

This Draft East Africa Standard covers the layout and design of petroleum bulk depots, and the installation of equipment used for the handling, storage and distribution of petroleum products that are stable at atmospheric temperature and pressure.

This standard does not cover the storage and distribution of LPG and equipment that is used for storage and dispensing at consumer premises including service stations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API RP 2003, Protection against ignitions arising out of static, lightning, and stray currents

API Spec 5L, Specification for line pipes

API Std 620, Design and construction of large, welded, low-pressure storage tanks

API Std 650, Welded steel tanks for oil storage

API Std 2000, Venting atmospheric and low-pressure storage tanks — Non-refrigerated and refrigerated

ASTM D 86-01, Standard test method for distillation of petroleum products at atmospheric pressure

NFPA 11, Standard for low-, medium-, and high-expansion foam

ISO 7165, Portable rechargeable fire extinguishers — Dry powder type extinguishers

IEC 60079-1, Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"

ISO 4642-1, Fire protection — Wheeled fire extinguishers — Performance and construction

ISO 11602-2, Fire protection — Portable and wheeled fire extinguishers

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ISO 5772, Rubber hoses and hose assemblies for measured fuel dispensing

NFPA 15, Standard for water spray fixed systems for fire protection

API Publication 2030, Application of fixed water spray systems for fire protection in the petroleum and petrochemical industries

IP METHOD 34,

IP METHOD 170

API Std 620,

API Std 650

API Std 2000,

IEC 60079; Electrical apparatus for explosive gas atmospheres — General requirements

3 Terms and definitions

For the purposes of this standard, the following definitions apply:

3.1 acceptable
that which meets the requirements of the approving authority

3.2 accredited person
a person registered in terms of the relevant statutory requirements of the respective Partner States

3.3 approved
that which has been authorized by the approving authority

3.4 approved apparatus
explosion-protected equipment that has been submitted to the appropriate approving authority for examination and testing and for which a certificate of approval for a prescribed application has been issued

3.5 approving authority
the relevant competent authority in the respective Partner States

3.6 blanketing
the technique of maintaining an atmosphere that is either inert or fuel-enriched in the vapour space of a container or vessel

3.7 boiling point
the temperature at which a liquid exerts a vapour pressure of 1 bar
3.8 **breathing apparatus**  
an apparatus that allows the wearer to breathe independently of the ambient atmosphere

3.9 **buildings**  
as defined in the relevant statutory requirements of the respective Partner States

3.10 **bulk depot**  
preamises (sometimes referred to as marketing installations or terminals), on which the capacity for the storage of flammable goods or combustible goods (or both) exceeds 200 m³ in above-ground tanks, on which goods are normally received from a refinery or other bulk depot by road, rail, sea or pipeline (or a combination of these), and from which such flammable goods or combustible goods (or both) are delivered

3.11 **bund (wall)**  
a wall designed to confine product spillage at the point of storage

3.12 **bunded area**  
an area bounded by ground contours that confine spillage, or an area surrounded by bund walls

3.13 **class**  
the type of petroleum product, based on flash point and boiling point:

3.14 **combustible-gas detector**  
an instrument used to measure the concentration of flammable vapours in air, up to the lower explosive limits (for example, an explosimeter); oxygen levels in the air and hydrogen sulphide levels and give an audible alarm or visible flashing light.

3.15 **combustible liquid**  
a liquid that has a closed-cup flash point from 37.8 °C to 93.3°C

3.16 **competent person**  
a person who has the necessary knowledge of and ability with regard to the particular process or type of plant and equipment to which this standard refers, to render him capable of the work involved

3.17 **designated person**  
a person assigned duties by the employer in compliance with relevant statutory requirements of the respective Partner States

3.18 **effluent**  
residual water or any other liquid resulting from the use of water for industrial purposes, including any substance suspended therein and any storm water flowing or seeping or being pumped from a site, while such a site is in production or after its temporary closure or permanent abandonment
3.19
**explosion-proof**
apparatus enclosed in a case that can withstand an internal explosion of a specific gas or vapour, can prevent the ignition, by arcs, sparks or explosions that occur inside the case, of a specific gas or vapour surrounding the case and cannot cause ignition of flammable atmosphere

3.20
**fire stop**
a barrier across pipeline trenches to prevent the spread of fire

3.21
**fire wall**
a wall intended to prevent the spread of fire or the passage of flammable liquids or gases

3.22
**flame arrestor/ flame trap**
a device used to prevent the passage of flame into or out of an apparatus or equipment

3.23
**flammable**
descriptive of a material that is capable of ignition

**NOTE** The term "inflammable" is not acceptable as a synonym for "flammable".

3.24
**flammable liquid**
liquid that has a flash point of below 38 °C

3.25
**flash point/closed-cup flash point**
the lowest temperature at which the application of a small flame causes the vapour above a liquid to ignite when the product is heated under prescribed conditions, in a "closed" container

3.26
**freeboard**
the height of a bund wall above the calculated liquid surface

3.27
**gas free**
descriptive of a vessel, a container or an area that contains an atmosphere in which the concentration(s) of flammable gases or toxic gases (or both) have been certified as being within the prescribed safe limits

3.28
**gas-free certificate**
a certificate, issued by a competent person, that certifies that tests have proved that the concentrations of flammable gases or toxic gases (or both) in the relevant atmosphere are within the prescribed limits

3.29
**hazardous area**
an area in which flammable gases or vapours are or might be present in the air in quantities sufficient to become hazardous
3.30 hazardous atmosphere
an atmosphere that presents a threat to human life because it contains a flammable gas or vapour in a concentration capable of ignition, or it contains toxic components, or it does not contain sufficient oxygen for breathing
NOTE The term refers exclusively to danger that arises from ignition, but it should be remembered that a hazardous condition also exists where there is a lack of oxygen or where the atmosphere contains toxic gas or vapour, or an inert gas (such as is sometimes used to purge a tank), in such a concentration as to endanger life.

3.31 inerting
a technique by which a combustible mixture is rendered non-ignitable by addition of an inert gas or a non combustible dust

3.32 interceptor/ gravity separator
an approved chamber or chambers included in a drainage system and so designed as to permit the passage of effluent but to retain any hydrocarbons that are not miscible in water and that could be carried by the effluent stream

3.33 manifold
one or more header pipes, with branch connections, used for collecting or distributing the products carried in pipelines, pumps or vessels

3.34 maximum allowable working pressure
the maximum pressure, steady state or static, that is permitted anywhere in a tank during normal service

3.35 mobile plant/ mobile equipment
plant or equipment that is mounted on its own wheels or on tracks that has other facilities that give it mobility

3.36 mounded tank
a tank that is above the ground or semi buried and completely covered by earth, sand or other suitable material

3.37 packed-product facility
a depot for the storage of one or more grades of flammable or combustible products in packages, i.e. a depot in which no product is stored in above-ground or in semi-buried tanks

3.38 permit
a document that is issued by a designated person, or persons, and that permits specific work to be carried out in one or more defined areas

3.39 protection for exposure
fire protection for structures on property adjacent to a liquid petroleum storage site

NOTE Fire protection for such structures should be approved when the structures are located either within the jurisdiction of any public fire department or adjacent to plants that have private fire services capable of providing cooling water streams on the structures.

3.40 respirator
an apparatus that allows the wearer to breathe filtered respirable air.

NOTE An atmosphere that is not ignitable is not necessarily respirable.

3.41 responsible engineer
an engineer who is registered with the relevant professional body in the respective Partner States.

3.42 safety gauze
a non-corrodible wire gauze, of nominal aperture size not exceeding 0.5 mm, that is used to prevent the passage of flames into or out of an apparatus, equipment or a building.

3.43 safety zone
an area around above-ground tanks and around semi-buried tanks that does not necessarily fall within the premises of the company that operates the site, but over which such company can ensure control and enforcement of safety requirements by a legally binding agreement.

3.44 safe atmosphere
an atmosphere that is life-supporting, non-toxic and incapable of being ignited.

3.45 semi-buried tank
a tank that is partly in the ground and completely covered by earth, sand or other suitable material.

3.46 source of ignition
any means of supplying sufficient energy to ignite a flammable atmosphere.

3.47 spark arrestor
a device that is capable of preventing the emission of incandescent particles from the exhaust systems of internal combustion engines into the atmosphere.

NOTE A spark arrestor is not necessarily a flame trap (flame arrestor).

A.3.1 accident
an unplanned event or sequence of events that results in undesirable consequences. An incident with specific safety consequences or impacts.

A.3.2 credible event
an event that has a degree of probability (likelihood) of occurring, or for which reasonably practical
mitigating actions can be taken by the owner of the depot to minimize the consequences (or both)

A.3.3 consequence
the direct, undesirable result of an accident, usually involving a fire, an explosion, or the release of toxic material. Consequences may be expressed as either quantitative or qualitative estimates of the effects of an accident in terms of factors such as health impact, economic loss, and environmental damage.

NOTE Severity is very often used as a synonym or to express the degree of consequence.

A.3.4 event
an occurrence related to equipment performance or human action external to the system that causes a system upset. An event is either the cause of or a contributor to an incident or accident, or is a response to the event that initiated an accident. Fire, explosion, and toxic release are typical events.

A.3.5 external event
any event that occurs external to the system considered.

NOTE Examples are: lightning, extremely unusual weather conditions, earthquake, landslide, flooding, actions of third parties or failure of their equipment outside of the property of the depot but impacting on the depot.

A.3.6 hazard
a chemical or physical condition that has the potential to cause damage to people, property, or the environment.

NOTE A common synonym is "risk source".

A.3.7 hazard evaluation/analysis
the analysis of the significance of hazardous situations, or other processes or activity. It uses qualitative techniques to pinpoint weaknesses in the design and operation of facilities that could lead to accidents.

A.3.8 hazard identification
the pinpointing of material, system, process, and plant characteristics that can produce undesirable consequences through the occurrence of an accident.

A.3.9 incident
the loss of hazardous material from containment or the release of hazardous forms of energy (for example, in a "near miss")

A.3.10 incredible event
an event that is extremely improbable (with, for example, a likelihood of less than 1 in 1 000), or for which "reasonably practical" measures to minimize the consequences are beyond the capabilities of the owner of the depot, or both.

A.3.11
likelihood
a measure of the probability or expected frequency of an event’s occurrence

A.3.12
probability
an expected chance for certain events to happen within a certain period of time

A.3.13
risk
the combination of the expected probability of an event and the consequence of that event. It is a
measure of economic loss or human injury in terms of both incident likelihood and the magnitude of
loss or injury. (Risk = Severity x Probability)

A.3.14
risk analysis
the development of a quantitative estimate of risk based on engineering evaluation and mathematical
techniques for combining estimates of incident consequences and frequencies. It is the systematic
identification and evaluation of risk objects and hazards

A.3.15
risk assessment
the process by which the results of a risk analysis (i.e. risk estimates) are used to make decisions,
either through relative ranking of risk reduction strategies or through comparison with risk targets

A.3.16
risk estimation
the process of combining the estimated consequences and likelihood of all incident outcomes from all
selected incidents to provide a measure of risk

A.3.17
risk object
any object that could institute a risk within the perimeter of a bulk storage depot (for example, tanks,
tank bund, loading racks, rail sidings, warehouses, workshops, etc.)

A.3.18
risk targets
objective-based risk criteria established as goals or guidelines for performance

A.3.19
worst case
the possible event with the worst consequences. There are three types of "worst case"

a) the consequences are so limited that the risk is unimportant, whatever the probability of the
event;

b) the consequences are so serious that the probability of the event must be very small (low) if there
is to be a tolerable level of risk; and

c) the worst possible consequences are irrelevant since the probability is so low that the risk is
negligible
3.49 **working area**
in regard to railway sidings, only that area on each side of the actual staging length of the rail tank car

3.50 **unrestricted area**
an area of which no part is classified as a hazardous area

3.51 **unstable liquid**
a liquid that, in the pure state or as commercially produced or transported, will vigorously polymerize, decompose, undergo condensation reaction, or become self-reactive under conditions of shock, pressure or temperature

4  **Classification for types of tanks, petroleum products and hazardous areas**
4.1 **Types of tanks**
one of the following types of tank, that are commonly used to store liquid petroleum products

4.1.1 **atmospheric tank**
a fixed-roof tank, that has a weak roof-to-shell seam, and that is designed to withstand an internal vapour pressure not exceeding (measured at the top of the tank) 3.5 kPa, and that is generally free-venting. (A tank with a vertical cone roof is a typical example.)

**NOTE** Atmospheric tanks are not designed for storing a liquid at a temperature at or equal to its boiling point.

4.1.2 **floating-roof tanks**
a type of tank that can be of two designs

4.1.2.1 **open-top floating-roof tank**
a tank that is designed to an approved standard (API Std 650 or equivalent), with a pontoon (double-deck metal floating roof) that meets the requirements of the design standard; or

4.1.2.2 **internal floating-roof tank**
a cone-roof tank with an internal floating roof or a lightweight metal pan, and with roof and eaves ventilation designed in accordance with an approved standard (API Std 650 or equivalent)

4.1.3 **low pressure tank**
fixed-roof tank, that has a strong roof-to-shell seam, and that is designed to withstand an internal pressure above 3.5 kpa, but not exceeding 103.4 kpa, measured at the top of the tank. (A tank with a hemispheroid top is a typical example)

4.2 **Classification of Petroleum products**
Petroleum products shall be classified as follows;

4.2.1 **Petroleum Products class types**
These are classified as follows;
a) Class 0: liquefied petroleum gases;
b) Class 1: liquids, which shall be subdivided as follows:
i) Class IA: liquids that have a closed-cup flash point of below 23 °C and a boiling point of below 35 °C.

ii) Class IB: liquids that have a closed-cup flash point of below 23 °C and a boiling point of 35 °C; or above

iii) Class IC: liquids that have a closed-cup flash point of 23 °C or above, but below 38 °C.

iv) Class II: liquids that have a closed-cup flash point of 38 °C or above, but below 60.5 °C;

v) Class IIIA: liquids that have a closed-cup flash point of 60.5 °C or above, but below 93 °C;

vi) Class IIIB: liquids that have a closed-cup flash point of 93 °C or above.

NOTE Product classification vary among different standards.

Classes II and III constitute the following:

If a class II or a class III combustible liquid should be stored or handled at temperatures above its flash point and at or above its boiling point, special precautions should be taken in both the layout and the operation for such a liquid.

4.3 classification of hazardous areas

hazardous areas shall be classified as follows

a) Zone 0: An area in which a flammable gas or vapour is continuously present in a concentration within its lower and upper limits of flammability;

b) Zone 1: an area in which:
i) a hazardous concentration of a flammable gas or vapour occurs intermittently or periodically under normal operating conditions, or

ii) a hazardous concentration of a flammable gas or vapour might occur frequently because of repair operations, or maintenance operations, or leakage, or

iii) breakdown or faulty operation of equipment or processes that might release a hazardous concentration of a flammable gas or vapour, might also cause simultaneous failure of electrical equipment;

c) Zone 2: an area in which operations that involve flammable or explosive substances, gases or vapours, or volatile liquids, are so well controlled that an explosive or ignitable concentration is likely to occur only under abnormal conditions.

5 Planning and construction of bulk depots

4.1 Design and construction of bulk storage tanks

4.1.1 General

Plans submitted for approval to the approving authority concerned shall be signed by a professional or responsible engineer who thereby certifies that such plans comply with the provisions of this standard. All tanks shall be designed and built in accordance with an approved standard (for example, API Standard 650).

4.1.2 Elevated tanks

An elevated tank shall be designed in such a way that it is supported on a structure with a 4 h fire rating.

4.1.3 Vertical tanks

A vertical tank shall consist of not more than one compartment.

4.2 Topography

4.2.1 Safety distances

Hydrocarbons are volatile under certain conditions and their vapours in specific concentrations are flammable. Precautions shall be taken to prevent their ignition and, in the event of fire, to prevent further spread. One facet of a total fire protection package is to reduce the likelihood of a fire by siting facilities at what is considered to be a safe distance from one another.

Safety distances do not guarantee protection from fire hazard, but they help to prevent the start of a fire by ensuring that any flammable vapour generated by one facility will diffuse to a concentration well below the lower explosive level (LEL) before it reaches any other facility or area where a source of
ignition might exist.

4.2.2 Bulk depot siting

4.2.2.1 The siting of a bulk depot is of paramount importance, not only from a marketing point of view but also from a fire and security point of view. Cognizance shall be taken on the following:

a) the fall of the ground in relation to residential areas and other risk areas that could be exposed in the event of accidental large-scale spillages;

b) access facilities to and around the site;

c) drainage systems, especially where these link up with the drainage system of the local authority;

d) available water supplies;

e) fire protection, security, and general service facilities in the area, including the fire services’ response time;

f) population densities around the premises;

g) future expansion;

h) good housekeeping (for example the removal of flammable materials such as rubbish, dry vegetation and oil-soaked soil);

i) the depth of the water table (if it is above the first impermeable layer) and the date of measurement;

j) the soil types down to the first impermeable layer, and the reduced level of the impermeable layer over the site; and

k) the location of any existing boreholes, aquifers or artesian wells within 500 m of the site, and an analysis of the water for hydrogen sulfide and hydrocarbons.

4.2.2.2 To facilitate future monitoring of the environment, the above information shall be obtained and recorded before construction commences.

4.3 Boundaries

In the interests of security, the depot shall be so enclosed as to prevent unauthorized access (see 9.6).

