OCIMF

Guidelines for the Handling, Storage, Use, Maintenance and Testing of STS Hoses

(First edition May 2021)

Issued by the

Oil Companies International Marine Forum
29 Queen Anne's Gate
London SW1H 9BU
United Kingdom
Telephone: +44 (0)20 7654 1200
Email: enquiries@ocimf.org

www.ocimf.org

First edition May 2021

The Oil Companies International Marine Forum (OCIMF)
Founded in 1970, the Oil Companies International Marine Forum (OCIMF) is a voluntary association of oil companies having an interest in the shipment and terminalling of crude oil, oil products, petrochemicals and gas, and includes companies engaged in offshore marine operations supporting oil and gas exploration, development and production.

Our vision is a global marine industry that causes no harm to people or the environment.

Our mission is to lead the global marine industry in the promotion of safe and environmentally responsible transportation of crude oil, oil products, petrochemicals and gas, and to drive the same values in the management of related offshore marine operations. We do this by developing best practices in the design, construction and safe operation of tankers, barges and offshore vessels and their interfaces with terminals and considering human factors in everything we do.

Contents

Glossary

Anti-static additive A substance added to a petroleum product to raise its electrical conductivity to a safe level, above 50 picoSiemens/metre (pS/m), to prevent accumulation of static electricity.

Best practice A method of working, or procedure, to aspire to as part of continuous improvement.

Bonding The connecting together of metal parts to ensure electrical continuity.

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.

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.

Cargo transfer Operation when crude oil, Liquefied Petroleum Gas (LPG) or other hydrocarbon products are moved from either a ship to another ship, a ship to a terminal or a terminal to a ship, by means of pumping.

Company The owner of the ship or any other organisation or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the shipowner and who, on assuming such responsibility, has agreed to take over all the duties and responsibility imposed by the *International Safety Management (ISM) Code.*

Earthing (also referred to as 'Grounding') The electrical connection of equipment to the main body of the 'earth' to ensure that it is at earth potential. On board ship, the connection is made to the main metallic structure of the ship, which is at earth potential because of the conductivity of the sea.

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

Flow rate The linear velocity of flow of liquid in a pipeline, usually measured in metres per second (m/sec). The determination of the flow rates at locations within cargo pipeline systems is essential when handling static accumulator cargoes.

Guidance Provision of advice or information by OCIMF.

Hazard Any event/object that could cause harm.

Hydrostatic test pressure This is the pressure at which the hose is hydrostatically tested at least annually.

Insulating flange A flanged join incorporating an insulating gasket, sleeves and washers to prevent electrical continuity between manifolds and hose strings.

International Safety Management (ISM) Code The ISM Code is an international standard for the safe management and operation of ships and for pollution prevention.

Manifold The flanged pipe assembly mounted on board ship to which the hose presentation flange or spool piece connects.

Maximum working pressure (MWP) 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.

Maximum allowable working pressure (MAWP) 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.

Presentation flange Hose flange for connection to either the ship's manifold or spool piece.

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.

Recommendations OCIMF supports and endorse a particular method of working or procedure

Risk Risk is the likelihood of harm if exposed to a hazard.

Ship to Ship (STS) Service Provider Companies sometimes employed to organise and assist with STS transfers. The services offered by these companies vary, but often include the provision of personnel and equipment to facilitate the STS transfer. The STS Service Provider may also supply the essential personnel and equipment needed, such as hoses, fenders and support craft. The STS Service Provider may also be referred to as an STS Contractor or STS Resource Provider. These include Dedicated Lightering Vessel Operators where vessel carry their own STS hoses and associated equipment.

Static electricity The electricity produced by movement between dissimilar materials through physical contact and separation.

Surge pressure A sudden increase in the pressure of the liquid in a pipeline, brought about by an abrupt change in flow velocity, e.g. through the starting or stopping of a pump, a rapid closure or opening of a valve or a reduction of pipeline diameter. The pressure surge may cause a rupture of the piping and an extensive oil spill.

Abbreviations

AFM	Asbestos Free Material
ASME	American Society of Mechanical Engineers
ANSI	American National Standards Institute
API	American Petroleum Institute
BOPP	Bi-Oriented Polypropylene
BS	British Standards
CDI	Chemical Distribution Institute (CDI)
EN	European Standards
IMO	International Maritime Organization
ISGOTT	*International Safety Guide for Oil Tankers and Terminals*
ISM Code	*International Management Code for the Safe Operation of Ships and for Pollution Prevention*
ISO	International Standards Organization
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
LSV	Lightering Support Vessel
MARPOL	International Convention for the Prevention of Pollution from Ships
MBR	Minimum Bend Radius
MSS	Manufacturers Standardization Society
NBR	Nitrile Butadiene Rubber
MAWP	Maximum Allowable Working Pressure
MWP	Maximum Working Pressure
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl Chloride
QRC	Quick-Release Coupling
SDS	Safety Data Sheet
SMS	Safety Management System
STS	Ship to Ship
STS Transfer	*Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Guide Gases*
SWL	Safe Working Load

Bibliography

API 5L Specification for Line Pipe (American Petroleum Institute (API))

ASME B16.5 Pipe Flanges and Flanged Fittings (American Society of Mechanical Engineers)

ASTM A105 Standard Specification for Carbon Steel Forgings for Piping Applications (ASTM International)

ASTM A285 Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength (ASTM International)

BS 1435-2:2005 Rubber hose assemblies for oil suction and discharge services – Part 2: Recommendations for storage, testing and use (British Standards Institute (BSI))

BS 4089:1999 Specification for metallic hose assemblies for liquid petroleum gases and liquefied natural gases (BSI)

BS EN 1765:2016 Rubber hose assemblies for oil suction and discharge services. Specification for the assemblies (BSI)

BS EN 12434 – Cryogenic flexible hoses (BSI)

BS EN 13482:2013 Rubber hoses and hose assemblies for asphalt and bitumen. Specification (BSI)

EN 13765:2018 Thermoplastic multi-layer (non-vulcanized) hoses and hose assemblies for the transfer of hydrocarbons, solvents and chemicals – Specification (European Standards)

EN 13766:2018 Thermoplastic multi-layer (non-vulcanized) hoses and hose assemblies for the transfer of liquid petroleum gas and liquefied natural gas – Specification (European Standards)

EN 1474-2 Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems - Part 2: Design and testing of transfer hoses (European Standards)

Guidelines for Liquid Chemical Hose Management (CDI)

International Safety Guide for Oil Tankers and Terminals (ISGOTT) (OCIMF)

ISO 1041-1:2011 Plastics – Symbols and abbreviated terms – Part 1: Basic polymers and their special characteristics (International Standards Organization)

Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases (OCIMF)

1 Introduction

Hose strings used during Ship-to-Ship (STS) transfers in a side-by-side configuration are a critical link between the two ships. They are subjected to repeated lifting, bending and folding and to the dynamic forces of ship movements at sea. All of these can result in loads and stresses within the hose. To provide greater reliability and longer life, hoses should be handled, stored, maintained, inspected and tested correctly at appropriate intervals.

This paper provides guidance to STS Service Providers, Masters, and operators of ships that use hose assemblies to transfer liquid-bulk cargoes via STS and to minimise hose damage from improper handling and storing. Compliance with proper inspection and testing procedures will also increase the probability of detecting potential failure areas at the right time.

Section two of this paper describes rubber hose assemblies which are commonly used for the transfer of MARPOL Annex I cargoes. Helix-reinforced rubber hoses are used in some locations for STS transfers but are not addressed in this paper. Section three relates to composite hoses. Corrugated metallic hoses are generally not used for STS Transfer Operations and are therefore not part of this guidance paper.

This paper does not cover specific details of hose construction as doing so might hinder the introduction of improved construction methods and techniques.

This paper should be read alongside the *Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases (STS Transfer Guide)* and the *International Safety Guide for Oil Tankers and Terminals (ISGOTT)* as it aims to provide additional guidance. Duplication between publications has been avoided where possible.

1.1 Roles and responsibilities

Roles and responsibilities between the STS Service Provider and ship's staff are described in the *STS Transfer Guide,* section 1.5.1: General.

Information about the size, length, type and quantity of the hose strings being delivered should be provided to the ships involved in the transfer so they can prepare their manifolds in advance. Any hoses supplied for the transfer should be provided with the most recent test certificate for tests undertaken at intervals not exceeding one year. More stringent testing frequency may apply based on local regulations.

When employed, the STS Provider's representative should be on deck in the manifold region of one of the vessels and visible to both ship's crew in order to ensure safe hose-handling practices are observed during hose connection and disconnection.

A competent ship's officer should be on deck during the handling and assembly of the STS transfer hoses and take a lead role in the management of STS hose operations aboard their ship, including:

- Lifting hoses from the Lightering Support Vessel (LSV) onto the ship.
- Hose deployment to other ship including verification of hose securing/supporting arrangement.
- Hose string assembly.
- Hose connection.
- Hose deployment to the other ship.
- Hose disconnection and draining.
- Hose recovery.
- Disassembly.
- Lowering hoses down from the ship deck into the LSV.

2 Rubber hose assemblies

In 1990, a new type of rubber cargo hose was developed to meet the unique requirements of offshore STS transfers. It is important to note that rubber STS hoses do not conform to any internationally recognised standard such as the International Standards Organization (ISO), British Standards (BS) or European Standards (EN). Manufacturers generally align with BS EN 1765 Rubber Hose Assemblies for Oil Suction and Discharge Services for the assemblies.

2.1 Hose types

Rubber STS hose assemblies closely align with the specifics of EN 1765 Type L (Light Weight) Hoses. Type L hoses are helix-free, do not suffer permanent deformation and are designed to be used where light weight, ease of handling and increased flexibility is required.

They differ from the standard in that:

- They feature a heavy-duty design with a high burst safety factor.
- The cover may be designed to be more durable but with reduced oil-resistant properties.
- STS hoses are commonly rated for 15 bar Maximum Working Pressure (MWP).

Other hose types may be used in STS operations depending on geographical location, local requirements and other specific operational needs. Further guidance on specific hose types should be sought from the hose manufacturer.

2.2 Electrical continuity

STS hoses should be compliant with BS EN 1765:2016, Grade Ω with a resistance greater than 25,000 and less than 1,000,000Ω over the length of the assembly (BS EN 1765:2016 Table 4 – Physical Properties of Finished Hose Assemblies).

This arrangement satisfies two competing electrical design goals:

- A conductive hose that allows safe dissipation of electrostatic charge.
- A discontinuous hose that prevents incendive arcing.

