CHAPTER 16

Marine Terminal Operations

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This chapter provides information on terminal procedures and activities that influence tanker/terminal operations. This includes the assessment of limiting environmental criteria for safe operations and provision for a safe means of access between the tanker and the terminal.

Operations requiring special procedures are described, including the double banking of tankers and the loading and discharging of cargo using tidal increases in depth of water (over the tide).

The chapter also includes an explanation of the phenomenon of pressure surge in pipelines and discusses the manner in which it may be assessed and controlled.

16.1 Limiting conditions for operations

Considering the existing restrictions on each berth, e.g. Safe Working Load (SWL) of the mooring system components and, if applicable, the operating envelopes of the MLAs and hoses. Terminal operators should establish Terminal Operating Limits (TOLs) defining the thresholds for:

- Manoeuvring during arrival and berthing.
- Berthing and mooring.
- Ceasing loading or discharging.
- Disconnecting cargo hoses or MLAs.
- Calling tug assistance.

- Removing the tanker from the berth.
- Manoeuvring during unberthing and departure.
- UKC limitations.

Operating limits should be based on prevailing environmental conditions, including:

- Wind speed and direction.
- Wave height and period.
- Speed and direction of the current.
- Swell conditions that may affect operations at the berth.
- Electrical storms.
- Environmental phenomena, for example, river bores or ice movement.
- Extremes of temperature that might affect loading or unloading.
- Height of tide.

Information on environmental limits should be passed on to the tanker personnel in pre-arrival communications (as detailed in the TIB), verified at the pre-cargo transfer conference and, where applicable, be formally recorded in the Ship/Shore Safety Checklist (SSSCL) (see chapter 25). Local weather forecasts and weather alerts received by terminal personnel should be passed to tanker personnel and vice versa.

The terminal should, if possible, have a locally installed anemometer for measuring wind speeds.

Tanker and terminal personnel should use all available means to obtain early warning on metocean conditions. This includes local observations and the use of live information obtained from a competent agency.

Provision of weather monitoring stations, at strategic locations around the terminal, provides the capability to monitor weather conditions and predict the onset of weather that could impact the safety of tankers and personnel.

Availability of equipment for the measurement of other environmental factors, e.g. current meter, tidal gauge and wave buoy, should be considered where identified as critical by a risk assessment.

When berths are positioned in open water, passing ship(s) speed, tidal flow, interaction between moored ships, space between other moored ships, minimum safe passing distances, movement of other vessels in the area and weather conditions should be assessed. Excessive movement caused by passing ships can cause significant damage to tanker and terminal assets.

When berths are positioned in canals, inland waterways and rivers, the above should be assessed with respect to passing ships, including restricted movement caused by the width of canal banks and buoyed channels and any safe speed restrictions that may be in place. Terminal and tanker personnel should be aware of potential increases in interaction in a canal or inland waterway that may be caused by a reduction in width or depth of water (UKC) within a waterway.

16.1.1 Risk assessment

Tanker and terminal operators should assess, determine and have clear guidance on the following:

- Operations that need to immediately cease (in addition to operations described in the first part of this section) in the event of adverse metocean conditions.
- Operations that can continue with precautions.

The risk assessment should consider, but not be limited to:

- Personnel exposure in the specific operation and environment.
- Vulnerability of the people and assets.
- Availability and reliability of protection system.
- Risks associated with stopping an activity or operation.

16.2 Electrical storms

When an electrical storm is detected, the following operations should be stopped:

- Handling of flammable products.
- Ballasting of tanks not free of hydrocarbon vapour.
- Sampling, gauging, purging, tank cleaning or gas freeing after the discharge of flammable products.

All tank openings, open manifolds or hose connections and vent valves should be closed or blanked, including any bypass valves fitted on the tank venting system.

At terminals where a site risk assessment has determined an increased probability of electrical storms, consideration should be given to the installation of equipment or provision of forecasting services to provide early notification of approaching electrical storms.

