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Large yachts — Quality assessment of life onboard — Stabilization/sea keeping

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 12, *Large yachts*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The lack of standards and criteria for the assessment of the ship-motion related to the risk of discomfort onboard of large yachts was reported to be an important issue for the industry, brokers, owners and representatives. There was not a recognized and accepted procedure, criteria and rating that can be used to compare yachts among each other and evaluate the impact of stabilization systems in the improvement of the comfort onboard.

The increased demand for comfort onboard of large yachts led to the development of several types of stabilization systems and to design large yachts with ship motions in mind. The intention of this document is to define an objective scale for comparison of different levels of comfort at several areas onboard of a large yacht in transit and at zero speed (DP or at anchor).

Large yachts — Quality assessment of life onboard — Stabilization/sea keeping

1 Scope

This document provides a comparative scale (no judgement) of motion-related comfort onboard yachts to be used for technical and commercial benefit. The scale consists of a maximum number of 5 stars, the higher the amount of stars, the higher the comfort onboard. It allows the selection of the most suitable yacht for a specific purpose, evaluates the impact of stabilization systems, compares designs and identifies the most comfortable position onboard.

The methodology, work flow and criteria proposed in this document are subject to possible improvements and do not take into account certain important aspects that influence the comfort onboard.

The following aspects are not covered in this document: jerk, the method to derive roll damping, stern quartering seas, risk of parametric roll, the influence of the steering devices, green water and waves impacts, compensation for yacht size, gender and age dependency, habituation.

By explicitly listing the aspects that are not covered in this document, the reader becomes aware of them and can improve the assessment with dedicated considerations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2631-1:1997, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
comfort
<biodynamics> subjective state of well-being or absence of mechanical disturbance in relation to the induced environment (mechanical vibration or repetitive shock)

Note 1 to entry: Many of the factors contributing to a comfortable state for crew and passengers are indicated in Figure 1.

Note 2 to entry: Some of these factors are being assessed and described in existing ISO standards, such as ISO 2631-1 for the vibrations and several others for the noise with respect to human beings.

Note 3 to entry: The comfort factors addressed in the study presented in this document are the ones related to motion, postural stability and the motion sea sickness.

Note 4 to entry: Some of the factors influencing comfort are a function of the extension to the exposure to that specific factor and its intensity, as well as to the gender, age and previous experiences of the subject experiencing discomfort. The mental state of the subjects plays also a very important role.

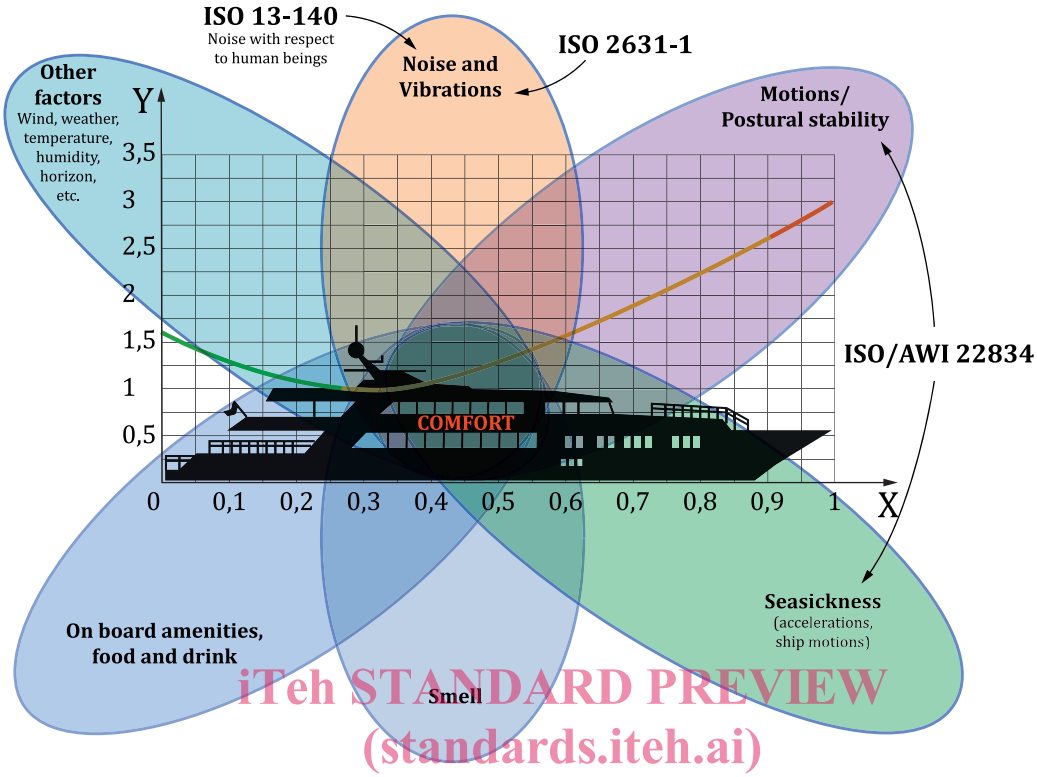

Figure 1 — List of elements contributing to comfort onboard

3.2
effective gravity angle
EGA
angle between the transversal acceleration and the sum of the vertical acceleration and the standard gravitational acceleration containing the static roll angle and also the dynamic components

Note 1 to entry: The EGA is the direct measure of the need to look for support for standing persons, but also for tipping or sliding of objects.

