

KATRADIS MARINE ROPES INDUSTRY S.A.

Synthetic Ropes • Steel Wire Ropes • Anodes • Anchors & Studlink Anchor chains • Worldwide Service



USER'S MANUAL

Siri® High Performance UHMWPE ROPES

Siri® High Performance UHMWPE ROPES



Siri® High Performance UHMWPE ropes exhibit the highest tensile properties of all synthetic fibers and are manufactured using innovative rope technology.

When compared to conventional fiber ropes and wire ropes, Siri® UHMWPE ropes have extra high strength, low weight, superior fatigue, abrasion and UV resistance, flexibility, easy one-man handling and wire-like elongation characteristics. They are the perfect replacement for wire ropes and are in service since more than 20 years.

The application of coating & heat setting procedure gives an enhanced structural stability and an improved coefficient of friction, necessary for efficient mooring & anchoring operations. This technology provides increased rope strength and controlled alignment of the fibers before their first use.

Considerable annual savings for the ship-owner / operator derive from the much faster mooring procedure with the use of the lightweight yet steel-like strong Siri® UHMWPE ropes, with reduced maintenance costs, easy storage, zero human injuries, clean deck (free from grease) and high performance.

Finally, Siri® UHMWPE ropes have the lowest snap back reaction under load, which is an advantage in favor of the safety on board for the personnel working near the ropes.

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Brief description of manufacturing process

The manufacturing process follows ISO 9001:2015 quality system and includes the following basic production steps:

- The twisting level where the UHMWPE yarns are twisted in rope yarns
- The twisting of rope yarns into strands
- The braiding of the rope is completed under good-practice braiding laylengths
- **Siri® Heat Setting process**
- In cases of covered ropes, the 32-strand jacket is overbraided on the UHMWPE core.
- After weighing of the final product and cutting specimens for breaking load testing, the eye splices are made in one or both ends.
- Then follows the marking and packaging to give a complete final product which is taken away for storage and/or transport.

Siri® High Performance UHMWPE ropes are produced and tested according to ISO 10325 (as well as all the updated relevant general standards like ISO 9554, ISO 2307 etc)

**Processed with the Siri® Heat-Setting Technology
for enhancing the rope mechanical properties**



KATRADIS MARINE ROPES INDUSTRY SA has developed the Siri® Heat-setting Technology, a two-step procedure integrated in the rope manufacturing process, resulting in increased structural stability and improvement of the mechanical properties of Spectra-Siri ropes. This procedure consists of the following stages:

- **Coating Process** - Polyurethane protection (NIKA-Thane coating) upon each fiber increasing the abrasion resistance
- **Stretching under heat conditions** - Providing under control uniformity of the whole rope length, structural stability and faster adjustments on the working conditions.

Description of quality control arrangement

The product quality control involves the following quality control steps/procedures:

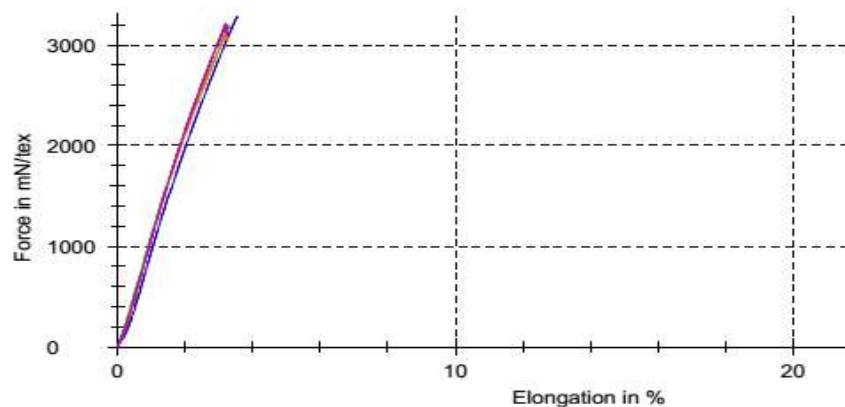
- Tenacity testing of the **UHMWPE untwisted yarns**.
- Yarn-To-Yarn abrasion test of the **UHMWPE yarns**
- UV resistance tests of the **UHMWPE yarns**
- Breaking strength testing of the rope yarns (**twisted UHMWPE yarns**)
- Breaking testing of rope specimens per batch order.



Table 1. UHMWPE yarns technical information

Density	0,97 kg/dm ³
Tenacity	> 35gr/den
Elongation (at break)	3,50%
Melting point	145 °C
UV resistance	Excellent

Series graph:



Test graph showing the tensile strength of NIKA-SIRI® UHMWPE yarns

ON-BOARD INSTALLATION



Before the use of Siri® UHMWPE High Performance ropes in mooring operations, it is important to give attention and care on the deck equipment, where the rope will be placed.

Also, below there are given instructions for proper installing of the ropes on winches considering the various safety factors. This way, the rope will exhibit maximum performance and provide safety for the demanding mooring operations.

Hardware / deck preparation

In case of deck equipment where wire ropes have been used as mooring lines, the following actions should take place:

- Smooth / regrind all surfaces on deck and on equipment (drums, bitts, chocks etc.) that are rusty and sharp.
- Repaint all surfaces on deck and on equipment that were in contact with steel wire rope.
- Check for sharp edges on flanges, winch drums and general in every hardware equipment on deck that the rope comes in contact with.



- Take special care in chocks, as these contact points are crucial during the mooring operation.



Installation on a winch

- **Uncoiling from a coil:** The coil must be free to rotate (vertically or horizontally) and unwind the rope. Wind carefully the rope on the storage drum using an appropriate device. Apply a small reference tension but mind the tension as well as the speed level to avoid the generation of excessive heat due to friction/abrasion. The first wraps must be as tight and firm as possible to avoid the slipping of the wraps from the top of the coil.

