SUB-COMMITTEE ON DESIGN
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Agenda item 5

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REVIEW OF THE 2000 HSC CODE & AMENDMENTS TO THE DSC CODE & THE 1994 HSC CODE

Consistency in determination of Operating Limitations

Submitted by the Royal Institution of Naval Architects

SUMMARY

Executive summary: There is a lack of consistency with which operating limits of high-speed craft are defined by different Administrations. This paper describes some of the issues that the Royal Institution of Naval Architects considers should be debated and resolved.

Action to be taken: Paragraph 5

Related Documents: DE 49/5/X

Introduction

1 This paper is being submitted in consultation with the IMO Naval Architecture Group of professional naval architecture societies.

2 The text of the Code of Safety for High-Speed Craft, 2000 incorporates various measures that determine the limits within which a high-speed craft is considered to be safe to operate.

3 It is the experience of the Royal Institution of Naval Architects that such limits are not being determined in a consistent manner.

4 Paper DE 49/5/X proposes that the Sub-Committee should debate this subject and the annex to this paper aims to inform that debate.

Action requested of the Sub-Committee

5 The Sub-Committee is invited to consider the information provided in this paper in relation to the setting of operating limitations on a consistent basis.

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ANNEX

1. INTRODUCTION

High-speed craft are as defined and regulated by the IMO Code of Safety for High-Speed Craft, 2000 (2000 HSC Code). An explicit element of this Code is that unrestricted operation is not suitable for high-speed craft and that operating limitations are necessary.

It has become apparent that different Administrations impose different operating limitations in the Permit to Operate for the same design of high-speed craft. It is also apparent that many Flag authorities simply repeat the Class Society structural operating limitations on the Permit to Operate. This leads to confusion in the industry and creates problems for both builders and operators. In this context, the term "operational limitations" should include any data that would restrict the craft operation as well as the structural limits that potentially might be inserted into the Permit to Operate.

Examples showing that much greater clarity and consistency is needed in prescribing how operating limitations are to be determined are provided in DE 49/5/X.

The purpose of this paper is to consider the rationale behind the way in which such operational limitations are decided.

Matters determining the operational limitations may be divided into three sectors:

- those affecting the safety of the craft as a whole.
- those specifically affecting the safety of the passengers and crew as individuals.
- those affecting the safety of persons outside the craft

It is suggested that the overall operational limitations applied to a given craft should be determined by the safe envelope of all of the above. They should be expressed in a form easily understood by both the Master and Watch-keepers of the craft, and by shore-side managers.

Attention is drawn to clauses 1.2, 1.3.4 and 1.4.61 of the 2000 HSC Code, which specifically relate to this subject.

2. STRUCTURAL SAFETY

Clearly it is vital that the craft is not operated outside the limitations to which the structure has been designed. Many classification society rules base their structural loadings on a nominal 1g acceleration (usually the mean of the 100 highest for passenger craft) at the longitudinal centre of gravity. In order to avoid exceeding this structural limitation, the societies publish a diagram developed from this assumption, which relates the maximum permitted speed of the craft to the ambient significant wave height. However this is only applicable to head seas, which are generally the most onerous case.

This is frequently misunderstood as being a "safe" operating limit for the craft. But if it only reflects conditions for which the craft's structure has been assessed, this is only "safe" in respect of the structure. Some Classification Societies require that a plaque is secured at the helm with the their wave height/speed table inscribed. Operators naturally take notice of this and are sometimes surprised when the craft clearly cannot operate in service at these wave heights.

Of course, under no conditions should the craft be operated outside the envelope of sea conditions to which the structure is considered to be safe.

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.

3. STABILITY & BUOYANCY

Several of the parameters used in evaluation of the stability and buoyancy relate to the environmental conditions. For example in:

- clause 2.6.11 the required minimum residual freeboard to downflooding is a function of the significant wave height corresponding to the Worst Intended Conditions, and

– Annex 7, 1.3 and 2.2, demonstration of sufficient residual stability uses the wind speed corresponding to the Worst Intended Conditions. Similarly in Annex 6, 1.1.4 and Annex 8, 1.1 and 2.1.4.3.

Therefore, the limiting significant wave height and the limiting mean wind speed used in compliance with the stability requirements should always be considered in setting the operational limits.

4. CRAFT HANDLING & SEAKEEPING

4.1 Safe Handling Limitations

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

– 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.

– many forms of high-speed craft may have to avoid excessive bow-down trim in order to preserve safe manoeuvring behaviour – see clause 17.2.1 of the 2000 HSC Code.

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.

