CHAPTER 18

Cargo Transfer Equipment

This chapter describes the MLAs and flexible hoses used to make the tanker/terminal connection, including drainage and containment equipment and practices. The type of equipment is described, together with recommendations regarding its operation, maintenance, inspection and testing. If not properly engineered and maintained, this equipment will provide a weak link that may jeopardise the integrity of the cargo systems and the drainage and containment of hydrocarbons.

18.1 Marine Loading Arms

18.1.1 Operating envelope

All MLAs have a specific operating envelope that considers the following:

- Tidal range.
- Minimum and maximum freeboards of the tankers for which the berth is designed.
- Height of the manifold centre presentation flanges above the waterline.
- Minimum and maximum manifold setbacks from the deck's edge.
- Limits for changes in horizontal position due to drift off and ranging.
- Minimum and maximum spacing when operating with other MLAs in a bank.

For manifold information see OCIMF/CDI's *Recommendations for Oil and Chemical Tanker Manifolds and Associated Equipment.*

The limits of the operating envelope should be understood by berth operators. MLA installations should have a visual indication of the operating envelope and/or be provided with alarms to indicate excessive range and drift.

The PIC of operations on a berth should ensure that the tanker's manifolds are kept within the operating envelope during all stages of loading and discharging operations. To achieve this, the tanker may be required to ballast or de-ballast in conjunction with cargo operations. For MLA design information see OCIMF's *Design and Construction Specification for Marine Loading Arms.*

18.1.2 Forces on manifolds

Most MLAs are counterbalanced so that no weight, other than that of the liquid content of the arm, is placed on the manifold. Because the weight of oil in the arms can be considerable (particularly for larger diameter arms), it is advisable for this weight to be relieved by a support or jack provided by the terminal.

Some arms have integral jacks that are also used to avoid overstressing of the tanker's manifold by the weight of the arm or by other external forces such as the wind. Where supports or jacks are used, they should be fitted in such a way that they stand directly onto the deck or some other substantial support. They should never be placed onto fixtures or fittings that are not capable of, or suitable for, supporting the load (see section 18.1.8).

The terminal operator should have detailed information on the forces exerted on the tanker's manifold by each MLA. This information should be readily available to the berth operator.

The berth operator's training should include the correct rigging and operation of MLAs. Berth operators should be aware of the consequences of inappropriate operation that may cause excessive forces on the tanker's manifold.

Some counterbalanced MLAs are made slightly tail heavy to compensate for clingage of oil residue to the manifold and to help the arm return to the parked position without using power when released from the tanker's manifold. Additionally, in some positions of operation, there can be an upward force placed on the manifold. Forces applied on manifolds by counterbalanced loading arms shall not exceed the allowable loading limits for manifold support. For manifold design information see OCIMF/CDI's *Recommendations for Oil and Chemical Tanker Manifolds and Associated Equipment.*

18.1.3 Tanker manifold restrictions

The material of manufacture, support and cantilever length of a tanker's manifold, together with the spacing intervals of adjacent outlets, should be checked for compatibility with the MLAs. Manifold flanges should be vertical and parallel to the tanker's side. The spacing of the manifold flanges will sometimes dictate the number of MLAs that can be connected, to avoid interference between adjacent MLAs. For recommendations regarding tanker manifold restrictions in terms of dimensions, materials and arrangement (see OCIMF/CDI's *Recommendations for Oil and Chemical Tanker Manifolds and Associated Equipment*).

18.1.4 Parking of arms

MLAs should be empty when parked and locked, but inadvertent filling may occur. The parking lock should only be removed after the arm has been checked and verified as empty.

If MLAs need to be moved for maintenance or inspection, the arms should be confirmed as depressurised and drained of product.

Parking locks secure the MLAs in the parked position. Slewing motion, as well as inboard and outboard arm movements, should be locked while parked. Slewing and inboard arms should be mechanically locked. The outboard arm may be hydraulically locked. Parking locks should be able to be operated by one person. The operator should be able to see if the parking lock is on. System pressure relief valves should operate if movement is attempted while the locks are engaged.

18.1.5 Ice formation

Ice formation will affect the balance of the MLA. Any ice should be cleared from the MLA before releasing the parking lock.

18.1.6 Mechanical couplers

Mechanical couplers need manifold flange faces to be smooth and free of rust to ensure a tight seal. Care should be taken when connecting a mechanical coupler to ensure that it is centrally placed on the manifold's flange, faces aligned, and that all claws or wedges are pulling evenly on the flange:

- Where O-rings are used in place of gaskets, these should be replaced according to the manufacturer's recommendations.
- Where gaskets are used, these should be replaced with new gaskets on each occasion.

18.1.7 Wind forces

Wind loading of MLAs may place an excessive strain on tanker manifolds, as well as on the arms, and the terminal operator should establish wind limits for operation. At terminals where wind loading is critical, a close watch should be kept on wind speed and direction. When terminal operating wind limits are reached, operations should be suspended and the MLAs should be drained and disconnected.

18.1.8 Precautions when connecting and disconnecting Marine Loading Arms

Operation of MLAs should be carried out from a location where connection flanges on the tanker are visible to the operator. Where necessary, wired and/or wireless remote control systems should be provided.

Operators should ensure that all personnel are clear of moving MLAs and do not stand between an MLA and the tanker's structure because of the risk of unexpected movements of both powered and unpowered MLAs during connection and disconnection. Where an elevated manifold platform is fitted, without fixed or movable protections, the area should be properly identified and marked by warning signs to prevent falls.

MLAs should be empty of product when manoeuvred for connection to the tanker. They should be drained after each operation, returned to the parked and locked position when empty and stowed empty. All parking locks, braces and any additional items used to secure the MLA ashore are removed.

The following should be considered when connecting/disconnecting powered and unpowered MLAs:

- Stored hazardous energy (see chapter 4) may cause the MLA to move on its own when parking locks and associated braces are removed or when disconnecting from the tanker manifold.
- A test of shore power, static and remote controls, as well as a test of backup power if applicable.
- Two guide ropes should be fitted, when connecting manually operated MLAs, to control the movement of the connection end. Guide ropes should be visually inspected before use.
- Creation of an exclusion zone around the MLA when it is being operated.
- Weather conditions at the time of operation of the MLAs.
- The type of product being transferred and any additional Personal Protective Equipment (PPE)/personal monitors and detection equipment required.
- Verifying that lines are drained before connection/disconnection of transfer of MLA.
- Checking the hydraulic system's integrity.