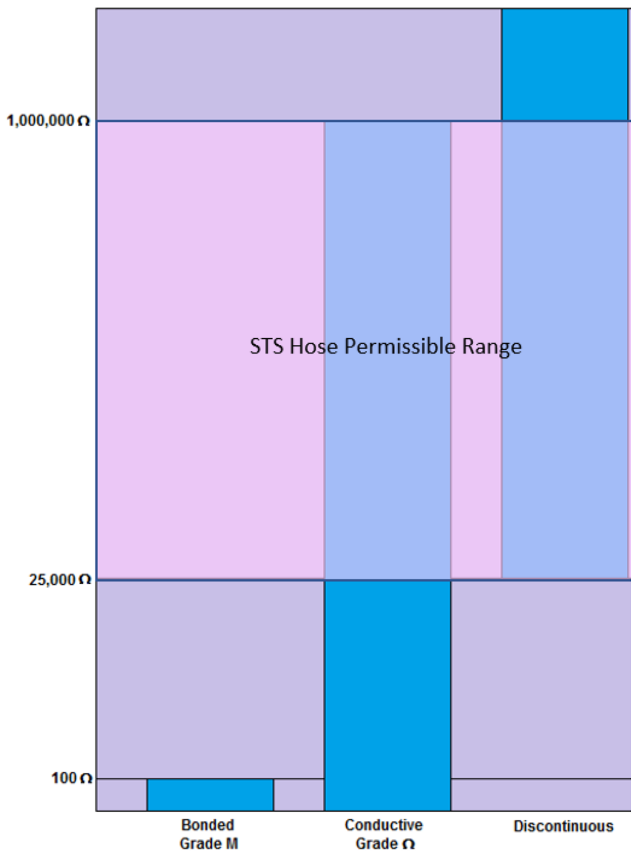


Figure 2.1: *STS hose electrical continuity*

2.3 Regulatory requirements

Some states or local authorities may enforce additional requirements for using rubber hose assemblies to transfer petroleum cargoes and oils. It is prudent to determine if there are any regulatory requirements and ensure compliance before using hoses in each jurisdiction.

2.4 Hose construction and physical characteristics

The length of each individual hose is typically up to 12 metres long. Hose strings are assembled from two or three individual hoses. Examples of industry common lengths of finished hose strings are 27.3 metres (3 x 9.1m hoses) or 24 metres (2 x 12m hoses). Other hose string lengths may be used depending on STS location, ship compatibility, manufacturers, etc.

All STS hoses have three primary components: the cover, reinforcement plies and liner.

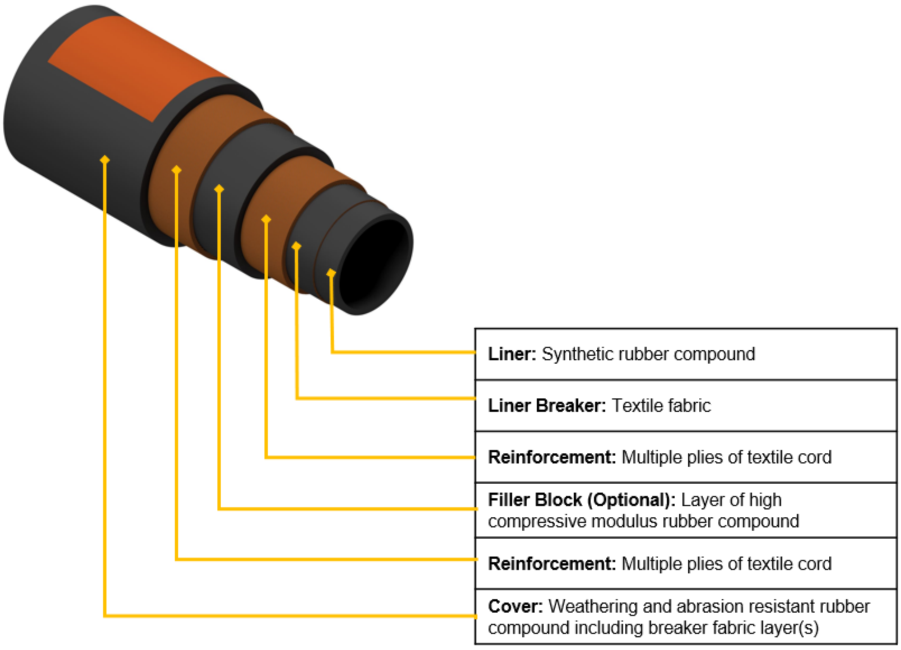


Figure 2.2: *Typical construction of rubber STS hose*

2.4.1 Liner

The function of the liner is to carry the fluid being transported by the hose. The liner is usually made from Nitrile Butadiene Rubber (NBR) and features:

- High chemical resistance to oils and fuels.
- High resilience and wear resistance.
- Good flexibility and adhesion to built-in steel fittings.

2.4.2 Liner breaker

A layer or layers of breaker fabric are normally incorporated within the cover matrix between the reinforcement and the outer rubber cover. The breaker layer serves as a manufacturing aid and both promotes adhesion and increases robustness of the cover matrix.

2.4.3 Reinforcement

The strength of a hose is provided by the reinforcement layer. Reinforcements are fabric (typically polyester or rayon) encapsulated in rubber to provide adhesion and prevent abrasion.

The reinforcement layers typical properties are:

- High tensile strength.
- High fatigue resistance.
- High tenacity.

2.4.4 Filler

Some STS hoses have an additional filler block between the reinforcement layers. The filler block is made from a high-compressive-modulus rubber compound that enhances the bending and tensile characteristics of the hose.

2.4.5 Cover

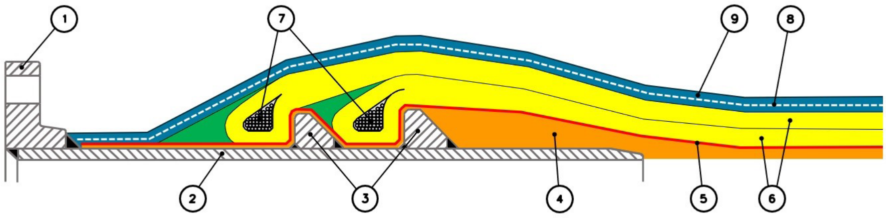
The cover protects the reinforcement of the hose from damage. The cover is typically made from a rubber compound that gives the following properties:

- High resilience and wear resistance.
- Cut resistance.
- Long fatigue life and high tensile strength.
- Smooth finish.

2.4.6 End fittings

There are three types of end fittings used for rubber hoses. Built-in, externally swaged or crimped, and internally expanded. Built-in fittings are the most reliable and should be used for rubber STS hoses. Externally swaged or crimped, and internally expanded end fittings, are not recommended for rubber STS hoses.

Built-in fittings are an integral part of the hose construction. The fittings consist of a flange and nipple. Raw hose components are assembled over the nipple. Binding wire is used to constrict the hose reinforcement material between the ribs on the nipple. An adhesive bond is made between the tube and the nipple of the end fitting when the whole assembly is vulcanised with the hose. The following figure shows a cross-section of a typical built-in end fitting.



No.	Description	Material
1	Flange	ASTM A-105
2	Nipple	API 5L
3	Rib	ASTM A-285C
4	Tube lining	NBR (Nitrile butadiene rubber)
5	Breaker	Nylon fabric
6	Reinforcement	Polyester cord
7	Bead wire	Steel wire cord
8	Breaker	Nylon fabric
9	Outer cover	CR (Chloroprene rubber)

Figure 2.3: *Typical built-in end fitting*

3 Composite hose assemblies

Figure 3.1: *Composite hoses*

Composite STS hose assemblies are typically used for liquefied gas and chemical transfers. These hoses are resistant to cryogenic cargoes, high-aromatic-content cargoes and various other cargoes that are not compatible with rubber compounds.

Composite STS hoses are very different from rubber hose assemblies, and it is important that users understand these differences as well as their properties. Composite hoses are lightweight and flexible, but it is important that the manufacturers' minimum bend radius (MBR) guidance is strictly followed.

3.1 Types of composite hoses

Composite hoses are designed for different cargo types. The following section describes general hose applications. Users should consult the manufacturer for guidance on the chemical and physical compatibility of hose and cargo.

3.2 Hose standards

Consistency in the manufacturing process is important to ensure that composite hoses perform safely and properly. There are internationally recognised organisations that define standards for the manufacture, inspection and testing of hose assemblies.

It is recommended that end users check that composite hoses are type-approved by a Classification Society. Type approval verifies that the hose has been designed and manufactured in conformance with the appropriate standard. The following list can be used to cross-reference applicable guidelines and standards:

- EN 13765 – Hydrocarbons (oils), solvents and chemicals.
- EN 13766 – Liquefied gases, including Liquid Petroleum Gas (LPG) and Liquid Natural Gas (LNG).
- EN 1474-2 – Design and testing of LNG transfer hoses.
- EN 12434 – Cryogenic flexible hoses.
- International Maritime Organization (IMO) International Gas Code.
- Chemical Distribution Institute's (CDI) *Guidelines for Liquid Chemical Hose Management.*

3.2.1 EN 13765: Hydrocarbons, solvents and chemical hose assemblies

EN 13765 defines standards for hoses used for the transfer of oils, solvents and chemicals. There are four types of composite hoses defined in EN 13765 based on their pressure and temperature ratings. Types 3 and 4 are used for STS transfers. Refer to table 1 in Ratings for EN 13765 Hoses – Hydrocarbons.

3.2.2 EN 13766: Liquefied gas hose assemblies

EN 13766 defines standards for hoses used for the transfer of liquefied gases. There are two types of composite hoses defined in EN 13766 based on their pressure and temperature ratings. Class A hoses are not designed for offshore use, whereas Class B hoses are, and they also have a safety factor of 5:1. It is recommended that class B hoses are used for STS. Type 1 and Type 2 hoses are defined by their different cargo temperature ratings. Refer to table 2 in Ratings for EN 13766 Hoses – Liquefied Gas Hose Assemblies

3.3 Regulatory requirements

Some regions have additional local legislation on the use of composite hose assemblies that should be met.

3.4 Hose construction and physical characteristics

Composite hose assemblies are constructed of an inner wire helix, a wall built from layers of liquid-tight films and reinforcing fabrics, an outer cover and an outer wire helix.

Because composite hose can be manufactured in long, continuous lengths, flange connections between the two ships may not be necessary. They can be coiled into smaller areas for storage and transportation, as long as the MBR is observed.