4.4 Tankage layout: minimum safety distances

4.4.1 General

4.4.1.1 Safety distances of tanks from each other or from property boundaries, public roads, third-party properties, safe areas and other facilities in the depot shall be based on either of the following two criteria:

a) the minimum distance through which flammable vapours, emitted during normal operational venting to the atmosphere, have to move away from the tank in order to become dispersed and diluted below the lower explosive limit; or
b) the minimum distance over which available protection measures against radiant heat from the tank would remain effective if the tank were to burn.

4.4.1.2 The safety distances given in 4.4.2 are the consequent minima that are regarded as necessary.

4.4.2 Safety distances

The minimum shell-to-shell spacing for horizontal tanks that contain class I, II or IIIA liquids shall be as given in Columns 3 and 4 of Table 1. For vertical floating roof tanks that contain class I, II or IIIA liquids shall be as given in Column 2. Safety distances are also illustrated in figure 1.

Table 1 — Minimum shell-to-shell spacing for tanks in the same bund

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impounding</td>
<td>Floating-roof tanks</td>
<td>Horizontal tanks/vertical fixed roof tanks</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class I or II liquids</td>
<td>Class IIIA liquids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tanks of diameter not exceeding 45 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote or in the tank bund</td>
<td>One-sixth of the sum of adjacent tank diameters but not less than 1 m</td>
<td>One-sixth of the sum of adjacent tank diameters but not less than 1 m</td>
<td>One-sixth of the sum of adjacent tank diameters but not less than 1 m</td>
<td></td>
</tr>
<tr>
<td>Tanks of diameter exceeding 45 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the tank bund</td>
<td>One-quarter of the sum of adjacent tank diameters</td>
<td>One-third of the sum of adjacent tank diameters</td>
<td>One-quarter of the sum of adjacent tank diameters</td>
<td></td>
</tr>
<tr>
<td>Remote</td>
<td>One-sixth of the sum of adjacent tank diameters</td>
<td>One-quarter of the sum of adjacent tank diameters</td>
<td>One-sixth of the sum of adjacent tank diameters</td>
<td></td>
</tr>
</tbody>
</table>
NOTE 1  Tanks used for storing stable liquids of class I, II or IIIA shall be separated in accordance with TABLE 1.

NOTE 2  If a class III liquid is stored adjacent to a class I or class II liquid, the larger of the class spacings shall be used.

NOTE 3  Where tanks are in a bunded area that contains class I or class II liquids, or that are in the drainage path of class I or class II liquids, and that are compacted in three or more rows, or in an irregular pattern, the approving authority shall be permitted to require greater spacing or other means of separation to make tanks in the interior of the pattern accessible for fire-fighting.

NOTE 4  The minimum horizontal separation between an LPG container and a class I, II or IIIA liquid storage tank shall be at least 6 m, except in the case of a class I, II or IIIA liquid tank that operates at a pressure exceeding 17.2 kPa or that is equipped with emergency venting that permits pressures to exceed 17.2 kPa, in which case the provisions of notes 1 and 2 will apply.

NOTE 5  Tanks should be so arranged and disposed that, irrespective of whether the tanks are erected within one or several bunded areas, any fires in nearby tanks in the same or adjacent bunded areas, or in equipment or buildings nearby will have minimal effect. As an additional safety factor, consideration can be given to ensuring the further protection of tanks from fire by mobile or stationary fire-fighting equipment.

NOTE 6  Tanks should be so arranged that, if a fire breaks out, fire-fighting can be carried out effectively with mobile and stationary fire-fighting equipment. Access for and operating availability of such equipment is therefore of prime importance. Tanks should be so sited that each tank is adjacent to a (fire) road or accessible to mobile fire-fighting equipment.

In the case of tanks that contain a stable liquid of class I, II or IIIA, at an operating pressure of 17.2 kPa or less, the minimum distance between the tank and any property boundary, public road or building shall be as given in Table 2.

Table 2 — Stable liquids
(at an operating pressure of 17.2 kPa or less)

<table>
<thead>
<tr>
<th>Type of tank</th>
<th>Level of protection</th>
<th>Minimum distance from the tank shell to the property boundary but not less than 2 m</th>
<th>Minimum distance from the tank shell to the nearest important building on the same property, but not less than 2 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floating-roof</td>
<td>Protection in case of exposure</td>
<td>Half of the diameter of the tank</td>
<td>One-sixth of the diameter of the tank</td>
</tr>
<tr>
<td>(all types)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>Diameter of the tank, but need not exceed 53 m</td>
<td>One-sixth of the diameter of the tank</td>
</tr>
</tbody>
</table>
In the case of tanks that contain a stable liquid of class I, II or IIIA, at an operating pressure exceeding 17.2 kPa, the minimum distance between the tank and any property boundary, public road or building shall be as given in Table 3.

### Table 3 — Stable liquids
(at an operating pressure exceeding 17.2 kPa)

<table>
<thead>
<tr>
<th>Type of tank</th>
<th>Level of protection</th>
<th>Minimum distance from the tank shell to the property boundary</th>
<th>Minimum distance from the tank shell to the nearest important building on the same property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any type</td>
<td>Protection in case of exposure</td>
<td>One-fifth of the values given in Column 2 of Table 4 but not less than 7.5 m</td>
<td>One-fifth of the values given in Column 3 of Table 4, but not less than 7.5 m</td>
</tr>
<tr>
<td>None</td>
<td>Three times the values given in Column 2 of Table 4, but not less than 15 m</td>
<td>One-fifth of the values given in Column 3 of Table 4, but not less than 7.5 m</td>
<td></td>
</tr>
</tbody>
</table>
Table 4 — Reference table

(to be used in conjunction with Tables 2 and 3)

<table>
<thead>
<tr>
<th>Tank capacity ( m^3 )</th>
<th>Minimum distance from the tank shell to the property boundary ( m )</th>
<th>Minimum distance from the tank shell to the nearest important building on the same property ( m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>1.0 – 2.2</td>
<td>3.0</td>
<td>1.5</td>
</tr>
<tr>
<td>2.201 – 45.0</td>
<td>4.5</td>
<td>1.5</td>
</tr>
<tr>
<td>45.001 – 82.0</td>
<td>6.0</td>
<td>1.5</td>
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<td>82.001 – 200.0</td>
<td>9.0</td>
<td>3.0</td>
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<td>200.001 – 378.0</td>
<td>15.0</td>
<td>4.5</td>
</tr>
<tr>
<td>378.001 – 1 892.5</td>
<td>25.0</td>
<td>7.6</td>
</tr>
<tr>
<td>1 892.501 – 3 785.0</td>
<td>30.5</td>
<td>11.0</td>
</tr>
<tr>
<td>3 785.001 – 7 570.0</td>
<td>41.0</td>
<td>13.7</td>
</tr>
<tr>
<td>7 570.001 – 11 355.0</td>
<td>50.0</td>
<td>17.0</td>
</tr>
<tr>
<td>11 355.001 or more</td>
<td>53.0</td>
<td>18.0</td>
</tr>
</tbody>
</table>

In the case of tanks that contain a class IIIB liquid, the minimum distance between the tank and any property boundary, public road or building shall be as given in Table 5.

Table 5 — Class IIIB liquids

<table>
<thead>
<tr>
<th>Tank capacity ( m^3 )</th>
<th>Minimum distance from the tank shell to the property boundary ( m )</th>
<th>Minimum distance from tank shell to the important building on the same property ( m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than or equal to 48</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>&gt; 48 – 112</td>
<td>3.0</td>
<td>1.5</td>
</tr>
<tr>
<td>&gt; 112 – 192</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>&gt; 192 – 384</td>
<td>4.5</td>
<td>3.0</td>
</tr>
<tr>
<td>&gt; 384</td>
<td>4.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>

The minimum distance between a tank and the toe of the inside of a bund wall shall be at least 1.5 m.
4.4.3 Normal venting for above-ground tanks

### General

Table: Class I, II and IIIA liquids

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Level of protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 1/2 diameter of tank</td>
<td>Protection in case of exposure</td>
</tr>
<tr>
<td>A2 1/2 diameter of tank</td>
<td>Protection in case of exposure</td>
</tr>
<tr>
<td>B1 1/2 diameter of tank</td>
<td>Approved foam or inerting system</td>
</tr>
<tr>
<td>2 x diameter of tank</td>
<td>Protection in case of exposure</td>
</tr>
<tr>
<td>B2 1/3 diameter of tank</td>
<td>Approved foam or inerting system</td>
</tr>
<tr>
<td>1/3 diameter of tank</td>
<td>Protection in case of exposure</td>
</tr>
</tbody>
</table>

C1 1/2 of values given in column 2 of table 2

NOTES
1. Applies only to tanks that are less than 45 m in diameter and that operate at pressures of less than 17.2 kPa, in the case of stable liquids. In the case of tanks that operate at pressures exceeding 17.2 kPa, see table 3.
2. The minimum distance between a tank and the toe of a bund wall shall be 1.5 m, and that between a bund wall and a property boundary shall be 3 m.
3. The minimum spacing between tanks shall be at least 1 m.

Table: Class IIIB liquids

NOTES
1. In the case of class IIIB liquids, see table 5.
2. The minimum distance between tanks shall be at least 1 m.
3. The minimum distance between a tank and the toe of a bund wall shall be 1.5 m, and that between a bund wall and a property boundary shall be 3 m.

### General safety distances

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 15 m</td>
<td>Class I</td>
<td>If boundary is open-type fencing</td>
</tr>
<tr>
<td>6 m</td>
<td>Class I</td>
<td>If boundary is a solid wall</td>
</tr>
<tr>
<td>6 m</td>
<td>Class II</td>
<td>If boundary is open-type fencing</td>
</tr>
<tr>
<td>3 m</td>
<td>Class IIIA</td>
<td>If boundary is a solid wall</td>
</tr>
<tr>
<td>E 15 m</td>
<td>Class I</td>
<td>No restriction</td>
</tr>
<tr>
<td>6 m</td>
<td>Classes II and IIIA</td>
<td></td>
</tr>
<tr>
<td>F 15 m</td>
<td>Classes I, II and IIIA</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1 — Typical bulk storage installation showing safety distances
All atmospheric storage tanks shall be adequately vented to prevent, in the case of a cone-roof tank, the development of a vacuum or pressure that could distort the roof, or in the case of other atmospheric tanks, the design pressure from being exceeded as a result of filling, emptying, and temperature changes. Protection shall be provided to prevent the overpressure in any pump from being discharged into the tank or vessel where the pump discharge pressure can exceed the design pressure of the tank.

4.4.3.2 Normal venting

Normal vents shall comply with the requirements of an approved standard, such as API Std 2000, or another acceptable standard, and shall be of size at least the same as that of the filling or withdrawal connection (whichever is the larger), but in no case shall the nominal inside diameter be less than 30 mm.

4.4.3.3 Vent flow

In the case of a tank or pressure vessel that has more than one fill or withdrawal connection, and where simultaneous filling and withdrawal can take place, the vent size shall be based on the maximum anticipated simultaneous flow.

4.4.3.4 Vent outlets

The outlets of all vents and vent drains on tanks that are equipped with venting to permit pressures from exceeding 17.2 kPa (1.72 x 10^-3 Bars) shall be arranged to discharge in such a way as to prevent localized overheating of, or flame impingement on any part of the tank, should vapours from such vents ignite.

4.4.3.5 Venting of tanks

4.4.3.5.1 Tanks and pressure vessels for storing class I liquids could be equipped with venting devices that are normally closed except when venting to pressure or vacuum conditions.

4.4.3.5.2 Tanks and pressure vessels for storing class IA, IB and IC liquids shall be equipped with venting devices that are normally closed except when venting under pressure or vacuum conditions, or with listed flame arrestors.

4.4.3.5.3 Tanks for storing class I liquids equipped with internal floating roofs shall be free venting.

4.4.3.5.4 Tanks for storing class II or class III petroleum products could be fitted with open vents.

4.4.3.5.5 Pressure and vacuum vents or open vents should not be fitted with fine mesh gauze (less than 6 mm) that is liable to become clogged with dust, dirt or ice and impair venting capacity. However, where such vents are equipped with screens to prevent the entry of foreign matter, the screen shall be of aperture size at least 6 mm.

4.4.4 Emergency venting

4.4.4.1 Every above-ground tank shall have some form of approved emergency venting that will relieve excessive internal pressure in the event of exposure to fire.

4.4.4.2 In the case of vertical tanks, emergency venting could be provided by a floating roof or, if the tank has a fixed roof, by a weak roof-to-shell seam that will fail before any other seam or plate of the tank shell or bottom.
4.4.4.3 If emergency venting is provided by means of pressure relieving vents, the venting capacity of normal vents together with emergency vents shall be sufficient to prevent failure of, in the case of a vertical tank, the shell or bottom or, in the case of a horizontal tank, of the shell or ends.

4.4.4.4 The emergency venting capacity provided shall be in accordance with an approved standard, such as API Std 2000.

4.5 Tank farms and bunding

4.5.1 General

Spillages and fires that involve bulk storage tanks could pose a risk to the depot, adjoining property, the community and the environment. The general purpose of tank farms and bunding is to limit, contain, divert, minimize and manage the impact of spillages and fires.

The design shall consider the optimization of tank farm and bunding sizes in conjunction with firefighting requirements of the tank farm and its limitations. The design shall also consider the risk of pollution to surface and ground water, soil and environment.

4.5.2 Spillage control

Spillage control can be provided by remote impounding and impounding around tanks by bunding or by a combination of the two.

In both types of impounding, the impoundment area shall be protected by adequately designed systems to prevent the contamination of ground water if such a risk exists.

4.5.2.1 Impounding around tanks by bunding

Where protection of adjoining property and waterways is by means of impounding by building bund walls around tanks, such bunding shall comply with the following:

a) slope of at least 1:100 away from the tank shall be provided for at least 15 m or the distance to the bund wall toe, whichever is less.

b) The volumetric capacity of the bunded area shall not be less than 110% of the amount of product that can be released from the largest tank in the bunded area, assuming a full tank. To allow for the volume occupied by the tanks, the capacity of the bunded area that encloses more than one tank shall be calculated after the volume of all the tanks, other than the largest tank, below the height of the bund wall has been deducted.

c) To permit access, the outside toe of the bund wall at ground level shall be no closer than 3 m to any property boundary that is or can be built upon.

d) Walls of the bunded area shall be of earth or concrete, and shall be designed to be liquid-tight and to withstand a full hydrostatic head of water. Earthen walls of height 1 m or more shall have a flat section, not less than 0.6 m wide at the top. The slope of an earthen wall shall not exceed the angle of repose of the material of which the wall is constructed.

In the case of tanks that contain liquids of class I, II or III, and that are situated in porous soils, bunded areas shall be impervious to prevent the seepage of spilled hazardous liquids to low-lying areas or waterways.

e) Except as provided for in (f) below, the wall height of the bunded area shall be restricted to 1.8 m.
f) Bund walls shall be permitted to be higher than the general maximum of 1.8 m where adequate
provisions are made for normal access and for the necessary emergency access to the tank,
valves and other equipment. A safe exit in and out of the bunded area shall also be provided.

g) Where the average height, measured from the interior grade, of a bund that contains class I
liquids exceeds 3.6 m, or where the distance between any tank and the top inside edge of a bund wall
is less than the height of the bund wall, provision shall be made for normal operation of valves and for
access to the tank roof without entry below the top of the bund. It should be possible to meet these
provisions through the use of remote-operated valves, elevated walkways, or similar arrangements.

NOTE Piping that passes through bund walls should be designed to prevent excessive stress as a result of
settlement of the soil or exposure to fire.

h) The minimum distance between a tank and the toe of an interior bund wall shall be at least 1.5 m.

i) Each bunded area that contains two or more vertical tanks shall be subdivided at least by
intermediate bund walls or by drainage channels, to prevent spills from one tank from endangering
adjacent tanks within that bunded area.

NOTE 1 Whenever two or more tanks that contain class I liquids, and of which one is of diameter exceeding 45 m, are located
in a common bunded area, intermediate bund walls shall be provided between adjacent tanks to hold at least 10 % of the
capacity of the tank so enclosed, and not including the volume displaced by the tank.

NOTE 2 Intermediate bund walls or drainage channels (or both) should be located between tanks so as to take full advantage
of the available space with due regard for the capacity of each individual tank. Intermediate bund walls should be of height
at least 0.5 m.

j) Where provision is made for draining water from bunded areas, such drains shall be controlled so
as to prevent flammable or combustible products from entering natural watercourses, public sewers or
public drains. Under fire conditions, the controls of such drainage shall be accessible from outside the
bunded area.

k) No storage of combustible materials shall be permitted in any bunded area.

4.5.2.2 Remote impounding

Where protection of adjoining property or waterways is by means of drainage to a remote impounding
area, such systems shall comply with the following:

a) A slope of at least 1:100 away from the tank and towards the impounding area shall be provided
for at least 15 m.

b) The impounding area shall have a capacity of at least 110% that of the largest tank. Where this is
impractical because of area restrictions, partial remote impounding for a percentage of the tank
capacity shall be permitted, remote from any tank or adjoining property. Bunding that meets the
provisions of 4.5.2.1 shall be provided for the volume that was not provided for by the partial
remote impoundment.

c) The route to and from the remote impounding system shall be designed such that, in the event of
a fire, the tank or the adjoining property is not seriously exposed.

d) The confines of the impounding area shall be designed such that, when the area is filled to
capacity, the liquid level is not closer than 15 m to any property boundary that is or can be built on, or
to any tank. Where partial remote impounding is used, the level in the partial impoundment shall meet
the provisions of this sub clause. Any excess volume shall meet the provisions for impounding by
bunding as provided for in 4.5.2.1, and the tank spacing shall be determined as for tanks impounded in accordance with Table 1.

