

## **CORRESPONDENCE GROUP ON GUIDELINES FOR UNIFORM OPERATING LIMITATIONS OF HIGH-SPEED CRAFT**

### **DISCUSSION DOCUMENT FOR ROUND 2A** **DRAFT RINA COMMENTS**

#### **Background**

This Correspondence Group was established by DE 50 with the following terms of reference:

- .1 *to develop draft Guidelines for uniform operating limitations of high-speed craft, taking into account documents DE 50/18, DE 49/5/3 and DE 49/INF.5 and comments and proposals made in plenary, as well as contributions from the COMSAR, NAV and SLF Sub-Committees as they become available; and*
- .2 *to submit a report to DE 51.*

This work is required to be carried out in the context of the new paragraph 1.9.7 inserted in the 2000 HSC Code by res. MSC.222(82) as follows:

- 1.9.7 *In determining the worst intended conditions and the operational limitations on all craft for insertion in the Permit to Operate, the Administration shall give consideration to all the parameters listed in annex 12. The limitations assigned shall be those that enable compliance with all of these factors.*

Annex 12 to the 2000 HSC Code, as also adopted by res. MSC.222(82) states in part:

*As a minimum, the following factors shall be considered:*

- .1 *The maximum distance from refuge implied by 1.3.4.*
- .2 *The availability of rescue resources to comply with 1.4.12.1 (category A craft only).*
- .3 *Minimum air temperature (susceptibility to icing), visibility and depth of water for safe operation as addressed by 1.4.61.*
- .4 *The significant wave height and maximum mean wind speed used when applying the requirements for stability and buoyancy in chapter 2 and associated annexes.*
- .5 *The safe seakeeping limitations (especially significant wave height) considering the known stability hazards listed in 2.1.5, the operating conditions on the intended route (see 18.1.3.2) and the motions experienced during operation defined in 3.3 of annex 9.*
- .6 *The structural safety of the craft in critical design conditions according to chapter 3.*
- .7 *The safe deployment and operation of evacuation systems and survival craft as required by 8.6.5.*

- .8 *The safe handling limitations determined in accordance with the sea trials required by chapter 17 and annexes 3 and 9, identifying any limitations on weight and centre-of-gravity position according to 17.3, and the effects of failures and malfunctions according to 17.4.*

### **Consideration of Issues**

As Round 1 raised some proposals that are fundamental to the outcome of the group, support or otherwise for those proposals was sought before attempting to develop a revised document.

Having received that indication of support as summarised in a separate document, the attached revised draft guidelines have been developed.

### **Necessary further action (eg. by other sub-committees)**

Advice from COMSAR to be sought in relation to the text provisionally inserted in Section 3. Square brackets paced around this text to reflect the fact that this subject lies within COMSAR's purview.

SLF 50 had no documents to consider in relation to this item, and therefore invited delegations to make proposals to this correspondence group on SLF matters for consolidation prior to consideration by SLF 51.

**RINA Comment:** There may also be input from NAV53 in relation to paper NAV53/15.

### **Comments requested**

Comments are sought on this document as follows:

- Matters in [ ]
- Specific comments on individual paras, particularly if the revised drafting does not reflect the majority of comments made in Round 2
- Comments in relation to SLF matters, specifically seakeeping, stability and operational measurement of wave height
- Comments in relation to input from Australian interests that indicates much greater emphasis should be given to wave period (or wave encounter period) and short-crestedness of seas in setting the operating limitations for sea conditions, rather than just significant wave height; also Australia contends that ride control systems should be operational for Annex 9 trials (other than section 4) – should ride- and steering-control systems be operational for calculating the polar diagram as they affect the horizontal accelerations?
- General comments

