Chapter 18

CARGO TRANSFER EQUIPMENT

This Chapter describes hard arms and flexible hoses used to make the connection between tanker and shore. 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 cargo system's integrity.

18.1 Metal Cargo Arms

18.1.1 Operating Envelope

All metal cargo arms have a designed operating envelope, which takes into account the following:

- Range of water level in berth.
- Maximum and minimum freeboards of the largest and smallest tankers for which the berth has been designed.
- Minimum and maximum manifold setbacks from the deck edge.
- Limits for changes in horizontal position due to drift off and ranging.
- Maximum and minimum spacing when operating with other arms in a bank.

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

The person in charge 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 deballast. (See also Section 11.2).

18.1.2 Forces on Manifolds

Most metal cargo arms 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 may be 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 other external forces such as the wind.

Terminals should have detailed information on the forces exerted on the tanker's manifold by each loading arm. This information should be readily available to the berth operator.

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

Where supports or jacks are utilised, 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.

Some counterbalanced arms are made slightly tail heavy to compensate for clingage of oil and to facilitate the arm's 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. For both these reasons, manifolds should also be secured against upward forces.

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, must be checked for compatibility with the arms. It is considered best practice for manifold flanges to be vertical and parallel to the tanker's side. The spacing of the manifold outlets will sometimes dictate the number of arms that can be connected, while interference between adjacent arms is to be avoided. In most cases, cast iron manifolds will be subjected to excessive stress unless jacks are used. Cast iron reducers and spool pieces should not be used. (See Section 24.6.3.) In some cases cast iron reducers and/or spool pieces are permanently fitted to the tanker's lines. If so, supports or jacks should be fitted directly onto the deck or some other substantial support. Furthermore directly connecting to any cast iron valves should be avoided at all time.

18.1.4 Inadvertent Filling of Arms while Parked

Loading arms are usually empty when parked and locked, but inadvertent filling may occur. The parking lock should only be removed after the arm has been checked and proven to be empty to avoid the possibility of an inadvertently filled loading arm falling onto the tanker's deck.

18.1.5 Ice Formation

Ice formation will affect the balance of the arm. Any ice should therefore be cleared from the arm before the parking lock is removed.

18.1.6 Mechanical Couplers

Most mechanical couplers require that the tanker's manifold flange face is smooth and free of rust for a tight seal to be achieved. Care should be taken when connecting a mechanical coupler to ensure that the coupler is centrally placed on the manifold flange and that all claws or wedges are pulling up on the flange. Where 'O' rings are used in place of gaskets, these should be renewed on every occasion.

18.1.7 Wind Forces

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

18.1.8 Precautions when Connecting and Disconnecting Arms

Due to the risk of unexpected movements of both powered and unpowered arms during connection and disconnection, operators should ensure that all personnel stand well clear of moving arms and do not stand between a moving arm and the tanker's structure. When connecting manually operated arms, consideration should be given to fitting two lanyards to control the movement of the connection end.

18.1.9 Precautions while Arms are Connected

The following precautions should be taken during the period that cargo arms are connected:

- Moorings should be monitored frequently by tanker and shore personnel and tended as necessary, so that any movement of the tanker is restricted to within the operating envelope of the metal arm.
- If drift or range alarms are fitted and are activated, all transfer operations should be stopped and remedial measures taken.
- The arms 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 arms should not foul each other.
- Excessive vibration should be avoided.

18.1.10 Powered Emergency Release Couplings (PERCs)

A Powered Emergency Release Coupling (PERC) is a hydraulically operated device to provide quick disconnection of a marine loading arm in an emergency, or when the operating envelope of a loading arm is exceeded. It has a valve on each side of the release point to minimise spillage. On release, from ashore the lower part of the coupling and its attendant valve remain attached to the tanker's manifold while the upper part and its attendant valve remain attached to the cargo arm, which is then free to rise clear of the tanker.

The Emergency Release System (ERS) is initiated in the following ways:

- Automatically, when the arm reaches the specified limit; alarms usually sound.
- Manually, from the central control panel ashore.
- Manually, using hydraulic valves in the event of loss of electrical power supply ashore.

The Emergency Release System (ERS) valves above and below the Emergency Release Coupling (ERC) are hydraulically or mechanically interlocked to ensure they close fully prior to ERC operation.

Once the emergency disconnection has been initiated, the valves adjacent to the PERC will close rapidly (typically in less than 5 seconds) and therefore precautions need to be taken to avoid a pressure surge (see Section 16.8). It is usual for the terminal to provide surge control facilities for this purpose, but if these are not available then special operating procedures may be necessary.

