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To whom it may concern

GMPHOM Hoses
Piping
Ships Deck Equipment
Steel Construction
Engineering
Hose Handling System
Large Diameter Rubber Hose

Operation & Maintenance Manual

1.0 INTRODUCTION

At offshore mooring installations, the hose strings are a critical link between the installation and tanker. When deployed, they are constantly subjected to the dynamic forces of the sea which can result in severe loads and stresses within the hose. To provide greater reliability and longer life, it is imperative that the hose be handled and stored correctly and be inspected and tested in a consistent manner at appropriate intervals.

The purpose of this document is to minimise hose damage from handling and storing, so as not to adversely affect operations by hose failure. Compliance with proper inspection and testing procedures will also increase the probability of detecting potential failure areas in a timely manner.

Thus, these recommendations have been prepared to provide the user with a guide to proper handling and storage and a means of determining the condition of the hoses in service and are generally in accordance with the 'OCIMF Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (Fifth Edition – 2009)'.

2.0 HOSE HANDLING

Although EMSTEC hoses are robustly constructed for a marine environment, they can be easily damaged from improper handling whether on land or sea. In general, while handling hoses adequate support is the key to the prevention of over-bending (kinking), which can lead to premature hose retirement.

Lifting

The recommended method of lifting a single hose section is to use the spreader bar and lifting straps provided with the hoses. The spreader bar provides a three-point lift on hoses up to 12.2 metres long, using a strap over the nipple area at each end and additional strapping, as appropriate, equally spaced between the end straps.

The lifting straps should preferable be flat nylon or equivalent reinforced cloth bands, and at least 150mm wide to prevent localised damage and chafing of the hose cover. Wire rope must not be used.

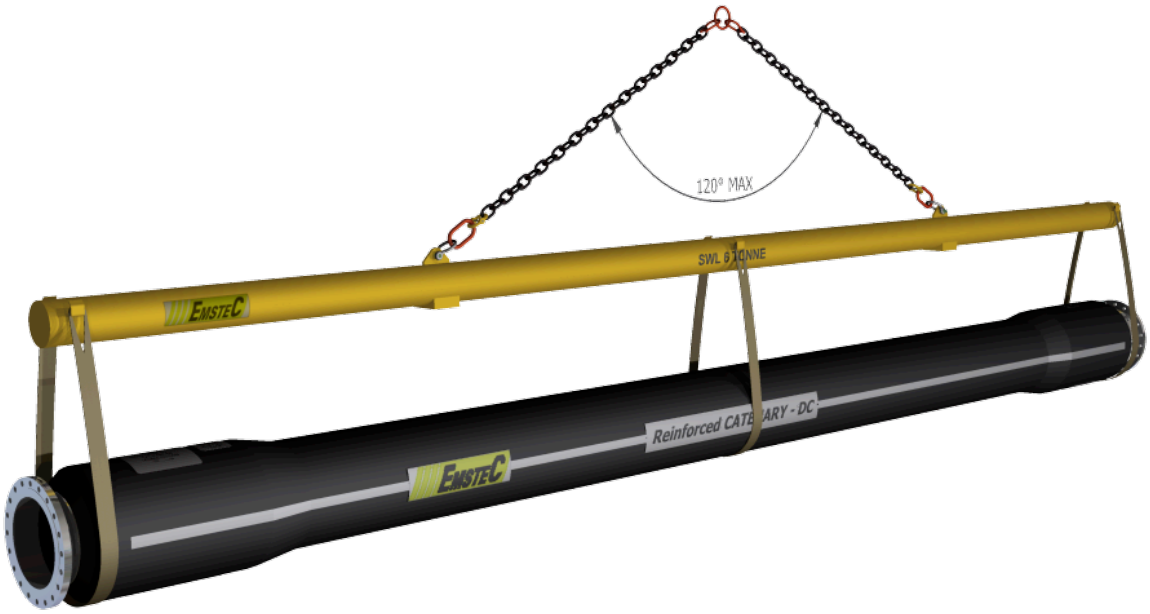

Figure 1 – Showing a Typical Spreader bar lifting arrangement

A hose should never be lifted by a single sling at the midpoint, or by two slings positioned one at each end. When moving a hose, it must be lifted properly and set down with care on adequate supports. A hose should never be dragged across the ground.

