CHAPTER 17

Marine Terminal Systems and Equipment

This chapter describes equipment that is available at the terminal, specifically at the tanker/terminal interface, including lifting, lighting, bonding and earthing equipment.

Emphasis is placed on ensuring that tankers and terminal remain electrically isolated and means of how that isolation is achieved.

17.1 Electrical equipment

The classification of hazardous areas for the installation or use of electrical equipment within a terminal is described in section 4.10.

Terminals should ensure that any electrical equipment provided is in accordance with a site specific electrical classification drawing, which shows hazardous zones at the berths in both plan and elevation format.

Electrical classification drawings should record the type and compliance of equipment installed within each zone. National legislation, international standards and company specific guidelines are to be complied with. A Planned Maintenance System (PMS) should address the continued integrity of the equipment installed and ensure it remains able to meet hazardous zone requirements.

Personnel carrying out maintenance on equipment within hazardous zones should be trained and certified as competent to carry out the work. Certification may be either by internal process or as required by regulatory bodies. All electrical maintenance should be carried out under the control of a permit to work system (see chapter 4).

17.2 Lifting equipment

17.2.1 Inspection and maintenance

All cargo transfer lifting equipment and/or means of access to such lifting equipment should be examined at intervals not exceeding one year and load tested at intervals not exceeding five years, or more frequently if mandated by local regulation or company requirements. Visual inspections should be performed by the berth operator before each use. Maintenance should be conducted in accordance with OCIMF/SIGTTO's *Jetty Maintenance and Inspection Guide*, national regulations and the manufacturer's recommendations. Tests, inspections and maintenance should be recorded in the terminal's PMS.

Equipment to be tested and examined includes:

- Cargo hose handling cranes, derricks, davits and gantries.
- Gangways and associated cranes and davits.
- Stores' cranes and davits.
- Slings, lifting chains, delta plates, pad eyes and shackles.
- Chain blocks, hand winches and similar mechanical devices.
- Personnel lifts and hoists.

Tests should be carried out by a qualified individual or authority and the equipment should be marked with its SWL, identification number and test date.

If lifting equipment is modified or repaired, it should be re-tested and re-certified before being placed back in service. Use of temporary mobile lifting devices should be risk assessed by terminal personnel, considering all operational hazards including structural jetty loads.

Defective equipment should be labelled as out of service, withdrawn from use immediately and only reinstated after repair, examination and, where required, re-certification.

17.2.2 Training in the use of lifting equipment

All personnel engaged in operating lifting equipment should be trained in its use. Training should be refreshed in accordance with local regulatory and company requirements. More information can be found in OCIMF's *Marine Terminal Operator Competence and Training Guide*.

17.2.3 Use of tanker lifting equipment

When terminals use a tanker's equipment for lifting hoses, terminal gangways, or other terminal equipment, checks should be made to ensure the equipment has an adequate SWL before its use. For hose handling, the terminal should establish a minimum SWL requirement based on the length of the hose to be lifted, including contents remaining when draining the hose. Terminal personnel should confirm that tanker cranes have been inspected and certified before use and this should be confirmed at the pre-transfer conference. The use of tanker cranes for lifting of submarine or floating hoses is referenced in OCIMF's *Single Point Mooring Maintenance and Operations Guide*, *Guidelines for the Design, Operation and Maintenance of Multi Buoy Moorings* and *Guidelines for Offshore Tanker Operations*.

17.3 Lighting

Terminals should have a level of lighting sufficient to ensure that all tanker/terminal interface activities can be safely conducted during periods of darkness.

Work areas designated for loading or unloading of cargo should maintain a minimum lighting level of 50 lux, or in accordance with local and national regulations. More information can be found in

EU standard 12464-2 and the UK Maritime and Coastguard Agency's (MCA) *Code of Safe Working Practices for Merchant Seafarers (COSWP).*

Other work areas at the terminal, outside of the manifold area, should maintain an adequate lighting level that, as a minimum, meets local and national regulation to ensure safe operations. Particular consideration should be given to lighting of the following areas:

- Berth or jetty-head working areas.
- Access routes.
- Tanker/terminal access.
- Berth or jetty perimeters.
- Boat landings.
- Mooring dolphins and walkways.
- Stairways to elevated gantries.
- Emergency escape routes.
- Water around berth, to detect spills and unauthorised craft.

