Guide for Tank Farms Inspection and Certification

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GENERAL CONDITIONS

Definitions:

"*Administration*" means the Government of the State whose flag the Ship is entitled to fly or under whose authority the Ship is authorised to operate in the specific case.

"IACS" means the International Association of Classification Societies.

"*Interested Party*" means the party, other than the Society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the ship builder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.

"*Owner*" means the registered owner, the ship owner, the manager or any other party with the responsibility, legally or contractually, to keep the ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in Part A, Chapter 2 of the Rules for the Classification of Ships or in the corresponding rules indicated in the specific Rules.

"Rules" in these General Conditions means the documents below issued by the Society:

(i) Rules for the Classification of Ships or other special units;
(ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
(iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations;
(iv) Guides to carry out particular activities connected with Services;
(v) Any other technical document, as for example rule variations or interpretations.

"*Services*" means the activities described in Article 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.

"Ship" means ships, boats, craft and other special units, as for example offshore structures, floating units and underwater craft.

"*Society*" or *"TASNEEF"* means Tasneef and/or all the companies in the Tasneef Group which provide the Services.

"*Surveyor*" means technical staff acting on behalf of the Society in performing the Services.

Article 1

1.1. The purpose of the Society is, among others, the classification and certification of ships and the certification of their parts and components. In particular, the Society:
(i) sets forth and develops Rules;
(ii) publishes the Register of Ships;
(iii) issues certificates, statements and reports based on its survey activities.

1.2. The Society also takes part in the implementation of national and international rules and standards as delegated by various G overnments.

1.3. The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which are regulated by these general conditions, unless expressly excluded in the particular contract.

Article 2

2.1. The Rules developed by the Society reflect the level of its technical knowledge at the time they are published. Therefore, the Society, although committed also through its research and development services to continuous updating of the Rules, does not guarantee the Rules meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.

2.2. The Interested Party is required to know the Rules on the basis of which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatemen t. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification.
The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.

2.3. The Society exercises due care and skill:
(i) in the selection of its Surveyors
(ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.

2.4. Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of the Ship or of the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

Article 3

3.1. The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of th e specific scope of the Service requested by the Interested Party or on its behalf.

3.2. No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as p art of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorised bodies and for no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties on the basis of the statements or information given by the Society. The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, is governed by the Rules of the Society, which is the sole subject entitled to make such interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.

3.3. The classification of a Ship, or the issuance of a certificate or other document connected with classification or certificati on and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaw orthiness,

structural integrity, quality or fitness for a particular purpose or service of any Ship, structur e, material, equipment or machinery inspected or tested by the Society.

3.4. Any document issued by the Society in relation to its activities reflects the condition of the Ship or the subject of certifi cation or other activity at the time of the check.

3.5. The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as Governments, designers, ship builders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.

These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the ship Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, t he Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.

In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.

In consideration of the above, the Interested Party undertakes to relieve and hold harmless the Society from any third party claim, as well as from any liability in relation to the latter concerning the Services rendered.

Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties with respect to the services rendered by the Society are described in the Rules applicable to the specific Service rendered.

Article 4

4.1. Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

4.2. In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested. In the event of late payment, interest at the legal current rate increased by 1.5% may be demanded.

4.3. The contract for the classification of a Ship or for other Services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30 days' notice to be given in writing. Failure to pay, even in part, the fees due for Services carried out by the Society will entitle the Society to immediately terminate the contract and suspend the Services.

For every termination of the contract, the fees for the activities performed until the time of the termination shall be owed to the Society as well as the expenses incurred in view of activities already programmed; this is without prejudice to the right to compensation due to the Society as a consequence of the termination.

With particular reference to Ship classification and certification, unless decided otherwise by the Society, termination of the contract implies that the assignment of class to a Ship is withheld or, if already assigned, that it is suspended or withdrawn; any st atutory certificates issued by the Society will be withdrawn in those cases where provided for by agreements between the Society and the flag State.

Article 5

5.1. In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see art. 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

Therefore, except as provided for in paragraph 5.2 below, and also in the case of activities carried out by delegation of Governments, neither the Society nor any of its Surveyors will be liable for any loss, damage or expense of whatever nature sustained by any person, in tort or in contract, derived from carrying out the Services.

5.2. Notwithstanding the provisions in paragraph 5.1 above, should any user of the Society's Services prove that he has suffered a loss or damage due to any negligent act or omission of the Society, its Surveyors, servants or agents, then the Society will pay compensation to such person for his proved loss, up to, but not exceeding, five times the amount of the fees charged for the specific services, information or opinions from which the loss or damage derives or, if no fee has been charged, a maximum of AED5,000 (Arab Emirates Dirhams Five Thousand only). Where the fees charged are related to a number of Services, the amount of the fees will be apportioned for the purpose of the calculation of the maximum compensation, by reference to the estimated time involved in the performance of the Service from which the damage or loss derives. Any liability for indirect or consequential loss, damage or expense is specifically excluded. In any case, irrespective of the amount of the fees charged, the maximum damages payable by the Society will not be more than AED5,000,000 (Arab Emirates Dirhams Five Millions only). Payment of compensation under this paragraph will not entail any admission of responsibility and/or liability by the Society and will be made without prejudice to the disclaimer clause contained in paragraph 5.1 above.

5.3. Any claim for loss or damage of whatever nature by virtue of the provisions set forth herein shall be made to the Society in writing, within the shorter of the following periods: (i) THREE (3) MONTHS from the date on which the Services were performed, or (ii) THREE (3) MONTHS from the date on which the damage was discovered. Failure to comply with the above deadline will constitute an absolute bar to the pursuit of such a claim against the Society.

Article 6

6.1. These General Conditions shall be governed by and construed in accordance with United Arab Emirates (UAE) law, and any dispute arising from or in connection with the Rules or with the Services of the Society, including any issues concerning responsibility, liability or limitations of liability of the Society, shall be determined in accordance with UAE law. The courts of the Dubai International Financial Centre (DIFC) shall have exclusive jurisdiction in relation to any claim or dispute which may arise out of or in connection with the Rules or with the Services of the Society.

6.2. However,

(i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and

(ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the

right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.

In the case of actions taken against the Society by a third party before a public Court, the Society shall also have the right to summon the Interested Party or the subject who requested the Service before that Court, in order to be relieved and held harmless according to art. 3.5 above.

Article 7

7.1. All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorisation of the Interested Party, except as provided for or required by any applicable international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of class, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.

Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

7.2. Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 above, the Society's clients hereby accept that the Society may participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific property of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning System. The Society will provide its clients with written details of such information sent to the involved Classification Societies.

7.3. In the event of transfer of class, addition of a second class or withdrawal from a double/dual class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificates, documents and information relevant to the classed unit, including its history file, as the other Classification Society may require for the purpose of classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty to ensure that, whenever required, the consent of the builder is obtained with regard to the provision of plans and drawings to the new Society, either by way of appropriate stipulation in the building contract or by other agreement.

In the event that the ownership of the ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which has come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

Article 8

8.1. Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

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1 INTRODUCTION

Storage tank farms are essential industrial facilities to accumulate oil, petrochemicals and gaseous products. Since tank farms contain huge mass of fuel and hazardous materials, they are always targets of serious accidents such as fire, explosion, spill and toxic release which may cause severe impacts on human health, environmental and properties.

Although having a safe layout is not able to prevent initiating accidents, however it effectively controls and reduces the adverse impact of such accidents.

Manufacture, handling and the use of dangerous substances and management of the pressurized systems have the potential to present major hazards not only to the workers but also to the members of the public nearby, assets and the environment.

Process safety considers how these major hazards can be assessed and controlled. Effective process safety management should reduce accidents and minimize adverse effects of accidents on human's health, environment and properties.

A storage tank farm (sometimes called an oil depot, installation or oil terminal) is an industrial facility for the storage of oil and/or petrochemical products where these products are transported to the end users or further storage facilities. A tank farm typically includes tanks, either above ground or underground, and gantries for discharging products into the road tankers or other vehicles (such as barges) or pipelines.

Tank farms are usually situated close to the oil refineries or in locations where marine tankers containing products can discharge their cargo. Some depots are attached to the pipelines from which they draw their supplies.

Tank farms play an important role in the logistics of products: they can help reduce the impact of demand spikes, and are increasingly becoming an important energy trading tool.

Tank farm contains a large quantity of fuel and hazardous chemicals; the hazards presented by storage tank farms depend on the material and on the type of storage. In a broad term, some principal hazardous events and the causes of hazards are given in Tables 1 and 2.

The major hazards in the storage tanks are fire, explosion, spill and toxic release. Among them, fire is the most common but explosion is particularly significant in terms of fatalities and loss.

The hazards presented in the storage tank farms can be minimize by having a safe and optimal layout.

Table 1: Hazardous events

	State	Storage	Hazardous events
Materials	Liquid	Atmospheric	1- Liquid release
			2- Tank or burn fire
			3- Tank explosion
	Liquefied gas	Pressure	1- Flashing liquid release
			2- Flammable vapor cloud
			3- Pool fire
			4- Running liquid fire
			5- Jet fire
			6- Vapor cloud fire
			7- Vapor cloud explosion
			8- BLEVE (Boiling Liquid Expanding Vapour Explosion)
Flammable	Liquefied gas	Refrigerated	1- Flashing Liquid release
			2- Flammable vapor cloud
			3- Tank or bund pool fire
			4- Running liquid fire
			5- Vapor cloud fire
			6- Vapor cloud explosion
			7- Running fire
	Liquid	Atmospheric	1- Liquid release
			2- Toxic gas cloud
			3- Tank explosion
Toxic	Liquefied gas	Pressure	1- Flashing Liquid release
			2- Flammable vapor cloud
			3- Liquid pool
			4- Toxic gas cloud
			5- BLEVE
	Liquefied gas	Refrigerated	1- Flashing Liquid release
			2- Flammable vapor cloud
			3- Liquid pool
			4- Toxic gas cloud

Table 2: Initiating events

Catastrophic failure of vessel or tank
Failure of or leak from other equipment, pipe work or fitting
Explosion in vessel or tank
Fire engulfing vessel or tank
Jet flame playing on vessel or tank
Overfilling of vessel or tank
Release occasioned by operations
Release occasioned by maintenance

2 SCOPE OF WORK

The purpose of this document is to provide a guideline for technicians involved in the process of certification of tanks and tank farms, in design phase as well as in operation and in life extension case.
The guideline can be used also by operators that perform inspection, giving a detailed checklist for both out of service and in service inspections.