How to lift a hose properly

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3.0 HOSE STORAGE

Temperature, humidity, ozone, sunlight, oils, solvents, corrosive liquids and vapours, insects and rodents may affect hose life in storage. Ideally, if available, hoses should be stored on steel framed pallets in accordance with the OCIMF publication entitled *"Guide to Manufacturing and Purchasing Hoses for Offshore* Moorings*"*. These pallets enable hoses to be stored up to three high, which in addition to reducing the area required for storage, eliminates any damage or distortion, which might result if stored directly on the ground. Storage on hose pallets also facilitates examination and makes the hose markings easily accessible for checking. They also help protect against insect and rodent attacks as the hoses are off the ground.

Whenever possible, hoses should be stored in cool, dark, dry areas or buildings with freely circulating air. Where closed storage is not possible, hoses should be covered with tarpaulins to protect them from sunlight. For locations where extreme temperatures apply, additional measures may be necessary such as storing the hoses in a climatically controlled warehouse. This is especially important at extremely cold locations.

The ends of the hoses should be covered with wooden blanks with 4 x 15mm diameter holes in the centre, to allow for air circulation and to prevent internal attack by rodents. It is also recommended to secure the wooden blanks in place using heavy-duty electrical ties, equi-spaced around the flange circumference. The use of nuts and bolts is also an option, however they can become corroded and seized during periods of long term storage, and difficult to remove.

Hose lengths should not be stored adjacent to operating equipment, which could generate ozone or heat.

Hose lengths should always be laid out straight, with wide supports on level ground. Such supports will provide easy access for the insertion of hose lifting slings under and around the hose.