PART 3 Marine Terminal Information

18.1.9 Precautions while Marine Loading Arms are connected

The following precautions should be taken when MLAs are connected:

- The tanker's moorings should be monitored and tended as necessary, so that any movement of the tanker is within the working envelope of the MLA.
- If drift or range alarms are activated, all transfer operations should be stopped and remedial measures taken.
- The MLAs should be free to move with the motion of the tanker. Care should be taken to ensure that hydraulic or mechanical locks cannot be inadvertently engaged.
- The MLAs should not clash with adjacent MLAs and equipment.
- Excessive vibration should be avoided.
- Tanker/terminal pressures should not exceed Maximum Working Pressure (MWP).

18.1.10 Powered Emergency Release Couplings

A Powered Emergency Release Coupling (PERC) is a hydraulically operated device fitted as part of an Emergency Release System (ERS) to provide quick disconnection of an MLA in emergency situations. The PERC has a valve on each side of the release point to minimise spillage. On release, the lower part of the coupling and its valve remain attached to the tanker's manifold while the upper part and its valve remain attached to the cargo arm, which is free to rise clear of the tanker. The valves above and below the release point are hydraulically or mechanically interlocked to ensure they are fully closed before operation.

The PERC is initiated in the following ways:

- Automatically, when the MLA reaches the specified envelope limit. This is normally accompanied by an alarm.
- Manually, using a push button on the central control panel.
- Manually, using hydraulic valves in the event of a loss of electrical power supply ashore.

Once the emergency disconnection has been initiated, the ERS valves adjacent to the PERC will close rapidly (typically in less than five seconds) and precautions need to be taken to avoid a pressure surge (see section 16.8). The terminal should provide surge control facilities for this purpose.

18.1.11 Inspection, testing and maintenance

Operation of an MLA, either powered or unpowered, can be a dangerous task. Consequently, the MLA should be in full working condition. To ensure this, three areas should be considered:

- Inspection.
- Testing.
- Maintenance.

These areas should include a structured schedule of pre-use, weekly, monthly, three monthly, six monthly, annual and five yearly inspection, testing and maintenance. The maintenance cycles should follow the guidelines given by the manufacturers of the MLAs they have in operation.

Further guidance for inspection, testing and maintenance of MLAs can be found in OCIMF's *Design and Construction for Marine Loading Arms* and OCIMF/SIGTTO's *Jetty Maintenance and Inspection Guide*.

18.2 Cargo hoses

18.2.1 General

Cargo transfer hoses may be of several types, e.g. rubber, composite and metallic, used in different services (dock, Ship to Ship (STS), floating) and for the transfer of various petroleum products. This section includes specific guidance for oil cargo hoses, but users should always consult applicable hose construction standards and the manufacturer's guidance.

Oil cargo hoses should conform to recognised standard specifications, or as recommended by OCIMF/established hose manufacturers. Hoses should be of a grade and type suitable for the service and operating conditions in which they are to be used.

Special hoses are required for use with high and low temperature cargoes. Manufacturers' recommendations can be found in BS 13482: *Rubber hoses and hose assemblies for asphalt and bitumen* and in BS 4089: *Specification for metallic hose assemblies for liquid petroleum gases and liquefied natural gases*.

The information on cargo hoses in the following sections is condensed from BS EN1765: *Rubber hose assemblies for oil suction and discharge services* and in BS EN13765: *Thermoplastic multi-layer (non-vulcanized) hoses and hose assemblies for the transfer of hydrocarbons, solvents and chemicals*. This information is provided to give a general indication of hoses that may be supplied for normal cargo handling duty.

Reference may also be made to OCIMF's *Guide to Manufacturing and Purchasing Hoses for Offshore Moorings* for information on hoses commonly used at conventional buoys, SPM facilities and Floating Production Storage and Offloading Units (FPSOs).

18.2.2 Types and applications

For normal duty, there are four basic types of rubber, rubber compound or composite hoses:

Rough bore (R)	Heavy and robust with an internal lining supported by a steel wire helix. It is used for cargo handling at terminal jetties. A similar hose is made for submarine and floating use. All Type R hoses are electrically continuous
Armoured rough bore (A)	In addition to an internal zinc coated steel wire helix, there should be an external helical armour of a similar material. Type A hoses are electrically continuous and may be lighter and more flexible than Type R
Smooth bore (S)	Used for dock operation where flexibility and lightness are important
Lightweight (L)	Used for discharge duty, STS transfers and bunkering, where flexibility and a light weight are important considerations

Type S and L hoses can be either electrically continuous or electrically discontinuous. Type S and L electrically continuous hoses are further subdivided into two grades, Grade M and Grade Ω. Grade M hoses are electrically bonded, with a maximum resistance of 100 ohms between end connections. Grade Ω hoses are electrically conductive, and the resistance between end connections can be as high as one million ohms. Grade Ω hoses are sometimes described as semi-continuous due to their intentionally higher resistance. However, it should be noted that there is no minimum resistance requirement for Grade Ω in the BS EN1765:2016 standard.

There are several special hose types of the same basic construction, but they are modified for specific purposes or service. These include subsea hoses or hoses for use in floating hose strings.