3 STATUTORY, SAFETY AND STANDARD REQUIREMENTS

- API ST 2610 l.e. Design, Construction, Operation, Maintenance and Inspection of Terminal and Tank Facilities.
- API ST 653 l.e. Tank Inspection, Repair, Alteration and Reconstruction.
- API ST 650 l.e. Welded Steel Tanks for Oil Storage.
- API Health and Environmental Affair Department. Publication n°340.
- API Publication 315 Assessment of Tank field Dike lining Material and Mathod.
- EEMUA (The Engineering Equipment and Material User Association) User's guide to the Inspection, Maintenance and Repair of Aboveground Vertical Cylindrical Steel Storage Tanks.
- National Fire Protection Act (NFPA 11-13-14-15-16-20-30).
- Apart from this, local rules and regulations pertaining to State and local industrial requirement should be taken into consideration.

4 DEFINITIONS

- **Aboveground storage tank (AST):** atmospheric vertical or horizontal, cylindrical, closed top, open top, or covered open top steel or fiberglass aboveground storage containers of various size and capacity over 1320 gallons and whose entire bottom is supported uniformly on the ground, completely on saddles, or other supports, ASTs may be either shop fabricated or field erected.
- **Bern (bund):** the area around the tank, inside the dike, normally used to contain spills and to provide access to the tank and surrounding equipment.
- **Liquid combustible** a liquid having a flash point at or above 100°F (37.8°C). See NFPA 30 for discussion of combustible classification.
- **Corrosion rate:** The total metal loss divided by the period of time over which the metal loss occurred.
- **Change in service:** A change from previous operating conditions involving different properties of the stored product such as specific gravity or corrosivity and/or different service conditions of temperature and/or pressure.
- **External inspection:** A formal visual inspection, as supervised by an authorized inspector, to assess all aspects of the tank as possible without suspending operations or requiring tank shutdown.
- **External floating-roof tank**: an aboveground tank with a floating roof, which has not fixed roof and has an open top.
- **Facility:** any building, structure, installation, equipment, pipeline, or other physical feature used in petroleum refining, storage, transportation, and distribution.
- **Fixed-roof tank:** an aboveground tank with no internal floating roof (IFR) that is covered by either a steel roof or aluminum dome.
- **Fitness for service assessment:** A methodology whereby flaws contained within a structure are assessed in order to determine the adequacy of the flawed structure for continued service without imminent failure.
- **Flammable liquid**: a liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 psi (abs.) equal to 2069 mmHg at 100°F (37.8°C). See NFPA 30 for discussion of combustible classification.
- **Hydro test:** A test performed with water in which static fluid head is used to produce test loads
- **Installation:** tanks, pumps, compressor, accessories, controls, piping and all other associated equipment required for the receipt, transfer, storage, blending, packaging and shipmen of petroleum products.
- **Internal floating-roof tank**: an aboveground tank with a fixed roof, whit a floating roof inside the tank.

- **Internal inspection**: A formal, complete inspection, as supervised by an authorized inspector of all accessible internal tank surfaces.
- **May:** the use of the word may indicate provisions that are optional and are the discretion of the designer or operator.
- **Must:** the use of word must indicated important legal or safety considerations and is mandatory.
- **Petroleum:** any crude oil, petroleum liquid or gaseous complex combination of hydrocarbon and related derivatives.
- **Petroleum contact wastewater:** water-containing product such as condensate from underground and aboveground petroleum storage tanks.
- **Process tank**: an aboveground or underground tank that forms a part of a refining process through which there is a steady, variable, recurring or intermittent flow of materials during the operation of the process.
- **Release prevention barrier (RPB):** the second line bottom of double steel bottom tanks, synthetic materials, clay liners and other barriers (AS for Appendix I of API STD 650).
- **Reconstruction:** Any work necessary to reassemble a tank that has been dismantled and relocated to a new site.
- **Repair:** Any work necessary to maintain or restore a tank to a condition suitable for safe operation. Typical examples of repairs include:
  a) Removal and replacement of material (such as roof, shell, or bottom material, including weld metal) to maintain tank integrity.
  b) Re-leveling and/or jacking of a tank shell, bottom, or roof.
  c) Addition of reinforcing plates to existing shell penetrations.
  d) Repair of flaws, such as tears or gouges, by grinding and or gouging followed by welding.
- **Shall:** the use of word shall indicate provision that is mandatory to meet the requirements.
- **Should:** the use of word shall indicate provision that are recommended but non mandatory.
- **SPCC:** Spill Prevention, Control and Counter measure.
- **Underground tank:** a buried container used to store petroleum, additives or other products for later use.

5 DESIGN

Tanks should be designed to a relevant standard, such as above mentioned.
In some instances single skin bottom tanks are a better option than double-bottomed tanks as these provide the optimum conditions for ensuring integrity of the tank floor by the inspection of tank floor plates. Disadvantages of double-bottom designs include settlement, product entrapment and modification to nozzle compensating plates.
Where double-bottomed tanks are provided, additional inspection measures should be provided in accordance with a relevant standard such as above mentioned. Leak detection should also be provided on double-bottomed tanks.
The following aspects shall be considered during development of equipment layout:

- Process Requirement: i.e. proper interconnection between equipment as per P&IDs to achieve the intended process parameters.
- Economy of piping material: minimize the quantity of costly piping.
- Erection & Construction requirement: erection scheme and schedule of all equipment must be considered during equipment layout to have smooth erection mainly in case of tall columns, heavy equipment like thick walled reactors, space for laying tall column, approach road for cranes / derrick for lifting the column or reactors and requirement of special foundation / pile etc.

Type of atmospheric storage tanks

- Atmospheric Tanks
- Low-pressure Tanks
- Pressurized Tanks
- Underground Tanks
- Double-walled Tanks

Different categories of tanks may be employed for used oil management. These are listed and briefly described below. In addition, prominent examples of the “applicable industry standard” for each category of tank are identified. The standards listed are often referred to as “consensus design standards” because they have received wide acceptance by regulating agencies and industries.

- **Atmospheric tanks:** are tanks designed to operate at pressures from atmospheric pressure through 0.5 to 1.0 psig (pounds per square inch gauge); Atmospheric tanks must not be used for management of a flammable or combustible liquid at a temperature above its boiling point.
- **Low-pressure tanks:** are designed to operate at pressures above 0.5 psig, but not more than 15 psig.
- **Pressurized tanks:** can be designed for pressures greater than 15 psig.
- **Underground tanks:** are tank installed underground.
- **Double walled tanks**: provide their own secondary containment when the outer shell completely contains any releases from the inner tank. They can be used as above or underground tanks.

Secondary Containment: as with leak prevention and detection concepts, secondary containment has

been adopted as an environmental protection measure, as well as a fire safety measure; the purpose of secondary containment is than to prevent migration of petroleum products from AST to the surrounding soil, ground water, or surface water in case of spill at an AST facility. In other words, the secondary containment must be sufficiently impervious to prevent migration of spilled products onto the land or into the water. Tank systems and containers must have secondary containment including dikes, berms, or retaining walls, and a floor. These barriers must be sufficiently impervious to petroleum products to prevent any product released into the containment system from migrating out of the system to the soil, ground water, or surface water. The required capacity of secondary containment depends on the type of product stored in the AST and in some cases, more restrictive requirements than those proposed below may be required by local regulations (for the technical indications the most widely recognized standard on secondary containment is in NFPA 30). Attention should be paid to the fact that the discussion of secondary containment cannot discern considerations regarding the facility drainage plan, which includes storm water drainage. (e.g. the capacity for secondary containment of dangerous wastes must be sufficient to contain the contents of the largest tank plus storm water from a 24-hour, 25 year storm event).

Construction materials and permeability requirements for Secondary Containment: secondary containment can be as simple as mounding up earth in the area to form earthen dikes, or as complex as constructing a steel-reinforced, liquid-tight concrete slab and coating it with an epoxy finish. In most cases, the simpler earthen-dike system is satisfactory. But there are several factors that should be considered in evaluating what kind of system is adequate for new or existing facilities. Some of the important factors are as follows:

- Regulatory requirements;
- Required minimum containment volume;
- Permeability of the containment system and liner (if used);
- Substance(s) being stored and the properties that affect release containment;
- Site conditions, environmental sensitivity, leak detection and monitoring systems;
- Release cleanup (sometimes the use of liners actually impairs the ability to clean up and remove a spill and contaminated soil).

Hydraulic Conductivity Requirements for Secondary Containment: containment area shall be designed to be liquid-tight, regarding this aspect the required hydraulic conductivity shall be between 10^{-6} and 10^{-7} cm/sec to consider material " sufficiently impervious".

Construction Materials for Secondary Containment: the toxicity, mobility and persistence of the liquids stored at a facility play a major role in evaluating the need for, and appropriate type of, a secondary containment liner. Many different types of materials have been used for secondary containment areas, below the most common ones are listed:

- Native soil;
- Bentonite and soil-bentonite admixtures;
- Asphalt;
- Concrete;
- Synthetic flexible membranes;
- Spray-on applications.

Sump Design and Maintenance: sump design and maintenance is critical for reliable secondary containment because potentially contaminated storm water and releases accumulate there. Also, sumps are often under a hydraulic head which can force liquids through any imperfections. The ideal situation is a blind sump free of cracks and gaps and covered with a high quality, low permeability concrete coating. If there are joints (i.e., potential gaps) in the sump, ideally they would include a water stop. If there are joints without water stops, they must be carefully sealed as described above. Any cracks must also be sealed. The sump, free of cracks and gaps, should be coated to further restrict leakage of fluids. It is more important to coat the sump than other parts of the secondary containment. As indicated above, this is because sumps contain fluids under a hydraulic head more often than other areas of a secondary containment (especially for outdoor systems).
Subsurface Piping: sumps connected to subsurface piping are not as reliable as blind sumps for ensuring an adequate secondary containment system. Some facilities may have subsurface piping connecting sumps to oil/water separators or some other treatment device. Subsurface piping is discouraged if there are viable alternatives.

Selection of atmospheric storage tanks

The layout and general design of a storage facility should be based upon considerations of safety, operational efficiency and environmental protection. A primary consideration is ensuring that the design of the storage tanks themselves is suitable for the classification of the hydrocarbon being stored.
The Table 3 summarizes the design of tank suitable for each class of hydrocarbon.

Layout and spacing

Ideally, tank layout should be optimized to ensure that there is sufficient access to tanks for firefighting and to minimize the risk of escalation in the event of a tank fire.
Minimum spacing for tanks is specified in the Table 4 below.