Lighting should be included as part of the terminal inspection and maintenance plan. See OCIMF/SIGTTO's *Jetty Maintenance and Inspection Guide.*

17.4 Tanker/terminal electrical isolation

17.4.1 General

Due to possible differences in electrical potential between the tanker and the berth, there is a risk of electrical arcing at the manifold during connection and disconnection of the terminal hose or MLA. To protect against this risk, there should be a means of electrical discontinuity at the tanker/terminal interface. This should be available at the terminal.

It should be noted that the subject of tanker to terminal electric currents is separate from static electricity, which is discussed in chapter 3.

17.4.2 Tanker to terminal electric currents

Large currents can flow in electrically continuous pipework and flexible hose systems between the tanker and terminal. The sources of these currents include:

- Cathodic protection of the jetty or the hull of the ship provided by either an impressed current system or by sacrificial anodes.
- Stray currents arising from galvanic potential differences between ship and shore or leakage effects from electrical power sources.

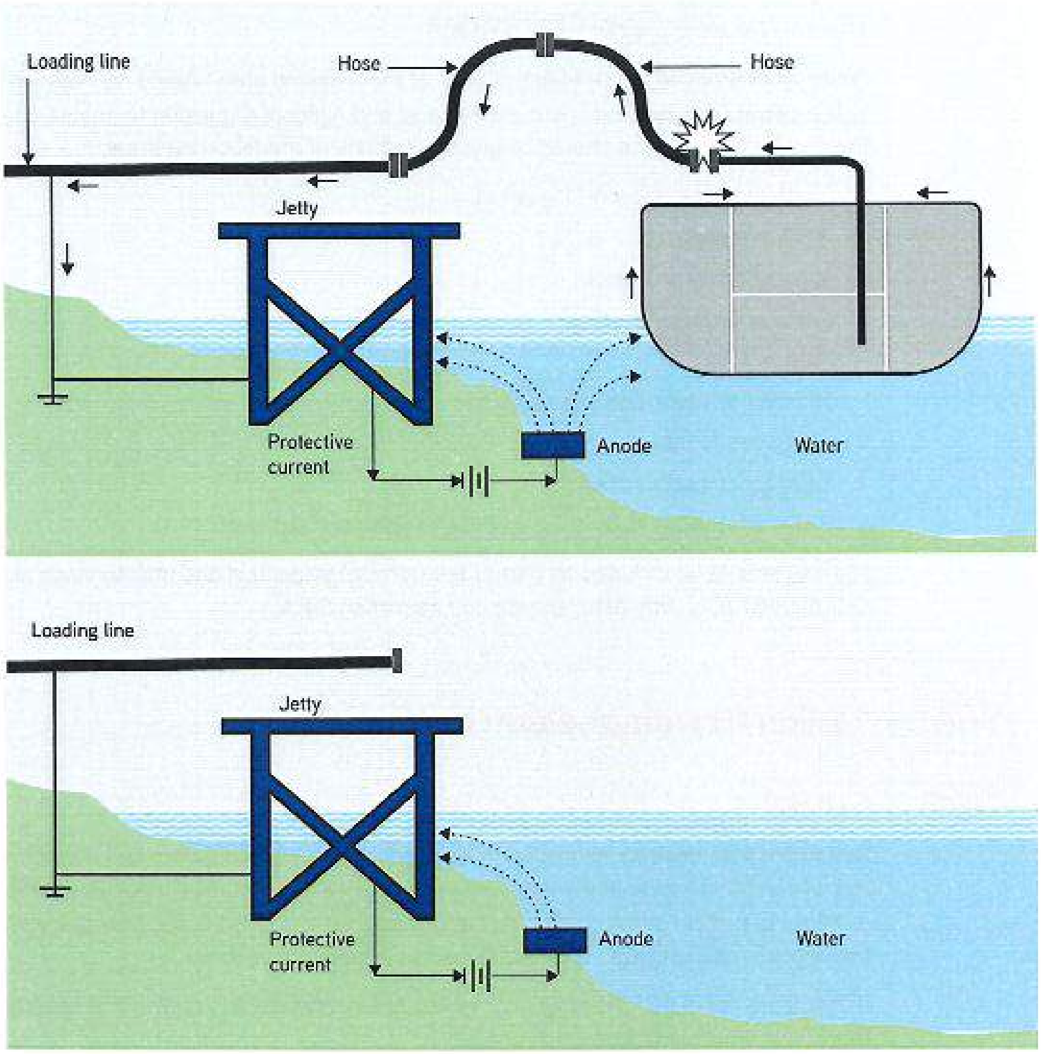

Figure 17.1: Stray currents from cathodic protection

An all metal MLA provides a very low resistance connection between tanker and terminal and there is a possibility of an incendive arc when the ensuing large current is suddenly interrupted during the connection or disconnection of the MLA at the tanker manifold. Similar arcs can occur with metallic connections between the flanges of each length of a flexible hose string.

To prevent electrical flow and subsequent arcing between a tanker and a terminal during connection or disconnection of the terminal hose or MLA, the terminal operator should ensure that there is sufficient electrical discontinuity between the jetty and tanker. This can be achieved by:

- Fitting MLAs with an insulating flange.
- Using Type R or Grade M (Type S or L) electrically continuous hoses with an insulating flange or insulating block fitted at one end of the hose string.
- Including one length only of electrically discontinuous hose in each continuous string.