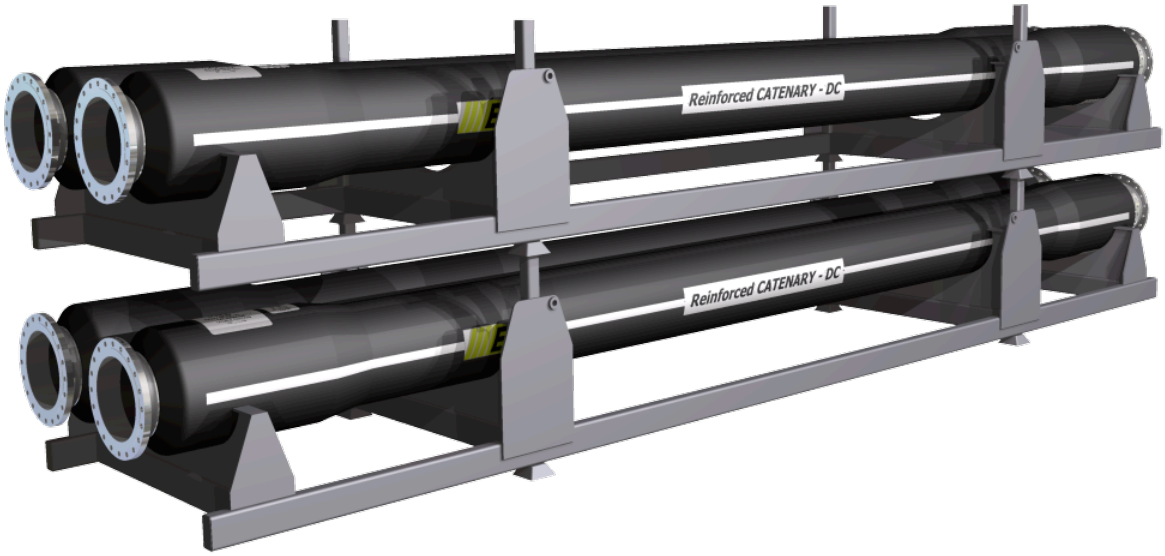


Figure 2 – Showing hoses stored on Storage/Transportation Racks

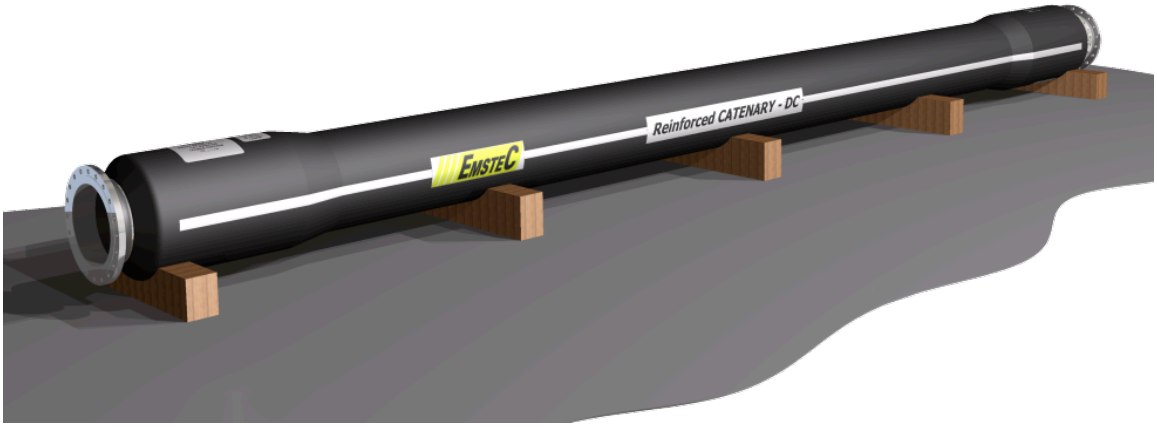


Figure 3 – Showing a hose laid out on typical supports

The hose lengths are marked with serial number, month and year of manufacture. These details are vulcanised into the hose outer cover and also welded onto the flange rims offset by 180°. These details should be carefully recorded to ensure that the oldest hose is issued first and that a rotational system is employed.
After use, and before returning a hose to storage, it should be drained and flushed out with water to remove any toxic or combustible vapours.

4.0 INSTALLATION

The Site of installation should have enough space for the entire hose string without over bending of the hoses. It should also have a shallow launch ramp with rollers or trolleys in order to prevent dragging on the ground. If the working space is limited the assembly of the string can also be done with part of it already launched.

The Minimum Recommended Bend Radius (MBR) as stated in the following table. It is not to be breached at all times.

Nominal Bore	6xID MBR Floating Hoses	4xID MBR Submarine Hoses and Floating Tanker Rail
(mm/inch)	(m/ft)	(m/ft)
150/6	0,9/3	0,6/2,0
200/8	1,2/4	0,8/2,7
250/10	1,5/5	1,0/3,3
300/12	1,8/6	1,2/4,0
400/16	2,4/8	1,6/5,3
500/20	3,0/10	2,0/6,7
600/24	3,6/12	2,4/8,0

HOSE PREPARATION

Suitable spanners, sockets and general tools should be available including podgers (tapered steel pins) to assist in aligning mating bolt-holes.

Experienced personnel who have been involved with flange assembly techniques will be required.

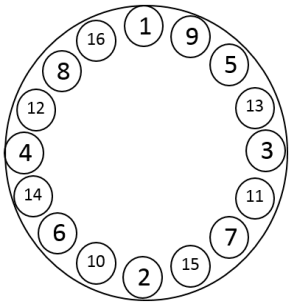
Each hose should be arranged in the right order and all flange faces should be clean and dry. In case of submarine hoses, they should be aligned so that the white line going from one hose end to the other is continuous along the entire hose string.

In case of double carcass hoses with integrated leak detection, every indicator should be checked whether it is activated or not. An already activated indicator has to be reported to EMSTEC immediately.

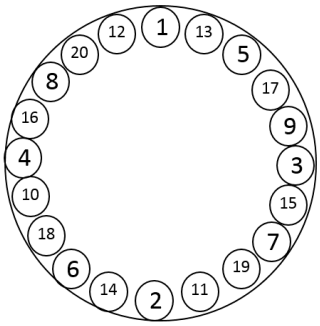
HOSE ASSEMBLY

The following jointing scheme has to be used. Tightening has to be done 4 times with 50-60%, 80-90% and twice 100% following the defined sequence below.

16'' – 150 lbs



20'' – 150 lbs



Whenever equipment such as marker beacons or floating hose end gear has to be installed it should be done after assembly rather than during. Submarine hoses should be fitted with floats before installation. The intended positions for the floats are highlighted through the collars that secure an even floatation position.

A hydrostatic pressure test is recommended after assembly as described in point 6.0.

ONSHORE LAUNCH AND TOWING

Launching from a jetty or dry dock after assembly is the most conventional and easiest way. Attention should be paid to a submarine hose string with floats. The floats shouldn't be dragged across the ground and when lifting the slings should not be around the floats but the hose body.