4.5.3 Packed-product facilities (warehouses) and pump slabs

Bund walls are not required around packed-product storage areas, storage buildings, filling sheds or pump slabs. Spillage control shall be provided where product is decanted or pumped.

The floors of packed-product facilities shall not be sunken, since petroleum vapours are difficult to clear from such locations and can accumulate and cause toxic and fire hazards.

4.5.4 Lighting

To facilitate night operations, tank farms shall be provided with adequate artificial lighting facilities that comply with the recommendations given in IEC 60079.

4.6 Location and spacing of buildings

4.6.1 General

All buildings shall comply with the relevant statutory requirements of the respective Partner States.

4.6.2 Administrative buildings

Administrative buildings shall be located in a safe area (preferably near the main gates), with access from the roadway so that visitors to the offices do not have to enter the working area of the depot. The walls of these buildings may form part of the outer boundary of the depot.

4.6.3 Operational facilities

Operational buildings (such as filling sheds and pump slabs) shall be spaced as follows:

a) No filling shed or pump slab that contains class I liquids shall be sited less than 15 m from any part of the outer boundary of the depot if the boundary is constructed of open-type fencing. At points where the open-type fencing is replaced by a solid wall, or if the depot is bounded by a solid wall, this distance may be reduced, but shall be at least 6 m. In the case of filling sheds for class II petroleum products, the above distances could be reduced to 6 m and 3 m respectively. For class III liquids, no distance limit is required.

b) Filling sheds and pump slabs where class I petroleum products are handled shall be sited at least 15 m from any building in which work that involves heat is done or where open fires are used (for example, reconditioning shops, tin factories, and soldering sheds). In the case of class II and class III petroleum products, this distance may be reduced to 6 m.

NOTE If the safety distances given in (a) or (b) above cannot be attained, firewalls may be used, subject to approval by the appropriate approving authority.

4.6.4 Service buildings

Service buildings do not constitute an inherent petroleum-fire hazard but might include open fires or other similar fire hazards. Service buildings shall be sited in safe areas away from places where products are stored and handled and out of the line of possible vapour travel (at least 15 m away in the case of class I products and at least 6 m away in the case of class II products).

4.6.5 Boiler houses, power plants and fire pump slabs
These buildings shall be so located in safe areas that their equipment can be safely operated in the event of a fire.

4.6.6 Buildings on boundaries

The walls of buildings other than buildings for which safety distances are given in 4.6.2, may form part of the boundary of a depot. Any openings in such walls shall have some suitable form of security.

4.7 Roadways

4.7.1 Traffic arrangements

4.7.1.1 On-site roads shall not be used for parking. Special parking areas shall be allocated for petroleum carrying vehicles.

4.7.1.2 Parking areas for bulk tankers shall be designed such that a large spill will not endanger the tank farm, buildings or any other structures. A parking area for private cars shall be allocated on a safe area, preferably on a part of the site that is remote and separated from operational areas.

4.7.1.3 Vehicles (other than those normally employed on the premises) shall not be used on on-site roads without the prior approval of the manager or his authorized representative. Suitable lighting is essential for night operations (See IEC 60079-1).

4.7.1.4 Where pipelines or cables are routed adjacent to roads, protective kerbing shall be provided. If kerbing cannot be provided, warning posts or fencing shall be provided to prevent accidental damage.

4.7.1.5 Symbolic safety signs and warning signs shall be provided where necessary. In large depots, the numbering or naming of roads is desirable.

4.7.2 Access for fire-fighting equipment

The effectiveness with which fire-fighting equipment can be used, particularly in the early stages of a petroleum-product fire, depends primarily on the speed with which such equipment can be brought into active use.

4.7.3 Layout

4.7.3.1 The layout of a depot should embody roadways or all-weather hard-surfaced tracks that give mobile equipment and persons access to hydrants and permit effective and safe use of the equipment, irrespective of the location of the outbreak of the fire or the direction of the wind. All such roads and tracks, exits and entrances to buildings, and access to fire-fighting equipment shall be unobstructed.

4.7.3.2 Hydrants and fire-fighting equipment shall be located such that they can be approached from different directions, and distinctly marked that they can be easily seen (reflective material is recommended to facilitate visibility at night). Hydrants shall be provided at positions that would enable any fire to be combated, irrespective of the wind direction.

4.7.4 Planning

When the layout of a bulk storage depot is being planned,

a) the roads shall be aligned in relation to the sitting of the tanks, plant and buildings such that basic
operational requirements are complied with, and ease of access is provided for fire-fighting purposes;

b) there shall be no cul-de-sacs;

c) in large bulk depots (i.e. of storage capacity exceeding 150,000 m³), a perimeter road with subsidiary intersecting roads that divide tank compounds or other operational areas or both shall be provided.

d) a uniform grid plan shall be used when the roadways are being designed;

e) where the approach of vehicles to and from a public highway is controlled by gates, the gates shall be set far enough back from the frontage to enable a vehicle to be halted clear of the highway;

f) adequate turning room shall be provided at junctions and taken care to avoid obstructing the vision of drivers, in accordance with Road Traffic regulations of respective Partner States.

g) roadways shall be constructed suitably and with due regard to the traffic and layout of the plant, and the roadways shall be properly maintained;

h) well-surfaced and well-drained main roads that are capable of accommodating two lines of traffic are recommended.

NOTE Subsidiary roads may be of single-track width with adequate passing bays, and a lower standard of surfacing and drainage is acceptable.

4.8 Railway sidings

4.8.1 The provision and construction of private sidings shall be in accordance with the relevant regulations of Partner States. Sidings shall be sited such that they cannot be cut off by a fire in another area and that they are accessible for fire-fighting purposes.

4.8.2 The position of the railway track relative to plant and to loading gantries of platforms shall be in accordance with the regulations of Partner States.

4.8.3 Loading sidings shall be located at least 15 m from the running line used by locomotives (electric or other), and rail tank vehicle staging points shall be located at least 15 m from tank shells, buildings in which work that involves heat is done, important buildings (for example, offices), bulk truck loading racks that handle class I products, package warehouses and filling sheds that contain class I products, and possible fire areas. In the case of package warehouses, filling sheds and bulk loading racks that handle class II and III products only, this distance may be reduced to 6 m.

4.9 Drainage and interceptors (see also Annex B)

4.9.1 Surface water — general

Drainage shall be planned in accordance with statutory regulations. Every advantage of natural seepage for disposal of surface water shall be utilized. Existing storm-water drains, rivers and streams shall be used to cope with the outflow, although it might be necessary to provide special catchment basins or seepage areas in large plants where heavy precipitation rates (that might temporarily be beyond the capacity of the local system) can be expected.

4.9.2 Surface water (tank farm areas)

4.9.2.1 Suitable drainage facilities shall be provided to deal with surface water and to dispose of fire-
fighting water. The water used to control a fire shall be of an acceptable quality (free from hydrocarbons, solvents, alcohols and any additives) before the water is passed into drains.

4.9.2.2 Outlets from tank farm areas shall be controlled by means of valves situated outside the bunded areas, because access to these valves might be needed during fire-fighting to release excess cooling water.

4.9.2.3 The valves shall be kept locked in the “closed” position at all times unless drainage is taking place under the control of a designated person. The valves shall be clearly identified and marked with the direction of opening.

4.9.3 Containment separation

Where it is necessary to use interceptors to separate contaminants from water, consult the relevant regulations. The collecting system shall be designed so as to minimize the amount of surface water that results from precipitation and normal drainage and that has to be routed through the interceptors (thus avoiding the need for inordinately large interceptors). This is best achieved by providing, where possible, separate systems for surface water and for water from contaminated sources such as tank farms and loading and filling areas. (For design details of an interceptor, see Annex B.)

4.9.4 Sewage

4.9.4.1 Sewage shall be disposed through the main sewerage system. Where it exists or through a waste water treatment system that meets regulations of respective Partner states. 4.9.4.2 Sewage systems shall not be connected to interceptors.

4.9.5 Washing of vehicles

4.9.5.1 All wash-bays shall be so designed that effluent, detergents and contaminated water are contained.

4.9.5.2 Run-off water that contains effluent shall be of such quality that it complies with the relevant regulations of respective Partner States before the water passes into the relevant drains.

4.9.5.3 Specially designed wetlands can also be considered for this purpose.

4.10 Loading and discharging facilities

4.10.1 Planning

In planning the layout of road and rail facilities, safety, the environment and efficiency shall be regarded as the basic considerations. The location of these facilities will be determined by the topography and by the proximity of risks from outside the property.

4.10.2 Safety of personnel

All access ladders and operating platforms to facilitate the handling of hoses, the dipping of tanks and the manipulation of valves shall comply with the relevant regulations of the respective Partner States.

5 Design and construction of plant, equipment, and buildings

5.1 Above-ground tankage

5.1.1 Due to various types of above-ground tankage that can be constructed, close consideration
(based on sound engineering principles, but within the framework of an approved standard (for example, API Std 620, API Std 650, or equivalent)), shall be given to tankage, especially with regard to foundations, venting (see API Std 2000), earthing (see IEC 60079), pipe connections, manholes, stairways, ladders, handrails, gauging equipment, floating roofs, diaphragm roofs, cathodic protection systems and maintenance facilities.

5.1.2 All new vertical tanks shall consist of not more than one compartment and shall incorporate a system that will give early warning of a floor-plate leak.

5.1.3 Elevated tanks shall be supported on structures with a fire rating of at least 4 h.

5.2 Pipelines

Underground water mains need not be constructed of steel but shall be designed to withstand a minimum test pressure of 1.5 times the working pressure.

5.2.1 Design of equipment and construction

All pipes, valves and pipe fittings used shall have been fabricated to an approved code or equivalent (e.g. API Spec 5 L), and shall have a safety factor that is adequate for the conditions of service.

5.2.2 Valves

5.2.2.1 Inside bunded areas, only valves that are of steel, are fire safe, and that comply with an approved standard shall be used (see also 5.2.1). Elsewhere in the depot, approved cast-steel valves may be used.

5.2.2.2 Valves shall be designed with a suitable factor of safety relative to the pressures and stresses likely to be met in service, and glands shall be such that they can be repacked without the removal of the valves from service.

5.2.2.3 Valves of other than the rising spindle type shall incorporate an indicator that shows clearly when they are in the open and the closed positions. Valves used in locations where frost damage can be expected, should be provided with means for draining valve bodies or shall be constructed of mild steel.

5.2.2.4 Where unidirectional fire-safe valves are installed, they shall be installed such that the contents of the tank are held back.

5.2.3 Pipe runs

5.2.3.1 Above ground

5.2.3.1.1 Pipelines over pathways, roadways and platforms shall be supported by gantries, bridges or other approved structures. Provision shall be made to ensure that personnel do not come into contact with hot product lines and steam lines. Pipeline flanges should have copper continuity line to prevent accumulation of static charges

5.2.3.1.2 In areas where frost is likely to occur, measures to prevent the freezing of water in pipelines shall be provided in the design of the pipelines. Such measures include draining points in pipelines where water could accumulate, insulation of the line or anti-freeze systems.

5.2.3.1.3 Where vehicular traffic could damage pipelines, provision shall be made to protect such pipelines (by means of guardrails, safety barriers or other suitable means).
5.2.3.1.4 Drains designed and intended for storm water control or effluent control (or both) shall not be used to house pipelines.

5.2.3.2 Below ground

5.2.3.2.1 At positions where buried pipelines pass under railways and roadways, and at other points at which heavy loads might be experienced, the pipelines shall be protected from uneven ground settlement.

5.2.3.2.2 If it is impossible to mark, at ground level, the direct route of a buried pipeline, drawings that give all the important details shall be kept.

NOTE The below-ground installation of product lines should be avoided.

5.2.3.2.3 Where pipelines are run in open trenches, the trenches should be either self-draining, or should have fire-stops installed at suitable intervals.

5.2.4 Protection against corrosion

5.2.4.1 The outer surfaces of above-ground pipelines shall be protected by a coating of an acceptable standard. All below-ground pipelines shall be protected in an acceptable way with suitable corrosion resistant materials.

5.2.4.2 A cathodic protection system shall follow the electrical safety requirements of IEC 60079.

5.2.5 Line identification

Colour markings or other acceptable means shall be used to identify the product or service for which pipelines and valves are intended and the relevant oil marketing company's colour coding of product pipe work). It is recommended that the lines be stencilled at strategic points, for example, fresh water main, salt water main, foam, base injection, etc. Letters that are clearly legible and of contrasting colour to the colour coding of the pipeline itself shall be used.

5.2.6 Testing

5.2.6.1 Before each completed pipeline is commissioned and, where applicable, before the closing of the trench(es) in which a product pipeline is laid, ensure that the pipeline is properly fabricated and free from leaks by testing it in accordance with the design code employed.

5.2.6.2 Buried pipelines shall be pressure-tested annually throughout their service life

5.2.6.3 Pipelines shall be fitted with adequate vent connections, drain connections and fittings to facilitate testing.

5.2.6.4 Thermal pressure relief shall be provided on all product pipelines.

5.2.7 Flow direction

Pipeline systems shall be designed, through use of L-port, T-port and non-return valves, such that the possibility of flow in unintended directions is minimized.

5.3 Hoses (for product)

5.3.1 Hoses shall comply with the requirements of ISO 5772 or with an equivalent approved specification, and shall be designed for a working pressure at least equal to the maximum working
pressure in the pipeline system.

5.3.2 Materials used for the outer covering of hoses shall be resistant to abrasion and to
deterioration arising from contact with petroleum products. Hoses shall be pressure-tested at least
once a year at a test pressure of 1.5 times the maximum working pressure, and records of such
pressure tests shall be kept and made available for inspections.

5.4 Pumping plant (for product)

5.4.1 General

All pumps for application and intended service in the petroleum industry shall be designed to an
approved standard.

5.4.2 Pumps

5.4.2.1 The type of pump to be used will be determined by the product characteristics and pumping
requirements.

5.4.2.2 Preferably use centrifugal pumps of single-stage or multi-stage design for all products except
viscous fuel oils. Where positive-displacement pumps can have significant advantages, they may be
used. Screw pumps and piston-type pumps are particularly suitable for handling heavy, heated
products.

5.4.2.3 Pumps shall be adequately supported.

5.4.2.4 Spill containment shall be provided for all pumps, and shall include suitable drainage.

5.4.3 Pipe manifolds and pumps

5.4.3.1 Pipe manifolds and pumps shall be protected in an acceptable way from stress induced by the
expansion and contraction of pipe lines.

5.4.3.2 Hose connections from manifolds are regarded as a fire risk and shall not be used
indiscriminately. Pumps and pump manifolds shall not be located inside a bunded area where class I
liquids are stored or pumped.

5.4.4 Electrical equipment

Electric motors that are used to drive pumps shall be rated for continuous operation at the maximum
power output likely to be required in service. Electric motors and associated equipment located within
a hazardous area shall conform to, and be installed in accordance with, the requirements of IEC
60079.

5.5 Loading and unloading of bulk road vehicles and bulk rail vehicles

5.5.1 Loading arrangements

5.5.1.1 Arrangements for either open or closed loading can be adopted to prevent splash loading.

5.5.1.2 Where top loading arrangements are used, the point of discharge from the loading arm shall
be positioned close to the bottom of the tank.

5.5.1.3 Where bottom loading arrangements are used, an overfill protection method shall be installed
to provide control of the quantity delivered to vehicle tanks.
5.5.2 Layout

5.5.2.1 In the layout of road-vehicle loading facilities and rail tank-vehicle loading facilities that handle class I (or class I combined with class II and class III) products, the safety distance shall be at least 15 m. If only class II and class III products are handled, this distance may be reduced to 6 m.

5.5.2.2 Allow for ease of vehicle access and exit, without the need for reversing. It is preferable to group road-vehicle loading points on islands that are parallel to one another. Such islands shall have suitable protection for the loading equipment.

5.5.2.3 The area adjacent to a railway siding where petroleum products are loaded or unloaded shall be graded such that a major product spillage will be contained. Where practicable, adequate paved dikes channels, etc., to control such a spillage shall be provided.

Rail-vehicle loading points shall be located alongside the track at intervals that suit the vehicle dimensions.

5.5.2.4 The section of track that serves the rail-vehicle loading facilities shall be reserved for this purpose only. The track and pipelines shall be properly bonded and earthed in accordance with the relevant regulations.

5.5.3 Road-vehicle loading areas

5.5.3.1 The loading areas shall be surfaced with materials that are resistant to damage by the product(s) and by fire.

5.5.3.2 The surface shall be graded such that spillage occurring at any one point will not flow under vehicles at any other point. An acceptable method of spillage control shall be provided at all filling points, including spillage containment with sufficient capacity to hold a minimum of two minutes' flow from the loading point with the largest capacity or 10,000 L whichever is higher.

5.5.3.3 The drainage system that is used shall be connected such that it drains the area to an interceptor.

5.5.4 Rail-vehicle loading and unloading areas

5.5.4.1 These areas shall be impervious. Any spillage that occurs, shall be contained and passed through an interceptor for recovery.

5.5.4.2 At loading facilities, spillage containment shall be provided, with sufficient capacity to hold a minimum of two minutes' flow from the loading point with the largest capacity or the capacity of the single largest rail vehicle whichever is higher.