⚠ See figure 1

- **The first layer must be wound on as close as possible. The next layers should be stacked on the valleys of the previous layer (as shown in the below pictures) or in a crossed over manner.**

⚠ See figure 2

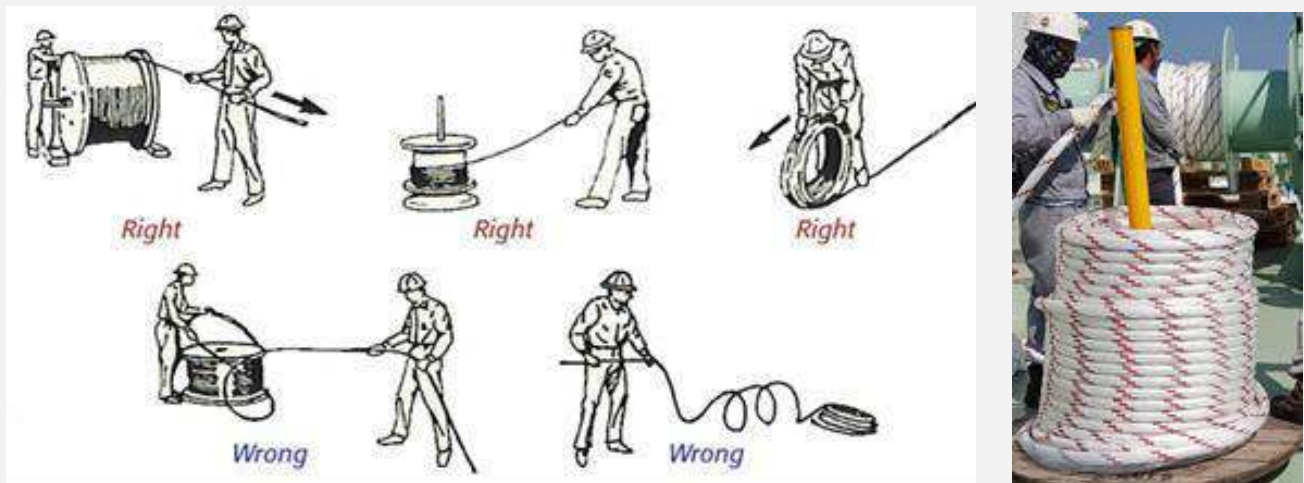


Figure 1

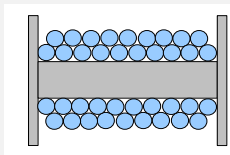


Figure 2

- ⚠ Be careful of the twist that may be introduced to the rope while winding it on the winch. Studies have proved that loss of strength amounts to 7% per turn per meter.
- ⚠ In cases of split mooring winch drums, the drum separator should have rounded edges where the rope passes through.



These metal surfaces that come in contact with mooring lines must be rounded and not sharp.



- ⚠ On the tension drum, the rope must have at least 8 to 10 wraps to avoid slippage. Also, the tension drum is operated with only one layer of mooring line. In some cases of urgent need for fewer wraps, the rope should have at least 6 wraps on the tension drum.



- ⚠ **On an undivided drum, outer layers of mooring line tend to embed into lower layers when under tension which can damage the mooring line. The split drum winch has been designed as a solution to this problem and is preferred by most operators.**

- ⚠ **OCIMF recommends that the primary brake should be set to hold 60% of the ship design MBL on the first layer.** The brake holding capacity for this type of winch is always quoted for the first layer on the tension drum. If more than one layer is wound onto the drum, then significant loss of brake holding power will result. For undivided drums, it is recommended to ask the winch manufacturer for guidance on maintaining the value for brake rendering.

(MBLSD) Ship Design Minimum Breaking Load: The MBL of a new, dry mooring line for which a ship's mooring system is designed. The MBLSD meets standard environmental criteria restraint requirements.

(LDBF) Line Design Break Force: The minimum break force at which a new, dry, spliced mooring line will break when tested acc. to CI1500B:2015. This value is declared by the manufacturer on each mooring line certificate. LDBF = 100% - 105% of MBLSD

MOORING OPERATION



Mooring operation is one of the most critical and hazardous tasks carried out on vessels. Mooring arrangements differ from port to port and careful re-planning of the mooring operation is essential.

Deck crew has to consider various safety precautions and understand working principles of deck machinery and systems. When it comes to mooring operations, additional precautions need to be taken to ensure crew members' safety.

- ✓ **As the ship nears the port the mooring winches are tried out, the breaks are tested, the mooring ropes are checked and positioned.**
- ✓ **Mooring lines must be as symmetrical as possible about the midship line of the vessel.**
- ✓ **Two or more lines leading in the same direction should always be of the same material (also tensile strength, elongation etc.) and construction.**
- ✓ **MIXED MOORING MUST BE AVOIDED.**

Rope Protection

- ▲ **Use chafe protection.** Every Siri® UHMWPE High Performance rope includes a NIKA®-Protector (special UHMWPE braided sleeve, installed from the production process, for the rope protection against external abrasion in areas such as chocks, bitts etc.). This easy-to-handle (user friendly) braided sleeve is highly wear and abrasion resistant and will substantially extend the service life of your mooring line.



NIKA®-Protector adjusted on the chock for the protection of the rope against abrasion. The material's low coefficient of friction reduces the operating local temperatures.



NIKA®-Eye Splice Protector is fixed on every rope eye, for maximum protection from internal and external abrasion and excellent efficiency for the cow-hitch connection.

- ▲ **If chafe protective sleeves are used on chocks, make sure they are adjusted properly as otherwise they can cause serious damage to the rope.**

Chock protective sleeve that has been folded during operation. This creates difficult contact surface and can result in abrasion damages.



Using of mooring tails

- ⚠ **When Siri® UHMWPE High Performance ropes are used as mooring line, this line must always include a mooring tail.** The tails must have good elongation properties in order to avoid shock loads. A shock load may damage the rope and lead to instant failure (even if the rope looked and/or was in good condition). Proposed materials are Nylon, PES and Mixed PES / Polyolefin.

