OSR WORKING PARTY REPORTS

Lifeline Material Working Party

Title: ISAF OSR Lifelines 140919
Date: 19th September 2014
By: ISAF OSR-SC Lifeline Working Party
(James Dadd (Chairman), Tom Rinda, Thomas Nilsson)

Terms of Reference:
i) To undertake a review of typical failures of life lines both stainless steel and UHMWPE investigating the primary reasons for failure of these materials as life lines;
ii) Identify methods to reduce or eliminate the reasons for failure for all materials studied
iii) To review the OSRs to determine if changes to the life line section should be undertaken
iv) To submit an interim report to the Sub-committee on the progress and work to date, additional work and a timetable. Submit a final report by 22 September with work undertake, analysis and recommendations
v) To submit any Submissions by 22 September 2014

The current OSR 3.14.6 states:

Lifeline Minimum Diameters, Required Materials, Specification

a) Lifelines shall be of:
   - stranded stainless steel wire or
   - High Modulus Polyethylene (HMPE) (Dyneema®/Spectra® or equivalent) rope (Braid on braid is recommended)
b) The minimum diameter is specified in table 8 below
c) Stainless steel lifelines shall be uncoated and used without close-fitting sleeving, however, temporary sleeving may be fitted provided it is regularly removed for inspection.
d) When stainless wire is used, Grade 316 is recommended.
e) When HMPE (Dyneema®/Spectra®) is used, it shall be spliced in accordance with the manufacturer's recommended procedures.
f) A taut lanyard of synthetic rope may be used to secure lifelines provided the gap it closes does not exceed 100 mm (4in). This lanyard shall be replaced annually at a minimum.
g) All wire, fittings, anchorage points, fixtures and lanyards shall comprise a lifeline enclosure system which has at all points at least the breaking strength of the required lifeline wire.

The purpose of the Working Party is not just to review the material properties of both stainless steel wire and HMPE rope, but to consider the environments in which the lifelines are used, considering all potential impacts on the long term usage of lifelines to prevent crew members ending up in the water.

From a purely technical perspective, based on various tests, the ultimate strength of HMPE alternatives is not questioned. It is clearly at least as strong as the wire option in these terms. Wire has been considered as having sufficient ultimate strength for the purpose of lifelines for a long time. As such it is agreed that the ultimate strength of the current diameters of HMPE cables is appropriate for use as lifelines.

Initially the Working Party considered that a repeat of initial cycling load tests on both HMPE and stainless should be carried out to further confirm the effects of hiking on wear on both lifeline types. However, this is affected by a large number of additional factors. Hiking is also not the only cause of failures of lifelines. As noted, we are to investigate primary reasons, not only the single primary reason.

Over the past year we have visited several events in countries where the OSR controls above are applied. At each of these we have discussed with competitors their views, and examined several solutions and viewed several practices. It has become clear that mechanical properties alone are not going to give us the answer.

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It seems quite commonly agreed that stanchion detail at the point where lifelines pass through them is critical to the lifespan of the HMPE. This is not as critical for stainless wire, as any imperfections are effectively polished by the stainless against stainless interaction. For the HMPE it is important that the material passes over a large radius, which is smooth and free of defects. There have been several cases in the past year where HMPE lifelines have failed as a result of poor preparation of the stanchion exits. We have not found any evidence of similar failures this year with wire. The simple answer is that when swapping from stainless wire to HMPE, new stanchions with the correct ferrule size and quality need to be purchased and maintained. However, as an example, a significant number of boats that arrived in Palma prior to Palma Vela 2014 had done so after a short delivery from the European mainland. In virtually every case where HMPE lifelines were used for racing, stainless wire was used for the delivery. The general reason for this that the crews gave was that it was trusted more. The result is that no matter how well designed the ferrules are, once stainless wire has been used, edges are created, and the edges on the ferrules where damage to the HMPE starts are introduced.

Dyneema lifeline failure during ORC Europeans 2014

Throughout the research into lifeline failures, the only ones reported were with HMPE lifelines. This is not to say that wire failures did not, and do not happen. Possibly this is due to HMPE being more closely scrutinised. However, it is clear that all lifelines need to be maintained appropriately and replaced when showing signs of wear. It does however appear that wire is generally far more resilient to the normal wear and tear experienced on a racing yacht.

This is further recognised by ISO 15085 and there are two paragraphs that stand out between the OSR and the ISO. ISO 15085 paragraph 12.1 states;

1. If a synthetic line is used it shall be chafe resistant, or protected against chafing, particularly in bearing areas on stanchions and pulpits.
2. If a periodical inspection or replacement of the synthetic line due to ageing, UV, or chafe, is needed, the period between inspections or maintenance, and the actions to be performed shall be indicated in the owner’s manual.

No such requirements are attached to steel wire by the standard. Defining set inspections regimes, inspection periods and documentation would be near to impossible to achieve, and would vary for each individual installation.

Example of Dyneema® lifeline chafe

It has also been noted that wear from running rigging chafing on the lifelines at speed can wear HMPE very rapidly. One example given was a 100 foot racer/cruiser that had brand new Dyneema® lifelines, being used for the first day. Whilst performing a gybe during training, allowing the asymmetric spinnaker sheets to run from the turning block, hard against the top lifeline, as was normally done with the stainless wire lifelines, the Dyneema® lifeline failed on the first gybe, having been cut through by the PBO braided cover of the sheet moving over it at speed.