To prevent deformation or collapse, composite hoses are manufactured with internal and external high-tensile steel helical wires. These inner and outer wires are applied with the same pitch so that the outer wire lies between the coils of the inner wire (pitch is the distance between wires in a coil).

For electrically continuous hoses, the wire helices are used to provide electrical continuity between hose ends.

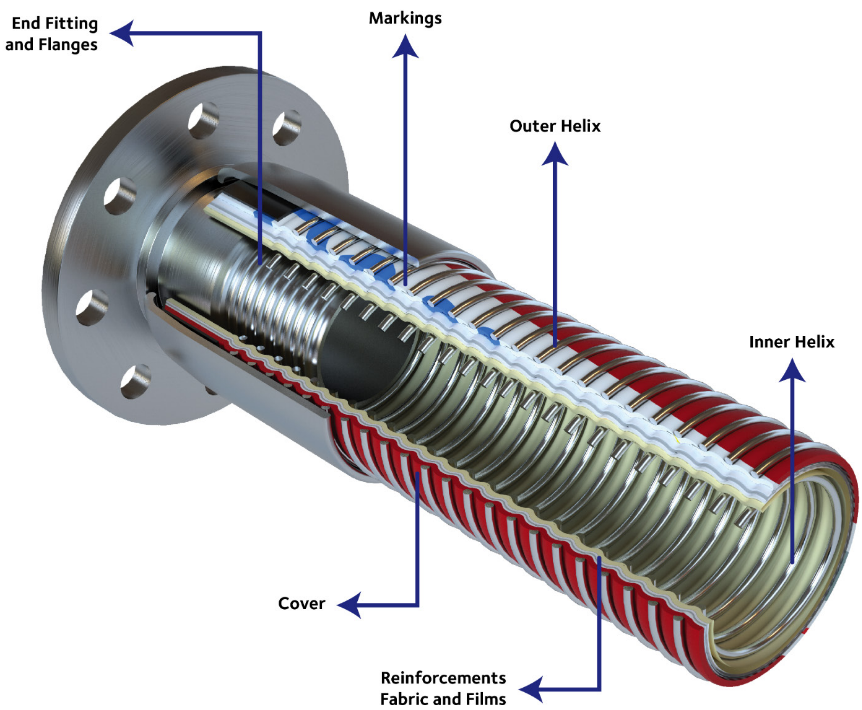


Figure 3.2: *Typical carcass construction of a composite STS hose*

3.4.1 Liner

The inner layer of films is called the liner. Liner materials vary depending on the specification and characteristics of the product being transferred. They should be compatible with the product being transferred.

3.4.2 Inner helix

The inner wire helix provides an interlock between the corresponding pitch of the outer helix wire. It is also the hoop support upon which the films and fabrics that comprise the hose wall are laid. The inner helix supports the hose body and prevents it from collapsing under a vacuum or negative pressure. The inner helix is exposed to the products being handled, so it should be made from a compatible material.

3.4.3 Reinforcement fabrics and liquid-tight films

Composite hoses can be manufactured with various thermoplastic materials and fabrics, providing a wide range of resistance to chemicals. Common thermoplastic materials are acrylic, polyamide (nylon), polyethylene, polypropylene, polyvinyl chloride (PVC) and polytetrafluoroethylene (PTFE). There are some disadvantages to these materials:

- Temperatures have an impact on strength, elongation and rigidity, and the manufacturer should be consulted.
- Composite hoses elongate significantly when pressurised or when under tension.

3.4.4 Outer helix

The outer wire helix provides an interlock between the corresponding pitch of the inner helix. Its primary functions are to provide enough strength to allow the hoses to achieve working pressures and to provide protection from external impact and abrasion. The outer helix is exposed to the ambient environmental conditions, so users should select materials that are able to withstand the expected conditions.

The outer cover protects the hose from environmental conditions, abrasion, impact, contamination and exposure.

3.4.5 End fittings

All composite hose assemblies are finished with metal ferrule end-fittings, which are swaged or crimped onto the hose body. There are two ways in which these end fittings are sealed:

- A gasket or seal.
- A thermoset resin such as epoxy.

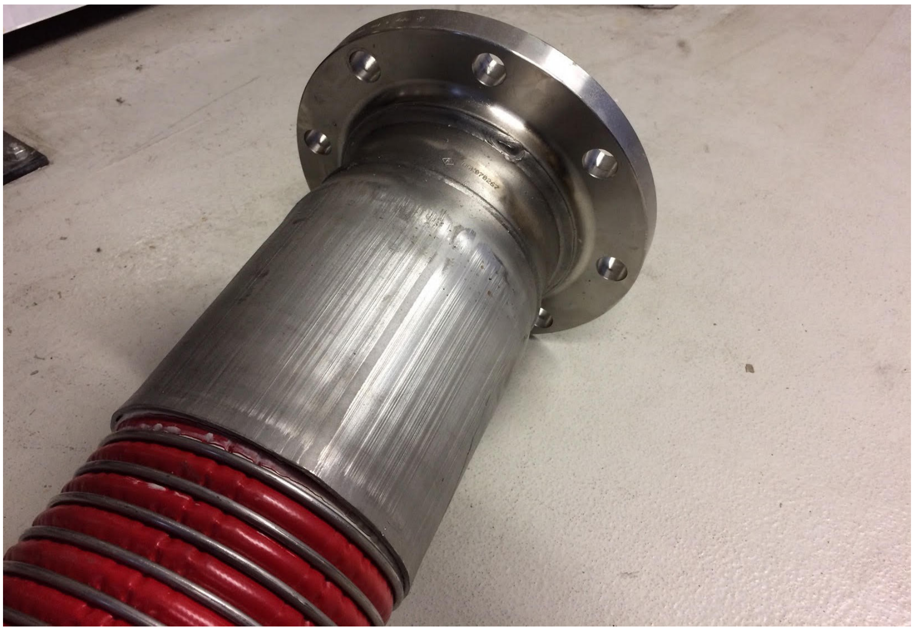


Figure 3.3: *Typical epoxy-sealed end fitting – (swaged and wet seal)*

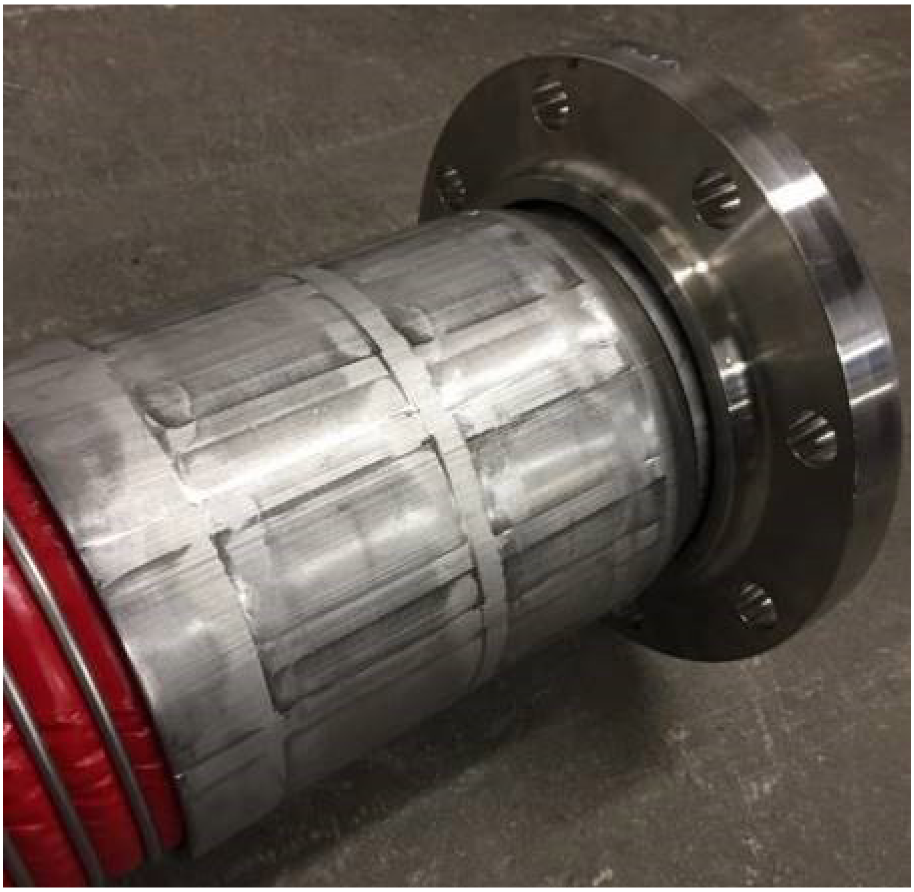


Figure 3.4: *Typical dry-sealed end fitting – (crimped and dry seal)*

4 Hose characteristics, compatibility, operating parameters and limitations

4.1 Flanges

Standard flange design is according to American Society of Mechanical Engineers (ASME) B16.5, Class 150. Flanges can have either raised or flat faces. Both are typically finished with concentric or spiral grooves.

Flanges are typically made from stainless or mild steel, depending on their application. The flange diameter, thickness, bolt configuration and pitch are determined by the industry standard to which they are constructed. These standards are based on pipe size and the required pressure and temperature ratings, most commonly:

- ASME/American National Standards Institute (ANSI) Class 150/300.
- Manufacturers Standardization Society (MSS).
- American Petroleum Institute (API).

Flat face flanges have the gasket surface on the same plane as the face of the bolt circle and are commonly fitted with full face gaskets. This combination is common in rubber hose assemblies.

Raised face flanges have their gasket-mating surfaces raised above the face of the bolting circle and are commonly fitted with ring gaskets. The raised portion concentrates the clamping pressure on the gasket surface. This combination is common in composite hose assemblies.

Fixed flanges are more difficult to connect to the manifold than floating flanges. A floating flange rotates around the body of the hose, so it can be lined up with the bolt holes on the manifold flange without having to twist the entire hose. Floating flanges require longer fasteners than fixed flange hoses.

Blind flanges are used to cap the end of the hose and protect its sealing surface when it is not in use. The design of the blind flange should be appropriate for the intended purpose.

LPG hoses may be fitted with ANSI 300 class flanges, which are suitable for use with pressurised LPG carriers.

PTFE or polyamide blanks are used between the hose flange face and the blind flange. These are intended to protect the blind flange from coming into contact with corrosive chemicals. These blanks should not be used as stand-alone blind flanges. See figure 4.1.