## APPENDIX

### SUGGESTED DRAFT OF GUIDELINES

#### 1 INTRODUCTION

- 1.1 An explicit element of the *Code of Safety for High-Speed Craft, 2000* (2000 HSC Code – “the Code”) is that unrestricted operation is not suitable for high-speed craft and that operating limitations are necessary. In this regard, attention is drawn to clauses 1.2, 1.3.4 and 1.4.61 of the Code
- 1.2 These guidelines have been prepared to assist in the uniform implementation of paragraph 1.9.7 and Annex 12 of the Code and to provide information on the rationale underpinning such operating limitations.
- 1.3 It should be noted that the factors listed in Annex 12 of the Code are prefaced by the words “as a minimum” and may, where appropriate, be supplemented by other factors where the flag and/or port State Administrations are of the view that those additional factors are applicable to the satisfactory operations of the craft under the Permit to Operate.  
**RINA, add: See section 8 for some examples for consideration.**
- 1.4 Matters determining the operating limitations set out in the craft’s Permit to Operate, as outlined in these guidelines, may relate to one or more of the following three sectors:
  - .1 those affecting the safety of the craft as a whole;
  - .2 those specifically affecting the safety of the passengers and crew as individuals; and
  - .3 those affecting the safety of persons outside the craft.
- 1.5 Any operating limitations resulting from consideration of those factors should be clearly communicated to the craft’s operating personnel and referenced on the Permit to Operate.

#### 2 MAXIMUM DISTANCE FROM REFUGE

- 2.1 Clause 1.3.4 gives time limits for passenger craft (4 hours) and cargo craft (8 hours) for the passage to a *place of refuge* (defined in 1.4.48 of Code) when proceeding at 90% of *maximum speed* (as defined in 1.4.37 of Code). This is to allow the craft to operate solely in areas where the

necessary shore-based support is available and to safely retire to shelter in the event of changes in the weather and hence sea state.

- 2.2 This limitation is generally set by the referenced provisions of the Code, but should be clearly stated in the craft's documentation and shown on the permit to operate unless covered indirectly (eg. by coordinates of boundaries of the operational area).

### **3 [AVAILABLE RESCUE AND OPERATIONAL SUPPORT RESOURCES]**

- 3.1 In some cases the operating limitations are functions of the resources available on the route, rather than the craft's limitations. Specifically, the Code is predicated on adequate communications facilities, weather forecasts and maintenance facilities being available within the area of craft operation. Taken in conjunction with the requirement for proximity to place of refuge, the weather forecast requirement is intended to facilitate timely decision-making with regard to seeking refuge.
- 3.2 In setting the operating limitations, the flag Administration should consider whether the wave height corresponding to the *Worst Intended Conditions* should be such as to permit the craft to complete its passage without relying on a drastic reduction in speed, thus increasing the exposure of the passengers and crew to progressively more severe conditions. Such consideration relates to the craft being considered its own best survival craft in deteriorating conditions.
- 3.3 Clause 1.2.7 of the Code states: "*in the intended area of operation, suitable rescue facilities will be readily available.*" Further, clause 1.4.12.1 states that a category A high-speed craft is one "*operating on a route where it has been demonstrated to the satisfaction of the flag and port States that there is a high probability that in the event of an evacuation at any point of the route all passengers and crew can be rescued safely within the least of:*
- *the time to prevent persons in survival craft from exposure causing hypothermia in the worst intended conditions,*
  - *the time appropriate with respect to environmental conditions and geographical features of the route, or*
  - *4 hours*"
- 3.4 The words "a high probability" in this text should be taken to mean that the probability of the criterion being fulfilled is at least [0.5]. Refer to Annex 3 of the Code in relation to use of the probability concept.

- 3.5 Although the Code gives no guidance on what constitutes “suitable rescue facilities”, the Permit to Operate should only be issued where the flag and relevant coastal State Administrations are satisfied that appropriate measures have been implemented and an appropriate assessment made that demonstrates to their satisfaction that the Code’s requirements are met across the operational area. For this purpose the Administration(s) may require the application for the Permit to Operate to be accompanied by an analysis of shipping traffic and other resources likely to be available in the operating area in the event that the craft evacuates and rescue is required. The assessment of suitable rescue facilities should not normally involve a trial evacuation or rescue exercise. ]