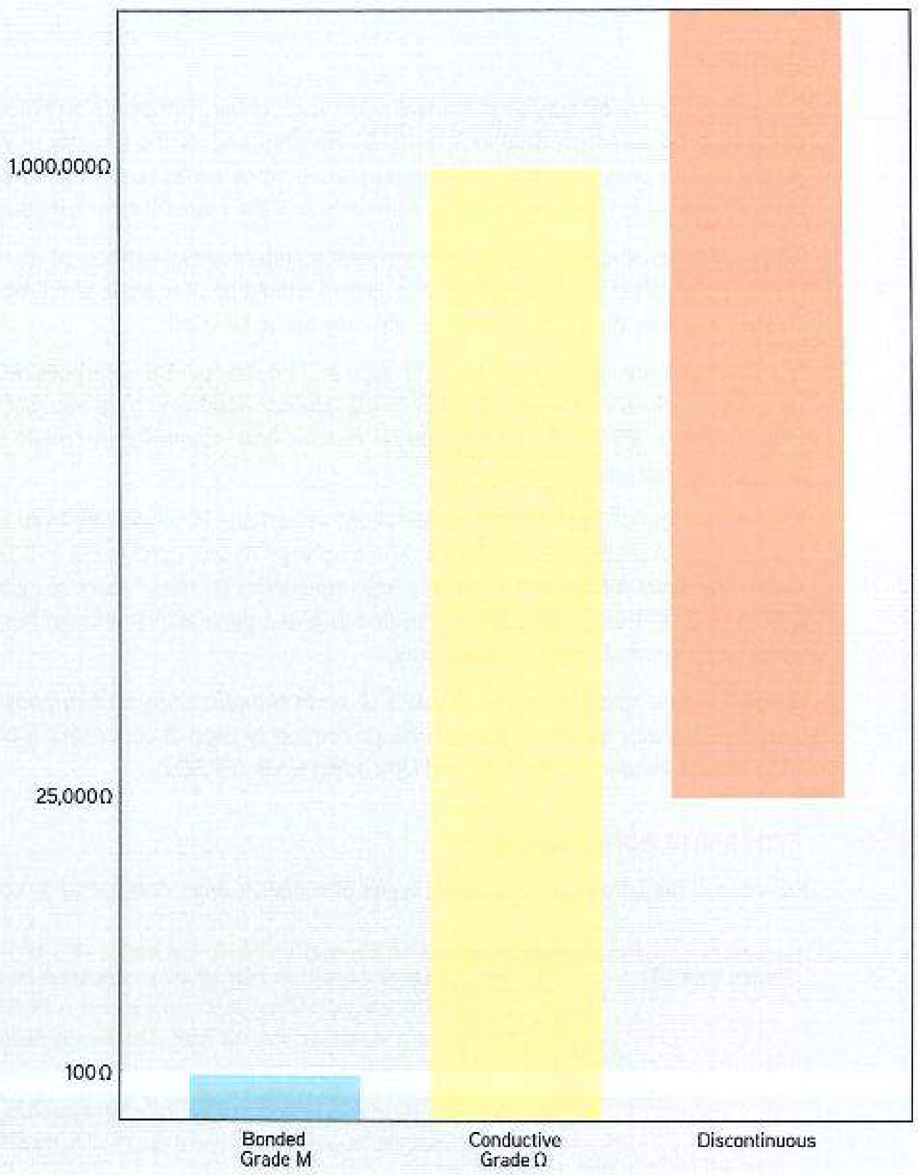

Figure 18.1: Differences in resistance between Grade M, Grade Ω and discontinuous hose types

Composite hoses

Specific types of composite hoses are generally designated for the properties of the cargo they are designed to carry/handle. Users should consult with the manufacturer for guidance on compatibility of hose and cargo.

Composite hoses may be used for the transfer of some petroleum cargoes, but may not be suitable for high viscosity cargoes. They are typically more flexible and lighter than rubber hoses. Composite hoses are constructed from materials, including:

- Galvanised, coated or stainless steel wire helices.
- Polypropylene (PP), polytetrafluoroethylene (PTFE) or polyethylene terephthalate linings.
- UV and chemically resistant PVC coated polyester covers.
- Galvanised or stainless steel outer helices.

Users of these hoses should ensure they understand the differences.

18.2.3 Performance

Rubber, rubber compound or composite hoses are usually manufactured for products having a minimum temperature of -20°C to a maximum of +82°C and an aromatic hydrocarbon content not greater than 50%. Such hoses are normally suitable for sunlight and ambient temperatures ranging from -29°C to +52°C.

18.2.4 Marking

18.2.4.1 Rubber hoses

Each length of hose should be marked by the manufacturer, in accordance with BS EN1765, with:

- The manufacturer's name or trademark, e.g. XXX.
- Identification with the dated standard specification for manufacture, e.g. EN1765:2016.
- Type and designation, e.g. A15.
- Nominal bore, e.g. 75.
- MWP, e.g. 15 bar.
- Symbol to identify electrical conductivity, e.g. M and Ω respectively (type S and L only).
- Quarter and year of manufacture, e.g. 2Q-2015.
- Manufacturer's serial number, e.g. 005.

Example XXX/EN1765:2016/A15/75/15bar/Ω/2Q2017/005

Electrically discontinuous assemblies should also have the words 'electrically discontinuous'. The marking should be permanent and durable.

After testing, the temporary elongation value should be painted legibly at each end of the hose in diametrically opposite positions.

18.2.4.2 Composite hoses

Each hose should be permanently marked at an interval of not greater than one metre with lettering of a minimum height of 10mm and with at least the following information:

- The manufacturer's name or identification mark, e.g. XXX.
- Number and year of standard, e.g. EN 13765:2018.
- Hose identification-type, e.g. type 2.
- Internal diameter, e.g. 40mm.
- MWP, e.g. 10 bar.
- Working temperature range, e.g. -30°C to 80°C.
- Material of inner liquid barrier layer, as referenced in EN ISO 1043-1, e.g. PP (polypropylene).
- Quarter and year of manufacture, e.g. 2Q-2015.

Example XXX/EN13765:2016/type 2/40/10bar/-30°C to 80°C/PP/4Q2017

In addition, each composite hose shall be permanently marked on the ferrule at one end with the following:

- Assembler's name or identification mark.
- The hose assembly serial number.
- Maximum Allowable Working Pressure (MAWP) for the assembly.
- The test date of the hose assembly.
- Quarter and year of hose assembly manufacture.

18.2.5 Flow velocities

The maximum permissible flow velocity through a hose is limited by the construction of the hose and its diameter. The hose manufacturer's recommendations and certification should provide details.

