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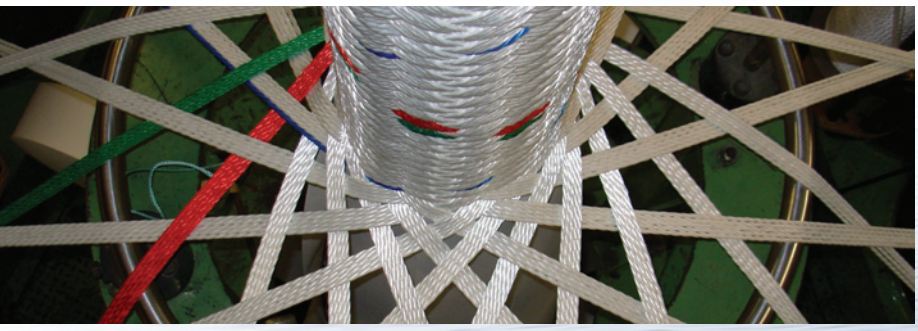

Single Point Mooring
SPM Operating & Maintenance Manual

OFFSHORE DIVISION

www.lankhorstropes.com

Royal Lankhorst Euronete GROUP BV

Lankhorst|Ropes

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SPM Hawser Operating and Maintenance Manual

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References

1. Mooring Equipment Guidelines, 3rd Edition [MEG3]
2. OCIMF '*Recommendations for Equipment Employed in the Bow Mooring of Conventional Tankers at Single Point Moorings*', 4th Edition – 2007.
3. OCIMF '*Single Point Mooring Maintenance and Operations Guide*', 2nd Edition – 1995.

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1. Introduction

These guidelines are heavily influenced by the OCIMF Guidelines specified in the reference section. The information set out in this document is of a general nature intended to provide guidance to all SPM operators. Environmental and operating conditions vary from terminal to terminal and it is the responsibility of each terminal to develop their own safe working practices. Lankhorst Ropes Offshore Division warrant that all products leaving the factory are free of defects due to material or workmanship, but can have no control over how the products are handled after leaving the factory.

2. Maintenance Guidelines

Optimum rope performance and extended life can be achieved, if operators observe and develop their own inspection, handling and maintenance procedures compatible with local environmental and operational conditions. Routine updating and review of maintenance procedures will enable operators to predict life expectancy of their hawsers within the parameters of the use for which they were first selected. This will allow a hawser to be retired on a scheduled basis provided that conditions of usage remain unchanged.

Abrasion

A significant number of SPM hawser problems are caused by cutting and abrasion. Very often the damage can occur during un-boxing, loading on supply vessels, or during actual deployment. It also happens frequently when there is not even a vessel at the berth and the rope is floating freely in the water or is in a secured position to the offshore loading tower. Damage arises when the hawser is in contact with any sharp edges on the mooring buoy or loading tower themselves, or from such common things as ladders, chains on support buoys, hose flanges on oil loading hoses, hose handling wires and indeed end termination's on the hawser itself. A loose thimble can abrade a rope, if the wave motion constantly moves the rope in the thimble when the hawser is not under tension during a mooring operation. Poorly designed or inferior quality thimbles may have rough surfaces or sharp edges which will also cut the surface fibres or strands of the rope.

Marine Growth and Oil Contamination

Marine growth will not degrade or physically damage the hawser even if heavily encrusted. This has been verified by tests on ropes deployed at buoy moorings for several years. However the growth will add weight and could cause flex fatigue failure of the rope fibres or indeed the rope system to ultimately sink. Similarly during a period of inactivity, a heavy concentration of oil scum in the surrounding seawater could lead to contamination of the hawser, which in high ambient temperatures, can become baked hard onto the hawser surface. This may consequently contribute to localised stiffening and flex fatigue damage to the hawser.

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General Maintenance

Little maintenance can be carried out to the rope hawser itself. Large used hawsers rarely can be repaired, although some systems are returned to the factory on occasions for re-splicing. All will have a reduced residual strength and after re-splicing will inevitably be shorter in length. The ancillary components such as chain, shackles and buoys are usually replaced at a different time scale interval to the rope hawser itself.

Preventative Maintenance

Always use special care when storing, unpacking, handling and installing a new hawser. New hawsers are more susceptible to damage, on land or on service vessels than when in the water.

Storing

Ropes should preferably be stored in their kraft paper or polythene lined packing case assuming they arrive in good condition, and internally are still clean and dry. The cases should be stored under cover out of direct sunlight and away from extreme temperatures.