18.2 Cargo Hoses

18.2.1 General

Oil cargo hose should conform to recognised standard specifications, or as recommended by OCIMF and confirmed by established hose manufacturers. Hose should be of a grade and type suitable for the service and operating conditions in which it is to be used.

Special hose is required for use with high temperature cargoes, such as hot asphalt, and also for use with low temperature cargoes.

The information on cargo hoses in the following Sections (18.2.2 to 18.2.5) is condensed from EN 1765 : 2005 and BS 1435-2 : 2005 ('Rubber Hose Assemblies for Oil Suction and Discharge Services'). It is provided to give a general indication of hoses that may be supplied for normal cargo handling duty, commonly referred to as 'dock hoses'.

Reference may also be made, as appropriate, to European Standard EN 12115 : 1999 (Rubber and Thermoplastics Hoses and Hose Assemblies) or EN 13765 : 2003 (Thermoplastic Multilayer (Non-vulcanized) Hoses and Hose Assemblies) or EN ISO 10380 : 2003 (Corrugated Metal Hoses and Hose Assemblies).

18.2.2 Types and Applications

For normal duty, there are three basic types of hose:

Rough Bore (R)
This type of hose is 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 (type R x M).

Smooth Bore (S)
Smooth bore hose is also used for cargo handling at terminal jetties, but is of lighter construction than the rough bore type and the lining is not supported by a wire helix. A similar hose is made for submarine and floating use (type S x M).

Lightweight (L)
Lightweight hose is for discharge duty or bunkering only, where flexibility and light weight are important considerations.

All of these types of hose may be supplied as either electrically continuous or electrically discontinuous.

There are a number of special hose types having the same basic construction, but which are modified for particular purposes or service.

18.2.3 Performance

Hose is classified according to its rated pressure and this pressure should not be exceeded in service. The manufacturer also applies a vacuum test to hoses supplied for suction and discharge service.

Standard 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 25%. Such hoses are normally suitable for sunlight and ambient temperatures ranging from -29°C to 52°C.

18.2.4 Marking

Each length of hose should be marked by the manufacturer with:

- The manufacturer's name or trademark.
- Identification with the standard specification for manufacture.
- Factory test pressure.
- Month and year of manufacture.
- Manufacturer's serial number.
- Indication that the hose is electrically continuous or electrically discontinuous.

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. However, operators should take other factors into account when deciding flow velocities. These should include, but not be limited to, the following:

- The factor of safety being applied.
- Any limitations imposed by flow velocities in the tanker's fixed piping system.
- Weather conditions causing movement of the hose.
- Age, service and condition of the hose.
- Amount of use and method of storing the hose.
- Other local considerations.

The following table is indicative of flow rates for hose supplied under the British Standard or the OCIMF guidelines.

Throughput at 12 metres / second Velocity			
Hose Nominal Inside Diameter		Throughput	
Inches	Millimetres	m^3/hour	Barrels/hour
2"	50	87	550
4"	101	349	2199
6"	152	783	4930
8"	203	1398	8794
10"	254	2188	13768
12"	305	3156	19852

Table 18.1 – Throughput v. Inside Diameter at Velocity of 12 m/s

18.2.6 Inspection, Testing and Maintenance Requirements for Dock Cargo Hoses

18.2.6.1 General

Cargo hoses in service should have a documented inspection at least annually to confirm their suitability for continued use. This should include:

- A visual check for deterioration/damage.
- A pressure test to 1.5 times the Rated Working Pressure (RWP) to check for leakage or movement of end fittings. (Temporary elongation at RWP should be measured as an interim step.)
- Electrical continuity test.

Hoses should be retired in accordance with defined criteria.

This guidance also applies to any tanker's cargo hoses used for tanker/shore connections and any other flexible hose connected to tanker or shore cargo systems, for example a jumper hose at the end of a ramp serving a pontoon berth.

The owner of the hose should attest that any hoses that it provides are certified, fit for purpose, in good physical condition and have been pressure tested.

Details of the various inspections and tests are given in the following sections.

18.2.6.2 Visual Examination

A visual examination should consist of:

- Examining the hose assembly for irregularities in the outside diameter, e.g. kinking.
- Examining the hose cover for damaged or exposed reinforcement or permanent deformation.
- Examining the end fittings for signs of damage, slippage or misalignment.

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

If for any reasons cargo hoses are not suitable for their intended purpose, on being withdrawn from service they should be clearly marked (or labelled) to avoid any improper use.

18.2.6.3 Pressure Test (Integrity Check)

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 or products at elevated temperatures.