- Using Grade Ω (Type S or L) hoses without an insulating flange and provided the resistance of each hose assembly has been tested and exceeds 25,000 ohms (see section 18.2.6.4). Note that Grade Ω hoses are not marked as electrically discontinuous and that test records should be checked to determine whether they provide adequate electrical discontinuity (see section 18.2.4).

A single length of electrically discontinuous hose is, typically, provided on the terminal side of the hose string, but may be provided at any location as long as all segments remain isolated from materials they could potentially touch, including the tanker hull and/or jetty deck. Use of more than one section of electrically discontinuous hose may result in electrically isolated sections that allow for the build-up of electrical potential within the isolated section. When non-conductive hoses are used for isolation purposes, care should be taken to ensure that conductive pathways are not introduced by lifting or support equipment, such as nylon or other non-conductive materials for lifting straps.

The additional resistance limits the flow of stray current, through the MLA or the hose string, to a safe level. However, the whole system should remain earthed, either to the tanker or to the shore. The above text refers to conventional alongside berths. OCIMF's *Single Point Mooring Maintenance and Operations Guide* should be referred to for guidance on hose strings at offshore facilities.

All metal on the seaward side of the insulating section should be electrically continuous to the tanker and all metal on the landward side should be electrically continuous to the jetty's earthing system. This arrangement will ensure electrical discontinuity between tanker and terminal and prevent arcing during connection and disconnection. Loading arm swivels should include bonding wires across flanges to ensure electrical continuity. If hoses are used for draining or purging loading arm contents and/or for hydraulics or lubricating systems, then these should also follow the same continuity and isolation requirements as the arm itself. When hoses are deployed on reels they should be electrically isolated.

The insulating flange or single length of discontinuous hose should not be short circuited by contact with external metal.

It should be noted that the requirements for electrical discontinuity also apply to the vapour recovery connection.