#### 4 WIND FORCE, MINIMUM AIR TEMPERATURE, VISIBILITY & DEPTH OF WATER

- 4.1 Clause 1.4.61, in defining the *Worst Intended Conditions*, makes specific reference to the following parameters, which should therefore appear on the Permit to Operate, when appropriate:
- .1 significant wave height (refer to section 5 of these guidelines)
  - .2 wind force (refer Chapter 2, 1.1.4 of Annex 6, 1.3 and 2.2 of Annex 7 and 1.1 and 2.1.4.3 of Annex 8. Eg. in worst intended conditions the **RINA: ~~maximum~~** wind pressure should not exceed that used in the craft’s stability calculations, **nor should it create excessive aerodynamic lift**) **RINA: How is this intended to be assessed?**
  - .3 minimum air temperature (reference for example brittle fracture properties of materials, susceptibility to icing and resulting effect on stability, **RINA, add: potential for light sea icing to cause hull damage to HSC at speed, potential for sea icing to render ports of refuge unusable, etc)** (**Note: Issue raised by Finland at NAV53**)
  - .4 visibility (eg. conditions of impaired vision and night navigation may necessitate improved navigation equipment or night vision equipment)
  - .5 minimum safe water depth (eg. safe navigation, bottom scouring, adverse effects on seabed flora & fauna, wash waves (see below)).
- 4.2 **RINA, add:** This list is not exhaustive. Clause 1.4.61 of the Code permits an Administration to include “*such other parameters as an Administration may require in considering the type of craft in the area of operation*”.
- 4.3 Minimum safe water depth may relate to local environmental regulations in addition to navigational safety. It may also take account of wash waves that are hazardous to nearby small craft and persons on the shoreline,

and any restrictions on craft speed on the specific route in relation to water depth<sup>1</sup> in order to avoid this should be stipulated in the Permit to Operate.

- 4.4 **RINA add:** Where the wash wave hazard is identified as a potential problem Administrations may require a risk assessment of the passage plan.<sup>2</sup>

## 5 SEA STATE LIMITATIONS - SIGNIFICANT WAVE HEIGHT

### 5.1 General

- 5.1.1 The *worst intended sea conditions* are usually set in terms of a *significant wave height* value as defined in 1.4.54 of the Code. These guidelines are prepared on the assumption that this parameter is used but the underlying principles are still applicable if another parameter is used.
- 5.1.2 For operational purposes, significant waveheight is most reliably measured either by satellite or by a system providing real-time monitoring of the height between the sea surface and a point on the craft in conjunction with gyroscopic measurement of accelerations at that point. Alternatively, significant waveheight readings could be provided by transmitting-type wave measurement buoys located along the route. In the absence of such systems, visual observations of significant wave height will be necessary, for which the guidance<sup>3</sup> provided at Appendix may be used.
- 5.1.3 Sea state limitations applicable to a craft may vary according to the craft's course relative to waves, but for each course should not be greater than the lowest sea state derived from taking account of the factors listed in the remainder of this section.
- 5.1.4 **RINA Add:** The significant wave height given in the Permit to Operate should not exceed that which enables full compliance with sections 5.2 to 5.6 below.
- 5.1.5 **RINA Add:** Where sea trials form part of the assessment of a craft, the *Worst Intended Conditions* specified on the craft's Permit to Operate should not exceed 140% of the significant wave height in which the verification trials were conducted. Furthermore such sea trials should only be required to be conducted on the first of a series of craft of the same design.

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<sup>1</sup> This is based on depth Froude Number but is also dependent on the depth profile adjacent to the shore.

<sup>2</sup> **RINA:** (Add guidance from UK MCA as an appendix.)

<sup>3</sup> Meteorological Office (UK), *The Marine Observers Handbook*, Her Majesty's Stationery Office, London, 1969

## 5.2 Damage Stability

- 5.2.1 In clause 2.6.11 of the Code, the required minimum residual freeboard to downflooding is a function of the significant wave height corresponding to the *Worst Intended Conditions*. **RINA, add: The *Worst Intended Conditions* should therefore not exceed the wave height limited by downflooding considerations.**

## 5.3 Structural Safety

- 5.3.1 It is clearly vital to the structural integrity of a high-speed craft that the craft is not operated outside the limitations to which the structure has been designed.