Other problems that have been noted relate to fenders being tied to the lifelines. One owner informed us that they had left their boat with the fenders tied to the Dyneema® upper lifeline one weekend, and when they had returned 2 weeks later the lifelines had cut through at the wire shrouds where they had tied a short length of lanyard between the V1s and the lifelines to prevent running rigging getting trapped in the gap. The tight 2mm lashing had held the lifeline tight up against the stainless wire standing rigging and the gentle movement caused by the fenders had caused the lifeline on that side to fail.

It is clear that there are additional issues that lifelines have to cope with that are currently not apparent. What is apparent is that we need to consider far more than the best case scenario, where the lifelines are correctly assembled, installed on appropriate stanchions, and adequately maintained.

What is becoming apparent is that these are new problems, that we have not had highlighted with stainless wire, and as such it seems reasonable to assume that stainless wire is not subject to the same shortfalls. It appears that steel wire can handle abuse and still fulfil the needs of a lifeline. This is highly questionable for HMPE.

The next question is what is the benefit of HMPE over wire? Clearly the most obvious one is weight. But this is a piece of safety equipment, and the weight benefits should not be high on our agenda. Other benefits such as ease of installation are questionable. Although you do not need specialised tools to splice HMPE as you do to seize wire, specific skills are needed, but this is probably a benefit to HMPE. It also appears that HMPE require considerably better understanding, more maintenance and replacement than stainless wire. It has also been suggested that HMPE is aesthetically more pleasing than wire. But surely most boats would look better with no lifelines at all. That is not relevant to this discussion.

Noting all the above, Tom Rinda has also stated:

> *I have no problem making a recommendation along the lines of your suggestion for Category 1-2-3 Offshore and Ocean Races, in the interest of certainty of safety for current requirements I do strongly believe that we should maintain the permissibility of over braided Dyneema lifelines as an acceptable alternative to 316 stainless steel wire rope lifeline material for Cat 4- and Day Racing in coastal venues. The HMWPE material is no less radical and prone to failure as PBO (known to deteriorate rapidly in physical properties when exposed to uV light and/or water) commonly employed in standing rigging, foils, and carbon fiber spars, sometimes prone to sudden failures with very sharp and dangerous shards accompanying the collapse of these structural sections and members.*
> *Properly maintained and inspected lifelines composed of Dyneema will be far less threatening since any evidence of chafe, which the only known cause of failure, is far easily to discover with*

diligent inspection of stanchion ferrules and end terminations. This is a regular practice on every race boat and could easily be mandated on occasion of pre race safety inspection. Dyneema rope has been a proven replacement for wire rope on many high load components of sailing and is common used now to replace even stainless steel shackles and attachment devices on the largest of the current Super Yacht fleet. Prudent application by designers could easily eliminate any currently recognized areas where chafe and deterioration may be an issue, specifically, better fairleads for spinnaker sheets, sacrificial rollers, better attachment of fenders while moored in port, etc.
The idea of a wholesale ban on this material would make the regulators look very much like retro Luddites when compared to all other applications of hi-modulus fibre based material currently in practice for sails, rigging, structures and controls in modern race yacht builds. Current advances in heat set tensioning and new compositions of the HMWPE material products have greatly alleviated the early objections to its use in areas such as halyards that would never have been developed had the material been banned wholesale from rigging use in the early days. It would be a tragedy of over-zealous regulation to stifle such development from its substitution for wire rope in lifelines in this draconian manner.

Conclusion

Previous research and test suggest that HMPE lifelines are capable of performing the necessary requirements that are met by wire lifelines in an ideal world, with correct assembly, associated materials, maintenance and usage. However, it is apparent that with the allowance of HMPE to be used for lifelines we have and will continue to see more failures than if HMPE is not permitted. The risk of crew members ending up in the water, both inshore and offshore is increased if HMPE lifelines are used rather than stainless steel wire, for reasons other than the materials ultimate strength, and for reasons that may be unrecognised by the crews until it is too late.

Recommended submission

Replace OSR 3.14.6 with

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d) ~~When stainless wire is used,~~ Grade 316 is recommended.
~~e) When HMPE (Dyneema®/Spectra®) is used, it shall be spliced in accordance with the manufacturer's recommended procedures.~~
~~e~~f) A taut lanyard of synthetic rope may be used to secure lifelines provided the gap it closes does not exceed 100 mm (4in). This lanyard shall be replaced annually at a minimum.
g) All wire, fittings, anchorage points, fixtures and lanyards shall comprise a lifeline enclosure system which has at all points at least the breaking strength of the required lifeline wire.

TABLE 8 – Minimum Diameters

LOA	Wire	~~HMPE rope (Single braid)~~	~~HMPE Core (Braid on braid)~~
Under 8.5 m (28 ft)	3mm (1/8 in)	~~4mm (5/32 in)~~	~~4mm (5/32 in)~~
8.5 m – 13 m	4mm (5/32 in)	~~5mm (3/16 in)~~	~~5mm (3/16 in)~~
Over 13 m (43 ft)	5mm (3/16 in)	~~5mm (3/16 in)~~	~~5mm (3/16 in)~~