The **Tail Design Break force (TDBF)** of the mooring tails must be at least **25%** greater (when wet) than the ship design Minimum Breaking Load of the Siri® High Performance rope.



(TDBF) Tail Design Break Force: The minimum break force at which a new spliced mooring tail will break when tested (in wet conditions) acc. to CI1500B:2015. This value is declared by the manufacturer on each mooring line certificate.

TDBF = 125% - 130% of MBL_{SD}

- ⚠ **The connection of a Siri® High Performance rope with the mooring tail can be done with the use of a mooring link (bolt type) or shackle (roller type) or directly with cow-hitch. The SWL of the link or shackle must be equal or greater than the WLL of the mooring line.**

For longer service lifetime & safety reasons, Siri® ropes must be connected as advised below:

Mooring Link: The main mooring line is attached to the body of the link and the synthetic mooring tail is attached to the bolt.



Mooring shackle: The main mooring line is attached to the roller of the shackle and the synthetic mooring tail is attached to the body.



Connection with shackle

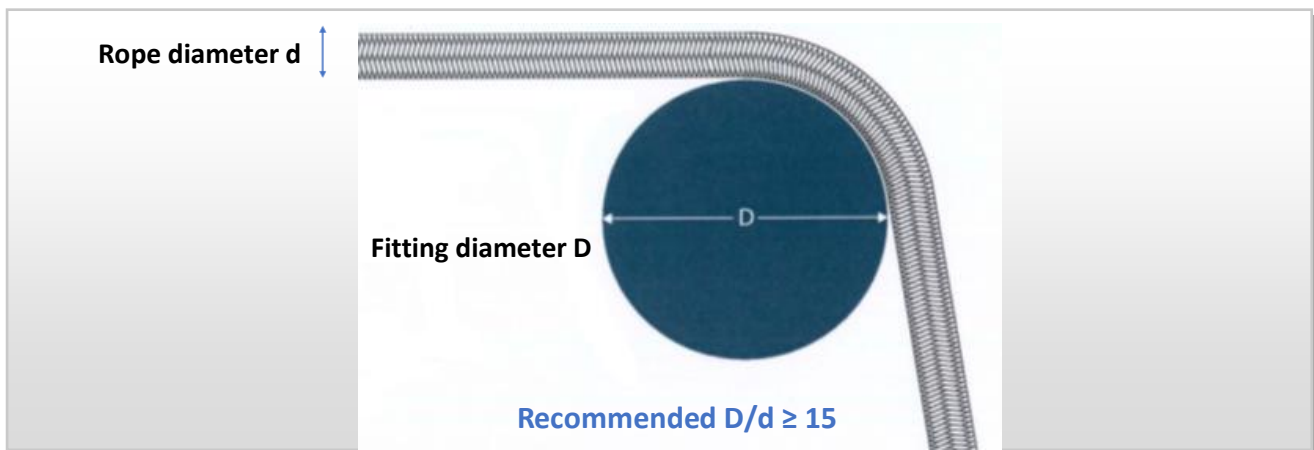


Connection with cow-hitch

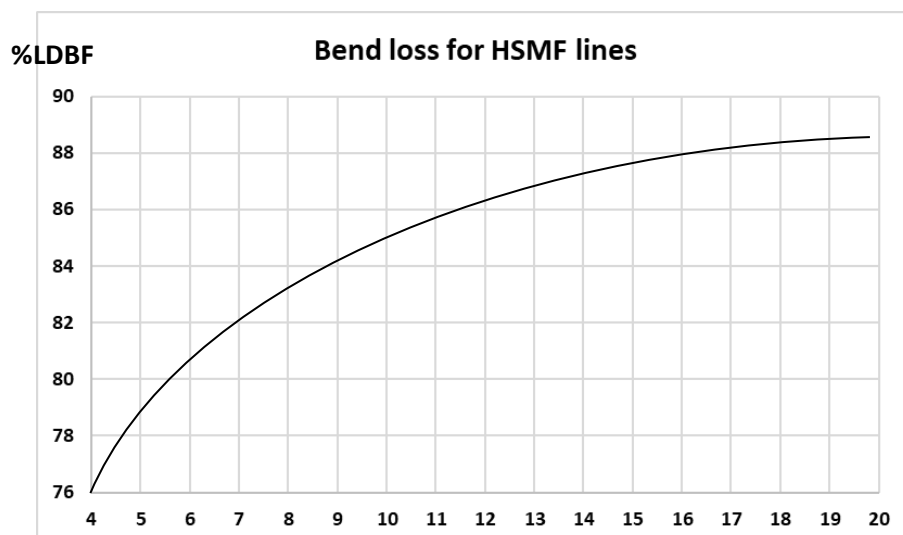


Minimum safety usage factors

- ⚠ The maximum Working Load Limit (WLL) of Siri® mooring lines must not exceed 50% of the ship design MBL (MBLsd).
- ⚠ The SWL of the bitts and other deck hardware should be equal or greater than the MBLsd of the employed mooring line.
- ⚠ Any bending of mooring lines will instantaneously reduce its breaking strength. Repeated bending will reduce the service life of the line. The D/d ratio (D: diameter of fitting, d: diameter of mooring line) should be as large as possible to maximize mooring line strength and working life.