- 5.3.2 In this regard, and bearing in mind the equivalence of safety standards of craft covered by the Code with those of SOLAS in accordance with SOLAS Chapter X, it should be noted that regulation II-1/3-1 requires that:

*.....ships shall be designed, constructed and maintained in compliance with the structural, mechanical and electrical requirements of a classification society which is recognized by the Administration in accordance with the provisions of regulation XI-1/1, or with applicable national standards of the Administration which provide an equivalent level of safety.*

- 5.3.3 Many classification society rules base their structural loadings on a nominal vertical acceleration (usually 1g) at the longitudinal centre of gravity. In order to avoid exceeding this structural limitation, the societies issue the craft with a diagram developed from this assumption, which relates the maximum permitted speed of the craft to the prevailing significant wave height. A diagram or graph needs only to be provided for head seas, which generally comprise the most onerous case, although other formats may be used to cover other headings (refer para 7.2 of these guidelines).
- 5.3.4 Sometimes speed reduction in waves may be involuntary, due to increased resistance. But quite often, deliberate speed reduction may be required in order to stay within safe limits.

## 5.4 Dynamic Stability

- 5.4.1 Safe operation of most high-speed craft is significantly affected by the sea state. Safe seakeeping limitations may be as a result of some of the examples listed in clauses 2.1.5 and 17.5.4.1 of the Code, including most

particularly: propensity to deck diving or broaching<sup>4</sup>; incidence of hull or wet-deck slamming; plough-in, yawing and turning.

- 5.4.2 Implied but not explicit these limitations should also include excessively violent motions affecting the passengers and crew (see also sub-section 5.8 of these guidelines).
- 5.4.3 Clause 18.1.3.2 of the 2000 HSC Code requires that the Administration be satisfied that the operating conditions on the intended route are within the capabilities of the craft. This should be verified during the trials conducted in accordance with Annex 9 and invoked by clause 17.2.1 of the Code.
- 5.4.4 Administrations should note that clause 3.1.2 of Annex 9 of the Code explicitly states that “*worst intended conditions, referred to in 1.4.57 of this Code, are those in which it shall be possible to maintain safe cruise without exceptional piloting skill. However, operations at all headings relative to the wind and sea may not be possible.*” This provision should be taken into account when setting operating limitations.
- 5.4.5 [Germany to provide information on their “map” concept]

## **5.5 Safe Deployment of Evacuation Systems & Survival Craft**

- 5.5.1 The Code places great emphasis on the ability to evacuate a high-speed craft quickly and safely, the maximum evacuation time being linked (in 4.8.1) to the Structural Fire Protection time. To this end, 8.6.5 requires that: “*Survival craft shall be capable of being launched and then boarded ... in all operational conditions and also in all conditions of flooding ....*”
- 5.5.2 “All operational conditions” includes all conditions up to and including the *Worst Intended Conditions* (defined in 1.4.61). In implementing 8.6.5, flag Administrations should take account of whether the operating limitations of the craft are less restrictive than the conditions to which the craft’s MESS and survival craft have been subjected during type-approval and as a result whether an evacuation in *worst intended conditions* is likely to be conducted in relative safety.
- 5.5.3 The Code does not account for compounding hazards and therefore assumes that the “operational conditions” in which survival craft are to be launched and boarded do not extend beyond *worst intended conditions* to *worst operating conditions*.
- 5.5.4 The worst intended conditions stated on the Permit to Operate should not exceed conditions **in which survival craft embarkation arrangements have**

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<sup>4</sup> **RINA:** Would a reference to the guidelines described in SLF 50/INF.4 be useful? The annex to this paper could be added as an appendix to the guidelines.



been demonstrated to be effective. In the case of MES evacuation arrangements, the specified worst intended conditions should not exceed the significant waveheight for which the MES has met the requirements of 12.6.2 of res. MSC.81(70) the *Revised recommendation on testing of life-saving appliances*. **RINA Comment:** We need to add further guidance on how to demonstrate this when an MES is not fitted. It would be helpful to add that, if required, a sea trial is only to be conducted on the first of class. Guidance is also needed as to the meaning to be attached to clause 12.6.2.4.3 of res MSC.81(70), viz: *the system should be tested, as far as practicable, on a vessel having similar characteristics to the types of ships the equipment is to be fitted to*. Does this mean that a separate type approval test is needed for each first of class? Or for each craft type (eg: monohull, conventional catamaran, wave-piercing catamaran, SWATH, etc,) ?