The towing should be performed with an empty hose string, with blind flanges mounted to either end in order to prevent ingress of water. Once in water even without floats a submarine hose string will float when completely empty. This might help to tow them to the intended place. Mounting Floats on either end of the string may also help them to stay afloat.

The towing should be executed with a vessel with a speed of max. 5 knots and even max. 3 knots when hose floats are installed.

OFFSHORE INSTALLATION

The general assembly of the hose string should follow the instructions given above. The assembly vessel should be large enough to handle at least two hose lengths with additional space to store the hoses. Suitable cranes and winches has to be available to move hoses around and to help launch the hoses.

When installing a submarine hose string with additional floats (see next chapter) the complete string has to be assembled and launched into water first. The descent of the hoses should be

done by steady flooding of the string, PLEM end first. Additional air bags, guide wires, draw bolts and skillets may be used to align the flanges correctly.

SUBMARINE HOSE FLOATS

Floats are used to shape the hose strings underwater in a certain way. Typical are the so called Chinese Lantern, Lazy-S and Step-S configuration connecting a Seabed Pipeline End Manifold (PLEM) with a CALM Buoy.

The hoses will likely have more collars than required floats. The collars, which require floats to achieve the intended configuration, are marked in EMSTEC's Orcaflex Report.

The installation of the floats is very easy:

1. Open float and slide it underneath the intended hose collar

2. Lower the hose slowly and ensure that the float's keyway fits onto the collar

3. Close float around the collar and close the clamp

4. To support diver work the clamps of all floats should be aligned equally (white stripe on hose may be used as orientation)

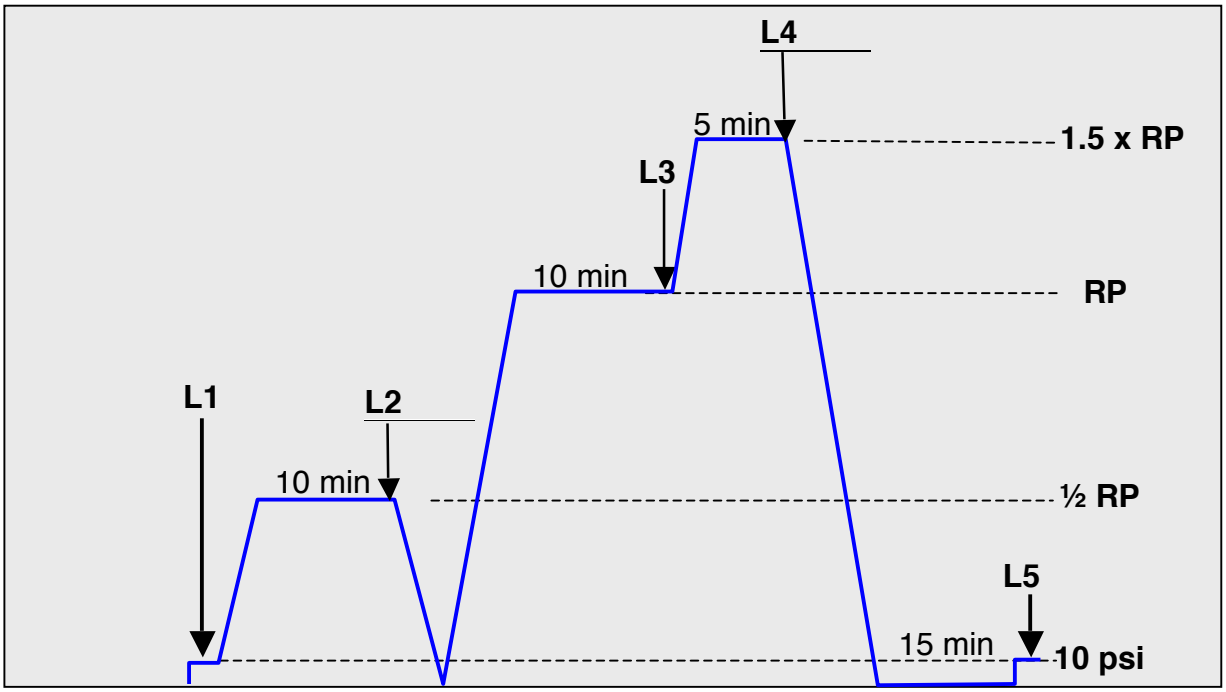
5. Tighten the tensioner until the float has a good grip onto the collar

Please note that after a certain time (approx. 4 months) in service, the hoses will not have the same shape as right after the installation. Divers will have to move around, add or remove floats.