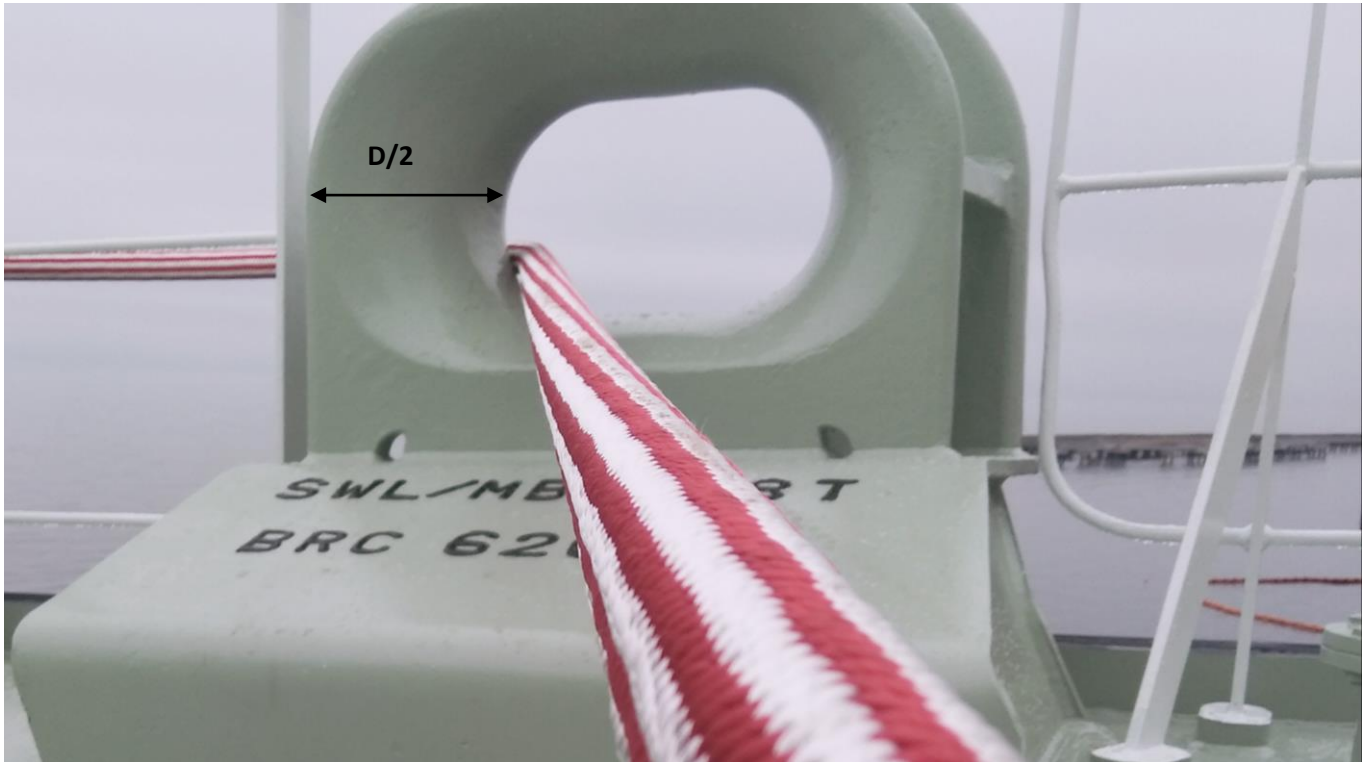


- ⚠ OCIMF (MEG4) recommends that the diameter D of bitts, pedestal fairleads, etc. that come in contact with mooring lines should be at least 15 times larger than the diameter of the line.



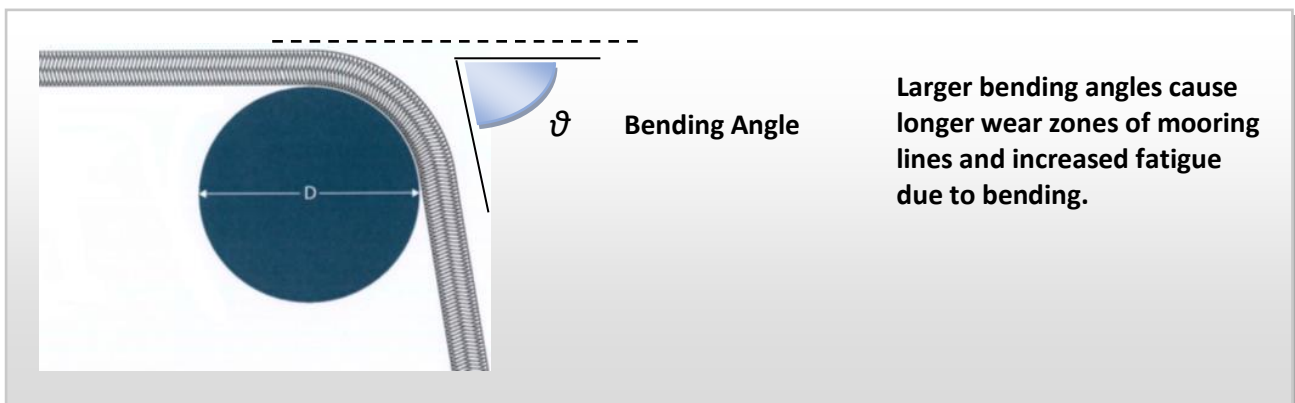
D/d

Graph showing the %LDBF in relation with the D/d



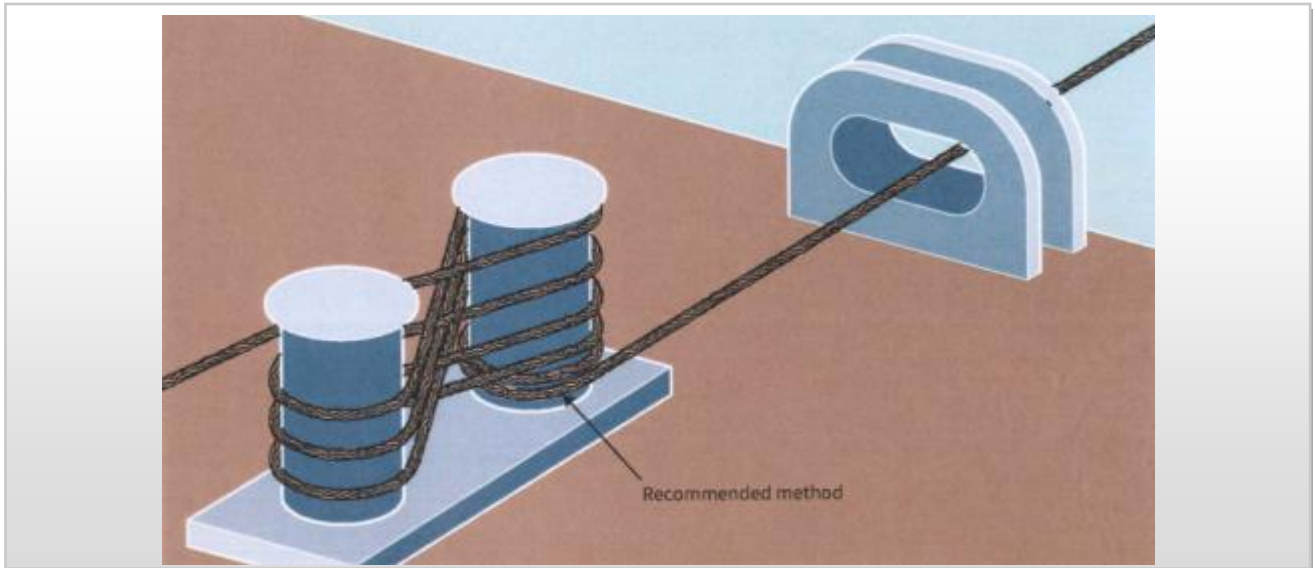
NIKA-Siri rope passing through closed chock. Half the diameter of the chock is showed for reference.