5.5.4.3 At unloading facilities, spillage containment shall be provided to hold the capacity of the single largest rail vehicle that can be accommodated at the siding.

5.5.5 Loading equipment

5.5.5.1 Loading equipment can be located at ground level or on a platform of a height that suits the transport fleet. Loading equipment shall be installed such that the strain on any metering unit does not exceed the design limit of the unit.

5.5.5.2 When automatic loading equipment is used, a manually operated shut-off valve for use in an
emergency shall be provided away from the risk area.

5.5.5.3 Where gravity loading methods are used and also where gravity flow to the equipment is possible, each supply line shall be fitted to the loading points with a quick-acting emergency stop-valve located at a safe distance from the loading area.

5.5.6 Platforms

All platforms shall comply with the relevant statutory requirements of the respective Partner States. Platforms above 2 m high shall be provided with fall protection systems.

5.5.7 Construction materials

Materials that are of adequate strength and that are non-combustible shall be used in the construction of loading structures.

5.5.8 Earthing

5.5.8.1 Before any connections are made to trucks or rail vehicles and before any flow of the product commences, an electrically continuous path (bond) shall be in place.

5.5.8.2 The accumulation of static electricity shall be reduced by earthing and bonding the loading or the unloading equipment (or both) in accordance with the recommendations given in IEC 60079.

5.5.9 Lighting

5.5.9.1 All lighting shall comply with relevant statutory requirements of the respective Partner States.

5.5.9.2 Electrical installations shall be in accordance with the recommendations given in IEC 60079-14.

5.6 Ship loading and discharging equipment

Ship loading and discharging facilities shall be designed in accordance with the relevant regulations given in the International Safety Guide for Oil Tankers and Terminals.

5.7 Package filling and packaged-oil warehouse buildings

5.7.1 General construction

5.7.1.1 All buildings shall comply with relevant statutory requirements of the respective Partner States.

5.7.1.2 Fire-resistant materials shall be used in the construction of buildings and equipment.

5.7.2 Spillage

Separator facilities shall be provided to contain any possible spillage and to prevent the spillage from leaking into sewage drains. (See also Annex B.)

5.7.3 Ventilation

5.7.3.1 All ventilation in buildings shall comply with relevant statutory requirements of the respective Partner States.
5.7.3.2 Unless the buildings have open sides, they shall have ventilation openings in opposite sides near the floor and near the roof.

5.7.4 Service doors, windows and skylights

Alternative means of escape in the event of a fire shall be specified.

5.8 Packed-product storage areas

5.8.1 Packed-product storage areas shall be provided with suitable drainage and measures against flooding.

5.8.2 The base of these storage areas shall be constructed from any suitable material that will provide support for the loads to be carried (including those imposed by any mechanical handling equipment to be used).

5.9 General site works

5.9.1 Design and construction of bund walls

5.9.1.1 Bund walls shall be constructed of concrete or any other impervious materials of adequate strength.

5.9.1.2 Bunds shall not be covered with any material that will deteriorate under the effects of any petroleum product.

5.9.1.3 All bunds shall be designed by a competent Engineer.

5.9.1.4 Due to the behaviour of other materials in the event of a fire, concrete bund walls are preferred.

5.9.1.5 Whenever a bund wall has been breached, the gap shall be made good as soon as possible, and not left open overnight while any tank it encloses has product in it. Pipelines that pass through bund walls shall be wrapped to protect them from corrosion and sealed to prevent leakage of product.

5.9.1.6 Main bund walls shall be strong enough to withstand the hydrostatic pressure to which they will be subjected if the space within the bund is filled with water. Cognizance shall be taken of the effect of heat exposure under fire conditions.

5.9.2 Bund floors

Bund floors shall be impervious.

5.9.3 Railway sidings

5.9.3.1 Railway sidings shall be constructed, operated and maintained in terms of the private siding of relevant statutory requirements of the respective Partner States.

5.9.3.2 Gates equipped with efficient latches to hold them open when required, shall be provided across railway lines. Prevent gates and fences from picking up electric charges from the rails by constructing the gates such that they cannot touch either running rails or check rails.

5.9.3.3 Electrical installations and earthing arrangements and provisions for the electrical isolation of private sidings from main-line electrified services shall conform to the relevant statutory requirements
of the respective Partner States.

5.9.3.4 No overhead cable shall cross a siding where rail vehicles are loaded or unloaded.

5.9.3.5 The working area, if it has an impermeable surface, shall have surface drainage on each side of the track or, alternatively, filter drains shall be installed to act as collectors.

5.9.3.6 The drains shall be led to an interceptor via a valved system. Adequate means and procedures for catching and disposing of product from leaks and spills shall be provided.

5.9.4 Drainage interceptors

5.9.4.1 Drainage interceptors shall be provided on all drainage systems where a spillage could occur.

5.9.4.2 Drainage interceptors shall comply with the requirements of 4.9. For design criteria of an interceptor, see Annex B.

5.9.5 Boundaries

Boundary fencing with a total vertical height (from ground level to the top of the fence line, including barbed wire) of at least 2.5 m is required. It shall be of an approved type of unclimbable fencing or walling, and may be of chain-link fencing, steel paling, brick or mass concrete walling, or of the slab and post concrete type. It will often be found that more than one type of boundary fencing can be usefully employed at the same depot, for example, chain-link or other open-type fencing for tank compounds, and brick or concrete walling for busy operational areas, particularly where these adjoin a public road.

NOTE Where a number of bulk depots that belong to different companies adjoin or are situated within a controlled and fenced area such as a dock, the above stipulations may be relaxed, subject to agreement by the approving authority.

6 Operations

Operating procedures shall comply with the relevant statutory requirements of the respective Partner States

6.1 Receiving bulk cargoes from ships

6.1.1 General

6.1.1.1 Throughout each unloading or loading operation, a designated person shall be on duty at the depot and a responsible ship’s officer shall be in attendance.

6.1.1.2 Frequent inspection of ship-to-shore hoses and pressure gauges by a person on duty is necessary in order to detect any possible hose leakage.

6.1.2 Regulations

6.1.2.1 All regulations contained in the International Safety Guide for Oil Tankers and Terminals, Ports and Fire authorities of the respective Partner States shall be strictly adhered to.

6.1.2.2 It is recommended that an extract of relevant port and depot regulations be handed to the master of a vessel on arrival.

6.1.3 Communications

6.1.3.1 An efficient communication system shall be set up between all persons involved in operations,
to ensure that cargo-handling operations are safe and efficient, and that immediate action can be taken in the event of an emergency.

6.1.3.2 Where class I and class II products are handled, communication equipment shall be acceptable explosion-proof equipment.

6.1.4 Earthing, bonding and insulation

All earthing, bonding and insulation shall comply with the requirements of IEC 60079-14

6.2 Loading and unloading of rail tank vehicles

It is recommended that the entry of rail tank vehicles into a siding and the loading and unloading operations be controlled by a designated person, who shall adhere to the relevant statutory requirements of the respective Partner States. In addition, the following shall be noted:

a) movement of rolling stock within 15 m of a rail tank vehicle that is being loaded or unloaded shall not be permitted, and locomotives that are not approved for use in hazardous areas shall not be permitted to approach closer than 15 m to a loading or unloading point during operations that involve class 0, class I, class II or class III products;

b) a warning notice (symbolic sign) shall be placed near both the loading and the unloading points and shall state the point beyond which locomotives shall not pass;

c) suitable warning notices (symbolic signs) shall be displayed during each loading or unloading operation;

d) a recognized distinctive code of sound signals and lights shall be used during shunting operations;

e) during loading and unloading operations, suitable warning notices shall be conspicuously displayed at the approach to internal sidings. Should the sidings fall outside the depot, the warning notices shall be displayed at both ends of the train;

f) smoking shall not be permitted in loading and unloading areas; and

g) splash filling or splash loading shall not be allowed

6.3 Loading and unloading of road vehicles

The following general safety rules shall apply during loading and unloading of road vehicles:

a) no vehicle shall be left unattended while loading or unloading is in progress;

b) accidental movement of the vehicle shall be prevented, and it shall be left in a gear that prevents movement;

c) all vehicle engines shall be switched off before loading, and shall not be restarted until all caps, cocks, valves and covers have been closed and secured;

d) no internal combustion engine (other than that of a vehicle specially equipped for transporting, handling, or pumping flammable liquids) shall be closer than 15 m to an area in which class I or class II products are being loaded or unloaded;

e) vehicles awaiting loading shall remain at a safe distance from the loading point;
f) smoking shall not be permitted;
g) heated products shall be handled with great care;
h) all personnel shall be provided with protective clothing for loading or unloading operations;
i) where operations involve switch loading, safety procedures shall be implemented (see API RP 2003);
j) splash filling or splash loading shall not be allowed

6.4 Containers

6.4.1 Containers used in the petroleum industry vary considerably in type and size. In order to select the type of pack that will be acceptable, it is necessary to consult the relevant statutory requirements of the respective Partner States.

6.4.2 The publications for containers available at present are:
a) IATA regulations, relating to the carriage of restricted articles by air; and

Note The publications listed above do not always give details of the components of the pack or of its minimum performance level.

7 Fire precautions and fire control in bulk depots

7.1 General

7.1.1 The protection facilities against fire hazards in bulk depots shall be achieved by good engineering design and construction standards.

7.1.2 Safe operational procedures and efficient plant and equipment maintenance shall be such that it is highly improbable that fire will break out.

7.2 Ignition sources

7.2.1 Any device or action that could cause a flame or spark shall not be permitted in restricted areas, unless authorized by an appropriate permit, the stipulations of which shall be strictly adhered to. (See also 7.2.3.)

7.2.2 Sources of ignition include but are not limited to the following:
a) cutting and welding;
b) electrical sparks;
c) frictional heat or sparks;
d) furnaces;
e) heating equipment;
f) hot surfaces;
g) lightning;
h) open flames;
i) ovens;
j) radiant heat;
k) smoking;
l) static electricity;
m) battery operated tools and instruments; and
n) stray currents and spontaneous ignition.

7.2.3 Welding, cutting and similar spark-producing operations shall not be permitted within the depot premises without an authorized hot-work permit (see 9.1.2 and 9.8).

7.3 Access control

7.3.1 Persons

7.3.1.1 All points of entry to depots shall be planned such that persons or passenger vehicles that enter or leave the depot can be observed.

7.3.1.2 Unauthorized persons shall not be permitted access to the depots.

7.3.2 Locomotives and rolling stock

7.3.2.1 Locomotives shall be permitted to enter hazardous areas only when they comply with entry conditions.

7.3.2.2 Trucks shall not be shunted onto or off sidings during loading and unloading operations.

7.3.2.3 Warning notices (see 7.15) against such shunting shall be displayed near the entrances to sidings during loading or unloading operations.

7.4 Housekeeping and vegetation

The site shall be kept free from obstructions and combustible rubbish. Vegetation that is liable to dry out and become a fire hazard shall be kept short and cuttings shall be removed.

7.5 Absorbents

Absorbents are basically recommended for containing spillages. Adequate supplies of absorbents shall be available at all times.

7.6 Work permits
Before any construction, repair, or maintenance work is carried out, the appropriate certificates or work permits (or both) shall be issued in terms of 9.8 (for examples, see Annex C).

7.7 Training (safety organization)

7.7.1 Each facility shall have a safety organization the size of which will depend upon the complexity of the operation.

7.7.2 The safety organization shall advise the management on the technical and legal aspects of safety and shall provide a programme for the improvement of safety performance (training programmes).

7.7.3 As many persons as practicable at each work site shall be given training in the use of the appropriate fire-fighting equipment. All actions shall comply with relevant statutory requirements of the respective Partner States.

7.7.4 Safety training

7.7.4.1 Safety training shall include operational procedures, emergency procedures and safe working procedures, information on specific hazards, first aid and fire-fighting, and the proper use of protective equipment such as breathing apparatus.

7.7.4.2 Periodic refresher training shall be conducted in accordance with relevant statutory requirements of the respective Partner States and records shall be maintained.

7.7.5 Emergency plans (on-site and off-site)

7.7.5.1 Emergency plans shall be prepared to cover foreseeable types of emergencies, which shall cover situations that range from a small incident to one of disaster proportions where considerable assistance from outside organizations is needed.

7.7.5.2 Any emergency plan shall comply with the regulations for major hazard installations as per relevant statutory requirements of the respective Partner States.

7.8 Scale of fire-fighting equipment

7.8.1 Water requirements

7.8.1.1 Water requirements shall be calculated on the basis of a full risk assessment, which shall be conducted by the competent engineer.

7.8.1.2 Water supplies shall be sufficient for supplying all the devices that could be used simultaneously for the specified time. This includes not only the volume required for foam apparatus, but also water that could be used for other fire-fighting operations, in addition to normal plant requirements. (See annex A.)

7.8.2 Supply rate

The total supply of water for fire-fighting shall be sufficient to supply water at the rate calculated under 7.8.1 for a period of at least 2 h on any approved rational fire-fighting design. When water requirements are being calculated, allowance shall be made for additional water supplies, for example water needed to cool adjacent tanks, etc.
7.8.3 Water pressure

Water shall at all times be supplied to the most remote site location at a running pressure not less than that required by the fire-fighting equipment at the design flow rate.

7.8.4 Pump connections

Suitable fire pump connections shall be provided to facilitate the pressurization of the water reticulation system in order to comply with 7.8.3. All pump connections (electrical or mechanical) shall be compatible with fire-fighting equipment used by the fire-fighting authority of the respective Partner States.

7.8.5 Hydrant mains

7.8.5.1 Wherever practical, the hydrant main shall be buried to withstand the vehicular traffic (for example, fire tenders). Suitable risers, spaced not more than 90 m apart, sufficient hydrant outlets, and hose connections shall be provided to meet the needs in any potential fire area. Hydrants that serve tank farm areas shall preferably be of the four-headed pillar type with a riser of minimum diameter 100 mm.

7.8.5.2 Hydrant outlets and hose connections shall be sited such that they will be at least 15 m from potential fire areas, and shall be compatible with the requirements of the fire-fighting authority of the respective Partner States.

7.8.6 Isolating valves

The fire main shall be provided with isolating valves that are spaced such that no damage or repair to the pipe system (exclusive of arteries) will necessitate the shut-down of an artery or of a section of pipe of length exceeding 300 m in any area.

7.8.7 Fire hoses

Fire hoses shall have fittings that are compatible with all the hydrant connections and shall be maintained for the worst-case fire scenario.

7.8.8 Foam applications

7.8.8.1 Normal finished foam is produced by introducing foam compound into water (usually at a rate of 3% to 6%) and then expanding the mixture with air for the type of low-expansion foam compound used. (The expansion factor is about 8:1.)

7.8.8.2 The foam may be applied by monitors that deliver it to the seat of the fire or, in the case of tanks, by dry risers or subsurface injection.

7.8.8.3 In the case of fixed-roof tanks, the application rate of the available mixture (solution) of foam compound and water for fire-fighting with low-expansion foam, can be calculated in litres per minute per square metre of total fire area. As a general rule, 6.5 L/min/m² of fire area will result in the fire being extinguished (see NFPA 11).

7.8.8.4 Depending on the design of the tank, foam may be applied either by direct projection or by means of dry risers. In the case of floating-roof tanks, it is usual to design fire-fighting facilities that cater for rim-seal fires only. This is most commonly done by applying low-expansion foam to the seal area. Vaporizing liquid systems are also used, especially in the case of crude-oil tanks. When foam is used, dry risers and foam dams shall be provided for.
7.8.8.5 An alternative method of applying foam is by injection via the base of a storage tank through product lines or special inlets (see NFPA 11). To avoid foam dilution, it is important to ensure that any injection point is above the water level of the tank bottom. Foams suitable and approved for base injection should be used.

7.8.9 Foam stocks

Sufficient foam compound shall be stocked to cater for the largest extinguishable fire in the greater of a fixed-roof tank and the largest possible spill area for 1 h, plus a complete reserve charge to cover the possibility of a second fire. Furthermore, it is recommended that some of the calculated requirements be held in terms of the mutual-aid arrangements between fire-fighting authority of the respective Partner States and industry.

7.8.10 Extinguishers

Conveniently placed hand-held fire extinguishers or large mobile fire extinguishers, or a combination of these, shall be provided, which shall comply with ISO 7165 and ISO 11601. The servicing of portable fire extinguishers shall comply with the requirements of ISO 11602-2.

7.9 Location and marking of equipment

7.9.1 Location plan

For ready reference in an emergency, a layout plan of the site shall be displayed in an easily accessible location so that authorized persons can have easy access to it.

The plan shall indicate the position and the nature of the contents of all product tanks, product pipe lines and valves, as well as the positions of water pipelines, hydrants, fire appliances, the fire control centre, emergency stop buttons, and access routes for fire-fighting equipment to reach all parts of the plant.

The plan shall also indicate the location of fire-fighting equipment and foam storage, including the quality and type of foam stored.

7.9.2 Emergency numbers

A notice on which the telephone numbers of the fire service and other emergency services shall be clearly recorded and shall be displayed near every telephone, at the control centre and at the gate of the site.

7.9.3 Tank identification

All tanks shall have their numbers painted on in two positions, one that is visible from the fire service access route and the other opposite it, as follows:

a) numerals and letters shall be in colours that contrast with that of the tank shell; and

b) characters shall be of such size as to be clearly visible and identifiable, of minimum height 290 mm and of minimum width 25 mm.