16.3 Double banking

Double banking occurs when two or more tankers are berthed alongside each other in such a way that the presence or operations of one tanker act as a physical constraint on the other. Double banking is sometimes used as a means of conducting multiple transfers between the terminal and more than one tanker at the same jetty. The outermost tanker may be moored to an inner tanker or to the terminal itself and hose strings led from the terminal, across the inner tanker, to the outermost or between the two tankers. This causes additional risk in management of the tanker/terminal interface.

In addition to the SSSCL, the relevant guidance can be found in OCIMF's *Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases (STS Guide)* and *International Safety Guide for Inland Navigation Tank-barges and Terminals (ISGINTT)*.

Documented procedures, derived from a risk assessment, should include:

- Designation of a responsible party for the supply of equipment and a Person In Charge (PIC).
- Relevant information from jetty structural and mooring analysis, including passing ship study.
- Relevant information from mooring compatibility assessment between ships.
- Safe arrival and departure operating limits, mooring fittings, mooring arrangements, personnel access, management of operational safety, liability, contingency planning, firefighting and emergency unberthing.
- Safe passage for other ships using the terminal berth(s) and port facilities.
- Transfer of personnel between double banked tankers.
- Pollution prevention.
- Provision of lighting.

16.4 Tanker/terminal access

16.4.1 General

Means of access between tanker and terminal are often addressed by national regulation, usually by the Port State or by the tanker's Flag State (see chapter 6 on security). Means of access must meet these standards and be correctly rigged by either tanker or terminal personnel, as appropriate.

Personnel should use the designated means of access between tanker and terminal.

16.4.2 Provision of tanker/terminal access

Responsibility for the provision of safe tanker/terminal access is jointly shared between tanker and terminal personnel. Requirements for provision of safe access should be detailed in the pre-arrival communications. The preferred means for access between tanker and terminal is a shore based gangway.

When terminal access facilities are not available and a tanker's gangway is used, the berth should have sufficient landing area to provide the gangway with an adequate clear run in order to maintain safe, convenient access to the tanker at all states of tide and changes in freeboard.

Irrespective of whether safe access is provided by the terminal or the tanker, the gangway should be subject to inspection as part of the ship/shore safety checks that are carried out at regular intervals throughout the ship's stay at the berth.

16.4.3 Access equipment

All means of access should meet the following criteria:

- Clear walkway.
- Continuous handrail on both sides.
- Electrically insulated to eliminate continuity between tanker and terminal.
- Adequate lighting.
- For gangways without self-levelling treads or steps, the maximum safe operating angle should be marked.
- Lifebuoys should be available with light and line on both tanker and terminal.
- Marked with SWL or maximum number of persons.
- Means of access should be placed as close as possible to crew accommodation areas and as far away as possible from the manifold.
- Provide, so far as practicable, safe access/egress to accommodations.
- Means of access also provide a means of escape. The location of any portable gangway should be carefully considered to ensure that it provides a safe access to any escape route from the jetty (see chapter 20).
- The jetty area for landing a tanker's gangway should be open, clearly identified and unobstructed with access to the area maintained clear.

16.4.3.1 Shore gangway

When provided by the terminal, a gangway should allow safe access between terminal and tanker.

In addition to the criteria in section 16.4.3, shore gangways should meet the following additional criteria, as appropriate:

- Remain clear of the tanker when in the stored position.
- Provide for locking against motion in the stored position.
- Allow free movement after positioning on the tanker.
- Have backup power or manual operation in the event of primary power failure.
- Be designed for berth specific operating conditions.

Automatic gangways may be provided, consisting of a stairway tower with an adjustable bridge that spans from the tower to the tanker's deck. The bridge section is adjusted for height depending on the tanker's freeboard.

At some berths, it may be necessary to provide access from an internal stairway below the working level of the berth.

Tankers with external deck framing, more commonly seen on chemical tankers and product carriers, pose particular challenges in their ability to provide a suitable area for the placement of shore gangways.

16.4.3.2 Portable gangways (tanker or terminal)

A portable gangway consists of a straight, lightweight bridging structure with side stanchions and handrails. The walking surface has a non-slip surface or transverse bars to provide foot grips for when it is at an incline. It is rigged perpendicular to the tanker's side and the working deck of the berth.