Unpacking

When unpacking from the crate always use the lifting sling provided and do not drag the hawser over rough ground. Dirt and grit picked up by the rope can work into the strands cutting the inside fibres during cyclic loading.

Post Installation / Operation

a) Maintain a hawser service history including any unusual heavy weather conditions.
b) Leave the berth if the weather deteriorates to a point where the hawser maybe over loaded.
c) Endeavour to prevent the tanker running up onto the buoy – the hawser may become trapped between the tanker hull, hose or buoy, where wave action can cause damage.
d) Educate support vessel operators to stay clear and avoid running over the hawser.
e) Keep the SPM installation free of any protrusions that may chafe the hawser.
f) Inspect the visible portion of the mooring system at the tanker end during each mooring. Note missing hawser floats where fitted.
g) Remover the hawser to storage during long idle periods when tankers are not on station.

Inspection

Any maintenance procedure has to include periodic visual examinations, to determine ropes current condition and estimated remaining lifetime.

a) Inspect for exterior damage, along the entire length but in particular, around splices, eyes and thimbles.

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b) Implement scheduled inspections of the entire hawser system, using service launch or divers.
c) Check buoy support chain and the connection point under the buoy.
d) Is the chain support buoy floating at the correct level? Damage will cause the buoy to ride lower in the water.
e) Examine chafe chains for wear – measure chain link diameter at the interlink bearing point. Chain should be replaced if diameter is reduced by more than 10% of original.
f) Survey floats for possible damage, replace missing floats and damaged lacings.

Residual Strength Inspection

It is virtually impossible to visually determine the residual strength of a used hawser. Ropes without obvious external damage, may have been weakened by long exposure in the water or overloading. This cannot be determined by visual inspection but some typical damage signs indicating overload or flex fatigue are: -

a) A very hard rope, where the strands are nearly impossible to prise open.
b) A hard rope that is oversized even when under slight tension of 500kg to 1000kg.
c) The rope circumference is 20% to 25% greater than what was observed when new.
d) A fuzzy or powdery residue is evident between the strands of a Lankhorst Double Braid rope, or an 8-strand Squareline rope. With Lankhorst GAMA 98® parallel strand circular braided ropes, a slight residue between the cover and cores is quite normal. If severe fluffing or powdering is evident, particularly between core strands, then this would be evidence of flex fatigue or tensile overload.
e) Fraying, fused or loose strands in the crotch of an eye splice.

Never proof test a used fibre rope above it's recognised SWL. Tests at any load do not guarantee that a further loading, to the same level, would not break the rope. An actual break test of a used hawser analysed against the service history of the hawser is the most expedient way to predict future performance of similar hawsers on the same buoy.

Retirement Criteria

Almost every SPM location is different, so we cannot give a single rule for retirement of the hawser. A large number of hawsers last at least six months or more, except in the most severe environments. In calm weather areas and sheltered water locations, ropes are sometimes left in service for up to two years.

Many operators use the number of tanker berthing's to determine retirement standards, while others use the number of hours the berth was actually occupied and some monitor the number of loadings above a certain load level.

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In any event, synthetic fibre rope hawsers gradually loose strength. Even floating in seawater under zero tension, but subject to the influence of wind and wave motion, many hawsers experience damage, with rapid reduction of strength.

It is impossible for the hawser manufacturer to provide specific recommendations and the operator must therefore develop his own procedures based on his experience of the location and product.

Lankhorst Ropes Technical Department
Due to the wide range of ropes supplied for Single Point Mooring systems, rope condition, and exposure to several factors affecting rope behaviour and the degree of risk to life and the environment, it is impossible to cover all aspects of maintenance likely to arise in this document. The facilities of our Technical Department are available to customers in all cases where any risk is involved or there is a question about use or maintenance.

3. Operating Guidelines

At an SPM or FSO/FPSO mooring, the shuttle tanker bow is secured to the buoy or FPSO using a specially supplied mooring system. This will generally consist of either one or two special mooring lines with chafe chains attached to the end of each hawser. The chains pass through the ships fairleads and are connected on board to specially designed chain stoppers or brackets located on the focsle for this purpose. The chain is typically manufactured from 76mm diameter links with a maximum safe working load of 250 tonnes, dependant upon the grade of steel used.

The chains and hawsers are supported in the water by a chain support buoy, and attached to the free end of the chain (sometimes via a short length of wire) is a floating polypropylene pick-up rope, generally 80mm in diameter and approximately 150 metres long.