6.0 ONSHORE INSPECTION & TESTING

Onshore Inspection and testing of the hoses as individual lengths should be conducted on a regular basis. In the case of a newly installed hose string (all hoses being brand new) all mainline hoses should be inspected and tested within 2 - 3 years of going into service. In the case of hoses that have already seen periods of service, the inspection and testing frequency should be every two years.

Both new and used hoses which have been in storage, should be pressure tested onshore as individual hose lengths, prior to installation. The hydrostatic test should be in accordance with GMPHOM 2009 FAT procedure, but modified to include a proof test to 1.5 X the rated pressure, as detailed in the diagram below:



GMPHOM 2009 Hydrostatic test format plus proof test. RP = Rated pressure (15 bar / 225 psi)

Note: The reason for adopting the above test format is that the temporary elongation measurements (L1 & L3) are taken at the same time / pressures as during the original FAT tests, and detailed on the hose test certificates, thus the results are directly comparable. The 5 minute proof test should only be carried out when testing individual hose lengths, **not when conducting in-situ testing** of hose string on the hose reel. Test records should be kept at each hose so that the temporary elongation under pressure can be compared to the original FAT test results. If the temporary or permanent elongation values obtain by tests conducted in the field exceeds the FAT values by 2%, the hose should be retired from service.

In the case of hoses that have been removed from service, once flushed and cleaned, each hose should be visually examined, internally and externally. All hoses assessed to be in good condition should be pressure tested using the test format detailed in 5.2, followed by vacuum and electrical continuity tests in accordance with GMPHOM 2009.

Detailed hose testing records/results should be maintained for each hose length, which should also include the following data: total length of time individual hoses have been in service, the number of off loadings completed, the total volume of oil transported and not least any abnormal events during their service life, e.g. severe weather conditions, abnormal configurations due to relative positions of the FPSO and tanker and excessive axial loading, for examples as a result of a mooring hawser breakage. Taking into account all of the above, a decision can be taken whether to retire a hose or keep it in service.

The following acceptance criteria should be utilised during onshore inspection and testing activities:

- **Pressure Test:** During the pressure test the hose shall be free of any leaks, substantial twist, distortion, localised bulges, undulations or other defects. If the temporary or permanent elongation values obtained during the field pressure test exceeds the FAT values by 2%, then the hose should be retired from service.
- **Outer Cover:** The cover on the hose serves to protect the hose reinforcement from damage. The cover should be cleaned and carefully examined to detect areas where reinforcement or floatation damage, such as cuts, gouges, tears and abraded spots may have occurred. If any reinforcement material is exposed, the extent of damage should be determined by visual inspection at rest and during the pressure test. If the damage is minor, it should be repaired and the hose returned to service. Hose repair kits are available from EMSTEC. If the damage is extensive, it is recommended that the hose be retired from service. The cover may show surface cracking or crazing due to prolonged exposure to sunlight or ozone. Such deteriorations, which does not expose reinforcing or floatation material, is not normally cause for retirement.
- **Hose Body:** The hose should be examined for any crushed or kinked areas and broken reinforcement as evidenced by any permanent distortion, longitudinal ridges or bulges. Bulged areas should be marked and examined during the pressure test. If these areas enlarge, become hard or exhibit other detrimental changes indicating a leaking tube or ruptured reinforcement, the hose should be retired from service.
- **Hose Lining:** Visual inspection should be made of the interior for any blisters, bulges or separation of the tube from the carcass. Any blisters, bulges or separation should be cause for retirement of the hose from service. The criteria applies equally to visual inspection and inspection during vacuum testing.
- **End fittings:** Exposed internal and external surfaces of flanges and nipples should be cleaned and examined for any cracks, corrosion or separation between the carcass and the nipple. In respects of any cracks being found the hose should be retired from service. Providing the level of corrosion has not compromised the minimal wall thicknesses can be cleaned and made good with zinc rich paint. Any separation between the nipple and the carcass should be referred to EMSTEC for assessment.