Hose assemblies are typically fitted with slip-on weld or lap-joint flanges. Slip-on weld flanges are fixed to the built-in nipple, which can create challenges when trying to connect the hoses to the manifold. Lap-joint floating flanges are also available and can be advantageous, especially in large-bore diameters. With a floating flange, the gasket face is integral to the hose nipple, but the flange is separate and free to rotate around the nipple. This means the flange can be rotated to facilitate alignment during connection. Because the gasket face is raised, longer fasteners are required for floating flange hoses.

For more detail on gaskets, see section 5.7.6.

Figure 4.1: *Hose flange protection blanks*

4.2 Markings on rubber hoses

Markings on rubber STS hoses should comply with the EN 1765 standard and the information listed below should be legibly marked and permanently vulcanised onto the outer cover of the hose. The label should be embedded onto both ends near the end fittings and on opposing positions on the hose body. The label should be in a contrasting colour to the hose body and include:

- Name of the manufacturer or their trademark.
- Type and designation of the hose.
- Nominal bore diameter.
- MWP.

- Quarter and year of manufacture.
- Serial number of the hose assembly.
- Electrical properties of the hose.

The initial temporary elongation following the manufacturer's pressure test should also be stencilled on the hose below the label.

A white, longitudinal stripe can be painted onto the outermost layer of the cover can be added by the manufacturer. This helps to identify any twist in the hose between the two ships' manifolds. The white stripe is only useful if the STS provider delivers the hoses in pre-assembled strings.

4.3 Markings on composite hoses

During the construction of a composite hose, a marking tape is applied to the outer cover of the hose assembly before the wire helix is installed. The tape serves as a permanent marking as per the standards and includes:

- Manufacturer's name, mark or logo.
- Standard to which it is constructed, such as EN 13765:2018 or EN 13766:2010.
- Hose identification including type of hose.
- Internal diameter.
- MWP.
- Working temperature range.
- Material of hose inner liquid barrier layer as referenced in ISO 1043-1:2011, e.g. Proof Pressure for PP (polypropylene) or PET (polyethylene terephthalate).
- Quarter and year of hose manufacture.

Marking tapes cannot withstand cryogenic conditions, and marking polyamide is only possible in large fonts. It is common for cryogenic hoses to have these marks etched or engraved onto the metal ferrule.

Some manufacturers use a colour-coding system to indicate the construction or cargo compatibility. There is no universally recognised code and end users should not make assumptions about the hose type based on the colour of the cover.

4.4 Hose/Product compatibility

Hose manufacturers should provide a chemical compatibility guide appropriate for the hose type and its intended use. Because there are many variables that may affect compatibility, due diligence is important. If there are any doubts about compatibility, it is recommended that the user seeks further guidance from the hose manufacturer and oil/chemical product supplier.

Hose manufacturers should ensure that following minimum information is made available:

- Product compatibility.
- Temperature range.
- Pressure range.
- Viscosity limits.
- Flow rate/velocity limitations.
- MBR.

The entity requesting STS services should provide as much information on the cargo as possible, including:

- Product details Safety Data Sheets (SDS).
- Presence of any additives.
- Viscosity.
- Cargo transfer temperature, pressure and flow rate.

Chemical resistance is only one aspect of hose compatibility. Operators should also consider physical or mechanical compatibility, particularly when transferring heavy oils or high-viscosity cargoes.

Highly viscous cargoes may not be compatible with some types of composite hoses. There have been cases where the wire helices have failed because of the turbulent flow of heavy crude or fuel oils. This type of hose failure can be worsened if the internal helix has been damaged (for example, due to kinking or heavy particles striking the helix).

Special hoses are required for use with high and low temperature cargoes after taking into account manufacturer's recommendations. Relevant standards should be referred to such as BS EN 13482:2013 and BS 4089:1999.

Caution: If during a cargo transfer there is an unexplained increase in pressure and/or decrease in flow rate, the operations should be stopped, and the hoses should be disconnected and visually inspected. These are possible indicators of a collapsed inner helix.

4.5 Explanation of pressure ratings for hoses

Hoses will be suitable for operation with product at internal pressures up to the MWP at operating temperatures.

ISGOTT provides the definitions and an illustration explaining the relationship between pressure definitions that are in common usage and describes the pressure/vacuum test procedures.

For vacuum rating, refer to EN 13765. Although there is no vacuum rating guidance in EN 13766 for cryogenic hoses, since hoses are manufactured and designed in a similar way, a vacuum rating of 0.9 bars absolute is used as a common reference.

4.6 Bend radius

Care should be taken when handling and supporting hose strings to avoid any kinking or over-stressing that may cause damage or reduce service life. To prevent damage when handling or supporting hoses, the hose's MBR should be taken into account. The MBR for storage and operation should be confirmed with the manufacturer.

Helix-free rubber STS hoses can be temporarily folded but should be returned to a straightened position as soon as possible and not kept in a sharp bend for extended periods of time.

Composite hoses should be well supported to prevent over-bending, especially near the end fittings. Over-bending can displace the helical wires, which could cause the hose to rupture or collapse. This risk is increased if temperatures exceed 60°C.

Users should be aware of the manufacturer's recommended MBR and ensure the limitation is not exceeded.

4.7 Flow rate

Flow rate is dependent on diameter, length, viscosity and pressure drop. Composite hoses have higher pressure losses than similarly sized smooth bore rubber hoses due to the inner wire helix. As the flow rate is increased, the pressure along the length of the hose drops dramatically. Users should consult the hose manufacturer to determine the maximum allowed flow rate for hose assemblies.

4.8 Product temperature

The minimum and maximum allowable product and ambient temperatures is specific to the hose type. This information should be requested from the hose manufacturers and made available on the hose test certificate.

5 Hose handling: rubber and composite assemblies/hoses

5.1 Transportation

Hoses are supplied to ships by STS Service Providers either in pre-assembled hose strings or in individual sections. Both are acceptable from a hose management perspective, as long as agreed by the ship Master and STS Service Provider before delivery. Dedicated Lightering Vessels may have their own hoses and fenders in which case these may be used.

In some locations, the STS Service Provider assembles individual hose sections ashore and the completed hose string is delivered to the ship. This delivery method is typical if the Service Provider employs large assist tugs or platform supply ships to support STS operations. These ships have large back decks that allow the hoses to be stored in compliance with the manufacturers' recommended MBR.

In most locations, hoses are delivered to the ships in individual sections. Hoses are delivered individually if smaller support ships are employed. These ships have very limited space and cannot accommodate long, pre-assembled hose strings.

Due to their lightweight and flexible design, composite hoses can be coiled into a crate or container or coiled onto a pallet.

5.2 Lifting/Support

Rubber hoses should be lifted from one end when oriented vertically. The MBR will be exceeded when a long hose is lifted by both ends. Although collapsible, some manufacturers' studies have shown that rubber STS hoses can be damaged after 5,000 cycles of 180° bending.

The outer helices of composite hoses are relatively delicate and susceptible to damage, which can lead to catastrophic failure of the hose. Hoses should be handled and supported with great care and should never be dragged across a deck or over ground.

5.3 Strops

Strops should be rated and certified by the manufacturer.

Hose-lifting strops should be positioned so that the hose will not fold over on itself (sharp kinks in the hose should be avoided). Wide strops are preferred. Strops should be placed strategically to allow the flange to align horizontally. This will improve hose connection efficiency.

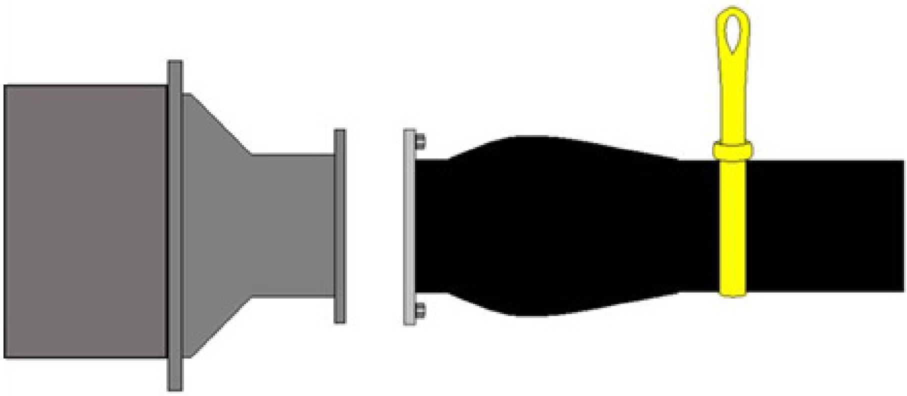


Figure 5.1: *Recommended strop position for horizontal alignment*

The strop should be placed as shown in figure 5.1. This will keep the hose bore horizontal when lifted. If a camlock and spool piece are fitted to the end of the hose, position the strop just behind the flange. This supports the additional weight of the Quick-Release Coupler (QRC).

For composite hoses, strops should be wide enough to support several turns of the outer helix. Strops narrower than the helix pitch should not be used. It is generally best to suspend the hose by the ferrule near the flange as opposed to lifting a hose along its body. Devices can be used to reduce likelihood of excessive bending during hose handling (see figure 5.3).

5.4 Strop retirement

Strops should be thoroughly inspected and replaced if they show any signs of damage or deterioration or evidence of chemical/oil exposure. A systematic retirement policy should be adopted and documented. If the strops are not identifiable (the labels are lost or unreadable), they should be retired.

5.5 Safe Working Load

Strops should not be loaded beyond their rated Safe Working Load (SWL). Strops should be large enough and long enough to be used safely and to be applied tightly enough to prevent the hose from slipping or falling.

5.6 Hose supports

Hoses should be supported using appropriate materials and methods that are compatible for the hose and cargo type. This prevents unnecessary stress on the manifold, while also making it more likely that hoses will have the correct bend radius where they cross the ship's rails.

The hose support should have a SWL large enough to support the weight of the hose and hose contents in a dynamic environment. Hose supports should be connected in such a way as to prevent twisting of the hose and secured to an appropriate strong point on board the ship, such as the manifold cruciform or suspended from the ship's manifold crane.

Securing the hose to the ship's manifold strong back rail (with rope of appropriate size and material) has additional benefits: it assists with restricting hose movement during operations.