As the shuttle tanker starts her approach to the buoy or FSO, a messenger line should be made ready on the focsle running through one of the bow fairleads. This messenger should pass through the chain stopper before going to a winch. If at all possible, the messenger should be secured around a winch drum so that the whole operation can be carried out on a 'Hands Off' basis.

The mooring operation should usually be supervised by a pilot stationed on the bow of the shuttle tanker. He should be accompanied by a responsible officer who should be in radio contact with the bridge, passing on the pilot's instructions.

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In order to avoid damage to submarine pipelines and anchor chains, the ships anchor should not be dropped except in an extreme emergency.

When the tanker is close to the SBM or FSO, the messenger should be lowered to a mooring launch for connection to the pick-up rope. When the launch is clear of the system should be started to be winched in. The pick-up rope should be fully retrieved until the chafe chain(s) passes through the fairlead and reaches the required position.

Care should be taken when winching in the pick-up rope and chafe chain to ensure that there is always some slack in the mooring assembly. It can be very dangerous to the mooring crew if the assembly becomes tight before the connection is completed, and the tanker should be carefully manoeuvred to ensure that this does not occur.

THE PICK-UP ROPE MUST NEVER BE USED TO HEAVE THE SHIP INTO POSITION OR TO MAINTAIN ITS POSITION.

Once the chafe chain is in position it should be secured to the chain stopper as quickly as possible.

Once the chain is connected and secured the pick-up rope should be slowly walked back until all weight is transferred to the chain stopper or Smit bracket.

Tendering of the moorings is not always required, however an experienced crew member should be posted forward at all times to observe the moorings and the SBM or FSO and to advise if the shuttle tanker starts to ride up on the SBM or FSO or starts to yaw excessively.

When unmooring, the chains should be walked back into the water and the pick-up rope should be slowly paid out through the fairleads.

It is recommended when mooring to an SBM or FSO to always have a few items of essential equipment such as a large axe, sledgehammer, and crow bar readily available to the crew.

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4. Recommended Spare Parts

A sufficient quantity of spare parts should be available to ensure reliable uninterrupted operation of the SPM.

The following recommendations for the quantities of spare parts to be kept in stock are based on a facility consisting of a single SPM. If the facility consists of more than one SPM a full spares back-up will not be required for each SPM.

Except where limited shelf life dictates otherwise, more than 100% back up may be required when both lead times and usage are taken into account.

Description	**Recommended Spares Qty**
Mooring hawsers	200%
Chain support buoys, shackle pins, thimbles & link	100%
Chafing chains (buoy side and tanker side)	200%
Hawser floats	100%
Messenger / Pick-up lines	200%
Marker buoys	100%

5. Record Keeping

The schedules necessary for regular maintenance, servicing and replacement of the components of a SPM can only be established with experience. The condition of individual components will depend upon specific design parameters, operating history and environmental factors and will differ for each SPM. A major requirement therefore is that detailed records are kept of each item of equipment in service or in spare stock.

Record Content - Records should include: -

- Basic data dimensions and strength.
- Dates received, dates in service and reason for retirement.
- The exact location of the item of equipment within the system.
- Details of wear observed during inspections.
- Details of subsequent tests, maintenance or repairs.

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Such records will be of invaluable assistance and are essential for ensuring efficient maintenance.

Observations made, and records kept, during the early months of operating a new SPM are of particular importance as these will give the first and earliest indication of the deterioration to be expected, particularly for components which require more frequent replacement.

Individual components of the SPM should be covered by records to a degree that will ensure they receive sufficient attention as required by their function in the system and the degree of wear observed. In this way, the risk of breakdown and unscheduled repair work will be substantially reduced.

Typical Areas to be Covered by the Record System

Pre and Post Mooring Checks
Each time a vessel berths at a SPM a general inspection should be made of all equipment and materials which are within easy reach at that time. Any small defects should be made good at the earliest opportunity so as to prevent further deterioration. A check list should be completed by the berthing master both before and after berthing. A sample of a Pre and Post Berthing Check List is in Appendix I.

Operating Mooring Data
The relevant sections of the "Operating Mooring Data" sheet should be filled in every hour a ship is on the mooring, and if possible every four hours at other times. In weather conditions that are changing rapidly, the frequency of observations should be increased so that a re-construction of the broad pattern can be carried out from the recorded data.