Table 3: Design of tank suitable for each class of hydrocarbon

CRUDE OIL DERIVATIVE CLASS	DEFINITION	RECOMMENDED STORAGE TANK DESIGN	
		Floating Roof	Fixed Roof
Class 0	Liquefied petroleum gases (LPG) **(1)**	not	yes
Class I	Liquids which have flash points below 21°C	not	yes
Class II (1)	Liquids which have flash points from 21°C up to and including 55°C, handled below flash point	not	not
Class II (2)	Liquids which have flash points from 21°C up to and including 55°C, handled at or above flash point	not	yes
Class III (1)	Liquids which have flash points above 55°C up to and including 100°C, handled below flash point	yes	not
Class III (2)	Liquid which have flash points above 55°C up to and including 100°C, handled at or above flash point	yes	not
Unclassified	Liquids which have flash points above 100°C	yes	not
(1): in a refinery or gas plant, LPG must be stored in pressure vessel; these containers are either cylindrical and horizontal or spherical.			

Table 4: Minimum spacing for tanks

FACTOR	MINIMUM SEPERATION FROM ANY PART OF THE TANK
Between adjacent fixed-roof tanks	Equal to the smaller of the following: (a) the diameter of the smaller tank; (b) half the diameter of the larger tank; (c) not less than 10 m.
Between adjacent floating-roof tanks	10 m for tanks up to and including 45 m diameter; 15 m for tanks over 45 m diameter. (The spacing is determined by the size of the larger tank).
Between a floating-roof tank and a fixed-roof tank	Equal to the smaller of the following: (a) the diameter of the smaller tank; (b) half the diameter of the larger tank; (c) not less than 10 m.
Between a group of small tanks and any tank outside the group	15 m
Between a tank and the site boundary, any designated non-hazardous area, process area or any fixed source of ignition	15 m

6 FABRICATION

The tanks can be designed in accordance with common industry standard like API Std 650 (Chapter 3, 4 and 5) or similar rules.

7 MAINTENANCE AND INSPECTION

Spill Prevention

There are many reasons for preventing oil from spilling or leaking onto the ground and into the waters of the state. Some basic reasons for preventing oil spills are:

- Reduces potential for health problems
- Reduces risks to the environment
- Saves money from lost product, fines and clean-up costs
- Saves reputations.

Every drop of oil spilled has an impact on the environment and costs money.

Causes of Oil Spills

Spills and leaks happen at Aboveground Storage Tank (AST) facilities for several reasons.

Some causes are:

Operator error

- Tanks overfilled
- Valves left open
- Poor transfer procedures
- Lack of product monitoring
- Potential problems not recognized
- Poor maintenance practices

Poorly designed or improperly installed facilities

- Inadequate security – vehicular traffic, children or vandals restricted area
- Facility located in flood zone or avalanche zone or any other area where natural disasters are likely to happen
- Falling snow and ice from tanks onto piping

Table 5: Oil loss by drips and drops

RATE	GAL./YEAR	CONTAMINATED SOIL (tons)	CONTAMINATED SOIL (Cubic yards)
1 drop/10 second	40	150 tons	270 yd^3
1 drop/5 seconds	80	300 tons	540 yd^3
1 drop/second	410	1,500 tons	2,700 yd^3
3 drops/second	1,200	4,500 tons	8,100 yd^3
Stream - breaks into drips	8,600	32,000 tons	57,600 yd^3
Note: 1 drop = 11/64 inch diameter - 1.8 tons per cubic yard			

Storage Tank Problems

- Tank design and construction
- Inadequate foundation or tanks setting directly on the ground
- Tank bottom and seams rusted, shell pitted, weeping or leaking
- Improper venting

Facility Piping Problems

- Piping installed without considering traffic area
- Threaded joints rather than welded
- Inadequate pipe support – sagging pipe is prone to cracking (threaded joints are particularly vulnerable)
- Valves not in good working order or corroded
- Pipe lying directly on ground – easily damaged
- Piping leaking or rusted from acidic soil
- No flex piping
- Pipes not hydrostatically tested annually

Secondary Containment Problems

- No dikes or secondary containment around tank farm
- Inadequate secondary containment – should be able to hold contents of largest tank plus 10% for local precipitation
- Containment unable to hold spilled product
- Holes or low areas in dikes
- Water pooled in secondary containment area
- Holes and rips in liners

Spill Prevention Measures and Tank Farms Maintenance

Routine inspections and maintenance are the two most important factors in preventing oil spills and leaks at AST facilities.

General Tank farms maintenance should include the following:

Good housekeeping: it is essential that the entire Tank farms be kept clean and free of unnecessary items. Tank farms are designed to store petroleum products so only items that are directly related to the operation of the facility should be stored there.

Safety: fire extinguishers must be kept pressurize and should be shaken every month. All other safety equipment must be in good working order.

Security: any holes in fence, locks on gates and burned out light bulbs should be repaired or replaced as soon as the deficiency is noted.

Aboveground Storage Tanks: Keep ASTs in sound condition.

- Follow manufacturer instructions or industry standards for maintaining vents, overfill devices, gauges, corrosion protection, water drains and other items associated with tanks.
- Keep tanks painted in a light color to minimize fuel expansion and to reduce corrosion and tank disintegration.
- Repair tanks as soon as problems are noted.
- Make sure signs on tanks are visible and legible.

Tank farms piping: Piping must be maintained in sound condition.

- Follow manufacturer instructions or industry standards for maintaining valves and corrosion protection devices.
- Change filters on a regular basis using set procedures.
- Hydrostatically test transfer piping yearly. Use water and hold it at 1,5 times the normal operating pressure. If using water is not feasible, approval from the U.S. Coast Guard to use product or air is required.
- Rewrap or repaint pipes when coating, wrapping or paint is wearing through or chipping.
- Repair or replace valves and/or pipes as soon as possible after problems are noted.
- Replace threaded pipe with welded pipe whenever possible.
- Protect piping from traffic as much as possible.

Secondary Containment: Keep the secondary containment area clear of debris, unnecessary items, snow, ice and standing water.

- Remove snow, taking care not to tear the liner. If shoveling the entire area isn't feasible, keep area around piping clean.
- Remove water, if sheen is visible, put water through a fuel-water separator, not directly into the environment.
- Remove vegetation, keep weeds, willows and trees out of secondary containment area.
- If tears in liner are noticed, repair them as soon as possible.

Spill Preparedness and Response: Keep response equipment accessible and in good working condition. The severity of spills can be minimized if operators are properly trained in spill response, including proper use of response equipment and materials.

- If emergency pumps and/or skimmers are kept at the site, start them up at least once a month.
- Describe the actions to take in the event of a spill.
- Deployment strategies for spill response materials and equipment.
- Discuss protection of critical and sensitive areas.
- Describe recovery of spilled product.
- Describe proper management of recovered product and contaminated soil.

(See relevant Checklist Form also for information because the form may be revised to meet the need of individual AST facilities).

Record Keeping - Records of all activities pertaining to the facility should be kept on location; these include but are not limited to:

- Copies of Inspections
- Operator inspections
- Government Inspections
- Maintenance Records
- Any major work done at the facility
- Hydrostatic test results
- As-built facility plans
- Operator training reports
- Reports of Oil Spills at the Tank Farms
- Where the spill occurred
- When the spill occurred
- Amount spilled
- Clean up procedures used
- Fuel Inventory Records
- Government required documents.

8 TANKS FARMS INSPECTIONS

The purpose of the formal inspection is to determine the tank's suitability for continued service, which is intended to meet the above mentioned standard integrity testing requirement. The formal tank inspection, which must be performed by a certified inspector, is intended to determine if the tank is fit for continued use or if it needs to be removed from service. There are three types of formal inspections:

1. **External inspection:** a documented inspection that is conducted by a certified inspector to assess the condition of the AST and determine its suitability for continued service without entry into the AST interior.
2. **Internal inspection:** a documented inspection that is conducted by a certified inspector to assess the internal **and** external condition of the AST and determine its suitability for continued service. A formal internal inspection satisfies the requirements of a formal external inspection and shall be considered equivalent to, or better than, a formal external inspection for the purposes of scheduling.
3. **Leak test:** a "point in time" test to determine if an the tank is liquid tight. It may be used as a tank integrity measure or as a supplement to other inspection procedures.

Inspections should be conducted on a regular basis in a standardized fashion. At manned facilities, informal inspections should be done on a daily basis (noting overall facility condition) when the operator walks through to open and close the facility. A more formal and thorough inspection should be completed monthly.

Inspectors: Must be knowledgeable of Tank Farm components, operations, spill prevention, preparedness and response and government requirements.

How to Conduct Inspections: When conducting the more formal and thorough inspection, the inspector should use the following protocol:

- Use a checklist to make sure all important areas are covered (see a Tank Farms Inspection Form). This form may be revised to meet the needs of individual Tank Farms.
- Complete the inspection form, writing down findings and conditions and be sure to initial, date and sign the form where indicated.
- Follow up on findings.
- Fix deficiencies.
- Report significant problems to management.

The inspection: Following is a detailed description of what to look for in routine, monthly Tank Farms inspections:

Housekeeping: Is the Tank Farms clean and clear of unnecessary items? It is important to keep facilities clean and free of unnecessary items because clutter would hinder clean-up in the event of a leak or spill; large items such as drums, lumber and other objects can break pipes, dent tanks and provide homes for unwanted animals. Poor housekeeping is a sign of negligence and shows a lack of concern for the facility.

Safety: Is all safety equipment in place and all safety precautions followed? Safety at AST facilities is of utmost importance and can save lives, prevent injury and protect property and the environment.

Fire extinguishers: There should be an adequate number of fire extinguishers in logical, appropriate locations. Fire extinguishers must be the proper type for the product stored. Extinguishers should be maintained in top notch condition, meaning they should be pressure charged and workable. It is a good idea to shake the extinguishers when conducting the monthly inspection. Prominent signs showing location of fire extinguishers should be posted.

No Smoking Signs: "No Smoking Permitted" signs should be posted in strategic locations at facilities.

Danger and Warning Signs: Individuals entering tank farms should be warned of potential dangers. Signs advertising this should be posted in visible locations.

Storage Tanks: Aboveground storage tanks are the most important component of Tank Farms. They should be maintained in good condition. This applies to all tanks, including "day tanks" as well as major storage tanks.

Soundness: Are there any visible leaks or drips from the tanks? Are there stains on the ground around the tank base? Check seams and welds and around bottom and shell seams. All leaks must be stopped and repairs made.

Corrosion Protection*:* Are there any signs of rust? Again, look around tank welds, shell seams, and bottom to side seams. If using sacrificial metals, make sure there is sufficient metal left. If using impressed current, make sure the proper amount of electricity is flowing.

Tank Signs: Each tank should be labeled with the name or product stored (diesel or gasoline, etc.) and storage capacity. Also whether it is a flammable or combustible product.

Vents*:* Check to make sure vents are clear and that there is no debris or snow plugging them.