Hoses for which the rated pressure has been exceeded must 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:

(i) Lay out the hose assembly straight on level supports which allow free movement of the hose when the test pressure is applied. Conduct an electrical continuity test.

(ii) 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 assembly with water until a constant stream of water is delivered through the vent.

(iii) Connect the test pump at one end.

(iv) Measure and record the overall length of the hose assembly. Slowly increase the pressure up to the Rated Working Pressure.

(v) Hold the test pressure for a period of 5 minutes whilst examining the hose assembly for leaks at the nipples or for any signs of distortion or twisting.

(vi) At the end of the 5 minute period and while the hose is still under full pressure, re-measure the length of the hose assembly. Ascertain the temporary elongation and record the increase as a percentage of the original length.

(vii) Slowly raise the pressure to 1.5 times the Rated Working Pressure and hold this pressure for 5 minutes.

(viii) 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.

(ix) 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 assembly is under test pressure, but the hose exhibits significant distortion or excessive elongation, the hose assembly should be scrapped and not returned to service.

18.2.6.4 Electrical Continuity and Discontinuity Test

When using flexible hose strings, one length only of hose without internal bonding (electrically discontinuous) may be included in the hose string as an alternative to using the insulating flange (see Section 17.5.2). All other hoses in the hose string should be electrically bonded (electrically continuous). Since electrical continuity can be affected by any of the physical hose tests, a check on electrical resistance should be carried out prior to, during and after the pressure tests.

Electrically discontinuous hose should have a resistance of not less than 25,000 ohms measured between nipples (end flange to end flange). The testing of electrically discontinuous hoses should be carried out using a 500 V tester.

Electrically continuous hoses should not have a resistance higher than 0.75 ohms/metre measured between nipples (end flange to end flange).

18.2.6.5 Withdrawal from Service

In consultation with the hose manufacturer, 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.

The temporary elongations at which smooth bore rubber hose assemblies should be withdrawn from service will vary with the type of hose assembly construction, such that either:

a) The temporary elongation, when measured as in Section 18.2.6.3 above, should not exceed 1.5 times the temporary elongation when the hose assembly was new.

   For example:

   Temporary elongation of new hose assembly: 4%

   Temporary elongation at test: 6% maximum

or

b) For hose assemblies where the temporary elongation of a new assembly was 2.5% or less, the temporary elongation at the test should not be more than 2% more than that of the new hose assembly.

   For example:

   Temporary elongation of new hose assembly: 1%

   Temporary elongation of old hose assembly: 3% maximum.

18.2.6.6 Explanation of Pressure Ratings for Hoses

Figure 18.1 provides an illustration of the relationship between several definitions of pressure that are in common usage. The individual terms are briefly described below:

Operating Pressure

This is a common expression to define the normal pressure that would be experienced by the hose during cargo transfer. This would generally reflect the cargo pump operating pressures or hydrostatic pressure from a static system.

Working Pressure

This is generally considered to mean the same as 'Operating Pressure'.

Rated Working Pressure (RWP)

This is the common oil industry reference that defines the maximum cargo system pressure capabilities. This pressure rating is not expected to account for dynamic surge pressures but does include nominal pressure variations as expected during cargo transfer operations.

Maximum Working Pressure (MWP)

This is the same as Rated Working Pressure and is used by BS and EN Standards for designing hoses to these standards.