- ⚠ Mooring line arrangements often require redirection from winches and bending of lines around pedestal rollers. Users should keep in mind that high bending angles can cause compression of the inside strands and yarns and also extensive wear when the line is under loading and unloading conditions.**



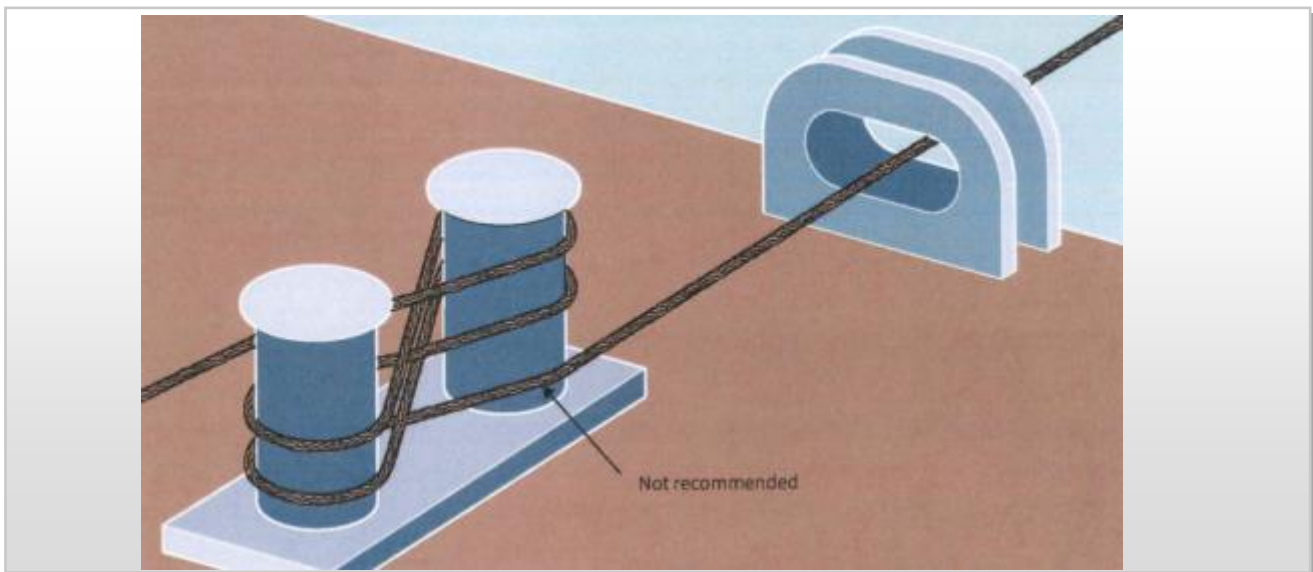
Securing Mooring Lines in figure 8 arrangement

It is recommended by MEG4 that when securing mooring lines to double post mooring bitts, two turns should be placed around the first post before beginning to belay figure of eights.



Recommended method of turning up a mooring line on bitts (two full turns around leading post)

If the two full turns of the mooring line around the first post are missing, a higher stress is induced in each post creating a tendency for the bitts to be pulled together. This method is not recommended and is illustrated below:



Incorrect figure of eight method for attaching a mooring line on mooring bitts

⚠ Always check for proper $D:d \geq 15$ ratio as recommended by OCIMF.

Safety issues

The underlying factors



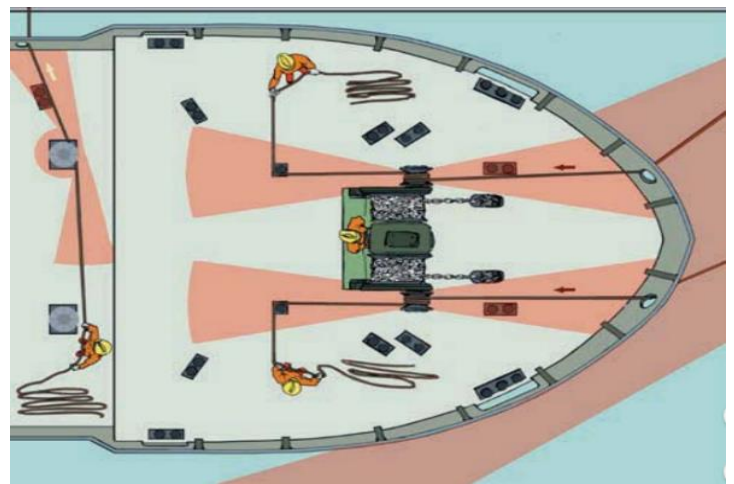
- ⚠ **ALWAYS CONSIDER** the high risk areas regarding snap-back effect of mooring ropes, as indicatively shown in the drawing below, when the line is under tension.