Acceptable flow velocities for rubber hoses are typically 15–21m/sec. The allowable flow velocity for a high velocity hose can be as high as 25m/sec.

Recommended flow velocities for composite hoses are lower as there is a helical wire in the bore, supporting the hose structure, which will result in much higher friction losses and drag. With higher velocities there is a risk of dislodging the internal wire in this hose design. Typical velocities are 7–9m/sec.

The limiting maximum flow velocity is often determined by the internal pipework of the tanker or terminal and depends on the nature of the product (see sections 12.1.7 and 11.3.3.2).

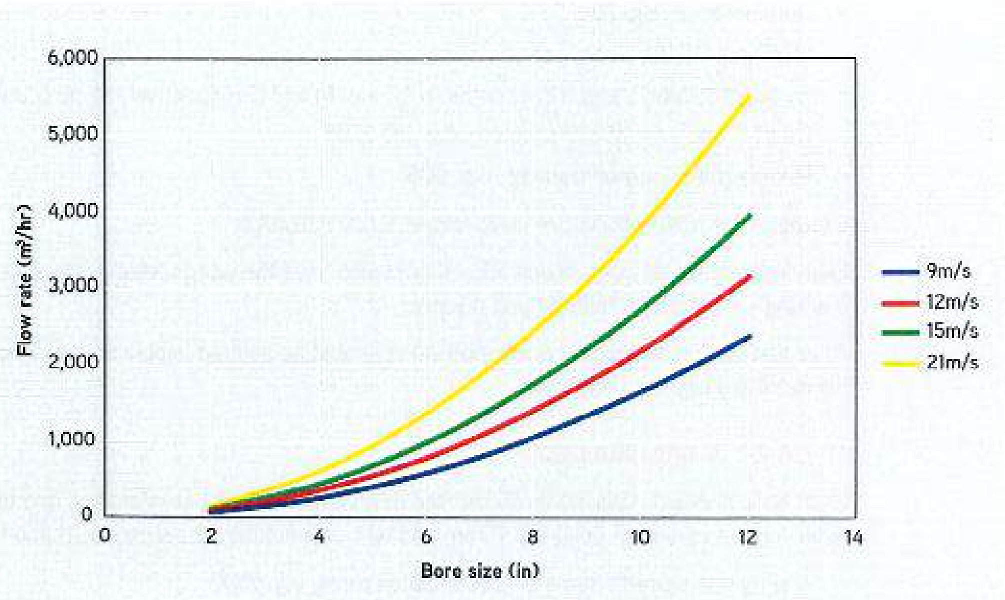

Figure 18.2: Maximum flow rate for given flow velocity and bore size

18.2.6 Inspection, testing and maintenance requirements for cargo hoses

18.2.6.1 General

Hoses in service should have a documented inspection at least annually to confirm their suitability for continued use.

Hoses should be retired in accordance with defined criteria (see section 18.2.6.5).

All hoses should be certified, fit for purpose, in good physical condition and should have been pressure tested. A record of all hose certificates should be maintained and made available for review by appropriate parties on request.

18.2.6.2 Visual examination

A visual examination should be carried out before each use and consist of examining the:

- Hose assembly for irregularities in the outside diameter, e.g. kinking.
- Hose cover for damaged or exposed reinforcement or permanent deformation.

- End fittings for signs of damage, slippage or misalignment.
- Internal liner, where applicable.
- Hose cover to determine if any cuts, gouges or abrasions have penetrated to a liquid barrier.
- For crushed or kinked areas, longitudinal ridges or bulges.

Additionally, for composite hoses:

- Pitch angle and spacing between wraps in outer helix wire, excessive corrosion, rust or scaling on wire helices.

A hose assembly exhibiting any of the above defects should be removed from service for a more detailed inspection to determine suitability for continued use. When a hose assembly is withdrawn from service following a visual inspection, the reason for withdrawal and the date should be recorded.

18.2.6.3 Hydrostatic pressure test

Hose assemblies should be hydrostatically tested to check their integrity. The intervals between tests should be determined in accordance with service experience but, in any case, should not be more than twelve months. Testing intervals should be shortened for hoses handling particularly aggressive products, for products at elevated temperatures or for older hoses.

If the rated pressure of a hose has been exceeded it should be removed and re-tested before further use.

A record should be kept of the service history of each hose assembly.

The recommended method of testing is as follows:

Rubber hoses

1. Lay out the hose straight on level supports that allow free movement of the hose when the test pressure is applied. Conduct an electrical continuity test.
2. Seal the hose by bolting blanking-off plates to both ends, one plate to be fitted with a connection to the water pump and the other to be fitted with a hand operated valve to release air through a vent. Fill the hose with fresh water until a constant stream of water is delivered through the vent.
3. Connect the test pump at one end and apply a pressure of 0.7 bar. Measure and record the overall length of the hose assembly between the measuring points.
4. Slowly increase the pressure up to the MWP. Hold this pressure for ten minutes.
5. Re-measure the length of the hose over the same surface as before.
6. Ascertain the temporary elongation and record the increase as a percentage of the original length.
7. Release the pressure to zero bar.
8. Leave the assembly relaxed for 15 minutes and then raise the pressure to 0.7 bar.
9. Re-measure the length of the hose over the same surface as before.
10. Slowly raise the pressure to 1.5 times the MWP and hold this pressure for five minutes.
11. Examine the hose assembly and check for leaks and any sign of distortion or twisting. Conduct an electrical continuity test with the hose at test pressure.
12. Reduce the pressure to zero and drain the hose assembly. Re-test for electrical continuity.

Composite hoses

1. Lay out the hose straight on level supports that allow free movement of the hose when the test pressure is applied. Conduct an electrical continuity test.
2. Seal the hose by bolting blanking-off plates to both ends, one plate to be fitted with a connection to the water pump and the other to be fitted with a hand operated valve to release air through a vent. Fill the hose with fresh water until a constant stream of water is delivered through the vent.
3. Connect the test pump at one end and apply a pressure of 0.7 bar. Measure and record the overall length of the hose assembly between the measuring points.
4. Slowly increase the pressure up to 1.5 times the MWP. Hold this pressure for ten minutes.
5. Re-measure the length of the hose over the same surface as before.
6. Ascertain the temporary elongation and record the increase as a percentage of the original length.
7. Slowly lower the pressure to 0.7 bar and stabilise.
8. Re-measure the length of the hose over the same surface as before.
9. Reduce the pressure to zero and drain the hose assembly. Re-test for electrical continuity.