4.2 Safe Seakeeping Limitations

Apart from structural limitations, the 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.

Implied but not explicit these limitations should also include excessively violent motions affecting the passengers and crew (see also 5 below).

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 is usually determined during the trials conducted in accordance with Annex 9 and invoked by clause 17.2.1. However, often these sea trials are not conducted at all.

Some Administrations set a fixed significant wave height limit regardless of the heading of the craft relative to the sea. However clause 3.1.2 of Annex 9 of the 2000 HSC 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.*"

Some builders have proposed that each craft should be provided with a polar diagram showing safely attainable speed versus wave height and relative heading. Often the safe speed in head seas will be less than that attainable on other headings. This approach is illustrated in Figure 1 below.

An alternative approach is a graph having different lines for head, beam and following seas, as illustrated in Figure 2 below. Another possibility is to require onboard monitoring of vertical and lateral accelerations and restrict craft speed by the observed accelerations rather than wave height.

5. PASSENGER SAFETY

5.1 Motions During Routine Operations

The 2000 HSC 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}, ie: Frequent or Reasonably Probable.

However examination of Table 1 in Annex 3 reveals that for Safety Level 1 (Minor Effect) this table only prescribes that horizontal accelerations should not exceed 0.2g.

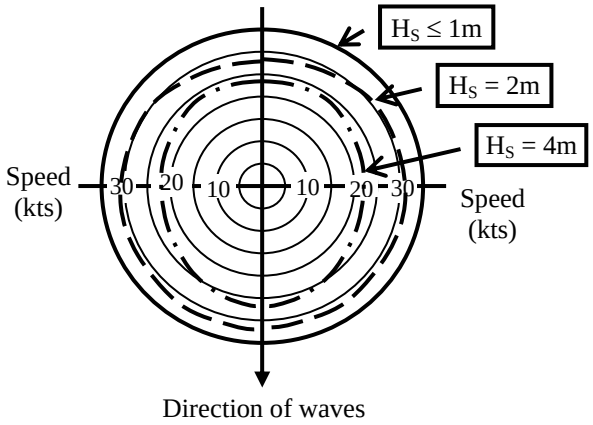

Figure 1

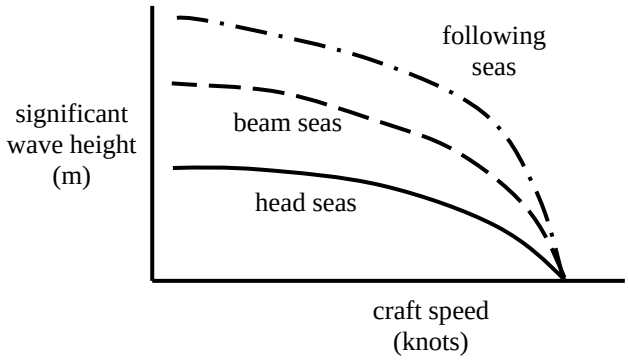

Figure 2

Whilst such a limitation is entirely appropriate, no limitation whatsoever is given in terms of vertical acceleration. Some people consider that such limitations need to be provided in the HSC Code, designed to protect the <u>*safety*</u> of passengers and crew rather than their *comfort*.

Consideration of vertical accelerations is arguably implicit in the wording of 17.1 of the Code (which requires acceleration measurements on all three axes), and in 3.2 and 3.3 of Annex 9, which refer to vertical accelerations (3.2) and *"nor shall any other craft characteristic motion …. exceed levels that could impede the safety of passengers."* (3.3.2).

In this context the question is whether people are liable to fall if standing or be thrown out of their seats due to excessively violent motion. Motion sickness is not the issue.

5.2 Motions During Abnormal Operations

Similarly, Table 1 in Annex of the 2000 HSC Code stipulates acceptable maximum horizontal accelerations for severe and extreme operating conditions.

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.

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 could be used to define the conditions in which passengers must be seated.

5.3 Application

Since currently the 2000 HSC Code stipulates <u>*maximum*</u> horizontal accelerations, it would be logical to stipulate maximum vertical accelerations. This may well be appropriate, since vertical maxima most strongly relate to the safety of the passengers.

Such limits should be satisfied at any point within the control stations and passenger accommodation spaces, in order that account is taken of the combined effect of heave, roll and pitch. Informed debate is needed before such limitations could be agreed.

Clarification is also needed as to the methodology for recording maximum accelerations, which may be of very short duration. In this process, Annex 9 could also be made very much clearer.

6. EVACUATION SAFETY

The 2000 HSC 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, clause 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 ..…"*.

