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	Testing and Extrapolation Methods High Speed Marine Vehicles Excerpt of ISO 2631, Seasickness and Fatigue	Effective Date 1999	Revision 00

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Excerpt of ISO 2631, Seasickness and Fatigue

1 PURPOSE OF PROCEDURE

Information about criteria for seasickness and fatigue.

2 EXCERPTS OF ISO STANDARDS 2631 FOR SEASICKNESS AND FATIGUE

The seasickness criterion according to ISO 2631/3 seems to be commonly used for assessment of passenger comfort. It gives limits for RMS values of the accelerations as a function of frequency (Fig. 1) which need some explanations. It refers to the az-component of the acceleration, related to a co-ordinate system having its origin in the heart of a man. The az component is along a direction in the foot- (or buttocks-) to-head axis. For a broad band spectrum the frequency in Fig. 1 means the. average frequency of a 1/3 octave band. A 1/3 octave band is defined as follows. Consider f1 and f2 to be the lower and upper frequency of the 1/3 octave band, then f2 = 21/3f1. The centre frequency of the 1/3 octave band is (f1f2)1/2. This means fl = f0/21/6 and f2= f021/6..

For a broad band spectrum the spectrum should be divided into 1/3 octave bands. The RMS value should be evaluated separately for each 1/3 octave band. The RMS value should be compared with the limits given in Fig. 1 for different exposure times. Since the motion sickness region in Fig. 1 is from 0.1 to 0.63 Hz, it implies that the "cobblestone" effect of a SES does not cause motion sickness. In the frequency range 1 to 80 Hz there are other criteria according to ISO 2631/1. These are related to workability or fatigue. An example is shown in Fig. 2.

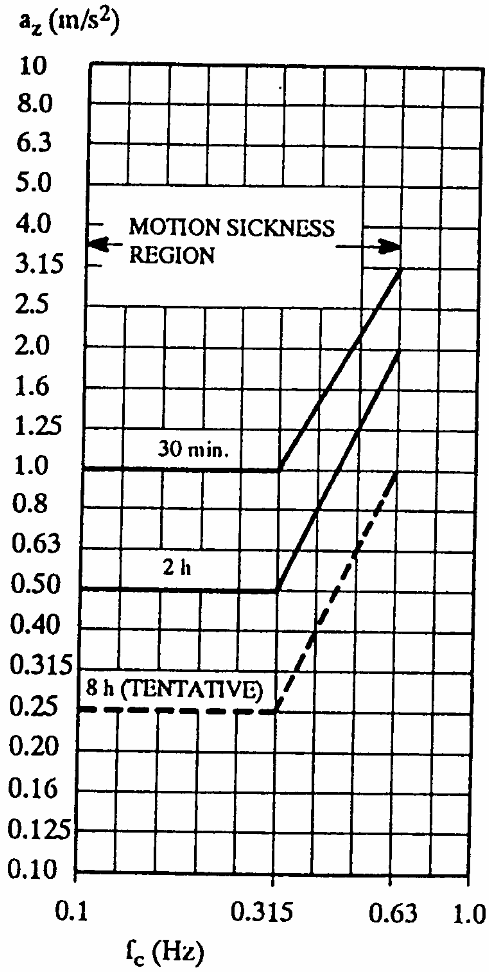


Fig.1 ISO 2631/3 Severe Discomfort Boundaries

The figure expresses the limits of the RMS value of the a_z-component of the acceleration as a function of frequency. Fig. 2 should be interpreted in the same way as Fig. 1. By multiplying the acceleration values in Fig. 2 by 2, one gets boundaries related to health and safety and by dividing the acceleration values in Fig. 2 by 3.15 one gets boundaries for reduced comfort.