If there are no signs of leakage or movement of the fitting while the used hose is under test pressure, but the hose exhibits significant distortion or excessive elongation, the hose should be scrapped and not returned to service.

If the integrity of the hose lining of smooth bore rubber hoses is in doubt, the hose should be additionally subjected to a vacuum test as follows:

1. Remove the blanks used for the pressure test and fit suitable plexiglass plates to the hose ends.
2. Apply a vacuum of at least 510mb gauge for a period of ten minutes.
3. Inspect the interior of the hose for blisters, bulges or separation of the lining from the carcass. Any damage to the lining should result in the hose being retired from service.
4. Release the vacuum.
5. Re-test for electrical continuity or discontinuity as appropriate.

It should be noted that lightweight hoses, composite hoses and rough bore hoses should not be subjected to a vacuum test.

18.2.6.4 Electrical continuity and discontinuity test

The electrical properties of a hose are determined during type testing of the hose design and verified through routine testing thereafter, in accordance with ISO 8031, as referenced by BS EN1765:2016.

Since electrical continuity can be affected by any of the physical hose tests, a check on electrical resistance should be carried out before, during and after the pressure tests.

Electrically discontinuous hoses should have a resistance of not less than 25,000 ohms, measured end flange to end flange.

Electrically continuous hoses (Type R, Type S Grade M, or Type L Grade M) should not have a resistance higher than 100 ohms, measured end flange to end flange.

Electrically continuous hoses (Type S Grade Ω, or Type L Grade Ω) should not have a resistance higher than 1,000,000 ohms measured end flange to end flange.

Electrical semi-continuous hoses have a resistance between 1,000 and 1,000,000 ohms, measured between nipples (end flange to end flange).

Composite hoses which are electrically continuous should have a resistance of less than 100 ohms, measured flange to flange.

18.2.6.5 Withdrawal from service

In consultation with the hose manufacturer, the retirement age should be defined for each hose type to determine when it should be removed from service, irrespective of meeting inspection and testing criteria.

A retirement register of hoses should be maintained, including the date and reason(s) for any hose retirement.

The retirement register should be made available for review by appropriate parties on request.

The retirement age should be based on a risk assessment that should consider the following as a minimum:

- Manufacturer's guidelines.
- Cargo type.
- Storage conditions.
- Hose handling and frequency of operation.
- Any experience of past failures.
- Any local regulatory requirements.

18.2.6.6 Explanation of pressure ratings for hoses

Figure 18.3 provides an illustration of the relationship between several definitions of pressure that are in common usage. The individual terms are briefly described below:

Maximum Working Pressure

The MWP is the maximum hose pressure capability. This pressure rating is expected to account for dynamic surge pressures and is used by BS and EN Standards for designing hoses.

Rated Working Pressure

The Rated Working Pressure (RWP) does not take into account dynamic surge pressures and is not to be confused with MWP. It is the working pressure expected during normal working conditions.

Factory test pressure

This is referenced in BS EN 1765 and is defined as equal to the MWP.

Maximum Allowable Working Pressure

The MAWP is used as a reference by the United States Coast Guard (USCG) and is commonly used by terminals to define their system equipment limitations.

Hydrostatic test pressure

This is the pressure at which the hose is tested at least annually.

Proof pressure

This is a one time pressure that is applied to production hoses to ensure integrity following manufacture and is equal to 1.5 times the MWP.

Burst test pressure

This is a test requirement for a single prototype hose to confirm the hose design and manufacture of each specific hose type. The pressure is equal to a minimum of four times the factory test pressure and must be applied in a specific manner and held for 15 minutes without hose failure.

PART 3 Marine Terminal Information

Burst pressure

This is the actual pressure at which a prototype hose fails. For a successful prototype hose, the burst pressure would exceed the burst test pressure.

