ISO Keel Failure Review 2023

Subject: ISO 12215-9 Review – Status Update

For: World Sailing

By: Richard Hinterhoeller – member of ISO/TC 188/WG35

Date: October 13, 2023

Status

In the 2022 update to World Sailing in Abu Dahbi, the working group (WG 35) had barely met. Over the following months WG 35 met regularly and achieved its goal of making a submission to the International Organization for Standardization Technical Committee 188 (Small Craft) (ISO TC/188) meeting which was held on June 9th in Haugesund, Norway.

Review

ISO 12215-9 was opened for review due to a request from World Sailing (see the original letter at the end of this report). The 2 points that the letter asked for consideration were:

1. Examine the Total Damage Ratio "MSF" value in ISO 12215-9
2. Establish if the current fatigue recommendations should be part of the mandatory requirements for 12215-9

Submission

The submission to TC188 recommended:

1. That the operational life of the craft is assumed to be 16 million cycles. This is doubles the current operational life and is consistent with the 2nd last bullet point in the 2020 letter "A reduction of 25% stress range would extend the fatigue life by a factor of 2."
2. Annex F remains informative (World Sailing requested that it be normative).
3. An additional factor which considers the proximity of keel bolts to a weld (bolt proximity factor) was introduced. A keel bolt near the weld will increase the stresses more than a keel bolt located farther away from the weld.

Note that once an ISO standard is opened for review, the entire standard is open for review. WG 35 found numerous portions of ISO 12215-9 which needed to be improved and which were included in the submission. This report focusses on changes requested in the World Sailing request.

Unaddressed Issues

Many issues, such as naval architects designing welded steel keels while being unfamiliar with metal fatigue, and fabricators manufacturing these keels without adequate knowledge, were raised in the World Sailing request letter. WG 35 is no closer to solving this.

Similarly, and perhaps more importantly, inspections which could uncover defects are not covered by either ISO or World Sailing. An informative appendix G, which addresses inspections, is in the works.

Original Letter from World Sailing

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3 August 2020
ISO TC 188/WG18

Sent by email to: Chair of TC188: Mr Thomas Marhevko, tmarhevko@outlook.com
CC: TC188 Secretariat: Anette Eriksson, anette.eriksson@sis.se
CC: ICOMIA: Patrick Hemp, Patrick@icomia.com
From simon.forbes@sailing.org

Dear Mr Marhevko,

Re: ISO 12215 Part 9 and Sailing Yacht Keel Fatigue

World Sailing, through its Offshore Special Regulations Structural Plan Review Scheme has established a process to have racing yachts reviewed and certified through Notified Bodies. This process uses ISO12215-9 amongst other standards. In 2019 World Sailing's Oceanic & Offshore and Special Regulations committees established a working party to investigate the requirements within ISO12215 Part 9 – Sailing Craft Appendages particularly related to the fatigue recommendations within the standard.

The Working Party includes representatives including Chairman of World Sailing Committees, National Sailing Authorities, Classification Societies, Sailing Class representatives. The working party was established due to the continued failure of sailing yacht keels (cruising and racing) with often the reason of failure related to fatigue.

It is notable that the standard states in Annex F – Simplified fatigue strength assessment, F.3.1 :

> *"The operational life of the craft is assumed to be 8 million stress cycles. This is based on an assumed operational envelope various times on different points of sail, average tacking 2 times for beating, average rolling periods for downwind, typical wave encounter periods, estimated heel angles and is only intended to be representative.*
> *This corresponds to about 25–30 years of moderate-to-high usage recreational sailing or about five years of very extensive ocean racing (one, 30 000 NM, competition plus associated training and preparation annually). This is 15 % of the figure of the number of cycles normally used in ship fatigue assessment."*

Our background investigation has established the following statistics and observations:

- In relation to the World Sailing OSR structural plan review, circa 60% of keels certified are hollow welded structures and around 5% are canting keels.

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- Welding design in sailing yachts seems to be frequently performed by novices or composite engineers and often rely on manufacturer's standards showing lack of understanding of structural importance.
- The fatigue methodologies in ISO 12215-9 has produced an awareness, but it is too slow. Designers need to have knowledge and capabilities through a process of "education".
- Fatigue Design is essential for metal keels and provisions already exist for proper design
- Production can be a "common" marine standard if instructions given on design drawings are appropriate
- The awareness of importance of a proper weld design, even today, is often poor
- The awareness of high strength steel properties and behaviour today is poor.
- High-profile projects with correct design are often not subject to failure.
- A reduction of 25% stress range would extend the fatigue life by a factor of 2.
- 25% better FAT class (quality) extends the life by a factor of 2.

World Sailing kindly request that ISO12215 Part 9 is opened for revision in respect of this criteria to investigate the validity of the keel fatigue requirement and also the option of making these recommendations a requirement under the standard. The working party has suggested the following areas for investigation under the proposed revision of ISO 12215-9 as follows:

- Examine the Total Damage Ratio "MSF" value in ISO 12215-9
- Establish if the current fatigue recommendations should be part of the mandatory requirements for ISO 12215-9

World Sailing recognise that this project may require additional assistance in terms of expertise and funding and request a dialogue with TC188 on how to best initiate the project as detailed above?

Yours sincerely

Stan Honey – Chairman of World Sailing Ocean and Offshore Committee, Professional Sailor and Navigator
Will Apold – Chairman of World Sailing Special Regulations Sub-committee, Sailor and owner SW96 Sorceress
Jason Smithwick – Chairman of World Sailing Keel Fatigue Working Party, RORC Rating Office Technical Director
Stuart Caruthers – Chairman of World Sailing International Regulations Commission, RYA Cruising Manager
James Dadd – World Sailing Special Regulations Sub-committee, International Maxi Association Technical Officer