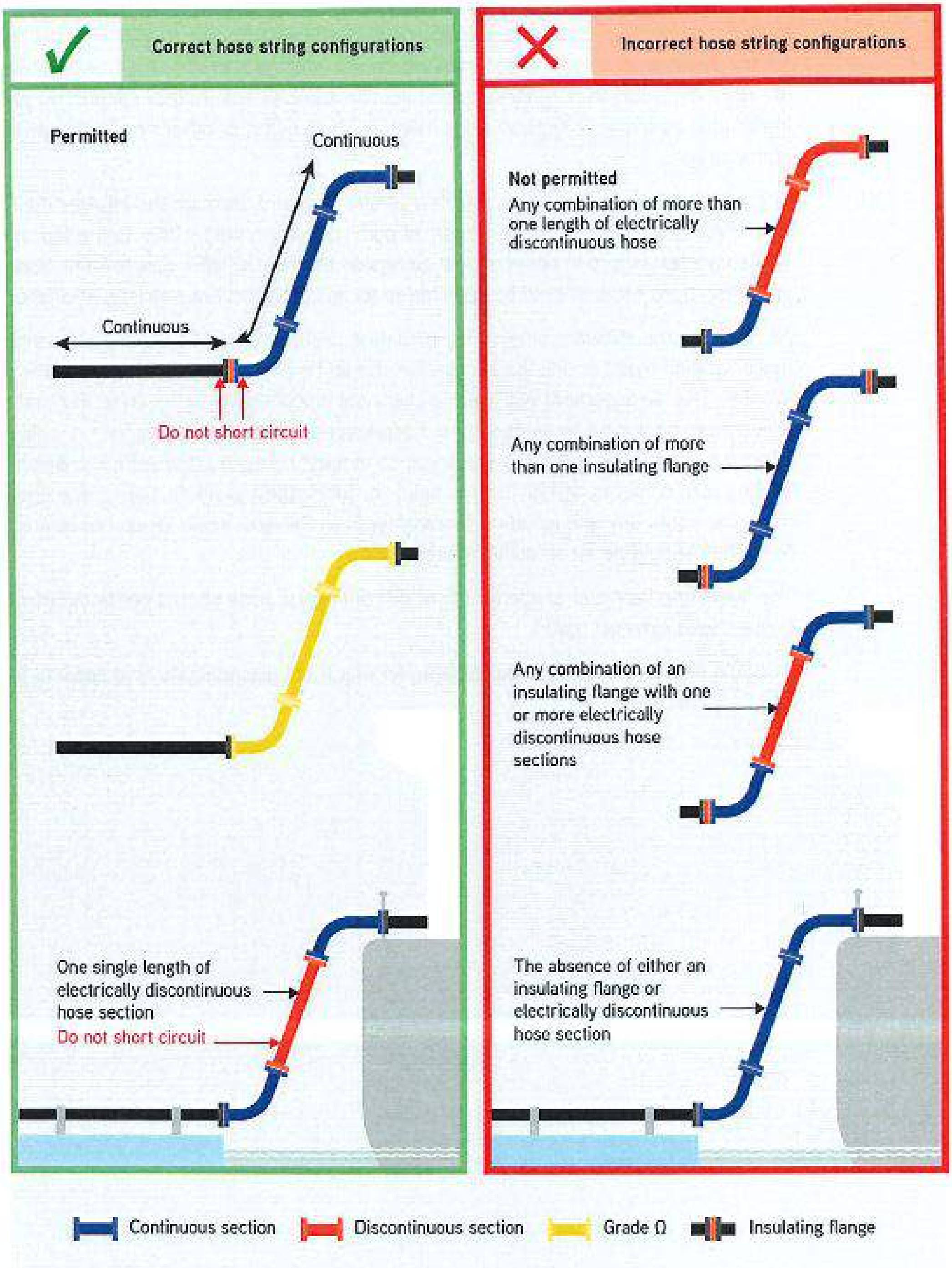

Figure 17.2: Hose string configurations for electrical isolation

Current flow can also occur through any other electrically conducting path between a tanker and terminal, for example mooring wires or a metallic ladder or gangway. These connections should be insulated to prevent further electrical interaction between the jetty and the tanker's hull. However, it is extremely unlikely that a flammable atmosphere would be present at these locations while electrical contact is made or interrupted.

Switching off cathodic protection systems of the impressed current type, either ashore or on the tanker, is not considered a feasible method of minimising tanker/terminal currents in the absence of an insulating flange or hose. A jetty that is handling a succession of tankers would need to have this cathodic protection switched off almost continuously and would, therefore, lose its corrosion resistance. In addition, if the jetty system remains switched on, it is probable that the difference of potential between the tanker and terminal will be less if the tanker also keeps its cathodic protection system energised. In any case, the polarisation in an impressed current system takes many hours to decay after the system has been switched off, so the tanker would have to be deprived of full protection not only while alongside, but also for a period before arrival in port.

17.4.3 Sea islands

Offshore facilities that are used for tanker cargo handling operations should be treated in the same way as shore terminals for the purpose of earthing and bonding (see section 17.4).

Switching off a cathodic protection system is not a substitute for the installation of an insulating flange or a length of non-conducting hose.