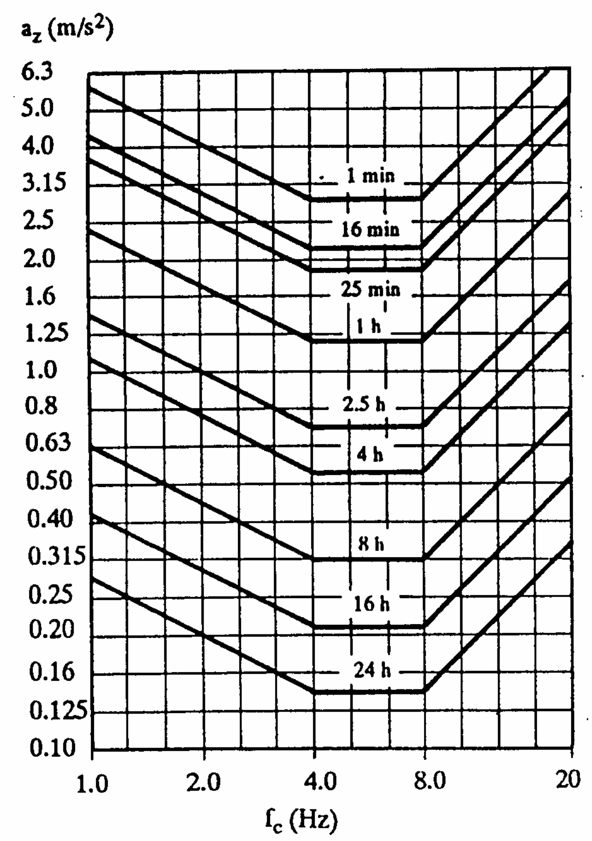
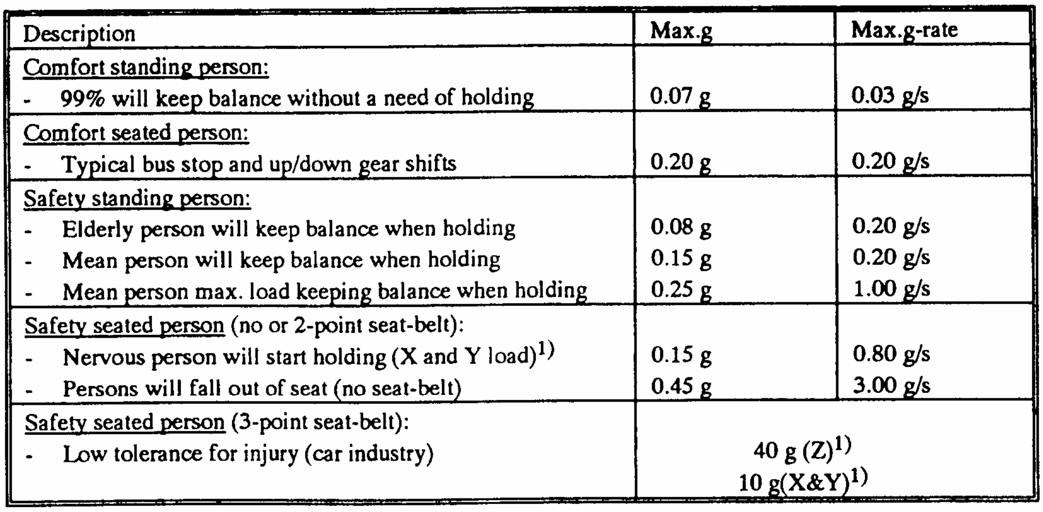


Figure 2. ISO 2631/1 Fatigue-Decreased Proficiency Boundaries

Safety Levels and Criteria. Evaluation of operational and safety performance must primarily be related to human comfort and risk of in .injuries or fatalities. Extensive research has been conducted in the train, bus and aviation industries in order to find relations between craft performance and human tolerance to fatigue, discomfort, injury and fatality. The most vital human tolerances can be defined by levels of g-loads, either single amplitude loads or long term oscillating loads. When considering HSMV operational safety, most of the critical situations will be the result of single occurrences resulting in single amplitude loads. Key information on human response to single amplitude accelerations in ground transport vehicles provided by Hoberock (1976) and Brooks et al. (1980) is summarized in Table 1.

Based on the human performance data of Table 1, safety levels are defined in the proposed operation and safety performance verification process described in Appendix IV of the new IMO HSMV code. The definition of safety levels is given in Table 2.

Documentation of operation levels in normal and worst intended conditions should also be established and documented by full scale tests. Test methods and a method for evaluation of statistical data are proposed. Model tests and mathematical simulations could be used to verify the performance in worst intended conditions, and limits should be documented, both related to passenger safety as specified in Table 2, and related to the actual structural design load of the craft.



Description	Max.g	Max.g-rate
Comfort standing person:		
- 99% will keep balance without a need of holding	0.07 g	0.03 g/s
Comfort seated person:		
- Typical bus stop and up/down gear shifts	0.20 g	0.20 g/s
Safety standing person:		
- Elderly person will keep balance when holding	0.08 g	0.20 g/s
- Mean person will keep balance when holding	0.15 g	0.20 g/s
- Mean person max. load keeping balance when holding	0.25 g	1.00 g/s
Safety seated person (no or 2-point seat-belt):		
- Nervous person will start holding (X and Y load)$^{1)}$	0.15 g	0.80 g/s
- Persons will fall out of seat (no seat-belt)	0.45 g	3.00 g/s
Safety seated person (3-point seat-belt):		
- Low tolerance for injury (car industry)	40 g (Z)$^{1)}$ 10 g(X&Y)$^{1)}$	

Table 1. Human Response to Single Amplitude Accelerations

It is emphasized that HSMV might have very special and individual hydrodynamic safety problems, such as

- Planing boats: porpoising, bow drop, chine walking, non zero constant heel and broaching
- Catamarans and SES: “deck diving”, wet deck slamming and broaching
- hydrofoils: cavitation or ventilation of struts/foils, limited control force capability, foil broaching.

The IMO HSMV code assumes that all critical hydrodynamic safety features in both normal, emergency and failure conditions should be documented by tests or analyses so that corrective actions can be conducted either by builder or operator. It is obvious that the ITTC community should be the main contributor to the understanding of hydrodynamic safety aspects by means of test facilities, theoretical and experimental knowledge.