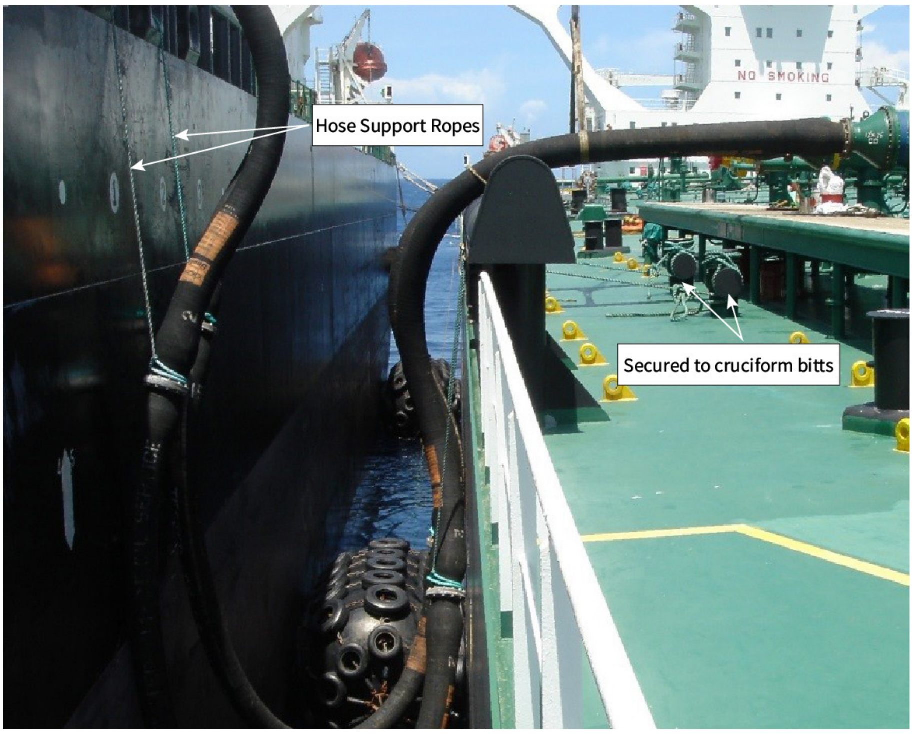


Figure 5.2: *Hose support ropes passed through fairleads and secured to cruciform bitts*

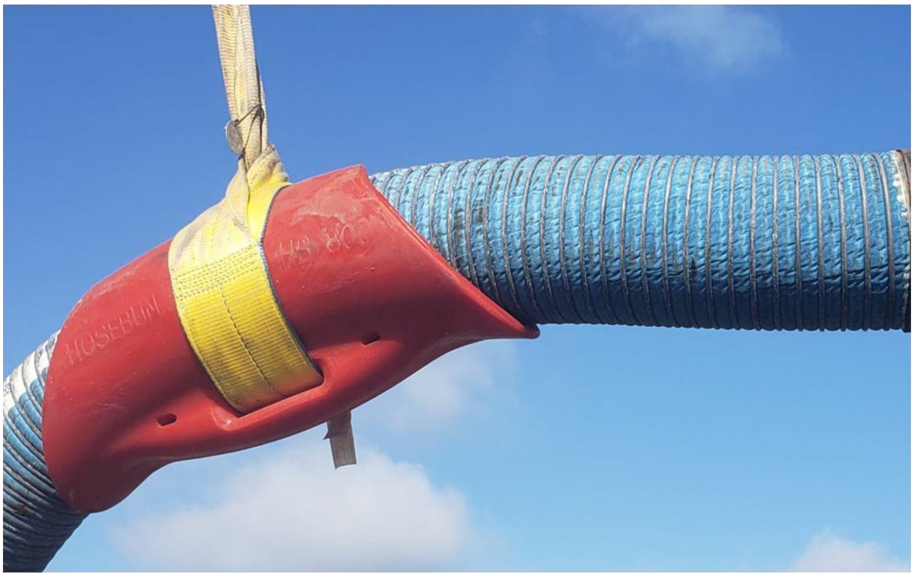


Figure 5.3: *Example of a proprietary Hosebun device*

5.7 Hose string assembly

Hoses can be delivered to ships in a pre-assembled string of two or three hose sections, or in individual sections that should be bolted together on board. There are advantages and disadvantages to both delivery methods. In general, hoses delivered by LSVs are pre-assembled. Hoses delivered by a small launch or tug are usually delivered in individual sections.

Composite hoses are generally easier to transport than rubber hose assemblies and are therefore available in longer lengths of up to 30 metres. End users should consider the advantages of using a single, long hose instead of a string assembled from multiple, shorter hose sections.

In addition to guidance in *ISGOTT,* the advantages and disadvantages of pre-assembled strings versus individual sections are noted below.

5.7.1 Pre-assembled strings

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 at the time of testing.
- Less time is required to connect hoses between two ships.
- There is additional assurance that strings are assembled correctly when continuous and discontinuous hose sections are used.
- Experienced personnel can easily install and tighten fasteners on pre-assembled hoses as more space and appropriate equipment are available ashore.

Disadvantages of pre-assembled strings:

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

5.7.2 Individual sections

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 MBR when lifted on board.

Disadvantages of individually delivered hose sections:

- Connecting hose sections on board ship requires space. It is more challenging for smaller ships and ships with exposed deck framing to support hoses during assembly.
- It can be difficult to reach and tighten fasteners underneath the hose. Spills have occurred due to fasteners working loose.
- There can be as many as three times the number of open flanges on deck when hose sections are delivered individually as opposed to when they are delivered in a continuous string. This increases the chance of an oil spill.
- Hose connection between ships may take longer as hose strings have to be assembled before being connected to the manifolds.
- Care should be taken when hoses are assembled on the other ship to check the assembly meets the receiving ship's standard before use.
- The integrity of flange connections is not verified by hydrostatic testing.

5.7.3 Configuration (continuous-discontinuous)

It is recommended that not more than one length of discontinuous hose be used in an individual string. An effective electrical continuity to earth from both ends of the discontinuous hose should be maintained.

By their construction, composite hoses are electrically continuous. It is necessary to use insulating flanges or spools to protect against discharge of static electricity, particularly when cargoes that are known static accumulators are being transferred. Some manufactures do provide the option of manufacturing hoses with one in-built insulation flange.

5.7.4 Bolting-up sequence

Hose connections are typically made with tools provided by the ship. STS Service Providers do not normally supply tools for connecting hoses, and torque wrenches are very rarely used for hose connections.

The proper sequence for bolting up a 12-, 10- or 8-inch hose is shown in figure 5.4. 12- and 10-inch hoses with Class 150 flanges have a 12-hole configuration. 8-inch hoses with Class 150 flanges have an 8-bolt configuration. These should be tightened as shown in figure 5.4.

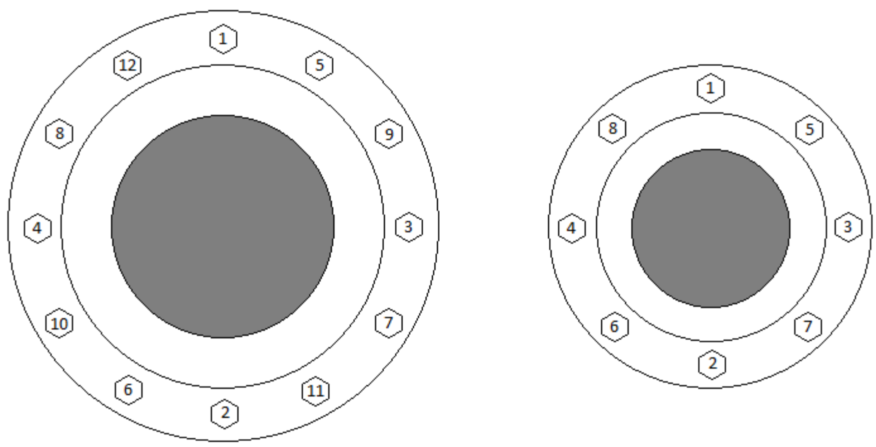


Figure 5.4: *Tightening sequence for 8", 10" and 12" flanges*

5.7.5 Fasteners

Hoses should be delivered by the STS Service Provider with enough fasteners to fill each hole. If bolts are used, they should be oriented so that the threads do not project outboard from the blind flange. Studs and nuts are preferred since either of the nuts can be removed if one of the nuts is damaged or stripped through thread galling. In any case, entire threaded section of nuts should be used when fastened using bolts or studs.

The fasteners used to connect hoses should be appropriately matched to ANSI Class 150 flanges typical of STS hoses. The fasteners should also be compatible with the gaskets used and the ambient and cargo temperatures. Guidance can be found in ASME B16.5, *Pipe Flanges and Flanged Fittings.*

Low-strength fasteners with yield strength greater than or equal to 206MPa (30ksi) are suitable for Class 150 flanges. Carbon steel fasteners should only be used where temperatures are greater than -20°C. Stainless steel fasteners should be carbide solution-treated.

Studs or bolts that have been strain hardened should be considered. These are Class II fasteners and are of intermediate strength. These are suitable with all listed materials and gaskets as long as it is verified that sealed joints can be maintained under rated pressures and temperatures.

In general, fasteners should never be repair welded, and undersized nuts/bolts or bolts with drilled heads should not be used.

5.7.6 Gaskets

Gaskets used on flanged connections are designed to absorb any irregularities in the flange faces and create a liquid-tight joint.

Gaskets should be compatible with the type of cargo being transferred as well as the working pressure and temperature. The recommendations of the gasket manufacturer should be followed for cargo compatibility and fastener tightness. Typical gaskets for the transfer of petroleum products are 3mm (1/8") thick compressed-fibre rings. A new gasket should be used every time the flange is opened.

There are three gasket material categories:

- Metallic.
- Semi-metallic.
- Non-metallic soft gaskets.

Materials commonly used in the manufacture of gaskets are:

- Vegetable fibres.
- Elastomers (rubber compounds).
- Flexible graphite.
- Laminated graphite (tang).
- Asbestos Free Material (AFM).
- PTFE.
- Silicone.
- Stainless steel.

Gaskets are available in several different patterns, each designed for specific flange types or applications. The most common are:

- **Ring-type gaskets.** These are positioned around the bore but inside of the bolt circle. On raised face flanges, these gaskets sit on the raised face. These gaskets are simple to manufacture and can be installed without completely disassembling the joint (drop-in gaskets). Three measurements are required when specifying ring-type gaskets: thickness, inside diameter (bore size) and outside diameter (typically bolt circle diameter minus one bolt diameter).
- **Full-face gaskets.** These have outside diameters equal to the flange diameter. Bolt holes should therefore be cut into these flanges so hose fasteners can pass though. Alignment is easier with full-face gaskets, but the entire joint should be disassembled for installation and removal. The required specifications for full-face gaskets are: inside diameter, outside diameter, thickness and bolt configuration (number and diameter of bolt holes and the diameter of the bolt circle). Measuring pitch circle diameter can be done by selecting two opposite bolt holes. Measure the distance between the outside edge of one hole to the inside edge of the opposite hole. This is the diameter on which the bolt holes are centred.