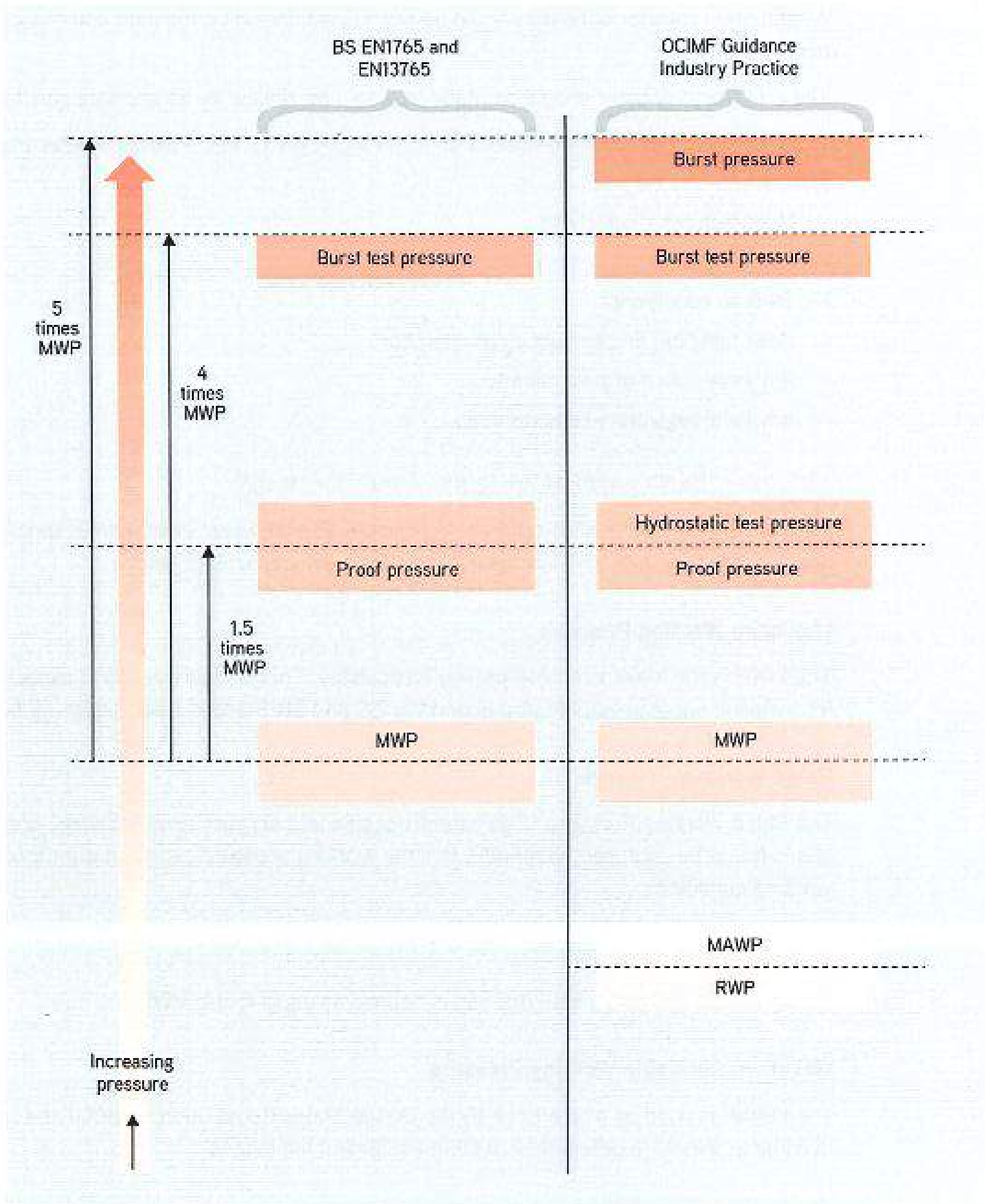

Figure 18.3: Illustration of terminology used for defining hose pressures

18.2.7 Hose flange standards

Flange dimensions and drilling should conform to OCIMF/CDI's *Recommendations for Oil and Chemical Tanker Manifolds and Associated Equipment*.

18.2.8 Operating conditions

Hoses should be selected according to the operating design conditions of the system in which they will be applied. Whenever the operating conditions may change, for example, product specification or temperature, flow rate or pressure, the compatibility of the hoses to be used should be verified.

18.2.9 Extended storage

New hoses in storage before use, or hoses removed from service for a period of two months or more, should as far as practicable be kept in a cool, dark, dry storage in which air can circulate freely. They should be drained and washed out with fresh water and laid out horizontally on solid supports, spaced to keep the hose straight. No oil should be allowed to come into contact with the outside of the hose.

Non-load bearing protective blanks (wood) with breathing holes should be fitted to prevent wildlife or other foreign bodies getting into the hoses.

If the hose is stored outside, it should be well protected from the ultraviolet rays of the sun. See BS 1435: *Rubber hose assemblies for oil suction and discharge services.*

18.2.10 Handling, lifting and suspending

Hoses should always be handled with care and should not be dragged over a surface or rolled in a manner that twists the body of the hose. Hoses should not be allowed to come into contact with a hot surface such as a steam pipe. Protection should be provided at any point where chafing or rubbing can occur.

Lifting bridles and saddles should be provided. The use of steel wires in direct contact with the hose cover should not be permitted. Certified lifting straps should be used. They should be positioned so the hose will not fold over on itself (sharp kinks in the hose should be avoided). Lifting equipment used should be appropriately sized to accommodate the weight of the hose when full of product.

Straps should be placed strategically to allow the flange to align horizontally. This will improve hose connection efficiency.

Excessive weight on the ship's manifold should be avoided. If there is an excessive overhang, or the ship's valve is outside the stool support, additional support should be given to the manifold. A horizontal curved plate or pipe section should be fitted at the ship's side to protect the hose from sharp edges and obstructions. Adequate support for the hose, when connected to the manifold, should be provided. Where this support is via a single lifting point, such as a hose crane, the hose string should be supported by bridles or webbing straps. Some hoses are specifically designed to be unsupported.