7.9.4 Equipment and hydrant points

7.9.5 All fire points (equipment and hydrant points) shall be clearly identified by the appropriate
signs according to an approved international standard. It is recommended that retro-reflective materials be used for this purpose.

7.10 Fire-fighting equipment

7.10.1 Portable and mobile fire extinguishers

7.10.1.1 Portable and mobile fire extinguishers shall comply with an approved standard (for example, ISO 7165 and ISO 11601).

7.10.1.2 Dry-chemical powders shall be of a type that is compatible with the intended application.

7.10.1.3 All fire extinguishers shall be protected from the weather.

7.10.2 Fire hoses

7.10.2.1 Fire-fighting hoses shall comply with an approved standard.

7.10.2.2 Hoses shall be inspected at least once every calendar year by a designated person. Hoses found to be defective on inspection shall be replaced or repaired immediately.

7.10.2.3 A record shall be kept that shows the date of each inspection and is signed by an appointed responsible person.

7.10.2.4 Fire-fighting hoses shall be housed or stored in weatherproof containers when not in use.

7.10.3 Couplings

7.10.3.1 Couplings for hoses, branch pipes, nozzles and connectors shall comply with relevant approved standards.

7.10.3.2 All couplings shall be compatible with the fire-fighting equipment of the fire-fighting authority of the respective Partner States.

7.10.4 Hydrants

All hydrants shall comply with relevant approved standards.

7.10.5 Fire alarms

7.10.5.1 Fire alarms shall be of such volume and tone that they are clearly distinguishable from background noise and are audible, under prevailing wind conditions, anywhere along the perimeter of the site.

7.10.5.2 Where an alarm is electrically powered, an independent source of power shall also be available.

NOTE Hand-cranked or compressed gas units may also be used.

7.10.5.3 An approved means of direct emergency communication with local emergency services shall be available.

7.10.6 Foam concentrates

7.10.6.1 Foam compound shall comply with an approved standard. A knowledge of the compatibility
of different foam compounds with one another and with dry chemicals, when used simultaneously in
fire-fighting, is essential, since outside bodies, such as the fire authority, might use different
compounds. Regular quality tests shall be carried out in accordance with the manufacturer's
recommendations.

NOTE It is recommended that low expansion foam is used.

7.10.6.2 Foam compound types shall be suitable for the risk presented by the product on hand. All
foam compound containers shall be clearly marked, appropriate to the type of compound. In this
regard, expert advice shall be obtained from approved standards or from the manufacturer (or from
both) (See NFPA 11).

7.10.6.3 Foam compound that is corrosive shall be stored in suitable containers.

7.11 Colour identification of fire-fighting equipment

All wheeled and portable fire-fighting equipment shall be painted a distinctive red.

Notices shall be displayed and the location of equipment that is not visible shall be clearly indicated.

7.12 Employees for fire fighting

7.12.1 All selected key employees shall be trained and remain competent to deal with all possible
emergencies and shall be conversant with the principles of fire-fighting and the operation of the
firefighting equipment provided in their work environment.

7.12.2 An adequate number of employees shall be trained to stand in for absent trained key
employees during periods of leave (including absences due to sickness) and on public holidays.

7.12.3 Records shall be kept of all training, as required by the relevant statutory requirements of the
respective Partner States.

7.13 Fire drills

After key personnel have been trained, fire drills shall be conducted regularly to maintain a
competence level. Records shall be kept of all fire drills, as required by the relevant statutory
requirements of the respective Partner States.

7.14 Co-operation with the fire authorities

7.14.1 It is essential to co-operate closely with the fire authorities and to ensure that the fire brigade
knows in advance the layout of the depot, what equipment and facilities are available, where they are
located, and how they are used.

7.14.2 It is essential that an adequate joint plan of action in the event of a fire or other emergency be
agreed upon in advance with the fire authority concerned, taking into account aspects such as the
nature of the product stored and special risks (if any) that exist in the depot.

7.15 Warning notices and signs

7.15.1 Warning notices or symbolic safety signs (or both) shall be displayed at all entrances to
hazardous areas.
7.15.2 Wind direction indicator shall be allocated at the highest visible point in site

7.16 Testing and records
7.16.1 All portable and wheeled fire-extinguishers shall be examined and tested periodically in accordance with ISO 11602-2.

7.16.2 All fire-fighting equipment and systems shall be inspected once every calendar year by a competent person.

7.16.3 A fire practice and inspection shall be carried out once every calendar year, and shall include the fire authorities personnel and fire equipment.

7.16.4 Records of all inspections, tests and practices shall be kept by the designated person, and any shortcomings shall be rectified as soon as possible. These records shall be made available for inspection at any time during normal working hours.

8 Protection and welfare of personnel

8.1 General

8.1.1 It is assumed that the layout of the depot, the type of plant and equipment installed, and the methods of operation are fully in accordance with the relevant recommendations given in this Standard.

8.1.2 All accidents and dangerous occurrences shall be reported to the designated person or safety representative, who shall arrange for medical attention for the injured and for the elimination of unsafe conditions or unsafe actions, or both.

8.2 Safety and protection measures

8.2.1 The following specific safety and protection measures shall be provided for in accordance with relevant statutory requirements of the respective Partner States

a) first-aid treatment;

b) medical assistance;

c) emergency treatment;

d) prevention of inhalation of fumes;

e) protective clothing;

f) protective footwear;

g) protective equipment;

h) breathing apparatus;

i) safety belts; and

j) safety goggles or eye shields.

8.2.2 Contact with petroleum products

Contact with petroleum products and the associated dangers require that the following points to be
attended to:

a) prevention and treatment of contamination;
b) prevention and treatment of occupational diseases;
c) prevention of contamination by leaded petrol;
d) provision of safe access to confined spaces;
e) correct handling of materials and packages by hand;
f) accident reports;
g) good housekeeping;
h) welfare facilities; and
i) material safety data sheet.

9 Maintenance of and extensions to depots

9.1 Risk assessment procedure

9.1.1 General

9.1.1.1 Before any extensions or alterations can be made to an existing depot, a full risk analysis shall be carried by a competent person. Any maintenance of or extensions or repair work to a petroleum depot shall follow but not be limited to the following procedure:

a) lay down clearly defined responsibilities;
b) adopt specific and explicit rules and regulations;
c) ensure that instructions and orders given are simple and clear; and

d) ensure that the cathodic protection system is turned off before the start of any work on pipelines, pumps, valves, etc.

9.1.1.2 The utmost vigilance is required to ensure that deviation from regulations is avoided, particularly when personnel are engaged in work in hazardous areas or when the staff of an outside contractor are employed. During such operations, tanks and plants that have been used for a class II petroleum product shall be treated as if they had been used for a class I product.

9.1.1.3 Tanks and items of plant that have been used for a class III petroleum product present a reduced risk, and do not require the same precautions as in the case of a class I or a class II petroleum product. Nevertheless, care is still necessary, and in the case of repairs and maintenance proceed with caution, bearing the proximity of any class I or class II plant in mind.

9.1.2 Hot work

When any hot work is to be carried out in a hazardous area that contains a petroleum product, a high degree of control and supervision shall be maintained. A permit that authorizes the work shall be issued in writing in accordance with 9.8. (See also Annex C.)
9.2 Repairs and alterations

9.2.1 General

Repairs or alterations shall not be permitted on any plant or equipment while such plant or equipment is in use (for example, when a tank or vessel is being loaded or unloaded). The local firefighting services shall be informed when water is not available or when any work is being carried out on major fire-fighting installations.

9.2.2 Equipment

When repairs or alterations necessitate the dismantling of essential items of plant such as valves, pumps and pipelines, a specific notice shall be issued to all concerned. The work shall not be started until acknowledgement of the notification has been received.

9.2.3 Tanks and vessels

9.2.3.1 No hot or other hazardous work shall be started inside a tank or vessel in which a class I, a class II, or a class III petroleum product has been stored until such time as the tank or vessel has been inspected, a gas-free certificate has been issued (see 9.10), all pipelines have been disconnected and all relevant authorities have been notified.

9.2.3.2 No person shall be allowed to enter a tank or vessel that has not been declared gas-free unless such person is equipped with suitable breathing apparatus. An observer shall be stationed at the manhole whenever work is to be done on such tank or vessel. Observers shall be instructed to watch the workers carefully and to take immediate action or summon assistance if any person(s) collapses inside the tank or vessel.

9.2.3.3 Observers and other rescue personnel shall be equipped with the proper safety gear so that they themselves will not succumb during rescue operations. Special attention shall be given to the manholes, scaffolding and rigging to ensure safe entry and exit.

9.2.3.4 When tank cleaning, repairs or alterations are involved, the special instructions applicable to this type of work shall be rigorously observed. (See Annex C.)

9.2.4 Pipelines, pumps and valves

In the event of a broken connection, no reliance shall be placed on closed valves. Complete drainage shall be effected and openings shall be closed properly by means of blank flanges or line blinds. Any spillage of product shall be collected and disposed of in an acceptable way. When continuity in a pipeline is broken, the work area shall be bridged with a heavy electrical jumper cable to reduce the risk of sparks from stray or induced currents.

9.2.5 Electrical equipment

An accredited person shall certify that the electrical equipment has been isolated and locked out safely before any repair, adjustment or test is commenced. Warning notices (symbolic signs) shall be hung onto or affixed to main switches or circuit-breakers, to prevent accidental switching-on while repairs are in progress. After repairs have been completed, an accredited person shall certify that the apparatus is in order, both mechanically and electrically, before it is brought back into use.

9.2.6 Lock-out requirements
Only authorized personnel shall be able to lock out equipment. All lock-out systems shall comply with the relevant statutory requirements of the respective Partner States.

9.2.7 Records

For certain types of plant and equipment such as pressure vessels, cranes, and electrical apparatus, an adequate system of keeping permanent records shall be maintained for all repairs, inspections and tests, in compliance with the relevant statutory requirements of the respective Partner States.

9.3 Personnel

9.3.1 Safety

All staff engaged in operational maintenance duties shall be fully acquainted with the relevant safety regulations of the respective Partner States.

9.3.2 Supervision

Maintenance and inspection work shall be planned and supervised by responsible members of staff, who shall ensure that all relevant precautions are observed.

9.3.3 Use of casual and contractors’ labour

When casual and contractors’ labourers are employed, they shall be familiarized with all the relevant precautions adopted by the depot. The necessary precautions to be taken shall have been thoroughly explained to them before any work is commenced.

When such labourers are employed in or adjacent to a hazardous area, strict supervision shall be arranged to ensure that all relevant precautions are observed.

9.4 Plant

When mobile plant is temporarily stationed in a hazardous area for maintenance, repair or other purposes, care shall be taken to ensure that the plant is of such construction that it is not likely to cause a fire by the emission of sparks or flames, or by any other source of ignition. No plant belonging to a contractor shall be used on the premises without the written permission of the depot manager or his authorized representative.

9.5 Access to site

The use of vehicles and plant on the site, particularly in hazardous areas, shall be defined and controlled and the routes to and from such areas shall be clearly indicated.

9.6 Temporary fencing

Personnel or contractors shall be prevented from gaining unauthorized access to a hazardous area and, when necessary, temporary fencing, portable barriers or screens shall be provided.

9.7 Notices

Warning notices shall be prominently displayed where necessary.

9.8 Permits
9.8.1 General

To ensure safety, construction and repair work shall only be performed in a depot if written permission has been granted by the manager or his authorized representative. All permits shall be issued by an authorised competent person.

All permits issued shall be specific with regard to their purpose.

A permit can be cancelled at any time if conditions are considered to have become unsafe. (See examples in Annex C.)

9.8.2 General or cold-work permits

General or cold-work permits shall be issued by the designated person to allow any work within the depot that does not involve hot work (which could cause ignition) or entry into confined spaces. (See examples in Annex C.)

9.8.3 Gas-free certificates

Gas-free certificates shall be issued by a person who has received formal training in the properties of flammable liquids and in the operation, calibration, maintenance and use of the type and model of gas testing device employed to determine the presence of hazardous vapours in the workplace, and who has been vested (in writing, by the employer) with authority to issue gas-free certificates. (See examples in Annex C.)

9.8.4 Hot-work permits

Hot-work permits shall be required wherever hot work is to be done in an area in which flammable vapours might exist. A hot-work permit is issued on the condition that a normally safe area remains safe for the duration of the work, or that an area which is normally hazardous be converted into a temporary safe area for the duration of the work. Hot-work permits shall be issued by a person who has been vested (in writing, by the employer) with authority to issue hot-work permits. (See examples in Annex C.)

9.8.4 Confined-space entry permits

9.8.4.1 Confined-space entry permits shall be required whenever it is necessary to enter a confined space that contains, or has contained, a flammable or toxic atmosphere and from which easy and ready escape is hampered. A gas-free certificate shall also be required. Confined-space entry permits shall be issued by a person who has been vested (in writing, by the employer) with authority to issue confined-space entry permits. (See examples in Annex C.)

9.8.4.2 The designated person may sub-delegate the extension of the period of validity of permits that he has issued to a responsible person, provided that conditions do not change in a way that would constitute an increased hazard.

9.9 Safety

9.9.1 Safety conditions

It is difficult to recommend hard and fast safety rules that should be observed during maintenance work in operating plants, and the recommendations given in this standard might have to be modified or adapted. Pay due regard to the petroleum operations being carried out at the time, and to the weather, humidity, wind direction, topographical features of the site, and the availability of assistance from
outside should emergencies arise during the work.

9.9.2 Safety distances

9.9.2.1 No hot work, riveting or welding shall be permitted within 15 m of a tank or vessel that contains class I or class II petroleum products, or within 6 m of one that contains class III petroleum products unless under special circumstances where special precautions are implemented.

9.9.2.2 These distances are minimum distances that might have to be increased because of local conditions or specific circumstances. Bear in mind also that an area that has been classified as safe could become hazardous owing to a change in wind direction. In addition to professional judgement, use a continuous gas detector to assess the conditions in each situation.

9.9.2.3 Ensure that any working tank of which any part is within these distances, is emptied, and that a gas free certificate is issued by a competent person. Where these distances cannot be adhered to, a competent person shall supervise the work (throughout its duration) and such person shall strictly enforce the necessary precautions.

9.9.3 Fire danger

In hazardous areas, special precautions shall be taken, such as the temporary resiting or supplementing of fire equipment to cover an emergency or, when it is deemed expedient, the provision of fire-watchers to detect incipient fire and to bring first-aid and fire-fighting equipment into immediate use. Brief but explicit instructions shall be given to any contractor regarding the action to be taken in the event of a fire.

9.10 Gas-freeing of tanks

9.10.1 General

9.10.1.1 A tank that has contained a volatile hydrocarbon might have to be gas-freeed before the tank can be cleaned or repaired. (This is done to protect persons from the toxic and asphyxial effects of the hydrocarbon, and to make the repair operation safe from the hazard of fire.)

9.10.1.2 When a combustible gas indicator (gas detector) has been used to confirm freedom from flammable vapours, the atmosphere within the tank could still be deficient in oxygen or could contain toxic components. In all cases of doubt, appropriate chemical tests shall be carried out.

9.10.2 Gas-free certificate

A gas-free certificate is required when:

a) any hot work is to be done in a restricted area; or
b) when entry into any confined space is required, i.e. in addition to the confined-space entry permit.

In the latter case, special attention shall be given to the oxygen content, as required by the relevant statutory requirements of the respective Partner States.

9.10.3 Vapour travel

9.10.3.1 Hydrocarbon vapours are denser than air and, although they can be dispersed easily and safely by a light breeze, a dangerous concentration can travel a considerable distance in a still atmosphere.
9.10.3.2 The large volume of an air-and-hydrocarbon-vapour mixture that could be released during a gas freeing operation can travel beyond the limits of the usual safety distances, and it is therefore recommended that all possible sources of ignition in the entire area be eliminated at all times during gas-freeing. Persons shall be kept clear of the bunded area and the down-wind area as far as possible, especially where gas and air from the tank cannot be discharged at a high level.

9.10.4 Lower explosive limit (LEL) and upper explosive limit (UEL)

9.10.4.1 Mixtures that contain about 1 % to 10 % (by volume) of petroleum vapours in air are flammable. If there is less than 1 % or more than 10 % of vapour, the mixture will be too lean or too rich to burn.

9.10.4.2 The limiting values of 1 % and 10 % are known as the lower explosive limit (LEL), and the upper explosive limit (UEL) respectively.

NOTE The approximate relationship between temperature, Reid vapour pressure, and explosive limits of petroleum products is given in Figure 2.

9.10.5 Measurement of vapour concentration

9.10.5.1 The quantity of vapour in an air-and-vapour mixture can be measured by means of a gas detector.

NOTE Gas detector scales are graduated from 0 to 100, their graduation being based on the lower limit of flammability of 1 %. A reading of 50 indicates 50 % of the lower limit of flammability (i.e. the mixture contains 0.5 % of vapour), and a reading of 20 on that scale indicates 0.2 % of vapour.

9.10.5.2 The instrument used for recording the concentration of this vapour shall be of approved design and shall be regularly calibrated and tested for accuracy.