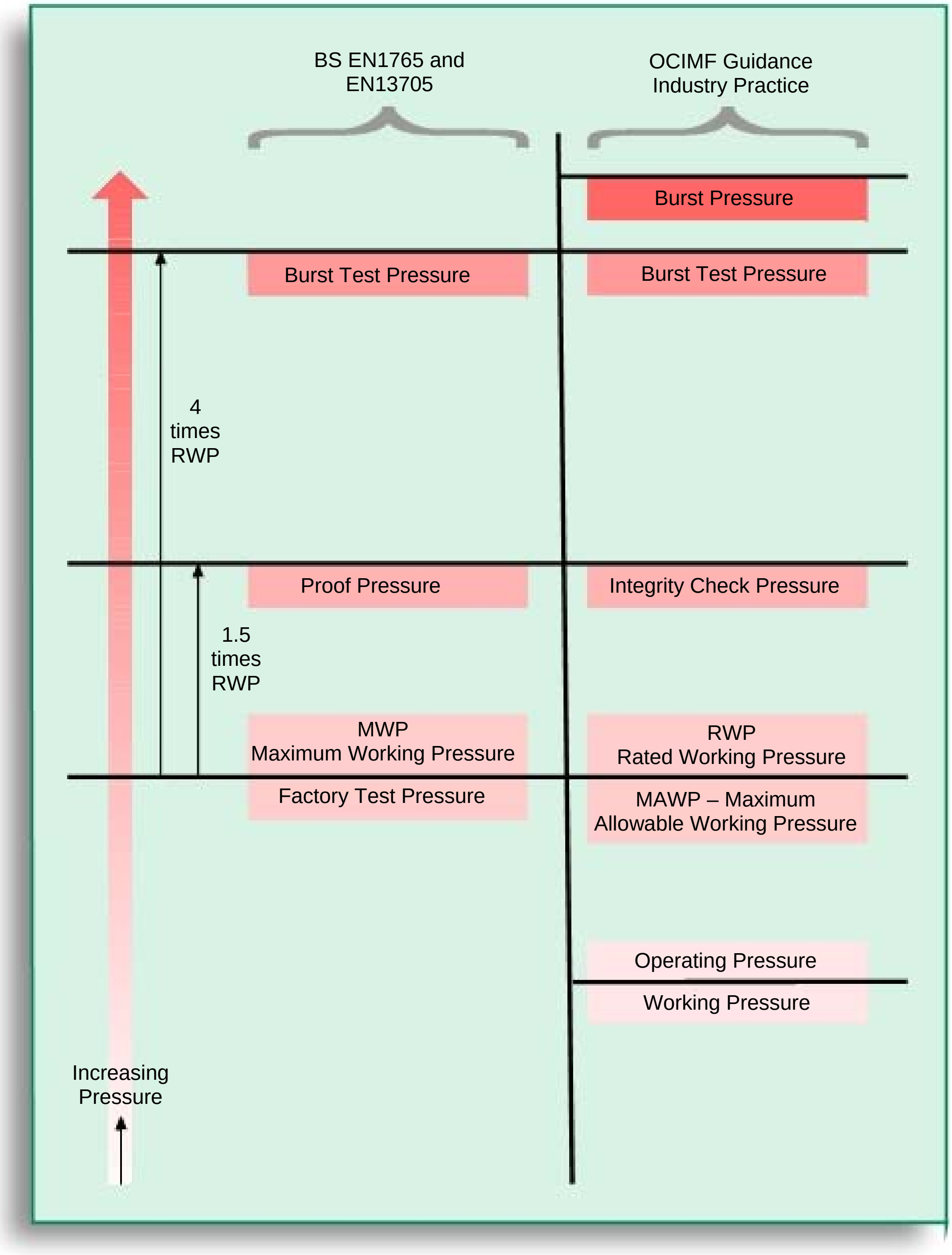

Figure 18.1 - Illustration of terminology used for defining hose pressures

Maximum Allowable Working Pressure (MAWP)

This is the same as Rated Working Pressure and Maximum Working Pressure. MAWP is used as a reference by the United States Coast Guard and is commonly used by terminals to define their system equipment limitations.

Factory Test Pressure

This is referenced in EN 1765 and is defined as equal to the Maximum Working Pressure, which in turn is the same as Rated Working Pressure.

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 Rated Working Pressure.

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 4 times the Factory Test Pressure and must be applied in a specific manner and held for 15 minutes without hose failure.

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.

18.2.7 Hose Flange Standards

Flange dimensions and drilling should conform to the local common standard (e.g. DIN / ISO / EN / ASA / ANSI, preferably PN 10) for flanges on shore pipeline and tanker manifold connections.

18.2.8 Operating Conditions

For oil cargo hose intended for use in normal duties:

- Oil temperatures in excess of those stipulated by the manufacturer, generally 82°C, should be avoided (see Section 18.2.3).
- The maximum permissible working pressure stipulated by the manufacturer should be adhered to and surge pressures should be avoided.
- The hose life will be shorter in white oil service than with black oils.

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 store 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.

If the hose is stored outside, it should be well protected from the sun.

Recommendations for hose storage are given in the OCIMF publication 'Guidelines for the Handling, Storage, Inspection and Testing of Hoses in the Field'.

18.2.10 Checks Before Hose Handling

It is the responsibility of the terminal to provide hoses that are in good condition, but the tanker's Master may reject any which appear to be defective.

Hose assemblies should be visually inspected on a regular basis. When hose assemblies are in constant or frequent use, the assembly should be inspected before each loading/unloading operation. Hose assemblies subject to infrequent use should be inspected each time they are brought into use.

18.2.11 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. Hoses should not be lifted at a single point with ends hanging down, but should be supported at a number of places so that they are not bent to a radius less than that recommended by the manufacturer.

Excessive weight on the tanker's manifold should be avoided. If there is an excessive overhang, or the tanker'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 tanker'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 derrick, the hose string should be supported by bridles or webbing straps. Some hoses are specifically designed to be unsupported.

