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

DISCUSSION DOCUMENT FOR ROUND 3

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 further developed.

Comments by China repeated their proposal for inclusion in section 7 of the formula from DE 50/18. However, as previous comments had not supported such inclusion (and in fact and deemed it to be impractical to apply such a formula to all types of craft covered by the Code), this insertion has not been made).

Norway pointed to their national practice of requiring sea trials to be conducted in worst intended conditions. However, Australian HSC builders advise that they are producing extrapolations of seakeeping behaviour using software that takes full account of non-linearity, as noted in the comments by United States, so the "limited extrapolation" provisions of paragraph 6.1 are largely unchanged, although they have been softened to take account of the fact that linear extrapolation is assumed in Annex 9 of the Code.

Some delegations requested in regard to the text of para 3.4 that the interpretation of "high probability" should be related to the definitions of Annex 3. This has been done in the revised text as far as practicable taking into account the reversal of the sense in which probability is used in this instance.

The "standard" text has been renumbered as proposed by RINA by combining the previous 5.2 and 5.3 into 5.1. RINA comments have been acted upon as appropriate in relation to, with the following explanatory notes:

- Text added in section 1 rather than 5.1.4 and 5.2.1 regarding the operating limitations shown on the Permit to Operate;
- Extrapolation text proposed by RINA for 5.1.5 covered in 6;
- 5.6.6 proposed by RINA has not been inserted as it involves introducing a discretion not provided for in the Code and is therefore likely to promote non-uniform implementation; and
- Section 8 proposed by RINA is outside of our scope, although the navigation safety aspects to which it refers are covered by section 4.

With regard to the content of section 5.5, the current draft text which is in accordance with the policy approach taken by some Administrations has been objected to by Australian HSC builders and liferaft/MES manufacturers, who point to the disparity between the proposed requirements and the same equipment being fitted on a SOLAS vessel. They also indicate that further heavy weather sea trials are not practical in regard to the dangers of injury to personnel involved in the trial (particularly retrieval of the equipment) although the equipment itself is capable of being safely deployed and performing satisfactorily in much higher sea states.

Australian industry has further requested deletion of the last two lines of the current draft guideline 5.5.5(inserted in response to a Danish comment), as industry's experience has shown type-approved MESs to perform satisfactorily on other types of HSC irrespective of the type of craft used for the type-approval heavy weather sea trial. For example, an MES subjected to type-approval testing on a catamaran is subjected to quick rolling and high loads due to sail effect sail effects and water resistance especially on the leeward side of the catamaran, whereas on a monohull the sail effect may be much smaller and rolling angles may be greater but slower. These differences tend to balance out and it would be impractical if not impossible to implement the proposed text.

Notwithstanding these comments, in finalising section 5.5 the group needs to bear in mind the Norwegian comment that "we don't want another SLEIPNER" (which was not fitted with MES).

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 have been retained around this text to reflect the fact that this subject lies within COMSAR's purview, even though the text in the draft has received general support.

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.

Similarly, NAV 53 invited comments on NAV issued to be directed to this correspondence group, with the outcome of the group and further submissions to be considered by NAV 54. The group should note that general support was expressed at NAV 53 for the content of NAV 53/15 and group members are invited to make proposals of text for the relevant amendments to that developed by this group.

It should be noted that provision for additional content has been deleted where that content has not been sufficiently defined for consideration by the group.

Comments requested

Noting that this is the final round before consideration of the draft report, comments are sought on this document in relation to any disputes as to the content of the attached draft guidelines and any suggestions for improvement of that text. It would be desirable for changes to be minimised where practicable.

Notwithstanding the foregoing, comments are specifically requested on the outstanding issues of section 5.5 in response to the comments from Australian industry.

It should be noted that the “extrapolation” figure of 140% in paragraph 6.1 has been placed in [ ] in view of the comments made in round 2A. The group needs to consider whether it is satisfied with this value and whether the information provided in this regard with regard to extrapolation is satisfactory or requires amendment to the text.

Any proposals for addition of SLF or NAV content to the draft would be welcomed.

All proposals should be in the form of specific draft amendments to the circulated text rather than general comments.

Suggestions as to specific matters needing to be covered-off in the covering pages to the Draft Guidelines would also be welcomed.

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.

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 The operating limitations established under these guidelines should relate to the craft's normal operations. For example, if an automatic ride control system is normally used in conditions approaching the *worst operating conditions,* then that system should be assumed operational for the establishment of the operating limitations but should also be included in the FMEA analysis specified in the Code.

1.6 Any operating limitations resulting from consideration of all the relevant factors outlined in the following sections of these guidelines should define the permitted operational envelope for the craft. Those limitations should be described in clear but succinct terms on the Permit to Operate and clearly communicated to the craft's operating personnel.