In cases where instruments are not available for recording certain weather criteria, best estimates should be made and the letter "E" inserted after the observation to draw attention to the fact that it was estimated. A sample of an "Operating Mooring Data Sheet" is given in Appendix II.

Equipment Performance
As stated previously, each item of equipment should be covered by the record system so that its condition can be monitored and any rapid deterioration quickly identified. Moreover, inspection and maintenance schedules can be modified, as necessary, in the light of experience gained.

Major items for which specimen record or performance sheets are given are as follows, and samples of record sheets are give in Appendix III - IV.

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Mooring Hawsers
To record the operating history and performance of mooring ropes based on the number and duration of berthing.

Other mooring assembly components such as chafing chains, triangular plates, chains and shackles.

Similar to those for mooring hawsers.

Overall SPM Performance
In addition to records for individual components, records of berth occupancy, throughput and downtime will, if maintained over a period of time, give a valuable indication of overall terminal performance. The required data should be entered every day. Monthly and yearly cumulative figures expressed as total times and percentages will indicate performance and utilisation trends. A sample of an "Overall SPM Performance Data Sheet" is given in Appendix V.

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Appendix I

Pre and Post Berthing Checklist

SPM Record	Berth Inspection Data
SPM Location	Date

Pre Berth Check:		SPM Check:	Post Departure Check:	
SATISFACTORY			SATISFACTORY	
YES	NO	Hawser Assembly	YES	NO
YES	NO	Chafing Chain	YES	NO
YES	NO	Support Buoys	YES	NO
YES	NO	Shackles	YES	NO
YES	NO	Messenger / Pick-up Ropes	YES	NO
YES	NO		YES	NO
YES	NO		YES	NO
YES	NO		YES	NO
YES	NO		YES	NO
YES	NO		YES	NO
YES	NO		YES	NO

Action Required:

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Appendix II
OPERATING MOORING DATA SHEET

Vessel:

Hourly Information Sheet

Date of Berthing:			Date	Time	H.W.	L.W.			Name	Cabin	Tel.
			H.W.					Pilot			
Time High Water:			L.W.					Insp.			
			H.W.					Insp.			
Range: mts			L.W.					B.M.			
			H.W.					Tug F.			
								Tug A.			
Time	Rate/Hr	Total	To Go	B.P. PSI	Temp Deg C	Draft Fwd/Aft	Mooring Angle / Wt	Ship's Head	Current	Wind	Remarks

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Appendix III

Mooring Ropes Performance Data

SPM Record Sheet:		Mooring Ropes Performance Data	
SPM Location:		Date:	
Position	**Individual**	**Port**	**Starboard**
Manufacturer			
Identification			
Construction			
Purchase Details			
Size			
Length			
Type			
Received			
Installed			
Removed			
Ships Berthed			
Time in Use			
Time in Position			
Reason for Removal			
Telemetry			
Information			
Cyclic Loading			
History			
Damage Report:			
Failure Report:			
Guidelines: Damage:- Broken Yarns / Strands, Fusion, External Wear, Thimble, Other Failure:- Damage, High Load, Incident, Weather, Other			

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Appendix IV
MOORING COMPONENTS PERFORMANCE DATA

SPM Record Sheet:														Mooring Components Performance Data					
SPM Location:														Date:					
Components	Manufacture		OCIMF Parts/Size		Received		Installed		Removed		Ships Berthed		Time In Use		Time In Position		Reason for Removal	
Buoy Side:	P	S	P	S	P	S	P	S	P	S	P	S	P	S	P	S	P	S
Chain																		
Triangle																		
Shackle																		
Shackle																		
Shackle																		
Shackle																		
Damage : Failure : Wear down Report:-																		
Ship Side	P	S	P	S	P	S	P	S	P	S	P	S	P	S	P	S	P	S
Pick-up Rope																		
Triangle																		
Shackle																		
Shackle																		
Shackle																		
Shackle																		
Triangle																		
Triangle																		
Pear Link																		
Support Buoy																		
Damage : Failure : Wear down Report:-																		

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Appendix V

Overall SPM Performance Data

SPM Record Sheet:	Overall SPM Performance Data
SPM Location:	Date:

Date	Wind		Wave		Current		Suitable For	Buoy Inoperable Due Defect / Maintenance	Buoy Inoperable Due to Weather	Buoy Occupancy
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
Total Downtime Over the Month in Hours:										
Percentage Downtime Over Month:										
Total Downtime Over the Year in Hours:										
Percentage Downtime Over Year:										

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