Paint: Paint protects the tank from exposure to the elements and reduces corrosion. Check for peeling, blistering or chipping.

Foundation: Is the foundation in good condition? If beams are used, are they cracked or rotten? If other materials are used to support the tanks, check for corrosion where the tank meets its foundation.

Gauges and overfill devices: Check to make sure gauges are working and test overfill alarms and shut-off devices.

Piping and Hoses: Many leaks in tank farms come from piping; therefore it is important to maintain piping in good working condition.

Soundness: Are there any drips, leaks or visible stains around the pipes or hoses? Look around valves, filters and connections.

Corrosion Protection: Are there signs of rust on the piping? Look around valves, connections and fittings. If using sacrificial metals make sure there is sufficient metal and if using impressed current, make sure the proper amount of current is flowing.

Support: Are pipe supports adequate and in good condition? Check for sagging and cracking pipes due to insufficient support and rusting or rotting pipe supports.

Nozzles: Are there any signs of rust or leaks from the nozzles?

Can they be turned on and off to completely stop product flow?

Valves*:* Are there any signs of leaks from the valves? Can the valves be turned on an off completely to stop product flow? Are the valves protected from tampering, locked and secure?

Protection: Are pipes protected from falling ice and snow, vehicles and foot traffic?

Coating, wrapping and paint*:* If the pipes are coated, wrapped or painted, check for wear and tear and chipping.

Secondary Containment: The purpose of secondary containment is to hold any product should

there be a spill. It is important that this area be of sufficient size and have the ability to hold spilled oil.

Size: Is the secondary containment area large enough to hold the capacity of the largest tank plus 10% for local precipitation?

Clear of water, snow, ice and vegetation: Is the secondary containment clear of standing water, snow and ice? If water or ice is in the containment area, there could be run-over if a tank failed. Snow could hide leaked or spilled product and vegetation could hamper clean-up.

Liner Soundness: Is the secondary containment area lined with a synthetic liner? Is the liner in good condition or are there any rips, tears or nonessential holes in it? If the liner is not sound, it will not hold spilled product. (Note: If the liner is holding rainwater, it is probably is in good condition and needs to be drained).

Spill Prevention and Response: It is important to be prepared should a spill occur. Quick response can reduce the amount of oil spilled, thus reducing health and environmental damage and saving money (see Spill Response Checklist Form). This form may be revised to meet the needs of individual AST facilities.

Response Plan: Does the facility have a response plan and is it located at the facility?

Each facility must have plans to deal with emergencies and all the facility operators and workers should be familiar with them.

Response Equipment: Is response equipment located at the site and is it in good working order? Do operators know how to use it? A minimum amount of oil spill response equipment should be located in specified areas of the facility and operators should know where it is and how to use it.

Government Requirements: Various state and federal agencies have requirements pertaining to AST facilities. Owners and operators should be familiar with regulations that apply to their facilities.

Other: During the inspection, list any other abnormalities or deficiencies noticed. Save inspection reports and correct problems as soon as possible.

Internal Tank Inspections: Aside from the routine facility inspections, it is a good practice to inspect the inside of ASTs on a regular basis. The American Petroleum Institute has a standard (API 653) which is designed for certified inspectors to follow for comprehensive AST inspections. Facility operators are not expected to conduct such rigorous inspections. However, with training and certification for **"Entering Confined Spaces"**, operators can conduct cursory internal inspections. For these inspections, tanks should be emptied and cleaned and the inside examined for holes and corrosion. For practical purposes these inspections should be conducted every ten years unless there is evidence of leaks or other reasons why the operator believes an internal inspection is necessary. Only trained and experienced persons should conduct internal inspections. Under no circumstances should anyone else enter the tanks.

Safety: AST facilities have several potential hazards. Operators should know what safety measures to take to prevent accidents and injuries from these hazards. Examples of hazards and safety measures follow:

Fire and Explosions – petroleum products are flammable and some are explosive.

Fire protection:

- Design and build facilities with safety in mind and in compliance with applicable fire and building codes.
- Make sure fire extinguishers are the proper type and located in strategic places. Keep them in good working order and pressurized. Operators must be trained with their proper use.
- No Smoking at AST facilities. Post signs stating this rule.
- No open flames at AST facilities.
- Do not store nonessential items and material such as empty gas cans, jerry jugs, rags and other items that are can start or spread fires at the facility.
- Material Safety Data Sheets (MSDS) for each product stored at the facility should be kept at the site.

General Tank Farms Safety:

- Clearly spell out operating and safety procedures.
- Maintain open communication within facility and with local emergency services.
- Maintain safety equipment in good working order.
- Tank overfills protection and warning devices.
- Emergency shut off switches.
- Shut off valves.
- Label each tank with contents and storage capacity.
- Do not permit unauthorized people in facility.

Personal Safety

- Wear safety-toed boots.

- Wear eye protection when appropriate
- Wear gloves when working in cold temperatures.
- Keep walkways and stairs free of ice and debris to avoid trips and falls.
- Do not enter storage tanks unless you have had proper training.

Fire Fighting Systems

Protection systems and fixed firefighting installations should be provided and comprise fixed/semi-fixed foam systems and cooling water sprays. Additionally, access to the tanks for mobile firefighting appliances, equipment and materials should be provided giving multiple points of attack with no dead-ends. In many cases it is safer and more practical to allow a tank fire to burn itself out; for instance, when there is no chance of escalation to other tanks, little environmental exposure or where the risks of fighting the tank fire are greater than not fighting it. Two notable exceptions are:

- Rim seal fires – these will take a long time to burn out
- Crude tank fires – these are susceptible to boil overs due to the presence of water

Broad principles of water and foam application have to be in accordance with NFPA 11 Standard for Low, Medium, and High-Expansion Foam can be used as a reference or similar.

As for process plant, dedicated fire-preplans should also be compiled for storage installations. These should specify type of attack, firewater and foam application rates, location of hydrants, semi-fixed installations and mobile apparatus, firewater containment and worst case scenarios. It is not within the remit of this position paper to detail emergency plans, but API 2021, Management of Atmospheric Storage Tank Fires, provides some guidance in this matter. Emergency response personnel should receive training on the fire preplans, and regular exercises should be conducted to assess the suitability of the preplan.

Water systems

Provision should be made for the application of cooling water to fixed roof tanks containing products adjacent to those containing Class I or II (petroleum) or wherever there is less than 1 x diameter of the largest tank between adjacent tanks. In particular, there should be cooling wherever there is less than 15 meters access between tanks.

As for NFPA 13 or equivalent

Water application should be provided by either fixed or semi-fixed systems. It is unlikely that mobile tenders would have sufficient capacity for water storage to mount a prolonged cooling water attack on a storage tank.

Water should not be applied to the roof area of floating roof tanks as this may result in the destabilization and sinking of the roof.

Foam firefighting systems

Whilst being a good cooling medium for tanks, water is not a suitable fire extinguishing medium for hydrocarbon fires. Therefore, foam is used for such applications. The design of foam fire-fighting systems, be they fixed or mobile, should be suitable for the types of fires they would be required to extinguish (or suitable for the cooling of adjacent equipment/tanks). Therefore each facility needs to have its own tailored firefighting system. Important issues to consider when designing and installing a fire fighting system include:

- Foam and the foam injection/proportioning systems must be compatible (also important if the supplier of foam is changed).
- Hydraulic design of foam systems must be specified.
- Foam selection must be appropriate for the type of fire likely e.g. AFFF, (Aqueous Film Forming Foam), should not be selected for polar solvents.
- Correct proportioning of foam that may otherwise result in foam that does not flow (too little water) or that quickly goes back to solution (too much water).
- Provision of facilities to aid the maintenance or testing of firefighting systems.
- Location of equipment, e.g. monitors not too far from tanks for foam application to tank surface.

Once a system has been designed and installed, it is critical that it is tested. Whilst this may be expensive, it is critical to ensure that the system actually completes the job it is intended to do. Ideally, systems should be tested at the manufacturers as it is then cheaper, quicker and easier to rectify any mistakes.

Floating roof tank fires

Rim seal fires are the most common type of fire on floating roof tanks. There is little chance of these escalating to other tanks or turning to full surface tank fires if the design, maintenance and layout of the tanks are suitable. This should not be considered a rule, however, as a poorly maintained tank could lose its integrity or be vulnerable to subsequent explosions, perhaps as a result of vapour ingress into one of the pontoons.

Rim seal protection should only be used on certain types of roofs (i.e. double deck, steel pontoon, etc.). Pan roofs for example, should have full surface protection.

The application of foam from a remote monitor (i.e. one outside the bund) would not represent best practice as it can create roof instability and potentially

escalate the incident. Additionally, remote monitors are wasteful of foam and cannot direct the jet so accurately as the objective is to apply foam to the rim seal as quickly and gently as possible (irrespective of the roof level) and to retain a complete foam seal for as long as possible.

The most common and (arguably) most effective method to control a rim seal fire is the application of foam via fixed rim seal pourers on the top of the shell wall. Even with simple, fixed purpose-built systems, such as rim seal pourers, there is the danger that basic errors can be made so that the system does not operate as intended. Such examples that should be avoided are:

- Top of foam dam below the top of the rim seal – this is especially an issue where secondary rim seals have been added to the tank to reduce tank emissions. The top of the foam dam should be at least 50 mm above the top of the rim seal, but ideally about 150 mm.
- Too many or too large gaps at the bottom of the foam dam. The purpose of the dam is to hold the foam in position around the circumference of the tank to reduce the amount of foam needed. This ensures efficient application to the rim seal and prevents unnecessary loads being placed on the tank roof. With large gaps at the bottom of the dam, a significant quantity of foam could leak to the roof. However, small, intermittently spaced drains should be provided to allow rainwater to drain away.
- Incorrect spacing of the foam pourers. Modern foams can flow in excess of 30 meters if proportioned correctly, although if there are changes to the foam type, foam proportion or even water supply, then the flow characteristics could be affected so that a foam seal is not possible.
- Forced/irregular addition of foam. The intention is to apply foam gently down the side of the tank shell so that it forms an even blanket within the rim seal area. If the pourer has been incorrectly positioned it may not apply the foam in such a way, e.g. catching on the top edge of the seal, resulting in splashing and loss of foam to the roof.
- Foam pourers located too high on the tank, exposing them to wind and impairing their passage to the rim seal itself.

To overcome these issues, tests should be conducted on the system to ensure it operates correctly. Depending upon the number of tanks being protected, annual testing frequency would be appropriate.