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).

2.3 The maximum distance from base port or place of refuge should be established in accordance with clause 18.1.4 of the Code.

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 an evacuation not being successful is at "remote" as defined in Annex 3 of the Code.

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.

3.6 Appropriate consideration should be given to the seasonal availability of resources. For example, presence of ice due to seasonal variation may render a specified place of refuge unusable due to navigational safety considerations.]

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 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 maximum wind pressure should not exceed that used in the craft's stability calculations, nor should it create aerodynamic lift beyond that associated with the craft's normal operating attitude)

.3 minimum air temperature (reference for example brittle fracture properties of materials, susceptibility to icing and resulting effect on stability, etc)

.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 The matters outlined in the preceding paragraph are intended to only comprise an illustrative and non-exhaustive list. They may be supplemented by the Administration.

4.3 Minimum safe water depth may relate to local environmental regulations or hazards to other craft, persons and property in the operational area in addition to navigational safety. For example, the Administration[1] may require investigation of wash waves generated by the craft 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[2] in order to avoid this should be stipulated in the Permit to Operate.

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 re 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 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[3] 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

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[1] Refer to United Kingdom Maritime and Coastguard Agency "Risk assessment of passage plan" at http://www.mcga.gov.uk/c4mca/mcga-guidance-regulation/mcga-dqs-ss_guidance_to_surveyors/mcga-dqs-ss-5-hsc1994/mcga-gr_gos_hsc1994-appendixd.htm

[2] This is based on depth Froude Number but is also dependent on the depth profile adjacent to the shore.

[3] Meteorological Office (UK), *The Marine Observers Handbook*, Her Majesty's Stationery Office, London, 1969

the lowest of the sea states derived from taking account of the factors listed in the remainder of this section.

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.*

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; 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.

5.5 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 been demonstrated effective. Subject to the following paragraph, this may require a practical demonstration of the effectiveness of proposed arrangements in worst intended conditions.

5.5.5 In the case of MES evacuation arrangements, no practical demonstration should be required under the preceding paragraph provided 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) (*Revised recommendation on testing of life-saving appliances)* and the Administration is satisfied that the craft used for that trial is closely similar to that for which the Permit to Operate is to be issued.

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 In applying these standards it should be noted that clause 4.3.1 of the Code advises that superimposed vertical accelerations exceeding 1.0g at the longitudinal centre of gravity should be avoided "unless special precautions are taken with respect to passenger safety". 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. Passengers must be seated before the onset of Level 2 in accordance with Code provisions 4.2.4 and Annex 9 para 3.3.2.

5.6.6 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, such as avoidance of bow-diving or broaching - see clause 17.2.1 of the 2000 HSC Code.

.3 Guidance in this safe handling may be obtained from Appendix B and MSC.1/Circ.1228 as appropriate bearing in mind that the latter document is largely addressed to conventional ships.

5.6.7 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.

5.6.8 Although clause 17.1 of the Code makes provision for use of data from model tests where appropriate, any use of such data should be confirmed by suitable trials of the craft or an identical craft.

5.6.9 Model test should be used to evaluate safe limits in situations that would be hazardous to investigate during sea trials.

5.6.10 The references to vertical accelerations in clause 4.3.1 and table 1 of Annex 3 of the Code should be interpreted as referring to the mean of the $1/100^{th}$ 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

6.1 The *worst intended conditions* of wind and sea will probably not be available for the conduct of the verification trials required by Chapter 17 of the Code, in which case some extrapolation of satisfactory trial results will be necessary. Where possible, any extrapolation should preferably take account of the non-linear nature of seakeeping behaviour. 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. Where satisfactory trials have been completed on a craft, then those trials are not required on subsequent identical craft.

7 Display of Operating Limitations

7.1 All operating limitations shown on the Permit to Operate, irrespective of whether they relate for example to geographical boundaries or limits of wind, weather and sea conditions, 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).

[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 waveheight. However, the installation of such instruments is only for the guidance of operating personnel and cannot be in lieu of the imposition of operating limitations with regard to sea state and the defining of 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.

Appendix A

Visual estimation of significant wave-height

The essence of these guidelines is that significant may be estimated from the craft at rest by varying the line of sight vertically until crests of the next two oncoming swells are aligned. The estimated (significant) wave height is then the height of the observation point above the craft's waterline.

Editorial Note: This information to be further elaborated in the "final" appendix, with insertion of an appropriate diagram, or else as a footnote to para 5.1.2 of the draft guidelines, whatever is the wish of the group.

APPENDIX B

[INSERT ANNEX FROM SLF 50/INF.4(OR TEXT CONDENSED THEREFROM)]