Portable gangways should not be landed on tanker's handrails, unless the handrails are designed for this purpose. When gangways are mounted over the tanker's handrails, access steps with handrails (bulwark ladders) should be provided to enable safe access to and from the deck.

Where practical, the gangway should be deployed at a gate in the tanker's handrails.

Portable gangways provided should be of adequate minimum length to safely operate throughout all states of tide, changes in freeboard and motions of the tanker.

16.4.3.3 Accommodation ladder

The accommodation ladder consists of a straight lightweight structure fitted with side stanchions and handrails, mainly intended for access to boats from the main deck. The steps are self-levelling, or formed as a large radius non-slip thread. The ladder is usually rigged parallel to the ship's side on a retractable platform fixed to the ship's deck. The ladder is limited in its use as an access to the shore because it is fixed in its location and cannot be used if the ship's deck is below the level of the berth's working deck.

16.4.3.4 Safety nets

Safety nets are not required if the gangway is fixed to the shore (see section 16.4.3.1) and provided with a permanent system of handrails. For other types of gangways and those fitted with rope or chain handrails or removable posts, correctly rigged safety nets should be provided.

The safety net should be rigged to prevent any person from falling into the water or directly onto the jetty/ground. It should extend from the ship's side at the boarding point to the bottom landing platform and suitability should be checked by a Responsible Person.

16.4.4 Alternative means of tanker/terminal access

If circumstances are such that a practical and safe means of access cannot be provided directly between tanker and terminal, the only safe alternative may be to use a boat to ferry personnel to/from the access point on the offshore side of tanker. If this means of access is used, an additional means of access and egress may also need to be provided for emergencies.

16.4.4.1 Personnel transfer by basket

Personal transfer baskets present unique safety risks and are not recommended except in specific circumstances. See OCIMF's *Transfer of Personnel by Crane between Vessels*.

16.4.5 Routine maintenance

All terminal gangways and associated equipment should be routinely inspected and tested. This requirement should be included in the terminal's planned maintenance programme. Mechanically deployed gangways should be function tested. Self-adjusting gangways should be fitted with alarms that should be routinely tested. More information can be found in OCIMF/SIGTTO's *Jetty Maintenance and Inspection Guide*.

16.5 Over the tide cargo operations

Over the tide cargo operations use tidal changes in water depth, either by finishing the loading of a tanker as the water depth increases towards high tide or discharging cargo to lighten a tanker before the low tidal level is reached.

Documented procedures should be established for terminals that require over the tide cargo operations. Procedures should be derived from a risk assessment process (see chapter 4).

The terminal should confirm that the tanker's equipment that is critical to the operation, such as cargo pumps and main engines, is operational prior to berthing and is kept available while the tanker is alongside at the critical stage.

16.5.1 Discharging over the tide

Discharge over the tide is where a tanker is required to use a berth where the laden arrival draught will exceed the available water depth at, or approaching, low water, but where it may be possible to discharge sufficient cargo to remain afloat. This procedure should be adopted where all parties concerned accept the risk involved and agree to adopt mitigating procedures to ensure that the tanker can be discharged in a timeframe to always remain afloat or be removed from the berth to a position where it can remain afloat.

16.5.2 Loading over the tide

Loading over the tide is undertaken where a tanker cannot remain safely afloat during the low water period. The tanker should stop loading at the draught at which it can remain afloat and recommence loading as the tide rises. Loading should not resume unless equipment critical for the departure of the tanker from the berth, e.g. main engine, is ready for use. The loading rate should allow the tanker to complete loading and allow time for cargo measurements, sampling, documentation, clearance formalities and unberthing while maintaining the required UKC.

16.6 Operations where the tanker is not always afloat

Operations where a tanker is not always afloat are considered exceptional and should only be permitted following a risk assessment and the implementation of all safeguards identified to deliver a safe operation.