9.10.6 Permissible petroleum vapour concentration

Vapour concentrations and the corresponding safeness of working conditions are given in Table 7.
Table 7 — Vapour concentration and worker safety

<table>
<thead>
<tr>
<th>Gas detector scale reading, $R$</th>
<th>Actual percentage of petroleum vapour (where lower limit is 1 %)</th>
<th>Working conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0 \leq R \leq 1$</td>
<td>0 to 0.01</td>
<td>Safe to work in lead-free atmospheres without breathing apparatus and to use naked lights and spark-producing or flame-producing equipment</td>
</tr>
<tr>
<td>$1 &lt; R &lt; 4$</td>
<td>Exceeding 0.01 but less than 0.04</td>
<td>Safe to work in lead-free atmospheres without breathing apparatus but unsafe to use naked lights or spark-producing or flame-producing equipment</td>
</tr>
<tr>
<td>$4 \leq R \leq 10$</td>
<td>0.04 to 0.1</td>
<td>Safe to work in lead-free atmospheres without breathing apparatus for short periods. Unsafe to use naked lights or spark-producing or flame-producing equipment</td>
</tr>
<tr>
<td>$R &gt; 10$</td>
<td>Exceeding 0.1</td>
<td>Unsafe without breathing apparatus. Unsafe to use any tool or equipment.</td>
</tr>
</tbody>
</table>

9.10.7 Methods of gas-freeing and their applicability

The methods of gas-freeing in 9.10.7.1 to 9.10.7.4 can be used, either singly or in combination.

9.10.7.1 Ventilation by forced or natural draught

This method is recommended in the case of storage tanks where the use of steam or water is impracticable or undesirable.

9.10.7.2 Flooding with water

Gas-freeing by flooding with water has the disadvantage that it cannot be relied on to remove all petroleum vapour, liquid, and solid residues. Furthermore, before the method is adopted, the tank and its foundations have to be verified as being capable of sustaining the mass of the vessel filled with water. To avoid the build-up of a static charge when this method is used, the flooding water shall be introduced at the base of a tank and, if a hose pipe is used, the flow rate shall be kept low and the nozzle shall be electrically earthed.

9.10.7.3 Steaming

This method can be used in the case of small storage tanks and medium-sized insulated tanks. In the case of certain products, complete removal by steam is not always possible, and a residue might
remain that could be ignited during welding. Only low-pressure steam shall be used, and steam hoses shall be electrically bonded to the tank shell.

NOTE Steam degassing can present the danger of tank implosion, should rapid steam condensation occur.

Figure 2 — Approximate relationship between temperature, Reid vapour pressure and explosive limits of petroleum products
9.10.7.4 Purging by inert gas or flue gas

This method can be used where it is impossible to displace flammable gases or liquids with steam, water or air because of their effect on the contents of the tank. This method involves a danger that, when air later displaces the inert gas, any pyrophoric deposits that are present could burst into flame. In addition, the tank atmosphere will not be fit to breathe after purging and the inert gas will have to be swept out with air and a test for sufficiency of oxygen will have to be carried out before anyone can enter without breathing apparatus.

9.10.8 Procedure for gas-freeing

The procedure for the gas-freeing of tanks varies according to the type of tank.

Gas-freeing does not ensure the safety of persons who enter tanks that have contained leaded petrol unless appropriate protective clothing is worn.

Conduct gas-freeing operations only under the direct supervision of a designated person, and use the appropriate procedure described in 9.10.8.1 to 9.10.8.4.

9.10.8.1 Above-ground fixed-roof vertical storage tanks (conventional types)

Carry out the following procedure:

a) Empty the tank of product.

b) Disconnect all pipelines at the tank valves, blank off open ends of pipes and, if there is any possibility that tubular housings and conduits connected to the tank for gauging or other instrumentation purposes might contain product, disconnect them.

c) Open all tank valves that lead to the atmosphere and all manhole covers in the roof of the tank.

d) Open shell manhole covers. Do this carefully and, by opening the covers only partially at first, prevent the escape of an excessive initial volume of gas.

e) Thoroughly ventilate the tank. Ventilation is normally assisted by the use of wind-sails at roof manholes, and by the use of a fan or an eductor if compressed air, steam or electric power is available.

As petroleum vapours are denser than air, it is preferable that fresh air be drawn into the tank at a high level and that the effluent vapour be extracted, via flexible trunking from a top manhole, at a low level (about 2 m above the tank floor).

If possible, do not expel air from a low level (for example from a manhole at the bottom or side), since vapour will concentrate in the bund area and create a hazard.

Continue ventilation until gas detector tests show either a safe concentration of, or freedom from petroleum vapour. A tank can be considered free from gas when a series of gas detector tests are carried out at 5 min intervals over a 30 min period at several places in the tank and all gas detector readings are below 4. Before anyone starts working in the tank, provide maximum dilution of the atmosphere in the working area by moving the air inlet to a low level. To prevent any build-up of flammable vapour when sludge is disturbed, continuous ventilation is necessary throughout a tank cleaning operation. Discontinue forced ventilation and tank-cleaning during an electrical storm.

Use a gas detector, as and when required, to check that tanks that have been freed from gas remain
gas free throughout the period during which maintenance work is being carried out.

9.10.8.2 Floating-roof tanks

Follow the same general procedure as detailed in 9.10.8.1. Facilitate entry by supporting the floating roof by its extended vertical columns (or other means), and open roof fittings, manhole covers, and dip hatches to facilitate ventilation. The use of wind-sails on this type of tank is often not practicable, but ventilation can be accelerated mechanically by the use of wind-scoops made of suitable material and located in the side manholes, or by the use of fans or eductors. When testing for vapour concentration, include the space in the tank that is above the roof and inside the pontoons. Open and ventilate pontoons and double decks, and use a gas detector to check each such space individually.

Ensure that water-drainage systems are clear of product, by opening and flushing them.

9.10.8.3 Above-ground horizontal tanks

After draining the horizontal tank as completely as possible of its contents, remove the manhole covers and use water as a flushing medium. Before flushing the tank, ensure that all pipelines are disconnected and blanked off and all apertures fully opened. Ventilation can be accelerated by means of a wind-sail or by mechanical means.

9.10.8.4 Below-ground and mounded tanks

Follow the same general procedure as in the case of fixed-roof tanks (see 9.10.8.1), but remember that it is essential to ventilate access chambers, valve chambers, and tunnels ancillary to the tank as well, and to include these places in the testing procedure.

9.11 Cleaning of tanks

9.11.1 Tanks used for the storage of leaded class 1 petroleum product

The cleaning of these tanks is a hazardous operation owing to the presence of toxic organic lead derivatives in the atmosphere and in the sludge and scale from the inside walls and roofs of the tanks. The tanks therefore require special treatment in the cleaning process, and the instructions issued by the manufacturer of the lead compound regarding the procedure and the safety measures to be adopted have to be observed rigidly. Tanks that have, at any time, contained a leaded product shall carry, near each manhole, a permanent warning notice to this effect.

9.11.2 Tanks used for the storage of unleaded class I and class II petroleum product

9.11.2.1 Cleaning under other than gas-free conditions

When the cleaning of a tank involves the entry of persons and the tank cannot be completely gas freed and maintained in that condition throughout the entire operation, the following precautions shall be observed:

a) Ensure that cleaning is carried out under the direct supervision of a qualified person.

b) Remove as much highly flammable liquid and sludge as possible from the tank through a closed pumping system, then drain out the remaining contents of the tank via the main and drain lines, and disconnect these and any other lines that are connected to the tank. Blank off all tank valves and disconnect pipelines. Reduce hand bailing and mopping-out to a minimum.

 c) Keep the tank as well ventilated as possible during cleaning operations.
d) All persons who enter the tank shall be equipped with safety equipment in accordance with the relevant statutory requirements of the respective Partner States. While work is in progress, ensure constant supervision by a qualified person stationed outside the tank and equipped with suitable breathing apparatus that enables him to enter immediately, should the need arise. A safety line shall also be immediately available.

e) The period for which persons may be allowed to remain in the tank continuously will vary with site conditions, but it is recommended that this period in no case exceeds 1 h 30 min and that there be a break of at least 30 min before such persons return to the tank.

f) Ensure that all clothing, any part of which has become saturated, is removed immediately and washed and dried before being worn again.

g) Examine, test, clean, and sterilize breathing apparatus on each occasion before use.

h) Ensure that the breathing apparatus correctly fits the person who is to wear it, and is maintained in sound working order.

i) During cleaning, use compressed-air-operated lights and equipment inside the tank.

Alternatively, battery-operated or mains-operated equipment and lighting may be used, provided that they are of flameproof, intrinsically safe, or approved construction. Connect electrical equipment to the power supply by means of a flexible lead of an approved type. Pass cables for lighting through the roof manhole. Do not use side manholes for this purpose, and do not allow the mass of suspended lighting to be carried by its cable.

j) Ensure that the accumulation of sludge and corrosion scale from the cleaning operation is handled in a wet state only, both in the tank and after removal. Disposal of this sludge and scale should be carried out by burning or by chemical treatment.

k) In the case of hard deposits that necessitate the use of chipping tools, ensure that the surface being chipped is kept thoroughly wetted during the operation.

l) Ensure that water hoses, fire extinguishers and sand are available in the immediate vicinity throughout tank-cleaning operations.

9.11.2.2 Cleaning under gas-free conditions

In the case of a tank that is free from gas and can be maintained in that condition throughout the entire operation, only the precautions given in 9.11.2.1 a), 9.11.2.1 f), and 9.11.2.1 j) have to be observed, while the workers should still be provided with suitable clothing.

Tanks that are being cleaned under gas-free conditions may be illuminated as in 9.11.2.1 i), or by low-voltage a.c. (below 50 V) portable lighting equipment. The supply cable to the flameproof transformers for low-voltage lighting equipment shall always be supported such that the cable is held clear of the ground, and a transformer shall never be taken inside a tank.

9.11.2.3 Cleaning of vehicle and other small tanks

Rail tank vehicles, road tank vehicles and storage tanks of limited size can be conveniently cleaned by equipment operated from outside the tank and in these cases only the precautions given in 9.11.2.1 a) and 9.11.2.1 j) have to be observed.
All effluent and excess water shall be treated before it is passed into the drainage systems.

9.11.3 Tanks used for the storage of class III petroleum product

Provided that tanks that previously contained a class III product are ventilated adequately during cleaning operations and that persons working in them wear suitable protective clothing, no special precautions are necessary.

10 Transportation of petroleum products (other than LPG) by road and by rail

All bulk road and rail vehicles for petroleum products shall be constructed in compliance with an approved standard and shall conform to sound engineering design.

The regulations for the transportation of hazardous goods and relevant statutory requirements of the respective Partner States shall be adhered to.

11 Pollution control

The design and operation of the installation shall be such that the storage and handling facilities will not cause contravention of the environmental regulations of the respective Partner States. In particular, all reasonable steps shall be taken to prevent pollution of both underground water and surface water. All waste shall be disposed of in an approved manner.
Annex A
(informative)

Determination of water requirements for the highest fire risk area

A.1 Introduction
Water requirements for fire-fighting purposes should be determined for the highest fire risk with the
largest fire surface area in a depot.

The fire risks in a depot should be determined by means of a risk assessment.

A.4 Hazard evaluation and risk assessment
There are numerous hazard evaluation techniques. Each technique has a specific purpose, benefits,
costs and limitations. Some are qualitative techniques whilst others are quantitative methods, and a
few are a combination of qualitative and quantitative methods.

A.4.1 The most common hazard evaluation techniques are:
   a) Safety review;
   b) Checklist analysis;
   c) Relative risk ranking;
   d) Preliminary hazard analysis (PHA);
   e) What-if analysis;
   f) Hazard and operability analysis (HAZOPS);
   g) Failure modes and effects analysis;
   h) Event tree analysis;
   i) Fault tree analysis;
   j) Cause-consequence analysis;
   k) What-if/checklist analysis; and
   l) Human reliability analysis.

A.4.2 The most suitable and practicable techniques for a petroleum bulk depot are any of the
following:
   a) Safety review;
   b) Checklist analysis;
c) Relative risk ranking;
d) PHA or HAZOPS; and
e) What-if analysis.

The technique(s) used for the hazard evaluation shall be at the discretion of the responsible engineer.

NOTE It has been found that the application of simple qualitative assessment techniques for depot assessments give results that are very similar to those of the more complicated in-depth techniques.

A.5 Consequence analysis

In addition to the hazard evaluation listed in A.4, there is another method, called quantitative consequence analysis (QCA). In most cases it is sufficient to estimate the order of magnitude of the consequences. It is not always necessary to estimate in great detail. In a few cases it may be necessary to conduct QCA for a depot, for example when modelling the spread of gases (toxic or LPG) and their effects.

A.6 Example of a risk analysis

NOTE This example only gives the key features of a full analysis.

The following details deal with PHA, one of the techniques listed in A.4, to serve as a typical illustration of a major risk analysis approach. The primary components of a PHA are:

a) hazard identification, which may be extended to hazard evaluation and, still further, to a quantitative risk analysis depending on the depth of analysis required to obtain more information;

b) risk index evaluation; and

c) risk mitigation

In A.6.1, the specific example of a PHA for a fuel depot is outlined.

A.6.1 Hazard identification, hazard evaluation and quantitative risk Assessment

A.6.1.1 List the various hazardous events

A.6.1.2 Follow each event through to its conclusion (without any controls applied) and record the consequences

A.6.1.3 Identify and record existing active and passive controls, which would limit the probability of the event or the severity of the consequences

NOTE 1 Examples of passive controls are: preventative safety measures such as engineering design and layout, equipment specifications, control of ignition sources, standard safe operating procedures, training of personnel in procedures, selection of fire-resistant materials, specialized electrical equipment, inspection and maintenance of facility.

NOTE 2 Examples of active controls are: emergency shut-off equipment, emergency shut-off and response procedures and training, provision of fire-fighting equipment and checks on the reliability of fire-fighting equipment.

A.6.1.4 Review the critical factors such as operating procedures, training, fire protection systems and emergency shutdown devices which could influence the likelihood of an event occurring, or the severity of the incident. The information obtained from such a review is then considered when
determining a risk index value for the event.

A.6.2 Risk matrix

A.6.2.1 Once the definition and ranking of likelihood and consequence are determined and tabulated, a corresponding 5 x 5 matrix can be constructed (see the example in Figure A.1). The risk index (RI) for any event is calculated as the product of its likelihood and its consequence value in the risk matrix.

Consequence

<table>
<thead>
<tr>
<th>Consequence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>Worker fatalities</td>
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<td>Public fatalities</td>
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<tr>
<td>Exceptionally high property damage costs</td>
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<tr>
<td>Widespread environmental impact</td>
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<td>Public outrage</td>
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Likelihood

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Highly improbable</th>
<th>Improbable</th>
<th>Infrequent</th>
<th>Frequent</th>
<th>Very probable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; once per 1 000 years</td>
<td>Once per 100 - 1 000</td>
<td>Once per 10 - 100</td>
<td>Once per 1 - 10</td>
<td>More than once per</td>
</tr>
</tbody>
</table>
The first steps in drawing up a risk matrix are to define the ranking of likelihood and the ranking of consequence (or severity) of events. Both the likelihood and consequence (or severity) of various events are given a ranking value on a subjective scale, as in the example of a five-point ranking given in Table A.1.
**Table A.1 — Universal system of ranking severity and likelihood**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ranking</strong></td>
<td><strong>Consequence or severity</strong></td>
<td><strong>Likelihood</strong></td>
</tr>
<tr>
<td>1</td>
<td>Unimportant / Negligible: No worker health effects No public health effects No property damage No environmental impact No adverse public reaction</td>
<td>Highly improbable &lt; once per 1 000 years</td>
</tr>
<tr>
<td>2</td>
<td>Limited / Minor: No worker injuries No public injuries Minor property damage Minor environmental impact Minor adverse public reaction</td>
<td>Improbable Once per 100 - 1 000 years</td>
</tr>
<tr>
<td>3</td>
<td>Serious / Marginal: Worker injuries Minor public injuries Moderate property damage Moderate environmental impact Moderately adverse public reaction</td>
<td>Infrequent Once per 10 -100 years</td>
</tr>
<tr>
<td>4</td>
<td>Very serious / Significant: Worker fatalities Public injuries Significant property damage Significant environmental impact Adverse public reaction</td>
<td>Frequent Once per 1 - 10 years</td>
</tr>
<tr>
<td>5</td>
<td>Catastrophic: Worker fatalities Public fatalities Exceptionally high property damage costs Widespread environmental impacts Public outrage</td>
<td>Very probable More than once per year</td>
</tr>
</tbody>
</table>

**A.6.2.3** The standard definitions of likelihood and severity may be modified to accommodate local factors relevant to the installation being evaluated and 3 x 3 or 4 x 4 risk matrices may be used. Examples that illustrate the use of likelihood and consequence definitions and ranking for a particular case study are given in Tables A.2 and A.3.
Table A.2 — Example of likelihood definitions and ranking

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Likelihood designation</strong></td>
<td><strong>Likelihood Ranking</strong></td>
<td><strong>Description/Definition</strong></td>
</tr>
<tr>
<td>Frequently</td>
<td>5</td>
<td>This type of event has occurred at this facility one or more times during the life of this type of process or piece of equipment.</td>
</tr>
<tr>
<td>Probable</td>
<td>4</td>
<td>It is expected that this event will occur at this facility at least once during the life of this type of process or piece of equipment.</td>
</tr>
<tr>
<td>Possible</td>
<td>3</td>
<td>This event may occur at this facility at least once during the life of this type of process or piece of equipment.</td>
</tr>
<tr>
<td>Seldom</td>
<td>2</td>
<td>This event is unlikely to occur at this facility, but it has occurred at least once somewhere else for this type of process or piece of equipment.</td>
</tr>
<tr>
<td>Unlikely</td>
<td>1</td>
<td>This event will not occur at any of the company’s depots, and the company is unaware of any other facility where it has occurred under similar circumstances.</td>
</tr>
</tbody>
</table>
Table A.3 — Example of severity definitions and ranking

<table>
<thead>
<tr>
<th>Severity designation</th>
<th>Severity ranking</th>
<th>Characteristics of the event</th>
</tr>
</thead>
</table>
| **Catastrophic**     | 5                | a) Closure of a major area\(^a\) in the depot for more than 5 days  
b) Significant impact on the community outside of the depot's property lines  
c) Numerous fatalities or severe injuries (inside or outside the depot)  
d) If two or more adjacent tanks could be exposed (and endangered) simultaneously, regardless of the wind direction |
| **Significant**      | 4                | a) Closure of a major area in the depot for 2 days to 5 days  
b) Minor damage outside the depot (cracked windows, etc.)  
c) Fatalities and severe injuries (only in the depot), minor injuries (outside the depot)  
d) If a single adjacent tank could be exposed (and endangered), regardless of the wind direction  
e) A fire in a strategic product tank, regardless of the number of additional tanks exposed containing, e.g., jet fuel for an aviation depot |
| **Marginal**         | 3                | a) Closure of operations at a major area of the depot for 2 d to 5 d  
b) Multiple severe injuries (in the depot)  
c) A full surface fire in any tank containing products such as illuminating paraffin, slops or additive, provided it does not present a hazard to adjacent tanks regardless of the wind direction |
| **Minor**            | 2                | a) Two days or less downtime  
b) Damages limited to equipment in the immediate area  
c) Minor injuries only |
A.6.2.4 The severity values used for a risk assessment study should be based on factors that are mutually agreed upon with the respective company management before use. Some critical aspects in the above example are:

a) The tank spacing between the tank on fire and the adjacent threatened tanks. If the tank spacing is less than one tank diameter of the tank on fire, it can be assumed that the adjacent tank would be exposed to excessive radiant heat loads, regardless of wind direction. If one adjacent tank is exposed, a severity value of 4 is assigned. If two adjacent tanks could simultaneously be exposed to the fire, a severity value of 5 is assigned.

b) The criticality of the tank on fire is a function of the product stored, and whether alternate storage arrangements could be made if a tank fire occurred. If there are difficulties regarding alternate storage arrangements for a strategically important product, a minimum severity value of 4 is assigned regardless of the number of additional tanks exposed to the fire.