- **Envelope gaskets.** These are used for severely corrosive products and are made from corrugated metal or rubber sheets enveloped in PTFE jackets. Envelope gaskets are sized similarly to ring-type gaskets.
- **Spiral-wound gaskets.** These are manufactured by winding strips of metal and soft fillers on a mandrel while under tension. Thick fillers wound under low pressure loads are used for lower pressure applications. These gaskets should be sized to ensure the winding component is seated properly between flat surfaces. Spiral-wound gaskets cannot extend beyond the raised face nor protrude inside of the flange bore.
- **Corrugated gaskets.** These are typically metallic gaskets available for Class 150 and 300 flanges where bolt loading is minimal. They are typically used for heat exchanger applications but can also be used for standard flange connections.

5.7.7 Insulating flanges

Insulating flanges can be used instead of a discontinuous length of hose. There are two types of insulating flanges:

- Type 1 insulating gasket kit comprises gaskets, bolt sleeves and washers. These are designed so each component at the flanged connection is electrically insulated.
- Type 2 insulating block is solid block insulator cast from a block of insulating material such as PTFE. The bolt holes of these blocks are offset so that each flange can be connected independently.

These components should be installed between the last hose and the manifold, provided that the hose body does not come into contact with any metallic component of the ship and that the hose is suspended by non-conductive slings. As an alternative, these can be installed between the last two hose flanges in a string.

Type 1 and Type 2 insulating flanges should not be used together in the same hose string. Do not use either type of insulating flange if one of the hoses in the string is discontinuous.

Since composite hoses are continuous (i.e. bonded, with a resistance less than 100Ω), an insulating flange is required.

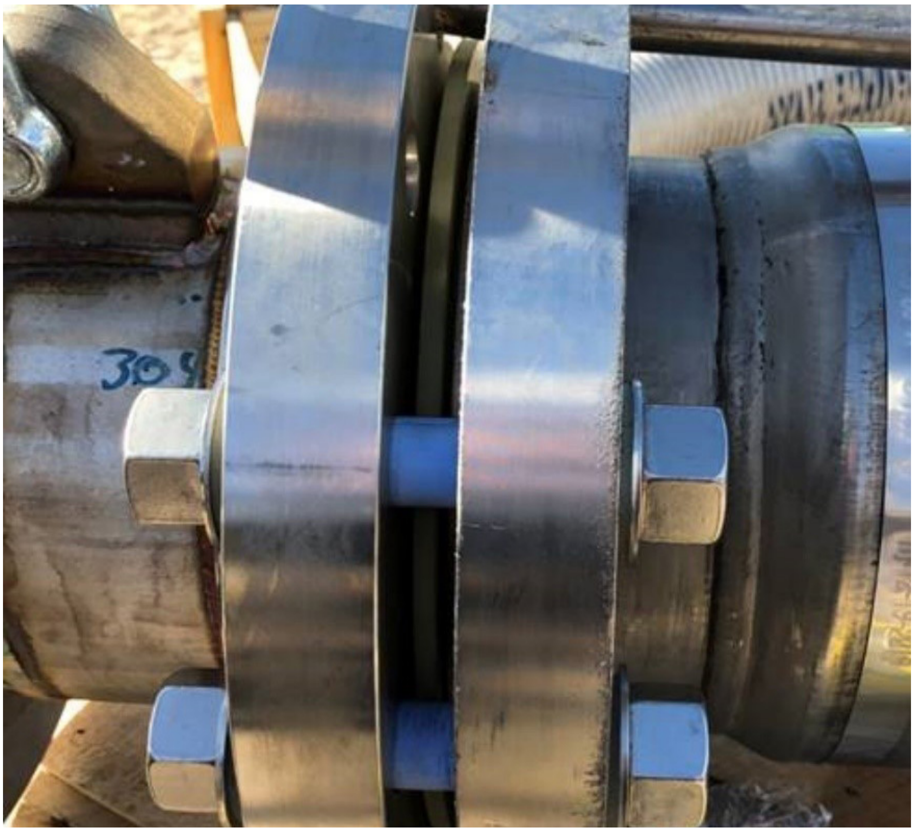


Figure 5.5: *Example of a Type 1 Insulator – insulating gasket kit*

Figure 5.6: *Example of a Type 2 Insulator – insulating block*

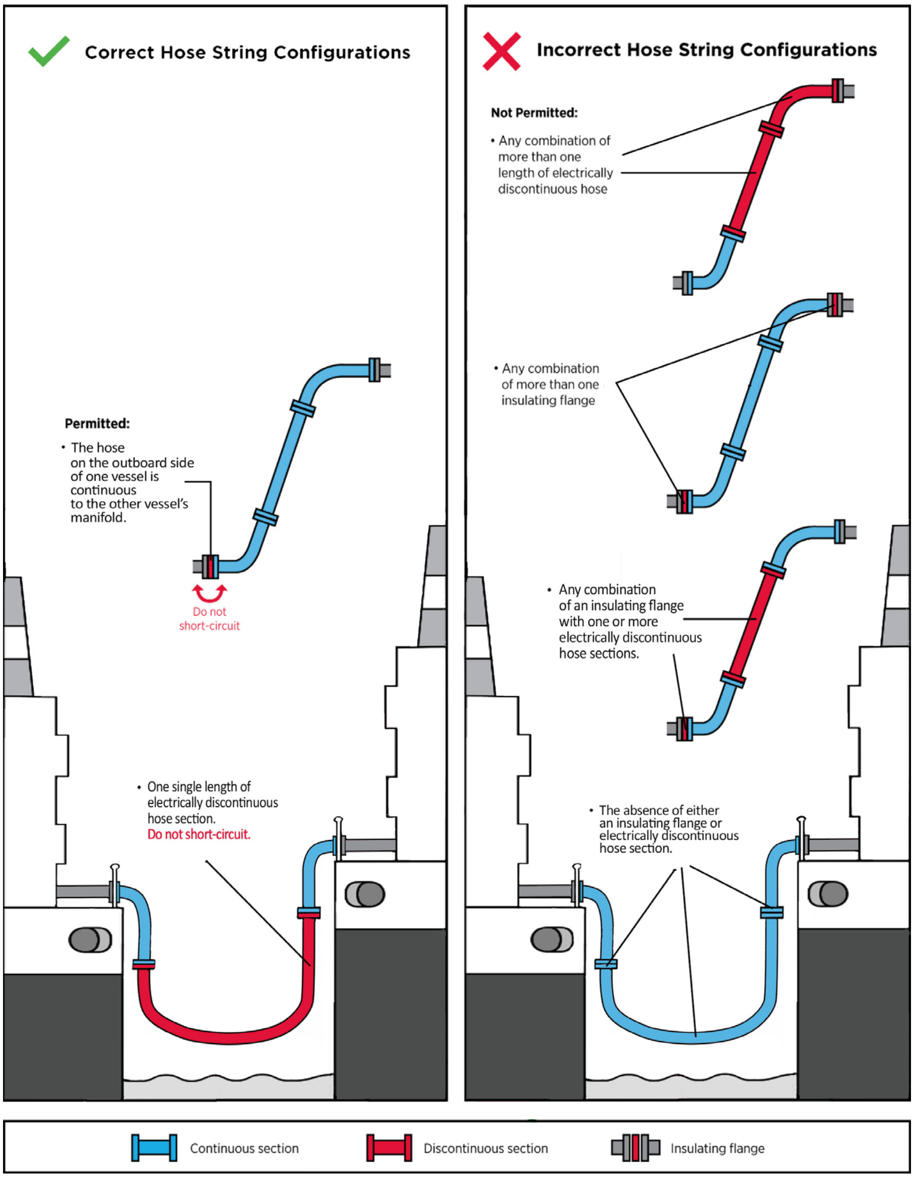


Figure 5.7: *Use of insulating flanges*

5.8 Inspection and testing

Inspection and testing of hoses and/or hose strings should be carried out by trained and competent persons.

The hoses and/or hose string should be inspected before connection to the ship manifolds to check its fitness for service and following disconnection from the ship manifolds to check its fitness for future service. Damaged sections should be replaced before any STS operation is undertaken if the damage is considered to be critical to the service.

5.8.1 Visual inspection external/internal

The external surfaces and any accessible internal surfaces should be visually inspected for indications of damage or deterioration. Refer to manufacturer's recommendations and appendices A and B for guidance on evaluating observed damage for rubber and composite hoses, respectively.

A critical aspect of composite hose integrity is uniform pitch of the wire helix along the entire length of the hose. Hoses should be examined to identify and evaluate any areas where dislocation of the wires may have occurred.

Unlike rubber hoses, composite hose covers are made up of very thin single ply fabric which can be easily damaged. If only one or two layers are abraded, it may be superficial, while hoses with deep cuts that penetrate to a layer of film should be removed from service. Some local jurisdictions consider any cover damage as grounds for discontinued use. End users must verify that their hoses are compliant with all regulations.

5.8.2 Flange integrity

All flanges should be inspected for damage, excessive corrosion and missing fasteners. Each fastener at each flange should be checked for tightness before the hose string is connected to the ship manifolds. Hoses with damaged flange faces should be withdrawn from service and inspected by a manufacturer's representative to determine if the hose can be repaired.

5.8.3 Periodic hose testing

Tests and inspections should be conducted every twelve months as a minimum. The testing and inspection frequency should take into account the types of products handled through the hose, the age of the hose and the severity of service conditions. A decision, dependent on the outcome of the testing and inspection regime, can then be made about whether to retire a hose or keep it in service.

It is recommended that STS Service Providers and/or Lightering Vessel Operators build up a database of wear, damage and failure frequency rates by comprehensive testing in order to establish appropriate retirement criteria and an on-shore testing cycle.

Repairs to hoses should only be carried out in accordance with the original manufacturer's instructions.

5.8.4 Test facilities

5.8.4.1 On shore/in-situ

Test programmes are generally carried out on shore. Regardless of location, hydrostatic tests should not be conducted unless there is enough space, equipment and competent personnel available to safely conduct the test, and a means of disposing or recycling the waste water in an environmentally responsible way.

5.8.4.2 Calibration of tools: gauges, tapes, torque wrenches

Procedures should be documented, and a record maintained for calibration of tools used in testing.