The type of operation varies depending on circumstances, e.g. taking the ground for a brief period during its stay at the berth, or a tanker being completely out of the water. The following should be considered:

- There should be agreement between the port, terminal and tanker owner/operator before the operation takes place.
- Seabed should be surveyed and proved to be flat and with no high spots.
- Slope of the seabed should not result in any excessive upthrust on the tanker's structure or cause any loss of stability when the tanker takes the ground.
- Tanker's hull strength should be sufficient to take the ground without excessive stress being placed on the structure. This may require the tanker's design and scantlings to be augmented to allow it to take the ground safely.
- Operation should not result in the tanker losing any of its essential services, e.g. cooling water for the machinery or its firefighting capability. This may require the incorporation of special design features into the tanker.

- As it will not be possible to remove the tanker from the berth in the event of an emergency, port operations need to address specific emergency procedures and the provision of appropriate firefighting equipment.
- Contingency plans should address the possibility of structural failure on the tanker and resultant pollution.

16.7 Generation of pressure surges in pipelines

16.7.1 Introduction

A pressure surge occurs when the flow rate of a liquid rapidly changes and becomes unsteady. Variations in the flow rate of a liquid are caused by events, e.g. pump starting or stopping, a valve opening or closing or a reduction of pipeline diameter.

During cargo transfer operations, a pressure surge can result in a significant loss of cargo containment as the cargo transfer system is exposed to a peak pressure exceeding the design pressure rating of the cargo transfer system.

Pressure surges may:

- Rupture one or more of the cargo system components.
- Create an inertial force exceeding the structural design rating of the pipeline supports, resulting in displacement of the cargo pipelines and failure of pipeline couplings.

16.7.2 Generation of a pressure surge

When liquid flows from one tank down a pipeline and through a valve into another tank, the pressure at any point in the system while the liquid is flowing has three components:

- Pressure on the surface of the liquid in the feed tank: in a tank with its ullage space open to atmosphere, this pressure is that of the atmosphere.
- Hydrostatic pressure at any point in the system in question: when the atmospheric pressure is added to the hydrostatic pressure this becomes an absolute pressure.
- Hydrodynamic pressure generated by the pump: this is highest at the pump outlet and decreases along the line downstream of the pump and through the valve to the receiving tank.

The total pressure generated by the pump to overcome resistance in the pipeline system is the sum of the hydrostatic and the hydrodynamic pressures and is affected by:

- Length, internal surface roughness and directional changes in the pipeline.
- Viscosity of the liquid being pumped.
- Nominal bore (diameter) of the pipeline.

Rapid closure of the valve puts a brief additional pressure upon all three components, due to the sudden conversion of the kinetic energy of the moving liquid into pressure. When the valve closes, the liquid immediately upstream of the valve is brought to rest instantly.

The sudden stop of flow of liquid is transmitted back up the pipeline as a pressure wave travelling at the speed of sound. If the pressure is not relieved, the result is a pressure wave that moves back and forth throughout the length of the pipe until it finally decays.

In most cases, valve closure is not instantaneous and there is some relief of the surge pressure through the valve while it is closing. Worst case is a valve shutting instantly, where damage to expansion couplings and butterfly valves can occur.

The damage caused by a pressure surge can be further increased by a vapour cavity collapse, which occurs when vapour cavities or bubbles in the liquid collapse when exposed to the pressure surge wave. Vapour cavities may be present in the high points of the cargo transfer system, such as the apex swivels of the MLA.

Many marine terminals have installed remotely operated valves that shut when a high-high level alarm ullage is reached in a receiving shore tank. The activation of a remotely operated valve while a ship is discharging to a shore tank may result in the whole cargo system being exposed to a pressure surge.

16.8 Reduction of pressure surge hazard

16.8.1 General precautions

Operational parameters for maximum allowable flow rates and minimum valve closure times should be established based on an engineering surge analysis.

Where motorised valves are installed, several steps can be taken to reduce the risk of pressure surge problems:

- Reduce the flow rate, i.e. the rate of transfer of cargo, to a value that makes the likely surge pressure tolerable.
- Increase the effective valve closure time. This will depend on the valve design but, in general terms, total closure times should be 30 seconds or greater.
- Use a pressure relief system, surge tanks or similar devices to absorb the effects of the surge sufficiently quickly.
- Provide a linked ship/shore ESD system including appropriate optional activators in the system to enable cargo pumps to be stopped immediately once a surge event is initiated. See chapter 18 for further information on linked ESD systems.
- Program valves to fail in last position to prevent unexpected and immediate closure due to power failure.