Inspections should be conducted regularly to ensure air inlets to foam generators are clear and that foam pourers are not blocked by, for example, birds' nests. Other good features to aid inspection or firefighting in the event of a system failure are:

- Walkway around the top of the floating roof tank – this can be the wind girder with a handrail around the circumference. This allows for the pourers to be accessed for maintenance or for fire fighters to access the roof with manual hoses.
- Provide a foam hydrant at the top of the tank (preferably at the top of the stairs) for fire fighters in the event of rim seal pourers becoming blocked. This also requires less equipment to be carried up the tank in the event of a rim seal fire. Careful consideration needs to be given as to the safety of personnel when attempting such a tactic.
- It is important that foam can be applied equally well when the floating roof is at high level and when it is at low level.

Other foam delivery systems that are more complex to varying degrees are:

Catenary systems – foam applied to the rim seal by local generators located directly within the foam dam through a supply line attached to the roof via the rolling ladder

Coflexip system – foam solution is applied in the same way as a catenary, although the supply pipe runs up.

9 CORROSION RATE AND INSPECTION INTERVALS

The inspection data should be the input data for determining the internal and external inspection interval and, consequently, the tank remaining life (as for API 653 /API 575 or equivalent).

Corrosion rate = $(t_{previous} - t_{actual})$ / years between $(t_{actual} ; t_{previous})$

With:

$t_{previous}$: the thickness, in inches or millimeters, recorded at the same location as t actual measured during a previous inspection.

Remaining life (years) = $(t_{actual} - t_{minimum})$ / Corrosion rate

With:

T_{actual} : the thickness, in inches or millimeters, recorded at the time of inspection for a given location or component.

$t_{minimum}$: minimum allowance thickness, in inches or millimeters, for a given location or component.

10 TECHNICAL DOCUMENTATION

A list of relevant documents that shall be submitted for the certification process is given in the following.

Relevant documentation include but is not limited to:

- Reference Design Code and a Manufacturer's Data Report according to de design code;
- User Design Specification, if any;
- Material test reports;
- Design calculations;

Additional documentation for in-service certification include but is not limited to:

- The updated design calculations;
- The inspection records for the component at the time of fabrication;
- Pressure-relieving device information including pressure relief valve and/or rupture disk setting and capacity information;
- A record of the original hydro tests;
- Documentation of any significant changes in service conditions including pressure, temperature, fluid content and corrosion rate;
- The date of installation and a summary of all alterations and repairs including required calculations, material changes, drawings and repair procedures, including PWHT procedures if applicable;
- Records of all hydrotests performed as part of any repairs;
- Results of prior in-service examinations including wall thickness measurements and other NDE results that may assist in determining the structural integrity of the component and in establishing a corrosion rate;
- Records of all internal repairs, weld build-up and overlay, and modifications of internals;
- Records of "out-of-plumb" readings.

11 TASNEEF TECHNICIANS PROFILE

Tasneef technicians involved in tank farm inspection shall be an API 653 Aboveground Storage Tank Inspector or shall be in possess of an equivalent certificate.

12 DELIVERABLES

At the end of the certification process, Tasneef will issue a certificate of conformity with this guideline and/or the reference design code.

Annex A – Spill Response Checklist

Annex A: Spill Response Checklist

Spill Response Checklist					
Tank Farms name:					**Date:**
No.	**Item**	**Done**	**Undone**	**Findings**	**Initials**
1	SURVEY INCIDENT				
1a	Identify release source & Material spilled				
1b	Threatened building/public and sensitive areas				
2	SAFETY FIRST – GET HELP				
2a	Facility Owner or Manager				
2b	Local Fire Department and Law Enforcement				
2c	Local Responders				
2d	Local Medical Personnel				
3	ANALYSE THE INCIDENT				
3a	Review MSDS Sheet				
3b	Predict spill behavior				
3c	Estimate extent of spill				
4	PROTECT THE PUBLIC				
4a	Authorized personnel only/Ribbon off area				
4b	Evacuate areas downwind & Stay upwind				
4c	Know when to stay away				
5	PLAN A RESPONSE				
5a	Identify response objectives				
5b	Get additional response material				
5c	Conduct safety briefing				
6	PUT ON PERSONAL PROTECTION GEAR				
6a	Disposable suit or rain gear				
6b	Hardhat/Eye protection				
6c	Neoprene Gloves/Rubber or safety-toed boots				
7	VERIFY SPILL SOURCE				
7a	Tanks				
7b	Pipes				
7c	Other sources				
8	CONTROL THE SPILL				
8a	Stop the transfer and close valves upstream				
8b	Place catch bucket or basin under leak				
8c	Apply temporary patch				
9	CONTAINT THE SPILL				
9a	Use response tool kit following deployment strategies				
9b	Pay attention to sensitive areas				

Annex A – Spill Response Checklist

Spill Response Checklist					
Tank Farms name:					**Date:**
No.	**Item**	**Done**	**Undone**	**Findings**	**Initials**
10	RECOVER, CLEAN AND REPORT				
10a	Capture and recover product before it hits the water				
10b	Clean-up product				
Notes or Recommended Future Action:					

Annex B: Checklist for tank inspections

A sample checklist illustrating tank components and auxiliary items that should be considered for internal and external inspection of tanks. This information is provided as guidance to the owner/operator for developing an inspection assessment schedule for any specific tank installation. The checklist format facilitates the recording of inspection findings.

Tank in-service inspection checklist

TANK IN-SERVICE INSPECTION CHECKLIST			
Designation:	**Contents:**		
Measured or Estimated Liquid Level:			**Tank Size:**
Inspector:			**Date:**
No.	**Item**	**Completed**	**Comments**
1	FOUNDATION		
	Measure foundation levelness and bottom elevations (see Appendix B for extent of measurements).		
1.1	Concrete Ring		
	a. Inspect for broken concrete, spalling, and cracks, particularly under backup bars used in welding butt-welded annular rings under the shell.		
	b. Inspect drain openings in ring, back of water draw basins and top surface of ring for indications of bottom leakage.		
	c. Inspect for cavities under foundation and vegetation against bottom of tank.		
	d. Check that runoff rainwater from the shell drains away from tank.		
	e. Check for settlement around perimeter of tank.		
1.2	Asphalt		
	a. Check for settling of tank into asphalt base which would direct runoff rain water under the tank instead of away from it.		
	b. Look for areas where leaching of oil has left rock Filler exposed, which indicates hydrocarbon leakage.		
1.3	Oiled Dirt or Sand		
	Check for settlement into the base which would direct runoff rain water under the tank rather than away from it.		
1.4	Rock		
	Presence of crushed rock under the steel bottom usually results in severe underside corrosion. Make a note to do additional bottom plate examination (ultrasonic, hammer testing, or turning of coupons) when the tank is out of service.		
1.5	Site Drainage		
	a. Check site for drainage away from the tank and associated piping and manifolds.		
	b. Check operating condition of the dike drains.		
1.6	Housekeeping		
	Inspect the area for buildup of trash, vegetation, and other inflammables buildup.		
2	SHELLS		
2.1	External Visual Inspection		
	a. Visually inspect for paint failures, pitting, and corrosion.		
	b. Clean off the bottom angle area and inspect for corrosion and thinning on plate and weld.		
	c. Inspect the bottom-to-foundation seal, if any.		
2.2	Internal (Floating Roof Tank)		

Annex B – Checklist for tank inspections

TANK IN-SERVICE INSPECTION CHECKLIST			
Designation:	**Contents:**		
Measured or Estimated Liquid Level:			**Tank Size:**
Inspector:			**Date:**
No.	**Item**	**Completed**	**Comments**
	Visually inspect for grooving, corrosion, pitting, and coating failures.		
2.3	Wind Girder (Floating Roof Tanks)		
	a. Inspect wind girder and handrail for corrosion damage (paint failure, pitting, corrosion product buildup), especially where it occurs at tack-welded junction, and for broken welds.		
	b. Check support welds to shell for pitting, especially on shell plates.		
	c. Note whether supports have reinforcing pads welded to shell.		
2.4	Riveted Shell Inspection		
	a. Inspect external surface for rivet and seam leaks.		
	b. Locate leaks by sketch or photo (location will be lost when shell is abrasive cleaned for painting).		
	c. Inspect rivets for corrosion loss and wear.		
	d. Inspect vertical seams to see if they have been full fillet lap-welded to increase joint efficiency.		
	e. If no record exists of vertical riveted seams, dimension and sketch (or photograph) the rivet pattern: number of rows, rivet size, pitch length, and note whether the joint is butt riveted or lap-riveted.		
3	SHELL APPURTENANCES		
3.1	Manways and Nozzles		
	a. Inspect for cracks or signs of leakage on weld joint at nozzles, manways, and reinforcing plates.		
	b. Inspect for shell plate dimpling around nozzles, caused by excessive pipe deflection.		
	c. Inspect for flange leaks and leaks around bolting.		
	d. Inspect sealing of insulation around manways and nozzles.		
	e. Check for inadequate manway flange and cover thickness on mixer manways.		
3.2	Tank Piping Manifolds		
	a. Inspect manifold piping, flanges, and valves for leaks.		
	b. Inspect Fire Fighting system components.		
	c. Check for anchored piping which would be hazardous to the tank shell or bottom connections during earth movement.		
	d. Check for adequate thermal pressure relief of piping to the tank.		
	e. Check operation of regulators for tanks with purge gas systems.		
	f. Check sample connections for leaks and for proper valve operation.		
	g. Check for damage and test the accuracy of temperature indicators.		
	h. Check welds on shell-mounted davit clips above valves 6 in. and larger.		
3.3	Autogauge System		
	a. Inspect auto gauge tape guide and lower sheave housing (floating swings) for leaks.		