NOTE: MEG4 Guidelines suggest that a snap-back area should not be marked on deck because such an approach gives a false sense of safety for the crew outside the marked areas. It is suggested that during mooring operations, all crew and personnel should become aware of the snap-back dangers and not be in close proximity of the tensioned mooring lines.

Siri®UHMWPE High Performance ropes have a much-reduced snap back reaction, limited and almost negligible, however, it is good for the personnel to get acquainted with the behaviour of the synthetic ropes, especially after having worked many years with wire ropes (that also have reduced snapback reaction).



It is impossible to work the lines without the crew standing in such a large and high-risk snap-back area.



The crew can work the lines without standing in high-risk snap-back zone.

- ⚠ **Any work that must be performed near to a mooring line under tension must be performed as quick as possible, but NOT HASTY, and with extreme caution.**

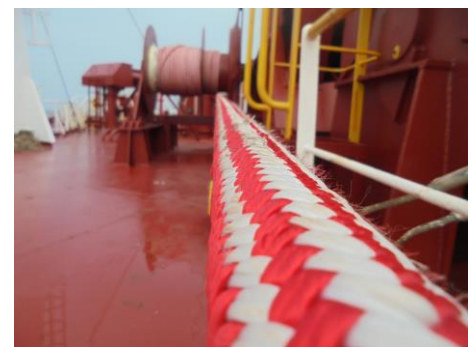
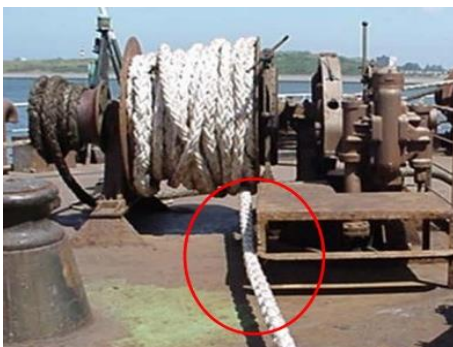
- ⚠ **Never let two ropes rub one another when they are under tension. There can be excessive heat build-up that will damage the fibers locally and impose a weak point in the line.**



- ⚠ **AVOID keeping mooring lines on drum ends. Lines must be kept in storage drums with appropriate wraps.**

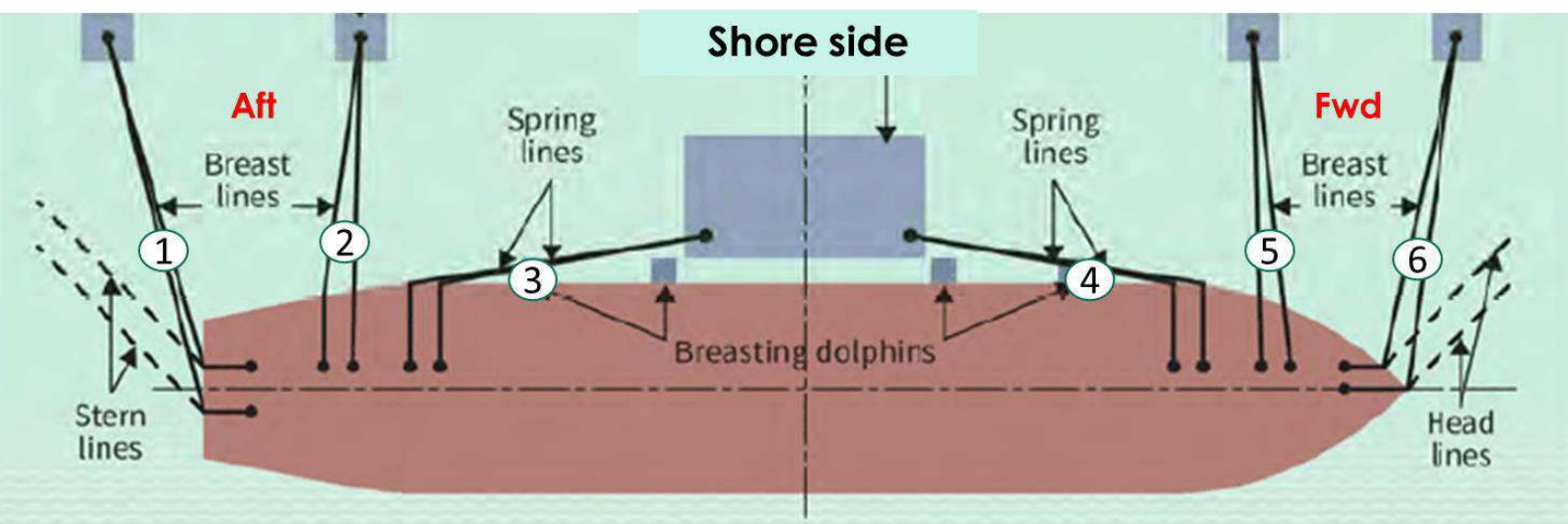
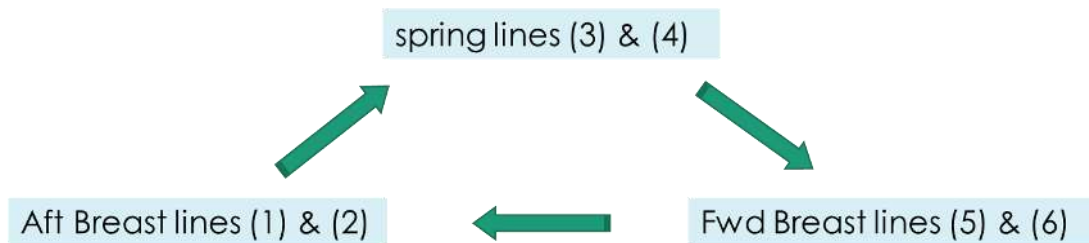


- ⚠ **MAKE SURE that there are no obstacles on the mooring line's directions. Parts of the vessel's construction that come in contact with mooring lines must be removed as they can cause rope damages that could lead to unexpected premature failure of the mooring line.**



ROPE CARE AND MAINTENANCE

- ▲ Unless otherwise recommended, on an annual basis reverse your mooring line end-for-end: bring the rear part of the rope in front and vice versa so that the wear is distributed and get a longer service life.
- ▲ Unless otherwise recommended, on an annual basis rotate the mooring lines as per below general scheme in order to get an efficient wear zone management.