IMO and national administrations are not, in principle, concerned about comfort and comfort criteria. Comfort criteria should mainly be based on the ISO criteria as introduced in Fig. 1 and Fig. 1. The effect of acceleration frequency is of vital importance and should be included in the evaluation of comfort limits and operational envelope (e.g. Soars, 1992). Roll and pitch motions also play major roles in the assessment of comfort. Relevant criteria are

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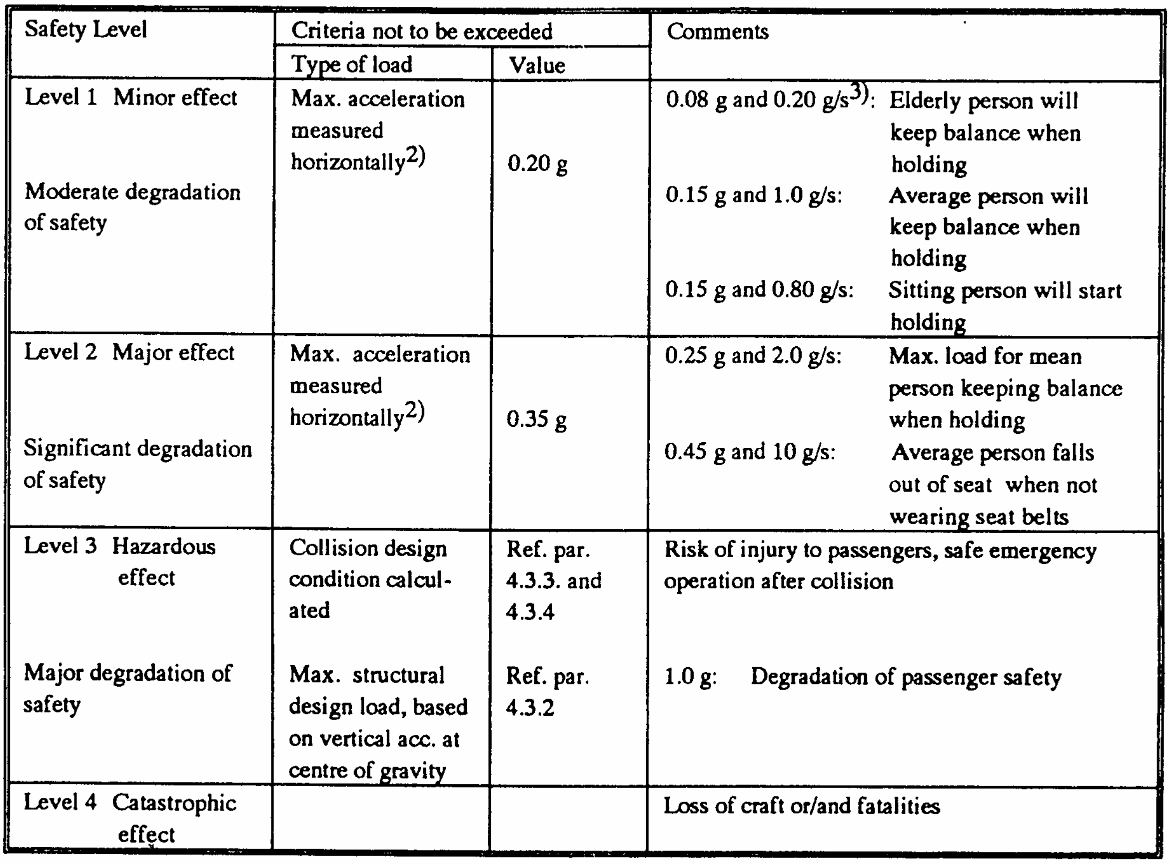
2) The recording instruments used shall be such that acceleration accuracy is better than 5% of the real value and frequency response should be minimum 20 Hz. Antialiasing filters with maximum passband attenuation 1:t5% should be used.

3) g-rate or jerk may be evaluated from acceleration/time curves.

presented in numerous naval studies. Nordforsk (1987) summarises relevant criteria connected with motion and acceleration parameters.



Safety Level	Criteria not to be exceeded		Comments
	Type of load	Value	
Level 1 Minor effect Moderate degradation of safety	Max. acceleration measured horizontally[2)]	0.20 g	0.08 g and 0.20 g/s[3)]: Elderly person will keep balance when holding 0.15 g and 1.0 g/s: Average person will keep balance when holding 0.15 g and 0.80 g/s: Sitting person will start holding
Level 2 Major effect Significant degradation of safety	Max. acceleration measured horizontally[2)]	0.35 g	0.25 g and 2.0 g/s: Max. load for mean person keeping balance when holding 0.45 g and 10 g/s: Average person falls out of seat when not wearing seat belts
Level 3 Hazardous effect Major degradation of safety	Collision design condition calculated Max. structural design load, based on vertical acc. at centre of gravity	Ref. par. 4.3.3. and 4.3.4 Ref. par. 4.3.2	Risk of injury to passengers, safe emergency operation after collision 1.0 g: Degradation of passenger safety
Level 4 Catastrophic effect			Loss of craft or/and fatalities

Table 2. Definition of Safety Levels

3 PARAMETERS

3.1 Recommendations of ITTC for Parameters

None