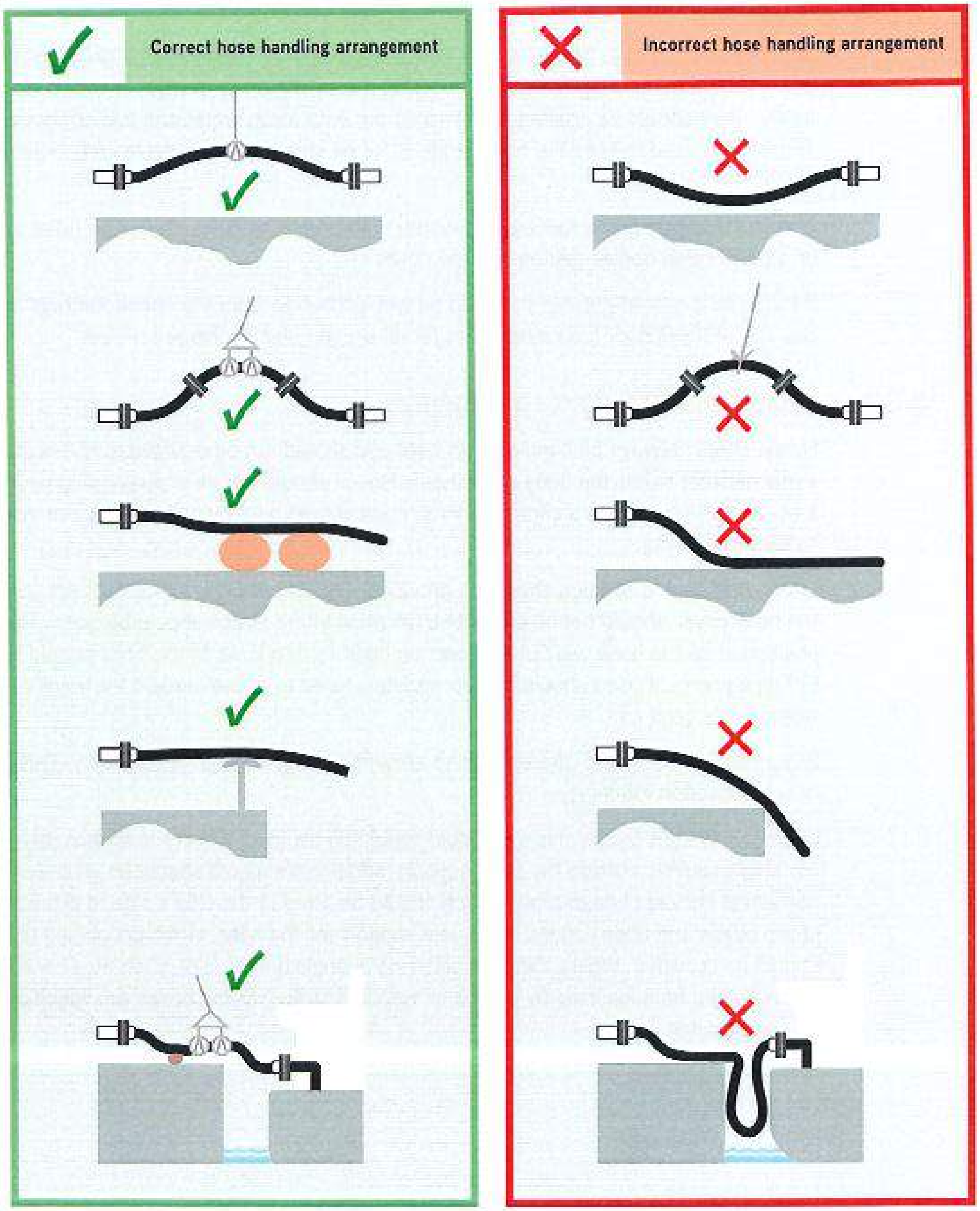

Figure 18.4: Hose handling arrangement

18.2.11 Adjustment during cargo handling operations

As the tanker rises or falls, as a result of tide or cargo operations, the hose strings should be adjusted to avoid undue strain on the hoses, connections and ship's manifold and to ensure that the radius of curvature of the hose remains within the limits recommended by the manufacturer. The minimum length of hose should be sufficient to cover all states of tide and tanker freeboard and motions.

18.2.12 Submarine and floating hose strings

Hoses in service at offshore mooring installations should be inspected periodically.

Particular attention should be paid to kinked or damaged sections, oil seepage from the hose flange areas, heavy marine growth and scuffing on the seabed. Where hose strings are lowered and raised repeatedly from the seabed, care should be taken to avoid damage caused by chains and lifting plates.

Care should be taken when lowering hose strings to avoid them coiling down. Dragging of hoses over the seabed should be minimised.

Before attempting to lift a hose string on board, the Responsible Officer should check that the total weight involved does not exceed the SWL of the ship's crane. The terminal should advise the total weight of the hose string to be lifted in relation to the height of the lift, which could be as much as eight metres above deck level for a tanker's manifold connection situated 4.6m inboard. In wave and/or swell conditions greater than one metre significant height, the movement of the hose may also impose dynamic loads. In these circumstances, the load to be lifted may be as much as 1.5 times the static weight of the hose and its contents (see section 18.2.13).

During the lifting of hose strings, contact with the ship's side and any sharp edges should be avoided.

When the hose string has been lifted to the required height for connecting to the manifold, and while it remains connected, the vertical section of the hose string should be supported by hang-off chains or wires made fast to a strong point on the ship's deck.

To prevent spills, the section between the last valve and the blank should be checked for oil under pressure before removing blanks from submarine or floating pipelines.

A visual inspection of each floating hose string should be made to check for damage, kinking or oil seepage before connecting it to the tanker's manifold.

If any damage to the hose is found that is likely to affect its integrity, the hose should be withdrawn from use to allow further inspection and repair.

See OCIMF's *Guide to Purchasing, Manufacturing and Testing of Loading and Discharge Hoses for Offshore Moorings* and *A Study into Crane Loads Associated with Hose Handling at Offshore Terminals.*

18.2.13 Hoses used in Ship to Ship transfers

Hoses for STS operations can be provided as pre-assembled strings, or in individual sections. There are advantages and disadvantages to both methods. Dedicated lightering vessels usually have their own hose strings and these hoses have to be inspected, tested and maintained.

Advantages of pre-assembled strings:

- The hoses are tested as a continuous string, which ensures liquid-tight integrity at each intermediate flange connection. This assurance is only applicable to the time of testing.
- The time required to connect hoses between two ships can be reduced.
- There is additional assurance that strings are assembled correctly when continuous and discontinuous hose sections are used.

Disadvantages of pre-assembled strings:

- Hoses may be folded when lifting them on board the ship.
- Fasteners may work loose as the hose strings are handled repeatedly and used for multiple operations.

Advantages of individually delivered hose sections:

- The inner liner of each hose can be inspected when the ends are open.
- Hoses are less likely to be bent beyond their Minimum Bend Radius (MBR) when lifted on board.
- Spreader bars can be used to support hoses during lifting.

Disadvantages of individually delivered hose sections:

- Connecting hose sections on board requires space.
- It can be difficult to reach and tighten fasteners underneath the hose and integrity of the flange connections is usually not verified by testing.

When composite hoses are used for STS, these hoses are usually manufactured to the length required and there are no intermediate flanges. Due to improved MBRs, composite hoses can be coiled.

The MBR for storage and operation should be confirmed with the manufacturer and adhered to when lifting or handling the hose. Some hoses are designed to be temporarily folded but should be returned to a straight position as soon as possible. Composite hoses used for STS should be well supported to prevent over bending, especially near end fittings.

A visual inspection of each hose string should be made before connecting it to the tanker's manifold to determine if damage has been caused by handling offshore or by contact with support craft structures. If the hose has been damaged it should not be used and a replacement should be provided.

When connecting the hose string to the tanker manifolds, the hose string should not twist between the two manifolds because this can restrict the flow of cargo. Some hose manufacturers embed a stripe in the outer hose cover to assist with alignment.