7.0 PERIODIC IN-SITU INSPECTION AND TESTING

External visual inspection should be carried during each deployment and retrieval of the hose string to verify the hoses are undamaged. Personnel should look for any localised kinked or damaged sections, oil seepage from the hose flange/nipple areas, heavy marine growth and scuffing. The presence of any minor localised damage or kinking should be recorded so that comparisons can be made with previous and future inspections. In the event of any major

areas of damage or leakage, the offending hose/s should be replaced and a leak integrity test performed, before commencing the next off loading.

The areas behind each of the flanges should be inspected to verify there are no substantial areas or any significant corrosion around the hose circumference at the point of transition from steel to rubber.

The following acceptance criteria should be utilised during offshore in-situ inspection and testing activities:

- **Leaks:** During the pressure test there shall be no leaks of signs of any seepage of oil. In the event of any leakage from the between the flanges, check the bolt torque values if less than specified retighten and repeat the pressure test. In the event of any leakage away from the flanged joints, the hose should be removed and replaced and the leaking hose sent ashore for investigation.
- **Outer Cover:** The cover on the hose serves to protect the hose reinforcement from damage. The cover should be cleaned and carefully examined to detect areas where reinforcement or flotation damage, such as cuts, gouges, tears and abraded spots may have occurred. If any reinforcement material is exposed, the extent of damage should be determined by visual inspection at rest and during the pressure test. If the damage is minor, it should be repaired and the hose returned to service. Hose repair kits are available from EMSTEC. If the damage is extensive, it is recommended that the hose be retired from service. The cover may show surface cracking or crazing due to prolonged exposure to sunlight or ozone. Such deteriorations, which does not expose reinforcing or flotation material, is not normally cause for retirement.
- **Hose Body:** The hose should be examined for any crushed or kinked areas and broken reinforcement as evidenced by any permanent distortion, longitudinal ridges or bulges. Any bulged areas should be marked and examined during the pressure test. If these areas enlarge, become hard or exhibit other detrimental changes indicating a leaking tube or ruptured reinforcement, the hose should be retired from service.
- **End Fittings:** The external surfaces of flanges and nipples should be examined for any cracks or corrosion. In respects of any cracks, the hose should be retired from service. Any separation between the nipple and the carcass should be referred to EMSTEC for assessment.

8.0 PERIODIC DESTRUCTIVE TESTING OF RETIRED HOSES

Consideration should be given to burst testing a selection of hoses that have been retired from service, followed by dissection and extraction of various material samples for laboratory testing to determine levels of degradation. The resulting data will provide valuable information in respect of the hose performance during its service life, at the same time

providing hard data to support the possibility of extending the routine service life of similar aged/type of hoses within a hose string.

All burst test and laboratory test data obtained should be recorded in the hose record system.

NOTE: CONDUCTING HOSE BURST TESTS IS POTENTIALLY VERY DANGEROUS AND SHOULD ONLY BE UNDERTAKEN BY SUITABLY EXPERIENCED PERSONNEL I.E. THE HOSE MANUFACTURER OR THEIR NOMINATED REPRESENATIVE.

9.0 HOSE REPAIRS (Outer cover damage)

Inevitably during the service life of the hose string, some hoses will sustain some damage. Major damage, such as kinking, broken helix wires collapsed linings etc. should be cause for immediate retirement of the hose. However, minor damage to the outer cover can be successfully repaired, often with the hose in-situ on the hose reel using a variety of hose repair techniques. Before attempting any repairs, it is of the utmost importance that the damaged areas be professionally (preferably by the hose manufacturer or his representative) assessed.

Belzona is one product typically used to repair areas of minor outer cover damage, however as no two damaged areas are alike, the repair procedure will need to be adjusted to suit the individual damaged areas. The basic repair procedure when using Belzona is detailed below:

- **Materials:**

  Belzona 2311 SR Elastomer
  Belzona 2911 / 2921 GP Conditioner
  Belzona 9111 Cleaner/Degreaser
  Belzona 9341 reinforcing tape
  Steel wire brush
  Belzona mixing spatula
  Small disposable working surface
  Small short-bristle brush

- **Method:**

  <u>Surface Preparation:</u>

1. Clean the damaged area trimming away any loose or frayed pieces of rubber
2. Scuff the surface of the damaged area and the perimeter using the steel wire brush
3. Brush away loose contamination and degrease the area using a clean rag moistened with Belzona 9111 Cleaner/Degreaser or any other effective cleaner that does not leave a residue (e.g. Methyl Ethyl Ketone – MEK