## 5.6 Safe Handling Limitations

- 5.6.1 The Code makes reference to three Safety Levels (see Table 1 in Annex 3) and prescribes the acceptable probability that each Safety Level may occur. Level 1 is expected to have a probability of occurrence of greater than  $10^{-5}$ , i.e. Frequent or Reasonably Probable. Table 1 in Annex 3 reveals that for Safety Level 1 (Minor Effect) only prescribes that horizontal accelerations should not exceed 0.2g.
- 5.6.2 **RINA amendments:** In applying these standards it should be noted that clause 4.3.1 of the Code contains ~~no~~ a 1.0g restrictions on vertical accelerations at the longitudinal centre of gravity “*unless special precautions are taken with respect to passenger safety*”. ~~(which may result in personal injury to passengers or crew) or upon~~ No restrictions are included on conditions that might give rise to motion sickness, ~~neither of which are deemed to have an effect on the craft's safe navigation~~. Restrictions on permissible vertical accelerations are included in generally relationed to the craft's structure (refer section 5.3 of these guidelines), but if the structure is designed for vertical accelerations exceeding 1.0g then hazards for safe seating of passengers and crew will ensue.
- 5.6.3 Similarly, Table 1 in Annex of the 2000 HSC Code stipulates acceptable maximum horizontal accelerations for severe and extreme operating conditions.
- 5.6.4 Table 2 in Annex 3 of the 2000 HSC Code makes it clear that Safety Level 2 relates to conditions when emergency procedures are required and passengers may be injured, and Level 3 to conditions when there is a large reduction in safety margins, and serious injury to a small number of occupants may occur.

5.6.5 The upper limit of Level 2 corresponds to the *Worst Intended Conditions* - see 3.3.2 of Annex 9 of the Code. The onset of Level 2 ~~eshould~~ be used to define the conditions in which passengers must be seated. **(RINA Note: see last sentence of clause 3.3.2 of Annex 9)**

5.6.6 **RINA, add:** It should also be noted that clause 3.3.2 of Annex 9 states that in the Worst Intended Conditions “*nor shall any other craft characteristic motion ... exceed levels that could impede the safety of passengers.*” In view of this text, Administrations may at their discretion require that passengers should remain seated in conditions in which the maximum superimposed vertical acceleration in any part of the public spaces may exceed [0.5]g, and that in the Worst Intended Conditions such accelerations will not exceed [1.0]g, unless they are satisfied that the hazard to passengers has been adequately considered and addressed, for example by requiring that seat belts are worn.

**(Note:** The numbers in [ ] are open to discussion. RINA is currently collating data, which will be submitted when ready. It is recognised that this can only be discretionary since the Code is not clear on the meaning of 3.3.2 of Annex 9.)

5.6.7 Many forms of high-speed craft may have safe handling limitations as suggested in 17.5.4.1 of the Code, for example:

- .1 Amphibious hovercraft may have to avoid certain speed and drift angle combinations in order that plough-in or skirt tuck-under and possible capsizing do not occur.
- .2 Many forms of high-speed craft may have to avoid excessive bow-down trim in order to preserve safe manoeuvring behaviour, **or** such as avoidance of bow-diving or broaching - see clause 17.2.1 of the 2000 HSC Code.

5.6.8 Chapter 17 of the 2000 HSC Code requires that safe handling limitations are determined by sea trials supplemented by model tests where appropriate, as described in Annex 9, and documented in the Craft Operating Manual. Sometimes such documentation may need to be reinforced by warning plaques. It should be noted that paragraph 17.4 of the Code requires the trials conducted under Annex 9 to include verification of the effects of failure(s) identified as being critical.