17.4.4 Tanker/terminal bonding cables

A tanker/terminal bonding cable does not replace the requirement for electrical discontinuity as described above. Use of tanker/terminal bonding cables may be dangerous and they should not be used.

While some national and local regulations still require mandatory connection of a bonding cable, it should be noted that the International Maritime Organization's (IMO) *Revised Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas* urges port authorities to discourage the use of ship/shore bonding cables and to adopt recommendations concerning electrical discontinuity.

If a bonding cable is required by national or local regulations, it should be inspected to see that it is mechanically and electrically sound. The connection point for the cable should be well clear of the manifold area. There should always be a switch on the jetty, in series with the bonding cable and of a type suitable for use in a Zone 1 hazardous area. It is important to ensure that the switch is always in the 'off' position before connecting or disconnecting the cable.

Only when the cable is properly fixed and in good contact with the tanker, should the switch be closed. The cable should be attached before the cargo hoses or arms are connected and removed only after the hoses or arms have been disconnected.

17.4.5 Insulating flange

An insulating flange is designed to prevent arcing caused by low voltage/high current circuits (usually below one volt, but potentially up to around five volts and with currents rising to possibly several hundreds of amps) that exist between tanker and terminal due to stray currents, cathodic protection and galvanic cells. There are two types typically in use at marine terminals: a traditional insulating flange (see figure 17.3) and a cast-nylon insulating flange (see figure 17.4), neither of which are intended to give protection against the high voltage but from potential low current sparks.

Therefore, even if the resistance of the flange drops below the 1,000 ohms stated in section 17.4.5.2 because of, for example, ice, salt spray or product residue, any current flow will still be limited to a few milliamps as the potential difference across the flange will be far less than is required to initiate an arc during connection or disconnection of MLAs or hoses. Conversely, trying to earth a low voltage/high current circuit with a bonding cable is difficult, even if a very low resistance cable is used. The total resistances of the cable circuit connections and any switching device, combined with the availability of a very large current, will effectively prevent the potential difference between the tanker and terminal from becoming zero and will render this circuit ineffective as a means of eliminating tanker/terminal currents in MLAs or hoses.

In the context of electrical isolation, the term insulating flange is used in alignment with other marine industry guidance documents, although the term isolation flange may also be used.

17.4.5.1 Precautions

It is recommended that the insulating flange is available at the terminal (shore side) rather than at the tanker and that, when fitting the insulating flange, the following should be considered:

- When the tanker to terminal connection is wholly flexible, as with a hose, the insulating flange should ideally be inserted at the jetty end where it is not likely to be disturbed. Flexible hoses should always be suspended or supported on non-conductive materials to ensure the hose to hose connection flanges do not rest on the jetty deck or other structure that renders the insulating flange ineffective.
- In place of a traditional insulating flange, a cast-nylon insulating flange joint can be used or bolted between two lengths of electrically conductive hose and/or flanges. The advantage of the cast-nylon insulating flange joint over an insulating flange is the wide gap between conductors that makes it is less prone to failure due to dirt, salt build-up or moisture accumulation. The non-conductive spool piece is also easy to install or replace.
- When the connection is a partly flexible and partly metal MLA, the insulating flange should be connected to the metal arm.
- For all metal MLAs, care should be taken to ensure that the flange is not short circuited by guy wires.
- The location of the insulating flange should be clearly labelled.