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

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

See also Figure 18.2.

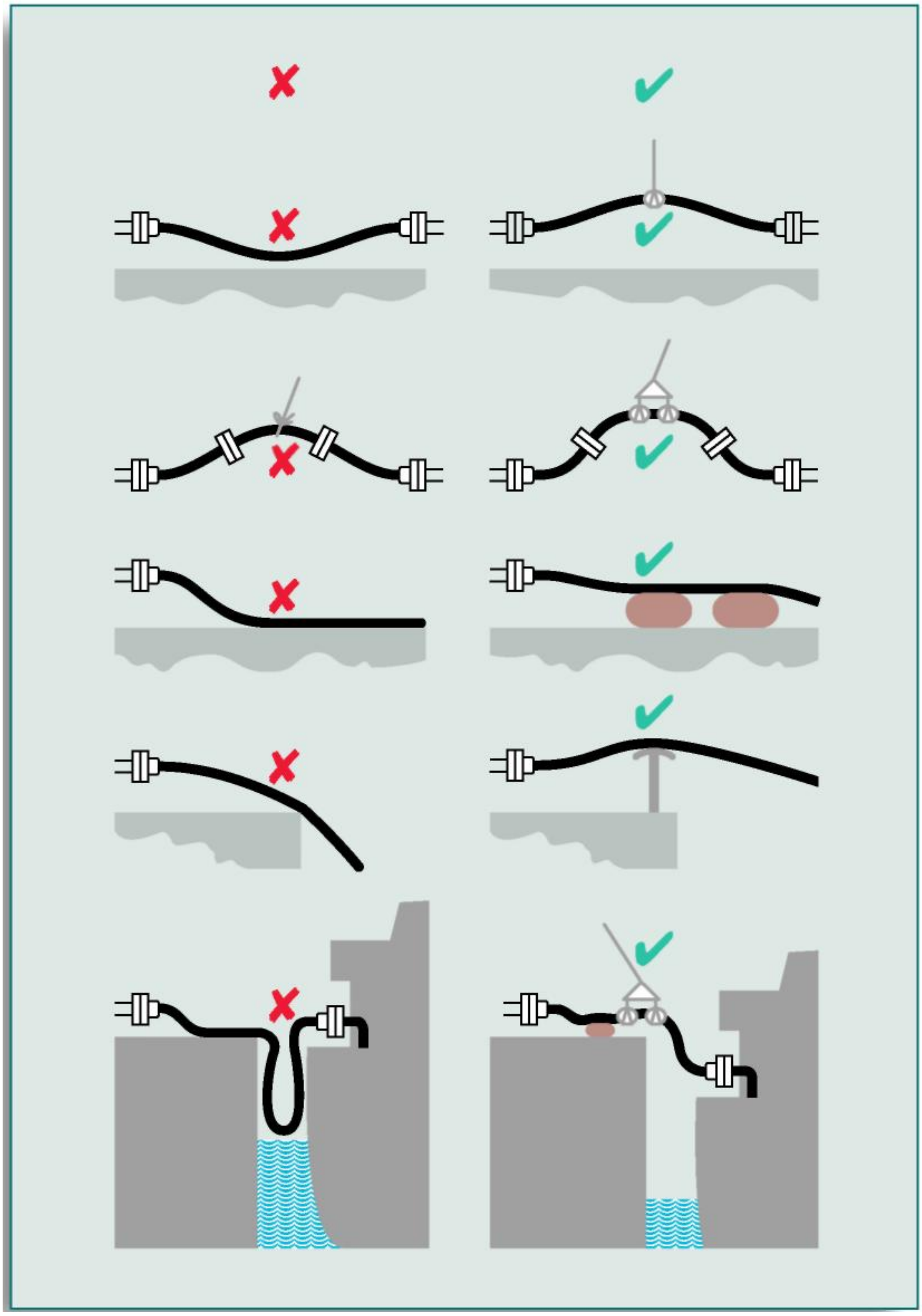

Figure 18.2 - Handling cargo hose

18.2.12 N/A

18.2.13 N/A

18.3 Vapour Emission Control Systems

Some terminals are equipped with vapour emission control systems 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, passed to visiting tankers for information, should also include details of the vapour recovery system for the information of visiting vessels.

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

Tanker and shore personnel should agree any constraints associated with the operation of the vapour emission control system during pre-transfer discussions. Confirmation that this information has been exchanged and agreed will be included within the Safety Check-List (see Section 26.3).

Section 11.1.13 should be referred to for information on the primary safety issues relating to cargo transfer operations using vapour recovery.