Line winch rotation general plan:

- Aft Breast lines (1) & (2) – to replace spring lines (3) & (4)
- Spring lines (3) & (4) – to replace Fwd Breast lines (5) & (6)
- Fwd Breast lines (5) & (6) – to replace Aft Breast lines (1) & (2)

- ⚠ **The normal operating condition of Siri® UHMWPE ropes is up to 50°C. Melted or fused fibers is an indication of higher temperature exposure.**
- ⚠ **Avoid making knots at all costs. They can reduce the line's strength by up to 50%. If needed, make eye splices instead.**
- ⚠ **Keep the ropes clean:** wash them with tap water on a regular basis (the time frame is to be decided upon operators' experience) to remove any dirt or sea salt. Such particles will act as “razors” and damage the fibers when dry.

Spread the mooring line on the deck and after the tap water scouring let it dry normally.

Nylon tails must be carefully dried as their strength starts to decrease in wet conditions.



- ⚠ **Conduct regular inspections on the rope and the hardware** (see more on the inspection practices).
- ⚠ **Under no circumstances the rope should contain oil/grease material, as it may cause chemical contamination and also foreign particle adhesion (which will create abrasive conditions).**



NO GREASE

Use NIKA-LUBE special lubricant for fiber ropes

NIKA-LUBE is a special lubricant, used to improve the abrasion performance of synthetic fiber ropes by reducing the friction coefficient of the contact surfaces. It is intended for applying on chocks, bits etc. where the abrasion is critical for the service life of mooring lines.

NIKA-LUBE spray kit is supplied by order including application instructions.



Storage conditions

Store the ropes in a clean environment under mild environmental conditions (avoid storage in high temperatures) and away from direct sunlight.

Store the ropes away from heat generating sources and chemicals. Good ventilation of the storage place is also preferable.



Determination of NORMAL / EXTREME Operating Conditions

Generally, mooring lines operate in various weather conditions, types of ports (sheltered or exposed – open sea), mooring arrangements and loading conditions. Such factors highly affect the service life of mooring lines and should be taken into consideration when evaluating their condition and performance.

Below, there is a table for determining the normal or extreme operating conditions of VECTRAN-Siri® ropes.

NORMAL OPERATING CONDITIONS	Operating temperatures up to 50°C
	Mooring at sheltered port
	Low wind forces (1-3 beaufort)
	Typical mooring layout
	Absence of swell
EXTREME OPERATING CONDITIONS	Operating temperatures exceeding 50°C
	Mooring at exposed terminal
	Ship-to-Ship operations
	High wind forces (over 5 beaufort)
	Presence of swell
	SPM, CBM or Multi Buoy Mooring layout



Typical mooring at sheltered berth

INSPECTION PRACTICES AND RETIREMENT CRITERIA



- ⚠ The rope should be inspected after each operation. An experienced person from the crew, assigned by the master or by the company, must be charged with the visual inspections. A diary log must be kept where as much information as possible must be recorded (mooring line history, hours of mooring operations, temperature exposure data etc.).
- ⚠ Also keep in mind that in order to have an indication of the remaining/current breaking strength of a line, the originally received coil should have an extra length of about 10 to 12 meters. This way, a breaking test in a specimen could be performed without limiting/affecting the line's length. For this extra length, the purchaser should make this notification during the order placement and always consult KATRADIS SA regarding the recommended mooring line testing.
- ⚠ It is recommended that mooring lines and tails that have reached the 75% of the ship design MBL (respectively) must be replaced.

The visual inspection must check the following (also useful guidance for complete inspection can be found in the User's Checklist Inspection).

Forunjacketed ropes:

In cases of jacket damages or removal, there is possibility that the inner core can be visible for inspection. The inspection of the core may include the following:

- **One strand of the rope is pulled out.** If it is possible, try and work it back to the rope, if it is in good condition (no significant wear). RETIRE THE ROPE? NO

Pulled out strand. The user must look out for the cause (possibly some snagging on deck equipment).



- **The rope has suffered extreme compression but there are no fused/melted fibers.** Try to flex the rope to remove compression. RETIRE THE ROPE? NO

Compression caused by bending of the rope. This can be a result of incorrect installation or critical angles during mooring operation.



- **Significant wear due to abrasive conditions.** Always protect this part of the rope when in contact with metal surfaces. RETIRE THE ROPE? NO

Using NIKA-Protector can prevent such damages and extend the service life of Siri® ropes



- **Extreme wear and/or reduced volume.** The percent of the volume decreased means greater decrease in line's strength. REPAIR THE ROPE (CUT AND RESPLICE IF ALLOWED and if remaining length is sufficient for mooring operations) OR RETIRE



Extreme wear



Extreme wear and reduced volume

- **The rope's surface is discolored.** Most probable cause is chemical contamination. There may also be some fiber fusion or some fibers may have become brittle. REPAIR THE ROPE (CUT AND RESPLICE IF ALLOWED and if remaining length is sufficient for mooring operations)



(*RESPLICE: forming a new rope eye after cutting the undesired length of the rope. The term does not refer to an end for end splicing of two rope lengths as this is considered as knot.)

Jacket Damages:

In case of a worn jacket or a pulled strand, **local repair** in the jacket could be performed (as long as it is verified that the load bearing core is in good condition and hasn't suffered any damage - for details refer to Unjacketed rope inspection instructions). For details refer to Unjacketed rope inspection instructions.

Abraded jacket



Cut jacket strands



Glazed (fused) strands on the jacket



Discoloration



When the jacket is damaged, we recommend inspection of the inner strength member. If the inner strength member is damaged then it may be necessary to downgrade the rope. The cause of the damage should be determined and if possible, removed.