5.8.5 Visual inspection

5.8.5.1 Cover

For rubber hoses, the cover should be cleaned and carefully examined to detect damaged areas such as cuts, gouges, tears and abraded spots. The extent of damage should be determined by visual inspection at rest and during pressure testing. If the damage is minor, it should be repaired and the hose returned to service. Hose repairs should be made with a suitable product in accordance with the product's manufacturer. Some hose manufacturers can provide hose-repair kits and instructions. If the nylon breaker is damaged, it is recommended that the hose be removed from service until repaired. Damage that extends into the reinforcement layer is cause for retiring the hose.

For composite hoses, the cover should be cleaned and carefully examined to detect areas where the reinforcement has been damaged. Cuts, gouges, tears and abraded spots may have occurred. If the extent of the damage penetrates to a liquid barrier (polymeric films) then the hose should be withdrawn from service. The extent of any damage should be determined by visual inspection at rest and during the pressure test. If the damage is minor, the hose may be returned to service. If the damage is extensive, it is recommended that the hose be retired from service.

The pitch angle and spacing between wraps in the outer wire helix should also be examined. The wire helix should be spaced uniformly along the length of the entire hose assembly. Nicked or damaged wires are cause for concern and the hose should be removed from service. Excessive corrosion, rust or scaling on the wire helices can be detrimental to the hose and should be evaluated by the manufacturer.

5.8.5.2 Carcass

For rubber hoses, the hose should be examined for crushed or kinked areas and broken reinforcement, indicated by any permanent distortion, longitudinal ridges or bulges. Hoses showing such defects should be removed from service.

For composite hoses, the hose should be examined for crushed or kinked areas and broken or displaced helices. Hoses should be inspected for any signs of permanent distortion, longitudinal ridges or bulges. Hoses showing such defects should be removed from service for further examination. If during the inspection, there is any doubt about the integrity of the hose, it should be removed from service.

5.8.5.3 Fittings

On rubber hoses, exposed internal and external surfaces of flanges and nipples should be cleaned and examined for cracks or excessive corrosion. Either condition should cause the hose to be retired from service. For composite hoses, the ferrule should be inspected for signs of corrosion, damage, cracks or elongation. Hoses with end fittings that have elongated during testing or use should be discarded, as this is a sign of a damaged or defective swage. Further use may cause the ferrule to slip off the end of the hose.

5.8.5.4 Liner

For rubber hoses, the hose liner should be visually inspected for ozone cracking, blisters, bulges, cuts or separation of the liner from the carcass. Any of these are cause for retirement of the hose from service. On composite hoses, the hose interior should be visually inspected for liner damage and displaced or damaged areas of the inner wire helix. Serious defects should be cause for retirement of the hose from service.

5.8.6 Hydrostatic pressure test

5.8.6.1 Rubber hose assemblies

The hose assembly is subjected to an internal hydrostatic pressure, and the elongation of the hose at that pressure is measured and recorded as the temporary elongation. After release of the internal pressure, the increase in length of the hose is re-measured and reported as the permanent elongation. The test should be carried out at ambient temperature (minimum 5°C).

Each hose should be pressure tested with water. The procedure should be as follows:

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.

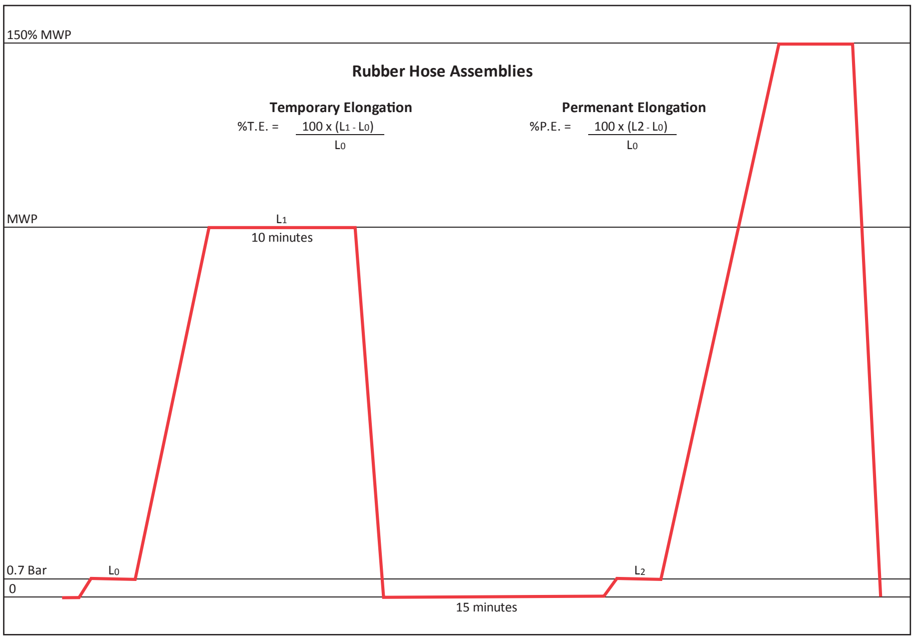


Figure 5.8: *Rubber hose assemblies: hydrostatic pressure test and timeline*

During hydrostatic testing at the time of manufacture, the maximum temporary elongation should not exceed 5% and the permanent elongation should not exceed 2% of the original length for the type of hoses used in STS operations (Type L) in accordance with BS EN 1765:2016.

Temporary elongation (T.E.) is derived from the formula: $\% \text{ T.E.} = \frac{100 \times (L_1 - L_0)}{L_0}$

Permanent elongation (P.E.) is derived from the formula: $\% \text{ P.E.} = \frac{100 \times (L_2 - L_0)}{L_0}$

Permanent elongation can be determined if recommended by the hose manufacturer and is considered part of hose retirement criteria.

In accordance with BS 1435-2: 2005 (Part 2 – *Recommendations for storage, testing and use*) during hydrostatic testing in service, different criteria apply (see examples below). To determine the maximum acceptable percentage of temporary elongation, multiply the T.E. at the time of manufacture (according to the certificate) by 1.5 (150%) except where the T.E. at the time of manufacture was less than 2.5%. In these cases, add 2.0 to the T.E. indicated on the manufacturer's certificate to determine the maximum T.E. permissible in field testing.

Example 1:
Temporary elongation at factory acceptance testing is 3.5%. The maximum allowable percentage of T.E. in field testing is 5.25 (3.5 x 150% = 5.25). If the T.E. calculated is 5.25 or less, then the hose is acceptable for continued use.

Example 2:
Temporary elongation at factory acceptance testing is 1.5%. The maximum allowable percentage of T.E. in field testing is 3.5 (1.5 + 2 = 3.5). If the T.E. calculated is 3.5 or less, then the hose is acceptable for continued use.

STS lightweight hoses should not be subjected to a vacuum test.

The following criteria should be assured before returning the hose to service:

- Temporary elongation not greater than the limits defined in BS 1435-2:2005.
- No leaks.
- No visual damage.
- No cracks or damaged parts during internal inspection.
- No cracks or damaged parts during end fitting inspection.
- Electrical continuity: see Electrical Continuity Test – Rubber Hoses.
- Manufacturer's recommendations.

5.8.6.2 Composite hoses

Composite hoses are hydrostatically tested in the same manner as rubber hose assemblies. However, due to the nature of their construction, composite hoses will elongate to a much greater extent than rubber hoses.

Each hose should be pressure tested with water. The procedure should be as follows:

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.

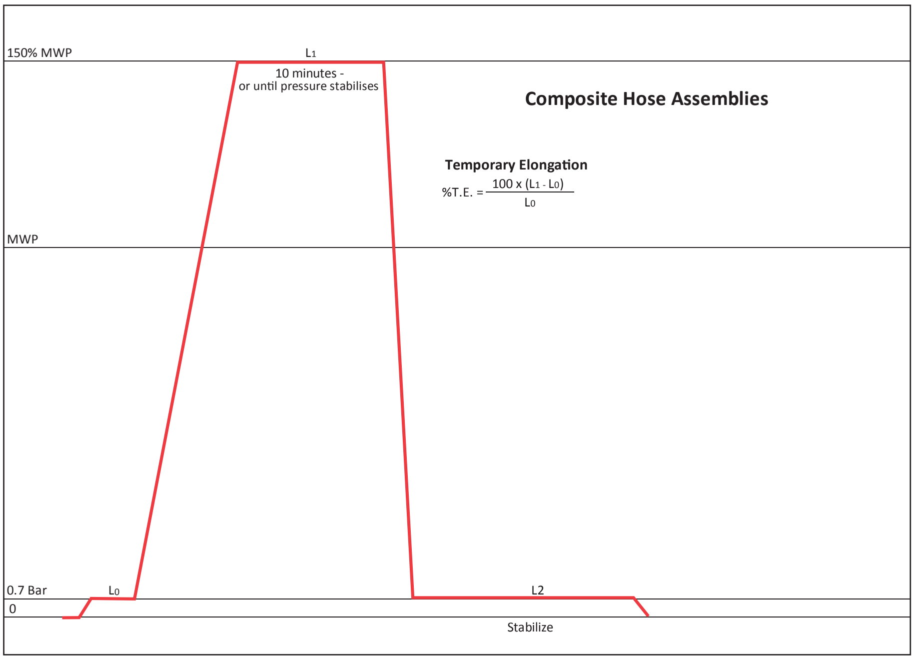


Figure 5.9: *Composite hose assemblies hydrostatic pressure test and timeline*

If the maximum temporary elongation exceeds 10% the hose should be retired from service in accordance with EN13765.

It should be noted that composite hoses should not be subjected to a vacuum test.

The following criteria should be assured before returning the hose into service:

- Temporary elongation not greater than 10%.
- No leaks.
- No visual damage.
- No cracks or damaged parts during internal inspection.
- No cracks or damaged parts during end fitting inspection.
- Electrical continuity (see section 5.8.7.1).
- Manufacturer's recommendations have been followed.

5.8.7 Electrical continuity test

5.8.7.1 Rubber hoses

Electrical tests should be carried out in accordance with the procedures described in *ISGOTT,* with the hose empty and before, during and after the hydrostatic tests. The hose should be conditioned for at least 16 hours at a relative humidity not greater than 70% before testing. The hose should be supported or suspended by non-conductive materials with flange rims cleared above ground level.

Electrically discontinuous hose should have a resistance that is no less than 25,000Ω, measured flange to flange. The testing of electrically discontinuous hose should be carried out using a 500-volt tester.

Electrically continuous hose should not have a resistance higher than 100Ω, measured flange to flange.

Electrically conductive (EN 1765 Grade Ω) hoses should have a resistance between 25,000 and 1,000,000Ω measured flange to flange.

5.8.7.2 Composite hoses

Electrical tests should be carried out in accordance with the procedures described in *ISGOTT,* with the hose empty and both before and after the hydrostatic tests. The hose should be supported or suspended by non-conductive materials with flange rims cleared above ground level.