Hoses should be properly supported by straps and hose support ropes. Straps should be placed strategically to allow the flange connection to align horizontally. Hose support ropes prevent unnecessary stress on the manifold and ensure hose maintain correct bend radiuses where they cross the rail. The rope size should be the minimum required to support the weight of the hose and of a size to enable operators to turn the hose around a cruciform bit at the manifold.

18.2.14 Electrical isolation

Due to possible differences in electrical potential between two ships intending to undertake cargo or bunker transfers via a transfer system, e.g. cargo hoses, there is a risk of electrical arcing at the manifold during connection and disconnection of the transfer system.

To protect against this risk, there should be a means of electrical discontinuity in the connection interface and this is normally provided by an insulating flange. Provision of the method of isolation should be agreed between the two ships prior to connection (see section 12.9.5).

18.3 Vapour Emission Control Systems

Many terminals are equipped with VECSs to receive and process vapours displaced from a tanker during loading operations. The terminal's operating manual should include a full description of the system and the requirements for its safe operation. The terminal's information booklet, provided to visiting tankers for information, should also include details of the vapour recovery system.

All shore personnel in charge of transfer operations should complete a structured training programme covering the particular VECS installed in the terminal. The training should include details of typical equipment installed on board tankers and related operating procedures.

Tanker and terminal personnel should be aware of any constraints associated with the operation of the VECS during the pre-transfer conference. Confirmation that this information has been exchanged and agreed to will be included in the SSSCL (see chapter 25).

See section 23.7.7 for information on the primary safety issues relating to cargo transfer operations using vapour recovery.

Terminal vapour hoses should be marked in a similar way to a tanker's vapour manifolds as indicated in section 23.7.7.

18.4 Cargo transfer drainage and containment

Drainage and containment facilities at the cargo transfer areas of marine terminals are an important aspect of containing spills, controlling pollution and preventing the progression of fires. Marine terminals should have provisions for safely draining the cargo transfer system, i.e. MLAs and hoses and containing any operational spillages and hydrocarbon releases mixed with rainwater. For detailed guidance on the design of drainage and containment facilities, see section 18.4.2.

All cargo transfer drainage and containment equipment should be inspected, tested and maintained in accordance with OCIMF/SIGTTO's *Jetty Maintenance and Inspection Guide.*

18.4.1 Marine Loading Arm/hose clearing

Terminals should have adequate provisions for the clearing of MLAs and hoses. A documented operating procedure should be in place for the type of clearing used.

A backup plan should be considered in the event that the primary means of clearing the arm or hose fails.

Acceptable methods for clearing the MLAs and hoses include:

- Gravity drain from MLA/hose directly to a sump and/or tanker.
- Purging MLA/hose with nitrogen to tanker/terminal.
- Stripping MLA/hose back into shore cargo lines.

Facilities and operating procedures for clearing cargo transfer equipment may also need to consider the following:

- Lifting equipment is provided to aid gravity draining of cargo hoses. Suitable means of checking that cargo transfer systems are drained and confirmed zero energy prior to connection/disconnection, e.g. bleeder valve or pressure gauge.
- Means of verification to ensure drain valves are closed prior to cargo transfer operations, e.g. interlock system, critical procedure.
- Adequate supply of nitrogen is available where necessary, i.e. contingency plan for when nitrogen supply is lost.

18.4.2 Jetty deck containment

Each terminal should have a continuous curbed area for the containment of spills near cargo transfer manifolds, sample points, valves and other potential sources that could leak directly into the marine environment.

In addition to the cargo transfer lines and associated small bore piping, other potential sources include:

- Hydraulic fluids from reservoirs near equipment such as arms, cranes, gangways.
- Pressure relieving valves.
- Atmospheric vents, e.g. sumps.
- Transformer oil for electrical equipment.
- Other components with non-welded joints, e.g. flanges, valves.

The containment areas and minimum curb height should be suitably sized to contain the extent of a potential spill and consideration should also be given to storm/rain water management and the magnitude of the rainfall intensity for the location. This will be derived from the intensity of the design storm and its relationship to a specified return period and duration equal to the time of concentration of the drainage area.

The deck within the curbed areas should be sloped into a dedicated catch basin that drains to a sump, or be provided with other means of preventing accumulation of product and avoiding overflow.

If the terminal is equipped with scuppers to facilitate drainage and containment of surface content, a work procedure should be developed to ensure scuppers are in place during cargo transfer and ensuring no hydrocarbons are present in containment area prior to removal. Procedure should include provisions for removing only one scupper at a time and ensuring an operator remains present at all times while scupper is removed.

Valves such as vacuum breakers and sample valves should be self-closing to prevent the operator from leaving valves open, which may potentially lead to a loss of containment.

Unused hoses, MLAs, manifold connections, drains, vents and gauge connections should be suitably blanked or capped. If equipment is fully connected to the cargo's manifold, blank flanges should be fully bolted and have the same rating as the system to which they are attached.

For terminals that are not dedicated to the transfer of oils/chemicals, consideration should be given to containment curbing and methods for draining cargo transfer equipment. For locations with recessed manifold pits, regular operator checks should be in place to ensure appropriate containment and drainage of cargo content. Consideration should be given to hydrocarbon detection systems.

18.4.3 Hydrocarbon sump tanks

When required, hydrocarbon sump tanks should be suitably sized to contain operational spills and stormwater and to fulfil cargo transfer system drainage requirements.

Consideration should be given to segregating heated and low-flash product into different sumps, unless a proper inerted system is fitted.

18.5 Emergency Shutdown systems

ESD systems for cargo transfers are used to stop the flow of cargo liquid and vapour in an emergency and to bring the cargo handling system to a safe, static condition.

It is recommended that tankers and terminals are provided with the necessary equipment to enable interconnection of ESD systems.

As a minimum, ESD systems should:

- Stop all cargo transfer pumps when an ESD is activated on the tanker or terminal.
- Stop the tanker's cargo transfer pumps when a terminal high level alarm is activated.

Further information can be found in OCIMF/CDI's *Linked Ship/Shore Emergency Shutdown Systems for Oil and Chemical Transfers*.