3.3
incidence of motion sickness
MSI
simple and concise statistically-based measure for predicting the incidence of motion sickness by exposure to vertical accelerations

Note 1 to entry: MSI expresses the percentage of people on board that suffer from sea sickness after a certain exposure time. For passengers vessels, a percentage of 10 % seems to be reported in literature.

Note 2 to entry: The duration of exposure is of one hour.

4 Waves

4.1 Irregular waves

Long crested irregular waves with a Jonswap wave spectrum shall be applied.

4.2 Equivalent scatter diagram, wave height and wave periods

The combined equivalent scatter diagrams of the western Mediterranean (area 47 of the global waves statistics GWS) and Caribbean seas (area 26 GWS) with a significant height between 1 m and 2 m and the periods indicated in Table A.3 and Figure A.3 shall be used.

5 Heading

A right-handed coordinate system shall be used. The 135° heading (bow quartering) shall be used.

Table A.2 and Figure A.4 indicate the heading convention and reference system.

6 Speeds

The two following speeds shall be used separately:

— 0 knots;

— 12 knots.

7 Definitions of the areas on board

Independently on where they are located onboard, the following five areas shall be used as a minimum:

1. owners cabin (OC)
2. dining area (DA)
3. wheel house (WH)
4. crew area (CA)
5. beach club (BC)

The coordinates of the selected areas shall be obtained by considering the geometrical centre of these areas with respect to the origin. The origin shall be reported. The Z-coordinate (vertical plane) shall be determined by considering the deck height of the corresponding area, adding 1,2 m to this height.

When the areas are distributed in a non-symmetrical way, the assessment shall be done for the area itself but also for the mirrored area with respect to the longitudinal ship's plane as well. In this way, the assessment is done for both the windward and leeward side of the non-symmetrical area.

When the destination of the areas onboard is not defined yet, at least five areas without name but uniquely identified (area 1, area 2, etc.) shall be used for the assessment of the comfort onboard following the procedure indicated in this document.

8 Calculation of MSI and EGA

8.1 General

For each of the five areas, the MSI and EGA shall be calculated and assessed in accordance with ISO 2631-1:1997, Annex D.

The EGA shall be calculated using Formula (1):

$$EGA(t) = \arctan\left(\frac{a_Y(t)}{a_Z(t)+g}\right) \quad (1)$$

where

a_Y transversal acceleration in [m/s^2];

a_Z vertical acceleration in [m/s^2];

g standard gravitational acceleration in [m/s^2].

NOTE The EGA contains not only the static roll angle but also the dynamic components [see Figure 2 and Formula (1)]. The EGA is a direct measure of the need to look for support for standing persons, but also for tipping or sliding of objects. Tipping occurs when the EGA is pointing outside the base of the subject. Sliding is dependent on the friction between the subject and the surface on which it is standing.

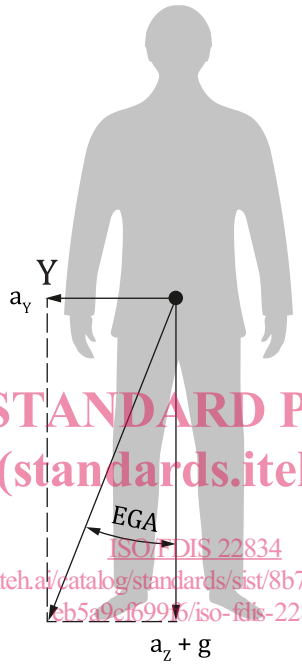

Figure 2 — Determination of the EGA

The assessment of these two quantities (MSI and EGA) is done by verifying the simultaneous fulfilment of the following criteria:

— The root mean square (RMS) of the EGA shall be lower than 2°;

— The MSI shall be lower than 10 %.

As indicated in Table B.2, there is a relation between the results of the calculations of MSI and EGA at the indicated conditions (the ship's speed, heading, wave height, periods, etc.) and the amount of stars. The fulfilment of the criteria is given as percentage of time: the up-time. This term is also known as workability.

8.2 Weighting factor

The equivalent weighting factors given in Table A.3 shall be used for each of the five areas onboard.

When there is the need to calculate the comfort on more than five areas onboard, equivalent weighting factors shall be used.

9 Stabilization systems

The calculation process shall be performed both with an active stabilization system and without a stabilization system, but not with a passive stabilization system. When a yacht is equipped with passive stabilization systems with elements that remain outside the hull, such a stabilization system contributes to the generation of damping like a bilge keel. The system is excluded when considering the "without" stabilization case. One of the purposes of the entire calculation process is to indicate the improvement in comfort obtainable by adopting a stabilization system with respect to the yacht without any system. The result is the number of stars per area onboard of the yacht without stabilization, and the number of stars per area onboard obtainable with an active stabilization system. The difference in the number of stars is owing to the contribution of the stabilization system to the comfort onboard.

10 Calculation of the ship motions (EGA and MSI)

There are several ways to calculate ship motions and the corresponding EGA and MSI: empirical methods, computer programmes and physical model testing. Since the star system proposed in this document is based on the calculation of two quantities (EGA and MSI) and the fulfilment of the related criteria, the same methodology shall be used to calculate these two quantities.

The fulfilment of the criteria is weighted with the percentage of the relevance of the peak periods.

Together with the results, the methodology used for the calculation shall be reported.