A.6.3 Risk mitigation

Risk mitigation involves the implementation of measures that reduce the risk index (RI) to an acceptable value. Such measures could be either passive or active controls (see A.6.1.4) or both.

If the RI for an event can be reduced to an acceptable level by passive control alone, and it is cost effective, then there is obviously no justification for additional fire protection systems. The example in A.6.1 and A.6.2 is only one typical example of one of the risk assessment techniques.

NOTE Generally, the oil industry worldwide tends to consider only those recommendations that would be necessary to reduce the risk index for an event to below 9. Additional mitigation measures could be taken to reduce the RI further, but might not be cost-justified. RIs of 8 and below are considered acceptable risks which the oil industry is prepared to take.

A.7 Water requirements for some typical events

Water requirements in the management of fire effects (see note) are expressed as total flow in litres per minute and calculated pressure.

NOTE The management of fire effects is the fire-fighting strategy which involves any one or a combination of the following, often in the priority order given:

a) safeguard exposures against fire;

b) control or contain fire; and

c) extinguish fire.

The water is applied together with foaming agents for extinguishing and, if required, for control of a petroleum fire. (Foaming agents are not necessarily required for safeguarding exposures and for control or isolation purposes.) Some typical events which are generally included in risk assessments are given in A.7.1 to A.7.4. The results of a risk assessment for a depot will identify the highest risk
with fire area that has the largest horizontal surface area.

A.7.1 Tank fire in the tank with the largest fire surface area

A.7.1.1 Calculation of water requirement for foam application to the tank on fire

The determination of water requirements is dealt with in the latest edition of NFPA 11 or in the information service of the supplier of foam and equipment. The following shall be taken into account when determining water requirements:

a) the tank dimensions;

b) the liquid surface area, in square metre;

c) the type of product;

d) the type of foam specified for the product;

e) the method of application;

f) the foam application rate for the method specified and for the product, in litres per minute per square metre of the liquid surface area;

g) the flow specification of foam appliances, in litres per minute, and the inlet pressure, in kilopascals;

h) the number of foam appliances required; and

i) the specified application time, in minutes.

NOTE For the calculation of the minimum pressure see 7.8.8.

A.7.1.2 Other water requirements

A.7.1.2.1 The determination of cooling water requirements (as in a) to c) is dealt with in the latest editions of NFPA 15 and oil industry specific API Publication 2030.

a) Cooling water for the tank on fire: at an application of 4.1 L / min / m\(^2\) of protected surface.

The application of cooling water to a tank is of potential benefit only for the exposed portions of the roof and those portions of the shell that are not in contact with the liquid (product) in the tank.

If a water spray is used, typically only the upper 3.7 m to 7.4 m of the shell is sprayed; up to 3.7 m rundown is allowed on inclined and vertical surfaces. (See API Publication 2030.) This amounts to 15.1 to 30.3 L / min / linear metre circumference of the tank for a fixed cooling system; or 30.3 to 62 L / min / linear metre for portable equipment.

b) cooling water for any adjacent tanks: as determined during the risk assessment, in general, if an adjacent tank is within one tank diameter of the tank on fire. This cooling water need only be applied to the exposed quadrant to half of the adjacent tank(s), at the application rate given in a).

Since the exact location of the exposing fire or the amount of liquid in the exposed tank may not be known before the fire occurs, total protection would require that the entire tank be sprayed.
However, water sprayed on surfaces that are not exposed to fire is wasted and takes resources from other fire suppression efforts. Application of cooling water by hose streams and monitors is generally a more efficient use of available water.

c) Once foam application to the tank on fire has commenced, cooling water for threatened tanks might not be required. The maximum water flow required for the tank on fire or the adjacent threatened tanks and facilities should be available.

A.7.1.2.2 Other water requirements to consider

Take into account any water required for the protection of fire-fighters and to be used for isolation of adjacent tanks if deemed necessary, and determined by the number of hose streams required at 250 L to 450 L per minute per hose.

A.7.2 Bund spill fire as a result of the largest tank failure

A.7.2.1 Calculation of water requirements for foam applications to bund spill fire

The largest tank is assumed to be full when it ruptures, spilling its contents into the bund. Refer to the latest edition of NFPA 11 and to the supplier(s) of foam and equipment for foam, equipment and water requirements.

The following have to be taken into consideration:

a) the total spill containment surface area, in square metres;

b) the type of product (hydrocarbon or polar solvent);

c) the method of foam application;

d) the foam type specified for the product;

e) the application rate for the foam, in litres per minute per square metre;

f) the minimum application time, in minutes; and

g) the minimum operating pressure required by the foam appliances being used.

A.7.2.2 Allowances

An allowance should be made for the application of foam into the failed tank if it has not totally collapsed. Calculate the water flow for foam application as in A.7.1.1.

A.7.2.3 Remote bunding

If remote bunding was provided as additional containment for the spill, then follow the same calculation as in A.7.2.1. Generally, the principle of remote bunding is to contain a spill in a safe location where there is no threat to adjacent facilities. If so, foam application need only commence in the remote bund once the fire in the main bund has been extinguished.

A.7.2.4 Water requirements

The required total water flow is equal to the requirement as determined in A.7.2.1 or A.7.2.3,
whichever is the greater, based on the principle of fighting one bund fire at a time.

A.7.2.5 Water flow availability

The total water flow shall be available from the fire main for at least 1 h. The total flow as given in A.7.2.4 should be guaranteed for the minimum application time for the type of application and for the type of product as defined in A.7.2, based on the principle of fighting the ground and bund fire first before fighting the tank fire.

A.7.3 Loading rack operational spill fire

The considerations in A.7.3.1 to A.7.3.5 are applicable to both bulk truck loading racks and rail sidings.

A.7.3.1 Distinguish clearly between the various types of event.

A.7.3.1.1 One event is the release of the total contents of a truck or tank car into the containment area and oil/water separator(s) or remote impounding area if provided, or both.

A.7.3.1.2 Another event could be the release of only a quantity of product which depends on the effectiveness of the emergency shut-off response.

NOTE The maximum allowable emergency shut-off response time should not be more than 2 min. The maximum anticipated spill in litres is then equal to the product of this response time (in minutes) and the spill release rate (in litres per minute).

A.7.3.1.3 Yet another event could be an explosion due to switch loading and the release of the contents of the tanker.

NOTE A bulk truck has a far greater likelihood of releasing the contents of at least one compartment (or more) than a tank car, because a bulk truck is constructed of aluminium and is loaded with closed domes for bottom loading, and emergency venting is generally not provided for. Tank cars are constructed of steel and loaded with open domes, thus providing adequate emergency venting. All of this should be considered in the risk assessment.

A.7.3.1.4 Yet another event is the derailment of a tank car, which could result in the total contents of the tank car being released as in A.7.3.1.1, or a portion of the tank car contents being released.

A.7.3.2 Design for the highest risk, as determined by a risk assessment of the various events.

A.7.3.3 Determine the spill fire area for the highest risk.

A.7.3.4 Refer to the latest edition of NFPA 11 and to suppliers of the foam and equipment to determine foam water requirements.

Calculate the foam water flow required in litres per minute.

The calculation of the water requirement should take into account the following:

a) the spill fire surface area at the loading rack or siding, in square metres (determined from the volume of product released and the topography of the containment area);

b) the type of product released (assume worst case type of product);

c) the method of foam application (foam/water sprinklers, fixed monitors, or portable equipment);

d) the type of foam;

e) the foam application rate in litres per minute per square metre; and
f) the minimum foam application time, in minutes.

Calculate the foam water required in litres per minute.

A.7.3.5 Ensure that cooling water for pressure fires (minimum 2 hoses, streams of 125 L to 250 L per minute) is provided if no fixed foam/water sprinklers or fixed monitors exist or only portable foam equipment is provided. Generally, pressure fires in depots would be extinguished by closing remote valves and switching off pumps, and a pressure fire on a tanker could be extinguished by dry chemical powder extinguisher. Additional water requirements for fire-fighters might be required for isolation if remote isolation is not provided (determine the number of hose, streams of 250 L to 450 L per minute). Hence calculate the total water flow requirements.

A.7.3.6 The total water flow requirements should be available for at least 1 h.

A.7.4 Operational spill fire in the bund due to a tank overfill

A.7.4.1 Refer to NFPA 11 and the suppliers of foam and equipment to determine the total water flow requirements. The calculation of the water requirement should take into account the following:

a) the anticipated spill volume (the product of the flow rate and the response time for emergency shut-off), in litres;

b) the spill fire area (determined from the volume of product released and the topography of the containment area), in square metres;

c) the method of foam application (fixed monitors or portable equipment);

d) the type of foam;

e) the foam application rate for type of foam and method of application, in litres per minute per square metre; and

f) the minimum foam application time, in minutes.

Calculate the total water flow requirements.

A.7.4.2 The total water flow requirements should be available for at least 1 h.

NOTE In the case of other operational spill fire events such as at pump manifolds etc., the determination of water requirements would be similar to the event given in A.7.4. Allowance could be made for cooling hose streams/reels and water for isolation, if required.

A.7.4.3 If stone ballast for the containment of operational spills is provided such that the volume of any anticipated spill can be completely contained within the voids, then the spill open surface area may be considered as (open) void area at the stone ballast surface, provided that the maintenance of these conditions are guaranteed.

The fire surface area may be considered as the (open) void area at the stone ballast surface and foam water requirements calculated as in A.7.4.1 and A.7.4.2.

NOTE 1 It is important that allowance is made in the expanded foam application technique, since expanded foam is designed to float and flow over the surface of the flammable liquid and will not readily flow over the stone ballast. This can be accomplished by use of, for example, hand-held foam nozzles and oscillating foam monitors. If fixed foam pourers are used it may be necessary to increase the application rate of foam/water solution or the number of foam pourers, or both, to ensure adequate coverage of the stone ballast surface area.
NOTE 2 Adequate underground drainage should be provided to rapidly clear the voids from any previous spills and water to maintain the operational spill capacity of the stone ballast voids. The capacity of the stone ballast voids should be designed to handle the anticipated operational spill during worst case conditions, namely during the design storm (generally the 2 year storm is assumed). (As this poses significant practical problems, it is not considered a viable option by the majority of oil industry members.)
Annex B
(normative)

Design criteria for interceptors (gravity separators)

B.1 General

From the results of experiments and from plant operating data, it has been determined that the design of waste water separators should be based on the rate of rise of oil globules that have an average diameter of 150 µm. This globule size, although somewhat arbitrary, has been adopted for design purposes because satisfactory oil removals are achieved when a particle of 150 µm diameter is used as a basis for design or investigation.

B.2 Design procedure

The vertical rate of rise, $V_t$, of an oil droplet in water is given by the formula:

$$V_t = 1.962 \times 10^{-9} \times \Delta \delta \times D^2 / \eta$$

where,

$V_t$ is the vertical rate of rise, in metres per hour;

$\Delta \delta$ is the difference in densities between water and oil, in kilograms per cubic metre;

$D$ is the diameter of the oil droplet, in micrometres; and

$\eta$ is the dynamic viscosity of water, in pascal-seconds.

Therefore, for water at 10 °C with a density of 997 kg/m$^3$ and a dynamic viscosity of $1.348 \times 10^{-3}$ Pa.s, diesel oil of density 860 kg/m$^3$ and an oil droplet size of 150 µm,

$$V_t = 1.962 \times 10^{-9} \times (997-860) \times 150^2 / 1.348 \times 10^{-3}$$

$$= 4.487 \text{ m/h}; \text{ or}$$

$$= 0.0748 \text{ m/min}$$

The interceptor should be so designed for a given water flow rate $q$ that there is sufficient time for the oil globules to rise all the way from the bottom of the interceptor to the under-surface. The design of the retention system around the spill origin and outlets should be able to cope even with the worst rainfall conditions and should therefore take into account the maximum rain density (this figure can be obtained from the Mean Annual Precipitation MPA map of the RSA), viz, 40 mm/h for both coastal and inland zones. Assuming that the rainwater runs off as fast as it is deposited, the maximum runoff becomes:

$$q = C.I.A./60000$$

where,

$q$ is the runoff flow capacity, in cubic metres per minute;
\( C \) is the runoff coefficient (e.g. 0.9 for concrete);
\( I \) is the rain intensity, in millimetres per hour; and
\( A \) is the catchment area, in square metres.

The horizontal velocity, \( V_h \), is given by:
\[
V_h = q / A_c
\]
where,
\( V_h \) is the horizontal velocity, in metres per minute;
\( q \) is the runoff flow capacity, in cubic metres per minute; and
\( A_c \) is the cross-sectional area of the separator, in square metres.

An acceptable maximum horizontal velocity \( V_h \), for the flow through an interceptor would be less than 0.91 m/min (3 ft/min or 55 m/h), or 15 \( V_t \), whichever is the smaller.

The length of the separator, \( L \), in metres, is given by:
\[
L = F (V_h/V_t) H d
\]
where,
\( F \) is a design factor (dimensionless); and
\( d \) is the depth of the separator, in metres.

The design factor \( F \) is the product of the short-circuiting factor, \( F_{sc} \), which can be taken as 1.2, and the turbulence factor, \( F_t \), which is a function of the ratio of \( V_h \) to \( V_t \):
\[
F = F_{sc} \times F_t
\]
The American Petroleum Institute gives the following recommended values of turbulence factors:

<table>
<thead>
<tr>
<th>( V_h / V_t )</th>
<th>Turbulence factor, ( F_t )</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>145</td>
</tr>
<tr>
<td>15</td>
<td>137</td>
</tr>
<tr>
<td>10</td>
<td>127</td>
</tr>
<tr>
<td>6</td>
<td>114</td>
</tr>
<tr>
<td>3</td>
<td>107</td>
</tr>
</tbody>
</table>

Furthermore, a separator should be designed within the following limits:

a) a depth \( d \) of between 1 m (3 ft) and 2.4 m (8 ft);
b) a recommended depth-to-width ratio greater than 0.3 and less than 0.5 i.e. \( d = 0.3 \, W \) to \( 0.5 \, W \), where \( W \) is the width of the separator; and

c) a width \( W \) of between 2 m (6 ft) and 20 m (60 ft).

**B.3 Example**

A separator is to be designed to cater for runoff from a concrete area 50 m x 45 m = \( 2250 \, m^2 \), assuming a maximum rain intensity of 40 mm/h. The design temperature is 10 °C, and waste water through the separator contains diesel with a density of 860 kg/m\(^3\) at 10 °C.

\[
q = \frac{C.I.A.}{60000} = 0.9 \left( \frac{H \times 40 \times 2250}{60000} \right) = 1.35 \, m^3/min
\]

\( V_t = 1.962 \)

\[
= 1.962 \times 10^{-3} \times (997-860) \times 1502/1.348 \times 10^{-3} = 4.487 \, m/h
\]

\( V_h = 15 \, V_t \)

\[
= 1.122 \, m/min
\]

which is greater than 0.91 m/min, therefore use \( V_h = 0.91 \, m/min \) as a maximum.