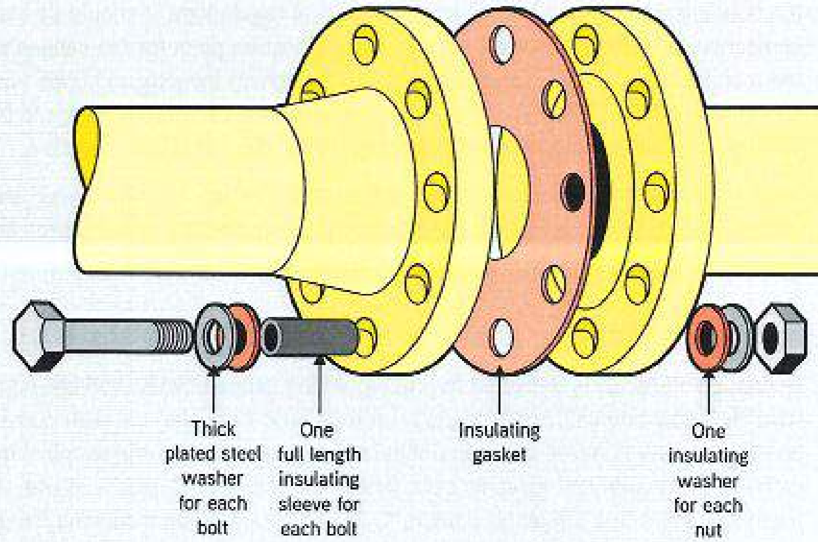

Figure 17.3: Typical insulating flange joint

While both types of insulating flange are effective and their use is accepted practice in the industry for safe transfer of cargo from ship to shore, a cast-nylon insulating flange has an advantage over the traditional insulating flange as it provides additional space between the two connecting flanges. This provides a benefit in the event of a failure that typically occurs when dirt/moisture accumulates between the two conductive flanges, circumventing the thinner traditional insulating flange joint.

However, the cast-nylon insulating flange joint has a disadvantage in that it is heavier than the traditional insulating flange, which adds weight at the joint and potentially contributes to a tighter bend radius in the hose at the interface joint due to loss of flexibility. This does not necessarily contribute to accelerated failure of the hose, but the terminal operator should be aware of this and plan it into the inspection and maintenance programme when handling hose with this joint.