Annex B – Checklist for tank inspections

TANK IN-SERVICE INSPECTION CHECKLIST			
Designation:	**Contents:**		
Measured or Estimated Liquid Level:			**Tank Size:**
Inspector:			**Date:**
No.	**Item**	**Completed**	**Comments**
	b. Inspect auto gauge head for damage.		
	c. Bump the checker on auto gauge head for proper movement of tape.		
	d. Identify size and construction material of auto gauge tape guide (floating roof tanks).		
	e. Ask operator if tape tends to hang up during tank roof movement (floating roof tanks).		
	f. Compare actual product level to the reading on the auto gauge (maximum variation is2 in.).		
	g. On floating roof tanks, when the roof is in the lowest position, check that no more than two ft of tape are exposed at the end of the tape guide.		
	h. Inspect condition of board and legibility of board-type auto gauges.		
	i. Test freedom of movement of marker and float.		
3.4	Shell-Mounted Sample Station		
	a. Inspect sample lines for function of valves and plugging of lines, including drain or return-to-tank line.		
	b. Check circulation pump for leaks and operating problems.		
	c. Test bracing and supports for sample lines and equipment.		
3.5	Heater (Shell Manway Mounted)		
	Inspect condensate drain for presence of oil indicating leakage.		
3.6	Mixer		
	a. Inspect for proper mounting flange and support.		
	b. Inspect for leakage.		
	c. Inspect condition of power lines and connections to mixer.		
3.7	Swing Lines: Winch Operation		
	a. Nonfloating. Raise, then lower the swing line with the winch, and check for cable tightness to confirm that swing line lowered properly.		
	b. Floating. With tank half full or more, lower the swing line, then let out cable and check if swing has pulled cable tight, indicating that the winch is operating properly.		
	c. Indicator. Check that the indicator moves in the proper direction: Floating swing line indicators show a lower level as cable is wound up on the winch. Non-floating swing line indicators show the opposite.		
3.8	Swing Lines: External Guide System		
	Check for leaks at threaded and flanged joints.		
3.9	Swing Lines: Identify Ballast Varying Need		
	Check for significant difference in stock specific gravity.		
3.10	Swing Lines: Cable Material and Condition		

Annex B – Checklist for tank inspections

TANK IN-SERVICE INSPECTION CHECKLIST			
Designation:	**Contents:**		
Measured or Estimated Liquid Level:			**Tank Size:**
Inspector:			**Date:**
No.	**Item**	**Completed**	**Comments**
	a. For no stainless steel cable, check for corrosion over entire length.		
	b. All cable: check for wear or fraying.		
3.11	Swing lines: Product Sample Comparison		
	Check for water or gravity differences that would indicate a leaking swing joint.		
3.12	Swing Lines: Target		
	Target should indicate direction of swing opening (up or down) and height above bottom where suction will be lost with swing on bottom support.		
4	ROOFS		
4.1	Deck Plate Internal Corrosion		
	For safety, before accessing the roof, check with ultrasonic instrument or lightly use a ball peen hammer to test the deck plate near the edge of the roof for thinning. (Corrosion normally attacks the deck plate at the edge of a fixed roof and at the rafters in the center of the roof first.)		
4.2	Deck Plate External Corrosion		
	Visually inspect for paint failure, holes, pitting, and corrosion product on the roof deck.		
4.3	Roof Deck Drainage		
	Look for indication of standing water. (Significant sagging of Fixed roof deck indicates potential rafter failure. Large standing water areas on a floating roof indicate inadequate drainage design or, if to one side, a no level roof with possible leaking pontoons.)		
4.4	Level of Floating Roof		
	At several locations, measure distance from roof rim to a horizontal weld seam above the roof. A variance in the readings indicates a no level roof with possible shell out-of-round, out-of-plumb, leaking pontoons, or hang-up. On small diameter tanks, an unlevel condition can indicate unequal loading at that level.		
4.5	Gas Test Internal Floating Roof		
	Test for explosive gas on top of the internal floating roof. Readings could indicate a leaking roof, leaking seal system, or inadequate ventilation of the area above the internal floating roof.		
4.6	Roof Insulation		
	a. Visually inspect for cracks or leaks in the insulation weather coat where runoff rain water could penetrate the insulation.		
	b. Inspect for wet insulation under the weather coat.		

Annex B – Checklist for tank inspections

TANK IN-SERVICE INSPECTION CHECKLIST			
Designation:	**Contents:**		
Measured or Estimated Liquid Level:			**Tank Size:**
Inspector:			**Date:**
No.	**Item**	**Completed**	**Comments**
	c. Remove small test sections of insulation and check roof deck for corrosion and holes near the edge of the insulated area.		
4.7	Floating Roof Seal Systems		
	a. Measure and record maximum seal-to-shell gaps at:		
	1. Low pump out.		
	2. Mid-shell.		
	3. High liquid level.		
	b. Measure and record annular space at 30-ft spacing (minimum of four quadrants) around roof and record. Measurements should be taken in directly opposite pairs.		
	1. _____ _____ Opposite pair 1.		
	2. _____ _____ Opposite pair 2.		
	c. Check if seal fabric on primary shoe seals is pulling shoes away from shell (fabric not wide enough).		
	d. Inspect fabric for deterioration, holes, tears, and cracks.		
	e. Inspect visible metallic parts for corrosion and wear.		
	f. Inspect for openings in seals that would permit vapor emissions.		
	g. Inspect for protruding bolt or rivet heads against the shell.		
	h. Pull both primary and secondary seal systems back all around the shell to check their operation.		
	i. Inspect secondary seals for signs of buckling or indications that their angle with the shell is too shallow.		
	j. Inspect wedge-type wiper seals for flexibility, resilience, cracks, and tears.		
5	ROOF APPURTENANCES		
5.1	Sample Hatch		
	a. Inspect condition and functioning of sample hatch cover.		
	b. On tanks governed by Air Quality Monitoring District rules, check for the condition of seal inside hatch cover.		
	c. Check for corrosion and plugging on thief and gauge hatch cover.		
	d. Where sample hatch is used to reel gauge stock level, check for marker and tab stating hold-off distance.		
	e. Check for reinforcing pad where sample hatch pipe penetrates the roof deck.		
	f. On floating roof sample hatch and recoil systems, inspect operation of recoil reel and condition of rope.		
	g. Test operation of system.		
	h. On ultra clean stocks such as JP4, check for presence and condition of protective coating or liner inside sample hatch (preventing rust from pipe getting into sample).		
5.2	Gauge Well		

Annex B – Checklist for tank inspections

TANK IN-SERVICE INSPECTION CHECKLIST			
Designation:	**Contents:**		
Measured or Estimated Liquid Level:			**Tank Size:**
Inspector:			**Date:**
No.	**Item**	**Completed**	**Comments**
	a. Inspect visible portion of the gauge well for thinning, size of slots, and cover condition.		
	b. Check for a hold-off distance marker and tab with hold-off distance (legible).		
	c. On floating roofs, inspect condition of roof guide for gauge well, particularly the condition of the rollers for grooving.		
	d. If accessible, check the distance from the gauge well pipe to the tank shell at different levels.		
	e. If tank has a gauge well washer, check valve for leakage and for presence of a bull		
5.3	Fixed Roof Scaffold Support		
	Inspect scaffold support for corrosion, wear, and structural soundness.		
5.4	Auto gauge: Inspection Hatch and Guides (Fixed Roof)		
	a. Check the hatch for corrosion and missing bolts.		
	b. Look for corrosion on the tape guide's and float guide's wire anchors.		
5.5	Autogauge: Float Well Cover		
	a. Inspect for corrosion.		
	b. Check tape cable for wear or fraying caused by rubbing on the cover.		
5.5	Sample Hatch (Internal Floating Roof)		
	a. Check overall conditions.		
	b. When equipped with a fabric seal, check for automatic sealing after sampling.		
	c. When equipped with a recoil reel opening device, check for proper operations.		
5.6	Roof-Mounted Vents (Internal Floating Roof)		
	Check condition of screens, locking and pivot pins.		
5.7	Gauging Platform Drip Ring		
	On Fixed roof tanks with drip rings under the gauging platform or sampling area, inspect for plugged drain return to the tank.		
5.8	Emergency Roof Drains		
	Inspect vapor plugs for emergency drain: that seal fabric discs are slightly smaller than the pipe ID and that fabric seal is above the liquid level.		
5.9	Removable Roof Leg Racks		
	Check for leg racks on roof.		
5.10	Vacuum Breakers		
	Report size, number, and type of vacuum breakers. Inspect vacuum breakers. If high legs are set, check for setting of mechanical breaker in high leg position.		
5.11	Rim Vents		
	a. Check condition of the screen on the rim vent cover.		
	b. Check for plating off or removal of rim vents where jurisdictional rules do not permit removal.		
5.12	Pontoon Inspection Hatches		
	a. Open pontoon inspection hatch covers and visually check inside for pontoon leakage.		
	b. Test for explosive gas (an indicator of vapor space leaks).		

Annex B – Checklist for tank inspections

TANK IN-SERVICE INSPECTION CHECKLIST			
Designation:		**Contents:**	
Measured or Estimated Liquid Level:			**Tank Size:**
Inspector:			**Date:**
No.	**Item**	**Completed**	**Comments**
	c. If pontoon hatches are equipped with locked down coves, check for vent tubes. Check that vent tubes are not plugged up. Inspect lock-down devices for condition and operation.		
5.13	Accessways		
	See Tank Out-of-Service Inspection Checklist, item12.		
Notes or Recommended Future Action:			