5.6.9 **RINA, add:** Model tests should be used to evaluate safe limits in situations that would be hazardous to investigate during sea trials.

5.6.10 **RINA, add:** The references to vertical accelerations in 5.6.6 above and in clause 4.3.1 and Table 1 of Annex 3 of the Code should be interpreted as referring to the mean of the 1/100 highest accelerations (**not** RMS), which should be measured using the criteria of footnote 1 of Table 1 of Annex 3.

## 6 Trials demonstrating performance in relation to operating limitations

**RINA Comment:** Should not this section be incorporated into section 5 above, ie: as 5.7?

- 6.1 The *worst intended conditions* of wind and sea may not be available for the conduct of the verification trials required by Chapter 17, in which case some extrapolation of satisfactory trial results may be necessary. Any extrapolation should take account of the non-linear nature of seakeeping behaviour. In such cases, the *worst intended conditions* specified on the craft's Permit to Operate should not exceed 140% of the significant waveheight in which the verification trials were conducted.

- 6.2 **RINA, add:** These trials should only be required to be conducted on the first of a series of craft of the same design.

## 7 Display of Operating Limitations

- 7.1 Operating limitations should be presented in a manner that provides simple and clear direction to the craft's personnel and should be posted in a prominent position in the operating compartment. Supplementary information may be provided in the Craft Operating Manual.

- 7.2 Limitations with regard to significant waveheight, if varied according to heading, may be presented in a number of forms, including:

- .1 polar diagram showing safely attainable speed versus wave height and relative heading, since the safe speed in head seas will often be less than that attainable on other headings (see Figure 1 below); or
- .2 graph(s) having different lines for heading angles from head through to stern at intervals of not more than 15 degrees (see Figure 2 below).

- .3 **RINA, add:** tabular form, eg: separate columns for head, beam or following seas

[Insert Figures 1 and 2 from DE 49/INF.5 here]

- 7.3 Instruments may be installed to guide the craft's personnel in maintaining safe operating conditions by direct onboard monitoring of vertical and lateral accelerations and/or measurement of wave height. However, the installation of such instruments cannot be in lieu of the imposition of operating limitations with regard to sea state and showing such limitations

on the Permit to Operate, even if the instrumentation system is that used for the conduct of trials in accordance with 17.1 of the Code.

## **8. OTHER PARAMETERS FOR CONSIDERATION (added by RINA)**

- 8.1 The definition of worst intended conditions given in clause 1.4.61 of the Code gives Administrations discretion to include other parameters in considering the type of craft in the area of operation. Some examples are given below.
- 8.2 The hazard to small craft and persons on the shoreline from wash waves generated by high-speed craft should be considered. If appropriate, Administrations may require a risk assessment of this hazard, which may indicate constraints are needed on craft speed in relation to depth of water, and location of turning points. Details of the method used by one Administration are given in Appendix ??.
- 8.3 Some Administrations constrain the *Worst Intended Conditions* in order to avoid passengers being exposed to very adverse weather conditions for an extended period of time. That is, they would not permit craft to depart in conditions already at the limit determined by the requirements described above. This issue could be addressed by, for example, restricting *Worst Intended Conditions* to those in which:
  - .1 a speed of (say) 70% of maximum speed may be maintained, or
  - .2 the planned voyage can be completed in no more than [35%] more than the scheduled time

Alternatively the craft might not be permitted to commence a voyage in conditions more than [70%] of the *Worst Intended Conditions*.
- 8.4 Where a route is considered to be especially vulnerable to grounding or stranding, an Administration may require a risk assessment of these hazards, considering the applicability of for example:
  - .1 minimum safety margins around particular hazards
  - .2 reduced speed in critical sections of a passage
  - .3 requiring two navigators in the control room during critical sections of the route

## **Appendix**

### **[Guidelines for Visual Estimation of Significant Wave Height**

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