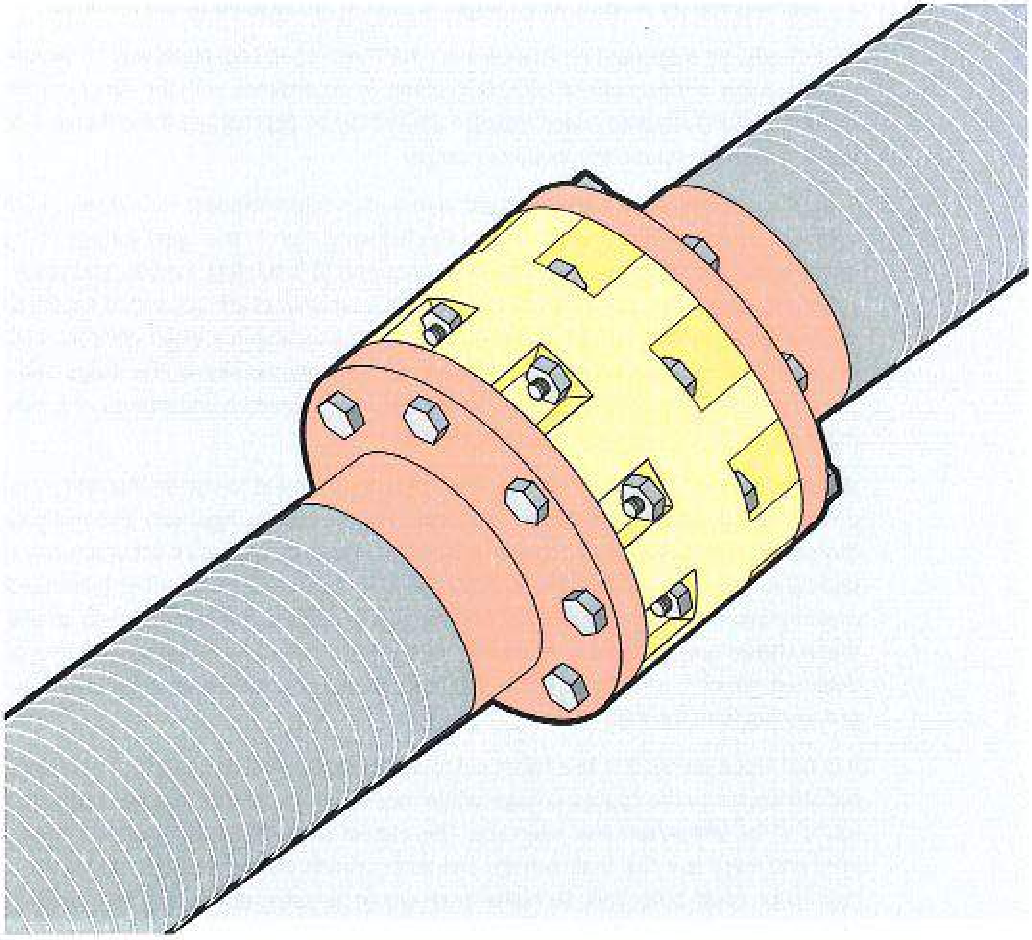

Figure 17.4: Cast-nylon insulating flange joint

17.4.5.2 Testing of insulating flanges

An insulating flange is designed to prevent the arcing caused by the voltage that can exist between tanker and terminal due to stray currents and other electrical phenomena. Such voltages are usually below one volt but can be up to five volts. Without an insulating flange (or other current limiting component, such as a discontinuous hose string) this voltage could result in a substantial current flowing between the tanker and terminal. This current flow could lead to arcing, creating an explosion risk if hydrocarbons are present.

If the resistance of the flange drops because of ice, salt spray or product residue, the current should still be limited to a few milliamps, which is considered low enough to prevent arcing during connection or disconnection of MLAs or hoses:

- Insulating flanges should be inspected and tested at least annually, but more frequent testing should be conducted based on the results of a risk assessment (see chapter 4). Factors to be taken into consideration when determining testing frequency should include the risk of deterioration due to environmental exposure, usage and damage from handling.
- Before testing, the atmosphere should be confirmed safe by means of atmosphere tests.

- The insulation flange should be clean and unpainted.
- Readings should be taken between the metal pipeline on the shore side of the insulation flange and the end of the hose or MLA when freely suspended. The measured value after testing should be greater than 1,000 ohms. A lower resistance could indicate damage or deterioration of the insulation.
- Test records for all insulating flanges should be maintained by the terminal.

Historically, no maximum resistance value has been specified. However, for avoidance of static accumulation, a maximum of 1,000,000 ohms, in accordance with the American Petroleum Institute's (API) *Recommended Practice 2003*, may be appropriate if the flange is to be used with a low conductivity (static accumulator) cargo.

Typical insulation testers are arranged with a user selectable test voltage, e.g. 1,000/500/250 volts DC. The test voltage is normally selected in relation to the rated voltage of the equipment under test. Since this consideration does not apply to insulating flanges, and since the acceptable resistance can be as low as 1,000 ohms, such instruments are not suited for on-site terminal routine testing. However, they can be used for type testing in a clean environment, e.g. at the manufacturer's workshop, where there will be no contamination of the flange and insulation readings will be many times higher. Routine testing should be undertaken at a lower voltage that is more suited to the expected resistance value.

When an MLA or hose is in service, it is not recommended to use an insulation tester with driving voltage above 50 volts DC (nominal). Higher test voltages can give misleading results at low resistances because of capacitive leakage. However, to ensure accuracy and repeatability, dedicated insulation testers are recommended for routine testing, rather than handheld multimeters. Insulating testers that operate at 50 volts DC are commercially available, but these should only be used after testing for the presence of hydrocarbons. If hydrocarbons are detected, either externally or within the hose, then a risk assessment should be carried out before proceeding with the test.

It is not recommended to use handheld multimeters for routine testing of insulating flange resistance, since the applied voltage when measuring resistance will be similar to that typically found at the tanker/terminal interface. This cannot be considered a true test of the insulation level and there is a risk that damage and deterioration will not be identified since the measured resistance could potentially be higher than would be achieved using a dedicated insulation tester. In any case, the test voltage applied should not be less than five volts DC (nominal).

17.4.5.3 Safety

Testing should be undertaken with instruments and methods selected to be compatible with any hazardous area associated with the location of the flange. When testing of an insulating flange is carried out in a hazardous area and/or with testing equipment not certified for use in such an area, the testing should be performed under the control of a permit to work (see chapter 4).

17.5 Earthing and bonding practice in the terminal

Earthing and bonding minimise the dangers arising from:

- Faults between electrically live conductors and non-current carrying metalwork.
- Atmospheric discharges (lightning).
- Accumulations of electrostatic charge.

Earthing and bonding system requirements will depend on the results of a risk assessment.