Annex B – Checklist for tank inspections

Tank out-of-service inspection checklist

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
1	OVERVIEW		
	a. Check that tank has been cleaned, is gas free, and safe for entry.		
	b. Check that the tank is completely isolated from product lines, all electrical power, and steam lines.		
	c. Check that roof is adequately supported, including Fixed roof structure and floating roof legs.		
	d. Check for presence of falling object hazards, such as corroded-through roof rafters, asphalt stalactites, and trapped hydrocarbons in unopened or plugged equipment or appurtenances, ledges, etc.		
	e. Inspect for slipping hazards on the bottom and roof decks.		
	f. Inspect structural welds on access ways and clips.		
	g. Check surfaces needing inspection for a heavy-scale buildup and check weld seams and oily surfaces where welding is to be done. Note areas needing more cleaning, including blasting.		
2	TANK EXTERIOR		
	a. Inspect appurtenances opened during cleaning such as lower floating swing sheave assemblies, nozzle interiors (after removal of valves).		
	b. Hammer test or ultrasonically test the roof.		
	c. Enter and inspect the floating roof pontoon compartments.		
3	BOTTOM INTERIOR SURFACE		
	a. Using a flashlight held close to and parallel to the bottom plates, and using the bottom plate layout as a guide, visually inspect and hammer test the entire bottom.		
	b. Measure the depth of pitting and describe the pitting appearance (sharp edged, lake type, dense, scattered, etc.)		
	c. Mark areas requiring patching or further inspection.		
	d. Mark locations for turning coupons for inspection.		
	e. Inspect all welds for corrosion and leaks, particularly the shell-to-bottom weld.		
	f. Inspect sketch plates for corrosion.		
	g. Check condition of internal sump, if applicable. Standing liquid should be removed from the sump to allow for complete inspection and vacuum testing of weld seams as appropriate. Sump bottom and sidewall plate and seams need to be evaluated for both product-side and soil-side corrosion.		
	h. Locate and mark voids under the bottom.		
	i. Record bottom data on a layout sketch using the existing bottom plates as a grid. List the number and sizes of patches required.		
	j. Vacuum test the bottom lap welds.		
	k. Hammer test or ultrasonically examine any slightly discolored spots or damp areas.		
	l. Check for reinforcing pads under all bottom attached clips, brackets, and supports.		
	m. Inspect floating roof leg pads for pitting or cutting, and excessive dimpling (indicating excessive loading).		
	n. Check the column bases of Fixed roof supports for adequate pads and restraining clips.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
	o. In earthquake zones 3 and 4, check that roof supports are not welded down to the tank bottom, but are only restrained from horizontal movement.		
	p. Check area beneath swing line cable for indications of cable cutting or dragging.		
	q. Mark old oil and air test connection for removal and patching.		
	r. Identify and report low areas on the bottom that do not drain adequately.		
	s. Inspect coating for holes, disbonding, deterioration, and discoloration.		
4	SHELL SEAMS AND PLATE		
	a. On cone up bottoms, closely inspect and gauge the depth of metal loss on the lower2 in. to 4 in. of the shell (area of standing water).		
	b. Measure the depth of pitting on each course.		
	c. Inspect and estimate the amount of metal loss on the heads of rivets and bolts.		
	d. Inspect shell-to-bottom riveted lap joints.		
	e. Inspect for vertical grooving damage from seal assembly protrusions.		
	f. Inspect existing protective coatings for damage, deterioration, and disbonding.		
	g. Check for areas of rubbing (indicating too much pressure by the seal assembly shoes or inadequate annular space).		
	h. Visually inspect the shell plates and seams for indications of leakage.		
	i. If the shell has riveted or bolted seams, record the leak locations by Film or chart in case the locations are lost during surface preparation for painting.		
	j. Measure annular space at 40-ft intervals.		
	k. Survey the shell to check for roundness and plumb.		
5	SHELL-MOUNTED OVERFLOWS		
	a. Inspect overflow for corrosion and adequate screening.		
	b. Check location of overflow that it is not above any tank valves or equipment.		
6	ROOF INTERIOR SURFACE		
6.1	General		
	a. Visually inspect the underside surface of the roof plates for holes, scale buildup, and pitting.		
	b. Hammer test or ultrasonically examine to check for thin areas, particularly in the vapor space of floating roofs and at edge of roof on cone roof tank.		
	c. Check all clips, brackets, braces, etc., welded to the roof deck plate for welded reinforcing pads and see that they have not broken free.		
	d. If no pad is present, penetrant test for cracking of the weld or deck plate.		
	e. Inspect for protective coating for breaks, disbondment, and deterioration.		
	f. Spark test the interior surface coating if recoating is not planned.		
6.2	Fixed Roof Support Structure		
	a. Inspect the support columns for thinning in the upper 2 ft.		
	b. On API columns (two channels welded together) check for corrosion scale breaking the tack welds, unless the joint between the channels is completely seal welded.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
	c. Check that the reinforcing pad on the bottom is seal-welded to the tank bottom with horizontal movement restraining clips welded to the pad.		
	d. Determine if pipe column supports are concrete Filled or open pipe. If open pipe,		
	e. Inspect and gauge rafters for thinning, particularly near the center of the roof. Report metal loss.		
	f. Check for loose or twisted rafters.		
	g. Inspect girders for thinning and check that they are attached securely to the top of the columns.		
	h. Report if the columns have cross bracing in the area between the low pump out of the top of the shell (for future internal floating roof installation).		
	i. Inspect and report presence of any roof-mounted swing line bumpers.		
	j. Photograph the roof structure if no rafter layout drawing exists.		
7	FIXED ROOF APPURTENANCES		
7.1	Inspection and Light Hatches		
	a. Inspect the hatches for corrosion, paint and coating failures, holes, and cover sealing.		
	b. On loose covers, check for a safety chain in good condition.		
	c. On light hatches over 30 in. across, check for safety rods.		
	d. Inspect the condition of the gaskets on bold or latched down hatch covers.		
7.2	Staging Support Connection		
	Inspect the condition of the staging support for corrosion.		
7.3	Breathers and Vents		
	a. Inspect and service the breather.		
	b. Inspect screens on vents and breathers.		
7.4	Emergency P/V Hatches		
	a. Inspect and service pressure/vacuum hatches. (Setting should be high enough to prevent chattering of breather during normal operation. See breather manufacturer's guide.)		
	b. Inspect liquid seal hatches for corrosion and proper liquid level in the seal.		
7.5	Sample Hatch		
	a. Inspect sample hatch for corrosion.		
	b. Check that the cover operates properly.		
	c. If the tank has no gauge well, check for a hold-off distance marker and check measurement.		
8	FLOATING ROOF		
8.1	Roof Deck		
	a. Hammer test the area between roof rim and shell. (If access for hammer testing is inadequate, measure the distance from the bottom edge of the roof to the corroded area and then hammer test from inside the pontoon.)		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
	b. In sour water service, clean and test all deck plate weld seams for cracking unless the lower laps have been seal-welded.		
	c. Check that either the roof drain is open or the drain plug in the roof is open in case of unexpected rain.		
	d. On flat bottomed and cone bottom roof decks, check for a vapor dam around the periphery of the roof. The dam should be continuous without break to prevent escape of vapors to the seal area from under the center of the roof.		
8.2	Floating Roof Pontoons		
	a. Visually inspect each pontoon for liquid leakage.		
	b. Run a light wire through the gooseneck vents on locked down inspection hatch covers to make sure they are open.		
	c. Inspect lockdown latches on each cover.		
	d. Check and report if each pontoon is:		
	1. Vapor tight (bulkhead seal welded on one side on bottom, sides, and top),		
	2. Liquid tight (seal-welded on bottom and sides only), or		
	3. Unacceptable (minimum acceptable condition is liquid tight).		
8.3	Floating Roof Cutouts		
	a. Inspect underside of cutouts for mechanical damage.		
	b. Inspect welds for cracks.		
	c. Inspect plate for thinning, pitting, and erosion.		
	d. Measure mixer cutouts and record plate thickness for future mixer installation or replacement. Plate thickness _____ .		
8.4	Floating Roof Supports		
	a. Inspect Fixed low and removable high floating roof legs for thinning.		
	b. Inspect for notching at bottom of legs for drainage.		
	c. Inspect for leg buckling or felling at bottom.		
	d. Inspect pin hole in roof guide for tears.		
	e. Check plumb of all legs.		
	f. Inspect for adequate reinforcing gussets on all legs through a single portion of the roof.		
	g. Inspect the area around the roof legs for cracking if there is no internal reinforcing pad or if the topside pad is not welded to the deck plate on the underside.		
	h. Inspect the sealing system on the two-position legs and the vapor plugs in the fixed low leg for deterioration of the gaskets.		
	i. On shell-mounted roof supports, check for adequate clearance based on the maximum floating roof movement as determined by the position of the roof relative to the gauge well and/or counter-rotational device.		
9	FLOATING ROOF SEAL ASSEMBLIES		
9.1	Primary Shoe Assembly		
	a. Remove four sections of foam log (foam-filled seals) for inspection on 90° locations.		
	b. Inspect hanger attachment to roof rim for thinning, bending, broken welds, and wear of pin holes.		
	c. Inspect clips welded to roof rim for thinning.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
	d. Shoes-inspect for thinning and holes in shoes.		
	e. Inspect for bit-metal bolts, clips, and attachments.		
	f. Seal fabric-inspect for deterioration, stiffening, holes, and tears in fabric.		
	g. Measure length of fabric from top of shoe to roof rim, and check against maximum anticipated annular space as roof operates.		
	h. Inspect any modification of shoes over shell nozzles, mixers, etc., for clearance.		
	i. Inspect shoes for damage caused by striking shell nozzles, mixers, etc.		
9.2	Primary Toroidal Assembly		
	a. Inspect seal fabric for wear, deterioration, holes, and tears.		
	b. Inspect hold-down system for buckling or bending.		
	c. Inspect foam for liquid absorption and deterioration.		
9.3	Rim-Mounted Secondaries		
	a. Inspect the rim-mounted bolting bar for corrosion and broken welds.		
	b. Measure and chart seal-to-shell gaps.		
	c. Visually inspect seam from below, looking for holes as evidenced by light.		
	d. Inspect fabric for deterioration and stiffness.		
	e. Inspect for mechanical damage, corrosion, and wear on tip in contact with shell.		
	f. Inspect for contact with obstructions above top of shell.		
10	FLOATING ROOF APPURTENANCES		
10.1	Roof Manways		
	a. Inspect walls of manways for pitting and thinning.		
	b. On tanks with interface auto gauges, check seal around gauge tape cable and guide wires through manway cover.		
	c. Inspect cover gasket and bolts.		
10.2	Rim Vent		
	a. Check rim vent for pitting and holes.		
	b. Check vent for condition of screen.		
	c. On floating roof tanks where the environmental rules require closing off the vent, check the vent pipe for corrosion at the pipe-to-rim joint and check that the blinding is adequate.		
10.3	Vacuum Breaker, Breather Type		
	a. Service and check operation of breather valve.		
	b. Check that nozzle pipe projects no more than 1/2 in. below roof deck.		
10.4	Vacuum Breaker, Mechanical Type		
	Inspect the stem for thinning. Measure how far the vacuum breaker cover is raised off the pipe when the roof is resting on high or low legs.		
	a. On high legs: _____ .		
	b. On low legs: _____ .		
10.5	Roof Drains: Open Systems, Including Emergency Drains		
	a. Check liquid level inside open roof drains for adequate freeboard. Report if there is insufficient distance between liquid level and top of drain.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
	b. If tank comes under Air Quality Monitoring District rules, inspect the roof drain vapor plug.		