"All operational conditions" includes all conditions up to and including the Worst Intended Conditions (defined in 1.4.61). In the past, some Administrations have interpreted clause 8.1.3.1 as meaning that the

ability to launch and board survival craft in the Worst Intended Conditions must be “tested to confirm that they comply with the requirements of this chapter" by conducting sea trials on each craft.

It follows from this that, if the survival craft or embarkation system do not function in the Worst Intended Conditions, then these latter must be reduced to the worst conditions in which this equipment has been shown to operate satisfactorily.

While this logic can be appreciated, some Administrations consider that the operating limitations should not be influenced in this way, because:

- of the practical difficulties in obtaining suitable sea conditions for the trial,
- of the very serious hazards experienced by the personnel involved, and
- the same logic is not applied to survival craft and means of embarkation fitted to normal ships.

Clearly therefore, these two contrasting approaches need to be brought together in some way to secure an internationally agreed approach to the setting of operational limits in the form of Worst Intended Conditions. This could involve development of guidelines taking account of the behaviour in the Worst Intended Conditions of the craft itself, survival craft and the means of evacuation into the survival craft, without recourse to a heavy weather evacuation trial for each craft to which the HSC Code applies.

Agreement is needed as to whether / how the results of sea trials of survival craft and embarkation equipment should influence the operating limitations of the craft. The present Code is not clear on this.

7. ROUTE CONSIDERATIONS

7.1 Introduction

In some cases certain of the operational limitations are functions of the route rather than the craft, and these should always be considered.

7.2 Ability to Complete the Planned Voyage

Clause 1.2 of the 2000 HSC Code includes the following statements:

> .5 *the craft will at all times be in reasonable proximity to a place of refuge, having due regard to the provisions of 1.3.4;*
>
> .6 *adequate communications facilities, weather forecasts and maintenance facilities are available within the area of craft operation;*

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 when proceeding at operational speed (90% of maximum speed when fully loaded). This is to allow the craft to safely retire to shelter in the event of changes in the weather and hence sea state.

Similarly the reason for clause 1.2.6 (above) is to ensure that the crew have ready access to weather forecasts, so that if necessary a decision to take refuge may be taken at an appropriate time.

Notwithstanding these provisions, it is not hard to foresee situations where the forecasts of sea conditions are not sufficiently accurate or the weather changes more rapidly than was anticipated. For this reason, some Administrations require that 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. However this idea, although many consider sensible, has no clear expression in the 2000 HSC Code.

Some such provision in the Code might be appropriate, and could be written to relate the speed attainable on any heading in the Worst Intended Conditions to that needed to complete the passage within a reasonable stipulated margin of time.

7.3 Rescue Availability

Clause 1.2.7 of the 2000 HSC Code states: *“in the intended area of operation, suitable rescue facilities will be readily available”*.

Similarly 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"*

However the Code gives no guidance on what constitutes "suitable rescue facilities", thus leading to inconsistent interpretation. It may be considered that some guidelines are necessary on evaluating the sufficiency of the rescue facilities in a given area.

7.4 Wash Waves

As we are now all aware, high-speed craft are capable of creating wash waves that are hazardous to nearby small craft and persons on the shoreline, and any restrictions on craft speed in relation to water depth in order to avoid this should be stipulated in the Permit to Operate.

In the UK, the MCA require that a risk assessment of the wash wave hazard is required to be conducted before a Permit to Operate is issued. This could become a formal requirement of the Code. For example:

– the Permit to Operate could refer to the wash control aspects of the passage plan, stipulating maximum and minimum speeds on each part of the route in order to avoid excessive wash, and

– a simple table of critical speed range against water depth[1] could be appended to the Permit to Operate, with instructions that operation in the critical speed range should be avoided.

7.5 Other Aspects

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:

- significant wave height
- wind force
- minimum air temperature (ref: susceptibility to icing?)
- visibility
- minimum safe water depth

It seems that Permits to Operate seldom mention any except the first parameter listed above.

8. CONCLUDING COMMENTS

Craft operating under the International Code of Safety for High-Speed Craft (2000) are required to operate within the restrictions of the Permit to Operate. It has been found that different Administrations are assigning different limitations to the same design of craft apparently for no logical reason.

The reason for this is thought to be a lack of clarity in the HSC Code, leading to variation in interpretation.

In the interests of regulators, owners and builders, and in the interests of consistent application of the HSC Code, this situation can be addressed by amending the Code and/or developing an MSC Circular.

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[1] This would be the same for all high-speed craft as it is based on depth Froude Number.