Hoses with a built-in insulating flange are considered electrically discontinuous and should have a resistance of no less than 25,000Ω measured flange to flange. The testing of electrically discontinuous hose should be carried out using a 500-volt tester.

Most composite hoses are electrically continuous and should have a resistance less than 100Ω, measured flange to flange.

5.8.8 Third-party verification

A third party, such as a Classification Society or a surveying company, should be employed to ensure that hose testing is conducted in compliance with recognised industry standards. Hose certificates should bear the stamp or mark of the third party as evidence.

5.8.9 Hose service life and retirement

5.8.9.1 Hose service life

The service life of a hose depends on factors such as age, handling, throughput and storage conditions. There are various approaches to gauging the life of a hose during the time it is in service. Service life expectancy should be based on a combination of testing and visual inspection (for visual inspection guidance, see sections 5.8.1 and 5.8.5).

In consultation with the manufacturer, and along with this guide, testing rubber hoses to BS 1435 Part 2, or composite hoses to EN 13765/6, is the preferred approach to determining fitness for continuing service. However, the rate of degradation is difficult to determine and long intervals between testing may not adequately prevent a hose failure, especially when the hose is at the end of its effective life.

Test records should be kept for each hose. It is recommended that temporary and permanent elongations be compared to previous readings to facilitate trending and to give early indication of maximum elongation exceedance.

The STS Service Provider should have a documented programme to measure the service life of their hoses and determine when they should be taken out of service.

5.8.9.2 Hose retirement

Hoses should be withdrawn from service and retired against defined criteria, which may include:

- Type of hose and nature of service.
- Manufacturer’s recommendations.
- Defects detected during visual inspections.
- Establishing in consultation with the manufacturer a defined period of service.
- When the temporary elongation of the hose, measured during pressure tests, exceeds the maximum allowable values for that specific type of hose.
- If, according to the manufacturer’s recommendations, the permanent elongation of the hose, measured during pressure tests, exceeds maximum allowable values for that specific type of hose.

It is recommended that STS Service Providers build up a statistical database of wear, damage and failure frequency rates in order to establish appropriate retirement criteria, always in close consultation with the manufacturer’s recommendations and in adherence to applicable standards and industry best practice.

5.8.9.3 Testing and marking of retired hoses
Hoses that have been retired or condemned should be clearly and permanently marked to prevent their inadvertent use. The markings should be large and clear so retired hoses can be readily identified.

5.8.9.4 Burst testing
Consideration should be given to destruction testing of retired hoses by pressure bursting and sectioning (cutting up) as appropriate. The data gained can be used to establish suitability for purpose and to gauge the extent of any damage and may be useful when determining hose service life and retirement criteria.

5.8.10 Records and forms
Records on the history and performance of individual hose components should be kept for efficient operation and maintenance of STS hoses. Proper records and inventories are necessary to:

- Provide operating personnel with a ready record of hoses that are on order, available on site as back-up spares, installed and operating on site, or that are damaged and taken out of service.
- Permit the operators to assess the hose's quality of performance and provide a basis for future selection and purchases.
- Pinpoint design inadequacies by focusing on hoses in the system that are prone to failure, damage or excessive wear.
- Provide a rational basis for the establishment of anticipated service life and the stockpiling of back-up hoses.
- Exercise any manufacturer's warranties that may apply.
- Meet requirements of local governmental regulations.

There are many different types of hose record systems in use. A manual card system is clear, brief and easy to maintain. It should, however, be considered the minimum requirement. The following data may be also recorded and maintained for each STS hose in inventory:

- Age.
- Number of times used.
- Product transported.
- Ambient temperature – each use.
- Cargo temperature – each use (only for heated cargoes).
- Average pressure – each use.
- Peak pressure – each use.
- Total volumetric throughput.
- Total hours in service.
- Unusual events.
- Testing records (results, frequency, etc.).
- Storage conditions – between each use.

5.8.11 Hose storage
Hose life in storage may be affected by temperature, humidity, ozone, UV, direct sunlight, oils, solvents, corrosive liquids and vapours, insects and rodents. Rubber hoses may be stored on steel framed pallets. These pallets allow hoses to be stored about three high, which, as well as reducing the area needed for storage, eliminates any damage or distortion that might result if they are stored directly on the ground. Pallets facilitate examination and make markings easily accessible for checking. They also help to protect against insect and rodents, because the hoses are off the ground. If pallets are not used, hose lengths should always be laid out straight, on wide supports and on level ground. Such supports should also allow suitable hose strops to be easily inserted under and around the hose for lifting or transporting.

Hoses should be stored in a cool, dark, dry area or building with freely circulating air. If closed storage is not possible, hoses should be covered to protect them from sunlight. For locations with extreme temperatures, additional measures may be needed, such as storing the hoses in a climate-controlled warehouse.

The ends of hoses should be covered with blanks. Hose lengths should not be stored next to operating equipment that could generate ozone or heat.

The serial number, and month and year of manufacture or date code number, should be carefully recorded to ensure that the oldest hose is issued first, using a rotational system.

After retirement from operational use, the hose should be drained completely and flushed fully with water to remove toxic or combustible liquids/vapours. Ensure that the waste water is disposed of in an environmentally responsible way and in accordance with all applicable company and regulatory requirements.

5.8.12 Camlock couplings

A camlock coupling connects the hose to the ship manifold using a number of cams. Camlock couplings can reduce the time needed to connect or disconnect the hose string from the ship manifold. They can also provide a means of quick disconnection in the event of an emergency or abnormal situation. Camlock couplings are used mainly where the hose strings are pre-assembled.

Figure 5.10: *Camlock coupling – integral and bolt-on short spool piece*

5.8.12.1 Installation/Operation

Once the flanges are mated, the lobes of the camlock coupling are rotated by hand into the locked position using a specially designed spanner. The lobes should not be tightened with a hammer, as this can damage the mechanism. Most camlock couplings have an integral short-distance spool piece to allow connection to the manifold using standard fasteners instead of the lobes.

5.8.12.2 Maintenance/Inspection

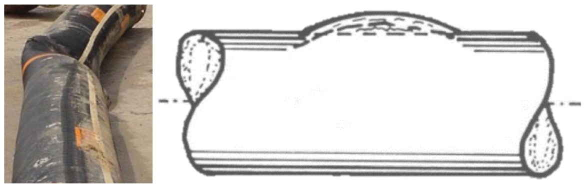
Camlock couplings should be visually inspected before each use. Camlock couplings typically require a lot of maintenance, which is the most common reason they are not used. Poorly maintained camlock couplings should not be used.

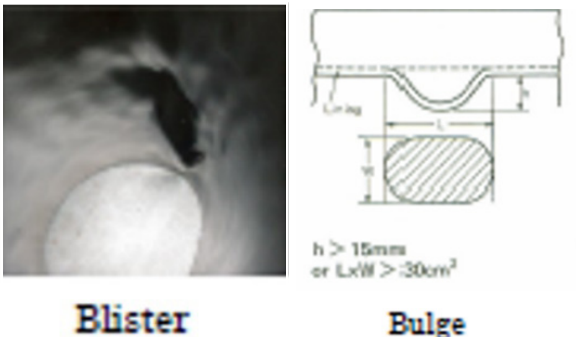
Appendices: Damage and degradation

The following tables provide guidance for evaluating damage or degradation found by visual inspection for rubber and composite hoses.

Appendix A: Guidance for evaluating damage or degradation on rubber hoses

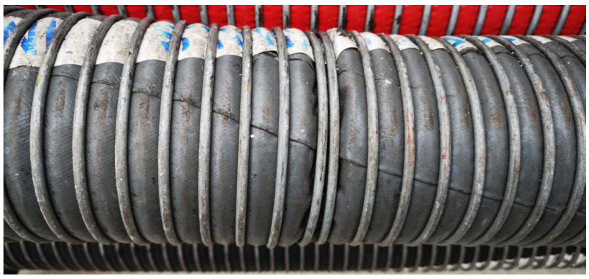
Hose manufacturer's guidance for damage assessment should be sought.

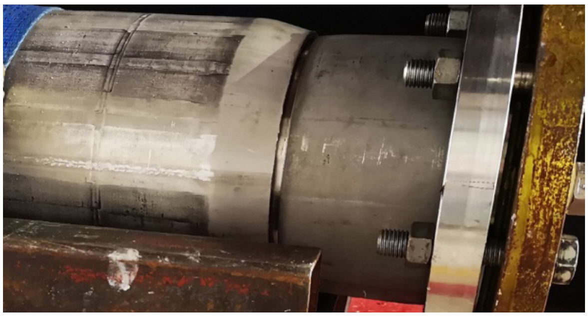
Inspect	Cause for Retirement	Representative Picture
Hose body	Kinking or other large permanent deformation.	
Hose cover	Reinforcement layer is damaged or exposed. Note: damage not extending to the reinforcement layer may be repaired and the hose returned to service.	
Flanges and nipples	1 Excessive corrosion is observed and the thickness has been reduced. 2 Irreparable damage to flange faces or deformation, which affects seal. 3 Inner and outer surface of nipple is extensively corroded. 4 Welded portion is extensively corroded.	
Inner lining	Cracks or cuts are observed. Note: cracks and cuts will propagate during service. Image viewed through a borescope or under a microscope.	

Inspect	Cause for Retirement	Representative Picture
Inner lining	Solvent cracking (e.g. from additive packages). Note: Image viewed through a borescope or under a microscope.	
Inner lining	Bulges or blisters protruding into bore. Note: Image viewed through a borescope or under a microscope.	

Appendix B: Guidance for evaluating damage or degradation on composite hoses

Hose manufacturer’s guidance for damage assessment should be sought.

Inspect	Cause for Retirement	Representative Picture
Outer helix Wire	Corrosion of the outer wire caused by scuffing, chemical attack, rusting, etc.	
Outer helix wire	Serious displacement of the outer wire.	
Inner helix wire	Collapse of the inner wire.	

Inspect	Cause for Retirement	Representative Picture
Hose body	Severe impact damage to the hose body.	
Outer cover	Serious scuffing of the outer cover (through to the inner reinforcing fabrics).	
End fitting	Ends moving away from ferrule.	
End coupling	Severely corroded couplings can result in loss of continuity.	

Our vision
A global marine industry that causes no harm to people or the environment

Oil Companies
International Marine Forum
29 Queen Anne's Gate
London SW1H 9BU
United Kingdom

T +44 (0)20 7654 1200
E enquiries@ocimf.org

ocimf.org