⇒ **NB:** Belzona 9111 can draw processing oils and waxes to the surface of some rubbers, particularly when new. This then impairs adhesion of the Belzona 2311 elastomer. Test for this on a small area of the hose cover – if on rubbing with a rag moistened with Belzona 9111, if a greasy film appears, the surface should not be degreased but simply abraded

Surface Conditioning:

1 Immediately apply a thin even coat of Belzona 2911 / 2921 General Purpose conditioner onto the surface using a short-bristle brush in a stippling motion to ensure a practical coverage

2 Allow the conditioner to become touch-dry – the time will depend upon the prevailing temperature, relative humidity and substrate – typically 30 to 60 minutes

Elastomer Application:

3 Cut open one sachet each of Belzona 2311 Base and Solidifier and mix on a suitable working surface thoroughly to achieve a uniform material free on any streakiness

4 Apply the elastomer to the damaged hose area ensuring that it overlaps onto the cover all around using the plastic applicator and pressure down firmly to remove entrapped air and ensure maximum surface contact.

⇒ **NB:** The Elastomer must be used within 2 hours of mixing.

The Elastomer should not be applied where:

- The temperature is below 50°C
- Relative humidity is above 90%
- Rain, snow, fog or mist is present
- Where there is moisture on the surface or likely to be deposited afterwards
- Once cured (after a min of 24 hours) the repaired area can be buffed smooth and blended to the original hose profile using an abrasive flap wheel.

10.0 HOSE REPAIRS (End fittings)

In the event that any areas of corrosion are found on the end fittings they can be repaired using zinc rich paint, “Zinga” paint being the preferred option. To make good any corroded areas, the following basic procedure should be followed:

- Remove all traces of corrosion using a wire brush (hand or powered) and polish the surface at the same time trying to avoid removing any of the hot dip galvanisation.
- Once the area to be made good has been cleaned, wash the surface with MEK and allow drying.

- Using a natural bristle paintbrush, apply a thick coat of Zinga and allow drying for a minimum of one hour. Apply a second coat of Zinga, if necessary, and allow drying.

11.0 HOSE RECORDS

The keeping of adequate records on the history and performance of the individual hose components is a prerequisite for the efficient operation and maintenance of offshore facilities. Proper records and inventories are necessary for the following reasons:

- To provide operating personnel with a real time inventory of all hoses, either in service, held onshore as spares, damaged or retired hoses and any hoses that have been ordered awaiting delivery.
- To permit the operator to assess the quality of performance of the hose and thus provide a basis for future selection and purchases
- To pinpoint design inadequacies by focusing on hoses in the system that are prone to failure, damage or excessive wear
- To provide a rational basis for the establishment of anticipated service life and the stockpiling of spare hoses
- To exercise any manufacturer's warranties that may apply
- To meet requirements of local governmental regulations

Refer to Section 11.0 ATTACHMENTS for recommended Hose Performance/Test Card.

12.0 ATTACHMENTS

Hose Service Record Card (Front page)

Hose Test Card (on backside of Hose service record card)

HOSE SERVICE RECORD CARD (Front of card)

Serial Number: _____

Manufacturer	Type	Size/Length	Delivery Date

Hose Service

Position	Date Installed	Date Installed	Months In service	Total Service	Total Nr. Bbls offloaded	Reason for move

In-situ test dates	Comments & Observations

Onshore test dates	

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Martin Kunzig

TEST DATA (Back of card)

Test Date	Length @ 0.7 bar (L1)	Length at RP 15 bar (L2)	Length @ 0.7 bar (L3)	Temporary Elongation %	Permanent Elongation %	Vacuum Test	Electrical Test (Ohms)

Temporary Elongation = $\frac{(L1-L2)}{L1} \times 100$ **Permanent Elongation = $\frac{(L3-L1)}{L1} \times 100$**

VISUAL INSPECTION/COMMENTS

- Fill in line 1 with the “factory test data” for each hose when it arrives on site. The “factory test data” is fully outlined on the hose test certificate, which is supplied with every hose.
- Fill in line 2, etc.
  Upon completion of annual or periodic inspections, the “test data” and “visual inspection/comments” sections should be filled in where appropriate.
- When the hose section is ultimately retired the “visual inspection/comments” column will indicate this and the card should be placed in the scrap yard file
- When space is exhausted, attach a second card.