To avoid excessively long separators, \( V_h \) should, in practice, be kept to a minimum. This can be done by increasing (within reason) the cross sectional area of the separator.

Therefore assume \( d = 1.3 \, m \)

From \( d = 0.5 \, H \, W \)

\[
W = 2.6 \, m
\]

Then \( A_c = d \, W \)

\[
= 1.3 \times 2.6 = 3.38 \, m^2
\]

and \( V_h = q / A_c \)

\[
= 1.35/3.38 = 0.4 \, m/min
\]
Hence \( \frac{V_h}{V_t} = \frac{0.4}{0.0748} \)
\[ = 5.34 \]

By interpolation between the listed turbulence factors,
\[ F_t = 1.125 \]

So that \( F = F_{sc} \times F_t \)
\[ = 1.2 \times 1.125 \]
\[ = 1.35 \]

This gives
\[ L = F \left( \frac{V_h}{V_t} \right) H_d \]
\[ = 1.35 \times 5.34 \times 1.3 \]
\[ = 9.37 \text{ m} \]

Therefore, the final dimensions of the separator would be:
- length = 9.4 m;
- width = 2.6 m; and
- depth = 1.3 m.
Annex C  
(informative)

Examples of typical work permits

C.1 Gas-free certificate

<table>
<thead>
<tr>
<th>GAS-FREE CERTIFICATE</th>
<th>(TO BE ISSUED IN CONJUNCTION WITH A PERMIT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERTIFICATE No. 000X</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE** – This certificate does not authorize any work to be carried out, or entry by a person into a confined space.

<table>
<thead>
<tr>
<th>Exact location of work area: GAS TESTING</th>
</tr>
</thead>
</table>

**NOTES**

- Meter make/model: ..............................................
- Serial No. ......................................................
- Calibration date: ................................................
- Date of test: ....................................................
- Time of test: ....................................................
- Results of test: ................................................
- % LEL ............ % O₂ .............................

**Signature of issuing officer** .................................

**Date:** ..........................................................

**Time of issue:** .............................................

I have **personally** tested the work area specified above, and certify it safe for the purpose of

- *HOT WORK*  
- *COLD WORK* (delete as applicable)

**THIS CERTIFICATE IS TO BE ATTACHED TO WORK PERMIT No. ........................................**

**AUTHORIZATION TO RE-ENDORSE**

- **Name of person authorized to re-endorse** ..........................
- **Certificate to be re-endorsed:** ...................................
- **Signature of issuing officer** ..................................
- **Date:** ........../........../..........  
- **Name of person authorized to re-endorse** ..........................
- **Certificate to be re-endorsed:** ...................................

NOTE – This certificate does not authorize any work to be carried out, or entry by a person into a confined space. Separate permits shall be issued for these purposes.
## C.2 Example of permit for entry into a confined space

<table>
<thead>
<tr>
<th>NOTE: This permit does not authorize any work to be carried out. A separate work permit shall be issued.</th>
<th>PERMIT FOR ENTRY INTO A CONFINED SPACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>THIS PERMIT IS VALID FOR A MAXIMUM OF 12 HOURS AND SHALL BE CANCELLED ON COMPLETION OF THE WORK</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work site:</th>
<th>Date and time of issue</th>
<th>Permit No. 000X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor’s name:.................................</td>
<td>Address:.................................</td>
<td></td>
</tr>
<tr>
<td>Contractor’s responsible person:......................</td>
<td>For performing the work specified for duration of this permit:.......................</td>
<td></td>
</tr>
</tbody>
</table>

### Special instructions

**GENERAL WORK PERMIT ISSUED**

<table>
<thead>
<tr>
<th>Any substance hazardous to health?</th>
<th>Personal safety requirements met?</th>
<th>Is a gas-free certificate required?</th>
<th>Is safety induction required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PERSONAL PROTECTION REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>EYES</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Goggles</td>
</tr>
<tr>
<td>Shield</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>PERSONAL PROTECTION REQUIRED</th>
</tr>
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<tbody>
<tr>
<td>EYES</td>
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<td>---------------------------------</td>
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<tr>
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<tr>
<td>Shield</td>
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</tbody>
</table>

I hereby certify that it is safe to do the specified location, provided that the indicated protective clothing and equipment are worn by all persons entering the tank, confined space, or other work area specified.

Signed:.................................................. at:................................. hours on:.................................

Print name:................................................. Company:.................................................

I confirm that I will comply with the requirements set out in this permit.

Signed:..................................................

Performing Authority

Print name:................................................. Date: dd-mm-ccyy

Permission is hereby granted to enter the above tank, confined space, or work area, as specified. This permit is valid until XX hours on dd-mm-ccyy

Signed:..................................................

Operating authority

Print name:................................................. Date: dd-mm-ccyy
C.3 Example of a hot-work permit

**HOT-WORK PERMIT**

This hot-work permit is valid for a maximum of 12 hours. To extend this permit it shall be renewed after each 12-hour shift by signature of the responsible operating authority and cancelled on completion of work.

<table>
<thead>
<tr>
<th>Work site</th>
<th>Date and time of issue</th>
<th>Permit No. 000X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor’s name………………………</td>
<td>Address …………………………………………………………</td>
<td></td>
</tr>
<tr>
<td>Contractor’s responsible person………………………………………</td>
<td>For performing the work specified for duration of this permit………</td>
<td></td>
</tr>
<tr>
<td>Description of work</td>
<td>Sketch of exact location</td>
<td></td>
</tr>
<tr>
<td>Special instructions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Any substance hazardous to health?**
  - No
  - Yes

- **Personal safety requirements met?**
  - No
  - Yes

- **Entry permit issued**
  - Number………………..

- **Approved contractor**
  - No
  - Yes

**PERSONAL PROTECTION REQUIRED**

<table>
<thead>
<tr>
<th>EYES</th>
<th>HANDS</th>
<th>EARS</th>
<th>BREATHING</th>
<th>BODY/OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goggles</td>
<td>PVC gloves</td>
<td>Ear protection</td>
<td>Canister mask</td>
<td>Safety</td>
</tr>
<tr>
<td>Shield</td>
<td>Ord.gloves</td>
<td>Air-supplied respirator</td>
<td>Rubber boots</td>
<td>PVC suit</td>
</tr>
</tbody>
</table>

**STANDARD CONDITIONS**

The standard conditions set out overleaf to be observed for:

**SPECIFIC CONDITIONS**

In addition to the general work-permit-specific conditions the following shall be complied with before work is commenced.

Yes or No to be written
DELETE ITEMS NOT APPLICABLE

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavations</td>
</tr>
<tr>
<td>2</td>
<td>Welding equipment</td>
</tr>
<tr>
<td>3</td>
<td>Flame cutting equipment</td>
</tr>
<tr>
<td>4</td>
<td>Hazardous materials</td>
</tr>
<tr>
<td>5</td>
<td>Compressors for breathing equipment</td>
</tr>
<tr>
<td>6</td>
<td>Wetting down</td>
</tr>
<tr>
<td>7</td>
<td>Drains</td>
</tr>
<tr>
<td>8</td>
<td>Fire extinguishers</td>
</tr>
<tr>
<td>9</td>
<td>Gas-free certification</td>
</tr>
<tr>
<td>10</td>
<td>Entry permit</td>
</tr>
</tbody>
</table>

RE-ENDORSEMENT OF PERMIT TO BE BY ………DAILY/HOURLY

AUTHORIZATION TO CARRY OUT WORK

I CERTIFY THAT THE ABOVE EQUIPMENT/SITE IS SAFE FOR HOT WORK TO BE CARRIED OUT BY PERSONS SUBJECT TO THE SPECIFIED REQUIREMENTS.

ISSUED BY: 1. Site mgr/supt……………………….. Permit valid from………………am/pm to……………….am/pm

I UNDERSTAND THE NATURE OF THE WORK AND CERTIFY THAT THE ABOVE CONDITIONS WILL BE OBSERVED AT RECEIVED BY CONTRACTOR/EMPLOYEE…………………………………………………………………………………………../………………………….

WORK COMPLETED WORK HAND-BACK

Time……………………………. Contractor/Employer Time………………. Received by site manager…….

Date…………………………………. Date:……../……/………..

C.3 Example of a hot-work permit (concluded)

THIS PERMIT IS RENEWED

I HAVE PERSONALLY CHECKED THAT THE CONDITIONS LISTED OVERLEAF HAVE NOT CHANGED AND I CONSIDER IT SAFE FOR WORK TO COMMENCE.

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOURS ON</td>
<td>HOURS ON</td>
</tr>
</tbody>
</table>

SIGNATURE (Operating authority)

DISPLAY OF PERMIT

THIS PERMIT SHALL BE CLEARLY DISPLAYED AT THE WORK SITE (WHITE COPY) WITH CONTRACTOR/EMPLOYEE PERFORMING THE WORK.

Pink copy to be given by hand to the site manager and the yellow copy to be kept by the person issuing the permit.

Upon completion of work and acceptance, the contractor/employee shall sign permit and hand it back to the site manager for closeout.

PERMIT ISSUE

Permits are to be issued by a site manager. They may be issued by the engineer, in which case they shall be countersigned by the site manager.

STANDARD CONDITIONS
1. EXCAVATIONS: If more than 1.5 m deep, the following conditions SHALL apply before entry is permitted:
   (i) an ENTRY permit shall be obtained;
   (ii) the sides of the excavations shall be suitably shored and graded back.

2 WELDING EQUIPMENT:
   (i) Is the equipment sited in a safe area?
   (ii) Are welding cables in good condition?
   (iii) Is there an insulating bridge in place where cables cross pipelines?
   (iv) Is the welding-circuit return cable positioned within 2 m of the job?
   (NOTE: Earth routing via installed plant is prohibited).

3 FLAME CUTTING EQUIPMENT:
   (i) Is the equipment sited in a safe area?
   (ii) Are oxyacetylene cylinders secured upright in a special trolley or rack?
   (iii) Confirm flashback arrestors fitted.
   Gas cylinders SHALL NOT be taken inside tanks or confined spaces and when not in use SHALL be turned off at the main cylinder valve.

4 HAZARDOUS MATERIALS:
   (i) Hot-work areas shall be kept free of loose flammable and combustible materials and empty drums. Confirm appropriate action taken.
   (ii) Where asbestos, lead or other critical materials are present in the work area, the appropriate statutory regulations and codes of practice shall be strictly observed. Confirm appropriate action has been taken.

5 COMPRESSORS
   The compressor should be sited upwind of the job in an approved safe FOR BREATHING flammable or toxic vapours EQUIPMENT: Confirm wind sock is in place.

6 WETTING DOWN
   During hot work, chipping, caulking of grinding and disk-cutting of materials concrete or other materials likely to cause a hazardous build-up of temperature, provision shall be made for thoroughly wetting the work being carried out is coolant available?

7 DRAINS
   All drains within 15 m of hot work shall be covered with tarpaulin or heavy gauge plastic and sand. Confirm drains are sealed.

8 FREE EXTINGUISHERS
   At least 2 fire extinguishers suitable for the job shall be available at the work site.
   Confirm extinguishers are available.
   A fire guard shall be stationed at the work area to take appropriate action in the event of a fire and to warn personnel and fire control. Is fire guard available?

9 GAS-FREE
   Before hot work may commence the work site shall be certified gas-free. Confirm CERTIFICATION certificate has been issued.

10 ENTRY PERMIT
    Any entry permit shall be obtained before entry is permitted into a confined space. Confirm entry permit has been issued.
### C.4 Example of a general or cold-work permit

**GENERAL/COLD-WORK PERMIT**

**THIS GENERAL/COLD-WORK PERMIT IS VALID FOR A MAXIMUM OF 12 HOURS.**
**TO EXTEND THIS PERMIT IT SHALL BE RENEWED AFTER EAC 12-HOUR SHIFT BY SIGNATURE OF THE RESPONSIBLE OPERATING AUTHORITY AND CANCELLED ON COMPLETION OF WORK.**

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<td></td>
</tr>
<tr>
<td>Personal safety requirements met?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry permit issued:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approved Contractor:</td>
<td></td>
<td></td>
</tr>
</tbody>
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#### PERSONAL PROTECTION REQUIRED

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#### STANDARD CONDITIONS

The standard conditions set out overleaf to be observed for:

1. Induction
2. Smoking
3. Cessation of work
4. Interference with plant & operations
5. Wind direction
6. Cold-cutting
7. Excavations
8. Mobile work machines
9. Electrical work

#### SPECIFIC CONDITIONS

In addition to the general work-permit specific conditions the following shall be compiled with before work is commenced.

1. Isolated from all pipelines
   i) by locked valves
   ii) by blanking
   iii) by disconnection
2. Depressed
3. Drained
4. Gas-free by ventilation
   Gas-free certificate number
5. Other conditions

DELETE ITEMS NOT APPLICABLE

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<td></td>
<td>Gas-free certificate number</td>
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<tr>
<td>5</td>
<td>Other conditions</td>
</tr>
</tbody>
</table>
### C.4 Example of a general or cold-work permit (continued)

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<tr>
<th>FROM</th>
<th>TO</th>
<th>SIGNATURE (Operating authority)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOURS ON</td>
<td>HOURS ON</td>
<td></td>
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#### DISPLAY OF PERMIT

- THIS PERMIT SHALL BE CLEARLY DISPLAYED AT THE WORK SITE (WHITE COPY) WITH CONTRACTOR/EMPLOYEE PERFORMING THE WORK.
- Pink copy to be given by hand to the site manager and the yellow copy to be kept by the person issuing the permit.
- Upon completion of work and acceptance, the contractor/employee shall sign permit and hand it back to the site manager for close-out.

#### PERMIT ISSUE

Permits are to be issued by a site manager. They may be issued by the engineer, in which case they shall be countersigned by the site manager.

#### STANDARD CONDITIONS

1. **INDUCTION**
   - Has the performing authority and associated work force attended the terminal/depot induction briefing?  
   - **YES**  
   - **NO**

2. **SMOKING**
   - Smoking is PROHIBITED within the terminal/depot except in those locations specifically designated.
   - No matches or lighters shall be carried within the terminal/depot operations area.
   - Confirm the performing authority has been advised.

3. **CESSATION**
   - All work SHALL cease immediately whenever.
     - (i) requested by the terminal/depot manager,
     - (ii) sounding of the FIRE/EMERGENCY evacuation alarm,
     - (iii) discovery of any potentially hazardous circumstances, and
     - (iv) when flammable or toxic vapours enter the work area.

4. **INTERFERENCE**
   - Within the conditions of this permit, contractor personnel to whom this permit is issued SHALL not interfere with terminal/depot operations nor any plant or equipment which is not part of the work for which this permit is issued.
   - **YES**  
   - **NO**
5 **WIND** Has the performing authority arranged a regular frequency for checking and recording the wind direction during the work period? Confirm wind sock is in place.

6 **COLD-CUTTING** All cutting edges SHALL be continually wetted with lubricant or water. Provision in place?

7 **EXCAVATIONS** Machine exactions shall not be allowed in areas where there are underground services, e.g. pipework, electric cables, drains and sewers.
   - Hand excavation?
   - Machine excavations?
   
   The sides of excavations that are not self-supporting, shall be suitably shored or graded back. All excavations SHALL be obtained before entering an excavation more than 1.5 m deep.

8 **MOBILE WORK** THEY SHALL comply with following conditions
   - **MACHINES**
     - (i) a spark-arrestor on each exhaust system,
     - (ii) overspeed shutdown device on a ir inlet, and
     - (iii) a shroud over each spark plug (where applicable).
   
   Machines SHALL be refueled while running
   Machines SHALL NOT be left unattended while running.

9 **ELECTRICAL WORK** (If the answer to any of these questions is NO, please state reason briefly).
   - Electrical work shall only be carried out on a general/cold-work permit after the live Supply has been isolated.
   - Has an electrical isolation (lock-out) been made?

C.5 **Example of an electrical work permit**

As it is possible that work of an electrical nature in a most hazardous area will be carried out by Technicians other than registered electricians (i.e. meter technicians, computer technicians, electronic, etc.) electrical permits shall comply with following requirements:

a) Name of electrical contractor and ECB registration number, or the name of the company if work is only electrically related.

b) Name of accredited person (electrician) and his qualification, i.e. master installation electrician, or name and qualification of technician if work is only electrically related.

c) Accredited person’s registration number.

d) Name(s) of personnel working under the accredited person or approved technician.

e) Safety lock-out requirements. (This shall be attended to and signed by the responsible person issuing the permit).

f) Full details of the equipment to be worked on.

g) Detailed description of the nature of the work involved.

h) Details of all instrumentation and equipment intended for use in the hazardous locations. (This shall be acceptable explosion protected equipment).

i) A section shall be provided in which the responsible electrician or technician shall sign a statement that the work has been completed in accordance with all safety regulations, that the equipment has been closed according to all explosion protection requirements, and that the plant has rendered safe for re-use in a hazardous location. Where applicable, a certificate of electrical compliance shall accompany this statement.

**NOTE** An illegible signature is not acceptable. The person concerned shall sign where necessary, and shall also print his name in block letters.
Bibliography

AICE, Guidelines for chemical process quantitative risk analysis

AICE, Guidelines for hazard evaluation procedures

API Publication 2030, Application of fixed water spray systems for fire protection in the petroleum industry

NFPA 11, Low-expansion foam

NFPA 15, Water spray fixed systems for fire protection

UNEP IE/PAC Technical Report No. 12, Hazard identification and evaluation in a local community