Where manually operated valves are used, good operating procedures should avoid pressure surge conditions. It is important that a valve at the end of a long pipeline should not be closed suddenly against the flow and so all changes in valve settings should be made slowly.

See chapter 12 for general guidance on correct operation of tanker valves.

16.8.2 Operational measures to reduce the risk of a pressure surge

In the operational context, the only practical precautions against the consequences of an inadvertent rapid closure is correct operation of the valves and/or to limit the linear flow rate of the oil to a maximum value related to the maximum tolerable surge pressure.

During the pre-transfer conference, tanker and terminal representatives should exchange information on managing the risks associated with pressure surge, including:

- Closure of automatic ESD valves.
- Rapid closure or opening of a manual or power operated valve.
- Sudden starting or stopping of a pump.
- Number of open cargo tank inlet valves.
- Elevation of shore tanks.
- Changes in pipeline and/or terminal tank that are planned to take place during cargo operations.

Terminals should have a documented tank changeover procedure, agreed during the pre-transfer conference, to reduce the risk of pressure surge.

Attention should be paid to whether the ship's pumps are positive displacement or centrifugal pumps, as this will impact surge risks related to unintentional closure of a terminal valve against the flow of cargo.

16.9 Hot work in hazardous areas in terminals

Hot work should not be allowed in the terminal while cargo operations are being carried out on a tanker, an adjacent tanker or in the terminal, without special precautions and the agreement of the tanker and terminal representatives.

It should be noted that dangerous or hazardous areas on the tanker and terminal may be wider than expected due to the alignment of the tanker alongside the terminal and the nature of operations taking place.

All hot work locations should be continuously monitored for the presence of flammable gas. The monitoring should take place in the immediate vicinity of the place or places where hot work is being carried out. If flammable gas is detected, all work should be immediately stopped, and the situation investigated before any approval to resume is authorised by the tanker and terminal managers.

When a risk assessment determines a fire watch is required, a fire watch with no other duties, except to watch for the presence of fire and to prevent the development of hazardous conditions, should be instituted. The fire watch team should have fire-extinguishing equipment readily available and be trained in its use. Before leaving the site and declaring the work completed, they should ensure that all hot surfaces have cooled and that no source of ignition exists.

16.10 Pigging

Pigging is a form of line clearing in which an object, often in the form of a rubber sphere or cylinder known as a pig, is pushed through the line by a liquid or by compressed gas. A pig may be used to clear the line completely, in which case it will usually be propelled by water or compressed gas, or to follow a previous grade to ensure that the pipeline remains as free of product as possible, in which case it is likely to be propelled by the next grade. In some cases, smart pigs, which may be self-propelled, are used to inspect pipeline condition for the purpose of renewal and preventing leaks.

A common arrangement for catching the pig is for the shore terminal to be outfitted with a pig receiver, which is mounted outboard of the tanker's manifold and from which the pig may be removed.

A pressure of about 2.7 bar (40 psi) is considered to be the minimum necessary to drive the pig, but pressures of up to 7 bar (100 psi) may be used.

Before any pigging operations are carried out, the Responsible Officer and the Terminal Representative should agree on the procedures and associated safeguards to be put in place. The propelling gas or liquid volumes, pressures, time required for the pig to travel along the line, volume of residual cargo in the line and the amount of ullage space available should be discussed and agreed.

During the pigging operation, terminal personnel should monitor the pressure upstream of the pig to ensure that it is not stuck in the line. Failure of the pig to arrive within the expected time period would also indicate that free movement of the pig has been restricted.

On completion of the pigging operation, terminal personnel should positively verify that the pig has arrived. Any residual pressure in the shore line should then be bled-off before opening the pig receiver or disconnecting MLAs or hoses.

Personnel at the receiving end should be aware that there may be sediment in the pig receiver unit and there should be procedures in place to deal with this, e.g., rags, absorbent material and drums. Considerations and measures should be in place for any toxic components that may be present during the retrieval.