	c. If emergency drain is not at the center of the roof, check that there are at least three emergency drains.		
10.6	Closed Drain Systems: Drain Basins		
	a. Inspect for thinning and pitting.		
	b. Inspect protective coating (topside).		
	c. Inspect basin cover or screen for corrosion.		
	d. Test operation of check valve		
	e. Check for presence of check valve where bottom of basin is below product level.		
	f. Inspect drain basin(s) to roof deck welds for cracking.		
	g. Check drain basin(s) outlet pipe for adequate reinforcement to roof deck (including reinforcing pad).		
10.7	Closed Drain Systems: Fixed Drain Line on Tank Bottom		
	a. Hammer test fixed drain line on tank bottom for thinning and scale/debris plugging.		
	b. Inspect supports and reinforcing pads for weld failures and corrosion.		
	c. Check that pipe is guided, not rigidly locked to support, to avoid tearing of tank bottom plate.		
10.8	Closed Drain Systems: Flexible Pipe Drain		
	a. Inspect for damage to exterior of pipe.		
	b. Check for obstructions that pipe could catch on.		
	c. Inspect shields to protect pipe from snagging.		
	d. Inspect results of hydrostatic test on flexible roof drain system.		
10.9	Closed Drain Systems: Articulated Joint Drain		
	a. Hammer test rigid pipe in flexible joint systems for thinning and scale/debris plugging.		
	b. Inspect system for signs of bending or strain.		
	c. Inspect results of system hydrostatic test.		
	d. Inspect landing leg and pad.		
10.10	Auto gauge System and Alarms		
	a. Check freedom of movement of tape through auto gauge tape guide.		
	b. Inspect sheaves for freedom of movement.		
	c. Test operation checker.		
	d. Inspect tape and tape cable for twisting and fraying.		
	e. Test the tape's freedom of movement through guide sheaves and tape guide pipe.		
	f. On open-top tanks, check that gate tapes with cables have no more than one foot of tape exposed with float at lowest point.		
	g. Check float for leakage.		
	h. Test float guide wire anchors for spring action by pulling on wire and releasing.		
	i. Inspect float wells in floating roofs for thinning and pitting of walls just above the liquid level.		
	j. Check that the auto gauge tape is Firmly attached to the float.		
	k. Inspect the tape cable and float guide wire fabric seals through the float well cover.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
	l. Inspect the bottom guide wire attachment clip: inspect for a temporary weighted bar instead of a permanent welded down clip.		
	m. Inspect board-type auto gauge indicators for legibility and freedom of movement of indicator.		
	n. Measure and record these distances to determine if seal damage will occur if tank is run over from:		
	1. Shell top angle to underside of tape guide system.		
	2. Liquid level on floating top to top of secondary seal.		
	o. Identify floating roofs where the tape is connected directly to the roof.		
	p. Overfill alarm: Inspect tank overfill prevention alarm switches for proper operation.		
11	COMMON TANK APPURTENANCES		
11.1	Gauge Well		
	a. Inspect gate well pipe for thinning at about two-thirds distance above the bottom: look for thinning at the edge of the slots.		
	b. Check for corrosion on the pipe joint. Check that sample cords, weights, thermometers, etc., have been removed from the pipe.		
	c. Check for cone at bottom end of pipe about one foot above the bottom.		
	d. Check condition of well washer pipe and that its flared end is directed at the near side of the hold off pad.		
	e. Check that supports for gauge well are welded to pad or to shell and not directly to bottom plate.		
	f. Check operation of gauge well cover.		
	g. Check presence of a hold-off distance marker in well pipe and record hold-off distance. Hold-off distance _____ .		
	h. Identify and report size and pipe schedule, and whether pipe is solid or slotted. Report slot size.		
	i. Check that the hold-off distance plate is seal-welded to the bottom and that any gauge well supports are welded to the plate and not directly to the bottom.		
	j. Inspect vapor control float and cable.		
	k. Check for presence and condition of gauge well washer.		
	l. Check for bull plug or plate blind on gauge well washer valve.		
	m. Inspect gauge well guide in floating roof for pitting and thinning.		
	n. Inspect the guide rollers and sliding plates for freedom of movement.		
	o. Inspect condition of gauge well pipe seal system.		
	p. On black oil and diesel services: if gauge well is also used for sampling, check for presence of a thief- and gauge-type hatch to avoid spillage.		
	q. Visually inspect inside of pipe for pipe weld protrusions which could catch or damage vapor control float.		
11.2	Sampling Systems: Roof Sample Hatches		
	a. Inspect roof-mounted sample hatches for reinforcing pads and cracking.		
	b. Inspect cover for operation.		
	c. For tanks complying with Air Quality Monitoring District rules, inspect sample hatch covers for adequate sealing.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
	d. Check horizontal alignment of internal floating roof sample hatches under fixed roof hatches.		
	e. Inspect the sealing system on the internal floating roof sample hatch cover.		
	f. Inspect floating roof sample hatch cover recoil reel and rope.		
11.3	Shell Nozzles		
	a. Inspect shell nozzles for thinning and pitting.		
	b. Inspect hot tap nozzles for trimming of holes.		
	c. Identify type of shell nozzles.		
	d. Identify and describe internal piping, including elbow-up and elbow-down types.		
11.4	For Nozzles Extended Into the Tank		
	a. Inspect pipe support pads welded to tank bottom.		
	b. Inspect to see that pipe is free to move along support without strain or tearing action on bottom plate.		
	c. Inspect nozzle valves for packing leaks and damaged flange faces.		
	d. Inspect heater stream nozzle flanges and valves for wire cutting.		
	e. Report which nozzles have thermal pressure relief bosses and valves.		
	f. In internal elbow-down Fill line nozzles, inspect the wear plate on the tank bottom.		
	g. On elbow-up fill lines in floating roof tanks, check that opening is directed against underside of roof, not against vapor space. Inspect impact are for erosion.		
11.5	Diffusers and Air Rolling Systems		
	a. Inspect diffuser pipe for erosion and thinning.		
	b. Check holes in diffuser for excessive wear and enlargement.		
	c. Inspect diffuser supports for damage and corrosion.		
	d. Check that diffuser supports restrain, not anchor, longitudinal line movement.		
	e. Inspect air spiders on bottom of lube oil tanks for plugging and damaged or broken threaded joints.		
11.6	Swing Lines		
	a. Inspect flexible joint for cracks and leaks.		
	b. Scribe the flexible joint across the two moving faces and raise end of swing line to check the joint's freedom of movement, indicated by separation of scribe marks.		
	c. Check that flexible joints over 6 in. are supported.		
	d. Inspect the swing pipe for deep pitting and weld corrosion.		
	e. Loosen the vent plugs in the pontoons and listen for a vacuum. Lack of a vacuum indicates a leaking pontoon.		
	f. Check the results of air test on pontoons during repairs.		
	g. Inspect the pontoons for pitting.		
	h. Inspect the pull-down cable connections to the swing.		
	i. Inspect the condition of the bottom-mounted support, fixed roof limiting bumper, or shell-mounted limiting bumper for wood condition, weld and bolt corrosion, and seal welding to bottom or shell.		
	j. Inspect safety hold-down chain for corrosion and weak links.		
	k. Check that there is a welded reinforcing pad where the chain connects to the bottom.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
	l. If the floating swing in a floating or internal floating roof tank does not have a limiting device preventing the swing from exceeding 60 degrees, measure and calculate the maximum angle possible with the roof on overflow. Max. angle on overflow _____ . (If the calculated angle exceeds 65 degrees, recommended installation of a limiting bracket.)		
	m. Inspect pull-down cable for fraying.		
	n. Inspect for three cable clamps where cable attaches to end of swing line (single reeved) or to roof assembly (double-reeved). Inspect sheaves for freedom of movement.		
	o. Inspect winch operation and check the height indicator for legibility and accuracy.		
	p. Inspect bottom-mounted sheave assembly at end of pontoon for freedom of rotation of sheave.		
	q. Inspect shell-mounted lower sheave assembly for freedom of rotation of sheave, corrosion thinning, and pitting of sheave housing.		
	r. Inspect upper sheave assembly for freedom of movement of sheave.		
	s. Inspect the cable counterbalance assembly for corrosion and freedom of operation.		
11.7	Manway Heater Racks		
	a. Inspect the manway heater racks for broken welds and bending of the sliding rails.		
	b. Measure and record the length of the heater and length of the track.		
11.8	Mixer Wear Plates and Deflector Stands		
	a. Inspect bottom and shell plates and deflector stands.		
	b. Inspect for erosion and corrosion on the wear plates. Inspect for rigidity, structural soundness, corrosion, and erosion of deck plates and reinforcing pads that are seal welded to the bottom under the deflector stand legs.		
	c. Measure for propeller clearance between the bottom of deflector stand and roof when the roof is on low legs.		
12	ACCESS STRUCTURES		
12.1	Handrails		
	a. Identify and report type (steel pipe, galvanized pipe, square tube, angle) and size of handrails.		
	b. Inspect for pitting and holes, paint failure.		
	c. Inspect attachment welds.		
	d. Identify cold joints and sharp edges. Inspect the handrails and midrails.		
	e. Inspect safety drop bar (or safety chain) for corrosion, functioning, and length.		
	f. Inspect the handrail between the rolling ladder and the gaging platform for a hazardous opening when the floating roof is at its lowest level.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
12.2	Platform Frame		
	a. Inspect frame for corrosion and paint failure.		
	b. Inspect the attachment of frame to supports and supports to tank for corrosion and weld failure.		
	c. Check reinforcing pads where supports are attached to shell or roof.		
	d. Inspect the surface that deck plate or grating rests on, for thinning and holes.		
	e. Check that flat-surface-to-flat-surface junctures are seal-welded.		
12.3	Deck Plate and Grating		
	a. Inspect deck plate for corrosion-caused thinning or holes (not drain holes) and paint failure.		
	b. Inspect plate-to-frame weld for rust scale buildup.		
	c. Inspect grating for corrosion-caused thinning of bars and failure of welds.		
	d. Check grating tie down clips. Where grating has been retrofitted to replace plate, measure the rise of the step below and above the grating surface and compare with other risers on the stairway.		
12.4	Stairway Stringers		
	a. Inspect spiral stairway stringers for corrosion, paint failure, and weld failure. Inspect attachment of stairway treads to stringer.		
	b. Inspect stairway supports to shell welds and reinforcing pads.		
	c. Inspect steel support attachment to concrete base for corrosion.		
12.5	Rolling Ladder		
	a. Inspect rolling ladder stringers for corrosion.		
	b. Identify and inspect ladder fixed rungs (square bar, round bar, angles) for weld attachment to stringers and corrosion, particularly where angle rungs are welded to stringers.		
	c. Check for wear and corrosion where rolling ladder attaches to gaging platform.		
	d. Inspect pivot bar for wear and secureness.		
	e. Inspect operation of self-leveling stairway treads.		
	f. Inspect for corrosion and wear on moving parts.		
	g. Inspect rolling ladder wheels for freedom of movement, flat spots, and wear on axle.		
	h. Inspect alignment of rolling ladder with roof rack.		
	i. Inspect top surface of rolling ladder track for wear by wheels to assure at least 18 in. of unworn track (track long enough).		
	j. Inspect rolling ladder track welds for corrosion.		
	k. Inspect track supports on roof for reinforcing pads seal-welded to deck plate.		
	l. Check by dimensioning, the maximum angle of the rolling ladder when the roof is on low legs. Max. angle _____ .		
	m. If rolling ladder track extends to within 5 ft of the edge of the roof on the far side, check for a handrail on the top of the shell on that side.		

Annex B – Checklist for tank inspections

TANK OUT-OF-SERVICE INSPECTION CHECKLIST			
Inspector		**Date**	
No.	**Item**	**Completed**	**Comments**
Notes or Recommended Future Action:			