Depending on the extent of the damage either a small repair or an extensive repair is recommended (See below sections: Small repairs & Extensive repairs).

Induced Twisting:

For jacketed ropes, the twisting can be identified from the non-linear indication of the colored jacket's strands. Below there is an example of rope that has suffered a number of twists which cause considerable strength reduction. The handling of braided ropes should be with care to avoid twists as much as possible.

BEST ACTION:

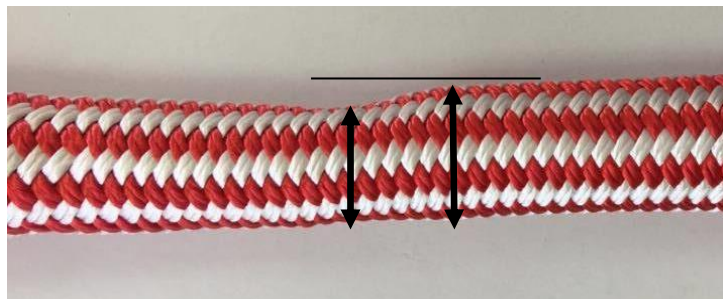
- Spread the twisted length of the rope along the deck and align in order to straighten the rope.

**Broken internal strands:**

A broken internal strand can be recognized from the diameter's reduction. Specifically, a 12% - 13% loss of the rope's diameter is expected when an internal strand has parted. Most likely the inside of the rope will become softer in the particular area.

BEST ACTION:

- REPAIR THE ROPE IF DAMAGE IS LOCAL (CUT AND RESPLICE, followed by TESTING FOR RESIDUAL STRENGTH) OR RETIRE IF DAMAGE IS IN EXTENDED LENGTH.

**Rope Diameter reduction:**

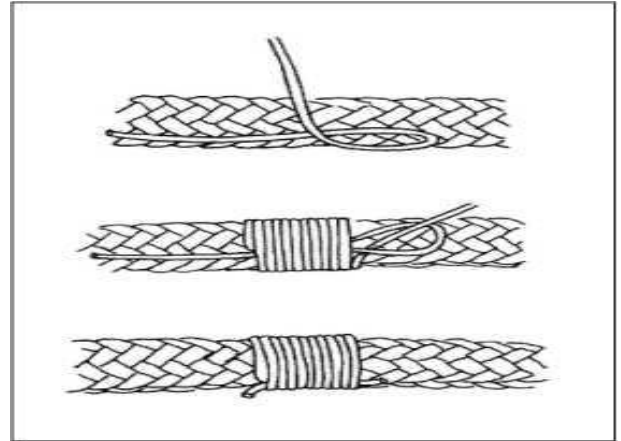
Always keep in mind the diameter changes of mooring ropes (due to extended exposure at very high loads or shock loads). For this purpose, it is recommended for the user to have a diameter measurement of the rope before its first use in operations and track any changes that may occur.

Generally, if a rope's diameter is decreased by over 20%, the rope should be retired.

Small repairs

The most durable method to make small repairs on the jacket braid requires the use of whipping twine and polyurethane glue.

Remove all the damaged yarns and coat the free yarn ends with the glue, in order to prevent further unraveling of the cover. Start whipping at least three centimeters away from the damage, as shown in the drawing. Lay a loop of twine across the rope, leaving a free tail after the damage zone of about ten centimeters. This tail has to be grasped later, so avoid covering it completely with whipping. With the working end of the twine, make multiple wraps around the rope from the tail end toward the apex of the loop, covering the loop until the whipping is at least three centimeters beyond the damage.



To finish the whipping, insert the working end of the small twine through the loop. Pull on the very end or tail of the small twine until the loop slides completely out of sight. Clip the ends close to the whipping.

If necessary, a temporary cover repair can be made using high quality adhesive tapes such as vinyl electrical tape, etc. A more permanent repair, as described above, should replace the tape as soon as possible.



Small repair by whipping

Extensive repairs

For extensive repairs the following tools are needed: replacement cover, some sewing twine and a large sewing needle. Optionally additional protection can be obtained by a two-component polyurethane.

A full set of such repairing tools can be obtained from the Repair Kit by KATRADIS SA.

Remove all the damaged yarns and inspect the rope. After inspection coat the free yarn ends with the glue, in order to prevent further unraveling of the cover. Wrap the damaged part in the replacement cover.

Stitch the web together, with a special knot that will prevent the stitching yarn from loosening when it is torn.



Protect the beginning and the end of the replacement cover with whipping. Start whipping at least three centimeters away from the edge, as shown in the drawing. Lay a loop of twine across the rope, leaving a free tail after the damage zone of about 10cm. This tail has to be grasped later, so avoid covering it completely.



With the working end of the twine, make multiple wraps around the rope from the tail end toward the apex of the loop, covering the loop until the whipping is at least three centimeters beyond the damage.

To finish the whipping, insert the working end of the twine through the loop. Pull on the very end or tail of the twine until the loop slides completely out of sight.

Clip the ends close to the whipping.



Information regarding packaging and traceability

The ropes are packaged in Polyethylene heat shrinking film. On this, there is a glossy label where it is marked /stated:

a) Product name / type b) Weight of the coil c) Length of the coil d) Construction of the rope (e.g. 12Strands) e) production code number and f) Date of Production

The marking on the product, also involves **metal labels (2 metal labels per coil)** where the unique code number of the rope coil is marked permanently for traceability purposes. This marking is being carried out in a way that it is visible, legible and indelible. This unique product code number is the reference to the manufacturer's certificate.





DISCLAIMER

Katradis Marine Ropes Industry S.A., to the best of its knowledge, uses reasonable efforts to include accurate and up-to date information on this manual; it does not, however, make any warranties or representations, either express or implied, as to its accuracy or completeness. All material and information provided on this manual are provided “as is” without warranty of any kind, either express or implied, including warranties of merchantability, fitness for a particular purpose, commercial viability, title or non – infringement.

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